BRANCH - MECHANICAL ENGINEERING

2nd Semester

SPECIALIZATION: HEAT POWER & THERMAL ENGINEERING/HEAT POWER ENGINEERING/THERMAL ENGINEERING

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Advanced Engg Thermodynamics.	4 - 0	4	100	50	-	-	-
Specialization Core-2 Refrigeration Engineering.	4 - 0	4	100	50	-	-	-
Elective –I (Specialization related) 1. Two-Phase Flow and Heat Transfer. 2. Thermal & Nuclear Power Plant. 3. Introduction to Computational Fluid Dynamics. 4. Computational Methods in Thermal Engineering.	4 - 0	4	100	50	-	-	-
Elective-II (Departmental related) 1. Internal Combustion Engine 2. Numerical Analysis 3. Heat Transfer Equipments. 4. Fluid & Gas Dynamics.	4 - 0	4	100	50	-	-	-
Elective-III (Other Departmental Related) 1. Analysis and Design of Heat Exchanger 2. Renewable Energy Systems. 3. Hydel Power & Wind Energy. 4. Advanced Fluid Mechanics.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

BRANCH - MECHANICAL ENGINEERING

2nd Semester

SPECIALIZATION: PRODUCTION ENGINEERING/PRODUCTION ENGINEERING & OPERATIONAL MANAGEMENT

Second Semester							
	Theory				Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Non-Traditional Machining	4 - 0	4	100	50	-	-	-
Specialization Core-2 Rapid Prototyping and Tooling	4 - 0	4	100	50	-	-	-
Elective–I (Specialization related) 1. Advanced Decision Modeling and Techniques 2. Metal Forming Technology 3. Computer Aided Design and Computer Integrated Manufacturing 4. Metrology & Non-Destructive Testing	4 - 0	4	100	50	-	-	-
Elective-II (Departmental related) 1. Composite Materials & Application 2. Quality Engineering & Reliability 3. Theory of Plastic Deformation. 4. Production Management.	4 - 0	4	100	50	-	-	-
Elective-III (From any department) 1. Quantitative Techniques in Production Management. 2. Alternative Energy. 3. Machine Fault Diagnosis and Signal Processing. 3. Finite Element Methods in Engineering. 4. Tribology.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

BRANCH - MECHANICAL ENGINEERING

2nd Semester

SPECIALIZATION: ***MACHINE DESIGN / MECHANICAL SYSTEMS DESIGN / SYSTEM DESIGN***

Second Semester							
Theory					Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Mechanics of Composite Materials	4 - 0	4	100	50	-	-	-
Specialization Core-2 Fatigue, Creep & Fracture	4 - 0	4	100	50	-	-	-
Elective –I (Specialization Related) 1. Finite Element Method 2. Bearing and Lubrication 3. Basic Mechanical Handling systems 4. Analysis and synthesis of Mechanism.	4 - 0	4	100	50	-	-	-
Elective-II (Departmental Related) 1. Optimum Design of Mechanical Systems 2. Robotics 3. Material Selection in Mechanical Design. 4. Experimental Stress Analysis	4 - 0	4	100	50	-	-	-
Elective-III(From any department) 1. Machine Vibration 2. Numerical Method for Engineers 3. Machine Learning 4. Computer Aided Design.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks:1050							
Total Credits: 28							

BRANCH - MECHANICAL ENGINEERING

2nd Semester

SPECIALIZATION:THERMAL AND FLUID ENGINEERING

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Advanced Engg Thermodynamics.	4 - 0	4	100	50	-	-	-
Specialization Core-2 Advanced Fluid Mechanics	4 - 0	4	100	50	-	-	-
Elective –I (Specialization Related) 1. Advanced Refrigeration Engg. 2. Gas Turbine & Jet Propulsion. 3. Introduction to Computational Fluid Dynamics. 4. Computational Methods in Thermal Engineering.	4 - 0	4	100	50	-	-	-
Elective-II (Departmental Related) 1. Heat Transfer in Two-phase Flow 2. Gas Dynamics 3. Heat Exchanger Analysis and Design. 4. Aircraft & Rocket Propulsion.	4 - 0	4	100	50	-	-	-
Elective-III (Other Department Related) 1. Cryogenic Technology. 2. Advanced Internal Combustion Engines. 3. Viscous Fluid Flow. 4. Wind Energy Conversion.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

BRANCH - MECHANICAL ENGINEERING

2nd Semester

***SPECIALIZATION:* CAD/CAM**

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Computer Numeric Control Part programming	4 – 0	4	100	50	-	-	150
Specialization Core-2 Computer Integrated Manufacturing	4 – 0	4	100	50	-	-	150
Elective –I (Specialization related) 1. Rapid Prototyping and Manufacturing 2. Mechantronics and Manufacturing Systems 3. Manufacturing Systems and simulation 4. Metrology And Non Destructive Testing	4 – 0	4	100	50	-	-	150
Elective-II (Departmental related) 1. Manufacturing Information System 2. Robotics 3. Performance Modeling And Analysis of Manufacturing System Performance 4. Computer Aided Process Planning	4 – 0	4	100	50	-	-	150
Elective-III(Departmental Related) 1. Design for manufacturing 2. Design of Material Handling Equipment 3. Management Information System 4. Machine Tool Technology	4-0	4	100	50			
Lab-2 Compute Aided Manufacturing Lab					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

BRANCH - MECHANICAL ENGINEERING

2nd Semester

SPECIALIZATION:* *MECHANICAL SYSTEM DESIGN & DYNAMICS / DESIGN & DYNAMICS

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Vibration of structures	4 – 0	4	100	50	-	-	150
Specialization Core-2 Dynamics of Rotors.	4 – 0	4	100	50	-	-	150
Elective –I (Specialization Related) 1. Acoustics 2. Machine Fault Diagnosis and Signal Processing 3. Mechatronics 4. Analysis and Design of Smart Materials and Structure	4 – 0	4	100	50	-	-	150
Elective-II (Departmental Related) 1. Non Linear Vibration 2. Bearing and Lubrication 3. Vibration and Shock Isolation 4. Experimental Stress Analysis	4 – 0	4	100	5 0	-	-	150
Elective-III (From any department) 1. Robotics and Automation 2. Random vibrations & Failure Analysis 3. Finite Element Method in Engineering 4. Computer Graphics and Visualization	4 – 0	4	100	50	-	-	150
Lab-2 (to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

DETAILED SYLLABUS OF SECOND SEMISTER M.TECH 2016-17 ADDMISSION BATCH

BRANCH - MECHANICAL ENGINEERING

SPECIALIZATION: CAD/CAM

Second Semester							
Theory					Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Computer Numeric Control Part programming	4 – 0	4	100	50	-	-	150
Specialization Core-2 Computer Integrated Manufacturing	4 – 0	4	100	50	-	-	150
Elective –I (Specialization related) 1. Rapid Prototyping and Manufacturing 2. Mechantronics and Manufacturing Systems 3. Manufacturing Systems and simulation 4. Metrology And Non Destructive Testing	4 – 0	4	100	50	-	-	150
Elective-II (Departmental related) 1. Manufacturing Information System 2. Robotics 3. Performance Modeling And Analysis of Manufacturing System Performance 4. Computer Aided Process Planning	4 – 0	4	100	50	-	-	150
Elective-III(Departmental Related) 1. Design for manufacturing 2. Design of Material Handling Equipment 3. Management Information System 4. Machine Tool Technology	4-0	4	100	50			
Lab-2 Compute Aided Manufacturing Lab					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

COMPUTER NUMERICAL CONTROL PART PROGRAMMING

1. INTRODUCTION:

Basic concepts in manufacturing systems, fundamentals of numerical control advantages of NC systems, Classification of NC systems, point to point and countering systems, incremental and absolute systems, open loop and close loop systems, encoder, punched tape.

2. FEATURES OF NC MACHINE TOOLS: Fundamental of machining , design consideration of NC Machine tools , methods of improving machine accuracy, tool deflection and chatter, lead screw, thermal deformations, increasing productivity with NC machines, machining centers.

3. NC PART PROGRAMMING : Introduction, NC coordinate system, manual part programming , coe and concepts types to tape formats, Tool length and radius compensation , point to point and contour programming examples, caned cycles, Subroutine, MACROS simple problems of drilling , turning , and two- dimensional milling.

4. COMPUTER AIDED PART PROGRAMMING: Advantages of computer aided programming, post processor, APT programming, Geometric statements, motion statements, additional APT statements, simple problems of APT programming.

5. CNC, DNC, AND ADAPTIVE CONTROL: Introduction, problems with conventional NC, principles of operation of CNC, features of CNC, advantages of CNC , direct numerical control, types and functions of DNC, advantages of DNC, Adaptive control machining systems, types, benefits of Adaptive control systems.

Books Recommended:

1. Numerical control and computer aided manufacturing –T.K.Kundra.P.N.Tao and N.K.Tewari.
2. Computer aided manufacturing –T.K.Kundra,P.N.Rao, and N.K.Tiwari(T.M.H)
3. Computer control of manufacturing systems –Y.Koren.
4. CAD/CAM-M.P.Groover and E.W.Zimmers(PHI)
5. Automation, production systems and CIM-M.P.Groover(P.H.I)
6. CAD/CAM- P.N.Rao(PHI)llations. 3. A.H. Nayfeh. Perturbation technique.

COMPUTER INTEGRATED MANUFACTURING

1. INTRODUICTION:

   Types of production system and their automation. CAD/CAM integration. Concept of FMS and CIMS.

2. ELEMENTS OF A GENERAL CIM SYSTEM:

   Type of the CIM systems. CAD?CAM link for CIMS> Manufacturing data base in a systems, equipment and their functions. Integration of robot in CIMS, Automatic storage and Retrieval system (AS/RS). Carousel, palletization and fixtures in process interfacing of storage with manufacture. 3. GROUP TECHNOLOGY: Co0ncept and terminology, part family formation , classification and coding systems for components ,Group Technology machine cells. Computer Aided process planning and route sheet development, CAPP system, Computer aided plant layout.

3. COMPUTER AIDED PRODUCTION PLANNING AND CONTROL:

   Inventory control and MRP, Computer aided cost estimation. Computer aided shop floor control, process monitoring , Computer aided inspection and quality control, SQC, SPC.

4. NET WORKING:

   Introduction to fundamentals of computer communications, networking, computer-machine –personnel communication links. Network architectures and techniques, Information flow in networks, network standards.

5. CIM DATABASE AND DATA BASE MANAGEMENT SYSTEM:

   Types, Management Information system, Manufacturing data preparation. Shop floor data collection systems, shop-floor control, sensors used ,tool management system automatic identification systems ,Barcode system.

6. CIMS CONFIGURATION:

   DNC based factory management and control, integrated CAD/CAM System and shared data base, Factories of the future. Impact of implementing CIMS on society. Introduction to rapid prototyping and rapid tooling Introduction to the concept of concurrent engineering.

Books Recommended:

1. M.P.Groover and E.W.Zimmers,CAD/CAM,Prentice hall of india, New Delhi.

2. M.P.Groover, Automation, production systems and computer Integrated Manufacturing , Prentice Hall of India ,New Delhi.

3. S. Kant Vajpayee, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi.

4. P. N. Rao, N. K. Tewari, T. K. Kundra, Computer Integrated Manufactring, Tata McGraw Hill, New Delhi.

5. Besant and Lui, CAD/CAM, Tata McGraw Hills, New Delhi.

6. H. Mitchell, CIM Systems – An Introduction to Computer Integrated Manufacturing, Prentice Hall, New Jersy.

7. P. Radhakrishnan and S. Subramanyan, CAD/CAM/CIM, New Age International P.ub, New Delhi.

8. Dr. Surender Kumar and Dr. A. K. Jha, CAD/CAM, Dhanpat Rai and Sons, New Delhi.

9. John Hartley, FMS at work, IFS Pub UK and North Holland, New York. Charles S. Knose, CAD/CAM System Planning & Implementation, Marcel Dekker, New York.

RAPID PROTOTYPING AND MANUFACTURING

INTRODUCTION: CAD-CAM and its integration, Development of CAD CAM. The importance of being Rapid, The nature of RP/T. The state of RP/T industry. Rapid Prototyping Defined. Time compression Technologies, Product development and its relationship with rapid prototyping. 2 PROCESS CHAIN FOR RAPID PROTOTYPING: Data Preparation (Pre-processing), Part Building, Post Processing. CAD Model Preparation, Reverse Engineering and CAD model, Digitizing Techniques: Mechanical Contact Digitizing, Optical Non-contact Measurement, CT Scanning Method, Data Processing for Surface Reconstruction. 3 Data interface for Rapid Prototyping: STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format. Open files. Repair of STL files. Alternative RP interfaces. 4 Part orientation and support generation: Factors affecting part orientation, various models for part orientation determination, the function of part supports, support structure design, Automatic support structure generation. 5 Model Slicing and Contour Data organization: Model slicing and skin contour determination, Identification of external and internal contours, Contour data organization, Direct and adaptive slicing: Identification of peak features, Adaptive layer thickness determination, Skin contour computation. Tool path generation. Part Building: Recoating, parameters affecting part building time, part quality. Post Processing: Part removal, finishing, curing. Other issues: Shrinkage, Swelling, Curl and distortion, Surface Deviation and accuracy, Build Style Decisions, 6. RAPID PROTOTYPING MACHINES: Classification, Description of RP Machines: SLA, SLS, FDM, 3D Printing, LOM, SDM, Contour Crafting, 3D Welding, etc., CNC-machines and hybrid systems. 7 RAPID TOOLING AND MANUFACTURING: Classification of RT Routes, RP of 15 Patterns, Indirect RT: Indirect method for Soft and Bridge Tooling, Indirect method for Production Tooling, Direct RT: Direct RT method for Soft and Bridge Tooling, Direct methodfor Production Tooling, Other RT Approaches. Rapid Manufacturing: Methods, limitations. 8 APPLICATION OF RP: Heterogeneous objects, Assemblies, MEMES and other small objects, Medicine, Miscellaneous areas including art.

Books Recommended:

1. Bjorke, Layer Manufacturing, Tapir Publisher. 1992.
2. Jacobs, PF (Ed), Rapid Prototyping and Manufacturing, Society of Manuf. Engrs, 1992.
3. Burns, M., Automated Fabrication: Improving Productivity in Manufacturing, 1993.
4. Jacobs, P.F. (Ed.), Stereolithography and Other RP&M Technologies: From Rapid Prototyping to Rapid Tooling, Society of Manuf. Engrs. NY, 1996.
5. Chua C. k. and L. K. Fai, Rapid Prototyping: Principles and Applications in Manufacturing.
6. Gibson, I. (Ed.), Software Solutions for Rapid Prototyping, Professional Engineering Publications, London., 2002.

MECHATRONICS AND MANUFACTURING SYSTEMS

1. INTRODUCTION Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design. 2. SENSORS AND TRANSDUCERS Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems. 3. MICROPROCESSORS IN MECHATRONICS 15 Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters -Applications - Temperature control - Stepper motor control - Traffic light controller. 4. PROGRAMMABLE LOGIC CONTROLLERS 8 Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC. 5. DESIGN AND MECHATRONICS 7 Designing - Possible design solutions - Case studies of Mechatronics systems.

Books Recommended:

1. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ., " Mechatronics ", Chapman and Hall, 1993.
3. Ramesh.S, Gaonkar, " Microprocessor Architecture, Programming and Applications ", Wiley Eastern, 1998.
4. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
5. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, " Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.

MANUFACTURING SYSTEMS AND SIMULATION

COMPUTER MODELING AND SIMULATION SYSTEMS 8 Monte Carlo simulation, Nature of computer modelling and simulation. Limitation of simulation, areas of application. Components of a system - discrete and continuous systems. Models of a system - a variety of modelling approaches. 2. RANDOM NUMBER GENERATION 10 Techniques for generating random numbers - midsquare method - the mid product method - constant multiplier technique - additive congruential method - linear congruential method - tests for random numbers - the Kolmogorov - Smirnov test - the Chi-Square test. 3. RANDOM VARIABLE GENERATION 8 Inverse transform technique - exponential distribution - uniform distribution - Weibull distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution. 4. DISTRIBUTION AND EVALUATION OF EXPERIMENTS 10 Discrete uniform distribution - Poisson distribution - geometric distribution - acceptance rejection technique for Poisson distribution gamma distribution. Simulation Experimenets - Variance reduction techniques - antithetic variables - verification and validation of simulation models. Variance reduction techniques - antithetic variables - verification and validation of simulation models. 5. DISCRETE EVENT SIMULATION 9 Concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem. Programming for discrete event systems in GPSS - Case studies

Books Recommended:

1.Jerry Banks and John S. Carson, II, "Discrete Event System Simulation", Prentice Hall Inc. 1984.

2. Gordon G, " Systems Simulation", Pentice Hall of India Ltd., 1991.

Reference Books:

1. Narsing Deo, "System Simulation with Digital Computer", Prentice Hall of India, 1979.

2. Francis Neelamkovil, "Computer Simulation and Modelling", John Wiley & Sons, 1987.

3. Ruth M. Davis and Robert M.O' Keefe, " Simulation Modelling with Pascal", Prentice Hall, Inc. 1989.

METROLOGY AND NON DESTRUCTIVE TESTING

MEASURING MACHINES Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology. 2. STATISTICAL QUALITY CONTROL 9 Data presentation - Statistical measures and tools - Process capability - Confidence and tolerence limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Realibility and life testing. 3. LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS 9 Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations. 4. RADIOGRAPHY 9 Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications. 5. ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES 9 Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

Recommended Books:

1. JAIN, R.K. " Engineering Metrology ", Khanna Publishers, 1997.
2. Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.
3. American Society for Metals, " Metals Hand Book ", Vol.II, 1976.
4. Progress in Acoustic Emission, " Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

MANUFACTURING INFORMATION SYSTEMS

1. INTRODUCTION 5 The evolution of order policies, from MRP to MRP II, the role of Production organization, Operations control. 2. DATABASE 7 Terminologies - Entities and attributes - Data models, schema and subschema - Data Independence - ER Diagram - Trends in database. 3. DESIGNING DATABASE 13 Hierarchical model - Network approach - Relational Data model -concepts, principles, keys, relational operations - functional dependence -Normalisation, types - Query languages. 4. MANUFACTURING CONSIDERATION 10 The product and its structure, Inventory and process flow - Shop floor control - Data structure and procedure - various model - the order scheduling module, input / output analysis module the stock status database - the complete IOM database. 5. INFORMATION SYSTEM FOR MANUFACTURING 10 Parts oriented production information system - concepts and structure -computerised production scheduling, on- line production control systems, Computer based production management system, computerised manufacturing information system - case study.

Books Recommended:

1. Luca G. Sartori, " Manufacturing Information Systems ", Addison-Wesley Publishing Company, 1988.
2. Date.C.J., " An Introduction to Database systems ", Narosa Publishing House, 1997.
3. Orlicky.G., " Material Requirements Planning ", McGraw-Hill Publishing Co., 1975.
4. Kerr.R, " Knowledge based Manufacturing Management ", Addison-wesley, 1991.

DESIGN OF MATERIAL HANDLING EQUIPMENT

(USE OF APPROVED DATA BOOK IS PERMITTED)

1. MATERIALS HANDLING EQUIPMENT 4 Types, selection and applications 2. DESIGN OF HOISTS 15 Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks - crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types. 3. DRIVES OF HOISTING GEAR 6 Hand and power drives - Travelling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings. 4. CONVEYORS 10 Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors. 5. ELEVATORS 10 Bucket eleevators: design - loading and bucket arrangements - Cage elevators - shaftway, guides, counter weights, hoisting machine, safety devices - Design of form lift trucks.

Books Recommended

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.

2. Spivakovsy, A.O. and Dyachkov, V.K., LConveying Machines, Volumes I and II, MIR Publishers, 1985.

Reference books:

1. Alexandrov, M., Materials Handling Equipments, MIR PUblishers, 1981.

2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958

PERFORMANCE MODELING AND ANALYSIS OF MANUFACTURING SYSTEM PERFORMANCE

1. MANUFACTURING SYSTEMS & CONTROL 10 Automated Manufacturing Systems - Modelling - Role of performance modelling - simulation models- Analytical models. Product cycle - Manufacturing automatiion - Economics of scale and scope - input/output model – plant configurations. Performance measures - Manufacturing lead time - Work in process - Machine utilization - Throughput – Capacity - Flexibility - performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works - Open systems interconnection model - Net work to network interconnections - Manufacturing automation protocol - Databse management system.
2. MANUFACTURING PROCESSES 10 Examples of stochastic processes - Poisson process, Discrete time Markov chain models - Definition and notation - Sojourn times in states - Examples of DTMCs in manufacturing - Chapman - Kolmogorov equation - Steady-state analysis. Continuous Time Markov Chain Models - Definitions and notation - Sojourn times in states - examples of CTMCs in manufacturing - Equations for CTMC evolution - Markov model of a transfer line. Birth and Death Processes in Manufacturing - Steady state analysis of BD Processes - Typical BD processes in manufacturing.
3. QUEUING MODELS 8 Notation for queues - Examples of queues in manufacturing systems - Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.
4. QUEUING NETWORKS 8 Examples of QN models in manufacturing - Little's law in queuing networks - Tandem queue - An open queuing network with feed back - An open central server model for FMS - Closed transfer line - Closed server model - Garden Newell networks
5. PETRI NETS 9 Classical Petri Nets - Definitions - Tansition firing and reachability - Representational power - properties - Manufacturing models. Stochastic Petri Nets - Exponential timed Petri Nets - Generalized Stochastic Petri Nets - modelling of KANBAN systems - Manufacturing models.

Text Books:

1. Viswanadham, N and Narahari, Y. "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi, 1994.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall, New Jersey, 1982.
3. Gupta S.C., & Kapoor V.K., "Fundamentals of Mathematical Statistics", 3rd Edition, Sultan Chand and Sons, New Delhi, 1988.

COMPUTER AIDED PROCESS PLANNING

1. INTRODUCTION

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning - Process Planning and Concurrent Engineering, CAPP, Group Technology.

2. PART DESIGN REPRESENTATION

Design Drafting - Dimensioning - Conventional tolerancing - Geometric tolerancing - CAD - input / output devices- topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optizsystem - The MICLASS system.

3. PROCESS ENGINEERING AND PROCESS PLANNING

Experienced, based planning – Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, Al.

4. COMPUTER AIDED PROCESS PLANNING SYSTEMS

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

5. AN INTERGARTED PROCESS PLANNING SYSTEMS

Totally intergarted process planning systems - An Overview - Modulus structure - Data Structure, operation Report Generation, Expert process planning.

Books Recommended:

1. Gideon Halevi and Roland D.Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.

2. Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.

3. Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.

4. Nanua Singh, "Systems Approach to Computer Intergrated Design and Manufacturing", John Wiley & Sons, 1996.

5. Rao, " Computer Aided Mnufacturing ", Tata McGraw Hill Publishing Co., 2000.

DESIGN FOR MANUFACTURING

1. INTRODUCTION

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

2. FACTORS INFLUENCING FORM DESIGN

Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on from design - from design of welded members, forgings and castings.

3. COMPONENT DESIGN-MACHINING CONSIDERATION

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area - simplification by separation - simplificaation by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

4. COMPONENT DESIGN - CASTING CONSIDERATIONS

Redesign of castings based on parting line considerations - Minimising core requirements, machined holes, redesign of cast members to obviate cores.

5. REDESIGN FOR MANUFACTURE AND CASE STUDIES

Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

Books Recommended:

1. Harry Peck, "Design for Manufacture", Pittman Publication, 1983.

2. Robert Matousek, "Engineering Design - A systematic approach", Blackie & sons Ltd., 1963.

Reference books:

1. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co., 1986.

2. Swift K.G., "Knowledge based design for manufacture, Kogan Page Ltd., 1987

ROBOTICS

Robotics: Historical back ground, Definitions. Laws of Robotics, Robotics systematic robot anatomy; Common Robot configurations, coordinate system, work envelop. Elements of robotic system and effector, actuators, controller, teach pendant, sensors Specification of robots. Applications, Safety measures. ; Robot Kinematics: Forward and reverse Kinematics of 3 DOF Robot arms. Homogeneous transformations. Kinematics equation using homogeneous transformations; Actuators: Hydraulic actuators. Pneumatic actuator, Electrical actuators, Directional control, Servo; Control Flow control valves. ; End effectors: Classification, Drive systems. Magnetic, Mechanical, Vacuum and Adhesive Grippers, force analysis in Grippers. ; Sensors: Need for sensing systems, Sensory devices, Types of sensors, Robot vision system Robot Languages and Programming: Types of Programming, Motions Programming, Robot Languages - VAL systems. ; Flexible automation: Technology, FMS, Function of Robot in FMS flexible manufacturing cell.

Essential Reading:

1. S.R. Deb, *Robotic technology and flexible automation* - TMH.

Supplementary Reading:

1. Lee, Fu, Gonzalez, *Robotics* - Mc Graw Hill.
2. Groover, *Industrial Robot* - Mc Graw Hill.
3. Paul Afonh, *Robots manufacturing and application* - John Wiley.

MANAGEMENT INFORMATION SYSTEM

1. INTRODUCTION: Concepts of management, Information and systems, History of information systems. Philosophies governing the development of information systems. Role of information systems in Organizations: Local and Global context. Additional perspectives as benefits from technical trends and innovations, special characteristics and enigmas of information .Information system and Business processes: Analyzing information system from a business perspective using work centered analysis of systems.

2. INFORMATION SYSTEM TAXONOMIES: Transaction processing system, management information systems. Decision support system, Executive information systems. Artificial intelligence, Expert Systems and Office automation system.

3. SYSTREM ANALYSIS AND DESIGN: Information system planning ,introduction challenges, strategic issues, selecting systems, project management issues. Methodology and implication of system analysis and design,SDLC, prototyping . End user development, off-the self software, out sourcing and application software.

4. TOOLS FOR INFORMATION SYSTEM DEVELOPMENT: Structural tools for analysis and design, tools to represent system data and process, tools for structured programming ,tools to convert programs specified into code.

5. DATA BASE DESIGN AND MANGEMENT: Components of DBMS, database models, Principle of DBMS.

6. STRATEGIC INFORMATION SYSTEMS: Characteristics, and plan. Business Information systems, MARIS, Information systems for manfuctring, human resource, Finance and accounts, and quality.

7. VLIENT SERVER COMPUTING: Developing, Clint server, organizational implication of c/s computing. Information system security and control.

8. ERP: Introduction, concepts, application advantages and disadvantages

Recommended books:

1. Uma G Guptha , Management information systems- a managerial perspective, Galgotia puplishers, New Delhi.

2. Edward Yourdon, structured analysis, prentice hall of India , New Delhi.

3. James A.O'Brien ,management information system (information system Technology in the Internet worked enterprises. Tata Mc Graw hills, New Delhi.

4. Steve Alter, Management information system Benjamin Cummins, new york.

5. Gerald V post and david L Anderson,Mangement information systems,solveing busnisses problem with information technology, Tata Mc-Graw Hills, New Delhi

6. Davis and Olson , management information systems Mc-Graw Hills, New York

7. Jawedkar, management information systems,Tata Mc-Graw Hills, New Delhi

8. Schultheis and sumner ,management information system (A management perspective),Tata Mc Graw Hills, New Delhi

9. Landon and Landon, Management Information Systems, Prentice hall of India New Delhi

MACHINE TOOL TECHNOLOGY

General classification of machine tools: Making and Auxiliary motions, Hydraulic transmission and the elements,Mechanical Transmission and the elements. General requirements of machine tools, Copy Turing, Transfermachines. ; Kinematics of machine tools: Drives in Machine tools, Mechanical drives for providing rotationalmotions, Requirements for layout of stepped drive, Designing the layout of mechanical drive, Mechanical drivefor reciprocation, Gear drive for feed motions, steeples drive. ; Strength and rigidity analysis of machine toolstructures: Basic Principles of design for strength and rigidity, Optimum design criteria, state compliance of M/C tool, Design of lathe beds, Design of columns for pillar drill, Radial drill milling machine, Analysis and designof tailstock assembly. ; Guide ways and power screws: Classification of guide ways, Material and Lubrication,Design criteria and calculation for slide ways, Design of guides under hydrostatic lubrication, Aerostatic slideways, Antifriction slide ways, Combination guide ways, Classifications of Power Jarms, Design Principles ofpower screw, Repower screw analysis. ; Machine tool spindles and the Bearings: Materials of spindles, Effect ofmachine tool compliance or machining accuracy, Design principles of spindles, Antifriction and sliding bearing; Cold rolling system in machine tools: Classification, control system for charging speeds and feeds, Ergonomicconsiderations applied for design of control members, Principles of automatic and adaptive control. Vibrationin Machine Tools: Sources and effects of vibration theory of chapter, Chapter in drilling, Milling and grinding,Elimination vibration, Stick-ship vibration and, Vibration.

Essential Readings:

1. G.C. Sen and A. Bhattacharya, Principles of machine Tools - New Central Book Agency.
2. N.K. Meheta, Machine Tool Design, TMH.

Supplementary Reading:

1. G.E. Dieter, Engineering Design:A Materials and processing approach, McGraw Hill, 1991

BRANCH - MECHANICAL ENGINEERING

SPECIALIZATION: HEAT POWER & THERMAL ENGINEERING/HEAT POWER ENGINEERING/THERMAL ENGINEERING

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Advanced Engg Thermodynamics.	4 - 0	4	100	50	-	-	-
Specialization Core-2 Refrigeration Engineering.	4 - 0	4	100	50	-	-	-
Elective –I (Specialization related) 1. Two-Phase Flow and Heat Transfer. 2. Thermal & Nuclear Power Plant. 3. Introduction to Computational Fluid Dynamics. 4. Computational Methods in Thermal Engineering.	4 - 0	4	100	50	-	-	-
Elective-II (Departmental related) 1. Internal Combustion Engine 2. Numerical Analysis 3. Heat Transfer Equipments. 4. Fluid & Gas Dynamics.	4 - 0	4	100	50	-	-	-
Elective-III (Other Departmental Related) 1. Analysis and Design of Heat Exchanger. 2. Renewable Energy Systems. 3. Hydel Power & Wind Energy. 4. Advanced Fluid Mechanics.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

Advanced Engineering Thermodynamics

Module-I

Review of Basics: First law and Second law analysis – concept of entropy – principle of increase of entropy – entropy generation – Availability – concept of energy – exergy analysis of combustion processes.

Module-II

Helm Holtz function – Gibb‘s function – OnSagar reciprocity relation. Thermodynamic relations, Maxwell‘s relations, T-dS equations – specific heat relations – energy equation – Joule Thomson effect – Clausius Claperyon Equation. Criteria for Equilibrium – Gibb‘s phase rule – Conditions for stability.

Module-III

Compressibility factor, fugacity and activity, computation from the generalized charts, dependence of fugacity and activity on pressure and temperature, chemical – equilibrium. Phase rule – ideal and real solution of gases, liquids, equilibrium system.

Module-IV

Statistical Thermodynamics: Thermodynamics probability, Maxwell statistics, Fermi Dirac and Bose – Einstein statistics, Entropy and probability, Degeneracy of energy levels, Partition functions. Kinetic Theory of Gases: Perfect gas model, Distribution of translational velocities distribution function, molecular collisions and mean free path, equipartition of energy.

Essential Readings:

1. A.S. Michael, *‘Thermodynamic for Engineers’*, Prentice Hall, 1972.

2. P.K. Nag., *‘Engineering Thermodynamics’*, II Ed., Mc-Graw Hill, 1995.

Supplementary Reading:

1. G.J. Van Wylen & R.E. Sonntag., *‘Fundamentals of Classical Thermodynamics’*, Willy Eastern Ltd. 1989 (Unit I, II & III)

2. J.P. Holman, *‘Thermodynamics’*, 4th Ed., McGraw Hill, 1988.

3. J. Hsieg, *‘Principles of Thermodynamics’*, McGraw Hill, 1978.

4. Lee and Sears, *‘Statistical Thermodynamics’*, Addition Wesley, 1976.

5. V. Nastrand, S. Glasstone., T*hermodynamics for Chemists’*, 1974.

6. M.D. Burghardt, *‘Engineering Thermodynamics for Engineers’*, Harper and Row, NY, 1987.

7. K. Wark, *‘Advanced Thermodynamics for Engineers’*, McGraw Hill, NY, 1987.

8. K. Smith, H.C. Van Ness, *Introduction to Chemical Engineering Thermodynamics*. McGraw Hill, 1987.

Advanced Refrigeration Engineering

Module I

Analysis of refrigeration cycle, principles of psychrometry properties and processes, Air washer, Cooling towers, dehumidifiers, wet bulb and dew point temperatures. Multistage cycle and their optimization.

Module II

Thermodynamic Properties of pure and mixed refrigerants. Eco-friendly Refrigerants vapour absorption cycle and its components. Ejector Refrigeration System, Vortex Tubes, Principle of liquefaction of gases, Dry ice manufacture, Magnetic Refrigeration System.

Module III

Analysis and thermal design of Refrigeration compressor, condenser, evaporator and flow control devices; Design, Lubrication, charging and testing of refrigeration plants, defrosting capacity control, system component balancing, Design and construction details of unitary refrigeration equipment.

Books

1. Refrigeration and Air Conditioning, C.P.Arora, Tata McGraw Hill
2. Refrigeration and Air Conditioning, Stoecker and Zones, McGraw Hill
3. Refrigeration and Air Conditioning, Domkundwar and Arora, Dhanpat Rai and Sons
4. Refrigeration and Air Conditioning, Manohar Prasad, East West Press
5. Refrigeration and Air Conditioning, P.L.Balaney

TWO-PHASE FLOW AND HEAT TRANSFER

Module-I

Definitions; Review of one-dimensional conservation equations in single phase flows; Governing equations for homogeneous, separated and drift-flux models;

Module-II

Flow pattern maps for horizontal and vertical systems; Simplified treatment of stratified, bubbly, slug and annular flows.

Module-III

Thermodynamics of boiling; Pool boiling- onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling; Flow boiling- onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling.

Module-IV

Condensation- Film and Dropwise condensation

Books:

1. Wallis, G.B., *One dimensional two-phase flows*, Mc-GrawHill 1969.

2. Collier, J.B. and Thome, J.R., *Convective boiling and condensation*, Oxford Science Publications, 1994.

3. L S Tong and Y S Tang. *Boiling Heat Transfer and Two-Phase Flow*. Taylor and Francis, 1997.

4. P B Whalley. *Boiling, Condensation and Gas-Liquid Flow*. Oxford University Press, 1987.

Thermal and Nuclear Power Plants

Module I :

Energy scenario. Overview of steam power plant. Analysis of steam cycles. Feedwater heaters. Deaerator and drain cooler. Optimization of cycle parameters, reheat and regeneration. Analysis of multi-fluid coupled cycles. Cogeneration of powerand process heat. Combined cycle power generation. Fuels. Combustion mechanisms. Draft systems. Combustion control. Furnaces for burning coal in fluidized beds and in pulverized form. Coal handling installation.

Module II :

Different types of boilers and their specific uses. Boiler mountings and accessories. Feedwater treatment. Boiler maintenance. Circulation theory. Downcomers and risers. Drum and its internals. Economiser. Convective and radiant super heaters. Superheat temperature control. Recuperative and regenerative air preheaters. Dust and ash removal systems. Environmental aspects of power generation

Module III:

Basic concepts of reactor physics, radioactivity. Neutron Scattering. Thermal and fast reactors. Nuclear cross-sections. Neutron flux and reaction rates. Moderator criteria. Reactor core design. Conversion and breeding. Types of reactors. Characteristics of boiling water, pressurized water, pressurized heavy water, gas cooled and liquid metal cooled reactors. Future trends in reactor design and operation. Thermal-hydraulics of reactors. Heavy water management. Containment system for nuclear reactor. Reactor safety radiation shields. Waste management. Indian nuclear power programme.

Text Book:

1. M. M. EI. Wakil. N*uclear Power Engineering'*, McGraw Hill Book Company, New York, 1987.
2. S. Glasstone and A. Setonske,*Nuclear Reactors, Engineering*, 3rd Ed, CBS Publishers and Distributors, 1992.

Reference

1. Loftness, *Nuclear Power Plants'*, D. Van Nostrand Company Inc, Princeton, 1964.
2. S. Sarg et al., *Physics of Nuclear Reactors'*, Tata McGraw Hill Publishing Company Ltd., 1985.
3. T. J. Connoly.,*Fundamentals of Nuclear Energy'*, John Wiley, 1978.

Introduction to Computational Fluid Dynamics

Introduction: Basic tools of CFD, Numerical Vs experimental tools; Mathematical Behavior of PDEs: Parabolic, Hyperbolic and Elliptic PDEs; Methodology of CFDHT: Discrete representation of flow and heat transfer domain: Grid generation, Governing equations and boundary conditions based on FVM/FDM, Solution of resulting set of linear algebraic equations, Graphical representation and analysis of qualitative results, Error analysis in discretization using FVM/FDM; Solution of 1-D/2-D steady/unsteady: Diffusion problems, Convection problems, Convection-diffusion problems, source term linearization; Explicit and Implicit Approach: Explicit and implicit formulation of unsteady problems, Stability analysis; Solution of Navier-Stokes Equations for Incompressible Flows: Staggered and collocated grid system, SIMPLE and SIMPLER algorithms; Special Topics in CFDHT: Numerical Methodology for Complex Geometry, Multi-block structured grid system, Solution of phase change Problems.

Essential Reading:

S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis, ISBN-10: 0891165223.

Supplementary Reading:

1. H. K. Versteeg and W. Malalasekra, Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall (2nd Edition), ISBN-10: 0131274988.
2. Jr. D. A. Anderson, Computational Fluid Mechanics and Heat Transfer by McGraw-Hill Education
3. M. N. Ozisik, Finite Difference Method, CRC (1st Edition).

Computational Methods in Thermal Engineering

Introduction: Concepts of consistency, stability, and convergence of numerical schemes. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences. Case studies selected from fluid mechanics and heat transfer. ; Finite Difference Method: Classification, Initial and Boundary conditions, Forward, Backward difference, Uniform and non-uniform Grids, Grid Independence Test. Basic finite difference schemes. Boundary treatments. Fourth order RK methods and Predictor-corrector methods and Natchsheim-Swigert iteration with applications to flow and heat transfer. ; Parabolic and hyperbolic problems: Model problems and stability estimates. Examples of the methods of lines. The Lax-Richtmyer equivalence theorem. Stability analysis. Discrete Fourier series. Von- Neumann stability analysis. Consistency, convergence and error estimates. Keller Box and Smith‘s method with applications to thermal boundary layers; Convection dominated problems: The failure of standard discretization, Upwinding and Higher order methods.

Supplementary Reading(s):

1. K.Muralidhar and T.Sundararajan, "*Computational Fluid Flow and Heat Transfer*", Narosa Publishing House,New Delhi1995.
2. P.S. Ghoshdasdidar, *"Computer Simulation of flow and heat transfer"* TMH Ltd., 1998.
3. S.V. Patankar, "*Numerical heat transfer fluid flow*", Hemisphere Publishing Co, 1980.
4. D.A. Anderson, I.I. Tannehill, and R.H. Pletcher, *Computational Fluid Mechanics and Heat Transfer*, Hemishphere Publishing Corporation, New York, USA, 1984.
5. C.A.J. Fletcher, ,"*Computational Techniques for Fluid Dynamics*
6. *Fundamental and General Techniques*, Springer-Verlag,1987.
7. T.K. Bose, "*Numerical Fluid Dynamics*" Narosa Publishing House, 1997.
8. T.K. Sengupta, *Fundamentals of Fluid Dynamics*, University Press, Hyderabad.

Advanced Internal Combustion Engines

Module I

Thermodynamic Analysis of I.C.Engine Cycles. Effect of design and operating parameters on cycle efficiency. Modified fuel-aircycle considering heat losses and valve timing. Engine dynamics and torque analysis. Use of Combustion chart. Thermodynamic cycle with supercharging both S.I. and C.I. Engines. Limits of Supercharging. Methods of Supercharging and Superchargers.

Module II

Fuels and combustion in S.I. engines, knocking and fuel rating. Energy balance, volumetric efficiency, measurement of indicated and brake power. Advanced theory of carburetion. Fuel Injection Systems for S.I. and C.I. Engines. Cooling of engine and governing of engine. Ignition system: conventional and electronic.

Module III

Variable compression ratio engine. Theoretical analysis, methods of obtaining variable compression ratio, Wankel rotary combustion engine, Stratified charged engine, Methods of charge stratification, Dual fuel and Multifuel engines, Biofuels, Variable Valve timing engines, Exhaust emissions, its measurement and control. Fault diagnosis of S.I. Engines.

Books

Fundamentals of I.C. Engines by H.B.Heywood, McGraw Hill

I.C.Engine Theory and Practices, Vol.I & II C.F.Taylor, MIT Press

I.C.Engine, Mathur and Sharma, Dhanpat Rai and Sons

Fundamentals of I.C.Engine by Ganeshan, Tata McGraw Hill

NUMERICAL ANALYSIS

Transcendental and Polynomial equations: Initial approximations, First Degree Equation, Iteration Methods Based on Second Degree equation, Multipoint iteration method, Rate of Convergence, Efficiency of a method.

System of Linear Algebraic Equations: Effects of Round-off Error, Operations Counts, Standard Methods of Solutions, Convergence analysis Eigen values and Eigenvectors Interpolation: Lagrange Polynomial Interpolation, Cubic Spline Interpolation,

Numerical Differentiation - Finite Differences: Construction of Difference Formulae. Accuracy of Finite Differences, Pade Approximations, Non-Uniform Grids.

Numerical Integration: Trapezoidal and Simpson's Rules, Error Analysis, Integration and Extrapolation, Quadrature.

Numerical Solution Of Ordinary Differential Equations: Initial Value Problems, Numerical Stability, Stability Analysis, Implicit, Runge-Kutta Methods, Multi-Step Methods, System Of First-Order Ordinary Differential Equations, Boundary Value Problems.

Numerical Solution of Partial Differential Equations: Semi-Discretization, von Neumann Stability Analysis, Modified Wave number Analysis, Implicit Time Advancement, Accuracy, Implicit Methods in Higher Dimensions, Approximate Factorization, Stability of the Factored Scheme, Alternating Direction Implicit Methods, Mixed and Fractional Step Methods, Elliptic Partial Differential Equations

Discrete Transform Methods: Discrete Fourier series, Applications, Finite Differenced Elliptic Equations, Fourier Spectral Numerical Differentiation, Discrete Transform and Applications, Numerical Differentiation.

Text Books:

1. Numerical Methods for scientific & Engg Computation- M. K. Jain, S. R. K. Iyengar & Jain.
2. Numerical Methods for Engineers – S. C Chapra and R. P. Canale. Mc GrawHill.

Reference Books

1. Numerical Methods – S. S. Rao.
2. Numerical Methods in Science & Engg: A Practical Approach – S. Rajashekharan. Wheeler Pub.
3. Numerical Recepies – W. H. Press, S. A. Teukolosky, W. T. Vetterling and B. P. Flannery Cambridge University Press.

HEAT TRANSFER EQUIPMENTS

Laws of conduction, convection and radiation; solution for some ideal geometries, Heat flow paths in seriesand parallel. Insulation systems – solid, foam, fiber, powder, vacuum and multilayer insulation. Design ofinsulation systems. ; Conductive heat flow devices – fins, heat sinks etc.; Convective heat transfer and flowfriction phenomena co-relations. Heat exchangers –their classification based on flow direction and constructiongeometry. Design of Shell & Tube, Plate fin, Matrix and other types of heat exchangers; use of TEMA codes.Design of heat exchangers for automotive, refrigeration, cryogenic and chemical process plants. Heat exchangers with phase change. ; Regenerative heat exchangers – dual regenerators as continuous heatexchangers, single regenerators in cryogenic devices. ; Radiation coolers, heat transfer in vacuum; cryopumps– their structure and design; cryogenic storage vessels – their structure and insulation system design.

Essential Reading(s):

1. R. K. Shah & D. P. Sekulic, Fundamentals of Heat Exchanger Design, John Wiley, 2003.
2. E. M. Smith Advances in Thermal Design of Heat Exchangers, John Wiley, 2005.

Supplementary Reading:

1. E. Hesselgreaves, Compact Heat Exchangers, Elsevier, 2001.
2. R.F. Barron, Cryogenic Systems, McGraw Hill, 1985.

FLUID AND GAS DYNAMICS

Euler equation, Bernoulli's equation, Navier strokes equations, moment of momentum , energy equations, Differential equations of energy , Potential flow theory, Velocity potential, Kinetic energy of irrotational flow, Two – dimensional sinks and sources, a doublet flow around bodies; cylinders , spheres and aerofoils, prediction of velocity and pressure distribution .

Introduction to compressible flow; velocity of sound and mach number, isentropic flow, flow with friction and heat transfer, analysis of flows with normal shock waves.

Ref. Books:

1. Raudkivi A.J. and Callander R.A ; Adv. Fluid Mechanics (Edward Arnold Publishers)
2. Biswas G and Som S. K. –Advanced Fluid Mechanics THM Publication.
3. Schlitching: Boundary Layer Theory (Mc-Graw Hill Publication)
4. Yahya: Compressible Fluid flow (Mc-Graw Hill Publication)
5. Shapiro: Compressible Fluid flow (Mc-Graw Hill Publication)
6 Zucrow, M.J. & Hoffmann J.D. Gas Dynamics (Jhon Wiley & Sons)
1. Radhakrishnan: Gas Dynamics (PHI)

HEAT EXCHANGER ANALYSIS & DESIGN

Constructional Details: Types, Fluid flow arrangements, parallel, Counter and Cross flow, shell and tube heat exchanger, Regenerators and recuperator. Condensers – Industrial applications. ; Heat Transfer: Modes of Heat Transfer, Overall heat transfer coefficient, Thermal resistance, Efficiency. Temperature Distribution and its implications, LMTD, effectiveness; Flow Distribution: Effect of Turbulence, Friction Factor, Pressure Loss, Orifice, Flow nozzle, Diffusers, Bends, Baffles, Effect of Channel Divergence, Manifolds.; Stress in tubes, Headers sets and Pressure vessels: Differential Thermal Expansion, Thermal stresses, Shear stresses, Thermal sleeves, Vibration, Noise, types of failures. ; Design Aspects: Heat transfer and pressure loss flow configuration effect of baffles. Effect of deviations from ideality. Design of typical liquid-liquid, gas-gas-liquid heat exchangers. Design of cooling towers.

Essential Reading:

1. W.M. Kays and A.L. London., Compact Heat Exchangers', 3rd Ed., TMH,1984.
2. A.P. Frass and M.N.Ozisik, Heat Exchanger Design',John Wiley & Sons Inc, 1965.
3. G.Walker, Industrial Heat Exchangers', A basic guide, TMH V Book Co., 1980.

Supplementary Reading:

1. 'Standards of the Tubular Exchanger Manufacturer Association', 6th Ed., Tubular Exchanger Manufacturers Association, New York, 1978.
2. D. Q. Kern,Process Heat Transfer', McGraw Hill Book Co., 1984.
3. E.A.D. Saunders., Heat Exchangers', Longman Scientific and Technical, New Delhi

Renewable Energy Systems

Module I

Energy scenario and renewable energy sources: global and Indian situation. Potential of non-conventional energy sources, economics. Solar Radiation: Solar thermal process, heat transfer devices, solar radiation measurement, estimation of average solar radiation. Solar energy storage: stratified storage, well mixed storage, comparison.

Module II

Hot water system,practical consideration, solar ponds, Non-convective solar pond, extraction of thermal energy and application of solar ponds. Wind energy: The nature of wind. Wind energy resources and modeling. Geothermal energy: Origin and types of geothermal energy and utilization.

Module III

OTEC: Ocean temperature differences. OTEC systems. Recent OTEC developments. Wave energy: Fundamentals. Availability Wave-energy conversion systems. Tidal energy: Fundamentals. Availability Tidal-energy conversion systems; Energy from biomass: Photosynthesis; Biomass resource; Utilization of biomass.

Books

S.P.Sukhatme, Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 1990.

G.L. Johnson, Wind energy systems, Prentice Hall Inc. New Jersey.

J.M.Kriender, Principles of Solar Engineering', McGraw Hill, 1987.

Reference

V.S. Mangal,Solar Engineering', Tata McGraw Hill, 1992.

N.K.Bansal, Renewable Energy Source and Conversion Technology', Tata McGraw Hill, 1989.

P.J. Lunde,Solar Thermal Engineering', John Willey & Sons, New York, 1988.

J. A. Duffie and W.A. Beckman, Solar Engineering of Thermal Processes', Wiley & Sons, 1990.

Hydel Power and Wind Energy

Module I:

Elements of hydropower scheme, hydropower development in India. Power house structures and Layout. Hydropower plants classification: Surface and underground power stations, Low-medium-high head plants-layout and components, pumped storage plants. Load and power studies: load curve, load factor, load duration curve, firm capacity, reservoir capacity, capacity factor

Module II:

Hydraulic turbines and types and classification, constructional features, selection, characteristic curves, governing of turbine, drafts tubes-types, hydraulic principles. Gates and valves types. Penstock and surge tanks.

Wind machine types, classification, parameters. Wind measurements, data presentation, power in the wind. Wind turbine aerodynamics, momentum theories, basic aerodynamics, airfoils and their characteristics

Module III:

Horizontal Axis Wind Turbine (HAWT) - Blade Element Theory, wake analysis, Vertical Axis Wind Turbine (VAWT) aerodynamics.

HAWT rotor design considerations, number of blades, blade profile, 2/3 blades and teetering, coning, power regulation, yaw system, tower.

Wind turbine loads, aerodynamic loads in steady operation, wind turbulence, static - dynamic - fatigue analysis, yawed operation and tower shadow, WECS control system, requirements and strategies.

Wind Energy Conversion System (WECS) sitting, rotor selection, Annual Energy Output (AEO).

Synchronous and asynchronous generators and loads, integration of wind energy converters to electrical networks, inverters. Testing of WECS.

Text Books

1. Water Power Engineering: M.M. Desmukh, Dhanpat Rai and Sons
2. Wind Energy Conversion Systems, Freris L.L., Prentice Hall 1990.

Reference Books

1. Water power Development: Mosonyi
2. Hydroelectric hand book: Creagar, W.P. and Justin, J.D., John Wiley & Sons, New York.
3. Davis' Handbook of applied hydraulics: Zipparro, V. J. and Hasen H., Mc-GrawHill, Inc
4. Hydropower structures : R.S.Varshiray, Nem Chand and Bros. Roorkee
5. Water Power Engineering: M.M.Dandekar and K.N.Sharma, Vikas Publication.
6. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.
7. Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985.

Advanced Fluid Mechanics

Description of fluid flow: with reference to translation, rotation and deformation concept of continuum, controlmass & control volume approach, Reynolds transport theorem. Steady flow and uniform flow.Velocity field, one & two-dimensional flow analysis, circulation and vorticity, stream function and velocitypotential function, potential flow, standard flow patterns, combination of flow patterns, flow net.Dimensional Analysis as a tool in design of experiments, identification of non-dimensionalnumbers and their significance, dimensional analysis methods.

Equations of motion for laminar flow of a Newtonian fluid - Viscous flow – Navier-Stoke's equations, simple exact solutions.Boundary Layer Theory-Formation, growth and separation of boundary layer-Integralmomentum principles to compute drag and lift forces-Mathematical models for boundarylayer flows.Turbulence, Origin of turbulence universal velocity distribution laws of turbulence, smooth rough andtransitional turbulent flow in pipes, pipe resistance equation for pipes design of pipe networks.Diffusion and dispersion of pollutants in natural streams.

References:

1. Som S. K and Biswas G "Introduction to Fluid Mechanics and Fluid Machines", TMH
2. Schlichting: "Boundary Layer theory", International Text – Butterworth
3. Fox R.W., Pitchard P.J, and McDonald A "Fluid Mechanics" Wiley India.
4. Rouse H. "Advanced Fluid Mechanics", John Wiley & Sons, N York
5. White F.M. "Viscous Fluid Flow", McGraw Hill Pub. Co, N York
6. Yalin, M.S. "Theory of Hydraulic Models", McMillan Co.
7. Mohanty A.K. "Fluid Mechanics", Prentice Hall of India, N Delhi.

BRANCH - MECHANICAL ENGINEERING

***SPECIALIZATION:** MACHINE DESIGN / MECHANICAL SYSTEMS DESIGN / SYSTEM DESIGN*

Second Semester							
	Theory				Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Mechanics of Composite Materials	4 - 0	4	100	50	-	-	-
Specialization Core-2 Fatigue, Creep & Fracture	4 - 0	4	100	50	-	-	-
Elective –I (Specialization Related) 1. Finite Element Method 2. Bearing and Lubrication 3. Basic Mechanical Handling systems 4. Analysis and synthesis of Mechanism.	4 - 0	4	100	50	-	-	-
Elective-II (Departmental Related) 1. Optimum Design of Mechanical Systems 2. Robotics 3. Material Selection in Mechanical Design. 4. Experimental Stress Analysis	4 - 0	4	100	50	-	-	-
Elective-III(From any department) 1. Machine Vibration 2. Numerical Methods for Engineers 3. Machine Learning 4. Computer Aided Design.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks:1050							
Total Credits: 28							

MECHANICS OF COMPOSITE MATERIALS

Classification and characterization of composite materials; fibrous, laminated and particulate composites; laminae and laminates; manufacture of laminated fiber reinforced composite material. Macromechanical behaviour of lamina; stress strain relations, engineering constraints for orthotropic materials. Stress strain relations for lamina of arbitrary orientation. Strength and stiffness of an orthotropic lamina; Biaxial strength theories. Micromechanical behavior of laminae. Rule of mixtures. Micromechanical behaviour of laminates: single layered configurations, symmetric laminates, anti-symmetric laminates, known symmetric laminates; strength of laminates; Interlaminar stresses; Design of laminates. Buckling and vibration of laminated beams, plates and shells.

Text Books:

Mechanics of Composite Materials – R. M. Jones. Taylor & Francis.

Reference Books:

1. Mechanics of Laminated Composite Plates and Shells – J. N. Reddy. CRC Press.
2. Stress Analysis of Fiber- Reinforced Composite Materials – M. W. Hyer. WCB Mc-GrawHill.

FATIGUE, CREEP AND FRACTURE

Fatigue: Types of fatigue loading and failure, Fatigue test, endurance limit; Fatigue under combine stresses; Influence of stress concentration on fatigue strength, Notch sensitivity, Factors influencing fatigue behavior.

Creep: Creep-stress-time temperature relations, Mechanics of creep in tension, bending, torsion, creep buckling. Members subjected to creep and combined stresses.

Fracture: Basic modes of fracture, Griffith of brittle fracture, Irwin's theory of fracture in elastic-plastic materials. Theories of linear elastic fracture mechanics, stress intensity factors, fracture toughness testing.

Text Books

1. Strength and Resistance of Metals - J. M. Lessels, John Wiley and Sons, Inc., 1954.
2. Mechanical Behaviour of Engineering Materials - Joseph Marin, PHI, 1966.
3. Fatigue Testing and Analysis - Y. Lee, J.Pam, R.B. Hathaway & M.E. Barkey Elsevier Press, 2005.
4. Engineering Fracture Mechanics - S. A. Meguid, Elsevier Press, 1989.

Reference Books

1. Mechanical Metallurgy - G. E. Dieter, Mc-Graw Hill Book Co., 1961.
2. Mechanical Behaviour of Materials - N. E. Dowling, PHI, 1997.
3. Introduction to Fracture Mechanics - Kare Hellan, Mc-Graw Hill Book Co., 1985.
4. The Practical Use of Fracture Mechanics - David Broek, MN Publishers, 1982.

Finite Element Methods

Basic Concepts: Introduction, Weak formulations, Weighted residual methods, Variational approaches, Element types. One-Dimensional Analysis: Basis steps, discretization, element equations, linear and quadratic shape functions, assembly, local and global stiffness matrix and its properties, boundary conditions, applications to solid mechanics, heat and fluid mechanics problems, axisymmetric problems. Plane Truss: Local and global coordinate systems, stress calculations, example problems. Beams: Introduction, Euler-Bernoulli beam element, numerical problems. Scalar Field Problems in 2-D: Triangular and rectangular elements, constant strain triangle, isoparametric formulation, higher order elements, six node triangle, nine node quadrilateral, master elements, numerical integration, computer implementation, Numerical problems. Plane Elasticity: Review of equations of elasticity, stress-strain and strain-displacement relations, plane stress and plane strain problems

Suggested books:

1. The Finite Element Method for Engineers- Huebner K.H., Dewhirst, D. L., Smith, D. E., and Byrom, T. G., 4th Ed., John Wiley and Sons 2001

2.The Finite Element Method in Engineering- S. S. Rao, 4th Ed., Elsevier Science 2005

3. An Introduction to Finite Element Methods - J.N.Reddy, 3rd Ed., Tata McGraw-Hill 2005

4. A First Course in Finite Elements – J.Fish and T. Belytschko, 1st Ed., John Wiley and Sons

BEARING & LUBRICATION

Introduction, Surfaces: Nature, Characterization and effects, Friction : Mechanisms and Types, Wear: Nature, Mechanism and types, Surface Temperature Formulation and Measurements, Friction and wear of metals, polymers and composites, Methods of improving tribological behavior.

Lubricants: Friction control and wear prevention, Characterization, types and selection, effects and testing of lubricants. Mechanisms of fluid flow : Reynolds equations and its applications to infinite long and short journal bearings and its limitations

Lubrications: Reigms; Hydrodynamics, Hydrostatics, Elastohydrodynamic lubrication, etc. Bearing Design and design considerations

Text Books

1. Introduction to Tribology of Bearings - B.C.Majumdar, Wheeler Publication, 1999.

Reference Books

1.Friction & Wear of Materials-E. Rabinowicz,John Wiley & Sons Inc.ISBN 0-471-83084-4,1995.

2. Tribology: Friction, Lubrication and Wear - Z. Andras Szeri, ISBN 0070626634, 1980

3. Principles and Applications of tribology - Bharat Bhusan, Hardcover, 1999.

4. Engineering Tribology(Tribology Series,24)-G.W. Stachowiak, A.W.Batchelor, ISBN 0444892354, 1993

5. Engineering Tribology - Prasant Sahoo, PHI Pvt. Ltd.

6. Fundamentals of Tribology - S.K.Basu, S.N.Sengupta, B.B.Ahuja, PHI Pvt. Ltd.

7. Tribology in Industries – S. K. Srivastava. S. Chand and Company Ltd., New Delhi.

BASIC MECHANICAL HANDLING SYSTEMS

Objectives and Principles of Material Handling. Classification of handling equipment. Quantitative techniques for analysis of material flow.

Design of basic elements like-wire ropes, chain hooks, shackles, grab, lifting electro-magnets, pulleys, sheaves, sprokets, drums, arresting gears, buffers, limit switches, rope tackle and pulley blocks, various power transmission units like gearing, belting, winches, capstans etc.

Kinematics analysis and basic design procedure of various forms of conveying and elevating equipments like scrapes, conveyors, Belt conveyor, Belt Chain, Bucket elevators, Enmasses chain conveyor, Overhead chain conveyors, crew and Ribbon conveyors, electric hoists, jibcranes, EOT cranes, Gantry cranes, Mobile Cranes etc.

Text Books

1. Material Handling Equipments - N. Rudenko. Envee Publishers, ND, 1978.
2. Conveying Machines (Vol I & II) - A.O.Spivakovsky, & V.K. Dyachkav. MIR Publication
3. Mechanical Engg Design - J.E.Shiegley. Mc-Graw Hill Book Co., 1986.
4. Design of Machine Elements - M.F. Spotts and T.E. Shoup. PHI, 1998.

Reference Books

1. Design of Machine Elements - V. Dobrovolsky, et al., MIR Publishers, 1977.
2. Machine Design - D.N. Reshetov. MIR Publishers, 1978.

ANALYSIS AND SYNTHESIS OF MECHANISMS

Basic concepts of kinematics and mechanisms-type, number and dimensions, kinematic pairs, chains andinversions, accuracy point and error analysis, velocity and acceleration analysis of different complex mechanism(I, II & III), gross motion in the 4-bar mechanisms, static and dynamic force analysis of mechanisms; Synthesisof coordinated positions, synthesis of mechanism to trace a curve or path generation, synthesis for functiongeneration; Dimensional synthesis, method of approach and optimization of a solution; Equivalent andconjugate linkages, four bar chains, copular curves, Robert's Law chebycheve's polynomials, path curvatureEuler -Savary equation, Polode curvature. ; Planer and spatial problems, graphical and analytical methods,finite displacements, analytical design of 4-bar mechanisms for coordinated motion. ; Cams: synthesis ofcam profiles, advanced cam curves, dynamic analysis, accuracy analysis and design of cams; Gears andgyroscopes: Elements of different secondary space curves, conjugate action, general mechanism, noncircularsensors, dynamics of gears, Gyrodynamics, gyroscopic actions in machines.

Essential Reading:

1. A. Ghosh & A.K. Mallik, Theory of Mechanism And Machines, Affiliated East-West Press: 1998

OPTIMUM DESIGN OF MECHANICAL SYSTEMS

Basic concepts: Unconstrained and constrained problems. The Kuln-Tucker conditions; Function of one variable, Polynomial approximation, Golden section method. Finding the bounds on the solution, a general strategy for minimizing functions of one variable; Unconstrained functions of n variables: Zero order, first-order and second-order methods, convergence criteria; constrained functions of n variables: linear programming, Sequential unconstrained minimization techniques, Direct Methods; Approximation techniques; Duality; General design application.

Text Books

1. Optimization for Engineering Design - K. Deb, PHI, 2005
2. Engineering Optimization - S.S.Rao, New Age International Pvt. Ltd. 1998.

Reference Books

Introduction to Optimization - J.C. Panth, Jain Brothers Publication, New Delhi, 1983

ROBOTICS

Robotics: Historical back ground, Definitions. Laws of Robotics, Robotics systematic robot anatomy; Common Robot configurations, coordinate system, work envelop. Elements of robotic system and effector, actuators, controller, teach pendant, sensors Specification of robots. Applications, Safety measures. ; Robot Kinematics: Forward and reverse Kinematics of 3 DOF Robot arms. Homogeneous transformations. Kinematics equation using homogeneous transformations; Actuators: Hydraulic actuators. Pneumatic actuator, Electrical actuators, Directional control, Servo; Control Flow control valves. ; End effectors: Classification, Drive systems. Magnetic, Mechanical, Vacuum and Adhesive Grippers, force analysis in Grippers. ; Sensors: Need for sensing systems, Sensory devices, Types of sensors, Robot vision system Robot Languages and Programming: Types of Programming, Motions Programming, Robot Languages - VAL systems. ; Flexible automation: Technology, FMS, Function of Robot in FMS flexible manufacturing cell.

Essential Reading:

1. S.R. Deb, *Robotic technology and flexible automation* - TMH.

Supplementary Reading:

1. Lee, Fu, Gonzalez, *Robotics* - Mc Graw Hill.
2. Groover, *Industrial Robot* - Mc Graw Hill.
3. Paul Afonh, *Robots manufacturing and application* - John Wiley.

MATERIALS SELECTION IN MECHANICAL DESIGN

Module I (12 hours)

Introduction: Materials properties – chemical, physical, mechanical, dimensional; Materials categories; Design process, conceptual design, embodiment design, detail design; Ideology of optimization, materials selection charts.

Performance indices: Performance, objective function, constraints, performance index; Calculational Model, Measure of Performance, Equations for constrained variables; Design-fixed parameters, free parameters.

Optimization of selection without considering shape effects: Recipe for optimization, Applying performance indices to selection charts; Primary constraints; Reality Check; Case studies – mirrors for large telescopes, table legs, structural materials for buildings, flywheels, springs, elastic hinges and couplings, pressure vessels, Vibration effects, stiff and high damping materials; Thermal effects, insulations, solar heating, heat exchangers.

Module II (14 hours)

Manufacturing and process selection: Classification of manufacturing processes, review of shaping, joining and finishing processes, Strategy for processes selecting, translation, screening, ranking; Selection charts, process-material matrix, process-shape matrix, mass bar-chart, thickness bar-chart, tolerance and surface-roughness bar-charts; Manufacturing cost; Case studies: forming a fan, fabricating a pressure vessel, economical casting.

Multiple Constraints in Materials Selection – Overconstrained Design: Decision matrices, selection stages, coupling equations, value functions; Multiple Selection Stage Method, Active Constraint Method, Coupling Equation Method; CES Software; Fully determined design; Massively overconstrained designs; Conflicting objectives, penalty functions and exchange constants; Case studies – shipbuilding, con-rods for high-performance engines, windings for high-field magnets, casing for mini-disk player or cell phone, disk-brake caliper.

Module II (10 hours)

Optimization of selection considering shape effects: Shape factors, Microscopic or micro-structural shape factors; Limits to shape efficiency, stiffness-limited design, strength-limited design, material indices that include shape, elastic bending of beams and twisting of shafts, failure of beams and shafts, co-selection of material and shape; Case studies – choosing

optimal I-beam, spars for man-powered planes, ultra-efficient springs, forks for a racing bicycle.

Designing hybrid materials: Families of configurations of hybrid materials - composites, sandwiches, lattices and segmented; method "A+B+configuration+scale"; Anisotropy; Case studies – metal matrix composites, refrigerator walls, natural materials.

Text book

1. M. F. Ashby, MATERIALS SELECTION IN MECHANICAL DESIGN, Third Edition

Reference books

1. J. E. Gordon, *The New Science of Strong Materials, or Why You Don't Fall Through the Floor*, Princeton University Press, Princeton, NJ.
2. J.E. Gordon, *Structures, or Why Things Don't Fall Down,* Da Capo Press.
3. M. F. Ashby and D. R. H Jones, *Engineering Materials Parts 1, 2, and 3*, Pergamon Press, Oxford, UK.
4. F. A. A. Crane and J. A. Charles, *Selection &Use of Engineering Materials*, Butterworths, London, UK.

EXPERIMENTAL STRESS ANALYSIS

Basic elasticity theory. Strain Measurement Methods: Various types of strain gauges, Electric Resistance strain gauges, semiconductor strain gauges, strain gauge circuits, transducer applications, recording instruments for static and dynamic applications.

Photoelasticity: Theory of photoelasticity, Analysis techniques, Three dimensional photoelasticity, Reflection Palanscope and application.

Brittle coating methods of strain indication. Grid method of strain analysis. Computer interfacing and on-line monitoring of strain and stress fields.

Text Books:

1. Experimental Stress Analysis – J. W. Dally and W. F. Riley. Mc GrawHill, 1965.

Reference Books:

1. Experimental Stress Analysis and Motion Measurement – R. C. Dove and P. H. Adams. PHI, 1965.

2. Applied Stress Analysis – A. J. Durelli. PHI, 1970.

MACHINE VIBRATION

Characterization of Engineering vibration problems. Model study through single degree of freedom analysis. Two degrees and Multi degree of freedom system with application. Continuous medium, Vibration measuring instruments, computational techniques like matrix iterations, Transfer Matrix method and other methods, Lagrange's Mechanics, system simulation technique.

Text Books

1. Mechanical Vibration: Theory and Applications - F.S. Tse, I.E. Morse and R.T. Hinkle. CBS Publishers, 2002.

2. Theory of Vibration with Application - W.T. Thomson, PHI, 1979.

Reference Books

1. Principles of Vibration Control - A. K. Mallick, East-West Press, 1990.

2. Mechanical Vibrations - S. S. Rao. Pearson, 2004.

3. Advanced Theory of Vibration - J. S. Rao. New Age Publication.

4. Introductory course on Theory and Practice of Mechanical Vibration - J. S. Rao and K. Gupta. NewAge Publication, 2004.

NUMERICAL ANALYSIS

Transcendental and Polynomial equations: Initial approximations, First Degree Equation, Iteration Methods Based on Second Degree equation, Multipoint iteration method, Rate of Convergence, Efficiency of a method.

System of Linear Algebraic Equations: Effects of Round-off Error, Operations Counts, Standard Methods of Solutions, Convergence analysis Eigen values and Eigenvectors Interpolation: Lagrange Polynomial Interpolation, Cubic Spline Interpolation,

Numerical Differentiation - Finite Differences: Construction of Difference Formulae. Accuracy of Finite Differences, Pade Approximations, Non-Uniform Grids.

Numerical Integration: Trapezoidal and Simpson's Rules, Error Analysis, Integration and Extrapolation, Quadrature.

Numerical Solution Of Ordinary Differential Equations: Initial Value Problems, Numerical Stability, Stability Analysis, Implicit, Runge-Kutta Methods, Multi-Step Methods, System Of First-Order Ordinary Differential Equations, Boundary Value Problems.

Numerical Solution of Partial Differential Equations: Semi-Discretization, von Neumann Stability Analysis, Modified Wave number Analysis, Implicit Time Advancement, Accuracy, Implicit Methods in Higher Dimensions, Approximate Factorization, Stability of the Factored Scheme, Alternating Direction Implicit Methods, Mixed and Fractional Step Methods, Elliptic Partial Differential Equations

Discrete Transform Methods: Discrete Fourier series, Applications, Finite Differenced Elliptic Equations, Fourier Spectral Numerical Differentiation, Discrete Transform and Applications, Numerical Differentiation.

Text Books:

1. Numerical Methods for scientific & Engg Computation- M. K. Jain, S. R. K. Iyengar & Jain.
2. Numerical Methods for Engineers – S. C. Chapra and R. P. Canale. Mc GrawHill.

Reference Books

1. Numerical Methods – S. S. Rao.
2. Numerical Methods in Science & Engg: A Practical Approach – S. Rajashekharan. Wheeler Pub.
3. Numerical Recepies – W. H. Press, S. A. Teukolosky, W. T. Vetterling and B. P. Flannery Cambridge University Press.

MACHINE LEARNING

Module: 1

Introduction, Linear classification, perceptron Update rule, perceptron convergence, generalization, Maximum margin classification, Classification errors, regularization, Logistic regression, linear regression.

Module: 2

Estimator bias and variance, active learning, on linear prediction, kernel, kernel regression, and Support vector machines (SVM) and kernels, kernel optimization and model selection, Model selection criteria.

Module: 3

Description length ,Feature selection, Combining classifiers, boosting margin and complexity, Margin and generalization, mixture models ,Mixture and expectation maximization,(EM) algorithm, Regularization.

Module: 4

Clustering and Spectral Clustering,Markov models, Hidden Markov Models(HMM),Bayesian Networks, Learning Bayesian Networks, Probabilistic inference, Collaborative filtering.

Text book(s):

1. Machine Learning, Mitchell, Tom, McGraw-Hill, ISBN: 97800704280, 3rd Edition.

Reference Book(s):

1. Neural Networks for pattern Recognition, Christopher, Bishop, Oxford University, Press, 1995, ISBN: 9780198538646.
2. Pattern Classification, Richard,Duda,Peter Hart and David Stork, Wiley Interscience,2000,ISBN:9780471056690
3. The Elements of Statistical Learning: Data Mining, Inference and prediction, Hastie.T.R.Tibshirani and J.H.Friedman, NY.Springer, ISBN: 9780387952840, 2005.
4. Information Theory, Interference and learning algorithms. MacKay, David, Cambridge University Press, ISBN: 9780521642989, 2003.

Computer Aided Design

Introduction: The design process, elements of CAD; Principles of Software Design: Characteristics of good software, data structures, algorithm design, flow chart, coding, top-down programming, modular programming, structural coding, testing of the software. Computer Graphics: Graphics display, transformations, visualizations, computer animation.3D Modeling and Viewing: Coordinate systems, sketching and sketch planes; Modeling aids and tools; Layers, grids, clipping, arrays, editing. Curves Modeling: Analytical and synthetic curves, curve manipulations. Surface Modeling: Surface representation and surface analysis, analytical and synthetic surfaces, surface manipulations, NURBS.SOLID MODELING: Geometry and topology, solid entities, solid representation, fundamental of solid modeling, half spaces, boundary representation, constructive solid geometry, sweeps, solid manipulations. Features: Feature entities, feature representation, three dimensional sketching, parametrics, relations, constraints, feature manipulation. Mass properties: Geometric and mass properties evaluation, assembly modeling, product data exchange.

Suggested books:

1. Zeid I., "Mastering CAD/CAM", Tata McGraw Hill. 2007
2. OnwubikoC., "Foundation of Computer Aided Design", West Publishing Company. 1989
3. Hsu T. R. and Sinha D. K., "Computer Aided Design: An Integrated Approach", West Publishing Company. 1991
4. Dimarogonas, A. D., "Computer Aided Machine Design", Prentice Hall. 1988
5. Mortenson, M. E., "Geometric Modeling", 3rd Ed., Industrial Press. 2006

BRANCH - MECHANICAL ENGINEERING

***SPECIALIZATION:** MECHANICAL SYSTEM DESIGN & DYNAMICS / DESIGN & DYNAMICS*

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Vibration of structures	4 – 0	4	100	50	-	-	150
Specialization Core-2 Dynamics of Rotors.	4 – 0	4	100	50	-	-	150
Elective –I (Specialization Related) 1. Acoustics 2. Machine Fault Diagnosis and Signal Processing 3. Mechatronics 4. Analysis and Design of Smart Materials and Structure	4 – 0	4	100	50	-	-	150
Elective-II (Departmental Related) 1. Non Linear Vibration 2. Bearing and Lubrication 3. Vibration and Shock Isolation 4. Experimental Stress Analysis	4 – 0	4	100	5 0	-	-	150
Elective-III (From any department) 1. Robotics and Automation 2. Random vibrations & Failure Analysis 3. Finite Element Method in Engineering 4. Computer Graphics and Visualization	4 – 0	4	100	50	-	-	150
Lab-2 (to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

Vibration of Structures

Force-Deflection properties of structure (Generalized Co-ordinates, virtual, influence coefficients, strain energy, stiffness method and Flexibility method) Principle of dynamics:- D'Alembert's principle, Hamilton's principle and Lagrange's Equations Natural modes of vibration:- Solution of the Eigenvalues problems and matrix Iteration, Energy Methods:- Rayleigh's method, The Rayleigh- Ritz method Effect of Rotatory international shear on Beam vibrations. Vibration of rotating beams Torsional and Bending Vibrations of beams: The Holzer method, The MyklestadThomson method Transfer matrix techniques, Finite elements techniques, Damping: Nature of Damping, Lagrange's equations with damping and for structural damping, viscous damping, Concept of critical viscous damping frequency response analysis for SDFS and MDFS with damping.

Text Books:

1. Walter C. Hurty & Moshe F. Rubinstein, "dynamic of structures", PHI,

2. Ray W. Clough And JosephPencine, "Dynamic of structures", International Student Edition.

Reference Books:

1. Tees, Mores and Hincle, Mechanical vibrations and it's applications, Students Edition.

2. A. H. Nayfeh and P. F. Pai, liner and Non-liner Structural Mechanics, WileyInterscience, 2004

DYNAMICS OF ROTORS

Rudiments of Rotor Dynamics, Rotor Dynamic considerations in machinery design, critical speeds and unbalance response. Factors affecting them such as gyroscopic action, internal damping, fluid film bearings. Methods for analysis such as Transfer Matrix, FEM etc. Vibration of Discs, disc gyroscopics, synchronous and non synchronous whirl, analysis of rotors mounted on hydrodynamic bearings, application to two spool and multispool rotors. Analysis of asymmetric shafts.Parametric excitation and instability due to fluid film forces and hysteresis. Effect of support nonlinearities. Rigid rotor balancing. Torsional vibration. Balancing of rotors. Concepts of condition monitoring.

Text Books:

1. Rotor Dynamics – J. S. Rao. New Age International Publications, 3rd Edition.

Reference Books:

1. Dynamics of Rotor Bearings Systems – M. J. Goodwin. Unwin Hyman

2. A Matrix Method in Elastomechanics – E. C. Petal and F. A. Leckie. Mc-Graw Hill.

3. Rotor Dynamics – E. K. Kramer. Springer Verlag.

4. Rotor Dynamics – H. D. Nelson and E. J. Guntur. Mc-Graw Hill Book Co.

5. Rotor Dynamics – J. S. Vance. Mc-Graw Hill Book Co.

6. Some Problems of Rotordynamics – A. Tondol. House of Czechoslovakia Academy of Science, Prague.

ACOUSTICS

Fundamentals of vibration, vibrations of continuous systems (strings, rods, beams and membranes), one dimensional wave equation, initial values and boundary conditions, acoustic wave equation, concept of impedance, sound radiation from simple sources, near field and far field, directivity of sources, sound waves in pipes standing waves and travelling waves, resonances, wave guides, lumped parameter modeling of acoustic systems, transmission of sound through partitions, dynamics of microphones and speakers, room acoustics, sound in enclosures (cylinders).

Recommended Books:

1. Fundamentals of Acoustics - Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens, James V. Sanders, Wiley, 1999.
2. Fundamentals of Physical Acoustics - David T. Blackstock, Wiley; 4th edition (December 30, 1999)
3. Sound and Structural Vibration - Frank J. Fahy, Elsevier India Pvt. Ltd, New Delhi, 2010.
4. Sound And Structural Vibration: Radiation, Transmission And Response - Frank J. Fahy, Paolo Gardonio, Academic Press, 2007.
5. Handbook of Acoustics - Malcolm J. Crocker, Wiley-Interscience, 1998.

MACHINE FAULT DIAGNOSTICS AND SIGNAL PROCESSING

Introduction. Maintenance Principles. Basics of Machine Vibration. Signal Analysis. Computer based data acquisition. Time domain Signal analysis. Introduction to MATLAB. Signal Processing Exercises with MATLAB. Fault detection transducers and instrumentation. Vibration monitoring. In- Situ field balancing of rotors. Condition monitoring of rotating machines. Noise monitoring. Wear and debris analysis.Thermography. Electrical Motor Current Signature Analysis. Ultrasonics in Condition Monitoring.NDT Techniques in Condition monitoring.

Text Books:

1. Introduction to Machinery Analysis and Monitoring – J. S. Mitchell. Pennwell Publishers.

Reference Books

1. Engineering Vibration – D. Inman. Tata Mc-GrawHill.
2. Vibration Monitoring and Diagnosis – Ralph A. Collocott. Chapman and Hall

MECHATRONICS

Fundamental of Mechatronics: Definition and concepts of Mechatronics, Conventional system vs. mechatronic system, Need and Role of Mechatronics in Design, Manufacturing and Factory Automation. Hardware components for Mechatronics Number system in Mechatronics, Binary Logic, Karnaugh Map Minimization, Transducer signal conditioning and Devices for Data conversion programmable controllers. ; Sensors and Transducers: An introduction to sensors and Transducers, use of sensor and transducer for specific purpose in mechatronic. ; Signals, systems and Actuating Devices: Introduction to signals, systems and control system, representation, linearization of nonlinear systems, time Delays, measures of system performance, types of actuating devices selection. ; Real time interfacing: Introduction, Element of a Data Acquisition and control system, overview of the I/O process. Installation of the I/O card and software. ; Application of software in Mechatronics: Advance application in Mechatronics. Sensors for conditioning Monitoring, Mechatronic Control in Automated Manufacturing, Micro sensors in Mechatronics. Case studies and examples in Data Acquisition and control. Automated manufacturing etc.

Text Books:

1. C.W. De Silva, Mechatronics: An Integrated Approach, Publisher: CRC;

Analysis & Design of Smart Materials and Structures

Introduction to smart materials and their applications; coupled field systems; hysteresis typical of smart structures and systems; limit analysis; analysis of standard forms of the smart components such as cables, wires, axial members, beams, frames, etc; analysis of smart structural systems such as VGTS, material selection and design of structural members.

REFERENCES

1. Engineering analysis of smart material systems , Donald J. Leo, John Wiley Sons.
2. Smart material systems: model development, R.C. Smith, SIAM.

FINITE ELEMENT METHODS IN ENGINEERING

Basic Concepts: The standard discrete system, Finite Elements of an elastic continuumdisplacement approach, Generalization of the finite element concepts-weighted residual and variational approaches, Element types: triangular, quadrilateral, sector, curved, isoparametric elements and numerical integration. Automatic mesh generation schemes. Application to structural mechanics problems: plane stress and plane strains, Axisymmetric stress analysis, three dimensional stress analysis, bending of plates. Introduction to the use of FEM in steady state field problems – heat conduction, fluid flow and nonlinear material problems, plasticity, creep etc. Computer procedures for Finite element analysis.

Text Books:

1. Finite Element Method: Its Basis and Fundamentals. O. C. Zienkiewicz, R. L. Taylor and J. Z. Zhu. Elsevier, 2005.

2. Finite Element Methods – J. N. Reddy. Tata Mc-Graw Hill.

3. Introduction to the Finite Element Method–C.S. Desai & J.F.Abel .East West Pvt. Ltd., 1972

BEARING AND LUBRICATION

Introduction-Historical background, Bearing concepts and typical applications. Viscous flow concepts-Conservation of laws and its derivations: continuity, momentum (N-S equations) and energy, Solutions of Navier-Strokes equations. Order of magnitude analysis, General Reynolds equation-2D and 3D (Cartesian and Cylindrical), Various mechanisms of pressure development in an oil film, Performance parameters. ; Boundary Layer Concepts-Laminar and turbulent flow in bearings, mathematical modeling of flow in high-speed bearings. Elastic Deformation of bearing surfaces-Contact of smooth and rough solid surfaces, elasticity equation, Stress distribution and local deformation in mating surfaces due to loadings, methods to avoid singularity effects, Estimation of elastic deformation by numerical methods-Finite Difference ; Method (FDM), Governing equation for evaluation of film thickness in Elasto Hydrodynamic Lubrication (EHL) and its solution, Boundary conditions. Development of computer. ; Programs for mathematical modeling of flow in bearings, Numerical simulation of elastic deformation in bearing surfaces by FDM.

Text Books:

1. B.C.Majumdar, Introduction to Tribology of Bearings.
2. Dr S.P.Srivastava, Lubricants Additives & Tribology, 2008, Tech book international,New Delhi

VIBRATION AND SHOCK ISOLATION

Vibration under general forcing conditions: Response under general periodic force, Periodic force of irregular from and non-periodic force response spectrum (for Base excitation, Earth quake response spectra and design under a shock environment) response to irregular forcing conditions using numerical methods, Vibration Control: Vibration monograph, and vibration criteria, reduction of vibration at the source, Balancing of rotating machines, whirling of rotating shaft, Balancing of reciprocating engines, controls of vibration and natural frequencies. Vibration Isolation: Vibration isolation systems with rigid foundation, isolation of science of vibration from surroundings, vibration isolation system with flexible foundation and with partially flexible foundation, shock isolation, active vibration control, vibration absorbers both damped and undamped.

Text Books:-

1. Mechanical Vibrations-S. S. Rao. Pearson
2. Theory of Vibrations with applications W. T. Thomason, CBS Publication
3. 3. Mechanical Vibration- J. S. Rau and K. N. Gupta, New-Age intimation

Computer Graphics & Visualization

Raster graphics and volume graphics. Video basics. Display devices and interactive devices; 2-D and 3-D graphics primitives. Clipping in 2-D and 3-D; Generation and projection of 3-D wire frame solid models, polygonal models. Space curves and surface models. Intersection of surfaces and blending; hidden line and hidden surface elimination algorithms. Ray-surface intersection and inverse mapping algorithms. Ray tracing for photo realistic rendering. Illumination models. Shading, Transparency, Shadowing and Texture mapping; Representation of colours. Visualization of experimental and simulated data. Surface construction from scattered data, 3-D data arrays and 2-D cross sections. Elevation maps, topological maps, contour maps and intensity maps; fractals for visualization of complex and large data sets. Algebraic stochastic and Geometrical fractals. Modeling of natural forms and textures using fractals; Visualization of multi variate relations . Flow visualization and hyper streamlines; visualization of Metrological, cosmological, seismic, biological data for scientific decision making. Animation, Modeling issues in dynamic visualization. Behavioral animation; walk through coordinate transformation and view transformation; virtual reality interfaces. Interactive and immersive systems for prototyping and visualization; Visualization in concurrent engineering. Interactive multimedia technology and standards for VideoGraphics-Audio integration and tele-video conferencing

Text Books

1. CAD/CAM : Computer-Aided Design and Manufacturing - M. P. Groover and E.W. Zimmer, PHI, 1995

Reference Books

1. AutoCAD 2002 - New Riders, Techmedia

2. Computer Aided Analysis and Design of Machine Elements - V. D. Rao, M. Ananda Rao and Rama Bhat. New Age International

Robotics and Automation

Introduction to robots, Internal and external sensors, actuators: hydraulic, pneumatic and electric actuators,programming of robots.Homogeneous transformations, D-H parameter notation, direct & inverse kinematics of manipulators: examples of kinematics of some common manipulator configurations.Jacobian, dynamics of manipulators: L-E formulation, N-E formulation, trajectory planning. Automation, types of automation, analysis of automated assembly systems, line balancing problems, analysis of automated material handling systems, automated storage and retrieval systems

Recommended Books:

1. Robotics: Fundamental concepts and analysis, A. Ghosal, Oxford university press
2. Industrial Robotics/Groover M P /Pearson Edu.
3. Robotics and Control/Mittal R K &Nagrath I J / TMH.
4. Robotics: Control, sensing, vision and intelligence, Fu, K., Gonzalez, R. and Lee, C. S. G McGraw Hill.
5. Robotic Engineering / Richard D. Klafter,
6. Introduction to Robotics / John J Craig / Pearson Edu. Prentice Hall
7. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd.
8. Automation, Production systems and Computer Integrated Manufacturing – M P Groover, Prentice Hall India.

Random Vibrations & Failure Analysis

Introduction, Fundamentals of probability theory: probability space, random variables, functions of random variables, Stochastic processes and random signals: stationarity, ergodicity, power spectrum, covariance functions, calculus of random processes, Linear single and multi degree of freedom structural systems: input-output relations, time domain and frequency domain analysis, linear and nonlinear systems, the fokker-Planck equation, Computational issues, Level crossing and first passage times, extreme value and peak distributions, Applications: random fatigue, probabilistic crack growth, risk analysis.

REFERENCES

1. A. Papoulis (1997). Probability, random variables and stochastic processes, McGraw-Hill, NY.
2. Y.K. Lin (1967). Probabilistic theory of structural dynamics. McGraw-Hill, New York.
3. N.C. Nigam (1983). Introduction to random vibrations. MIT Press, Massachusetts.
4. L.D. Lutes, S. Sarkani (2004). Random vibrations: analysis of structural and mechanical systems, Elsevier.
5. J. Solnes (1997). Stochastic processes and random vibrations: Theory and practice. John Wiley & Sons, Chichester.

Experimental Stress Analysis

Basic elasticity theory. Strain Measurement Methods: Various types of strain gauges, Electric Resistance strain gauges, semiconductor strain gauges, strain gauge circuits, transducer applications, recording instruments for static and dynamic applications. Photoelasticity: Theory of photoelasticity, Analysis techniques, three dimensional photoelasticity, Reflection Palanscope and application. Brittle coating methods of strain indication. Grid method of strain analysis. Computer interfacing and on-line monitoring of strain and stress fields.

Text Books:

1. Experimental Stress Analysis – J. W. Dally and W. F. Riley. Mc-GrawHill, 1965.

Reference Books:

1. Experimental Stress Analysis and Motion Measurement – R. C. Dove and P. H. Adams. PHI, 1965.

2. Applied Stress Analysis – A. J. Durelli. PHI, 1970.

Nonlinear Vibration

Introduction, Linear vibration, Free vibrations of undamped systems with nonlinear restoring forces, Free oscillations with damping and the geometry of integral curves – a) study of singular points, b) applications using the notion of singularities, Forced oscillations of systems with nonlinear restoring force, self sustained oscillations – a) free oscillations, b) forced oscillations in self-sustained systems, Hill's equation and its application to the study of the stability of nonlinear oscillations.

Text Books:

1. A.H. Nayfeh, Applied nonlinear dynamics: analytical, computational, and experimental methods, Wiley-Interscience, Jan. 1995.

2. Ali H. Nayfeh, Nonlinear interactions: analytical, computational, and experimental methods, Wiley-Interscience, June 2000.

Reference Books:

1. A.H. Nayfeh and P.F. Pai, Linear and nonlinear structural mechanics, WileyInterscience, May 2004.

2. A.H. Nayfeh and D. T. Mook. Non-linear oscillations.

3. A.H. Nayfeh. Perturbation Technique.

BRANCH - MECHANICAL ENGINEERING

SPECIALIZATION: PRODUCTION ENGINEERING/PRODUCTION ENGINEERING & OPERATIONAL MANAGEMENT

Second Semester							
	Theory				Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Non-Traditional Machining	4 - 0	4	100	50	-	-	-
Specialization Core-2 Rapid Prototyping and Tooling	4 - 0	4	100	50	-	-	-
Elective–I (Specialization related) 1. Advanced Decision Modeling and Techniques 2. Metal Forming Technology 3. Computer Aided Design and Computer Integrated Manufacturing 4. Metrology & Non-Destructive Testing	4 - 0	4	100	50	-	-	-
Elective-II (Departmental related) 1. Composite Materials & Application 2. Quality Engineering & Reliability 3. Theory of Plastic Deformation. 4. Production Management.	4 - 0	4	100	50	-	-	-
Elective-III (From any department) 1. Quantitative Techniques in Production Management. 2. Alternative Energy. 3. Machine Fault Diagnosis and Signal Processing. 3. Finite Element Methods in Engineering. 4. Tribology.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

Non-Traditional Machining

Needs for nontraditional machining processes, classification and comparative analysis, Abrasive jet machining: Fundamental principle, application process parameters, MRR models. Water jet machining: Fundamental principle, application process parameters. Chemical machining: Principle of operation, etch ants and mask ants, photochemical process, equipment, applications. Electrochemical machining: Process principle, Analysis of material removal, dynamics of ECM Process, tool design, applications. Ultrasonic machining: Physical principles of USM, Process parameters, Transducers types materials and design, horn design, shaws model of MRP, other applications of Ultrasonic. Electrical discharge machining: Operating principles of EDM, Effects of Dielectric fluids, Electrode materials ,power generators, process parameters and their effects, flashing, wire EDM process, applications. Laser Beam Machining: Lasing process, types of lasers (Gas and solid state), lasing mediums, laser material processing-cutting, drilling, surface treatment, special applications.

Reference Book:

1. Advanced Machining Processes by Hassan Abdel- Gawad E l- Hofy Tata McGraw Hill,
2. V. K. Jain Advanced Machining Processes, Allied Publishers, 2009.
3. Gary F. Benedict, Nontraditional Manufacturing Processes, Taylor & Francis, 1987
4. J. A. Mc Geough, Advanced Methods of Machining, Springer, 1988
5. P K Mishra, Non Conventional Machining, Narosa India publication
6. Hassan El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill Prof Med/Tech, 2005.
7. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill Education, 1980
8. James A. Brown, Modern Manufacturing Processes, Industrial Press, 1991.
9. J. A. Mc Geough, Micromachining of Engineering Materials, Taylor & Francis, 200

Rapid Prototyping and Tooling

Review of solid modeling techniques with comparison advantages and disadvantages, basic principal of RP processes, classification of RP processes various industrial RP systems like stereo lithography, fused deposition modeling, selective Laser Sintering, Laminated object manufacturing, 3D printing, Ballistic particle modeling etc, roll of rapid prototyping and rapid tooling in product development and simultaneous engineering. Process planning for rapid prototyping, STL file generation defects in STL files and repairing algorithm, slicing and various slicing procedures, accuracy issues in rapid prototyping, strength of RP parts, surface roughness problem in rapid prototyping, part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc, rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting. Introduction to reverse engineering, integration of reverse engineering and rapid prototyping.

Text Book:

Rapid Prototyping and Tooling, Karunakaran K.P, Vijay P Bapat, Ravi B, Rapid Prototyping Cell, IIT-Mumbai.

Reference Book

1. Computer Aided Manufacturing, Elanche Zhian C, Sunder Selwyn T. Shanmuga Sundar G, Laxmi Publications

2. Rapid Prototyping: Theory and Practice by Ali K Kamrani, Springer Publication

Advanced Decision Modeling Techniques

Network analysis: The shortest route problem, the minimal spanning tree problem, the maximal flow problem. Dynamic Programming: Deterministic and probabilistic dynamic programming. Game Theory: Simple games, Games with mixed strategies, graphical solution, solving by linear programming. Decision Analysis: Decision making with and without Experimentation, Decision Trees, Utility function. Simulation: formulation implementing a simulation model, Experimental design for simulation. Algorithms for linear programming: The dual simplex method, parametric linear programming. Integer Programming: The branch and bound technique, a branch and bound algorithms for binary linear programming a bound and scan algorithm for mixed integer linear programming, formulation possibilities through mixed integer programming. Nonlinear programming: The Kuhn-Tucher conditions, Quadratic programming, convex programming.

Text Book:

1. Operations Research - Fredrick S. Hillter and Gerald J. Liebumana, 2nd Ed. (Chap. 5, 6, 7, 14, 15,16, 17 and 18)

Metal Forming Technology

Technological advances in metal forming process- forging, rolling, extrusion, wiredrawing and sheet metal forming, design of roll pass and rolling schedules, description of typical cold rolling and hot rolling mill plants computer aided die design for forging, extrusion and wiredrawing, automation in metal forming processes, recent development in forming equipment(high speed presses etc) advances in sheet metal forming, sheet metal die design, formability evaluation, unconventional forming process like hydrostatic extrusion, high energy rate forming process, hydro forming of sheets and tubes, power forming, finite element simulation of forming processes.

Text Books

1. Dieter.G.E., "Mechanical Metallurgy", McGraw-Hill Co. SI Edition. 1995. 2. Nagpal. G.R., "Metal Forming Processes", Khanna Pub., New Delhi, 2000. **Reference Books**

1. Kurt Lange "Handbook of Metal Forming". Society of Manufacturing Engineers. Michigan. USA. 1988
2. Avitzur, "Metal Forming - Processes and Analysis", Tata McGraw-Hill Co. New Delhi, 1977.
3. ASM Metals Handbook. Vol.14, "Forming and Forging", Metals Park, Ohio, USA, 1990.
4. Taylor Altan, Soo I.K. Oh, Harold.L.Gegel. "Metal Forming: Fundamentals and Applications", ASM. MetalsPark. Ohio, USA, 1983

Computer Aided Design & Computer Integrated Manufacturing

.

Introduction to CAD/CAM, representation of curves, surfaces and solids for CAD/CAM applications, computational geometry for manufacturing, product design for manufacture and assembly, computer aided process planning, computer aided assembly planning, computer aided inspection and reverse engineering, manufacturing processes simulation, virtual and distributed manufacturing, computer integrated manufacturing.

Fundamental of Manufacturing and Automation: Production operation and automation strategies, Manufacturing industries, Types of production function in manufacturing, Production concept and mathematical models, Automation strategies. Group Technology: Part families, Part classification and coding, Production flow analysis, Machine cell design, Benefits of Group Technology. Industrial Robotics: Robotic programming, Robotic languages, work cell control Robot cleft design types of robot application, processing operations. Flexible Manufacturing system: What is FMS ?, FMS work station, Material Handling and storage systems, Computer control system, Analysis methods for flexible manufacturing systems, application & benefits. Computer Integrated Manufacturing: What is CAD, CAM & CIMS? CIM Data base Model and Manufacturing data base. Computer aided process planning, Computer integrated Production Planning system. Brief introduction to concurrent Engineering, Rapid Prototypes and Reverse Engineering Programmable Logic controllers: Parts of PLC, Operation and application of PLC, Fundamentals of Net workings. Computer Aided Quality Control: QC and CIM, objectives of CAQC, CMM, Flexible Inspection systems.

Text Books:

1. Automation, Production systems & Computer Integrated Manufacturing - M.P. Groover, PHI.
2. CAD, CAM & CIM - P. Radhakrishna and V. Raju, New Age International

Reference Books:

(1) Principles of CAD/CAM/CAE - Kunwoolee.
(2) Computer aided design and manufacturing –Farid M.L a mirouche.

METROLOGY AND NON DESTRUCTIVE TESTING

MEASURING MACHINES Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope - Use of computers - Machine vision technology - Microprocessors in metrology. 2. STATISTICAL QUALITY CONTROL Data presentation - Statistical measures and tools - Process capability - Confidence and tolerence limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Realibility and life testing. 3. LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations. 4. RADIOGRAPHY Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications. 5. ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

Recommended Books:

1. JAIN R.K. "Engineering Metrology", Khanna Publishers, 1997.
2. Barry Hull and Vernon John, "Non Destructive Testing", MacMillan, 1988.
3. American Society for Metals, "Metals Hand Book ", Vol.II, 1976.
4. Progress in Acoustic Emission, "Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

Composite Materials

Introduction: Classification and characteristics of composite materials, Mechanical behavior of composite, Constituents, Reinforcement materials, Filter – Additive applications and advantages of composites. Processing: Initial form of constituent materials, manufacturing procedures for fiber reinforced plastics, quality control and testing of composites. Mechanical behavior: Stress – Strain relations of anisotropies materials, engineering constants for orthotropic and isotropic materials, plane stress conditions, stress-strain relation for a lamina of arbitrary orientation, strength of an orthotropic lamina. Behavior of Laminated Composites: Classical lamination theory evaluation of laminate stiffness experimental determination of strength of laminates, essential design consideration.

Text Books:

1. Mechanics of composite materials - R.M. Jones, Mc-Graw Hill.
2. Fiber Reinforced Composite – materials manufacturing and design - P. K. Mallick, Marcel Decker, New York.

QUALITY ENGINEERING AND RELIABILITY

Statistics: Statistical Methods: Important statistical distribution and their properties, correlation and regression,multiple regression analysis. Statistical Inference: t-tests, F-tests, Chi-square tests, ANOVA, DOE and RSM,time series analysis. ; Quality Engineering: Taguchi's quadratic loss function, off line and on-line quality control,importance of parameter design. Experimental design principles for product and process design, two-levelexperimental for full factorial and fractional factorial design. S/N ratio, inner and outer arrays, experimentaldesign for control and noise factors ANOVA in Engg. Design, computer software's in experimental design.Components of TQM, PDCA cycle, TQM implementation. Quality costs, Ishikawa diagram, brain storming QCS,QFD, JIT philosophy and techniques. Characteristics features and clauses of ISO 9000 standards, certificationprocedures, quality audit procedure, Implementation procedures; Reliability: System effectiveness missionreliability design adequacy, operational readiness serviceability performance indices, their evaluation, uses and limitations; Reliability models of maintained systems, fundamental definitions, relationship between reliabilityand maintainability single equipment systems parallel stand by K-out-of n-configuration steady state availability.Maintainability predication; Inspection policies bases on profits, downtime and performance degradation,inspection under emergency condition.

Essential Reading:

1. Freund and Miller, Statistics for engineering and scientists by PHI
2. Quality Engineering using Robust design by M/s Phadke, Prentice Hall.

Supplementary Reading:

1. S S. Singh, Total quality control essentials by McGraw Hill Inc.93 Singapore.
2. P. Gopalkrishnan, A.K.Banerjee, Maintenance and spare parts management by PHI, 1991.
3. L.S. Srinath, Reliability Engineering by EWP.

Theory of Plastic Deformation

True stress-strain curve, Bauschinger effect, theory of plasticity, empirical equations to strain, strain curves, three dimensional stress and strain, invariants of stress and strain Yield criteria of metals, Treasca and Von Misces theory, Pandtl Reuss and Levy-Mises stress-strain relations work handling. Plastic instability application to rods in tension, thin walled pipes spherical shells subjected to internal pressure circular natural diaphragm. Equilibrium approach, concepts of friction in metal forming column friction and constants shear friction factor. Application of stress equilibrium approach to extrusion, drawing, rolling and forging, Discipline field theory, application to frictionless flat punch and wedge indentation, simple solution for frictionless extrusion and drawing. Upper and lower bound theorems, application plane-strain problems, simple indentation and extrusion using hodographs.

Text Books:

1. Plasticity for mechanical Engineering - Johnson, Von Nostrand. (Chap.1, 2, 2, 4, 5, 10,12,13)

Reference Books:

1. An introduction to the principles of Metal working - Rowe, Edward Arnold, 1968
2. Metal Forming Processes and Analysis -Avitzur, TMH, 1977

PRODUCTION MANAGEMENT

Introduction to Production Management: Role of production/operation management, Decision making in production/operation management cost models. Analytical methods: System concepts-analytical methods in production/ operation. Design of Production System: Design of production and services distribution and facility location processes and job design layout of physical facilities line. Production planning and control: Demand for casting and operation-aggregate planning.

Text Book:

1. Modern Production Management - Buffa, 5th Ed, John Wiley.

Quantitative Techniques in Production Management

Frequency distribution, measure and central tendency-comparing of mean, median and mode, Measuring variability, Probability-introductory ideas, probability distributions, Sampling and sampling distribution, estimation, testing hypothesis, chi-square and analysis of variance, Simple regression and correlation, multiple regression and modeling techniques, non-parametric methods, time series, Linear programming, Simplex method, Transportation problems, assignment problems.

Text Book:
Modern Production Management - Buffa, 5th Ed, John Wiley

Reference Books:

Production & Operation Management –Strategies &Tactics (Quantitative Methods and Applied Statistics)

Alternative Energy

Direct Energy Conversion**:** Introduction: Fuel Cells-Working principles, descriptions and classification, electrochemistry of H2-O2 cells, Ernst equation and e.m.f., efficiency calculations, application: Solar Photovoltaic (SPV)-Semiconductors & junctions, working principles, descriptions, I-V chatacteristics,efficiency and fill factor: Thermoelectric devices-Working principles, descriptions: Magneto Hydro Dynamics (MHD) –Working principles, descriptions/classification, e.m.f. calculations (Faraday & Hall configurations), application.

Non-conventional Energy Conversion**:** Solar thermal energy: Air and water heating, power generation, desalination, Solar geometry, collectors, storage (solar pond); Wind Energy Conversion. Principle of conversion, Types of turbines, Geo-thermal energy-Principle of Conversion, classification of plants. Tidal, Wave and Ocean Thermal (OTEC) energy conversion: Basic principles, Description of different types of plants. Pumped storage hydro-Principle of storage and conversion. Alternative Fluids as Energy Carrying Media.

Text Books:

1. Sukhatme, S.P., ‘Solar Energy Principle of Thermal Collection and Storage’, TMH, 1990.
2. Kriender, J.M., ‘Principles of Solar Engineering’, McGraw Hill, 1987.

Reference Books:

1. Mangal, V.S., ‘Solar Engineering’, Tata McGraw Hill, 1992.
2. Bansal, N.K., ‘Renewable Energy Source and Conversion Technology’, TMH, 1989.
3. Peter J. Lunde., ‘Solar Thermal Engineering’, John Willey & Sons, New York, 1988.
4. Duffie, J.A and Beckman W.A., ‘Solar Engineering of Thermal Processes’, Willey & Sons, 1990

MACHINE FAULT DIAGNOSTICS AND SIGNAL PROCESSING

Introduction. Maintenance Principles. Basics of Machine Vibration. Signal Analysis. Computer based data acquisition. Time domain Signal analysis. Introduction to MATLAB. Signal Processing Exercises with MATLAB. Fault detection transducers and instrumentation. Vibration monitoring. In- Situ field balancing of rotors. Condition monitoring of rotating machines. Noise monitoring. Wear and debris analysis.Thermography. Electrical Motor Current Signature Analysis. Ultrasonics in Condition Monitoring.NDT Techniques in Condition monitoring.

Text Books:

1. Introduction to Machinery Analysis and Monitoring – J. S. Mitchell. Pennwell Publishers.

Reference Books

1. Engineering Vibration – D. Inman. Tata Mc GrawHill.
2. Vibration Monitoring and Diagnosis – Ralph A. Collocott. Chapman and Hall

Finite Element Methods in Engineering

Basic Concepts: Introduction, Weak formulations, Weighted residual methods, Variational approaches, Element types. One-Dimensional Analysis: Basis steps, discretization, element equations, linear and quadratic shape functions, assembly, local and global stiffness matrix and its properties, boundary conditions, applications to solid mechanics, heat and fluid mechanics problems, axisymmetric problems. Plane Truss: Local and global coordinate systems, stress calculations, example problems. Beams: Introduction, Euler-Bernoulli beam element, numerical problems. Scalar Field Problems in 2-D: Triangular and rectangular elements, constant strain triangle, isoparametric formulation, higher order elements, six node triangle, nine node quadrilateral, master elements, numerical integration, computer implementation, Numerical problems. Plane Elasticity: Review of equations of elasticity, stress-strain and strain-displacement relations, plane stress and plane strain problems

Suggested books:

1. The Finite Element Method for Engineers- Huebner K.H., Dewhirst, D. L., Smith, D. E., and Byrom, T. G., 4th Ed., John Wiley and Sons 2001

2.The Finite Element Method in Engineering- S. S. Rao, 4th Ed., Elsevier Science 2005

3. An Introduction to Finite Element Methods - J.N.Reddy, 3rd Ed., Tata McGraw-Hill 2005

4. A First Course in Finite Elements – J.Fish and T. Belytschko, 1st Ed., John Wiley and Sons

TRIBOLOGY

Viscosity of Lubricants, Liquid and solid lubricants, Additives, Hydrostatic, Bearings, Slides Bearings, Journal bearing, End leakage, Bearing Materials, Lubrication of gears chains and Tapes and Roller Bearings.

Text:

1. E. I. Radzimogky – Lubrication of bearing (John Willey)
2. Brewer – Basic Lubrication Practice (Reinhold – 1955) Chapters 5, 7, 8 & 9.

BRANCH - MECHANICAL ENGINEERING

SPECIALIZATION: THERMAL & FLUID ENGINEERING

Second Semester							
	Theory				Practical		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Advanced Engg Thermodynamics.	4 - 0	4	100	50	-	-	-
Specialization Core-2 Advanced Fluid Mechanics	4 - 0	4	100	50	-	-	-
Elective –I (Specialization Related) 1. Advanced Refrigeration Engg. 2. Gas Turbine & Jet Propulsion. 3. Introduction to Computational Fluid Dynamics. 4. Computational Methods in Thermal Engineering.	4 - 0	4	100	50	-	-	-
Elective-II (Departmental Related) 1. Heat Transfer in Two-phase Flow 2. Gas Dynamics 3. Heat Exchanger Analysis and Design. 4. Aircraft & Rocket Propulsion.	4 - 0	4	100	50	-	-	-
Elective-III (Other Department Related) 1. Cryogenic Technology. 2. Advanced Internal Combustion Engines. 3. Viscous Fluid Flow. 4. Wind Energy Conversion.	4 - 0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

Advanced Engineering Thermodynamics

Review of Basics: First law and Second law analysis – concept of entropy – principle of increase of entropy – entropy generation – Availability – concept of exergy – exergy analysis of combustion processes. Helm Holtz function – Gibb‘s function – OnSagar reciprocity relation. Thermodynamic relations, Maxwell‘s relations, T-dS equations – specific heat relations – energy equation – Joule Thomson effect – Clausius Claperyon Equation. Criteria for Equilibrium – Gibb‘s phase rule – Conditions for stability. Compressibility factor, fugacity and activity, computation from the generalized charts, dependence of fugacity and activity on pressure and temperature, chemical – equilibrium. Phase rule – ideal and real solution of gases, liquids, equilibrium system. Statistical Thermodynamics: Thermodynamics probability, Maxwell statistics, Fermi Dirac and Bose – Einstein statistics, Entropy and probability, Degeneracy of energy levels, Partition functions. Kinetic Theory of Gases: Perfect gas model, Distribution of translational velocities distribution function, molecular collisions and mean free path, equipartition of energy.

Essential Readings:

1. A.S. Michael, *‘Thermodynamic for Engineers’*, Prentice Hall, 1972.
2. P.K. Nag., *‘Engineering Thermodynamics’*, II Ed., McGraw Hill, 1995.

Supplementary Reading:

1. G.J. Van Wylen & R.E. Sonntag., *‘Fundamentals of Classical Thermodynamics’*, Willy Eastern Ltd. 1989 (Unit I, II & III)
2. J.P. Holman, *‘Thermodynamics’*, 4th Ed., McGraw Hill, 1988.
3. J. Hsieg, *‘Principles of Thermodynamics’*, McGraw Hill, 1978.
4. Lee and Sears, *‘Statistical Thermodynamics’*, Addition Wesley, 1976.
5. V. Nastrand, S. Glasstone, *Thermodynamics for Chemists’*, 1974.
6. M.D. Burghardt, *‘Engineering Thermodynamics for Engineers’*, Harper and Row, NY, 1987.
7. K.Wark*, ‘Advanced Thermodynamics for Engineers’*, McGraw Hill, NY, 1987.
8. K. Smith, H.C. Van Ness, *Introduction to Chemical Engineering Thermodynamics*. McGraw Hill, 1987.

Advanced Fluid Mechanics

Description of fluid flow: with reference to translation, rotation and deformation concept of continuum, controlmass & control volume approach, Reynolds transport theorem. Steady flow and uniform flow.Velocity field, one & two-dimensional flow analysis, circulation and vorticity, stream function and velocitypotential function, potential flow, standard flow patterns, combination of flow patterns, flow net.Dimensional Analysis as a tool in design of experiments, identification of non-dimensionalnumbers and their significance, dimensional analysis methods.

Equations of motion for laminar flow of a Newtonian fluid - Viscous flow – Navier-Stoke's equations, simple exact solutions.Boundary Layer Theory-Formation, growth and separation of boundary layer-Integralmomentum principles to compute drag and lift forces-Mathematical models for boundarylayer flows.Turbulence, Origin of turbulence universal velocity distribution laws of turbulence, smooth rough andtransitional turbulent flow in pipes, pipe resistance equation for pipes design of pipe networks.Diffusion and dispersion of pollutants in natural streams.

References:

1. Som S. K and Biswas G "Introduction to Fluid Mechanics and Fluid Machines", TMH
2. Schlichting: "Boundary Layer theory", International Text – Butterworth
3. Fox R.W., Pitchard P.J, and McDonald A "Fluid Mechanics" Wiley India.
4. Rouse H. "Advanced Fluid Mechanics", John Wiley & Sons, N York
5. White F.M. "Viscous Fluid Flow", McGraw Hill Pub. Co, N York
6. Yalin, M.S. "Theory of Hydraulic Models", McMillan Co.
7. Mohanty A.K. "Fluid Mechanics", Prentice Hall of India, N Delhi.

Advanced Refrigeration Engineering

Module I

Analysis of refrigeration cycle, principles of psychrometry properties and processes, Air washer, Cooling towers, dehumidifiers, wet bulb and dew point temperatures. Multistage cycle and their optimization.

Module II

Thermodynamic Properties of pure and mixed refrigerants. Eco-friendly Refrigerants vapour absorption cycle and its components. Ejector Refrigeration System, Vortex Tubes, Principle of liquefaction of gases, Dry ice manufacture, Magnetic Refrigeration System.

Module III

Analysis and thermal design of Refrigeration compressor, condenser, evaporator and flow control devices; Design, Lubrication, charging and testing of refrigeration plants, defrosting capacity control, system component balancing, Design and construction details of unitary refrigeration equipment.

Books

1. Refrigeration and Air Conditioning, C.P.Arora, Tata McGraw Hill
2. Refrigeration and Air Conditioning, Stoecker and Zones, McGraw Hill
3. Refrigeration and Air Conditioning, Domkundwar and Arora, Dhanpat Rai and Sons
4. Refrigeration and Air Conditioning, Manohar Prasad, East West Press
5. Refrigeration and Air Conditioning, P.L.Balaney

Gas Turbine & Jet Propulsion

Introduction, application, shaft power gas dynamics – Compressibility effect, steady one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, isentropic two dimensional, supersonic expansion and compression; Centrifugal fans Blowers and Compressors: Principle of operations, work done and pressure rise, slip factor, diffusers, compressibility effects, non dimensional qualities for plotting compressor characteristics. Bray ton cycle, regeneration and reheating cycle analysis; Axial flow fans and compressors: Elementary theory, degree of reaction, three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance, and compressibility effects. Performance characteristics. ; Combustion system: Form of combustion, important factors affecting combustion chamber design, combustion processes, combustion chamber performance, practical problem. ; Axial flow turbines: elementary theory, vortex theory, choice of blade profile, pitch and chord ; estimation of stage performance, he cooled turbine. ; Prediction of performance of simple gas turbines: component characteristic, off design shaft gas turbine, equilibrium running gas generators, off design o free turbine and jet engine, methods of displacing the equilibrium, running line, incorporation of variable pressure losses, methods of improving part load performance, matching procedure for twin spool engines, behavior of gas turbine.Gas turbine rotors and stresses.

Supplementary Reading:

1. J.E Lee, *Theory and design of stream and gas turbine*.
2. Cohen & Rogers, *Gas Turbines*

Introduction to Computational Fluid Dynamics

Introduction: Basic tools of CFD, Numerical Vs experimental tools; Mathematical Behavior of PDEs: Parabolic, Hyperbolic and Elliptic PDEs; Methodology of CFDHT: Discrete representation of flow and heat transfer domain: Grid generation, Governing equations and boundary conditions based on FVM/FDM, Solution of resulting set of linear algebraic equations, Graphical representation and analysis of qualitative results, Error analysis in discretization using FVM/FDM; Solution of 1-D/2-D steady/unsteady: Diffusion problems, Convection problems, Convection-diffusion problems, source term linearization; Explicit and Implicit Approach: Explicit and implicit formulation of unsteady problems, Stability analysis; Solution of Navier-Stokes Equations for Incompressible Flows: Staggered and collocated grid system, SIMPLE and SIMPLER algorithms; Special Topics in CFDHT: Numerical Methodology for Complex Geometry, Multi-block structured grid system, Solution of phase change Problems.

Essential Reading:

S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis, ISBN-10: 0891165223.

Supplementary Reading:

1. H. K. Versteeg and W. Malalasekra, Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall (2nd Edition), ISBN-10: 0131274988.
2. Jr. D. A. Anderson, Computational Fluid Mechanics and Heat Transfer by McGraw-Hill Education
3. M. N. Ozisik, Finite Difference Method, CRC (1st Edition).

Computational Methods in Thermal Engineering

Introduction: Concepts of consistency, stability, and convergence of numerical schemes. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences. Case studies selected from fluid mechanics and heat transfer. ; Finite Difference Method: Classification, Initial and Boundary conditions, Forward, Backward difference, Uniform and non-uniform Grids, Grid Independence Test. Basic finite difference schemes. Boundary treatments. Fourth order RK methods and Predictor-corrector methods and Natchsheim-Swigert iteration with applications to flow and heat transfer. ; Parabolic and hyperbolic problems: Model problems and stability estimates. Examples of the methods of lines. The Lax-Richtmyer equivalence theorem. Stability analysis. Discrete Fourier series. Von- Neumann stability analysis. Consistency, convergence and error estimates. Keller Box and Smith‘s method with applications to thermal boundary layers; Convection dominated problems: The failure of standard discretization, Upwinding and Higher order methods.

Supplementary Reading(s):

1. K.Muralidhar and T.Sundararajan, "*Computational Fluid Flow and Heat Transfer*", Narosa Publishing House,New Delhi1995.
2. P.S. Ghoshdasdidar, *"Computer Simulation of flow and heat transfer"* TMH Ltd., 1998.
3. S.V. Patankar, "*Numerical heat transfer fluid flow*", Hemisphere Publishing Co, 1980.
4. D.A. Anderson, I.I. Tannehill, and R.H. Pletcher, *Computational Fluid Mechanics and Heat Transfer*, Hemishphere Publishing Corporation, New York, USA, 1984.
5. C.A.J. Fletcher, ,"*Computational Techniques for Fluid Dynamics*
6. *Fundamental and General Techniques*, Springer-Verlag,1987.
7. T.K. Bose, "*Numerical Fluid Dynamics*" Narosa Publishing House, 1997.
8. T.K. Sengupta, *Fundamentals of Fluid Dynamics*, University Press, Hyderabad.

TWO-PHASE FLOW AND HEAT TRANSFER

Module-I

Definitions; Review of one-dimensional conservation equations in single phase flows; Governing equations for homogeneous, separated and drift-flux models;

Module-II

Flow pattern maps for horizontal and vertical systems; Simplified treatment of stratified, bubbly, slug and annular flows.

Module-III

Thermodynamics of boiling; Pool boiling- onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling; Flow boiling- onset of nucleation, heat transfer coefficients, critical heat flux, effect of sub-cooling.

Module-IV

Condensation- Film and Dropwise condensation

Books:

1. Wallis, G.B., *One dimensional two-phase flows*, Mc-GrawHill 1969.

2. Collier, J.B. and Thome, J.R., *Convective boiling and condensation*, Oxford Science Publications, 1994.

3. L S Tong and Y S Tang. *Boiling Heat Transfer and Two-Phase Flow*. Taylor and Francis, 1997.

4. P B Whalley. *Boiling, Condensation and Gas-Liquid Flow*. Oxford University Press, 1987.

GAS DYNAMICS

Module I:

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations ; Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number;

Module II:

Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves ; Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers ; Adaiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line ;

Module III:

Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction ; Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point ; Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Essential Reading:

1. L. D. Landau and E. M. Lifshitz, Fluid Mechanics. 2nd ed., Butterworth-Heinemann, 1995.
2. H. W. Liepmann, and A. Roshko, Elements of Gas Dynamics, Dover Pub, 2001.

Supplementary Reading:

1. P. H. Oosthuizen and W. E. Carscallen. Compressible Fluid Flow. NY, McGraw-Hill, 1997.
2. M. A. Saad, Compressible Fluid Flow. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1993.
3. F. M. White, Viscous Fluid Flow. 2nd ed. New York: McGraw-Hill, 1991.
4. A. H. Shapiro, Compressible Fluid Flow 1 and 2. Hoboken NJ: John Wiley.

HEAT EXCHANGER ANALYSIS & DESIGN

Constructional Details: Types, Fluid flow arrangements, parallel, Counter and Cross flow, shell and tube heat exchanger, Regenerators and recuperator. Condensers – Industrial applications. Heat Transfer: Modes of Heat Transfer, Overall heat transfer coefficient, Thermal resistance, Efficiency. Temperature Distribution and its implications, LMTD, effectiveness; Flow Distribution: Effect of Turbulence, Friction Factor, Pressure Loss, Orifice, Flow nozzle, Diffusers, Bends, Baffles, Effect of Channel Divergence, Manifolds.; Stress in tubes, Headers sets and Pressure vessels: Differential Thermal Expansion, Thermal stresses, Shear stresses, Thermal sleeves, Vibration, Noise, types of failures. ; Design Aspects: Heat transfer and pressure loss flow configuration effect of baffles. Effect of deviations from ideality. Design of typical liquid-liquid, gas-gas-liquid heat exchangers. Design of cooling towers.

Essential Reading:

1. W.M. Kays and A.L. London., _Compact Heat Exchangers', 3rd Ed., TMH,1984.
2. A.P. Frass and M.N.Ozisik, Heat Exchanger Design',John Wiley & Sons Inc, 1965.
3. G.Walker, _Industrial Heat Exchangers', A basic guide, TMH V Book Co., 1980.

Supplementary Reading:

1. 'Standards of the Tubular Exchanger Manufacturer Association', 6th Ed., Tubular Exchanger Manufacturers Association, New York, 1978.
2. D. Q Kern,Process Heat Transfer', McGraw Hill Book Co., 1984.
3. E.A.D. Saunders., Heat Exchangers', Longman Scientific and Technical, New Delhi

Aircraft & Rocket Propulsion

Introduction, Rocket system and aerodynamics of rockets, Fundamentals of gas turbine engines, Illustration of working principles of gas turbine engine, Propulsion system and operating principle, Thermodynamics of propulsion system, Engine performance parameters, The ramjet cycle, Working principles of ideal ramjet cycle, The turbojet cycle, Working principles of turbojet cycle, Non-ideal turbojet cycle, Axial flow fans and compressors, Polytrophic efficiency of compression, Calculation of stage performance and overall performance, Working principles of turbofan cycle, Rocket performance, Introduction and working principles of multistage rocket, Solid propellant rockets, Liquid propellant rockets ,Thrust control in liquid rockets Cooling in liquid rockets, Hybrid rockets, Limitations of hybrid rockets, Relative advantages of liquid rockets over solid rockets

Supplementary Reading: -

1. G.C. Oates, *Aerothermodynamics of Aircraft Engine Components*, AIAA Education Series, New York, 1985.

2. W.W. Bathie, *Fundamentals of Gas Turbines*- John Wiley & Sons, 1984.

3. M.L. Mathur, and R.P. Sharma, *Gas Turbine Jet and Rocket Propulsion*, Standard Publishers and Distributors, Delhi, 1988.

4. P.G. Hill, *Mechanics and Thermodynamics of Propulsion*- Addison Wesley, 1970.

5. S.M. Yahya, *Fundamentals of Compressible Flow* - John Wiley, New York, 1982.

6. A.K. Mohanty, *Fluid Mechanics* - Prentice Hall, New Delhi, 2003.

Cryogenic Technology

Introduction: Cryogenic heat transfer applications, Material Properties at cryogenic temperatures, specific heats and thermal conductivity of solid, liquid and gases, Cryogenic insulations, gas-filled and evacuated powders and fibrous materials, microsphere and multi-layer insulations. ; Conduction: One-dimensional steady-state and transient conduction, conduction in composite materials, thermal contact resistance, cool-down in coated surfaces and fluid-storage vessels. ; Convection: Free and forced convection over external surfaces and tubes, Heat transfer in nearcritical region and its correlations, Kapitza conductance. ; Two-Phase Heat Transfer: Flow regimes, pressure drop, Lockhart-Martinelli correlation, pool boiling, forced convection boiling; Radiation: Radiation from LNG fires, free-molecular flow and heat transfer, free-molecular heat transfer in enclosures. ; Heat Exchanger: Cryogenic heat exchanger types, NTU-effectiveness design method, Giauque-Hampson design, Plate-fin and perforated-plate heat exchanger design, effect of variable specific heat, effect of longitudinal heat conduction, effect of heat transfer from ambient, Regenerators, Regenerator design.

Essential Reading:

1. R.F. Barron, *Cryogenic Systems'*, McGraw Hill, 1985.
2. R.B. Scott, *Cryogenics Engineering'*, Van Nostrand & Co., 1962.

Supplementary Reading:

1. H. Weinstock, *Cryogenic Technology'*, 1969.
2. K. D. Timmerhaus and T. M. Flynn., *Cryogenic Process Engineering'*, Plenum Press, New York, 1989.
3. R. W. Vance., *Cryogenic Technology'*, John Wiley & Sons Inc., New York, London, 1971.
4. Sengapatha, A. Bose, *Cryogenics – Progress and Applications'*, Tata McGraw Hill, 1987

Advanced Internal Combustion Engines

Module I

Thermodynamic Analysis of I.C.Engine Cycles. Effect of design and operating parameters on cycle efficiency. Modified fuel-aircycle considering heat losses and valve timing. Engine dynamics and torque analysis. Use of Combustion chart. Thermodynamic cycle with supercharging both S.I. and C.I. Engines. Limits of Supercharging. Methods of Supercharging and Superchargers.

Module II

Fuels and combustion in S.I. engines, knocking and fuel rating. Energy balance, volumetric efficiency, measurement of indicated and brake power. Advanced theory of carburetion. Fuel Injection Systems for S.I. and C.I. Engines. Cooling of engine and governing of engine. Ignition system: conventional and electronic.

Module III

Variable compression ratio engine. Theoretical analysis, methods of obtaining variable compression ratio, Wankel rotary combustion engine, Stratified charged engine, Methods of charge stratification, Dual fuel and Multifuel engines, Biofuels, Variable Valve timing engines, Exhaust emissions, its measurement and control. Fault diagnosis of S.I. Engines.

Books

Fundamentals of I.C. Engines by H.B.Heywood, McGraw Hill

I.C.Engine Theory and Practices, Vol.I & II C.F.Taylor, MIT Press

I.C.Engine, Mathur and Sharma, Dhanpat Rai and Sons

Fundamentals of I.C.Engine by Ganeshan, Tata McGraw Hill

VISCOUS FLUID FLOW

Preliminary concepts; Conservation of mass, momentum and energy; Exact solutions of the viscous flow equations: Couette flows, Poiseuille flow through ducts, unsteady duct flows; Laminar boundary-layers: integral analysis and similarity solutions; Laminar free shear flows: jet, wake, and plume; Stability of laminar flows; Turbulent flow: fundamentals, Reynolds-averaged equations, velocity profile in wall-bounded flows, turbulent flow in pipes and channels, turbulent free-shear flows (jet, wake, and plume); Turbulence modelling: zero, one, and two equation models of turbulence; Numerical methods.

Books:

1. Frank M White, *Viscous Fluid Flow*, McGraw-Hill, 1991.
2. Schlichting and Gersten. *Boundary-Layer Theory*. Springer-Verlag, 2000.
3. F S Sherman, *Viscous Flow*, McGraw-Hill, 1990.

WIND ENERGY CONVERSION

Sources and characteristics of wind, selection of site, wind resource assessment, power in the wind; classification of wind turbines, horizontal and vertical axis wind turbines, wind turbine aerodynamics, applications-wind diesel systems, wind farms, wind pumps and offshore wind turbines; turbine airfoils and rotor wakes, operational characteristics; structural considerations, wind turbine acoustics, electric power systems, economic assessment, environmental and social issues.

Books:

1. J F Walker, and N Jenkins, *Wind Energy Technology*, John Wiley and Sons, 1997.
2. D A Spera, (Ed.), *Wind Turbine Technology*, ASME, 1994.
3. N G Calvert, *Windpower Principles: Their Application on the Small Scale*, London, Griffin, 1978.
4. F R Eldridge, *Wind Machines*, NY: Von Nostrand Reinhold, 1980.
5. D M Eggleston, and F S Stoddard, *Wind Turbine Engg. Design*, Von Nostrand, New York, 1987.
6. L L Freris, (Ed.), *Wind Energy Conversion Systems*, Prentice Hall, London, 1990.
7. D M Simmons, *Wind Power*, Noyes Data Corp. NewJersey, 1975.