

Semester V

Sl. No.	Category	Code No.	Course Title	Hours per week			Total Contact Hrs/Week	Credit
				L	T	P		
1	Programme core course-16	MEPC501	Advanced Manufacturing Processes	3	0	0	3	3
2	Programme core course-17	MEPC502	Theory of Machines & Mechanisms	2	0	0	2	2
3	Programme core course-18	MEPC503	Industrial Engineering & Management	2	0	0	2	2
4	Programme core course-19	MEPC504	CAD/CAM Lab	0	0	2	2	1
5	Programme core course-20	MEPC505	Manufacturing Engineering Lab-II	0	0	2	2	1
6	Programme elective course-2	MEPE506/A	Computer Aided Design and Manufacturing	3	0	0	3	3
	(Any One to be selected)	MEPE506/B	Refrigeration & Air-conditioning					
7	Programme elective course-3	MEPE507/A	Mechatronics	3	0	0	3	3
	(Any One to be selected)	MEPE507/B	Industrial Robotics & Automation					
8	Open elective course-1	(Any one to be selected from Annexure-I)		3	0	0	3	3
9	Summer Internship-II (6 weeks) after IV Semester	MESI509	Summer Internship-II	0	0	0	0	3
10	Major Project	MEPR510	Major Project- I	0	0	2	2	1
			Total	16	0	6	22	22

ADVANCED MANUFACTURING PROCESSES

Course Code	MEPC501
Course Title	Advanced Manufacturing Processes
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Mechanical Engineering Manufacturing
Course Category	Programme core course-16

Course Outcomes: - By the end of the course, the students are expected to

CO1: Know the Operation and control of different advanced machine tools and equipment. **(K1)**

CO2: Produce jobs as per specified requirements by selecting the specific machining process. **(K2)**

CO3: Develop the mind set for modern trends in manufacturing and automation. **(K1)**

CO4: Identify the different fabrication methods viz., sheet forming, blow moulding, laminating and reinforcing of plastics. **(K2)**

Course Content:-

Module- 1: Jigs & Fixtures

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 6) Know the functions of Jigs and Fixtures.
- 7) Know the design of drill jigs.
- 3) Basic principles of the clamping.

Detailed content of the unit: -

Definition of jig; Types of jigs: Leaf jig, Box and Handle jig, Template jig, Plate jig, Indexing jig, Universal jig, Vice jigs - constructional details of the above jigs; General consideration in the design of drill jigs; Drill bush; Types of fixtures: Vice fixtures, Milling fixtures, Boring fixtures, Grinding fixtures - constructional details of the above fixtures; Basic principles of location; Locating methods and devices; Basic principles of the clamping; Types of clamps: Strap clamps, Cam clamps, Screw clamps, Toggle clamps, Hydraulic and Pneumatic clamps.

Module- 2: Jig Boring

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 1) Application of Jig boring on vertical milling machine.
- 2) Know the applications of jig-boring machines.
- 3) Identify different fabrication methods of plastic processing

Detailed content of the unit: -

Introduction; Jig boring on vertical milling machine; Types jig boring machines: Open front machine, Cross rail type machine - constructional details & their working; System of location of holes.

Plastic Processing: Processing of plastics; Moulding processes: Injection moulding, Compression moulding, Transfer moulding; Extruding; Casting; Calendaring; Fabrication methods-Sheet forming, Blow moulding, Laminating plastics (sheets, rods & tubes), Reinforcing; Applications of Plastics.

Module- 3: Modern Machining Processes

Number of class hours: 8 Hrs.

Suggestive Learning Outcomes:

Detailed content of the unit: -

- 1) Able to distinguish between non-conventional machining and traditional machining processes.
- 2) Application of different non-traditional machining (NTM).
- 3) Influence of the process parameter in NTM.

Detailed content of the unit: -

Introduction – comparison with traditional machining; Ultrasonic Machining: principle, Description of equipment, applications; Electric Discharge Machining: Principle, Description of equipment, Dielectric fluid, tools (electrodes), Process parameters, Output characteristics, applications; Wire cut EDM: Principle, Description of equipment, Controlling parameters; applications; Abrasive Jet Machining: principle, description of equipment, application; Laser Beam Machining: principle, description of equipment, application; Electro Chemical Machining: description of equipment, application.

Module- 4: CNC Milling Machines

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 1) Know about the advancements in the area of manufacturing and production processes.
- 2) Acquire the knowledge & skills necessary for working in modern manufacturing environment.
- 3) Know the working of machine tool automation.

Detailed content of the unit: -

Vertical and horizontal machining center: Constructional features, Axis identification, Electronic control system. Automatic tool changer and tool magazine; CNC programming: Preparatory functions (G code), miscellaneous functions (M code), Part programming including subroutines and canned cycles. Principles of computer aided part programming.

Machine Tool Automation: Introduction and Need; (A) Single spindle automates, transfer lines. (B) Elements of control system, Limit switches, Proximity switches, Block diagram for feedback and servo control system, Introduction to PLC, Block diagram of PLC.

Module- 5: Special Purpose Machines (SPM)

Number of class hours: 4 Hrs.

Suggestive Learning Outcomes:

- 1) Get familiarized with, Special Purpose Machine (SPM) and its design
- 2) Understand different types of maintenance
- 3) Concept of Total Productive Maintenance (TPM).

Detailed content of the unit: -

Concept, General elements of Special Purpose Machine (SPM), Productivity improvement by SPM, Principles of SPM design

Maintenance of Machine Tools: Types of maintenance, Repair cycle analysis, Repair complexity, Maintenance manual, Maintenance records, Housekeeping. Introduction to Total Productive Maintenance (TPM).

Reference Books:

1. Production Technology – HMT, Bangalore, Tata Mc-Graw Hill
2. CNC machines – Pabla B. S. & M. Adithan, New Age international limited.
3. Non conventional Machining – P. K. Mistra, NarvasaPublishining House
4. Manufacturing Processes – Begman& Amsted, John Willey and Sons.
5. Advanced manufacturing technology – David L. Goetsch
6. Exploring Advanced Manufacturing Technologies – Stephen F. Krar& Arthur Gil, Industrial Press.

THEORY OF MACHINES & MECHANISMS

Course Code	MEPC502
Course Title	Theory of Machines & Mechanisms
Number of Credits	2(L: 2, T: 0 P: 0)
Prerequisites	NIL
Course Category	Programme core course

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

CO1: Understand Kinematics and Dynamics of different machines and mechanisms [K1]

CO2: Select Suitable Drives and Mechanisms for a particular application [K2]

CO3: Appreciate concept of balancing and Vibration. [K3]

CO4: Develop ability to come up with innovative ideas. [K4]

CO5: Understand different types of cams and their motions and also draw cam profiles for various motion. [K1]

Course Content:-

Module- 1: Cams and Followers

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Explain the concept of Cams and Followers.
- 2) Draw the profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion.

Cams and Followers: Concept; Definition and application of Cams and Followers; Classification of Cams and Followers; Different follower motions and their displacement diagrams like uniform velocity, SHM, uniform acceleration and Retardation; Drawing of profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion (graphical method).

Module-2: Power Transmission

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Calculate the Velocity Ratio, Ratio of tight side and slack side tension; Centrifugal tension and Initial tension of different types of belt drive.
- 2) Describe the principal of different types of gears and gear trains.

Power Transmission: Types of Drives – Belt, Chain, Rope, Gear drives & their comparison; Belt Drives - flat belt, V– belt & its applications; Material for flat and V-belt; Angle of lap, Belt

length. Slip and Creep; Determination of Velocity Ratio, Ratio of tight side and slack side tension; Centrifugal tension and Initial tension; Condition for maximum power transmission (Simple numerical); Chain Drives – Advantages & Disadvantages; Selection of Chain & Sprocket wheels; Methods of lubrication; Gear Drives – Spur gear terminology; Types of gears and gear trains, their selection for different applications; Train value & Velocity ratio for compound, reverted and simple epicyclic gear train; Methods of lubrication; Law of gearing; Rope Drives – Types, applications, advantages & limitations of Steel ropes.

Module-3: Flywheel and Governors

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Understand the concept, function, application and significance of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine.
- 2) Describe the principal of different types of Governors.

Flywheel and Governors: Flywheel - Concept, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine (no Numerical); Coefficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance; Governors - Types and explanation with neat sketches (Centrifugal, Watt and Porter); Concept, function and applications & Terminology of Governors; Comparison between Flywheel and Governor.

Module- 4: Brakes, Dynamometers, Clutches & Bearings

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Explain the basics of different types of Brakes, Dynamometers.
- 2) Describe the Construction and working of different types of Clutches & Bearings.

Brakes, Dynamometers, Clutches & Bearings: Function of brakes and dynamometers; Types of brakes and Dynamometers; Comparison between brakes and dynamometers; Construction and working of i) shoe brake, ii) Band Brake, iii) Internal expanding shoe brake iv) Disc Brake; Concept of Self Locking & Self energizing brakes; Numerical problems to find braking force and braking torque for shoe & band brakes; Construction and working of i) Rope Brake Dynamometer, ii) Hydraulic Dynamometer, iii) Eddy current Dynamometers; Clutches- Uniform pressure and Uniform Wear theories; Function of Clutch and its application; Construction and working of i) Single plate clutch, ii) Multi plate clutch, iii) Centrifugal Clutch iv) Cone clutch and v) Diaphragm clutch. (Simple numerical on single and Multi plate clutch); Bearings – i) Simple Pivot, ii) Collar Bearing, iii) Conical pivot Torque & power lost in friction (no derivation) Simple numerical.

Module- 5: Balancing & Vibrations

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Demonstrate the Concept of balancing for single rotating mass and for several masses revolving in same plane.
- 2) Explain the Concept and terminology used in vibrations and their effects.

Balancing & Vibrations: Concept of balancing; Balancing of single rotating mass; Graphical method for balancing of several masses revolving in same plane; Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies.

Reference Books:

1. Theory of machines – S.S, Rattan, Tata McGraw-Hill publications.
2. Theory of machines – R.K. Bansal, Laxmi publications
3. Theory of machines – R.S. Khurmi & J. K. Gupta, S. Chand publications.
4. Dynamics of Machines – J B K Das, Sapna Publications.
5. Theory of machines – Jagdishlal, Bombay Metro – Politan book Ltd

INDUSTRIAL ENGINEERING & MANAGEMENT

Course Code	MEPC503
Course Title	Industrial Engineering& Management
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Programmecorecourse

Course Outcomes: - By the end of the course, the students are expected to

CO1: Explain the different types of layout and plant maintenance with safety. (K2)

CO2: List and explain the need of method study and work measurements. (K2)

CO3: Explain the production planning and quality control, and its functions. (K2)

CO4: Understand the basic principles, approaches and functions of management and identify concepts to specific situations. (K2)

CO5: List and explain the different financial sources and methods of inventory management. (K2)

Course Content:-

Module- 1: Plant Engineering and Plant Safety

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Understand Plant layout.
- 2) Explain Materialhandling equipment.
- 3) Describe Plant maintenance
- 4) Illustrate Importance of Plant Safety.

Detailed content of the unit: -

Plant Engineering: Plant; Selection of site of industry; Plant layout; Principles of a good layout; Types; Process; Product and Fixed position; Techniques to improve Layout; Principles of Material handling equipment; Plant maintenance; Importance; Break down maintenance; Preventive maintenance and Scheduled maintenance.

Plant Safety: Importance; Accident: Causes and Cost of an Accident, Accident Proneness, Prevention of Accidents; Industrial disputes; Settlement of Industrial disputes; Collective bargaining; Conciliation; Mediation.

Module- 2: Work Study, Method Study and Work Measurement

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 4) Describe Work Study techniques.
- 5) Explain Method Study procedure.
- 6) Define and explain Work Measurement.

Detailed content of the unit: -

Work Study: Productivity; Standard of living; Method of improving Productivity; Objectives; Importance of good working conditions

Method Study: Definition; Objectives; Selection of a job for method study; Basic procedure for conduct of Method study; Tools used; Operation process chart; Flow process chart; Two handed process chart; Man Machine chart; String diagram and flow diagram.

Work Measurement: Definition; Basic procedure in making a time study; Employees rating factor; Application of time allowances: Rest, Personal, Process, Special and Policy allowances; Calculation of standard time; Numerical Problems; Basic concept of production study; Techniques of Work Measurement; Ratio delay study; Synthesis from standard data; Analytical estimating and Pre determined Motion Time System (PMTS).

Module- 3: Production Planning and Control, Quality Control

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Demonstrate the methods of Production Planning and Control.
- 2) Explain different types of Quality Control techniques.

Detailed content of the unit: -

Production Planning and Control: Introduction; Major functions of Production Planning and Control; Pre planning; Methods of forecasting; Routing and Scheduling; Dispatching and Controlling; Concept of Critical Path Method (CPM); Types of Production: Mass Production, Batch Production and Job Order Production; Characteristics; Economic Batch Quantity (EBQ); Principles of Product and Process Planning; Make or Buy decision; Numerical problems.

Quality Control: Definition; Objectives; Types of Inspection: First piece, Floor and Centralized Inspection; Advantages and Disadvantages; Statistical Quality Control; Types of Measurements; Method of Variables; Method of Attributes; Uses of X, R, p and c charts; Operating Characteristics curve (O.C curve); Sampling Inspection; Single and Double Sampling plan; Concept of ISO 9001:2008 Quality Management System Registration/Certification procedure; Benefits of ISO to the organization.

Module- 4: Principles of Management and Personnel Management

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Describe different Principles of Management.
- 2) Explain the scope of Human Resource Management.
- 3) Define Job Evaluation, Merit Rating and Wages and Salary Administration.

Detailed content of the unit: -

Principles of Management: Definition of Management; Administration; Organization; F.W.Taylor's and Henry Fayol's Principles of Management; Functions of Manager; Types of Organization: Line, Staff, Taylor's Pure functional types; Line and staff and committee type; Directing; Leadership; Styles of Leadership; Qualities of a good leader; Motivation; Positive and Negative Motivation; Modern Management Techniques; Just In Time; Total Quality Management (TQM); Quality circle; Zero defect concept; 5S Concept; Management Information Systems.

Personnel Management: Responsibility of Human Resource Management; Selection Procedure; Training of Workers; Apprentice Training; On the Job training and Vestibule School Training; Job Evaluation and Merit Rating; Objectives and Importance; Wages and Salary Administration; Components of Wages; Wage Fixation; Type of Wage Payment: Halsey's 50% Plan, Rowan's Plan and Emerson's efficiency plan; Numerical Problems.

Module- 5: Financial Management and Material Management

Number of class hours: 5 Hrs.

Suggestive Learning Outcomes:

- 1) Describe the basics Financial Management.
- 2) Explain the methods of Material Management.

Detailed content of the unit: -

Financial Management: Fixed and Working Capital; Resources of Capital; Shares Preference and Equity Shares; Debentures; Type of debentures; Public Deposits; Factory Costing: Direct Cost; Indirect Cost; Factory Overhead; Selling Price of a product; Profit; Numerical Problems; Depreciation; Causes; Methods: Straight line, sinking fund and percentage on Diminishing Value Method; Numerical Problems.

Material Management: Objectives of good stock control system; ABC analysis of Inventory; Procurement and Consumption cycle; Minimum Stock, Lead Time, Reorder Level-Economic Order Quantity problems; Supply Chain.

Reference Books:

1. Industrial Engineering & Management, S.C. Sharma, Khanna Book Publishing Co. (P) Ltd., Delhi
2. Industrial Engineering and Management, O.P. Khanna, Revised Edition, Dhanpat Rai Publications (P) Ltd., New Delhi – 110002.
3. Management, A global perspective, Heinz Weirich, Harold Koontz, 10th Edition, McGraw Hill International Edition 1994.
4. Essentials of Management, 4th Edition, Joseph L. Massie, Prentice-Hall of India, New Delhi 2004.
5. Principles and Practices of Management, Premvir Kapoor, Khanna Publishing House, N. Delhi

CAD/CAM LAB

Course Code	MEPC504
Course Title	CAD/CAM LAB
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Engineering graphics, Computer Aided Machine Drawing
Course Category	Programme core course

Course Outcomes: - By the end of the course, the students are expected to

- CO1: Understand the fundamentals and use CAD (K2).
- CO2: Conceptualize drafting and modelling in CAD (K2).
- CO3: Interpret the various features in the menu of solid modelling package (K2).
- CO4: Synthesize various parts or components in an assembly (K5).
- CO5: Prepare CNC programmes for various jobs (K3).

Course Content:-

S.No.	Topics for practice
PART-A	Introduction: Part modelling; Datum Plane; constraint; sketch; dimensioning; extrude; revolve; sweep; blend; protrusion; extrusion; rib; shell; hole; round; chamfer; copy; mirror; assembly; align; orient.
	Exercises: 3D Drawings of 1). Geneva Wheel; 2). Bearing Block; 3). Bushed bearing; 4). Gib and Cotter joint; 5). Screw Jack; 6). Connecting Rod: Note: Print the orthographic view and sectional view from the above assembled 3D drawing.
PART-B	CNC Programming and Machining: Introduction; 1). Study of CNC lathe, milling; 2). Study of international standard codes: G-Codes and M-Codes; 3). Format – Dimensioning methods; 4). Program writing – Turning simulator – Milling simulator, IS practice – commands menus; 5). Editing the program in the CNC machines; 6). Execute the program in the CNC machines; Exercises: Note: Print the Program from the Simulation Software and make the Component in the CNC Machine.
	CNC Turning Machine: (Material: Aluminium/Acrylic/Plastic rod) 1. Using Linear and Circular interpolation - Create a part program and produce component in the Machine. 2. Using Stock removal cycle – Create a part program for multiple turning operations and produce component in the Machine. 3. Using canned cycle - Create a part program for thread cutting, grooving and produce component in the Machine.
	CNC Milling Machine (Material: Aluminium/ Acrylic/ Plastic) 1. Using Linear interpolation and Circular interpolation – Create a part program for grooving and produce component in the Machine. 2. Using canned cycle - Create a part program for drilling, tapping, counter sinking and produce component in the Machine.

	3. Using subprogram - Create a part program for mirroring and produce component in the Machine.
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Reference Books:

1. Machine Drawing – P.S. Gill S. K. Kataria& Sons, Delhi, 17th revised edition, 2001
2. Mechanical Draughtsmanship - G.L. TamtaDhanpat Rai & Sons, Delhi, 1992
3. Inside AutoCAD – D. Raker and H. Rice, BPB Publications, New Delhi, 1985
4. CAD/CAM/CIM – P. Radhakrishnan, S. Subramaniyan & V. Raju, New Age International Pvt. Ltd., New Delhi, 3rd Edition,
5. Engineering AutoCAD, A.P. Gautam & Pradeep Jain, Khanna Book Publishing Co., Delhi

MANUFACTURING ENGINEERING LAB-II

MEPC406	MEPC505
Course Title	Manufacturing Engineering Lab-II
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Manufacturing Engineering
Course Category	Programme core course

Course outcomes:

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

- CO1: Dismantle and assemble the components on drilling, shaping, milling and grinding machines. [K3]
- CO2: Perform operations on drilling, shaping, milling and grinding machines. [K4]
- CO3: Produce articles of industrial application such as Spur gear, square headed bolt, V- block. [K4]
- CO4: Make use of various measuring instruments for taking dimensions. [K2]
- CO5: Servicing of drilling, shaping, milling and grinding machines. [K3]

List of Practical / Activities (To perform minimum 6 practical)

1. Drilling Exercise (Three different sized holes for different materials maintaining uniform distance between them)
2. Milling-square-hexagon from round bars with indexing and without indexing
3. Generation of spur gear teeth on a round bar
4. Simple planning exercise cutting 'T' slots (one model)
5. Shaping a Hexagon on a round bar, key ways, grooves splines
6. Shaping step block cut dovetail to angles 60, 90, 120 degrees
7. Cylindrical grinding of external surface and internal surface using universal grinding machines
8. Grinding Cutting tools to the required angles
9. Grinding of milling cutters etc, on a tool and cutter grinder Mechanical Engineering Curriculum Structure 250
10. Grinding flat surface on a surface grinder using magnetic chuck and clamping devices
11. Dismantling some of the components of drilling machine and service, assemble the same
12. Dismantling some of the components of shaper head and then assemble the same
13. Dismantling some of the components of Milling machines and service, assemble the same
14. Servicing of universal grinding machine

Reference Books:

1. Elements of Workshop Technology (Volume I & II) – HajraChowdry&Bhattacharaya, Media Promoters, 11th Edition, 2007
2. Introduction of Basic Manufacturing Processes and Workshop Technology – Rajender Singh, New age International (P) Ltd. NewDelhi, 2006
3. Production Technology – HMT, 18th edition, Tata McGraw Hill, New Delhi
4. Manufacturing process – Myro N Begman, 5th edition, Tata McGraw Hill, New Delhi

COMPUTER AIDED DESIGN AND MANUFACTURING

Course Code	MEPE506/A
Course Title	COMPUTER AIDED DESIGN AND MANUFACTURING
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Computer Aided Machine Drawing Practice
Course Category	Programme elective course

Course Outcomes: - By the end of the course, the students are expected to

- CO1: Clarify the concepts of drafting and modelling using CAD (K2).
- CO2: Articulate the need for integration of CAD and CAM (K2).
- CO3: Interpret the concepts of flexible manufacturing system (K2).
- CO4: Employ NC part programming and manual part programming (K3).
- CO5: Illustrate Group Technology (K2).

Course Content:-

Module- 1: Fundamentals of CAD/CAM:

Number of class hours: 6 hrs.

Suggestive Learning Outcomes:

- 1) Know automation.
- 2) Correlate design workstation and graphic terminal.
- 3) Distinguish system software and application software.
- 4) Prepare CAD database.
- 5) Apply 3D-Wire frame modelling.

Detailed content of the unit: -

Fundamentals of CAD/CAM: Automation; Design process; Application of computers for design;

Benefits of CAD; Computer configuration for CAD applications; Design workstation; Graphicterminal; CAD Software: Definition of system software and application software; CAD database andstructure.

Geometric Modelling: 3D-Wire frame modelling; Wire frame entities and their definitions; Interpolationand Approximation of curves; Concept of Parametric and Non-parametric representation ofcurves; Curve fitting techniques.

Module- 2: Surface Modelling:

Number of class hours: 6 hrs

Suggestive Learning Outcomes:

- 1) Recognize parametric space of surface.
- 2) Comprehend sweep representation.
- 3) Use solid Modelling.

Surface Modelling: Algebraic and Geometric form; Parametric space of surface; Blending functions; Parameterization of surface patch; Subdividing; Cylindrical surface; Ruled surface; Surface of revolution; Spherical surface; Composite surface; Bezier surface; Solid Modelling: Definition of cell composition and spatial occupancy enumeration; Sweep representation; Constructive solid geometry; Boundary representations.

Module-3: NC Control Production Systems:

Number of class hours: 6 hrs

Suggestive Learning Outcomes:

- 1) Recognize Numerical control.
- 2) Compare NC part programming and manual part programming.
- 3) Prepare computerized part program.

NC Control Production Systems: Numerical control; Elements of NC system; NC part programming; Methods of NC part programming; Manual part programming, Computer assisted partprogramming; Post processor; Computerized part program.

Module-4: Group Technology:

Number of class hours: 6 hrs

Suggestive Learning Outcomes:

- 1) Illustrate Group Technology.
- 2) Classify parts.
- 3) Demonstrate MRP.

Group Technology: Part families; Parts classification and coding; Production analysis; Machine cell design; Computer aided process planning: Retrieval type and Generative type; Machinability data systems; MRP and its Benefits.

Module- 5: Flexible manufacturing system:

Number of class hours: 6 hrs

Suggestive Learning Outcomes:

- 1) Understand the F.M.S equipment.
- 2) Summarize CIM system and its benefits.

Flexible manufacturing system: F.M.S equipment; Layouts; Analysis methods and benefits; Computer aided quality control; automated inspection: Off-line, On-line, Contact, Non-contact; Coordinate measuring machines; Machine vision; CIM system and Benefits.

Reference Books:

1. CAD/CAM Principles and Applications, P.N.Rao, Tata McGraw-Hill
2. Computer Aided Design and Manufacturing, Groover M.P. & Zimmers Jr, Prentice hall of India
3. CAD/CAM/CIM, RadhaKrishna P. & Subramanyam, Wiley Eastern Ltd

REFRIGERATION & AIR-CONDITIONING

Course Code	MEPE506/B
Course Title	Refrigeration & Air-conditioning
Number of Credits	3(L: 3, T: 0, P: 0)
Prerequisites	Thermal Engineering – I (MEPC302)
Course Category	Programme elective course

Course Outcomes: - By the end of the course, the students are expected to

- CO1: Define refrigeration and types of Refrigeration cycles. (K1)
- CO2: Explain Vapour Compression and Vapour Absorption System working principles. (K2)
- CO3: Classify the components required for refrigeration system and identify the refrigerants. (K2)
- CO4: Describe the controlling components for a refrigeration system and summarize the application of refrigeration. (K2)
- CO5: Explain the working principles of Air-conditioning systems and predict faults in refrigeration & air-conditioning system. (K2)

Course Content:-

Module- I: Introduction to Refrigeration

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 4) Classify different types of refrigeration.
- 5) Explain the working principles of refrigeration cycles.
- 6) Describe the merits and demerits of air refrigeration.

Detailed content of the unit: -

Definition of Refrigeration; Refrigerating effect-unit of refrigeration-Coefficient of performance; Types of Refrigeration-Ice, dry ice, Steam jet, Throttling, Liquid nitrogen refrigeration; Carnot refrigeration Cycle; Air refrigeration- Bell - Coleman cycle, PV& TS diagram; Advantage and disadvantages in air refrigeration; Simple problems

Module- II: Refrigeration systems

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 3) Describe the vapour compression refrigeration cycle with flow diagram.
- 4) Explain the vapour absorption refrigeration cycle with flow diagram.
- 5) Compare vapour compression refrigeration cycle with vapour absorption refrigeration cycle.

Detailed content of the unit: -

Basic Components, Flow diagram of working of Vapour compression cycle; Representation of the vapour compression cycle on P-H, T-S & P-V Diagram; Expression for Refrigerating effect, work done and power required; Types of Vapour Compression cycle; Effects of super heating and under cooling, its advantages and disadvantages; Simple Vapour absorptions cycle and its flow diagram; Simple Electrolux system for domestic units; Comparison of Vapour absorption and vapour compression system; Simple problems on vapour compression cycle.

Module- III: Refrigeration equipments, refrigerants and lubricants

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 4) Classify compressor with example.
- 5) Describe various types of condensers and evaporators required for refrigeration system
- 6) Tabulate the refrigerants by group number.

Detailed content of the unit: -

Compressor - types of compressors; Hermetically sealed and Semi hermetically sealed compressor; Condensers - Air Cooled, water cooled, natural and forced draught cooling system; Advantages and disadvantages of air cooled and water-cooled condensers; Evaporators -natural, convection, forced convection types.Introduction to refrigerants; Properties of good refrigerants; Classification of refrigerants by group number and commonly used refrigerants in practice; Detection of refrigerants leakage; Charging the system with refrigerant; Lubricants used in refrigeration and their properties.

Module- 1V: Refrigerant flow controls and application of refrigeration

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 4) Describe the flow of refrigerant through controlling components.
- 5) Explain the evaporator pressure regulator.
- 6) Identify the application of refrigeration.

Detailed content of the unit: -

Capillary tube; Automatic Expansion valve; Thermo static expansion valve; High side and low side float valve; Solenoid valve; Evaporator pressure regulator.Slow and quick freezing; Cold storage and Frozen storage; dairy refrigeration; Ice making industry; Water coolers

Module- V: Air conditioning, refrigeration and air-conditioning tools

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 4) Identify the factors affecting air-conditioning.
- 5) Define psychrometric process.
- 6) Describe various types of faults in refrigeration and air-conditioning system.

Detailed content of the unit: -

Introduction to Air conditioning; Factors affecting Air conditioning; Psychrometric chart and its use; Psychrometric process-sensible heating and cooling, Humidifying and dehumidifying; Adiabatic saturation process; Equipments used in air conditioning cycle; Air conditioning units and plants. Tools used in refrigeration and Air conditioner installation; Installation procedure; Faults in refrigeration and air conditioning system; servicing procedure.

Reference Books:

- 1.Refrigeration and Air Conditioning – Sadhu Singh, Khanna Book Publishing Co., New Delhi
2. Refrigeration and Air Conditioning – S. Domakundawar, Dhanpat Rai publications.
3. Refrigeration and Air Conditioning – A.S.Sarao& G.S. Gabi, 6th edition, Satya Prakashanpublications,New Delhi, 2004.
4. Principles of Refrigeration – Roy J.Dossat, 5th edition, Pearson Publications, 2001.
5. Refrigeration and Air Conditioning – M.ZakriaBaig, Premier/ Radiant Publishing House.
6. Refrigeration and Air Conditioning – C.P Arora, Tata McGraw Hill Education, 2000.

MECHATRONICS

Course Code	MEPE507/A
Course Title	Mechatronics
Number of Credits	3(L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Programme elective course

Course Outcomes: - By the end of the course, the students are expected to

- CO1: Describe about various types of controllers and sensors. (K2)
- CO2: Explain the various mechanical, electrical and pneumatic actuation systems. (K2)
- CO3: Discuss the mathematical model, system model and input/output systems. (K2)
- CO4: Explain the basic PLC architecture and PLC programming concepts. (K2)
- CO5: Describe the design examples of Mechatronics system and the condition monitoring of production systems using sensors. (K2)

Course Content:-

Module- 1: Introduction to Mechatronics and Measurement System terminology

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 7) Recognize the importance of Mechatronics.
- 8) Classify different types of control systems.
- 9) Describe different types of sensors.

Detailed content of the unit: -

Mechatronics; Importance of Mechatronics; Systems: Measurement systems; Control systems and their types; Closed-loop control System; Automatic water level controller; Sequential controllers-washing machine; Displacement, Position & Proximity Sensors; Velocity and Motion Sensors; Force Sensors; Fluid Pressure Sensors; Flow Sensors; Liquid Level Sensors; Temperature Sensors; Light Sensors; Selection of Sensors

Module- 2: Mechanical Actuation Systems; Electrical Actuation Systems and Pneumatic & Hydraulic Systems

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 6) Describe the gear trains, belt & chain drives and bearings.

- 7) Explain the switches & relays, motors and servomotors.
- 8) Define DCV, PCV and rotary actuators.

Detailed content of the unit: -

Types of motion; Freedom and constraints; Loading; Gear Trains; Pawl & Ratchet; Belt & Chain drives; Bearings: Selection, Ball & Roller bearings; Mechanical aspects of motor selection. Switches & Relays; Solenoids; D.C Motors; A.C.Motors; Stepper Motors: Specifications and Control of stepper motors; Servomotors: D.C Servomotor and A.C Servomotor, Power supplies; DCV; PCV; Cylinders; Rotary actuators.

Module- 3: Mathematical Model, System Model and Input/Output Systems

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 7) Classify different system building blocks.
- 8) Describe various types of engineering systems.
- 9) Explain interfacing and interface requirements.

Detailed content of the unit: -

Introduction to Mathematical model; Mechanical System building blocks; Electrical System building blocks; Fluid System building blocks; Thermal System building blocks. Engineering Systems: Rotational, Translational Systems; Electro-Mechanical System; Hydro-Mechanical System. Interfacing; Input/output ports; Interface requirements: Buffers, Handshaking, Polling and interrupts, Serial interfacing; Introduction to PIA; Serial communications interface; Example of interfacing of a seven-segment display with a decoder.

Module- 4: Programmable Logic Controller (PLC)

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 7) Define basic block diagram and structure of PLC.
- 8) Explain the Ladder diagram and its logic functions.
- 9) Describe data handling and analog input/output.

Detailed content of the unit: -

Definition; Basic block diagram and structure of PLC; Input/Output processing; PLC Programming: Ladder diagram, its logic functions, Latching and Sequencing; PLC mnemonics;

Timers; Internal relays and Counters; Shift registers; Master and Jump Controls; Data handling; Analog input/output; Selection of PLC.

Module- 5: Design Examples, Advanced Applications in Mechatronics and Sensors for Condition Monitoring Systems of Production Systems

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 7) Identify the design process stages and possible design solutions.
- 8) Explain the case studies of Mechatronics systems.
- 9) Describe various types of monitoring method.

Detailed content of the unit: -

Design process stages; Traditional Vs Mechatronics designs; possible design solutions: Timed switch, Wind-screen wiper motion, Bath room scale; Case studies of Mechatronics systems: A pick-and-place robot, Car park barrier, Car engine management system, Automatic Camera and Automatic Washing Machine only. Examples of Monitoring methods: Vibration monitoring, Temperature monitoring, Wear behavior monitoring; Mechatronics control in automated manufacturing: Monitoring of Manufacturing processes, On-line quality monitoring, Model based systems, Hardware in-the-loop simulation, Supervisory control in manufacturing inspection, Integration of heterogeneous systems.

Reference Books:

1. Mechatronics – W. Bolton, Pearson Education India.
2. A Text Book on Mechatronics – R.K.Rajput, S.Chand& Co, New Delhi.
3. Mechatronics – M.D.Singh& Joshi, Prentice Hall of India.
4. Mechatronics – HMT, Tata McGraw Hill, New Delhi.
5. Mechatronics System – Devadas Shetty, PWS Publishing
6. Exploring Programmable Logic Controllers with applications – Pradeep Kumar Srivatsava, BPBPublications.

INDUSTRIAL ROBOTICS & AUTOMATION

Course Code	ME/PE -507/B
Course Title	Industrial Robotics & Automation
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Programme elective course

Course Outcomes: - By the end of the course, the students are expected to

CO1: Explain robot anatomy, classification, characteristics of robot.(K1)

CO2: Explain the various robotic actuators on hydraulic, pneumatic and electrical drives. **(K2)**

CO3: Describe various types of sensors and concepts on robot vision system. **(K2)**

CO4: Explain the concepts of robot programming languages **(K3)**

Course Content:-

Module- 1: Fundamentals of Robotics

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 1) Familiar with the various drive systems for robot
- 2) Understand the Robot controller
- 3) Sensors and their applications in robots and programming of robots.

Detailed content of the unit: -

Introduction; Definition; Robot anatomy (parts) and its working; Robot Components: Manipulator, End effectors; Construction of links, Types of joints; Classification of robots; Cartesian, Cylindrical, Spherical, Vertical articulated; Structural Characteristics of robots; Mechanical rigidity; Effects of structure on control work envelope and work Volume; Robot work Volumes, comparison; Advantages and disadvantages of robots.

Module- 2: Robotic Drive System and Controller

Number of class hours: 6 Hrs.

Suggestive Learning Outcomes:

- 1) Familiar with the various drive systems for robot
- 2) Understand the Robot controller
- 3) Sensors and their applications in robots and programming of robots..

Detailed content of the unit: -

Actuators; Hydraulic, Pneumatic and Electrical drives; Linear actuator; Rotary drives; AC servo motor; DC servo motors and Stepper motors; Conversion between linear and rotary motion; Feedback devices; Potentiometers; Optical encoders; DC tachometers; Robot controller; Level of Controller; Open loop and Closed loop controller; Microprocessor based control system; Robot path control: Point to point, Continuous path control and Sensor based path control; Controller programming.

Module- 3: Sensors

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 1) Classify compressor with example.
- 2) Describe various types of condensers and evaporators required for refrigeration system
- 3) Tabulate the refrigerants by group number.

Detailed content of the unit: -

Requirements of a sensor; Principles and Applications of the following types of sensors: Position sensors (Encoders, Resolvers, Piezo-Electric); Range sensors (Triangulation Principle, Structured lighting approach); Proximity sensing; Force and torque sensing.

Introduction to Machine Vision: Robot vision system (scanning and digitizing image data); Imageprocessing and analysis; Cameras (Acquisition of images); Videocon camera (Working principle & construction); Applications of Robot vision system: Inspection, Identification, Navigation & serving

Module-4: Robot kinematics and Robot Programming

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 1) Forward Kinematics and Reverse Kinematics of Manipulators.
- 2) Solving Deviations and Problems.
- 3) Basic of Robot programming Languages.

Detailed content of the unit: -

Forward Kinematics; Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of Freedom (In 2 Dimensional); Deviations and Problems. Teach Pendant Programming; Lead through programming; Robot programming Languages; VAL Programming; Motion Commands; Sensor Commands; End effector commands; and Simple programs

Module- 5: Automation

Number of class hours: 6 Hrs

Suggestive Learning Outcomes:

- 1) To conceptualize automation and understand applications of robots in various industries.

- 2) Basic elements of automated system, advanced automation functions, levels of automation.
- 3) Application of robots in machining; welding; assembly and material handling.

Detailed content of the unit: -

Basic elements of automated system, advanced automation functions, levels of automation

Industrial Applications: Application of robots in machining; welding; assembly and material handling.

Reference Books:

1. Introduction to Robotics: Analysis, Systems, Applications – Saeed B. Niku, Pearson Education Inc. New Delhi 2006.
2. Industrial Robotics: Technology, Programming and Applications – M.P. Groover, Tata McGrawHill Co, 2001.
3. Robotics Control, Sensing, Vision and Intelligence – Fu.K.S. Gonzalz.R.C and Lee C.S.G, Mc- Graw Hill Book Co, 1987
4. Robotics for Engineers – Yoram Koren, McGraw Hill Book Co, 1992.
5. A Text book on Industrial Robotics – Ganesh S. Hedge, Laxmi Publications Pvt. Ltd., New Delhi, 2008.
6. Robotics Technology and Flexible Automation – S.R. Deb & Sankha Deb, Tata McGraw-Hill, 2010.
7. Elements of Robotics Process Automation, Mukherjee, Khanna Publishing House, Delhi, 2018

Summer Internship-II

Course Code	SI-509
Course Title	Summer Internship-II
Number of Credits	3 (L: 0, T: 0, P: 0)
Prerequisites	Fundamental and basic practical skills of relevant discipline/programme
Course Category	Internship

Internships may be full-time or part-time; they are full-time in the summer vacation and part-time during the academic session.

Sl. no.	Schedule	Duration	Activities	Credits	Hours of Work
1	Summer Vacation after 4 th Semester	6 Weeks	Industrial/Govt./NGO/MSME/ Rural Internship/Innovation / Entrepreneurship ^{##}	3	120 Hours

(^{##}During the summer vacation after 4th Semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship /Innovation /Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry. In case a student want to pursue his/her family business and don't want to undergo internship, a declaration by a parent may be submitted directly to the TPO.)

Course Outcome: -

After completion of the course, students will be able to:

C.O.1: Describe a better understanding of the engineering / technological workplace(K2).

C.O.2: Develop and demonstrate workplace competencies necessary for professional and academic success (K2).

C.O.3: Classify career preferences and professional goals (K3).

C.O.4: Develop preliminary portfolio including work samples from the internship (K2).

C.O.5: Increase competitiveness for full-time engineering employment / start-up (K3).

Course Content:-

Internships are educational and career development opportunities, providing practical experience in a field or discipline. The Summer Internship-II is a student centric activity that would expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. An internship may be compensated, non-compensated or some time may be paid. The internship has to be meaningful and mutually beneficial to the intern and the organization. It is important that the objectives and the activities of the internship program are clearly defined and understood. Following are the intended objectives of internship training:

1. Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
3. Exposure to the current technological developments relevant to the subject area of training.
4. Experience gained from the 'Industrial Internship' in classroom will be used in classroom discussions.
5. Create conditions conducive to quest for knowledge and its applicability on the job.
6. Learn to apply the Technical knowledge in real industrial situations.
7. Gain experience in writing Technical reports/projects.
8. Expose students to the engineer's responsibilities and ethics.
9. Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control.
10. Promote academic, professional and/or personal development.
11. Expose the students to future employers.
12. Understand the social, economic and administrative considerations that influence the working environment of industrial organizations
13. Understand the psychology of the workers and their habits, attitudes and approach to problem solving.

Overall compilation of Internship Activities / Credit Framework:

Major Head of Activity	Credit	Schedule	Total Duration	Sub Activity Head	Proposed Document as Evidence	Evaluated by	Performance appraisal/ Maximum points/ activity
Innovation / IPR / Entrepreneurship	3	Summer Vacation after 4 th Semester	6 Weeks	Participation in innovation related completions for eg. Hackathons etc.	Certificate	Faculty Mentor	Satisfactory/ Good/ Excellent
				Development of new product/ Business Plan/ registration of start-up	Certificate	Programme Head	Satisfactory/ Good/ Excellent
				Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.	Certificate	President/ Convener of ICC	Satisfactory/ Good/ Excellent
				Work experience at family business	Declaration by Parent	TPO	Satisfactory/ Good/ Excellent
Internship	3	Summer Vacation after 4 th Semester	6 Weeks	(Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise/ Online Internship	Evaluating Report	Faculty Mentor/ TPO/ Industry supervisor	Satisfactory/ Good/ Excellent
Rural Internship	3	Summer Vacation after 4 th Semester	6 Weeks	Long Term goals under rural Internship	Evaluating Report	Faculty Mentor/ TPO/ NSS/ NCC head	Satisfactory/ Good/ Excellent

STUDENT'S DIARY/ DAILY LOG

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students.

The daily training diary should be signed at the end of each day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and get ratified on the day of his visit.

Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- a) Regularity in maintenance of the diary.
- b) Adequacy & quality of information recorded.
- c) Drawings, sketches and data recorded.
- d) Thought process and recording techniques used.
- e) Organization of the information.

INTERNSHIP REPORT

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, TPO and Faculty Mentor. The Internship report will be evaluated on the basis of following criteria:

- a) Originality.
- b) Adequacy and purposeful write-up.
- c) Organization, format, drawings, sketches, style, language etc.
- d) Variety and relevance of learning experience.
- e) Practical applications, relationships with basic theory and concepts taught in the course.

Major Project - I

Course Code	CEPR-510
Course Title	Minor Project
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Project Work (PR)

Course Outcome:-

After completion of the course, students will be able to:

C.O. 1: Demonstrate a sound technical knowledge of their selected project topic and the knowledge, skills and attitudes of a professional engineer (K2).

C.O. 2: Develop the skill of working in a Team (K3).

C.O. 3: Design engineering solutions to complex problems utilising a systems approach (K6).

C.O. 4: Design the solution of an engineering project involving latest tools and techniques (K6).

C.O. 5: Develop the skill of effective communication with engineers and the community at large in written and oral forms. (K3)

Course Content:-

The major project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

- 1) Develop sound knowledge about the domain of the project work.
- 2) Perform detailed study about various components of a project.
- 3) Learn to be an important member of a team for successful execution of a project work.
- 4) Study about methodologies and professional way of documentation and communication related to project work.
- 5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
- 6) Develop project report as per the suggested format to communicate the findings of the project work.

- 7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
- 8) Knowledge of how to organize, scope, plan, do and act within a project thesis.
- 9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
- 10) Demonstrate the implementation of a major project work.