Master of Technology

In

Mechanical Engineering (Manufacturing)

Course Structure & Syllabus

Department of Mechanical Engineering

National Institute of Technology Hamirpur

Hamirpur (HP) – 177005, India

Course Structure of M.Tech. Mechanical Engineering (Manufacturing)

SEMESTER-I

Sr. No.	Course No.	Course Name	Teaching Schedule			Hours/ week	Credit
			L	T	P		
1	ME-651	Theory of Casting and Welding	4	0	0	4	4
2	ME-652	Computer Integrated Manufacturing Systems	4	0	0	4	4
3	ME-653	Logistics and Supply Chain Management	4	0	0	4	4
4	ME-7MN	Programme Elective- I	4	0	0	4	4
5	ME-7MN	Programme Elective –II	4	0	0	4	4
6	ME-654	Manufacturing Engineering Lab-I	0	0	4	4	2
Total			**20**	**0**	**4**	**24**	**22**

Programme Elective-I & II: List of Programme Electives is given in the Annexure.

SEMESTER-II

Sr. No.	Course No.	Course Name	Teaching Schedule			Hours/ week	Credit
			L	T	P		
1	ME-661	Machining Science and Technology	4	0	0	4	4
2	ME-662	Mechatronics and Robotics	4	0	0	4	4
3	ME-663	Quality System and Reliability Engineering	4	0	0	4	4
4	ME-7MN	Programme Elective –III	4	0	0	4	4
5	ME-7MN	Programme Elective –IV	4	0	0	4	4
6	ME-664	Manufacturing Engineering Lab-II	0	0	4	4	2
Total			**20**	**0**	**4**	**24**	**22**

Programme Elective-III & IV: List of Programme Electives is given in the Annexure.

SEMESTER-III

Sr. No.	Course No.	Course Name	Hours/week	Credit
1	ME- 800	M.Tech. Dissertation	--	20
Total				**20**

SEMESTER-IV

Sr. No.	Course No.	Course Name	Hours/week	Credit
1	ME- 800	M.Tech. Dissertation	--	20
Total				**20**

Total Credit of the Programme = 84

Annexure
List of Programme Electives

Programme Elective-I:

ME-721: Materials and Materials Characterization

ME-722: Design and Analysis of Experiments

ME-723: Product Lifecycle Management

Programme Elective-II:

ME-726: Additive Manufacturing Technologies

ME-727: Computer Aided Design for Manufacturing

ME-728: Tool Design

Programme Elective-III:

ME-731: Optimization Methods in Engineering

ME-732: Soft Computing Methods in Engineering

ME-733: Finite Elements in Engineering

Programme Elective-IV:

ME-736: Metal Forming Processes and Analysis

ME-737: Laser Material Processing

ME-738: Manufacturing of Non-Metallic Products

Course Name: **Theory of Casting and Welding**

Course Code: **ME-651**

Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge of design of different components related to casting such as pattern, core, gate, riser etc.
- To understand the concepts of cooling and solidification of metal and alloys in casting processes.
- To impart the knowledge of the physics involved behind different welding techniques.
- To impart knowledge of advanced welding processes such as underwater welding, welding in space.

Course Content

Theory of Metal Casting: Overview and Classification, Mould Parting Analysis, Pattern Design; Core Design; Gating Design and Analysis: Mould Filling Characteristics, Fluidity and Turbulence, Types of Gating Element Design, Mould Filling Analysis Including Effect of Different Head Losses, Cooling and Solidification, Solidification of Pure Metals and Alloys, Nucleation and Growth, Progressive and Directional Solidification, CFR; Mathematical Treatment of Solidification (Solidification Time and Rate): Insulating Mould, Predominant Interface Resistance, Constant Casting Surface Temperature, Predominant Resistance in Mould and Solidified Metal, Feeder Design and Analysis: Feeder Shapes and Location, Risering Curves, NRL Method of Riser Design, Risering of Complex Casting, Feeding Distance and Riser Placement, Feed Aid Design.

Theory of Metal Welding: Overview and Classification of Welding Processes, Theory of Arc Welding: Physics of Welding Arc, Welding Power Sources, Constructional Features, Static and Dynamic Characteristics, Duty Cycle, Welding arc Characteristics and its Relationship with Power Source, Arc Efficiency, Arc Below; Metal Transfer: Classification, Forces Acting on The Drop, Metal Transfer Mechanism, Transition Current, Melting Rate, Effect of Polarity, Deposition Efficiency; Theory of Resistance Welding: Principle of Contact Resistance, Calculation of Current, Time and Voltage for Spot Welding, Choice of Electrode Material, Electrode Shapes, Shunt Current, Theory of Electron Beam Welding, Ultrasonic Welding, Explosive Welding, Friction Stir Welding, Electromagnetic Pulse Welding, High Velocity Projectile Impact Welding, Welding of Plastic, Underwater Welding and Welding in Space, Welding of Cryogenic Materials, Thermal Stresses and Distortion in Welded Structures.

Course Outcomes

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

CO1: Identify the process requirements to manufacture a specific product by casting and welding processes.

CO2: Describe the effects of various parameters on the quality of the product produced.

CO3: Describe the mechanism of metal transfer in electric arc welding.

CO4: Assess the various potential areas in manufacturing industries where the knowledge of advanced welding processes can of great use.

Books and References

1. Fundamentals of Metal Casting by R. A. Flinn, Addison Wesley.
2. Manufacturing Science by Ghosh and Malik, East West Press New Delhi.
3. The Physics of Welding by J. F. Lancaster, Pergamon Press.
4. Principles of Welding by R.W. Messler, John Wiely & Sons.

Course Name: **Computer Integrated Manufacturing Systems**
Course Code: **ME-652**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To introduce process of simplification of production processes, product designs, and factory organization.
- To impart knowledge about automation of production processes and a business functions that support them.
- To enable and integrate all production and support processes using networks and other information. Technologies.

Course Content

Introduction: Manufacturing Enterprise: External and Internal Challenges, World-Class Order-Winning Criteria, CIM- Definition, Benefits and Implementation Steps, Manufacturing Systems: Classification, Elements or Sections of a Typical Manufacturing Organization, Structure and Functional Areas of CIM System-CAD, CAPP, CAM, CAQC, ASRS, Advantages of CIM.

Planning and Scheduling Functions in CIM System: Aggregate Production Planning (APP), Master Production Schedule (MPS), Material Requirement Planning (MRP), Capacity Requirement Panning (CRP), Manufacturing Resource Planning (MRP-II), Just-in-Time Production Systems and Concept of Enterprise Resource Planning (ERP).

Computer-Aided Process Planning: Approaches–Variant and Generative, Feature Classification and Recognition, Process Classifications and Selections, Machines and Tool Selection, Setting Process Parameters, Process Sheet Documentation.

Database and Communication in CIM System: Data Communication Technologies, Database Management Technologies, Automated Data Collection in Shop Floor.

Flexible Manufacturing Systems: Introduction, Configurations of Workstations, Planning, Applications and Benefits, Cellular Manufacturing, Group Technology.

Intelligent Manufacturing Techniques: World Class Manufacturing, Lean Manufacturing, Agent Technology, Reengineering, Material Requirement Planning, Enterprise Resource Planning, JIT Production System, Kanban System, Automation, Automated Material Handling, Storage and Retrieval Systems.

Course Outcomes

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

CO1: Identify multiple factory floor functions which could be integrated through computer assisted applications.
CO2: Describe structure and functional areas of CIM system.
CO3: Apply principles of intelligent manufacturing techniques.
CO4: Assess the direct control and monitoring of all the manufacturing oriented operations.

Books and References

1. Computer-Integrated Manufacturing by J.A. Rehg and W.K. Henry, Pearson Education, New Delhi.
2. Automation Production Systems and Computer-Integrated Manufacturing by M.P. Groover, Pearson Education Singapore.
3. Principles of Computer Integrated Manufacturing by S. K. Vajpayee, PHI Delhi.
4. Systems Approach to Computer Integrated Design and Manufacturing by Nanua Singh, John Wiley & Sons, New Delhi.
5. Computer Integrated Manufacturing- An Introduction with Case Studies by Paul G. Ranky, Prentice-Hall International.

Course Name: **Logistics and Supply Chain Management**
Course Code: **ME-653**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about maximization of overall value generated through the connected network of individuals, organizations, resources, activities and technologies involved in the manufacturing.
- To introduce cost reduction mechanism while maintaining quality and timely management of different operational activities.
- To teach how to improve the overall organizational performance and customer satisfaction by improving product and service delivery to customer.

Course Content

Introduction: Concepts, Drivers and Obstacles, Planning Demand and Supply in a Supply Chain, Demand Forecasting.

Physical Distribution: Participation in the Physical Distribution Functions, The Environment of Physical Distribution, Channel Design Strategies and Structure, Electing Channel Members, Setting Distribution Objectives and Tasks, Target Markets and Channel Design Strategies.

Logistics Management: Logistics as Part of SCM, Logistics Costs, Different Models, Logistics Subsystem, Inbound and Outbound Logistics, Bullwhip Effect in Logistics, Distribution and Warehousing Management.

Purchasing & Vendor Management: Centralized and Decentralized Purchasing, Functions of Purchase Department and Purchase Policies, Use of Mathematical Model for Vendor Rating / Evaluation, Single Vendor Concept, Management of Stores, Accounting for Materials, Aggregate Planning, Management of Inventory in Global Supply Chain.

Supply Chain: Building Blocks of Supply Chain Network, Performance Measures in Decisions in the Supply Chain World, Models For Supply Chain Decision Making, Supply Chain Inventory Management, Economic Order Quantity Models, Recorder Point Models, Multichannel Inventory Systems, Supply Chain Facilities Layout, Capacity Planning, Inventory Optimization, Dynamic Routing and Scheduling. Role of Information Technology in Supply Chain, E-Business and the Supply Chain, Factors Influencing Logistics and Decision, Bench Marking and Performance Measurement, Supply Chain Risk, Reverse Logistics, Green Supply Chain.

Course Outcomes

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

CO1: Identify ways to fulfill customer demand through efficient resources.

CO2: Describe the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from point of origin to point of consumption.

CO3: Apply principles of effective distribution and optimization of pre & post inventory levels.

CO4: Assess the product demand by driving customer value, improving responsiveness, facilitating financial success and building a good network.

Books and References

1. Supply Chain Management by John T. Mentzer, SAGE Publication, New Delhi.
2. Business Logistics/Supply Chain Management by Ballou & Srivastava, Pearson Education, New, Delhi.
3. Supply Chain Logistics Management by Bowersox, Closs and Cooper, Tata McGraw-Hill.
4. Logistics and Supply Chain Management by Martin Christopher, Financial Times Prentice New Delhi.
5. Supply Chain Management: Text and Cases by Janat Shah, Pearson Education, New Delhi.

Course Name: **Machining Science and Technology**
Course Code: **ME-661**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To study the basics and mechanics of metal machining.
- To study the different types of cutting tools, tool materials & geometry of cutting tools.
- To understand the details of grinding process.
- To learn introductory concepts of various advanced machining processes.

Course Content

Introduction: Need and Classification of Machining Processes, Types of Studies in Machining Processes – Experimental and Theoretical.

Cutting Machining: Mechanics of Turning, Drilling and Milling, Specifications of Cutting Tools for Turning, Drilling and Milling, Measurement of Cutting Forces and Temperature.

Abrasive Machining: Mechanics of Abrasive Grinding, Specification of Grinding Wheel, Classifications of Grinding Processes, Wheel Conditioning, Elastic Emission Machining.

Erosive Machining: Process Principle, Applications, Equipments, Process Analysis and Tool Design of Electro-Discharge Machining (EDM), Ultrasonic Machining (USM) and Electro-Chemical Machining (ECM), Process Principle, Applications and Equipments for Beam Machining Processes (LBM, EBM and IBM), Jet Machining Processes: (AJM, WJM, AWJM and IWJM), Chemical Machining Processes (CHM, PCM and BCM).

Course Outcomes

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

CO1: Describe the mechanism of metal removal in different machining processes.
CO2: Describe the effect of different grinding and dressing parameters on forces and surface integrity.
CO3: Implement the knowledge of advanced machining processes to machine the components made of difficult-to-machine materials.
CO4: Describe the various aspects of tool design in advanced machining processes.

Books and References

1. Introduction to Machining Science by G. K. Lal, New Age International Publisher Limited, New Delhi.
2. Principles of Abrasive Processing by M. C. Shaw, Clarendon Press.
3. Advanced Machining Processes by V. K. Jain, Allied Publisher, Mumbai.
4. Advanced Machining Processes by Hassan El-Hofy, Mc-Graw Hill Inc., New York.
5. Advanced Methods of Machining by J. A. Mc Gough, Chapman and Hall, London.

Course Name: **Mechatronics and Robotics**

Course Code: **ME-662**

Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To develop an ability to identify, formulate, and solve engineering problems.
- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
- To develop ability to integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.

Course Content

Mechatronics: Definition and Approach of Mechatronics, Measurement and Control Systems, Microprocessor Based Controllers and Mechatronics Approach; Sensors and Transducers: Performance Terminology, Displacement, Velocity, Position, Proximity, Force, Fluid Pressure, Liquid Level, Temperature, Light Sensors, Procedure for Selection; Signal Conditioning: Op Amp, Protection, Digital Signals, Multiplexes and Digital Signal Processing, Pulse Modulation; Pneumatic and Hydraulic Systems: Actuation Systems, Directions, Pressure and Process Control Valve, Pneumatic and Hydraulic Systems; Electrical Actuation System: Mechanical Switches, Solid State Switches, Solenoid, DC/AC Motors, Stepper Motors; Microprocessor and its Application: Architecture of Microprocessor 8085, Instruction Set, Embedding a Microprocessor into a Mechatronics System.

Robotics: Need and Classifications of Robots, Robot Peripherals, Sensors, Machine Vision: Image Processing & Analysis, Application of Artificial Intelligence, Voice Communication; Robot Control Units: Motion Controls. Robot Kinematics, Homogeneous Transformations, Forward & Inverse Kinematics, Problems of Dynamics, Differential Relationships, Motion Trajectories, Dynamics of Robot Control of Single & Multiple Link Robot, Static Force Analysis.

Robot Programming: Different Languages Expert Systems. Robot Applications in Manufacturing, Material Transfer & Machine Loading/Unloading, Processing Operations, Inspection, Automation, Robot Cell Design, Control, Recent Developments and Special Applications, Micro & Bio Robotics.

Course Outcomes

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

CO1: Model and analyze electrical and mechanical systems and their interconnection.

CO2: Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.

CO3: Demonstrate knowledge of electrical circuits and logic design.

Books and References

1. Mechatronics: Principles, Concepts and Applications by Mahalik, TMH New Delhi.
2. Mechatronics by HMT, TMH New Delhi.
3. Mechatronics by W. Bolton, Pearson Education.
4. Robotic Technology and Flexible Automation by S.R Deb, TMH New Delhi.
5. Industrial Robotics by Fu & Gonzales, TMH New Delhi.

Course Name: **Quality System and Reliability Engineering**

Course Code: **ME-663**

Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To define a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives.
- To coordinate and direct an organization's activities to meet customer and regulatory requirements to improve its effectiveness and efficiency on a continuous basis.

Course Content

Fundamental of Quality: Contribution of Quality Gurus, Quality Cost, Statistical Process Control & Process Capability, Acceptance Sampling Plans for Attribute and Variable, Taguchi Quality Loss Function and Concept of Robust Design, Concept of Six Sigma, FMEA, QFD, Poka Yoke, ISO 9000 Series of Standard, QS 9000, TQM, Quality Circles. Benchmarking.

Statistical Quality Control (SQC): Definition, Benefits and Limitation of SQC, Quality Assurance, Quality Cost, Variation in Process & Process Capability, Process Capability Studies and Simple Problems, Theory of Control Chart, Uses of Control Chart, Control Chart for Variables-X Chart, R Chart and S Chart.

Process Control for Attributes: Control Chart for Attributes , Control Chart for Proportion or Fraction Defectives - p Chart and np Chart, Control Chart for Defects - C and U Charts, State of Control and Process Out of Control Identification in Charts, Acceptance Sampling, Lot By Lot Sampling, Types – Probability of Acceptance in Single, Double, Multiple Sampling Techniques, O.C. Curves Producer's Risk and Consumer's Risk, AQL, LTPD, AOQL Concepts, Standard Sampling Plans for AQL and LTPD, Uses of Standard Sampling Plans.

Reliability: Life Testing, Objective, Failure Data Analysis, Mean Failure Rate, Mean Time to Failure, Mean Time Between Failure, Hazard Rate, System Reliability, Series, Parallel and Mixed Configuration, Simple Problems, Maintainability and Availability, Simple Problems, Acceptance Sampling Based on Reliability Test, O.C. Curves, Quality and Reliability, Reliability Improvement Techniques, Use of Pareto Analysis, Design for Reliability, Redundancy Unit and Standby Redundancy, Optimization in Reliability, Product Design, Product Analysis, Product Development, Product Life Cycles.

Integrated Quality Control: Contemporary Developments in the Field of Quality Management, The Role of Quality Control in the Modern Enterprise, Responsibility as a Result of Poor Quality, Quality and Standardization, Fundamental Concepts of the Croatian Legislation, Norms and Standard System.

Course Outcomes

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

CO1: Identify three components of quality system: high accuracy, compliance with applicable standards, and high customer satisfaction.

CO2: Describe the ways to induce quality in every segment of manufacturing organization.

CO3: Apply principles of Total Quality Management.

CO4: Assess each measure of Quality and Reliability to insure product's competency in world market.

Books and References

1. Statistical Quality Control by V. Grant, Eugene, McGraw-Hill, New Delhi.
2. Reliability Engineering by L.S. Srinath, Affiliated East West Press, New Delhi.
3. Statistical Quality Control by R.C. Gupta, Khanna Publishers, Delhi.
4. Quality Control by D.H. Biesterfield, Prentice Hall, Delhi.
5. Practical Reliability Engineering by Connor, John Wiley, Delhi.

Course Name: **Materials and Materials Characterization**

Course Code: **ME-721**

Course Type: **Programme Elective-I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To provide a recapitulation to the basics of different engineering materials.
- To provide the understanding of surface texture, surface roughness parameters, surface roughness measuring instruments and techniques.
- To provide a thorough introduction to the principles and practice of diffraction.
- To provide basic description of a range of common characterization methods for the determination of the structure and composition of solids.

Course Content

Introduction to Materials: Scope and Classification of Engineering Materials, Types, Properties and Applications of Metals and Alloys, Super Alloy, Polymers, Ceramics, Composites, Piezoelectric Materials (PZT) and Shape Memory Alloys (SMA).

Surface Texture Characterization: Surface Texture, Components of Surface Texture, Distinction between Flat and Smooth Surfaces, Parameters used in Surface Roughness Measurement and their Significance, Surface Roughness Measuring Instruments and Techniques.

Scanning Electron Microscopy (SEM): Theory and Principles, Construction, Controls and Operation of Scanning Electron Microscopy, Electron Gun Parameters, Imaging Parameters, Image Contrast (Topographic and Atomic Number Contrasts), Environmental Scanning Electron Microscopy, High Resolution SEM Imaging, EDS/EDAX Analysis.

Transmission Electron Microscopy (TEM): Theory and Principles, Construction and Controls.

Electron Micro Probe Analyzer: Theory and Principles, Quantitative and Qualitative Analysis.

X-ray Diffraction (**XRD):** Principle, Crystallography and Rietveld Analysis, Quantitative and Qualitative Analysis, Residual Stress Analysis, Determination of Layer Thickness, Small Angle X-Ray Scattering (SAXS), Atomic Pair Distribution Function.

Atomic Force Microscopy (AFM): Principle, Sample Preparation and Mounting, Scanning Techniques, Image Capturing, Manipulation and Analysis Techniques.

Thermal Analysis: Principles and Applications of Thermal Analysis, Dynamic Mechanical Analyzer. Mechanical Property Characterization

Electron Microscopy Techniques: Principles and Characterization Techniques Related to Measurement of Tensile, Compressive, Hardness, Fatigues and Fracture Toughness Properties.

Course Outcomes

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

CO1: Understand the fundamental of engineering materials and surface texture.
CO2: Describe theory and practice of X-ray and electron diffraction.
CO3: Identify basic elements of electron microscopy.
CO4: Identify basic aspects of optical characterization methods.

Books and References

1. Materials Science and Engineering: An Introduction by William D. Callister and David G. Rethwisch, Wiley.
2. Elements of X-Ray Diffraction by B.D. Cullity, Prentice Hall, New Delhi.
3. Fundamental of Light Microscopy and Electronic Imaging by Douglas B. Murphy, Kindle Edition.
4. Engineering Metrology by R. K. Jain, Khanna Publishers.

Course Name: **Design and Analysis of Experiments**
Course Code: **ME-722**
Course Type: **Programme Elective-I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To design the experiment that aims to describe the variation of information under conditions those are hypothesized to reflect the variation.
- To predict the outcome by introducing a change of the pre-conditions which is represented by one or more independent variables by identifying control variables.
- To explore main concerns in experimental design that includes the establishment of validity, reliability, and replicability.

Course Content

Introduction, Basic Principles and Applications of Experimental Design, Statistical Methods, Sampling and Sampling Distributions, Randomized Designs, Paired Comparison Designs, Mean and Variances of Normal Distribution, Analysis of Variance (ANOVA); Checking of Model Adequacy, Practical Interpretation of Results, Determination of Sample Size, The Random Effects Model, The Regression Approach to the ANOVA, Non Parametric Methods, Experiments With Blocking Factors, Latin Square Design, Graeco-Latin Square Design and Balanced Incomplete Block Designs; Factorial Experiments; Two Factor Factorial Design and General Factorial Design, Fitting Response Curves and Surfaces, Blocking in a Factorial Design. Two-Level Factorial Designs; 2^2 and 2^3 Design, General 2^k Design: Single Replicate and un-replicated, Addition of Center Points, Blocking and Confounding; Factorial Design in Two Blocks; Two-Level Fractional Factorial Designs; General 2^{k-P} Fractional Factorial Design; Regression Modeling and Linear Regression Models; Hypothesis Testing in Multiple Regression, Prediction of New Regression Observations, Regression Model Diagnostics, Testing for Lack of Fit; Response Surface Methodology: Introduction, Method of Steepest Ascent, Analysis of a Second Order Response Surface; Experimental Design for Fitting Response Surface; Experiments with Computer Models, Random Effects Models; Two-Factor Factorial with Random Factor and Two-Factor Mixed Model, Rules for Expected Mean Square; Approximate *F* Tests; Non Normal Response and Transformations, Unbalanced Data in a Factorial Design, Analysis of Covariance, Repeated Measures.

Course Outcomes

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

CO1: Identify and select suitable experimental design for the study.
CO2: Describe the variation of information under conditions those are hypothesized to reflect the variation.
CO3: Apply the principles of statistics.
CO4: Assess the risk of measurement error and selecting the suitable variables for the study.

Books and References

1. Design and analysis of experiments by D.C. Montgomery, Wiley.
2. Design and analysis of experiments by Angela M. Dean and Daniel Voss, Springer.
3. Experiments: Planning, analysis and optimization by C.F. Jeff Wu and S. Michael, Hamada Publishers.

Course Name: **Product Lifecycle Management**
Course Code: **ME-723**
Course Type: **Programme Elective-I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To understand how the life of a product passes through multiple phases, involves many professional disciplines, and requires many skills, tools and processes.
- To get familiar with the strategies involved in each life cycle stage so that the offering should be managed efficiently for the buyers to get value from it.

Course Content

Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications, PLM Strategies: Industrial Strategies, Strategy Elements, Its Identification, Selection and Implementation, Developing PLM Vision and PLM Strategy , Change Management for PLM.

Product Development: Definition and Objective, Role of Designer in Product Development, Manufacturing & Economic Aspects of Product Development, Product Promotion & Development. Integration of Environmental Aspects in Product Development: Sustainable Development, Design For Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.

Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.

Technology Forecasting (TF): Evolution for TF and its Importance, Role of TF in Different Phases of PLM, Future Mapping, Methods of Technology Forecasting: Relevance Trees, Morphological Methods and Mission Flow Diagram, Combining Forecast of Different Technologies.

Course Outcomes

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

CO1: Identify various stages involved in the life cycle of a product.
CO2: Describe the various types of analysis involved, once the product is designed and put into market
CO3: Apply principles of cost analysis.
CO4: Assess and enable the organizations to overcome the increased complexity and engineering challenges of developing new products for the global competitive markets.

Books and References

1. Product Lifecycle Management: Driving the Next Generation of Lean Thinking by Michael Grieve, Tata McGraw Hill.
2. Product Lifecycle Management: Paradigm for 21st Century Product Realization by John Stark, Springer-Verlag.
3. Product Design for the Environment-A life Cycle Approach by Fabio Giudice and Guido La Rosa, Taylor & Francis.

Course Name: **Additive Manufacturing Technologies**

Course Code: **ME-726**

Course Type: **Programme Elective-II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To acquaint students with the concept of Additive Manufacturing (AM), various AM technologies, selection of materials for AM, modeling of AM processes, and their applications in various fields.

Course Content

Introduction: Traditional Manufacturing v/s Additive Manufacturing (AM); Computer Aided Design (CAD) and AM; AM Process Chain; Application Level: Direct Processes, Rapid Prototyping, Rapid Tooling, Rapid Manufacturing; Indirect Prototyping and Tooling, Indirect Manufacturing, Simultaneous Engineering and Additive Manufacturing Technologies (AMT), Support Structure in AM, Generation of Physical Layer Modelling: Virtual Prototyping. Tessellation (STL Format) and Tessellation Algorithms. Defects in STL Files and Repairing Algorithms. Various Slicing Procedures. Accuracy and Surface Quality in AM, Effect of Part Orientation on Accuracy, Surface Finish, Build Time and Cost; Various Rapid Tooling Techniques. Introduction to Reverse Engineering.

Materials for AM: Different Materials used for AM. Use of Multiple Materials, Multi-Functional and Graded Materials in AM. Role of Solidification Rate. Evolution of Non-Equilibrium Structure, Structure Property Relationship. Grain Structure and Micro-Structure.

Technologies of AM: Liquid Based-Stereo Lithography and Solid Ground Curing; Powder Based-Selective Laser Sintering and Three-Dimensional Printing; Solid Based-Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM), Micro and Nano AM Processes.

Mathematical Models for AM Processes: Transport Phenomena Models; Temperature, Fluid Flow and Composition, Buoyancy Driven Flow, Surface Tension Driven Free Surface Flow (Study of Molten Pool). Case Studies: Numerical Modelling of Fusion Based AM Process, Powder Bed Melting Based Process, Droplet Based Printing Processes, Residual Stress, Part Fabrication Time, Optimal Orientation and Optimal Layer Thickness. Defects in AM, Role of Transport Phenomenon and its Formation. Simulations (Choice of Parameters, Experimental Data and Comparison between Simulation and Experiments), Model Validation for Different Aspects.

Course Outcomes

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

CO1: Identify areas where the knowledge of additive manufacturing can be applied through the theoretical studies.

CO2: Describe portrayal of additive manufacturing and prototyping, their concepts, techniques, recent trends and challenges for the future.

CO3: Assess the areas where additive manufacturing can make a greater contribution to industrial capabilities.

Books and References

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, by I. Gibson, D. Rosen and B. Stucker, Springer.
2. Rapid Prototyping: Principles and Applications in Manufacturing by Chua C. K. and L. K. Fai, World Scientific Publishing Co., Inc.
3. Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid manufacturing by Andreas Gebhardt, Hanser Publishers.
4. Laser Induced Materials and Processes for Rapid Prototyping by Lu, Fuh and Wong, Springer.

Course Name: **Computer Aided Design for Manufacturing**

Course Code: **ME-727**

Course Type: **Programme Elective-II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To understand the fundamentals of computer based 3D modelling.
- To understand the concepts of analysis, optimization and drafting using specialized software.
- To educate the students to develop the different components using optimized parameters.

Course Content

Introduction: Introduction and Application of CAD and its Applications in Manufacturing, Basic Elements of CAD, Steps of CAD.

Fundamentals of CAD: Modelling 2D and 3D, CAD Modelling Techniques and Their Applications for Modeling of Different Dies and Cutting Tools using Specialized Software

Analysis: Stress Analysis, Temperature Analysis, and Fluid Flow Analysis with respect to Dies and Cutting Tools using Specialized Software.

Optimization: Optimization Techniques and their Application for Design Optimization.

Drafting: Methods of Representation of CAD Output Data in Different Formats and Files.

Applications of CAD: Modelling, Analysis, Optimization and Drafting of Casting Dies of metals, molding dies for plastic products**,** Forging and Extrusion Dies for metals, and cutting tools (single point and multi-point).

Course Outcomes

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

CO1: Model the different dies/cutting tools using solid modelling software.

CO2: Understand the basic principles of CAD analysis, optimization and drafting using specialized software.

CO3: Develop different dies/cutting tools using optimized parameters.

Books and References

1. CAD/CAM Theory and Practice by I. Zeid, Tata-McGraw Hill.
2. Mathematical Elements for Computer Graphics by David Rogers and Adams, McGraw Hill.
3. Solid Modeling by Computers From Theory to Applications by Pickett, Mary S., Boyse, John W. Plenum Press, New York,.
4. Engineering Analysis with ANSYS Software by Tadeusz Stolarski, Y. Nakasone, S. Yoshimoto, Elsevier.
5. Introduction to Solid Modeling using SolidWorks by William E. Howard, Joseph C. Musto, McGraw-Hill.

Course Name: **Tool Design**
Course Code: **ME-728**
Course Type: **Programme Elective-II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To develop competency in understanding different cutting tools and its working principles.
- To understand the tool geometry of single point tools, drill bits and milling cutters.
- To know the forces in different tools while material removal or plastic deformation on the job.
- To understands the different design criteria for dies, jigs and fixtures in conventional and NC machines.
- To select proper material for the design of the tool, dies and fixtures.

Course Content

Introduction: Tool Design – Need and Classification of Tools; Basic Principles of Design of Tools.

Design of Cutting Tools: Basic Requirements, Design of Single Point Cutting Tools, Design of Milling Cutters, Design of Drills, Reamers, Taps and Inserts, Determining Shank Size for Single-Point Carbide Tools, Determining Insert Thickness for Carbide Tools, Design of Chip Breakers and Design of Form Tools.

Design of Holding Tools: Classification of Holding Devices, Locating and Clamping Methods & Devices, Principles of Six-Point Location.

Design of Dies: Need and Classification of Form Dies, Design of Forging Dies, Wire Drawing Dies and Extrusion Dies, Design of Piercing and Blanking Dies, Design of Progressive, Compound and Combination Dies.

Design of Jigs: Type of Drill Bushes, Classification of Drill Jigs, Design of Drill Jigs.

Design of Fixtures: Design of Milling Fixtures, Design of Turning Fixtures.

Design of Press Tool: Introduction to Die Cutting Operations, Introduction to Press and Classifications, Die Set Assembly With Components, Introduction to Centre of Pressure, Examples of Centre of Pressure.

Tool Design for NC Machines: Tool Design for NC Machines; Fixture Design for NC Machine, Cutting Tools for NC Machine, Tool Holding Methods for NC Machine, ATC and APC for NC Machine, Tool Presetting for NC Machine.

Course Outcomes

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

CO1: Understand the design considerations in different cutting and forming tools.

CO2: Understand the analysis and design of the different dies, jigs and fixtures.

CO3: Understand the difference between tool holding and workpiece clamping methods in conventional and NC machines.

Books and References

1. Tool Design by Herman W. Pollack, Prentice Hall.
2. Tool Design by Donaldson, Tata McGraw Hill.
3. Machine Tool Design & Numerical Control by N. K. Mehta, Tata McGraw Hill.
4. CMTI: Machine Tool Design Handbook, Tata McGraw Hill.

Course Name: **Optimization Methods in Engineering**

Course Code: **ME-731**

Course Type: **Programme Elective-III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To formulate the design problems as mathematical programming problems.
- To determine the degree of attainment of the goals with the available resources.

Course Content

Introduction: Introduction, Terminologies, Design Variables and Constraints, Objective Function, Variable Bounds, and Problem Formulation.

Linear Programming Based Methods: Simplex Method, Duality in Linear Programming. Single Variable Optimization Problems: Optimality Criterion; Bracketing Methods: Exhaust Search Method, Bounding Phase Method; Region Elimination Methods: Interval Halving Method, Fibonacci Search Method, Golden Section Method, Successive Quadratic Estimation Method.

Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method. Multi-variable Optimization Algorithms: Optimality Criteria, Unidirectional Search, Direct Search Methods: Box Method, Hooke-Jeeves Pattern Search Method, Powell's Conjugate Direction Method, Gradient Based Methods: Cauchy's Steepest Descent Method, Newton's Method, Marquan Method, Conjugate Gradient Method, Variable-Metric (DFP) Method.

Constrained Optimization Methods: Kuhn Tucker Conditions, Transformation Methods: Penn Function Method, Method of Multipliers (MOM), and Sensitivity Analysis.

Specialized Optimization Methods: Integer Programming: Penalty Function Method, Branch and Bo' Method, Geometric Programming.

Non-Traditional Optimization Methods: Genetic Algorithms, Simulated Annealing, Tabu Search and Ant Colony Optimization, Particle Swarm Optimization; Applications to Engineering Optimization Problems.

Course Outcomes

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

CO1: Identify the required techniques to achieve a desired set of objectives.

CO2: Describe the best satisfying solution under a varying amount of resources and priorities of the goals.

CO3: Apply principles of resource optimization.

CO4: Assess the suitability of technique for optimizing the real world problem.

Books and References

1. Optimization for Engineering Design: Algorithms and Examples by Kalyanmoy Deb, Prentice Hall of India Private Limited, New Delhi.
2. Multi-Objective Optimization using Evolutionary Algorithms by Kalyanmoy Deb, Wiley India Pvt. Ltd., New Delhi.
3. Engineering Optimization: Theory and Practice by S.S Rao, New International (P) Limited Publishers, New Delhi.
4. Engineering Optimization - Methods and Applications by Ravindran, Ragsdell and Rekla, John Wiley & Sons, Delhi.

Course Name: **Soft Computing Methods in Engineering**

Course Code: **ME-732**

Course Type: **Programme Elective-III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To cover fundamental concepts used in soft computing.
- To understand concepts of Fuzzy Logic (FL) and Artificial Neural Networks (ANNs) and optimization techniques using Genetic Algorithm (GA).
- The course will provide exposure to theory as well as practical systems and software.

Course Content

Introduction to Soft Computing: Need and Classification of Soft Computing Methods

Artificial Neural Networks: Characteristics, Learning Methods, Taxonomy, Evolution of Neural Networks, Basic Models,, Important Technologies, Applications, Single Layer Perceptron's, Multi-1 Feed-Forward Neural Networks, Learning Processes, Radial Basis Function Networks, Recurrent Networks, Principal Component Analysis; Applications of ANN in Engineering.

Fuzzy Sets and Fuzzy Logic: Operations on Fuzzy Sets Crisp Relations and Fuzzy Relations, Cartesian Product of Relation, Classical Relation, Fuzzy Relations, Tolerance and Equivalence Relations, Non-Iterative Fuzzy Sets, Genetic Algorithm, Introduction, Biological Background, Traditional Optimization and Search Techniques, Genetic Basic Concepts, Membership Functions, Features, Fuzzification, Methods of Membership Value Assignments, Defuzzification, Lambda Cuts, Methods, Fuzzy Arithmetic and Fuzzy Measures, Fuzzy Arithmetic Extension Principle, Fuzzy Measures, Measures of Fuzziness, Fuzzy Integrals, Fuzzy Rule Base and Approximate Reasoning, Truth Values and Tables, Fuzzy Propositions, Formation of Rules, Decomposition of Rules, Aggregation of Fuzzy Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Overview of Fuzzy Expert System, Fuzzy Decision Making, Applications of Fuzzy systems in Engineering.

Genetic Algorithm: Genetic Algorithm and Search Space, General Genetic Algorithm, Operators, Generational Cycle, Stopping Condition, Constraints, Classification, Genetic Programming, Multilevel Optimization, Real Life Problem, Applications of GA in Engineering.

Course Outcomes:

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

CO1: Indentify the idea of conceptual intelligence in machines.

CO2: Describe the reasoning, thinking, analyzing and detecting that correlates the real world problems to the technically inspired methods.

CO3: Apply principles of extension of Heuristics: Neural Networking, Fuzzy Logics and Genetic Algorithm.

CO4: Assess more complex systems which are often remained intractable to conventional mathematical and analytical methods.

Books and References

1. Neural Networks: A Comprehensive Foundation by S. Haykin, Pearson.
2. Fuzzy Logic with Engineering Application by T. J. Ross, John Wiley and Sons.
3. Evolutionary Computation by D.B. Fogel, IEEE Press.

Course Name: **Finite Elements in Engineering**

Course Code: **ME-733**

Course Type: **Programme Elective-III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- The main objective of this subject is to provide a practical training in engineering design using finite element methods.
- To use the methods in practice and to critically assess and evaluate the results.

Course Content

Introduction: Concept of Finite Element Method (FEM), History, FEM Based Packages, Applications of FEM, Approaches of FEM: Galerkin's and Raleigh-Ritz, Step by Step Procedure of FEM Applications.

FEM for 1-D Heat Transfer and Stress Analysis Problems: Governing Equation and Boundary Conditions for Describing Steady State Problems of Heat Transfer (Fin and Composite Wall) and Stress Analysis (Axial Deformation of Bar); Finite Element Formulation Following the Steps of Integral Formulation, Discretization and Polynomial Approximation using Standard 1-D Elements; Development and Evaluation of Elemental Matrices; Assembly of Matrices using Assembly Rules, Imposition Procedure for Application of Essential Boundary Conditions and Numerical Solution of Finite Element Equations; Post Computation of the Solutions.

FEM for 2-D Heat Transfer Problems: General Governing Equation and Boundary Conditions for Describing Steady State 2-D Problems of Heat Transfer; Finite Element Formulation Following the Steps of Integral Formulation, Discretization and Polynomial Approximation using Standard 2-D Elements; Development and Evaluation of Elemental Matrices; Assembly Rules, Imposition Procedure of Essential Boundary Conditions and Numerical Solution of Finite Element Equations; Post Computation of the Solutions.

FEM for 2-D Stress Analysis Problems: Governing Equation and Boundary Conditions for Describing Steady State Plane and Axisymmetric Elastic Stress Analysis Problems: Finite Element Formulation Following the Steps of Integral Formulation, Discretization and Polynomial Approximation using Standard 2-D Elements, Development and Evaluation of Elemental Matrices; Assembly Rule, Imposition of Essential Boundary Conditions and Numerical Solution of Finite Element Equations; Post Computation of the Solutions.

Software Practices: Finite Element Analysis on a Software System for Finding Solution of FEM Based Real Life Problems Related to Heat Transfer and Stress Analysis.

Course Outcomes

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

CO1: Recognize the significance and importance of finite elements to the professional engineer.

CO2: Provide experience of developing good models and how to interpret the numerical results in engineering.

Books and References

1. Introduction to Finite Elements in Engineering by Chandrupatla and Belegundu, PHI, New Delhi.
2. The Finite Element Method in Engineering by S.S. Rao, Butterworth Heinemann, Boston.
3. An Introduction to the Finite Element Method by J.N. Reddy, TMH, New Delhi.
4. The Finite Element Method using MATLAB by Kwon and Bang, CRC Press, New York.

Course Name: **Metal Forming Processes and Analysis**

Course Code: **ME-736**

Course Type: **Programme Elective-IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge of different metal forming processes.
- To impart knowledge of different theories/theorem of metal forming.
- Forming load and power estimation during different metal forming processes.
- To make the students aware about the effect of different process parameters and their controlling.

Course Content

Introduction to Plasticity: Overview and Classification of Metal Forming Processes, Criteria of Yielding and Flow Rules under Complex State of Stress, Consideration of Friction and Temperatures in Metal Forming, Plastic Anisotropy and Instability.

Analysis using Equilibrium Theorem: Principle of Slab Method and its Application for Load and Power Calculation in Forging of Hollow Disc, Drawing of Tubes and Non-Circular Wires, Extrusion through Curved Dies, Rolling with Flat Rolls and Angular Rolls.

Analysis using Limit Theorem: Understanding of Upper Bound Theorem and its Applications for Plane Strain Forging, Axisymmetric Upsetting, Plane Strain Drawing, Plane Strain and Axisymmetric Extrusion.

Analysis using Slip Line Theorem: Theory of Slip Lines, Velocity Equations, Velocity and Stress Discontinuities, Hencky's Theorem, Construction of Slip Line Fields and Hodograph, Application of Slip Line Field Technique in Plane Strain Forging, Indentation by Flat and Wedge Shape Punch and Plain Strain Drawing.

Course Outcomes

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

CO1: Select the suitable forming process for a particular component as per its application and use.

CO2: Apply different theorems for finding load and power for metal forming processes.

CO3: Describe the relation between friction and temperature generation in metal forming process.

Books and References

1. Introduction to Engineering Plasticity by Lal and Reddy, Narosa Pub. House, New Delhi.
2. Metal Forming Processes and Analysis by B. Avitzur, McGraw Hill Inc.
3. Fundamental of Metal Forming Processes by Juneja, New Age Inc. Publisher.
4. Plasticity for Mechanical Engineers by Johnson and Mellor, Nostrand Co. London.
5. Mathematical Theory of Plasticity by Hill, Oxford Unversity Press, Oxford.

Course Name: **Laser Material Processing**

Course Code: **ME-737**

Course Type: **Programme Elective-IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart in-depth knowledge of laser assisted processes such as laser machining, laser welding, laser heat treatment, laser glazing, laser alloying etc.
- To brief the students about the interaction of laser with different metals, alloys, ceramics, polymers and composites.

Course Content

Introduction: Concept of Laser, Basic Mechanisms in Lasers, Properties of Laser, Types of Laser, Gas, Liquid and Solid-State Lasers; Pulsed and CW Lasers.

Laser-Material Interaction: Interaction of Laser with Metals, Ceramics, Polymers, Composites and other Materials; Laser Heating Fundamentals.

Laser Forming: Process Principle, Analysis and Applications of Laser Forming Processes such as Bending and Deep Drawing.

Laser Machining: One, Two and Three-Dimensional Laser Machining, Process Principle, Analysis and Applications of Laser Drilling, Cutting, Turning, and Milling Processes, Laser Assisted Machining (LAM).

Laser Welding: Principles, Significance of Laser Welding Variables, Laser Welding of Various Materials Including Steel, Aluminum and its Alloys and Titanium and its Alloys.

Laser Heat Treatment: One Dimensional Thermal Heating and Cooling of Metals, Mechanisms of Hardening in Steel and Cast Irons.

Lasers Surface Engineering: Laser Glazing, Laser Alloying, Microstructural Considerations in Laser Rapid Heating Process.

Course Outcomes

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

CO1: To select the best suitable laser for processing of different work piece materials.

CO2: To study the parametric influences during laser material processing.

CO3: To understand the theoretical model of laser material processing.

Books and References

1. Laser Material Processing by W.M. Steen, Springer.
2. Laser Materials Processing by M. Bass, North Holland Publishing Co., Amsterdam.
3. Laser Machining- Theory and Practice by G. Chryssolouris, Springer Verlog, NY Inc.
4. Industrial Lasers and Their Applications by J.T. Luxon and D.E Parker, Prentice-Hall, Englewood Cliffs, NJ.

Course Name: **Manufacturing of Non-Metallic Products**

Course Code: **ME-738**

Course Type: **Programme Elective-IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the structure and properties of non-metallic materials, their specific applications, processing techniques and possible causes of defects.
- To introduce the fundamental concepts relevant to forming, machining techniques and equipment; manufacturing of products of different shapes; behaviour of material in different stages of product development.
- To enable the students to understand the factors that cause the change in properties during processing; factors causing defects; factors necessary to control the process for sound product.

Course Content

Introduction to Non-Metallic Materials: Classification, Structure and Properties, Traditional and Advanced Engineering Applications of Non-Metals.

Polymers: Classification of Polymers, Engineering Properties and Applications of Polymers, Polymer Processing Techniques: Injection Molding, Thermoforming, Compression Molding, Transfer Molding, Sheet Forming Process Etc. General Behavior of Polymer Melts, Machining of Polymers, Plastic Component Design.

Rubbers: Properties and Applications of Rubber, Rubber Forming Processes, Design Considerations and Component Sizing, Molding and Vulcanizing of Tyres.

Glass: Types of Glasses, Processing and Manufacturing Techniques of Glass Vessels: Characteristics, Glass Forming Machines, Hollow Wares Flat Glasses, Fiberglass, Bulbs, Bottles, Heat Absorbing Glasses, Amber Glass.

Ceramics: Processing of Ceramics, Powder Processing, Powder Preparation and Sizing, Pre-Consolidation, Shape-Forming Processes; Pressing: Uniaxial Pressing, Isostatic Pressing, Casting: Slip Casting, Tap Casting, Plastic Forming: Extrusion, Injection Molding, Compression Molding, Roll Forming, Jiggering. Densification: Theory of Sintering, Mechanism of Sintering, Modified Densification Processes, Machining of Ceramics: Mounted Abrasive Machining, Free Abrasive Machining, Impact Abrasive Machining, Chemical Machining.

Composites: Classification and Properties of Composites, Processing Methods of Polymeric Matrix Composites, Ceramic Matrix Composites: Properties and Secondary Processing Techniques.

Rapid Prototyping (RP) in Manufacturing of Non-Metallic Products: Introduction of RP Techniques, Different RP Processes and Equipment used in Manufacturing of Non-Metallic Components.

Course Outcomes

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

CO1: Identify difference between metals and non metals; plastics and rubber; glass and ceramics.

CO2: Describe how to produce parts of different shape and sizes of different non metallic materials.

CO3: Apply principles of manufacturing specially forming, casting, machining and powder metallurgy.

CO4: Assess the machinability of different non-metallic products, process and equipment requirements, product nature and quality.

Books and References

1. Polymer Science and Technology-Plastics, Rubber, Blends and Composites by Ghosh, TMH.
2. Rubber Processing Technology, Materials and Principles by J.L. White, Hanser Publishers.
3. Glass Engineering Handbook by E. B. Shand, McGraw-Hill.
4. Introduction to Ceramics by Kingery Bowen and Uhlmann, John Wiley & Sons publishers.
5. Handbook of Composites by George Lubin, Springer.

Course Name: **Manufacturing Engineering Lab - 1**
Course Code: **ME-654**
Course Type: **Core**

Contact Hours/Week: **04** Course Credits: **02**

Course Objectives:

- To enhance the students' understanding of pattern making, mold preparation, welding processes, CIM etc. by hand on practices in laboratory.
- To develop the understanding of concepts behind CNC machines and part programming.
- To understand how supply chain effectiveness is affected by its parameters.

Course Content

List of Experiments

1 Green sand mould preparation after designing of pattern, gating and feeder for the given dimension of casting.
2 Measurement of clay content, moisture content and permeability of green sand.
3 Measurement of hardness, compressive and shear strength of a sample made of green sand.
4 To study the effects of arc and gas welding processes on microstructure and hardness of a given sample.
5 To study the effect of MIG and TIG welding processes on microstructure and hardness of given samples.
6 To study the construction details of the setup and performing spot and seam welding on given samples.
7 Flaw detection in a welded joint using dye penetrant testing method.
8 To study the CNC lathe machine, developing part programme for a given product and manufacturing the same on CNC lathe machine.
9 To study the CNC milling machine, developing part programme for a given product and manufacturing the same on CNC milling machine.
10 To study the CIM system available in the laboratory and developing a program to manufacture a component as per given drawing with automatic material and handling and machining.
11 Construction of control chart and interpretation of its patterns for variables/attributes.
12 To enhance supply chain effectiveness, develop statistical model (Structural Equation Model) using SPSS software with the given data for the set of variables of a product.

Course Outcomes

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

CO1: Develop and execute the part program on CNC machine.
CO2: Select suitable machining processes for the specific object manufacturing.
CO3: Detect the flaw in welded joints using dye penetrant testing method.
CO4: Decide best suitable parameters for SCM effectiveness.

Course Name: **Manufacturing Engineering Lab-II**
Course Code: **ME-664**
Course Type: **Core**

Contact Hours/Week: **04** Course Credits: **02**

Course Objectives

- To enhance the students' understanding of machine tools, cutting forces, EDM, robot programming etc. by hand on practices in laboratory.
- To develop the understanding of measurement on coordinate measuring machine, surface roughness tester etc in laboratory by practical applications.

Course Content

List of Experiments

1 To study the effect of speed, feed and nose radius on surface roughness in turning operation.
2 To study the effect of cutting speed on temperature generation in turning operation using thermocouple.
3 To study the tool flank wear and chip morphology during turning operation at various feed and speed.
4 To study, measurement and analysis of cutting forces in milling operation at varying parameters using dynamometer on milling machine.
5 Performance investigation and measurement of temperature in horizontal milling machine at varying cutting parameters.
6 To study the electric discharge machine and the effect of different EDM parameters on material removal rate and tool wear rate.
7 To study the effect of different EDM parameters on surface roughness of a machined sample.
8 To study and analysis of grinding forces in surface grinding operation at varying parameters.
9 To study a class room robot and developing the program for performing the pick and place task.
10 To study the different components of a modular automation production system demonstrating the operations of a bottling plant and running the sequential operations by developing and executing the program.
11 To study the SCARA robot and performing the operation of sorting the containers on the basis of weight by developing the program.
12. To develop hierarchical decomposition model for understanding difference among the quality of low, medium and high carbon steel using fuzzy logic tool box provided by MATLAB.

Course Outcomes

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

CO1: Decide best suitable parameters in machining.
CO2: Understand the effect of machining parameters on the output.
CO3: Select suitable machining processes for the specific object manufacturing.