COURSES OF STUDY

FOR

M.TECH.

(MECHANICAL SYSTEM DESIGN)

IN

MECHANICAL ENGINEERING

AT

N. I. T. SRINAGAR

J&K – 190006

Course Structure

1. A student has to complete a minimum of 64 credits for the award of M.Tech Degree. The credit structure is as follows:

Core : 34 credits

Project : 24 credits

Electives : 06 credits

2. Full time duration: 2 years

3. Part time duration: 3 years.

4. Full time student has to take 12 to 18 credits in each semester.

5. Part time student has to take 9 to 12 credits in each semester.

FIRST SEMESTER

S. No.	Subject	C	L	T	P
MSD 101	Systematic Design Approach	4	3	0	2
MSD 102	Finite Element Method	4	3	0	2
MSD 103	CAD	4	2	0	4
MSD 104	Design Optimization	4	3	0	2
Total Credits & LTP		16	11	0	10

SECOND SEMESTER

S. No.	Subject	C	L	T	P
MSD 201	Life Cycle Design	4	3	0	2
MSD 202	Design Against Fatigue	3	2	0	2
MSD 203	Seminar	3	0	0	6
MSD 204	Elective –I	3	2	0	2
MSD 205	Elective –II	3	2	0	2
Total Credits & LTP		16	09	0	14

ELECTIVE I	ELECTIVE II
MSD 20* Structural Dynamics	MSD 20# Applied Fracture Mechanics
MSD 20* Continuum Mechanics	MSD 20# Advanced Control Systems
MSD 20* Wear Analysis & Control	MSD 20# Advanced Manufacturing systems
MSD 20* Micro Scale & Nano Scale Heat Transfer	MSD 20# Value Engineering
	MSD 20# Viscous Flow Theory

THIRD SEMESTER

S. No.	Subject	Credits	L	T	P
MSD 301	Design of Tribosystems	4	3	0	2
MSD 302	Advanced Engine Design	4	3	0	2
MSD 303	Dissertation	8	0	0	16
Total Credits & LTP		16	6	0	20

FOURTH SEMESTER

S. No.	**Subject**	**Credits**	**L**	**T**	**P**
MSD 401	Dissertation	16	0	0	32
Total Credits & LTP		**16**	**0**	**0**	**32**

MSD 206 Communication Skills and research techniques Compulsory audit (for Research candidates) Check the course number, it is 206 on pp 20. Moreover, it should not be included on this, as it is a Pre-Ph.D. course.

Course No.:MSD 101 SYSTEMATIC DESIGN APPROACH C L P(4 3 2)

UNIT I

System concepts, Typical Mechanical systems, System design, Old and new Design, Concurrent design approach, Life Cycle Design (LCD), Life Cycle cots (LCC), Introduction to three phases of design -Conceptual, Embodiment and Detailed Design stage. Conceptual Design stage (CDS)-Feasibility phase of design- Customer requirements / Need analysis, Social status, Market survey, political based, etc. Actual needs, Problem formulation, Analysis of Product Concept hunt, Innovation, creativity , Brain storming, fantasy, Empathy, systematic search, Feasibility analysis, physical reliability, Economic viability, Financial & Social acceptability, Evaluation of concepts using decision making methods, Weighted sum method, Fuzzy decision making, TOPSIS, AHP, Functional Analysis – Reliability, maintainability, Manufacturing, Marketing, Serviceability, Safety, recycling/ disposal/ reuse. Structural analysis, Life cycle design parameters at Conceptual design stage.

UNIT II

Reliability, Failure rate, Reliability of mechanical and Mechatronic systems, Reliability of series and parallel systems, Reliability modelling, Redundancy , use of linear modelling and nonlinear modelling, Reliability of new and old systems ,Reliability , Weight and cost at conceptual design stage, Maintainability Analysis, Diagnosability, Identification and Isolation of Faults, Failure cause analysis, (FCA), Fault tree analysis (FTA), Failure mode and effects analysis (FMEA), and Failure mode, effects and criticality analysis (FMECA) through functions.

UNIT III

Optimization – Single & Multi-variable Safety & Aesthetics, Material selection as decision making- alternatives, criteria, weight, use of various material selection methods and their application to material selection for gear, bearings, spring, shafts, etc, Recycling / reuse analysis, Embodiment design stage, Synthesis, use of space, spatial analysis, Components and assembly packaging, use of tables for determining relationship for synthesis- with examples; such as hospital rooms, Synthesis of small systems- Heat convector, Washing machine, etc. Detailed design stage- prototyping, Pilot plant level, Documentation, Drawings, Trouble shooting.

(Each Student will be assigned a specific problem related to design and all knowledge imparted to them will be used in design problem)

Text Books :

1. Pahl, G. and Beitz,W., "Engineering Design," *Springer Verlag, London, 1984.*
2. Ullman, D.G., "The Mechanical Design process," *McGraw Hill, N.Y. 1992.*
3. Suh,N.P., " The Principles of Design", *Oxford University Press, N.Y.1990.*
4. Newton, D. and Broomley, R., "Practical Reliability Engineering," John *Wiley & Sons India , 2002.*

Reference Book:

International Organisation for Standardization (ISO) 14040, "Environmental Management-Life Cycle Assessment –Principles and framework," *Second edition*, ISO Publications., *2006.*

Course No.:MSD 102 FINITE ELEMENT METHOD C L P(4 3 2)

UNIT I

Physical problems and finite element method (FEM), simulations and visualizations in FEM, Integral formulations for numerical solutions, Variational method, sub-domain method, collocation, Galerkin's method, least squares method, element matrices, Analysis of beams, trusses, one dimensional formulations, two dimensional formulations, Co-ordinate systems, local, global and natural, area coordinates and continuity, strong and weak forms, Hamilton's principle, domain discretization, properties of shape functions, shape functions for trusses.

UNIT II

Strain matrices and element matrices in local and global coordinates for trusses and beams , Rate of convergence and high-order one dimensional elements, Use of commercial code for specific problems on beams and trusses, FEM for frames, Case study of a typical frame e.g., a bicycle, FEM for 2-D solids, construction of shape functions for 2-D elements, strain matrix and element matrices for 2-D elements, linear rectangular element and shape function construction, Gauss integration, Linear quadrilateral elements and coordinate mapping .

UNIT III

Quadratic and cubic triangular elements, rectangular elements and Lagrange elements, Serendipity type of elements and elements with curved edges, FEM for plates and shells, Shape functions and element matrices for plates and shells, elements in local and global coordinate systems for plates and shells, some specific case study on plates and shells using a commercial code, FEM for 3-D solids, meshing and solution procedures.

A Term paper on recent advances in the field.

Text Books:

1. Segerlind L.J, "Applied Finite Element Analysis", *John Wiley Publishers, Second Edition, 1976.*

Reference Book:

1. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Element Analysis", *Prentice Hall,1976.*

Course No.:MSD 103 **CAD** **C L P(4 2 4)**

UNIT I

Introduction, Computer display of machine elements, computer analysis of machine elements. Curve fitting techniques, point plotting techniques, line drawing displays, two and three dimensional transformations, clipping and windowing, segmentations, geometric modeling.

UNIT II

Three-dimensional graphics, curves and surfaces, hidden surface elimination; shading. Graphic input devices, graphic input techniques; Input functions; Raster graphics fundamentals. 3-D modelling, 3-D graphics and Graphics Standards.

UNIT III

Optimization strategies: Classical Methods; Linear and nonlinear programming in reference to various mechanical design problems; such as: gears, gear box, bearings, friction devices, etc. Software related to mathematical analysis; Manufacturing and database management; Computer hardware; Expert systems; features, activities and uses

Text Books:

1. Hsu. T. R. and Sinha, D. K., "Computer-Aided Design, an Integrated Approach", *West Publishing Company, New York, 1992.*

2. Sproll, R. A. and Kalley, G., "Computer Graphics", SCHAUM's' outline series, *McGraw-Hill, New York, 1986.*

3. Rao, S. S., "Engineering Optimization, Theory and Practice", 3rd edition, *John Wiley Publications, New York, 1996.*

Reference Books

1. Sproll R. F., Sutherland, W. R. and Ullner, M. K., "Device Independent Graphics", *McGraw Hill. New York, 1998.*

Course No.:MSD 104 DESIGN OPTIMIZATION C L P (4 3 2)

UNIT I

Motivating examples of calculus of variations, Fundamental lemmas of calculus of variation, Euler-Lagrange (E-L) equations, Applications of E-L equation, Extensions of E-L equation to multiple derivatives, independent variables, multiple state variables.

Isoperimetric problems-global and local (finite subsidiary) constraints, Applications of optimizing functional subject to constraints, Applications in mechanics: strong and weak forms of governing equations, Variable end conditions--transversality conditions. Size optimization of a bar for maximum stiffness.

UNIT II

Optimization with side constraints (variable bounds), Worst load scenario for an axially loaded stiffest bar, Min-max type problem with stress constraints, Beam problems for stiffness and strength, Optimization of a beam for given deflection, Variational formulations for the eigen-value problems: strings, bars, beams, and other elastic structures, Optimum design of a column, Variable-thickness optimization of plates, sufficient conditions for E-L optimum,

UNIT III

Finite dimensional optimization- A summary and highlights of Numerical optimization techniques using the optimization tool-box in MATLAB, Gear design optimization.

Text Book:

1. Robert Weinstock, "Calculus of Variations with Applications to Physics and Engineering", *Dover publications, 1974.*

Reference Books:

1. Gupta, A.S., " Calculus of Variations with Applications", *Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.*
2. Gelfand, I.M., Fomin,S.V., "Calculus of Variations", *Dover publications, 2000.*

Course No.: MSD 201 LIFE CYCLE DESIGN C L P (4 3 2)

UNIT I

Definition of life cycle design, life cycle engineering , Concurrent design engineering, Decision making methods, use of decision making methods at conceptual design stage, Selection of decision making process for design, Fuzzy decision making for LCD,

UNIT II

Design for functions, Structural Hierarchies, Function based failure approach, Cost Design for Manufacturing, Design for marketing, Design for Serviceability/ Maintainability , Design for Recycling, Design for Reliability, Design for Safety,

UNIT III

Optimization, Design for Recycling, Life cycle management, Life cycle cost (L.C.C.), initial cost, maintenance cost, cost of manufacturing, cost for environment, and cost of recycling

Text Books:

1. Dixon, J.R., Poli,C., "Engineering design and design for manufacturing", Fieldstone Publishers, Conway, M.A., 1995

2. Kausik, A., "Concurrent Engineering Theory and Practice," *John Wiley, 1992.*

Reference Book:

1. Grant, W.I., Coombs,C., Moss,R.Y., "Handbook of Reliability engineering and management",*2nd edition, McGraw Hill,* 1996.

Course No.:MSD 202 DESIGN AGAINST FATIGUE C L P (3 2 2)

UNIT I

Introduction to design against fatigue, Fatigue as a phenomenon in the material, Different phases of fatigue life, Initiation and growth, Damage and mechanisms, Characteristic features of fatigue failures and its implications on design, Stress concentration at notches, Stress gradients, Stress concentration factors for design, for examples; such as: hole in a plate with pure shear, elliptical hole in biaxial stress field, Effect of residual stresses, Stress intensity factors for various geometries, Effect of geometry factors on stress intensity factor, Cracks with curved crack fronts, Use of data pertaining to stress intensity factors for design

UNIT II

Fatigue properties for design, Description of fatigue properties of unnotched specimens, Fatigue diagrams including Smith diagram, Mean stress effects, Size effect, Effect of type of loading, tension, bending and torsion and combined loading on fatigue properties, Stress based fatigue analysis and design, S-N diagrams with construction details, fatigue limit testing, finite life region, Design of S-N curves in finite life region, fatigue strength testing, fatigue limit based on modifying factors and S-N curves, notch effect at fatigue limit, estimate of fatigue life of notched components, Mean stress effect, Morrow's line, combined proportional loads

UNIT III

Strain based fatigue analysis and design, test methods and procedures, analysis of cyclic and monotonic behavior of materials, transient response under cyclic loads, steady state and cyclic stress strain behavior and hysteresis, constant amplitude behavior, high cycle and low cyclic fatigue, Coffin-Manson approach, Mean stress correction methods

Text Book:

1. Schijve J., "Fatigue of structures and materials", *Kluwer Academic Publishers, 2001.*

Reference Books:

1. Barsom, J. M., Rolfe, S. T., "Fracture and Fatigue control in structures", *Englewood Cliffs Prentice-Hall,3rd Edition, 1999.*
2. Suresh S., "Fatigue of Materials",*Cambridge University Press, 2nd Edition, 1998.*
3. Yukitaka M. "Metal Fatigue: Effects of small defects and non-metallic inclusions", *Elsevier, 2002.*

Course No.: MSD 20* **STRUCTURAL DYNAMICS** **C L P(3 2 2)**

UNIT I

Mathematical models, free vibration, Response to harmonic excitation, Response to operator forms of excitation, Periodic excitation of undamped and damped multi-degree of freedom systems and continuous system.

UNIT II

General dynamic excitation, Principles of vibration isolation, Vibration absorption, Numerical evaluation of normal modes, natural frequencies and response of systems, The algebraic Eigen-value problem and the operator Eigen-value problem.

UNIT III

Hamilton's principle, Lagrange's equations, Qualitative behaviour of Eigen-values, Equations of motion for continuous systems, Rayleigh's quotient for continuous systems, Response of continuous systems to arbitrary excitations.

Text Book:

1. Meirovitch, L., " Methods of Analytical Dynamics", *Dover Publication1997.*

Reference Book:

1. Meirovitch, L., "Elements of Vibrations", *McGraw Hill,1986.*

Course No. :MSD 20* CONTINUUM MECHANICS C L P(3 2 2)

UNIT I

Suffix notation (Not in the beginning) . Algebra of tensors, Calculus of Tensors. Scalar, vector and tensor functions. Gradient, divergence and curl of a tensor. Continuum hypothesis. Description of motion. Lagrangian and Eulerian description. Deformation gradient tensor. Displacement gradient tensor. Strain displacement relations. Principal strains.

UNIT II

Description of motion, Material and local time derivatives. Stretching and vorticity, Path lines stream lines, vortex lines. Transport formula. Cauchi and Piolla Kirchoff stresses. Normal and shear stresses. Principal stresses.

UNIT III

Conservation of linear and angular momentum. Conservation of energy. Material objectivity. Equations of linear elasticity. Boundary value problem. Hook's law. Equations of fluid mechanics.

Problems related to applications to design of cams, shafts and gears.

Text Book:

1. Chandrasekharaiah, D.S. and Debnath, L., " Continuum Mechanics," *Prism Books Pvt. Ltd., Bangalore, India, 1943.*

Reference Book:

1. Gurtin, M.E. "An Introduction to Continuum Mechanics," *Academic Press, N.Y. 1981.*

Course No.:MSD20* WEAR ANALYSIS & CONTROL C L P(3 2 2)

UNIT I

Introduction to wear control, types of wear, Adhesive wear, two-body and three-body abrasive wear, erosive wear, cavitation wear, etc.

Tribo systems and tribo-elements, Measurement of Surface roughness Re, Rz, Experimental studies on friction on various tribosystems using pin-on-ring (POR)and pin-on-disc (POD) machines, etc. Sample preparation, wear measurement of various tribo-elements, using POR and POD machines. Calculation of wear volume and wear coefficient, comparison with existing data.

UNIT II

Diagnosis of wear mechanisms using optical microscopy and scanning electron microscopy, etc., Wear resistant materials, wear resistant coatings, eco-friendly coatings designing for wear, systematic wear analysis, wear coefficients, filtration for wear control.

UNIT III

Component wear, bushings, lubricated piston rings and cylinder bore wear, dry piston rings, rolling bearings, seal wear, gear wear, gear couplings, wear of brake materials, wear of cutting tools, chain wear. Boundary lubrication, Hydrodynamic lubrication, EHD lubrication.

Case studies.

Text Books:

1. Czichos, H., "Tribology:A system approach to the science & technology of friction, lubrication and wear", Series 1, *Elsevier Publications,1982*.
2. Glaeser,W. A., "Tribology series – Vol. 20," *Elsevier Publications,1992.*
3. Neale, M.J., "The Tribology Hand Book," *Butterworth Heinemann, London, 1995.*

Reference Book:

1. Peterson, M. B., Winer, W.O., "Wear Control Handbook," *ASME, NY. 1980*.

Course No.:MSD20* MICROSCALE AND NANOSCALE HEAT TRANSFER

C L P (3 2 2)

UNIT I

Introduction & Overview of Microscopic Thermal Sciences, Fundamentals of Thermodynamics, Heat Transfer Basics, Statistical Mechanics of Independent Particles, Basic Quantum Mechanics, Local Average and Flux, The Mean and Free path, Transport Equations and Properties of Ideal Gases, Shear Force and Viscosity, Heat Diffusion, Mass Diffusion, Intermolecular Forces, The Boltzman Transport Equation, Microfluidics and Heat Transfer,

UNIT II

Specific heat of solids, Lattice vibration in solids, The Debye Specific Heat Model, General Expressions of Lattice Specific Heat, Nanocrystals and Carbon Nanotubes, Electrical and Thermal Conductivity of Solids, Thermoelectricity, Onsager's Theorem and Irreversible Thermodynamics, Electron and Phonon Transport, General Classifications of Solids, The Dispersion Relation for Real Crystals, Photoelectric effect, Electrical Transport in Semiconductor Devices, Optoelectronic applications

UNIT III

Nonequilibrium energy transfer in Nanostructures, Thermal Radiation Fundamentals, Radiative properties of Multilayer structures, Radiative properties of Thin films on a thick substrate, Waveguides and Optical Fibers, Surface plasmon and phonon polaritons, Radiation Transmission through nanostructures, Spectral and Directional Control of Thermal Radiation, Radiation Heat Transfer at Nanometre Distances.

Text Book:

1. Zhang, Z.M., " Nano/ Microscale Heat Transfer," *McGraw Hill,2007.*

Reference Books:

1. Kakac S, " Microscale Heat Transfer", *NATO Science Series, Springer,2004.*
2. Sobhan C.B., Peterson, G.P., "Microscale & Nanoscale Heat Transfer," *CRC Press, 2008.*

Course No.MSD20[#] APPLIED FRACTURE MECHANICS C L P(3 2 2)

UNIT I

Introduction to fracture mechanics, Failure of structures, energy criterion, Stress intensity factor approach, material properties and fracture, Linear Elastic Fracture Mechanics, Griffith energy balance, energy release rate, instability and R-curve analysis

Stress analysis of cracks, details of crack-tip plasticity with Irwin's approach, some models with special reference to yield strip model

UNIT II

Plane stress and plane strain fracture analysis, plasticity zone shape and its physical significance, crack-tip triaxiality, mixed mode fracture, Biaxial loading and fracture of structural members, Westergaard's stress function applications, Fracture resistance of materials, The effect of alloying and second phase particles, The effect of temperature, Introduction to fail-safety and damage tolerance, Means to provide fail safety, Required information for fracture mechanics approach, Fracture behaviour of welded components.

UNIT III

Fractography, Interpretation of fracture surface features with examples, environmental assisted cracking in metals, brittle fast fracture in polymers, design problems on obtaining information on stress intensity range from fractographs, Typical structural failures in service with some case studies; like fractures of welded vessels, critical joints of storage tanks, Nil Ductility Transition temperature related failure case studies, Lessons from failures with respect to design considerations, analytical options of fracture control, practical elements of fracture control including stress-toughness-crack size, limitation and errors affecting design, fabrication, and inspection procedures, Design considerations with selected formulas for critical stress intensity factors, synthesis of LEFM (??) methodology, materials characteristics, and stress analysis with examples.

Text Book:

1. Anderson T. L "Fracture Mechanics", *CRC Press,1999.*

Reference Books:

1. Barsom J.M., Rolfe, S. T., "Fracture and fatigue control in structures". *ASTM, International, 1999.*

Course No.: MSD 20# ADVANCE CONTROL SYSTEM C L P (3 2 2)

UNIT I

Block diagram algebra of mechanical, electrical and electromechanical systems, their state space representation and relation between state variable & other system representations, Z-transform, the inverse z-transform.

UNIT II

State space equations and their solution. Methods of computing state transition matrix. Eigen values of system matrix. System stability, controllability & observability. Pole placement design.

UNIT III

Multivariable system. System response algebra and stability. Adaptive control systems: System parameters estimation and self tuning control. Fuzzy logic control: fuzzy sets, fuzzy logic control algorithms.

Examples and exercises on Mechanical system design for control.

Text Book:

1. Granklin, G.F., Powell, J.D., "Feedback control of Dynamic systems", 3rd edition, *Addison Wesley, 1991*.

Reference Book:

1. Dorf, R.C., Bishop, R.H., "Modern control systems", 8th edition, *Pearson education, 1999.*

Course No: MSD 20# ADVANCED MANUFACTURING SYSTEMS C L P(3 2 2)

UNIT I

Advanced manufacturing system concepts, Manufacturing automation, Programmable and hard automation. Design Automation, Application of CAD to manufacturing systems, Design for manufacturing and assembly. Computer Aided Engineering Analysis, Computer Aided Engineering evaluation. Rapid Prototyping, Stereolithography, Selective laser sintering, FDM (??), Laminated objected manufacturing, Polyjet technology. Robots, their classifications and applications. Introduction to Robot programming. PLC's and their applications.

UNIT II

Introduction to Micro/ Nano machining, Principles of machining. Mechanics of Micro-machining. Abrasive Micro machining. Diamond Micro- grinding/turning. Ultrasonic Micro-machining. Electro-discharge Micro-machining, Laser Micro-machining, Electrochemical, Micro-machining, Chemical Micro-machining , Ion Beam Machining, Electron Beam Machining, Elastic emission machining, Abrasive flow finishing, Magnetic Abrasive finishing, Magneto rheological abrasive flow finishing, Magnetic float polishing

UNIT III

Introduction to Micro fabrication, microelectronic and micromechanical devices, Crystal growing and wafer preparation, High resolution lithography Diffusion and Ion Implantation. Etching Metallization and testing, Wire bonding and packaging, Yield and reliability of chips, PCB's, The L I G A, Micro fabrication process, Solid free form fabrication of devices, Measuring techniques for micro features, Measuring techniques for nano features, Microhardness tester , Laser scanners, Robustness and selection of manufacturing processes, Factories of future.

Term paper on recent advances in the field.

Text Books

1. Degarmo, E.P., Black, J.T. and Kohser, R.A, " Materials and Processes in Manufacturing", *Prentice Hall of India,* 2006.
2. Anthony, E., "Fluid Power with applications", *Prentice Hall of India, 2007.*

Reference Book:

1. Serop K. Steven, "Manufacturing Processes for Engineering Materials", *Prentice Hall of India,2004.*

Course No.:MSD 20# VALUE ENGINEERING C L P (3 2 2)

UNIT I:

Introduction to value engineering (VE) & value analysis (VA), Life Cycle of a product, Methodology of VE, reasons for the existence of unnecessary costs. Quantitative definition of Value, use Value and Prestige value, Estimation of product Quality/Performance, types of Functions, relationship between use functions and Esteem Functions in product design, functional cost and functional worth, effect of value improvement on profitability, Tests for poor Value, Aims of VE systematic Approach.

UNIT II

Elementary introduction to V.E job plan/ functional approach to value improvement, various phases and techniques of the job plan, factors governing project selection, Types of projects, Life cycle costing for managing the total value, concepts in LCC, Present value concept, Annuity concept, net present value, Pay Back period, internal rate of return (1RR) on investment, Examples and Illustrations. Creative thinking and creative judgement, positive or constructive discontent, Tangible and intangible costs of implementation, false material, labour and overhead saving, VE/VA yardsticks, relationship between savings and probability of success, Reliability Estimation, system Reliability, Reliability elements in series and parallel (Check topics on reliability; are these to be included).

UNIT III

Phases and techniques of Value engineering Job plan:

General Phase, Information phase, Function phase, Creativity/Speculation Phase, Evaluation Phase, Investigation Phase and Recommendation Phase*:* Value improvement recommendation theory, determination of cut-off point (cop), road blocks in implementation. Decision Matrix/Evaluation Matrix, Quantitative comparison of Alternatives, Estimation of weights factors and efficiencies, utility transformation functions, bench marking, perturbation of weight factors (sensitive, analysis), Examples.

FAST Diagramming: Critical path of functions, HOW, WHY & WHEN Logic, Supporting and all time functions.

Term paper on recent advances in the field.

Text Book:

1. Arthur E. Mudge, "Value Engineering- A Systematic Approach", *McGraw Hill Book Co. 1971.*

Reference Books:

1. Miles L.D., "Techniques of value Analysis and Engineering", *McGraw Hill Book Co. New York, 1970.*
2. ASTME-American society for Tool and Manufacturing Engineers," Value engineering in Manufacturing", *Prentice Hall Inc. 1967.*

Course No.:MSD 20# VISCOUS FLOW THEORY C L P(3 2 2)

UNIT I

Historical Outline, Fundamentals equations of motion and continuity applied to fluid flow, General stress system in a deformable body, Stoke's hypothesis, The Navier-Stokes equations, Exact solutions of the Navier-Stokes equations, Parallel flow through a straight channel and Couette flow, The Hagen-Poiseuille theory of flow through a pipe, A general class of non-steady solutions

UNIT II

Laminar Boundary Layers, Boundary Layer Equations in Plane Flow, General properties and Exact solutions of the boundary-layer equations for Plane flows, Similar solutions of the Boundary-Layer Equations, Wake Behind bodies, Boundary Layer at Moving Wall, Momentum-Integral equations, Energy Integral equation, Moment-of-Momentum Integral Equations, Approximate Methods for the solution of the two- dimensional, steady boundary-layer equations, Laminar flow against pressure gradient

UNIT III

Boundary Layer Control (Suction/blowing), Continuous suction and Blowing, Similar solutions, Some Experimental results on the Laminar-turbulent Transition, Stability theory, General properties of the Orr-Sommerfield equation, Fundamentals of turbulent flow, Apparent turbulent stresses, Derivation of the stress tensor of apparent turbulent friction from the Navier-Stokes equations, Prandtl's mixing length theory, Von Karman's similarity hypothesis, Universal velocity distribution laws, Von Karman's velocity distribution law, Turbulent flow through pipes, Turbulent boundary layers at zero pressure gradient for a smooth flat plate, The incompressible turbulent boundary layer with pressure gradient, Turbulent boundary layer with suction and injection.

Text Books:

1. Schlichting S., " Boundary Layer Theory", *McGraw Hill, 2001*
2. White F.W., "Viscous Fluid Flow", McGraw *Hill,1990.*

Reference Books:

1. Muralidhar K.M., Biswas G, " Advanced Engineering Fluid Mechanics", *Narosa, 2003.*
2. Batchelor,G.K., "An Introduction to Fluid Dynamics", Cambridge University Press, 1990.
3. Yuan,S.W., " Foundation of Fluid Mechanics", *Prentice-Hall,1989.*

Course No.:MSD 301 DESIGN OF TRIBOSYSTEMS C L P(4 3 2)

UNIT I

Application of system concepts to tribology, Function of Tribomechanical systems, Structure of Tribo-mechanical systems, Tribological interaction, Functional plane, mechanical work plane, thermal plane and material plane. Role of tribo processes in mechanical systems, Wear as a system property. Contact Mechanics, number of bodies taking part in contact process, macro geometry of bodies, Deformation mode; elastic , plastic and elastic-plastic, Types of relative motion; static contact, rolling contact, sliding contact, contact physics and geometry, contamination layer, absorbed gas layer, oxide layer, work hardened layer, metal substrate.

UNIT II

Materials for various tribo-components, materials for plane bearing, materials for gear, materials for brakes, clutches, materials for Internal combustion engines, ceramics and special alloys, cermets, polymer materials, selection considerations in design.

UNIT III

Design of various tribo-elements; such as: Plane bearing, Gear, Seals, Piston and cylinder, Friction devices, cutting tools, chains. Design of lubrication systems.

Text Book:

1. Czichos, H., "Tribology: A system approach to the science & technology of friction, lubrication and wear,"– Tribology Series 1, *Elsevier Scientific Publishing Company, Amsterdam, Netherland, 1978.*

Reference Books:

1. Peterson, M. B., Winer, W. O., "Wear Control Handbook," *ASME, N. Y., 1992.*
2. Glaeser, W. A., "Tribology: Materials for Tribology," –Tribology series – Vol. 20, *Elsevier, N. Y. 1992.*
3. Stolarski, T., "Tribology in Machine Design", *Butterworth-Heinemann, N. Y., 1990.*

Course No.: MSD302 ADVANCED ENGINE DESIGN C L P(4 3 2)

UNIT I

Engine Classifications. Geometrical Properties of internal combustion engines. Basic engine definitions and design oriented numericals. Method of verifying the rated power specification of engine manufacturers. Design of automotive spark ignition engine. Design of Racing Car Engine. Design of naturally aspirated diesel engine. Design of turbocharged diesel engine. Design of heavy duty truck diesel engine. Criteria for division of total displacement volume into multi-cylinder engine concept. Concept of firing order.

UNIT II

. Balancing of reciprocating and rotary forces in single and multicylinder engines. Design considerations for selecting the bore to stroke ratio for engines. Pollution from internal combustion engines. Mechanism of pollution in internal combustion engines. National and European emission standards. Pollution control in internal combustion engines.

UNIT III

Engine performance with alternative fuels. Comparison of physico-chemical properties of alternative fuels for I C Engines. Study of various factors that govern the fuel - mileage concepts of vehicles based on internal combustion engines. Main components of electronic fuel injection system. Design of electronic fuel injection system. Throttle body injection, port injection and direct fuel injection techniques for internal combustion engines.

Text Book:

1. Hoag , "Advanced Engine Design", *SAE Publication,2005.*

Reference Books:

2. Heywood,J.B., " Internal combustion Engine fundamentals", *McGraw Hill book co., 1989.*

Course No.: MSD 206 Communication Skills and Research Techniques (Audit)

Basics of communication, communication skills, public speaking, communication methods and media, e-mail and learning through internet, multimedia presentation, effective meeting, professional care of your voice, group discussions and interviews, literature survey, research techniques, optimization of research parameters, making video films, basic elements of ETV production, distance education.