M. Tech.
Mechanical Engineering

Study Scheme of M. Tech. Mechanical Engineering

SEMESTER 1st							Marks		Total
S No	Subject Code	Subject Name	L	T	P	Credit	Int.	Ext.	
1	MTME-21101	Advanced Engineering Materials	4	0	0	4	50	100	150
2	MTME-21102	Finite Element Analysis	3	1*	0	4	50	100	150
3	MTME-21103	Advanced Design of Mechanical Systems	3	1*	0	4	50	100	150
4	MTME-21104	Operations Management	4	0	0	4	50	100	150
5	MTME-21105	Advanced Thermodynamics	4	0	0	4	50	100	150
			18	**2**	**0**	**20**	**250**	**500**	**750**

SEMESTER 2nd							Marks		Total
S No	Subject Code	Subject Name	L	T	P	Credit	Int.	Ext.	
1	MTME-21201	Research Methodology	3	1*	0	4	50	100	150
2	MTME-21202	Tribology	4	0	0	4	50	100	150
3	MTME-21203	Modern Manufacturing Processes	4	0	0	4	50	100	150
4	MTME-21204	Computational Fluid Dynamics	3	1*	0	4	50	100	150
5	MTME-21XXX	Elective –I	4	0	0	4	50	100	150
			18	**2**	**0**	**20**	**250**	**500**	**750**

SEMESTER 3rd							**Marks**		**Total**
S No	**Subject Code**	**Subject Name**	**L**	**T**	**P**	Credit	**Int.**	**Ext.**	
1	MTME-21XXX	Elective-II	4	0	0	4	50	100	150
2	MTME-21XXX	Elective-III	4	0	0	4	50	100	150
3	MTME-21301	Project	-	-	12	6	50	50	100
4	MTME-21302	Seminar	-	-	4	2	100	--	100
		Total	**8**	**0**	**16**	**16**	**250**	**250**	**500**

SEMESTER 4th							
S No	**Subject Code**	**Subject Name**	L	T	P	Credit	**Evaluation Criteria**
1	MTME-21401	Dissertation	0	0	28	14	Satisfactory/ Non Satisfactory

List of Elective Subjects

List of Electives - I

1. MTME-21205 Advanced Welding Technology
2. MTME-21206 Advanced Material Characterization Techniques
3. MTME-21207 Rapid Prototyping
4. MTME-21208 Advanced Metal Cutting
5. MTME-21209 Advanced Casting Processes
6. MTME-21210 Product Design and Development

List of Elective - II

1. MTME-21214 Engineering Design Optimization
2. MTME-21215 Advanced Vibration Engineering
3. MTME-21216 Mechatronics
4. MTME-21217 Dynamics of Rotating Machines
5. MTME-21218 Experiential Stress Analysis
6. MTME-21219 Sustainable Design and Manufacturing
7. MTME-21220 Vibration and Noise Control
8. MTME-21221 Composite Materials
9. MTME-21222 Instrumentation and Control Engineering

List of Elective - III

1. MTME-21223 Advanced Internal Combustion Engines
2. MTME-21224 Design of Steam Turbine
3. MTME-21225 Convective Heat Transfer
4. MTME-21226 Combustion Engineering
5. MTME-21227 Conductive & Radiative Heat Transfer
6. MTME-21228 Solar Energy Utilization
7. MTME-21229 Design of HVAC systems
8. MTME-21230 Design and Optimization of Thermal Systems
9. MTME-21231 Advanced Heat and Mass Transfer
10. MTME-21232 Refrigeration and cryogenics
11. MTME-2133 Air conditioning system design

MTME-21101 ADVANCED ENGINEERING MATERIALS

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Classification and Selection of Materials**
   Classification of materials, properties required in Engineering materials, Criteria of selection of materials, Requirements / needs of advance materials. (5)

2. **Composite Materials**

   Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials. (7)

3. **Ceramics and Glasses - Bio-ceramics**

   Nearly inert ceramics, bio-reactive glasses and glass ceramics, porous ceramics; Calcium phosphate ceramics: grafts, coatings Physico-chemical surface modification of materials used in medicine. (7)

4. **Low & High Temperature Materials**

   Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials. (7)

5. **Smart Materials**

   Shape Memory Alloys, Varistors and Intelligent materials for bio-medical applications, Polymers and Plastics from industry. Development, important properties and applications of these materials. (7)

6. **Nanomaterials**

   Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials. (7)

Books Recommended:

1. Engineering Material Technology by James A. Jacobs & Thomas F. Kilduff. Prentice Hall.
2. Materials Science and Engineering by WD. Callister Jr., Wiley India Pvt. Ltd., 2010
3. Engineering Design: A Materials and Processing Approach by G.E. Dieter, McGraw Hill, 1991.

4. Materials Selection in Mechanical Design by M.F. Ashby, Pergamon Press, 1992.
5. Introduction to Engineering Materials & Manufacturing Processes by NIIT, Prentice Hall of India.
6. Engineering Materials Properties and Selection by Kenneth G. Budinski, Prentice Hall of India.
7. Selection of Engineering Materials by Gladius Lewis, Prentice-Hall, New Jersey, US.

MTME-21102 FINITE ELEMENT ANALYSIS

Internal Marks: 50 **L T P**
External Marks: 100 **3 1 0**
Total Marks: 150

1. **Introduction to Finite Element Method**
   Basic concept, Historical background, engineering applications, general Description, comparison with other methods. (5)

2. **Formulations and Variation Methods**

   Need for weighted, integral forms, relevant mathematical concepts and formulae, weak formulation of boundary value problems, variational methods, Rayleigh –Ritz method and weighted residual approach. (5)

3. **Finite Element Techniques**

   Model boundary value problem, finite element discretization, element shapes, sizes And node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solution, post-processing, Compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Langrange and Hermit Polynomials. (10)

4. **Applications to Solid and Structural Mechanics Problems**

   External and internal equilibrium equations, one-dimensional stress-strain relations, plane stress and strain problems, axis symmetric and three dimensional stress-strain problems, strain displacement relations, boundary conditions compatibility equations, analysis of trusses, frames and solids of revolution, computer programs. (8)

5. **Application to Heat Transfer Problem**

   Variational approach, Galerkin approach, one-dimensional and two-dimensional steady state problems for conduction, convection and radiation, transient problems. (5)

6. **Application to Fluid Mechanics Problems**

   In viscid incompressible flow, potential function and stream function formulation, incompressible viscous flow, stream function, velocity-pressure and stream function-vorticity formulation, solution of incompressible and compressible fluid film lubrication problems. (7)

Books Recommended:

1. Introductory Finite Element Method by Chandrakant S Desai, Tribikram Kundu
2. The Finite Element Method: Volume 2 by O C Zienkiewicz, R L Taylor
3. Building Better Products With Finite Element Analysis by Vince Adams, Abraham Askenazi
4. Finite Element Implementation by Y K Cheung
5. Finite Element Analysis With Personal Computers by Champion, J M Ensminger, Edward R Champion
6. Programming the Finite Element Method by Ian M. Smith, Vaughan Griffiths
7. The Finite Element Method for Engineers by Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom
8. The Finite Element Method and Its Reliability by Ivo Babuska, T Strouboulis

MTME-21103 ADVANCED DESIGN OF MECHANICAL SYSTEMS

Internal Marks: 50 **L T P**
External Marks: 100 **3 1 0**
Total Marks: 150

1. **Introduction**
   System design approach for product design, its objectives and constraints, Integrated process design for Robust product design, Managing costs. (5)

2. **Integrated Environment**

   Integrating CAE, CAD, CAM tools, Simulating product performance and manufacturing Processes digitally, Need for industrial design impact, design process investigation of customer needs, conceptualization, refinement, management of the industrial design process, technology driven products, user driven products assessing the quality of industrial design. (7)

3. **Material Selection**

   Working principle, Materials and Manufacturing Design principles, Possible solutions, Materials choice, Influence of materials on form design of welded members, forgings and castings.(6)

4. **Component Design**

   Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by Separation, simplification by amalgamation, Design for machinability, Redesign of castings based on line considerations, Minimizing core requirements, machined holes, redesign of cast members to obviate cores.(6)

5. **Design for Manufacture**

   General design principles for manufacturability,: strength and mechanical factors, mechanisms selection, evaluation method, Process capability, Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks.(6)

6. **Design for Assembly**

   Assembly processes, Handling and insertion process, Manual, automatic and robotic assembly, Cost of Assembly, Number of Parts, DFA guidelines. (4)

7. **Design for the Environment**

Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines with example / application, Lifecycle assessment, Basic method, Design to minimize material usage, Design for recyclability, Design for Energy efficiency, Design to regulations and standards. Design for sustainability. (6)

Books Recommended:

1. Product Design and Development by Karl T.Ulrich and Steven D.Eppinger, 1999, McGraw Hill International Edns.
2. Design for Assembly Automation and Product Design by G. Boothroyd, 1980, New York, Marcel Dekker.
3. Design for Manufacture handbook by Bralla, 1999, Mc Graw Hill.
4. Product Design for Manufacture by Boothroyd, G, Heartz and Nike, 1994, Marcel Dekker.
5. Engineering Design and Design for Manufacture and Structural Approach by Dickson, John. R, and Corroda Poly, 1995, Field Stone Publisher, USA.
6. Design for the Environment by Fixer, J, 1996, McGraw Hill.
7. Design for the Environment by Angle Wood Cliff, Graedel T. Allen By. B, Prentice Hall.

MTME-21104 OPERATIONS MANAGEMENT

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Basic concepts of operations and production management, Types of manufacturing systems and their characteristics, scope of operations management. (6)

2. **Product and Process Design**

   System planning and design, long-range planning, product and process design and technological considerations, MACRO and MICRO process design.(6)

3. **Demand Forecasting**

   Role of demand forecasting in operations decisions; various demand patterns, qualitative and quantitative techniques of demand forecasting, introduction to standard software used in demand forecasting. (6)

4. **Production Planning and Scheduling**

   Aggregate production planning, operation scheduling, various scheduling criteria, lot sizing, job shop control; Mutli-stage manufacturing systems, their scheduling and management, capacity planning, introduction to standard software used for Production Planning and Scheduling. (8)

5. **Materials Planning**

   Details of material requirement planning (MRP), manufacturing resource planning (MRP-II) and enterprisewide resource planning (ERP) with their various techniques, JIT and JIT-II concepts. (7)

6. **Facilities Planning**

   Plant design, types and considerations in the plant location, plant layout types, design, evaluation, principles and types of material flow, optimum plant layout. (7)

Books Recommended:

1. Modern Production/Operations Management by Buffa, E. S. and Sarin, R. K, John Wiley & Sons.
2. Production Operations Management by Adam, E., Jr. and Ebert, R. E., Pearson Education.
3. Operations Management: Policy, Practice, and Performance Improvement by Brown, S.,

Blackmon, K., Cousins, P. and Maylor H., Butterworth-Heinemann.
4. Operations Management by Dervitsiotis, K. N., McGraw Hill.
5. Production and Operations Management by Starr M. K.,Thomson Business Information.
6. Operations Management: Processes & Supply Chains by Karjewski, L. J, Ritzman, L. P. and Malhotra, M. K., Pearson Education.
7. Operations Management by S. Anil Kumar & N. Suresh, New Age International Publishers.

MTME-21105 ADVANCED THERMODYNAMICS

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Review of Thermodynamic Laws and Corollaries**
   Transient Flow Analysis, Second law of thermodynamics, Entropy, Availability and unavailability, Irreversibility, Thermodynamic Potentials, Maxwell's relations, Specific Heat relations, Mayer's relation, Evaluation of Thermodynamic properties of working substance.

   P.V.T. surface, Equations of state, Real Gas behavior, Vander Waal's equation, Generalised compressibility Factor, Energy properties of Real Gases, Vapour pressure, Clausius– Clapeyron Equation, Throttling, Joule–Thompson coefficient. Non-reactive Mixture of perfect Gases, Governing Laws , Evaluation of properties, Psychrometric properties and psychrometric chart , Air conditioning processes , Cooling Towers, Real Gas mixture. (10)

2. **Chemical Reactions**

   Combustion, Combustion Reactions, Enthalpy of Formation, Entropy of Formation, Reference Levels for Tables, Energy of formation, Heat of Reaction, Adiabatic flame Temperature- General problems, Enthalpies, Equilibrium. Chemical Equilibrium of Ideal Gases, Effects of Non-reacting Gases Equilibrium in Multiple Reactions. The VantHoff's Equation. The chemical potential and phase Equilibrium, The Gibbs phase Rule. (8)

3. **Power Cycles**

   Review, Binary vapour cycle, co-generation and Combined cycles, Second law analysis of cycles, Refrigeration cycles. (6)

4. **Thermodynamics of Irreversible Processes**

   Introduction, phenomenological laws, Onsager Reciprocity Relation, Applicability of the phenomenological Relations, Heat Flux and Entropy Production, Thermodynamic phenomenon, Thermoelectric circuits. (8)

5. **Direct Energy Conversion**

   Introduction, Fuel Cells, Thermo-electric energy, Thermo-ionic power generation - Thermodynamic devices, Magneto Hydrodynamic Generators, Photo-voltaic cells. (8)

Books Recommended:

1. Fundamentals of Thermodynamics, Sonntag, Borgnakke and Van Wylen, Wiley, 6th Edition
2. Thermo dynamics, Doolittle, Messe
3. Basic and Applied Thermodynamics, P.K. Nag, TMH
4. Thermodynamics, Moran and Shapario
5. Thermodynamics, Holman, McGraw Hill
6. Irreversible Thermodynamics, HR De Groff.
7. Engineering Thermodynamics, PL.Dhar

MTME-21201 RESEARCH METHODOLGY

Internal Marks: 50 **L T P**
External Marks: 100 **3 1 0**
Total Marks: 150

1. **Introduction to Research and Review Process**
   Nature and objective of research, Research topic, Literature review, Formulation of problem, Research design, Sampling techniques, Data collection, Statistical and sensitive analysis of data, Interpretation of result and report writing. (6)

2. **Introduction to Design of Experiment**

   Basic principles, Error analysis in experiments, Classification of experimental designs, Design and analysis of one, 2k and 3k factors experiments, Completely randomized and randomized complete block designs (8)

3. **Taguchi Design and ANOVA**

   Taguchi method, Design of Experiments with the help of orthogonal arrays, Selection of parameters and Taguchi's Robust parameter design, Analysis of Variance, Main effects and interactions, Two-factor and three factors interaction and analysis of variance, Noise factors, Tolerance on control factors. Formation and analysis of Signal-to-Noise Ratio. (10)

4. **Response Surface Method and Other Approaches to Process Optimize**

   Introduction to response surface methodology, analysis of second order response surface, blocking in response surface design, the response surface approach to robust design, problem solution. (6)

5. **Statistical Software**

   Application of Statistical Softwares like SPSS, MS Excel, Mini Tab or MATLAB Software in Data Analysis. (6)

6. **Research Ethics**

   Plagiarism tools, reproducibility and accountability. (4)

Books Recommended:

1. Numerical Methods with Applications by Autar K Kaw, Egwu E Kalu, And Duc Nguyen
2. Design and Analysis of Experiments, Douglas C. Montgomery, John Wiley & Sons (Asia) Pvt Ltd.
3. Numerical Methods for Engineers, Chapra and Canale, 4th edition, 2005, Tata Mc Graw Hill.
4. Engineering Optimization, S.S.Rao, 3rd edition, 2000, New Age.
5. Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, 7th Edition, 2002, Pearson Education.
6. Statistics in Research, Bernand Ostle and Richard N.Mensing 3rd ed, 1975, Oxford & IBH Pub Co.
7. Research Methodology: Methods and Techniques by C.R. Kothari, Gaurav Garg , New Age international Publishers.

MTME-21202 TRIBOLOGY

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Background, Meaning of tribology, Cost of friction and wear, Types of contacts, Types of motions, Types of deformations, Surface energy and flash temperature theory, Interdisciplinary approach. (8)

2. **Friction and Wear**

   Topography of engineering surfaces, Material properties influencing friction, Cause/source of friction, Laws of friction, Friction characteristics, Friction of metals, non-metals, lamellar solids, ceramics and polymers, Energy dissipation mechanism, Stick-lip motion, Measurement of friction, Types of wear: abrasive, erosive, cavitation and adhesive wear , Wear mechanism, Theories of wear, Friction effecting wear, Wear of metals and non-metals, ceramics and polymers, Wear measurements in dry and wet environments and Wear equipment. (8)

3. **Lubrication**

   Importance, Types and mechanism of lubrication, squeeze film, hydro-static, hydrodynamic, elasto-hydrodynamic and plasto-hydrodynamic lubrication, Solution of Reynold's equation in two and three dimensions, Pressure distribution, load carrying capacity and friction forces in oil films, Coefficient of friction in Journal bearing, A brief introduction of solid lubricants and their applications. (8)

4. **Tribology of Bearings**

   Principle, Operations and Selection Criteria: : hydrodynamic bearing, hydrodynamic journal bearing, hydrostatic bearing, rolling element, ball bearing, roller bearing, needle roller bearing, Design of bearing/journal bearing, Clearance in journal bearing, Minimum film thickness, Sommar-field number, Heat generation and cooling. (8)

5. **Industrial Applications of Tribology**

   In metal working: effect of friction, Classification of plastic deformation in rolling, drawing, extrusion, forging, sheet-metal, metal removaland metal finishing, Lube share in metal working process, In Mining: Tools and cutters, Tribology in excavation, loading, haulage and hoisting, In paper and glass fibre industry. (8)

Books Recommended:

1. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Limited
2. Sushil Kumar Srivastava, Tribology in Industries, S. Chand and Company Limited
3. B. S. Prabhu, Industrial Tribology, Tribological Failure and Their Analysis
4. Gwidon W. Stachowiak and Andrew W. Batchelor, Engineering Tribology

MTME-21203 MODERN MANUFACTURING PROCESSES

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Introduction to different advanced processes, importance and applications of advanced manufacturing processes. Overview: non-conventional machining Processes. (6)

2. **Mechanical Machining Processes**

   Abrasive jet machining, Ultrasonic machining, Abrasive flow finishing, Magnetic abrasive finishing, Water jet cutting, Abrasive water jet machining process: working principle, theory of material removal, process variables and parametric analysis, process performance, determination of material removal rate and surface finish. (8)

3. **Thermodynamic Machining Processes**

   Electrical discharge machining (EDM), Electrical discharge grinding (EDG), WEDM, LBM, PAM, EBM: working principle, theory of material removal, process variables and parametric analysis, process performance, determination of material removal rate and surface finish. (6)

4. **Electrochemical and Chemical Machining Processes**

   Chemical machining (ChM), ECM, ECG, electrochemical stream drilling (ESD), electrochemical deburring (ECDe), shaped tube electrolytic machining (STEM): working principle, theory of material removal, process variables and parametric analysis, process performance, determination of material removal rate and surface finish. (8)

5. **Powder Metallurgy**

   Important characteristics and methods of producing powders, Different techniques to form the miniature product from metal power, Extruding, Isostatic molding, Fibre metal process, Sintering Hot pressing. (6)

6. **Special Manufacturing Processes**

   Physical vapor deposition, chemical vapor deposition, thermal metal spraying and Additive manufacturing such as 3-D printing. (6)

Books Recommended:

1. Advanced Manufacturing Processes by G.F. Benidict, Marcel Deker publisher.
2. Non-conventional Machining Processes by P.K. Mishra, Narosa Publication.
3. Manufacturing Processes by B.H. Amsteal, Philip F. Ostwald & Myron L. Bengeman, John Wiley & Sons, eighth edition
4. Manufacturing Analysis by N. Cook.
5. Modern Machining Processes by P.C. Pandey and H.S. Shan, Tata McGraw-Hill Education
6. Advanced Machining Processes by V.K.Jain

MTME-21204 COMPUTATIONAL FLUID DYNAMICS

Internal Marks: 50 **L T P**
External Marks: 100 **3 1 0**
Total Marks: 150

1. **Introduction**
   Motivation and role of computational fluid dynamics, concept of modeling and simulation. Benefits and limitations of CFD software tools. (6)

2. **Governing Equations of Fluid Dynamics**

   Continuity equation, momentum equation, energy equation, various simplifications, dimensionless equations and parameters, convective and conservation forms, incompressible hermos flows, source panel method and vortex panel method. (6)

3. **Nature of Equations**

   Classification of PDE, general Thermos of parabolic, elliptic and hyperbolic equations, boundary and initial conditions. (6)

4. **Finite Difference Method**

   Discretization, various methods of finite differencing, stability, method of solutions. (6)

5. **Finite Volume Methods**

   Integral Approach, discretization & Higher order scheme. (4)

6. **Turbulence Modelling**

   Turbulence, effect of turbulence on N-S equations, different turbulent modelling scheme, Error and uncertainty. (6)

7. **Incompressible Viscous Flows**

   Stream function-vorticity formulation, solution for pressure, applications to internal flows and boundary layer flows. (6)

Books Recommended:

1. Ghosdastidar, P. S., Computer Simulation of Flow and Heat Transfer, McGraw Hill (1998)
2. Roache, P. J., Computational Fluid Dynamics, Hermosa (1998).
3. Wendt, J. F., Computational Fluid Dynamics An Introduction, Springer-Verlag (2008).
4. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa (2008) 2nd ed.
5. Jaluria, Y. and Torrance, K. E., Computational Heat Transfer, Taylor & Francis (2003).

MTME –21205 ADVANCED WELDING TECHNOLOGY

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Classification of welding processes, weldability, welding defects, causes and remedies, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and micro-structural products in weld metal, epitaxial, cellular and dendritic solidification, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of microstructures and properties of weld metal. Heat affected zone, re- crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals. Welding symbols, safety and hazards in welding. (8)

2. **Welding Arc**

   Arc efficiency, temperature distribution in the arc, arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiation and maintenance, role of electrode polarity on arc behaviour and arc stability, analysis of the arc; Effects of voltage/current, polarity, welding speed on bead geometry and mechanical properties of weld. (7)

3. **Welding Consumables and Welding Power Sources**

   Classification and selection of welding electrodes and filler rods, Welding fluxes, Role of flux ingredients and shielding gases, Electrode coatings, Arc welding power sources, Basic characteristics of power sources for various arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorized units, inverter systems, Arc length regulation in mechanized welding processes. (8)

4. **Metal Transfer and Melting Rate**

   Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate. (7)

5. **Advanced Welding Processes**

   Selection of suitable welding process, Theory, principle, technique, advantages, applications, limitations and analysis of advanced welding processes such as Electro-Slag welding, Thermit welding, Ultrasonic welding, Plasma arc welding, Electron Beam welding, Laser Beam welding, Friction welding, Friction stir welding, Forge welding, Diffusion welding, Explosive welding, Atomic hydrogen welding, Microwave welding, Hybrid welding; Resistance welding processes namely Spot, Seam, Projection, Up-set,

Flash welding; Other basic welding processes such as Oxy-fuel gas welding, MIG welding, TIG welding, Submerged arc welding and Allied welding processes viz. Brazing, Braze welding, Soldering. (10)

Books Recommended:

1. R. S. Parmar, Welding Engineering and Technology, Khanna Publishers
2. P. N. Rao, Manufacturing Technology, Foundry, Forming and Welding, Tata McGraw Hill
3. Jean Cornu, Advanced Welding Systems, IFS
4. Richard L Little, Welding and Welding Technology, Tata McGraw Hill
5. Rossi, Welding Technology, McGraw Hill
6. Koenigsberger and Adaer, Welding Technology, Macmillan

MTME – 21206 ADVANCED MATERIAL CHARACTERIZATION TECHNIQUES

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Materials characterization - definition; importance and application. Principles and general methods of compositional, structural and defect characterization. (6)

2. **Diffraction Techniques**

   X-ray diffraction: Introduction, principles, Instrumentation, Specimen preparation, Types of analysis, Data collection for analysis, Applications, Limitations applications and limitations. (7)

3. **Microscopy**

   Optical, electron (TEM & SEM) and electron microprobe analysis, scanning probe methods (STM, AFM, EFM, MFM etc.): Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations. (7)

4. **Optical Spectroscopy**

   UV, visible, IR and Raman spectroscopy: Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations. (7)

5. **Electron Spectroscopy**

   Auger and photoelectron spectroscopy: Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations. (6)

6. **Thermal Methods**

   DTA, TGA, DSC, TMA and DMA: Basic principles, Instrumentation, working principles, Applications, Limitations. (7)

Books Recommended:

1. Materials Characterization Techniques- Sam Zhang, Lin Li, Ashok Kumar
2. Materials Characterization-Yang Lang
3. Auger and X-ray photoelectron spectroscopy- D. Briggs and M. P. Seah
4. An Introduction to Material Characterization- P. R. Khangaonkar
5. Materials Characterization, ASM Hand Book Vol. 10, Edited by: ASM International Handbook

MTME – 21207 RAPID PROTOTYPING

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction to Rapid Prototyping**
   Classification of Manufacturing Processes, Introduction to Rapid Prototyping, Rapid Prototyping and its Impact, Engineering design process, Product development, Product Prototyping and Product Development, Need of Product Prototyping, Prototype Planning and Management, Product and Prototype Cost Estimation, Prototype Design Methods and tools. (6)

2. **Materials Selections and Product Prototyping**

   Geometrical Modelling Techniques, Wireframe Modelling, Surface Modelling and solid modelling, Prototyping Materials, Modelling of Material Properties, Modelling and Design of Materials and Structures. (7)

3. **Rapid Prototyping Processes**

   Rapid Prototyping Overview, Rapid Prototyping Procedure, Liquid-Based RP Processes, Solid-Based RP Processes, Powder-Based RP Processes. (6)

4. **Direct Digital Prototyping and Manufacturing**

   Solid Models and Prototype Representation, Reverse Engineering for Digital Representation, Prototyping and Manufacturing Using CNC Machining, Fully Automated Digital Prototyping and Manufacturing. (7)

5. **Direct Methods for Rapid Tool Production**

   Classification of Direct Rapid Tool Methods, Direct ACESTM Injection Moulds, Laminated Object Manufactured (LaM) Tools, DTM Rapid Tool, Sand Form, EOS Direct Tool Process, Direct Metal Tooling using 3Dp. applications of Rapid Prototyping: Functional Models, Pattern for Investment and Vacuum Casting, Medical Model, and Art Models, Engineering Analysis Models. (8)

6. **Indirect Methods for Rapid Tool Production**

   Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core, Sand Casting, Keltool Process. (6)

Books Recommended:

1. Rapid prototyping and engineering applications by Frank W. Liou, CRC press publications.
2. Rapid manufacturing by DT Pham & SS Dimov, Springer
3. Product design by Kevin otto &, kristin wood, Pearson publication

MTME – 21208 ADVANCED METAL CUTTING

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Machining fundamentals: work-tool contact, machinable surface, Kinematics of work tool interaction, kinematic elements involved in metal cutting action during different processes, Steriometry of cutting tools: basic shape of cutting tool, tool in hand and system of Tool Nomenclature, standards, Tool Geometry, tool point reference system. Method of master line for rake angle, vector method for rake angle inter relationship. (4)

2. **Oblique Cutting**

   Normal chip reduction coefficient under oblique cutting, True shear angle, effective rake, influx reg on consideration for deformation, Direction of maximum elongation, effect of cutting variables on chip reduction coefficient, Forces system in oblique cutting, effect of wear land on force system. Force system in milling, effect of helix angle, vulf's method, spaan's model for oblique cutting. (5)

3. **Mechanism of Chip Formation**

   Deformation of uncut layer in shear, Methods for frozen chip samples, classification of chips, mechanics of chip curl, factors involved in chip formation analysis, Dynamic shearing strain in chip formation, Effect of nose radius, effect of cutting variables on chip reduction coefficient. (5)

4. **Cutting Forces and Dynamometer**

   Measurement of forces, basic requirement in force measuring techniques, transducers for force measurement, design requirement of dynamometers, different types of force measuring instruments, dynamics of dynamometers, dynamometers for measurement of forces during turning, drilling and milling. Effect of cutting variables on cutting forces. Theoretical determination of cutting forces: Ernst and Merchants upper bond solution, Merchant's second solution and machining constant. (5)

5. **Fundamental Factors Which Effect Tool Forces**

   Correlation of standard mechanized test. (Abuladze-relation), nature of contact and stagnant phenomena, Rates of strains, shear strain and normal strains distribution, Kinetic coefficient of friction analysis, Built up edge phenomena, Effect of cutting variables on BUL and BUE. (4)

6. Failure of Cutting Tools

Tool materials, tool failure, analysis of plastic failure (Form stability criterion), Analyzing failure by brittle fracture, wear of cutting tools, criterion, Flank and creature wear analysis, optimum tool life, tool life equations (Taylor's, woxen etc.) Tool life test, machining optimization predominant types of wear: flank, crater, abrasive, adhesive, diffusion wear models, wear measurements techniques, Theory of tool wear, oxidative, Mathematical modeling for wear, Test of machinability and influence of metallurgy on machinability. (5)

7. Economics of Machining

Economic tool life; Gilbert's Model, Optimal cutting speed for Maximum production; Maximum profit cutting speed, objective criteria for optimization, selection of optimum cutting parameters under various restrictive conditions, Brewer and Reuda;s optimization for maximum power constraint and maximum feed, Bjrcke's Generalized Model, Sensitivity analysis in Machining economics, Economy based on Non Taylorian Tool life laws; Economics of multipass cutting. (4)

8. Advance Metal Machining

Composite cutting, ceramic and super alloys cutting, cutting tool selection, process parameters and geometry effect on machinability during cutting of composite, ceramics and super alloys. (4)

9. Surface Integrity and Finishes

Surface metallurgy and topography, factors affecting the surface quality, the numerical assessment of the machined surface, ISO recommendation for assessment of machined surface, super finishing processes, and kinematics of super finishing. Mechanics of lapping and honing, three body abrasion. (4)

Books Recommended:

1. Metal cutting theory and practice by A. Bhattacharyya, Central book, Publisher, Calcutta-9
2. Metal cutting by M. Shaw
3. Manufacturing Science by Amitava Ghosh, and Asok kumar Mallik, Affiliated East-West Press Private Limited, New Delhi

MTME – 21209 ADVANCED CASTING PROCESSES

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Introduction**
   Ferrous and non-ferrous materials and their properties, Pattern materials, types and allowances, Characteristics, Ingredients and additives of moulding sand, core sands, Structure of silica and different types of clays, bonding mechanism of silica-water-clay system, Swelling of clays, sintering adhesion and colloidal clay, silica grain shape and size distribution, standard permeability A.F.S. clay, Special sand additives. (8)

2. **Solidification of Metals**

   Nucleation and growth in metals and alloys, Free energy concept, Critical radius of nucleus, Segregation, Progressive and directional solidification, Constitutional super cooling, Columnar equiacquiesced and dendritic structures, Freezing of alloys, Centreline feeding resistance, Rate and time of solidification, mould constant, Fluidity of metals, Volumes redistribution, Solidification simulation, Analysis of the process. (8)

3. **Gate and Riser Design**

   Various elements of gating system, gating-system design for ferrous and non-ferrous materials, Top, bottom and inside gating, Different methods for riser design, Riser design shape, size and placement, Effect of appendages on risering, Effective feeding distances for simple and complex shapes, Use of chills, Aspiration of gases, Directional solidification stresses in castings, Metal mould reactions, Expansion scale and metal penetration, Analysis of the process. (8)

4. **Advanced Casting Processes**

   Investment casting, Shell mould casting, Full mould casting, Vacuum casting, Die casting, Permanent mould casting, Continuous casting, Centrifugal casting, Squeeze casting, Slush casting. (8)

5. **Casting Defects, Heat-Treatment of Castings and Moulding Sand Testing**

   Casting defects, causes and remedies; Heat treatment of steel, iron and stainless-steel castings; Moulding sand testing and control, Repair and salvage of castings, Quality control in foundries. (8)

Books Recommended:

1. Flimm, Fundamentals of Metals Casting, Addison Wesley
2. P. N. Rao, Manufacturing Technology - Foundry, Forming and Welding, Tata McGraw Hill
3. Heine Loper and Resenthal, Principles of Metal Casting, McGraw Hill
4. Salman &Simans, Foundry Practice, Issac Pitman
5. Richard W. Heine, Principles of Metal Casting Processes, McGraw Hill
6. P. L. Jain, Principles of Foundry Technology, Tata McGraw Hill
7. Metals Handbook - Metal Casting, ASME

MTME –21210 PRODUCT DESIGN AND DEVELOPMENT

Internal Marks: 50 **L T P**
External Marks: 100 **4 0 0**
Total Marks: 150

1. **Creative Thinking and Organizing For Product Innovation**

   The product design function, Locating ideas for new products, selecting the right product, Qualifications of the product design engineer, Creative thinking, Curiosity and imagination, Ideas generate ideas, Taking time to think, Using a systematic producer for product innovation, Setting responsibilities for new product development, Structural units for new product development, Functions of the new product development unit, Opportunities for the product design engineer. (12)

2. **Criteria for Product Success**

   Areas to be studied preparatory to design, Principles of values and laws of appearance, Incorporating quality and reliability into the design, Man-machine consideration, Designing for case of maintenance. (8)

3. **Cost and Product Development**

   Source of funds for development cost product costs, Estimating the product cost, Kinds of cost procedures, Cost reduction. (8)

4. **Integrated Approach to Product Development**

   Diffusion of innovation. Generation, screening and development of new product ideas, Product life cycle and new product development, Economic analysis-evaluation of new product ideas/concepts, Value analysis, Test marketing of new product launch. (12)

Books Recommended:

1. Product design and Manufacturing by Chitale and Gupta, Prentice Hall 1997.
2. Taguchi Methods Explained by Bagchi, Prentice Hall 1997 (Practical steps to robust design).
3. Product design and process Engineering by Nible & Drper, Mc Graw Hill.
4. Design and Marketing of new products by Urban G.L & Houser, Prentice Hall 1980
5. Marketing management by Kotler Phillips, Prentice Hall 1990
6. New product Development by Mascarenhas Oxford, 1987 (it is Marketing Research & Managerial Calculate)
7. Product Management by Kaushal O.P & Lalvani Pub. House, 1967
8. The Management of Innovation Burns & Stalk Tasstoch Publication, 1961