**SUBJECT CODE: MPE-101**
**SUBJECT NAME: ADVANCED METAL FORMING**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 1 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Core Course |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| Sr. No. | **Course Outcomes (Cos)** |
|---|---|
| 1 | understand and apply the mechanism of deformation for different metal forming processes and develop analytical relation between input and output parameters of process. |
| 2 | analyze the heat generation and heat transfer mechanism due to friction and deformation during various metal forming processes. |
| 3 | understand and analyze the concept of yield criteria applicable to different material deformation processes |
| 4 | apply theoretical and experimental techniques for measurement of important outcomes of metal forming processes |
| 5 | understand the different lubrication mechanisms, lubricants and other valuable affecting the metal forming processes under different working conditions |
| 6 | understand the different types of defects, causes and apply their remedial measures in metal forming processes |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Basics of Plastic deformation** | True stress and true strain, True stress-strain curves, Selection of stress-strain curves for cold and hot working processes, Yield criteria: Tresca's maximum shear stress condition and Von-Mises strain energy criterion, Heat generation and heat transfer in metal forming processes, Temperatures in quasi continuous forming operations. Examination of metal forming processes, Metal forming as a system and classification of metal forming processes based upon different parameters | **10** |
| **Unit 2** | **Forging processes** | Working loads for plain strain forging of strip and disc under conditions of well lubrication and sticking of material with die and under mixed conditions, Prediction of working loads under above approach (simple plain strain and axis symmetric problems) | **4** |
| **Unit 3** | **Drawing processes** | Prediction of working loads and maximum deformation analysis of the processes of wire drawing/tube drawing, strip drawing and extrusion. Various parameters/variables affecting the processes of wire drawing, tube drawing, strip drawing and extrusion, Various methods of tube drawing and their comparison. | **4** |
| **Unit 4** | **Rolling process** | Classification of rolling mills, Prediction of roll pressure for flat strip rolling in the leading and lagging zones, Roll separating forces, Torque on the roll, Affect of front and back tensions, Affect of support rolls, Condition for unaided entry of work piece into the rolls, Condition for continuous rolling, Maximum draft, Various factors which affect rolling process. | **6** |
| **Unit 5** | **Deep drawing process** | Deep drawing of circular blanks, Prediction of radial stress and punch load, Ironing, Wrinkling, Different aspects of process : Blank holding, Drawing ratio, Die profile radius, Punch profile radius, Radial clearance, Drawing speed and Lubrication, Various parameters/variables affecting the deep drawing process | **4** |
| **Unit 6** | **Lubrication in metal** | Principle and mechanism of lubrications, Classification of lubricants, Hydrodynamic lubrication, Boundary and extreme pressure lubricants, Solid | **4** |

| | | | |
|---|---|---|---|
| | **forming processes** | lubricants, Lubricants used for rolling, extrusion, wire drawing and forging processes. General properties of lubricants. | |
| **Unit 7** | **Defects in various metal forming processes** | Defects in rolling, forging, extrusion, wire drawing and deep drawing , their causes and remedial measures | **4** |

**Text Books**

1. Principles of Industrial Metal working Processes by G.W. Rowe, ( CBS Publishers & Distributors).
2. Technology of Metal Forming Processes by Surender Kumar, (Prentice-Hall of India Pvt. Ltd.)
3. Theory of Plasticity and Metal Forming Processes by Dr. Sadhu Singh, (Khanna Publishers)
4. Production Engineering by P.C.Sharma, (S.Chand & Company Ltd.)
5. Mechanical Metallurgy by George E. Dieter, (McGraw-Hill Book Company)

**References:**

1. Metal Forming - Fundamentals and Applications by Taylan Altan,Soo-Ik Oh and Harold L. Gegel, (American Society for Metals)
2. Metal Forming : The application of limit analysis by Betzalel Avitzur, (Marcel Dekker, Inc USA)
3. Metal Forming Practice : Processes - Machines – Tools by Heinz Tschaetsch,(Springer International Edition)

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**SUBJECT CODE: MPE-102**
**SUBJECT NAME: ADVANCED METAL CASTING**

| | |
|---|---|
| **Programme: M**. Tech. (PE**)** | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 1** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3Hrs |
| **Total Marks:** 150 | **Status:** Core Course |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | understand and apply the principles of metal casting processes and develop analytical relation between input and output process parameters |
| 2 | understand, analyze and apply the concept of cooling rate of materials in metal casting |
| 3 | apply theoretical and experimental techniques for measurement of important outcomes of casting processes like hardness, dimensional accuracy etc. |
| 4 | understand the model of casting economics and optimization and its measurement |
| 5 | apply the fundamentals of physics to develop theoretical relations for different types of casting processes |
| 6 | Understand principles of destructive and non-destructive testing for casting defects |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Basics of silica and silicates** | Structure of silica and different types of clays, bonding mechanism of silica – water-clay systems, swelling of clays, sintering adhesion and colloidal clay, silica grain shape and size distribution, standard permeability A.F.S. clay. | **6** |
| **Unit 2** | **In-gradients and additives of moulding sand** | Characteristics, Ingredients and additives of moulding sand, core sands. | **2** |
| **Unit 3** | **Solidification** | Solidifications of metals, nucleation, free energy concept, critical radius of nucleus, nucleation and growth in metals and alloys, constitutional super cooling, columnar, equiaxed and dendrite structures, freezing of alloys, centre- | **10** |

| | | | |
|---|---|---|---|
| | | line feeding resistance, rate of solidification, time of solidification, mould constant, fluidity of metals, volumes re-distribution, analysis of the process. | |
| **Unit 4** | **Riser and gating design** | Riser design shape, size and placement, effect of appendages on risering, effective feeding distances for simple and complex shapes, use of chills, gating design, filling time, aspiration of gases, top, bottom and inside gating, directional solidification, stresses in castings, metal mould reactions, expansion scale and metal penetration, analysis of the process | **8** |
| **Unit 5** | **Various moulding and casting processes** | Hot box, cold box process, investment casting, shell moulding, full mould process, die casting, ceramic shell mould, vacuum moulding process applications, advantages and limitations | **4** |
| **Unit 6** | **Non-ferrous Die-casting** | Die casting of aluminium and its alloys, brass and bronze | **4** |
| **Unit 7** | **Casting defects** | Destructive and non-destructive testing for casting defects | **2** |

**Text Books**


1. Fundamentals of Metals Casting by R.A.Flimm; Addison Wesley
2. Principles of Metal Casting by Heine Loper and Resenthal; McGraw Hill
3. Product Design & Process Engineering by Hielel and Draper; Mcgraw Hill
4. Foundry Practice by Salman & Simans; Issac Pitman.


**References:**


1. Hand Book of Composite Materials-ed-Lubin.
2. Metals Handbook- Metal Casting; ASME


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**SUBJECT CODE: MPE-105**
**SUBJECT NAME: ENTREPRENEURSHIP**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 1 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 5% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Elective-I |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | evaluate the project appraisal reports |
| 2 | design and analyse the risk associated with a new project |
| 3 | evaluate and improve the existing project |
| 4 | study and implementation of government polices |
| 5 | design technical and financial reports |
| 6 | judge and evaluate the creativity and entrepreneurial properties of individual |

**Detailed Contents:**

| Sr. No | Title | Content Details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Meaning and Importance, Evolution of term 'Entrepreneurship',Factors influencing entrepreneurship', Psychological factors, Social factors, Economic factor, Environmental factors, Characteristics of an entrepreneur, Entrepreneur and Entrepreneur, Types of entrepreneur:- According to Type | **4** |

| | | | |
|---|---|---|---|
| | | of Business, According to Use of Technology, According to Motivation, According to Growth, According to Stages, New generations of entrepreneurship viz. social entrepreneurship, Edupreneurship, Health entrepreneurship, Tourism entrepreneurship, Women entrepreneurship etc. & Barriers to entrepreneurship | |
| **Unit 2** | **Entrepreneurial Motivation** | Motivation, Maslow's Theory, Herjburg's Theory, McGragor's Theory, McClelland's Need – Achievement Theory, Culture & Society, Values / Ethics & Risk taking behavior | **5** |
| **Unit 3** | **Creativity** | Creativity and entrepreneurship, Steps in Creativity, Innovation and inventions, Using left brain skills to harvest right brain ideas, Legal Protection of innovation, Skills of an entrepreneur, Decision making and Problem Solving (steps in decision making) | **5** |
| **Unit 4** | **Organisation Assistance** | Assistance to an entrepreneur, New Ventures, Industrial Park (Meaning, features, & examples), Special Economic Zone (Meaning, features & examples), Financial assistance by different agencies, MSME Act, Small Scale Industries, Carry on Business (COB) licence, Environmental Clearance, National Small Industries Corporation (NSIC), Government Stores Purchase scheme (e-tender process), Excise exemptions and concession, Exemption from income tax, Quality Standards with special reference to ISO, Financial assistance to MSME , Modernization assistance to small scale unit, The Small Industries Development Bank of India(SIDBI), | **6** |
| **Unit 5** | **State Industrial Corporationst** | The State Small Industries Development Corporation(SSIDC), Export oriented units, Incentives and facilities to exports entrepreneurs, Export oriented zone, Export-Import Bank of India, Other agencies for industrial assistance, Other Corporations with focus as specific segments, State Industrial Development Corporation (SIDC), State Financial Corporation (SFCs), Directorate General of Supplies and Disposals(DGS & D), Khadi and Village Industries Commission (KVIC), Industrial Estate, Financing of Industrial Estates, Registration with DGS & D, Registration Categories, Registration Procedure , Benefits of DGS & D & Information facilities centre in DGS & D | **5** |
| **Unit 6** | **Rules And Legislation** | Applicability of Legislation, Industries Development (Regulations) Act, 1951., Factories Act, 1948., The Industrial Employment (Standing Orders) Act, 1946, Suspension, Stoppage of work, Termination of employment, Environment (Protection) Act, 1986, The sale of Goods Ac, 1950, Industrial Dispute Act 1947 & GST Act | **5** |
| **Unit 7** | **Project Report** | Introduction, Idea Selection, Selection of the Product / Service, Aspects of a Project, Phases of a Project, Project Report, Contents of a Project Report, Proforma of a Suggested Project Report for a manufacturing Organization, Human Project Report, Financial Report & Technical Reports | **6** |

**Text Books**

1. Entrepreneurship development programme in India and its relevance to developing countries by VG Patel; EDI-India; Ahmedabad (1987)
2. Developing of New Entrepreneurship by EDI India; Ahmedabad (1987)
3. Self –made Impact making Entrepreneurship by G.R. J ain and M.A.Ansari; by EDI India; Ahmedabad (1988)

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**SUBJECT CODE: MPE-106**
**SUBJECT NAME: JIG FIXTURE & PRESS DESIGN**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 1 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 25% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Elective-I |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | design jigs for different jobs and products |
| 2 | design Fixture for different jobs and products |
| 3 | evaluate the economics of designing of jigs and fixtures |
| 4 | study advancements in designing of jigs and fixtures |
| 5 | design Dies and die components |
| 6 | design and evaluate forming dies and equipment's |

**Detailed Contents:**

| Sr. No | Title | Content Details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction to Jigs & Fixture** | Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design. | **2** |
| **Unit 2** | **Elements of Jig & Fixtures** | Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods and chip control. Locating Devices: Surface location, Rest blocks, pins, V-blocks, N Equalizers, Profile locators. Consideration of Safety factor while designing of Jig Fixture and Gauge, materials used in jigs and fixture, locating principle, locating methods and devices, standard parts, Basic Clamping principles, cutting forces, Rigid clamping, wedge clamping, Cam clamping, quick action clamps, Toggle clamps, simultaneously acting clamps. Jig Bushes | **6** |
| **Unit 3** | **Design of Jigs** | Plate jigs, Box jigs, Indexing jigs, Milling fixtures, and Indexing-milling fixtures, turning fixtures, Grinding fixtures, Universal jigs, Design Problems Design of Universal Jigs, Hydro & Pneumatic Jigs, Indexing Jigs | **6** |
| **Unit 4** | **Design Of Fixtures** | Indexing Fixtures: Indexing methods, Linear, Rotary, Indexing jigs, Indexing fixtures. Assembly and Welding Fixture – Principles Broaching fixtures, and Assembly Fixtures. Boring fixtures. Hydro & Pneumatic Fixtures, Turning Fixtures, Milling Fixtures Grinding Fixtures and Design Problems of Fixtures | **6** |
| **Unit 5** | **Elements of Die** | Punch, Punch Plate, Die Plate, stripper plate, Top Plate, Shank, Guide pillar, Guide Bushes, gauges, Stock guides ,Die stops, Nest Gages and Pushers, Stock material utilization and strip layouts. Materials selection and used for above referred parts. | **4** |
| **Unit 6** | **Die Design** | Types of Die Sets, Spring selection process. Design of blanking, Piercing Dies, Types and function of Pilots. Calculation of cutting force and stripping force, importance of cutting force, calculation of press tonnage, calculation of cutting clearance, importance of cutting clearance. Method of reducing the cutting force, Calculation of die size and punch size for blanking and piercing operation. Function of screw hole and dowel holes, Effects of Die and Punch life. | **5** |

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|---|---|---|---|
| **Unit 7** | **Types of Dies** | Introduction to Bending Dies, Design of Bending Dies, Introduction to Inverted Dies and Compound Dies function of various parts of Inverted dies and Compound dies. Design of compound and Inverted Dies. Definition and Introduction of Progressive dies Introduction of Trimming Dies, Notching, Side action Dies, Combination Dies, Flanging Dies, Difference between Drawing and Forming operation, Introduction to Draw Dies, Inverted Draw Dies, Deep drawing process Forming Dies | **5** |
| **Unit 8** | **Advancements in Jig Fixture and Die Design** | Computer Aided Jigs & Fixtures, Jigs & Fixtures for CNCs Role of Jig Fixtures in FMS, Automated Die Sets, Computer Controlled Dies | **2** |

**Text Books**

1. Jigs and Fixtures Design by Franklin-D-Jones.
2. Jigs and Fixtures by Colovin; F.H. and Massachusettes Institute of Technology.
3. Tool Design by Donaldson

**Reference Books**

1. Jigs and Fixtures Design by Hardy; H.W.
2. Jigs and Fixtures Design by Haughton; P.S.
3. Jigs and Fixtures by Parson

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**SUBJECT CODE: MPE-107**

**SUBJECT NAME: ADVANCE PLANT LAYOUT DESIGN**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 1 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 10% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Elective-I |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | design Systematic an Industrial Plant |
| 2 | evaluate the site locations and factors effecting the plant layouts |
| 3 | design material handling system of Plant |
| 4 | study and evaluate different types of material equipment's |
| 5 | evaluate different maintenance techniques used in running effective plant |
| 6 | design and evaluate different safety norms |

**Detailed Contents:**

| Sr. No | Title | Content Details | Credit Hrs |
|---|---|---|---|
| **Unit 1** | **Introduction to Facilities Planning** | Scope of Facilities Planning – Importance & Objectives, Nature Of Location Decision, Affecting Facility Location, Single & Multiple Facility Location Models, Qualitative Considerations in Facility Location, Factors Urban v/s Rural Location, Site Selection Location Pattern In India. | **3** |
| **Unit 2** | **Site Location** | Importance of location, hierarchy of location problems, factors affecting site location; factors in heavy manufacturing location, light industry location, warehouse location, retail location. Various theories/models of site location like bid rent curves, Weber's isodapanes, Weber's classification of industries, Hoover's tapered transport rates, agglomeration, factor rating method, single facility location, load-distance model, break-even analysis, transportation method. New plant location and shut down under dynamic conditions. | **5** |

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|---|---|---|---|
| **Unit 3** | **Systematic Layout Planning 1** | Plant Layout – Introduction, Types of Plant Layout: Product, Process, Fixed Postion, Hybrid – Cellular, FMS, etc. Phases of Layout Planning, Systematic Layout Planning, P-Q Analysis, Flow of Materials Analysis – Charting & Diagram Techniques, Activity Relationship Analysis – REL Diagram, Space Requirements & Availability, Techniques of Space Determination | **6** |
| **Unit 4** | **Systematic Layout Planning 2** | Systematic Layout Planning: Modifying Considerations, Practical Limitations, Selection of Layout – Techniques of Layout, Installation of Layout, Concept of Line Balancing: Heuristics, Assessing Performance. Computerized Layout Planning – Introduction & Concept. CORELAP, ALDEP | **6** |
| **Unit 5** | **Material Handling** | Principles of Material Handling , Material Handling Function, Scope And Functions Of Material Handling , Manual Mechanical Handling Ratio, MH Equipment Types Positioning Equipment, Unit Load Equipment, Auto Identification & Control Equipment, Transport Equipment – Conveyors, Cranes, Industrial Trucks. Storage Equipment, AGVs & Robots | **5** |
| **Unit 6** | **Systematic Handling Analysis** | Handling Analysis, External Integration, Classification of Materials, Layout Considerations, Analysis of Moves, Visualization of Moves, Flow Diagram – DI Plot, Preliminary Handling Plans, Modifications & Practical Limitations, Calculation of Requirements, Evaluation of Alternatives, Installation | **4** |
| **Unit 7** | **Maintenance** | Role Of Maintenance Management, Organization & Systems Of Maintenance Management, Types Of Maintenance: Breakdown, Preventive, Predictive. | **4** |
| **Unit 8** | **Safety** | Industrial Safety – Training for Safety, Communicating Safety Messages, Safe Practices in Industry, Safety Considerations in Manual & Mechanical Handling, Transportation, Role of Factory Inspector, Safety Officer Safety of Hazardous, explosive and Chemical materials in an industry | **3** |

**Text Books**


1. Richard Muther, Practical Plant layout, McGraw Hill Book Company, New York
2. J.M Apple, Plant Layout & Material Handing, John Woley & Sons, N. York
3. G.K Aggarwal, Plant layout & material handling, Jain Publishers, New Delhi
4. Krajewski, Operations Management, Pearson Education, New Delhi


**Reference Book**


1. Tompkins, While Facilities Planning, John Wiley & Sons, New York.
2. Francis White, Facility Location & Layout, PHI, New Delhi
3. Vijay Sheth, Facilities Planning and Materials Handling, Marcle Decker, New York.


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**SUBJECT CODE: MPE- 108**

**SUBJECT NAME: PRODUCT DESIGN AND DEVELOPMENT**

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|---|---|
| **Programme: M**. Tech. (PE**)** | **L: 3 T: 0 P: 0** |
| **Semester: 1** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective II |

**Additional Material Allowed in ESE: NIL**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | analyze, evaluate and apply the methodologies for product design, development and management. |
| 2 | understand the technical and business aspects of the product development process. |
| 3 | apply creative process techniques in synthesizing information, problem-solving and critical thinking. |
| 4 | use basic fabrication methods to build prototype models for hard-goods and soft-goods and packaging. |
| 5 | skilled in implementation of gathering data from customers and establish technical specification |
| 6 | apply technique of PDD Manufacturing. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Introduction to product design. Classification/ Specifications of Products. Principal requirements of good product design. Importance of product design in industry. Essential factors and considerations affecting product design. Product design methodology and techniques. | **6** |
| **Unit 2** | **Visual Design** | Basic elements and concepts of visual design. Materials, forms, function and color relationships. Color theory. Product graphics and different methods of product graphics. Visual communication. | **6** |
| **Unit 3** | **Ergonomics** | Human engineering considerations in product design. Human factors in design principles of user-friendly designs. Introduction of ergonomics, man/ machine/environment systems concept. Development of ergonomics. Psychological & physiological considerations. | **6** |
| **Unit 4** | **Controls and Displays** | Hand controls and foot controls, location of controls and work place envelope. Recommendation about hand and foot push buttons, rotary selector switches, hand wheels, crank levers etc. Instruments and displays. | **6** |
| **Unit 5** | **Material Packaging** | Packaging and function of a package. Packaging materials their characteristics and applications. Packaging design considerations. Modern packaging processes. | **4** |
| **Unit 6** | **Value Engineering** | Value engineering, concept, advantage and applications. Value. Types of values. Analysis of function, using and evaluating functions. Value engineering techniques. Value control. | **4** |
| **Unit 7** | **Product Development** | Defining new Product and their classification. Product life cycle. New product development process. Product development and testing. | **4** |

**Text Books:**

1. B. W. Niebel and A. B. Draper - Product design and process engineering.
2. Arthur E. Mudge - Value engineering: a systematic approach.
3. Morris Asimov - Introduction to Design.
4. W. H. Mayall - Industrial design for engineers.

**Reference books:**

1. Hand Book of Maynard's Industrial Engineering - Kjell b. Z andin.
2. Introduction to Product Design and Development for Engineers- Ali Jamnia.
3. Product Design and Manufacture - Wen, Jiuba.

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**SUBJECT CODE: MPE- 109**

**SUBJECT NAME: ADDITIVE MANUFACTURING PROCESS AND APPLICATIONS**

| | |
|---|---|
| **Programme: M**. Tech. (PE**)** | **L: 3 T: 0 P: 0** |
| **Semester: 1** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective II |

**Additional Material Allowed in ESE: NIL**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | define the various process used in Additive Manufacturing. |
| 2 | analyze and select suitable process and materials used in Additive Manufacturing. |
| 3 | identify, analyze and solve problems related to Additive Manufacturing. |
| 4 | apply knowledge of additive manufacturing for various real-life applications. |
| 5 | apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing. |
| 6 | do selection of AM technologies using decision methods |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction to Additive Manufacturing (AM)** | Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing. | **6** |
| **Unit 2** | **Additive Manufacturing Processes** | Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM). | **8** |
| **Unit 3** | **Additive Manufacturing Machines and Systems** | Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing. | **8** |
| **Unit 4** | **Pre-Processing in Additive Manufacturing** | Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials. | **6** |
| **Unit 5** | **Post-Processing in Additive Manufacturing** | Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating | **8** |

**Text Books:**


1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing,Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003


**Reference books:**


1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004


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**SUBJECT CODE: MPE-110**
**SUBJECT NAME: FLEXIBLE MANUFACTURING SYSTEMS**

| | |
|---|---|
| **Programme: M**. Tech. (PE**)** | **L: 3 T: 0 P: 0** |
| **Semester: 1** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 10% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective II |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | classify and distinguish FMS and other manufacturing systems including job-shop and mass production systems. |
| 2 | explain processing stations and material handling system used in FMS environments. |
| 3 | design and analyze FMS using simulation and analytical techniques. |
| 4 | understand tool management in FMS. |
| 5 | analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS. |
| 6 | understand the Machine Computer Interface |

**Detailed Contents:**

| Sr. No. | Title | Content Details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **FMS Introduction and Description** | limitations with conventional manufacturing, Need for FMS Introduction, Definition, Basic Component of FMS, Significance of FMS, General layout and configuration of FMS, Principle Objectives of FMS, Benefits and limitations of FMS, Area of Application of a FMS in Industry, Various Hardware and Software required for an FMS, CIM Technology, Hierarchy of CIM, FMS Justification Description and Classifications of Manufacturing Cell, Unattended Machining, Cellular versus Flexible Manufacturing. | **4** |
| **Unit 2** | **Group Technology** | Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT | **4** |
| **Unit 3** | **Turning and Machining Centres** | Introduction, Types ,Construction and Operation Performed on Turning enter, Automated Features and Capabilities of Turning Centres, General Advantages and Disadvantages of Vertical and Horizontal Machining Centres, Pallet and Part Loading and Programming Options in Machining Centres, Automated features and capabilities of a Machining Centres | **4** |
| **Unit 4** | **Coordinate Measuring Machines** | Introduction, Types, Construction and General Functions of CMM, Operational Cycle Description, CMM Applications, Importance to Flexible Cells and Systems | **3** |
| **Unit 5** | **Automated Material Movement & Storage System** | Introduction, Types of AGV and Their principle of working, Advantages, Limitation and General AGV Guide path, Robots, Benefits of using Industrial Robots, Basic components and benefits of Automated Storage and Retrieval Systems, Conveyors and Pallet Flotation System, Queuing Carousels and Automatic Work Changers, Coolant and Chip Disposal and Recovery system. | **4** |
| **Unit 6** | **Computer Controled FMS** | Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends .Computer function, FMS | **6** |

| | | | |
|---|---|---|---|
| | | data file, system reports planning the FMS, analysis method for FMS, application and benefits | |
| **Unit 7** | **FMS Simulation & Data Base** | Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database. DBMS and their applications in CAD/CAM and FMS distributed systems in FMS –Integration of CAD and CAM - Part programming in FMS, tool data base - Clamping devices and fixtures data base. | **6** |
| **Unit 8** | **Interfacing of computers** | Machine tool controllers and handling systems: communications standards - programmable Logic Controllers (PLC's) – Interfacing - Computer aided Project planning – dynamic part scheduling. | **5** |

**Text Books**


1. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 1991.
2. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., 1994.
3. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.
4. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt., New Delhi, 1996.
5. Kalpakjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishsing Co., 1995.


**Reference Books**


1. Paul Ranky., "The design and operation of FMS", IFS publication, 1983.
2. Mikell P Groover, "Automation Production systems, Computer Integrated Manufacturing", Prentice Hall, 1987.
3. David J.Parrish, "Flexible Manufacturing" Butterworth-Heinemann, 1990.


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**SUBJECT CODE: LMPE-101**

**SUBJECT NAME: ADVANCED MANUFACTURING PROCESSES LABORATORY**

| | |
|---|---|
| **Programme:** M.Tech. (PE) | **L:** 0 **T:** 0 **P:** 4 |
| **Semester:** 1 | **Teaching Hours:**4 |
| **Theory/Practical:** Practical | **Credits:** 2 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** Nil |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 hr |
| **Total Marks:** 100 | **Status:** Compulsory |

**On Completion of the course, the student will have the ability to:**

| CO# | Course Outcomes(CO) |
|---|---|
| 1 | analyze the working of various advanced manufacturing processes |
| 2 | understand the advantages and limitations of advanced manufacturing processes |
| 3 | evaluate performance of various components involved in advanced manufacturing processes |
| 4 | check the proper working of various advanced manufacturing processes |
| 5 | measure/determine the changes in the output due to change in certain input conditions |
| 6 | explain the phenomenon of various advanced manufacturing processes |

| S. No. | Experiment |
|---|---|
| 1 | To study fused deposition modelling process and its process parameters |
| 2 | To perform screw extrusion for preparation of feed stock filament |
| 3 | To determine heat capacity for polymeric samples using differential scanning calorimetry |
| 4 | To determine the coefficient of friction during dry sliding wear |
| 5 | To perform vapour smoothing of 3D printed polymeric functional prototypes and its process parametric optimization |
| 6 | To perform erosion testing (of given job/sample) and its process parametric optimization |

R**eference Material**

Manuals available in Laboratory.

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**SUBJECT CODE: LMPE-102**

**SUBJECT NAME: ADVANCED MACHINING AND CASTING PROCESSES LABORATORY**

| | |
|---|---|
| **Programme:** M.Tech. (PE) | **L:** 0 **T:** 0 **P:** 4 |
| **Semester:** 1 | **Teaching Hours:**4 |
| **Theory/Practical:** Practical | **Credits:** 2 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** Nil |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 hr |
| **Total Marks:** 100 | **Status:** Compulsory |

**On Completion of the course, the student will have the ability to:**

| CO# | Course Outcomes(CO) |
|---|---|
| 1 | analyze the working of various advanced machining and casting processes |
| 2 | understand the advantages and limitations of advanced machining and casting processes |
| 3 | evaluate performance of various components involved in advanced machining and casting processes |
| 4 | check the proper working of various advanced machining and casting processes |
| 5 | measure/determine the changes in the output due to change in certain input conditions |
| 6 | explain the phenomenon of various advanced machining and casting processes |

| S. No. | Experiment |
|---|---|
| 1 | To study vacuum moulding process and its process parameters |
| 2 | To perform machining of MS with HSS tool (single point cutting tool) with measurement of tool tip temperature, chip formation, force measurement using dynamometer and process parametric optimization |
| 3 | To study investment casting process and its process parameters |
| 4 | To perform EDM (of given job/sample) and its process parametric optimization |
| 5 | To perform electrochemical machining (of given job/sample) and its process parametric optimization |
| 6 | To perform ultrasonic drilling (of given job/sample) and its process parametric optimization |

R**eference Material**

Manuals available in Laboratory.

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**SUBJECT CODE: MRM-101**

**SUBJECT NAME: RESEARCH METHODOLOGY AND IPR**

| | |
|---|---|
| **Programme: M**. Tech. (PE**)** | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 1** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 30% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Core Course |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | understand research problem formulation. |
| 2 | analyse research related information. |
| 3 | follow research ethics. |
| 4 | understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. |
| 5 | understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. |
| 6 | understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations | **6** |
| **Unit 2** | **Literature survey** | Effective literature studies approaches, analysis Plagiarism, and Research ethics | **4** |
| **Unit 3** | **Technical writing** | Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee | **6** |
| **Unit 4** | **Nature of Intellectual Property** | Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. | **8** |
| **Unit 5** | **Patent Rights** | Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. | **6** |
| **Unit 6** | **New Developments in IPR** | Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. | **6** |

**Text Books:**


1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008


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**SUBJECT CODE: MAC-105**
**SUBJECT NAME: CONSTITUTION OF INDIA**

| | |
|---|---|
| **Programme: M**. Tech. (PE) | **L:** 2 **T:** 0 **P:** 0 |
| **Semester: 1** | **Teaching Hours:** 24 |
| **Theory/Practical:** Theory | **Credits:** 0 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 0% |
| **External Marks:** Nil | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 50 | **Status:** Audit Course 1 |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. |
| 2 | discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. |
| 3 | discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. |
| 4 | discuss the passage of the Hindu Code Bill of 1956. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **History of Making of the Indian Constitution** | History, Drafting Committee, (Composition & Working). | **4** |
| **Unit 2** | **Philosophy of the Indian Constitution** | Preamble, Salient Features. | **4** |
| **Unit 3** | **Contours of Constitutional Rights & Duties** | Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy and Fundamental Duties. | **4** |
| **Unit 4** | **Organs of Governance** | Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions. | **4** |
| **Unit 5** | **Local Administration** | District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy. | **4** |
| **Unit 6** | **Election Commission** | Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women. | **4** |

**Text Books:**


1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.


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**SUBJECT CODE: MPE-103**
**SUBJECT NAME: ADVANCED WELDING PROCESSES**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Core Course |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | understand and apply the principles of welding processes and develop analytical relation between input and output process parameters |
| 2 | understand, analyze and apply the concept of cooling rate of materials in welding |
| 3 | apply theoretical and experimental techniques for mode of metal transfer |
| 4 | understand the concept of forces acting on welding arc and arc efficiency |
| 5 | apply the fundamentals of physics to develop theoretical relations for different types of welding processes |
| 6 | understand principles of destructive and non-destructive testing for welding defects |

**Detailed Contents:**

| S. No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Classification of welding process** | Basic classification of welding processes, weldability, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and micro-structural changes in weld metal, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of microstructures and properties of weld metal, heat affected zone (HAZ), re-crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals. | **4** |
| **Unit 2** | **Welding arc** | Arc efficiency, temperature distribution in the arc; arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiation and maintenance, role of electrode polarity on arc behavior and arc stability, analysis of the arc. | **4** |
| **Unit 3** | **Coated electrodes** | Electrode coatings, classification of coatings of electrodes for SMAW, SAW fluxes, role of flux in-gradients and shielding gases, classification of solid and flux code wires. | **4** |
| **Unit 4** | **Fusion welding processes** | Manual metal arc welding (MMAW), gas tungsten arc welding (GTAW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW) and CO welding processes, plasma arc, submerged arc welding, electro gas and electro slag welding, analysis of the process. | **4** |
| **Unit 5** | **Welding power sources** | Arc welding power sources basic characteristics of power sources for various arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, inverter systems. Arc length regulation in mechanized welding processes | **5** |
| **Unit 6** | **Metal Transfer and Melting Rate** | Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate. | **4** |
| **Unit 7** | **Solid State welding** | Theory and mechanism of solid state welding, techniques and scope of friction welding, diffusion welding, cold pressure welding and ultrasonic welding, high energy rate welding, analysis of the process | **4** |
| **Unit 8** | **Welding Techniques using radiation energy** | Technique, scope and application of the electron beam and laser welding processes | **4** |
| **Unit 9** | **Welding defects** | Destructive and non-destructive testing for welding defects | **3** |

**Text Books:**

1. Welding processes & technology by Dr. R.S.Parmar Khanna Publishers
2. Welding Engineering & Technology by Dr. R.S.Parmar Khanna Publishers
3. Modern Arc Welding Technology by S.V. Nandkarni Oxford & IDH publishing Co.
4. Principles of Welding Technology by L.M. Gourd ELBS/ Edward Arnold
5. The Physics of welding by Lancaster; Pergaman Press

**References Books:**

1. The Metallurgy of welding by Lancster; George Allen & Unwin Ltd. U.K.
2. Metals Handbook- Metal Casting; ASME
3. Welding handbook, Vol. 1 & 2, seventh edition; American welding society
4. ASME Procedure Handbook of ARC welding; Lincoln Electric Co. USA
5. The Solid phase welding of metals by Tylecote; Edward Arnold Pvt. Ltd.
6. Welding & Welding Technology Richard L. Little, McGraw Hill
7. Welding Technology by Rossi; McGraw Hill
8. Welding Technology by Koenigsberger and Adaer; Macmillan.

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**SUBJECT CODE: MPE-104**
**SUBJECT NAME: ADVANCED METAL CUTTING**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 70% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Core Course |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | understand and design tool geometry of the basic cutting tools like single point cutting tool, drills etc. |
| 2 | solve the problems related with the measurement of cutting forces, tool wear and should be able to deal with various parameters effectively. |
| 3 | measure and improve tool life of various cutting tools. |
| 4 | simulate various machining processes and apply economics of machining. |
| 5 | understand the different types of defects, causes and apply their remedial measures in metal cutting processes. |
| 6 | develop economics of metal machining and abrasive machining. |

**Detailed Contents:**

| S. No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction to Metal Cutting** | Introduction, system of Tool nomenclature, Tool Geometry, Mechanism of Chip, formation and forces in orthogonal cutting, Merchant's force diagram. | **4** |
| **Unit 2** | **Oblique Cutting** | Normal chip reduction coefficient under oblique cutting, true shear angle, effective rake, influx region consideration for deformation, direction of maximum elongation, effect of cutting variables on chip reduction co-efficient, forces system in oblique cutting, effect of wearland on force system, force system in milling, effect of helix angle. | **6** |
| **Unit 3** | **Fundamentals of Dynamo-metry** | Theoretical determination of forces, angle relations, heat and temperature during metal cutting; distribution, measurement, analysis, theoretical estimation of workpiece temperature, hot machining. | **6** |
| **Unit 4** | **Fundamental factors which effect tool forces** | Correlation of standard mechanised test. (Abuladze – relation), nature of contact and stagnant phenomenon, rates of strains, shear strain and normal strain distributions, cutting variables on cutting forces. | **6** |

| | | | |
|---|---|---|---|
| **Unit 5** | **Cutting Tools** | Tools materials analysis of plastic failure (from stability criterion), Analysis failure by brittle fracture, wear of cutting tools, criterion, flank and crater wear analysis, optimum tool life, tool life equations, (Taylor's woxen etc) Tool life test, machining optimization, predominant types of wear; abrasive, adhesive, diffusion wear models, wear measurements and techniques, theory of tool wear oxidative mathematical modelling for wear. | **6** |
| **Unit 6** | **Economics of Metal machining** | Machinability, test of machinability and influence of metallurgy on machinability. Economics of Metal machining. | **4** |
| **Unit 7** | **Abrasive Machining** | Mechanics of grinding, cutting action of grit, maximum grit chip thickness, energy and grit force temperature during grinding, wheel wear, grinding, process simulation, testing of grinding wheels, mechanics of lapping and honing, free body abrasion. | **4** |

**Text Books:**


1. Sen & Bhattacharya, "Principles of Machine tools", New Central Book Agency.
2. Brown, "Machining of Metals", Prentice hall.
3. Shaw, "Principles of Metal cutting", Oxford I.B.H.
4. Arshimov & Alekree, "Metal cutting theory & Cutting tool design", MIR Publications.


**References Books:** Machining Science – G.K. Lal

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**SUBJECT CODE: MPE-111**
**SUBJECT NAME: PRODUCTION AND INVENTORY CONTROL**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective III |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | describe and analyze distinct concepts within production planning and explain how these can be used to plan and control the physical flow of information and products in the production companies. |
| 2 | know about business forecasting and market survey in the dynamic environment. |
| 3 | schedule production by using different techniques and evaluate different capacity alternatives/strategies to meet the customer demand. |
| 4 | know about inventory control techniques and evaluate different inventory alternatives/ strategies. |
| 5 | Know about the concepts of JIT-I and JIT-II. |
| 6 | demonstrate and apply the concept of Value Engineering. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Production Planning and Control (PPC)** | Introduction and Need of Production Planning and Control, Objectives, Phases and Functions of Production Planning and Control, parameters for PPC. | **4** |
| **Unit 2** | **Forecasting** | Introduction to Forecasting, uses of forecasts, types of forecasting, forecasting: needs and uses, Forecasting v/s Prediction, Basic Elements of Forecasting, Forecasting Error Measures, Forecasting Performance Measures, Steps in the Forecasting Process, Forecasting Models, Market Survey. | **6** |
| **Unit 3** | **Operations Planning and Scheduling Systems** | Components of Operations Planning and Scheduling System, Aggregate Planning (Objectives ,Process, Strategies, guidelines, methods, Advantages and Limitations), Master Production Schedule (MPS), Material Requirement Planning (MRP), Manufacturing Resources Planning (MRP II), Enterprise Resource Planning(ERP), | **10** |

| | | | |
|---|---|---|---|
| | | Capacity Planning (Introduction, Measurement of Capacity Planning, Capacity Utilization and Efficiency, Estimate Capacity Requirements, Estimating Future Capacity Needs, Factors Influencing Effective Capacity), Routing (Advantages, Steps /procedure, Techniques), Scheduling (Purpose, Types, Principles, Inputs, Categories, Methodology/Techniques), Dispatching (Duties, Procedure and Rules of Dispatching) | |
| **Unit 4** | **Inventory Control** | Inventory Costs, Inventory Classification, Inventory Management, Demand of Inventory, Lot Sizing, Push System vs. Pull System Inventory Control, Inventory Control Systems, Basic Stock Control Methods, Economic Order Quantity (EOQ) Models, Deterministic and Stochastic Models, EOQ and Quantity Discount, EOQ Model with Non-Instantaneous Receipt, EOQ Model with Planned Shortages, Finding the Optimal Order & Back Order Level Production Lot Size with Planned Shortages, JIT-I,JIT-II, computer application in Production and Inventory Control. | **8** |
| **Unit 5** | **Value Engineering** | Introduction to Value Engineering, Objectives of value analysis, , Difference between value analysis and value engineering, When to apply value analysis, Difference between Value Engineering and Cost Reduction, Value Engineering Job Plan, Techniques of value analysis/engineering, Advantages of Value Engineering. | **8** |

**Text Books:**


1. Chase, Aquilano & Jacob, "Production/Operations Management", Tata McGraw Hill, New Delhi, 2000.
2. Krejewski, "Operations Management", Pearson Education Asia, New Delhi, 2002.
3. Ebert and Adams, "Production/ Operations Management", Prentice Hall of India, New Delhi, 2005.


**Additional Books:**


1. Chary, S.N., "Production and Operations Management", Tata McGraw Hill.
2. Arora, K.C., "Production and Operations Management", Laxmi Publications.


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**SUBJECT CODE: MPE-112**
**SUBJECT NAME: QUALITY ASSURANCE**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective III |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | demonstrate and apply the concept Inspection in an industrial organization. |
| 2 | develop in-depth knowledge of quality control and management. |
| 3 | develop in-depth knowledge on various aspects of quality management systems |
| 4 | apply various quality controls tools in the industries to enhance the quality. |
| 5 | develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implementable solutions to those. |
| 6 | explain the concept of reliability. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Inspection** | Objectives and functions of inspection in industry, Inspection Planning, Types of Inspection, Difference Between Inspection And Quality Control, Non-Destructive Testing, Radiography, Magnaflux, Fluorescent Penetrant Inspection and Ultrasonic Testing, Organization of Inspection, computer aided inspection, economics of inspection, reference to relevant BIS codes. | **4** |
| **Unit 2** | **Quality Control** | Quality control concept and objectives, Total Quality Control, organization for quality control, Quality Control Procedures, concept and use of Quality Circles. Total Quality Management, Quality assurance. | **6** |

| | | | |
|---|---|---|---|
| **Unit 3** | **Quality Management System (QMS)** | Introduction to QMS/certification system, benefits of a QMS, ISO 9001:2000 requirement, steps to registration, documentation requirements , principles in ISO 9000, Introduction to ISO 14000, elements and clauses of ISO 14001, benefits of implementation of ISO 14000,. | **5** |
| **Unit 4** | **Statistical Quality Control** | Theory of statistical tolerances, general theory of control charts, control charts for variable and attributes, group control charts, control charts with variable group size, moving average and moving range charts acceptance control charts for trended universe average, cumulative sum control charts, difference control charts, use of Q.C. curves. | **8** |
| **Unit 5** | **Acceptance sampling** | Introduction to Acceptance sampling, multiple and sequential sampling plans, multi-level sampling plans, acceptance sampling by variables, advantages and limitations, sampling plans by using different criteria, techno-economic comparison of various types of sampling plans. | **8** |
| **Unit 6** | **Reliability** | Basic concept of reliability, its importance in quality design, methods for its improvement, failure rate curve, life testing, quality-reliability relationship. | **5** |

**Text Books:**


1. Kenedy, E.V. & Andrews Donald, "Inspection and Gauging", Industrial Press Inc., 1977.
2. Juran, J.M. & Gryan, F.M, "Quality Planning and Analysis", Tata McGraw Hill, 1995.
3. Grant, E.L. & Richards, S.L., "Statistical Quality Control", McGraw Hill, 1998.


**Additional Books:**


1. Mahajan. M, "Statistical Quality Control", Dhanpat Rai & Co., 2008.
2. Khanna, O.P, "Industrial Engineering and Management", Dhanpat Rai & Publication, 2007.


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**SUBJECT CODE: MPE-113**

**SUBJECT NAME: ADVANCED INDUSTRIAL TRIBOLOGY**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 2 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 10% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective III |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| Sr. No. | Course Outcomes (Cos) |
|---|---|
| 1 | understand the mechanism of friction, wear and lubrication and analytical relation between variables |
| 2 | understand the concept of types of wear and their measurement under different environments |
| 3 | understand the laws and mechanism of sliding and rolling friction |
| 4 | understand the mechanism of lubrication, their performance with respect to different variables |
| 5 | apply these mechanisms of tribology in the design of different types of bearings considering various input and output parameters |
| 6 | apply the applications of solid lubricants in various metal forming processes depending upon their characteristics. |

**Detailed Syllabus:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Friction, wear and lubrication, types of engineering contacts: conforming and non-conforming, types of relative motion: rubbing, sliding, oscillating and rolling, Surface interactions, elastic and plastic deformations, properties of materials, surface energy and flash temperature theory | 4 |
| **Unit 2** | **Friction** | Laws of sliding friction, concept of adhesion, Tabor's model of friction, elastic thermo friction, rolling friction, measurement of friction. | 4 |

| | | | |
|---|---|---|---|
| **Unit 3** | **Wear** | Laws of wear, Types of wear such as adhesive, delamination, abrasive, fatigue, corrosive, fretting, erosive, electrical and oxidative. Measurement of wear in dry and different environments. Prevention and control of wear and friction in machines, wear of cutting tool and dies, study of abrasion in grinding, lapping and honing | 10 |
| **Unit 4** | **Lubrication** | Mechanisms of lubrication, Boundary, Squeeze film hydrodynamic and elasto hydro-dynamic and hydro static lubrication, plasto hydrodynamic lubrication, Solution of Reynolds's equation in two and three-dimensional flow. Pressure distribution load carrying capacity friction forces in oil film and Co-efficient of friction in joumal bearing. Sold lubricants types and applications. | 6 |
| **Unit 5** | **Bearing design** | Design of bearing : Clearance in journal bearing, minimum film thickness, sommar-field Number, Oil grooves and flow of oil in axial and circumferential grooves cavitations and turbulence in oil bearings. Heat generation and cooling of bearings, Hydrostatic and dynamic bearings and their applications in machine tools. Design of air bearing and other gas bearings. | 6 |
| **Unit 6** | **Rolling friction** | Reynold's slip, Heathe cote slip, selection of roller bearings and their methods of lubrication, design aspects and modes of bearing failures and elasto hydro dynamic lubrication. | 4 |
| **Unit 7** | **Solid lubricants** | Categories and Applications in metal forming processes. Characteristics of an ideal solid lubricant. | 2 |

**Text Books**

1. Tribology Principles and Design Applications by R. D. Arnell, P.B.Davies, J. Halling and T.L.Whomes (Springer-Verlag)
2. Tribology in industries by Sushil Kumar Srivastava (S. Chand & Company Ltd.)
3. Fundamentals of Tribology by S.K.Basu, S.N. Sengupta and B.B.Ahuja (PHI learning private limited)

**References:**

1. Tribology Data Handbook : An Excellent Friction, Lubrication and Wear Resource by E.Richard Booser, (CRC Press-Taylor and Francis Group)
2. Friction,Wear,Lubrication by Kenneth C.Ludema and Oyelayo O.Ajayi, (CRC Press-Taylor & Francis Group)
3. Mechanical wear fundamentals and testing by Raymond G.Bayer, (CRC Press-Taylor & Francis Group)
4. Handbook of lubrication and tribology by Robert W.Bruce, (CRC Press-Taylor & Francis Group)

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**SUBJECT CODE: MPE-114**

**SUBJECT NAME: INDUSTRIAL ROBOTIC DESIGN**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 05% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective IV |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | identify potential areas for automation and justify need for automation |
| 2 | select suitable major control components required to automate a process or an activity |
| 3 | translate and simulate a real time activity using modern tools and discuss the benefits of automation. |
| 4 | explain the basic principles of Robotic technology, configurations, control and programming of Robots. |
| 5 | design an industrial robot which can meet kinematic and dynamic constraints. |
| 6 | choose the appropriate Sensor and Machine vision system for a given application. |

**Detailed Syllabus:**

| Sr. No | Title | Content Details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement. Control System and Components: basic concept and medias controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system | **6** |
| **Unit 2** | **Motion Analysis and Control** | Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller. | **7** |
| **Unit 3** | **End Effectors** | Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics. Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application. | **7** |
| **Unit 4** | **Robot Programming** | Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations. Robot Languages: Textual robot Languages, Generation, Robot language structures, Elements in function. | **8** |
| **Unit 5** | **Robot Cell Design and Control** | Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detect ion, Work wheel controller. Robot Application: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application. | **8** |

**Text Books**


1. Automation, Production System & Computer Integrated by Groover Prentice Hall India Manufacturing
2. Principles of Automation & Automated Production Process Malov and IvanovMir Publication
3. Automation in Production Engineering Oates and Georgy Newness
4. Robotics K.S. Fu, R.C. Gonzalez, C.S.G. Lee ,McGraw Hill
5. Robotics, J.J. Craig Addison-Wesely
6. Robot Engineering: An Integrated Approach R.D. Klafter. Prentice Hall India,


**Reference Books**


1. Robotics for Engineers -YoramKoren, McGraw Hill International, 1st edition, 1985.
2. Industrial Robotics-Groover, Weiss, Nagel, McGraw Hill International, 2nd edition, 2012.
3. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI, 1st edition, 2009.
4. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.
5. Stochastic Models of Manufacturing Systems Buzacott & shanty Kumar, Prentice Hall India


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**SUBJECT CODE: MPE-115**

**SUBJECT NAME: NON-CONVENTIONAL MACHINING PROCESS**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective IV |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | understand the evolution, classification and need of nontraditional machining technology |
| 2 | understand and demonstrate the process principle and physical description; apply the parametric effect on process performance; solve problems related to process modeling, selection and material removal mechanics of mechanical energy based processes |
| 3 | understand and demonstrate the process principle and physical description; apply the parametric effect on process performance; solve problems related to process modeling, selection and material removal mechanics of thermal and electro-thermal energy based processes |
| 4 | understand and demonstrate the process principle and physical description; apply the parametric effect on process performance; solve problems related to process modeling, selection and material removal mechanics of chemical and electro-chemical energy based processes |
| 5 | access possibilities for hybrid nontraditional machining processes |
| 6 | apply the applications of various non-conventional processes in appropriate field by considering their advantages and disadvantages. |

**Detailed Syllabus:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Basics of non-conventional machining processes** | Need of non-conventional machining in comparison to conventional machining processes, classification of non-conventional machining processes based upon energy type, mechanics of material removal and energy source. | **2** |
| **Unit 2** | **Mechanical processes** | Abrasive jet machining, Water jet machining, and Ultrasonic machining: Introduction, mechanics of process, process parameters, machining characteristics, abrasive jet machines, process capability, applications, limitations and advantages. | **8** |
| **Unit 3** | **Thermal and electro-thermal energy based processes** | Electric discharge machining: Mechanism of metal removal, spark erosion generators, electrode feed control, machine tool selection, selection of tool material and tool design, applications, future trends.<br>Plasma arc machining : Mechanics of material removal, process parameters, type of torches, equipment, safety precautions<br>Electron beam machining: Generation and control of electron beam, thermal and non-thermal type electron beam machining, process capabilities and limitations.<br>Laser beam machining: Apparatus, material removal, thermal analysis, metallurgical effects, advantages, limitations. | **12** |
| **Unit 4** | **Chemical and electro-chemical energy based processes** | Electrochemical machining : Electrochemistry of process, electrochemical machining plant, process advantages, applications, limitations<br>Electrochemical grinding, de-burring, honing: Material removal, accuracy, advantages, applications<br>Chemical machining: Elements of the process, resists, etchants, advantages and applications | **10** |
| **Unit 5** | **Hybrid nontraditional machining processes** | Hot machining, High velocity forming of metals, explosive forming : principles and applications, | **4** |

**Text Books**


1. Modern machining processes- P C Pandey and H S Shan (Tata McGraw-Hill publishing company limited)
2. Manufacturing Science- Amitabha Ghosh and Asok Kumar Mallik (East-West press private limited)
3. Non-traditional manufacturing processes- Gary F. Benedict (Taylor & Francis)
4. Advanced methods of machining- J.A.McGeough (Springer)

**Reference Books**

1. Advanced machining processes (Nontraditional and hybrid machining processes)- Hassan EI-Hofy (McGraw-Hill)

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**SUBJECT CODE: MPE-116**
**SUBJECT NAME: COMPUTER AIDED DESIGN**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective IV |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | describe the role of computer systems in design and manufacturing. |
| 2 | understand and create geometric models by using various techniques of geometric modeling. |
| 3 | apply geometric transformations on different models entities. |
| 4 | describe the key concept of NC/CNC/DNC. |
| 5 | create and validate NC part program data using manual data input. |
| 6 | evaluate integration of CAD/CAM and business aspects in an industry. |

**Detailed Syllabus:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | CAD/CAM contents and tools; history of CAD/CAM development; CAD/CAM market trends; Definition of CAD/CAM tools, Industrial look at CAD/CAM. | **2** |
| **Unit 2** | **CAD/CAM Hardware** | Introduction; types of systems; CAD/CAM systems evaluation criteria; input devices; output devices, hardware integration and networking; hardware trends. | **2** |
| **Unit 3** | **CAD/CAM Software** | Introduction; graphics standards; basic definition and modes of graphic operations; user interface; software modules, modelling and viewing; software documentation; software development; efficent use of CAD/CAM Software; Software trends. | **4** |
| **Unit 4** | **Microprocessor based CAD/CAM** | Introduction; several features, system implementation; hardware components and configuration; micro-based CAD software; file translation; operating systems, mechanical applications; micro-CAD trends; product distribution trends. | **4** |
| **Unit 5** | **Mathematical Representation of Curves** | Introduction; wire frame models; wire frame, entities, curves representation, parametric representation of analytical and synthetic curves, curve, manipulation; design and Engineering applications. | **5** |
| **Unit 6** | **Mathematical Representation of Surfaces** | Introduction, surface models, surface entities, surface representation, parametric representation of analytic and synthetic surfaces, surface manipulation. | **4** |
| **Unit 7** | **Mathematical Representation of Solids** | Introduction, solid models, solid entities, solid representation, fundamentals of solid modelling, half –spaces; boundary representation; constructive solid geometry sweep representation, solid modelling based applications; design and engineering applications. | **4** |
| **Unit 8** | **Geometric Transformations** | Introduction; transformation of geometric models, mappings of geometric models; inverse transmission and mappings; projections of geometric models; design and Engineering applications. | **4** |

| | | | |
|---|---|---|---|
| **Unit 9** | **Mechanical Assembly and Tolerancing** | Introduction; assembly modelling, representative schemes, generation of assembling sequences; tolerance concepts. | **4** |
| **Unit 10** | **Part Programming and Manufacturing** | NC, CNC and DMC machines, part programming, manufacturing processes, process planning, tool path generation; design and Engineering applications. | **3** |

**Text Books**


1. CAD/Cam by Mikell P. Groover Mecry Wo Elimmers, Jr. 1991.
2. The CAD/Cam Hand Book by Bedford Masa Chusetles.
3. Automation, Production Systems,and Computer Aided Manufacturing, Prentice Hall by Groover M.P.
4. Numerical Control and Computer Aided Manufacturing by Pressman, R.N. and William, J.E. John Wiley & Sons New York.
5. CAD/CAM Theory and practise by Ibrahim Zeid; Tata McGraw Hill, New Delhi (1998)


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**SUBJECT CODE: LMPE-103**

**SUBJECT NAME: ADVANCED WELDING PROCESS LABORATORY**

| | |
|---|---|
| **Programme:** M.Tech. (PE) | **L:** 0 **T:** 0 **P:** 4 |
| **Semester:** 2 | **Teaching Hours:**4 |
| **Theory/Practical:** Practical | **Credits:** 2 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** Nil |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 hr |
| **Total Marks:** 100 | **Status:** Compulsory |

**On Completion of the course, the student will have the ability to:**

| CO# | Course Outcomes(CO) |
|---|---|
| 1 | analyze the working of various advanced welding processes |
| 2 | understand the advantages and limitations of advanced welding processes |
| 3 | evaluate performance of various components involved in advanced welding processes |
| 4 | check the proper working of various advanced welding processes |
| 5 | measure/determine the changes in the output due to change in certain input conditions |
| 6 | explain the phenomenon of various advanced welding processes |

| S. No. | Experiment |
|---|---|
| 1 | To study TIG welding and pulsed TIG welding process and its parameters |
| 2 | To perform friction and friction stir welding of thermoplastics |
| 3 | To compare mode of metal transfer in MIG and TIG welding process |
| 4 | To determine arc efficiency in TIG welding |
| 5 | To perform metal arc welding by varying input parameters |
| 6 | To perform spot, seam welding for given job and its process parametric optimization |

R**eference Material**

Manuals available in Laboratory.

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**SUBJECT CODE: LMPE-104**

**SUBJECT NAME: MECHANICAL AND MORPHOLOGICAL CHARACTERIZATION LABORATORY**

| | |
|---|---|
| **Programme:** M.Tech. (PE) | **L:** 0 **T:** 0 **P:** 4 |
| **Semester:** 2 | **Teaching Hours:**4 |
| **Theory/Practical:** Practical | **Credits:** 2 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** Nil |
| **External Marks:** 50 | **Duration of End Semester Exam(ESE):** 1.5 hr |
| **Total Marks:** 100 | **Status:** Compulsory |

**On Completion of the course, the student will have the ability to:**

| CO# | Course Outcomes(CO) |
|---|---|
| 1 | analyze the working of various mechanical testing |
| 2 | understand the advantages and limitations of tensile testing |
| 3 | evaluate performance of various components involved in morphological testing |
| 4 | understand the working of metallurgical microscope |
| 5 | understand destructive/ non-destructive methods for characterization |
| 6 | explain the phenomenon of deformation via morphological characterization |

| S. No. | Experiment |
|---|---|
| 1 | To perform tensile testing of standard specimens for measurement of Young's modulus, peak strength etc. |
| 2 | To perform compression testing of standard specimens for evaluation of compressive strength |
| 3 | To perform impact testing of standard samples |
| 4 | To perform flexural testing of standard samples |
| 5 | To study working and operation of tool makers microscope for morphological analysis |
| 6 | To study working of metallurgical microscope for evaluation of porosity. |

R**eference Material**
Manuals available in Laboratory.

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**SUBJECT CODE: MAC-106**
**SUBJECT NAME: PEDAGOGY STUDIES**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 2 **T:** 0 **P:** 0 |
| **Semester: 2** | **Teaching Hours:** 16 |
| **Theory/Practical:** Theory | **Credits:** 0 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 0% |
| **External Marks:** Nil | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 50 | **Status:** Audit Course 2 |

**Additional Material Allowed in ESE: Scientific Calculator**
**On completion of the course, the student will have the ability to understand:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries? |
| 2 | what is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? |
| 3 | how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction and Methodology** | Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching. | **4** |
| **Unit 2** | **Thematic overview** | Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education. | **2** |
| **Unit 3** | **Evidence on the effectiveness of pedagogical practices** | Methodology for the in depth stage: quality assessment of included studies, how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies | **4** |

| | | | |
|---|---|---|---|
| **Unit 4** | **Professional development** | Alignment with classroom practices and follow up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes. | **4** |
| **Unit 5** | **Research gaps and future directions** | Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact. | **2** |

**Text Books:**


1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic math's and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.


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**SUBJECT CODE: MPE-117**
**SUBJECT NAME: OPERATIONS MANAGEMENT**

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|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 3 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective V |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | Explain the scope and function of operations management. |
| 2 | develop the functions of work and job design, facility and capacity planning. |
| 3 | apply Production Planning and Control and maintenance management in the dynamic environment of an organization. |
| 4 | apply the concept of Quality assurance in an organization. |
| 5 | analyze distinct concepts within value engineering and explain how these can be used in materials and products in Industries. |
| 6 | demonstrate purchasing, store management and inventory control techniques and evaluate different inventory alternatives/strategies. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Operations Management (OM)** | Introduction, History and decisions of Operations Management, Production functions. | **4** |
| **Unit 2** | **Work and Job design** | Work design (Techniques-Work study and Method Study), Job Design (Design, Environmental and Organizational factors, Behavioral dimensions of job design, Socio-technical approach to job design). | **4** |

| | | | |
|---|---|---|---|
| **Unit 3** | **Facilities planning** | Importance of Facilities Planning, Product and Process selection, Facilities Location, facilities layout and materials handling. | **4** |
| **Unit 4** | **Capacity planning** | Capacity Planning (Introduction, Measurement of Capacity Planning, Capacity Utilization and Efficiency, Estimate Capacity Requirements, Estimating Future Capacity Needs, Factors Influencing Effective Capacity). | **4** |
| **Unit 5** | **Production Planning and Control (PPC)** | Introduction and Need of Production Planning and Control, Objectives, Phases and Functions of Production Planning and Control, parameters for PPC. | **4** |
| **Unit 6** | **Maintenance Management** | Terotechnology, Objectives of Maintenance, Types of Maintenance Systems, Total Productive Maintenance. | **4** |
| **Unit 7** | **Quality assurance** | Quality, Quality Management, Quality Assurance v/s Quality Control, Quality Assurance Systems, Components of Quality Assurance, quality circles formation and procedure. | **4** |
| **Unit 8** | **Material Management** | Purchase system and purchase principles, Inventory Management, Stores management, Standardization, Codification and variety reduction, Waste management. | **4** |

**Text Books:**


1. Chunawala Patel, "Production and Operation Management", Himalya Publishers., 1995.
2. Bhagde, S.D, "Production and Materials Management", U.S.G Publishers, 1995.
3. Plossl, G.W& Wight, O.W., "Production and Inventory Control", Prentice Hall, 1967.


**Additional Books:**


1. Chary, S.N., "Production and Operations Management", Tata McGraw Hill.
2. Jae K. Shim, "Operations Management", Barron's Educational Series, 1999.


**E-Books:**


1. Gifford, Charlie, "Hitchhiker's Guide to Operations Management", International Society of Automation [ISA]. 2007.
2. Jain K.C., Verma P.L., Kartikey P., "Production and Operations Management",


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**SUBJECT CODE: MPE-118**

**SUBJECT NAME: MATERIALS MANAGEMENT**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 3 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 20% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective V |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | explain the scope and function of material management. |
| 2 | develop the functions of purchasing, inventory management and receiving & shipping. |
| 3 | apply business functions in the dynamic environment. |
| 4 | explain inventory control techniques and evaluate different inventory alternatives/strategies |
| 5 | analyze distinct concepts within material management and explain how these can be use materials and products in Industries. |
| 6 | apply the concept of store management in an organization. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Material Management** | Scope and importance of materials and inventory Management, Functions and objectives of material Management. Introduction to Material Planning, Factors affecting Material Planning, Classification and Codification of Materials, Standardization and Simplification. | **6** |

| | | | |
|---|---|---|---|
| **Unit 2** | **Purchasing** | Introduction to Purchasing, Classification of Purchases, Principles of Scientific Purchasing, Objectives and functions of purchasing, Purchase Techniques, Purchasing Procedure, Quality considerations in purchasing. | **6** |
| **Unit 3** | **Material Handling** | Primary Handling activities- Receiving, In-storage Handling and shipping, Basic Handling Considerations, receiving functions. | **6** |
| **Unit 4** | **Inventory Control** | Inventory Costs, Inventory Classification, Inventory Management, Demand of Inventory, , lead time, stock outs, Lot Sizing, Push System vs. Pull System Inventory Control, Inventory Control Systems, Basic Stock Control Methods, Economic Order Quantity (EOQ) Models, Deterministic and Stochastic Models, EOQ and Quantity Discount, EOQ Model with Non-Instantaneous Receipt, EOQ Model with Planned Shortages, Finding the Optimal Order & Back Order Level Production Lot Size with Planned Shortages, simulation models for inventory analysis. | **10** |
| **Unit 5** | **Store Management** | Concept, Responsibilities and functions of store management, Types of stores, Coding, Store Accounting and Store Verification, Management of Surplus, Scrap and Obsolete Items. | **8** |

**Text Books:**


1. Bhagde, S.D, "Production and Materials Management", U.S.G Publishers, 1995.
2. Plossl, G.W& Wight, O.W., "Production and Inventory Control", Prentice Hall, 1967.
3. Mahajan, M., "Industrial Engineering and Production Management", Dhanpat Rai & Co., 2007.


**Additional Books:**


1. Chary, S.N., "Production and Operations Management", Tata McGraw Hill.
2. Arora, K.C., "Production and Operations Management", Laxmi Publications.


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**SUBJECT CODE: MPE-119**
**SUBJECT NAME: ADVANCE OPERATIONS RESEARCH**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 3 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 95% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Program Elective V |

**Additional Material Allowed in ESE: Scientific Calculator, Random Number Table, Normal Distribution Table**
**On completion of the course, the student will have the ability to:**

| CO#. | Course Outcomes (Cos) |
|---|---|
| 1 | analytical use methods such as mathematical programming, queuing theory, multi criteria analysis which are helpful in assessing the various practical problems with the appropriate logical structure. |
| 2 | enhance the skill of Postgraduate students in clarifying critical data elements and their role as model inputs. |
| 3 | solve the networking problems in various projects which are time dependent |
| 4 | enhance the Decision making process of engineering on the basis of mathematical modeling |
| 5 | evaluate different alternatives of Transportation and Assignment Models |
| 6 | design and evaluate different simulation techniques |

**Detailed Contents:**

| Sr. No | Title | Content Details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Definition, characteristics, objectives and necessity, scope of operation research. History of operation research, Various Applications in different fields of Engineering. | **2** |

| | | | |
|---|---|---|---|
| **Unit 2** | **Linear Programming** | Introduction to linear programming, formulation of linear programming problems, graphical solution, he Theory of simplex solution, alternative optimal solution, unbounded solutions, infeasible solutions, simplex algorithm & method, Method of Penalties, Two Phase Method, Duality & Sensitivity Analysis, limitations of linear programming, revised simpler method | **6** |
| **Unit 3** | **Transportation & Assignment Model** | Definition of transportation model, formulation and solution methods, and degeneracy in transportation problems. Traveling salesman model, Assignment model, comparison with transportation model, formulation and solution methods, and their industrial applications | **5** |
| **Unit 4** | **Queuing Models** | Application of queuing models, characteristics of queuing models, single channel queuing theory, solution to single channel with poison arrivals and exponential service infinite population model, limited and unlimited service, Queuing with parallel channels with limited and unlimited service. Bulk input, bulk service, priority queue discipline, queues in series,.Industrial applications of queuing theory, Queues Models: | **4** |
| **Unit 5** | **Dynamic programming** | Dynamic Optimisation Models, Dynamic programming, principles of optimality, characteristics of dynamic programming problem, deterministic programming models for solution of investment problem, allocation problem, production scheduling and equipment replacement problem, probabilistic dynamic programming. | **5** |
| **Unit 6** | **Decision Theory** | Decision-making environments: Decision-making under certainty, uncertainty and risk situations; Uses of Decision tree, | **3** |
| **Unit 7** | **Game Theory** | Game Theory: Concept of game; Two-person zero-sum game; Pure and Mixed Strategy Games; Saddle Point; Odds Method; Dominance Method and Graphical Method for solving Mixed Strategy Game -Sequencing Problem: Johnsons Algorithm for n Jobs and Two machines, n Jobs and Three Machines, Two jobs and m Machines Problems., Brown's algorithm. | **4** |
| **Unit 8** | **Simulation** | Concept and use of simulation, advantages and limitations of the simulation technique, generation of random numbers, Monte-Carlo simulation, computer-aided simulation: applications in maintenance and inventory management. Simulation Models: Generation of Random number. Use of Computers for system simulation. | **3** |
| **Unit 9** | **Network Analysis** | Work breakdown structure, network logic, critical path, CPM and PERT, slack and floats. Resourses Leveling & Time cost trade off | **4** |

**Text Books**


1. P.K. Gupta and D.S.Hira, "Operations Research ", S. Chand and company
2. A.H. Taha, "Operation Research", Macmillan Publishing Company
3. Operation research by Manohr Mahajan (Dhanpat Rai& Co. Publisher)


**Reference Books**


1. W.D. Miller and M.K Starr, "Executive Decisions and operations Research", ,Prentice Hall Inc, Eglewood Cliffs, N.J,
2. Vijay Gupta Bhushan Kumar K.K.Chawla, "Applied Operation research",KalyaniPublishers
3. R. K. Gupta, "Operations Research", Krishna publishers


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**SUBJECT CODE: MPE-120**
**SUBJECT NAME: INDUSTRIAL SAFETY**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 3 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 0% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Open Elective 1 |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | explain the basic terminology, legislation and standards involved in Industrial Safety. |
| 2 | recognising the factors contributing towards Industrial Hazards and Accidents. |
| 3 | apply various preventive measures to ensure Industrial Safety. |
| 4 | demonstrate the concept of Wear and Corrosion and their prevention. |
| 5 | identify of faults in machine tools and their general causes |
| 6 | demonstrate the concept of Periodic and preventive maintenance. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Industrial safety** | Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods. | **6** |
| **Unit 2** | **Fundamentals of maintenance engineering** | Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment. | **6** |
| **Unit 3** | **Wear and Corrosion and their prevention:** | Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods. | **8** |
| **Unit 4** | **Fault tracing** | Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes. | **8** |
| **Unit 5** | **Periodic and preventive maintenance** | Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance. | **8** |

**Text Books:**


1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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**SUBJECT CODE: MPE-121**
**SUBJECT NAME: OPERATIONS RESEARCH**

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|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 3 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 0% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Open Elective 1 |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | apply the dynamic programming to solve problems of discreet and continuous variables. |
| 2 | apply the concept of non-linear programming. |
| 3 | carry out sensitivity analysis. |
| 4 | model the real world problem and simulate it. |

**Detailed Contents:**

| S.No. | Title | Content details | Credit Hrs. |
|---|---|---|---|
| **Unit 1** | **Introduction** | Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models. | **8** |
| **Unit 2** | **Linear Programming Problem (LPP)** | Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming. | **6** |
| **Unit 3** | **Nonlinear programming** | Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT. | **6** |
| **Unit 4** | **Scheduling and sequencing** | single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming | **8** |
| **Unit 5** | **Competitive Models** | Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation. | **8** |

**Text Books:**


1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010


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**SUBJECT CODE: MPE-122**
**SUBJECT NAME: COMPOSITE MATERIALS**

| | |
|---|---|
| **Programme:** M. Tech. (PE) | **L:** 3 **T:** 0 **P:** 0 |
| **Semester:** 3 | **Teaching Hours:** 36 |
| **Theory/Practical:** Theory | **Credits:** 3 |
| **Internal Marks:** 50 | **Percentage of Numerical/Design/Programming Problems:** 0% |
| **External Marks:** 100 | **Duration of End Semester Exam(ESE):** 3hr |
| **Total Marks:** 150 | **Status:** Open Elective 1 |

**Additional Material Allowed in ESE: Scientific Calculator**

**On completion of the course, the student will have the ability to:**

| CO#. | **Course Outcomes (Cos)** |
|---|---|
| 1 | identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites. |
| 2 | develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products. |
| 3 | analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites. |
| 4 | apply knowledge of composite mechanical performance and manufacturing methods to a composites design project |
| 5 | critique and synthesise literature and apply the knowledge gained from the course in the design and application of fibre-reinforced composites. |

**Detailed Contents:**

| **S.No.** | **Title** | **Content details** | **Credit Hrs.** |
|---|---|---|---|
| **Unit 1** | **Introduction** | Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. | **8** |
| **Unit 2** | **Reinforcements** | Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions. | **6** |
| **Unit 3** | **Manufacturing of Metal Matrix Composites** | Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications. | **6** |
| **Unit 4** | **Manufacturing of Polymer Matrix Composites** | Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications. | **8** |
| **Unit 5** | **Strength** | Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations. | **8** |

**Text Books:**


6. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
7. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.


**References:**


4. Hand Book of Composite Materials-ed-Lubin.
5. Composite Materials – K.K.Chawla.
6. Composite Materials Science and Applications – Deborah D.L. Chung.
7. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.


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