List of Ph.D. Course work subjects that can be offered under Mechanical Engineering Group from 2024

GROUP 1		GROUP 2		GROUP 3		GROUP 4	
Subject Code	Name of the subject	Subject Code	Name of the subject	Subject Code	Name of the subject	Subject Code	Name of the subject
PHME101	Modern Trends in Management	PHME201	Optimum Design	PHME301	Knowledge Management	PHME401	Nano Technology
PHME102	Maintenance Engineering & Management	PHME202	Project Management	PHME302	Energy Management	PHME402	Product Data Management
PHME103	Product Planning & Marketing	PHME203	Quality by design	PHME303	Human Resource Management	PHME403	Financial Management
PHME104	Industrial Relations	PHME204	Thermal power station-II	PHME304	Managerial Economics	PHME404	Computer Applications in Management
PHME105	Product data management	PHME205	Organizational Behavior	PHME305	Surface treatment & finishing	PHME405	Dynamics and Mechanism Design
PHME106	Composite Materials	PHME206	Advanced Operation Research	PHME306	Theory of Elasticity and Plasticity	PHME406	Product Design and Development
PHME107	Advanced Theory of Vibrations	PHME207	Tribology and Bearing Design	PHME307	Mechatronics system design	PHME407	Smart material & structure

PHME108	Experimental Stress Analysis	PHME208	Rotor dynamics	PHME308	Theory of Plates and Shells	PHME408	Measurement systems &Experimental Techniques
PHME109	Industrial Design & Economics	PHME209	Fracture Mechanics	PHME309	Virtual Reality	PHME409	Thermal Power Station-I
PHME110	Jigs and Fixtures Design	PHME210	Rapid Prototyping	PHME310	Advanced Machine Design	PHME410	Design and analysis of piping
PHME111	Non-Conventional Energy system	PHME211	Design Analysis	PHME311	Failure Mechanism and analysis	PHME411	Design for manufacture
PHME112	Theory of SI and CI Engines	PHME212	Finite Element Analysis	PHME312	Conventional Energy Conversion System	PHME412	Advanced Metal Joining Process
PHME113	Energy Conversion-I	PHME213	Biomass Energy Systems	PHME313	Applied numerical analysis	PHME413	Ferrous & nonferrous foundry practice
PHME114	Heat Transfer	PHME214	Energy storage	PHME314	Energy from Wastes	PHME414	Non Destructive Testing
PHME115	Computer Integrated Manufacturing and Automation	PHME215	Design of Heat Exchangers	PHME315	Computational heat transfer& fluid flow	PHME415	Production system & control
PHME116	Theory of Metal Cutting	PHME216	Advanced Fluid Mechanics	PHME316	Alternate Fuel for IC Engines	PHME416	Optimum design

PHME117	Quantitative Techniques in Decision Making	PHME217	Conduction and Radiation Heat Transfer	PHME317	Thermodynamics and Combustion Engineering	PHME417	Modeling of management information system
PHME118	Fluid power and control Engg.	PHME218	Theory and Design of Steam and Gas Turbines	PHME318	CNC Machining	PHME418	Robotics for industrial automation
PHME119	Maintenance of Machinery	PHME219	Robotics	PHME319	Theory of Metal Forming	PHME419	Micro Electro Mechanical Systems (MEMS)
PHME120	Computer aided design	PHME220	Simulation and Modeling of Mfg. System	PHME320	Die Casting and Die Design	PHME420	Theoretical stress & analysis
PHME121	Advanced material technology	PHME221	Tool Design	PHME321	Quality and reliability Engg	PHME421	Wind Energy system
PHME122	Computer graphics	PHME222	Non Traditional Machining	PHME322	Gauges and Measurements	PHME422	Computer control of manufacturing system
PHME123	Computational fluid dynamics	PHME223	Flexible Manufacturing System	PHME323	Agile Engineering	PHME423	Machine Tool Dynamics
PHME124	Power plant design	PHME224	Modeling simulation and analysis of manufacturing system	PHME324	Financial management	PHME424	Structural Design

PHME125	Artificial intelligence & expert system in automation	PHME225	Microprocessor & Micro controller	PHME325	Knowledge based management	PHME425	Fluid Power And Control Engineering
PHME126	Concurrent engineering for manufacturing	PHME226	Theory of Elasticity	PHME326	Lean manufacturing system	PHME426	CAD/CAM
PHME127	Theory of Plasticity	PHME227	Energy conversion-II	PHME327	Nuclear Energy Conversion	PHME427	Material Management & logistic support
PHME128	Advanced product design	PHME228	Operation and maintenance of hydraulic & Pneumatic systems	PHME328	Convective Heat & Mass Transfer	PHME428	Condition based maintenance
PHME129	Advanced power plant cycles	PHME229	Noise measurement analysis &control	PHME329	Production tooling	PHME429	Engine Flow &Combustion
PHME130	Experimental Methods in Materials & Mfg. (Lab)	PHME230	Experimental Methods in Materials & Mfg. (Lab)	PHME330	Experimental Methods in Materials & Mfg. (Lab)	PHME430	Experimental Methods in Materials & Mfg. (Lab)

Group I

PHME101 - MODERN TRENDS IN MANAGEMENT

1. **Just in Time Ideas:** Introduction of JIT Concepts, Difference between Conventional Material Control technique and IIT, Steps in implementing JIT, J.I.T. as a management Kaizen concept, Feasibility of JIT concepts to Indian Industries.

2. **Implementing a Program for continuous Improvement:** Japanese concept of continuous Improvement. (KAIZEN mean continuous Improvement), Innovation concept of Improvement, Need for continuous improvement, Steps in implementing continuous improvement.

3. **Quality Circles:** Definition of quality circles, Quality circles as a tool for problem solving, Q.C. as a group oriented KAIZEN.

4. **Kanban System:** Definition of KANBAN, Difference between PULL & PUSH Systems of Material Control, KANBAN as a Push System, KANBAN as JIT concept.

5. **Concurrent Engineering:** Definition of Concurrent Engineering. Design for Manufacturing and Assembly (DFMA), Concurrent Engineering, Team, Advantages of concurrent Engineering.

REFERENCE BOOKS:

1. Amaldo Hernandez: “Just in Time Manufacturing” PH International.
2. David Hutehins: “Just in Time – Productivity Process”, Jaco Publications.
3. Ingle Sord: “Quality Circles”.

PHME102 - MAINTENANCE ENGINEERING & MANAGEMENT

Objectives and functions of Maintenance, Maintenance Strategies. Organization for Maintenance.

Failure Statistics: Breakdown time distributions, Poisson, Exponential and Normal distribution.

Maintenance Planning: Overhaul and Repair: Meaning and Difference, optimal overhaul/Repair / Replace maintenance policy for equipment subject to breakdown**.**

Replacement Decisions: Optimal interval between preventive replacement of equipment subject to breakdown, group replacement

Maintenance Systems: Fixed Time Maintenance, Condition based Maintenance, Operate to Failure, opportunity maintenance, Design out maintenance, total productive maintenance.

Inspection Decision: Optimal Inspection frequency (for maximization of profit and minimization of downtime) Non-destructive Inspection, Lubrication program development, CPM and PERT *in* maintenance, Scheduling techniques, Spare parts Management, Repair cycle, Repair Complexity and Maintenance control Indices. Concept of Terrotechnology.

TEXT BOOKS:

1. Kelly and M. J. Harris "Management of Industrial Maintenance", Butterworth and Company Limited.
2. AKS Jardine "Maintenance, Replacement and Reliability", Pitman Publishing.
3. Joseph D. Pat ton "Preventive Maintenance "Instrument Society of America.
4. P. Gopala Krishnan and A. K. Banerjee "Maintenance and Spare parts Management".
5. H. P. Garg "Industrial Maintenance"
6. Siachi Nakajima "A guide to TPM"

REFERENCE BOOKS:

1. **Stainer** "Planet Engineering Hand Book", McGraw Hill.
2. **Lindley R. Higgins** "Maintenance Engineering Hand Book",
3. **L.C. Morrow** "Maintenance Engineering Hand Book".

PHME103 - PRODUCT PLANNING & MARKETING

Chapter 1: Product strategy and planning product and market evolution successful product development.

Chapter 2: New product strategy, a proactive new product development process. Market definition and entry strategy.

Chapter 3: Consumer measurement, perceptual mapping, consumers perceptions of new existing product.

Chapter 4: Product positioning –Preference analysis and benefits segmentation.

Chapter 5: Forecasting sales potential.

Chapter 6: Launching product and services

TEXT BOOKS:

1. Design and Marketing of new products -Glen L. Urban. John R. Hauser
2. Product Planning and Management -William L. Moore & Edgar- A. Pessemier

PHME104 - INDUSTRIAL RELATIONS

1. **Characteristics of Industrial Labour:** Social consumption of Industrial Labour -The Sex component of workers -Emergence of tribal Labour -low level of literacy -heterogeneity of labour class - undifferentiated class character -high rate of absenteeism and turnover -Migratory character -causes of migration - Evil effects migration benefits of migration.

2. **Trade Unionism** -Meaning and concept -characteristics of TU's -Functions of TU's- Principles regulating trade union functions -methods of achieving objectives - Types and structure of TU's - Trade Union Movement in India -Problems of TU's -Worker's Education and Training.

3. **Industrial Relations:** Concepts, Approaches and Organization -HRD in perspective -Special features of Industrial work -Importance of Industrial Relations -Basic facts about IR, Objectives of IR, Scope and Approaches to IR - Evolution of IR

4. **Anatomy of Industrial conflict** -Industrial conflicts /disputes -definition and essentials of a disputes - causative factors of industrial conflict -Industrial factors -Management attitude towards labour - Government machinery' -other causes. Strikes -forms of strike -Lockouts -Legal and illegal strike - Right to strike -Prevention of strikes.

5. **Preventive measures for Industrial Disputes:** Labour Welfare Officer a11d Labour Welfare Work - Importance and need -Qualification -Functions and duties -Basic features of Labour welfare work - need- Aims- Approaches- Scope. Tripartite and Bipartile bodies -Standing orders and Grievance procedure -Ethical codes and IR -Wage policy and Wage Regulation Machinery - Workers Participation in Management -collective Bargaining -conciliation – agreement – arbitration – adjudication

6. **Labour Legislations:** Trade Union Act -the Industrial Employment or Standing Orders Act -the Industrial Disputes Act -payment of Wages Act- Minimum Wages Act -Maternity Benefit Act - Factories Act

REFERENCE BOOKS:

1. Industrial Relations in India -MEMoria -Himalaya Publishing House -New Delhi
2. Personnel Management and Industrial Relations - Arun Monappa -PHI

PHME105 - PRODUCT DATA MANAGEMENT

INTRODUCTION: Introduction to PDM-present market constraints-need for collaboration- Internet and developments in server-client computing.

COMPONENTS OF PDM: Components of a typical PDM set-up-hardware and software- document management-creation and viewing of documents -creating parts-version control of parts and documents - case studies.

CONFIGURATION MANAGEMENT: Base lines-product structure-configuration management -case studies.

PROJECTS AND ROLES: creation of projects and roles -life cycle of a product- life cycle management -automating information flow -work flows-Creation of work flow temp1ates-life cycle -work flow integration -case studies.

CHANGE MANAGEMENT: Change issue-change request-change investigation- change proposal-change activity-case studies.

GENERIC PRODUCTS AND Variants: Products configuration-comparison between sales configuration and products generic-generic product modeling in configuration modeler-use of order generator for variant creation -registering of variants in product register-case studies.

REFERENCE BOOKS:

1. David Bed worth. Mark Henderson & Philips Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill Inc., 1991.
2. Terry Quatrain "Visual Modeling with Rational Rose and UML", Addison Wesley, 1998.
3. Wind-chill R5.0 Reference manuals, 2000.

PHME106 - COMPOSITE MATERIALS

1. **Introduction to composite materials:**
2. Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction.

3. **Micro mechanical analysis of a lamina :**
4. Introduction, Evaluation of the four elastic moduli – Rule of mixture, ultimate strengths of unidirectional lamina.

5. **Macro mechanics of a lamina :**
6. Hooke's law for different types of materials, number of elastic constants, Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, Engineering constants – angle lamina, Invariants, Theories of failure.

7. **Macro Mechanical analysis of laminate :**
8. Introduction, code, Kirchoff hypothesis – CLT, A, B & D matrices, Engineering constants, Special cases of laminates, Failure criterion.

9. **Manufacturing :**
10. Lay up and curing – open and closed mould processing – Hand lay –up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods.

11. **Application developments -** aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

12. **Metal matrix composites:** Re-inforcement materials, types, Characteristics & selection, base metals- selection, applications.

TEXT BOOKS:

1. Mein Schwartz "Composite Materials handbook" Mc Graw Hill Book Company, 1984.
2. Autar K. Kaw "Mechanics of composite materials" CRC Press New York.

REFERENCE BOOKS:

1. Rober M. Joness "Mechanics of composite materials" Mc-Graw Hill Kogakusha Ltd.
2. Michael W, Hyer "Stress analysis of fiber Reinforced composite materials" Mc-Graw Hill International.
3. Krishan K. Chawla "Composite material science and Engineering" Springer.
4. P.C. Mallik "Fibre reinforced composites" Marcel Decker.

PHME107 - ADVANCED THEORY OF VIBRATIONS

1. **System with single degree of freedom**: Review of free and forced vibration with or without different types of damping, vibration isolation and transmissibility.

2. **System with More than one degree of freedom**: Systems with two degree of freedom, undamped vibration absorbers, equation of motion using influence coefficients, generalized co-ordinates and co-ordinates coupling, orthogonalty of natural modes; free and forced vibration of multi-degree of freedom with viscous Damping: Lagrange's equations.

3. **Solution of Eigen Value problem, Transfer Matrix and Modal Analysis**: Self Excited vibrations; criterion of stability; effect of friction on stability with common Examples.

4. **Non-Linear Vibrations**: Introductions of Non linear vibration, free vibration with Non-linear spring force or non linear damping, phase plane, energy curves, integral curves lie nard's graphical construction, method of isoclines.

5. **Introduction to Random vibration**: Mathematical descriptions of stochastic Process, stationary and ergodicity, Gaussion random process, correlation function and power spectral density, Introduction to diagnostic maintenance and signature analysis.

TEXT BOOK:

1. Graham Kelly "Fundamental of Mechanical Vibration" Tata McGraw Hill.
2. Singeresu S Rao. "Mechanical Vibrations" Pearson Education Inc.
3. Den Hartog, Mechanical Vibration, McGraw Hill.

REFERENCES BOOKS:

1. Srinivasn P. Mechanical vibration Analysis, TMH.
2. Stoker, Non –linear vibration, Interscience.
3. Meirovitch , Elements of Vibration Analysis, McGraw Hill.
4. Kelly, Schaum series" Mechanical Vibration" McGraw Hill.
5. William Thompson "Theory of vibration with applications" Pearson Education Inc

PHME108 - EXPERIMENTAL STRESS ANALYSIS

1. **Electrical Resistance Strain gauges:** Types of gauges – gauge construction – gauge selection – gauge mounting – strain gauge circuits. Potentiometer and Wheat Stone's bridges – Static and dynamic strain analysis – strain gauge data reduction – Rosette gauges – Semiconductor strain gauges – Indicating and Recording Instruments Technology.
2. **Photoelasticity:** Nature of light – Crystal optics – Two dimensional Photoelasticity Stress optic law – Polariscopes – Isochromatics and Isoclinics – Secondary Principal stresses fractional fringe order determination – stress analysis – Stress separation techniques – Fringe multiplication techniques – model Material – Selection – Calibration – scaling model to prototype. Three-dimensional photo – elasticity – stress freezing techniques – photoelastic data – reduction. Axisymmetric problems.

3. Scattered Light Photoelasticity Principles. Polariscope set up and data reduction.
4. Birefringence coating techniques – Sensitivity reinforcing and thickness effects – data reduction – Stress separation techniques – Photoelastic strain gauges.
5. Moire technique – Geometrical approach – sensitivity of Moire data - data reduction in plane and out plane Moire methods – Moire photography – Moire grid production.
6. Non-destructive Stress Analysis Techniques. Brittle coating technique Principles – data and data reduction coating Materials, coating techniques and examples.
7. Introduction to Holography: Introduction – Equation for plane waves and spherical waves Intensity – Coherence – Spherical radiator as an object (record process) Hurter – Driffeld curve reconstruction process General case.

TEXT BOOKS:

1 Dally and Riley, "Experimental Stress Analysis". McGraw Hill.

2 Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, "Experimental Stress Analysis". Tata McGraw Hill.

3 Sadhu Singh "Experimental Stress Analysis". Hanna publisher.

REFERENCE BOOKS:

1 M. M. Frocht, "Photoelasticity Vol I and Vol II. John Wiley & sons.

2 Perry and Lissner, "Strain Gauge Primer".

3 Kuske, Albrecht & Robertson "Photo elastic Stress analysis" John Wiley & Sons.

4 Dave and Adams, "Motion Measurement and Stress Analysis".

5 Hand Book of Experimental Stress Analysis". by A. S. Kobayassin (Ed), SEM/VCH,II edition.

PHME109 - INDUSTRIAL DESIGN & ECONOMICS

INTRODUCTION: An approach to industrial design -elements of design structure for industrial design in engineering application in modern manufacturing systems.

ERGONOMICS AND INDUSTRIAL DESIGN: Introduction -general approach to the man- machine relationship- workstation design-working position.

CONTROL AND DISPLAYS: Shapes and sizes of various controls and displays-multiple, displays and control situations -design of major controls in automobiles, machine tools etc., - design of furniture - redesign of instruments.

ERGONOMICS AND PRODUCTION: ergonomics and product design -ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data- use of computerized database. Case study.

VISUAL EFFECTS OF LINE AND FORM: The mechanics of seeing- psychology of seeing general influences of line and form.

COLOUR: Colour and light -colour and objects- colour and the eye -colour consistency- colour terms- reactions to colour and colour continuation -colour on engineering equipments.

AESTHETIC CONCEPTS: Concept of unity- concept of order with variety -concept of purpose style and environment-Aesthetic expressions. Style-components of style- house style, observation style in capital goods, case study.

INDUSTRIAL DESIGN IN PRACTICE: General design -specifying design equipments- rating the importance of industrial design -industrial design in the design process.

TEXT BOOKS:

1. Mayall W. H. "Industrial design for Engineers", London Hiffee books Ltd. 1988.
2. Brain Shakel (Edited), "Applied Ergonomics Hand Book". Butterworth scientific. London 1988.
3. Introduction to Ergonomics -R. C. Bridger, McGraw Hill Publications.
4. Human factor Engineering -Sanders & McCormick McGraw Hill Publications.

NOTE: The first three chapters need detailed study that could be covered from the books mentioned below.

1. Introduction to Ergonomics –R. C. Bridger.
2. Human Factor Engineering -Sanders & McComlick.

Exercises on line work, rendering and modeling of real objects to be conducted during tutorial classes.

Guidelines for setting the Question Paper:

(Any five out of Eight questions)

a) Seven questions should consist of two sub-questions.
b) One question on short notes.
c) Emphasis should be given on sketches and illustrations while setting the questions.
d) Question paper pattern

Sl. No.	Q. No.	Chapter No. & Topic	Book No.
1	1	1. Introduction 2. Ergonomics & Industrial Design	1 & 3
2	2	3. Controls and Displays	2, 3 & 4
3	3	4. Ergonomics and Production	2, 3 & 4
4	4	5. Visual Effect of Line and Form	1
5	5	6. Colour	1
6	6	7. Aesthetic Concepts	1
7	7	8. Industrial Design and Practice	1
8	8	Short Notes (Any four out of six)	Covering all chapters

PHME110 - JIGS AND FIXTURES DESIGN

INTRODUCTION: Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design.

LOCATION: Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods and chip control.

LOCATING DEVICES: Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators.

CLAMPING: Basic principles, cutting forces, Rigid clamping, wedge clamping, Cam clamping, quick action clamps, Toggle clamps, simultaneously acting clamps.

GUIDING ELEMENTS: Jig bushes, Standards, Setting gauges.

INDEXING JIGS & FIXTURES: Indexing methods, Linear, Rotary, Indexing jigs, Indexing fixtures.

DESIGN OF JIGS AND FIXTURE BODIES AND OTHER ELEMENTS:TYPES OF JIGS AND FIXTURES.Plate jigs, Box jigs, Indexing jigs, Milling fixtures, and Indexing-milling fixtures, turning fixtures, Grinding fixtures, Universal jigs and fixtures, welding fixtures, Broaching fixtures.

Preparation and Presentation of typical designs in the form of drawings for the following

1. Drill Jig
2. Drilling and Reaming Jigs
3. Milling Fixtures
4. Indexing Jigs
5. Indexing Milling Fixtures.
6. Turning Fixtures
7. Welding Fixtures
8. Turning Mandrel
9. Grinding Mandrel
10. Broaching Fixtures.

REFERENCE BOOKS:

1. An Introduction to Jig and Tool Design -KEMPSTER M.H.A.- Bristol- ELBS 3rd Edt. 1974.
2. Jigs & Fixtures -JOSHI P .H.- New Delhi -Tata McGraw Hill Pub. Co. Ltd., 11th print 1999.
3. Jigs. & Fixtures & Gauges -BOYES E. WILLIAM-Michigan -SME 1st Edt. 1986.

PHME111 - NON CONVENTIONAL ENERGY SYSTEM

Introduction: World production and reserves of commercial energy sources, Energy alternatives, forms of non-conventional energy sources, features of power systems.

Solar Energy Systems: Solar radiation geometry, Estimation and measurement of solar energy. Thermal systems: Water heating, Drying, Cooking, Desalination, Solar refrigeration, solar ponds. Photovoltaic systems: Types and characteristics of Photovoltaic cells, Solar cell arrays, Balance of system

Biomass Energy Systems: Thermo-chemical route: Problems and special features associated with gasifier engine system, gasifier engine system, Case study of Hosahalli biomass gasifier engine generator system.

Bio-chemical Route: The biogas engine as a module integrated into an energy system.

Economic and operational considerations: Adoption of plant, Engine and driven machine – dimensioning of biogas plant and gas storage, Choice of engine, driven machine and transmission, Biogas engine and water pump, Biogas engine and electric generator.

Wind Energy Systems: Orientation systems and Regulating devices, Design of blades: Aerodynamic configuration of rotor and Determination of the blade structure. Description and performance of vertical axis wind mills. Use of wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems

Energy from water:OTEC–Principle of operation, Open & Closed OTEC cycles,

Wave energy: Wave energy conversion machines and recent advances

Tidal Energy: Single basin and double basin tidal systems

Small-Mini-Micro hydro system: concepts, Types of turbines, Hydrological analysis.

Other energy sources: Geothermal Energy Conversion, Nuclear fusion energy

TEXTS / REFERENCE BOOKS:

1. S. P. Sukhatme “Solar Energy-Principles of Thermal Collection & Storage”, TMH Publishing Co., New Delhi.
2. John A Duffie & William A Beckman “Solar energy Thermal Processes” Wiley–Inter science publication, New York
3. G. D. Rai “Non Conventional Energy Sources”, Khanna publisher, New Delhi
4. Klaus Von Mitzlaff “Engine for biogas”, Published by Friedr Vielveg and Sohn Braunschweig, Germany – 1988
5. Desire Le Gouriers: “Wind Power Plants : Theory & Design”, Pergamon Press, 1982
6. H P Garg & J Prakash : “Solar Energy – Fundamentals and Applications”, Tata McGraw Hill Publishing company limited, New Delhi
7. Srivatsava, Shukla and Ojha: “Technology and Application of Biogas”, Jain Brothers, New Delhi, 1993.

PHME112 - THEORY OF SI AND CI ENGINES

Combustion in Spark Ignition Engines:

Thermodynamic analysis of SI engine combustion : burned and unburned mixture states, Analysis of cylinder pressure data, Combustion process characterization, Flame structure and speed: flame structure, laminar burning speeds, flame propagation relations, Cyclic variations in combustion, partial burning, and misfire: definitions, causes of cycle-by-cycle and cylinder to cylinder variations, partial burning, misfire and engine stability, Spark Ignition: Ignition fundamentals, conventional ignition systems, alternative ignition approaches, Abnormal Combustion: Knock and surface ignition, knock fundamentals, fuel factors.

Combustion in Compression Ignition Engines:

Types diesel combustion systems : Direct injection systems, Indirect injection systems, Comparison of different combustion systems, Analysis of cylinder pressure data: Combustion efficiency, DI engines, IDI engines, Fuel spray behaviour: Fuel injection, overall spray structure, atomization, spray penetration, droplet size distribution and spray evaporation, Ignition Delay: Definitions and discussion, fuel ignition quality, auto-ignition fundamentals, physical properties affecting delay, effect of fuel properties,.

Pollutant Formation and Control:

Nature and extent of problem, Nitrogen Oxides: Kinetics of NO formation, formation of NO_2 NO formation in spark ignition engines, No formation in compression ignition engines.

Carbon Monoxide:

Unburned Hydrocarbon Emissions: Flame quenching and oxidation fundamentals, HC emissions from SI engines, HC emission mechanism in CI engines.

Particulate Emission: SI engine particulates, Characteristics of Diesel particulates, particulate distribution within the cylinder, soot formation fundamentals, soot oxidation, adsorption and condensation, Exhaust Gas Treatment:, Available options, Catalytic converters, thermal reactors, particulate traps.

TEXTS / REFERENCE BOOKS:

1. Osamu Hirao & Richard Pefley: “Present and Future Automotive Fuels”, Wiley Interscience Publication. NY. 1988.
2. John B. Heywood: “Internal Combustion Engines Fundamentals”, McGraw Hill International Edition,
3. R. P. Sharma & M. L. Mathur: “A Course in Internal Combustion Engines”, D. Rai & Sons.

PHME113 - ENERGY CONVERSION-I

Principles of Thermal Energy To Work Conversion Devices

Introduction. Number and sequential order of components in a heat engine. Heat engine working cycles. Principle types of non-phase change cycles. Comparison of practical engine cycles. Properties of air and air tables. Regenerative cycles. Brayton cycle with multistage compression and expansion, inter-cooling and reheating. Closed cycles and their advantages. Jet propulsion. Problems.

The internal combustion engine

Reciprocating devices and internal combustion engines. Types of internal combustion engines. Some terms and definitions relating to IC engines. The gas engine. The actual indicator diagram. Volumetric efficiency. Knocking and detonation in IC engines. Performance characteristics of IC engines. Testing of IC engines. Energy balance on an IC engine. Problems.

Reciprocating Compressors

The air compressor. Work input for single – stage compressor, Effect of clearance. Real indicator diagram. Multistage air compressors. Optimum inter-stage pressure. Energy exchange in multistage compression. The refrigerant vapor compression. Problems.

Refrigeration

Introduction, The air-cycle refrigeration. The mechanical vapor compression refrigeration cycle. Practical vapor compression cycle. Desirable properties of refrigerants. Common refrigerants. Vapor absorption refrigeration system. The heat pump.

Air-Conditioning

Atmospheric air and psychrometric properties. DBT, WBT, DPT, partial pressure. Specific and relative humidity and the relation, enthalpy and adiabatic saturation temperature. Construction and use of psychrometric chart. Analysis of various psychrometric processes. Summer and winter air-conditioning systems.

TEXT /REFERENCE BOOKS:

1. V. Kadambi and Manohar Prasad: “An Introduction to ENERGY CONVERSION”, Volume II, 2002.
2. T. D. Eastop and A McConkey: “Applied Thermodynamics for Engineers & Technologists”, 5th Edition

PHME114 - HEAT TRANSFER

Introduction: The modes of heat transfer, the laws of heat transfer, problems Heat conduction in solids: Simple steady state problems in heat conduction, concept of thermal resistance, the critical radius problem, the differential equation of heat conduction, heat generation, two dimensional steady state heat conduction, unsteady state processes, extended surfaces- fins, other techniques for solving heat conduction problems, the finite difference method for steady state situations, the finite difference method for unsteady state situations, problems.

Thermal radiations: basic concepts, emission characteristics and laws of black body radiation, radiation incident on a surface, solid angle and radiation intensity, heat exchange by radiation between two black surface elements, heat exchange by radiation between two finite black surfaces, the shape factor, radiant heat exchange in an enclosure having black surfaces, heat exchange by radiation between two finite parallel diffuse-gray surfaces, heat exchange by radiation in an annular space between two infinitely long concentric cylinders, radiant heat exchange in an enclosure having diffuse gray surfaces, problems.

Principles of fluid flow: the law of conservation of mass –the differential equation of continuity, differential equations of motion in fluid flow –Navier-strokes equations, laminar flow in a circular pipe, turbulent flow in a pipe, the velocity boundary layer, laminar flow over a flat plate, the integral method-an appropriate technique for solving boundary layer problems, turbulent flow over a flat plate, problems.

Heat transfer by forced convection: the differential equation of heat convection, laminar flow heat transfer in circular pipe, turbulent flow heat transfer in a pipe, the thermal boundary layer, heat transfer in laminar flow over a flat plate, the integral method, analogy between heat and momentum transfer, heat transfer in turbulent flow over a flat plate, flow across a cylinder, flow across a bank of tubes, problems.

Heat transfer by natural convection: natural convection heat transfer from a vertical plate, correlations for a horizontal cylinder and a horizontal plate, correlations for enclosed spaces, problems.

Heat exchangers: types of heat exchangers, direct transfer type of heat exchangers, classification according to flow arrangement, fouling factor, logarithmic mean temperature difference, the effectiveness-NTU method, other design consideration. Compact heat exchangers.

Condensation and boiling: film and drop condensation, film condensation on a vertical plate, condensation on a horizontal tubes, bank of tubes, effect of superheated vapour and of non-condensable gases, types of boiling: correlations in pool boiling heat transfer, forced convection boiling, problems.

REFERENCE BOOKS:

1. S P Sukhatme : A text book on heat transfer – Universities Press
2. M N Ozisik : Heat transfer – TMH
3. Incropera and Dewitt : Heat transfer

PHME115 - COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION

Production development through CIM: Production development cycle, sequential and concurrent engineering, soft and hard prototyping.

Computer Process Monitoring: Process control methods, direct digital control, supervisory computer control, steady state optimal control, one line search strategies, adaptive control.

Computer Aided Quality Control: The computer in Q.C, Contact inspection methods, non-contact inspection methods, CMM, Compute-Aided testing, Integration of CAQL with CAD/CAM.

Fundamentals of Networking: Principles, techniques, networking methods, network standards, Ethernet, Internet, system security, remote systems, NFS, ATM, EWN, document and work flow management.

Detroit type of Automation: Flow lines, Transform Mechanisms, work pattern transfer, Different methods, Problems.

Analysis of Automated flow lines: Analysis of transfer lines without storage with storage buffer single stage, Double stage, Multistage with problems, Automated assembly systems, Design for automated assembly parts feeding devices analysis of Multi station assembly machine, Analysis of Single stage assembly machine, automated inspection principles and methods, sensors, coordinate, measuring machine, machine vision system, optical inspection method.

Automated material Handling Storage: material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/revival systems, caroused storage systems work in process storage, interfacing handling & storage with manufacturing.

TEXT BOOKS:

1. CAD/CAM – Zimmers & Grover PHI.
2. CAD/CAM/CIM – P. Radhakrishna, New Age International.
3. M. P. Grover, Automation, Production systems & computer Aided manufacturing Prentice Hall.

REFERENCE BOOKS:

1. CAD/CAM – Zeid, Mc-Graw Hill
2. CAD/Cam, P. N. Rao.
3. Koren.Y “robotics for engineering” Mc-Graw Hill.
4. Rooks. B. (ed) “Robert vision & Sensory controls vol-3 North Holland.

PHME116 - THEORY OF METAL CUTTING

Geometry of Cutting Tools: Nomenclature of single point tool, and multi point tool, Effect of cutting parameters on tool geometry, Index able inserts.

Tool Materials: Desirable properties of tool materials, Types of tool materials like Carbon tool steels; H.S.S cemented carbides, ceramics, CBN and coated tools. **(06 Hrs)**

Mechanics of Metal Cutting: Classification of cutting process, chip formation, types of Chips, Mechanism of chip formation. Geometry of chip I single point cutting, forces on Chip velocity relationship, Friction in Metal Cutting. **(06 Hrs)**

Measurement of Cutting forces: Requirement of Dynamometer, Classification of cutting force dynamometer, Lathe tool dynamometer, Drill, Milling and Grinding Dynamometer. **(06 Hrs)**

Thermal Aspects in Metal Cutting: Heat sources in metal cutting, Temperature in chip formation, temperature distribution, experimental determination of tool temperature. **(06 Hrs)**

Cutting fluids: Properties of cutting fluids, selection of cutting fluids, application of cutting fluids and recommended cutting fluids. **(06 Hrs)**

Tool wear: Different wear mechanisms, Types of tool wear like coater, flank, and diffusion, etc tool wear measurement. **(06 Hrs)**

Tool life: Different tool wear criterion, Tool life equations, effect of process parameters in tool life, tool life tests. Factors affecting machinability. **(05 Hrs)**

Economics of Machining: Costs associated with machining operations cutting speed and tool life for minimum cost of production. **(05 Hrs)**

REFERENCE BOOKS:

1. Metal cutting principles by M. C. Shaw -Oxford Publication
2. Metal cutting by E. H. Trent.
3. Fundamentals of Metal Machining by Boothroyd.
4. Fundamentals of metal cutting & Machine Tools by B. L. Juneja & G. S - Sekhar, Wiley Eastern
5. Metal Cutting by V. C. Venkatesh & S. Chandrasekharan -Pantice Hall
6. Metal cutting by Dr. B. J. Ranganath -Vikas Publications.

PHME117 - QUANTITATIVE TECHNIQUES IN DECISION MAKING

1. **Introduction:**
   Statistics and managerial decisions, statistical data and Operations Research techniques. **(02 Hrs)**

2. **Presentation and Analysis of Statistical data:**
   Tables and graphs as data presentation devices, Frequency distribution, histogram and cumulative frequency curves. **(02 Hrs)**

3. **Fundamentals of Statistics, probability and probability distributions:**
   Measures of central tendency and location, Measure of dispersion, skewness and kurtosis, Probability and rules of probability, Random variables and probability distributions – Binomial, Poisson, Hyper geometric and Normal. **(06 Hrs)**

4. **Decision Making under Uncertainty:**
   Alternative criteria for decision under uncertainty, Bayesian approach and Incremental analysis. **(04 Hrs)**

5. **Correlation, Regression and Multivariate Analysis:**
   Bivariate frequency distribution and scatter diagram, Correlation analysis and Regression analysis, Non linear regression, auto correlation and multiple regression analysis, Multivariate analysis. **(06 Hrs)**

6. **Linear Programming Problem:**
   Formulation of L.P.P., Solution of L.P.P. by graphical method, Solution of L.P.P. by simplex method, Concept of duality and solution of dual problems, Solution of L.P.P. by dual simplex method. **(10 Hrs)**

7. **Transportation and Assignment Problems:**
   Structure of transportation problem and various methods to find I.B.F.S., Optimality test of transportation problems by MODI method, Solution of degeneracy and unbalanced transportation problems, Assignment problems and solution by Hungarian method and Traveling Salesman problem. **(06 Hrs**

8. **Theory of Games:**
   Two person zero sum game, Minimax & maximin strategies, Solution of game by dominance rules, arithmetic and algebraic methods, Solution of game by graphical method and method of matrices, Solution of game by Linear programming approach and approximate method to solve game problems. **(08 Hrs)**

9. **Network Analysis:**
   PERT and CPM, Network construction and determination of critical path, Calculation of ES, EF, LS, LF, TF, FF and IF, Crashing of a project, Scheduling of a project. **(04 Hrs)**

10. **Waiting Line:**
    Basic structure of queuing systems and characteristics, Expressions for M/M/1 queuing model. **(02 Hrs)**

11. **Simulation of Management systems:**
    Simulation and Monte Carlo method, Waiting line and inventory simulation models. **(02 Hrs)**

REFERENCE BOOKS:

1. Srivastava U.K. et. all - "Quantitative Techniques for managerial decisions", New Age International Private Limited
2. Gupta and Heera - "Operations Research: An Introduction", S. Chand and Company
3. H. Taha - "Operations Research", Prentice Hall India.
4. Hillier and Liberman "Introduction to Operations Research", McGraw Hill International.

PHME118 - FLUID POWER AND CONTROL ENGG.

The Hydraulic Power Unit: the hydraulic pump-gear type, rotary piston pumps, the oil reservoir. The oil filter, connecting motor and pump. Power unit difficulties. Intensifier or pressure booster. **(06 Hrs)**

Valves: The relive valve, relief valve difficulties. The master control valve, three way four way valves, pilot valve applications, master control valve and difficulties. The reducing valve and their difficulties. Flow control valve and their difficulties. The air release valve – check the surge damping valve, pressure switches. **(08 Hrs)**

Hydraulic Cylinders Intensifiers and Motors: non rotating type cylinder, single acting type, double acting type, piston and piston packing, piston rods, cylinder covers, rotating cylinders, intensifier motors. **(06 Hrs)**

Hydraulic Accumulators: Need of accumulators, the dead weight accumulator, the spring load accumulators, air or gas operated accumulators, use of accumulators as leakage compensator as secondary source of energy, as fluid make up device for synchronizing ram movement of two cylinder, to provide emergency source of power, as holding device as shock suppressor, use in dual pressure circuit, use as lubricant dispenser. **(08 Hrs)**

Synchronizing the Movement of Fluid Power Rams: Factors affecting synchronizing, use of mechanically linked pistons, use of hydraulic motors as metering devices, use of double cylinders in series, use of air hydraulic cylinders in series, use of equal capacity pumps. **(08 Hrs)**

Pneumatic Control Components: Pneumatic cylinders, single acting cylinders, double acting cylinders, special type cylinders, valves, directional valves, valve actuation non return valves, pressure control valves flow controls valves, air meters, hydro pneumatic equipments. **(08 Hrs)**

Pneumatic Control System: general notes in control system design, logic control circuits, production of circuit diagrams, symbols, circuit diagrams, control mode, will dependent control, travel dependent controls time dependent control, combined control, program control, sequence control, electro pneumatic for clamping, metal working, material handling and safety circuit for the press for safe guarding operators hands. **(08 Hrs)**

TEXT BOOKS:

1. Harry L. Stewart – hydraulic & Pneumatic Power for Production, The Industrial Press, New York
2. S. R. Mujumdar, Pneumatic systems principles and maintenances, Tata McGraw Hill.

REFERENCE BOOKS:

1. Andrew Parr, Hydraulic systems.
2. Pippenger, Hicks, Industrial Hydraulics McGraw Hill.

PHME119 - MAINTENANCE OF MACHINERY

1. **Modes of Mechanical Failure:** Definition of Failure Mode -Failure modes observed in practice - Different Failure modes and their importance in maintenance. **(06 Hrs)**

2. **Functions of Failure:** Functions and Performance Standards -Functional Failures - Failure Modes - Failure Effects. **(06 Hrs)**
3. **Failure Consequences:** Hidden Failure Consequences -Safety and Environmental consequences- Operational Consequences -Non-Operational Consequences. **(06 Hrs)**

4. **Reliability Centered Maintenance:** Introduction -Changing world of maintenance - Maintenance and RCM -The seven Basic Questions –Implementing RCM - Achievements of RCM. **(08 Hrs)**

5. **Classification of mechanical Equipment:** Machine Tools- Utilities- Equipment- working principal – Basic Maintenance needs- Maintenance efforts – trouble shooting- maintenance checklists- Pneumatics and Hydraulics in Maintenance **(08 Hrs)**

6. **Maintenance Procedures and Processes:** Range of Maintenance Activities. - Methods of Stopping Corrosion -Painting for Maintenance -Electroplating and other Coating Processes in Maintenance. **(06 Hrs)**

7. **Repair Technology:** Welding in Maintenance - Types and Applications-Metallization- **(06 Hrs)**

8. Heat Treatment in Maintenance. **(06 Hrs)**

REFERENCE BOOKS:

1. Cost Effective Maintenance -Design and Implementation -William T. File- Butterworth and Heinemann.
2. Reliability Centred Maintenance John Moubray -Butterworth and Heinemann.
3. Maintenance Engineering Handbook -Lindley Higgings
4. Plant Engineering Handbook -Stainer -McGraw Hill
5. Failure of Materials in Mechanical Designs -Analysis, Prediction and Prevention - Collins J.A. -John wiley and Sons.

PHME120 - COMPUTER AIDED DESIGN

Chapter 1: Introduction to CAD/CAM

Definition, Product cycle & CAD/CAM, Automation & CAD/CAM **(02 Hrs)**

Chapter 2: Computer graphics and Database:

Introduction, Software configuration of a Graphic system, Functions of a Graphics package, Constructing the Geometry, Transformations, Data Base Structure and Content, Wire-Frame Features & CAD/CAM Integration. **(04 Hrs)**

Chapter 3: Computer Aided Design System Hardware:

Introduction, Graphics Input Devices, Light Pens, Analogue devices, Keyboard devices, Graphic display devices, CRT displays, Plasma panel displays, Graphic output devices, Pen Plotters, Electrostatic plotters, Other graphic output devices, Modes of operation. CAD System Configuration **(08 Hrs)**

Chapter 3: Computer Aided Design System Software:

Introduction- Operating System, Graphics system, The overlay system. Graphics Database structure & handling, Operating features, Symbols, Macros. Editing Facility, Data Selection, Graphic transformation, Plotting. Graphic standards- GKS and CORE, GKS-3D and PHIGS, IGES, Other Graphic Standards **(08 Hrs)**

Chapter 4: Transformation System:

Display, Windowing and Clipping, Two-dimensional transformations, Three-dimensional transformations, Linear transformations. **(06 Hrs)**

Chapter 5: Geometric Modelling:

Introduction - Dimensions of models, Types of models, Construction of solid models. Wire frame Models, Wire frame Entities, Curve Representation. Parametric Representation of Analytic Curves - Review of Vector Algebra, Lines, Circles, Ellipses, Parabolas, Hyperbolas, Conics. Parametric Representation of Synthetic Curves - Hermite Cubic Splines, Bezier Curves, B-Spline Curves, Rational Curves. Curve Manipulations - Displaying, Evaluating Points on Curves, Blending, Segmentation, Trimming, Intersection. Transformation Design and Engineering Applications - Problems. **(08 Hrs)**

Chapter 6: Surface Models

Introduction - Surface Models, Surface Entities, Surface Representation. Parametric Representation of Analytic Surfaces - Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Parametric Representation of Synthetic Surfaces - Hermit Bicubic Surface, Bezier Surface, B-Spline Surface, Coons Surface, Blending Surface, Offset Surface, Triangular Patches, Sculptured Surface, Rational Parametric Surface. Surface Manipulations - Displaying, Evaluating Points & Curves on Surfaces, Segmentation, Trimming, Intersection, Projection, Transformation. Design & Engineering applications - Problems.

(06 Hrs)

Chapter 7: Mechanical Assembly

Introduction, Assembly Modeling - Parts Modeling & Representation, Hierarchical Relationships, Mating Conditions. Inference of position from mating conditions. Representation schemes - Graph structure, Location graph, Virtual Link. Generation of Assembling Sequences - Precedence Diagram, Liaison-Sequence analysis, Precedence Graph. Assembly Analysis – Problems. **(06 Hrs)**

Chapter 8: Finite Element Modeling & Analysis

Introduction - General Procedure of the Finite Element Method. Finite Element Analysis, Development of Integral Equations, Continuum Discretization, Assembly of Element Equations, Imposing Boundary Conditions, Lumping External Applied Loads, Solution of Global equations, Convergence of Finite Element Solutions. **(06 Hrs)**

TEXT BOOKS:

1. C. B. Besant and ewk Lui Computer Aided design and manufacture, Affiliated East West, India 1988.
2. Ibrahim Zeid, CAD/CAM Theory & Practice, Tata McGraw Hill 1998.

REFERENCES BOOK:

1. M. P Groover and 3 E W Zinmers, CAD/CAM Computer aided Design and Manufacture, prentice hall 1984.

PHME121 - ADVANCED MATERIAL TECHNOLOGY

Chapter – 1: DEVELOPMENT OF NEWER MATERIALS

Properties of Materials, Structure property relationship.
Newer materials – Ceramics and Composite materials
Ceramics – Fine ceramics, Types of ceramics,
Structure of Ceramics, Properties of Ceramics, Applications.
Composite materials – Types – Metal matrix Composites (MMC),
Ceramic Matrix Composites (CMC),
Polymeric composites
Structure, Properties and Applications of different composite materials. **(10 Hrs)**

Chapter – 2: POWDER METALLURGY

Introduction, Production of Powder, Characterization & Testing of Powders, Powder Conditioning, Powder Compaction, Sintering, Finishing operations, Applications of PM components. **(14 Hrs)**

Chapter – 3: PROCESSING OF COMPOSITES

Processing of MMC, CMC, Vacuum infiltration, squeeze casting, pressure die casting, Rheocasting, Compocasting, Super plastic forming, Processing of PMC, Hand lay up, Bag molding process, Autoclave molding, Compression molding, Pultrusion, Filament winding, Resin Transfer molding, Injection molding. **(14 Hrs)**

Chapter – 4: SURFACE TREATMENT

Surface Engineering, Surface quality, & integrity, concepts, Mechanical treatment, Thermal & Thermochemical treatment, Thermal spraying processes and applications,
Vapour depositions processes and applications, Ion-treatment, Laser Treatment. **(14 Hrs)**

REFERENCE BOOKS:

1. Materials and Processing in Manufacturing - E.Paul Degarmo, J. T. Black, Ronald A Kohser.
2. Powder Metallurgy – A. K. Sinha
3. Fiber Reinforced Composites – P. K. Mallick
4. Metal Matrix Composites – Minoru Taya, Richard J. Arsenault
5. Composite Materials Hand book – M.M.Schwartz, McGraw Hill.

Question Pattern:

One Question from Chapter – I
Two Question from Chapter – II
Two Question from Chapter – III
Two Question from Chapter – IV
One Question on Short notes (From all Chapters)
Total 8 Questions.

PHME122 - COMPUTER GRAPHICS

1. Introduction, Graphics station peripherals (I/O Devices) graphics standards. Line Algorithms: Vector generation and Bresenham's line algorithm, text, Segment, windowing and clipping algorithms. Bresenham's circle generation algorithms. **(10 Hrs)**

2. 2D transformations, Introduction, Representation of points, transformation matrices, transformation of points, transformation of straight lines, rotation, reflection, scaling, combined transformations, translations and homogeneous coordinates, rotation about an arbitrary point, reflection through an arbitrary line, projection- A geometric interpretation of homogeneous coordinates, overall scaling, homogeneous representation, 3D modeling and transformations, introduction, 3D scaling, shearing, rotation, reflection, translation, multiple transformations, rotations about an axis parallel to a coordinate axis, rotation about an arbitrary axis in space, reflection through an arbitrary plane, Orthographic and Perspective projections -1,2,3 point perspective projections. **(06 Hrs)**
3. Conics, parametric representation of ellipse, parabola and hyperbola problems on conic sections, Bezier B-Spline and cubic Spline curves. **(10 Hrs)**
4. Surface description and Generation: Introduction, surface of revolution, sweep surfaces, quadric surfaces, piecewise surface representation, mapping parametric surfaces, bilinear surface, ruled and developable surfaces, linear coons surfaces, coons cubic surface, Bezier surfaces, B-spline surfaces. **(12 Hrs)**

5. Visual realism: Hidden line removal: Sorting, Coherences, Silhouette representation, Priority algorithm, Hidden Surface Removal; Z-Buffer algorithm. Warnocks's algorithm and Hidden solid Removal: Ray-tracing algorithms (parallel and perspective). **(06 Hrs)**

6. Coloring and shading: colour models (RGM, CMY, HSB) Constant shading, Gourand and phong shading. **(04 Hrs)**

7. Animation: Hardware requirement for animation, Animation types: Frame- buffer Animation, real time play back and real time animation. Animation techniques: Key frame technique, simulation approach, Hybrid approach, Animation of articulated bodies. **(04 Hrs)**

TEXT BOOKS:

1 Ibraham Zeid, “CAD/CAM-Theory and Practice” McGraw Hill.
2 Harrington, “Computer Graphics” McGraw Hill Co.
3 Rogoer’s Adams, “Mathematical Elements for Computer Graphics”, McGraw Hill.
4 Schaum’s Series, “Computer Graphics”, McGraw Hill.

REFERENCE BOOKS:

1 William M. Newman, “Principles of Interactive Computer Graphics”, McGraw Hill.
2 Van- Damn Foley “Computer Graphics” Pearson Education.

PHME123 - COMPUTATIONAL FLUID DYNAMICS

1. **Basic Concepts:** Dimensionless form of equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems; Properties of numerical solutions (Consistency, Stability, Conservation, Convergence and Accuracy) **(10 Hrs)**

2. **Finite Difference Methods:** Discretisation; Boundary conditions; error propagation; Introduction to spectral methods; examples. **(10 Hrs)**

3. **Finite volume method:** Surface & volume integrals; Interpolation & differentiation; Boundary conditions; Examples. **(10 Hrs)**

4. **Linear & Non linear equation systems**: Gausian Elimination; LU decomposition; Tridiagonal Systems; Iterative methods; convergence; ADI & other splitting methods; multi-grid method; Coupled equations; Simultaneous solutions, sequential solutions & under relaxation. Non linear systems **(10 Hrs)**

5. Initial value problem & Boundary value problems; Implicit & Explicit Schemes; 20 and 3D examples. **(10 Hrs)**

6. Heat and Mass transfer Problems; Multi Phase Flows **(10 Hrs)**

TEXT BOOKS:

1. Computational Methods for Fluid Dynamics 3"d edition, J.H. Ferziger & M. Peric, Springer, 2002
2. Numerical Solutions of Partial Differential Equations, Finite Difference methods, 3rd ed., G.D. Smith, Oxford University Press. 1986

REFERENCE BOOKS:

1. Computational Fluid Dynamics, T. J. Chung, Cambridge Univ. Press, 2002
2. Partial Differential Equations for Scientists and Engineers, Farlow, John Wiley, 1982

PHME124 - POWER PLANT DESIGN

1. **(i) Thermal Plant:** Review of Thermodynamics; Vapor power cycles; Regeneration; Reheat cycles; Fuels and Combustors analysis. Types of steam generators; Furnace design; Heat transfer; Design of accessories; Water walls Draft systems design' Estimation of Net Plant heat rate **(14 Hrs)**

   (ii) Steam Turbine: .Classification; Design of Multi stage power. plant turbine; Mollier chart; Velocity diagrams; Governing; Instrumentation; Lubrication; Estimation of specific steam consumption. **(07 Hrs)**

   (iii) Design of surface condensers for plant; Estimation of size; Feed water heaters **(04 Hrs)**

   (iv) Design of cooling towers; Natural draft use of psychometric chart; Feed Water Treatment **(04 Hrs)**

   (v) Study of Micro processor control in power plant **(04 Hrs)**

   (vi) Steam Generator Inspection Methods; IBR Quality materials **(04 Hrs)**

   (vii) Power Plant Economics-Cost of generation per kwh. Effecting Load Factor on cost per kwh. **(03 Hrs)**

2. Combined cycle power plant (STAG). Estimation of efficiency **(03 Hrs)**

3. Cogeneration' Technology and Systems applied to various industry Viz. sugar, petrochemical, textile, paper etc. Design of plant and equipments. Estimation of efficiency cost analysis Instrumentation & control. **(10 Hrs)**

4. **Environmental aspects of Energy & Pollution Control.** Introduction; Air quality standards various Air pollutants and control measures in power plants etc. Thermal pollution Nuclear Wastes and Management. **(07 Hrs)**

[Note: During the assignment session students will be engaged in design calculations leading to a complete product at the end of the course)

TEXT BOOKS:

1. Power plant technology, EI Wakel M.M, McGraw Hill.
2. Power Plant Engineering, P.K.Nag, 2"d Ed. Tata McGraw Hill, 2002.

REFERENCE BOOKS:

1. Principles of Energy Conversion, Culp Jr., McGraw Hill. .
2. Power Plant Engg., R.J. Rajput, Laxmi Publications New Delhi.
3. Steam Turbine Cycles, K.J. Salisbury
4. Steam Turbine Theory & Practice, W.S. Keerton
5. Boiler Furnaces -R. Dolezal
6. Power Plant Engg., Dornkundwar & Arora, Dhanpat Rai & Sons
7. Energy Technology, S. Rao&Dr. Parulekar, Khanna Publications.

PHME125 - ARTIFICIAL INTELLIGENCE & EXPERT SYSTEM IN AUTOMATION

1. **Artificial Intelligence:** Overview of Artificial Intelligence, The Importance, Early Work and Related Fields. Artificial Intelligence in CAD, Application of Artificial Intelligence in Design, Scope and History of AI. The AI Problems, Task Domains of AI, AI Techniques. Application of AI in Matching, Pattern Recognition. **(12 Hrs)**

2. **AI Components, Languages and Strategies:** Definition and Importance of Knowledge, Components of Knowledge, Knowledge Based System, Knowledge representation, Organization, Manipulation and Acquisition. Strategies for Knowledge Acquisition, Knowledge Representation Languages, Issues in Knowledge Representation. A Network Representation Language. Introduction to LISP, Syntax and Numeric Functions, Search Strategies in LISP, Recursive Unification, Function Interpreters and Embedded Languages. Logic Programming in LISP. Streams and Delayed Evaluation. Object Oriented Representation. An Expert System Shell in LISP. **(16 Hrs)**

3. **Automated Reasoning:** The General Problem Solver and Difference Tables. Resolution Theorem Proving. Machine Learning. Perceptron Learning, Back Propagation Learning, Competitive Learning. The Genetic Algorithm, The Genetic Programming. Artificial Life and Society Based Learning. **(08 Hrs)**

4. **Knowledge Based Design Aids:** Inference Process, Backward Chaining, Forward Chaining, Hybrid Chaining. Feature Based Modeling, Feature Recognition, Design by Features, Application of Feature Based Models. Role of AI in Manufacturing. Fuzzy Logic and Neural Networks. **(08 Hrs)**

5. **Expert System Architecture:** Rule based System Architectures, Non Production System Architectures, Dealing with Uncertainty, Knowledge System Building tools, Expert Systems Architecture, Structure of an Expert System, Building an Expert System, Representing and using Domain Knowledge. Expert System Shells. **(08 Hrs)**

TEXT BOOK:

1. Introduction to Artificial Intelligence and Expert Systems – DAN. W. Patterson, PHI.
2. Artificial Intelligence, Fourth Edition, by George. F. Luger, Pearson Education, Asia.

REFERENCE BOOKS:

1. Artificial Intelligence: An Engineering Approach, Robert J. Schalkeff, PHI
2. A Guide to Expert Systems - Donald A Waterman, Addison Wesley.
3. Artificial Intelligence – Elain Rich, McGraw Hill.
4. Principles of Artificial Intelligence – Springer-Verlag, Berlin, PHI
5. Artificial Intelligence Using C – Herbert Schildt, Osborne, McGraw Hill.

PHME126 - CONCURRENT ENGINEERING FOR MANUFACTURING

1. **Introduction:** Introduction. Review of Historical Events. Push and Pull for New Paradigms. Areas of Manufacturing Competitiveness. Product and Services. Process and Methodologies. Performance Indicators, Manufacturing Competitiveness.

2. **Survey of CE techniques:** Japanese Success, European Environment and CE in US Automotive industries. **(06 Hrs)**

3. **Life-Cycle Management:** Shrinking Life Cycle. Life-Cycle Management. New Product Introduction. Strategic Technology Insertions. Managing Continuity. Managing Revision Changes. Life-Cycle Cost Drivers. Life-Cycle Management Tools. Sequential Versus Concurrent Engineering. Life-Cycle Management. **(06 Hrs)**

4. **Process Reengineering:** Understanding and Managing Change, Reengineering Approaches. Tenents of Process Improvement. Work Flow Mapping. Information Flow-Charting. Enterprise Models. Process Improvement Methodology. Change Management Methodology. Concurrent Process Reengineering. **(06 Hrs)**

5. **Concurrent Engineering Definitions:** Introduction, CE Definitions. Basic Principles of CE. Components Of CE. Concurrency And Simultaneity. Modes of Concurrency. Modes of Cooperation. Benefits Of Concurrent Engineering. **(08 Hrs)**

6. **System Engineering:** Introduction. An Automobile Manufacturing Process. System Engineering. Systems Thinking. Approaches to System Complexity. Sharing and Collaboration in CE 300. System Integration. Agile Virtual Company. **(06 Hrs)**

7. **Information Modeling:** Information Modeling. Modeling Methodology. Foundation of Information Modeling. Concurrent Engineering Process Invariant. Enterprise Model-Class. Specification Model-Class. Product Model-Class. Process Model- Class. Cognitive Models. Merits and Demerits. **(08 Hrs)**

8. **Intelligent Information System:** Enabling Elements. Major Barriers. Vision of the Future. Levels of Intelligence. Product Intelligence, Process Intelligence. Technical Memory, Flexible Computer Integrated Manufacturing (FCIM), Groupware. **(06 Hrs)**

9. **The Whole System:** Introduction. Conventional Design and Development Process. A Transformation Model for a Manufacturing System. CE Enterprise System Taxonomy. Integrated Product and Process Development. Transformation System for Product Realization. Key Dimensions of a CE Specification Set. Artifact's Intent Definitions. **(06 Hrs)**

TEXT BOOKS:

1. "Concurrent Engineering Fundamentals-Integrated product and process organization" Vol I & II, Prasad.B, PHI
2. Concurrent Engineering-Shortening lead times, Raising Quality and Lowering Costs, Johan.R. Hartely, Productivity press, Portland, Oregon 1992.

REFERENCE BOOKS:

1. Concurrent Engineering-The Product Development Environment for the 1990's, Carter DE and Baker BS, Addison Wesley Publishing Company.

PHME127 - HEORY OF PLASTICITY

1. Definition and scope of the subject**,** brief review of elasticity, Octahedral stress, spherical and deviatoric stress, invariance in terms of the deviatoric stresses, representative stress.
   Engineering and natural strains, cubical dilation, finite strains co-efficients Octahedral strain, strain rate and the strain rate tensor. **(12 Hrs)**

2. Yield criteria for ductile metal – Von Mises, Tresca, yield surface for an Isotropic Plastic materials, Stress space, experimental verification of Yield criteria, Yield criteria for an anisotropic material. **(10 Hrs)**

3. Stress – Strain Relations – Plastic stress-strain relations – Prandtl Roeuss Saint Venant, Levy – Von Mises, experimental verification of the Prandtl-Rouss equation, Yield locus, symmetry convexity, normality rule etc. **(10 Hrs)**

4. Upper and lower bound theorems and corollaries. **(05 Hrs)**

5. Application to problems: Uniaxial tension and compression, bending of beams, torsion of rods and tubes, simple forms of indentation problems using upper bounds. Problems of metal forming: extrusion, drawing, rolling and forging. **(10 Hrs)**

6. Slip line theory, **(05 Hrs)**

TEXT BOOKS:

1. R. A. C. Slater, “Engineering Plasticity – Theory and Application to Metal Forming Process”, McMillan Press Ltd .
2. Sadhu Singh, “Theory of Plasticity and Metal forming Process”, Khanna Publishers, Delhi.

REFERENCE BOOKS:

1. Johnson and Mellor, “Plasticity for Mechanical Engineers”.
2. Haffman and Sachs, “Theory of Plasticity”,
3. Chakraborty “Theory of plasticity” Mc Graw Hill

PHME128 - ADVANCED PRODUCT DESIGN

Elements of Design

Introduction to basic elements and concepts of visual design: line, texture, colour, form balance, proportion, size, shape, mass, unity and variety. Spatial relationship and compositions in 2 and 3 dimensional space, 2 dimensional radii manipulation and form transition. Graphic composition and layout. Use of grids. **(06 Hrs)**

Product Design – I

Factors influencing the context and the products. Assessing relevance of available products with respect to the context. Problem areas and the limitations. Familiarisation studies and programming for detailed investigation of context. Developing questionnaires, interviewing users and selecting suitable techniques to study use behaviour and reactions, interviewing and observing user and photographic studies of products in use. Market demands and manufacturing constraints. Data analysis. Role of creativity in understanding of latent needs. **(10 Hrs)**

Applied Ergonomics

Gross human anatomy, Anthropometry, static and dynamic, Muscles and work physiology, Static and dynamic work including maximum capacity, Bio-mechanics. Environmental condition including thermal, illumination, noise and vibration. Biological transducers and nervous system including their limitation. Controls and display Psycho physiological aspect~ of design. Research techniques in Ergonomic data generation, interpretation and application of statistical methods. Case analysis. **(06 Hrs)**

Visual Communication

Geometry of elements in products and its application in object drawing. Product presentation in various media like pencil, ink and colour, Presenting thoughts and ideas in, design through sketches, perspective and exploded views. Presentation of product design concepts through simplified graphics presentation

(06 Hrs)

Product Design – II

Role of creativity in problem solving study of inhibitions, conformity and vertical thinking. Brain storming, synectics to develop creative attitude and open mind. Detailed discussion on stages in design process. Complimentary nature of systematic and creative thinking in various stages of design process. Methodology for visual analysis of products. Principles of value analysis, use and definition of function.

(12 Hrs)

Analysis and Organization of Control & Displays

Function of control and display elements dials, knobs, push buttons, handles and electronic displays. Investigations and study of visual, functional and ergonomic requirements of control and display elements. Legibility of display elements, Character of different typefaces and their readability. Printing and transfer techniques. Product graphics. Study of different textures and patterns. Area, volume and proportion. Order and system. **(04 Hrs)**

Studies in Form

Exploration and study of formal elements to develop visual awareness, imagination and creative insight. Form elements in the context of product design, 2 & 3 dimensional radii manipulation; joints, grooves and openings, 2 & 3 dimensional form transition, Introduction to colour and colour as elements of design. Colour classification and dimensions of colour: hue, value and chroma relationships. Colour dynamics and interaction of colours. Colour meaning and traditions. Psychological use of colours. Colour in nature. Colour and form relationships. **(08 Hrs)**

Product Detailing

Detailing in plastic products, while using manufacturing processes, F.R.P. moulding. Detailing for fabricated products in sheet metal, steel1ubes and angles, aluminium sheets and extruded sections, detailing while using fabric materials, form and other cushions, leather and cloth in combination with materials like wood and metal. **(08 Hrs)**

TEXT BOOKS:

1. Successful Product Design, Hollins. B and Pugh S, Butterworths, London, 1990.
2. Handbook of Product Design for Manufacture, Bralla, J.G., McGraw- Hill, New York, 1988.

REFERENCE BOOKS:

1. Designing for Production, Baldwin E.N. and Niebel B.W.-, Edwin Homewood, Illinois, 1975.
2. Design methods, Seeds of Human Futures, Jones, J.C., John Wiley, New York, 1978.

PHME129 - ADVANCED POWER PLANT CYCLES

Review of various ideal cycles, Rankine and Brayton and fuel air cycles **(06 Hrs)**

Thermodynamics optimization of design parameters **(06 Hrs)**

Real cycle effects internal and external irreversibilitites, pressure drops, heat loss, condenser air leakage, fouling of heat transfer surfaces, combustion losses and their impact on the thermodynamic cycle. optimization of real and double reheat cycles **(12 Hrs)**

Analysis of off design performance, combined cycles ideal and real cycles thermodynamic analysis, design of alternate schemes for combined cycles single, dual and triple pressure cycles, and their optimization **(10 Hrs)**

Retrofit of ageing power plants, parametric analysis effects of gas and steam cycle variables, **(08 Hrs)**

Binary vapor and kalian cycles, Thermo chemical and hydrogen and oxygen cycles, Cycles for nuclear power plants (PWR, BWR, PHWR, FBR). All simulations will involve extensive use of numerical techniques as part of laboratory work. **(10 Hrs)**

REFERENCE BOOKS:

1. El Wakil : Power Plant Engineering TMH
2. D Culp : Principles of Energy Conversion
3. P K Nag : Thermal Power Station

Group II

PHME201 - OPTIMUM DESIGN

1. **Introduction:** Engineering application of optimization, multivariable optimization Statement of a optimization problem. Design Vector, Design constraints, objective function, classification of optimization problems. **(04 Hrs)**

2. **Classical optimization technique:** Single variable optimization, with equality Constraints solution by direct substitution, solution by the method of constrained Variation. Solution by the method of lagrange multipliers, multivariable optimization with inequality constraints Kuhn – Tucker condition. **(08 Hrs)**

3. **Non-linear programming:** (One Dimensional minimization method) Numerical method, Unimodal function, Unrestricted search, Exhaustive search. Dichotomous search, Fibonacci and Golden section method. **(08 Hrs)**

4. **Interpolation method:** Quadratic and Cubic Nonlinear programming (Unrestricted Optimization Technique) Random search methods, Univate method, powels method, Simplex method. **(08 Hrs)**

5. **Descent methods:** Steepest descent, conjugate gradient, variable metric method. **(06 Hrs)**

6. **Non linear programming:** (Constrained Optimization problem) Characteristic of a constrained problem. **(08 Hrs)**

7. **Direct methods:** The complex method, cutting plane method, methods of Feasible directions. **Indirect Methods:** Transformation technique, change variables and elimination of variables, penalty function methods- interior and exterior penalty function. **(10 Hrs)**

TEXT BOOK:

1. S. S. Rao, Optimisation – Theory and Application, Willey Eastern.

REFERENCE BOOKS:

1. R. L Fox Optimization methods for Engg. Design, Addison – Wesley
2. GSG Beveridge and R. S. Schechter, Optimisation Theory and practice.
3. Ram, Optimisation and Probability in System Engg. Van Nostrand.

PHME202 - PROJECT MANAGEMENT

1. **Introduction:** Identification of Investment Opportunities, Market and Demand Analysis -Technical Analysis -Investment Outlay. **(10 Hrs)**

2. **Means of Financing -**Profitability and Breakeven Analysis -Cash Flows of Projects -Tax factor in investment Analysis -Interest -Compounding and Discounting. **(10 Hrs)**

3. **Appraisal Criteria and Selection of Investment** -cost of capital -analysis of Risk -Financial Projection, social Cost Benefit Analysis **(10 Hrs)**
4. **Manpower Management in Projects** -Functional Approach to Manpower Management, - the Element of decision Process -Project Team Concepts - Field Autonomy- Policies Governing Projects. **(12 Hrs)**

5. **Networks Techniques in Project Management** -*PERT/CPM* Analysis - Administrative aspects of Capital Investment. **(10 Hrs)**

REFERENCE BOOKS:

1. Projects - appraisal, preparation, budgeting and implementation - Prasannachandra -Tata MCgraw hill.
2. Hand book of project management -Dennis lock.
3. Project management -Dennis lock.

PHME203 - QUALITY BY DESIGN

GN: Define customer needs - Quality Function Deployment, Concept generation as System Technique (FAST), Use brains storming and selection processes, Six accept reduction phase. Review functional requirements, product specifications, concepts, Select candidate. Concept evaluation phase ugh method, and technical risks, output, Conclusions and recommendations. **(28 Hrs)**

N: Reliability design, Critical parameter management; Value engineering, Failure-analysis (FMEA). Prototype building and testing, Pre-production model and testing, gauche method, Statistical process control, product development cycle. **(24 Hrs)**

TEXT BOOKS:

1. Through design, mcgraw- hill 1993.
2. Engineering quality by design, marcel dekker inc, New York.

REFERENCE BOOKS:

1. Velocity function deployment, Marcel dekker inc, New York.
2. Techniques for value analysis and Engineering, 1972.
3. Management for quality imprudent, productivity press.
4. Design, addition -Wesley, wokingham, 1991.
5. Matar, designing for quality, chapman & hall.
6. Indolence through quality and reliability, applied 1989.
7. Design for excellence, mcgraw -hill inc, New York, 1996.
8. Function development -productivity process.

PHME204 - THERMAL POWER STATION-II

Power Station Layout and Siting: Planning for new power station, site selection and investigation, site layout. **(05 Hrs)**

Station design and layout: Concept, station layout, T.G. systems, boiler systems, cooling water plant, coal handling, ash and dust handling, gas congregation and storage gas turbine plant. **(05 Hrs)**

Turbine generator and aux: Schemes, turbine blading, casing, rotors and vibration and couplings, bearings pedestals, turning gears, lubrication system, jacking oil system, gland sealing, flange heating, LP exhaust cooling system,, drain system, by pass system. **(06 Hrs)**

Feed heating system: HP feed heating, deaerator system; LP feed heating, auxiliary steam system **(06 Hrs)**

Condenser: On load cleaning, different pumps, cooling towers **(05 Hrs)**

Instrumentation and control: TG instruments, controls, boiler following turbine and turbine following boiler. **(05 Hrs)**

Operation and Maintenance of TG: Start up and shut down procedure, start up curves, maintenance of TG and aux., safety and fire protection **(05 Hrs)**

Performance: Performance of TG, condenser, feed water heater, cooling tower and pumps. **(05 Hrs)**

Piping: Fundamentals, pipeline sizing and specialties, piping layout engineering, piping analysis, pipe supports, thermal insulation. **(05 Hrs)**

Economic analysis of power plants and tariffs: the cost of electrical energy calculation. **(05 Hrs)**

REFERENCE BOOKS:

1. Modern Power Station Practice - Vol A to .E.BEIL Pergramon press
2. Power Plant engineering -EL -Wakil Tata Mcgraw hill.

PHME205 - ORGANIZATIONAL BEHAVIOR

1. **The Foundations of Organization Behavior** -Historical Background, Research Methodology, Theoretical Frameworks. OB in global context. Role of Information Technology, TQM, Learning Organizations **(10 Hrs)**

2. **Individual Behavior** Biographical Characteristics, Ability, Personality, Learning, Implications for Performance and satisfaction. Perception and Individual Decision-Making Values, Attitudes and *Job* Satisfaction. **(11 Hrs)**

3. **Basic Motivation Concepts** -Work Motivation Approaches -Content and Process Theories of Work Motivation -Contemporary Theories of Work Motivation -Motivation through Job Design, Quality of work Life, Goal Setting. **(11 Hrs)**

4. **Foundations of Group Behavior** -Communication and Group Decision Making -Leadership Styles and Skills -power and Politics -Conflict and Inter -group Behavior. **(10 Hrs)**

5. **Organization Culture** -organizational Change -Organizational Development Organizational Climate -Work stress**.** **(10 Hrs)**

REFERENCE BOOKS:

1. Organizational behavior- Fred luthans -mcgraw hill
2. Human behavior at work -Keith Davis -prentice hall India
3. Organizational behavior- Stephen p. Robbins -prentice hall India
4. Organizational psychology -robin, kolb, etc.

PHME206 - ADVANCED OPERATION RESEARCH

Basics of Operation Research: Introduction, Development of operation Research, art of modeling, phase of operation Research Study **(12 Hrs)**

Linear and Dynamic Programming: Introduction, Applications to Industrial problems Formations of mathematical models, solutions of L.P. Problems of nature of products mix, resource allocation, transportation and assignment by graphical Simplex and Dual simplex methods. Commutations techniques for the solution of L.P. Problem. Sensitivity analysis. Introduction to integer programming - Formulation and solutions, elements of dynamic programming applications, Recursive equation, representation and solution. **(20 Hrs)**

Probabilistic Models:

Decision theory and games theory, Decision under risk and decision under uncertainty. Inventory models with probabilistic demand (Simple cases) queuing models. Queuing theory and embedded Markow chains Introduction to simulation. **(20 Hrs)**

REFERENCE BOOKS:

1. Jackoff and Sasieni "Operation Research".
2. Gillet "Operation Research" Tata McGraw Hill.
3. Warger "operation Research" McGraw Hill.
4. Heny Taha "operation Research" McMillian.
5. **Revidran "Operation Research" J ohn.**
6. Pannerselvam ‘Operations research’ Prentice Hall 2002.

PHME207 - TRIBOLOGY AND BEARING DESIGN

1. **Introduction to Tribology**: Introduction, Regime of lubrication, Classification of contacts, lubrication theories. **(06 Hrs)**

2. **Hydrodynamic Lubrication**: Newton's Law of viscous forces (derivations). Flow through stationary parallel plates. Hagen's poiseville's theory, viscometers. Flow through capillary tube. Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe. Expression for load carrying capacity. Location of center of pressure, Numerical problems. Concept of lightly loaded bearings. Comparison between lightly loaded and heavily loaded bearings. Load carrying capacity of idealized full journal bearings, Numerical problems. Introduction to Elasto – hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution. **(20 Hrs)**

3. **Hydrostatic Bearings**: Different system of hydrostatic lubrication, Expression for discharge load carrying capacity. Torque calculations. Numerical problems. **(06 Hrs)**

4. **Porous & Gas Bearings**: Introduction to porous bearings. Equation for porous bearings. Introduction to gas lubricated bearings. Governing differential equation for gas lubricated bearings. Fretting phenomenon. **(12 Hrs)**

5. **Magnetic Bearings & Applications**: Introduction to magnetic bearings. Different equations used in magnetic bearings. Magneto-gas dynamo bearings. Advanced bearing technology. Service application chart. Lubrication of specific equipment in specific industries. Lubrication organization. Case studies of tribological problems. Magneto-hydrodynamic bearings. **(10 Hrs)**

TEXT BOOKS:

1. Mujamdar. B. C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001.
2. Radixmovsky, "Lubrication of Bearings –Theoritical principles and design" The Oxford press Company, 2000.

REFERENCES BOOKS:

1. Dudley D.Fuller" Theory and practice of Lubrication for Engineers", New York Company. 1998
2. Moore "Principles and applications of Tribology" Pergamon press.
3. Susheel Kumar Srivasthava "Tribology in industry" S.Chand and Co.
4. Pinkus 'O' Stemitch. "Theory of Hydrodynamic Lubrication"
5. Gerhand schwetizer, Hannes Bleuler & Alfons Traxler, "Active Magnetic bearings", Authors working group, www.mcgs.ch., 2003.

PHME208 - ROTOR DYNAMICS

1. **Fluid Film Lubrication:** Basic theory of fluid film lubrication, derivation of generalized Reynolds equations, boundary conditions, fluid film stiffness and Damping coefficients, stability and dynamic response for hydrodynamic journal bearing, two lobe journal bearings. **(04 Hrs)**

2. **Stability of Flexible Shafts:** Introduction, equation of motion of a flexible shaft With rigid support, radial elastic friction forces, rotary friction, friction Independent of velocity, friction dependent on frequency, different shaft stiffness Constant, gyroscopic effects, on-linear problems of large deformationApplied forces, instability of rotors in magnetic field.
   (08 Hrs)

3. **Critical Speed:** Dunkerley's method, Rayleigh's method, Stodola's method **(02 Hrs)**

4. **Rotor Bearing System:** Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, simple model with one concentrated mass at the center. **(05 Hrs)**

5. **Turborotor System Stability by Transfer Matrix Formulation:** The general turbolator system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions. **(10 Hrs)**

6. **Turborotor System Stability by Finite Element Formulation:** The general turborotor system, generalized forces and co-ordinates system assembly element matrices, consistent mass matrix formulation, lumped mass model, lineared model for journal bearings, system dynamic equations for stability analysis non dimensional stability analysis, unbalance response and transient analysis.

7. **Blade Vibration:** Centrifugal effect, transfer matrix and finite element, approaches, **(08 Hrs)**

REFERENCE BOOKS:

1. Cameron “Principles of Lubrication” Longmans
2. Bolotin, “Nonconservative problems of the theory of elastic stability” Pergamon
3. Peztel, Lockie, “Matrix methods of Elastomechanics” McGraw Hill.
4. Timosenko, Young, “Vibration Problems in Engineering” Von Nostrand
5. Zienkiewicz, “The Finite Element Method”, McGraw Hill.

PHME209 - FRACTURE MECHANICS

1. Fracture Mechanics Principles: Introduction sources of micro and macro cracks fracture criterion based on stress concentration and theoretical strength Griffith's energy, Balance approach, subsequent modifications, stress intensity factor approach.
2. Stress Analysis for Members with Cracks, Linear elastic fracture mechanics crack tip stresses and deformations, relation between stress intensity factor and fracture toughness stress intensity based solutions, 3-D cracks.
3. Crack tip Plastic Zone: Plastic zone estimation, plane stress plane strain, yielding fracture mechanics. Irwin's model, Dugdale's model.
4. Experimental determination of Fracture, Toughness, Specimen size requirements and various stress procedures, effects of temperature, loading rate and plate thickness on fracture toughness.
5. Elastic–Plastic Fracture Mechanics: Introduction, Elastic–Plastic fracture criteria, crack resistance curve(R), Path-independent integrals, J-integral, J-integral fracture criterion, crack opening displacement (COD), experimental determination of J-integral and COD.
6. Fatigue and Fatigue crack growth rate: Fatigue loading and deign concepts, various stages of fatigue crack propagation, fatigue crack growth laws, design applications, ariable amplitude loading.
7. Linear static fracture Mechanics Design Concepts: General fracture mechanics design procedure for terminal failure, design selection materials design, application examples including fatigue loading. Mixed mode fracture: Introduction, the stress criterion, strain energy density, 2_D linear elastic crack problems.
8. Dynamic Fracture: Introduction, Mohr's model, strain energy release rates, crack branching, practical applications of crack arresting techniques. Experimental determination of dynamic SIF.
9. NDT and Fracture Mechanics: Introduction, various NDT methods used in Fracture mechanics.

TEXT BOOKS:

1. Jayatilake, "Fracture of Engineering Brittle Materials, "Applied Science", London.
2. Anderson, T. L "Fracture Mechanics - Fundamental and Applications", CRC press 1998

REFERENCE BOOKS:

1. S.A. Meguid " Engineering fracture mechanics" Elsevier
2. David Broek, "Elementary Engineering Fracture Mechanics" Noordhoff.
3. Rolfe and Barsom, "Fracture and Fatigue Control in Structures", Prentice hall.
4. Karen Hellan, "Introduction to Fracture Mechanics", McGraw Hill.
5. Knott, "Fundamentals of Fracture Mechanisms", Butterworths.
6. Liefbowitz, "Fracture", Volume II.

PHME210 - RAPID PROTOTYPING

INTRODUCTION: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. **(03 Hrs)**

STEREO LITHOGRAPHY SYSTEMS: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. **(05 Hrs)**

SELECTIVE LASER SINTERING: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. **(04 Hrs)**

FUSION DEPOSITION MODELLING: Principle, Process parameter, Path generation, Applications. **(03 Hrs)**

SOLID GROUND CURING: Principle of operation, Machine details, Applications. **(03 Hrs)**

LAMINATED OBJECT MANUFACTURING: Principle, of operation, LOM materials. Process details, application. **(04 Hrs)**

CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model market, 3-D printer. Genisys Xs printer HP system 5, object Quadra systems. **(06 Hrs)**

LASER ENGINEERING NET SHAPING (LENS)

RAPID TOOLING: Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc >Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling. **(10 Hrs)**

SOFTWARE FOR RP: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools. **(06 Hrs)**

RAPID MANUFACTURING PROCESS OPTIMIZATION: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation. **(10 Hrs)**

ALLIED PROCESSES: vacuum casting, surface digitizing, surface generation from point cloud, surface modification-data transfer to solid models. **(04 Hrs)**

TEXT BOOKS:

1. Paul F. Jacobs: "Stereo lithography and other RP & M Technologies", SME, NY 1996.
2. Flham D. T & Dinjoy S.S "Rapid Manufacturing" Verlog London 2001.
3. Rapid automated by Lament wood. Indus press New York

REFERENCE BOOKS:

1. Terry Wohlers "Wohler's Report 2000" Wohler's Association 2000.
2. Rapid prototyping materials by Gurumurthi, IISc Bangalore.

NOTE: To cover syllabus by referring to the following books and websites for the respective chapters.

Chapter no.	Topic	Book Name / Web Site
1	• Introduction • Classification of RP system	• www.cadcamnet.com • www.home.att.net.castelisland • Rapid Manufacturing by D. T. Pham & S. S. Dimov.
2	• Stereolithography	• Rapid Manufacturing by D. T. Pham & S. S. Dimov. • Stere lithography & other RP & M Technologies by aul F. Jacobs.
3	• Selective Laser Sintering	• www.cadcamnet.com
4	• Fusion Deposition Modeling	• www.cadcamnet.com • Rapid Manufacturing by D. T. Pham & S. S. Dimov • A Brief Introduction: Rapid Prototyping by Amitabh gosh.
5	• Solid Ground Curing	• Rapid Manufacturing by D. T. Pham & S. S. Dimov
6	• Laminated Object Manufacturing	• Rapid Manufacturing by D. T. Pham & S. S. Dimov • A Brief Introduction: Rapid Prototyping by Amitabh gosh.
7	• Concept Modelers	• Rapid Manufacturing by D. T. Pham & S. S. Dimov
8	• Laser Engineering Net Shaping (LENS)	• www.optomee.com
9	• Rapid Tooling • Quick Cast • Direct aim & Keltool	• Rapid Manufacturing by D. T. Pham & S. S. Dimov. • Stere lithography & other RP & M Technologies by aul F. Jacobs. • www.3dsystems.com
10	• Software for PP	• www.materalise.com
11	• Process Optimisation • Introduction to Taguchi's method for optimization	• Rapid Manufacturing by D. T. Pham & S. S. Dimov.
12	• Allied Process • Vacuum casting	• Stere lithography & other RP & M Technologies by aul F. Jacobs. • www.mep-group.co.uk

Question Paper Pattern:

Chapter No.1 to 8 → 60% → 05 Questions.
Chapter No.9 & 12 → 30% → 02 Questions.
Chapter No.10 & 11 → 10% → 01 Questions.

Sl. No.	Q. No.	From Chapter No. & Topic	Book Name / Web Site
1	2	1. Introduction 2. Stereo lithography	Rapid Manufacturing by D. T. Pham & S. S. Dimov.
2	1	3. Selective Laser Sintering 4. Fusion Deposition Modeling	www.cadcamnet.com & Rapid Manufacturing by D. T. Pham & S. S. Dimov.
3	1	5. Solid Ground Curing 6. Laminated Object Manufacturing	Rapid Manufacturing by D. T. Pham & S. S. Dimov. & A Brief Introduction: Rapid Prototyping by Amitab gosh
4	1	7. Concept Modelers 8. Laser Engineering Net Shaping (LENS)	Rapid Manufacturing by D. T. Pham & S. S. Dimov. & www.optomee.com
5	2	9. Rapid Tooling 12. Allied Process	Rapid Manufacturing by D. T. Pham & S. S. Dimov. & Stere lithography & other RP & M Technologies by aul F. Jacobs. www.mep-group.co.uk
6	1	10. Software for RP 11. Rapid Manufacturing Process Optimization	Rapid Manufacturing by D. T. Pham & S. S. Dimov. & www.materalise.com

PHME211 - DESIGN ANALYSIS

INTRODUCTION:

Modeling, meshing, Boundary conditions, Loads, Optimization. **(08 Hrs)**

SHEET METAL ANALYSIS:

Metal Flow Analysis, Heat analysis, Micro structure analysis, Stress analysis, Thermo mechanic processing, Heat transfer analysis, Residual stress analysis, Static analysis, Contact analysis, Buckling analysis, Bending analysis, Natural frequency. **(14 Hrs)**

MOLD ANALYSIS:

Shrinkage analysis, Warpage analysis, Flow analysis. **(06 Hrs)**

DIE CASTING ANALYSIS:

3D -mesh generation, Heat flow, fluid flow, Stress and Strain, Microstructure modeling, inverse modeling, die life estimation. **(12 Hrs)**

SOFTWARE USED:

Mold flow, Pro-cast; Pro-Mechanica, De-form. **(12 Hrs)**

REFERENCE BOOK:

1. Operating Manuals of mold flow, PSG-cast, PSG Mechanica, Deform.

PHME212 - FINITE ELEMENT ANALYSIS

1. Calculus of variation, Introduction to calculus of variations, Introduction to equilibrium equations in elasticity, Euler's Lagrange's equations, Principal of virtual work, virtual displacements, Principles of minimum potential energy, boundary value, initial value problems, Flexibility approach, Displacement approach, Different problems in structural analysis.
2. FEM Procedure, Derivation of FEM equations by variation principle polynomials, Concept of shape functions, Derivation for linear simplex element, Need for integral forms, Interpolation polynomials in global and local coordinates.
3. Weighted residual Methods: Concept of weighted residual method, Derivation of FEM equations by Galerkin's method, Solving cantilever beam problem by Galerkin's approach, Derivation of shape functions for CST triangular elements, Shape functions for rectangular elements, Shape functions for quadrila1.eral elements.

   Higher order Elements: Concept of iso-parametric elements, Concept of sub-parametric and super - parametric elements, Concept of Jacobin matrix.
4. Numerical Integration: Numerical Integration, one point formula and two point formula for 2D formula, Different problems of numerical integration evaluation of element stiffness matrix, Automatic mesh generation schemes, Pascal's triangle law for 2D shape functions polynomial, Pascal's triangle law for 3D shape function polynomials, Shape function for beam elements, Hermition shape functions.
5. Convergence: Convergence criteria, Compatibility requirements, Geometric isotropy invariance, Shape functions for iso-parametric elements, Special characteristics of stiffness matrix, Direct method for deriving shape functions using Langrage's formula, Plane stress problems.

6. Analysis of structures: Truss elements, Analysis of truss problems by direct stiffness method. Analysis of frames and different problems, Different axi-symmetric truss problems.

TEXT BOOK:

1. The Finite Element method -ZIENKIEWICZ.O.C.Tata McGraw Hill Pub. New Delhi, 2000

REFERENCE BOOKS:

1. Finite Elements in Engineering:- Chandrupatta, et. AI. Prentice Hall of India Pvt. Ltd., New Delhi, 2000
2. Concepts and Applications of Finite Element Analysis: COOK. D. Robert. Malus.S.David, Plesha E. Michel, John wilely & sons 3rd Edn. New York, 2000
3. Finite Element Analysis -C. S. Krishnanmoorthy, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1995
4. Introduction to the Finite Element method -Desai / ABEL-C.B.S. Publishers & Distributors, New Delhi 2000

PHME212 - BIOMASS ENERGY SYSTEMS

Introduction: Relevance of biomass as an energy source, Biomass Resources, Cultivated biomass resources, Water-to-biomass resources, Advantages associated with biomass resources, Availability of biomass for energy generation. **(06 Hrs)**

Energy plantation: Concept, Objectives and advantages. **(06 Hrs)**

Wasteland development: Extent of water lands in India, Nature of waste lands. **(06 Hrs)**

Biomass Conversion Processes: Combustion, Biochemical and Thermo chemical.

Gasification: Fuels for gasification, Properties of biomass - size, size distribution, bulk density, volatile matter, ash and ultimate analysis. **(06 Hrs)**

Air gasification in a down draft gasifier, Types of gasifiers, Gasifier engine system, Use of producer gas in SI & CI engines, Reasons for decorating, Problems associated with gasifier engine system and its efficiency **(06 Hrs)**

Performance of Dual Fuel Engine: Power capacity, Diesel substitution, Thermal efficiency, Smoothness of operation, Load following capability, Maintenance and durability, Exhaust emissions.

Design of a Down draft gasifier

Cooling–cleaning systems

Performance evaluation of a Down draft gasifier. **(08 Hrs)**

Bio-conversion Process: The process, Types of biogas plants, Design of biogas plants, Factors affecting gas generation rate, Biogas engine for water pumping and electric power generation applications, Government programmes, **(06 Hrs)**

Wood fuelled Cooks stoves, Effects of various stove parameters, Effects of various stove components, Current versions of improved stoves, Efficiency of stoves, Utilization of biomass based fuels for thermal and shaft power applications **(08 Hrs)**

TEXTS / REFERENCE BOOKS:

1. A. Kaupp and J. R. Goss: “State of Art Report for small scale Gas Producer Engine Systems”, Friedr Vieweg & Sohn Verlags, Gmbh, Braunschweig, 1984.
2. T. B. Reed: “Biomass Gasification Principles and Technology”, Noyes Data Corporation,Energy Technology Review, No.67, U.S.A., 1981.
3. O P Vimal & M S Bhatt: “Wood Energy Systems”, K L Publications, New Delhi – 1989
4. S Rao & B B Parulkar: “Energy Technology” Khanna Publishers Delhi – 1999

PHME214 - ENERGY STORAGE

Importance and modes of energy transport and storage **(04Hrs)**

Thermal energy storage (sensible and latent heat storage) **(04 Hrs)**

Mechanical Energy Storage: gravitational energy storage, elastic energy storage **(04Hrs)**

Electromagnetic energy storage: static field, transient electric field, magnetic materials, radiant storage. **(04 Hrs)**

Electro-chemical energy conversion and storage: The electrochemical cell, Fuel cells, batteries. **(04 Hrs)**

Chemical energy storage (organic fuels) **(04 Hrs)**

High temperature storage **(04 Hrs)**

Compressed air energy storage **(04 Hrs)**

Thermo chemical storage **(04 Hrs)**

Emerging technologies and examples of energy storage **(04 Hrs)**

Testing of storage systems **(04 Hrs)**

Thermal modeling of energy storage systems **(04 Hrs)**

Total energy systems **(04 Hrs)**

TEXTS / REFERENCE BOOKS:

1. Johannes Jensen & Bent Sorensen : “Fundamentals of energy storage”
2. Collins : “Batteries Vol. I & II”.
3. S. U. Faulk & A. J. S SaIkins : “Silver Zinc - Alkaline storage systems”

PHME215 - DESIGN OF HEAT EXCHANGERS

Design principle of heat transfer equipment, LMTD and NTU method, design of double pipe heat exchanger, shell and tube heat exchanger, compact heat exchangers, plate and heat pipe type, feed water heaters, drain coolers and floor coil heaters.

Design of boiler furnace water wall tubes, super heaters, re-heaters and economizers.

Design of regenerative and recuperative air pre-heaters. **(26 Hrs)**

Design of Steam condensers, fuel oil heaters, fuel oil suction heaters and fires heaters.

Analysis mass transfer equipment's like cooling towers, spray ponds etc. Mechanical design of heat exchangers, use of commercial software packages for design and analysis, optimization. **(26 Hrs)**

REFERENCE BOOKS:

1. S. Kokac, Heat Exchangers-Thermal, Hydraulic fundamentals and design, hemisphere. McGraw Hill
2. D. Q Kern and Kraus: Extended surface heat transfer McGraw Hill
3. W. M Krays and A. C London: Compact heat exchangers McGraw Hill
4. A. P. Frass and M. N. Ozisik Heat Exchange design, John vilely and sons
5. D. Q Kern: Process heat transfer McGraw Hill
6. V. Ganapathy: Applied heat transfer

PHME216 - ADVANCED FLUID MECHANICS

Incompressible and in viscid flow in two dimensions: The continuity equation, Stream function for uniform stream, sources and sink, flow field due to source and sink, doublet, two dimensional flow past solid bodies, and vortex potential, Velocity functions, two dimensional airfoil theory, conformal transformation, Thin airfoil theory, airfoil of finite span, effect of viscosity and compressibility. **(12 Hrs)**

Viscous fluid flow: Equation of continuity, equation of motion, derivation of N S equations, energy equations in incompressible flows. Limiting cases of small viscosity, exact solution, theory of hydrodynamic lubrication. Two dimensional laminar boundary layer, flow separation, effect of pressure gradient, the exact solution, boundary layer thickness, skin friction, approximate methods of solution, momentum integral equation, two-dimensional flow with zero pressure gradient, flow with pressure gradient, boundary layer circulation, stresses stability of laminar boundary layer. Turbulent flow, additional turbulent stresses. Boussiwesq's hypothesis, Prandtl's mixing length hypothesis, universal velocity distribution, turbulent flow in pipes, turbulent boundary layer with zero pressure gradient.

(20 Hrs)

Three-dimensional flow: Equation of continuity, Stoke's stream function, flow, velocity potential function, standard flow patterns, uniform flow source doublet, line source line sink and uniform flow function, flow past stream-lined body. **(12 Hrs)**

Gas Dynamics: Compressible effect, steady 1D compressible flow, perfect gas flow in a duct, isentropic flow with friction, normal and oblique shocks **(08 Hrs)**

REFERENCE BOOKS:

1. Grimsons : Advanced fluid mechanics
2. Yuan : Fundamentals of fluid mechanics
3. H. R. Vailentine: Applied hydrodynamics
4. J. K. Vennard and Robert L. Street: : Elementary fluid mechanics

PHME217 - CONDUCTION AND RADIATION HEAT TRANSFER

Conduction: Derivation of generalized conduction equation for an isotropic, inhomogeneous solids, conductive tensor, concepts of iso- tropjc and homogeneous conductivity. Steady state conduction recapitulation of fundamentals analysis and design variable and cross section and circumferential tins. Analysis of heat conduction in 2-D fins, 2-D and 3-D conduction in solids with- complex boundary conditions and heat generation, Transient conduction: Recapitulation of transient conduction in simple systems. Analysis of transient heat conduction with complex boundary. **(20 Hrs)**

Conditions: application of Duhamel's theorem, special topics: the use of Laplace transformation in linear conduction, problems, The use of Green function in the solution of the equations of conduction, Numerical methods; Fundamentals of discrimination treatment of boundary conditions, on linearity of properties, anisotropy and complex boundaries **(16 Hrs)**

Radiation: Recapitulation of fundamentals of radiative heat transfer, radiative properties of surfaces, methods of estimating configuration factors, heat exchange between diffusively emitting and diffusively reflecting surfaces. Radiant energy transfer through absorbing, emitting and scattering media. Combined conduction and radiation systems: fins, introduction to solar radiation in earth's atmosphere. **(16 Hrs)**

REFERENCE BOOKS:

1. V. S Arpaci - Conduction Heat Transfer
2. E. M Sparrow, R. D Cess - Radiation Heat Transfer
3. R. Siegal and J. R Howell-Thermal radiation heat transfer

PHME218 - THEORY AND DESIGN OF STEAM AND GAS TURBINES

Steam turbine types: Introduction, classification of turbines as to flow passages and arrangement, classification as to use and operating conditions, other classifications and recapitulation of classification. **(02 Hrs)**

Gas-turbine types: Introduction, gas turbine engine and its components, classification according to application, cycle, and fuel, combined steam and gas turbine power plants, some advantages of gas turbine. **(02 Hrs)**

Gas dynamics: Compressibility effect , steady 1D compressible flow, perfect gas flow in a duct, isentropic flow with friction, normal and oblique shock waves, isentropic 2D, supersonic expansion and compression. **(02 Hrs)**

Design of Nozzles: Introduction, construction, critical pressure ratios, losses, divergence and position angles, wet and super saturated steam, shock waves in nozzles, discharge coefficients, and nozzle calculations. **(03 Hrs)**

Energy Interchange in Fluid Machinery: Introduction: momentum principles, streamline theory, momentum and circulation, energy changes in fluid. **(02 Hrs)**

The impulse turbine: Introduction, forces, relative velocity, blade velocity, work and efficiency, ideal blades, velocity diagram, theoretical analysis of stage work and efficiency, combined nozzle and blade efficiency, staging, Curtis staging, velocity ratio, mixed staging. **(03 Hrs)**

The Reaction turbine: Introduction, velocity diagrams, theoretical work and efficiency-symmetrical reaction stage, comparison of energy-absorbing abilities of various stages.
The Axial flow Compressor: Introduction, velocity diagrams, and energy transfer from rotor to fluid. **(03 Hrs)**

Design of Turbine Flow Passages: Introduction, Iscentropic velocity ratio, energy distribution, carry-over effect. **(02 Hrs)**

Impulse turbine flow passage: Blade profiles, pitch, width, and height, entrance/exit angels, efflux angles, and losses in passages. **(02 Hrs)**

Reaction turbine flow passage: Blade angles, profiles, and gauging, pitch, width, and height, losses in passages. **(02 Hrs)**

Flow passage with radial equilibrium: Free and forced vortex, requirements for radial equilibrium, velocity diagrams, airfoil elements and principle, limitations of single airfoil principle, cascade principle, general comments on design of turbine flow passages, velocity ratio relations, design calculations impulse and multi stage flow passages. **(02 Hrs)**

Mechanical aspects of turbine design: Introduction, losses, disc Junction, Windage Losses, Leakage, preventive measures to reduce leakage, Labyrinth seals, carbon-ring seals, water, steam, and air seals, special sealing devices, leakage efficiency, bearing losses, radiation losses, miscellaneous losses, stage output and efficiency, turbine output. **(03 Hrs)**

The Turbine Rotor: Blade stresses, centrifugal stresses, bending stresses, vibrations, disc stresses, blade fastenings, lacing wires, cooling of gas turbine blades, shrouding. **(02 Hrs)**

Metallurgical considerations: Properties of metals, damping, corrosion, creep, endurance, oxidation, workability, characteristics and properties of some alloys other than steel. **(02 Hrs)**

Turbine Casing and Accessories: Steam-turbine casing, gas turbine casings, and joints. **(02 Hrs)**

Steam turbine Control and Performance: Introduction: control and supervisory instruments, principles of governing, direct-acting speed-responsive governors, characteristics of the simple speed-responsive governor, speed-responsive governors with servomotors, hydraulic speed-responsive governor, pressure regulators, speed regulation and parallel operation, emergency governors. **(03 Hrs)**

Performance: Introduction, effect of throttle governing, effect of initial pressure and temperature changes, effect of nozzle governing, Parsons number and quality factor, performance of automatic extraction turbines, performance of the mixed-pressure turbine, A-C generator, AIEE-ASME preferred standard turbine. **(02 Hrs)**

The Centrifugal Compressor: Introduction, description and operation, energy transfers and relations, losses, adiabatic efficiency, effect of compressibility, the diffuser, Prewhirl, performance characteristics, pressure coefficient and slip factor, surging, centrifugal compressor design calculations. **(03 Hrs)**

The Axial-flow Compressor: Introduction, stage characteristics, blading efficiency, design coefficients, blade loading, lift coefficient and solidity, cascade characteristics, blade angles, Mach number and Reynolds number, three-dimensional flow considerations, supersonic axial-flow air compressor, performance characteristics, axial-flow computations. **(03 Hrs)**

Combustion: Introduction, thermo chemistry of combustion, combustion equations, laws of gas mixtures, entropy of a mixture of ideal gases, chemical equilibrium, heat of reaction, the Le Chatelier principle, dynamics, heats of reaction and heats of combustion, reference state, flame temperatures, dissociation. **(03 Hrs)**

The mechanics of combustion: Combustion mechanisms, physical characteristics of combustion and reactive mixtures, pressure losses. **(02 Hrs)**

The Combustor: requirements, efficiency, fuel injection and atomization, combustion chamber. **(02 Hrs)**

REFERENCE BOOKS:

1. J. F. Lee Theory and design of steam and gas turbine, MGH
2. Cohen and Rogers, Gas Turbines
3. Church, Steam turbines
4. W. J. Kerton-Steam turbine theory and practice, C. B. S Publishers

PHME219 - ROBOTICS

Introduction: Definition, types and representation of robots, Construction of manipulators, Advantages and disadvantages of various kinematics structures. Applications. Pneumatic, Electric and Hydraulic actuators, characteristics and control, Non-servo robots, motion planning, Feedback systems, encoders, Servo control, PTP & CP. **(16 Hrs)**

Kinematics, Homogeneous Co-ordinates, solution of Inverse kinematics problems. Multiple solutions, Jacobean work-envelopes, Trajectory planning, manipulator dynamics and force control. **(10 Hrs)**

Robot sensors, vision, Ranging, LASER Acoustic, tactile, Developments in sensor technology, sensory control, Programming languages-VAL, RAIL, AML. **(12 Hrs)**

Mobile Robots- Introduction, land surface robots-arrangement of wheels and tracks navigation for land vehicles – control and communications, types of operation of mobile robots, legged robots-Leg number and arrangement – control – climbing robots submersible robots in air and space – Automated Guided Vehicles (AGV) Walking Devices. **(14 Hrs)**

REFERENCE BOOKS:

1. J. Duffy, “ANALYSIS OF MECHANISUM AND ROBOT MANIPULATERS”, John Willey & Sons, 1980.
2. B. Rooks (ED) “ROBOT VISION AND SENSERY CONTROLS”, Vol3, North Holland.
3. M. P. Groover, “INDUSTRIAL ROBOTICS”, MGHI.
4. Craig, “ROBOTICS”, Addison-Wesley.
5. D. J. Todd, “WALKING MACHINES – AN INTRODUCTION TO LEGGED ROBOTS”, Kogan Page Ltd, London, 1985.
6. Y. Koren, “ROBOTICS FOR ENGINEERS”, MGH

PHME220 - SIMULATION AND MODELING OF MANUFACTURING SYSTEMS

PRINCIPLE OF COMPUTER MODELLING AND SIMULATION: Monte Carlo simulation. Nature of computer- modeling and simulation. Limitations of simulation, areas of applications. **(06 Hrs)**

SYSTEM AND ENVIRONMENT: Components of a system -discrete and continuous systems, Models of a system -a variety of modeling approaches. **(06 Hrs)**

DISCRETE EVENT SIMULATION: Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, too server queue, simulation of inventory problem. **(06 Hrs)**

STATISTICAL MODELS IN SIMULATION: Discrete distributions, continuous distributions. **(04 Hrs)**

RANDOM NUMBER GENERATION: Techniques for generating random numbers- Mid square method -the mod product method -Constant multiplier technique -Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smimov test -the Chi-square test. *** Ivica Cmkovic, Ulfaskluna and Annita borsen Dohlgvist Publisher Artechhouse. **(08 Hrs)**

RANDOM VARIABLE GENERATION: Inversion transforms technique-exponential distribution. uniform distribution, weibul distribution, continuous distribution, generating approximate normal variates-Erlang distribution. **(06 Hrs)**

EMPIRICAL DISCRETE DISTRIBUTION: Discrete uniform -distribution poisson distribution - geometric distribution -acceptance -rejection technique for Poisson distribution gamma distribution. **(06 Hrs)**

DESIGN AND EVALUATION OF SIMULATION EXPERIMENTS: variance reduction techniques - antithetic variables, variables-verification and validation of simulation models. **(06 Hrs)**

SIMULATION SOFTWARE: Selection of simulation software, simulation packages. **(06 Hrs)**

TEXT BOOKS:

1. Jerry Banks & John S Carson II, "Discrete Event System Simulation". Prentice Hall Inc. 1984.
2. Gordan. G. "Systems Simulation", Prentice Hall India Ltd, 1991.

REFERENCE BOOKS:

1. Nusing Deo, "System Simulation with Digital Computer", Prentice Hall of India 1979.
2. Francis Neelamkovil, "Computer Simulation and Modeling", John Wilely & Sons, 1987.
3. Rath M. Davis & Robert M O Keefe, "Simulation Modeling with Pascal'. Prentice Hall Inc.1989.

PHME221 - TOOL DESIGN

1. **Tool-design Methods**

   Introduction, the design procedure, drafting and design techniques in tooling drawing **(02 Hrs)**

2. **Tool-making Practices**

   Introduction, tools of the tool maker, hand finishing and polishing, screws and dowels, hole location, jig-boring practice, installation of drilling bushings, punch and die bushings, punch and die manufacture, EDM, EDM for cavity applications, tracer and duplicating mills for cavity applications, low-melting tool materials. **(04 Hrs)**

3. **Tooling Materials and Heat Treatment**

   Introduction, properties of materials, ferrous tooling materials, non-ferrous tooling materials, non-metallic tooling materials, heat treatment and tool design. **(02 Hrs)**

4. **Design of Cutting Tools**

   Introduction, the metal cutting process, revision of metal cutting tools-single point cutting tools, milling cutters, drills and drilling, reamers, taps. Selection of carbide tools, determining the insert thickness for carbide tools. **(04 Hrs)**

5. **Design of Tools for Inspection and Gaging**

   Introduction, work piece quality criteria, principles of gaging, types of gages and their applications, amplification and magnification of error, gage tolerances, selection of material for gages, indicating gages, automatic gages, gaging positionally toleranced parts, problems. **(04 Hrs)**

6. **Locating and Clamping Methods**

   Introduction, basic principle of location, locating methods and devices, basic principle of clamping. **(02 Hrs)**

7. **Design of Drill Jigs**

   Introduction, types of drill jigs, general considerations in the design of drill jigs, drill bushings, methods of construction, drill jigs and modern manufacturing. **(04 Hrs)**

8. **Design of Fixtures**

   Introduction, types of fixtures, fixtures and economics. **(02 Hrs)**

9. **Design of Press-working Tools**

   Power presses, cutting operations, types of die-cutting operations and their design, evolution of blanking and progressive blanking dies **(04 Hrs)**

10. **Design of Sheet Metal Bending, Forming and Drawing Dies**

    Introduction, bending dies, forming dies, drawing dies. Evolution of a draw die, progressive dies and selection of progressive dies. Strip development for progressive dies, evolution of progressive dies, examples of progressive dies. Extrusion dies, drop forging dies and auxiliary tools, problems.

    (06 Hrs)

11. **Tool Design for Joining Processes**

    Introduction, tooling for physical joining processes, tooling for soldering and brazing, tooling for mechanical joining processes, problems. **(04 Hrs)**

12. **Tooling for Casting**

    Introduction, tooling for sand casting, shell moulding, metal moulding and die-casting, problems.

    (04 Hrs)

13. **Tool Design for NC Machine Tools**

    Revision of NC control, fixture design for NC machine tools, cutting tools and tool-holding methods, automatic tool changers and tool positioners. **(04 Hrs)**

14. **Plastics as Tooling Materials**

    Introduction, plastics commonly used as tooling materials, application of epoxy plastic tools, construction methods, metal-forming operations with Urethane dies, calculating forces for Urethane pressure pads, problems. **(04 Hrs)**

TEXT BOOKS:

1. Cyril Donaldson, GH Lecain and VC Goold, Tool Design, 3rd editon, TMH Publishing Co Ltd., New Delhi, 2000
2. ASTME, Fundamentals of Tool Design, PHI (P) Ltd., New Delhi, 1983

REFERENCE BOOKS:

1. Cutting tool design by Rodin Mir publications.
2. Metal cutting & Tool design by arshinov
3. Press working of metals by HINMA

PHME222 - NON TRADITIONAL MACHINING

Introduction: Need for non-traditional machining processes. Processes selection classification on-comparative study of different processes. **(04 Hrs)**

Mechanical Process: Ultrasonic Machining-Definition-Mechanism of metal elements of the process-Tool feed mechanism, theories of mechanics of causing effect of parameter applications. **(04 Hrs)**

Abrasive Jet Machining: Principles – parameters of the process applications-advantages and disadvantages. **(04 Hrs)**

Thermal Metal Removal Processes: Electric discharge machining-Principle of operation – mechanism of meta removal basic EDM circuitry-spark erosion get Analysis of relaxation type of circuit-material removal rate in relaxation circuits- critical resistance parameters in Ro Circuit-Die electric fluids-Electrodes for sparl surface finish, applications. **(08 Hrs)**

Electro chemical and chemical processes: Electro chemical machining (ECM) Classification ECM process-principle of ECM – Chemistry of the ECM parameters of the processes-determination of the metal removal rate – dynamics of ECM process-Hydrodynamics of ECM process-polarization-Tool Design-advantages and disadvantages-applications. Electro Chemical Grinding-Electro Chemical holding Electrochemical deburring. **(08 Hrs)**

Chemical Machining: Introduction-fundamental principle types of chemical machining Maskants-Etchenes- Advantages and disadvantages-applications. **(04 Hrs)**

Plasma Machining: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters-process characteristics – type of torches applications. **(04 Hrs)**

Electron beam machining (EBM): Introduction-Equipment for production of Electron beam – Theory of electron beam machining – Thermal & Non thermal types characteristics – applications. **(04 Hrs)**

Laser Beam Machining (LBM): Introduction-principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations-applications **(04 Hrs)**

Ion Beam Machining: Introduction-Mechanism of metal removal and associated equipment-process characteristics applications **(04 Hrs)**

High Velocity forming process: introduction – development of specific process selection-comparison of conventional and high velocity forming methods – Types of high velocity forming methods-explosion forming process-elector hydraulics forming magnetic pulse forming. **(04 Hrs)**

REFERENCE BOOK:

1. Bhattacharya “New technology” Institution of Engineers, India
2. HMT “Production technology” Tata Mc Graw Hill.
3. P. C Pandy & H. S. Shan “Modern Machining Process” Tata Mc Graw Hill.
4. ASM “Metals hand book” Vol-3.
5. F.M Wilson “High velocity forming of metals” ASTME Pretice Hall.
6. Adithan “Modern Manufacturing Method”
7. P. K. Mishra “Modern Machining Processes”.

PHME223 - FLEXIBLE MANUFACTURING SYSTEM

PART – A

FMS – AN OVERVIEW: Definition of an FMS – Types & configurations concepts – Types of flexibility & performance measures. Function of FMS host computer – FMS host and area controller function distribution. **(04 Hrs)**

DEVELOPMENT & IMPLEMENTATION OF AN FMS: Planning phase – Integration – System configuration – FMS layouts – Simulation – FMS Project development steps. Project management – Equipment development – Host system development – planning – Hardware & Software development. **(08 Hrs)**

AUTOMATED MATERIAL HANDLING & STORAGE: Functions – Types – Analysis of material handling equipments, Design of Conveyor & AGV systems. Problems. **(05 Hrs)**

AUTOMATED STORAGES: Storage system performance – AS/RS – Carousel storage system – WIP storage system – interfacing handling storage with manufacturing. **(05 Hrs)**

MODELLING AND ANALYSIS OF FMS: Analytical, Heuristics, Queuing simulation and Petrinet modeling techniques-scope applicability and limitations. **(06 Hrs)**

PART – B

CONCEPTS OF DISTRIBUTED NUMERICAL CONTROL: DNC system – Communication between DNC computer & machine control unit – Hierarchical processing of date in DNC system – Features of DNC systems. **(06 Hrs)**

SCHEDULING & LOADING OF FMS: Introduction – Scheduling of operations on a single machine – 2 machine flows hop scheduling – 2 machine jop shop scheduling, 3 machine flow shop scheduling – scheduling 'n' operations on 'n' machines – Scheduling rules – loading problems – Tool management of FMS – material Handling system schedule. Problems.

Inspection & Cleaning stations. CMM**,** Sequence of operations, Advantages Types of CMM, Problems. **(10 Hrs)**

FMS RELATIONAL: Economic and technological justification for FMS – as GT, JIT – operation and evaluation – Personnel and infra structural aspects – typical case studies – Future prospects. **(08 Hrs)**

TEXT BOOKS:

1. Parrish D J, Flexible manufacturing, Butter Worth – Heinemann, Ltd Oxford, 1993
2. GROOVER M P, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall India (P) Ltd, 1989.
3. Kusiak A, Intelligent Manufacturing Systems, Prentice Hall, Englewood Clitts, NJ, 1990.
4. William W. Luggen – Flexible Manufacturing Cells & Systems, Prentice hall, NJ

REFERENCE BOOKS:

1. CONSIDINE D M, and CONSIDINE G D, Standard Handbook of Industrial Automation, Chupman and Hall, London, 1986.
2. Viswanatham N & Narahari Y, Performance Modeling of Automated Manufacturing Systems, Prentice Hall of India (P) Ltd, 1992.
3. Ranky P G, The design and Operation of FMS, IFS Pub. Uk, 1988.
4. Dr. H. K. Shivanand, "Flexible Manufacturing System" – Dhanpat Rai Publications, New Delhi.

PHME224 - MODELING SIMULATION AND ANALYSIS OF MANUFACTURING SYSTEM

1. **Principles of Modeling & Simulation:** Basic Simulation Modeling, Limitation of Simulation, Monte - Carlo Simulation, Areas of Applications, Discrete and Continuous Systems. **(12 Hrs)**

2. **Modeling Approaches:** Modeling Complex Systems, Simulation Software, Basics Probability and Statistics, Building Valid and Credible Simulation Models. **(10 Hrs)**

3. **Random Number and Variable Generation:** Selecting Input Probability Distributions, Random Number Generators, Generating Random Variants, and Output Data Analysis for a Single System. **(10 Hrs)**

4. **Statistical Techniques:** Comparison of Alternative Systems, Variance Reduction Techniques. **(10 Hrs)**

5. **Simulation Studies:** Discrete Event Simulation, Simulation of Inventory Problems, Experimental Design and Optimization, Simulation of Manufacturing Systems, Case Studies. **(10 Hrs)**

TEXT BOOKS:

1. Simulation, Modeling and Analysis –Averill Law & David M. Kelton, TMH 3rd Edition.
2. Discrete event and Simulation Systems – Banks & Carson, Prentice Hall Inc.

REFERENCE BOOKS:

1. System Simulation- Gordon, PHI.
2. System Simulation with Digital computer – Deo, PHI
3. Computer Simulation and Modeling – Francis Neelamkovil, John Wiley & Sons.

PHME225 - MICROPROCESSOR & MICRO CONTROLLER

1. **Introduction To Microprocessors:** Introduction to Microprocessors, Microprocessor based Computer Systems, Architecture of 8085, 8086. Segmentation and Memory Addressing. **(06 Hrs)**

2. **Microprocessors Assembly Language Programming:** Addressing Modes of 8086, Data Movement Instructions. Instruction Encoding, Arithmetic and Logic Instructions. Programming Examples. Machine Control and Miscellaneous Instructions. **(10 Hrs)**

3. **Hardware Feature Of 8086:** Pin Outs and Pin Functions. Clock Generator, Bus Buffering, Latching and Timing Diagrams. Ready and Wait State. **(04 Hrs)**

4. **Interrupt Systems, Memory and I/O Interfacing In Microprocessors:** Introduction to Interrupts, Interrupt related Instructions, Interrupt Processing, Memory Devices, Address Decoding, 8/16-Bit Memory Interfacing, DRAM Memory Systems. Introduction to I/O Interfacing. Memory Mapped and I/O Mapped I/O; Application examples related to Stepper Motor, Temperature Control and Robot Control. **(10 Hrs)**
5. **Introduction to Micro Controllers:** Introduction, Comparing Microprocessors and Micro Controllers, Z-80, 8051, PIC Micro Controllers, PIC Development Tools. The Micro Controller Survey, 4Bit, 8Bit, 16Bit And 32 Bit Micro Controllers. Develop Systems for Micro Controllers.

6. **Micro Controllers Architecture:** 8051 Architecture, PIC Architecture, 8051 Micro Controller Hardware, Input/Output Pins, Ports and Circuits, External Memory, Counter And Timers, Serial Data Input/Output, Interrupts. **(04 Hrs)**

7. **Basic Assembly Language Programming Concepts In Micro Controllers:** The Mechanics Of Programming, The Assembly Language Programming Process, PAL Instructions, Programming Tools and Techniques. Addressing Modes, Data Exchanges, Code Memory Read-Only Data Moves, Push Pop Op Codes, Logical Operators, Arithmetic Operators, Jump and Call Instructions. Programming Concepts for 8051 and PIC. **(10 Hrs)**
8. **Micro Controller Applications:** Introduction, Key Boards, Displays, Pulse Measurement, D/A and A/D Conversions, Multiple Interrupts. Programming the 8255. **(04 Hrs)**

TEXT BOOKS:

1. Advanced Microprocessors and IBM PC, K. Udaya Kumar & B.S. Umashankar TMH
2. Design with PIC and Micro controllers. John B Peatman, Pearson Education

REFERENCE BOOKS:

1. The Intel Microprocessors Fourth Edition, Barry .B.Brey, PHI
2. Microprocessors and Interfacing, Douglas V.Hall, McGraw Hill
3. Computer Organization and ALP, Michael Throne , Addison Wesley
4. Essentials of ALP, Rajaraman, Radhakrishna, PHI
5. The 8051 Micro Controller Architecture, Programming, and applications. Kenneth J. Ayala, Penram International

PHME226 - THEORY OF ELASTICITY

1. Introduction: Definition and Notation for forces and stresses. Components of stresses, equations of Equilibrium, specification of stress at a point. Principle stresses and Mohr's diagram in three dimension. Boundary conditions, Strain components, specification of strain at a point, compatibility equations. **(08 Hrs)**

2. Stress-strain relation and the general equation of elasticity. Generalised Hooke's law in terms of engineering constants. Formulation of elasticity problems. Existence and uniqueness of solution, Saint-Venant's principle, principle of super-position and reciprocal theorem. **(08 Hrs)**
3. Two dimensional problems in Cartesian co-ordinates – Airy's stress function, investigation for simple beam problems. Bending of a narrow cantilever beam under end load, Simply supported beam with uniform load, use of Fourier series to solve two dimensional Problem. **(08 Hrs)**

4. Two-dimensional problems in polar co-ordinates. General equations, stress distribution symmetrical about an axis, Pure bending of curved bar, strain components in polar coordinates, rotating disk and cylinder, bending of a curved bar by a force at the end, effect of circular holes on stress distribution in plates, concentrated force at a point of a straight boundary, any vertical loading of a straight boundary, forces acting on the end of a wedge, stresses in a circular disk. **(10 Hrs)**
5. Thermal stresses-field equation, stresses in thin disk and long cylinder, 2-D problems in Curvilinear co-ordinates. **(04 Hrs)**
6. Torsion of prismatic bars, soap film analogy, membrane analogy, torsion of thin open and closed tubes. **(08 Hrs)**
7. Elastic Stability: Simple bending of prismatic bars, combined bending & compression of prismatic bars, axial compression – elastic stability, buckling load for column with constant cross section.

TEXT BOOKS:

1. Wang C. T. "**Applied Elasticity"**, McGraw Hill Book Company.
2. Timoshenko and Goodier, **"Theory of Elasticity"**, McGraw Hill Book Company.

REFERENCE BOOKS:

1. T. G. Sitharam "**Applied Elasticity**" Interline publishing.
2. L. S. Srinath, "**Advanced Mechanics of Solids**", Tata McGraw Hill Book Company.
3. Sadhu Singh, "**Theory of Elasticity**", Khanna publisher
4. Phillips, Durelli and Tsao, "**Analysis of Stress and Strain**", McGraw Hill Book.

PHME227 - ENERGY CONVERSION-II

Principles of Turbo machinery

The Turbo machine. The turbo machine and positive displacement machines. Static and stagnation states, Application of first and second laws to Turbo machines. Efficiency of turbo machines. Problems **(08 Hrs)**

Energy exchange in Turbo machines

The Euler turbine Equation, Fluid Energy changes, Impulse and Reaction, Turbines utilization factor, Compressors and Pumps. Problems **(06 Hrs)**

Flow through Nozzles and Blade passages

Introduction, Steady flow through nozzles, Area changes and one-dimensional isentropic flow, Effects of friction in flow passages, Characteristics of Converging and Diverging Nozzles, Flow of Wet steam through nozzles, Diffusers Problems **(08 Hrs)**

Axial and Centrifugal Compressors

Axial Compressors: Stage velocity triangles, enthalpy – entropy diagrams, flow through blade rows, stage losses and efficiency, work done factor, low hub-tip ratio stages, super sonic and trans sonic stages, performance characteristics, problems

Centrifugal Compressors: Elements of centrifugal compressor stage, stage velocity diagrams, enthalpy-entropy diagram, nature of impeller flow, slip factor, diffuser, volute casing, stage losses, performance characteristics, problems. **(12 Hrs)**

Rotary fans and blowers

Introduction, Centrifugal blower, types of Vane shapes, Size and speed of Machine, Vane shape: efficiency, stresses, and characteristics. Actual performance characteristics, The slip co-efficient, Fan laws and characteristics, **(06 Hrs)**

Centrifugal and Axial Flow Pumps

The centrifugal pump, definitions, pump output and efficiency, multistage centrifugal pumps, axial flow pump. Problems **(06 Hrs)**

Power Transmitting Turbo-machines

Introduction, theory, fluid of hydraulic coupling, torque converter. **(06 Hrs)**

TEXTS / REFERENCE BOOKS:

1. V. Kadambiand Manohar Prasad: “An Introduction to ENERGY CONVERSION Volume III, 2002
2. S M Yahya: “Turbines, Compressors and Fans”, Second Edition.
3. V Ganesan: “Gas Turbines”, 2002,

PHME228 - OPERATION AND MAINTENANCE OF HYDRAULIC & PNEUMATIC SYSTEMS

Fundamentals of Hydraulics: Hydraulics systems, Hydraulic Fluids, Hydraulics systems: Basic industrial systems, system inputs, system outputs, the control of the system, servo systems, hydraulics, circuits-symbols and diagrams, **(06 Hrs)**

Hydraulic system components: Reservoir, accumulator pumps motors, hydraulic cylinders, hydraulic values, filters and strainers, pressure gauges, flow meters, pressure switches, hydraulic stools, pipes and fittings. **(06 Hrs)**

Installation of hydraulics Systems: Hydraulics assembles, hydraulics on the machine, pipe work, tube fittings, seals and adaptors, flexible hoses and quick action couplings, pipe anchoring painting, filling installation check over. **(08 Hrs)**

Operation and maintenance procedures: Understanding the principles of hydraulics, cause of pressure, pressure loss, energy loss by leakage, power balance of the system, cleanliness, air bleed and points, operate controls, values settings, trouble shooting of hydraulics systems, preventive maintains, staring and stopping, information equipment and facilities, circuit diagrams, components data, p .M schedules, tool kit modification and repair, pressure gauge connection, sealing methods, charging an accumulator, charging procedure, fault finding. **(10 Hrs)**

Pneumatic power unit- Introduction-Areas of application of pneumatic power unit- elements of pneumatic power units. **(06 Hrs)**

Pneumatic circuit symbols- circuit symbols-values symbols-directions control values. Actuation of values- non return values-pressure control values-flow control values-air cylinders-classification and maintains. Circuits- elements-control of simple acting and double acting cylinders- simultaneous control of two cylinders -one cycle operation circuit. **(10 Hrs)**

Trouble-shooting of pneumatic systems- Documentation- the causes and effects of malfunctions-maintains. **(06 Hrs)**

REFERENCE BOOKS:

1. Farel Bardbury "Hydraulics systems and Maintains" London ILIFFE Books.
2. R. B Gupta -"Principles of Hydraulics"
3. Fento Didactic "Pneumatics -Basic level text books"
4. P. Srillariam "Text book of pneumatic" Premier publishing house Hydrabad.

PHME229 - NOISE MEASUREMENT ANALYSIS &CONTROL

Introduction: Fundamental of Acoustics. **(04 Hrs)**

Sound propagation, transmission and absorption, **(04 Hrs)**

Structure borne sound, Sound radiation. **(04 Hrs)**

Noise generation in Machinery **(04 Hrs)**

Noise Ratings and standards. **(04 Hrs)**

Human Tolerance Levels. **(04 Hrs)**

Equivalent Sound Levels. **(04 Hrs)**

Noise Measurement Techniques **(03 Hrs)**

Instruments for noise measurement. **(03 Hrs)**

Noise Control At source, Along the path, at the receiver end. **(03 Hrs)**

Materials for noise Absorption. **(03 Hrs)**

Dissipative and reactive Mufflers. **(03 Hrs)**

Active noise control **(03 Hrs)**

Case Studies. **(06 Hrs)**

TEXT BOOKS:

1. John E. Foreman "Sound Analysis and Noise Control" Van Nostrand Reinhold Publication.
2. Dudley "Machinery noise control"

REFERENCE BOOK:

Current Literature.

Group III

PHME301 - KNOWLEDGE MANAGEMENT

INTRODUCTION: Knowledge -what, why -information to knowledge -classification of knowledge - categories, types, components, integration -creating the knowledge edge. Knowledge management- definition, value -drivers -personal focused, process, economic. -knowledge management versus existing technologies. **(14 Hrs)**

IMPLEMENTING KNOWLEDGE MANAGEMENT: Infrastructural evaluation -analyzing existing infrastructure -enabling technologies for knowledge management -aligning KM and business strategy - knowledge maps to link knowledge to strategy -strategic imperatives for a successful KM systems. **(14 Hrs)**

KNOWLEDGE MANAGEMENT SYSTEM ANALYSIS, DESIGN AND DEVELOPMENT: KM architecture and design -knowledge audit and analysis -designing KM team -creating KM system blueprint -developing the KM system; **(08 Hrs)**

DEVELOPMENT AND EVALUATION: Pilot testing, deployment using the Results Driven Icrementalism (RDI) methodology -the CKO, reward structures, technology and change management - metrics for knowledge work. **(12 Hrs)**

CASE STUDIES: Aerospace industry, sales and marketing, customer support -KM assessment kit - alternative schemes for structuring KM systems front end -software tools. **(04 Hrs)**

TEXT BOOKS:

1. Amrit Tiwana, "Knowledge Management Toolkit, The Practical Techniques for Building a Knowledge Management System", Prentice Hall, Bk & Cd Rom edition. December7, 1999.
2. Louis Carter: (Editor), Phil Harkins (Editor), Amy Timmins (Editor), Hubert St. Onge. "Best Practices in Knowledge Management & Organizational Learning Handbook" Linkage Press, 2000.

General Guidelines for Paper Setters:

1. Eight questions should be set out of which students shall answer any five full questions. All questions carry equal marks (i.e. 20 marks each)
2. Questions shall be set in the following order
   a) Two full questions from 1st chapter-- Introduction.
   b) Two full questions from 2nd chapter -implementing KM.
   c) Two and half full questions from 3rd chapter --KM analysis, design and development.(Half questions should carry 1O marks and to be included in short notes).
   d) One full question from 4th chapter.--Development and evaluation.
   e) Half question from 5th chapter -Case Studies.
3. Prescribed text book and the syllabus to be covered from "K.M. tool kit by. Amrit Tiwana"

PHME302 - ENERGY MANAGEMENT

General energy problem, Energy use patterns and scope of conservation.

Energy Management Principles: Need, Organizing, Initiating and managing an energy management program. **(06 Hrs)**

Energy Auditing: Elements and concepts, Types of energy audits, Instruments used in energy auditing. **(04 Hrs)**

Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows - single amount, uniform series. **(06 Hrs)**

Financial appraisal methods: Payback period, Net present value, Benefit-cost ratio, Internal-rate of return & Life cycle costs/benefits. **(06 Hrs)**

Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system. **(06 Hrs)**

Cogeneration: Concepts, Types of cogeneration systems, Performance evaluation of a cogeneration system. **(04 Hrs)**

Waste Heat Recovery: Potential, benefits, waste heat recovery equipments.
Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods. **(06 Hrs)**

Industrial Insulation: Insulation materials, Insulation selection, Economical thickness of insulation. **(04 Hrs)**

Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), Heat treatment by induction heating in the electric arc furnace industry **(04 Hrs)**

Energy Conservation in Electric Utility and Industry: Energy costs and two – part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factor in energy conservation - Power factor improvement methods, Energy conservation in industries **(06 Hrs)**

TEXTS / REFERENCE BOOKS:

1. S. C. Tripathy: “Electric Energy Utilization and Conservation”, TMG Delhi, 1991.
2. Wayne C. Turner: “Energy Management Handbook”, Wiley Interscience Publication, NY, 1982.
3. D. A. Reay: “Industrial Energy Conservation”, Pergamon Press. 1980.
4. T. L Boten: “Thermal Energy Recovery”, Wiley, 1980.
5. Industrial Energy Conservation Manuals: MIT Press.

PHME303 - HUMAN RESOURCE MANAGEMENT

1. **Introduction to Human Resources:** Importance of Human Resources -Human Resource Planning, Job Analysis and Methods. **(08 Hrs)**

2. Recruitment- Recruiting Sources: **Recruiting Efforts with possible constraint -ability to attract incumbents** **(08 Hrs)**

3. **The Selection Process:** Cost of Selection -discrete Selection Process -The Comprehensive Approach - Key Elements in successful Predictors -selection Devices -Employment Tests and Interviews -Job 'Previews and Background Investigation -Socializing the New Employee**.** **(09 Hrs)**
4. Employee Training: **Determination of Training Needs and Priorities -Forn1al Employee Training Methods -Methods, for Training Managers Evaluating Training Effectiveness.** **(09 Hrs)**

5. **Career Development:** Value of Effective Career Development -External versus Internal Dimensions to a career -Career Stages. **(08 Hrs)**

6. Motivating the Employees: **Different Theories and Approaches to work Motivation -Job Design. Work Scheduling and Motivation -Performance Appraisals -Rewarding the Productive Employee.** **(09 Hrs)**

7. **Compensating the Work Force:** Compensation Administration -Factors influencing the Compensation Administration -job Evaluation and Pay structure -Incentive Compensation Plans - Benefits and Services. **(09 Hrs)**

8. **Maintaining the Work Force:** Labor Relations -some Legislation governing Labor Relations -Safety and Health of Workers -Combating Stress and Burnout Problems -Employee Discipline -disciplinary Actions -collective Bargaining Process. **(08 Hrs)**

REFERENCE BOOKS:

1. Principles of personnel management -flippo –Mc graw hill
2. Personnel principles and policies for modern manpower -yoder prentice hall India
3. Personnel/human resource management -terry leap & Michael crino -collier Macmillan publishers.
4. Personnel and human resource management -MEMoria himalaya publishing Company.

PHME304 - MANAGERIAL ECONOMICS

1. **DEMAND ANALYSIS**
   a) Demand theory
   b) Preference and Choice
   c) Empirical Demand curves
   d) Goods Characteristics Approach **(16 Hrs)**

2. **PRODUCTION & COST**
   a) Production Theory and Estimation: Organization of Production and the Production Function, Production Function with two variable inputs, optimal combination of inputs. Returns to scale. Empirical Production Functions.
   b) Cost components – Cost functions, Empirical cost functions. **(16 Hrs)**

3. **MARKET STRUCTURES:**
   a) Perfect Competition: Meaning characteristics and importance, price and output determination in the short run and long run. Derived demand for inputs, shortcomings of perfect competition.
   b) Monopoly: Meaning, characteristics and importance, comparison with perfect competition, short run and long run analysis evaluation.
   c) Monopolistic competition: Meaning, characteristics and importance short run and long run analysis.
   d) Oligopoly: Meaning, characteristics and importance, Non – Collusive oligopoly and the kinked demand curve, collusive oligopoly, efficiency implications of oligopoly.

4. **PRICING IN PRACTICE: Cost**-plus pricing, Evaluation of cost plus pricing Incremental Analysis in pricing.
5. **Capital Budgeting** Meaning and Importance, protecting Cash Flows Present Value and Internal Rate of Return, Comparison of NPV and IRR

6. Economic Growth, Development and planning Economic aggregates and Economic Relationships. **(20 Hrs)**

REFERENCE BOOKS:

1. ECONOMICS: PRINCIPLES, PROBLEMS AND POLICIES -Campbell R. McConnell, McGraw Hill
2. THEORY AND PROBLEMS OF MICRO ECONOMIC THEORY -Dominic Salvatore, McGraw Hill
3. MANAGERIAL ECONOMICS -Joel Dean -PHI
4. MANAGERIAL ECONOMICS -Dominic Salvatore, McGraw Hill.

PHME305 - SURFACE TREATMENT & FINISHING

1. Fundamentals of Electro plating, galvanizing, Hot dip metal coating, thin coating, thin coating, chromium plating, Nickel plating. **(08 Hrs)**

2. Vacuum coating, FVD & CVD metal spraying – Methods, surface preparation, mechanical properties of sprayed metals, plasma coating. **(10 Hrs)**

3. Plastic coating of metal – PVC coating Spherodising process details, phosphate coating-mechanism of formation. **(08 Hrs)**

4. Testing of surface coating-methods. **(08 Hrs)**

5. Heat treatment methods, Annealing, Normalizing, Tempering, Case hardening methods, flame hardening sub zero treatment. **(10 Hrs)**

6. Heat treatment methods for gears, spindles, cutting tools. **(08 Hrs)**

REFERENCE BOOKS:

1. Surface preparations & finishes for metals. James A Murphy, McGraw Hill.
2. Principles of metal surface treatment and protection, Pergamon press Gabe, David Russell.
3. Handbook of mtal treatment and testing – John wiley & sons.
4. Heat treatment of metals by Zakrov MIR Publications.
5. Metals hand book – ASM.

PHME306 - THEORY OF ELASTICITY AND PLASTICITY

PART – I ELASTICITY

1.1) ANALYSIS OF STRESS

Introduction -Body force, Surface force, Stress vectors, State of stress at a point, normal and shear stress, rectangular stress components, stress components on an arbitrary plane. Principal stresses, Stress Invariant -Mohr's circle for three-dimensional state of stress-Differential equation of equilibrium, Surface traction, boundary condition. **(06 Hrs)**

1.2) ANALYSIS OF STRAIN

Introduction -normal strains and shear strain. Rectangular strain. Components -State of strain at a point - Plane State of strain. **(06 Hrs)**

1.3) STRESS -STRAIN RELATIONS

Hooke's Law -Compatibility equation -formulation of Elasticity problem-Saint Venant's principle - principle of super position -Uniqueness of solution reciprocal theorem. **(06 Hrs)**

1.4) Solution of plane elasticity problem in rectangular coordinates. Airy's stress function -bending of a hollow cantilever beam under end-load-bending of a simply supported beam with uniform load. **(04 Hrs)**

1.5) Solution of plane elasticity problem in polar coordinates –general equation in 2D polar coordinates - stress distribution in axi symmetric: bodies, symmetric about an axis, pure bending of curved bars. **(04 Hrs)**

1.6) Torsion of prismatic bars. Membrane analogy torsion of thin open sections and thin tubes. **(04 Hrs)**

PART – II PLASTICITY

2.1) Introduction -Octahedral stress -decomposition of stress into hydrostatic and pure shear state effective stress. **(04 Hrs)**

2.2) Strain -cubical dilation -finite coefficient octahedral stress -effective strain special and deviator strain- strain rate tension. **(06 Hrs)**

2.3) Yield criteria -Von Mises and Tresca -yield surface for isotropic plastic materials for an anisotropic material. **(06 Hrs)**

2.4) Stress strain relations- Prandil Reuus levy saint Venant Von Mises Equation experimental verification of Prandil Reuss equation -yield locus. Typical --solution of methods for plastic problem in metal working process. **(06 Hrs)**

REFERENCE BOOKS:

1. Advanced Mechanics of Solids - SRINATH L.S.: Tata McGraw Hill Publication Company Ltd., 20th 2001 Reprint.
2. Theory of Elasticity -TIMOSHENKO S. P. & GOODIER J. N.: Singapore Tata McGraw Hill 3rd print 1970.
3. Applied Elasticity -WANG C. T. Eastern: Economic Edition -2000.

PHME307 - MECHATRONICS SYSTEM DESIGN

1. **Introduction**: Definition and Introduction to Mechatronic Systems. Modeling & Simulation of Physical systems Overview of Mechatronic Products and their functioning measurement systems. Control Systems, simple Controllers. **(08 Hrs)**

2. **Study of Sensors and Transducers:** Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics. **(09 Hrs)**
3. **MEMS and Microsystems:** Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. **(10 Hrs)**

4. **Data Presentation Systems:** Basic System Models, System Models, Dynamic Responses of System. **(11 Hrs)**

5. **Advanced Applications in Mechatronics:** Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, User-friendly design. **(14 Hrs)**

TEXT BOOKS:

1. W. Bolton “Mechatronics” Pearson Edition
2. HSU “MEMS and Microsystems design and manufacture” TMH

REFERENCES BOOKS:

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics” PHI.
2. Fine Mechanics and Precision Instruments. Pergamon Press, 1971.
3. Shetty and Kolk “Mechatronics System Design” Thomson.
4. Mahalik “Mechatronics” TMH.
5. Mechatronics – HMT, TMH.

PHME308 - THEORY OF PLATES AND SHELLS

1. Bending of long rectangular plate into a cylindrical surface, Differential equation - Bending of plated with different boundary conditions – Long plate on elastic foundation. **(04 Hrs)**

2. Pure Bending: Moment and curvature relations problems of simply supported plates-strain energy impure bending. **(05 Hrs)**

3. Symmetrical Bending of Circular Plates: Differential equation uniformly loaded plates-concentricity loaded plates-plated loaded at the center. **(10 Hrs)**

4. Rectangular Plates: Differential equations – solution of simply supported plate various loading conditions, viz, uniformly distributed load, Hydrostatic pressure and concentrated load, central as well as non-central, Navier and Levy type solutions with various edge boundary conditions, viz., all edges simply supported, two opposite edge fixed and two adjacent fixed. **(10 Hrs)**

5. Bending of plate under combined action of lateral and transverse loads derivation of differential equation, simply supported rectangular plate. **(05 Hrs)**

6. Introduction to shell Structures – General description of various types.
   Membrane Theory of thin shells (Stress Analysis): Cylindrical shells – Spherical Shells- Shells of double curvature, viz, cooling tower Hyperbolic, parabolic and elliptic paraboloid. **(07 Hrs)**

7. Membrane deformation of shells: Symmetrical loaded shell, symmetrically loaded spherical shell. General Theory of Cylindrical Shells: Circular cylindrical shell loaded symmetrically, **(06 Hrs)**

8. General equation of circular cylindrical shells. Approximate investigation of: Bending of circular cylindrical shell. **(05 Hrs)**

REFERENCE BOOKS:

1. Timoshenko, Woinowsky and Krieger, “Theory of plates and Shells”, McGraw Hill, Newyork.
2. Flugge, “Stresses in Shells”, Springer Verlag, Berlin.
3. Goldnvizer, “Theory of Elastic Thin Shells”, Pergamon Press, New York.
4. R. Szilard “Theory and analysis of plates” Prentice hall.

PHME309 - VIRTUAL REALITY

Review of Computer Graphics: Review of computer graphics, 2D graphics.2D primitives and transformations. algorithm to digitize the graphic entities, rasterization, 3D graphics. 3D primitives and transformations, projections and viewing, algorithms for hidden line removals, lighting. shading and ray tracing. **(08 Hrs)**

VR Devoces: Input devices-track balls, 3D Mouse, data gloves, Virtual hand and trackers, output devices graph terminal, stereo glasses, head mounting devjces, vision dome, caves. **(04 Hrs)**

Applications: Virtual prototyping, behavior simulation, digital mockup, walk thru/flythrough. Virtual training/simulation, micro electro mechanical systems and nanotechnology. **(04 Hrs)**

Vr Modelling language: History, Concepts, systax, basic nodes-group, transform switch, LOD etc, geometry nodes-indexed face set, indexed line set, coordinate, coordindwx, textures etc. sensor nodes-time sensor touch sensor, sphere sensor, cylinder sensor and proximity sensor, scriping- VRML Script and JAVA Script. **(08 Hrs)**

Tutorials and samples: VRML authoring tools-3D studio MAX, cosmo World, VRML Pad (editor) VRML Viewing tools-cosmo player, auto Vue, SGI's open inventor, virtual collaborative tools-V collab. **(04 Hrs)**

Practical Lab: V Collab. **(24 Hrs)**

TEXT BOOKS:

1. Janes D, Foley et al., "Computer Graphics-Principles and practice" Second edition. in C, Addision - Wesley 1997.
2. Jed Hartman and Josie wernecke, "The VRML- 2.0 hand book" Addision-Wesley 1997.
3. R Carey and G Bell "The Annocated VRML 2.0 hand book Addision-Wes!ey 1997.

PHME310 - ADVANCED MACHINE DESIGN

Part- A

1. **Introduction:** Role of failure prevention analysis in mechanical design, modes of mechanical failure, review of failure theories. **(06 Hrs)**

2. **Fatigue design methods:** Strategies in fatigue design, design criteria, analysis & testing, fatigue test & stress life approach-loading, stress life curves, influencing factors, life estimation, cyclic deformation and strain life approach- approach to life estimation, influencing factors. **(10 Hrs)**
3. Fundamentals of LEFM and application to fatigue crack growth -LEFM concepts, crack tip plastic zone fracture toughness, fatigue crack growth, means stress effects, cyclic plastic zone size, crack closure, elasto-plastic fracture mechanics, Notches & their effects, -SN approach & strain-life approach, applications related to crack growth & life estimation. **(14 Hrs)**

4. Fatigue from variable amplitude loading, spectrum load and cumulative damage-quantification, cumulative damage theories, load interaction and sequence effects, cycle counting methods, life estimation-stress and strain life approaches. **(08 Hrs)**

5. **Statistical aspects of fatigue:** Definitions and quantification of data scatter, probability distributions, tolerance limits, regression analysis, reliability analysis. **(06 Hrs)**

6. **Surface failure:** Introduction, surface geometry, mating surface, friction, adhesive wear, abrasive wear, corrosion wear, surface fatigue spherical contact, cylindrical contact, general contact, dynamic contact stresses, surface fatigue strength. **(08 Hrs)**

Part- B

Design and computerized drafting of systems like lifts, elevator, Robot arm, gripper etc.
(Each problem can be assigned to a group of students, group discussion and design auditing can be held before finalizing the design. This would be a part of tutorials & internal tests.)

TEXT BOOKS:

1. Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, Henry o. Fuchs "Metal Fatigue in engineering" John wiley Newyork, Second edition. 2001.
2. Jack. A. Collins, "Failure of Materials in Mechanical Design". John Wiley Newyork 1992.
3. Machine Design, Robert L. Norton, Pearson.

REFERENCE BOOKS:

1. Liebowtiz, Fracture (Vol IV to VI) , Academic
2. S. A. Meguid," Engineering Fracture Mechanics", Elsevier Science Publisher Ltd., London, 1989.
3. Dieter " Mechanical metallurgy" Mc Graw Hill
4. Gassner, Shutz (Bis), Fatigue Design Procedure, Pergamon.
5. Smith Nicolsons (Eds), Advances in Creep Design, Applied Science.
6. Basowaki, Reliability, Theory of Practices, Prentice Hall.
7. S. Suresh, "Fatigue of Materials", Cambridge university press, Cambridge, U.K.

PHME311 - FAILURE MECHANISM AND ANALYSIS

Fundamental causes of failure of materials. **(06 Hrs)**

Classifications of failure:
Instantaneous Damage and cumulative damage, Failure patterns and distributions, failure data Analysis, Objective of failure analysis, step by step procedure for metallurgical failure analysis. **(08 Hrs)**

Ductile and brittle fracture, micro mechanism of fractures, Fatigue fracture, Fundamental of crack propagation. **(03 Hrs)**

Corrosion failure, Environment induced fractures. **(03 Hrs)**
Wear failures, fretting failure high temperature failures. **(03 Hrs)**

Creep and stress ruptures. **(03 Hrs)**

Plain bearing failures, rolling bearing failure. **(03 Hrs)**

Gear failures -failure of friction surfaces. **(03 Hrs)**

Seal failures. **(03 Hrs)**

Shaft failure. **(03 Hrs)**

Failure of pressure vessels. **(03 Hrs)**

Failure detection methods. **(03 Hrs)**

Failure prevention methods. **(03 Hrs)**

Case studies. **(05 Hrs)**

REFERENCE BOOKS:

1. Kh. B. Krdonsity, "Models of failure", Springer Vertag -1969.
2. L. F. Pau "Failure Diagnosis and Performance Monitoring", Marcel Dekker Inc.
3. "Lubrication and wear", The institution of Mechanical Engineering.
4. H. P. Garg "Industrial Maintenance".
5. Catangelo and Heiser Wiley "Analysis of Metallurgical Failures".
6. L. Engel and H. Klingale Wolfe "An atlas of metal damage".
7. Failure Analysis & prevention American Society of Metal Hand Book V 10.11 and 17

PHME312 - CONVENTIONAL ENERGY CONVERSION SYSTEM

Introductory lecture on different types of thermal power stations & their salient features, Indian Energy Scenario. **(04 Hrs)**

Analysis of Steam Cycles: Rankine Cycle, Superheat and reheat, Regeneration, feed water heating, open or direct-contact feed water heaters, Choice of feed water heaters, Placement of feed water heaters. **(06 Hrs)**

Fire tube boiler, water tube boilers and early development, Water tube boilers : Recent developments, Steam drum, Deaerator. **(04 Hrs)**

Typical layout of Steam Power Plant, Surface condenser, Cooling tower, Efficiency of steam power plants. **(04 Hrs)**

Hydro-Electric Power Plant: Site selection for hydro-electric power plants, Classification of hydro-electric power plants, Run-off river plants without pondage, Run-off river plants with pondage, Storage reservoir plants, Pumped-storage plants. General arrangement of an hydro-electric plant and its operation, Selection of prime-movers for hydro-electric power plants, Advantages & Disadvantages of hydro-electric power plants. **(06 Hrs)**
Diesel-Electric Power Plants : Different systems of diesel power plant. Supercharging of diesel engines, Layout of diesel power plant. **(04 Hrs)**

Nuclear Energy: Principles of nuclear power generation, Nuclear fusion & fission, energy from fission and fuel burnup, radio activity, Neutron energies, thermal neutrons, nuclear cross sections, Fission reactor types, reactor control, fuel arrangements in a thermal reactor, Pressurized water reactor, pwr power plant, Boiling water reactor, BWR power plant, Gas cooled reactor, high temperature gas cooled reactor. **(06 Hrs)**

Concept of breeding, Fast breeder reactors, Liquid metal fast breeder reactor and accessories. **(06 Hrs)**

Environmental Aspects of Power Generation, Introduction, constituents of the atmosphere: Oxides of sulphur, Nitrogen and Carbon and their effect on human health and vegetation, The green house effect, acid rains, particulate matter, Flue gas desulphurization systems, electrostatic precipitators, fabric filters and baghouses. **(06 Hrs)**

Thermal pollution by thermal and nuclear power plants, water pollution by thermal power plants, Radio-active pollution of environment by nuclear power plants, radio-active waste disposal. **(06 Hrs)**

TEXTS / REFERENCE BOOKS:

1. M. N. El Vakil: “Power Plant Technology”, Mc Graw Hill, 1984.
2. Arora & S. Domkundwar : “Power Plant Engineering”, Dhanpat Rai & Sons.
3. M. N. El Vakil: “Nuclear Power Engineering” Mc Graw Hill.
4. Glasstone: “Nuclear Reactor Engineering”
5. P. K. Nag: “Power Plant Engineering”, II Edition, TMH, 2001
6. G. R. Nagpal: “Power Plant Engineering”, 14th Ed. Khanna Pub. 2000.

PHME313 - APPLIED NUMERICAL ANALYSIS

Computer Arithmetic and Errors: Truncation error, Round off error, Error in original data, Propagated error, Floating point arithmetic, Arithmetic accuracy in computers, Errors in converting values, Absolute Vs relative error, Significant digits. **(06 Hrs)**

Solution of Algebraic and Transcendental Equations
Bisection method, iteration method, Method of false position, Newton–Raphson method, Graeffe's root squaring method, Order of convergence of the above methods **(06 Hrs)**

Solution of linear system of equations:
Direct methods – Gauss elimination, Method of factorization
Iterative methods – Jacobi, Gauss Seidel Method. Eigen value by iteration–Power method **(04 Hrs)**

Interpolation: Finite difference – Forward, Backward, Central difference, Differences of a polynominal, Newton's formulae for interpolation. Gauss central difference interpolation formula, interpolation with unevenly spaced points – Lagrange's interpolation formula, Hermite interpolation formula **(06 Hrs)**

Numerical differentiation and numeric integration:
Numerical differentiation – High accuracy differentiation formulae, Richardson extrapolation **(04 Hrs)**
Numerical Integration: Newton-Cote's integration formulae, Trapezoidal rule–a composite formula, Romberg integration, Simpson's Rules – 1/3 rule and 3/8 rule, Gaussian quadrature, **(06 Hrs)**

Numerical solution of Ordinary Differential Equations:
Taylor's series method, Euler and Modified Euler method, Runge–Kutta methods,

Multi step methods: Milne's method & Adam's Moulten method **(06 Hrs)**

Numerical Solutions of Partial Differential Equations
General 2^{nd} order linear partial differential equations: Elliptic, Parabolic and Hyperbolic. Finite difference approximation to derivatives **(04 Hrs)**

Laplace equation: Jacobi method, Gauss–Seidel method, The ADI method
Parabolic Equations: Explicit method, Implicit method, Crank – Nicolson method **(04 Hrs)**

Introduction to Finite Element Method: Steps involved in FEM, Comparison between finite difference and finite element methods, Application of finite element method **(06 Hrs)**

TEXT BOOKS/ REFERENCES:

1. S S Sastry: "Introductory Methods of Numerical Analysis", 3rd Edition, PHI New Delhi – 1998.
2. C. E Gerald and P.O. Wheatley: "Applied Numerical Analysis", 5^{th} Edition, Addison – Wesley Publication – 1994.
3. S. C. Chapra and R. P. Canale: "Numerical Methods for Engineers", 3rd edition, MGH – 1998

PHME314 - ENERGY FROM WASTES

Sources & types of wastes (Industrial, Municipal, agro, domestic). Generation of wastes, Pollution standards, Wastes characterization. **(04 Hrs)**

Functional elements of waste management

Technological aspects related to waste generation, on site handling, storage, collection, transfer, transport. **(04 Hrs)**

Processing techniques and equipment (volume reduction, size reduction, component separation, dewatering, drying). **(04 Hrs)**

Recovery of value added components: Recycling, conversion products and energy **(06 Hrs)**

Conversion technologies: Incineration, Thermo-chemical conversions. **(06 Hrs)**

Biochemical conversions: biogas & ethanol **(06 Hrs)**

Conventional Chemical & biological treatment **(04 Hrs)**

Waste disposal, Environmental impact (toxic & non-toxic) **(06 Hrs)**

Utilization of energy generated, power generation **(04 Hrs)**

Waste management issues: Planning, organization & control

Hazardous & toxic wastes, hazard & its management, classification, generation, handling, processing and disposal. **(04 Hrs)**

Industrial safety **(04 Hrs)**

TEXTS / REFERENCE BOOKS:

1. P. N. Cheremisinoff & A. C. Morresi: “Energy from Solid Wastes”, Marcel Dekker Inc, New York & Base., 1978.
2. Bhinde A. D., Sundaresan B. B.: “Solid Waste Management in Developing Countries, NEERI, 1988.
3. T. Bonner, B. Desai et. al: “Hazardous Waste Incineration Engineering”, Noyes Data Co. 1981.
4. C. L. Mantell: “Solid Wastes Origin, Collection Processing and Disposal, John Wiley & Sons.
5. Ed. Brian D. Clark & Alexander Gilard: “Perspective on Environmental Impact Assessment”, D. Reidal Publishing Co.
6. Sarkanen & Tillvnan: “Progress in Biomass Conversion”, Vol-II.
7. Baum & Parker: “Solid waste disposal Incineration and Landfill”.

PHME315 - COMPUTATIONAL HEAT TRANSFER& FLUID FLOW

Review of equations governing fluid flow and heat transfer **(06 Hrs)**

Applied numerical methods: Roots of a equation, numerical integration, solutions of a systems of simultaneous linear algebraic equations **(08 Hrs)**

Numerical solution of ordinary differential equations: IV and BV problem, analytical and numerical solutions, IVP of first order, simultaneous first order IVP, two point BVP. **(08 Hrs)**

Finite difference: Discritization, consistency, stability and fundamentals of fluid flow modeling, application in heat conduction and convection, steady and unsteady flow. **(08 Hrs)**

Solution of viscous incompressible flow: Stream function and vorticity formulation.
Solution of N S equations for incompressible flow using MAC and SIMPLE algorithms **(08 Hrs)**

Finite element method: Weighted residual and variational formulation, interpolation, application to fluid flow and heat transfer. **(08 Hrs)**

Finite volume method: Introduction, regular finite volume, discritization techniques, application to steady fluid flow and heat transfer **(04 Hrs)**

Commercially available CFD softwares **(02 Hrs)**

REFERENCE BOOKS:

1. K Murlidhar and T Sounderrajan : Computational fluid flow and heat transfer – Narosa
2. D A Anderson, J C Tannehill, R H Pletcher : Computational fluid mechanics and heat transfer –TMH
3. J A Anderson: Computational fluid dynamics –MGH Int.

PHME316 - ALTERNATE FUEL FOR IC ENGINES

Fuels: Introduction, Structure of petroleum, Refining process, Products of refining process, Fuels for spark ignition, Knock rating of SI engine fuels, Octane number requirement, Diesel fuels and Numericals. **(06 Hrs)**

Properties of petroleum products: Specific gravity, Density, Mokecular weight, Vapour pressure, Viscosity, Flash point, Fire point, Cloud point, Pour point, Freezing point, Smoke point & Char value, Aniline point, Octane Number, Performance Number, Cetane Number, Emulcification, Oxidation Stability, Acid Value/Number, Distillation Range, and Sulphur content. **(12 Hrs)**

Alternative fuels for I.C. engines: Need for alternative fuels such as Ethanol, Methanol, LPG, CNG, Hydrogen, Biogas and Producer gas and their methods of manufacturing. **(08 Hrs)**

Single Fuel Engines: Properties of alternative fuels, Use of alternative fuels in SI engines, Engine modifications required, Performance and emission characteristics of alternative fuels in SI mode of operation v/s gasoline operation. **(06 Hrs)**

Dual fuel Engine: Need and advantages, The working principle, Combustion in dual fuel engines, Factors affecting combustion in dual fuel engine, Use of alcohols, LPG, CNG, Hydrogen, Biogas and Producer gas in CI engines in dual fuel mode. Engine modifications required. Performance and emission characteristics of alternative fuels (mentioned above) in Dual Fuel mode of operation v/s Diesel operation. **(08 Hrs)**

Biodiesels: What are biodiesels, Need of biodiesels, Properties of biodiesels V/s petro diesel, Performance and emission characteristics of biodiesels v/s Petro diesel operation. **(06 Hrs)**

Availability: Suitability & Future prospects of these gaseous fuels in Indian context.
Environmental pollution with conventional and alternate fuels, Pollution control methods and packages. **(06 Hrs)**

TEXTS / REFERENCE BOOKS:

1. R.P Sharma & M.L.Mathur: “A Course in Internal Combustion Engines”, D. Rai & Sons.
2. O. P. Gupta: “Elements of Fuels, Furnaces & Refractories”, Khanna Publishers, 2000.
3. Domkundwar V. M.: “Internal Combustion Engines”, I Edition, Dhanpat Rai & Co., 1999
4. John B. Heywood: “Internal Combustion Engines Fundamentals”, McGraw Hill International Edition,
5. Osamu Hirao & Richard Pefley: “Present and Future Automotive Fuels”, Wiley Interscience Publication. NY. 1988.

PHME317 - THERMODYNAMICS AND COMBUSTION ENGINEERING

Second law of thermodynamics, reversibility and corollaries of the second law of entropy. **(06 Hrs)**

Available energy, availability of open and closed systems. **(06 Hrs)**

Properties of gases and gas mixtures, combined first and second law. **(06 Hrs)**

Laminar premixed flames, physical description, simplified analysis, factors influencing flame velocity and thickness, flame speed correlation for selected fuels quenching, flammability and ignition, flame stabilization. **(06 Hrs)**

Laminar diffusion flames – Burning jets, Non-reacting constant density laminar jet, Jet flame physical description, Simplified theoretical description, Flame lengths for circular port and slot burners, Soot formation and description. **(06 Hrs)**

Droplet evaporation and burning, Some applications, simple model of droplet evaporation, simple model of droplet burning. **(06 Hrs)**

Turbulent premixed flames, Some applications, Definition of turbulent flame speed, Structure of turbulent premixed flames, Wrinkled laminar flame regime, Distributed reaction regime, Flame stabilization. **(06 Hrs)**

Turbulent Non premixed flames, Jet flames and other configurations. **(04 Hrs)**

Burning of solids, Coal fired boiler, heterogeneous reactions, burning of carbon one film model and two film model, particle burning times. **(06 Hrs)**

TEXT/ REFERENCE BOOKS:

1. Sonntag Borgnakke Van Wylen: Fundamentals of Thermodynamics, 6th Edn. John Wiley and Sons, 2003
2. Stephen R Turns: “An Introduction to Combustion–Concepts and Applications” MGH–1996
3. Forman A Williams: “Combustion Theory” 2nd Edition, Benjamin / Cummings Publication-1985

PHME318 - CNC MACHINING

INTRODUCTION **(04 Hrs)**

CNC MACHINE PROGRAMMING:

TURNING

Ways of Turning, Pans of CNC Machine, Working method of CNC, Co-ordinate system, CNC Co-ordinate System, Dimensioning System, Datum point & Reference point, Movement Instruction, Machine Instruction, Tool Instruction, Dimension Instruction, Datum point shift, Basic Programming in Turning, Introduction to G & M Codes, ISO Program format, Sample Program, Create Programming for Step Turning, Contour Program, Taper Turning, Drilling, Grooving, Boring, Threading & Parting, Measuring Tool offset & length, Load Program, Check tool management, Safety regulation in turning **(20 Hrs)**

MILLING

Ways of Milling, Parts of CNC machine, working method of CNC, Co-ordinate System, CN C Co-ordinate system, Dimensioning System, Datum point & Reference point, Movement Instruction, Machine Instruction, Tool Instruction, Dimension Instruction, Datum point shift, Basic Programming in Milling, Sample Program, Create Programming for Components, Tests, Simulation, Contour Program Using ATC, Standard Milling, Pocket Milling, 'Slot milling, Circular Pocketing, drilling (Pecking), mirror Image, Datum Shift, Rotation, Label Function, Measuring Tool offset & length, Load Program, Check tool management, Documenting the program, Safety Regulation in Milling. **(20 Hrs)**

CASE STUDIES

Trail on Sinumerik 2100 Lathe Machine, Trail on Heidenhain Control Milling Machine, Trail on Fanuc Control Turning Machine **(08 Hrs)**

REFERENCE BOOKS:

1. CNC -A first look –LUGGIN
2. Advances NC –GROOVER

PHME319 - THEORY OF METAL FORMING

1. **Introduction Forming process**, Introduction to metal forming, Effect of temperature on forming process-hot working, cold working. Effect of Metallurgical structure, Effect of speed of deformation work of Plastic deformation, Friction in forming operation. **(08 Hrs)**
2. **Forging:** Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging. **(08 Hrs)**
3. **Rolling of Metals:** Classification, forces and geometrical relationships in rolling. **(08 Hrs)**
4. **Variables in rolling**, Deformation in rolling, Defects in rolled products, Residual stresses in rolled products. Torque and Horsepower. **(08 Hrs)**
5. **Extrusion:** Classification, Extrusion equipment, variables in extrusion, Deformation in extrusion, Extrusion defects, Work done in extrusion. **(06 Hrs)**
6. **Drawing:** Principles of Rod and wire drawing, variables in wire drawing, Residual stresses in rod, wire and tube drawing, Defects in Rod and wire drawing. **(06 Hrs)**
7. **Sheet Metal forming:** Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products. **(08 Hrs)**

REFERENCE BOOKS:

1. Mechanical Metallurgy – Dieter G.E. – Mc Graw Hill Publications.
2. Principles of Metal working – R.Rowe-Arnold London.
3. Metals Handbook –Volume II –ASM.
4. Fundamentals of working of metals-Sach G. Pergamon Press.

PHME320 - DIE CASTING AND DIE DESIGN

INTRODUCTION

Classification of Castings, Sand casting, Metal mould castings, Plastic moulds casting, Investment casting, Gravity die casting, Pressure die casting, Advantages of Die casting, Die casting process, vacuum casting. **(04 Hrs)**

DIE CASTING ALLOYS:

Low fusion alloys, High fusion alloys, Properties. **(02 Hrs)**

DIE CASTING MACHINES

History of die casting machines, Hot chamber machine, cold chamber machine, Horizontal machine, Vertical machine, Die locking, Toggle locking, Hydraulic locking, Injection systems, knock out pins and plates, ejector system furnaces, loading of metal into hot chamber. **(08 Hrs)**

FEED SYSTEM

Gates, Runners, Taper tangent runner system, Precession layout, Spreader, shot sleeve, shot weight calculations etc., **(04 Hrs)**

DIE CONSTRUCTION

Cores, Cavities, pillars and bushes, ejectors, bolster plates. **(04 Hrs)**

COOLING SYSTEM

Core cooling, Cavity cooling, cooling of shot sleeve, cooling of spreader, baffles, cooling calculations. **(04 Hrs)**

TYPES OF DIES

Single cavity dies, Multi cavity dies, combination dies, unit dies, trimming and finishing of components, Inspection of components, safety, SPC & visual control techniques.

DIES WITH SIDE CORES

Construction, Actuation of side cores. **(08 Hrs)**

DIE CASTING, DEFECTS AND REMEDIES

Preparation and Presentation of typical designs in the form of drawings following

1. Cold chamber die casting dies.
2. Hot chamber die casting dies.
3. Single cavity die casting dies.
4. Multi cavity die-casting dies.
5. Dies with side cores.

REFERENCE BOOKS:

1. Die casting -DO EHLER H.A. New York -McGraw Hill Book Co-Inc. International Student Edt. 1951.
2. The Die casting Book -STREET. C. ARTHUR, Surrey, England -Portcullis Press Ltd., 2nd Edt. 1986.

PHME321 - QUALITY AND RELIABILITY ENGINEERING

1) Basic Concepts

Definitions of Quality and Reliability, Parameters and Characteristics, Quality control, Statistical Quality Control, Reliability concepts. **(04 Hrs)**

2) Concepts in Probability and Statistics

Events, Sample Space, Probability rules, Conditional probability, Dependent and Independent Events, Application of Probability concepts in Quality Control, Problems **(06 Hrs)**

3) Statistical Aspects and Probability Distributions

Statistical Tools in Quality Control, The Concept of Variation, Graphical Tools for data representation and analysis, Discrete and Continuous Distributions, Normal, Poisson, Binomial, Weibull Distribution, Problems **(08 Hrs)**

4) Failure Data Analysis

Introduction, Failure Data, Quantitative measures, MTTF, MTBF, Bathtub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis **(06 Hrs)**

5) Acceptance Sampling

Fundamentals of acceptance sampling, types of acceptance sampling, military std 105, O-C Curve, AQL, LTPD, AOQL.

6) System Reliability

Series, Parallel and Mixed Configuration, Block Diagram Concept, r-out-of-n structure solving problems using mathematical models. **(06 Hrs)**

7) Reliability Improvement and Allocation

Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Prediction and Analysis, Problems **(10 Hrs)**

8) Maintainability and Availability

Introduction, Formulas, Techniques available to improve maintainability and availability trade-off among reliability, maintainability and availability, Simple problems. **(04 Hrs)**

REFERENCE BOOKS:

1. Halpern, Seigmund (1978) "The Assurances Sciences", Prentice Hall International, New Jersey, U.S.A
2. Juran, J.M and Gryna, F.M. (1982) "Quality Planning and Analysis", Tata McGraw Hill publishing Company Ltd., New Delhi, India.
3. Blanchard, Benjamin S. (1986) "Logistics Engineering and Management", Prentice Hall International, New Jersey U.S.A.
4. Kraus, John W. (1988) "Maintainability and Reliability", Handbook of Reliability Engineering and Managemtn, Editors – Ireson. W.G. and Cooms, C.F. McGraw Hill Book Company Inc. U.S.A.
5. Srinathm K. S. (1985) "Concepts in Reliability Engineering" Affiliated East-West Press Private Limited, New Delhi, India

PHME322 - GAUGES AND MEASUREMENTS

FITS AND TOLERANCE

Limits Fits and Tolerances. **(12 Hrs)**

INTRODUCTION TO GAUGES

Types of Gauges, Taylor's Principles and its application, Calculation of Dimension of limit gauges, taper gauges, Thread gauges, Function gauges and Manufacturing process of gauges. **(20 Hrs)**

DESIGN EXERCISE

Design of Plug Gauge, Ring Gauge, Snap Gauge. Indicator Gauge, Taper plate Gauge, Taper Plug Gauge, Thread Gauge and Position Gauge. **(20 Hrs)**

REFERENCE BOOKS:

1. Engineering Metrology by R.K. JAIN New Delhi -Khanna Publications -4th Edtn. -1976.
2. B.l.S. Books.
3. Dimensional Metrology and Geometric conformance by TMEH

PHME323 - AGILE ENGINEERING

INTRODUCTION – What is agile Manufacturing? – Competitive environment of the future the business case for agile manufacturing conceptual framework for agile manufacturing. **(06 Hrs)**

FOUR CORE CONCEPTS: Strategy driven approach – integrating organization, people technology interdisciplinary design methodology. **(06 Hrs)**

AGILE MANUFACTURING AND CHANGE MANAGEMENT: The change implications. Post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal, product costing – performance, measurement and control systems, Traditional organization, control technological and design paradigms traditional problems in workplace-organizational issues – role of technology. **(14 Hrs)**

AGILE MANUFACTURING ENTERPRISE DESIGN: Agile manufacturing – enterprise design – system concepts as the basic manufacturing theory – joint technical & organizational design and a model for the design of agile manufacturing enterprise, enterprise design process insights into design processes, what is interdisciplinary design, Main issues – simple design example. **(13 Hrs)**

SKILL & KNOWLEDGE ENCHANCING TECHNOLOGIES FOR AGILE MANUFACTURING: Skill and Knowledge enhancing Technologies – scheduling – technology design strategic-Design Concepts. Design and Skill of Knowledge enhancing Technologies for machine tool systems – Historical overview, Lessons, problems and Future development. **(13 Hrs)**

REFERENCE BOOKS:

1. Paul T. Kidd – Agile manufacturing – Forging new Frontiers, Addison Wesley Publication-1994
2. Dr. M. P Chowdiah (Editor) – Agile Manufacturing – Proceeding of International Conference on agile manufacturing – TATA Mc Graw Hill Publications 1996
3. Paul T Kidd – Agile manufacturing – Forging Neat Furniture's Addition Wesley Pub (1994)
4. Part T Kidd – Concurrent Engg.
5. Part T Kidd – World Class Manufacturing

PHME324 - FINANCIAL MANAGEMENT

Financial management:

Introduction to finance, Objectives of financial management-profit maximization, Changing role of financial managers, organization of finance function, Indian financial system. **(06 Hrs)**

Investment decisions:

Time value of money, investment evaluation techniques- payback period, accounting rate of return, net present value, IRR, profitability index, Estimation of cash flow for new project- replacement projects, depreciation tax shield, Conflict in ranking as per DCF & their criteria. **(08 Hrs)**

Cost of capital:

Basic concepts, cost of debenture capital, cost of preference capital, cost of equity capital, discussion on dividend capitalization model & CAPM (covering only the final result), cost of retained earnings, determination of weight average cost of capital & marginal cost of capital schedule. **(08 Hrs)**

Working capital management:

Factors influencing working capital requirements, current assets policy & current assets finance policy, determination of operating cycle & cash cycle, estimation of working capital requirements of a firm.

Capital structure Decisions:

Capital structure & market value of a firm, planning the capital structure, capital structure policy, capital structure of a new company. **(08 Hrs)**

Sources of long term funds in India:

Issue of shares, term loans, debentures & other instruments, international financing instruments- long & short term, financing through leasing & hire purchase institutional finance available in India, a brief discussion of the functioning of primary markets. **(08 Hrs)**

Dividend policy:

Relevance of dividend decisions,- dividend policies, stable dividend, stable payment, growth, factors affecting the dividend policy. **(06 Hrs)**

Financial planning & financial leverage:

Basis of financial planning, sales forecast method, pro-forma P&L account method, pro-forma balance sheet method, determination of external financing requirement, Determination of operating leverage, financial leverages and Total leverage. **(08 Hrs)**

TEXT / REFERENCE BOOKS:

1. Prasanna Chandra, " Financial Management (Theory & Practice) TMH
2. Weston & Brigham, " Essentials of Managerial Finance"
3. Pandey, I. M., "Financial Management"

PHME325 - KNOWLEDGE BASED MANAGEMENT

1. **Introduction:** Artificial Intelligence in Cad, Applications of Artificial Intelligence in Design. Scope and History of AI. Structure of an Expert System, Building an Expert System. Strategies for Knowledge Acquisition, Components of Knowledge. Knowledge Representation, Production Systems, Decision Tables, Frame Systems, Graphs and Semantic Networks. **(10 Hrs)**
2. **Knowledge Representations:** Knowledge Representations Process, Purposes, Contexts and Agents, Knowledge Soup, Knowledge Acquisition and Sharing. Knowledge Representation Languages, Issues in Knowledge Representation. A Network Representation Language. Introduction to LISP. Search Strategies in LISP, A Recursive Unification Function. Interpreters and Embedded Languages. Logic Programming in LISP. Streams and Delayed Evaluation. An Expert System Shell in LISP. **(14 Hrs)**
3. **Decision Support Systems:** Introduction. Basis of Decision Making. Typical Progressive Models. Intelligent Models. Smart Regenerative System. Life-Cycle Values. Total Life-Cycle Cost. Compatibility Analysis. Sensitivity Analysis. Life-Cycle Ranking or Rating Scheme. **(06 Hrs)**
4. **Learning Processes and AI Algorithms:** The General Problem Solver and Difference Tables. Resolution Theorem Proving. Machine Learning, Perceptron Learning, Back Propagation Learning, Competitive Learning. The Genetic Algorithm, The Genetic Programming. Artificial Life and Society Based Learning. Methods of Inference, Reasoning under Uncertainty, Inexact Reasoning. **(10 Hrs)**
5. **Knowledge Based Design Aids:** Inference Process, Backward Chaining, Forward Chaining, Hybrid Chaining. Expert System Shells, Feature Based Modeling, Feature Recognition, Design by Features, Application of Feature Based Models. Role of AI in Manufacturing. **(06 Hrs)**
6. **Design of Expert Systems and Applications**: Benefits and Examples of Expert Systems. Design of Expert Systems, Introduction to CLIPS, Pattern Matching, Modular Design and Execution Control Fuzzy Logic and Neural Networks, Typical Expert System MYCIN, DENDRAL, PROSPECTOR. **(06 Hrs)**

TEXT BOOKS:

1. A guide to Expert Systems – Donald A Waterman, Addison Wesley.
2. Principles of Artificial Intelligence – Springer-Verlag, Berlin

REFERENCE BOOKS:

1. Understanding Decision Support System and Expert Systems – McGraw Hill
2. Artificial Intelligence – Elain Rich, McGraw Hill.
3. Artificial Intelligence using C, Herbert Schildt, McGrawHill.
4. Introduction to Artificial Intelligence and expert systems – DAN.W. Patterson, PHI
5. Expert systems Principles and programming, III edition, Joseph Giarrantano, Vikas-Thomson
6. Knowledge representation, Logical, Philosophical and computational foundations, John Fsowa, Vikas Thomson Learning.

PHME326 - LEAN MANUFACTURING SYSTEM

Chapter -1: Just in time production system. JIT Logic -Pull system Japanese approach to production elimination of waste - Jit implementation requirements Jit application for job shops
Case studies
Page 239 -260
Production and Operations Management
Chase 1 Aquilano **(06 Hrs)**

Chapter -2: Kanban system:- Kanban rules supplier Kanban and sequence schedule used by supplier. Monthly information & daily information. Later replenish system by Kanban sequenced withdrawal P system by sequence schedule table -problems & counter measures in applying Kanban system to subcontractors -Supplier Kanban circulation in the paternal manufacturer -structure of supplier Kanban sorting office. **(09 Hrs)**

Chapter 2 & 3 of TPS

Chapter -3:
The rise & fall of Mass Production
Mass production, work force, organization, tools, product –logical limits of mass production, Sloan as a necessary compliment to Ford.
Case study:- Rouge Production Plant.
Pages 21 to 47
TMTCW **(06 Hrs)**

Chapter -4: the rise of lean production:- Birth place, concrete example, company as community, Final assembly plant, product development and engineering. Changing customer demand, dealing with the customer, future of lean production.
Page 48 to 65 –TMTCW **(04 Hrs)**

Chapter -5: Shortening of production lead times -reduction of setup times, practical procedures for reducing setup time.
Page 105 -142 TPS **(03 Hrs)**

Chapter -6: Standardization of operations. Machine layout, multi function workers and job rotation. Improvement activities to reduce work force and increase worker morale -foundation for improvements.
Page 145 to 217 TPS **(04 Hrs)**
Chapter -7: Elements of lean production viz G M Framingharn -Toyota Takaoka Mass Production V /s lean production, diffusing lean production.
Pages 75 to 84 TMCTW **(04 Hrs)**

Chapter -8: Managing lean enterprise:- Finance, Career ladders, geographic spread and advantages of global enterprise.
Pages 192 to 209 TMCTW **(04 Hrs)**

Chapter -9: Prospects for catching up.

Simplicity in the natural state -institutional factors -life time employment -educational commodities -quality & productivity in full circle.

Page 199 to 218

Japanese manufacturing techniques Schonberger, Richards. **(06 Hrs)**

Chapter -10:

An action plan :

Getting started -

Creating an organization to channel your streams.

Install business system to encourage lean thinking.

The inevitable results of 5 year commitment.

Page 247 -271

Lean thinking -Womack, James P. **(06 Hrs)**

REFERENCE BOOKS:

1. Productions and Operations Management -Chasel Aquilino
2. Toyoto production system -An integrated approach to Just in Time -By Yasuhiro Monden -Engineering aild Management Press -Institute of Industrial Engineers Norcross Georgia.
3. The Machine that changed the World. The Story of Lean Production By James P Womack, Daniel T Jones, and Daniel Roos -Harper Perennial edition published 1991.
4. Lean Thinking -By James Womack.
5. Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity By Richard Schourberger.
6. Quality Function Development -by James Bossert, ASQC Press 1991.
7. Straight talk on design of experiments -by Launshy and Weese.

Note on Question paper pattern:

Chapter of syllabus	Chapter & Book	Weightage
Chapter 1	Production & Operations Management Chase/Aquilano	1
Chapter 2	Chapter 2 & 3 of TPS	1
Chapter 3	Page 21-47 – TMTCW	½
Chapter 4	Pages 48 to 65 – TMTCW	½
Chapter 5	Pages 105-142 – TPS	1
Chapter 6	Pages 145-217 – TPS	1
Chapter 7	Pages 75 – 84 –TMTCW	1
Chapter 8	Pages 192-209-TMTCW	½
Chapter 9	Pages 192-218 Japanese Manufacturing Techniques – Schonberger, Richards	½
Chapter 10	Pager 247-271 – Lean thinking – Womack, James P	1

TPS: Toyota Production System

TMFCW: The machine that changed the world.

PHME327 - NUCLEAR ENERGY CONVERSION

Radioactivity, Nuclear reactions, Cross sections, Nuclear fission, Power from fission, Conversion and breeding, **(10 Hrs)**

Neutron transport equation, Diffusion theory approximation, Pick's law, Solutions to diffusion equation for point source, Planar source, etc. Energy loss in elastic collisions, Collision and slowing down densities. Moderation in hydrogen, Lethargy, concept, **(16 Hrs)**

Moderation in heavy nucleus. Moderation with absorption, Resonance absorption, NR and NRIM approximations. Multi-region reactors, Multigroup diffusion methods, Thermal reactors, Heterogeneous reactors. Reactor kinetics, in hour equation, Coefficients of reactivity, Control, Fission product poison. Perturbation theory **(16 Hrs)**

Environmental impact; Natural and artificial radioactivity, reactions from nuclear power plant, effluents, high level wastes **(10 Hrs)**

REFERENCE BOOKS:

1. J. R. Lamarsh : Introduction to Nuclear Reactor Theory, Wesley,
2. Duderstadt and L. J. Hamilton : Nuclear Reactor Analysis, John Wiley

PHME328 - CONVECTIVE HEAT & MASS TRANSFER

Fundamentals: Reynolds transports theorem: Derivation of N-S equation; concepts of boundary layer; velocity and thermal boundary layers, integral solution, similarity, Effect of wall heating condition - unheated starting length, arbitrary wall temperature and uniform heat flux. The effect of longitudinal pressure gradient; flow past a wedge and stagnation flow effect of suction and blowing. **(12 Hrs)**

Laminar duct flows: convection in fully developed flow and developing flow. Effect of wall boundary condition. **(08 Hrs)**

Natural convection: external flows: boundary layers: integral similarity solution, natural convection from vertical walls, inclined walls, horizontal walls, horizontal and vertical cylinders and spheres. internal natural convection; stable and unstable stratification, R-B convection in rectangular and cylindrical enclosures. **(12 Hrs)**

Turbulent flows: fundamentals of turbulent heat convection. Turbulent boundary layer. Turbulent duct flows. **(08 Hrs)**

Convection with change of phase: condensation, boiling, melting. Mass transfer fundamental: Pick's law, diffusive and convective mass transfer: velocities, fluxes and species conservation equation s. Mass exchangers. Simulation heat and mass transfer - evaporative cooling. **(12 Hrs)**

REFERENCE BOOKS:

1. W. M Kays and London -Convective Heat and mass transfer
2. E. R. G Eckert and R. M Drake - Analysis of heat Transfer.

PHME329 - PRODUCTION TOOLING

Part- 1

Production Drawings; Surface finish and machining processes; Limits, Fits and Positional Tolerances; Selection of Fits; Geometrical Tolerances; Machining Errors and their determination; Methods for improving machining accuracy **(08 Hrs)**

Part- 2

Jigs and Fixtures, Types; Design of jigs & Fixtures for production of Components; Applications for NC System **(18 Hrs)**

Part- 3

Sheet metals for components; Design of progressive, compound press tools; Design of Bending and deep drawing Tools; Selection of Presses **(20 Hrs)**

Part- 4

Plastic Moulding; Injection Moulding; Compression Moulding; Plastic-properties and applications; General Mould Construction; Ejection, Feed system, parting surface, Mould cooling, splits & Cores; Procedures for designing an injection mould, Mould design drafting practice, Moulding machines - Injection & compression. **(14 Hrs)**

TEXT BOOKS:

1. Fundamentals of Fixture Design, Korskow, MIR Publishers, Moscow, 1989.
2. Basic Die Making, Advanced Die Making, D. Eugene Oster Gaard.
   Mc Graw Hill Book Company, 1967.

REFERENCE BOOKS:

1. Injection Mould Design -R G W Pye, Longman Scientific and Technical Books, Essex, England 1989
2. Fundamentals of manufacturing Engineering, V.M. Kovan and others, MIR Publishers, Moscow,1989
3. Dimensioning for Interchangeable Manufacture, E.T.Fortini, Industrial Press Inc, New York,1967.
4. Dimensioning and Tolerancing for Quality Production, M. F. Spotts, Prentice Hall Englewood Cliff,1 983.
5. Tool Design, Donaldson, Lecain & Gold, Tata McGraw Hill, New Delhi, 2000
6. Tool Engineers Hand book, F. W. Wilson, Tata McGraw Hill, New Delhi, 1968.
7. Die Design Handbook, ASM handbook, SME publications, 1990.
8. Techniques of Press working Sheet Metal, Donald F Eary & Edward A. Reed Prentice Hall, Inc. Engle Cliff, New Jersey, 1989.
9. Machinery's "Yellow Backs"
   a) Moulding Bakelite Materials No-3
   b) Plastics Materials Hand book No-40
   c) Plastic Moulds No-44
   d) Die sinking Engraving Machines No-45
   e) Spark machining No-46

Group IV

PHME401 - NANO TECHNOLOGY

INTRODUCTION

- Overview of Nanoscience and Engineering.
- Classification of nanostructures, Nanoscale Architecture.
- Scaling and miniaturization laws.
- Why use miniaturization technology-Effect of the Nanometer length scale.
- Fabrication processes- Top down and Bottom up processes.
- Characterization Techniques. **(02 Hrs)**

PHYSICS OF NANOSCIENCE **(15 Hrs)**

ELECTRONICS PROPERTIES OF ATOMS AND SOLIDS

- The isolated atom - Bonding between atoms - LCAOs. – Van der Waals forces- Dispersion interaction - Orientational interaction – Induction interaction.
- Stating Schrodinger's wave equation and its importance - Physical significance of wave function - Eigen values and Eigen functions.
- The Free electron (particle) model and energy bands- particle in 1-D potential well of infinite height (discussion on energy values, wave functions – normalization and probability densities).
- Particle in 1- D potential well of finite height - Concept of tunneling.
  - Heisenberg's uncertainty principle- Derivations of Density of states for 3D, 2D, 1D and 0D, and graphical representations. **(06 Hrs)**

EFFECTS OF NANOMETER LENGTH SCALE

- Changes to the system total energy.
- Changes to the system structure.
- How nanoscale dimensions affect properties- structural, thermal, chemical, mechanical, magnetic, optical and electrical. **(02 Hrs)**

SEMICONDUCTOR PHYSICS – TO UNDERSTAND INORGANIC SEMICONDUCTOR NANOSTRUCTURES

- What is a semiconductor?
- Doping
- The concept of effective mass
- Carrier transport, mobility and electrical conductivity
- Optical property of semiconductors
- Excitons
- The pn junction
- Phonons
- Types of semiconductors **(04 Hrs)**

QUANTUM CONFINEMENT IN SEMICONDUCTOR NANOSTRUCTURES

- Quantum confinement in one dimension: quantum well.
- Quantum confinement in two dimensions: quantum wires.
- Quantum confinement in three dimensions: quantum dots.
- Superlattices.
- Band offsets. **(03 Hrs)**

CHEMISTRY OF NANOSCIENCE

- Concepts and Materials – Chemistry of Carbon
- **FULLERENES** - structure and synthesis, chemical reactivity-Chemistry of higher fullerenes-applications. **(02 Hrs)**
- **NANOTUBES** - carbon forms structured by energetic species-amorphous nanotubes and crystalline forms, Carbon- an ideal model system to study structuring by energetic species, structuring of amorphous carbon forms, structuring of ordered sp^2 forms, structuring carbon forms. Synthesis and purification of multiwalled and single walled carbon nanotubes: Electric arc (arc evaporation) technique, laser ablation, catalytic decomposition of hydrocarbons purification. Structure and properties of carbon nanotubes, Inorganic nanotubes- structure, synthesis and properties. **(04 Hrs)**
- Electron transport in nanotubes.
- Ballistic, Spintronics, Coulomb blockade and Nanowires.
- Organic semiconductors, Organic light emitting diodes. **(11 Hrs)**

SELF-ORGANIZATION

- Phase behaviour of nanoparticle suspensions, hard sphere behaviour, soft repulsions, and weakly attractive suspensions. **(01 Hrs)**

CATALYSIS

- Nanocrystalline zeollites- Hydrothermal synthesis of nanocrystalline zeollites-application in environmental catalysis, selective partial oxidation reactions of hydrocarbons and photo catalytic decomposition of organic contaminations using nanocrystalline zeollites. **(04 Hrs)**

NANOCLUSTERS- Properties and applications in catalysis.

SURFACE AND INTERFACE CHEMISTRY

- Colloid systems – Colloids theory of coagulation, micells, nanocrystals and their superlattices. Background of the measurement of surface forces and interface forces.
- Optical, thermal and magnetic properties of nanomaterials. **(02 Hrs)**

APPLICATIONS

- Biosensors, Optical tweezers, Paints.
- Laser materials, Membranes and mesoporous materials, Water purification
- Molecular motors, Nanospring, Nanobalance.
- Atomic manipulation – Quantum corrals, Quantum mirage.

FABRICATIONS AND CHARACTERIZATIONS OF NANOSTRUCTURES

- Top-down verses Bottom-up fabrication processes. **(10 Hrs)**

TOP-DOWN PROCESSES

- Milling
- Silicon VLSI fabrication processes – Doping, Oxidation / Deposition, Etching,
- Lithographic processes – Photo, e-beam, Foucused ion beam, X-ray.
- Soft Lithography
- Machining – Macromachining, Micromachining, LIGA.(MEMS processes).
- APPLICATIONS

- Nano- and Micro-machines (NEMS and MEMS)
- Nanotube FET, Interconnects and Electron emitters **(05 Hrs)**

BOTTOM – UP PROCESSES

- Vapor deposition methods – MBE, OMVPE.
  - Hetrostructures, Quantum Wells, Multiple Quantum Wells
  - Quantum Wires and Quantum Dots
  - Modulation doping devices, Resonant Tunneling Devices
  - QWIP, Quantum Well lasers, photonic crystals, Nanocomputing.
- Liquid Phase methods – molecular and biological computing.
- Colloidal methods
- Sol-gel methods
- Electrodeposition
- Self-assembly and self-organization processes **(05 Hrs)**

CHARACTERIZATIONS **(06 Hrs)**

BASICS OF SCATTERING PHYSICS RELATED TO CHARACTERIZATION.

- X-rays and their interaction with matter.
- Electron and their interaction with matter.
- Phonon scattering.
- Plasmon scattering.
- Single-electron excitation.
- Direct radiation losses.
- Neutrons and their interaction with matter.
- Ions and their interaction with matter.
- Elastic scattering and diffraction. **(03 Hrs)**

TECHNOLOGY OF CHARACTERIZATION

- Profilometry, Optical microscope, SEM, TEM, FIB.
- STM, AFM, Surface Raman Scattering, Wettability (contact angle) measurements, Small angle X-ray diffraction and electron diffraction. **(03 Hrs)**

FABRICATIONS AND CHARACTERIZATIONS OF NANO STRUCTURES

- Milling
- Silicon VLSI fabrication processes -Doping, Oxidation /Deposition, Etching,
- Lithographic processes –Photo, c-beam, Focused ion beam, X-ray.
- Soft Lithography
- Machining – Macromachining, Micromachining, LIGA. (MEMS processes).
- APPLICATIONS
  - Nano- and Micro-machines (NEMS and MEMS)
- Liquid Phase methods -molecular and biological computing.
- Colloidal methods
- Sol-gel methods
- Electrodeposition
- Self-assembly and self-organization processes **(06 Hrs)**

NANOTRIBOLOGY

Composition and structure of surfaces natural condition: oxide and hydrocarbon films surface segregation and reaction with environments, thermodynamics structure of surfaces, atomistic simulations methods to study composition and structure of surfaces composition -Auger electron spectroscopy, X -ray photoelectron spectroscopy structure -LEED, STM/ AFM, XRD, HREM

Chemical interactions on surfaces, adsorption and deposition on surfaces (physisorption and chemisorption); Langmuir adsorption isothenn, desorption from surfaces: Electronic properties and surface reactions relevant to tribology, density functional studies analysis structure sensitivity lubricant degradation.

Nanomechanical properties: Determination of surface mechanical properties (AFM/ nanoindentation), simple friction theories -effects of surface composition and structure: on friction environmental and temperature effects, relationship with surface chemistry, mixed and boundary lubrication, failure mechanisms. **(12 Hrs)**

REFERENCE BOOKS:

1. Handbook of Nanoscience Engineering and Technology, Ed. William A.Goddard III, Donald W.Brenner, Sergey Edwart Lyschevski and Gerald J.Iafrate, CRC Press, New York (2003).
2. Microlithography Fundamentals in Semiconductor Devices and Fabrication Technology, by Ueno T., Ito T. and Nonogaki S., Marcel Dekker (1998).

3. Semiconductor Lithography: Principles, Practices and Materials, by William Moreau, Plenum Press (1988).
4. Sub-Half Micron Lithography for ULSI, Ed. by Matsui S., Ochiai Y., and Suzuki, K., Cambridge University Press (1999).
5. Nanolithography: A Borderland Between STM, EB, IB and X-ray Lithographies, Ed. by Gentili M., Giovannella C., and Selci S., NATO Asi Series E: Applied Sciences, vol. 264, Kluwer Academic Publishers (1994).
6. Solid State Physics, by G.I. Epifanov, Mir Publishers (1979).
7. Semiconductor Devices - Physics and Technology, by S.M. Sze, John Wiley & Sons (2003).
8. Introduction to Semiconductor Devices, by Kevin F. Brennan, Cambridge University Press (2005).
9. The MEMS Handbook, by M.Gad-El-Hak.
10. Nanoscale Science and Technology, Ed. by Robert Kelsall, Iam Hamley and Mark Geoghegan, John Wiley & Sons (2005).
11. Fundamental of Machine Elements, by Hamrock, Jacobson and Schmid.
12. Tribology, Principles and Design Applications, by Arnell et al.
13. Tribology Handbook, by B.Bhushan.
14. Principles and Applications of Tribology, by B.Bhushan.

    Fluid Film Lubrication, by Hamrock.

PHME402 - PRODUCT DATA MANAGEMENT

INTRODUCTION: Introduction to PDM-present market constraints-need for collaboration Internet and developments in server-client computing. **(10 Hrs)**

COMPONENTS OF PDM: components of a typical PDM setup-hardware and document management-creation and viewing of documents -creating parts-version Control of parts and documents -case studies. **(10 Hrs)**

CONFIGURATION MANAGEMENT: Base lines-product structure-configuration management-case studies. **(06 Hrs)**

PROJECTS AND ROLES: creation of projects and roles -life cycle of a product- life cycle management -automating information flow -work flows -creation of work flow. templates-life cycle -work now integration -case studies. **(10 Hrs)**

CHANGE MANAGEMENT: Change issue-change request-change investigation-change proposal-change activity-case studies. **(04 Hrs)**

GENERIC PRODUCTS AND VARIANTS: Products configuration-comparison between sales configuration and products generic-generic product modeling in configuration modeler-use of order generator for variant creation -registering of variants in product register-case studies. **(12 Hrs)**

REFERENCE BOOKS:

1. David Bedworth. Mark Henderson & Philips Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill Inc., 1991.
2. Terry Quatrain, "Visual Modeling with Rational Rose and UML ", Addison Wesley, 1998.
3. Wind-chill R5.0 Reference manuals, 2000,
4. “Implementing and integrating product data management and software configuration management” by Ivica CmKovic, Ulfaskwnd and Annita person dohlgurst publisher Artechhouse.

PHME403 - FINANCIAL MANAGEMENT

1. **Introduction to Financial Management**: Objectives, functions & scope, evolution interface of Financial Management with other functional areas, environment of corporate finance. **(04 Hrs)**
2. **Indian financial system**: Financial Markets -money market, capital market, Govt. Securities market, All India Financial Institutions DBI, IFCI, ICICI, IRBI, EXIM Bank, SFCs, SIDCs Investment Institutions -LID, GIC, V TI, mutual funds Commercial banks: NBFCs **(04 Hrs)**
3. **Time value of money Introduction**: Future value of a single cost flow, multiple flows and annuity, present value of a single cash flow. **(05 Hrs)**
4. **Risk & Return**: Risk & return concepts, risk in a portfolio, context, relationship between risk & return **(05 Hrs)**
5. **Valuation of Securities**: Concept of valuation, equity valuation
   Dividend: Dividend capitalization approach & ratio approach. **(04 Hrs)**
6. **Financial Statement analysis**: Ratio analysis, time series **analysis**, Du pont analysis, funds flow analysis. **(04 Hrs)**
7. **Leverage**: Concept of leverage, opening leverage, financial Leverage, total leverage. **(04 Hrs)**
8. **Sources of long term finance**: Equity capital & preference capital, Debenture capital, term loan & deferred credit, Govt. Subsidies, Sales tax Deferments & exception, leasing and hire purchase. **(06 Hrs)**
9. **Cost of Capital and Capital Structure**: Cost of debentures, term Loans, Equity capital & retained earning, weighted average cost Of Capital, Systems of weighting. Introduction to capital structures, factors affecting capital structure, feature of an optimal capital structure, capital structures, Capital Structure theories, tradition position, MM Position and its critique imperfections. **(06 Hrs)**
10. **Dividend Policy**: Traditional position, water model, gorden model, Miller and modugliani position, rational expectations model. **(04 Hrs)**
11. **Estimation of working capital**: Objectives of working capital (Conservative Vs Aggressive policies) static Vs Dynamic view of W.C., Factors affecting the composition of W.C., interdependence among Components of W.C., operating cycle approach to W.C. **(06 Hrs)**

REFERENCE BOOKS:

1. Fundamentals of Financial Management- James C. Van Home 2.
2. Financial Management & Policy -James C. Van Horne
3. Financial Management -I.M. Panday
4. Management Accounting & Financial Management- M. Y. Khan & P. K. Jain
5. Management Accounting Principles & Practice -P. Saravanavel

PHME404 - COMPUTER APPLICATIONS IN MANAGEMENT

1. **Overview of computers –** Selection of hardware and software. **(12 Hrs)**

2. **Computer Applications –** Exercises in word processing, Spread sheets, database and graphics. **(12 Hrs)**

3. **Specific Managerial Applications –** creation and editing documents like business letters reports, MEMos, etc., making slide shows and presentations **(14 Hrs)**

4. **Use of Internet –** using facilities like email, search engines, global databases, net based shopping etc. **(14 Hrs)**

REFERENCE BOOKS:

1. Computers for beginners – V. K. Jain
2. Microsoft Office for Dummies – Roger Parker
3. Managerial Communication – Paul R Timm
4. Business Communication – Zane Quible, Margaret Johson and Dennis Mott.

PHME405 - DYNAMICS AND MECHANISM DESIGN

1. **Geometry of motion:** Introduction, Analysis and Synthesis, Mechanism terminology, Planar, spherical and spatial mechanisms, mobility, kinematic inversion, Grashoff's law, Mechanical advantage, Coupler curves, five bar, six bar chains, Equivalent mechanisms, Unique mechanisms. **(04 Hrs)**
2. **Generalised principles of dynamics:** Fundamental laws of motion, Generalised coordinates, Configuration space constraints, Virtual work, Principle of virtual work, Energy and momentum, Work and kinetic energy, Equillibrium and stability, Kinetic energy of a system, Angular momentum, Generalised momentum. **(10 Hrs)**
3. **Lagrange's Equation:** Lagrange's equation from D'Alembert's principles, Hamilton principles, Lagrange's equation from Hamilton principle, Application of Lagrange's equations for conservative and non conservative, autonomous systems with holonomic and non holonomic constraints, Application to systems with very small displacements and to impulsive motion. **(12 Hrs)**
4. **Synthesis of Linkages:** Type, Number, and Dimensional synthesis, Function generation, Path generation and Body guidance, Precision Point, Chebychev spacing, Position synthesis of general slider crank mechanism, crank mechanism with optimum transmission angle, Three position synthesis, Point position reduction, Four precision point, The overlay method, Coupler curve synthesis using complex algebra, Freudenstein's Equation. Two position synthesis of slider crank chain mechanism and crank rocker mechanism, crank mechanism with optimum transmission angle. Graphical method of Dimensional synthesis:- Poles and relative poles of four bar linkage. Relative poles of slider crank chain and Crank rocker mechanism. **(18 Hrs)**
5. Synthesis of Spatial Linkage: introduction to spatial linkage, spatial mechanisms, the position problem, Position analysis of the RGGR mechanism, The Eulerian angles, a theorem on angular velocities and acceleration, The Hooke's universal joint. **(08 Hrs)**

TEXT BOOKS:

1. E. Shigley & J. J. Uicker "Theory of Machines and Mechanism" McGraw Hill Company.
2. Greenwood "Principles of Dynamics", Prentice Hall of India, 1988.
3. Ghosh and Mallick "Theory of Mechanism and machines" East West press.

REFERENCES BOOKS:

1. Erdman Sandor "Advanced Mechanism Design" Prentice Hall.
2. Soni A.H "Mechanism synthesis and analysis", McGraw Hill.

PHME406 - PRODUCT DESIGN AND DEVELOPMENT

INTRODUCTION: Characteristics of successful product development who Designs and develops products, duration and cost of product development, the challenges of product development. **(02 Hrs)**

DEVELOPMENT PROCESSES AND ORGANIZATIONS: A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. **(04 Hrs)**

PRODUCT PLANNING: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. **(04 Hrs)**

IDENTIFYING CUSTOMER NEEDS: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. **(04 Hrs)**

PRODUCT SPECIFICATIONS: What are specifications, when are specifications established, establishing target specifications setting the final specifications. **(04 Hrs)**

CONCEPT GENERATION: The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process. **(04 Hrs)**

CONCEPT SELECTION: Overview of methodology, concept screening, concept scoring, caveats. **(02 Hrs)**

CONCEPT TESTING: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process. **(03 Hrs)**

PRODUCT ARCHITECTURE: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. **(05 Hrs)**

INDUSTRIAL DESIGN: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. **(05 Hrs)**

DESIGN FOR MANUFACTURING: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. **(05 Hrs)**

PROTOTYPING: Prototyping basics, principles of prototyping, technologies, planning for prototypes. **(04 Hrs)**

PRODUCT DEVELOPMENT ECONOMICS: Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. **(03 Hrs)**

MANAGING PROJECTS: Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation. **(03 Hrs)**

TEXT BOOK:

1. **Product Design and Development:** Karl. T. Ulrich, Steven D Eppinger,. Irwin McGrawHill-2000.

REFERENCE BOOKS:

1. **Product Design and Manufacturing:** A C Chitale and R C Gupta, PH1
2. **New Product Development:** Timjones. Butterworth Heinmann,, Oxford. UCI. 1997
3. **Product Design for Manufacture and Assembly:** Geoffery Boothroyd, Peter Dewhurst and Winston Knight.

QUESTION PAPER PATTERN:

1. Questions to be set based on text book Product Design & Development by K. T. Ulrich & S. D. Eppinger.
2. Two out of eight questions should be open - ended questions requiring applications of materials covered in the book on (i) Concept generation, & selection & Industrial design.
3. Remaining six questions should broadly cover the remaining topics.
4. Students are expected to answer five questions choosing at least one open ended question.

PHME407 - SMART MATERIAL & STRUCTURE

1. **Overview** of Smart Materials, Structures and Products Technologies. **(03 Hrs)**

2. **Smart Materials (Physical Properties)**
   Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magnetoelectric Materials.
   Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials, Fiber-Optic Sensors.
   (07 Hrs)

3. **Smart Sensor, Actuator and Transducer Technologies**
   Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Impact Hammers; MEMS Sensors; Sensor Arrays
   Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; Fluidic Pumps; Motors
   Smart Transducers: Ultrasonic Transducers; Sonic Transducers; Air Transducers **(10 Hrs)**

4. **Measurement, Signal Processing, Drive and Control Techniques**
   Quasi-Static and Dynamic Measurement Methods; Signal-Conditioning Devices; Constant Voltage, Constant Current and Pulse Drive Methods; Calibration Methods; Structural Dynamics and Identification Techniques; Passive, Semi-Active and Active Control; Feedback and Feed forward Control Strategies **(14 Hrs)**

5. **Design, Analysis, Manufacturing and Applications of Engineering Smart Structures and Products:** Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products. Emphasis on structures, automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications products, as well as medical and dental tools and equipment.

REFERENCE BOOKS:

1. M. V. Gandhi and B. So Thompson, Smart Materials and Structures, Chapman & Hall, London; New York, 1992 (ISBN: 0412370107).
2. B. Culshaw, Smart Structures and Materials, Artech House, Boston, 1996 (ISBN:0890066817).
3. A. V. Srinivasan, Smart Structures: Analysis and Design, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).
4. A. J. Moulson and J. M. Herbert, Electroceramics: Materials, Properties, Applications, 2nd Edition, John Wiley & Sons, Chichester, West Sussex; New York, 2003 (ISBN: 0471497479).
5. G. Gautschi, Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
6. K. Uchino, Piezoelectric Actuators and Wtrasonic Motors, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).

7. G. Engdahl, Handbook of Giant Magnetostrictive Materials, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
8. K. Otsuka and C. M. Wayman, Shape Memory Materials, Cambridge University Press,. Cambridge; New York, 1998 (ISBN: 052144487X).
9. Eric Udd, Fiber Optic Sensors: An Introduction for Engineers and Scientists, John Wiley & Sons, New York, 1991 (ISBN: 0471830070).
10. Andre Preumont, Vibration Control of Active Structures: An Introduction, 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966).
11. Hojjat Adeli, Control. Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future, John Wiley, New York, 1999 (ISBN: 047135094X).
12. T. T. Soong, Passive Energy Dissipation Systems in Structural Engineering, Wiley, Chichester;New York, 1997 (ISBN: 0471968218).

PHME408 - MEASUREMENT SYSTEMS &EXPERIMENTAL TECHNIQUES

Introduction: Basic concepts of measurement methods, single and multi point measurement Min space and time. Processing of experimental data, curve fitting and regression analysis. **(05 Hrs)**

Design and Construction of Experimental facilities: wind tunnel, general test rigs, Test cells for flow visualization and temperature mapping. **(05 Hrs)**

Modeling and Simultaneous of Measurement System: Lumped analysis, first order and second order systems: Frequency response and time constant calculation. Response of a generalized instrument to random data input, FFT analysis, Temperature.

Measurement Design, Construction and Analysis of liquid and gas thermometers, resistance thermometer with wheat stone bridge. Thermo -electric effect. Construction, testing and calibration of thermocouples and thermopiles, Analysis of effect of bead size and shielding on time constant and frequency response. Characteristics of thermocouple. **(10 Hrs)**

Optical techniques:

Pyrometers. radiation thermometers and interferometers.

Humidity measurement Conventional methods, electrical transducers: Dunmox humidity and microprocessor based dew point instrument. Calibration humidity sensors. **(06 Hrs)**

Flow and Velocity Measurement: industrial flow measuring devices, design, selection and calibration. velocity measurements, pitot tubes, yaw tubes, pitot static tubes; frequency response and time constant calculation. Hot-wire anemometer; 2d/3d flow measurement and turbulence measurement. Laser application in flow measurement. Flow visualization technique s. Combustion photography. **(08 Hrs)**

Pressure Measurement: Analysis of liquid manometer, dynamics of variable area and inclined manometer. Pressure transducers design and analysis.

Speed and torque measurement: Design and development of instrument for speed and torque measurement of rotating system; Application in IC engines. **(08 Hrs)**

Air Pollution sampling and measurement; Units for pollution measurement, gas sampling technique s, particulate sampling technique, gas chromatography.

Data Acquisition systems: Fundamentals of digital signals and their transmission, A/D-and D/A converters, Basic components of data acquisition system. Computer interfacing of digital instrument and data acquisition systems; Digital multiplexes, Data acquisition board (DAQ), Digital image processing fundamentals. **(10 Hrs)**

REFERENCE BOOKS:

1. J. P Holman -Experimental Methods for Engines.
2. E. O Doebelon -Measurements systems Application and Design.
3. BEIL modern Power station Practice.
4. Beckwith and Buck: Mechanical measurements.

PHME409 - THERMAL POWER STATION-I

Steam Generator and Auxiliaries: High pressure boilers, classification, schemes¸ circulation, nature of fuels and its influence on design, furnaces, PF burners, types location in furnace, PF milling plant, oil and gas burner types and location, arrangement of oil handling plant. **(07 Hrs)**

Disposition of heating Surfaces: Furnace circuit, steam side and waterside corrosion, pressure parts, super heater, re-heater, and economizer, de-super heater, air heater, on-load cleaning of boilers. **(09 Hrs)**

Dust Extraction Equipment: Bag house, electrostatic precipitator, draught systems, FD, ID and PA fans, chimneys, flue and ducts, dampers, thermal insulation and line tracing, FBC boilers and types., waste heat recovery boilers. **(06 Hrs)**

Water system -Impurities in water and its effects, feed and boiler water corrosion, quality of feed water, boiler drum water treatment and steam purity, water treatment, clarification, demineralization, evaporation and revise osmosis plant . **(07 Hrs)**

Instrumentation and Control: SG measurement, temperature, pressure, flow, level, dust, smoke, PH, dissolved oxygen, conductivity etc., Super heater steam temperature control, drum level control, furnace draft control, differential pressure control, mill air flow and temperature control, combustion control, air flow and fuel flow control, SCAPH steam control, burners sequence control, load control, unit load control, boiler following turbine controls, integrated load control, ID, FD and PA fans and other protection and interlocks. **(09 Hrs)**

Operation and Maintenance of SG and aux.: Pre commissioning activities, Boiler start up and shut down procedures, emergencies in boiler operation, Maintenance of SG and aux. **(06 Hrs)**

Performance: Boiler efficiency and optimization, coal mill, fans, ESP **(06 Hrs)**

EIA study: Pollutants emitted, particulate matter, SO x and NO x and ground level concentration, basic study of stack sizing **(06 Hrs)**

REFERENCE BOOKS:

1. Modern Power Station Practice Vol B & C Peragamon press-1991.
2. El – Wakil – Power Plant Engineering – TMH.
3. Steam & its Uses – Babcock and Wilcox.
4. Steam generator and auxiliaries –BHEL training book.

PHME410 - DESIGN AND ANALYSIS OF PIPING

Fundamentals of piping: Introduction, classification of pipes, pipe fittings, flanges, pipe joints, pipe designation, pipe materials, basic concepts of fluid mechanics, piping codes.

Pipeline sizing: pipe wall thickness calculation, pipeline sizing and pressure drop calculations, values and specialties, catalogues, expansion joints, pressure vessels, heat exchangers, storage tanks. **(06 Hrs)**

Valves and specialties: Description of valves, valves components, materials of constructions, specialties, strainers, steam traps, expansion joints, design of anchor, guide and support requirements, rubber expansion joints, painting and corrosion protection. **(06 Hrs)**

Piping layout engineering: Introduction, definition of piping system, general arrangement, flow diagram and piping drawings, general guidelines and check list, specific requirements, flexible requirements, pipe rotating methods, pipe rack planning, layout around pumps. **(05 Hrs)**

Piping analysis: Introduction, types of loadings, system classification, seismic category, establishment of design, service and test loading conditions analytical requirement for piping stress analysis, types of analysis, stress acceptance criteria. **(05 Hrs)**

Computer aided design and piping: Introduction, lay module, ISO module, optical modules, and commercial software's available. **(05 Hrs)**

Design of pipe supports: different pipe supports and its design. **(05 Hrs)**

Pressure vessels and heat exchangers: Pressure vessels, process data sheets, preparation of MDS, radiography, codes and standards, Jacked vessels, types of heat exchangers, TEMA standards, and storage tanks. **(05 Hrs)**

Thermal insulation: Introduction, thermal conductivity, insulating materials, factors influencing, service temperature range, insulation thickness, heat loss calculation, corrosion, steam traced piping. **(05 Hrs)**

Procurement: Enquiring specifications, bid analysis and purchase recommendation, vendor drawing series, piping specifications. **(05 Hrs)**

Fabrication and erection of piping systems: pre-fabrication, erection, testing, welding inspection, inspection and testing of piping valves and specifications **(05 Hrs)**

REFERENCE BOOKS:

1. Nayyar (Mohinder L) : Piping hand book
2. Rose : Piping design for power plants

PHME411 - DESIGN FOR MANUFACTURE

1. **EFFECT OF MATERIALS & MANUFACTURING PROCESSES ON DESIGN**
   - Major phases in design & manufacture
   - Effect of material properties on design
   - Effect of manufacturing process on design
   - Material selection process, Cost per unit property & Weighed properties methods. **(08 Hrs)**
2. **TOLERANCING***
   - Tolerance specification & representation of various tolerances. their significance in assembly.
   - Geo-material tolerances for assembly line -True position tolerancing
   - Cumulative effect of tolerances in assembly.
   - Interchangeability and selective assembly in manufacturing.
   - Process capability & its significance with ref to tolerancing.
   - Achieving larger machining tolerances. **(10 Hrs)**
3. **DATUM FEATURES***
   - Functional datum
   - Datum for manufacturing
   - Changing the datum. **(08 Hrs)**
4. **DESIGN CONSIDERATIONS***
   - Design of components with casting considerations
   - Pattern, Mould, and Parting line
   - Cored holes and Machine holes
   - Identifying the possible and probable parting line
   - Castings requiring special sand cores
   - Designing to obviate sand cores. **(06 Hrs)**
5. **COMPONENT DESIGN***
   - Component design with machining considerations like design for turning components-milling, drilling and other related processes including finish-machining operations. **(06 Hrs)**
6. **DESIGN OF GAUGES***
   - Design of gauges for checking components in assembly with emphasis on various types of limit gauges for both hole and shaft. **(06 Hrs)**
7. **CASE STUDIES: (Related to above topics and also including followings)**
   - Redesign to suit manufacture of typical assemblies.
   - Tolerance design of a typical assemblies
   - Design to minimize cost of a product
   - Computer Aided DFMA **(08 Hrs)**

NUMERICALS INCLUDED

TEXT BOOKS:

1. Harry Peck, "Design for Manufacture", Pitman Publications, 1983 for topics 2 to 5.
2. Dieter -"Machine Design", McGraw Hill Publications for topic 1.
3. R. K.Jain -"Metrology", Khanna Publications for topic 6.
4. Geoffrey Boothroyd, peter dewhurst, Winston Knight, “product design for manufacture and assembly”. Mercel dekker .inc. New york.

GUIDELINES:

- Questions for Theory Exams to be set from first six topics.
- Topic 7 will be tutorials and lab sessions.

PHME412 - ADVANCED METAL JOINING PROCESS

1. Distortion, methods to avoid distortion. Stresses in Joint Design **(06 Hrs)**
2. Welding and Cladding of dissimilar materials, overlaying and surfacing **(06 Hrs)**
3. Electro Slag, Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding. **(18 Hrs)**
4. Advanced soldering and Brazing processes different types. **(05 Hrs)**
5. Welding of plastics. **(04 Hrs)**
6. Inspection of Welds: Destructive techniques like Tensile, Bend, Nick break, Impact & Hardness. Non Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye penetrant, Gamma ray inspection. **(08 Hrs)**
7. Welding Symbols- Need for, Representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples **(03 Hrs)**
8. Welding Design - Introduction, Principles of sound welding design, Welding joint design. Welding positions, Allowable strengths of welds, under steady loads. **(03 Hrs)**
9. Quality Control In Welding - Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts. **(04 Hrs)**
10. Computer-Aided Welding Design – Introduction, Principles of sound welding design, Welding joint design, Welding positions, Allowable strengths of welds, under steady loads. Weld throat thickness, Solved and unsolved examples. **(04 Hrs)**

REFERENCE BOOKS:

1. Welding Engineering Handbook by A.W.S.
2. Welding Engineering by Rossi.
3. Advanced Welding processes – Nikodaco & Shansky MIR Publications.
4. Welding Technology by O. P. Khanna.
5. Welding for engineers by Udin, funk & Wulf.
6. Welding and welding technology– R. L. Little.

PHME413 - FERROUS & NON FERROUS FOUNDRY PRACTICE

Principles of liquid metal processing, introduction. **(06 Hrs)**

Physical chemistry, free energy composition diagram, fluidity of cast metals, hot tears Treatment of liquid metals, **(06 Hrs)**

Desulphurisation, dephosphorisation inoculation theory and practices, **(06 Hrs)**

Grain refinement and modification of aluminum-alloys thermodynamics property of aluminum. **(06 Hrs)**

Copper and base alloys. **(06 Hrs)**

Composite control metal mould, slag metal and refractory slang reaction. **(08 Hrs)**

Gases in metals, degassing, vacuum melting and casting, alloy steels. **(06 Hrs)**

ADI cast ferrous and non ferrous metal melting and refining techniques. **(08 Hrs)**

REFERENCE BOOKS:

1. J. Merphy "Non -ferrous Foundry Practice"
2. Henie R. W. and Roseenthal, “Principles of Metal Casting”
3. Phelke. "Uniprocess in Extractive Metallurgy”.

PHME414 - NON DESTRUCTIVE TESTING

Introduction to ND testing: selection of ND methods, visual inspection, leaks testing, Liquid penetration inspection, its advantages and limitations. **(06 Hrs)**

Magnetic particle inspection: Methods of generating magnetic field, types of magnetic particles and suspension liquids – steps in inspection – application and limitation. **(08 Hrs)**

Eddy current inspection: principles, operation variables, procedure, inspection coils, and detectable discounts by the method. **(08 Hrs)**

Microwave inspection: Microwave holography, applications and limitations. **(06 Hrs)**

Ultrasonic inspection: Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A, B, C scans transmission, resonance techniques transducer elements, couplets, search units, contact types and immersion types inspection standard-standard reference blocks, inspection of products like casting, extrusions, rolled product, weld set. **(08 Hrs)**

Radiography inspection: Principles, radiation source-Rays and gamma rays-rays tubes, radio graphic films, scenes and filters, image intensifiers, techniques charts, industrial radiography, image quality, radiography sensitivity, Peneramotors, electron, neural radiology, application of ICT. Thermal inspection principles, equipment inspection methods applications. **(08 Hrs)**

Optical Holography: Basics of Holography, recording and reconstruction-info metric techniques of inspection, procedures of inspection, typical applications.
Acoustical Holography: systems and techniques applications. Indian Standard for NDT. **(08 Hrs)**

REFERENCE BOOKS:

1. McGonnagle JJ “Non Destructive testing” – Garden and reach New York
2. Non destructive Evolution and quality control” volume 17 of metals hand book 9 edition asia internal 1989
3. Davis H.E Troxel G.E Wiskovil C.T the Testing instruction of Engineering materials Mc graw hill.

PHME415 - PRODUCTION SYSTEM & CONTROL

Product Characteristics: Material and geometric considerations, **(04 Hrs)**

Manufacturability considerations. **(04 Hrs)**

Group technology-process and machine characteristics. **(04 Hrs)**

Basic considerations. **(04 Hrs)**

Production levels, data-base for machining. **(06 Hrs)**

Process planning. Alternative solutions, computer-aided methods, assessing cost effectiveness. **(06 Hrs)**

Layout designs. Computer aided techniques, Flexible layouts. **(06 Hrs)**

Simulation and modeling of the Production systems. **(06 Hrs)**

Demand forecasting, capacity planning and material requirement planning, **(06 Hrs)**

Shop floor control J.I.T. and Kanban, decision support management. **(06 Hrs)**

REFERENCE BOOKS:

1. T.E. Vollmann, etal., ED., Manufacturing planning and control systems, galgitia pub. (p) Limited, India 1987.
2. Vahid Lotfi and C. Card Pejel, decision support system for production and operation management, Irwin Boston, USA, 1989.

PHME416 - OPTIMUM DESIGN

1. **Introduction:** Engineering application of optimization, multivariable optimization Statement of a optimization problem. Design Vector, Design constraints, objective function, classification of optimization problems. **(04 Hrs)**

2. **Classical optimization technique:** Single variable optimization, with equality Constraints solution by direct substitution, solution by the method of constrained Variation. Solution by the method of lagrange multipliers, multivariable optimization with inequality constraints Kuhn – Tucker condition. **(08 Hrs)**

3. **Non-linear programming:** (One Dimensional minimization method) Numerical method, Unimodal function, Unrestricted search, Exhaustive search. Dichotomous search, Fibonacci and Golden section method. **(08 Hrs)**

4. **Interpolation method:** Quadratic and Cubic Nonlinear programming (Unrestricted Optimization Technique) Random search methods, Univate method, powels method, Simplex method. **(08 Hrs)**

5. **Descent methods:** Steepest descent, conjugate gradient, variable metric method. **(06 Hrs)**

6. **Non linear programming:** (Constrained Optimization problem) Characteristic of a constrained problem. **(08 Hrs)**

7. **Direct methods:** The complex method, cutting plane method, methods of Feasible directions. **Indirect Methods:** Transformation technique, change variables and elimination of variables, penalty function methods- interior and exterior penalty function. **(10 Hrs)**

TEXT BOOK:

1. S. S. Rao, Optimisation – Theory and Application, Willey Eastern.

REFERENCE BOOKS:

1. R. L Fox Optimization methods for Engg. Design, Addison – Wesley
2. GSG Beveridge and R. S. Schechter, Optimisation Theory and practice.
3. Ram, Optimisation and Probability in System Engg. Van Nostrand.

PHME417 - MODELING OF MANAGEMENT INFORMATION SYSTEM

1. **Information Basics:** Definition of information system, classification of IS, Need for Information system, Contemporary approaches to information system, Key system applications in the organization, Challenges of information systems. Impact of IT, IS for Knowledge work. **(04 Hrs)**

2. **Managing with Information and its Resources:** Managing in 21st Century, Strategic planning and IS, Information needs for strategic planning, IS for decision support, Quality and privacy issues. Information resource management, strategic planning for IS function, justification for IS, IT/IS facilities and operations, security control and Audit. **(04 Hrs)**

3. **Information systems and Organizations:** Relationship between organizations and information systems, feature of organizations, effect of organizations on information systems, effect of information systems on organizations. **(04 Hrs)**

4. **Information, Management and Decision-making:** Role of managers, Decision making, Individual models of decision-making, Organizational models of decision-making. **(04 Hrs)**

5. **Information system Development:** system development life cycle and methodologies, principles of system design. System analysis- Definition, Strategies and Phases. **(06 Hrs)**

6. **Object oriented Technology:** Object orientation, object oriented analysis (OOA), system development through OOT, Object Oriented Languages. OOT and MIS. **(06 Hrs)**

7. **System modeling:** Introduction to system modeling, system concepts for data modeling, logical data modeling, and construction of data model. Process modeling: Introduction to process modeling, system concepts for process modeling, data flow diagram, logical process modeling, construction of process model. **(10 Hrs)**

8. **System Design;** Definition, Strategies and Phases of system design. **(04 Hrs)**

9. **Ethical and Social impact of information systems:** Ethical and social issues related to systems, Ethics in an information society, moral dimensions in information systems. **(02 Hrs)**

10. **Decision Support Systems:** DSS issues, Structure Constructions-approaches, generators, tools, software and cost benefits and simple examples of applications. **(04 Hrs)**

11. **Management science & system modeling for MIS**: Management science & its models, kinds & use of models for analysis of system characteristics, Simulation & construction of models. **(04 Hrs)**

TEXT BOOKS:

1. Management information systems organization and technology, 4th edition, Kenneth C. Laudon and Jane P. Laudon, Prentice Hall India.
2. Systems analysis and design methods, 4th edition, Jeffery L. Whitten and Lonnie D. Bentley Tata McGraw Hill.

REFERENCE BOOKS:

1. Management Information Systems-Conceptual foundations, Structure and development, Davis.G.B, McGraw Hill Intl.Book.Co.
2. Management Information Systems,Robert Schulties and Marry summer, Tata McGraw Hill Publishing Co., Ltd. New Delhi.
3. Management Information System - A Concise Study, S.A. Kelkar, PHI
4. Management Information systems – W. S Jawadekar. TMH
5. Information System for modern management – Murdick Ross & Claggett – PHI

PHME418 - ROBOTICS FOR INDUSTRIAL AUTOMATION

1. **Introduction:** Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Transformation and Block Diagram of Spring Mass System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Different Types of Controllers, Control Approaches of Robots **(06 Hrs)**

2. **Kinematics of Robot Manipulator:** Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation & Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation. **(12 Hrs)**

3. **Robotic Workspace & Motion Trajectory:** Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. **Robotic Motion Trajectory Design:** – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:- 4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories. **(06 Hrs)**

4. **Dynamics of Robotic Manipulators:** Introduction, Bond Graph Modeling of Robotic Manipulators, Examples of Bond Graph Dynamic Modeling of Robotic Manipulator. Brief Discussion on Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Preliminary Definitions, Generalized Robotic Coordinates, Dynamic Constraints, Velocity & Acceleration of Moving Frames, Robotic Mass Distribution & Inertia Tensors, Newton's Equation, Euler Equations, The Lagrangian & Lagrange's Equations. Application of Lagrange–Euler (LE) Dynamic Modeling of Robotic Manipulators: - Velocity of Joints, Kinetic Energy T of Arm, Potential Energy V of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass, Dynamic Equations of Motion for A General Six Axis Manipulator. **(10 Hrs)**

5. **Robot Teaching:** Introduction, Various Teaching Methods, Task Programming, Survey of Robot Level Programming Languages, A Robot Program as a Path in Space, Motion Interpolation, WAIT, SIGNAL & DELAY Commands, Branching, Robot Language Structure, various Textual Robot Languages Such as VAL II, RAIL, AML and their Features, Typical Programming Examples such as Palletizing, Loading a Machine Etc, **(06 Hrs)**

6. **Robot Sensing & Vision:** Various Sensors and their Classification, Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors. **(06 Hrs)**

7. **Industrial Applications:** Objectives, Automation in Manufacturing, Robot Application in Industry, Task Programming, Goals of AI Research, AI Techniques, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies. **(06 Hrs)**

TEXT BOOKS:

1. A Robot Engineering Textbook – Mohsen Shahinpoor – Harper & Row publishers, New York.
2. Robotics, control vision and intelligence, Fu, Lee and Gonzalez. McGraw Hill International.
3. Introduction to Robotics, John J. Craig, Addison Wesley Publishing.

REFERENCE BOOKS:

1. Robotics for Engineers, Yoram Koren, McGraw Hill International.
2. Industrial Robotics, Groover, Weiss, Nagel, McGraw Hill International.
3. Robot Technology Fundaments, Keramas, Thomson Vikas Publication House.
4. Company Fundamentals of Robotics Analysis and Control, Schilling, PHI.
5. Introduction to Robotics, Niku, Pearson Education, Asia.
6. Foundation of Robotics, Yoshikawa, PHI (EEE).
7. Robotic Engineering - An Integrated approach, Klafter, Chmielewski and Negin, PHI.
8. Robot Vision and Sensor Controls, Rooks B, Vol-3 North Holland.

PHME419 - MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

Concepts of MEMS (Micro Electro mechanical system) - Principles, application and design. **(12 Hrs)**

Principles, application and design of Bio MEMS. **(12 Hrs)**

Principles, application and design of RF MEMS. **(12 Hrs)**

Principles, application and design of High temperature MEMS. **(12 Hrs)**

Principles, application and design of Optical MEMS. **(12 Hrs)**

TEXT BOOKS:

1. Fundamentals of micro fabrication, the science of miniaturization- Max J.Madou, Nanogen corporation, USA, CRC press, March 2002.

PHME420 - THEORETICAL STRESS & ANALYSIS

Analysis of Stress: Definition and notation of stress; Differential Equations of Equilibrium; Specification of Stress at a point; Principal Stresses; Boundary Conditions in terms of surface Forces. **(06 Hrs)**

Analysis of Strain: Strain components; Specification of strain at a point; compatibility equations. **(04 Hrs)**

Stress-Strain Relations: Generalized Hooke's Law; Generalized Hooke's law in terms of engineering elastic constants; Strain energy; General Theorems -Uniqueness theorem, Principle of superposition, Saint Venants Principle. **(04 Hrs)**

Plane Stress and Plane Strain Problems: Governing Differential equations; Airy's Stress function; 2-D problems in rectangular and polar co-ordinates; Bending of Cantilever Loaded at the end; Bending of Simply Supported Beam by uniform load; Thick cylinder under uniform pressure; Shrink fits; Effect of small circular holes in strained plates; stresses in rotating discs and cylinders; rotating disc of variable thickness; Thermal stresses in thin Discs and long cylinders. **(20 Hrs)**

Torsion: Torsion of circular and elliptical bars; Membrane analogy, Torsion of thin open sections, Torsion of thin tubes. **(06 Hrs)**

Energy Principles: Principle of potential Energy; Principle of Complimentary Energy; The principles of potential and complimentary energy considered as variational principles; Rayleigh-Ritz Method; Galerkin Method; Reciprocal Theorem and Castigliano's Theorems. **(10 Hrs)**

Bending of Thin Plates: Differential equation for the bending of thin plates, Boundary conditions, Bending of Simply Supported rectangular plates, Bending of rectangular plates with clamped edges **(10 Hrs)**

TEXT BOOKS:

1. Theory of Elasticity, 3rd ed., S. P. Timoshenko and J.N. Goodier, McGraw Hill. 1970.

REFERENCE BOOKS:

1. Applied Elasticity, C. T. Wang, McGraw Hill Book Co. Inc 1953.
2. Advanced Solid Mechanics, L. S. Srinath, PHI, 2002

PHME421 - WIND ENERGY SYSTEM

Introduction: Historical uses of wind, History of wind electric generations **(06 Hrs)**

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution **(08 Hrs)**

Wind Measurements: Biological indicators, Rotational anemometers, other anemometers, Wind direction **(06 Hrs)**

Wind Turbine Power, Energy and Torque: Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds. **(08 Hrs)**

Wind Turbine Connected to the Electrical Network: Methods of generating synchronous power, AC circuits, The synchronous generator, Per unit calculations, The induction machine, Motor starting, Capacity credit features of electrical network **(06 Hrs)**

Wind turbines with Asynchronous Electric Generators: Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator. **(06 Hrs)**

Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells. **(06 Hrs)**

Economics of Wind Systems: Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity **(06 Hrs)**

TEXT/REFERENCE BOOKS:

1. Garg L Johnson: “Wind Energy Systems” Prentice Hall. Inc, New Jersey – 1985
2. Desire Le Gouriers: “Wind Power Plants: Theory and Design” Pergamon Press – 1982

PHME422 - COMPUTER CONTROL OF MANUFACTURING SYSTEM

Introduction: Fundamentals of numerical control, advantages limitations of N.C systems-classification of N.C systems. **(04 Hrs)**

Features of N.C. Machine tools: design consideration of N.C machine tools — increasing productivity with N.C machines-marching center tooling for CNC machine. **(08 Hrs)**
System device: device, feed back devices-counting devices digital analog converters **(06 Hrs)**

Interpolations: DDA integrators, simple and symmetrical DD reference word CNC interpolators. **(08 Hrs)**

N.C part programming: Introduction-punched tape-manual part programming computer aided programming, APT programming. **(08 Hrs)**

Control loops for N C Systems: Introduction-control loops for point and counting systems. **(06 Hrs)**

Computerized numerical control: CNC concepts-advantage of CNC references pale techniques-sampled data techniques microcomputers in CNC. **(06 Hrs)**

Adaptive control systems: adaptive control with optimization Adaptive control with constraints-variable gains AC systems. **(06 Hrs)**

TEXT BOOKS:

1. Martin J. Numerical control of machine tools
2. M. Koren “Computer Controls of Manufacturing Systems”;

REFERENCE BOOKS:

1. Y. Koren & J. Benuri “Numerical control of machine tools”, Khanna
2. Wilson F. M “Numerical control in manufacturing” Mc Graw Hill Newyor

PHME423 - MACHINE TOOL DYNAMICS

General vibrations theory: Review of systems with one and two degree of freedom; damped, undamped, free and forced vibrations, beat phenomenon; transmissibility of vibration and vibration isolation; theory of vibration isolation theory of vibration measurement; torsional vibration; Holzer method. **(12 Hrs)**

Dynamic of structures: Force and stiffness method. Eigne value problem using lumped mass technique, application to simple structure with low damping. **(10 Hrs)**

Chatter in machine tools: Basic pattern of chatter in metal cutting; regenerative chatter; mode coupling, limit width of cut; importance of negative real component of reacceptance; dynamic cutting force co-efficient; prediction of machine tool instability; study of chatter behaviour in lathe; drilling and milling machines; CIR rig.
(20 Hrs)

Damping in machine tools: Material and system damping; dynamic, impact and active type dampers; methods of damping improvement in machine tools. **(10 Hrs)**

TEXT BOOKS:

1. F. Koeningberger and J. Tlusty, “Machine Tool Structures”, Pergamon press, 1970

REFERENCE BOOKS:

1. G. Sweeny, “Vibration of Machine Tools”, Machinery Publishing Col., 1971
2. D. B. Welbourne and J. D. Smith, “Machine Tool Dynamics: An Introduction”

PHME424 - STRUCTURAL DESIGN

Types of Aerial Vehicles, their basic principles, advantages, disadvantages, limitations - Structural Design Concepts, advantages and disadvantages. Structural layout planning and Structural Weight. **(06 Hrs)**

Design for Manufacturing Aircraft Loads - Materials - Buckling and Stability - Cutouts - Fasteners and Structural Joints. **(06 Hrs)**

Wing Box Structure - Wing Leading and Trailing Edges Control surfaces-Empennage Structure - Fuselage - Fuselage Detail Design Wing and Fuselage Intersection. **(06 Hrs)**

Landing Gear - Engine Mounts - Advanced Composite Structures - Structural Joint. Design - Fatigue, Damage Tolerance and Fail-Safe Design - Weight Control and Balance-Optimum Design Concepts.
Introduction to Practical Aircraft Stress Analysis - Wing Stress Analysis. Fuselage Stress Analysis. **(06 Hrs)**

Loads and Stresses on Ribs and Frames - Special Wing Problems - Structural Analysis of a Delta Wing. **(06 Hrs)**

Wing and Fuselage Buckling - Analysis Technologies of Composite Aircraft Components and Joints-Structuring, Bending, Twisting Couplings. **(06 Hrs)**

Introduction to Computer, Based Analysis Tools and their Applications to Typical Aerospace Structures. **(04 Hrs)**

Introduction to Finite Element Methods. **(04 Hrs)**

TEXT BOOKS:

1. "MICHEL C.Y. NIU", Airframe Structural Design.
2. "E.F. BRUHN", Analysis and Design of Flight Vehicle Structures.

REFERENCE BOOKS:

1. "M.F. RUBINSTEIN", Matrix Computer Analysis of- Structures.
2. "J.S. PREZEMINENIECK", Theory of Matrix Structural Analysis.
3. ARORA J S, Introduction to Optimum Design, McGraw Hill, 1989

PHME425 - FLUID POWER AND CONTROL ENGINEERING

The Hydraulic Power Unit: the hydraulic pump-gear type, rotary piston pumps, the oil reservoir. The oil filter, connecting motor and pump. Power unit difficulties. Intensifier or pressure booster. **(06 Hrs)**

Valves: The relive valve, relief valve difficulties. The master control valve, three way four way valves, pilot valve applications, master control valve and difficulties. The reducing valve and their difficulties. Flow control valve and their difficulties. The air release valve – check the surge damping valve, pressure switches.
(08 Hrs)

Hydraulic Cylinders Intensifiers and Motors: non rotating type cylinder, single acting type, double acting type, piston and piston packing, piston rods, cylinder covers, rotating cylinders, intensifier motors.
(06 Hrs)

Hydraulic Accumulators: Need of accumulators, the dead weight accumulator, the spring load accumulators, air or gas operated accumulators, use of accumulators as leakage compensator as secondary source of energy, as fluid make up device for synchronizing ram movement of two cylinder, to provide emergency source of power, as holding device as shock suppressor, use in dual pressure circuit, use as lubricant dispenser.
(08 Hrs)

Synchronizing the Movement of Fluid Power Rams: Factors affecting synchronizing, use of mechanically linked pistons, use of hydraulic motors as metering devices, use of double cylinders in series, use of air hydraulic cylinders in series, use of equal capacity pumps. **(08 Hrs)**

Pneumatic Control Components: Pneumatic cylinders, single acting cylinders, double acting cylinders, special type cylinders, valves, directional valves, valve actuation non return valves, pressure control valves flow controls valves, air meters, hydro pneumatic equipments. **(08 Hrs)**

Pneumatic Control System: general notes in control system design, logic control circuits, production of circuit diagrams, symbols, circuit diagrams, control mode, will dependent control, travel dependent controls time dependent control, combined control, program control, sequence control, electro pneumatic for clamping, metal working, material handling and safety circuit for the press for safe guarding operators hands.
(08 Hrs)

TEXT BOOKS:

1. Harry L. Stewart – hydraulic & Pneumatic Power for Production, The Industrial Press, New York
2. S. R. Mujumdar, Pneumatic systems principles and maintenances, Tata McGraw Hill.

REFERENCE BOOKS:

1. Andrew Parr, Hydraulic systems.
2. Pippenger, Hicks, Industrial Hydraulics McGraw Hill.

PHME426 - CAD/CAM

INTRODUCTION
CAD/CAM defined the product cycle and CAD/CAM. **(03 Hrs)**

COMPUTER AIDED DESIGN
Introduction, Geometric Modeling Technique, Wire frame, Surface modeling, Representation of Curves, Design of Curved shapes Cubic Splines Bezier Curves, B-Splines Nurbs and β -Splines Representation of Surfaces, Design of Surfaces, Parametric Design of Surfaces Bi-Cubic Polynomial surface patches Bazier, Bi-cubic Surface Patches. Surface modeling in commercial Drafting and Modeling software. Conceptual Shapes design-Sketching the geometry and other features for conceptual design Hardware in CAD.
(10 Hrs)

GRAPHIC SOFTWARE CONCEPTS
Introduction, Software configuration of graphic system standards for graphic programming feature of GKS and other graphic standard. PHIGS exchange of CAD data between software package Initial graphics exchange specification (IGES) Graphic Standard. **(06 Hrs)**

TRANSFORMATION
2D and 3D Transformation. **(02 Hrs)**

COMPUTER AIDED MANUFACTURING
Numerical Control -Introduction Need of NC machine tool, Elements of NC manufacturing CNC -Principle of Operation of CNC, Feature of CNC., DNC -Types of DNC, Advantage and Disadvantage, APT Programming system, APT language, APT statements, Micro statement in APT, APT word definition' Workstation based programming system.
(08 Hrs)

COMPUTER INTEGRATED MANUFACTURING.
Fundamentals of CIM, Automation and CAD/CAM. group technology, part formation Part classification and Coding, Production flow analysis, Machine cell design, Benefits of group technology, computer aided process planning, type capp system benefits of cap, production planning and control, introduction, Computer integrated production management systems, cost planning and control. **(10 Hrs)**

ROBOTICS
Robot technology, Robot Programming, Robot application, flexible manufacturing system (fms), definition, workstation, material handling and storage system, computer control system, planning the FMS, analysis method for FMS, application and benefits. **(06 Hrs)**

MANUFACTURING SYSTEM INTEGRATION
Shop floor control and automatic identification technique, computer network for manufacturing. **(05 Hrs)**

TEXT BOOK:
CAD/CAM by Groover & Zimmer

REFERENCE BOOK:
CAD/CAM/CIM by Radhakrishna

PHME427 - MATERIAL MANAGEMENT & LOGISTIC SUPPORT

Over view on the growth of aviation and aviation industry. **(02 Hrs)**

Concept of aircraft development cycle production and product support and concurrent engineering. **(07 Hrs)**

Aircraft Materials: Desirable properties, Metallic materials and alloys, non- metallic materials & consumables, Composites and Introduction to smart materials. **(08 Hrs)**

Requirement analysis, estimation and material planning for prototype, production and product support. **(07 Hrs)**

Documents for materials management function. **(05 Hrs)**

Material provisioning, procuring, inspection and acceptance and storing. **(06 Hrs)**

Control of flow of materials and inventory management. **(05 Hrs)**

Commercial and financial aspects involving in country and international purchases, contracts, license agreements. **(06 Hrs)**

Logistic support: **(04 Hrs)**

TEXT BOOK:

1. Chenna Keshu Sand Ganapathy K K: Aircraft Production Technology and Management;

REFERENCE BOOK:

1. Horne, DF: Aircraft Production Technology

PHME428 - CONDITION BASED MAINTENANCE

Chapter 1: Condition Based Maintenance

Introduction, Principles, Economics and Application; Condition Monitoring Methods. Economics of Condition Monitoring, Setting up a CM Activity, Implementation of Condition Based Maintenance, Consequences of implementation of CBM. Information System, Selection of Monitoring Methods, Assessment of monitoring techniques, Case studies. **(06 Hrs)**

Chapter 2: Vibration Monitoring and analysis

Introduction, Machinery signatures, Selection of Transducers. Analysis Techniques, Machine failure modes, Measurement location, Vibration severity criteria, Vibration frequency analysis. Permanent Monitoring, Case studies. **(06 Hrs)**

Chapter 3: Vibration Monitoring of ball and roller bearings

Introduction, Shock pulse method, SPM for testing Antifriction bearings, Manual Monitoring

Continuous monitoring, The Kurtosis method, Fiber optics system, Vibration signature analysis, Contact resistance method, Case studies. SPM and its Applications. **(06 Hrs)**

Chapter 4: Non-Destructive testing and specialized techniques.

Introduction, Visual testing, Liquid Penetrate inspection, Water-washable method. Precleaning, Penetrant application, Dwell time, Excess surface-penetrate removal, Surface drying, Developer application, Interpretation, Post-emulsifiable penetrants, Solvent-Soluble penetrants.

Radiographic examination, X-ray Apparatus, X-ray generation, Tube shielding, Control console, Other X-ray sources, Electrostatic or Ven De Graffgenerators, Linear accelerators. Gamma-ray Radiography-Sources-Radium, Thallium 170, Iridium 192, Cobalt 62. Isotope Projectors-Geometric factors, Radiographic film, Radiograph. Safety Hazards and Government control; Cost.

Sonics, Ultra Sonics, Pulse echo technique, Transmission technique, Resonance technique, Frequency modulation techniques.

Acoustic imaging, Ultra sonic triangulation fault location Acoustic emission technique (AET)- Instrumentation, Transducers, Preamplifier and filter, Main amplifier and Signal processing/ Display unit, Signals and processing, Magnetic testing Methods, Current flow Magnetisation, Induction Magnetic Flow Method, Induction Threading bar method, Induction Magnetising Coil method, Induced Current flow method, Magnetic particle Inspection Inks, Strippable Magnetic film, Eddy Current apparatus, Cost.

Thermography-Thermographic Equipment, Application of Thermography,

Corrosion monitoring, Need for corrosion monitoring, Fields of application, Monitoring Techniques, Resistance techniques.

Other probe techniques-Analytical technique and others. **(14 Hrs)**

Chapter 5: Performance Trend monitoring

Introduction, Thermodynamic and Fluid dynamic analysis, Primary and Secondary, performance parameter, Steam turbine performance parameters, Case examples. **(06 Hrs)**

Chapter 6: Mechanical fault diagnosis by wears monitoring & lubricant analysis

Introduction, Source of Contamination, Significant oil contaminants, Used oil Contamination-time trends, Changes in the carrier fluid, Ferratic wear debris.

Wear process monitoring techniques- Direct debris detection methods, Debris collection methods.

Lubricant sampling & analysis-Sampling, Lubricant sampling methods, Lubricant analysis methods, Interpretation of results, Indications from the amount of debris present, Indication from the size distribution of debris, Application of chemical analysis of debris, Wear detection using proximity monitors, Case examples.

(08 Hrs)

Chapter 7: Condition Monitoring case Studies & Applications

Failure of fan bearings- History of failures, Analysis of the failures, Solution.

High frequency vibration of gas compressor-History of trouble, Analysis of trouble, Solution.

Monitoring of cracks in rotors- Turbocompressor misalignment. Detection of faulty electrical components. Turbine shell distortion. Symptoms and Detections **(06 Hrs)**

TEXT BOOKS:

1. R. A., Caollacatt Chapman “Mechanical Fault Diagnosis and Condition Monitoring”, Chapman and hall 1977.

REFERENCE BOOKS:

1. L. F. Pau Marcel Deker “Failure Diagnosis and Performance Monitoring”.
2. Update CEP ISTE New Delhi “Condition Monitoring and condition based maintenance”.
3. Current Literature.

PHME429 - ENGINE FLOW & COMBUSTION

Gas exchange process: Inlet & exhaust processes in four stroke cycle, volumetric efficiency, flow through valves, residual gas fraction, exhaust gas flow rate and temperature variation, super charging, turbo charging **(08 Hrs)**

Charge motion with in the cylinder: Intake jet flow, mean velocity turbulence characteristics, swirl, squish, pre chamber engine flows, crevice flow and blow by, flows generated by piston cylinder wall interaction. **(08 Hrs)**

Combustion in SI engines: Essential features of the process, thermodynamics analysis, burned and unburned mixture states, analysis of cylinder pressure data, combustion processes characterization, flame structure and speed, cyclic variations in combustion, partial burning and misfire, spark ignition and alternative approaches, abnormal combustion, knock and surface ignition. **(08 Hrs)**

Combustion in CI engines: Essential features of the process, types of diesel combustion systems, fuel spray behavior, and ignition delay, mixing controlled combustion. **(06 Hrs)**

Pollutant formation and control: Nature of the problem, nitrogen oxide, carbon monoxide, unburnt hydrocarbon emissions, particulate emissions, exhaust gas treatment **(06 Hrs)**

Engine heat transfer: Model of heat transfer, engine energy balance, intake and exhaust heat transfer, radiations from gases, flame radiation component, temperature distributions, effect of engine variables. **(08 Hrs)**

Modeling of real engine flow and combustion: Classification of models, governing equations of conservation of mass, conservation of energy, intake and exhaust flow models, thermodynamic based in-cylinder models, fluid mechanics based models. **(08 Hrs)**

REFERENCE BOOKS:

1. IC Engines fundamentals by John. B. Heywood
2. IC engines by Colin. Ferguson
3. Applied Thermodynamics by Ferguson