DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE

&

DETAILED SYLLABUS

For

M.TECH

SPECIALIZATION

IN

PRODUCTION ENGINEERING

(Effective from 2019-20)

VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY

BURLA, SAMBALPUR

PIN-768018

PEOs and POs of M.Tech. in Production Engineering (PE)

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO: To be able to apply knowledge of various approaches in manufacturing technology and automation, for solving real time engineering problems.

Programme Educational Objectives (PEOs):

- Apply management principles to manage projects of inter-disciplinary nature adhering to professional ethics.
- Analyze, design and evaluate engineering products and processes using the knowledge of mathematics, science, engineering and IT tools.
- Engage in lifelong learning to adapt to changing needs for professional advancement

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Program Outcomes (POs):

- An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems
- Understanding of the concepts of production technologies with emphasis on cutting edge tools like digital production, reverse engineering etc.
- To be able to use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in mechanical engineering
- Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities
- An ability to communicate effectively as an individual or as a team leader in manufacturing activities.
- Ability to engage in independent research and lifelong learning in the broadest contest of technological changes in manufacturing technology and automation.

Semester I

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-1		Advanced Casting and Welding	3	0	0	3
2	Core-2		Theory of Machining and Grinding	3	0	0	3
3	PE-1		1. Theory of Plasticity and Metal Forming Processes 2. Robotics and Flexible Manufacturing 3. Machine Tool Technology	3	0	0	3
4	PE-2		1. Inspection and Quality Assurance 2. Operation Management 3. Mathematical Methods in Manufacturing	3	0	0	3
5	Common		Research Methodology & IPR	3	0	0	3
6	Lab-1		Manufacturing Engg. Lab.-I	0	0	2	2
7	Lab-2		Manufacturing Engg. Lab.-II	0	0	2	2
8	Audit -1 (Any one)		1. Constitution Of India 2. Stress Management By Yoga 3. Pedagogy Studies	0	0	0	0
Total Credits							19

Semester II

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-3		Non-Traditional Manufacturing Process	3	0	0	3
2	Core-4		Computer Aided Design and Manufacturing	3	0	0	3
3	PE-3		1. Tools and Dies Design 2. Composite Materials and Processing 3. Introduction to Nanotechnology	3	0	0	3
4	PE-4		1. Concurrent Engineering 2. Surface Engineering 3. Finite Element Analysis in Manufacturing	3	0	0	3

5	Common		Minor project & Seminar	0	0	3	2
6	Lab-3		Manufacturing Engg. Lab.-III	0	0	3	2
7	Lab-4		Manufacturing Engg. Lab.-IV	0	0	3	2
8	Audit -2 (Any one)		1. English For Research Paper Writing 2. Value Education 3. Personality Development Through Life Enlightenment Skills	0	0	0	0
Total Credits							18

Semester III

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	PE-5		1. Tribology in Design and Manufacturing 2. Inventory System 3. Rapid Prototyping	3	0	0	3
2	OE-1		1. Reliability Engineering 2. Maintenance Engineering & Management 3. Laser Materials Processing	3	0	0	3
3	Project		Dissertation (Phase-I)	0	0	10	10
Total Credits							16

Semester IV

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Project		Dissertation (Phase-II)	0	0	16	16
Total Credits							16

GRAND TOTAL CREDITS: 19+18+16+16= **69**

FIRST SEMESTER

ADVANCED CASTING AND WELDING (Core 1):

Course Objectives:

- Study of various metal casting and joining processes
- Control of parameters for sound casting and welding
- Thermal and fluid transfer mechanism during these processes
- Metallurgical effects of casting and joining
- NDT testing and inspection

Course Contents:

Module-I (8 Hours)

Gating system for casting, Elements of a gating system, Sprue, Sprue base well, Gates, Gating System Design, Pouring time, Choke area, Gating Ratios, Ingate design, Slag Trap Systems, Risering Design, Caine's Method, Modulus Method, Naval Research Lab Method, Chills, Feeding aids

Module-II (8 Hours)

Solidification of Metals, Freezing of a pure Metal, Nucleation and Growth, Shrinkage, freezing of alloys, Thermal characteristics of the mould, casting defects, gas defects, pouring metal defects, Metallurgical defects

Module-III (8 Hours)

Basic Metallurgy of fusion welds, general theory of solidification of metals and alloys, homogeneous and heterogeneous nucleation, Effect of welding speed on grain structure, properties of weld metals, fusion boundary zone, heat affected zone, properties of heat affected zone

Module-IV (8 Hours)

Welding stress and distortion, residual stress, causes of residual stress, effect of weld thermal cycle and shrinkage on residual stresses, Reaction stresses, stresses generated by phase transformation, Measurement and calculation of residual stresses in weld metals.

Module-V (8 Hours)

Pre-heat and post weld heat treatment, Methods of Pre-heating, Advantages and limitations of pre-heating, weld defects, classification, arc welding defects and other than arc welding defects, Weld inspection, residual inspection, NDT testing.

Text Books:

1. Manufacturing Technology, Vol.1 P.N.Rao, TATA Mc Graw Hill
2. Welding Engineering and Technology by R.S.Parmar, Khanna Publication

Course Outcomes:

- Discriminate the knowledge of principles, operations and applications of different casting and welding processes.
- Analyze the effects of process parameters on the quality of cast and weld products.
- Select the NDT techniques for the evaluation of cast and weld components.
- Apply the knowledge of welding in Heavy Engineering and nuclear industries.
- To be able to select heat treatment processes for various applications
- To be able to relates to casting processes in industries.

THEORY OF MACHINING AND GRINDING (Core 2):

Course Objectives:

- Study of various machining processes

- Material removal methods, input parameters during machining
- Theoretical derivation of equations for temperature, strain, force
- Tool wear mechanism, Automation during machining
- High speed machining and its applications

Course Contents:

Module-I (8 Hours)

Function of different angles of cutting tools, Tool geometry and nomenclatures-ASA, ORS, NRS systems, Conversion of angles, Geometry of twist drill and slab milling cutters, Tool materials.Mechanism of chip formation, mode of failure under stress, fracture and yielding mechanism, Type of chips, Factors involved in chip formation, shear plane, Effect of cutting variable on chip reduction coefficient, Chip formation in drilling and milling.

Module-II (8 Hours)

Force system in turning, Merchant circle diagram, velocity relationship and Kronenberg relationship, Stress in conventional shear plane, Energy of cutting process, restricted cutting, force analysis during oblique cutting, Earnstand Merchant angle relationship, Lee-shafer relationship, Forces in drilling and plane slab milling, Measurement of forces-dynamometer for measuring turning and drilling forces.

Module-III (8 Hours)

Thermo dynamic of chip formation-The shear plane temperature-Interface temperature from dimensional analysis-Experimental determination of chip tool interface temperature, Coolant-Theory of cutting action at the chip tool interface, Techniques for application of cutting fluids.

Module-IV (8 Hours)

Tool Wear: Criteria of wear, Machinability and tool life, Flank wear-Taylor's tool life equation, crater wear, causes and mechanism of tool failure, Vibration and chatter in machining, Economics of metal machining, On-line control in metal machining.

Module-V (8 Hours)

High speed grinding: Tool Geometry, High performance super-abrasive grinding wheels,Metal-ceramic joining, Ultra high speed grinding with monolayer CBN grinding wheel. Machining and grinding under cryogenic environment. Micro and nanogrinding of glasses and ceramics in ductile regime using diamond grinding wheel.

Text Books:

1. Metal cutting theory and Practice: A. Bhattachary, New Central Book Agency (P) Ltd.
2. Machining and Machine Tools: A. B. Chattopadhyay, Wiley-India Publication.
3. Grinding Technology, Stephen Malkin, ChangshengGuo, Industrial Press.

Reference Books:

1. Metal Cutting Principles: M. C. Shaw, Oxford University Press.
2. Metal Cutting: Edward M. Trent, Paul K. Wright, Butterworth Heinemann Publication.
3. Metal Machining Theory and Practices: T. H. C. Childs, K. Maekawa, T. Obikawa, Y. Yamane, Butterworth Heinemann Publication.
4. Fundamentals of metal machining and machine tools: G. Boothroyd, International Student Edition

Course Outcomes:

- Ability to acquire knowledge in machining of suitable materials
- Ability to select optimum parameters for the respective machining process
- Ability to know the effect of temperature during machining and its remedial methods
- To acquire knowledge on characterization of tools and the concept of machinability
- To summarizes the merits andadvantages of high speed grinding process

THEORY OF PLASTICITY AND METAL FORMING PROCESS (Professional Elective 1):

Course Objectives:

- Fundamental knowledge on plasticity
- Yield criteria of materials
- Idea about the role of friction in metal working and method to find out minimum force requirement in different metal working processes
- Construction of slip line field in metal working operation.
- Force estimation using upper bound approach.

Course Contents:

Module-I (8 Hours)

Fundamentals plasticity: True stress-strain curve. Bauschinger effect. Empirical equations to stress-strain curves. Three-dimensional stress and strain, 3D stress invarients

Module-II (8 Hours)

Yield criteria of materials: Tresca and Von-Mises theory, PrandtlReuss and Levy Mises stress strain relations, work hardening.

Module-III (8 Hours)

Equillibrium approach: Concepts of friction in metal forming, Coulumb friction and constant shear friction factor (m). Application of stress equilibrium approach to extrusion, drawing, rolling and forging.

Module-IV (8 Hours)

Slip line field theory: Applications to frictionless punch and wedge indentation. Simple solution for frictionless extrusion, drawing.

Module-V (8 Hours)

Upper and lower bound theorems: Application to plane strain problems, Simple indentation and extrusion using hodographs.

Text Book(s):

1. Engineering Plasticity – W. Johnson (Von Nostrand)
2. Mechanical Metallurgy – Dieter (Mc Graw Hill)

Reference Book(s)

1. An Introduction to Principles of Metal Working – G.W.Rowe
2. Metal Forming: Processes and Analysis – Avitzur (TMH)

Course Outcomes:

- Analyse three dimensional stress and strain
- Predict the failure of material subject to a particular stress
- Estimate the minimum requirement of force to deform material.
- Draw the slip line field during extrusion and drawing.
- Estimate the maximum force requirement in turning and extrusion process.

ROBOTICS AND FLEXIBLE MANUFACTURING(Professional Elective 1):

Course Objectives:

- To improve student's knowledge on various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions.
- To develop student's knowledge on kinematics analysis of robot systems.
- To provide the student with knowledge of different elements of robotic sensors.
- To provide basic concepts associated with robot control and function of robots in FMS.

Course Contents:

Module-I (8 Hours)

Robotics: Historical background, Definitions, Laws of Robotics, Robotic system and robot anatomy, common robot configurations. Coordinate system, work envelop.

Module-II (8 Hours)

Robot Kinematics: Forward and reverse Kinematics of 3-DOF and 4-DOF Robot arms. Homogeneous Transformations, Kinematic Equations using homogeneous transformations.

Module-III (8 Hours)

Elements of robotic system – end effector, actuators, controller, teach pendant, sensors, Specification of robots. Applications, safety measures Actuators: Hydraulic actuators, Pneumatic actuators, Electrical actuators. Directional control, servo control, Flow control valves.

Module-IV (8 Hours)

End effectors: Classification, Drive systems, Magnetic, Mechanical, Vacuum and Adhesive grippers, Force analysis in a gripper. Sensors: Need for sensing systems, sensory devices, Types of sensors.

Module-V (8 Hours)

Robot vision system, Robot Languages and Programming: Types of programming, Motion programming, Robot language – VAL systems. Flexible Automation: Technology, FMS, Function of Robot in FMS, Flexible manufacturing cell.

Course Outcomes:

- To explain the basic principles of Robotic technology, configurations, control and programming of Robots.
- To design an industrial robot which can meet kinematic and dynamic constraints and describe the concept of Robot kinematics and dynamics
- To choose the appropriate Sensor and Machine vision system for a given application.
- To explain the basic principles of programming and apply it for typical Pick & place, loading & unloading and palletizing applications.
- To identify how automation can be used in production system and give exposure flexible manufacturing concepts.

MACHINE TOOL TECHNOLOGY (Professional Elective 1):

Course Objectives:

- Study of various machine internal parts
- Dynamics of machining by varying parameters
- Design of machine parts
- Automation of machine parts
- Control of noise during machining

Course Contents:

Module-I (8 Hours)

General classification of machine tools, working and auxiliary motions, Mechanical transmission and its elements, General requirement of machine tools.Kinematics of Machine Tools – Stepped and step less drive, Basic considerations in the design of drives, Variable speed range in machine tools, Graphical representation of speed, structure diagram, selection of optimum ray diagram, Design of speed and feed gear boxes, step-less regulation of speed and feed rates.

Module-II (8 Hours)

Machine tool Structures: Design criteria, materials, static and dynamic stiffness, Basic dynamic stiffness, Basic design procedure, design of beds and columns, Model technique in design of machine tool structures.

Module-III (8 Hours)

Guideways and Power Screws: Classification of guidways, material and Lubrication, design criteria and calculations for guideways, designs of guides under hydrostatic lubrication, Aerostatic slideways, Antifriction guideways, Combination guideways, Classification of power screws, Design principles of power screws, Elimination of backlash.Machine Tool spindles and its Bearings: Materials of spindles, Effect of machine tool compliance on machining accuracy, Design principles of spindles, Antifriction and sliding bearings.

Module-IV (8 Hours)

Controlling systems in Machine Tools, Classification, Control systems for changing speeds and feeds, Ergonomic considerations applied to design of control members, principles of automatic and adaptive control.

Module-V (8 Hours)

Vibration in Machine Tools-Forced Vibration, self-excited vibration, stick-slip vibration and its minimization, vibration isolation.

Text Books:

1. Machine Tools Design, N.K. Meheta, TMH.
2. Design of Machine Tools, S.K. Basu, D.K.Pal, OIBH.
3. Principles of Machine Tools, G.C.Sen, Bhattacharya, New Central Book Agency.
4. Metal Cutting Theory and Practice, A. Bhattachary, New Central Book Agency (P) Ltd.
5. Machining and Machine Tools, A. B. Chattopadhyay, Wiley-India Publication.

Course Outcomes:

- Ability to identify various parts of machine tools
- Ability in controlling size of the machines by Machine elements
- Ability to apply various design aspects of spindles and bearings
- Knowledge in steps of automation and its various features
- Ability to reduce vibration and chatter developing on machine tools

INSPECTION AND QUALITY ASSURANCE(Professional Elective 2):

Course Objectives:

- Need of inspection for engineering application.
- Use of common inspection tools.
- Study of system reliability.
- Study of statistical quality control.
- Some modern techniques for total quality management.

Course Contents:

Module-I (8 Hours)

Inspection: Need for inspection, Precision & Accuracy, Interchangeability, selective assembly, Taylor's Principle of limit gauge design.

Module-II (8 Hours)

Use of slip gauge, Use of sine bar, Measurement of surface roughness by Talysurf, Inspection of V-thread by Tool Makers Microscope. Inspection of gear, 2-wire and 3-wire method of measurement, Gear tooth calliper.

Module-III (8 Hours)

Reliability: Failure data analysis, hazard models, constant hazard, linearly increasing hazard, system reliability.

Module-IV (8 Hours)

Quality Assurance – Statistical quality control, control chart, process control chart for attributes & variables, Acceptance sampling, OC curve, sampling plan, AOQL, AQL.

Module-V (8 Hours)

Quality circle, Total quality control, Taguchi method, Kaizen system, Kanban, ISO 9000, Quality documentation, Quality audit.

Text Book(s):

1. Engineering Metrology, R. K. Jain, Khanna Publish
2. Reliability Enginering, L. S. Srinath, East West Press.

Reference Book(s):

1. Statistical Quality Control – E. C. Grant, Leavenworth Mc.Graw Hill Books Co.
2. Quality Assurance through ISO 9000 – H. D. Gupta, South Asia Pub.
3. Quality Circle in India- S. R. Udpa, TMH

Course Outcomes:

- To be able to design plain limit gauges.
- To be able to use various inspection tools.
- To be able to determine the system reliability.
- To be able to control the quality of products using statistical tools.
- To be able to use some modern quality control techniques.

OPERATION MANAGEMENT (Professional Elective 2):

Course Objectives:

- Concept of Operation management and its strategies
- Basic knowledge on Product design
- Basic concept of Line balancing
- Basic principle of Maintenance management
- Some ideas on Modern Production Tools

Course Contents:

Module-I (8 Hours)

Introduction: Functional subsystem of anOrganization, Definition of Operation Management, System Concept of Production, Strategic Management- Corporate Strategies, Generic Competitive Strategies, Functional Strategies, Gross Domestic Product (GDP) and its impact, World Class Manufacturing

Module-II (8 Hours)

Product design and analysis: what is product design and analysis, concept of new product development, steps of product design

Module-III (8 Hours)

Line Balancing, Concept of mass Production system, Objective of Assembly Line Balancing, Rank Positional Weight Method, Stochastic Assembly Line Balancing

Module-IV (8 Hours)

Maintenance, Planning & Control: Objectives of Maintenance, Types of maintenance, basic reasons fr replacement, Replacement problems, Determination of maintenance crew size using Analytical Queing Model, Total Productive Maintenance: Objectives, Waste elimination, Benefits, Pillars of TPM

Module-V (8 Hours)

Modern Production Management Tools:Just In Time Manufacturing, Computer Integrated Manufacturing, Total quality management, Poke a Yoke, Kaizen, Lean Manufacturing

Text Books:

1. Production and Operation Management, E E Adam, R J Ebert, Prentice Hall of India, 2004
2. Production and Operation Management, R Paneerselvam, Prentice Hall of India, 2005

Course Outcomes:

- Different strategies of operation management
- Designing of a new product
- Line balancing
- Maintenance management
- Some techniques of Modern production management

MATHEMATICAL METHODS IN MANUFACTURING (Professional Elective 2):

Course Objectives:

- Use of mathematical equations for graphical analysis
- Design of compactable analysis for various manufacturing methods
- Optimization of manufacturing methods by various techniques
- Study of algorithmsfor fitting response curves and surfaces
- Study of Taguchi contribution to experimental Design

Course Contents:

Module-I (8 Hours)

Frequency distributions, Central tendency, AM, GM, Weighted mean, mode median, Dispersion, Coefficient of variation, Probability distribution, Bionominal, Poission, Normal distribution. Sampling distribution, types: Random sampling, sample size & standard error, point estimate, interval estimate, Hypothesis testing. Hypothesis Testing of mean with different conditions. Differences in mean, Chi squares as test of independence, as test of goodness fit.

Module-II (8 Hours)

Experiments with single factor, Analysis of variance, Fixed effect model Estimation of model parameters, Comparison of individual treatment means, Orthogonal contrasts, Scheffes method of comparing contrasts, Comparing pairs of treatment means, Model adequacy checking, plot of residuals, choice of sample size, OC curves, Method of CI estimation, Fitting response curves, Regression Approach Orthogonal Polynomials.

Module-III (8 Hours)

Factorial Designs, Two factor factorial design, statistical analysis of fixed effect model, Estimation, choice of sample size, Random & Mixed model

Module-IV (8 Hours)

Fitting response curves and surfaces, General Factorial design. 2k Factorial Design, Single replicate, Addition of center points to the 2^k design Yates Algorithm for 2^k design, 3^k design, Yates of Algorithm for 3^k design.

Module-V (8 Hours)

Response surface methods & designs, Methods of steepest Ascent, Analysis of 2nd order model, Fitting response surface, Evolutionary operation. Taguchi contribution to experimental Design: Quantity engg., Philosophy, Taguchi approach to parameter design.

Text Book(s):

1. Statistics for Management – Richard I. Leviz, PHI
2. Design and Analysis of Experiments – D.C.Montogomery, John Wiley & Sons.

Course Outcomes:

- Arrange the application of numerical method for non-linear problems
- Apply numerical methods for manufacturing processes
- Evaluate the numerical results of manufacturing processes
- Analysis of algorithms for fitting response curves and surfaces
- In depth study of modeling byTaguchi contribution to experimental Design

SESSIONALS

Manufacturing Engg. Lab.-I

Manufacturing Engg. Lab.-II

SECOND SEMESTER

NON-TRADITIONAL MANUFACTURING PROCESS(Core 3):

Course Objectives:

- Study of various non-traditional machining processes
- Application of these machining methods in various fields
- Material removal processes by movement of electrons
- Use of heat by Laser and Electron Beam for removal of materials
- Use of advance coating technology in various fields

Course Contents:

Module-I (8 Hours)

Need for Non-traditional Machining: Classification, Ultrasonic machining principle, Transducer, Magnetostrictive material, Analysis for Material Removal Rate by Shaw, Effect of process parameters, Application.

Module-II (8 Hours)

Abrasive Jet Machining: Principle, Application, Advantages and disadvantages Variables in AJM. Water Jet Machining: Jet Cutting equipment, Principle, advantages, Practical Applications.

Module-III (8 Hours)

Electrochemical Machining: Principle. Determination Material Removal Rate, evaluation of metal removal rate, Dynamics of ECM process, Tool design, Advantages, Application, Limitation, Electro-chemical grinding, Electro Discharge Machining: mechanism of material removal, Basic EDM circuitry and principles of operation, Analysis of relaxation circuits, Concepts of critical resistance, Machining accuracy and surface finish. Tool Material, Di-electric fluid, Applications and limitations,

Module-IV (8 Hours)

Laser Beam Machining: Lasing process and principle, population inversion, Principle of Ruby laser, Nd: YAG Laser and CO_2 Laser, Electron Beam Machining: Basic principle, Controlling parameters and focal distance, Plasma Arc Machining: Generation of Plasma, Equipments, Torch, Classification, Direct and indirect torches and applications, parameters effecting cutting, Advantages.

Module-V (8 Hours)

Principle of Coating Technology: Mechanism, Chemical and Physical vapour deposition, Application, Metal Spraying, Metallic coating, Plasma flame spraying.

Text Books:

1. Non-Conventional Machining, P. K. Mishra, Narosa Publication
2. Manufacturing Science, A. Ghosh, A. K. Mallick, East West Publication
3. Modern Machines Process, P. C.Pandey, H. S. Shan, Tata McGraw Hill

Course Outcomes:

- Select suitable machining process for suitable materials
- Select optimum parameters for the respective machining process
- Summarizes the merits and demerits of the non-traditional manufacturing process
- Advanced methods for removal of materials in nano scale
- Recent use of advanced coating for surface engineering

COMPUTER AIDED DESIGN AND MANUFACTURING(Core 4):

Course Objectives:

- To understand the fundamentals of computer aided design and manufacturing.
- To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc. and to understand the different geometric modelling techniques so as to visualize how the components look like before its manufacturing or fabrication.
- To learn the part programming languages and NC programming skills.
- To understand how CNC/DNC system works for better productivity and know the importance of group technology, computer aided process planning, computer aided quality control.
- To learn the overall configuration and elements of computer integrated manufacturing systems.

Course Contents:

Module-I (8 Hours)

Fundamentals of CAD: The design process, applications of computer for design, creating the Manufacturing, Database, The design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, the CPU secondary storage.

Module-II (8 Hours)

Computer graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, transformations, Database structure and content, wire frame versus solid modelling.

Module-III (8 Hours)

CAM – Introduction, Numerical Control and NC Part Programming: NC Coordinate system, NC motion control system, Economics of NC, Manual and Computer Aid Programming, the APT language, NC programming with interactive graphics.

Module-IV (8 Hours)

Problems with conventional NC, NC technology: CNC, DNC combined DNC/CNC system, Adopter control manufacturing systems.

Module-V (8 Hours)

Computer Integrated manufacturing system, Machine Tools and related Equipment, Materials Handling and Storage system, computer system.

Text Book(s):

1. Computer Aided design and Manufacture, Grover M.P.Simmers, E.W. Prentice Hall

2. CAD/CAM/CIM,P.Radhakrishnan&Subramanyam, Willey Eastern Limited.
3. Principles of Computer Aided Design and Manufacturing / FaridAmirouche / Pearson.

Course Outcomes:

- Describe and identify the parts, to choose the functions and operations of a CAD / CAM system and draw up specifications.
- Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix.
- Generate NC part programmes to run the system for machining works.
- Explain the operation of a CAD / CAM system to assess its performanceand describe the use of GT and CAPP for the product development.
- Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.

TOOLS AND DIES DESIGN(Professional Elective3):

Course Objectives:

- To improve student's knowledge on material selection, product design and analysis.
- To develop student's knowledge in designing tool such as broach tool, single point cutting tool and form tool.
- To provide information regarding forging process and forging die design.
- To Classify sheet metal operation on basis of cutting and non cutting operation.
- To provide basic concepts in designing jigs and fixtures by locating and clamping system

Course Contents:

Module-I (8 Hours)

System approach to production design, Elements of a product manufacturing facility, materials selection, interchangeability & standardization, use of new technology, value engineering and analysis, cost analysis.

Module-II (8 Hours)

Design of single-point cutting tools, Tool strength and rigidity calculation, selection of tool angles, chip breakers, carbide, tipped tools, High production cutting tools. Form Tools: Types of form tools, method of determining the profile of circular and flat form of tool, analytical and graphical method. Cutting process in broaching, geometric elements of broach teeth, Design of Internal & external surface broach, calculation of no. of teeth, Rigidity, cutting force, power.

Module-III (8 Hours)

Forging Design-Allowances, Forging process, Forging die design, Drop forging Dies and auxiliary tools, Upset forging.

Module-IV (8 Hours)

Design for sheet metal works: Press working-shearing action, center of pressure, clearance, cutting force, Die block design, punch design, punch support, stop, pilot, stripper, knockout, blanking & piercing die design, progressive & compound die design, Drawing dies, metal flow, Blank diameter, Drawing force.

Module-V (8 Hours)

Jigs & Fixture design: Locating & clamping, principles of location, clamping, devices, materials for locating & clamping elements, Design principles, Design of Drilling Jig & Milling fixtures.

Course Outcome:

- To apply the concept of system design.
- To explain basic rule for tool and die design
- To choose the appropriate metal forming process for a given application.
- To explain the principles for locating and clamping of devices.
- To identify newly emerging technologies in the field of Tool & Die making.

COMPOSITE MATERIALS AND PROCESSING (Professional Elective 3):

Course Objectives:

- To familiarize the students with recent advances in engineering materials and selection particularly for composites and its terminologies used.
- To analyze the different processing/ fabrication techniques of composite materials especially fiber components.
- To analyze the properties and characteristics of anisotropic materials in comparison to conventional isotropic materials.
- Understand and analyze the properties and characteristics of orthotropic materials in comparison to conventional isotropic materials.
- To understand the mechanisms of composite deformation and fracture.

Course Contents:

Module-I (8 Hours)

Introduction of Composites and their classifications: Based on reinforcement and Matrix with advantages, limitations and applications. Laminae and laminates. Interface in composites: Types of interface in composites, wettability and bonding. Test for measuring interfacial strength. Basic terminologies; volume fraction, weight fraction and Rule of mixtures, Density & void content.

Module-II (8 Hours)

Fabrication techniques: pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding. Diffusion bonding and powder metallurgy methods, joining of composites. Other manufacturing processes; Processing of MMC- Diffusion bonding; Stir casting; Squeeze casting. Basic properties of GRP, CFRP, Al-B, Casting and Particulate composites.

Module-III (8 Hours)

Stress-strain relations for anisotropic materials; Generallized Hook's law; Stiffenesses, Compliances & engineering constants for orthotropic materials. Mechanical properties of unidirectional composite lamina. Longitudinal and transverse Young modulus, shear modulus, Poisson ratio. Empirical relationship of Halpin-Tsai. Longitudinal and transverse Strength. Composites under compressive loading. Properties of angle ply lamina. Transformation of Young moduli, shear modulus. Concept of coupling coefficients.

Module-IV (8 Hours)

General and special orthotropic materials. Psai Pagano invariants Strength of orthotropic lamina. Biaxial strength theories. Maximum strength, maximum strain theory. Tsia-Hill maximum work theory. Tsai Wu tensor theory.

Module-V (8 Hours)

Codes and engineering representation of Laminates. Macro mechanical behavior of a laminate. Laminate stiffness for different types; symmetric, anti-symmetric, cross ply laminates. Stresses in different laminae in a laminate. Configurations and design of laminates for special properties Strength and mechanism of failure in a composite laminate. Concept of FPF(First Ply Failure and total failure). Hygroscopic and thermal stresses.

Course Outcomes:

- Explain concept of the composite materials and its terminologies used.
- Understand and analyze the fabrication techniques of composite materials.
- Students will also have sound understanding of theory of elasticity and mechanics of anisotropic materials.
- Student will also able to understand behavior and specialties of orthotropic materials.
- Students will understand and analyze the properties and performance of composites

INTRODUCTION TO NANOTECHNOLOGY(Professional Elective 3):

Course Objectives:

- Study of Nano science and nanotechnology
- Synthesis of Nanomaterials
- Study of Nanotribology
- Study of Nanocharacterization
- Study of its applications in various fields

Module-I (8 Hours)

Background and Definition of Nanotechnology,MEMS/NEMS, Microelectronics fabrication methods, Principles of MEMS, Mechanical MEMS, Thermal MEMS, Magnetic MEMS.

Module-II (8 Hours)

Nanomaterial Synthesis and Applications: Introduction to Carbon Nanotubes, Structure, Synthesis, Growth, Properties and Application, Nanowires, Introduction to Micro/Nanofabrication, Stamping Techniques for Micro and Nanofabrication: Methods and Applications, Materials Aspects of Micro and Nanoelectromechanical Systems, MEMS/NEMS Devices and Applications, Introduction to Micro Fluids.

Module-III (8 Hours)

Micro/Nanotribology and Materials Characterization Studies Using Scanning Probe Microscopy, Friction and Wear on the Atomic Scale, Nanoscale Mechanical Properties-Measuring Techniques and Applications, Nanomechanical Properties of Solid Surfaces and Thin Films, Mechanical Properties of Nanostructures,Kinetics and Energetics in Nanolubrication.

Module-IV (8 Hours)

Application of Nanotechnology: Nano-Grating System, Nano Lithography, Nanotechnology for Data Storage Applications, Microactuators for Dual-Stage Servo Systems in Magnetic Disk Files,

Module-V (8 Hours)

Micro/Nanotribology of MEMS/NEMS Materials and Devices, Mechanical Properties of Micromachined Structures, Thermo and Electromechanics of Thin-Film Microstructures, High Volume Manufacturing and Field Stability of MEMS Products, MEMS Packaging and Thermal Issues in Reliability.

Books:

1. Nanotechnology: N. Taniguchi, Oxford University Press
2. Handbook of Nanotechnology: B. Bhushan, Springer Verlag

3. Micromanufacturing and Nanotechnology: N. P. Mahalik, Elsevier Science
4. Foundation of MEMS: C. Liu, Prentice Hall
5. Introduction to Nanotechnolgy: C. P. Poole, F. J. Owens, Wiley Interscience

Course Outcomes:

- Evolution of Nanotechnology and its field of applications
- Techniques used for synthesis of Nanomaterials and its advancements
- Nanotribology and its applications in surface engineering
- Nanocharacterization of advanced materials
- Applications in production of high technology materials

CONCURRENT ENGINEERING(Professional Elective 4):

Course Objectives:

- Study of Concurrent Engineering and its impact
- Study of Concurrent Engineering Design and idealization control
- Study of Manufacturing Concepts and Automation
- Study of Project Management anddesign
- Study of new product development and Bottleneck technology development

Course Contents:

Module-I (8 Hours)

Introduction: Extensive definition of CE - CE design methodologies, Organizing for CE, CE tool box collaborative product development. Use of Information Technology: IT support, Solid modeling, Product data management, Collaborative product commerce.

Module-II (8 Hours)

Design Stage: Life-cycle design of products, Opportunity for manufacturing enterprises, Modality of Concurrent Engineering Design, Automated analysis idealization control, Concurrent engineering in optimal structural design - Real time constraints.

Module-III (8 Hours)

Manufacturing Concepts and Analysis: Manufacturing competitiveness, Checking the design process, Conceptual design mechanism- Qualitative Physical approach, An intelligent design for manufacturing system, JIT system, Low inventory, Modular, Modeling and reasoning for computer based assembly planning, Design of Automated manufacturing.

Module-IV (8 Hours)

Project Management: Life Cycle semi realization, Design for economics, Evaluation of design for manufacturing cost, Concurrent mechanical design, Decomposition in concurrent design

Module-V (8 Hours)

Negotiation in concurrent engineering design studies, Product realization taxonomy, Plan for Project Management on new product development, Bottleneck technology development

Text Book(s):

1. Concurrent Engineering Fundamentals: Integrated Product Development- Prasad, Prentice Hall.
2. Concurrent Engineering: Automation Tools and Technology- Andrew Kusaik, Wiley.

Reference Book(s):

1. Integrated Product Development- Anderson MM and Hein, L. Berlin, Springer Verlag.
2. Successful Implementation of Concurrent Product and Process- Sammy G Sinha, Wiley.

Course Outcomes:

- Knowledge of Concurrent Engineering and its applications in industries

- Knowledge of Concurrent Engineering Design and constraints
- Knowledge on various manufacturing concepts and automation methods
- In depth study of Project Management and cost evaluation
- Knowledge of new product development procedureslike removal ofBottleneck

SURFACE ENGINEERING(Professional Elective 4):

Course Objectives:

- To develop fundamental understanding and the role of materials to allow surface selection for mechanical contacts and their surrounding environmental conditions.
- To develop range of surface treatments and advanced coatings that are designed minimize wear, friction and surface oxidation/corrosion.
- To learn recent trends of coating methodologies
- To study atomic behavior of coatings(s)
- To characterize the advanced coatings by various instruments

Course Contents:

Module-I (8 Hours)

Surface dependent engineering properties, viz., wear, friction, corrosion, fatigue, reflectivity, emissivity, etc.; common surface initiated engineering failures; mechanism of surface degradation; importance and necessity of surface engineering

Module-II (8 Hours)

Classification and scope of surface engineering in metals, ceramics, polymers and composites, tailoring of surfaces of advanced materials. Surface protection (Physical); surface modification (Chemical) techniques: classification, principles, methods, and technology; conventional surface engineering methods: carburising, nitriding, cyaniding, diffusion coating, hot dipping, galvanizing etc.; electrochemistry and electro-deposition; scope and application of conventional surface engineering techniques in engineering materials; advantages and limitations of conventional processes.

Module-III (8 Hours)

Recent trend in surface engineering: chemical vapour deposition (CVD); physical vapour deposition (PVD), types of PVD, balanced and unbalanced magnetron sputtering, arc evaporation, plasma spray coating; plasma assisted ion implantation; surface modification by directed energy beams like ion, electron and laser beams; energy transfer, beam configuration and modes, surface integration.

Module-IV(6 Hours)

Heat and mass transfer (composition and temperature profile) during directed energy beam irradiation; novelty of composition and microstructure; post irradiation characterization (microstructural & compositional) and testing/evaluation of surface-properties; structure-property correlation.

Module-V (8 Hours)

Physical and mechanical characterization of coatings. Various methods for evaluating the performance of the coating.

Text Books:

1. Surface Engineering of Metals, Principles, Equipment, Technologies, Tadeusz Burakowski, Tadeusz Wierzchon, CRC Press
2. Handbook of Hard Coatings Deposition Technologies, Properties and Applications, Rointan F. Bunshah, Noyes Publication
3. Handbook of Thin-Film Deposition Processes and Techniques, Principles, Methods, Equipment and Applications, Krishna Seshan, Noyes Publications

4. Material Science of Thin Films, Milton Ohring, Academic Press

Reference Books:

1. Handbook of Physical Vapor Deposition (PVD) Processing, Film Formation, Adhesion, Surface Preparation and Contamination Control, Donald M. Mattox, Noyes Publications
2. Introduction to Surface and Thin Film Processes, John A. Venables, Cambridge University Press
3. Physics and Chemistry of Interfaces, Hans-Jürgen Butt, Karlheinz Graf, Michael Kappl, WILEY-VCH GmbH & Co. KGaA
4. ASM Handbook, Volume-18, Friction, Lubrication, and Wear Technology

Course Outcomes:

- Demonstrate knowledge of basics of surface engineering
- Demonstrate an understanding of plasma, electron emission, ionization, and different types of discharges.
- Demonstrate an understanding of advanced different methods of coating depositions
- Demonstrate an awareness of different types of surface protection against wear, oxidation, and corrosion
- Demonstrate an understanding of various mechanical and tribologicalproperties of coatings and coating characterization using modern analytical techniques

FINITE ELEMENT ANALYSIS IN MANUFACTURING(Professional Elective 4):

Course Objectives:

- To gain understanding of finite element method and to know about the matrix method and its application while solving different structural problems
- To solve bar and beam problems.
- To solve problems related to two dimensional problems
- To solve axisymmetric problems and know about the isoparametric formulations
- To analyze problems related to three dimensional and to solve plate bending problems.

Course Contents:

Module-I (8 Hours)

Basics of FEM- Initial value and boundary value problems- weighted residual, Galerkin and Raleigh Ritz methods- Review of Variational calculus- Integration by parts- Basics of variational formulation. Steps in FEA- Discretization, Interpolation, derivation of element characteristic matrix, shape function, assembly.

Module-II (8 Hours)

Imposition of boundary conditions- Solution and post processing- One dimensional analysis in solid mechanics and heat transfer.

Module-III (8 Hours)

Global and Natural co-ordinates- Shape functions for one and two dimensional elements- Three noded triangular and four noded quadrilateral element- Nonlinear analysis- Isoparametric elements- Jacobian matrices and transformations- Basics of two dimensional axi-symmetric analysis.

Module-IV (8 Hours)

FE analysis of metal casting- Special considerations, latent heat incorporation, gap element- Time stepping procedures- Prediction of grain structure- Basic concepts of plasticity- Solid and flow formulation- Small incremental deformation formulation- FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.

Module-V (8 Hours)

Pre Processing, Mesh generation, element connecting, boundary conditions, input of material and processing characteristics- Solution and post processing- Overview of application packages such as ANSYS and DEFORM- Development of code for one dimensional analysis and validation.

Text Book(s):

1. An Introduction to the Finite Element Method- J.N. Reddy,McGraw-Hill.
2. Finite Element Method in Engineering- S.S. Rao, Pergammon Press.

Reference Book(s):

1. Metal Forming and the Finite Element Methods- S. Kobayashi, Soo-Ik-Oh and T. Altan, Oxford University Press.
2. The Finite Element Method in Heat Transfer Analysis- R.W. Lewis, K. Morgan, H.R. Thomas and K.N. Seetharaman, JohnWiley.

Course Outcomes:

- Understand the types of approximation methods and use of finite element method.
- Could solve the truss and beam problems.
- Solve different types of two dimensional problems.
- Understand the importance of isoparametric formulations and its applications to two dimensional problems.
- Solve the three dimensional problems and plate bending problems

SESSIONALS

- **Mini Project**
- **Manufacturing Engg. Lab.-III**
- **Manufacturing Engg. Lab.-IV**

THIRD SEMESTER

TRIBOLOGY IN DESIGN AND MANUFACTURING(Professional Elective 5):

Course Objectives:

- To help student understand the criticality of relatively moving surface in contact and its problem in induustry.
- To help student to be acquainted with various theories of friction, wear, underlying principle and the inter relationship of bearing performance parameters.
- To help student to evaluate bearing performance parameters in case of hydrodynamic bearings.
- To help student identifying the specific application of thrust bearing, hydrostatic and squeeze film bearing.
- To allow student to understand the concept of tribology and it's application in designing mechanical systems.

Course Contents:

Module-I (8 Hours)

Surfaces, Friction and Wear- Topography of the surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials, friction in extreme conditions, Wear, types of wear, Mechanism of wear, Wear resistance materials, Surface treatment, Surface modifications, Surface Coatings

Module-II (8 Hours)

Lubricants and their physical properties lubricants standards, Lubrication Regimes Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects, Elasto hydrodynamic and plastohydrodynamic and magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Design and performance analysis of thrust and journal bearings

Module-III (8 Hours)

Full, partial, fixed and pivoted journal bearings design, Lubricant flow and delivery, power loss, Heat and temperature rotating loads and dynamic loads in journal bearings, special bearings, Hydrostatic Bearing design.

Module-IV (8 Hours)

Geometry and Kinematics, Materials and manufacturing processes, Contact stresses, Hertzian stress equation, Load divisons, Stress and deflection, Axial loads and rotational effects, Bearing life capacity and variable loads, ISO Standards, Oil films and their effects, Rolling Bearings Failures.

Module-V (8 Hours)

Surface topograpghy measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, Bearing vibration measurement.

Text Books:

1. Basic Lubrication Theory: A Cameron, Ellis Herward Ltd.
2. Introduction to Tribology of Bearings, B C Majumdar, A H Wheeler

Reference Books:

1. Engineering Tribology, J A Williams, Oxford University Press
2. Tribology Hand Book, M J Neale, Butterworth Heinemann

Course Outcomes:

- To introduce students to the field of tribology.Students will demonstrate basic understanding of friction, lubrication, and wear processes.
- To enhance students' awareness of tribological issues in the design of machine components,such as journal bearings, thrust bearings, hydrostatic bearing, gas bearing, seals, and gasket systems.
- Student will be able to design and conduct experiments, as well as analyze and interpret data.
- Students will be able to design a tribological system for optimal performance.
- Students will be able to develop skill for communicating research results and technical presentations.

INVENTORY SYSTEM (Open Elective1):

Course Objectives:

- Study of inventory methods
- Study of various techniques for reducing inventory
- Management of inventory methods
- Concepts used in distribution of materials

Course Contents:

Module-I (8 Hours)

Material System, Importance of Inventory in production distribution system. Purchasing – Functions, Procedures – Value Analysis in Purchasing – Vendor Selection, Rating and Development – Buying Seasonal Commodities, Purchasing under Uncertainty, Purchasing capital equipments, Public buying.

Stores Management – Location & layout, Stores System, Storing practice, Quality of incoming material, Stores accounting & stock verifications, absolete& surplus, Scrap disposal.

Module-II (8 Hours)

Raw Materials Inventory System: Concept, Function, Inventory cost, Inventory models assuming certainty & risk, Quantity discount. Economical order quantity, Economical manufacturing batch size, Safety stock, Joint ordering policy – Probabilistic Inventory system: (Q,r) and (R,S) policies.

Inventory Management: ABC analysis, VED analysis, Perpetual inventory system. Periodic inventory system, Japanese inventory system.

Module-III (8 Hours)

Material Requirement Planning: Bill of material, level coding, Master Production scheduling, Gross requirement determination, Net requirements, Lot size determination techniques (Wasner-werifin, Silver-meal heuristic, part-period Balancing), Offsetting Safety stock in MRP.

Module-IV (8 Hours)

Manufacturing Resource Planning: MRP under capacity constraints, Capacity requirement planning, Just-in-time concept: Pull & Push system, Essential conditions of JIT application, practical implementation of JIT through Kanban & other systems.

Module-V (8 Hours)

Physical distribution of Materials: Finished product – Classification, Product features, Branch decisions, packaging decisions, Labelling decisions, product line decision, Distribution channel-nature, Function, Channel behaviour, Physical distribution-warehousing. Transportation, Placing-Products-Retailing. Advertising media selection, sales promotion personal selling.

Course Outcomes:

- Cite the types of inventory, and the need for reorder points, safety stock, and economic order quantities.
- Note the manner in which inventory can be incorporated into a company's competitive strategy, and the situations in which certain strategies should be employed.
- Identify the policies that should be used to control inventory, and the situations in which they should be used.
- State the types of forecasting variations that can be used, how forecasts can be incorrect, and what can be done to mitigate these effects.
- Identify the components of the major production management systems, as well as the techniques used to improve the flow of inventory through the production process.

RAPID PROTOTYPING(Professional Elective 5):

Course Objectives:

- Introduction on prototypes
- Development of Prototype using stereo lithography techniques
- Development of prototype using Laser Sintering
- Basic knowledge of Rapid Tooling
- Process Optimization

Course Contents:

Module-I (8 Hours)

Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, Survey of applications, Growth of RP industry, Classification of RP systems.

Module-II (8 Hours)

Stereolithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application.

Module-III (8 Hours)

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.

Module-IV (8 Hours)

Rapid Tooling: Indirect Rapid tooling -Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Direct Rapid Tooling- Sand casting tooling, Laminate tooling, Soft Tooling vs. Hard tooling.

Module-V (8 Hours)

Rapid Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation. Surface digitizing, surface generation from point cloud, surface modification- data transfer to solid models.

Text Book(s):

1. Stereolithography and other RP& M Technologies- Paul F. Jacobs, Society of Manufacturing Engineers, NY.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling- D.T. Flham and S.S.Dimov, Springer Verlag.

Reference Book(s):

1. Rapid Prototyping: Principles and Applications in Manufacturing- C.C. Kai and L.K.Fai, World Scientific Co.
2. Rapid Prototyping & Manufacturing- Paul F. Jacobs, McGraw-Hill.

Course Outcomes:

- Basic knowledge on prototyping
- Skill of developing a prototyping using Stereo lithography Processes
- Skill of developing prototyping using selective Laser sintering
- Knowledge on Rapid Tooling
- Knowledge on Rapid Manufacturing Process optimization

RELIABILITY ENGINEERING(Open Elective 1)

Course Objectives:

- Study of basic concepts of reliability
- Study of probability distributions and response
- Study of deterministicand probabilistic approach
- Study of Monte Carlo method and regression analysis
- Study of new softwares and case studies

Course Contents:

Module-I (8 Hours)

Reliability; basic concepts, Uncertainty in engineering systems;Modeling, Multiple random variables, product failure theories, Failuremodels, Limit state function, Probability distribution, PDF & CDF,

Module-II (8 Hours)

Evaluation of joint probability distribution, Markov Process, StochasticFinite Element Analysis, Randomness in response variables, Firstand higher order methods for reliability assessment,

Module-III (8 Hours)

Deterministic& probabilistic approach, Risk based design, Central limit theorem,load and resistance approach

Module-IV (8 Hours)
Fault tree approach, system reliability,stress strength interference method, Monte-Carlo and other simulationtechniques, Regression analysis
Module-V (8 Hours)
Software based reliability analysis, Sensitivity analysis and reliability based design optimization, international standards, Applications & case studies.
Books:
1. Reliability Engineering, E. Balagurusamy, McGraw Hill
2. Reliability Engineering, Theory and Practices, Ilia Vonta, Mangey Ram, CRC Press
Course Outcomes:
- In depth analysis of reliability
- Evaluation of probability distributions by various methods
- Evaluation of deterministic and probabilistic approach
- In depth analysis of Monte Carlo method and regression analysis
- Design of reliability factors by new softwares

MAINTENANCE ENGINEERING & MANAGEMENT(Open Elective 1)

Course Objectives:
- Study of various types of maintenance
- Study of maintenance planning and control
- Study of maintenance operations and analysis
- Study of planning and scheduling of machines
- Study of various productive maintenance

Course Contents:
Module-I (8 Hours)
Importance of maintenance, Objectives of maintenance, Types of maintenance, Maintenance systems, Planned and unplanned maintenance, Breakdown maintenance, Corrective maintenance, Opportunistic maintenance, Routine maintenance, Preventive maintenance, Predictive maintenance, Condition based maintenance systems, Design-out maintenance, Selection of maintenancesystems.

Module-II (8 Hours)
Maintenance planning and scheduling, establishing a maintenance plan, Safety precautions – Characteristics of items to be maintained, Classification of items, Maintenance procedure, Guidelines for matching procedures to items, Maintenance organization, Resource characteristics, Resources structure, Maintenance control, Administrative structure, Training of maintenancepersonnel.

Module-III (8 Hours)
System operations and documentation, Documenting maintenance operations, Record keeping, Data collection and analysis, Failure statistics,
Module-IV (8 Hours)
Planning and scheduling plant shutdowns, Depreciation and Machine Life, Replacement policies, Spares and types of spares, sparesplanning.
Module-V (8 Hours)

Network techniques in maintenance activities, Evaluation of maintenance performance. Total productive maintenance – development and scope, Basic systems of TPM, Procedures and steps. Productivity circles, TPM as a part of TQM, benefitsof TPM.

Text Book(s):

1. Maintenance Planning and Control, A. Kelly, EastWestPress.
2. Mechanical Fault Diagnosis, R.A.Collacott, Chapman andHall.

Reference Book(s):

1. Managing Maintenance Resources, A.Kelly,Butterworth-Heinemann.
2. Handbook of Maintenance Management, Levitt Joel, IndustrialPress.

Course Outcomes:

- Understanding various types of maintenance and their applications
- In depth study of maintenance planning, control and applications
- Analysis of various maintenance operations andstatistics
- Understanding planning and scheduling and their impact on plant
- In depth analysis of various productive maintenance and benefits

LASER MATERIALS PROCESSING(Open Elective):

Course Objectives:

- Basic knowledge on different laser systems
- Thermal analysis of material due to laser beam interaction
- Surface modification using laser
- Basic principle of laser cutting of materials
- Knowledge on laser drilling and welding of materials

Course Contents:

Module-I (8 Hours)

Laser Systems- Laser beam characteristics, laser principles, High power lasers for materials applications, Principles and working of CO_2, Nd:YAG and Excimer laser, Optics for irradiation.

Module-II (8 Hours)

Thermal process in Interaction zones- Laser Materials processing parameters, Conduction and convection, Analytical models in one dimensional heat flow, Depth of irradiation with respect to energy density, Reflectivity of material with respect to wave length, Rate of heating, cooling and temperature gradient.

Module-III (8 Hours)

Laser Metallurgy- Laser surface treatment, Transformation hardening, Rapid quenching, Methods to obtaindesired penetration depths, Laser surface alloying, Laser surface cladding, Shockhardening, Advantages of laser surface treatment.

Module-IV (8 Hours)

Laser Cutting and Drilling- Laser instrumentation for cutting and drilling, cut quality and process characteristics, methods of cutting. Laser Welding- Process mechanisms (Key hole and Plasmas), operating characteristics, process variations, imperfections.

Module-V(8 Hours)

Laser drilling and welding:Laser instrumentation for laser drilling, hole quality control, laser welding process mechanism, operating characteristics, defect in laser drilling and welding.

Text Book(s):

1. Opto electronics – An introduction- W. J. Hawkes, Prentice Hall of India.
2. Laser Processing of Engineering Materials- J.C. Ion,Butter Worth-Heinemann.

Reference Book(s):

1. Laser Materials Processing- W.M. Steen, Springer Verlag.
2. High power laser applications- J.F.Reddy, Academic Press.

Course Outcomes:

- Basic principles of working of common industrial lasers
- Knowledge on thermal behavior of materials due to laser interaction
- Basic principles of surface modifications of materials using laser
- Basic principles of laser cutting
- Basic principles of laser drilling and welding

SESSIONALS

Dissertation (Phase-I)

FOURTH SEMESTER

Dissertation (Phase-II)