Form: **MP 06 (i)**
(Clause 9.5.1)

Motilal Nehru National Institute of Technology Allahabad

1. Course Structure of M. Tech. Mechanical (Production Engineering)

I Semester:

S. No.	Subject Name	Code	L	T	P	Cr
1.	Material Characterization Techniques	ME21111	4	0	0	4
2.	Computer Integrated Manufacturing Systems	ME21112	4	0	0	4
3.	Elective I		4	0	0	4
4.	Elective II		4	0	0	4
5.	Elective III		4	0	0	4

Total Credits = 20

II Semester:

S. No.	Subject Name	Code	L	T	P	Cr
1.	Advanced Machining Processes	ME22113	4	0	0	4
2.	Production Engineering Lab	ME22211	0	0	6	4
3.	Elective IV		4	0	0	4
4.	Elective V		4	0	0	4
5.	Elective VI		4	0	0	4

Total Credits = 20

III Semester:

S. No.	Subject Name	Code	Credits
1.	State of the art Seminar / Special Study / Term Project	ME23661	4
2.	Thesis	ME23611	16

IV Semester:

S. No.	Subject Name	Code	Credits
1.	Thesis	ME24611	20

Note: The distribution of thesis evaluation marks will be as follows.

1. Supervisor (s) evaluation component: 60%
2. Oral Board evaluation component: 40%

List of Electives for M. Tech Mechanical Engineering (Production Engineering)

Elective-I		
Sl. No.	**Subject Code**	**Subject Name**
1	ME21331	Theory of Casting and Welding
2	ME21332	Advanced Industrial Engineering
3	ME21333	Manufacturing of Non-Metallic Products

Elective-II		
Sl. No.	**Subject Code**	**Subject Name**
1	ME21334	Optimization Methods in Engineering
2	ME21335	Soft Computing Methods
3	ME21336	Design and Analysis of Experiments

Elective-III		
Sl. No.	**Subject Code**	**Subject Name**
1	ME21337	Additive Manufacturing Technologies
2	ME21338	Advanced Manufacturing Systems
3	ME21339	Tool Design

Elective-IV		
Sl. No.	**Subject Code**	**Subject Name**
1	ME22340	Finite Element Method in Engineering
2	ME22341	Metal Forming Analysis
3	ME22342	Computer Aided Design for Manufacturing

Elective-V		
Sl. No.	**Subject Code**	**Subject Name**
1	ME22343	Mechatronic Applications in Manufacturing
2	ME22344	Laser Material Processing
3	ME22345	Computer Aided Manufacturing

Elective-VI		
Sl. No.	**Subject Code**	**Subject Name**
1	ME22346	Logistics and Supply Chain Management
2	ME22347	Total Quality Management
3	ME22348	Innovation and Intellectual Property Rights

Mechanical Engineering Department

Course Code:**ME21111**
Course Name: **Material Characterization Techniques**

Introduction to Materials: Scope and classification of engineering materials ;Types, properties and applications of metals and alloys; Superalloy; Polymers; Ceramics; Composites; Piezoelectric materials (PZT); Shape memory alloys (SMA) and Micro-electro-mechanical (MEMS) materials.

Optical Microscopy Techniques: Specimen preparation techniques; Elements of phase identification, grain size determination, inclusion analysis, Image analysis

Scanning Electron Microscopy: Theory and principles, construction, controls & operation ofscanning electron microscopy, Electron gun parameters, Imaging parameters, Image contrast(topographic and atomic number contrasts), Environmental scanning electron microscopy, Highresolution SEM imaging, EDS / EDAX analysis.

Transmission Electron Microscopy: Theory and principles, construction and controls.

Electron Micro Probe Analyzer: Theory and principles, Quantitative and qualitative analysis.

XRD: Principle, Crystallography and Rietveld analysis, Quantitative and qualitative analysis, Residual stress analysis, Determination of layer thicknesses, Small Angle X-ray Scattering (SAXS), Atomic Pair Distribution Function

AFM: Principle, sample preparation and mounting, scanning techniques, image capturing andmanipulation, and analysis techniques.

Thermal Analysis: Principles and applications of thermal analysis; Dynamic Mechanical Analyzer.

Mechanical Property characterization: Principles and characterization techniques related to Tensile, compressive, hardness, fatigue and fracture toughness properties.

References:

1. Materials Characterization, Vol. 10, ASM Hand Book
2. Cullity, B.D., Elements of X-Ray Difraction, Prentice Hall
3. Jahanmir, S., Friction and Wear of Ceramics, CRC press
4. Electron Microscopy and Analysis by Goodhew, Humphreys and Beanland
5. Thermal Analysis of Materials by Speyer, R.F., Marcel Decker, 1994.

Mechanical Engineering Department

Course Code:**ME21112**
Course Name: **Computer Integrated Manufacturing Systems**

1 **Introduction**: Manufacturing Enterprise: External and Internal Challenges, world-class order-winning criteria, CIM- definition, SME manufacturing wheel, CIM benefits and implementation steps; Manufacturing Systems: Classification, elements or sections of a typical manufacturing organization.

2 **Functions and Components of CIM System:** Design process, concurrent engineering, Concept of CAD/CAM and CIMS.

3 **Database and Communication in CIM System:** Data Communication technologies, Database Management technologies, Automated data collection in shop floor.

4 **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).

5 **Group Technology and Cellular Manufacturing:** Concept of Group Technology and its Application, Classification and Coding Techniques; Clustering Techniques and Cellular Manufacturing, Flexible Manufacturing Systems

6 **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.

References:

1. Computer-Integrated Manufacturing by J.A. Rehg and W.K. Henry, Pearson Education
2. Automation, Production Systems and Computer-Integrated Manufacturing by M.P. Groover, Pearson Education Singapore
3. Vajpayee, S. K., Principles of computer-integrated manufacturing, PHI
4. Systems Approach to Computer Integrated Design and manufacturing by Nanua Singh, John Wiley & Sons.
5. Computer Integrated Manufacturing and Engineering by Rembold, Nnaji and Storr, Addison Wesley Publishing Company.
6. Computer Integrated Manufacturing- an Introduction with case studies by Paul G. Ranky, Prentice-Hall International.

Mechanical Engineering Department

Course Code:**ME22113**
Course Name: **Advanced Machining Processes**

1 **Introduction:** Description of need and clasification of machining processes; Types of Studies in Machining Processes-Experimental and Theoretical

2 **Advaned Cutting Machining:** Principles, Equipments and Applications of Hard Cutting and High Speed Cutting

3 **Advaned Abrasive Machining:** Priciples, Equipments and Applications of Deep Grinding and High Speed Grinding; Cocept of Ductile Regime Grinding; Working Principle and Applications of Electrolytic In Process Dresssing (ELID) Grinding and Elastic Emission Machining; Process principle; Mechanism of material removal; Process Parameters; Process Capabilities; Applications of Abrasive Flow Machining, Magnetic Abrasive Machining, Magneto Rheological Machining and Magnetic Float Polishing

4 **Advaned Erosive Machining:**Process Principle, Applications, Equipments, **Process Analysis and Tool Design** of Electro-Discharge Machining (EDM); Ultra-Sonic Machining (USM) and Electro-Chemical Machining (ECM);

5 **Advaned Erosive Machining:** 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)

6 **Advaned Hybrid Machining:**Process Principle, Applications and Equipments for Electro-Discharge Abrasive Grinding, Electro-Chemical Abrasive Grinding, Electrolytic Magnetic Abrasive Machining, and Electro-Chemical Discharge Machining

References:

1. Advanced Machining Processes by V.K. Jain, Allied Publisher, Bombay
2. Advanced Machining Processes by Hassan El-Hofy, Mc-Graw Hill Inc., New York
3. Nonconventional Machining by P.K. Mishra, Narosa Publishing House, New Delhi
4. Modern Machining Processes by P.C. Pandey and H.S. Shan, TMH Limited, New Delhi
5. Advanced Methods of Machining by J.A. McGough, Chapman and Hall, London.
6. Non-Traditional Manufacturing Processes by G.F. Benedict, Marcel Dekker Inc, New York
7. Micromachining of Engineering Materials by J.A. McGough, Marcel Dekker Inc, New York
8. Introduction to Micromachining by V.K. Jain, Narosa Publishing House, New Delhi

Mechanical Engineering Department

Course Code:**ME22211**
Course Name: **Production Engineering Lab**

List of Experiments

1. Study of Horizontal and Vertical Milling Machines. Performance Study and Measurement of Cutting Forces and Temperature in Horizontal Milling (**Mechanical Workshop**)
2. Study of Surface and Cylindrical Grinding Machines. Performance Study and Measurement of Grinding Forces and Temperature in Surface Grinding (**Mechanical Workshop**)
3. Green Sand Mould Preparation after designing of Pattern, Gating and Feeder for the given dimension of the casting. (**Mechanical Workshop**)
4. Study and Performance Study of GMAW (MIG) welding. (**Mechanical Workshop**)
5. Study about Power Press for Blanking and Deep Drawing (**Mechanical Workshop**)
6. Study about EDM and EDM related parameters (**Machine Tool Laboratory**)
7. Study about Nd: YAG Laser Beam Machine. Conducting experiment for Laser Beam Cutting and Laser Beam Drilling in metallic sheet. (**Machine Tool Laboratory**)
8. Demonstration and programming of CNC turning and milling (**CAM Laboratory**)
9. Demonstration and programming of Robot (**CAM Laboratory**)
10. Demonstration and study of coordinate measuring machine (CMM)/ surface roughness tester/flatness measurement (**Metrology Laboratory**).
11. Industrial visit related to production engineering industries.

Mechanical Engineering Department

Course Code: **ME21331**

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

Theory of Casting: Overview and Classification; Mould Parting Analysis; Pattern Design; Core Design; Gating Design and Analysis- mould filling characteristics: fluidity and turbulence, types of gating system and gating element design, mould filling analysis including effect of different head losses; Cooling and Solidification: Solidification of pure metals and al1oys, 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 distances and riser placement, feed aid design

Theory of 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 blow; Metal Transfer: classification, forces acting on the drop, metal transfer mechanisms, 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

References:

1. Solidification of Castings by R.W. Ruddle, Institute of Metals London
2. Principles of Solidifications by B. Chalmers, McGraw-Hill Publishing Co.
3. Principles of Welding by R.W. Messler, John Wiley & Sons
4. The Physics of Welding by J. F. Lancaster, Pergamon Press
5. Science and Engineering of Casting Solidification by D.M. Stefanescu
6. Manufacturing Science by Ghosh and Mallik
7. Fundamentals of Metal casting by Flinn, Addison Wesley
8. Principles of Metal casting, Heine, Looper & Rosenthal, McGraw Hill.

Mechanical Engineering Department

Course Code: **ME21332**
Course Name: **Advanced Industrial Engineering**

Production Planning and Control: Introduction to PPC and Preplanning**;** Planning: The Production Order, Quantities in Batch Production, Batch-size Determination under Boundary Conditions, Machine Capacity, Scheduling, Batch Production Scheduling; Control: Elements of Control Procedure, Computer-Assisted Production Control, Inventory Control, Quality Control, Production Cost Control

Productivity: Productivity and Production, Measurement of Productivity, Productivity Index, Means of Increasing Productivity, Improving Productivity by Reducing Work Content, Productivity Improvement Procedure, "Six lines of Attack" to Improve Productivity, Productivity and Fatigue.

Equipment Replacement Policy: Reasons for replacement of Equipments, Methods of Replacement Analysis, Replacement Models, Development of Systematic Equipment Replacement Programme, Advantages of Sound Equipment Replacement Programme

Materials Management and Purchasing: Definitions, Objectives, Functions of Materials Management, Factors Promoting Economies in Materials Management, Purchasing, Duties, Functions and Responsibilities of Purchasing Department, Buying Techniques/Tenders, Purchasing Procedure, Methods of Purchasing, Purchasing Organization

Job Analysis, Job Evaluation, Merit Rating: Definitions, Objectives and Principles of Job Evaluation, Procedure for Installing Job Evaluation, Methods of Job Evaluation, Merit Rating, Selection of Factors in Setting up Rating Method, Methods of Merit Rating.

Value Analysis: Concepts, Definition and Objectives and Applications of Value Analysis, Techniques of Value Analysis and Value Engineering.

Management by Objectives, Exception and Information System

References:

1. Elements of Production, Planning and Control by Samuel Eilon, Universal Publishing Co.
2. Industrial Engineering and Management: a New Perspective by P.E. Hicks, McGraw-Hill
3. Handbook of Industrial Engineering: Technology and Operations Management by GavrielSalvendy,John Wiley & Sons.
4. Maynard's Industrial Engineering Handbook by Harold Maynard&K. Zandin,McGraw-Hill
5. Industrial engineering and Production Management by M. Mahajan, Dhanpat Rai & Co.
6. Industrial Engineering and Management by C. Natha Muni Reddy, New Age International

Mechanical Engineering Department

Course Code: **ME21333**
Course Name: **Manufacturing of Non-Metallic Products**

Polymers: Classification; Characteristics of Thermoplastics and Thermosetting plastics; Injection and Extrusion molding; Compression and Transfer molding; Blow and Rotational molding; Calendaring and Thermoforming; Lamination and pultrusion.

Rubber: Characteristics; Additives applications; Stages in raw rubber and latex rubber technology; Processing of rubbers; Manufacturing techniques for tires, belts, hoses, foot wears, cellular products and cables. Manufacture of latex based products.

Glass: Characteristics; Glass forming machines; hollow wares flat glasses, fiberglass, bulbs, bottles, heat absorbing glasses, amber glass and their manufacturing methods, general plant layouts for manufacture of different types of glasses.

Ceramics: Classification; Characteristics of traditional ceramics, structural ceramics, fine ceramics, bio ceramics, and ceramic super conductors. Ceramic processing techniques: hot pressing; hot isostatic pressing (HIP); Sintering, injection molding, slip casting, tape casting, gel casting and extrusion.

Composites:Requirements of reinforcement and matrix; Manufacturing of composites: Casting, Solid state diffusion, Cladding, HIP, Liquid metal infiltration, Liquid phase sintering; Preparation of molding compounds and prepregs; hand layup method; autoclave method; filament winding method; compression molding; reaction injection molding; knitting; braiding.

References

1. Polymer Science and Technology- Plastics, Rubber, Blends, and Composites by Ghosh, TMH
2. Rubber Processing Technology, Materials and Principles, 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

Mechanical Engineering Department

Course Code: **ME21334**
Course Name: **Optimization Methods in Engineering**

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

Linear Programming: Simplex Method, Duality in Linear Programming.

Single Variable Optimization Problems: Optimality Criterion, Bracketing Methods: Exhaustive 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.

Multivariable 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, Marquardt's Method, Conjugate Gradient Method, Variable-metric (DFP) Method.

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

Specialized Algorithms: Integer Programming: Penalty Function Method, Branch and Bound Method, Geometric Programming.

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

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, Fourth Edition, New Age International (P) Limited Publishers, New Delhi.
4. Engineering optimization - methods and applications by Ravindran, Ragsdell, and Reklaitis, John Wiley & Sons, Inc.

Mechanical Engineering Department

Course Code: **ME21335**
Course Name: **Soft Computing Methods**

Introduction to soft computing; Neurons and neural networks, Single layer perceptron's, Multi-layer feed-forward neural networks; Learning processes, Radial basis function networks; Recurrent neural networks, Principal component analysis, Applications of neural networks.
Introduction to Fuzzy logic, Operations on fuzzy sets, Fuzzy relations, Fuzzy implications, Introduction to fuzzy logic controllers (FLC), Construction of data base and rule base of FLC, Inference mechanisms, Defuzzification methods, Applications of fuzzy systems; Genetic algorithms and its applications.

References:

1. Neural Networks: A comprehensive Foundation by Haykin, Pearson Education.
2. Introduction to artificial neural systems by J. M. Zurada, Jaico Publishing House.
3. An Introduction to Fuzzy Logic for Practical Applications by Tanaka and Niimura, Springer.
4. Fuzzy logic with engineering applications by T. J. Ross, Wiley India Pvt. Ltd.
5. Multi-Objective Optimization using Evolutionary Algorithms by K. Deb, Wiley India Pvt. Ltd.
6. An Introduction to Genetic Algorithms by T M. Mitchell, MIT Press.
7. Practical Genetic Algorithms by Haupt and Haupt, Wiley.

Mechanical Engineering Department

Course Code: **ME21336**
Course Name: **Design and Analysis of Experiments**

Introduction, Basic Principles and Applications of Experimental Design, Statistical Methods Sampling and Sampling Distributions, Randomized Designs, Paired Comparison Designs, Mean and Variances of Normal Distributions. 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, Nonparametric Methods ANOVA. 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; 22 and 23 Design; General 2k Design: Single Replicate and Unreplicated, Addition of Center Points, Blocking and Confounding; Factorial Design in Two Blocks; Two-Level Fractional Factorial Designs; General 2k-p Fractional Factorial Design; Regression Modeling and Linear Regression Models; Hypothesis Testing in Multiple Regression, Prediction of New Response 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 Designs for Fitting Response Surfaces; Experiments with Computer Models Random Effects Models Random Effects Models; Two-Factor Factorial with Random Factors and Two-Factor Mixed Model, Rules for Expected Mean Squares; Approximate F Tests; Non normal Responses and Transformations, Unbalanced Data in a Factorial Design, Analysis of Covariance, Repeated Measures.

References

1. Design and Analysis of Experiments by Douglas C. Montgomery, Wiley.
2. Design and Analysis of Experiments by Angela M. Dean, Daniel Voss
3. Experiments: Planning, Analysis, and Optimization by C. F. Jeff Wu, Michael S. Hamada

Mechanical Engineering Department

Course Code: **ME21337**
Course Name: **Additive Manufacturing Technologies**

Traditional manufacturing v/s AMTs; 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 Additive Manufacturing; Generation of the physical layer model; Virtual Prototyping. Tessellation (STL format) and tessellation algorithms. Defects in STL files and repairing algorithms. Slicing and various slicing procedures. Accuracy and Surface quality in Additive Manufacturing. Effect of part deposition orientation on accuracy, surface finish, build time, support structure, cost etc. Various Rapid tooling techniques. Introduction to Reverse Engineering; Reverse engineering and Additive Manufacturing.

Materials Science for AM: Different materials used for AM. Use of multiple materials, malti functional and graded materials in AM. Role of solidification rate. Evolution of nonequilibrium structure. Structure property relationship. Grain structure and microstructure.

AM Technologies: Powder based AM processes involving sintering and melting (selective laser sintering, laser engineered net shaping, electron beam melting, high energy beam involvement). Printing processes (droplet based 3D printing) Solidbased AM processes extrusion based fused deposition modeling (FDM), Laminated object manufacturing (LOM) Stereolithography. Microand nanoadditive manufacturing process.

***Mathematical models for AM*:** Transport phenomena models: temperature, fluid flow and composition, buoyancy driven flow, surface tension driven free surface flow (study of molten pool). Case studies: Numerical Modeling of fusion based AM process, Powder bed melting based process, Droplet based printing process. Residual stress, part fabrication time, part fabrication cost, optimal orientation and optimal layer thickness. Defect in AM and role of transport phenomena on its formation. Simulations (choice of parameter, experimental data and comparison between simulation and experiments) Model validation for different aspects.

References

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing byIan Gibson, David W. Rosen, Brent Stucker, Springer
2. Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Andreas Gebhardt, Hanser Publishers, 2011.
3. Laser Assisted Fabrication of Materials by Majumdar and Manna, Springer Series in Material Science
4. Laser Induced Materials and Processes for Rapid Prototyping by Fuh and Wong, Kluwer Academic Press
5. Numerical modeling of the additive manufacturing (AM) processes of titatium alloy,Zhiqiang Fan and Frank Liou
6. Rapid Prototyping: Principles and Applications by Chua, Leong and Lim, World Scientific

Mechanical Engineering Department

Course Code: **ME21338**
Course Name: **Advanced Manufacturing Systems**

Introduction to Production and Layout System: Types of production systems, Types of plant Layout, advantages and disadvantages of various production systems and Layout.

Lean, Agile and Quick Response Manufacturing (QRM): Introduction, benefits from Lean, Agile and Quick Response Manufacturing, Difference between Lean, Agile and Quick Response Manufacturing.

The Methodology for Transforming your organization in Lean: Understanding products, processes, and Demand, Line lay out and work station Identification with process linking and balancing, The Kanban Strategies, Managing inventory with Kanban system.

Project Management for Implementation: Team establishment, The lean implementation milestones checklist, Managing the Lean Manufacturing Line.

Agile Manufacturing Enterprise Design: Enterprise Design, The Enterprise Design Process, Interdisciplinary Design, Management Accounting and Investment Appraisal.

Agile Manufacturing Implementation: Skill And Knowledge Enhancing Technologies For Agile Manufacturing, Enablers of Agile Manufacturing, Agile Enterprise design strategies Implementation Framework, Issues, Problems, and Future Developments

Rethinking Production and Materials Management for QRM: Reorganizing production, Structured methodology for implementing cellular Manufacturing, creative thinking for cellular manufacturing, capacity and lot sizing decisions, Materials and production planning in QRM Enterprise, The new Material control and Replenishment system for QRM, QRM approach to supplier relation; Rethinking office operation for QRM: Principles of quick response for office operations, Tools to implement quick response for office cell (Q-ROC) and system dynamics principle for quick response

QRM in Product Introduction: Extending QRM to new product introduction.

Creating QRM enterprises: Management Support, Organization structure, performance measurement, cost system, and steps to implement QRM.

Reconfigurable Manufacturing system (RMS): Components, capabilities and challenges of Reconfigurable manufacturing system, technologies enabling reconfiguration.

Concepts of Holonic Manufacturing Systems, Agent-Based Manufacturing Systems, Web-based Manufacturing, e-manufacturing, customized manufacturing, Virtual Manufacturing.

References:

1. Lean Manufacturing Implementation: A Complete Execution Manual for Any Size Manufacture by Dennis P. Hobbs, J. Ross Publishing, Inc.
2. Agile Manufacturing: The 21st Century Competitive Strategy by A Gunasekaran, Elsevier publication,
3. Quick Response Manufacturing: A Companywide Approach to Reducing Lead Times by Rajan Suri, Productivity Press
4. It's About Time: The Competitive Advantage of Quick Response Manufacturing by Rajan Suri, Productivity Press
5. How To Implement Lean Manufacturing by Lonnie Wilson, McGraw-Hill Professional

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Mechanical Engineering Department

Course Code: **ME21339**

Course Name: **Tool Design**

Design of Cutting Tools: Basic Requirements, Design of single point Cutting Tools, Design of Milling Cutters, Design of Drills and Drilling, Design of Reamers, Design of Taps, Design of Inserts, Determining Shank Size for Single-point Carbide Tools, Determining the Insert Thickness for Carbide Tools, Design of Chip Breakers, and Design of form tools

Design of Dies: Design of Casting dies, Moulding dies, and Forming dies

Design of Work Holding Devices: Basic requirements of work holding devices; Location: Principles, methods and devices; Clamping: Principles, methods and devices

Design of Drill Jigs: Definition and types of Drill Jigs, General Considerations in the Design of Drill Jigs, Drill Bushings, and Drill Jigs

Design of Fixtures: Fixtures and Economics, Types of Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, and Grinding

Tool Design for NC Machine Tools: Fixture Design for Numerically Controlled Machine Tools: Cutting Tools for Numerical Control, Tool-holding Methods for Numerical Control

Gages and Gage Design: Limits fits and tolerances, Geometrical tolerances-specification and measurement, Types of gages, Gage design, gage tolerances, and Material for Gages

References:

1. Fundamentals of Tool Design by ASTME, Prentice Hall of India Pvt. Ltd.
2. Tool Design by Donaldson, Tata-McGraw Hill
3. Jigs and Fixtures by Joshi, Tata-McGraw Hill
4. Principals of Machine Tools Design by Sen & Bhattacharya, New Central Book Agency Kolkata.
5. Machine Tool Design by Mehta N.K., Tata McGraw Hill
6. Machine tool Design by CMTI, Tata McGraw Hill
7. Machine Tool Structures by Koenigsberger and Tlusty, Pergamon Press

Mechanical Engineering Department

Course Code: **ME21340**
Course Name: **Finite Element Method in Engineering**

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 and Radially Symmetric Scalar Field Problems: General Governing Equation and Boundary Conditions for descibing steady state problems of Heat Transfer, Solid Mechanics, Fluid Dynamics, Electrostatics and Magnetostatic; Finite Element Formulation following the steps of Integral Formulation, Descritization 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; Finite Element Formulation of Transient Problems

FEM for Plane (2-D) and Axisymmetric SINGLE VARIABLE Problems: General Governing Equation and Boundary Conditions for descibing steady state problems of Heat Transfer, Solid mechanics, Fluid Dynamics, Electrostatics and Magnetostatics; Finite Element Formulation following the steps of Integral Formulation, Descritization and Polynomial Approximation using Standard 2-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; Finite Element Formulation of Transient Problems

FEM for Plane (2-D) and Axisymmetric MULTI-VARIABLE 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, Descritization and Polynomial Approximation using Standard 2-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 3-D Problems: Governing equation and Boundary conditions for describing steady state Heat Transfer and Elastic Stress Analysis Problems, Finite Element Formulation following the steps of Integral Formulation, Discretization and Polynomial Approximation using Standard 3-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

Software Practices: Finite Element Analysis on a software system for finding solution of FEM based real life Problems

References:

1. An Introduction to Finite Element Method by J.N. Reddy, TMH, New Delhi
2. The Finite Element Method in Engineering by S.S. Rao, Butterworth Heinemann, Boston
3. Introduction to Finite Elements in Engineering by Chandrupatla and Belegundu, PHI, New Delhi
4. The Finite Element Method for Engineers by Huebner, Dewhirst, Smith and Byrom, John Wiley and Sons, Singapore
5. The Finite Element Method Using MATLAB by Kwon and Bang,CRC Press, New York

Mechanical Engineering Department

Course Code: **ME21341**
Course Name: **Metal Forming Analysis**

Introduction to Plasticity: Overview and classification of Metal Forming Processes; Criteria's 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 ofUpper 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

References

1. Introduction to Engineering Plasticity by Lal and Ready, Narosa Pub. House, ND
2. Metal Forming Processes and Analysis by B. Avitzur, McGraw Hill Inc.
3. Fundamentals 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 University Press, Oxford

Mechanical Engineering Department

Course Code: **ME21342**

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

Introduction to CAD/CAM/CAE for manufacturing. Prototyping cycle for product design, manufacture and life management. Competitive design and manufacturing cycles for rapid product realization. CAD tools and industry adoption of standards.

Introduction to geometric modelling. Basic modelling and representation of lines, curves, surfaces and solids. Constructive Solids Geometry. Surface modelling techniques. Solids Modelling. Boundary Representation. Spatial enumerative techniques. Object representation. Object validation. Constraints and feature modelling. Feature based data representation. Object visualization. Texturing. Ray tracing and related algorithms. Assembly modelling. Feature based analysis. Disassembly analysis. Manufacturing analysis.

Dimensioning, Tolerance and fits representation and analysis. Product manufacturing planning. Design Structure matrix. Data extraction for product design analysis. Elements of primary processes CAD modelling – Casting, Rapid prototyping etc. Tools for automated generation of cutter path from CAD representation in secondary processes. Rapid Prototyping and machine data generation from CAD models. Elements and data structures for standards based data exchanges – IGES, STEP, STP etc. Web-based product visualization and collaboration. Web based manufacturing planning.

Advanced topics: • Surface generation methods – algorithm examples. • Cutter path generation software development. • Development of interaction methods to exchange C

References:

1. Geometric Modeling by Michael E. Mortenson, Industrial Press Inc.
2. CAD/CAM Theory and Practice by I. Zeid, Tata-McGraw Hill, 2006
3. Computer-Aided Engineering Design by B Sahay and A Saxena, Springer
4. Computational Geometry for Design and Manufacture by Faux and Pratt, John Wiley

Mechanical Engineering Department

Course Code: **ME21343**

Course Name: **Mechatronic Applications in Manufacturing**

Introduction to mechatronic systems and components, Review of integration of mechatronics at different levels, Principles of basic electronics, Digital electronics review: number system, gates, flip-flops, counters, registers, tristate concept, TTL and CMOS circuits, memories. Embedded electronics, Basics of Microcontroller & Microprocessors architecture and instruction set, machine cycles, interrupts, instruction set, memory and I/O interfacing, programming techniques, Timer/Counters, Serial Interfacing and communications, Interfacing to keyboards and displays, Standard busses. Microcontrollers and their applications, integrated circuits, sensors, actuators, and other electrical/electronic hardware in mechatronic systems. Microprocessor based measurement and control: D/A and A/D conversion, data acquisition systems, encoders, interfacing of motors and transducers. Selection of mechatronic components, namely sensors like encoders and resolvers. Stepper and servomotors; Solenoid like actuators; Transmission elements like Ball screw and Controllers. Analysis of mechatronic systems with applications to motion control, robotics, CNC systems, and others. Case studies of applications in process and discrete manufacturing.

References:

1. Mechatronics: Principles, Concepts and Applicationsby Mahalik, TMH New Delhi
2. Mechatronics: electronic control systems in mechanical and electrical engineering by Boltan, W., Longman, Singapore
3. Mechatronics by HMT, Tata McGraw-Hill, New Delhi

Mechanical Engineering Department

Course Code: **ME21344**

Course Name: **Laser Material Processing**

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 Deepdrawing.

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, aluminium 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 in Surface Engineering Applications: Laser glazing; Laser alloying; Microstructural considerations in laser rapid heating process

References:

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

Mechanical Engineering Department

Course Code: **ME21345**
Course Name: **Computer Aided Manufacturing**

Introduction of CAM: Concepts and Objectives; Evolution and Benefits; Role of management

NC/CNC Machine Tools: NC and CNC Technology: Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re circulating ball screw, anti-friction slides, step/servo motors. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric sub routines.

Programmable Logic Controllers: Relay Device components, Programmable controller architecture, programming a programmable controller, tools for PLC logic design.

Flexible Manufacturing System: Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of flexibility and FMS, FMS lay out and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Flexible Fixturing, Flexible Assembly Systems.

Robot Technology: Introduction: Robot Anatomy, Laws of Robot, Human System and Robotics, Coordinate system, Specifications of Robot. Power sources, actuators and Transducers, Robotic Sensors, Grippers, Robot Safety, Robot Programming and Robot Applications, Economic Considerations of Robotics system, Robot Kinematics and Dynamics, Robot Arm Dynamics. Concepts of Computer Vision and Machine Intelligence.

Material Handling and Storage: Overview of material handling equipment's, automated material handling equipment's – AGVs, conveyor systems, performance analysis of material handling systems, automated material storage systems – ASRS and carousel storage, analysis of automated storage systems.

Automated quality Control Systems: Computer-aided quality control, Programming and applications of CMM

References:

1. Computer Control of Manufacturing systems by Koren, McGraw Hill
2. Automation, Production System & Computer Integrated Manufacturing by M.P. Groover, PHI
3. Computer-Aided Manufacturing by Chang, Wysk and Wang, Pearson Prentice Hall
4. Computer Aided Manufacturing by Rao, Tiwari and Kundra, Tata McGraw Hill
5. Programmable Logic Controllers by Petruzella F D, McGraw Hill

Mechanical Engineering Department

Course Code: **ME21346**

Course Name: **Logistics and Supply Chain Management**

Introduction to Logistics and Supply Chain Management; Concepts, Drivers and obstacles; Planning Demand and supply in a supply chain-Demand forecasting; Aggregate Planning; Management of Inventory in global supply Chain; Role of Information Technology in supply chain; E-Business and the Supply chain; Factors influencing logistics and decision; Bench making and performance measurement; Supply chain risk and Reverse logistics and Green Supply Chain

References:

1. Supply Chain Management by John T. Mentzer, SAGE Publication.
2. Supply Chain Management: Strategy, Planning, and Operation by Chopra, Meindl and Kalra,
3. Business Logistics/Supply Chain Management by Ballou &Srivastava, Pearson Education.
4. Supply Chain Logistics Management by Bowersox, Closs, Cooper, Tata McGraw-Hill
5. Logistics and Supply Chain Management by Martin Christopher, Financial Times Prentice
6. Supply Chain Management: Text and Cases by Janat Shah, Pearson Education
7. Textbook of Logistics & Supply Chain management by D.K. Agrawal,Macmillan.

Mechanical Engineering Department

Course Code: **ME21347**
Course Name: **Total Quality Management**

1 **Introduction**: Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

2 **TQM Principles**Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.method. Theories as presened by quality gurus

3 .**Performance measures**, basic concepts and strategies , cost of quality, improvement action and plan, Quality awards: Malcolm Baldridge, Deming, etc., balanced score card method

4 **TQM tools :** Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs,

5 **Statistical analysis for quality and experimental design**The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Concept of six sigma, factor mode and effect analysis and identification of stages, t-test and F -test, orthogonal design, Taguchi's quality function, orthogonal design

6 **Quality system**, Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits.

7 **Case studies and discussion of practical industrial and service problems**

References:

1. Total Quality Management by Dale H.Besterfiled, Pearson Education Asia, Indian Reprint
2. Introduction to Total Quality: Quality Management for Production, Processing and Services, by Goetsch and Davis, Prentice Hall
3. Total Quality Management bySuganthi and Samuel, PHI
4. The Management and Control of Quality by James R. Evans and William M. Lindsay,South-Western (Thomson Learning), 2005.
5. Juran's quality handbook by Joseph M. Juran, McGraw Hill

Mechanical Engineering Department

Course Code:**ME21348**
Course Name: **Innovation and Intellectual Property Rights**

1 **Introduction**

Historical and philosophical background of patents and other intellectual property, Need to protect inventor interests, IPR: meaning and significance, The types of intellectual property, Introduction to the leading International Instruments concerning Intellectual Property Rights: the Berne Convention, Universal Copyright Convention, The Paris Convention, Patent Co-operation Treaty, TRIPS, The World Intellectual Property Organization (WIPO) and the UNESCO

2 **Overview of patents, copyrights, trademarks and trade secrets**

The construction of a Patent, Legal fundamentals of patent protection for useful inventions, Patent proliferation, requirements for getting a patent, Indian Patent Law

Copyright in context, The terms of copyright, Legal fundamentals of copyright protection, Critical differences between patent and copyright protection, Indian Copyright Law.

Trademarks defined, The economic function of trademarks, Legal fundamentals of trademark protection, Indian Trademarks Law.

Trade secrets defined, Legal fundamentals of trade-secret protection.

3 **Key Business Concerns in Intellectual Property Rights**

Intellectual Property as an Instrument of Development, Commercialisation of Intellectual Property Rights by Licensing, Determining Financial Value of Intellectual Property Rights, Negotiating Payments Terms in Intellectual Property Transaction, Intellectual Property Issues in the Sale of Business, Legal Auditing of Intellectual Property, Due Diligence of Intellectual Property Rights in a Corporate Transaction, Intellectual Property and market failure.

4 **Infringements and Case studies related to IPR**

Infringement defined, Determination of Infringement, Defences to Infringement, Research exemption, invalidity, misuse, failure to mark, laches and estoppel, and first sale doctrine; Rights and obligations among co-inventors, co-authors, employers, and licensees.

References:

1. Intellectual Property Rights- A Primer by R. Anita Rao & V. Bhanoji Rao, Eastern Book Company Lucknow.
2. Intellectual Property and Open Source: A Practical Guide to Protecting Code by Van Lindberg,SPD Pvt. Ltd.
3. Intellectual Property Management in R&D Collaborations: The Case of the Service Industry Sector by Martin A. Badder,Physica-Verlag Heidelberg, New York.
4. Law of Copyright and Industrial Designs by P. Narayanan, Eastern law House, Delhi.
5. Intellectual Property by W.R. Cornish, Sweet & Maxwell, London.
6. Principles of Intellectual Property by N.S. Gopalakrishnan& T.G. Agitha, Eastern Book Company, Lucknow.