DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE
&
DETAILED SYLLABUS
For
M.TECH

SPECIALIZATION
IN
MACHINE DESIGN & ANALYSIS
(Effective from 2010-11)

VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY
BURLA, SAMBALPUR
PIN-768018

VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY,BURLA
COURSE STRUCTURE FOR 2-YEARS M.Tech.DEGREE COURSE in
MECHANICAL ENGINEERING ON MACHINE DESIGN & ANALYSIS SPECIALISATION
TO BE EFFECTIVE FROM (2011-12)

MACHINE DESIGN & ANALYSIS

1st Year First Semester	**L-T-P**	**CR**	**1st Year Second Semester**	**L-T-P**	**CR**
Applied Elasticity and Plasticity	4-0-0	4	FEM in Engineering	4-0-0	4
Advance d Mechanics of Solids	4-0-0	4	Composite Materials	4-0-0	4
Machine Vibration Analysis	4-0-0	4	Experimental Stress Analysis	4-0-0	4
ELECTIVES (Any two)			**ELECTIVES (Any two)**		
1.Automatic Control Systems	4-0-0	4	1.Advanced Theory of Mechanisms and Machines	4-0-0	4
2.CAD and Computer Graphics	4-0-0	4	2.Product Design	4-0-0	4
3.Fatigue,Creep and Fracture	4-0-0	4	3.Tribology	4-0-0	4
4.Neural Networks and Artificial Intelligence	4-0-0	4	4.Engineering Design Optimization	4-0-0	4
5.Robotics and Flexible Manufacturing	4-0-0	4	5.Mechatronics	4-0-0	4
Engg. Software Lab.	0-0-3	2	Design Project of Mechanical Systems	0-0-3	2
Analysis and Design Engg.Lab.	0-0-3	2	Advanced Design Engg. Lab.	0-0-3	2
Seminar – I	0-0-3	2	Seminar – II	0-0-3	2
Comprehensive Viva-Voce - I		2	Comprehensive Viva-Voce – II		2
Total	**20-0-9**	**28**	**Total**	**20-0-9**	**28**

SECOND YEAR (3rd Semester)	**C**	**SECOND YEAR (4th Semester)**	**C**
Dissertation Interim Evaluation	10	Dissertation Open Defence	5
Comprehensive Viva-Voce	3	Dissertation Evaluation	20
Seminar on Dissertation(100)	2		

Total Credit : 96

APPLIED ELASTICITY AND PLASTICITY

Fundamental assupmptions in elementary elasticity, stress, strain, displacement and rotation, equation of equilibrium and compatibility, boundary conditions, Hooke's Law plane stress and plane strain, two dimensional problem, in rectangular and polar co-ordinate, elementary three dimensional problems.

Text: 1. Timoshenko, Goodier – Theory of Elasticity (Mc.Graw Hills)
Chapter 1,2,3 (Art.1721) 4 (Art 25 to 33 & Art.36 & 37), 8,9(Art.76-79 and 10
2. Introduction to Plasticity, Plastic stress, Strain relation
Hoffman and Sachs – Theory of Plasticity (Mc.Graw Hills) Chapters 5 and 6

FINITE ELEMENT METHODS IN ENGINEERING

Structural stiffness and network analysis, Assembly and analysis of a structure, Finite elements of an elastic continuum, Displacement approach, Minimisation of total potential energy, convergence criteria. Generalisation of finite element concepts, Nodeless variables, Alternative approaches to finite element formulations. Plane stress and plane strain, Element characteristics, some practical applications. Axisymmetric stress analysis, element characteristics, some illustrative examples. Three Diemsnional Analysis : Practical Problems. Plate Bending Formulations of FEM. Finite element formulation for large deformation : Masticity and Crop etc. Computer methods and computer programmes, Data input, stiffness generations, Assembly and solution of equations and output of results.

Text Books: 1. The Finite Element method in Engineering Science – O.C. Zienkiwiecs, TMH
2. Introduction to finite element method – Abel and Desal, EWP

ADVANCED MECHANIC OF SOLIDS

Theory of Elasticity: Plane stress and strain, stress in three dimensions, principal stresses, maximum shearing stress, equations of equilibnrium and compatibility, simple problems. Torsion of prismatical bars of narrow rectangular cross sections, rolled profile section and thin tubes. Application on energy methods. Various analogies.
Plates: Pure bending of plates. Bending of plates by distribute lateral load. Symmetrical bending of circular plates, combine bending and tension or compression of plates strain energy in bending of plates. Deflection of rectangular plates with simple supported edges. Bending of plates with initial curvature.
Shells: Membrance theory of cylindrical sheel. General flexures theory of open cylindrical sheels, General membrance theory of the shells, hyperbolic paraboloids, conoids and exisymmetic shells.

Reference: 1. Theory of Elasticity – Timoshenko and Goodier
2. Theory of Elastic Stability – Timoshenko and Gere
3. Theory of Plates and Shells – Timoshenko and Krieger.

COMPOSITE MATERIALS

Introduction : Introduction-classification and characteristics of composite materials-Mechanical behaviour of composites-constituents: Reinforcements-Matrices-Fillers-Additives-Applications and advantages of composites.
Processing: Initial form of constituent materials-Manufacturing procedures for fiber-reinforced plastics-quality control-testing of composites.
Macromechanical Behaviour: Stress strain relations of anisotropic materials-Engineering constants for orthotropic and isotropic materials-Plano stress condition-Stress-strain relations for a lamina of arbitrary orientation-strength of an orthotropic lamina.
Behaviour of Laminated Composites: Classical lamination theory-Evaluation of laminate stiffnesses-Experimental determination-Strength of laminates-General design considerations.

Text Books: 1. R.M.Jones – Mechanics of composite Materials, Mc Grew Hill Book Co.,
2. Fibre-Reinfored composites-Materials, Manufacturing and Design. P.K.Mallick Marcel Dekken, Inc. New York & Basel.

MECHANICAL VIBRATION ANALYSIS

Generalised co-ordinates. Lagrange's Equation. Hamiltons' principle, Theory of oscillation of single degree freedom system with application to Vibration isolation and vibration measurement. Multidegree freedom system with application to measurement. Multiple degree of freedom systems with applications to dynamic vibration absorbers. Application of matrix to vibrational problems, General theory of small oscillation of conservative systems, principlal frequencies and modes. Normal co-ordinate, Orthogonality relations, vibrations of straings beams, membraince and plates. Introduction of Rayleigh and Rayleigh-ritz Methods. Lap lace Transforms and operational Methods.

Text: 1. W.T. Thompson- Mechanical Vibration
2. Karman & Brot – Mechanical Methods in Engg.(Relevant Topics only)
3. U.P. Den Hortag – Mechanical Vibrations(Relevant topic only)

EXPERIMENTAL STRESS ANALYSIS

Wire Resistance strain gauges: Experimental determination of static and dynamic strains using electrical strain gauges. Moire fringe techniques. Theory and practice of photoelasticity. Brittle Lacquer Techniques.

Text: 1. Dove and Adams- Experimental Stress Analysis and Motion Measurements.
2. Durelli and Riley Introduction to Photo-Mechanics.
3. Jessop and Harris – Photo-elasticity Principles and Methods.

AUTOMATIC CONTROL SYSTEM

Closed loop and open loop systems, Design principle of control systems, Laplce Transform method, Transfor Functions block diagrams, deriving transfer functions of physical system signal, Flow Graphs, Proportional, Derivative and integral controller, impulse response functions.
First order systems, second order systems, higher order systems. Routh stability criterian, static and dynamic error co-efficients, Introduction to system optimization.
Root locus plots, root locus analysis, closed loop frequency responselag, lead compensations.
Nonlinear control systems, describing function analysis of nonlinear control systems. Introduction to discrete time systems, state space representation of systems, Liapunov stability analysis, optional control systems based on quadratic performance indexes. Adaptive con troll systems.

Ref: 1. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall, India.

ADVANCED THEORY OF MECHANISM & MACHINES

Dynamic force analysis of mechanism, analytical and graphical techniques. Dynamic motion analysis, flywheels, balancing of rotors and multi cylinder reciprocating machines, critical speeds of rotors.
Cams: Synthesis of cam profiles, advanced cam curves and optional layout for given pressureanalge, Dynamic analysis of cams, Accuracy analysis and design of cams.
Gears: Elements of differential geometry, space curves, surfaces and conjugate action.
Genevga mechanisms, and non circular gears dynamics and design of gears.
Gyroscopes, Gyrodynamics inertial guidance systems, scopic action in machines.

References:
1. A.K. Ghosh and A.K.Mallik, Theory of Mechanisms and Machines, Affiliated East West Press Pvt. Ltd., Madras, 1976.
2. Mabie and Ocvirk, Mechanism and Dynamics of Machinery
3. Roothbart, Cams John Wiley, Pub.1956
4. A.R. Holowenko, Dynamics of Machinery, Wiley New York, 1955.

CAD & COMPUTER GRAPHICS

Fundamental of CAD: The design process, Application of computers for design. Creating the manufacturing database. The design workstation, Graphics terminal, operator input devices, Plotters and other output devices. The CPU, Secondary storage.
Geometric transformation of simple figures to different shapes by matrix method.
Computer Graphics Software: Configuration, Graphic packages, constructing the geometry, Transformation, Database structure and content.
The benefits and cost of CAD: Principles of concurrent Engineering. Soft and hard prototyping, Workflow in Concurrent Engineering. Key factors influencing the success of Concurrent Engineering.
Graphic Workstation. Hardware of workstation, Advanced modelling techniques-Wire frame model, surface modelling, Solids modelling. Wire frame versans Solids modelling.
Modelling facilities in solid modeller.

Automated Drafting, Menu based drafting, Use of software for drawing/colour processing.
Optimum Design: Optimum Design for Normal Specification, Optimum design for Redundant specification.
Simple Engineering Design Problems.

Text Books:
1. CAM: Computer Aided design & Manufacturing-MP Groover & E.W.Zimmer Jr. PHI. CAD.
2. CAD,CAM,CIM: P. Radhakrishana & S. Subramanyam – New Age International Publishers.
3. Optimization Theory & Applications: SS Rao, Wiely Eastern Ltd.
4. Rogers.

PRODUCT DESIGN

The Product-scope, types of product Design requirements-functional, operating, portability, shipment, installation, use maintenance, appearance & cost.
Design factors-functions, attributes, circumstances, Resources, restraints, and uncertainly Design logic.
Design method-stages, investigation product design, development test.
Design for function, Designing for use, design for appearance, Design for production.
Standardization – Effects of standard, quality, reliability, Interchangeability, variety reduction.
Value Engineering – Value analysis, Analysis of function.
Material selection, properties, cost manufacturing process.

Text Books :
1. Engg. Product Design – W.D. Cain –Business Book Ltd.
2. Value Engg. – L.D.Miles

FATIGUE CREEP & FRACTURE

Fatigue : Fatigue under normal conditions, Controlling factors in fatigue. Design for fatigue. Fracture Theories of strength and working stresses.

Text : Strength and Resistance of Materials – by J.M. Lessles, Chapter 6, 7, 8 & 11.

Creep: Temperature and Creep Stress-strain properties, creep in tension, Creep in bending, Creep in Torsion, Creep buckling, Members subjected to creep and combined stresses.

Text : Mechanical Behaviour of Engg. Materials by J. Marin Chapter 7 & 8.

Fracture : Basic modes of fracture, Grith theory of Brittle fracture Irwin's theory of fracture in elastic-plastic materials, theories of linear elastic fracture mechanics, stress intensity function, Fracture toughness testing.

Text: Fracture Mechanics – KN Heller.

TRIBOLOGY

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

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

NEURAL NETWORKS AND ARTIFICIAL INTELLIGENCE

Introduction to Data Bases, Artificial Intelligence, Need for Knowledge Based Systems in Mechanical Engineering. Representation of Knowledge: Conceptual dependencies, Semantic, Networks, Frames, Production Systems. Object Oriented Data Bases for Knowledge Bases Systems. Control Structures: Exhaustive Search, Pruning, Search Methods. Methods of Inference. Top-Down and Bottom-up approaches. Control structures with uncertainty. Certainty Factors. Fuzzy Theory. Machine Learning. Knowledge Engineering: Languages and Tools for Knowledge Engineering. Completeness and Consistency in Rule-Based Systems. Expert System Development. Expert System support Environment. Neural Networks. Fundamentals of Parallel Processing. Hopfield Networks. Artificial Neural Networks. Application of Neural Networks: Inspection, Vision, Real-time Process Control, Diagnostics of machines and multi-sensor integration, approaches to Die and Tool Design. Design compatibility analysis for simultaneous engineering.

ENGINEERING DESIGN OPTIMIZATION

Basic concepts: Unconstrained and constrained problems. The Kuln-Tucker conditions; Functions of one variable; Polynomial approximations, Golden section method. Finding the bounds on the solution, A gen eral strategy for minimizing functions of one variable; Unconstrained functions of n variables: Zero-order, first-order and second-order methods, convergence criteria; constrained function of n variables; Linear programming, Sequential unconstrained minimization techniques, Direct methods; Approximation techniques; Duality; General design applications.

ROBOTICS AND FLEXIBLE MANUFACTURING

Robotics: Historical background, Definitions, Laws of Robotics, Robotic system and robot anatomy, common robot configurations, Coordinater system, work envelop, Elements of robotic system-end effector, actuators, controller, teach pendant, sensors, Specification of robots. Applications, safety measures.
Robot Kinematics: Forward and reverse Kinematics of 3-DOF and 4-DOF Robot arms. Homogeneous Transformations, Kinematic Equation using Homogenerous transformations.
Actuators: Hydraulics actuators, pne3matic actuators, Electrical actuators, Directional Control, Servo Control, Flow Control Valves.
End Effectors: Classification, Drive systems, Magnetic, Mechanical, Vacuum and Adhesive Grippers, Force analysis in a Grippers.
Sensors: Need for sensing systems, sensory devices, Types of sensors, Robot vision system.
Robot Languages and Programming: Type of programming, Motions Programming, Robot Languages-VAL Systems.
Flexible automation: Technology, FMS, function of Robot in FMS, Flexible Manufacturing cell.

Text Books: 1. Robotics Technology and flexible Automation: S.R.Deb, Tata Mc.Graw Hill
2. Robotics: Lee, Fu, Gonxalez, Mc.Graw Hill

3. Industrial Robot: Groover, Mc. Graw Hill.

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MECHATRONICS

Mechatronics: Definition and scope, Key issue in Mechatronics.
Electronics for Mechanical Engineers: Conductor, Insulator, Semiconductors, Passive components used in Electronics, Transformers, Transistors, Silicon Controlled Rectifiers, Integrated Circuit, Digital Circuits.
Mechatronics Elements: Machine structure, Guide ways, Feed driver, Spindle/Spindle Bearings, Measuring systems, Control, Software and User interface, Gauging, Tool monitoring system.
Assembly Technique: Guide ways, Ball screw and nut, Feedback Elements, Spindle Bearing, shop tools and equipments for assemble, Hydraulics.
Drives and Electrical: Drives, Spindle drives, Feed drives, DC motor, Servo principle, Drive optimization, Drive protection, Selection Criteria for AC drives, Electric elements.
CNC System : Introduction, Configuration of the CNC system, Interfacing, Monitoring, Diagnostic, Machine Data, Compensation for machine accuracies, PLC programming, NDC.

Text: 1. Mechatronics, HMT Ltd., Tata Mc Graw Hill Publication, New Delhi.

ENGINEERING SOFTWARE LABORATORY

Computation & programming in Fortran & C, C++.
Object oriented programming, use of packages.

DESIGN PROJECT OF MECHANICAL SYSTEM

ANALYSIS AND DESGN ENGG. LABORATORY

1. Experiment of Universal Testing Machine.
2. Experiment on Fatigue machine
3. Experiment on NDT set up
4. Experiment on Damped vibration system
5. Experiment on vibration set up with modulated frequency of Excitation.

ADVANCED DESIGN ENGG. LABORATORY

1. Measurement of strain by strain gauge
2. Measurement of component strain by using strain rosette
3. Analysis of stress by photo elasticity method
4. Experiment on vibration meter.

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VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY,BURLA
COURSE STRUCTURE FOR 2-YEARS M.Tech.DEGREE COURSE in
MECHANICAL ENGINEERING ON HEAT POWER ENGINEERING SPECIALISATION
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HEAT POWER ENGINEERING

1ST Year (First Semester)	L-T-P	CR	1ST Year (Second Semester)	L-T-P	CR
Advance Engineering Thermodynamics	4-0-0	4	Convective Heat Transfer	4-0-0	4
Conduction and Radiation Heat Transfer	4-0-0	4	I.C.Engines	4-0-0	4
Fluid & Gas Dynamics	4-0-0	4	Experimental Techniques for Thermal Engineering	4-0-0	4
Elective (any Two)			Elective (any Two)		
1.Crogenic Technology	4-0-0	4	1.Air Conditioning Engineering	4-0-0	4
2.Solar Engineering	4-0-0	4	2.Thermal system Simulation and design.	4-0-0	4
3.Thermal power Plant	4-0-0	4	3.Combustion	4-0-0	4
4.Finite Element method	4-0-0	4	4.Numerical Heat Transfer.	4-0-0	4
5.Refrigeration Engineering.	4-0-0	4	5.Boiling, Condensation and Two Phase Flow	4-0-0	4
Engg. Software Lab.	0-0-3	2	Design Project of Heat Power System	0-0-3	2
Heat Power Engg. Lab	0-0-3	2	Advance Heat Power Lab	0-0-3	2
Seminar-I	0-0-3	2	Seminar-II	0-0-3	2
Comprehensive Viva-voce-I		2	Comprehensive Viva-voce-II		2
Total	20-0-9	28	Total	20-0-9	28
2nd Year (Third Semester)			2nd Year (Fourth Semester)		
Dissertation Interim Evaluation		10	Dissertation Open Defence		5
Comprehensive Viva-voce		3	Dissertation evaluation		20
Seminar on Dissertation		2			
Total Credit:					96

ADVANCE ENGINEERING THERMODYNAMICS

Recapitulations of fundamentals, Analysis of simple closed and open systems. First and Second Law of Thermodynamics, Entropy, Analysis of variable flow process, Availability and irreversibility, Properties of gases and mixtures. Real gases, Generalized compressibility charts, General conditions for Thermodynamic equilibrium, Criterion for equilibrium under various conditions of isolation, Significance of Thermodynamic potentials, Chemical equilibrium . Concept of fugacity and activity, Thermodynamic of reactive systems, stoicheometry, First and Second Law analysis of chemical reactions, Ideal gas mixtures, Ideal solution. Irreversible thermodynamics: Entropy generation, The Gouy Stodala Theorem, system communicating with more than one reservoir, adiabatic systems, Characteristics feature of irreversible systems and processes , Relationship between entropy generation and viscous dissipation, Thermal energy storage, Thermal operation of storage elements, energy destruction during thermal storage series of storage units, Optimum flow rate, Energy storage units, Refrigeration storage.

Ref Books:

1. Van-Wylen, G.J. and Sanntag. R.E- Fundamentals of Classical Thermodynamics (Wiley)
2. Reynolds and Penkin – Engg. Thermodynamics (M-Graw- Hill Publication)
3. P.K.Nag – Engg. Thermodynamics (THM Publication)
4. A.Benjan – Entropy generation in fluid flow and heat Transfer (A Wiley Intersciene publication)

CONDUCTION AND RADIATION HEAT TRANSFER

Conduction : Derivation of generalized conduction equation for anisotropic inhomogeneous solids, concepts of isotropic and homogeneous conductivity ,Steady state conduction, recapitulations of fundamentals, analysis and design of variable cross-section and circumferential fins in 2D,2D conduction in solids with complex boundary conditions and heat generation . Transient conduction recapitulation of Transient conduction with simple systems , analysis of Transient conduction with complex Boundary conditions . The use of Laplace transformation in linear conduction problems , Numerical methods, Fundamental of discretization, Relaxation method, treatment of boundary condition , non linearity, properties anisotropy and complex boundaries.

Raadition : Recapitulations of fundamentals, radiative properties of surfaces method of estimating the configuration factors, Heat exchange among diffusely emitting and diffusely reflecting surfaces ,Radiant energy through absorbing emitting and scattering media, Various methods for solving the Inegro-differential equation.

Ref. Books :

1. Arpaci –Conduction and heat transfer (Abridged Edition.GINN Press)
2. Modest, F.M – Radiative transfer (Mc Graw –Hill)
3. Ozisk , M.N – Interaction radiation heat transfer with conduction and Convection .
4. Domkundwar & Arrora - Heat Transfer (Dhanpat Rai and Sons)

FLUID AND GAS DYNAMICS

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

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

Ref. Books :

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

CRYOGENIC TECHNOLOGY

Introduction ; Low temperature properties , Mechanical , Thermal , Electric and Magnetic Properties , Properties of cryogenic fluids

Gas liquification systems ; simple Linde – hompson system , precooled Lindehompson systems for Ne, H_2 , He ; Collins Helium liquefaction systems , critical components of liquefaction systems .

Gas separation and purification systems ; properties of mixtures . principle of gas separation , i.e , simple condensation of evaporation , rectification .

Air separation systems, Argon separation systems , Helium separation systems .Gas purification methods

Cryogenic refrigeration systems (Liquid and gas as refrigerant); Joule Thomson refrigeration systems, cascade or precooled Joule –Thomson refrigeration systems , cold gas refrigeration system .

(solid as working media) ; Magnetic cooling , its thermodynamics aspect . magnetic refrigeration system , thermal valves , nuclear demagnetization

Measurement system for low temperature ; Temperature , pressure flow rate , Applications ; super conducting Bearings , motors , cryotrons , chemical rockets, space simulation , nuclear rockets , Blood and tissue preservation .

Ref. Books :

1. Barron. R. – Cryogenics (Ch. – 1,2,3,4,5,6,9) (Mc- Graw Hill Publishing Company Ltd.)

SOLAR ENGINEERING

Introduction ; Energy sources and their availability, renewable energy sources prospects of renewable energy sources .
Solar radiation and its measurement : solar constant , solar radiation at the earth's surface , solar radiation geometry, solar radiation measurement estimation of solar radiation, solar radiation on tilted surfaces.
Flat plate collectors : Physical principles of conversion of solar radiation into heat, transmissivity of cover system, energy balance equation and collector efficiency , thermal analysis of flat plate collector , collector performance tests. Testing procedures.
Concentrating collectors; - Cylindrical parabolic collector, performance analysis, compound parabolic collector , tracking of compound parabolic collector, performance analysis.
Energy storage : Introduction, sensible heat storage, Latent heat storage, thermo chemical storage .
Solar pond ; introduction, description , performance analysis, experimental studies, operational problems, application of solar ponds.
Application of solar energy: Solar water heating, space heating and cooling, solar photo-voltaic, solar distillation, solar pumping, solar pumping, solar furnace, solar cooking. Solar drying, green houses.

Ref. Books :

1. J.A Duffie and W.A .Beckman – Solar Engineering of thermal processes (Jhon Wiley and sons)
2. S.P. Sukatme : Solar Energy (TMH Publishing Company Ltd.)
3. G.D. Rai – Non conventional Energy Sources (Khanna Publishers)

THERMAL POWER PLANT

Introduction : Types of power plants , Vapour power cycles, Gas turbine cycles, Combined cycle, Cogeneration ,Techno economic analysis of power plants, Feasibility studies , Variable load problem , Fuels and combustion, Fossil fuel steam generators , Pulverized coal, oil , and gas fired boilers and steam super heaters, Steam generator of nuclear power station , Steam and gas turbine , Regenerative feed water heating of thermal and Nuclear power plants, Condenser , Circulating water system , colling Towers , Site selection, Enviromental aspect of power generation ,Flue Gas cleaning and ash removal , Safety system of Nuclear power plants , Operation of power plants . instrumentation of power plants .

Ref. Books ;

1. P.K.Nag – Power plant Engg.- TMH Publication (ch.1.2.3.4.5.6.7.8.9)
2. El Wakil –Power plant technology (Mc Graw Hill Publishing Company Ltd.)

FINITE ELEMENT METHOD

Fundamental Concept: Strain displacement relation , stress- strain relation . Plane stress, Plane strain problem minimization of total potential energy (principle of Virtual works),
Concept of an Element; Displacement model , Shape functions for one Dimensional and two Dimensional problems , Constant strain Triangle . Iso parametric representation , Generalized co-ordinates
Element stiffness Matrix: Assembly procedure, Treatment of Boundary condition . Elimination approach , Penallty approach, some practical application.
Solution of Linear Equations: Gauss Elimination Method, Gauss seidel method . Convergence criteria.

Scalar field problems: Variation formulation, Application to steady stae heat transfer in one and two dimension , simple problem on fluid flow, steam function formulation
Computer method and Computer programmes , Automatic mesh generation, Data input, stiffness generation , solution of equations .

Ref. Books :

1.Abel and Desai : Introduction to finite element method (EWP)
2. O.C.Ziennkiwicz : The finite element ,method in Engineering science (TMH Publication)
3.Chandrupatla and Belegundu ; Introduction to finite elements in Engineering (PHI)

REFRIGERATION ENGINEERING

Thermodynamic properties of pure and mixed refrigerants and their selection .
recapitulation of thermodynamics of refrigeration systems , Vapour compression system, Multistage compression systems , Use of flash coolers, Vapour absorption systems ,ejector refrigeration systems, vertex tubes, Principle of liquefication of gases , solid ice production , Magnetic refrigeration systems , Analysis and thermal design of reciprocating centrifugal and screw compressors, computer simulation of refrigerant compressors , Expansion devices-capillary tubes,automatic and thermostatic expansion valves , design of capillary tubes , Thermal Design of evaporators , condensers ,component matching and system integration .

Ref. Books :

1. C.P. Arrora, Refrigeration & Air conditioning (TMH Publication)
2. Stoecker and Zones : Refrigeration & Air conditioning (Mc Graw Hill)
3. Domkundwar & Arrora : Refrigeration & Air conditioning (Dhanpat Rai & Sons)
4. Monohar Prasad : Refrigeration & Air conditioning (EWP)

CONVECTIVE HEAT TRANSFER

Fundamentals: Scale analysis , Renold transport theorem , Deviation of N-S Equation and energy ;concept of boundary layer , velocity and thermal boundary layer , Integral solution , similarity solution , effect of wall heating conditions. Unheated starting length , arbitrary wall temperature , and uniform heat flux , the effect of longitudinal pressure gradient ,
Laminar Duct Flows : Convection in fully developed flow and developing flow effect of wall boundary conditions.
Natural convection : Laminar Natural convection ,External flows , boundary layers
Scale analysis , integeral similarity solutions , uniform wall heat flux . effect of thermal stratification , natural convection from vertical walls . Inclined walls, horizontal walls , horizontal and vertical cylinders and sphere.
Natural convection in enclosures ; Transient heating from side , boundary layer resign , the shallow enclosure limit , fluid layers heated from below . Other configuration rectangular enclosures and cylindrical enclosures.
Turbulent flows :Fundamentals of turbulent heat convection ,scaling laws of transition , instability of in viscid flow , General criterion for transition to turbulents . Turbulent boundary layer . Time average equation . Mixing length model . Velocity distribution, wall friction in boundary layer flow, heat transfer in boundary layer flow , Turbulent duct flows , refined turbulence models , free turbulence : Jets ,plumes and wakes .

Ref. Books:

1. Bejan , A - Convective Transfer , Jhon wiley and sons (Ch-1,2,3,4,5,6,7,8,)
2. Kays W . M and Crawford M . E - (Mc Graw Hill) (Mc Graw Hill ,1980)

3. Cebaeci, T . , and Bradshaw , P., Physical and computational aspects of convective heat transfer (Springer – Verlag)

I C ENGINES

Thermodynamics analysis of I C Engine cycles, Fuel-air cycles and actual cycles thermal efficiency and fuel consumption, use of combustion charts.

Super charging : Thermodynamic cycles with super charging , supercharging of S.I and C.I engines , effect of super charging on engine performance , limits of supercharging in C. I engines, method of super charging, superchargers.

Stratified charge engines: Methods of charge stratification, stratification by fuel injection and positive ignition, swirl stratified charge engine, general chacterstics of stratified charge engines.

Variable compression ratio engine; Theoretical analysis, method of obtaining variable compression ratio engine.

Dual fuel and multi fuel engines: The working principle , combustion in dual fuel engines , super charge dual fuel engines , knock control in dual fuel systems , performance of dual fuel engines ,characteristics of multi-fuel engine, performance of multi-fuel engines.

Gas Turbines : Open and closed cycle gas turbines , Thermodynamics analysis of ideal basic cycle with regeneration ,reheat and inter-cooling , practical gas turbine cycle , optimum pressure ratio , performance of gas turbines .

Gas Turbine components : The compressor , the combustion chamber , fuel injection , turbine material and construction, temperature and pressure limitation .

Jet propulsion : Power of propulsion , propulsion efficiency , turbo jet engine , turbo -prop engine and ram-jet engine .

Ref Books :

1.Taylor & Taylor : IC Engine (Int. Book Co)
2.M.L. Mathur & R.P. Sharma – IC Engines (Dhanpat Rai & Sons)
3.M.Khovakh : Motor vehicle Engines (MIR Publishers, Moscow)
4.H. Cohen & G.F.C. Rogers : Gas Turbine Theory (Longmans)
5.Khajuria & Dubey : Gas Turbines (Dhanpat Rai & Sons)
6.V.M. Domkudwar : I.C Engines (Dhanpat Rai & Sons)
7.C.F. Taylor : IC Engine in theory and practice (MIT Press)

EXPERIMENTAL TECHNIQUES FOR THERMAL ENGINEERING

Introduction, Basic concepts of measurement methods, single and multi-point measurement in space and time, processing of experimental data, Error analysis and estimation, Random error, Systematic error, curve fitting, regression analysis, Measurement of temperature:

Thermocouple, analysis of effect of bead size and shielding on time constant and frequency response characteristics of thermocouples. Errors due to conduction and radiation in well type thermocouple, thermocouple installations, resistance and resonant quartz thermometer, pyrometry, Low temperature measurement. Measurement of heat flux and thermal conductivity.

Measurement of pressure: Very low pressure measurement, Pirani gauge, Mclead Gauge, and other gauges.

Measurement of flow rate and velocity: Principle and theory of Rotameter, Ventry meter, Nozzle, Orifice meter, Hot wire anemometer, Non-intrustive measurement. Gas flow meter.

Principle and theory of measurement of concentration, Chromatography Measurement of humidity.

Optical techniques in measurement : Shadograph, Schliren Technique. Interferrometer.

Ref Books : 1. J.P.Holman : Mechanical Measurements (Mc Graw Hill – 1989)
3. Doeblin, E.O.: Mec hanical Measurements (Int. Edition, 1983)

AIR-CONDITIONING ENGINEERING

Psychometric, Air-conditioning calculations, Comfort scales and measures concepts of effective temperatures. Solar heat gains through gains through glass, buildings, heat storage, diversity and stratification, Internal heat gains.

Dehumidification and humidification equipment, Cooling towers, spray chambers, cooling and humidifying coils, Design of air-duct system. Room air distribution principles, Various types of air-conditioning systems, Temperature, pressure and humidity controls, Various types of system controls, Building automation systems.

Ref Books : 1. C.P.Arrora, Ref & Air Conditioning (TMH Publication)
2. Stoecker and Zones: Refrigeration and Air Conditioning (Mc Graw Hill)
3. Domukundwar & Arrora: Refrigeration and Air Conditioning (Dhanpat Rai & Sons)
4. Manohar Prasad: Refrigeration and Air Conditioning (EWP)
5. Zones, W.P.- Air Conditioning Engg. (Edward Arnold Press)

THERMAL SYSTEM SIMULATION AND DESIGN

Types of simulation – Components and system simulation
Equation fitting and mathematical modelling: Component simulation, Polynomial representation, Langrange interpolation, Best fit equations, Exponent form, Function of two variables, examples: Heat exchangers, Evaporators etc.
System simulation: Introduction, classes of systems, information flow diagrams, utility of information flow diagrams, sequential and simultaneous calculations, successive substitutions, solution of nonlinear simultaneous equations, Taylors series expansion, use of Newton Raphson method, examples of simulation of thermal systems.

Optimization: Introduction, levels of optimization, mathematical representation of optimization problems.
Optimization Procedures: Langrange multipliers, search methods, dynamic programming, linear programming, comprehensive case studies of thermal systems.

Ref Books : 1. W.F.Stoecker: Design of Thermal systems, Mc Graw Hill Publication
2. Gillet: Operation research.

COMBUSTION

Introduction, Review of chemical thermodynamics and chemical kinetics, heat of formation, heat of reaction, calculation of adiabatic flame temperature, equilibrium calculations, conservation equations for multi-component systems, pre-mixed systems, flammability limits, detonation and deflagration, detonation wave structure, transition from deflagration of detonation, methods for solving laminar flame problems, Effect of different variables on flame speed, methods of measuring lame velocity. Flame quenching, non-premixed systems, Burke-Schmann's theory of laminar diffuse flames, droplet burning, laminar diffusion flame jets. Coflow and counterflow diffusion flames. Burning of solids, practical aspects of combustion, combustion and the environment, fire and combustion, practical devices, burners, explosives, propulsion methods, combustion chambers.

Ref Books : 1. J.M.Smith: Chemical Engineering Kinetics (Mc Graw – Hill Co.Pub.Co. Ltd.)
2. Roger A. Strehlow: Combustion Fundamentals (Mc Graw Hill Publishing Co. Ltd.)

NUMERICAL HEAT TRANSFER

Brief overview of numerical methods, numerical integration, roots of non-linear equations, solution of simultaneous equations and ordinary differential equations, initial and boundary value problems with application to heat transfer problems, Introduction of PDE, their types, we3ll-posedness, governing equations in heat transfer and fluid dynamics, level of approximation, introduction to equations governing turbulent flow and heat transfer, conduction and radiation heat transfer, finite difference method of Discretization, finite difference of approximation and truncation error, round off error and discretization errors, accuracy, consistency, stability and convergence, one and two-dimensional heat conduction equations, various discretization schemes, their accuracy and stability.

Solution methods for boundary layer equations in incompressible flow, and convection, Solution methods for incompressible flow Navier – stokes equation, stream function vorticity and primitive variable methods. Application of numerical methods to Radiation.

Ref Books :
1. Patankar, S.V – Numerical Heat Transfer and Fluid Flow, (Hemisphere Pub.Cor.1980)
2. Anderson, D.A.,Tannehill J.C.,and Pletchure, RH – Computatinal Fluid Flow and Heat Transfer, (Hemisphere Pub.Cor., 1984)
3. Murlidhar., K and Sunderrajan. T. – Computer Aided Heat Transfer and Fluid Flow (Narosa Pub. House)
4. Adams, J.A. , and Rogers, D.F.- Computer Aided Heat Transfer Analysis (Mc Graw Hill Publication)
5. Jaluria, Y., and Torrance, K.E., - Computational Heat Transfer (Hemisphere Pub. Corporation)

BOILING, CONDENSATION AND TWO PHASE FLOW

Heat transfer in condensation: The process of condensation and types of condensation, Film condensation of stagnant vapours, Nusselt film condensation theory, Daviation from Nusselt condensation theory. Consideration of resistance by the condensation film, Resistance at the phase interface effect of non-condensable gases. Wave formation on film surface, Temperature dependent property values, Turbulent film condensation, Practical equations for Single tubes, Tube bundles, drop condensation of stagnant vapors, Introduction to laminar and turbulent film condensation over vertical tybes Fundamentals of two phase flow; homogeneous, separated and drift flux models, two phase flow pressure drop, suspension of particles, pressure drop in porous media and fluidization, annual two phase flow, bubble dynamics in cavitation and nucleate boiling heat transfer; nucleation.

Ref Books :
1. Walls B.G. – One Dimensional two phase flow (Mc Graw Hill)
2. Knapp. R.P. – Cavitation, (Mc Graw Hill – 1970)

Engineering Software Laboratory : (Any five experiments)

1. Survey on CFD softwares and their comparison
2. Mesh generation technique by applying technical computing languages
3. Numerical modelling of steady-state conductive heat transfer for simple and complex boundary conditions,(for all co-ordinate systems)
4. Numerical modelling of transient conductive heat transfer for simple and complex boundary conditions in homogeneous/heterogeneous medium.
5. Numerical modelling of Radiative heat transfer in a participating medium, Overview of different radius models.
6. Application of Fluent/phoenix/NISA for simulation of heat and fluid flow.
7. Development of non-dimensional mass/energy/momentum equations for laminar/turbulent flow.

Heat Power Engineering Laboratory : (Any five experiments)

1. Morse Test on B.M.C. petrol engine
2. Heat balance sheet of gasifier Diesel Engine
3. Load Test on various injection pressure on the Kirloskar two cylinder Diesel Engine.
4. Blended diesel fuel test on variable compression ratio engine.
5. Determination of heat transfer co-efficient in Formed/natural convection heat transfer.
6. Determination of thermal conductivity of various insulating powedens.
7. Determination of emissivity of a plate.
8. Determination of volumetric efficiency of two state reciprocating compressor with intercooling.
9. Experiment on hot bath and cold bath experiment for applying on enclosure.

Design Project of Heat Power Systems : (Only one for each student)

1. Application of zero ODP refrigerants and the design changes of existing systems.
2. Design of a 1000TR cold storage/Ice plant etc.
3. Exergy analysis of a power plant/Engine/Furnace.
4. Design of a summer/winter A/C for high/low capacity.
5. Design of furnace/combustion chamber of SI/CI Engine.
6. Design of natural/forced convection/mix-convection enclosures.
7. Design and combustion analysis of furnaces for Bio-gas, wood-gas, fluidized bed etc.
8. Design and analysis of steel casting/welding/heat-treatment.

Advanced Heat Power Engineering Laboratory : (Any five experiments)

1. Calibration and selection of thermocouples.
2. Measurement of solar radiation intensity.
3. Plotting of isotherms by using temperature data logger.
4. Flow visualization techniques in an enclosure by (a) shadow graph (b) scheieren's apparatus (c) Iaser-dopplar PIV.
5. Mach-zehnder's interferometer and its application for capturing interferogram.
6. Effect of surface roughness on emissivity.
7. Effect of temperature on modulus of elasticity of a steel specimen.
8. Application of alternate fuels (green fuels, wood-gas, natural gas etc) on the performance of SI/CI engines and effect of varicable compression ratio.
9. Heat affected zone during plasma/TIG/MIG/Laser cutting/welding.
10. Critical heat flux.

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE
&
DETAILED SYLLABUS
For
M.TECH

SPECIALIZATION
IN
PRODUCTION ENGINEERING
(Effective from 2010-11)

VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY
BURLA, SAMBALPUR
PIN-768018

VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY,BURLA
COURSE STRUCTURE FOR 2-YEARS M.Tech.DEGREE COURSE in
MECHANICAL ENGINEERING ON PRODUCTION ENGINEERING SPECIALISATION
TO BE EFFECTIVE FROM (2011-12)

PRODUCTION ENGINEERING

1ST Year (First Semester)	L-T-P	CR	1ST Year (Second Semester)	L-T-P	CR
Theory of Plasticity and Metal Forming Process(MME-1111)	4-0-0	4	Industrial Engineering (MME-1211)	4-0-0	4
Advanced casting & Welding (MME-1112)	4-0-0	4	Non-Traditional Manufacturing Process (MME-1212)	4-0-0	4
Theory of Machining and Grinding (MME-1113)	4-0-0	4	Computer Aided Design and Manufacturing (MME-1213)	4-0-0	4
Electives (any Two)			Elective (any Two)		
1.Robotics and Felxible Manufacturing (MME-1114)	4-0-0	4	1.Tools and Dies Design (MME-1214)	4-0-0	4
2.Machine Tool Technology (MME-1115)	4-0-0	4	2.Finite Element Method(MME-1215)	4-0-0	4
3.Inspection and Quality Assurance (MME-1116)	4-0-0	4	3.Operation Management (MME-1216)	4-0-0	4
4.Mathematical Methods in Manufacturing (MME-1110)	4-0-0	4	4.Inventory System (MME-1217)	4-0-0	4
			5.Human Resource Management (MME-1218)	4-0-0	4
Seminar-I (MME-1183)	0-0-3	2	Seminar-II (MME-1283)	0-0-3	2
Manufacturing Engg. Lab.-I (MME-1181)	0-0-3	2	Manufacturing Engg. Lab.III (MME-1281)	0-0-3	2
Manufacturing Engg. Lab.-II (MME-1182)	0-0-3	2	Manufacturing Engg. Lab.-IV (MME-1282)	0-0-3	2
Comprehensive Viva-voce-I (MME-1184)		2	Comprehensive Viva-voce-II (MME-1284)		
Total	20-0-9	28	Total	20-0-9	28

2nd Year (Third Semester)	C	2nd Year (Fourth Semester)	C
Dissertation Interim Evaluation	10	Dissertation Open Defence	5
Comprehensive Viva-voce	3	Dissertation evaluation	20
Seminar on Dissertation	2		
Total Credit:			96

THEORY OF PLASTICITY & METAL FORMING PROCESS

Fundamentals plasticity: True stress-strain curve. Bauschinger effect. Empirical equations to stress-strain curves. Three-dimensional stress and strain invariants and strain.

Yield criteria of materials: Tresca and Von-Mises theory, Prandtl Reuss and Levy Mises stress strain relations, work hardening.

Equillibrium approach: Concepts of friction in metal forming, Coulumb friction and constant shear friction factor (m). Application of stress equilibrium approach to extrusion, drawing, rolling and forging.

Slip line field theory: Applications to frictionless punch and wedge indentation. Simple solution for frictionless extrusion, drawing.

Upper and lower bound theorems: Application to plane strain problems, Simple indentation and extrusion using hodographs.

Text Book(s): 1. Engineering Plasticity – W. Johnson (Von Nostrand)
2. Mechanical Metallurgy – Dieter (Mc Graw Hill)

Reference Book(s)
1. An Introduction to Principles of Metal Working – G.W.Rowe
2. Metal Forming : Processes and Analysis – Avitzur (TMH)

ADVANCED CASTING & WELDING

Classification of casting, advantages and limitation of casting, Basic steps in making sand casting, patterns, Molding processes and material, molding processes equipment and machanization. Molding sand, Testing of molding sand. Core chaplets, core materials amd properties.

Solidification of metals, freezing of a pure metal, Nucleating and growth, shrinkage, Freezing of alloys, Thermal characteristics of the mold, other properties related to the freezing mechanism.

Pouring and feeding of casting – Gating system, types of gates, Design of gating system, Riser, Design of riser, location riser, use of chills, Casting defects, inspection.

Welding and welding processes, classification, cast-weld process. Arc and Flame welding, resistance welding, solid-state welding, allied process, Thermal cutting process, modes of welding, position of welding.

Heat flow in arc welding, Temperature distribution in linear. butt welds, Temperature distribution in semi-infinite plate (3-dimentional case), Temperature distribution in large (infinite) plate of finite thickness, efficiency of heat source.

Basic Metallurgy of fusion welds, General theory of solidification of metals and alloys, Homogeneous nucleation, Heterogeneous Nucleation, Freezing of alloys, effect of welding speed on grain structure, properties of weld metals, Fusion boundary zone, Heat Affected Zone.

Welding stress and distortion, residual stresses, causes of residual stress, effect of weld thermal cycle and shrinkage on residual stresses, reaction stresses, stresses generated by phase transformation, measurement and calculation of residual stressed in weldments.

THEORY OF MACHINING AND GRINDING

Basic shapes of machining tools, Wedge action, function of different angles of cutting tools, tool geometry and Nomenclatures-ASA, ORS, NRS systems. Conversion of angles, Geometry of twist dill & slab milling cutter, Grinding of single point cutting tool, Tool materials.

Mechanism of chip formation, mode of failure under stress, fracture & yielding mechanism, types of chips, factors involved in chip formation, shear plane, effect of cutting variables on chip reduction coefficient, chip formation in drilling and milling.

Force system in turning, Merchant circle diagram, velocity relationship and Kronenberg relationship. Stress in conventional shear plane. Energy of cutting process, restricted cutting, Force analysis during oblique cutting. Earnest & Merchant angle relationship, Lee-shafer relationship, Forces in drilling & plane slab milling, Measurement of forces-dynamometer for measuring turning & drilling forces.

Thermodynamics of chip formation – The shear plane temperature-Interface temperature from dimensional analysis-Experimental determination of chip tool Interface temperature. Coolants-Theory of cutting fluid action at the chip tool interface, Techniques for application of cutting fluids.

Tool Wear: Criteria of wear, Machinability and tool life, Flank wear-Taylor's tool life equation, crater wear, causes & mechanism of tool failure.

Vibration & chater in machining. Economics of metal machining. On-line control in metal machining.

Text Book(s): 1. Metal Cutting Theory & Practice – A.Bhattacharya, C.B.Pub.
2. Fundamentals of Metal Machining & Machine Tools- Boothroyd-International student Edition.
3. Fundamentals of Metal Cutting & Machine Tools – Juneja & Sekhon, New Age International.
4. Principles of Metal Cutting – By G. Kuppuswamy, Universities Press.

ROBOTICS & FLEXIBLE MANUFACTURING (ELECTIVE-I)

Robotics: Historical background, Definitions, Laws of Robotics, Robotic system and robot anatomy, common robot configurations. Coordinate system, work envelop, Elements of robotic system – end effector, actuators, controller, teach pendant, sensors, Specification of robots. Applications, safety measures.

Robot Kinematics: Forward and reverse Kinematics of 3-DOF and 4-DOF Robot arms. Homogeneous Transformations, Kinematic Equations using hgomogeneous transformations.

Actuators: Hydraulic actuators, Pneumatic actuators, Electrical actuators. Directional control, servo control, Flow control valves.

End effectors: Classification, Drive systems, Magnetic, Mechanical, Vacuum and Adhesive grippers, Force analysis in a gripper.

Sensors: Need for sensing systems, sensory devices, Types of sensors, robot vision system.

Robot Languages and Programming: Types of programming, Motion programming, Robot language – VAL systems.

Flexible Automation: Technology, FMS, Function of Robot in FMS, Flexible manufacturing cell.

Text Book(s): 1. Robotics Technology and Flexible Automation: S.R.Deb.Tata Mc Graw Hill.

Reference Book(s)

1. Robotics: Lee, Fu, Gonzalez, Mc Graw Hill
2. Industrial Robots: Groover, Mc Graw Hill

MACHINE TOOL TECHNOLOGY (Elective – I)

General classification of machine tools, working and auxiliary motions, Hydraulics transmission and its elements, Mechanical transmission and its elements, General requirement of machine tools.

Kinematics of Machine Tools – Stepped and step less drive, Basic considerations in the design of drives, Variable speed range in machine tools, Graphical representation of speed, structure diagram, selection of optimum ray diagram, Design of speed and feed gear boxes, step-less regulation of speed and feed rates.

Machine tool Structures: Design criteria, materials, static and dynamic stiffness, Basic dynamic stiffness, Basic design procedure, design of beds and columns, Model technique in design of machine tool structures.

Guidways and Power Screws: Classification of guidways, material and Lubrication, design criteria and calculations for guideways, designs of guids under hydrostatic lubrication, Aerostatic slideways, Antifriction guidways, Combination guidways, classification of power screws, Design principles of power screws, Recirculating power screws assemblies, Elimination of backlash.

Machine Tool spindles and its Bearings: Materials of spindles, Effect of machine tool compliance on machining accuracy, Design principles of spindles, Antifriction and sliding bearings.

Controlling systems in Machine Tools – Classification, Control systems for changing speeds and feeds, Ergonomic considerations applied to design of control members, principles of automatic and adaptive control.

Vibration in Machine Tools – Forced Vibration, self-excited vibration, stick-slip vibration and its minimization, vibration isolation.

Text Book(s): 1. Machine Tools Design – N.K. Meheta, TMH
2. Design of Machine Tools – S.K. Basu, D.K.Pal, OIBH
3. Principles of Machine Tools –
G.C.Sen & Bhattacharya, New Central Book Agency.

INSPECTION & QUALITY ASSURANCE (Elective-I)

Inspection: Need for inspection, Precision & Accuracy Interchangeability, selective assembly, Taylor's Principle of limit gauge design. Use of slip gauge, Use of sine bar.

Measurement of surface roughness by Talysurf, Inspection of V-thread by Tool Makers Microscope. Inspection of gear, 2-wire and 3-wire method of measurement, Gear tooth calliper.

Reliability: Failure data analysis, hazard models, constant hazard, linearly increasing hazard, system relaiability.

Quality Assurance – Statistical quality control, , frequency distribution, control chart, process control chart for attributes & variables.

Acceptance sampling, OC curve, sampling plan, AOQL, AQL, Selection of sampling plan.

Quality circle, Total quality control, Japanese method of quality control, Taguchi method, Kaizen system.

Quality system, ISO 9000, Quality documentation, Quality audit.

Text Book(s): 1. Engg. Metrology – R. K. Jain, Khanna Publish
2. Statistical Quality Control – E. C. Grant & Leavenworth Mc.Graw Hill Books Co.
3. Quality Circle in India- S.R.Udpa, TMH
4. Quality Assurance through ISO 9000 – H.D.Gupta, South Asia Pub.
5. Reliability Engg. – L. S. Srinath, East West Press.

MATHEMATICAL METHODS IN MANUFACTURING (Elective-I)

Frequency distributions, Central tendency, AM, GM, Weighted mean, mode median, Dispersion, Coefficient of variation, Probability distribution, Bionominal, Poission, Normal distribution.

Sampling distribution, types: Random sampling, sample size & standard error, point estimate, interval estimate, Hypothesis testing. Hypothesis Testing of mean with different conditions. Differences in mean, Chi squares as test of independence, as test of goodness fit.

Experiments with single factor, Analysis of variance, Fixed effect model Estimation of model parameters, Comparison of individual treatment means, Orthogonal contrasts, Scheffes method of comparing contrasts, Comparing pairs of treatment means, Model adequacy checking, plot of residuals, choice of sample size, OC curves, Method of CI estimation, Fitting response curves, Regression Approach Orthogonal Polynomials.

Factorial Designs, Two factor factorial design, statistical analysis of fixed effect model, Estimation, choice of sample size, Random & Mixed model, Fitting response curves and surfaces, General Factorial design.

2k Factorial Design, Single replicate, Addition of center points to the 2^k design Yates Algorithm for 2^k design, 3^k design, Yates of Algorithm for 3^k design.

Response surface methods & designs, Methods of steepest Ascent, Analysis of 2^{nd} order model, Fitting response surface, Evolutionary operation.

Taguchi contribution to experimental Design: Quantity engg., Philosophy, Taguchi approach to paramenter design.

Reference Book(s)

1. Statistics for Management – By Richard I. Leviz, PHI
2. Design and Analysis of Experiments – By D.C.Montogomery, John Wiley & Sons.

INDUSTRIAL ENGINEERING

Linear Programming, Graphical Method, Primal and Dual problem, simplex method.

Transportation and assignment problems, Queuing theory-poission's and exponential service time, single server and multi server models.

Network analysis including PERT & CPM

Productivity: Importance, Productivity ratio, Productivity measurement, Productivity index.

Forecasting: Methods – moving average, exponential smoothing, Regression analysis, coefficient of co-relation, Delphi, Market survey.

Facilities Planning: Site location, facilities layout, work place design, working conditions – noise illumination etc.

Motion study – Principles of Motion – economy, Time Study – standard time.

Production Planning & Control: Aggregate Planning, Sequencing, Line balancing, Flow control, Dispatching, expendiating Gantt chart. Line of balance, Learning curve.

Text Book(s):

1. Introduction of Operations Research – Hillier & Liberman Holden.
2. Production Systems: Planning & Control: Giggs, J.L.(4^{th} Edition),John Wiley & Sons
3. Motion & Time Study: Barnes R.M.(7^{th} Edition) John Wiley & Sons.

NON – TRADITIONAL MANUFACTURING PROCESSES

Need for Non-traditional Machining: Classification, process selection-Ultrasonic machining principle, Transducer, Magnetostrictive material, Analysis for Material Removal Rate by Shaw, Effect of process parameters, Application.

Abrasive Jet Machining: Principle, Application, Advantages and dis advantages Variables in AJM.

Water Jet Machining: Jet Cutting equipment, Principle, advantages, Practical Applications.

Electrochemical Machining: Principle. Faraday's Law, Determination Material Removal Rate, evaluation of metal removal rate, Dynamics of ECM process, Tool design, Advantages, Application, Limitation, Electro-chemical grinding, Deburring and Honing.

Electro Discharge Machining: mechanism of material removal, Basic EDM circuitry and principles of operation, Analysis of relaxation circuits, Concepts of critical resistance, Machining accuracy and surface finish. Tool Material, Di-electric fluid, Application limitation.

Laser Beam Machining: Lasing process and principle, population inversion, Principle of Ruby laser, Nd: YAG Laser and CO_2 Laser, Power control of laser output. Application.

Electron Beam Machining: Basic principle, Controlling parameters and focal distance.

Application Ion Beam Machining: Principle and Mechanism, Application

Plasma Arc Machining: Generation of Plasma, Equipments, Torch, Classification. Direct and indirect torches and applications, parameters effecting cutting, Advantages.

Principle of Coating Technology: Physical and Chemical vapour deposition, Application, Electroforming, Metal Spraying, Metallic coating, Plasma flame spraying.

Text Book(s): 1. Modern Machines Process by P. C.Pandey & H. S.Shan.
2. New Technology: By A. Bharracharya.
3. Manufacturing Processes: Anstead, Ostwald & Begeman, John Wiley Sons.
4. Processes and Materials of Manufacturing: By Lindberg. PHI

COMPUTER AIDED DESIGN AND MANUFACTURING

Fundamentals of CAD: The design process, applications of computer for design, creating the Manufacturing, Database, The design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, the CPU secondary storage.

Computer graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, transformations, Database structure and content, wire frame versus solid modelling.

CAM – Numerical Control and NC Part Programming: NC Coordinate system, NC motion control system, Economics of NC, Manual and Computer Aid Programming, the APT language, NC programming with interactive graphics.

Problems with conventional NC, NC technology: CNC, DNC combined DNC/CNC system, Adopter control manufacturing systems.

Computer Integrated manufacturing system, Machine Tools and related Equipment, Materials Handling system, computer system.

Text Book(s): 1. Computer Aided design and Manufacture, Grover M.P.Simmers, E.W, Prentice Hall
2. CAD/CAM/CIM P.Radhakrishnan & Subramanyam, Willey Eastern Limited.
3. Automation, Production System and CIM, Goover, Prentice hall

TOOL & DIES DESIGN (Elective-II)

System approach to production design, Elements of a product manufacturing facility, materials selection, interchangeability standardization, use of new technology, value engineering and analysis, cost analysis.

Design of single-point cutting tools, Tool strength and rigidity calculation, selection of tool angles, chip breakers, carbide, tipped tools, High production cutting tools.

Form Tools: Types of form tools, method of determining the profile of circular and flat form of tool, analytical and graphical method.

Cutting process in broaching, geometric elements of broach teeth, Design of Internal & external surface broach, calculation of no. of teeth, Rigidity, cutting force, power.

Forging Design-Allowances, Forging process, Forging die design, Drop forging Dies and auxiliary tools, Upset forging.

Design for sheet metal works: Press working-shearing action, center of pressure, clearance, cutting force, Die block design, punch design, punch support, stop, pilot, stripper, knockout, blanking & plercing die design, progressive & compound die design, Drawing dies, metal flow, Blank diameter, Drawing force.

Jigs & Fixture design: Locating & clamping, principles of location, clamping, devices, materials for locating & clamping elements, Design principles, Design of Drilling Jig. Milling fixtures.

Text Book(s):
1. Fundamentals of Tool Design: By ASTME, PHI
2. Metal Cutting Theory & Cutting Tool Design: By Arshinov, MIR Pub.
3. A Text Book of Production Engg.: By P.C.Sharma, S.Chand & Co
4. Tool Design: By Donaldson, Le Cain & Goold, TMH
5. Fundamentals of Tool Engg. Design: By Basu, Mukherjee & Mishra, Oxford & IBH.

FINITE ELEMENT METHODS IN ENGINEERING(Elective-II)

Structural stiffness and network analysis. Assembly and analysis of a structure.

Finite elements of an elastic continuum. Displacement approach. Minimisation of total potential energy, convergence criteria.

Generalisation of finite element concepts, Modeless variables: Alternative approaches to finite element formulations.

Plane stress and plane strain. Element characteristics. Some practical applications.

Axisymmetric stress analysis. Element characteristics. Some illustrative examples.

Plate Bending Formulations of FEM.

Finite element formulation for large deformation: Masticity and Crop etc., Three Dimensional Analysis: Practical Problems.

Computer methods and computer programmes, Data input, stiffness generations. Assembly and solution of equations and output of results.

Text Book(s): 1. The Finite Element Method in Engineering Science By Zienkiwicz. TMH.

Reference Book(s)

1. Introduction to Finite Element Method By Abel and Desai, EWP.

OPERATION MANAGEMENT(Elective-II)

System view of Operations, strategic Role of operations. Operation strategies for competitive advantage, meeting Global challenges of operations.

New product Design: Product life cycle, product Development process: Process Technology, project, jobshop, batch, Assembly line, continuous manufacturing, Process Technology life cycle. Process Technology Trends.

Group Technology and Cell Formation, Rank order clustering method for machine – component Assignment.

Sequencing and Scheduling: Single machine sequencing: Basics and performance Evaluation Criteria, methods for minimizing mean flow time, parallel machines: Minimization of make span, flow shop sequencing: 2 and 3 machine cases jobshop scheduling: priority Dispatching Rules.

Modern Trends in manufacturing: Just in Time(JIT) system: Shop Floor control by Kanbans, Total Quality Management, Total Productive maintenance, ISO 9000, Quality Circle, Kaizen, Poke Yoke, Supply Chain Management.

Text Book(s): 1. E.E. Adam and R.J. Ebert"Production and Operation Management" Prentice Hall of India, 2004
2. R. Paneerselvam. "Production and Operation Management", Prentice Hall of India, 2005.

INVEN TORY SYSTEM (Elective – II)

Material System, Importance of Inventory in production distribution system.
Purchasing – Functions, Procedures – Value Analysis in Purchasing – Vendor Selection, Rating and Development – Buying Seasonal Commodities, Purchasing under Uncertainty, Purchasing capital equipments, Public buying.

Stores Management – Location & layout, Stores System, Storing practice, Quality of incoming material, Stores accounting & stock verifications, absolete & surplus, Scrap disposal.

Raw Materials Inventory System: Concept, Function, Inventory cost, Inventory models assuming certainty & risk, Quantity discount. Economical order quantity, Economical manufacturing batch size, Safety stock, Joint ordering policy – Probabilistic Inventory system: (Q,r) and (R,S) policies.

Inventory Management: ABC analysis, VED analysis, Perpetual inventory system. Periodic inventory system, Japanese inventory system.

Material Requirement Planning: Bill of material, level coding, Master Production scheduling, Gross requirement determination, Net requirements, Lot size determination techniques (Wasner-werifin, Silver-meal heuristic, part-period Balancing), Offsetting Safety stock in MRP.

Manufacturing Resource Planning: MRP under capacity constraints, Capacity requirement planning, Just-in-time concept: Pull & Push system, Essential conditions of JIT application, practical implementation of JIT through Kanban & other systems.

Physical distribution of Materials: Finished product – Classification, Product features, Branch decisions, packaging decisions, Labelling decisions, product line decision, Distribution channel-nature, Function, Channel behaviour, Physical distribution-warehousing. Transportation, Placing-Products-Retailing. Advertising media selection, sales promotion personal selling.

HUMAN RESOURCE MANAGEMENT (Elective – II)

Evolution of management thought, Contribution of Taylor, Fayol & Mayo, Organisation as a system, Approaches to management, Functions, managers. Social responsibility of managers, Japanese management & theory-z.

Planning: Types of plans, objectives, Strategies, Policies, Procedures, Rules & programmes. Principles of planning. Decisions making-Development of alternatives, Evaluating, Decision tree.

Organising: Organisational structure, Division of work, Formal & Informal organization, Span, Departmentation, Line and Staff authority relationship, Functional authority Delegation of authority, Principles of organizing.

Staffing: System approach to staffing, Man power planning matching person with the job-selection methods, selection test, interview, Group discussion, Training need, Inputs. Learning & training, training methods, Evaluation of training, Performance appraisal-methods, Management by objective, Internal mobility, Job evaluation, Merit Rating, Incentives system – Profit sharing, Wage Incentive scheme payment of wages Act. Payment of Bonus Act.

Leading: Human factor in managing, Behavioral models, Mc Gregor's Theory-X & Theory-Y, Creativity & Innovation, Leadership – Ingredients of leadership, Leadership traits, Behaviour & Style.

Controlling: Basic control process – Elements in organizational behaviour, Human Resources approach, system approach, Motivational patterns, Role play, Status, Model of motivation, Maslow's hierarchy of needs, perception, job satisfaction and performance, Quality of work life, job enrichment, Core dimension of jobs, Discipline Preventive and corrective discipline, Hot-stove rule, Counselling approach to discipline, Stress-causes & counselling.

Employee participation: Pre-requisites, Benefits, Transaction analysis, Group dynamics, Team work, Meetings, Brain storming, Managing change-resistance to change, implementing change successfully, Trade Union-labour legislation. Collective bargaining, Grievance system, Factory Acts, Safety & Employee welfare.

Communication: Importance process, Types, 2 way communication, Formal & informal communication, Barriers in communication.

Text Book(s):
1. Essential of Management: By Koontz, O' Donnell & Welhrich, Mc Graw Hill International Edition.
2. Human Behaviour at work: By Keith Davis, TMH
3. Personnel Management: By Monappa & Salyadain, TMH
4. Personnel/Human Resource Management: By De Cenzo & Robbins, PHI