SEMESTER VII

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	ME19701	Automation in Manufacturing	3	0	0	3
2	PC	ME19702	Finite Element Analysis	3	1	0	4
3	PC	ME19703	Mechatronics	3	0	0	3
4	PE	ME1935*	Professional Elective III	3	0	0	3
5	PE	ME1945*	Professional Elective IV	3	0	0	3
6	OE	ME1990*	Open Elective-II	3	0	0	3
Practical							
7	PC	ME19704	Simulation and Analysis Laboratory	0	0	2	1
8	PC	ME19705	Mechatronics Laboratory	0	0	2	1
9	EE	ME19706	Project Work (Phase I)	0	0	6	3
			Total	**18**	**1**	**10**	**24**

SEMESTER VIII

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	HS	BA19352	Total Quality Management	3	0	0	3
2	PE	ME1955*	Professional Elective V	3	0	0	3
3	PE	ME1965*	Professional Elective VI	3	0	0	3
Practical							
4	EE	ME19802	Project Work (Phase II)	0	0	12	6
			Total	**9**	**0**	**12**	**15**
							Total Credits : 164

PROFESSIONAL ELECTIVE I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME19151	Advanced Internal Combustion Engines	3	0	0	3
2	PE	ME19152	Industrial Robotics	3	0	0	3
3	PE	ME19153	Composite Materials	3	0	0	3
4	PE	ME19154	Hydraulics and Pneumatics	3	0	0	3

PROFESSIONAL ELECTIVE II

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME19251	Micro Electro Mechanical Systems	3	0	0	3
2	PE	ME19252	Smart Materials	3	0	0	3
3	PE	ME19253	Gas Dynamics and Jet Propulsion	3	0	0	3
4	PE	ME19254	Process Planning and Cost Estimation	3	0	0	3

PROFESSIONAL ELECTIVE III

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	IT19357	Internet of Things	3	0	0	3
2	PE	IT19358	Artificial Intelligence	3	0	0	3
3	PE	ME19351	Computer Integrated Manufacturing Systems	3	0	0	3
4	PE	ME19352	Computational Fluid Dynamics	3	0	0	3

PROFESSIONAL ELECTIVE IV

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME19451	Unconventional Machining Processes	3	0	0	3
2	PE	ME19452	Additive Manufacturing processes	3	0	0	3
3	PE	ME19453	Solar Energy System	3	0	0	3
4	PE	ME19454	Production Planning and Control	3	0	0	3

PROFESSIONAL ELECTIVE V

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	ME19551	Refrigeration and Air Conditioning	3	0	0	3
2	PE	ME19552	Non-Destructive Evaluation Techniques	3	0	0	3
3	PE	ME19553	Design of Jigs, Fixtures and Press Tools	3	0	0	3
4	PE	ME19554	Maintenance Engineering	3	0	0	3

PROFESSIONAL ELECTIVE VI

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	BA19151	Entrepreneurship Development	3	0	0	3
2	PE	BA19353	Engineering Economics	3	0	0	3
3	PE	ME19651	Productivity Management and Re-Engineering	3	0	0	3
4	PE	ME19652	Welding Technology	3	0	0	3

OPEN ELECTIVE I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	OE	ME19901	Renewable Energy Sources	3	0	0	3
2	OE	ME19902	3D Printing	3	0	0	3

OPEN ELECTIVE II

S.No.	Category	Course Code	Course Title	L	T	P	C
1	OE	ME19903	Robotics	3	0	0	3
2	OE	ME19904	Safety Engineering and Environmental Systems	3	0	0	3

ONE CREDIT COURSES

S. No	Category	Course Code	Course Title	L	T	P	C
1	OCC	ME19951	Non-Destructive Testing	0	0	2	1
2	OCC	ME19952	3D CAD Design	0	0	2	1
3	OCC	ME19953	CNC Milling	0	0	2	1
4	OCC	ME19954	Solid Modeling	0	0	2	1
5	OCC	ME19955	Industrial Robotics	0	0	2	1
6	OCC	ME19956	Industrial Automation	0	0	2	1
7	OCC	ME19957	Fluid Flow Simulation	0	0	2	1
8	OCC	ME19958	Computer Aided Reverse Engineering	0	0	2	1

Checked and verified the course code and name both in the curriculum and syllabus

COORDINATOR
BOARD OF STUDIES

HEAD OF THE DEPARTMENT

DEAN ACADEMICS

CONTROLLER OF EXAMINATIONS

PRINCIPAL

SEMESTER VII

ME19701 AUTOMATION IN MANUFACTURING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- get a brief exposure to automation principles.
- learn the concepts of automation in material handling and storage Systems
- know about components involved in automated manufacturing processes.
- understand the need and basics of Industry 4.0.
- acquire knowledge in the fundamentals of Internet of Things and Industrial Internet of Things

UNIT I INTRODUCTION TO AUTOMATION 9

Introduction - Automation in Production Systems - Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automating; automation principles and strategies - the USA Principle, Ten Strategies for Automation and Process Improvement, and an Automation Migration Strategy; basic elements of automated system - Power to Accomplish the Automated Process, Program of Instructions, Control System; Levels of automation.

UNIT II AUTOMATED MATERIAL HANDLING AND STORAGE SYSTEM 9

Overview of material handling-Material transport equipment, Design Considerations in Material Handling- Material Transport Equipment- Industrial Trucks, Automated Guided Vehicles, Conveyors, Cranes and Hoists. Introduction to Storage Systems-Storage System Performance; Conventional Storage Methods and Equipment; Automated Storage Systems- Fixed-Aisle Automated Storage/Retrieval Systems.

UNIT III AUTOMATED MANUFACTURING SYSTEM 9

Components and classifications of manufacturing systems, Automated production lines - Fundamentals, system configurations, work part transfer mechanisms, storage buffers, control of production line, applications, Automated assembly systems - fundamentals.

UNIT IV INDUSTRY 4.0 9

Industrial revolution: Phases of development, Evolution of Industry 4.0, Environmental impacts of industrial revolution, Design requirements of Industry 4.0, Drivers of Industry 4.0 - Cyber Physical Systems and Next Generation Sensors, Introduction to Augmented Reality and Virtual Reality, Introduction to Artificial Intelligence.

UNIT V INDUSTRIAL INTERNET OF THINGS 9

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Basics of Industrial IoT: Introduction, Industrial Internet Systems, Industrial Sensing & Actuation, Industrial Processes, Applications of IIoT - Food industry, Healthcare, Power plants.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- discuss the requirements of automation in manufacturing systems.
- demonstrate knowledge on automation in material handling and storage systems.
- describe the components involved in the automation of production lines
- appraise the implementation of industry 4 0 elements like artificial intelligence in manufacturing
- apply internet of things in the industrial automation systems

TEXT BOOKS

1. Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 2016, Fourth edition, Pearson Education, New Delhi.
2. Pethuru Raj and Anupama C. Raman "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.

REFERENCES

1. Radhakrishnan.P, Subramanyan.S, Raju.V, CAD/CAM/CIM, New age International, New Delhi.
2. Kaushik Kumar , Divya Zindani , Paulo Davim.J. Industry 4.0- Developments towards the Fourth Industrial Revolution
3. Yusuf Altintas, Manufacturing Automation, 2012, Cambridge University Press, USA.
4. Gupta A. K., Arora S. K., Industrial Automation and robotics, 2013, Third Edition, University Science Press, New delhi.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO2	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO3	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO4	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO5	3	-	2	-	3	-	-	-	-	-	-	2	2	3

ME19702 **FINITE ELEMENT ANALYSIS** **3 1 0 4**

COURSE OBJECTIVES

To enable the students to

- understand the basics of FEA and classical techniques in FEA.
- study the methods to assemble finite element equations, boundary conditions and post processing.
- learn about the CST element, Load vectors and applications to heat transfer.
- study about plane stress, plane strain and axi -symmetric problems formulation.
- gain knowledge on iso-parametric formulation, shape functions, numerical integration and stiffness integration.

UNIT I INTRODUCTION **12**

Historical background - Relevance of FEA to design problems, Application to the continuum Discretisation - Matrix approach, Matrix algebra - Gaussian elimination - Governing equations for continuum - Classical Techniques in FEM - Weighted residual method - Ritz method-Application of FEA.

UNIT II ONE DIMENSIONAL PROBLEMS **12**

Finite element modelling - Coordinates and shape functions - Potential energy approach- 1D Element matrices and vectors - Assembly for global equations - Boundary conditions - Shape functions - Applications to axial loadings of rods - Extension to plane trusses- problems in the 1D truss - Finite element formulation of stiffness matrix and load vectors - Assembly to Global equations -boundary conditions -Solutions and Post processing- Heat transfer problems.

UNIT III TWO DIMENSIONAL PROBLEMS - SCALAR VARIABLE PROBLEMS **12**

Finite element modelling - CST element - co-ordinate element - Element equations, Load vectors and boundary conditions - Shape functions - Application to thermal and assembly - boundary conditions and solutions.

UNIT IV TWO DIMENSIONAL PROBLEMS - VECTOR VARIABLE PROBLEMS **12**

Vector Variable problems - Elasticity equations - Plane Stress, Plane Strain and Axisymmetric problems - Formulation - element matrices - Assembly - boundary conditions and solutions.

UNIT V ISOPARAMETRIC ELEMENTS FOR TWO DIMENSIONAL PROBLEMS **12**

Natural coordinates, Isoparametric elements, Four node quadrilateral element - Shape functions - Element stiffness matrix and force vector - Jacobian Matrix - Numerical integration - Stiffness integration - Displacement and Stress calculations.

TOTAL PERIODS: 60

COURSE OUTCOMES

At the end of the course, the students will be able to

- gain the basic idea of Finite Element Method and understand different mathematical Techniques used in FEM analysis
- utilize the methods to assemble finite element equation of structural problems and non-structural problems.
- apply knowledge of the basics like CST element, plane stress, plane strain conditions and finding solution to heat transfer problems.
- Solve two dimensional problems using axi-symmetric element, plane stress conditions with different boundary conditions.
- appreciate the concept of Mapping of elements from natural to local coordinate system, displacement and stress calculations with numerical integration for solving 2D problems.

TEXT BOOKS

1. Chandrupatla. T.R and A.D, "Introduction to Finite Elements in Engineering", Fourth Edition, Pearson Education, 2018.
2. Seshu.P, "Text book of Finite Element Analysis", 10th Print, PHI Learning Private Limited, New Delhi, 2003.

REFERENCES

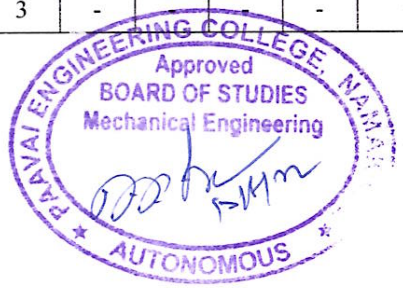
1. Logan D.L, "A First course in the Finite Element Method", 5th Edition, Cengage Learning India Pvt. Ltd, 2012.
2. Rao S.S., "The Finite Element Method in Engineering", Pergammon Press, 2010.
3. David V Hutton "Fundamentals of Finite Element Analysis", Third Edition, McGraw-Hill Int, 2004.
4. Robert D.Cook, David.S, Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis", Fourth Edition, Wiley, 2003.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO2	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO3	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO4	3	-	2	-	3	-	-	-	-	-	-	2	2	3
CO5	3	-	2	-	3	-	-	-	-	-	-	2	2	3



ME19703 **MECHATRONICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the structural and functional principles of sensors and transducers
- know about various actuation systems of mechatronic components
- get a precise idea about the system structural models and working of controllers
- learn about the structure and processing of PLC
- gain knowledge about the elements and techniques involved in Mechatronic systems

UNIT I MECHATRONICS, SENSORS AND TRANSDUCERS **9**

Introduction to Mechatronics - measurement Systems - control system - Sensors and Transducers: Performance Terminology Static and dynamic Characteristics of Sensor, Potentiometers - Strain gauge element -Differential transformer-Limit and proximity sensor - Hall effect sensor - Tacho-generator-Temperature sensors -bimetallic strip - RTD -Thermistors - Thermocouples- Light sensors - selection of Light sensors

UNIT II ACTUATION SYSTEMS **9**

Pneumatic and Hydraulic Systems-Valve-Direction Control valve- Value symbol-Cylinder -sequencing Mechanical System -Rotational and Translational motion- Cams- Ratchet and pawl-Belt and Chain Drives Mechanical Switches-Solid state switch- Diode-SCR-TRIAC Stepper motor AC & DC Servo motor

UNIT III SYSTEM MODELS AND CONTROLLERS **9**

Mechanical system building blocks- Fluid system building blocks—Thermal system building blocks—Rotational and Translational system—Electromechanical system-Hydraulic mechanical systems Control mode -Two step mode - Proportional mode—Integral mode - Derivative Mode - PID controller - Velocity control—Architecture of 8085 and 8051

UNIT IV PROGRAMMABLE LOGIC CONTROLLER **9**

Programmable Logic Controllers - Basic Structure - Input / Output Processing- Logic Function - Ladder Programming -- Mnemonics- Latching and Internal Relays - Sequencing - Timers, - Shift Registers - Master and Jump Controls -- Data handling - Analogs Input / Output-- Selection of PLC.

UNIT V DESIGN OF MECHATRONICS SYSTEM **9**

Design process - Traditional and Mechatronic Design - Examples of mechatronics system--Engine Management system Micro electromechanical system and automobile air bag--Case studies of Mechatronics systems- Pick and place Robot- car park barrier- Automotive control system.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- discuss the interdisciplinary applications of electronics, electrical, mechanical and computer systems for the control of mechanical, electronic systems and sensor technology
- describe the principles of various automation systems utilized in mechatronic components
- discuss programmable peripheral interface, architecture of 8085 and 8051 along with various device interfacing
- explain the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of mechatronic engineering
- design a mechatronic system using the knowledge and skills acquired through the course and also from the given case studies

TEXT BOOKS

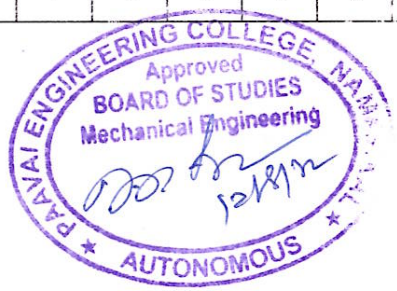
1. Bolton,W, "Mechatronics" , Pearson education, Sixth edition, 2015
2. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford University Press, 2008.

REFERENCES

1. Rajput. R.K, "A Textbook of Mechatronics", S. Chand & Co, Fourth edition, 2014
2. Devadas Shetty and Richard A.Kolk. "Mechatronics systems design", PWS Publishing company,2007.
3. Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, Third Edition, 2006.
4. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	1	-	-		-	-	-	-	-	-	2	2
CO2	2	-	1	-	-	-	-	-	-	-	-	-	2	2
CO3	2	-	1	-	-	-	-	-	-	-	-	-	2	2
CO4	2	-	1	-	-	-	-	-	-	-	-	-	2	2
CO5	2	-	1	-	-	-	-	-	-	-	-	-	2	2



ME19704 SIMULATION AND ANALYSIS LABORATORY 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- become familiar with software tools needed to analyze engineering problems.
- get exposure to different applications of simulation and analysis tools
- get practice to solve real time problems in air conditioning, hydraulic/pneumatic systems and cam mechanisms through simulation software C / MAT lab
- be conversant with stress analysis(Mechanical, thermal) and heat transfer analysis through simulation software

A. Simulation

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of MATLAB to solve simple problems in vibration

B. Analysis

1. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
2. Stress analysis of a plate with a circular hole
3. Stress analysis of rectangular L bracket
4. Stress analysis of an axi-symmetric component
5. Mode frequency analysis of a 2 D component
6. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
7. Harmonic analysis of a 2D component
8. Thermal stress analysis of a 2D component
9. Conductive heat transfer analysis of a 2D component
10. Convective heat transfer analysis of a 2D component

TOTAL PERIODS: 30

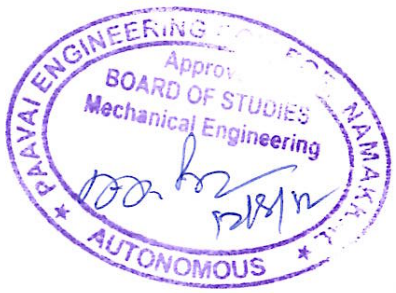
COURSE OUTCOMES

At the end of the course, the students will be able to

- simulate components like Air conditioning system, Hydraulic and pneumatic cylinder and cam follower mechanism.
- do simple analysis in both structural and non-structural problems.
- solve thermal conductivity and thermal stress related problems using simulation software
- model, analyze and simulate experiments to replicate real world systems and evaluate the performance.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	2



ME19705 **MECHATRONICS LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- acquire practical knowledge on working principles of hydraulic, electro pneumatic kit with Programmable Logic Controller (PLC)
- learn interfacing of servo controller for open and closed loop circuits
- know interfacing of Proportional, Integral and Derivative (PID) controller and stepper motor
- get practical hands on experience with Assembly Language Programming using 8085 microprocessor

LIST OF EXPERIMENTS

1. Design of basic pneumatic circuits using Electro pneumatic trainer kits.
2. Simulation of Hydraulic and Pneumatic circuits using simulation software
3. Circuits with multiple cylinder sequences in Electro pneumatic using PLC
4. Servo controller interfacing for open loop
5. Servo controller interfacing for closed loop
6. Speed control DC motor by PID controller interfacing
7. Stepper motor interfacing with 8051 Micro controller (i) Full step resolution (ii) Half step Resolution
8. Assembly language programming of 8085 - Addition - Subtraction - Multiplication - Division
9. Speed control circuit using basic hydraulic kit
10. Study of image processing technique.

TOTAL PERIODS: 30

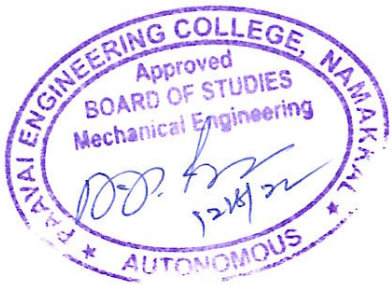
COURSE OUTCOMES

At the end of the course, the students will be able to

- simulate Hydraulic, Pneumatic and Electric circuits using software tool
- conduct experiments using servo controller
- apply speed control of stepper motor using PID
- apply the fundamentals of assembly level programming of microprocessors and microcontroller

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	2



ME19706 **PROJECT WORK (PHASE I)** **0 0 6 3**

COURSE OBJECTIVES

To enable the students to

- develop ability to identify problems and solve through project works.
- get exposure to literature review related to identified problem and finding the gap to solve through project work.
- get exposure to required design procedure, experimental setup, analysis package to solve the identified problem.
- prepare project reports and practice to face viva- voce examination.

GUIDELINES

1. The students are expected to get formed into a team of convenient groups of not more than 4 members for a project.
2. Every project team shall have a guide who is the member of the faculty of the institution. Identification of student group and their faculty guide need to be completed within the first two weeks from the day of the beginning of 7th semester.
3. The group has to identify and select the problem to be addressed as their project work and study literature survey to finalize a comprehensive aim and scope of their work.
4. 30% of the total work of the project work has to be completed by end of 7th semester.
5. A mini project report (of the phase-I) to this effect has to be submitted by each student group.
6. Three reviews and end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 4) along with their faculty guide as a member the review team.
7. The same team of faculty will evaluate the Project Phase - I report. This evaluation will form 50% of the internal assessment mark. The remaining 50% of the internal assessment mark will be given at the end of the 8th semester, at the time of completing the full project work.

TOTAL PERIODS: 90

COURSE OUTCOMES

On completion of the project work, the students will be able to

- identify feasible problems to solve through project works
- collect literature through research journals and identify the gap in selected area
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimization techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project
- prepare project report as per format and confidently face viva voce with proper PPT for presentation

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**													
COs	Programme Outcomes(POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	2	2	2	3	3	3	2	2	2
CO2	3	2	2	-	-	2	2	2	3	3	3	2	2	2
CO3	3	2	2	-	-	2	2	2	3	3	3	2	2	2
CO4	3	2	2	-	-	2	2	2	3	3	3	2	2	2

BA19352 **TOTAL QUALITY MANAGEMENT** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the importance of quality management, customer perception and retention.
- acquaint with the principles and philosophies of quality management.
- understand the significance of statistical process control for quality management.
- ascertain quality management tools and techniques.
- familiarise with the norms governing quality systems and implementations.

UNIT I INTRODUCTION TO QUALITY MANAGEMENT 9

Definitions, TQM framework, benefits, awareness and obstacles; Quality – vision, mission and policy statements; Customer Focus – customer perception of quality, translating needs into requirements, customer retention, dimensions of product and service quality, cost of quality.

UNIT II PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT 9

Overview of the contributions of Deming, Juran, Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio; Concepts of Quality circle, Japanese 5S principles and 8D methodology.

UNIT III STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY 9

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributes; Process capability – meaning, significance and measurement – Six sigma concepts of process capability; Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

UNIT IV TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT 9

Control Charts, Process capability, Concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function, TPM - Concepts, improvement needs and Performance measures.

UNIT V QUALITY SYSTEMS ORGANIZING AND IMPLEMENTATION 9

Need for ISO 9000; ISO 9001-2008 Quality System - Elements, documentation, Quality Auditing; QS 9000 - ISO 14000 - Concepts, requirements and benefits, TQM implementation in manufacturing and service sectors.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- frame effective quality policies.
- apply the quality philosophies and practices in business.
- implement the statistical process control and process capability to enhance quality.
- examine the quality tools to enhance organization's quality performance.
- value and practice quality systems.

TEXT BOOKS

1. Panneerselvam.R, Sivasankaran. P, Quality Management, PHI Learning, 2014.
2. Dale H.Besterfield, CarolBesterfield-Michna, Glen H. Besterfield, Mary Besterfield -Sacre, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management (TQM), Fifth edition, Pearson Education, 2018.

REFERENCES

1. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2010.
2. Poornima M.Charantimath, Total Quality Management, Pearson Education, Second Edition, 2011.
3. Douglas C. Montgomory, Introduction to Statistical Quality Control, Wiley Student Edition 4th Edition, Wiley India Pvt Limited, 2008.
4. Indian standard – Quality Management Systems – Guidelines for performance improvement (Fifth Revision), Bureau of Indian standards, New Delhi.

CO – PO Mapping:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	2	-	-	3	-	1	-
CO3	-	-	-	-	2	-	1	-	-	-	-	-	1	-
CO4	-	-	-	-	-	-	-	-	-	2	-	-	-	2
CO5	-	-	-	-	-	2	-	3	-	-	-	-	-	2

ME19802 **PROJECT WORK (PHASE II)** **0 0 12 6**

COURSE OBJECTIVES

To enable the students to

- develop ability to identify problems to solve through project works.
- acquire knowledge on literature review related to project problem and how to find the gap.
- gain exposure to required design procedure, experimental setup, analysis package to solve the identified problem.
- get trained in preparing project reports and to face reviews and viva voce examinations

GUIDELINES

1. The students are expected to get formed into a team of convenient groups of not more than Members on a project.
2. Two mid semester review and another end semester review for the progress of the project work have to be conducted by a team of faculty along with the faculty guide as a member of the review team.
3. Progress of project work has to be monitored by the project guide and committee periodically.
4. Attendance for review is mandatory. If a student fails to attend review for some valid reasons, one more chance may be given.
5. The project report should be submitted by the student, one week before the model examination.

TOTAL PERIODS: 180

COURSE OUTCOMES

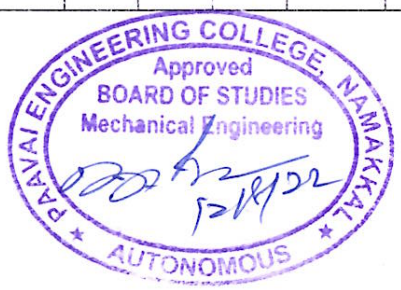
On completion of the project work, the students will be able to

- take up any challenging practical problems and find solution by formulating proper methodology.
- collect literature through research journals and identify the gap in selected area.
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimization techniques/availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	3	2	2	2	3	3	3	2	2	2
CO2	3	2	2	-	3	2	2	2	3	3	3	2	2	2
CO3	3	2	2	-	3	2	2	2	3	3	3	2	2	2
CO4	3	2	2	-	3	2	2	2	3	3	3	2	2	2



IT19357 **INTERNET OF THINGS** 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the overview of Internet of Things with various design levels and templates.
- describe the generic design methodology for internet of things with python programming.
- know about the Raspberry pi and Arduino and how to program it using Python
- understand the use of cloud platforms & frameworks for developing IoT applications.
- analyze the characteristics and applications of domain specific IoTs for real life scenarios.

UNIT I INTRODUCTION TO IoT 9

Introduction - Definition and Characteristics of IoT; Physical Design of IoT; Logical Design of IoT; IoT Enabling Technologies; IoT Levels and Deployment Templates.

UNIT II IOT SYSTEMS-LOGICAL DESIGN USING PYTHON 9

Motivation for using Python - Logical Design using Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date / Time Operations, Classes, Python Packages of Interest for IoT.

UNIT III IOT PHYSICAL DEVICE P& ENDPOINTS 9

Basic building blocks of Iot device-Raspberry Pi, Board details, Programming Raspberry pi with Python; Arduino; IoT Protocols.

UNIT IV IOT PHYSICAL SERVERS & CLOUD OFFERINGS 9

Introduction to Cloud Storage Models & Communication APIs-WAMP, Xively Cloud; Django; Skynet IoTMessaging Platform; Amazon Web Services for IoT.

UNIT V APPLICATIONS 9

Home Automation; Smart Cities - Environment, Energy; Retail, Logistics; Agriculture; Industry; Health and Lifestyle.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- understand the basic concepts and technologies used in internet of things.
- apply the generic design methodology for internet of things with python programming to design the model.

- gain the knowledge of raspberry pi device and its use in cloud platforms and other frameworks for developing iot applications.
- understand the processes of collecting and analyzing data generated by iot systems in the cloud.
- obtain the knowledge of the different types of domain specific iots for real life applications.

TEXT BOOKS

1. ArshdeepBahga, Vijay Madisetti, Internet of Things - A hands - on approach‖, Universities Press, 2015.

REFERENCES

1. CharalamposDoukas, Building Internet of Things With the Arduino, Volume 1, published by Createspace, 2012.
2. Andrian McEwen, Hakim Cassimally, "Designing the Internet of Things", 1st edition, John Wiley & Sons Ltd, 2014.
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", 1st edition, CRC Press, 2013.

CO PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	3	1
CO2	2	1	-	-	-	-	-	-	-	2	-	-	2	1
CO3	2	1	-	-	-	-	-	-	-	2	-	-	2	1
CO4	2	1	-	-	-	-	-	-	-	1	-	-	2	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	2	1

IT19358 **ARTIFICIAL INTELLIGENCE** 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire a knowledge of various methods of different problem solving and searching.
- understand the concepts of knowledge representation.
- understand about inference and how to solve the problems using various inference technique.
- realize the concepts of planning and learning.
- understand the method of various AI applications.

UNIT I INTRODUCTION 9

Introduction to AI - Problem formulation, Problem Definition; Production systems - Control strategies, Search strategies, Problem characteristics, Production system characteristics, Specialized productions system; Problem solving methods; Problem graphs; Matching; Indexing and Heuristic functions; Hill Climbing; Depth first and Breath first; Constraints satisfaction; Related algorithms; Measure of performance and analysis of search algorithms.

UNIT II REPRESENTATION OF KNOWLEDGE 9

Game playing; Knowledge representation - Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus; Knowledge representation using other - Structured representation of knowledge.

UNIT III KNOWLEDGE INFERENCE 9

Knowledge representation; Production based system; Frame based system. Inference - Backward logic chaining, Forward chaining; Rule value approach; Fuzzy reasoning.

UNIT IV PLANNING AND EXPERT SYSTEM 9

Basic plan generation systems - Strips, Advanced plan generation systems, K strips; Strategic explanations - Why, Why not and how explanations; Expert systems - Architecture of expert systems, Roles of expert systems,Knowledge Acquisition; Typical expert systems Applications - MYCIN, DART, XOON.

UNIT V AI APPLICATIONS 9

AI Applications - Language Models, Information Retrieval, Information Extraction, Natural Language Processing, Machine Translation, Speech Recognition; Robot - Hardware, Perception, Planning, Moving.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- demonstrate awareness of intelligent agents and problem solving using uninformed, informed and local search methods.
- develop knowledge about usage of propositional logic and first order logic for making inferences.
- use the knowledge and the process of inference to derive new facts.
- describe the use of planning and explain about various expert systems.
- design and develop various AI systems.

TEXT BOOKS

1. Kevin Night and Elaine Rich, Nair B, "Artificial Intelligence", 3rd edition, McGraw Hill- 2017.
2. Stuart Russel and Peter Norvig, "AI -A Modern Approach", 3rd Edition, Pearson Education 2015.

REFERENCES

1. Lavika Goel "Artificial Intelligence Concepts and Applications", Wiley 2021.
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2015.
3. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education 2013.

CO-PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates strength of correlation) 3-Strong,2-Medium,1-Weak													
COs	Programme Outcomes (POs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	-	-	-	-	-	-	1	3	2
CO2	3	3	3	3	2	-	-	-	-	-	-	1	3	2
CO3	3	3	3	3	2	-	-	-	-	-	-	1	3	2
CO4	3	3	3	3	2	-	-	-	-	-	-	1	3	2
CO5	3	3	3	3	2	2	-	-	-	-	-	1	3	3

ME19351 COMPUTER INTEGRATED MANUFACTURING SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the integration concept of CAD/CAM, Production planning and control under CIM.
- familiarize the principles of computer aided process planning and introduce the various database for implementation of CIM.
- gain knowledge on the design of a manufacturing cell and the elements of cellular manufacturing system.
- learn about the components of Flexible Manufacturing System and AGVs.
- understand the basic concepts of CIM models and the application of computer in inspection.

UNIT I INTRODUCTION 9

Types of Manufacturing-Evolution of Computer Integrated Manufacturing-CIM Hardware and CIM Software-Development of CIM-Computerized elements of CIM system-Product Development Cycle-Concurrent Engineering-Example of Concurrent Engineering- Types of production - Manufacturing Metrics and Economics - Production Performance Metrics -Manufacturing Cost.

UNIT II CIM DATA BASE MANAGEMENT SYSTEMS AND COMPUTER AIDED PROCESS PLANNING 9

Introduction -Database Requirements of CIM -Data Base -Database Management - Features of a Database Management System -Database Models -DBMS Architecture -Product Data Management (PDM) - Advantages of PDM - Process Planning -Structure of A Process Planning-Software Information Required For Process Planning -Operation of a typical Computer Aided Process Planning Software -Cad Based Process Planning - Certain Limitations and Problems-Methods of Computer Aided Process Planning - Variant Process Planning -Generative Process Planning -Implementation Considerations Process Planning Systems.

UNIT III GROUP TECHNOLOGY AND CELLULAR MANUFACTURING 9

Group Technology(GT) - Part Families - Parts Classification and coding -OPITZ Part Coding system - Production flow Analysis - Cellular Manufacturing- Composite part concept - Machine cell design and layout - Quantitative analysis in Cellular Manufacturing -Rank Order Clustering Method - Arranging Machines in a GT cell - Hollier Method.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM(FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM(AGVS) 9

Types of FMS and Flexibility - FMS Components - FMS Application and Benefits - FMS Planning and Implementation Issues - Quantitative analysis of in FMS - FMS workstation -material handling and storage systems -Automated Guided Vehicle System (AGVS) - Types of AGVS - Applications - Vehicle Guidance technologies -Vehicle Management and Safety.

UNIT V CIM MODELS AND COMPUTER AIDED QUALITY CONTROL 9

Introduction -Esprit - CIM OSA Model -The NIST - AMRF Hierarchical Model - The Siemens Model of CIM -The CIM Model of Digital Equipment Corporation -The IBM Concept of CIM-QC and CIM - Inspection and Testing-Objectives of CAQC -Role of Computer in Qc-Non-Contact Inspection Methods-Computer Aided Inspection Using Robots -Integrated Computer Aided Inspection Systems -Flexible Inspection System (FIS)

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- describe the importance and scope of CIM in fabrication/manufacturing industries.
- prepare CAPP(Computer Aided Process Planning) for manufacturing processes.
- demonstrate implementation of cellular manufacturing system in industries.
- explain about FMS, AGVs and its applications.
- appreciate and utilize different models available for computer aided inspection.

TEXT BOOKS

1. Mikell.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India,2016.
2. Radhakrishnan.P, Subramanyan.S. and Raju.V.,"CAD/CAM/CIM",2nd Edition, New Age International (P) Ltd, New Delhi, 2008.

REFERENCES

1. Gideon Halevi and Roland Weill, "Principles of Process Planning-A Logical Approach", London,2012.
2. Singh.N, "Systems Approach to Computer-Integrated Design and Manufacturing", Wiley India Pvt Ltd., 2011.
3. Rao.P.N Tewari and Kundra. T.K,"Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.
4. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:
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COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	2	-	-	2	-	-	-	1	1	1
CO2	2	-	-	-	2	-	-	2	-	-	-	1	1	1
CO3	2	-	-	-	2	-	-	2	-	-	-	1	1	1
CO4	2	-	-	-	2	-	-	2	-	-	-	1	1	1
CO5	2	-	-	-	2	-	-	2	-	-	-	1	1	1

PAAVAI ENGINEERING COLLEGE NAMAKKAL
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Mechanical Engineering
AUTONOMOUS

ME19352 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the concept and basic equation that govern fluid flow.
- acquire knowledge on various discretization methods and solving methodologies.
- gain knowledge on solving conduction and diffusion heat transfer problems
- understand the basic elements of convection-diffusion process of fluid flow.
- understand the boundary conditions and implementations on various domain

UNIT I BASIC GOVERNING EQUATIONS IN CFD 9

Introduction to CFD - working of CFD code - Problem solving with CFD - basic governing equations of fluid flow and heat transfer - mass conversation equation (3d) - momentum equation in three dimension - energy equations in three dimensions - Naiver stoke equations for a Newtonian fluid- Classification of partial differential equations- Initial and Boundary value problems. Turbulence model.

UNIT II GRID GENERATION AND SOLUTION ALGORITHMS 10

Introduction, Structured and Unstructured Grids, Hybrid Grids, Algebraic, Elliptic, Hyperbolic Grid generation. Unstructured grids of triangular and Tetrahedral, Unstructured grids of Quadrilateral and Hexahedral, Cartesian Mesh, Adaptive Mesh. Tri-diagonal matrix algorithms (TDMA), Pressure based algorithms, SIMPLE, SIMPLER and PISO algorithms.

UNIT III CONDUCTION - DIFFUSION PROCESSES 10

Discretization techniques using finite difference methods - Taylor's Series. Finite volume method for one, two and three - dimensional steady state diffusion problems, Discretization of unsteady diffusion problems -Explicit. Implicit and Crank-Nicholson's schemes, Stability of schemes. Generating and solving one dimensional steady state diffusion problem.

UNIT IV CONVECTION - DIFFUSION PROCESSES 8

One dimensional convection - diffusion problem, Central difference scheme, upwind scheme - Hybrid and power law discretization techniques - QUICK scheme.

UNIT V IMPLEMENTATION OF BOUNDARY CONDITIONS 8

Introduction - inlet boundary condition - outlet boundary condition - wall boundary conditions - constant pressure boundary conditions -symmetry boundary conditions - advanced boundary conditions - solutions. case studies.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- formulate the required governing equations for flow and heat transfer problems.
- identify the suitable grids for computing and implement solution techniques.

- discretize the governing equations of flow and heat transfer problems for conduction diffusion process.
- solve the diffusion equations for convection - diffusion process
- implement boundary conditions to solve problems.

TEXT BOOKS

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite Volume Method", Pearson Education Ltd. Second Edition, 2007.
2. Anderson, J.D., "Computational fluid dynamics - the basics with applications", 2012.

REFERENCES

1. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
2. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K., 2001.
3. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer", Hemisphere Publishing Corporation, New York, USA, 2001.
4. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.

CO - PO Mapping

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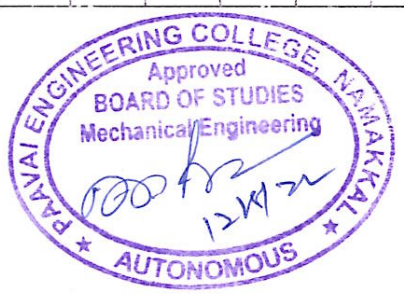
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-		-	-	2	3	3



ME19451 UNCONVENTIONAL MACHINING PROCESSES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know about working principles of various mechanical processes like Abrasive jet machining, Water jet machining and Ultrasonic Machining
- learn about working principles of various electrical energy based processes
- gain in depth knowledge on chemical and electro chemical processes and its applications
- familiarize with thermal energy based processes like laser beam, electron beam and ion beam machining processes.
- understand the general principles involved in micromachining and hybrid micromachining processes along with applications.

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Need for non - traditional machining methods - Classification of modern machining processes - considerations in process selection. Materials, applications. Abrasive Jet Machining (AJM) - Water Jet Machining (WJM) - Abrasive Water Jet Machining (AWJM) - Ultrasonic Machining (USM) - Elements of the process, mechanics of metal removal process parameters, applications and limitations.

UNIT II ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM) - Working Principle - Equipment's -Process Parameters - Surface Finish and Material Removal Rate - Electrode or Tool - Power and Control Circuits - Tool Wear - Dielectric - Flushing - Wire Cut EDM - Applications.

UNIT III CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical Machining (CHM) - Fundamentals of electro chemical machining, Electrochemical grinding, electro chemical honing and deburring process- mask-ants - etchants - electro chemical reactions-metal removal rate in ECM, Tool design, Surface finish and accuracy economic aspects of ECM - Fundamentals of chemical, machining, advantages and applications.

UNIT IV THERMAL ENERGY BASED PROCESSES 9

Electron beam machining - Laser beam machining - Ion Beam Machining - Equipment - Process Characteristics - Advantages - Disadvantage - Applications. Plasma arc machining process, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.

UNIT V MICROMACHINING 9

Introduction - Need of Micro Machining - Condition of Micro Machining -- Importance of non-traditional machining in micromachining domain - Classification of Micro Machining - Micro USM, Micro LBM, Micro ECM - Hybrid Micromachining Ultrasonic assisted micromachining.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain about classification, applications and recent updations in modern machining processes.
- describe the working principles, process parameters and equipment used in unconventional machining processes.
- discuss the fundamentals of chemical and electro chemical processes.
- be conversant with the principles, applications and selection parameters of thermal energy based metal removal processes.
- demonstrate the working principles and applications of micromachining and hybrid micromachining processes.

TEXT BOOKS

1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi,2015
2. Golam kibria, B.Bhattacharyya, J.Paulo Davim "Non traditional Micromachining processes", Springer International publishing, AG 2017

REFERENCES

1. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing". Prentice Hall of India Pvt. Ltd., New Delhi, 2001
2. Benedict. G.F. "Nontraditional Manufacturing Processes" Marcel Dekker Inc., New York,2012.
3. Pandey P.C. and Shan H.S. "Advanced Machining Processes" Tata McGraw-Hill, New Delhi, 2017.
4. M.K Singh "Unconventional Machining processes", New age International publishers,2010

CO - PO Mapping

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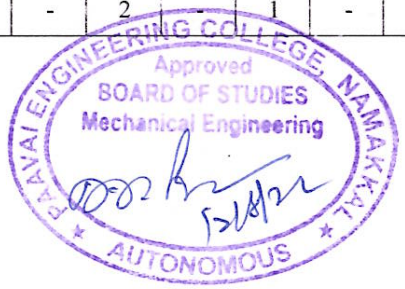
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	-	-	-	2	-	1	-	-	-	-	2	3
CO2	3	3	-	-	-	2	-	1	-	-	-	-	2	3
CO3	3	3	-	-	-	2	-	1	-	-	-	-	2	3
CO4	3	3	-	-	-	2	-	1	-	-	-	-	2	3
CO5	3	3	-	-	-	2	-	1	-	-	-	-	2	3



ME19452 ADDITIVE MANUFACTURING PROCESSES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand various Additive Manufacturing Processes for different industrial applications.
- familiarize the various Liquid based additive manufacturing technologies
- learn different Solid based additive manufacturing technologies
- know about different Powder based additive manufacturing technologies
- gain knowledge on tooling methods, post processing and future scope of 3D printing technologies.

UNIT I INTRODUCTION 9

Introduction to 3D Printing (Additive Manufacturing) - Impact of AM on Product Development - Historical development, benefits of AMT, commonly used terms, process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, Classification of AMT process, Applications to various fields - Reverse Engineering -need, factors to be considered and applications.

UNIT II LIQUID BASED SYSTEMS 9

Stereo lithography apparatus (SLA), Digital Light Projection (DLP), Continuous Liquid Interface Production (CLIP), Solid ground curing (SGC) - models and specifications, process, working, principle, materials, applications, advantages and disadvantages.

UNIT III SOLID BASED SYSTEMS 9

Fused Deposition Modeling (FDM, Laminated Object Manufacturing (LOM) and MULTI-JET MODELING SYSTEM (MJM) - models and specifications, process variables, working principle, materials, applications, advantages and disadvantages.

UNIT IV POWDER BASED SYSTEMS 9

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Direct Metal Deposition (DMD), Ballistic Particle Manufacturing (BPM), Selective Laser Melting (SLM) and Electron Beam Melting (EBM) - working principle, construction, process variables, materials and applications.

UNIT V TOOLING, APPLICATIONS AND FUTURE DIRECTIONS OF 3D PRINTING 9

Rapid tooling: Classification of Tooling, Direct and Indirect tooling methods, Soft and Hard tooling methods, Silicone rubber moulding, Epoxy tooling, Spray Metal Coating. Applications of AM: Aerospace, Automotive, Biomedical, Product Development, Commercialization, Trends and Future Directions in 3D printing technology.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the principles of various Additive Manufacturing processes for application to different industrial needs.

- discuss various Liquid based additive manufacturing processes for their applications.
- explain different Solid based additive manufacturing processes and their suitability for applications
- discuss the different Powder based additive manufacturing processes, advantages and applications.
- describe the significance of tooling methods, post processing requirements and scope of 3D applications.

TEXT BOOKS

1. Chua C.K, Leong K.F and Lim C.S, Rapid Prototyping: Principles and Applications, second edition, World Scientific, 2005.
2. Ian Gibson, David Rosen and Brent Stucker, Additive Manufacturing Technologies, Springer Publications,2015

REFERENCES

1. Pham.D.T and Dimov.S.S, Rapid manufacturing, Springer-Verlag, London, 2001
2. Hopkinson, Hague, Dickens, Rapid Manufacturing: An Industrial Revolution for the Digital Age. Wiley, 2005
3. Andreas Gebhardt, Understanding Additive Manufacturing, Hanser Publishers, 2011
4. Liou W. Liou, Frank W. Liou, "Rapid Prototyping and Engineering applications: A Tool Box for Prototype development", CRC Press, 2013

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
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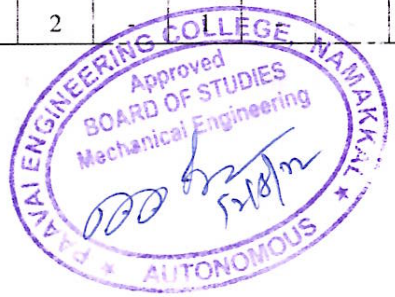
CO1	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2



ME19453 **SOLAR ENERGY SYSTEM** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the basic principles of solar radiation and instrument to measure the solar radiation energy.
- familiarize with solar collectors, construction and operation of solar collectors.
- learn the fundamental concepts about solar energy concentrators.
- gain knowledge on the variety of solar systems used to store solar energy.
- know about the applications of solar systems in various fields.

UNIT I INTRODUCTION AND SOLAR RADIATION **9**

Introduction - Source of radiation - Electromagnetic wave spectrum - Solar constant - Spectral distribution - Extra-terrestrial and Terrestrial radiation- Beam, diffuse and global radiation - solar radiation measurement: Pyranometer, Pyrheliometer, Sunshine recorder, Solar Cell - Photovoltaic Cell.

UNIT II SOLAR COLLECTOR **9**

Solar collectors: classification - comparison of concentrating and non-concentrating types - Air, liquid heating collectors, Flat plate collectors: construction, working principle and effect of various parameters on performance - testing of flat plate collectors.

UNIT III CONCENTRATORS **9**

Concentrating collectors and reflectors - Parabolic concentrators, non-imaging concentrators, other forms of concentrating collectors. Tracking - receiver shape and orientation -reflectors - reflectors orientation.

UNIT IV SOLAR ENERGY STORAGE **9**

Solar energy storage systems - Necessity of storage for solar energy - Chemical energy storage - Thermal energy storage - stratified storage - well mixed storage - comparison - Hot water system - solar ponds -Non-convective solar pond - extraction of thermal energy application of solar ponds.

UNIT V APPLICATION OF SOLAR SYSTEMS **9**

Solar powered absorption air conditioning system, solar cooler, solar power station, water pump, chimney, dryer, dehumidifier, still, desalination, furnace, solar energy economics and performance analysis.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- discuss about solar radiations and their conversion into energy forms
- utilize the working principle of solar collectors to design such devices.
- explain the fundamentals of different types of solar concentration collectors and reflectors.
- gain a deep knowledge on variety of solar systems used for solar energy storage systems.
- explore new ideas for applications of solar systems in for various fields.

TEXT BOOKS

1. Rai,G.D, "Solar Energy Utilization", Khanna Publishers, Fifth Edition , New Delhi,2014.
2. Goswami.D.Y, "Principles of Solar Engineering", Taylor and Francis, 2015.

REFERENCES

1. Sukhatme S.P. J K Nayak, Solar Energy, Tata McGraw Hills P Co., ISBN: 9789352607112, 4th Edition, 2017.
2. Chetan Singh Solanki, "Solar Photovoltatics -Fundamentals, Technologies and Applications", PHI Learning Private limited, 3rd Edition, 2015.
3. Duffie, J. A. & W. A. Beckman., "Solar Engineering of Thermal Processes", John Wiley & Sons, Inc., 4th Edition, 2013.
4. Martin A. Green, "Solar Cells Operating Principles, Technology, and System Applications", Prentice-Hall, 2008.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
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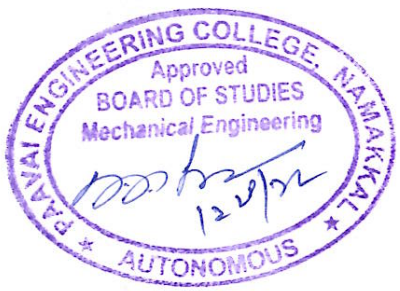
CO1	3	2	2	-	2	2	1	-	-	-	2	2	3	3
CO2	3	2	2	-	2	2	1	-	-	-	2	2	3	3
CO3	3	2	2	-	2	2	1	-	-	-	2	2	3	3
CO4	3	2	2	-	2	2	1	-	-	-	2	2	3	3
CO5	3	2	2	-	2	2	1	-	-	-	2	2	3	3



ME19454 **PRODUCTION PLANNING AND CONTROL** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the concepts of production planning, product development and design and break-even analysis
- become familiar with basic procedure, selection, work measurement involved in work study
- gain knowledge on value analysis ,product planning, routing, batch production and balancing analysis of process capabilities of product planning and process planning.
- learn methods of scheduling, material requirement planning, kanban, dispatching process and techniques for aligning completion time of production scheduling
- study concepts like inventory control, bin system, ABC analysis, just in time system and other recent trends in production planning and control

UNIT I INTRODUCTION **9**

Objectives and Functions of Production Planning and Control - steps in production planning and control - Types of production - Product development and design - Marketing aspect - Functional aspect -Operational aspect - Durability and dependability aspect aesthetic aspect. Profit consideration - Standardization, Simplification &Specialization - Break even analysis -Economics of a new design

UNIT II WORK STUDY **9**

Work Study - Definition, Need, Advantages, Objectives of Method study and Work measurement - basic method study procedure - Selection - Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study - work measurement - Techniques of work measurement - Time study - Steps - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING **9**

Product planning - Extending the original product information-Value analysis - Problems in lack of product Planning- Process planning and routing - Pre-requisite information needed for process planning - Steps in process planning - Quantity determination in batch production-Machine capacity, Balancing - Analysis of process capabilities in a multiproduct system.

UNIT IV ROUTING AND SCHEDULING **9**

Routing: Definition – Routing Procedure – Route Sheets – Bill of Material – Factors Affecting Routing Procedure Scheduling: Definition - Difference with Loading - Scheduling Policies - Techniques - Standard Scheduling Methods - Aggregate Planning - Chase Planning - Expediting - Controlling Aspects

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC **9**

Inventory control - Purpose of holding stock - Effect of demand on inventories - Ordering procedures. Two bin System - Ordering cycle system - Determination of Economic order quantity (EOQ) and economic lot

size- Always Better Control (ABC) analysis-Recorder procedure-Introduction to computer integrated production planning Systems-elements of Just in Time (JIT) - Fundamentals of MRP II and Enterprises Resource Planning (ERP).

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- internalize the concepts of production control, product development, break even analysis and economics of new design.
- thoroughly understand production components like selection, recording procedure, work measurement, time study and predetermined motion time standards.
- demonstrate knowledge on product planning, value analysis, planning and routing, batch Production and balancing, an analysis of multi product system
- be conversant with production control, scheduling, products sequencing, material requirement planning, kanban, dispatching and manufacturing lead time and techniques of scheduling.
- implement techniques of inventory control, ordering procedure, two bin system, ABC analysis and elements of Just in Time systems.

TEXT BOOKS

1. James. B. Dilworth, "Operations management - Design, Planning and Control for Manufacturing and services" Mcgraw Hill International edition 2005.
2. Martand Telsang, "Industrial Engineering and Production Management", S.Chandand Company, First edition,2000.

REFERENCES

1. KanishkaBedi,"Production and Operations management", Oxford university press,2nd Edition 2007.
2. Norman Gaither, G. Frazier, "Operations management" Thomson learning 9th edition,2007.
3. Jain.K.C and L.N.Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers, 2002.
4. Samson Eilon, "Elements of production planning and control", Universal Book Corpn.2001.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
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CO4	3	2	2	-	2	2	1	-	-	-	2	2	3	3
CO5	3	2	2	-	2	2	1	-	-	-	2	2	3	3

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ME19551 REFRIGERATION AND AIR CONDITIONING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- get familiar with the basic principles and concepts of refrigeration system and their environmental consequences.
- understand the fundamentals of refrigeration system components, properties of refrigerants and applications of refrigeration systems.
- know about different types of compressors and condensers and expansion devices used in vapor compression refrigeration system.
- learn the working principle of different VAR systems, how to estimate the COP and other performance factors of VAR systems.
- gain knowledge on different air conditioning systems.

(Use of approved refrigeration charts permitted)

UNIT I REFRIGERATION CYCLE 9

Introduction to Refrigeration- Unit of Refrigeration and C.O.P- Review of thermodynamic principles of refrigeration- Air cycle refrigeration system- multistage and multiple evaporator systems -Ideal cycles - Refrigerants Desirable properties - Classification - Nomenclature - Ozone Depletion Potential (ODP) and Global Warming Potential (GWP).

UNIT II REFRIGERATION SYSTEM COMPONENTS AND REFRIGERANTS 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle - sub cooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system - low temperature refrigeration - Cascade systems - problems. Equipment's: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III VAPOUR COMPRESSION REFRIGERATION 9

Introduction - Simple vapour compression system, Methods and application - Refrigerants Properties, selection of refrigerants, alternative refrigerants - Aircraft refrigeration, single stage cycle, Factors affecting the performance of a simple vapour compression system -Pressure-Enthalpy (P-h) chart - multi stage cycle - multi compressor - multi evaporator and cascade system.

UNIT IV VAPOUR ABSORPTION REFRIGERATION 9

Simple vapour absorption system-Practical vapour absorption system-Properties of ideal refrigerant, Absorbent and refrigerant -absorption combination-Coefficient of performance of an ideal vapour absorption system-Lithium Bromide and Ammonia water system-Steam jet refrigeration system.

UNIT V AIR CONDITIONING SYSTEMS 9

Introduction-Factors affecting comfort air conditioning system-Air conditioning system-Equipment's used in an air conditioning systems-comfort, winter, summer, central and industrial air conditioning system-Room sensible heat factor-Effective room sensible heat factor.

TOTAL PERIODS: 45

COURSE OUTCOMES

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

- explain the basic concepts and terms involved in refrigeration and Air- Conditioning systems like refrigerants, refrigeration cycle, compressor, COP and environmental effects of these systems.
- describe the operations of components involved in cooling systems like compressors, expansion devices etc.
- discuss operation, performance and applications of vapour compression Refrigeration systems.
- perform calculations related to the performance of vapour absorption refrigeration systems and discuss its sub-units.
- be conversant with different Air-conditioning systems and their applications.

TEXT BOOKS

1. Rajput.R.K, "Refrigeration and Air-Conditioning" , S.K. Kataria& Sons, 3rd Edition:2015.
2. Khurmi.R.S ,"Refrigeration and Air-conditioning" S.Chand, Dec 2006.

REFERENCES

1. Arora. C.P., "Refrigeration and Air Conditioning", Tata McGraw-Hill New Delhi, 2008.
2. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd., 2010.
3. Ramesh Arora," Refrigeration and Air-conditioning", Prentice Hall of India, 2010.
4. Domkundwar, Arrora and Domkundwar, "Refrigeration and Air Conditioning", DhanpatRai and co,2009.

CO - PO Mapping

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CO1	3	3	3	2	-	-	3	-	-	-	-	2	3	2
CO2	3	2	2	2	2	-	3	-	-	-	-	2	3	3
CO3	3	3	3	2	2	-	3	-	-	-	-	2	3	2
CO4	3	3	3	2	2	-	3	-	-	-	-	2	3	3
CO5	3	3	3	2	2	-	3	-	-	-	-	2	3	3

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ME19552 NON - DESTRUCTIVE EVALUATION TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the basic concepts of non - destructive testing and its limitations.
- gain knowledge of NDT methods like liquid penetrant and magnetic particle testing
- know the basic principles of eddy current and thermography testing.
- understand the principles and components involved in ultrasonic testing and acoustic emission
- familiarize the working principles, equipment involved in radiography techniques.

UNIT I INTRODUCTION TO NON-DESTRUCTIVE TESTING 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection - Unaided and aided.

UNIT II LIQUID PENETRANT TESTING AND MAGNETIC PARTICLE TESTING 9

Liquid penetrant Testing-Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing-Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING 9

Thermography - Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal - Concept, example, advantages & limitations. Eddy current Testing - Principle, properties of eddy currents. Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations.

UNIT IV ULTRASONIC TESTING AND ACOUSTIC EMISSION 9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique - Principle, AE parameters, Applications.

UNIT V RADIOGRAPHY 9

Introduction - Principle, Equipment of Radiography testing, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- describe knowledge on various NDT techniques to carry out inspections in accordance with the established procedures.
- evaluate concepts involved in the liquid penetrant and magnetic testing methods.
- demonstrate knowledge on thermography and eddy current testing methods.
- employ the functions of transducer and principle of ultrasonic testing at appropriate places.
- illustrate knowledge on radiography techniques and its elements.

TEXT BOOKS

1. Prakash Ravi., "Non-destructive Testing Techniques", New Age International Publishers. 1st Rev Edition., 2017.
2. Paul E Mix, "Introduction to Non-destructive Testing: a training guide, Wiley", 2nd edition New Jersey., 2005.

REFERENCES

1. Charles. J. Hellier., "Handbook of Non-destructive evaluation", 2nd edition McGraw Hill., New York, 2013.
2. Prasad.J and Nair.C.G.K., "Non-Destructive Test and Evaluation of Materials", Tata McGraw- Hill Education, 2nd edition 2011.
3. Baldev Raj., B. Venkataraman., O. J.Varde., Nerulikar., "Practical Magnetic Particle Testing", Narosa Publishing House.,2007.
4. Rao. B.P.C., "Practical Eddy Current Testing", Alpha Science International Limited, 2006.

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CO3	2	1	1	3	2	-	-	-	-	-	-	1	2	2
CO4	2	1	1	3	1	-	-	-	-	-	-	1	2	2
CO5	2	1	1	3	2	-	-	-	-	-	-	1	2	2

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ME19553 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the functions of Jigs and Fixtures.
- gain proficiency in design and development of jigs.
- understand the principles, functions and design practices of Fixtures.
- gain the knowledge on design of different types of cutting dies.
- become familiar with forming techniques and tool design.

UNIT I LOCATING AND CLAMPING PRINCIPLES 9

Objectives of tool design- Function and advantages of Jigs and fixtures - Basic elements - principles of location - Locating methods and devices - Redundant Location - Principles of clamping - Mechanical actuation - pneumatic and hydraulic actuation Tolerances and materials used.

UNIT II DESIGN AND DEVELOPMENT OF JIGS 9

Types of drill jigs - General considerations in the design of drill jigs - Drill bushings - Types, methods of construction - Simple designs of Plate, Channel, Box, Post, Angle plate, Turnovers and Pot Jigs. Design and development of jigs for given component.

UNIT III DESIGN AND DEVELOPMENT OF FIXTURES 9

Principles - Types of fixtures - Fixtures for machine tools: Lathe, Milling, Boring, Broaching and grinding - Assembly fixtures - Inspection and Welding fixtures. Design and development of fixtures for given component.

UNIT IV DESIGN OF PRESS TOOLS 9

Complete design and preparation of standard views of simple blanking, piercing, compound and progressive dies -fine Blanking dies.

UNIT V FORMING TECHNIQUES AND EVALUATION 9

Drawing and deep drawing, bulging, swaging, embossing, coining, curling, hole flanging, shaving and sizing, assembly- recent trends in tool design- computer Aids for sheet metal forming Analysis - basic introduction - tooling for numerically controlled machines- setup reduction for work holding - Single minute exchange of dies - Poka Yoke.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- describe knowledge on the selection of jigs and fixtures with appropriate actuation technique
- become proficient in design considerations of different types of jigs for various products.
- implement in practice the principles of design and development of fixtures for different components

- apply acquired knowledge to design different types of cutting dies
- design dies for various forming operations and appraise computer aided techniques for tool design.

TEXT BOOKS

1. Joshi, P.H., "Jigs & Fixtures", Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
2. Edward G Hoffman, "Jigs & Fixture Design", Thomson - Delmar Learning, Singapore 2004.

REFERENCES

1. Venkataraman.K., "Design of Jigs, Fixtures and Press Tools", John Wiley & Sons, 2015.
2. Hiram E Grant, "Jigs and Fixture" Tata McGraw-Hill, New Delhi, 2003.
3. "Fundamentals of Tool Design", CEEE Edition, ASTME, 1999.
4. Kempster, "Jigs & Fixtures Design", The English Language Book Society", 2001.

CO - PO Mapping

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CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2	3	2
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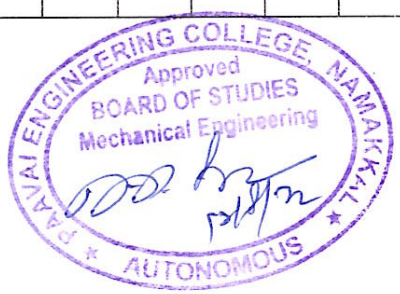
CO5	3	2	2	-	-	-	-	-	-	-	-	2	3	2



ME19554 **MAINTENANCE ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the principles of maintenance and planning activities required for maintenance systems.
- know about the maintenance policies and modern tools of maintenance.
- gain knowledge on condition monitoring
- get in-depth knowledge of repair methods of machine elements and its maintenance.
- gain insight into reliability and safety in maintenance.

UNIT I PRINCIPLES AND MAINTENANCE SYSTEM PLANNING **9**

Basic Principles of maintenance planning-Objectives and principles of planned maintenance activity - Importance and benefits of sound Maintenance systems: Maintenance systems - reactive, preventive or proactive systems - machine availability -Mean time between failures (MTBF), Mean time to repairs (MTTR) and mean down time (MDT) - Factors of availability-Hazard rate.

UNIT II MAINTENANCE POLICIES AND TECHNIQUES **9**

Maintenance Schedules, repair cycle- Total Productive Maintenance- Overall Equipment Effectiveness (OEE) and World Class Maintenance - Seven Modern Tools - Applications. Data Acquisition for Effective Management of Computerized Maintenance Management System (CMMS) - Logic Tree Analysis.

UNIT III CONDITION MONITORING **9**

Condition Monitoring -Cost comparison with and without CM - On-load testing and off-load testing - Methods and instruments for CM-Temperature sensitive tapes-Pistol thermometers -Condition Monitoring Techniques -Vibration analysis-Thermograph - lubrication methods - wear debris analysis

UNIT IV RELIABILITY ENGINEERING AND SAFETY IN MAINTENANCE **9**

Reliability - Definition, failure data, failure density, failure rate, mean failure rate, types of failures, failure rate curve. System Reliability- series, parallel and mixed configuration. Safety - Definition - methods of enhancing safety - modern industrial scenarios - safety tools - quantification of safety - hazards and its management.

UNIT V FAILURE ANALYSIS AND REPAIR METHODS FOR BASIC MACHINE ELEMENTS **9**

Failure analysis - tools -fault tree analysis - event tree analysis-Root cause analysis - Failure mode and Effect analysis (FMEA) - Failure mode and Effect criticality analysis (FMECA). Repair methods for beds, sideways, spindles, gears, lead screws and bearings - Equipment records -Job order systems.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- describe the principles involved in the planning of maintenance in industries.
- apply different maintenance policies and techniques in industrial management systems.

- describe tools and techniques involved in condition monitoring.
- utilize failure analysis tools and identify and repair methods for maintenance of machine elements.
- synthesize the functional concepts of reliability and safety engineering into maintenance system.

TEXT BOOKS

1. Srivastava S.K., "Maintenance Engineering (Principles - Practices and Management)", 2nd Edition, S. Chand & Co., NewDelhi, 2014.
2. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand & Co., New Delhi, 2013.

REFERENCES

1. Venkataraman.K., "Maintenance Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, 2010
2. Garg M.R., "Industrial Maintenance", S. Chand & Co., 2010.
3. Srinath L.S., "Reliability Engineering", East-West Press, New Delh , 2009.
4. White E.N., "Maintenance Planning", I Documentation, Gower Press, 2005.

CO - PO Mapping

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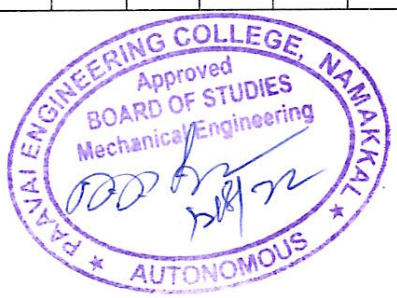


BA19151 ENTREPRENEURSHIP DEVELOPMENT 3 0 0 3

COURSE OBJECTIVES

To enable students to

- understand the management principles.
- build the entrepreneurial competencies and analyse the support rendered by government and other agencies in entrepreneurship development.
- understand the business opportunities and to prepare a feasibility report.
- propose a business plan.
- appraise and comprehend the various factors to be considered for launching a small business.

UNIT I Basics of Management: 9

Management: Meaning, Definition, Nature and Importance; Roles of management, Functions of Management, Levels of Management, Functional areas of Management: Marketing, Finance, Production, HRM, IT, Research and Development.

The Evolution and Development of Management Thought: Classical, Neo-classical, System and Contingency Approaches, An Overview.

UNIT II Entrepreneurial Competence and Environment 9

Entrepreneurial Competence: Entrepreneurship, Definition, Role and expectations, Entrepreneurial styles and types, Characteristics of the Entrepreneur, Entrepreneurial Competencies, Functions of an Entrepreneur.

Entrepreneurial Environment: Role of Socio-Cultural, Economic and Political Environment, Institutional Support for small entrepreneurs, Assistance Programme for Small Scale Units, Institutional Framework, Central and State Government Industrial Policies and Regulations.

UNIT III Entrepreneurial Development 9

Ownership Structures, Proprietorship, Partnership, Company, Co-operative, Franchise.

Identification of Business Opportunity, Preparation of Feasibility Report, Financial and Technical Evaluation, Project Formulation, Common Errors in Project Formulation, Specimen Project Report.

Entrepreneurial Development Programs, Role of SSI Sector in the Economy, IAS Units, Failure, Causes and Preventive Measures, Turnaround Strategies.

UNIT IV Business Plan Preparation, Financing Ventures 9

Business Plan: Business opportunities-SWOT, Business plan process, Feasibility Study, Functional plan, Marketing plan, Operational plan, Organizational plan, financial plan, Evaluation Criteria.

Financing ventures: sources of raising capital, seed funding, venture capital funding, funding opportunities for start-ups in India.

UNIT V Women Entrepreneurship & Entrepreneurship in various sectors 9

Women Entrepreneurship: Growth of women Entrepreneurship, Problems faced by Women Entrepreneurs, Development of women Entrepreneurship.

Entrepreneurship in Informal Sector: Rural Entrepreneurship, Entrepreneurship in Sectors like Agriculture, Tourism, Health care, Transport and allied services.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, the students will be able to

- implement the necessary managerial skills to become an entrepreneur.
- take up self-employment having been exposed to entrepreneurial environment.
- select a best business idea by using appropriate methods to assess its viability.
- formulate a business plan and deploy the resources for sustainable growth.
- analyse channels and means of launching a small business in any sector.

TEXT BOOKS

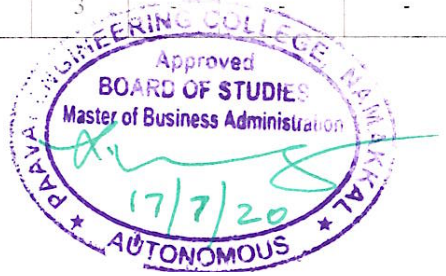
1. Khanka S.S, "Entrepreneurial Development", S. Chand and Company Limited, New Delhi, 2016.
2. Saravanavel. P, "Entrepreneurial Development", Ess Pee Kay Publishing House, Chennai, 2013.

REFERENCES

1. Donald L. Sexton and Raymond W.Smilor, "The Art and Science of Entrepreneurship", Ballinger Publishing Company, 2008.
2. Clifford M.Baumback & Joseph R.Mancuso, "Entrepreneurship and Venture Management". Prentice Hall, 1975.
3. Gifford Pinchot, "Intrapreneuring" Harper & Row Publishers, New York, 2005.
4. Mathew Manimala, "Entrepreneurship Theory at the Crossroads", Paradigms and Praxis, Biztrantra, 2nd Edition, 2015.

CO – PO Mapping:

Mapping of Course Outcomes with Programme Outcomes: (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	-	-	2	-	1	-	-	2
CO3	-	-	2	-	-	-	-	-	-	-	-		1	2
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	1
CO5	-	-	-	-	-	-	-	2	-	-	3	-	-	-



BA19353 ENGINEERING ECONOMICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- gain knowledge about the fundamental concepts in economics.
- identify the structure of market, demand and supply in modern world.
- interpret the relation between production and cost.
- comprehend the economic indicators.
- have an awareness about government policies.

UNIT I ECONOMICS: THE STUDY OF CHOICE 9

Defining Economics – The Field of Economics - confronting scarcity - Factors of Production-the Production Possibility frontier; Micro-Macro Economics - Definition, Scope, Paradox for Micro Economics, Distinction between Micro and Macro Economics.

UNIT II MARKET STRUCTURE, DEMAND AND SUPPLY 10

Market Structure - Introduction about different market structure; Demand and Supply - Demand, Supply; Equilibrium - Law of Demand and Supply, Elasticity of Demand and Supply, types, Estimation of Demand and Supply, Putting Demand and Supply to Work; Government Intervention in Market Prices - Price Floors and Price Ceilings.

UNIT III PRODUCTION AND COST 10

Production Choices and Costs - The Short Run and Long run, Law of Proportions – the importance of production in managerial Decisions, Cost – output functions, cost in short run and Long run, Economies and diseconomies of scale; Revenue – concepts, types, total Revenue, Average Revenue and Marginal Revenue.

UNIT IV ECONOMIC INDICATORS 9

Inflation – Meaning, Causes, Types, Effects, Demand Pull Inflation, Cost Push Inflation.– Effects of Inflation, Inflationary gaps; Deflation – Causes and effects of Deflation, Stagflation – Measures to control Inflation and deflation, Trade Cycle; Price Discrimination – definition, concepts, types and conditions, Pricing methods in practice, Multi product pricing.

UNIT V GOVERNMENT POLICY 7

Monetary Policy - Problems and Controversies of Monetary Policy; The Use of Fiscal Policy - Issues in Fiscal Policy, Inflation, National Income and Trade Cycle.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- appraise the concepts in economics.
- analyse the market structure, demand and supply in a market.
- formulate production, cost and revenue plans.
- assess the economic indicators resulting in price hikes
- interpret the government policies and trade cycle.

TEXT BOOKS

1. Panneerselvam. R, Engineering Economics, 2nd Edition, PHI Learning, 2014.
2. N. Gregory Mankiw, Principles of Economics, 8th edition, Thomson learning, New Delhi, 2017.

REFERENCES

1. William Boyes and Michael Melvin, Textbook of Economics, Biztantra, 7th edition 2008.
2. Paul A. Samuelson, William D. Nordhaus, Sudip Chaudhuri and Anindya Sen, Economics, 19th edition, Tata McGraw Hill, New Delhi, 2011
3. Richard Lipsey and Alec Chrystal, Economics, 13th edition, Oxford, University Press, New Delhi, 2015.
4. Karl E. Case and Ray C. Fair, Principles of Economics, 12th edition, Pearson, Education Asia, New Delhi, 2017.

CO – PO Mapping:

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CO1	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	-	-	2	-	1	-	-	2
CO3	-	-	2	-	-	-	-	-	-	-	-		1	2
CO4	-	-	-	2	-	-	-	-	-	-	-	-	-	1
CO5	-	-	-	-	-	-	-	2	-	-	3	-	-	-

ME19651 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the concepts of productivity improvement techniques.
- learn the systems used for productivity measurement and evaluation process.
- know about how the planning and implementation of innovative concepts are carried out.
- familiarize modern practices in Re-engineering process
- acquire ideas of new tools like process improvement models along with BPR and IT

UNIT I INTRODUCTION 9

Basic concept and meaning of Productivity - Significance of Productivity - Factors affecting Productivity - Productivity cycle, Scope of Productivity, Engineering and Management.

UNIT II PRODUCTIVITY MEASUREMENT AND EVALUATION 9

Productivity measurement in International, National and Industrial level - Total Productivity Model - Productivity measurement in Manufacturing and Service sectors - Performance Objective Productivity (POP) model - Need for Productivity Evaluation - Evaluation Methodology.

UNIT III PRODUCTIVITY PLANNING AND IMPLEMENTATION 9

Importance of Productivity Planning- Short-Term versus Long-Term Productivity Planning- Technology-Based Productivity Improvement Techniques- Laser, Energy and Group Technology, Employee-Based Productivity Improvement Techniques- Zero Defects, Time Management- Product-Based Productivity Improvement Techniques- Reliability Improvement, Managerial aspects of Productivity Implementation. Schedule, Productivity audit and control.

UNIT IV RE-ENGINEERING PROCESS 9

Definition, Fundamentals of process reengineering - Principles, Methodology and guidelines for Organization Transformation, DSMCQ and PMP organization Transformation models - Process Improvement.Models like PMI, Edosomwan, LMICIP and NPRDC Models.

UNIT V BPR TOOLS AND IMPLEMENTATION 9

Analytical and Process Tools and Techniques - Role of Information and Communication Technology in BPR - Requirements and steps in BPR Implementation - Case studies.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- internalize concepts of productivity management.
- describe the differences among small, medium and large measurements of productivity and evaluation process.
- aggregate the salient characteristics of productivity measurement models.

- design new models of Business Process and Re-engineering.
- develop new tools using latest techniques like IT for productivity improvement

TEXT BOOKS

1. Sumanth, D.J."Productivity Engineering and Management", TMH, New Delhi, 2000.
2. Gopalakrishnan, P. and Banerji, A.K., "Maintenance and Spare Parts, Management", Prentice - Hall of India Pvt. Ltd., 2002.

REFERENCES

1. Phusavat. K, Fankham-ai K, Haapasalo. H, and Lin. B, "Productivity Management in an Organization", 2011.
2. Edosomwan, J.A. "Organizational Transformation and Process re- Engineering", British Cataloging in publications, 2006.
3. Premvrat, Sardana, G.D. and Sahay, B.S. "Productivity Management - A systems approach",Narosa Publications, New Delhi, 2002.
4. Prokopenko. J, "Productivity Management, A Practical Handbook", International Labour Organisation, 2000.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	2	2	2	-	-	-	-	-	2	2	2
CO2	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO3	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO4	2	3	2	3	2	-	-	-	-	-	-	2	2	2
CO5	2	3	2	3	2	-	-	-	-	-	-	2	2	2

ME19652 **WELDING TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand welding techniques and principles of gas and arc welding
- learn the concepts of resistance welding and various resistance welding processes.
- gain knowledge of solid state welding process for engineering applications
- acquire knowledge on special welding processes and welding automation.
- know about different testing methods of weldment and weldability of different metals.

UNIT I WELDING PRINCIPLES, GAS AND ARC WELDING PROCESSES 9

Classifications of Welding Processes - Power Sources - Arc characteristics- VI Characteristics -Metal Transfer Modes - Gas Welding - Air Acetylene welding, Oxyacetylene welding- Arc Welding: Shielded metal arc welding - Submerged arc welding - TIG welding - MIG welding - Plasma arc welding - Electro slag welding processes -Safety aspects in welding - advantages, limitations and applications.

UNIT II RESISTANCE WELDING PROCESSES 9

Spot welding - Seam welding - Projection welding - Resistance Butt welding - Flash Butt welding - Percussion welding - High frequency resistance welding processes - advantages, limitations and applications

UNIT III SOLID STATE WELDING PROCESSES 9

Cold welding - Diffusion bonding - Explosive welding - Ultrasonic welding - Friction welding- Forge welding - Roll welding- Hot pressure welding processes - advantages, limitations and applications.

UNIT IV SPECIAL WELDING PROCESSES AND WELDING AUTOMATION 9

Thermit welding - Atomic hydrogen welding - Electron beam welding - Laser Beam welding- Friction stir welding - Under Water welding - Metal Surfacing and Spraying Processes - Dissimilar metal joints - Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT V TESTING OF WELDMENTS AND WELDABILITY 9

Destructive Tests: Tensile Test, Ductility Test, Toughness Test, And Fatigue Test -Non-Destructive Test: Visual Inspection, Liquid Penetrant Test, Magnetic Particle Test, Radiographic Test, Ultrasonic Testing of Weldment - Weldability of Steel, Aluminium alloys, Copper alloys and other non-ferrous metals .

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- demonstrate knowledge on gas and arc welding processes.
- illustrate the fundamental principles of several resistance welding processes.
- discuss solid state welding processes and identify their applications.
- explain the need for special welding processes and welding automation
- appraise the destructive and non-destructive testing of weldment through different techniques.

TEXT BOOKS

1. Dr.R.S.Parmer, "Welding Processes and Technology", 3rd edition, Khanna Publishers, NewDelhi, 2014.
2. Baldev Raj, V.Shankar, A.K.Bhaduri, "Welding Technology for Engineers", ASM International, 2006.

REFERENCES

1. Little R.L., "Welding and Welding Technology", Tata McGraw Hill Publishing Co., Ltd., NewDelhi, 2017.
2. K.S.Yadav. "Advanced Welding Technology", Standard Book Huse Publishers, 2017
3. O.P.Khanna, "Welding Technology", DhanpatRaiPublications,2013.
4. Nadkarni S.V. "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.

CO - PO Mapping

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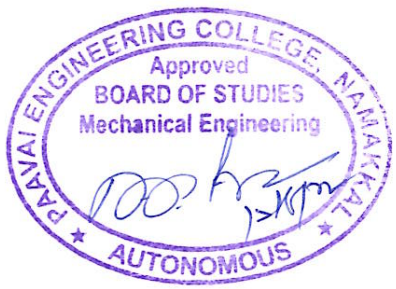
CO1	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO2	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO4	3	3	-	-	-	-	-	-	-	-	-	2	2	3
CO5	3	3	-	-	-	-	-	-	-	-	-	2	2	3



ME19903 **ROBOTICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the functions of the basic components of a Robot.
- study the use of various types of End of Effectors and drives.
- know the use of various sensors in Robotics.
- acquire knowledge on Robot Kinematics and Programming.
- Learn about the vision systems in automation and implementation of Robots in industries.

UNIT I FUNDAMENTALS OF ROBOTICS SYSTEM **8**

Robot- History of robotics, Basic components of robots (Laws of robotics), -Robot Anatomy-Co-ordinate Systems, Work Envelope, types and classification-Functions, Specifications Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - functionaries- Need for Robots-Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS **9**

Pneumatic Drives -Hydraulic Drives-Mechanical Drives-Electrical Drives -D.C. Servo Motors, Stepper Motor, and A.C. Servo Motors - Salient Features, Applications and Comparison of all these Drives. End Effectors - Grippers -Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; External Grippers.

UNIT III SENSORS **10**

Requirements of a sensor, Principles and Applications of the following types of sensors - Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters),Proximity Sensors(Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors,(Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING **10**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Introduction to DH Matrices -Teach Pendant Programming -VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT V MACHINE VISION AND IMPLEMENTATION OF ROBOT **8**

Introduction to Machine vision - functional block diagram of machine vision system - Sensing and Digitizing - Image processing and analysis. RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- differentiate the various types of industrial robots and their architecture.
- apply different types of drive systems and end effectors for robot operations
- apply appropriate sensors for different types of robots.
- write robot programming for specific applications and appraise the significance of kinematics in robot movements.
- apply machine vision system for image processing and implement robotics in industries with safety aspects.

TEXT BOOKS

1. Groover, M.P. "Industrial Robotics- Technology, Programming and Applications", McGraw-Hill, 2005
2. Richard. D.Klafter., "Robotic Engineering", Prentice-Hall International, Inc. -1988

REFERENCES

1. Funk's. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co.,2008
2. Deb, S.R. "Robotics Technology and Flexible Automation" Tata McGraw Hill, 2003.
3. Yore Koran, "Robotics for Engineers", McGraw-Hill Book Co.,2001
4. Richard. K. Miller, "Industrial Robot Handbook", Springer, 2013

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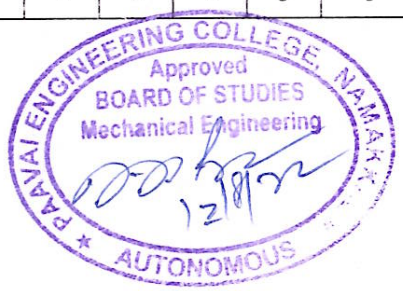
CO1	3	-	-	-	-	-	-	-	3	3	-	-	-	3
CO2	3	-	-	-	-	3	-	-	3	3	-	-	-	3
CO3	3	-	1	-	-	3	-	-	3	3	-	-	-	3
CO4	3	-	2	-	-	-	-	-	3	3	-	-	-	2
CO5	3	-	3	-	-	-	-	-	3	3	-	-	-	1



ME19904 SAFETY ENGINEERING AND ENVIRONMENTAL SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the fundamentals and significance of safety along with safety auditing and also learn about ISO45001 and Factories Act, 1948
- identify electrical, chemical and mechanical works related hazards and gain knowledge on them.
- learn about safety working practices in workplaces and protective equipment.
- know about preventive measures for fire safety and safety aspects of building design.
- acquire knowledge on environment hazards, ergonomics and occupational health.

UNIT I INTRODUCTION TO SAFETY ENGINEERING & MANAGEMENT 9

Safety Engineering: Fundamentals of safety-Significance, general instructions, awareness, hazard identification-safety planning and inspection, safety symbols, ISO45001-elements and Main provisions of Factories Act 1948 - Safety management: Introduction, classification of accidents - Principles of safety management, Management safety policy-safety auditing-stages in plant life.

UNIT II SAFETY WORKING PRACTICES 9

Safe working environment- Management of hazards in work environment. Fire safety instructions, safety instructions in use of electricity, welding, hand tools, workshop and garages. Personal safety of human body parts- Protection of eye, Head, Respiratory system, hearing system, hand and foot, personal protective equipment.

UNIT III ELECTRICAL, CHEMICAL AND MECHANICAL HAZARDS 9

Electrical Hazards: Introduction to electrical safety, Electric shock situations, Prevention of shocks, electrical safety systems and training. Chemical hazards: Industrial toxicology-Harmful effects-Dust explosions-Hazards due to flammable gas, Bulk fire and toxic release-control measures. Mechanical hazards: Introduction-safety devices-portable ladders, ropes, chains, slings, lifting equipment, Mechanical handling equipment.

UNIT IV FIRE SAFETY AND BUILDING DESIGN 9

Fire hazards: Introduction - Classification of fire, Fire extinguishers - water fire extinguishers, Foam fire, Dry powder, CO2 Gas cartridge fire extinguishers - Fire detectors and fire-fighting system - Maintenance. Building Design: general requirements of building design in fire protection, walls and openings, roofs, Basements, Escape from building, electrical installations, fire-fighting in buildings, tips to prevent fire outbreaks.

UNIT V ENVIRONMENTAL HAZARDS AND OCCUPATIONAL HEALTH 9

Industrial waste- Introduction, types and sources, harmful effects, control, waste recovery, treatment and waste disposal. Occupational Ergonomics: Introduction, human body, heart, posture, office ergonomics, Ergonomics for woman at work, Anthropometry Occupational stress: Work related stress, source, signs and measurement of stress. Stress management systems, and prevention of stress, stress, health and productivity Occupational health: Significance of industrial health, Occupational Safety and Health Act, Health program, First Aid.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- give priority to safety and gain good grounding in safety auditing, ISO45001and Factories Act 1948.
- become safety conscious and follow safe working practices and wear/use work related protective gadgets/tools.
- differentiate among electrical, chemical and mechanical hazards and plan safety measures accordingly.
- get sensitized about fire accidents, how to act at fire emergencies and also follow safe aspects in building design.
- know technically about environment hazards, ergonomics and occupation hazards and take control measures.

TEXT BOOKS

1. Jain R. K and Sunil S. Rao, "Industrial Safety, Health and Environment Management Systems" Khanna Publishers, Fourth Edition, 2015.
2. Prashar and Pratiba Bansal, "Industrial Safety and Environment", Katson Publication, New Delhi 2005.

REFERENCES

1. Deshmukh L. M., "Industrial Safety Management", Tata McGraw Hill, 2010.
2. Krishnan N.V., "Safety Management in Industry", Jaico Publishing House, Bombay, 2001.
3. Mahajan S. P., "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 2005.
4. William E. Clark, "Firefighting Principles &Practices", Fire Engineering Books and Videos, 2nd edition 2003.

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

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