Study Scheme of M. Tech. Mechanical Engineering
(Batch 2017 Onwards)

SEMESTER 1st		Contact Hours/Week			Maximum Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MTME-101	Advanced Engineering Materials	4	0	0	50	100	150	4
MTME-102	Finite Element Analysis	3	1*	0	50	100	150	4
MTME-103	Advanced Design of Mechanical Systems	3	1*	0	50	100	150	4
MTME-104	Operations Management	4	0	0	50	100	150	4
MTME-105	Advanced Thermodynamics	4	0	0	50	100	150	4
	Total	**18**	**2**	**0**	**250**	**500**	**750**	**20**
Total Contact Hours/Week = 20								
* Tutorials involve problems solving sessions including practice on relevant software								

SEMESTER 2nd		Contact Hours/Week			Maximum Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MTME-201	Research Methodology	3	1*	0	50	100	150	4
MTME-202	Tribology	4	0	0	50	100	150	4
MTME-203	Modern Manufacturing Processes	4	0	0	50	100	150	4
MTME-204	Computational Fluid Dynamics	3	1*	0	50	100	150	4
MTME-XXX	Elective –I	4	0	0	50	100	150	4
	Total	**18**	**2**	**0**	**250**	**500**	**750**	**20**
Total Contact Hours/Week = 20								
* Tutorials involve problems solving sessions including practice on relevant software								

SEMESTER 3rd		Contact Hours/Week			Maximum Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MTME-YYY	Elective-II	4	0	0	50	100	150	4
MTME-ZZZ	Elective-III	4	0	0	50	100	150	4
MTME-301	Project	-	-	12	50	50	100	6
MTME-302	Seminar	-	-	4	100	--	100	2
	Total	**8**	**0**	**16**	**250**	**250**	**500**	**16**
Total Contact Hours/Week = 16								

SEMESTER 4th		Contact Hours/Week			Evaluation Criteria	Credits
Subject Code	**Subject Name**	**L**	**T**	**P**		
MTME-401	Dissertation	0	0	28	Satisfactory/Unsatisfactory	**14**
	Total Contact Hours/Week = 28					

Total Credits for the Programme: 70

List of Elective Subjects for M. Tech. Mechanical Engineering

List of Electives (Manufacturing & Industrial Engineering)

1.	MTME-205	Advanced Welding Technology
2.	MTME-206	Automation and Robotics
3.	MTME-207	Advanced Material Characterization Techniques
4.	MTME-208	Rapid Prototyping
5.	MTME-209	Advanced Metal Cutting
6.	MTME-210	Advanced Casting Processes
7.	MTME-211	Maintenance and Reliability Engineering
8.	MTME-212	Supply Chain Management
9.	MTME-213	Product Design and Development

List of Elective (Design)

1.	MTME-214	Engineering Design Optimization
2.	MTME-215	Advanced Vibration Engineering
3.	MTME-216	Mechatronics
4.	MTME-217	Dynamics of Rotating Machines
5.	MTME-218	Experiential Stress Analysis
6.	MTME-219	Sustainable Design and Manufacturing
7.	MTME-220	Vibration and Noise Control
8.	MTME-221	Composite Materials
9.	MTME-222	Instrumentation and Control Engineering

List of Elective (Thermal)

1.	MTME-223	Advanced Internal Combustion Engines
2.	MTME-224	Design of Steam Turbine
3.	MTME-225	Convective Heat Transfer
4.	MTME-226	Combustion Engineering
5.	MTME-227	Conductive & Radiative Heat Transfer
6.	MTME-228	Solar Energy Utilization
7.	MTME-229	Design of HVAC systems
8.	MTME-230	Design and Optimization of Thermal Systems
9.	MTME-231	Advanced Heat and Mass Transfer

Note:

(A) Student can opt Elective I, II &III subjects from the entire list electives as above.

(B) If a student selects all the three elective subjects form the same group of electives and also completes his / her project and dissertation in the same field, he /she may be awarded a separate / additional certificate indicating the more concentration in a particular field e.g. Manufacturing and Industrial, Design or Thermal of his / her M. Tech degree.

MTME-101 ADVANCED ENGINEERING MATERIALS

L	T	P
4	0	0

Classification and Selection of Materials

Classification of materials, properties required in Engineering materials, Criteria of selection of materials, Requirements / needs of advance materials.

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.

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.

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.

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.

Nanomaterials

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

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-102 FINITE ELEMENT ANALYSIS

L	T	P
3	1	0

Introduction to Finite Element Method

Basic concept, Historical background, engineering applications, general Description, comparison with other methods.

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.

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.

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.

Application to Heat Transfer Problem

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

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.

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-103 ADVANCED DESIGN OF MECHANICAL SYSTEMS

L	T	P
3	1	0

Introduction
System design approach for product design, its objectives and constraints, Integrated process design for Robust product design, Managing costs.

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.

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.

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.

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.

Design for Assembly
Assembly processes, Handling and insertion process, Manual, automatic and robotic assembly, Cost of Assembly, Number of Parts, DFA guidelines.

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.

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-104 OPERATIONS MANAGEMENT

L	T	P
4	0	0

Introduction
Basic concepts of operations and production management, Types of manufacturing systems and their characteristics, scope of operations management.

Product and Process Design
System planning and design, long-range planning, product and process design and technological considerations, MACRO and MICRO process design.

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.

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.

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.

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.

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-105 ADVANCED THERMODYNAMICS

L	T	P
4	0	0

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.

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.

Power Cycles

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

Thermodynamics of Irreversible Processes

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

Direct Energy Conversion

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

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-201 RESEARCH METHODOLGY

L	T	P
3	1	0

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.

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

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.

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.

Statistical Software

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

Research Ethics

Plagiarism tools, reproducibility and accountability.

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-202 TRIBOLOGY

L	T	P
4	0	0

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.

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.

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.

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.

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.

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-203 MODERN MANUFACTURING PROCESSES

L	T	P
4	0	0

Introduction

Introduction to different advanced processes, importance and applications of advanced manufacturing processes. Overview: non-conventional machining Processes.

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.

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.

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.

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.

Special Manufacturing Processes

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

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-204 COMPUTATIONAL FLUID DYNAMICS

L	T	P
3	1	0

Introduction

Motivation and role of computational fluid dynamics, concept of modeling and simulation. Benefits and limitations of CFD software tools.

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.

Nature of Equations

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

Finite Difference Method

Discretization, various methods of finite differencing, stability, method of solutions.

Finite Volume Methods

Integral Approach, discretization & Higher order scheme.

Turbulence Modelling

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

Incompressible Viscous Flows

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

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).
6. Patankar, S. V., Numerical Heat Transfer and Fluid Flow, Taylor & Francis (2007).

MTME –205 ADVANCED WELDING TECHNOLOGY

L	T	P
4	0	0

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.

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.

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.

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.

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.

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 – 206 AUTOMATION AND ROBOTICS

L	T	P
4	0	0

Introduction to Automation

Automation production system, Mechanization & Automation, Types of automation, expectations from automation, reasons for automating, basic elements of an automated system, levels of automation, Automation strategies, Mechanical, electrical. Hydraulic and Pneumatic automation devices and controls, Economics of automation.

Manufacturing Automation

High Volume Manufacturing automation; classification and type of automatic transfer machines, automation in part handling and feeding, automated flow lines and analysis, design of single model, multi-model and mixed model production lines. Programmable manufacturing automation; CNC machine, programmable robots, Flexible manufacturing automation; single station manufacturing cell, group technology and cellular manufacturing, flexible manufacturing systems, transfer lines and similar automated manufacturing systems, automated assembly systems.

Robot Technology

Automation and Robots, Robot physical configuration, Classification of Robot Basic, Manipulation of Robot Components, Degree of Freedom and Degree of Motion, Joints and Symbols, Economic and Social Issues, Principles of Robots, Applications. Robot Programming Methods, Advantages and Disadvantages of Robot, Requirement of a Robot in an Industry, Operational Capabilities level of a Robot, Modular Robot Components, Wrist Mechanism.

Production Support Machines and Systems

Industrial robots, automated material handling, transfer devices and feeders – classification, construction details and application of transfer devices and feeders used for job orienting and picking, automated guided vehicles, automated storage and retrieval.

Books Recommended:

1. Automation, Production system and Computer Integrated Manufacturing by Grover, 3rd Edition, 2011, Pearson Education.
2. Fundamentals of Robotics Analysis and Control by Robert J Schilling, Tata Mc Graw Hill Education
3. Hydraulic Systems by S R Majumdar, Tata Mc Graw Hill Education
4. Pneumatic Systems by S R Majumdar, Tata Mc Graw Hill Education.
5. Robotics by Appuu Kuttan K. K., I K Internationals.
6. Introduction to Robotics by S K Saha , New York, Mc Graw Hill

MTME – 207 ADVANCED MATERIAL CHARACTERIZATION TECHNIQUES

L	T	P
4	0	0

Introduction
Materials characterization - definition; importance and application. Principles and general methods of compositional, structural and defect characterization.

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

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.

Optical Spectroscopy
UV, visible, IR and Raman spectroscopy: Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations.

Electron Spectroscopy
Auger and photoelectron spectroscopy: Introduction, principles, Instrumentation, Specimen preparation, imaging modes, applications and limitations.

Thermal Methods
DTA, TGA, DSC, TMA and DMA: Basic principles, Instrumentation, working principles, Applications, Limitations.

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 – 208 RAPID PROTOTYPING

L	T	P
4	0	0

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.

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.

Rapid Prototyping Processes

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

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.

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

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

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 – 209 ADVANCED METAL CUTTING

L	T	P
4	0	0

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.

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.

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.

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.

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.

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.

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.

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.

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.

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 – 210 ADVANCED CASTING PROCESSES

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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

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.

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

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

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.

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 – 211 MAINTENANCE AND RELIABILITY ENGINEERING

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Introduction

Concept of maintenance and terotechnology, objective and importance of maintenance engineering, functions and classification, types of maintenance: corrective, renovative, preventive, breakdown, planned, proactive, predictive etc.

Maintenance Planning and Control

Basic requirements of maintenance systems, responsibilities of maintenance engineering department, control and coordination in maintenance, Maintenance planning, Daily/monthly/annually maintenance schedule, Format/preparation of equipment history, failure analysis report, daily maintenance progress report, Total productive maintenance (TPM)

Safety and House Keeping In Maintenance

Hazards: classification, important factors of hazards and causes of accidents, categories of hazards and measurement, procedure of minimizing hazard, different safety devices, their applications and safety checklist. Factors governing housekeeping, housekeeping maintenance and inspection.

Reliability and Hazard Rates

Reliability, maintainability, failure, hazard rate concept, availability, Reliability structure and optimum design configuration of series, parallel, combination of series and parallel, redundancy structure. Mean time to failure (MTTF), mean time between failures (MTBF), mean time to repair (MTTR). Breakdown time distribution. 5-WHY concept for root cause.

Reliability Prediction and Analysis

Quantitative estimation of reliability: Kuder-Richardson formula, Statistical estimation of reliability. ReliaSoft's Lambda hybrid automated reliability predictor. Reliability prediction based on exponential distribution, system reliability analysis – block diagram method, fault tree and success tree methods, event tree method, failure model, failure mechanism.

Reliability Design

Design for reliability, design process, assessment methodology, reliability allocation, reliability improvement, selection of components to improve system reliability.

Recommended Books:

1. Industrial Engineering and Management Khanna O.P Dhanpat Rai & Sons 1994
2. A textbook of Reliability and Maintenance Engineering by Dr. Alakesh Manna, I K International.
3. Maintenance Planning and Control, Kelly A Buttersworth & Co. 1984
4. Maintenance and Spare parts Management, Krishnan G. Prentice Hall 1991
5. Reliability Engineering and Technology, Gupta, A.K Macmillan India Ltd. 1996
6. Introduction to Reliability Engineering Lewis E.E John Willey & Sons
7. Reliability Engineering, Srinath L.S., East West Press 1991

MTME – 212 SUPPLY CHAIN MANAGEMENT

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Supply Chain Drivers and Obstacles

Four drivers of supply chain inventory transportation, facilities, and information, a framework for structuring drivers, role of each driver in supply chain, obstacles to achieve strategic fit.

Supply Chain Performance

Objectives of supply chain, stages of supply chain, supply chain process cycles, customer order cycle, replenishment cycle, manufacturing cycle, procurement cycle, push/pull view of supply chain processes, importance of supply chain flows, examples of supply chain, supply chain strategies, achieving strategic fit, product life cycle, the minimize local cost view, the minimize functional cost view, the maximize company profit view, the maximize supply chain surplus view.

Managing Economies of Scale in A Supply Chain

Role of cycle inventory in a supply chain, economies of scale to exploit fixed costs, economies of scale to exploit quantity discounts, short term discounting, estimating cycle inventory related costs, determining appropriate level of safety inventory.

Transportation in A Supply Chain

Facilities affecting transportation decisions, modes of transportation and their performance characteristics, design options for a transport network, trade-offs in transportation decision, tailored transportation, routing and scheduling in transportation, making transportation decisions in practice.

Logistics and Competitive Strategy

Competitive advantage, gaining competitive advantage, advantage through logistics, mission of logistics management, supply chain and competitive performance, changing logistics environment.

Measuring Logistics Costs and Performance

The concept of total cost analysis, principles of logistics costing, logistics and the bottom line, logistics and share holder value, customer profitability analysis, cost drivers and activity based costing.

Benchmarking the Supply Chain

Benchmarking the logistics process, mapping supply chain processes, supplier and distributor benchmarking, identifying logistics performance indicators, setting benchmarking priorities.

Coordination in A Supply Chain

Lack of supply chain coordination and the Bullwhip effect, effect of lack of coordination on performance, obstacles to coordination, managerial levers to achieve coordination, achieving coordination in practice.

Books Recommended:

1. Logistics and Supply Chain Management by Martin Christopher, Pearson Education Asia (2002).
2. Supply Chain Management–Strategy, planning and operation‘s, by Peter Meindl Pearson Education, Asia.
3. Marketing logistics: A Supply Chain Approach, by KK Kapoor & P Kansal Pearson Education Asia.
4. Production and operation Management by Alan Muhlemann, John Oakland & Keith Lockyer Macmillan India Publications (2000).
5. Production and Operations Management by K. Aswathappa, & K.S.Bhat, Himalaya Publishing House, Mumbai (2000).
6. Production and operations Management by R. Panneerselvan, Prentice Hall of India, Delhi.
7. Essentials of Supply Chain Management by S.G. Deshmukh.

MTME – 213 PRODUCT DESIGN AND DEVELOPMENT

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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.

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.

Cost and Product Development

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

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.

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

MTME – 214 ENGINEERING DESIGN OPTIMIZATION

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Introduction to Optimization

Terminology; Optimization problem statement, Iterative optimization, Existence and uniqueness of solutions, Necessary and sufficient conditions.

Unconstrained Optimization Techniques

General principles of optimization; Problem formulation & their classifications; Single variable and multivariable optimization; Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods; Interpolation methods.

Constrained Optimization Techniques

Optimization with equality and inequality constraints; Direct methods; Indirect methods using penalty functions, Lagrange multipliers; Geometric programming.

Advanced Optimization Techniques

Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

Application in Design

Structural applications – Design of simple truss members; Design applications – Design of simple axial, transverse loaded members for minimum cost, weight; Design of shafts and torsionally loaded members, Design of springs. Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms; Optimum design of simple linkage mechanisms.

Books Recommended:

1. Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995.
4. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989.

MTME- 215 ADVANCED VIBRATION ENGINEERING

L	T	P
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Introduction

Viscous damping, Logarithmic decrement, Torsional system with viscous damping, Free vibration, Coulomb damping, Hysteretic damping, Equivalent viscous damping. Introduction to Coupled Vibrations. Hamiltons Principle, Galarkin Method, Shape Functions.

Two Degree of Freedom System

Introduction to free vibrations of undamped system, Torsional system, Coordinates coupling and principal coordinates, Damped free vibrations, Forced vibration of undamped system, Forced vibration with damping, Dynamic vibration absorber, Orthogonality principle.

Multi Degree of Freedom System

Equation of motion, method of influence coeffiecents, Lagrange's equation, Mode shape orthogonality, Rayleigh-Proportional damping, General Viscous damping, Harmonic excitations, Laplace transform solution, Model analysis for undamped and damped systems. Simple example on vibration in Plates and Shells, Dean and Plass Method.

Numerical Techniques to Find Natural Frequencies

Rayleigh's method, Holzer's method, Matrix iteration method, Cholesky decomposition, Jacob diagonalization method, Inverse simultaneous and subspace iteration method.

Vibration Analysis of Continuous System

Transverse vibration of strings, Longitudinal vibration of rods, Torsional vibration of shaft and beams, Effects of the rotary inertia and shear deformation, Approximate solution methods: Rayleigh's, Rayleigh-Ritz, Galerken's methods. Collocation Method, Transfer Matrix.

Transient and Random Vibration Analysis

Response to impulse excitation, Arbitary forcing function, Base excitation, Laplace transformation method, Response to random inputs, Shock response spectrum, Non Linear Vibrations, Numerical integration methods in vibration analysis : Problem and Case Study.

Finite Element Method Applied to Vibrations

Equations of motions of complete system of finite elements application in the domain of vibration, Incorporation of boundary conditions, Consistent and lumped mass matrices for bar, beam etc. Model reduction problem. Holzers Method, Stodola Method, Matrix Iteration and Inversion Method.

Books Recommended:

1. A textbook of Mechanical Vibration by J.Srinivas & V. Dnkkipati Rao, Prentice Hall of India Pvt. Ltd. New Delhi
2. Non Linear Mechanical Vibration by P.Srinivasan, New Age Publishers

3. Elements of Mechanical Vibration Ananlysis by Leonard Meiorvtch,Mc Graw Hill
4. Theory of Vibration with Application by Thomas, PHI
5. Vibration by Daniel J Inman, PHI
6. Fundamentals of Vibration by Roger A Anderson.
7. Vibration Problems in Engineering by S Timoshenko. D. H. Young, W.Weaver

MTME- 216 MECHATRONICS

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Introduction

Basics fundamentals, Definition and concept, Need of Mechatronics in mechanical Engineering, Elements of Mechatronics system, Mechatronics Design process, Systems, Measurement Systems, Control systems, Microprocessor based controllers, Advantages and Disadvantages of mechatronics system.

Dynamic Models

Block diagrams, Laplace Transformation, Transfer Function, State Space Models, Control actions, linear system analysis.

Fluid Power Control

Fluid power control elements, Standard graphical symbols, Construction and performance of fluid power generators, hydraulic and pneumatic cylinders, construction design and mountings, hydraulic and pneumatic valves for pressure, flow and direction control, servo valves and simple servo system with mechanical feedback, governing differential equation and its solution for step position input, basic hydraulic and pneumatic circuits. Pneumatic logic circuit design for a given time-displacement diagram.

Sensors and Transducers

Types of Transducers, Characteristic Parameters used in transducers, Displacement, Position, Proximity, Velocity, Motion, Force, Acceleration, Light and Piezoelectric Sensors, Selection of sensors.

Actuating Devices and Process Controllers

D C Motors, Permanent magnet stepper motors, Piezo-electric actuators, Controller Principles, Two Position, Proportional, Derivative, Integral, PD and PID Controller.

System And Frequency Response

Static Response, Poles, Zeros and Stability, Types of Responses, (Transient, Steady-state, Total, Frequency): Experimental determination of frequency response, Polar plots (Nyquist diagrams), Gain margin and Phase margin, Bode diagrams, Lead and lag compensators.

Signal Conditioning, Digital Electronics and Systems

Signal Conditioning, The Operational amplifier, Noise Reduction, Current to Voltage and Voltage to Current, Voltage to Frequency and Frequency to Voltage Converters, Analogue to digital,Digital to analogue conversion, Sampling theorem, , Types of Digital filters, Digital logic control, Microprocessors and Microcontrollers, Introduction to PLC.

Mechatronics System

Traditional and Mechatronics designs, Possible mechatronics design solutions, Case studies of Mechatronic systems, Application of mechatronics in manufacturing and automation (Machine tool and Automobile).

Recommended Books:

1. Mechatronics Integrated Mechanical Electronic Systems by K P Ramachandran & G K Vijayaraghavan& M S Balasundaram, Wiley, 1st Edition (2011)
2. Mechatronics by W Bolton, Pearson Education Publications, 3rd Edition (2007)
3. Mechatronics System Design by Devdas Shetty & Richard A. Kolk, Cengage Learning, 2nd Edition (2012)
4. Pneumatic Systems: Principles and Maintenance by S. R. Majumdar, Tata McGraw-Hill Education

MTME- 217 DYNAMICS OF ROTATING MACHINES

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Introduction

Rotating machine components, Aspects of rotating machine behaviour, Co-ordinate systems, Steady state rotor motion, Elliptical motion, Single degree of freedom systems, Free and forced vibrations. The two degrees of freedom rotor system, Geared systems, Translational motion, Natural frequencies and Natural modes, Steady state response to unbalance, Linear rotor dynamics, Non-linear rotor dynamics, Non-stationary rotor dynamics.

Torsional and Axial Dynamics

Modeling of rotating machinery shafting, Multi degree of freedom systems, Determination of natural frequencies and mode shapes, Branched systems, Numerical methods for fundamental frequency, Torsional critical speeds, Axial vibration.

Rigid Rotor Dynamics 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 elastic rotor, Unbalance response, Orbital Analysis and Cascade Plots, Simple shafts with several disks, Effect of axial stiffness, Determination of bending critical speeds, Campbell diagram.

Influence of Bearings on Rotor Vibrations

Support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings, Computation and measurements of journal bearing coefficients, Mechanics of Hydro dynamic Instability, Half frequency whirl and Resonance whip, Design configurations of stable journal bearings.

Balancing of Rotors

Single plane balancing, Multi-plane balancing, Balancing of rigid rotors, Balancing of flexible rotors, Influence coefficient and modal balancing techniques for flexible rotors.

Books Recommended:

1. J. S. Rao, “Rotor Dynamics”, New Age International Publishers, New Delhi.
2. S. Timoshenko, D H. Young and W. Weaver, “Vibration Problems in Engineering”, John Wiley.
3. W J Chen and J E Gunter, “Introduction to Dynamics of Rotor – Bearing Systems”, Trafford Publishing Ltd.

MTME- 218 EXPERIMENTAL STRESS ANALYSIS

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Principles of Experimental Approach

Introduction to ESA, Advantages of ESA techniques, Necessity of various ESA methods, methodology of problem solving by ESA Strategy.

Strain Measurement Techniques

Introduction to strain measurement: Review of Stress, Strain, and Hooke's Law: Definition of Stress and Strain Tensors, Constitutive Models Strain Gages: Properties of Strain gauge Systems, Types Resistance Strain gauges: Construction, Mounting methods, Gage Sensitivity, Strain Gage Circuits: Wheatstone bridge, constant current circuits Calibration of circuits, Bridge Sensitivity and Measurement Corrections, Thermal Corrections Gage Factor, Performance Characteristics, Environmental effects. Recording Instruments: Static and Dynamic Recording, Digital Data Acquisition Systems, Telemetry Systems Strategy.

Strain Analysis Methods

Three element rectangular strain rosette, correction, stress gauges, over-deterministic methods for strain analysis, residual stress determination Applications: Application of strain gauges for measurement of load, temperature, pressure, vibration, stress and strain etc.

Optical Methods of Stress Analysis

Basic of Optics, Optical Instrumentation Moire Fringe technique-theory and experimental procedures, Fractional fringe measurement -Tardy's Method , Babinet Soleil Method. Strategy.

Theory of Photoelasticity, Polariscope

Plane polariscope, Circular polariscope,Different Arrangements photoelastic photography, Photoelastic materials-properties, selection, casting methods, caliberation. Analysis Techniques-Determination of direction of Principal stresses at given point, Determination of exact fringe order N and the principal stress Separation methodsMethod based on Hooke's Law, Electrical analogy method, Oblique incidence method,Shear difference method, Scaling model results to prototype. Application of photoelasticity to 2-D and 3-D Stress analysis Strategy

Optical Methods for Determining Fracture Parameters

Irwins methods, application. of moiré and isopachic fringe pattern to determine stress intensity factor, mixed mode intensity factors Strategy.

Coating Techniques

Bifringent coating- stress-optic and strain-optic relation, sensitivity and coating materials, fringe order determination. Brittle coating technique. Strategy

Holography

Plane and spherical waves - coherence - holographic setup - Interferometry - Displacement measurement -obtaining Isopachics, Strategy.

Books Recommended:

1. Experimental Stress Analysis by Sadhu Singh, Khanna Publishers, New Delhi, 1996.
2. Experimental Stress Analysis by JW Dalley and WF Riley, McGraw Hill Book Company, N.Y. 1991
3. Experimental Stress Analysis by LS Srinath et al, Tata McGraw Hill Company, New Delhi, 1984.
4. Mechanical Measurements by R.S.Sirohi & HC Radhakrishna, New Age International (P) Ltd. 1997
5. Structural assessment by F.K Garas, J.L. Clarke, & GST Armer, Butterworths, London, 1987
6. Experimental Stress Analysis and Motion Measurement by Dove and Adams, Prentice Hall of India, 1965

MTME- 219 SUSTAINABLE DESIGN AND MANUFACTURING

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Concepts of Sustainability and Sustainable Development

Need for sustainable development - Components of sustainability- Social, Economic, Environmental dimensions - Linkages between technology and sustainability - Sustainable Manufacturing –Scope, Need, design, practice, matrices and Benefits, Sustainable business models, Waste minimization

Tools and Techniques of Sustainable Manufacturing

Environmental Conscious Quality Function Deployment, Life cycle management and assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly -Sustainable Product Development – Various Phases.

EIA Methods

CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters - Interactions between energy and technology and their implications for environment and sustainable development.

Design for Recycling

Eco friendly product design methods – Methods to infuse sustainability in early product design phases – Multi-Criteria Decision Making in Sustainability.

Frameworks for Measuring Sustainability

Indicators of sustainability – Environmental, Economic, Societal and Business indicators - Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

Books Recommended:

1. G. Atkinson, S. Dietz, E. Neumayer, Handbook of Sustainable Manufacturing, Edward Elgar Publishing Limited
2. D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, UN New York
3. P. P. Rogers, K.F. Jalal, J. A. Boyd, An Introduction to Sustainable Development, Earthscan, London
4. P. Lawn, Sustainable Development Indicators in Ecological Economics, Edward Elgar Publishing Limited.
5. S. Asefa, The Economics of Sustainable Development, W.E. Upjohn Institute for Employment Research

MTME- 220 VIBRATION AND NOISE CONTROL

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Multi Degree Freedom System

Free Vibration equation of motion. Influence Coefficient (i) Stiffness Coefficient (ii) Flexibility Coefficient. Generalized coordinates, and Coordinate couplings. Langranges Equations Matrix Method Eigen Values Eigen Vector problems. Modal Analysis.Forced Vibrations of undamped system and modal analysis.

Multi Degree System Numerical Methods

(i)Rayleigh`s Method, (ii)Rayleigh-Ritz Method (iii) Holzer`s Method (iv)Methods ofMatrix iterations (v) Transfer Matrix Method and Impulse response and frequency response functions.

Continuous System and Transient Vibrations

Vibrations of String, Bars, Shafts and beams, free and forced vibration of continuous systems. Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response functions.

Vibration Control and Measurement

Balancing of rotating machine, In-situ balancing of rotors, control of natural frequency introduction of damping, vibration isolation & vibration absorbers.FFT analyzer, vibration exciters, signal analysis. Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, fault diagnosis.

Random and Non-Linear Vibrations

Expected values auto and cross correlation function, Spectral density, response of linear systems, analysis of narrow band systems. Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase-plane technique, Duffing's equation, jump phenomenon, Limit cycle, perturbation method.

Noise and Its Measurement

Sound waves, governing equation its propagation**,** Fundamentals of Noise, Decibel, Sound Pressure level, Sound Intensity, Sound fields, reflection, absorption and transmission .Noise measurement, Sound meter, Allowed exposure levels and time limit by B.I.S., Octave Band analysis of sound, Fundamentals of Noise control, source control, path control, enclosures, noise absorbers, noise control at receiver.

Books Recommended

1. W T Thomson,Theory of Vibrations with Applications, CBS Publishers Delhi
2. S. S. Rao, Mechanical Vibrations, Addison-Wesley Publishing Co.
3. Leonard Meirovitch, Fundamentals of Vibration, McGraw Hill International Edison.
4. Ashok Kumar Mallik, Principles of Vibration Control, Affiliated East-West Press.
5. A H Church, Mechanical Vibrations, John Wiley & Sons Inc

6. J P Den Hartog, Mechanical Vibrations, McGraw Hill.
7. Srinivasan, Mechanical Vibration Analysis, McGraw Hill.
8. Kewal Pujara,Vibration and Noise for Engineers, Dhanpat Rai & Sons

MTME- 221 COMPOSITE MATERIALS

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Introduction of Composite

Composites and their classification, Particulate composites, Hybrid composites, Long aligned fiber composites.

Introduction of Polymers

Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics – Applications – Merits and Demerits

Reinforcements

Glass fibers, Boron fibers, Carbon fibers, Organic fibers, Ceramic fibers, Nonoxide fibers, Comparison of different types of fibers.

Matrix Materials

Polymers, metals, Ceramic matrix materials and their properties

Processing of Composites

Hand lay-up, Pre peg processing, Press molding, Vacuum molding, Filament winding, extrusion, Pultrusion, liquid metal infiltration process, Diffusion bonding and powder metallurgy methods, joining of composites, Basic properties of GRP, CFRP, Al-B, Casting and Particulate composites.

Properties and Applications

Modulus, Strength, Thermal characteristics, Aging, Fatigue, Creep, Transport properties, Matrix connectivity, Aerospace application, Structural, Defense biomedical application, Machine tools, Automobiles applications.

Books Recommended:

1 Chawla K.K., Composite Materials, Springer (2008)
2. Harris B., Engineering Composite Materials, Maney Publishing (1998).
3. Callister, W.D., Materials Science & Engineering: An Introduction, Wiley & Sons (2007
4. Rauwendaal,C., Polymer extrusium, Hanser publishers, 2000.

MTME- 222 INSTRUMENTATION AND CONTROL ENGINEERING

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Measuring Instruments

Principle of operation of galvanometer, PMMC, Moving Iron instruments, Resistance measurements using Wheatstone bridge, Kelvin Double Bridge, Ohm meter, AC bridges: Maxwell bridge, Maxwell Wein bridge, Hey's Bridge, Schering Bridge, Anderson Bridge, Campbell Bridge.

Instrumentation for Generation and Analysis of Waveforms

Signal generators: Fixed and variable AF oscillators, AF sine and square wave generator, Function generator: Square and pulse generator, Sweep generator, wave analyzer, Harmonic distortion analyzer, Spectrum analyzer, Spectrum analysis.

Introductory Concepts

Plant, Systems, Servomechanism, regulating systems, Disturbances, Open loop control system, Closed loop control systems, Linear and non-linear systems, Time variant and invariant, Continuous and sampled-data control systems, Block diagrams, some illustrative examples.

Modelling

Formulation of equation of linear electrical, Mechanical, Thermal, Pneumatic and hydraulic system, Electrical, Mechanical analogies. Transfer function, Block diagram representation, Signal flow graphs and associated algebra, Characteristics equation.

Time Domain Analysis

Typical test - Input signals, Transient response of the first and second order systems. Time domain specifications, Dominant closed loop poles of higher order systems, Steady state error and coefficients, Pole-zero location and stability, Routh-Hurwitz Criterion.

Frequency Domain Analysis

Closed loop frequency response, Bode plots, Stability and loop transfer function. Frequency response specifications, Relative stability, Relation between time and frequency response for second order systems. Log. Magnitude versus Phase angle plot, Nyquist criterion for stability.

Control Components

Error detectors - Potentiometers and synchros, servo motors, A.C. and D.C. techno generators, Magnetic amplifiers.

Books Recommended:

1. Theory and Applications of Automatic Controls by B C Nakra and S P Singh, New Age Publisher.
2. Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney, Dhanpat Rai & Company.

3. Electronic Instrumentation and Measurement Techniques by W. D. Cooper, Prentice Hall.
4. Electronic Instrumentation by H. S. Kalsi, Tata McGraw Hill.
5. Modern Control System by Dorf Richard C. and Bishop Robert H., Addison -Wesley, Pearson New Delhi.
6. Modern Control Engineering by Ogata K. Prentice Hall.

MTME- 223 ADVANCED INTERNAL COMBUSTION ENGINES

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Spark Ignition Engines

Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers

Compression Ignition Engines

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbocharging.

Pollutant Formation and Control

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

Alternative Fuels

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.

Recent Trends

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOx Adsorbers - Onboard Diagnostics.

Books Recommended:

1. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications.
2. Ganeshan, " Internal Combustion Engines", Tata Mc-graw Hill.
3. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines"., Dhanpat Rai & Sons.
4. Duffy Smith, "Auto Fuel Systems", The Good Heart Willcox Company, Inc., 1987.
5. Eric Chowenitz, "Automobile Electronics", SAE Publications, 1995

MTME- 224 DESIGN OF STEAM TURBINE

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Steam Turbine Types

Principal of operations of stream turbines, Comparison of steam engines and steam turbines, Simple impulse turbine, Compounding of steam turbines, Pressure compounded impulse turbine, Simple velocity compounded impulse turbine, Pressure –velocity compounded impulse turbine, Difference between impulse and reaction turbine.

Flow of Steam Through Impulse Turbine Blades

Velocity diagram for impulse turbine, multistage impulse turbine with single row wheel, optimum ratio of blade velocity to steam velocity, impulse blade section, advantages and disadvantages of velocity compounded steam turbines.

Flow of Steam Through Impulse Reaction Turbine Blades

Impulse reaction turbine with similar blade section and half degree reaction (Parsons' Turbine), comparison of enthalpy drop in various stages of reaction turbines, height of impulse turbine stage blading, impulse reaction turbine blade section.

Energy Losses in Steam Turbine

Energy losses in nozzle, moving blade, wind age, partial admission losses, losses due to wetness of steam, mechanical losses.

State Point Locus, Reaheat Factor and Design Procedure

State point losses for multistage steam turbine, reheat factor, internal and other efficiencies, correction of reheat factor for finite number of stages, design procedure for impulse and impulse reaction turbines.

Regenerative Feed Heating, Reheating and Water Extraction Cycle

Most ideal regenerative feed reheating cycle, advantages and disadvantages of regenerative feed heating over Rankine cycle, prevention from erosion and corrosion, case study of actual regenerative water extraction cycle.

Back Pressure, Passout and Mixed Pressure Turbine Cycle

Back pressure turbine, passout turbine, process of passout turbine with single extraction, partial extraction, throttle governing, full extraction, nozzle control, working of mixed pressure turbine.

Governing and Performance of Steam Turbine

Need of governing, comparison of throttle and nozzle control governing, by pass governing of reaction turbine, speeder gear, governing characteristics.

Construction, Stress Analysis, Operation and Maintenance Of Steam Turbine

Construction of nozzle and diaphram, design requirements of nozzle, construction of turbine blade, blade material, vibration of blades, rotor construction and it's balancing, stresses in turbine blading disc, aims and objective of maintenance.

Books Recommended:

1. Steam and Gas Turbines by R. Yadav.
2. Steam Turbines by P. Shylakkhin
3. Steam Turbine Theory and Practice by W.J. Kearton

MTME- 225 CONVECTIVE HEAT TRANSFER

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Governing Equations

Continuity, Momentum and Energy Equations and their derivations in different coordinate systems, Boundary layer Approximations to momentum and energy.

Laminar External Flow and Heat Transfer

(a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method).

Laminar Internal Flow and Heat Transfer

(a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions.

Natural Convection Heat Transfer

Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate, effects of inclination, Natural convection in enclosures, mixed convection heat transfer past vertical plate and in enclosures.

Turbulent Convection

Governing equations for averaged turbulent flow field (RANS), Analogies between heat and Mass transfer (Reynolds, Prandtl-Taylor and von Karman Analogies), Turbulence Models (Zero, one and two equation models), Turbulent flow and heat transfer across flat plate and circular tube, Turbulent natural convection heat transfer, Empirical correlations for different configurations.

Books Recommended:

1. Convective Heat and Mass Transfer, 4th Edition by W. Kays, M. Crawford and B. Weigand, McGraw Hill International, 2005.
2. Convective Heat Transfer, 2nd Edition by S. Kakac and Y. Yener, CRC Press, 1995.
3. Convection Heat Transfer, 3rd Edition by A. Bejan, John Wiley, 2004
4. Fundamentals of Heat and Mass Transfer, 7th Edition by F.P. Incropera and D. Dewitt, John Wiley, 2011.
5. Boundary Layer Theory, 8th Edition by H. Schlichting and K. Gersten, Springer-Verlag, 2000.

MTME- 226 COMBUSTION ENGINEERING

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Introduction

Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel, Various combustion mode, Scope of combustion.

Thermodynamics of Combustion

Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermochemistry, adiabatic temperature, chemical equilibrium.

Chemistry of Combustion

Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

Physics of Combustion

Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.

Premixed Flame

One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.

Diffusion Flame

Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion.

Combustion and Environment

Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.

Books Recommended:

1. D.P. Mishra, Fundamentals of Combustion, Prentice Hall of India, New Delhi,
2. Kuo K.K. “Principles of Combustion” John Wiley and Sons
3. Strehlow R A., “Fundamentals of combustion” McGraw Hill Book Company.

MTME- 227 CONDUCTIVE AND RADIATIVE HEAT TRANSFER

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Fundamentals of Convection

Physical Mechanism of Convection, Classification of Fluid Flows, Velocity Boundary Layer, Thermal Boundary Layer, Laminar and Turbulent Flows, Heat and Momentum Transfer in Turbulent Flow, Derivation of Convection Equations for a Flat Plate, Solutions of Convection Equations for a Flat Plate, Non-dimensionalized Convection Equations and Similarity, Functional Forms of Friction and Convection Coefficients, Analogies between Momentum and Heat Transfer.

External Forced Convection

Drag and Heat Transfer in External Flow, Parallel Flow over Flat Plates, Flow across Cylinders and Spheres, Flow across Tube Banks.

Internal Forced Convection

Average Velocity and Temperature, The Entrance Region, General Thermal Analysis, Laminar Flow in Tubes, Turbulent Flow in Tubes.

Natural Convection

Physical Mechanism of Natural Convection, Equation of Motion and the Grashof Number, Natural Convection over Surfaces, Natural Convection from Finned Surfaces and PCB, Natural Convection into Enclosures, Combined Natural and Forced Convection.

Fundamentals of Thermal Radiation

Thermal Radiation, Blackbody Radiation, Radiation Intensity, Radiative Properties, Atmospheric and Solar Radiation

Radiation Heat Transfer

The View Factor, View Factor Relations, Radiation Heat Transfer: Black Surfaces, Radiation Heat Transfer: Diffuse, Gray Surfaces, Radiation Shields and the Radiation Effects, Radiation properties of Gases and Vapors.

Books Recommended:

1. Heat and Mass Transfer, Fundamentals & Applications, Fourth Edition, Cengel, Y., Ghajar, A. McGraw-Hill.
2. J.P. Holman “Heat Transfer”, Tata McGraw –Hill

MTME- 228 SOLAR ENERGY UTILIZATION

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Introduction
Energy demand and supply, energy crisis, conventional and nonconventional energy resources, solar energy applications.

Solar Radiation
Sun, solar radiation, attenuation by atmosphere, solar radiation on earth, measurement, presentation and utilization of data.

Heat Transfer Concepts
Radiation characteristics of surface and bodies, absorbance, reflectance and transmittance, selective surface, sky radiation and wind convection.

Flat Plate Collectors
General description of flat plate collectors, general characteristics, performance, short term and long term performance, design.

Focusing Collectors
General description of focusing solar collectors, concentrators, receivers and orienting systems, general characteristics, performance, materials, design.

Energy Storage
Energy storage in solar process system, different types of storages, characteristics and capacity of storage medium, solar pond.

Solar Heating and Cooling
Passive heating and cooling, nocturnal radiations, green house concept, ponds, active heating and cooling, solar water heaters, absorption cooling, combined solar heating and cooling systems, performance, economics of solar heating and cooling.

Solar Process Modeling
Solar process systems and components, component models, system models.

Solar Photovoltaics
Description and principle of working, performance characteristics, efficiency of solar cells, module design, PV systems, applications.

Books Recommended:
1. Duffie, J.A. and Beckman, W.A., “Solar Engineering of Thermal Processes”, John Wiley & Sons.
2. Goswami, D.Y., Kreith, F. and Kreider J., “Principles of Solar Energy”, Taylor & Francis.

3. Sukhatme, S.P. and Naik, J.K., “Solar Energy”, 3rd Ed., Tata McGraw Hill.
4. Garg, H.P. and Prakash, J., “Solar Energy”, Tata McGraw Hill.
5. Tiwari, G.N.,“Solar Energy”, Narosa Publishing House.
6. Meinel, A.B., “Applied Solar Energy”, Addison Wesley

MTME-229 DESIGN OF HVAC SYSTEM

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Introduction to HVAC
Scope, Concepts of air conditioning system, Central air conditioning system, Psychometric chart, Components of AHU and its components

Refrigerant
Types, Evaporating and condensing properties, Refrigerant pipe sizing methods

Cooling & Heating Load Estimations
Basics of heat transfer in building, Understanding of outdoor & indoor conditions, Sources of heat gain, Heat loss calculations

Design of Air Distribution System
Components of air distributing system

Design of Ventilation System
Introduction, Restaurant and kitchen ventilation system design

Chilled Water System Design
Introduction, Classification, Chillar arrangements, Cooling tower arrangements, types of cooling tower & expansion tank connections. Pumps required in chilled water system, Chilled water system pipe designing

Equipment Selection
AHU & FCU classification and selection, Package unit selection DX-Chiller selection, Cooling tower selection mixed air temperature calculation. HRF for open & closed compressor, Expansion tank selection

Erection of Equipments
Detailing & Installation of Chillers, Detailing & Installation of Air handling units, Detailing & Installation of Package units, Detailing & Installation of Fan coil units. Detailing & Installation of Condensing units

Estimation of Systems
Understanding the tendering requirements, Quantity take off, Preparing inquiry for suppliers & finalizing the suppliers, Final billing & quotations finalization

Drafting of HVAC Systems
Introduction, preparation of floor drawings, Project work Load calculation, Duct designing & Equipment selection

Books Recommended:

1. Fundamentals of HVAC Systems by Robert McDowall, Elsevier Science
2. Refrigeration and Air Conditioning Technology, Eugene Silberstein, Bill Oohnson, Bill Whitman, John Tomczyk, CENGAGE Learning Custom Publishing.
3. Handbook of Air Conditioning and Refrigeration by Shan K. Wang, McGraw-Hill

MTME-230 DESIGN AND OPTIMIZATION OF THERMAL SYSTEMS

L	T	P
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Introduction

Introduction to design and specifically system design. Morphology of design with a flow chart. Market analysis, profit, time value of money, an example of discounted cash flow technique. Concept of workable design, practical examples on workable system and optimal design.

System Simulation

Classification. Successive substitution method - examples. Newton Raphson method - one unknown - examples. Newton Raphson method - multiple unknowns - examples. Gauss Seidel method - examples. Rudiments of finite difference method for partial differential equations, with examples.

Regression And Curve Fitting

Need for regression in simulation and optimization. Concept of best fit and exact fit. Exact fit - Lagrange interpolation, Newton's divided difference - examples. Least square regression - theory, examples from linear regression with one and more unknowns - examples. Power law forms - examples. Gauss Newton method for nonlinear least squares regression – examples.

Optimization

Introduction. Formulation of optimization problems – examples. Calculus techniques – Lagrange multiplier method – proof, examples. Search methods – Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search – numerical examples. Method of steepest ascent/ steepest descent, conjugate gradient method – examples. Geometric programming – examples. Dynamic programming – examples. Linear programming – two variable problem –graphical solution. New generation optimization techniques – Genetic algorithm and simulated annealing - examples. Introduction to Bayesian framework for optimization examples.

Books Recommended:

1. Essentials of Thermal System Design and Optimization, Prof. C.Balaji,Aue Books, New Delhi in India and CRC Press in the rest of the world.
2. Design and optimization of thermal systems,Y.Jaluria, Mc Graw Hill.
3. Design of thermal systems, W.F.Stoecker, Mc Graw Hill.
4. Introduction to optimum design, J.S.Arora, Mc Graw Hill.

MTME-231 ADVANCED HEAT AND MASS TRANSFER

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Conduction

General conduction equations, boundary & initial conditions, radial fins & fin optimization, multidimensional heat conduction, transient heat conduction.

Convection

Forced convection, velocity and thermal boundary layers, laminar and turbulent flow, boundary layer approximations, convection transfer equations, dimensionless parameters, empirical correlations, free convection, empirical correlations for external free convection flows for various geometries and orientations, heat pipes, Nano fluids and their applications.

Boiling and Condensation

Pool boiling, correlations, forced convection boiling, two phase flow, laminar film condensation on a vertical plate, turbulent film condensation, film condensation in horizontal tubes, drop wise condensation correlations

Thermal Radiation

Thermal radiations and associated laws, radiation exchange between surfaces, view factor, network method, reradiating surfaces. Multimode heat transfer, gaseous emission and absorption.

Books Recommended:

1. Fundamental of Heat and Mass Transfer by Frank P. Incropera and David P. Dewitt, Wiley India (2002).
2. Convection Heat Transfer by Adrian Bejan, Wiley India (2003).
3. Convective Heat Transfer by Sadik, K. and Yaman, Y, CRC Press (1995).
4. Convective Heat and Mass Transfer Kays by W.M. and Crawford, McGraw Hill (2005).
5. Thermal Radiative Transfer and Properties by Brewster, M.Q., John Wiley (2006).
6. Heat Transfer by Holman, J.P, McGraw Hill (2007).