Department of Mechanical Engineering

Curriculum and Syllabi for M. Tech. in Design & Manufacturing (D & M)

With effect from 2019 entry batch

PO Statements:

1. Graduates will demonstrate sound domain knowledge on wider perspective to become successful professionals.
2. Graduates will demonstrate an ability to identify, formulate and solve design and manufacturing problems.
3. Graduates will demonstrate an ability to conceptualize designs of design and manufacturing system or component and evaluate them to select optimal feasible solution considering safety, environment and other realistic constraints.
4. Graduates will demonstrate skill of good researcher to work on a problem, starting from scratch, to research into literatures, methodologies, techniques, tools, and conduct experiments and interpret data.
5. Graduates will demonstrate research skills to critically analyse complex design and manufacturing problem for synthesizing new and existing information for their solutions.
6. Graduates will demonstrate skills to use modern engineering tools, software and equipment to analyze and solve complex engineering problems.
7. Graduates will exhibit the traits of professional integrity and ethics and demonstrate the responsibility to implement the research outcome for sustainable development of the society.
8. Graduates will be able to communicate effectively to comprehend and write effective reports following engineering standards.
9. Graduates will demonstrate skills of presenting their work unequivocally before scientific community, and give and take clear instructions.
10. Graduate will demonstrate traits of manager in handling engineering projects and related finance, and coordinate workforce towards achieving their goals.
11. Graduates will exhibit the traits of good academician and engage in independent and reflective lifelong learning.

Course Structure

Semester I

S. N.	Code	Subject	L	T	P	Credits
1.	ME 5201	Principles of Industrial Design & Manufacturing	3	0	0	3
2.	ME 5202	Computer Aided Design	3	0	0	3
3	ME 5101	Computer Aided Manufacturing	3	0	0	3
4.	ME 5xxx	Elective-I	3	0	0	3
5.	ME 5xxx	Elective-II	3	0	0	3
6.	ME 5203	Design and Manufacturing Lab-I	0	0	3	2
7.	ME 5210	Seminar	0	0	2	1
		Total contact hours/credits	**15**	**0**	**5**	**18**

Semester II

S. N.	Code	Subject	L	T	P	Credits
1.	ME 5204	Advanced Solid Mechanics	2	1	0	3
2.	ME 5205	Production and Operations Management	3	0	0	3
3	ME 5106	Robotics & Automation	3	0	0	3
4.	ME 5xxx	Elective – III	3	0	0	3
5.	ME 5xxx	Elective – IV	3	0	0	3
6.	ME 5206	Mini Project	0	0	2	1
7.	ME 5207	Design & Manufacturing Lab-II	0	0	3	2
		Total contact hours/credits	**15**	**0**	**7**	**18**

Semester: III and IV

S. N.	Code	Subject	L	T	P	Credits	Semester
1	ME 6299	Project	-	-	-	14	III and IV
		Total contact hours/Credits	-	-	-	14	---

Elective-I

S. N.	Code	Subject	L	T	P	Credits
1.	ME 5231	Entrepreneurship & Management	3	0	0	3
2.	ME 5232	Advanced Mechatronics	3	0	0	3
3	ME 5301	Advanced Material Science	3	0	0	3
4.	ME 5303	Composite Materials	3	0	0	3
5.	ME 5235	Soft Computing	3	0	0	3
6.	ME 5237	Metal Cutting	3	0	0	3
7.	ME 5238	Modelling and Simulation	3	0	0	3

Elective-II

S. N.	Code	Subject	L	T	P	Credits
1.	ME 5302	Structural Property Correlation of Engineering Materials	3	0	0	3
2.	ME 5247	Computational Methods & Computer	3	0	0	3

		Programming				
3	ME 5241	Theory of Elasticity	3	0	0	3
4.	ME 5131	Optimization Techniques	3	0	0	3
5.	ME 5249	Principles of Tribology	3	0	0	3
6.	ME 5133	Innovation & Product Design	2	1	0	3
7.	ME 5244	Theory of Plates and Shells	3	0	0	3

Elective- III

S. N.	Code	Subject	L	T	P	Credits
1.	ME 5138	Additive Manufacturing	3	0	0	3
2.	ME 5306	Fabrication of Engineering Materials	3	0	0	3
3	ME 5239	Manufacturing Management	3	0	0	3
4.	ME 5307	Modern Manufacturing Methods	3	0	0	3
5.	ME 5149	Non Traditional Techniques for Optimum Design	3	0	0	3
6.	ME 5134	Non Destructive Testing of Materials	3	0	0	3
7.	ME 5240	Rapid Prototyping and Tooling	3	0	0	3

Elective- IV

S. N.	Code	Subject	L	T	P	Credits
1.	ME 5105	FEM in Engineering Applications	3	0	0	3
2.	ME 5139	Engineering Fracture Mechanics	3	0	0	3
3.	ME 5148	Ergonomics & Aesthetics	3	0	0	3
4.	ME 5242	Rotor Dynamics	3	0	0	3
5.	ME 5243	Theory of Mechanical Vibration	3	0	0	3
6.	ME 5245	Theory of Plasticity	3	0	0	3
7.	ME 5246	Theory of Uncertainty	3	0	0	3

Detailed Syllabi

ME 5201	Principles of Industrial Design & Manufacturing	L	T	P	C
	M.Tech. (D & M), First Semester (Core)	3	0	0	3

Introduction: Engineering design process and its structure, Steps in design process, Morphology of design, Mechanical engineering design, Traditional design methods, Design synthesis, Aesthetic and ergonomic considerations in design, Use of standards in design, Selection of preferred sizes, design for Maintenance (DFM), design for manufacture, assembly, shipping, maintenance, use, and recyclability. Design checks for clarity, simplicity, modularity and safety, Design organization and communication, technical reports, drawings, presentations and models.

Materials Selection: Performance characteristics of materials, Materials selection process, Economics of materials, Evaluation methods of materials selection –cost versus performance relation, weighted index, value analysis, Materials in Design: Design for Brittle Fracture, Design for Fatigue Failure, Design for Corrosion Resistance, Design with Plastics, Design with Brittle Materials.

Modeling and Simulation in Design: Linear and Non-linear models, Buckinghum π-theorem, Monte Carlo Simulation, Basics of meta-models, Applications of FDM and FEM in design

Manufacturing Considerations in Design: Role of processing in design, Types of manufacturing processes, Economics of manufacturing, Design for castings, Forgings, Sheet metal forming, Design for machining, Powder metallurgy, Welding, Heat treatment, Assembly, Corrosion resistance, Designing with waste management, Design for manufacturability.

Cost Evaluation: Categories of costs, Methods of developing cost estimates, Cost indexes, Cost capacity factors, Estimating Plant Cost, Design to cost, Manufacturing costs, Value Analysis in Costing, Activity-Based Costing, Learning Curve, Life cycle costing.

Economic Decision Making: Mathematics of time value of money, Cost comparison, Depreciation, Taxes, Profitability of investments, Inflation, Sensitivity and break-even analysis, Uncertainty in economic analysis, Benefit cost analysis,

Failure and Reliability in Design: Probabilistic and Non-probabilistic approach, Cause-effect analysis, Failure modes and analysis, Fault Tree analysis, Robust vs. reliability based design.

Texts/References:

1. George Ellwood Dieter: Engineering Design: A Materials and Processing Approach: McGraw-Hill; 4th edition
2. V. B. Bhandari: Design of Machine Elements: TMH, 3/e
3. G. Pahl, W. Beitz, J. Feldhusen, K. H. Grote, Engg. Design: A Systematic Approach, Springer
4. I. M. Pandey, Financial Management, 11th Ed., Vikas Pub. House
5. Linda C. Schmidt, Product Engineering and Manufacturing, 2nd Edition,
6. Shuchen B. Thakore and B. I. Bhatt, Intro. to Process Engineering and Design, McGraw Hill

Course Outcomes:

1. To learn the fundamental concepts and exhaustive applications of design and manufacturing process, morphology, synthesis and different considerations of industrial design and manufacturing.

2. Understanding the detail aspects of design communications e.g., preparing the technical presentation, report, thesis.
3. To learn thoroughly the various aspects of the material selection process for cost-effective value-added design and manufacturing of components and system.
4. To gain practical knowledge on manufacturing considerations, modelling and simulations and failure and reliability analysis in the design and manufacturing with subsequent recommendations.
5. To get trained on different types of costs and estimation in design for prudent economic decision making in industrial design and manufacturing.

ME 5202	**Computer Aided Design**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Core)	3	0	0	3

Introduction: Overview of computer aided engineering design.

Transformation: Representation of points; Transformation matrix; Transformation of a point; Homogeneous coordinates; General transformation –rotation, reflection, translation, sealing and sharing; Combined transformation; Solid body transformation; Parallel projections –orthographic, axonometric and oblique; Perspective projections –single-point, two-point, three-point and vanishing points.

Plane Curves: Curve representation –parametric and non-parametric curves, like circle, ellipse, parabola and hyperbola; Conic sections.

Space Curves: Representation of space curves; Cubic splines; Parabolic blending; Bezier curves; B-spline curves.

Surface Generation: Surfaces of revolution; Sweep surfaces; Quadric surfaces; Bilinear surfaces; Ruled and developable surfaces; Coons linear surfaces; Coons bi-cubic surfaces; Bezier surfaces; B-spline surfaces.

Solid Body Modeling: Designing a 3D model, like a machine part; Hidden surface removal.

Texts/References:

1. Mathematical Elements for Computer Graphics. David F. Rogers and J. Alan Adams, Tata McGraw-Hill Edition.
2. Computer Graphics. Roy A. Plastock and Gordon Kalley, McGraw-Hill Book Company.
3. Computer Aided Design: A basic and Mathematical Approach. S K Srivastava, IK Publishing House.
4. Introduction to Computer Aided Design. C K Maiti, Pan Stanford Publishing Pte. Ltd.
5. Fundamentals of Computer Aided Design. K Goyal, S K Kataria and Sons.

Course Outcomes:

1. Understand geometric transformation techniques in CAD.
2. Develop algorithms and write code for solving simple geometric transformation problems
3. Develop mathematical models to represent curves.
4. Model engineering components using solid modelling techniques.
5. Design and analysis of engineering component

ME 5101	Computer Aided Manufacturing	L	T	P	C
	M.Tech. (D & M), First Semester (Core)	3	0	0	3

Introduction to Computer Aided Design (CAD), Computer Aided Process Planning (CAPP), Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM), product cycle and automation in CAD/CAM, Need of CAD/CAM.

Process Planning: Basic concepts of process planning, computer aided process planning (CAPP), Retrieval or variant and generative approach of CAPP, Implementation consideration of CAPP.

Numerical control of Machine tools: Principles of Numerical control (NC), Computer Numerical control (CNC), Direct Numerical control (DNC), comparison between conventional and CNC systems, Classification of CNC system, NC coordinate system, positional control, system devices; drives, ball screws, transducers, feedback devices, counting devices, signal converters, interpolators, adaptive control system.

NC Part programming: Concept, format, codes, preparatory and miscellaneous coded, manual part programming, APT programming, macros, fixed cycles.

Group Technology (GT): Introduction, needs of GT, part families, classification and coding systems, GT machine cells, benefits of GT.

CIM and FMS: Introduction, hierarchical computer system, components of CIM types of manufacturing systems, transfer lines, flexible manufacturing system (FMS), The manufacturing cell, tool management and workpiece handling system, benefits of CIM.

Texts/References:

1. Groover, Automation, Production systems and computer integrated manufacturing, PHI
2. Groover and Zimmer, CAD/CAM, PHI
3. Chang, Wysk and Wang, Computer Aided Manufacturing PHI
4. Yoram Koren, “Computer control of manufacturing system” McGraw Hill Book Co.
5. B.L. Jones, Computer Numerical Control, John Wiley and Sons
6. Rao, Tiwari and Kunda, Computer Aided Manufacturing, Tata McGraw Hill
7. Vajpayee, Principles of Computer Integrated Manufacturing, PHI
8. Radhakrishna Subramanyan and Raju, CAD/CAM/CIM, New Age International (P) Ltd.
9. Sharma, Fundamentals of Computer aided Manufacturing, S. K. Kataria and Sons.

Course Outcomes:

1. Describe terminologies used in computer aided manufacturing processes.
2. Develop the classification and coding techniques for part families.
3. Develop the Computer aided Process Plans for the parts to be manufactured.
4. Acquainted with NC, CNC, DNC and adaptive control in machine tools to apply in practical fields.
5. Identify the various components of CNC machines and describe their functions.
6. Write CNC Program for machining components.
7. Develop products with the use of CNC machines
8. Correlate the NC technologies with FMS, CIM systems.

ME 5203	Design and Manufacturing Lab-I	L	T	P	C
	M.Tech. (D & M), First Semester (Core)	0	0	3	2

Heat treatment of ferrous alloys, metallographic investigation of bare and heat treated ferrous alloys, hardness test of bare and heat treated ferrous alloys, tensile testing of bare and heat treated ferrous alloys, micro-hardness testing, fracture testing of metals and polymers, preparation of laminated composites, mechanical and fracture testing of laminated composites, synthesis of nano- particles using planetary ball mill, Sol-Gel method for synthesis of Nano particles, thermal characterization of materials, design of mechanical system (prime mover / non-prime mover/innovative product design)

Course Outcomes:

1. Implement the ideas of design and manufacturing related concepts in attacking real life problems.
2. Select suitable testing methods for quantifying qualities of materials with respect to design attributes.
3. Practice fabrication methods for nano materials and composites
4. Comment on the quality attributes of various materials using standards tests

ME 5210	Seminar	L	T	P	C
	M.Tech. (D & M), First Semester (Core)	0	0	2	1

Individual students are required to choose a topic of their interest from design and manufacturing related topics preferably from outside the M. Tech. syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least two/three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Evaluation shall be based on the following pattern:
Report = 40 marks
Concept/knowledge in the topic = 30 marks
Presentation = 30 marks
Total marks = 100 marks

Course Outcomes:

1. Prepare good slides and present a particular topic effectively.
2. Develop team spirit and leadership qualities through group activities.
3. Develop confidence for self-learning and overcome the fear of public presentations.
4. Update knowledge on contemporary issues, prepare technical report and do presentations on these issues.

ME 5231	Entrepreneurship & Management	L	T	P	C
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Introduction to Entrepreneurship: Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, agencies in entrepreneurship management and future of entrepreneurship.

The Entrepreneur: Meaning of entrepreneur, the skills required to be an entrepreneur, the entrepreneurial decision process, and role models, mentors and support system.

Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition.

Preparing a Business Plan: Meaning and significance of a business plan, components of a business plan, and feasibility study.

Financing the New Venture: Importance of new venture financing, types of ownership securities, venture capital, types of debt securities, determining ideal debt-equity mix, and financial institutions and banks.

Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property, and marketing the new venture.

Managing Growth in New Venture: Characteristics of high growth new ventures, strategies for growth, and building the new venture capital.

Harvesting Rewards: Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy.

E-Entrepreneur, Leadership, Motivation & Productivity. Decision Making, Business Plan, S.S.I., System approach, Organization as system, MIS. Quality, TQM, ISO 9000 Standards.

Texts/References:

1. Entrepreneurship by Hisrich, Peters, Shepherd, Manimala; McGraw Hill Education India Private Limited; 9th edition
2. Entrepreneurship by Rajeev Roy; Oxford University Press India; Second edition
3. Entrepreneurship by Alpana Trehan; Dreamtech Press
4. Management and Entrepreneurship by N.V.R. Naidu, T. Krishna Rao; I K International Publishing House Pvt. Ltd
5. Shankar: Entrepreneurship: Theory & Practice: McGraw-Hill
6. A.K. Singh: Entrepreneurship Development & Management: Laxmi Publication
7. David H. Holt: Entrepreneurship: -New Venture Creation: Prentice Hall Publication
8. Randolph & Ponker: Effective Project Planning & Management: Longman Higher Education

Course Outcomes:

1. Recognize the need of entrepreneurship in recent scenario in job creation of job seeking
2. Criticize the various business opportunities among available options
3. Evaluate various business plans in making effective business models
4. Formulate methodologies for adapting entrepreneurship models with current market demands
5. Calculate financial aspects of business models and revenue generation ideas

ME 5232	Advanced Mechatronics	L	T	P	C
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Introduction: Definition of Mechatronics, Scope, key elements, Conventional Vs Mechatronics Systems; Need of Mechatronics in Mechanical Engineering; Electrical/Electronic systems i.e. conductors, Insulators and Semiconductors, passive components used in electronics, transformers, transistors, integrated circuits, digital circuits.

Sensors: Strain gauge, Potentiometers, Tachometers, Linear variable differential transformer, piezoelectric accelerometer, Hall effect sensors, Optical Encores, Resolver, Induction, Tactile and Force sensors.

Actuators: Pneumatic and Hydraulic Actuators, Electrical actuators, stepper motors, DC motors, AC motors.

Electronics fundaments: Brief review of some semiconductor devices. The operational Amplifier. Binary variable and logic, Boolean Algebra, Logic circuits. Digital-to-analog converters, analog-to-Digital converters.

Control systems: Mathematical modeling of physical systems, sensors and actuators, System equations, controllability, observability, pole placement technique, PID Controller.

Applications: Case studies of control of hydraulic, pneumatic, mechanical and electrical system, Application of CNC machines & Robotics. Applications of Mechatronics in Manufacturing and Automation Case Studies.

Texts/References:

1. Analytical Robotics and Machatronics, Wolfram Stadler, McGraw Hill.
2. Robotic engineering, Rlafter, PHI.
3. Machatronics, AMT
4. Automatic Control System, B.C. Kuo, Ogata, PHI
5. Introduction to Digital computer electronics, A.P. Mahind, TMH
6. Measurement Systems, E.O. Doeblin, McGraw Hill
7. Bolton W. "Mechatronics", 2ndEdition, Pearson Education, New Delhi (1999)
8. Necsulelscu Dan, "Mechatronics", Pearson Education, New Delhi (2002)
9. Mechatronics by Mahalik, Spinger.

Course Outcomes:

1. Identify mechatronics components for its uses and applications.
2. Create components using principles of mechatronics for solving engineering problems
3. Evaluate the effectiveness of mechatronics components over conventional components
4. Detect flaws in mechatronics components
5. Develop control systems for active and passive systems used in mechatronics systems

ME 5301	**Advanced Material Science**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Composites: Dispersion strengthened composites, particulate composites, Fiber reinforced composites, characteristics of fiber reinforced composites, Fiber reinforced system and applications, Laminar composites materials, Application of laminar composites.

Polymers: Typical Thermoplastics, structure property relationship in thermoplastics, effect of temperature on thermoplastics, Mechanical properties of thermoplastics.

Micro-electro mechanical systems (MEMS) & NANO Micromachining, Importance of different levels of structure to the material behavior, Technological significance.

Powder metallurgy: Powder metals, P/M process, P/M materials, P/M heat treatment, P/M applications.

Texts/References:

1. J. F. Shackesford and MK. Muralidhana, Introduction to Material Science, Pearson Education.
2. DR. Askeland and PP. Phule, Essentials of materials Science and Engineering, CENGAGE Learning.
3. Advanced Topics in Material Science and Engineering. J L Lopez, Kluwer Academic.
4. Powder metallurgy. B K Datta, PHI.
5. Materials Science and Engineering, an Introduction, William D. Callister. John Willey and Sons Inc. Singapore.
6. Physical Metallurgy: Principle and Practice, V. Raghavan. Prentice Hall India Pvt Ltd.

Course Outcomes:

1. Ability to apply knowledge of mathematics, science and engineering.
2. Ability to use the techniques, skills and modern engineering tools necessary to engineering practice.
3. Ability to design machining/micromachining process to meet desired needs.
4. Ability to identify, formulate and solve engineering problems to frame design rules for polymer / composite /Nano materials.
5. Ability to communicate effectively.

ME 5303	**Composite Materials**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Fibre Reinforced Plastics (FRP): Definition; Types; General properties and characteristics; Reinforcing materials –particles, fibers, whiskers; Properties of reinforcing materials; Matrix materials; Additives; Properties of FRP materials; Applications

Manufacturing Processes: Open mold processes –Hand layup, Spray up, Vacuum bag, Pressure bag & autoclave, Centrifugal casting, Filament winding; Closed mold processes –Compression molding, Resin transfer molding (RTM), Injection molding, Pultrusion; SMC & DMC products, etc.

Designing Fibre Reinforced Plastics: Design variables; Selection of fiber-matrix and manufacturing process; Effects of mechanical, thermal, electrical and environmental properties, Fiber orientation, Symmetric and asymmetric structure; Effects of unidirectional continuous and short fibers; Lamination theory; Design equations, Design for failure; FEA design packages; Design examples & case studies in FRP.

Engineering Ceramics And Metal Matrix Composites: Reinforcement materials; Matrix; Characteristics and specialized properties like –Weibull modulus, high temperature strengths, wear & frictional property improvements; Selection criteria; Advantages and limitations in use of ceramics & MMCs; Fracture mechanics; Applications.

Ceramic & Polymer Metal Composites: CMC & PMC Characteristics, Various types, Advantages& Limitations, Applications. Role of Mixtures Reinforcement –Particles –Fibres. Carbon/Carbon Composites-Advantages, Limitations-Sol-Gel techniques –Chemical Vapor Deposits. Applications.

Texts/References:

1. Haslehurst. S.E. "Manufacturing Technology ", ELBS, London, 1990.
2. Krishnan K. Chawle. "Composite Material: Science and Engineering" Second Edition, Springer, 1998
3. T. W. Clyne, P.J. Withers, "An Introduction to metal matrix composites", Cambridge University Press, 1993.
4. F. C. Campbell "Structural Composite Materials", Materials Park, ASM International, 2010

Course Outcomes:

1. Students will be able to apply core concepts in mechanics of composite materials to solve engineering problems.
2. Select the most appropriate process for fabricating and characterization of composite component.
3. Ability to analyze problems with respect to macro mechanical behavior of lamina.
4. Ability to analyze problems with respect to micro mechanical behavior of lamina
5. Ability to analyze problems with respect to macro mechanical behavior of laminate.

ME 5235	**Soft Computing**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Introduction: Introduction to soft computing, difference between hard computing and soft computing, need for soft computing, applications of soft computing.

Artificial neural network: Neurons and neural network, Neural network types, structure of neural network, basic model of neural network, single layer perceptron, multi-layer perceptron, radial basis function network, self-organizing map (SOM), recurrent neural network, training of neural network, supervised and unsupervised learning of neural network, applications of neural network.

Fuzzy logic: Concept of fuzzy logic and fuzzy sets, classical sets, fuzzy relations and rule base, fuzzy arithmetic, fuzzy reasoning and clustering, defuzzification, neuro-fuzzy systems, applications of fuzzy systems.

Genetic algorithm: Concept of genetic algorithm (GA), binary GA, real GA, GA operators, selection, crossover and mutation, optimizations through GA – single objective and multi objective, applications of GA.

Soft computing tools: Different tools for soft computing applications – MATLAB, WEKA, FisPro, kappalab, GUAJE Fuzzy.

Uncertainty quantification: Soft computing for uncertainty modeling and quantification.

Texts/References:

1. D K Pratihar: Soft Computing Fundamentals and Applications, Alpha Science International.

2. Ikvinderpal Singh: Soft Computing, Khanna Publishers.
3. N P Padhy, S P Simon: Soft Computing with MATLAB programming, Oxford University Press, India.
4. S Kaushik, S Tiwari: Soft Computing Fundamentals, Techniques and Applications, McGraw Hill India.
5. T Andrea: Soft Computing, Springer.
6. S N Sivanandam, S N Deepa: Principles of Soft Computing, Willey India.

Course Outcomes:

1. Identify the needs of soft computing in engineering applications
2. Differentiate the use of soft computing over other computing techniques
3. Implement the techniques in soft computing for solving engineering problems
4. Inspect methodologies for soft computing for suitable applications
5. Work on various tools for soft computing applications to solve real life engineering problems

ME 5237	**Metal Cutting**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Introduction: Essential features in metal cutting, the chip, the chip tool interface, Chip flow under conditions of seizure, the built up edge, machined surface.

Forces in metal cutting: Stress on shear plane, Forces in metals and alloys, Stresses on tool, Stress distribution.

Heat in metal cutting: Heat in chip formation, Heat in the tool work interface, Heat in the absence of flow zone, Methods of tool temperature measurement, Tool/work thermocouple, Inserted thermocouples, Changes in hardness and microstructures in steel tool, measured temperature distribution in tools.

Cutting tool materials: Different type of cutting tool materials and relevant characteristic features.

Texts/References:

1. Metal cutting – E.M. Trent
2. Metal cutting: Theory and Practice – A. Bhattacharyya
3. Manufacturing Processes – B. H. Amstead, Phillipe Ostwald. Myron L. Begeman

Course Outcomes:

1. Apply cutting mechanics to metal machining based on cutting force and power consumption.
2. Select cutting tool materials and tool geometries for different metals.
3. Select appropriate machining processes and conditions for different metals.
4. Learn effect of heat in metal cutting.

ME 5238	**Modelling and Simulation**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-I)	3	0	0	3

Unit I: Introduction to systems and modeling - discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation. Discrete event simulation and their applications in queuing and inventory problems.

Unit II: Random number generation and their techniques - tests for random numbers.

Unit III: Random variable generation.

Unit IV: Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

Unit V: Simulation languages and packages - FORTRAN, C , C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies - Simulation of manufacturing and material handling system.

Texts/References:

1. Jerry Banks and John S, Carson II "Discrete Event system Simulation", Prentice Hall, 1984.
2. Geoffrey Gordon, "System Simulation", Prentice Hall, 1978.
3. Francis Neelamkovil, "Computer Simulation and Modelling", John Willey and sons, 1987.

Course Outcomes:

1. Understand the techniques of modeling in the context of hierarchy of knowledge about a system and develop the capability to apply the same to study systems through available software.
2. Learn different types of simulation techniques.
3. Learn to simulate the models for the purpose of optimum control by using software.

ME 5302	**Structural Property Correlation of Engineering Materials**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-II)	3	0	0	3

Introduction: Stiffness, Strength, and Toughness, Types of mechanical behaviour, Relevance, Measurement, data, Macroscopic, continuum behaviour, Physical mechanisms controlling behaviour.

Elasticity: Introduction, Stress, strain, compliance and stiffness tensors, Physical origin of elastic moduli, Generalized Hooke's law and its application to crystals, designing for modulus and Composites.

Continuum Plasticity: True stress-true strain, Necking and Considerer's Criterion, Yield Criteria and yield locus, Normality, Isotropic and kinematic hardening, Plastic stress-strain relations.

Fracture: Importance of Fracture Mechanics, Griffith Fracture Theory, Crack Driving Force & Energy Release Rate, Modes of fracture, Stress intensity factors, Similitude, Role of Crack-tip Plasticity--Plastic Zone Size & Shape, K-dominance, Fracture Toughness-Microstructural Issues.

Fatigue: Total life approaches, Fatigue design approaches, HCF and LCF, Fatigue crack inhibition, Fatigue crack growth, Paris law and models, Threshold, Damage tolerant approach, Striations, Different stages of fatigue crack growth, Examples.

Mechanical Testing Behaviour: Mechanical Characterization: Mechanical Property characterization-Principles & characterization techniques related to tensile, compressive, hardness, fatigue, and fracture toughness properties. Deformation, Super plasticity Stress-strain diagram, Determination of YS, UTS, MoE, %E, %RA, Hardness testing, true stress-strain diagram, stretcher strain characteristics, effects of cold working, & n values, poison's ratio, Deep drawn quality of sheets, Impact test, bend test, shear test, Significances of property evaluation, SN curves and fatigue life, non-destructive testing, residual stress measurements, corrosion testing, wear & tear characteristics, slow strain rate characteristics.

Texts/References:

1. G E Dieter, Mechanical Metallurgy, McGraw-Hill

2. R W Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons
3. M F Ashby and DRH Jones, Engineering Materials 1, Butterworth-Heinemann
4. D Hull and D J Bacon, Introduction to Dislocations, Pergamon
5. Fracture Mechanics –T.L. Anderson, CRC Press.

Course Outcomes:

1. Outline various engineering material properties like elasticity, plasticity, fracture behaviour, fatigue
2. Compare various materials for specific engineering applications to avoid failure
3. Examine material characterization techniques for property evaluation of various engineering materials
4. Estimate material properties by standard testing practices
5. Plan for formulating material selection philosophies for engineering applications

ME 5247	Computational Methods & Computer Programming	L	T	P	C
	M.Tech. (D & M), First Semester (Elective-II)	3	0	0	3

Introduction to computer Programming: Discussion on at least one programming language, like C, C++ JAVA, MATLAB, etc.

Error analysis in numerical computation: Absolute error; Relative error; Round-off error and Truncation error.

Solution of Single variable nonlinear equations: Bracketing method –graphical method, incremental method, bisection method and false position method; Open methods –fixed point iteration, Newton-Raphson method and Secant method.

Roots of singe variable polynomials: Polynomial deflation; Bairstow's method and Muller method.

Solution of a system of multi-variable equations: Linear system of equations-Gauss elimination method. Gauss-Jordan method, matrix inversion, LU decomposition, Jacobi iteration and Gauss-Seidel iteration; Nonlinear system of equations-fixed point iteration. Newton's method, Jacobian matrix and Seidel iteration.

Curve fitting: Least-square line fitting; Exponential curve fitting; polynomial curve fitting –Lagrange polynomial and Newton's polynomial; Interpolation by piecewise spline function –linear spline, quadric spline and cubic spline.

Eigen values and Eigen vectors: Eigen values of a homogenous matrix and eigen values of a symmetric matrix.

Numerical differentiation: Finite difference methods-forward, backward and centre.

Numerical integration: Newton-Cotes quadrature-trapezoidal rule and Simpson's rules; Romberg integration and Gauss quadrature.

Solution of ordinary differential equations: Initial value problem-Euler's methods and Gunge-Kutta methods; Boundary value problems-shooting method, finite difference methods.

Solution of partial differential equations: Elliptic equations and parabolic equations.

Texts/References:

1. Numerical Methods for Engineers, Steven C. Chapra and Raymond P. Canade, Tata McGraw-Hill Publishing Company Ltd.

2. Numerical Methods for Mathematics Science and Engineering. John H. Mathews. Prentice-Hall of India Pvt. Ltd.
3. Applied Numerical Analysis. Curtis F. Gerald and Patrick O. Wheatley, Addison Wesley.
4. Computer Oriented Numerical Methods. V Rajaraman, PHI.

Course Outcomes:
1. Students will be able to apply core concepts in numerical methods to solve engineering problems using computer programs.
2. Student will be able to perform numerical methods for various mathematical operations such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Student will be able to perform numerical methods to evaluate the roots of single and multi-variable polynomials.
4. Capable to efficiently solve a system of linear equations and find their eigenvalues and eigenvectors as well as apply regression analysis to data sets.
5. Ability to write efficient, well-documented MATLAB code to solve the numerical methods and present numerical results in an informative way.

ME 5241	**Theory of Elasticity**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), First Semester (Elective-II)	3	0	0	3

Surface and Body forces, Stress and Strain Tensor, Transformation Laws, Lagrangian and Eulerian Description, Equation of Elasticity (Equilibrium, Constitutive law and Boundary Conditions), Cauchy's formula, Principle of Stresses, Lami's stress Ellipsoid, Cauchy stress quadratic, octahedral stress, Stress-strain relationship, Uniqueness of Solutions, St. Venant's Principle, Strain Energy functions, Two-dimensional problems in rectangular coordinates (polynomial solution, bending of beam, Fourier series solution). Two-dimensional problems in polar coordinates (Axisymmetric problems – rotating discs, Cylindrical shells, plate with a hole, infinite plate with point load, curved beams). Two- dimensional problems in curvilinear coordinates using stress functions. Torsion (circular and non- circular cross section, membrane analogy, thin walled members, hydrodynamic analogy). Scalar and Vector potentials, Strain potentials. Plane state of stress and strain (Two & Three Dimensional), Airy's stress function for problems, Representation of biharmonic function using complex variables, kolosoff- Mushkelishvili method. Thermal stress and its Applications to problems of curved beam, thick cylinder and rotating disc, stress concentration.

Texts/References:

1. S. Timoshenko and J.N. Goodier, Theory of Elasticity, McGraw Hill International Publication.
2. Vitor Dias da Silva, Mechanics and Strength of Materials, Springer.
3. I.S. Sokolnikoff, Mathematical Theory of Elasticity, McGraw-Hill International Publication
4. A.E. Green and W. Zerna, Theoretical Elasticity, Dover Publications
5. L.D. Landau and E.M. Lifschitz, Theory of Elasticity, Pergamon Press
6. F.P. Beer, E.R. Johnston and J.T. DeWolf, Mechanics of Materials, McGraw-Hill International Publication.

Course Outcomes:

1. Able to solve the problems of 3-D elasticity with confidence.
2. Can independently work with the problems of 2-D elasticity in Cartesian/Polar Coordinates.
3. Familiarized with the use of Airy's stress function in 2-D problems of elasticity in Cartesian/Polar Coordinates.

4. Equipped with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion.

ME 5131	Optimization Techniques	L	T	P	C
	M.Tech. (D & M), First Semester (Elective-II)	3	0	0	3

Introduction: Definition of optimization and its importance; Basic terminologies – design variables/vector, cost/objective function, constraints and variable bounds, etc; Different types of optimization problems –based on number of variables, based on nature of variables, based on constraints, based on approaches used, based on number of objectives, etc.

Single variable unconstrained optimization: Global optimum point; Local optimum point; Stationary point; Optimality criteria; Graphical method for optimum point; Direct methods for bracketing the optimum point –Exhaustive search method and Bounding phase method; Refining the bracketed optimum point through region elimination methods –Interval halving method, Fibonacci search method and Golden section search method; Gradient based methods –Bisection method. Newton-Raphson method and Secant method.

Multi-variable unconstrained optimization: Optimality criteria; Unidirectional search; Direct methods – Simplex search method, Hooke-Jeeves pattern search method and Powell's conjugate direction method; Gradient based methods –Cauchy's steepest descent method, Newton's method, Marquardt's method, Conjugate gradient method and Variable metric method.

Multi-variable linear and constrained optimization: Definition and formulation of linear programming problem; unrestricted variables; slack variables; artificial variables; feasible design; infeasible design; basic solution; basic feasible solution; Simplex method for less-than-equal type of constraints; Simplex method for equality and greater-than-equal types of constraints.

Multi-variable nonlinear and constrained optimization: Kuhn-Tucker conditions; Sensitivity analysis; Transformation methods –interior penalty function method, exterior penalty function and method of multipliers; Direct methods –variable elimination method, complex search method and random search method; Gradient based methods –cutting plane method, sequential linear programming and feasible direction method.

Integer and mixed optimization: Penalty function method and branch-and-bound method.

Texts/References:

1. Kalyanmoy Deb, "Optimization for Engineering Design – Algorithms and Examples" Prentice Hall of India Pvt. Ltd.
2. Jasbir S. Arora, "Introduction to Optimum Design" McGraw-Hill International Editions
3. Ashok D. Belegundu and Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering" Pearson Education

Course Outcomes:

1. Students will be able to get awareness about the real world problems, their understanding and ability to formulate mathematical models of these problems.
2. Students will be able to understand the major limitations and capabilities of deterministic operations research modeling as applied to problems in industry or government.
3. Student will learn to handle, solve and analyzing problems using linear programming and other mathematical programming algorithms.

4. Students will also be able to learn different techniques to solve Non- Linear Programming Problems.
5. Student will also able to learn different search techniques, which are based on iterative methods, to find optimal solutions of Non-Linear Programming Problems. Also students will be able to understand multistage decision problems.

ME 5249	Principles of Tribology	L	T	P	C
	M.Tech. (D & M), First Semester (Elective-II)	3	0	0	3

Introduction: History, Industrial Importance.

Engineering Surfaces: Properties and Measurement: Measurement Methods, Surface Profilometry, Statistical Description, and Fractal Description.

Surface Contact: Non-conforming Surface Contact Geometry, Stresses in Non-conforming Contacts, Contact of Rough Surfaces, Numerical Surface Contact Models.

Adhesion: Adhesion at Solid-Solid Contact, Basic Models, Factors influencing Adhesion, Adhesion produced by Surface Tension, Stiction, Adhesion at the Contact between Rough Surfaces.

Friction: Measurement Methods, Origin of Friction, Friction Theories, Mechanisms, Friction of Metals, Non-metallic Materials: Ceramics, Polymers, Solid Lubricants.

Wear: Types: Adhesive, Abrasive, Corrosive, Fatigue, Minor Forms: Fretting, Erosion, Percussion, Delamination Theory, Wear Debris Analysis, Wear Testing Methods, Wear of Metals, Ceramics, Polymers, Systems Approach for Wear Reduction.

Thermal Considerations in Sliding Contact: Measurement of Surface Temperature in Sliding: Thermocouples, Thin Film Sensors, Radiation Detectors, Metallographic Observation, Liquid Crystals etc., Theoretical Analyses: Archard's Approach, Multiple Heat Input Considerations.

Surface Engineering: Surface Treatments: Microstructural and Thermochemical Treatments, Surface Coatings: Hard Facing, Vapour Deposition Processes: PVD, CVD, PECVD etc., Selection of Surface Treatment / Surface Coatings.

Nanotribology: Measurement Tools: Surface Force Apparatus, Scanning Tunnelling Microscope, Atomic / Friction Force Microscope, Measurements, Fabrication Techniques for MEMS / NEMS, Atomic Scale Simulations.

Texts/References:

1. Introduction to Tribology of Bearings. B. C. Majumdar, A. H. Wheeler & Co. Ltd., New Delhi,1999
2. Basic Lubrication Theory. A. Cameron and C. M. McEttles, Wiley Eastern Ltd., New Delhi, 1987.
3. Engineering Tribology. P. Sahoo, PHI Learning, 2005.
4. Principles of Tribology. H Ping, Willey.

Course Outcomes:

1. Review the need of the tribology of engineering materials for suitable applications
2. Describe surface properties of materials for engineering applications
3. Apply the principle of friction in tribology perspective
4. Interpret surface engineering practices for improving material selection and improvements
5. Study the advancements in tribology like nano tribology for future applications

ME 5133	Innovation & Product Design	L	T	P	C
	M.Tech. (D & M), First Semester (Elective II)	2	1	0	3

Introduction: History of design and innovation. Use of technology in day to day life, in agriculture, manufacturing, sanitation, medicine, transportation, information processing, and communications. Comparison of the work of past and current designers across a range of settings.

Fundamentals of Design: Perception of gap and need in user experience. Concepts and ideas. Visualization of ideas through drawing. Computer generated design using auto CAD software.

Optimization in Design: Introduction, Siddal's Classification of Design Approaches, optimization by Differential Calculus, Langrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method of Optimum Design.

Human engineering Consideration in Product Design: Introduction, Human Being as Applicator of Forces, Anthropometry: Man as Occupant of Space, The Design of Controls, The Design of Displays, Man/Machine information Exchange.

Components: Study of basic Electrical, Mechanical, and Electronics components, materials and their properties.

Tools and Manufacturing: Use of basic tools such as milling machine, drill presses, band saws, grinders, Manufacturing processes such as welding techniques and tool making.

Modern Approaches to Product Design: Concurrent Design, Quality Function Deployment (QFD)

Case studies: Constructing prototype and testing.

Texts/References:

1. Bryan Lawson What Designers Know, ELSEVIER
2. Karl T. Ulrich Design: creation of artifacts in society University of Pennsylvania
3. Lucienne T. M. Blessing, Amaresh Chakrabarti DRM, A Design Research Methodology, SPRINGER
4. John Heskett Design: A very short Introduction, OXFORD
5. John Kolko Exposing the Magic of Design, OXFORD
6. AK Chitale & RC Gupta Product Design & Manufacturing, PHI.

Course Outcomes:

1. Identify the necessity of product development
2. Apply the concept of design for design
3. Apply the concept of human engineering in product design
4. Identity the requirement of basic tools for product developments

ME 5244	Theory of Plates and Shells	L	T	P	C
	M.Tech. (D & M), First Semester (Elective-II)	3	0	0	3

Introduction: Classical bending theory of plates, rectangular and circular plates with various edge conditions and loading, plates of various shape, strain energy method, approximate method in the theory of plates

Elastic shells: Introduction to differential geometry, various theories of thin elastic shells, fundamental equations.

Static analysis of shells: Membrane analysis of shells of revolution, bending analysis of shells of revolution, approximate solutions.

Dynamic analysis of shells: Free and forced vibration of shells, buckling of shells, and use of numerical methods on shells under static and dynamic loading.

Texts/References:

1. S. Timoshenko and S. K. Woinowsky, "Theory of Plates and Shells", McGraw-Hill International, 2007
2. J. N. Reddy, "Theory and Analysis of Elastic Plates and Shells", CRC Press, 2006.
3. E. Ventsel and T. Krauthammer, "Thin Plates and Shells", Marcel Dekker, Inc., 2001.
4. A. Ugural, "Stresses in Plates and Shells", McGraw Hill, 1999.
5. P. L. Gould, "Analysis of Shells and Plates", Springer-Verlag, 1988.
6. C. L. Dym., "Introduction to the Theory of Shells", Hempshire Publishing Corp., 1990.

Course Outcomes:

1. Choose various plates and shells for different applications based on the analysis of plates and shells (apply).
2. Analyze the conditions of failure of plates and shells against different loading conditions (analyze).
3. Compare different numerical models for estimating behaviour of plates and shells under different loading conditions (evaluate).
4. Recommend proper geometry and specifications of plates and shells for specific requirement (evaluating).
5. Test the feasibility of the geometry of plates and shells for specific engineering application (creating).

ME 5204	Advanced Solid Mechanics	L	T	P	C
	M.Tech. (D & M), Second Semester (Core)	2	1	0	3

Advanced Strength of Materials: Beam Bending and Stability problems, Analysis of Thick Cylinder and Rotating Disk etc., Application of Energy Methods. Equation of Stress Equilibrium: Cauchy's

Equation, Stress Quadratic, Principle stresses; Strain Compatibility: Strain Displacement Relations, Principle Strains; Stress and Strain Invariants. Generalized Hook's law, Lame's Equation of Equilibrium. Introduction to Theory of Plasticity. Experimental stress analysis: basic concept of measuring systems. Causes and types of experimental errors, models and scale factors. Strain gauges: mechanical, optical, electrical etc., Rosette analysis, dynamic applications, strain gauge circuits, recording and indicating devices, digital interfacing, data acquisition and processing. Introduction to theory of photo elasticity.

Texts/References:

1. L.S. Srinath, Advanced Mechanics of Solids, THM Publishing Co. Ltd., New Delhi.
2. R.G. Budynas, Advanced Strength and Applied Stress Analysis, McGraw Hill Publishing Co.
3. A.P. Boresi, R.J. Schmidt, Advanced Mechanics of Materials, John Willey and Sons Inc.
4. S.P. Timoshenko, J.N. Goodier, Theory of Elasticity, McGraw Hill Publishing Co.
5. P. Raymond, Solid Mechanics for Engineering, John Willey & Sons.
6. J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw Hill Publishing Co., New York.

Course Outcomes:

1. Solve Bending and stability problem
2. Analyze and solve the engineering problem related to thick cylinder and rotating disc
3. Analyze the experimental error related to measurement.
4. Select the appropriate strain gauge to measure and record real time strain data.

ME 5205	Production and Operations Management	L	T	P	C
	M.Tech. (D & M), Second Semester (Core)	3	0	0	3

Product development: Principal of good product design, Component and tolerance design, Efficiency, quality and cost construction, Product life cycle. Standardization, simplification, diversification.

Quality management: Quality analysis and control, Total Quality Management, TQM and continuous improvement, customer focus, Quality awards and concepts, PDCA cycles, Bench marking, Quality function deployment, Taguchi Method, Design of Experiments, Zero defects and six sigma, Quality circle.

Forecasting techniques: Forecasting, Casual and time series models, moving average, exponential smoothening, trend and seasonality.

Aggregate Production Planning: Master scheduling, bills of materials and MRP, Purpose and scope, Basic strategies, disaggregating methods, Order control and flow control, Routing, Scheduling and priority dispatching, Operations scheduling.

Logistic and facility Design: Facility location factors, evaluation of alternatives, Types of plant layout, evaluation, Computer aided layout, Assembly line balancing.

JIT, Kanban pull system, Bottleneck scheduling and theory of constraints.

Management information system: Value of information, Information storage and retrieval system-data base and data structure, Interactive system, and knowledge base systems.

Texts/References:

1. Production & Operations Management by Panneerselvam R Publisher: PRENTICE HSecond Edition.
2. Theory And Problems In Production And Operations Management by Chary, S N Publisher: Tata McGraw-Hill
3. Production Management – a New Concept by V K Dubey Publisher: Commonwealth Publishers
4. Production And Operations Management by KanishkaBedi Publisher: Oxford University Press.

Course Outcomes:

1. Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness.
2. Analyze and evaluate various facility alternatives and their capacity decisions, develop a balanced line of production & scheduling and sequencing techniques in operation environments
3. Develop aggregate capacity plans and MPS in operation environments.
4. Plan and implement suitable materials handling principles and practices in the operations.
5. Plan and implement suitable quality control measures.

ME 5106	**Robotics & Automation**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Core)	3	0	0	3

Introduction: Development of industrial robotics, definition of robot and its classification.

Robot Anatomy: Configuration of robots, robot work volume, geometric analysis of robot.

Robot Kinematics: Positions representations, forward and inverse kinematics of multi degree of freedom of robot. Concept of object oriented programming and its application in robotics.

Robot Dynamics: Introduction to mathematical modeling for forward and inverse kinematics analysis, inverted pendulum and its application in biped motion analysis.

Robot Peripherals: End effectors, grippers, sensors, machine vision and their industrial applications. Automation: Introduction, types of automation, applications of automation, transfer systems, feeders, feed tracks, trays and pallets, escapements, parts placing mechanisms, application of robot in automation and manufacturing operations like welding, spray coating, cutting operations, moulding, machine loading, pick and place, assembly and inspection.

Texts/References:

1. M.P. Groover, Industrial Robotics, Mc.Graw Hill Book Co.
2. M.P. Groover, Automation, Production systems and computer integrated manufacturing, PHI
3. G. Boothroyd. C. Poli, L.E, Murch, Automatic Assembly, Marcel Dekker
4. J. J. Craig Introduction to Robotics, Addition Wesley

Course Outcomes:

1. Apply the concept to robotics in industry
2. Synthesis the robotic configuration
3. Synthesis the mathematical modeling with robotic motion analysis
4. Utilize the robot peripherals to enhance the capability of robot for automatic holding, sensing the object for industrial application.

ME 5206	**Mini Project**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Core)	0	0	2	1

Geometric modeling of engineering components using CAD software, Numerical analysis of engineering products, Experimental investigations on various manufacturing processes, Composite materials

Course Outcomes:

1. Approach real life problem for its solution
2. Apply theoretical knowledge to perform various experimental and numerical investigations.

ME 5207	**Design and Manufacturing Lab-II**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Core)	0	0	3	2

Tribological behavior of materials, Material development, Mechanical Testing of materials, Computational Analysis of Engineering components,

Course Outcomes:

1. Implement the ideas of design and manufacturing related concepts in attacking real life problems.
2. Select suitable testing methods for quantifying qualities of materials with respect to design attributes.
3. Practice different methods for material developments
4. Comment on the quality attributes of various materials using standards tests

ME 5138	**Additive Manufacturing**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Introduction: Overview and History of Additive Manufacturing, CAD-CAM and its integration, Traditional Prototyping Vs. Rapid Prototyping (RP), Benefits of AM, Classification of Additive Manufacturing Processes: Additive, Subtractive, Formative, Generic AM Process, Applications in Product Development.

Cad Modelling and Data Processing: Introduction, Data Processing for Additive Manufacturing Technology: 3D solid modeling software and their role in AM, CAD model preparation, Data interface for Additive Manufacturing: Creation of STL file, Problem with STL file, STL files Manipulation, Beyond the STL file, Additional Software to Assist AM; Part orientation, Support Structure Design, Model Slicing Algorithms and Contour Data Organization, Direct and Adaptive Slicing, Tool Path Generation; Software for Additive Manufacturing Technology: MIMICS, MAGICS.

Additive Manufacturing Processes: Classification, Liquid Based System: Stereolithography Apparatus, Solid Ground Curing, Polyjet: Process Physics, Material and Technological Aspects, Process Parameters, Advantages, Applications and Case Study; Solid based system-Fused Deposition Modeling, Laminated Object Manufacturing, Contour Crafting: Process Physics, Material and Technological Aspects, Process Parameters, Advantages, Applications and Case Study; Powder based system: Selective Laser Sintering, Selective Laser Melting, Laser Engineered Net Shaping, Electron Beam Melting, Three Dimensional Printing: Process Physics, Material and Technological Aspects, Process Parameters, Advantages, Applications and Case Study; Other Associated Technology, Metal and Hybrid Systems.

Post Processing: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-Thermal and Thermal Techniques.

Issues in Additive Manufacturing: Variation from one AM Machine to Another, Pre- & Post processing, Metal System, Accuracy Issues in Additive Manufacturing, Strength of AM Parts, Surface Roughness Problem in Additive Manufacturing, Part Deposition Orientation and Issues like Shrinkage, Swelling, Curl and Distortion; Materials, Machine Design: Larger Scale or Smaller Scale, Layer Forming Quality, Material Delivery, Cost, Reliability, Operation and Others.

Reverse Engineering: Introduction, Measuring Device- Contact type and Non-Contact Type, CAD Model Creation from point Clouds, Preprocessing, Point Clouds to Surface Model Creation, Medical Data Processing: Types of Medical Imaging, Software for Making Medical Models, medical materials, Other Applications: Case study.

Recent Advances and Applications: Rapid Tooling (Direct and Indirect RT), New Materials Development, Bi-metallic parts, Application Examples for Aerospace, Defense, Aerospace, Automotive and Biomedical Applications of AM- Computer Aided Tissue Engineering (CATE), Case studies; Trends and Future Directions in Additive Manufacturing.

Texts/References:

1. Rapid Prototyping: Principles And Applications by C.K. Chua, K.F. Leong, C.S. Lim, 3rd Edition, World Scientific Publishing Co Pte Ltd
2. Rapid Prototyping: Theory & Practice, A. K. Kamrani, E. A. Nasr Springer
3. Additive Manufacturing, A. Bandyopadhyay, S. Bose CRC Press; 2nd edition
4. Rapid Prototyping: Principles and Applications in Manufacturing, R. Noorani Wiley

Course Outcomes:

1. Understand the broad range of AM processes, devices, capabilities and materials that are available.
2. Learn how to create physical objects that satisfy product development/prototyping requirements, using advanced/additive manufacturing processes and suitable materials.
3. Fabricate an actual multi-component object using advanced/additive manufacturing process.
4. Articulate the various trade-offs that must be made in selecting advanced/additive manufacturing processes, devices and materials to suit particular product requirements

ME 5306	Fabrication of Engineering Materials	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Ferrous metals: Iron-Carbon equilibrium diagram; Effects of alloy additions; Types of steel – plain carbon steels, low alloy steels, heat treatable steels, tool steels, die steels, stainless steels, special steels; International systems to classify steel grades – AISI/SAE, DIN, EN series/BS, BIS; Automotive grades and compositions; Mechanical, thermal, electrical and physical properties of steels, applications.

Steel making: Principles of steel making, melting practices – Development of steel making processes, physiochemical principles and kinetic aspects of steel making, carbon boil, oxygen transport mechanism, desulphurization, dephosphorization, slag-functions, composition control, properties and theories, raw materials for steel making and plant layout, Effects of melting practices on end product. Principle equipment used and applications of steel making processes.

Cast iron: Types of Cast irons – grey cast irons, alloy CI, Spheroidal cast irons, white iron, malleable iron, vermicular cast irons; Chemical compositions and properties.

Aluminium and aluminium base alloys: Enhancing properties of aluminium for auto applications; Classification system and grades of alloys; Roles of alloy additions on properties; Significance of various equilibrium diagrams in designing alloys; Solution treatment (age hardening) and microstructural changes; Chemical compositions & properties of aluminium alloys; Environmental benefits of recycling. Aluminium alloy melting practices; Component forming processes – castings, extrusions, sheet forming and forgings, material defects and their significances on properties and performances on end product; Automotive applications of aluminium alloys and manufacturing processes for body to Power train components.

Magnesium and titanium base alloys: Properties and benefits over other traditional metals; Classifications of alloys; Melting practices; Manufacturing processes – Casting, extrusion and forging processes; Solution treatment and microstructures; Alloy compositions and properties; Surface coatings; Auto applications and limitations.

Texts/References:

1. William D. Callister, Jr., “Materials Science and Engineering an Introduction”, John Wiley & Sons, 6th Edition, Inc., 2004. \
2. V. Raghavan, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 5th Edition, 2007
3. Hajra Choudhary, “Elements of Workshop Technology”, Asia Publishing House, Vol. I & II; 1996
4. R. K. Jain and S.C. Gupta, “Production Technology”, Khanna Publishers, 1997
5. H.M.T. “Production Technology”, Tata McGraw Hill, 1990
6. Avner, S. H., “Introduction to Physical Metallurgy”, second edition, McGraw Hill, 1985.
7. Flinn, R. A., Trojan, P.K., “Engineering Materials and their Applications”, Jaico 4th Edition, 1999.
8. Ashby M. F., “Material Selection in Mechanical Design”, Butter Worth 3rd Edition, 2005. Smithells Metals Reference Book, Eighth Edition

Course Outcomes:

1. Conceptually explain the classification schemes that are used to categorize engineering materials.
2. Use binary phase diagrams to predict microstructures and also to understand precipitation hardening.
3. Understand how thermal treatments affect the microstructure and, thus, properties of materials.
4. To promote an understanding of the relationship between material structure, processing and properties.

5. To give students the background required to pursue further studies in materials processing, design and related engineering fields.

ME 5239	Manufacturing Management	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Strategy planning: Nature of production-inventory management systems. Strategic, Tactical and Operational decisions. General discrete location-allocation problems - features and formulations. Facility location models - median model - distribution model - brown and Gibson model

Tactical planning: Aggregate production planning - ways to absorb demand fluctuations - costs relevant to aggregate production planning - aggregate production planning models - Inventory management - EOQ decision rules - costs in an inventory system - simple lot size model

Scheduling: Operations scheduling - Flow shop - n jobs – 2 machine Johnson's rule, 2 Jobs –M machine, N-Jobs M machine Sequencing Job on parallel machine - Assembly Line Balancing- Project Scheduling-crashing of project network with cost trade off

MRP & MRP-II: Material Requirement Planning (MRP) - working of MRP - Use of MRP system - evolution from MRP to MRP II - master production scheduling - rough cut capacity planning - capacity requirement planning - Lot sizing in MRP II system.

SCM & quality management: Concept of supply management and SCM, Flow in supply chains, Key issues in supply chain management, Decision phases in supply chain, concept of quality management - standards for quality management - statistical process control - Taguchi method of quality control.

Texts/References:

1. H.G. Menon, “TQM in New Product Manufacturing”, McGraw Hill, 1992.
2. Hax and Candea, “Production and Inventory Management”, Prentice Hall, 1984.
3. Buffa. “Modern Production Management”, John Welley, 1983.

Course Outcomes:

1. Make management level decisions within a manufacturing environment including operations management, supply chain management.
2. Analyze planning, professional and engineering decisions within a manufacturing environment.
3. Evaluate cost effectiveness of manufacturing products, processes and operations.
4. Manage a sustainable supply chain using a variety of effective tools and techniques.

ME 5307	Modern Manufacturing Methods	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Introduction to Modern Manufacturing Methods, their needs in today’s manufacturing scenario, identification and characteristics of these processes, conventional versus modern manufacturing methods.

Mechanical Processes: Abrasive jet machining, Water jet machining, Abrasive water jet machining, Abrasive flow machining, Ultrasonic machining, Ultrasonic welding, their working principles, equipments, process capabilities, applications, advantages and limitations.

Chemical and Electrochemical Processes: Chemical machining, Photo chemical machining, Electrochemical machining, drilling, grinding, deburing, their working principles, equipments, process capabilities, applications, advantages and limitations.

Electrothermal Processes: Electro discharge machining (EDM), Electrodischarge wire cutting or wire EDM, Electrodischarge grinding, Electrochemical discharge grinding, their working principles, equipments, process capabilities, applications, advantages and limitations.

Electron Beam Machining, Electron Beam welding, Plasma arc cutting, Ion beam machining.

Laser Processing: Process principle, type of laser, equipments, and laser processes: drilling, cutting, machining, welding, heat treating, cladding; applications, advantages and limitations.

High energy rate forming: Electromagnetic forming, explosive forming, electrohydraulic forming, their process principles, applications.

Introduction to some emerging trends in manufacturing: Micro manufacturing, manufacturing processes lead towards micro-manufacturing, micro electro mechanical systems (MEMS), Rapid prototyping, concept of nanotechnology.

Texts/References:

1. V. K. Jain, Advanced Machining Processes, Allied Publishing Pvt. Ltd.
2. G. F. Benedict, Nontraditional Manufacturing Processes, Marcel Dekker Inc
3. P. K. Mishra, Nonconventional Machining, Narosa Publishing House
4. A. Ghosh & A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd.
5. G. Boothroyd & W. A. Knight, Fundamentals of Machining and Machine Tools, CRC Press Taylor & Francis Group
6. A McGeogh, Advanced Methods of Machining, Chapman & Hall
7. N. P. Mahalik, Micro manufacturing and Nano-Technology, Springer

Course Outcomes:

1. To introduce students to the basic concepts of modern manufacturing with particular emphasis on forming and machining processes.
2. To introduce students to the scientific principles underlying in machining processes so as to enable them to calculate performance measures like material removal rate.
3. To develop knowledge of appropriate process parameters applicable for various advanced machining processes and their effects on performance measures.
4. To introduce students to the machining setups to develop knowledge of machine tools used in advanced manufacturing.
5. To make students aware of the necessity of modern manufacturing processes and for the best use of these processes for material processing with particular emphasis on safety and environmental considerations.

ME 5149	**Non Traditional Techniques for Optimum Design**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Introduction: Definition and importance of a nontraditional technique. Advantages over a classical technique.

Genetic Algorithm (GA): Introduction; Chromosome representation and initialization- binary and real representation; GA operators – selection, crossover and mutation; Elite preserving mechanism; Schema theory; Constraints handling; GA for combinatorial problems – permutation representation and real-coded representation; Multi-objective optimization – concept of dominance, non-dominated sorting, ranking and crowding distance.

Differential Evolution (DE): Introduction; Chromosome representation; Target, base and trail vectors; Mutation and crossover; DE for combinatorial problems; Differences between DE and other nontraditional techniques.

Particle Swarm Optimization (PSO): Introduction; Chromosome representation; Global, population and local best solutions; Velocity and position of a solution; PSO for combinatorial problems; Differences between PSO and other nontraditional techniques.

Introduction to other nontraditional techniques: Like simulated annealing, tabu search algorithm, artificial neural network, and ant colony optimization.

Texts/References:

1. Optimization for Engineering Design-Algorithms and Examples – Kalyanmoy Deb; Prentice Hall of India Pvt. Ltd., New Delhi; 1995.
2. Multi-Objective Optimization using Evolutionary Algorithms – Kalyanmoy Deb; John Wiley & Sons Ltd, England; 2001.
3. Differential Evolution: A Practical Approach to Global Optimization – Kenneth V. Price, Rainer
4. M. Storn and Journi A. Lampinen; Natural Computing Series, Springer; 2005.
5. Particle Swarm Optimization – Maurice Clerc; ISTE Publishing Company; 2006.

Course Outcomes:

1. Distinguish between non-traditional and traditional techniques for optimum design
2. Apply the concept of GA in multi-objective problem solving
3. Select differential evolution for solving real life problems
4. Implement the concept of particle swarm optimization for solving industrial problem.

ME 5134	Non Destructive Testing of Materials	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Introduction: Review of destructive testing, limitations of destructive testing, need for non-destructive testing, fundamentals and introduction to non-destructive testing, scope and limitations of NDT, Visual examination methods, different visual examination aids.

Dye penetrant Testing: Principle, procedure, characteristics of penetrant, types of penetrants, penetrant testing materials, fluorescent penetrant testing method– sensitivity, application and limitations

Magnetic Particle Testing: Important terminologies related to magnetic properties of material, principle, magnetizing technique, procedure, equipment, fluorescent magnetic particle testing method, sensitivity, application and limitations

Ultrasonic Testing: Basic principles of sound propagation, types of sound waves, principle of ultrasonic testing, methods of ultrasonic testing, their advantages and limitations, piezoelectric material, various types of transducers/probe, calibration methods, use of standard blocks, technique for normal beam inspection, flaw characterization technique, defects in welded products by ultrasonic testing, thickness determination by ultrasonic method, study of a, b and c scan presentations, advantage, limitations acoustic emission testing, principles of acoustic emission testing and techniques

Radiographic testing: Radiographic testing: X-ray and Gamma-Ray radiography, their principles, methods of generation, industrial radiography techniques, inspection techniques, applications, limitations, types of films, screens and penetrameters. Interpretation of radiographs, safety in industrial radiography

Leak and pressure testing: Leak and pressure testing: definition of leak and types, principle, various methods of pressure and leak testing, application and limitation

Eddy current testing: Eddy current testing: principle, instrument, techniques, sensitivity, application, limitation of thermal methods of NDT.

Materials characterization: Basic principles, interaction of radiation and particle beams with matter, diffraction methods, images, optical, scanning, transmission electron, scanning tunneling and field ion microscopy, microanalysis and spectroscopy, energy dispersive, wavelength dispersive, Auger processes, electron, ion growth, secondary-ion mass spectrometry (SIMS), electron spectroscopy for chemical analysis (ESCA), Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC).

Texts/References:

1. Barry Haul, Vernon John: Non Destructive Testing, Springer – Verlag New York Inc., 2012.
2. Paul E Mix: Introduction to Nondestructive Testing: A Training Guide, Willey – Blackwell, 2005.
3. Ravi Prakash: Non-Destructive Testing Techniques, New Academic Science Ltd., 2009.
4. Baldev Raj: Practical Non Destructive Testing, Narosa Publishing House, 2009.
5. Yang Leng: Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Wiley VCH, 2013.
6. Khangaonkar P R: An Introduction to Material Characterization, Penram International. Publishing (India) Pvt. Ltd., 2008.

Course Outcomes:

1. Be differentiate between destructive and non-destructive testing methods.
2. Be able to identify the types of equipment used for each non-destructive testing.
3. Be able to explain the purpose of the equipment, application, and standard techniques required to perform major non-destructive testing of materials and components.
4. Be able to go to specific code, standard, or specification related to each testing method.
5. Acquire the knowledge and essential skills to identify strengths and weaknesses in materials used in fabrication

ME 5240	**Rapid Prototyping and Tooling**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Elective-III)	3	0	0	3

Introduction: Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital Prototyping - Virtual prototyping-Introduction to RP Softwares.

CAD Modelling and Data Processing for RP: CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation

Liquid Based and Solid Based Rapid Prototyping System: Stereolithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, Three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Powder Based Rapid Prototyping Systems: Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

Rapid Tooling: Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods

RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP

Texts/References:

1. Rapid prototyping: Principles and applications, second edition, Chua C. K., Leong K. F., and Lim C. S., World Scientific Publishers, 2003
2. Rapid Tooling: Technologies and Industrial Applications, Peter D. Hilton, Hilton/Jacobs, Paul F. Jacobs, CRC press, 2000.
3. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003
4. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W. Liou, Frank W. Liou, CRC Press, 2007.
5. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006

Course Outcomes:

1. Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications
2. Explain direct metal laser sintering, LOM and fusion deposition modeling processes
3. Demonstrate solid ground curing principle and process
4. Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components

ME 5139	**Engineering Fracture Mechanics**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction: Historical perspective, Fracture mechanics approach to design, Overview and Classification. Linear Elastic Fracture Mechanics Griffith's theory of brittle failures; Irwin's stress intensity factors.

Linear elastic fracture mechanics: The stress analysis of crack tips, macroscopic theories in crack extension, Instability and R-curves, Crack tip plasticity, K as a failure criterion, Mixed mode of fracture, analytical and experimental methods of determining K.

Elastic plastic fracture mechanics: Crack tip opening displacement, J integrals, crack growth resistance curves, crack tip constraint under large scale yielding, creep crack growth.

Microscopic theories of fracture: Ductile and cleavage fracture, ductile-brittle transition, inter-granular fracture.

Fatigue crack propagation: Fatigue crack growth theories, crack closure, microscopic theories of fatigue crack growth.

Applications of theories of fracture mechanics in design and materials development.

Texts/References:

1. T. L. Anderson: Fracture Mechanics - Fundamentals and Applications: CRC Press.
2. G. E. Dieter: Mechanical Metallurgy: McGraw Hill.

3. R. W. Hertzberg: Deformation and Fracture Mechanics of Engineering Materials: John Wiley& Sons Inc.
4. D. Broek: Elementary Engineering Fracture Mechanics: Kluwer Academic Publishers.
5. T. Rolfe and J. M. Barson: Fracture and Fatigue Control in Structures: PHI.
6. Prashant Kumar: Elements of Fracture Mechanics: Tata McGraw Hill.

Course Outcomes:

1. Explain reasons behind common mechanical failure.
2. Differentiate failure mechanisms under plane stress and plane strain condition.
3. Calculate theoretical fracture strength and experimental fracture strength through EPFM, CTOD and J-integral.
4. Interpolate the effect of crack inside brittle and ductile materials.
5. Extrapolate the effect of energy release rate on fracture of materials.

ME 5148	**Ergonomics & Aesthetics**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction: Ergonomics, Social significance of ergonomics

Posture and Movement: Biomechanical, physiological and anthropometric background, Human biological, ergonomic and psychological capabilities and limitation. Sitting, standing, Hand and arm postures, change of postures; lifting, carrying, pulling and pushing movement.

Information and operation: Visual, Hearing and other senses/information, Controls, types of controls, Relation between operation and operation, Expectation, User friendliness, Different forms of Dialogue.

Environmental Factors: Noise, Vibration, Illumination, Climate, Chemical Substances.

Work Organization: Analysis and design of job requirements, work place arrangements, materials handling devices systems and machine controls for the improvement of human work place.

The Ergonomics Approach: Project Management, Advances in applied bio-mechanics and ergonomics.

Aesthetics: Aesthetic judgement, Aesthetic universals, Principles of aesthetics, Aesthetic in Marketing, Information technology, Industrial design.

Texts/References:

1. Work Study and Ergonomics by S. Dalela, Publisher: Standard Publishers
2. An Introduction to Human Factors Engineering By Wickens Christopher D, Publisher: Prentice Hall
3. Human Factors Engineering by Chandler Allen Phillips, Publisher: John Wiley and sons inc.
4. Human Factors in Engineering and Design by Sanders Mark S, Publisher: McGraw Hill
5. Ergonomics for beginners: A quick reference guide by Jan Dul, Bernard A, Weerdmeester, 2nd Edition, CRC press.

Course Outcomes:

1. Learn the social significance of ergonomics
2. Apply the concept of ergonomics in product design
3. Analyse the essential environmental factor affecting the human.
4. Create effective workplace arrangement.

ME 5105	FEM in Engineering Applications	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction to FEM. Theory for 1-D element and 2-D element. Focus on software development and usage for 1-D, 2-D and 3-Delements. Variational methods. Element types and properties. Boundary conditions. Stress-strain determination. Solution techniques. Mesh refinement. Convergence criterion. Frames, beams and axial element. Plane stress. Plain strain. Ax symmetric problems. Plate bending. Fluid mechanics and Heat transfer, Modules modeling and elastic analysis. Super elements. Structural instability of frames and beams.

Pre Processing, Mesh generation, element connecting, boundary conditions, input of material and processing characteristics – Solution and post processing - Overview of application packages such as ANSYS/ SIMULIA (Abaqus)/Nastran/Altair-Hyper Works. Applications of FE analysis in metal casting, cutting tools, structural analysis of parts, heat transfer etc.

Texts/References:

1. J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw-Hill
2. K. J. Bathe, Finite Element Procedures, Klaus-Jurgen Bathe
3. O. C. Zienkiewicz, The Finite Element Method.
4. C. S. Krishnamurthy, Finite Element Analysis: Theory & Programming, TMH Publishing Co.
5. S. S. Rao, The Finite Element Method in Engineering, Pergamon Press.

Course Outcomes:

1. Understand the concept of finite element method for solving Mechanical Engineering problems
2. Formulate and solve manually problems in 1-D structural systems involving bars, trusses, beams and frames.
3. Develop 2-D FE formulations involving triangular, quadrilateral elements and higher order elements.
4. Apply the knowledge of FEM for stress analysis, model analysis, heat transfer analysis and flow analysis.
5. Develop algorithms and write FE code for solving simple design problems and understand the use of commercial packages for complex problems.

ME 5242	Rotor Dynamics	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction: Overview of Various Rotor Dynamics Phenomena & Recent Trends, Single-DOF Damped Rotor Model, the Jeffcott Rotor Model, Jeffcott Rotor Model with an Offset Disc, Translational motion, Steady state response to unbalance, effect of flexible support.

Rigid Rotor System and Critical Speed: Rigid disk equation - Rigid rotor dynamics, Rigid rotor and flexible rotor, The gyroscopic effect on rotor dynamics, Whirling of an unbalanced simple flexible rotor, Unbalance response, Effect of axial stiffness, Determination of bending critical speeds, Campbell diagram.

Torsional vibration of rotor and multi degrees freedom system: The direct and transfer matrix method, Simple geared and branched system. Multi degree of freedom systems, Simple shafts with several disks, Determination of natural frequencies and mode shapes, Numerical methods for fundamental frequency.

Influence of Bearings on Rotor Vibrations: Symmetrical long rigid shaft on isotropic and anisotropic flexible bearing, Symmetrical flexible shaft on isotropic and anisotropic flexible bearing. Governing Equations and Free Vibration in Continuous Systems.

Rotor Balancing and Conditional Monitoring: Single plane balancing, Multi-plane balancing, Balancing of rigid rotors, Balancing of flexible rotors, Influence coefficient and modal Balancing techniques for flexible rotors, Vibration based condition monitoring of rotating machinery.

Texts/References:

1. J. S. Rao, “Rotor Dynamics”, New Age International Publishers, New Delhi.
2. M. J. Goodwin, Dynamics of rotor bearing systems, Unwin Hyman, Sydney, 1989.
3. S. Timoshenko, D H. Young and W. Weaver, “Vibration Problems in Engineering”, John Wiley.
4. W J Chen and J E Gunter, “Introduction to Dynamics of Rotor – Bearing Systems”, Trafford Publishing Ltd.
5. T. Yamamoto and Y. Ishida, “Linear and Nonlinear Rotor Dynamics: A Modern Treatment with Applications”, John Wiley.
6. V J. S. Rao, “Vibratory Condition Monitoring of Machines”, Narosa Publishing House.

Course Outcomes:

1. Basics of the rotor dynamics phenomena with the help of simple rotor models and consequently carry out the analysis for different practical rotor systems.
2. Able to develop the vibration models of rigid and flexible rotor system with unbalance. Also learn to determine critical speed from Campbell diagram.
3. Get basic idea of multi degrees of freedom rotor system, geared and branched system. Learn numerical methods which will helps to formulate the response of system.
4. Learn design of rotor-shaft systems with different kinds of bearings. Get basic understanding of continuous Rotor dynamic system.
5. Learn different balancing methods for rigid and flexible rotor. Learn condition monitoring which will be useful for futuristic model fault diagnostic.

ME 5243	**Theory of Mechanical Vibration**	**L**	**T**	**P**	**C**
	M.Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models.

SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert’s method, Energy method, Free Vibration: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration.

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers.

Multi degree of freedom systems: Introduction, Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis

Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method.

Texts/References:

1. L. Meirovich, Elements of Vibration analysis, Tata Mc-Graw Hill:
2. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education
3. W.T. Thompson, Theory of Vibration, CBS Publishers,
4. Clarence W. de Silva, Vibration: Fundamentals and Practice, CRC Press LLC,

Course Outcomes:

1. Exemplify and summarize the causes and effect of vibration in mechanical systems and identify discrete and continuous systems
2. Model the physical systems in to schematic models and formulate the governing equations of motion.
3. Infer the role of damping and stiffness and inertia in machine tools
4. Analyze the Rotating/reciprocating systems and abele to compute the critical speeds.
5. Analyze and design machine support structures, Vibration Isolators, Vibration Absorbers.
6. Summarize the concept of mode, node and frequencies and calculate the free and forced vibration responses of multi degree of freedom systems through model Analysis.

ME 5245	Theory of Plasticity	L	T	P	C
	M.Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction: Introduction to theory of plasticity, relevant stress strain analysis, comparison with elastic behaviour of materials.

Fundamental equations: Description of equations of plastic states, elastic plastic equilibrium problems, elastic plastic bending and torsion, beams and frames, problem with spherical and cylindrical symmetry.

Plastic instability: Introduction to plastic instability, mechanism of metal forming, theory of slip line field, steady and non-steady problem in plane stress and strain, dynamic problems, viscoplasticity, creep, introduction with numerical application.

Texts/References:

1. L. Meirovich, Elements of Vibration analysis, Tata Mc-Graw Hill:
2. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education

3. W.T. Thompson, Theory of Vibration, CBS Publishers,
4. Clarence W. de Silva, Vibration: Fundamentals and Practice, CRC Press LLC,.

Course Outcomes:

1. Choose a proper model for analysis of engineering components based on the loading conditions (apply).
2. Analyze the plastic state for various engineering components to predict deformation and failure (analyze).
3. Compare between the models of elasticity and plasticity for engineering analysis (evaluate).
4. Recommend proper instability theory and mechanism of metal forming in actual practice (evaluating).
5. Test the conditions of material deformation under theory of plasticity (creating).

ME 5246	**Theory of Uncertainty**	**L**	**T**	**P**	**C**
	M. Tech. (D & M), Second Semester (Elective-IV)	3	0	0	3

Introduction: Fundamentals of Uncertainty, Types of Uncertainty, Principles of Uncertainty, Indeterminacy, Frequency, Belief Degree, Sources of Uncertainty, Propagation of uncertainty, Uncertain Logic, Uncertain Inference, Uncertain Process, Probability theory and Chance theory, Model calibration, Model validation and verification, Surrogate models, Parameter selection, Sensitivity Analysis, Various Scale-based applications, Noisy data interpretation.

Uncertainty Measures and Variable: Measurable Space, Uncertain space, Independence, Polyrectangular theorem, Conditional Uncertain Measure, Uncertain Variables, Distribution, Operational Laws, Expected value, Variance, Moment, Entropy, Distance, Conditional Uncertainty Distribution, Uncertain Sequence, Uncertain Vector.

Uncertain Programming: Numerical Method, Machine Scheduling Problem, Multi-objective Programming, Goal Programming, Multilevel Programming.

Uncertainty Modeling methods and Sampling Techniques: Deterministic and Non-deterministic Approach, Probabilistic and Non-probabilistic modeling, High dimensional model representation, Response Surface methods, Random variable and Random field Approach, Kriging model, Model reduction, Various Sampling and optimization techniques and Solutions.

Risk and Reliability Analysis: Loss Function, Structure Function, Risk Index and Reliability Index, Series and Parallel System, k-out-of-n System, First order reliability method (FORM), Second order reliability method (SORM), Solution of engineering real-life problems.

Texts/References:

1. Handbook of Uncertainty Quantification - Editors: Roger Ghanem, David Higdon, Houman Owhadi (Eds.), Springer
2. Uncertainty Quantification and Stochastic Modeling with Matlab - Eduardo Souza de Cursi, Rubens Sampaio, Springer
3. Introduction to Uncertainty Quantification - T.J. Sullivan, Springer
4. Uncertainty Quantification: Theory, Implementation, and Applications - Ralph C. Smith, SIAM

5. Handbook of Uncertainty Quantification - Editors: Ghanem, Roger, Higdon, David, Owhadi, Houman (Eds.), Springer
6. Uncertainty Quantification in Composite Structures – A Metamodel Based Approach, S. Dey, T. Mukhopadhyay, S. Adhikari, CRC Press.

Course Outcomes:

1. Describe the principles of uncertainty and its fundamentals.
2. Apply the significance of uncertainty in real life scenario.
3. Solve the uncertainty problems.
4. Analyze the sources and propagation of uncertainty in any systems.
5. Quantify the uncertainty in the systems.