University of Pune, Pune
B. E. (Mechanical) Structure (2008 Course)
With effect from June 2011

Code	Subject	Teaching Scheme		Examination Scheme				
		L	P/D	P	TW	Or	Pr	Total
	Semester I							
402041	CAD/CAM Automation	4	2	100	25	--	50	175
402042	Dynamics of Machinery	4	2	100	25	50		175
402043	Industrial Fluid Power	4	2	100	25	50		175
402044	Elective I ***	4	2	100	25			125
402045	Elective II	4		100				100
402046 A	Project Work		2					
	Total of Semester I	**20**	**10**	**500**	**100**	**100**	**50**	**750**
	Semester II							
402046 B	Project Work		6		100	50		150
402047	Power Plant Engineering	4	2	100	25	50		175
402048	Mechanical System Design **	4	2	100	25	50		175
402049	Elective III ***	4	2	100	50			150
402050	Elective IV	4		100				100
	Total of Semester II	**16**	**12**	**400**	**200**	**150**		**750**

** Theory paper of 4 hours duration

*** The term work marks shall be based on assignments / seminar as prescribed by subject syllabus.

*** 402050D Open Elective – BoS Mechanical will declare the list of subjects which can be taken under open electives or any other Electives that are being taught in the current semester as Elective – IV under engineering faculty or individual college and Industry can define new elective with proper syllabus using defined framework of Elective IV and GET IT APPROVED FROM BOARD OF STUDIES AND OTHER NECESSARY STATUTORY SYSTEMS IN THE UNIVERSITY OF PUNE BEFORE 30th DECEMBER.

Elective I

402044 A	Energy Audit and Management
402044 B	Product Design and Development
402044 C	Design of Pumps, Blowers and Compressors
402044 D	Tribology

Elective II

402045 A	Automobile Engineering
402045 B	Machine Tool Design
402045 C	Quantitative and decision making Techniques

Elective III

402049 A	Computational Fluid Dynamics
402049 B	Finite Element Method
402049 C	Robotics
402049 D	Advanced Air Conditioning and Refrigeration

Elective IV

402050 A	Industrial Heat Transfer Equipments
402050 B	Management Information System
402050 C	Reliability Engineering
402050 D	Open Elective

Legend:

L	Lecture	TW	Term work
P/D	Practical/ Drawing	Or	Oral
P	Paper	Pr	Practical

Dean, Faculty of Engineering

Chairman, BOS
Mechanical Engineering

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402041 CAD/CAM AND AUTOMATION

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks
		Practical	50 Marks

Section I

1 Computer Graphics **8**

Transformation-Introduction, Formulation, Translation, Rotation, Scaling, Reflection Homogenous Representation, Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations,

Projections: Orthographic, Isometric, and Perspective.

Introduction to open GL and commands required for the transformation.

2 Modelling **10**

Curves:-Introduction, Analytic Curves, Line, Circle, Parabolas, Hyperbolas, Ellipses, Conics, Synthetic Curves, Hermite Cubic Spline, Bezier Curve, B-Spline Curve, Numericals on above topic.

Surfaces:-Introduction, Surface Representation, Analytic Surfaces, Synthetic Surfaces,

Hermite bicubic Surface, Bezier surfaces, B-spline Surfaces, Coons Surface. No analytical treatment.

Solids: Introduction, Geometry and Topology, Solid Representation, Boundary Representation, Euler's equation, Constructive Solid Geometry, Boolean operation for CSG, Hybrid modeling, Feature Based Modeling, Parametric modeling, constraint based modeling, Mass, area, volume calculation.

3 Finite Element Analysis **8**

Introduction, Stress and Equilibrium, Boundary Condition, Strain - Displacement Relations, Stress-Strain Relation, Temperature Effects, Potential Energy and Equilibrium: - Rayleigh-Ritz Method, Galerkin's Method.

One Dimensional Problem: Finite Element Modelling, Coordinate and Shape function, Potential Energy Approach, Galerkin Approach, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations, Quadratic Shape Function, Temperature Effects .

Trusses: Introduction, 2D Trusses, Assembly of Global Stiffness Matrix.

Introduction, Constant Strain Triangle Problem, Modeling and Boundary Conditions.

Section II

4 Computer Aided Manufacturing **8**

CAD Hierarchy, Integrating CAD, NC and CAM, NC programming using G and M codes adoptable to FANUC controller for lathe and milling, Generative programming on CNC, DNC, Adaptive control system, CIM,CAPP.

5 Introduction to Automation **10**

Types of Automation, Transfer line mechanism, Geneva mechanism, Group Technology, Automated guided Vehicles, Automatic Storage and Retrieval System, Flexible Manufacturing System

6 Robot Technology **8**

Classification and Structure of Robotic Systems Point-to-Point Robotic Systems, Continuous Path Robotic System. Configurations of Robotic system, Joints, Drives, Controller, Types of end effectors mechanical, magnetic, pneumatic etc., Industrial Applications of Robots, Robot Programming, Programming Languages.

Term Work

The term work shall consist of record of sis assignments of problems based on the following topics:

1. OpenGL program on transformation
2. Stress and deflection analysis of two dimensional truss using finite element package.
3. Stress and deflection analysis of any Mechanical component consisting of 2-D or 3-D elements using finite element package.
4. Tool path generation using CAM software and Manufacturing on CNC.
5. Demonstration on any one industrial robot or Industrial visit to automation plant.
6. Assignment on Robot gripper design/ Robot programming.

Reference Books

1. Ibrahim Zeid and R. Sivasubramanian - CAD/CAM - Theory and Practice Tata McGraw Hill Publishing Co. 2009
2. Ibraim Zeid, "Mastering CAD/CAM" – Tata McGraw Hill Publishing Co. 2000
3. Chandrupatla T.R. and Belegunda A.D. -Introduction to Finite Elements in Engineering" - Prentice Hall India.
4. Segerling L.J. - Applied Finite Elements Analysis" John Wiley and Sons.
5. Rao P.N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co.
6. Groover M.P.-Automation, production systems and computer integrated manufacturing' - Prentice Hall of India
7. Yoram Koren - Robotics McGraw Hill Publishing Co.
8. James G. Keramas, Robot Technology Fundamentals, Delmar Publishers.
9. S.R.Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
10. Lakshiminarayana H. V. Finite Element Analysis (Procedures in Engineering), University Press, 2004.
11. Chandrupatla T. R., Finite Element Analysis for Engineering and Technology, University Press, 2009.
12. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402042 DYNAMICS OF MACHINERY

Teaching Scheme		Examination Scheme	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks
		Oral	50 Marks

Section I

1 Balancing **8**

Balancing of rotating masses in one and several planes, balancing of reciprocating masses in single and multi cylinder engines: in-line, radial and V-type, primary and secondary balancing analysis, concept of direct and reverse cranks method, static and dynamic balancing machines.

2 Single Degree of Freedom Systems - Free and Damped Vibrations **8**

Fundamentals of Vibration: Elements of a vibratory system, S.H.M., degrees of freedom, modeling of a system, concept of linear and non-linear systems, equivalent spring, linear and torsional systems.

Undamped free vibrations: Natural frequency by equilibrium and energy methods for longitudinal and torsional vibrations.

Damped free vibrations: Different types of damping, equivalent viscous damping, free vibrations with viscous damping - over damped, critically damped and under damped systems, initial conditions, logarithmic decrement, dry friction or coulomb damping - frequency and rate of decay of oscillations.

3 Single Degree of Freedom Systems - Forced Vibrations **10**

Forced vibrations of longitudinal and torsional systems, Frequency Response Functions - Simple harmonic excitation, excitation due to reciprocating and rotating unbalance, base excitation, magnification factor, resonance phenomenon and phase difference, Quality Factor, Vibration Isolation, Force and Motion transmissibility.

Section II

4 Two Degree of Freedom Systems - Undamped Vibrations **8**

Free vibration of spring coupled systems – longitudinal and torsional, natural frequency and mode shapes, Holzer Method, Free vibration of mass coupled systems, geared systems, undamped-vibration absorber, critical speed of light shaft having single rotor - damped and undamped systems.

5 Introduction to Noise **10**

Sound concepts, human hearing mechanisms, fundamentals of noise, decibels, sound pressure level, sound intensity, sound fields, sound reflection, absorption and transmission, concept and governing equation with co-relation of each other.

6 Experimental Noise and Vibration **8**

Instruments – Exciters, Measuring devices and analyzers.

Types of Vibration Tests – Free and Forced. Human Exposure to Noise and Vibration - Acceptable vibration and Noise standards

Control – Basics of noise and vibration, Control of natural frequency, Vibration isolators, and Absorbers, Noise source control, path control, enclosures, absorbers, noise control at receiver (No numerical treatment)

Term Work

The Term Work shall consist of any eight experiments of following list.

1. Experimental verification of dynamic balancing of rotating masses.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
3. To verify natural frequency of torsional vibration of two rotor system and position of node.
4. To determine critical speed of single rotor system.
5. To determine resonance frequency of transverse vibration of beam.
6. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration.
7. To study shock absorbers and to plot transmissibility curve.
8. Measurement of vibration parameters like frequency, amplitude, velocity, acceleration of any vibrating system by using vibration measuring instruments.
9. Noise measurement and analysis using appropriate instrument
10. Analysis of machine vibration, signature, using any analysis software package.

Reference Books

1. Beven, T, "Theory of Machines", CBS Publishers and Distributors, New Delhi
2. Jagdishlal, "Theory of Machines", Metropolitan Publishers
3. Uicker J. J., Pennock G. R. and Shigley J. E. (2006) Indian Edition, "Theory of Machines and Mechanisms" Oxford University Press, New York.
4. Hannah and Stephans, "Mechanics of Machines", Edward Aronold Publication.
5. Gosh A. and Malik A. K. "Theory of Mechanism and Machines", Affiliated East - West Press Pvt. Ltd. New Delhi.
6. Rattan S. S. "Theory of Machines", Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Grover G. K. "Mechanical Vibrations", Nem Chand and Bros.,Roorkee
8. Thomson, W. T., "Theory of Vibration with Applications", CBS Publishers and Distributors
9. Rao S. S. "Mechanical Vibrations", Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. New Delhi.
10. Kelly S. G. "Mechanical Vibrations", Schaum's outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
11. Meirovitch, "Elements of Mechanical Vibrations", McGraw Hill
12. Steinberg, D. S., "Vibration Analysis for Electronic Equipments", John Wiley and Sons.
13. Pujara, K., "Vibration and Noise for Engineering", Dhanpat Rai and Company.
14. Bell, L. H. and Bell, D. H., "Industrial Noise Control – Fundamentals and Applications", Marcel Dekker Inc.
15. Bies, D. and Hansen, C. "Engineering Noise Control - Theory and Practice", Taylor and Francis

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402043 INDUSTRAIL FLUID POWER

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks
		Oral	50 Marks

Section I

1 Introduction to Fluid Power **8**

Fluid power system: Components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications such as hydraulic press/Jack (Numerical treatment). Fluids for hydraulic system : Types, properties, selection. Additives, effect of temperature and Pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, material, quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers, sources of contamination and contamination control, heat exchangers.

2 Pumps **8**

Types, classification, principle of working and constructional details of Vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic Power transmission.

Power units and accessories: Types of power units, reservoir assembly, constructional details, pressure switches, temperature switches, Temperature switches.

Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor

3 Fluid Power Control **10**

Symbols for hydraulic and pneumatic circuits. Control of fluid power through different valves such as pressure control valves, directional control valves, and flow control valves (Principle, classification, constructional details, symbols, advantages, disadvantages and applications).

Flow rate, working pressure, differential pressure

Check valve, Servo valves, Proportional valves and Cartridge valves, cut off Valves.

Section II

4 Hydraulics: **8**

Actuators: (i) Linear and Rotary. (ii) Hydraulic motors- Types- Vane, gear, Piston types, radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders. (Numerical treatment)

Industrial circuits – Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit.

5 Pneumatics **8**

Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compressors. (ii) Comparison of Pneumatics with Hydraulic power transmissions. (iii) Types of filters, regulators, lubricators, mufflers, dryers. (iv) Pressure regulating valves, (v) Direction control valves, two way, three way, four way valves. Solenoid operated valves, push button, lever control valves. (vi) Speed regulating - Methods used in Pneumatics. (vii) Pneumatic actuators-rotary, reciprocating.(viii) Air motors- radial piston, vane, axial piston (ix) Basic pneumatic circuit, selection of components(x) Application of pneumatics in low cost Automation and in industrial automation

Introduction to vacuum and vacuum measurement, Vacuum pumps, types, introduction to vacuum sensors and valves. Industrial application of vacuum

6 System Design **8**

Design of hydraulic/pneumatic circuit for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Students are advised to refer manufacturers' catalogues.).

List of experiments

Minimum of 8 experiments from the following; out of which serial no. 1 to 4 are compulsory, three from serial no. 5 to 9 and one from serial no 10 and 11. Record of experiments and assignments shall be submitted in the form of journal.

1. Trial on Gear/Vane/Piston pump and plotting of performance characteristics.
2. Following experiments to be done on hydraulic trainer:
    1. Regenerative circuit
    2. Speed control circuit
    3. Sequencing circuit
    4. Transverse and feed circuit
3. Following experiments to be done on pneumatic trainer:
    a. Automatic reciprocating circuit
    b. Speed control circuit
    c. Pneumatic circuit involving shuttle valve/ quick exhaust valve
    d. Electro pneumatic valves and circuit
4. Design report of a hydraulic or pneumatic system using manufacturer's catalogue.
5. Study of accumulators and intensifiers.
6. Industrial visit to study automation by means of hydraulic and pneumatics such as LPG bottling plant etc
7. Study of compressed air generation and distribution systems.
8. Study of simple hydraulic systems used in practice such as copy turning attachment, hydraulic clamps, jack, dumper, forklift etc.
9. Study and Demonstration of hydraulic system such as hydraulic press, Injection moulding machines.
10. Testing of pressure relief valve.
11. Testing of liner actuator.

Suggested Exercise (May be attached Journal)

Compilation of file (with logical sequence) of catalogues of pneumatic and hydraulic system manufacturers with ref. to above major components. Best file to be kept in library for future ref.

Reference Books

1. Pinches, Industrial Fluid Power, Prentice hall
2. D. A. Pease, Basic Fluid Power, Prentice hall
3. J. J. Pipenger, Industrial Hydraulics, McGraw Hill
4. H. L. Stewart, Hydraulics and Pneumatics, Industrial Press
5. A. Esposito, Fluid Power with application, Prentice hall
6. B. Lall, Oil Hydraulics, International Literature Association
7. Yeaple, Fluid Power Design Handbook
8. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books.
9. Majumdar, Pneumatic Systems, Tata McGraw Hill
10. ISO - 1219, Fluid Systems and components, Graphic Symbols
11. Majumdar, Oil Hydraulics- Principle and Maintenance, Tata McGraw Hill.
12. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics can be referred.

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402044A ENERGY AUDIT & MANAGMENT

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks

Section I

1 General Aspects of Energy Management **8**

Current energy scenario - India and World, Current energy consumption pattern in global and Indian industry, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy and environment, Need of Renewable and energy efficiency.

2 Energy Auditing **10**

Need of Energy Audit, Types of energy audit, Components of energy audit, Energy audit methodology, Instruments, equipment used in energy audit, Analysis and recommendations of energy audit - examples for different applications, Energy audit reporting, Energy audit software.

Energy conservation opportunities in Boiler and steam system, Furnace, DG sets, HVAC system, pumping system, Cooling tower and Compressed air system.

3 Energy Economics **8**

Costing of Utilities- Determination of cost of steam, natural gas, compressed air and electricity.

Financial Analysis Techniques - Simple payback, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Risk and Sensitivity analysis.

Section II

4 Energy Efficiency in Thermal Utilities **10**

Energy performance assessment and efficiency improvement of Boilers, Furnaces, Heat exchangers, Fans and blowers, pumps, Compressors and HVAC systems. Steam distribution, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.

5 Electrical Energy Management and Lighting **8**

Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Distribution and transformer losses. Electrical motors- types, efficiency and selection. Speed control, Energy efficient motors. Electricity Act 2003.

Lighting - Lamp types and their features, recommended illumination levels, lighting system energy efficiency.

6 Cogeneration and Waste Heat Recovery **8**

Cogeneration- Need, applications, advantages, classification, the cogeneration design process.

Waste heat recovery- Classification and application, Potential for waste-heat recovery in Industry, Commercial WHR devices, saving potential.

CDM projects and carbon credit calculations

Term Work

1. Carry out the Energy audit of a small scale industry/institute and submit report with recommendation.
2. Carry out the Energy audit of HVAC or Compressed air or Boiler and steam system and submit report with recommendations.
3. Carry out the Energy audit of Electrical system.

4. Electrical tariff calculations
5. Study and visit to any one alternate energy source installation

Reference Books

1. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, The Fairmont Press Inc., 7th Edition.
2. Energy management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition, Georgia.
3. Handbook on Energy Audit and Environment management, Abbi Y. A., Jain Shashank, TERI, Press, New Delhi, 2006
4. Energy Performance assessment for equipment and Utility Systems.-Vol. 2,3.4 BEE Govt. of India
5. Boiler Operator‘s Guide Fourth Edition, Anthony L Kohan, McGraw Hill
6. Energy Hand book, Second edition, Von Nostrand Reinhold Company - Robert L.Loftness.
7. www.enrgymanagertraining.com
8. www.bee-india.nic.in

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402044 B PRODUCT DESIGN AND DEVELOPMENT

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks

Section I

1 Introduction to Product Design and Development **8**

Definition of product design, design by evolution and innovation, factors in product design, morphology of product design (seven phases), standardization, simplification and specialization in product design, modern approaches- concurrent design and quality function deployment, product development, product development versus product design, types of design and redesign, modern product development process, product development team and product development planning with reference to ISO standard, difference between product verification and production validation, introduction to prototyping, rapid prototyping methods.

2 Product Development – Technical and Business Concerns **8**

Technology Forecasting and Technology S-Curve (Technology Stage), Mission Statement and Technical Questioning, Economic Analysis of Product, Customer Needs and Satisfaction, Customer Population and Market Segmentation, Customer Needs-Types and Models, Gathering Customer Needs Information, Analysis of Gathered Information.

3 Product Development from Concept to Product Function **10**

Generating concepts, information gathering, and brainstorming, morphological analysis, concept selection-design evaluation, estimation of technical feasibility, concept selection process, Pugh's concept, selection charts, numerical concept scoring, process of concept embodiment, system modeling, FMEA, functional modeling and decomposition, fast method, subtract and operate procedure, establishing system functionality, augmentation and aggregation.

Section II

4 Product Development in the Context of Reverse Engineering **8**

Product Teardown Process, Tear Down Methods - Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used In Benchmarking - Indented Assembly Cost Analysis, Function - Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Architecture

5 Design for Manufacture, Assembly and Environment **10**

Design guidelines, design for manufacture, design for assembly, design for piece part production, manufacturing cost analysis, need and importance of design for environment, global, local and regional issues, basic DFE methods-guidelines and applications, life cycle assessment - basic method, weighed sum assessment method, life cycle assessment method, DFX, product testing, product validation, field trials, virtual trials, iterations

6 Introduction to Product Life Cycle and Product Data Management **8**

Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components/Elements of PLM, Emergence of PLM, Significance Of PLM, Customer Involvement, Product Data and Product Workflow, The Link Between Product Data and Product Workflow, Different Phases of Product Life Cycle and corresponding technologies.

Term work

A] Any six assignments from following;

1. Morphological analysis
2. Quality Function Deployment (QFD)
3. Technical feasibility and S-curve
4. FMEA
5. Product Tear Down
6. Design for Manufacturing (DFM)
7. Product Life cycle Management (PLM)
8. Identifying customer needs
9. Concept Selection Process

B] One assignment on actual product design with virtual product validation.

Reference

1. A. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice - Hall India.
2. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000.
3. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education Inc.
4. Grieves, Michael, Product Lifecycle Management McGraw-Hill, 2006. ISBN 0071452303
5. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub. 1986
6. ISO Standard: 9001:2008: Clauses 7.1, 7.2, 7.3

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402044 C DESIGN OF PUMPS, BLOWERS AND COMPRESSORS

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks

Section I

1 Review of principles of Fluid Machinery **4**

Basic equations of energy transfer between fluid and rotor, Performance characteristics, Dimensionless parameters, Specific speed, stage velocity triangles, work and efficiency.

2 Theory of Pumps **8**

Calculation of tangential and axial thrust methods to minimize axial thrust, impellers, casings, volute pumps, vanes, velocity vector diagrams and work done by pumps, developed head, efficiency and losses in pumps, specific speed, calculation of power requirement, operating characteristics.

3 Design of Pumps **10**

Design procedure and design optimization of Pumps. Thermal design- Selection of materials for high temperature and corrosive fluids. Hydraulic design- Selection of impeller and casing dimension using industrial manuals. Introduction to computer programs for iterative and interactive design.

Section II

4 Theory of Fans and Blowers **10**

Classification of blowers, Basics of stationary and moving air, Eulers characteristics, velocity triangles and operating pressure conditions, Equations for blowers, Losses and hydraulic efficiency flow through impeller casing inlet nozzle. volute, diffusers, leakage disc friction mechanical losses,. Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers. Applications of blowers and fans.

5 Design of Fans and Blowers **8**

Design procedure for selection and optimization of Blowers. Stage pressure rise, stage parameters and design parameters. Design of impeller and casing dimension in aerodynamic design. Introduction to computer programs for iterative and interactive design

6 Theory and Design of Compressors **8**

Basic theory, classification and application, Working with enthalpy-entropy diagram, construction and approximate calculation of centrifugal compressors, impeller flow losses, slip factor, diffuser analysis, performance curves of centrifugal compressors. Basic design features of axial flow compressors; velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage of axial flow compressors.

Term Work

Any six assignments based on above syllabus.

Reference Books

1. Shepherd, D.G., "Principles of Turbomachinery", Macmillan, 1969.
2. Austin H. Chruch, "Centrifugal pumps and blowers", John wiley and Sons, 1980.
3. Turbine, "Compressors and Fans" S.M.Yahya, Tata Mc-Graw Hill Publishing Company, 1996
4. Val S.Labanoff and Robert Ross, "Centrifugal Pumps Design and Applications" Jaico P House.
5. Igori Karassik, "Pump Hand Book," McGraw-Hill International Edition.
6. G.K.Sahu "Pumps" New age international publishers.
7. John Tuzson, "Centrifugal Pump Design," Wiley Publication.
8. Stepanff, A.J., "Blowers and Pumps ", John Wiley and Sons Inc., 1965.

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402044 D TRIBOLOGY

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 hrs/week	Term work	25 Marks

Section I

1 Introduction to Tribology **8**

Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, lubrication, basic modes of lubrication, lubricants, properties of lubricants - physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion.

Types of sliding contact bearings, comparison of sliding and rolling contact bearings

2 Friction and Wear **8**

Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation.

Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.

3 Hydrodynamic Lubrication **10**

Hydrodynamic lubrication: Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold's equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing

Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, center of pressure, friction in tilting pad thrust bearing.

Section II

4 Hydrostatic Lubrication **8**

Hydrostatic lubrication: Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions.

Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane.

5 Elasto-hydrodynamic Lubrication and Gas Lubrication **8**

Elastohydrodynamic Lubrication: Principle and application, pressure - viscosity term in Reynold's equation, Hertz theory. Ertel-Grubin Equation

Gas lubrication: Introduction, merits and demerits, applications.

Lubrication in metal working: Rolling, forging, drawing and extrusion. Bearing materials, bearing constructions, oil seals, shields and gaskets

6 Surface Engineering **10**

Introduction to surface engineering, concept and scope of surface engineering, manufacturing of surface layers, solid surface-geometrical, mechanical and physico chemical concepts, superficial-layer, development of concept, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer.

Surface Engineering for Wear and Corrosion resistance: Diffusion, coating, electro and electro-less plating, hot deep coating, metal spraying, cladded coating, crystallizing coating, selection of coating for wear and corrosion resistance, potential properties and parameters of coating.

Term Work: The Term Work shall consist of,

A] Any one case study of the following

1. Friction in sliding/ rolling contact bearing.
2. Wear of cutting tool.
3. Corrosion and Surface coating.
4. Sliding/ rolling contact bearing performance.

B] Assignment based on the Tribological design of the system like I C Engine, Machine Tool, Rolling Mill.

OR

Industrial visit: students should visit the industry to study the lubrication systems or to study the techniques of surface coating.

OR

Seminar on recent trends in Tribology or related areas: A seminar on recent trends in Tribology or related areas shall be given by the student. A seminar report shall be submitted as a part of term work.

Reference Books

1. Cameron A., "Basic Lubrication Theory", Wiley Eastern Ltd.
2. B. C. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi
3. Fuller D. D., "Theory and Practice of Lubrication for Engineers", John Wiley and Sons
4. Halling J., "Principles of Tribology", McMillan Press Ltd.
5. B. Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill
6. Davis J., "Surface Engineering for corrosion and Wear Resistance", Woodhead Publishing, 2001
7. V.B. Bhandari., "Design of Machine Elements" Tata McGraw Hill Pvt Ltd.
8. Tadausz Burakowski, "Surface Engineering of Metals: Principles, Equipments, Technologies", Taylor and Francis

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402045A AUTOMOBILE ENGINEERING

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks

Section I

1 Introduction to Automobile Engineering **8**

Automobile history and development, Classification, vehicle layout- engine location and drive arrangement, safety regulations, specifications of vehicles, Type of vehicle bodies, Chassis types, constructional details, Frames, sub frames, frameless vehicles, vehicle dimensions), details of chassis material, Vehicle life development cycle overview

2 Drive Train **8**

Classification of clutches, Single-plate, Multi-plate, Cone, diaphragm spring, Centrifugal, Clutch materials, Electromagnetic, vacuum operated, fluid flywheel, Necessity of gear box, Manual gear box -Constant mesh, Sliding mesh, Synchromesh, Geared automatic transmission, Torque convertor, Epicyclic, Continuous variable transmission, Electronic transmission control, overdrive, Propeller Shaft, Constant Velocity joint, Differential and final drive, Non slip differential

3 Front Axle, Steering System, Rear Axle, Wheel and Tyres **10**

Purpose and requirement front axle, steering mechanism, steering geometry, center point steering, cornering force, slip angle, scrub radius, steering characteristic, steering gearbox, Power steering, collapsible steering

Live and dead axles, live axle arrangement, single, double and triple reduction rear axle, Wheel construction, alloy wheel, wheel alignment and balancing, type of tyres, tyre construction, tread design

Section II

4 Suspension System, Brakes **8**

Sprung and unsprung mass, Roll centre, Types of suspension linkages, Type of springs- leaf, coil, air springs, hydro gas suspension, rubber suspension, interconnected suspension, self leveling suspension(active suspension), damping and shock absorbers Types of brake systems - drum, disc, Operation- mechanical, hydraulic, air brakes, servo and power braking, Stopping distance, ABS.

5 Electrical System, Modern Trends **8**

Electrical systems, battery types and construction, lighting, horn, indicators, sprays, wipers, Staring system, Instruments

Sensors and actuators, Electronic Control Unit, Electronic stability program, traction control devices,

Electrical car layout, Hybrid drives,

6 Vehicle Performance **8**

Vehicle performance parameters, road resistance, traction and tractive effort, power requirement for propulsion, road performance curves, Stability of vehicles. SAE vehicle axis system, vehicle body moments, roll over

Vehicle safety-active, passive safety, air bags, seat belt, types of collisions- front, rear, side,

Vehicle interior and ergonomics, comfort, NVH in automobiles

Reference Books:

1. K. Newton and W. Seeds, T.K. Garrett,‘ Motor Vehicle’ 13th Edition, Elsevier publications
2. Hans Hermann Braess, Ulrich Seiffen, handbook of Automotive Engineering, SAE Publications
3. William H. Crouse., ”Automotive Mechanics‘ - Tata McGraw Hill Publishing House
4. Joseph Heitner, ”Automotive Mechanics‘ -C.B.S Publishers And Distributors
5. SAE Manuals and Standard
6. Automobile Mechanics -.N. K. Giri
7. Automobile Electrical Equipment -P. S. Kohali
8. Narang G. B. S ,‘Automobile Engineering‘ - S. Chand and Company Ltd.
9. Singh Kripal - Automobile Engineering -Volume 2 New Chand Jain.

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402045B MACHINE TOOL DESIGN

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks

Section I

1 Drives **10**

Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box.

2 Design of Machine Tool Structure **8**

Analysis of forces on machine tool structure, static and dynamic stiffness.
Design of beds, columns, housings, bases and tables.

3 Design of Guide-ways **8**

Functions and types of guide-ways, design criteria and calculation for slide-ways, design of hydrodynamic, hydrostatic and aerostatic slide-ways, Stick-Slip motion in slide-ways.

Section II

4 Design of Spindles, Spindle Supports and Power Screws **10**

Design of spindle and spindle support using deflection and rigidity analysis, analysis of anti-friction bearings, preloading of antifriction bearing.
Design of power screws: Distribution of load and rigidity analysis.

5 Dynamics of machine tools **8**

Dynamic characteristic of the cutting process, Stability analysis, vibrations of machine tools. Control Systems, Mechanical and Electrical, Adaptive Control System, relays, push button control, electrical brakes, drum control.

6 Special features in Machine Tool Design **8**

Design considerations for SPM, NC/CNC, and micro machining, Retrofitting, Recent trends in machine tools, Design Layout of machine tool using matrices.
Step-less drives Design considerations of Step-less drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking,

Text Books

1. N.K. Mehta, "Machine Tool Design", Tata McGraw Hill, ISBN 0-07-451775-9.
2. Bhattacharya and S. G. Sen., "Principles of Machine Tool", New central book agency Calcutta, ISBN 81-7381-1555.
3. D. K Pal, S. K. Basu, "Design of Machine Tool", 4th Edition. Oxford IBH 2005, ISBN 81-204-0968

Reference Books:

1. N. S. Acherkan, "Machine Tool", Vol. I, II, III and IV, MIR publications.
2. F. Koenigsberger, "Design Principles of Metal Cutting Machine Tools", The Macmillan Company New York 1964

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402045C QUANTITATIVE AND DECISION MAKING TECHNIQUES

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks

Section I

1 Quantitative Methods **10**

Definition, Evolution and Classification of Quantitative Methods and Operations Research Techniques, Methodology, Advantages and Limitations., Decision Theory, Meaning and Steps in Decision Making, Types of Management Decisions, Decision under Certainty, under Risk, under Uncertainty, Decision Trees, Utility Theory. Theory of Games, Introduction, Minimax and Maximin Principle, Solution of Game with Saddle Point, Solution by Dominance, Solution by Graphical Method, m x n size Game Problem, size Game Problem,

2 Linear Programming **8**

Introduction, Formulation, Basic Method of Solving Transportation Problem, Simplex Methods, Duality and Sensitivity Analysis. Introduction to Parametric, Integer and Non-linear Programming

3 Transportation Problem **8**

Introduction, Formulation, Basic Method of Solving Transportation Problem, Optimization Methods like UV and Stepping Stone Method. Trans-shipment Methods as an Extension of Transportation. Assignment Problem- Hungarian Method to solve Assignment Problem. Travelling Salesman as an Extension of Assignment Problem.

Section II

4 Queuing Theory **10**

(a) Inventory - Deterministic Models, Shortage, without shortage
(b) Simple Probabilistic Inventory Models, Concept of Service level,
(c) Queuing Theory - Introduction, Basis Structure, Terminology and Applications. Queuing Model M/M/1: ∞/FIFO, MCSR.
(d) Simulation Techniques for Inventory and Queuing Problems, Monte-Carlo Simulation

5 Investment Analysis **8**

(a) Break-Even Analysis, Payback Period Method, A(A)R Method, DCF Method, IRR Method, Probabilistic Models, Risk Adjusted Discount Rate, Certainty-Equivalent Approach, EMV, Hiller and Hertz's Model.
(b) Replacement Analysis, Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly.

6 Network Models **8**

(a) Network Models - Shortest Route, Minimal Spanning and Maximal Flow Problems.
(b) Introduction to Multi Object Decision Making-Goal Programming Formulation.
(c) Deterministic Sequential Decision Making, Dynamic Programming,

Text books:

1) Quantitative Techniques by N.D.Vora.
2) Operations Research by H. Taha.
3) Operations Research by Hira Gupta.
4) Operations Research by J.K.Sharma.

Reference books:

1) Hillier F.S., and Lieberman G.J., Operations Research, Eight Edition, Mc. Tata McGraw Hill Pvt. Ltd., ISBN-13:978-0-07-060092-8.
2) Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey, ISBN: 978-81-265-1256-0.

University of Pune, Pune
B E (Mechanical) Part I (2008 Course)
402046A PROJECT WORK

Teaching Scheme
Practical 2 hrs/week

Section I

Objective

- To embed the skill in group of students (strictly four) to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.
- To encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.
- The project may be in-house, sponsored by an Industry.

Project Load
Maximum two groups of four students per group, shall work under one faculty member of department. The group of one student is strictly not allowed.

Project Definition
Project work shall be based on any of the following:

1. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
2. Experimental verification of principles used in Mechanical Engineering Applications.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.

Project Term Work:
The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for
   a. Searching suitable project work
   b. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.
   c. Brief report of feasibility studies carried to implement the conclusion.
   d. Rough Sketches/ Design Calculations
   e. Synopsis

The group should submit the synopsis in following form.

   i. Title of Project
   ii. Names of Students
   iii. Name of Guide
   iv. Relevance
   v. Present Theory and Practices
   vi. Proposed work
   vii. Expenditure
   viii. References

2. The synopsis shall be signed by the each student in the group, approved by the guide(along with external guide in case of sponsored projects) and endorsed by the Head of the Department
3 Presentation: The group has to make a presentation in front of the faculty of department at the end of semester.

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402046B Project Work

Teaching Scheme		**Examination Scheme**	
		Theory	100 Marks
Practical	6 Hrs/Week	Oral	50 Marks

Project Report

Project report should be of 50 to 60 pages. The report must be hard bound. For standardization of the project reports the following format should be strictly followed.

1 Page size : Trimmed A4
2. Top Margin : 1.00 Inches
3. Bottom Margin : 1.32 Inches
4. Left Margin : 1.5 Inches
5. Right Margin : 1.0 Inches
6. Para Text : Times New Roman 12 point font
7. Line Spacing : 1.5 Lines
8. Page Numbers : Right aligned at footer. Font 12 point Times New Roman
9. Headings : New Times Roman, 14 Points, Boldface
10. Certificate
    - All students should attach standard format of Certificate as described by the department.
    - Certificate should be awarded to project group and not individual student of the group
    - Certificate should have signatures of Guide, Head of Department and Principal.
    - Entire Report has to be documented as one chapter.

11. **Index of Report**

    i) Title Sheet
    ii) Certificate
    iii) Acknowledgement
    iv) Synopsis
    v) List of Figures
    vi) List of Photographs/ Plates
    vii) List of Tables
    viii) Table of Contents
    1. Introduction
    2. Literature Survey/ Theory
    3. Design/ Experimentation/ Fabrication/ Production/ Actual work carried out for the same.
    4. Observation Results
    5. Discussion on Result and Conclusion

12. References : References should have the following format

    For books:
    "Title of Books", Authors; Publisher; Edition;
    For Papers:
    "Title of Paper", Authors; Conference Details; Year.

Important Notes

- Project group should continue maintaining a diary for project and should write (a) Book referred (b) Company visited (c) Person contacted (d) Computer work done (e) Paper referred (f) Creative thinking.
- Students are expected to publish a paper on the project either in various paper contests or at least within department.
- The Diary along with Project Report shall be assessed at the time of oral examination
- One copy of the report should be submitted to Institute/ Department, One copy to
- Guide and one copy should remain with each student of the project group.

Term Work evaluation

1 The project term work shall be evaluated on the basis of reviews. In first semester two reviews are to be taken and evaluated for total 30 marks (15 marks each)

2 In semester two, two reviews are to be taken for total 30 marks (15 marks each)

3 The final presentation shall be taken in front of external examiner and to be evaluated for 40 marks
   - 10 marks for presentation for group,
   - 15 marks for quality of the project work.
   - 15 marks for quality of the project report.

Oral Examination

4 Oral examination shall be conducted with final presentation of the project. The distribution of marks shall be
   - 15 marks for contribution of the student in the project work
   - 15 marks shall be awarded for achieving the objectives of the project set forth.
   - 20 marks for Question/ Answer

   The external examiner shall be preferably Industrial expert in the same field or senior teaching faculty from other University. In case, the external examiner is appointed by the college authorities, the bio data of the external examiner may please be sent to The Chairman BOS Mechanical Engineering so that the examiner shall be included in the Panel of Examiners for the Project oral.

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402047 POWER PLANT ENGINEERING

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	25 Marks
		Oral	50 Marks

Section I

1 Power Plants **8**

Introduction, Factors affecting Selection of Site, Schematic Diagrams and relative merits of steam, Gas, Diesel, Hydro Power Plants. Present status of power generation in India. Role of private and government organization, State Level Scenario, Load Shedding. Carbon credits

Economic Analysis: Introduction, Cost of electric Energy, Fixed and operating cost (with numerical treatment), Selection and Type of Generation ,Selection of generation equipment, Performance and Operation Characteristics of power plants and Tariff methods.

2 Thermal and Co-Generation Power Plant **8**

Introduction, general layout of modern thermal power plant, working of thermal power plant, coal classification, coal handling, coal blending, coal desulphurization, Indian coals, selection of coal for TPP., coal handling, storage, preparation and feeding, ash handling and dust collection, fluidized bed combustion systems, steam turbines, condensers, cooling pond and cooling tower, condenser efficiency and vacuum efficiency (with numerical treatment), necessity of feed water treatment, high pressure boilers and importance of water purity, thermodynamic cycles. Cogeneration power Plant (with numerical treatment).

3 Hydroelectric and Gas Turbine Power Plant **10**

Hydroelectric Power Plant: Hydrograph, flow duration curve, site selection, classification of HPP, and their field of use, capacity calculation for hydro power, dam, head water control, penstock, water turbines, specific speeds, governors, hydro electric plant auxiliaries, plant layout, automatic and pumped storage, project cost of hydroelectric plant. Advantages of hydro power plant

Gas Turbine Power Plant: Plant layout, method of improving output and performance, fuel and fuel systems, method of testing open and closed cycle plants, operating characteristics, applications, free piston engine plant, limitation and application, combined cycle plants, advantages, need of generation power plant in power systems based load station and peak load station, concept of maximum and optimum pressure ratio, actual cycle, effect of operating variable on thermal efficiency, regeneration, inter-cooling, reheating, performance of closed and semi closed cycle gas turbine plant (with numerical treatment).

Section II

4 Nuclear and diesel Power Plant **10**

Elements of nuclear power plant, nuclear reactor and its types, fuels moderators, coolants, control rod, classification of nuclear power plants, waste disposal.

Diesel Power Plant: Diesel engine performance and operation, plant layout, log sheet, application, selection of engine size.

5 Instrumentation and Equipments in Power Station **8**

Generator and exciters, earthling of power system, power and unit transformer, circuit breakers, protective equipments, control board equipment, elements of instrumentation, plant layout, switch gear for power station auxiliaries, recent developments in methods of power generation, introduction to magneto hydrodynamic, fuel cells , geothermal, solar power, tidal power.

6 Environmental and Equipments in Power Station **10**

Environmental aspects: Introduction, Constitutes of the atmosphere, Different pollutants +due to thermal power plant and their effect on human health, environmental control of different pollutants such as particulate matter, oxides of sulphur (Pre and Post Treatments) oxides of Nitrogen ,Global warming and green house effect, Thermal Pollution of Water and its control.

Term Work

List of Experiments: **(Any Eight)**

1. Visit to Thermal Power Plant
2. Visit to Nuclear/Gas Turbine/Hydro Power Plant
3. Study Of Fluidised Bed Combustor
4. Trial on Diesel power Plant
5. Trial on Steam Power plant
6. Study Of Power Plant Instruments
7. Study of Environmental Impact of Power Plant
8. Tariff Study (Domestic and Industrial)
9. Study Of Co-generation Plant
10. Study of Non conventional power plant.

Reference Books

1. Domkundwar and Arora “Power Plant Engineering“, Dhanpat Rai and Sons, New Delhi
2. E.I. Wakil, “Power Plant Engineering“, Publications, New Delhi
3. P. K. Nag, “Power Plant Engineering“, Tata McGraw Hill, New Delhi
4. R. K. Rajput,“ Power Plant Engineering“, Laxmi Publications, New Delhi.
5. R. Yadav - Steam and Gas turbines, central publishing house, Allahabad
6. G. D. Rai Non conventional energy sources,

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402048 MECHANICAL SYSTEM DESIGN

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	25 Marks
		Oral	50 Marks

Section I

1 Design of Cylinders and Pressure Vessels **10**

Cylinders: Thick and thin cylinders, thin cylindrical and spherical vessels, Lame's equation, Clavarino's and Birnie's equations, design of hydraulic and pneumatic cylinders, auto frettage and compound cylinders, gasketed joints in cylindrical vessels (No derivation).

Pressure Vessels : Modes of failures in pressure vessels, unfired pressure vessels, classification of pressure vessels as per I. S. 2825 - categories and types of welded joints, weld joint efficiency, stresses induced in pressure vessels, materials for pressure vessel, thickness of cylindrical shells and design of end closures as per code, nozzles and openings in pressure vessels , reinforcement of openings in shell and end closures - area compensation method, types of vessel supports (theoretical treatment only)

2 Design of I. C. Engine components **8**

Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod, design of crank-shaft and crank-pin, Design of valve gear system.

3 Optimum Design **8**

Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equation, subsidiary design equations and limit equations, optimum design with normal and redundant specifications of simple machine elements like: tension bar, transmission shaft, helical spring and pressure vessel.

Section II

4 Statistical and Product Design Considerations **10**

Statistical considerations in design, Frequency distribution - Histogram and frequency polygon, normal distribution - units of measurement of central tendency and dispersion - standard deviation - population combinations - design for natural tolerances - design for assembly - statistical analysis of tolerances, mechanical reliability and factor of safety. **Aesthetics and Ergonomic considerations in product design:**

Ergonomic considerations, relation between man, machine and environmental factors, design of displays and controls, practical examples of products or equipment using ergonomic and aesthetic design principles

Design for manufacture, assembly and safety: General principles of design for manufacture and assembly (DFM and DMFA), principles of design of castings and forgings, design for machining, , design for welding, design for safety.

Introduction to Design Of Experiments (DOE).

5 Design of Machine Tool Gearbox **8**

Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, deviation diagram, difference between numbers of teeth of successive gears in a change gear box, analysis of a twelve speed gear box.

6 Design Principles of Material Handling Systems **8**

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of

conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys, introduction to design of cranes.

Term Work

Term work shall consists of

1. One design project:

The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D CAD software) - one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted. Projects shall be in the form of design of mechanical systems including pressure vessel, conveyor system, multi speed gear box, I.C engine, etc.

2. Assignments:

The assignment shall be internally presented in the form of power point presentation, by a group of three to five students. A report of assignment (Max 8 to 10 pages) along with print out of ppt is to be submitted.

Each student shall complete any three of the following:

1. Design review of any product/ system for strength and rigidity considerations.
2. Design review of any product/system for manufacturing, assembly and cost considerations.
3. Design review of any product/system for aesthetic and ergonomic considerations.
4. Analysis of any product/system using reverse engineering.
5. Case study of one patent from the product design point of view.
6. Failure mode and effect analysis of one product/component.
7. Concurrent Engineering.

Reference Books

1. Shigley J. E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Pub. Co. Ltd.
2. M. F. Spotts, "Mechanical Design Analysis", Prentice Hall Inc.
3. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Pub. Co. Ltd.
4. Black P.H. and O. Eugene Adams, "Machine Design" McGraw Hill Book Co. Inc.
5. "Design Data", P.S.G. College of Technology, Coimbatore.
6. I.S. 2825: Code for unfired pressure vessels.
7. Johnson R.C., "Mechanical Design Synthesis with Optmisation Applications", Von Nostrand -Reynold Pub.
8. Dieter G.E., "Engineering Design", McGraw Hill Inc.
9. S.K. Basu and D. K. Pal, "Design of Machine Tools', Oxford and IBH Pub Co.
10. N. K. Mehta , "Machine tool design', Tata McGraw Hill Pub. Co.
11. Rudenko,"Material Handling Equipment", M.I.R. publishers, Moscow
12. Sharma, P. C. and Agarwal, D. K., "Machine Design", S. K. Kataria and Sons, Delhi
13. Pandy, N. C. and Shah, C. S., "Elements of Machine Design", Charotar Publishing House,
14. Mulani, I. G., "Belt Conveyors"
15. Ray T.K, "Mechanical Handling and Materials" , Asian Books Pvt Ltd.

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402049A COMPUTATIONAL FLUID DYNAMICS

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	25 Marks

Section I

1 Governing Equations **9**

Conservation Equations, Derivation of Mass Momentum and Energy equations in differential and integral forms, Application to simple control volumes

2 Discretization and Conduction **9**

Overview, Discretization Methods, Taylor Series expansion, finite approximation of first order derivatives using FDS, BDS, CDS, second order derivatives, steady state Conduction equation solution (relaxation, over-relaxation)

3 Transient Conduction: **9**

1d Transient conduction, explicit, implicit and semi-implicit methods, tridiagonal matrix solver, 2D conduction equation discretization, Boundary conditions : Dirichlet, Neumann and mixed.

Section II

4 ADI schemes and Hyperbolic systems **9**

Alternating Direction Implicit methods, Lax Wendroff, MacCormack schemes for linear wave equation

5 Convection-Diffusion systems **9**

Upwind differencing, 2D Convection diffusion equation,
Introduction to finite volume

6 Flow Solver **9**

Pressure Correction- SIMPLE algorithm, Practical guidelines for CFD simulation processes (Grid Generation types, problem setup, types of boundary conditions)

Term Work

Assignments: Any Eight

1. Problems on Gauss-Siedel/Jacobi/TDMA.
2. Numerical simulation of quasi one dimentional nozzle flow.
3. Analysis of boundary layer over a flat plate. *(Blasius equation)*
4. Transient Conduction equation in 2 dimensions
5. Convection-Diffusion Equation in 2 dimensions
6. Analysis of internal flow
7. Analysis of external flow: Aerofoil or similar shape
8. Validation of natural convection in a square cavity.
9. CFD analysis of heat transfer in pin fin.
10. Study of different mesh generation schemes.

Reference Books:

1) Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", Taylor and Francis
2) J. D. Anderson, "Computational Fluid Dynamics - The Basics With Appications", McGraw

Hill
3) C T Shaw, “Using Computational Fluid Dynamics“
4) H K Versteeg, W Malalasekera ,“An introduction to Computational Fluid Dynamics“
5) P S Ghoshdastidar, “Computer simulation of flow and heat transfer“
6) Jiyuan Tu, Guan Heng Yeah, C Liu, “Computational Fluid dynamics“, Elsevier
7) T. J. Chung, “Computational Fluid dynamics“, Cambridge University Pres.
8) Charles Hirsch, “Numerical Computation of Internal and External Flows“, Vols I and II, Wiley
9) Sengupta Tapan K., Fundamentals of Computational Fluid Mechanics, University Press, 2005.
10) Pradeep Niyogi, S. K. Chakravarti and M. K. Laha; ‘Introduction to Fluid dynamics’, Person Education, 2005

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402049 B FINITE ELEMENT METHOD

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	50 Marks

Section I

1 Introduction **8**

Theoretical background - Ritz method, Finite difference method and Finite element method, Brief History of FEM, General FEM procedure, Applications of FEM in various fields, Advantages and disadvantages of FEM.

Review of Matrix Algebra (Vectors, Matrices, Symmetric banded matrix, Determinants, Inverses, Eigen values), Partitioning of matrix, Cholesky's decomposition of matrix, Consistent units. Solutions of simultaneous equations – banded skyline solutions

Review of Solid Mechanics – Stress equilibrium equations, Strain-Displacement equations, Stress-Strain-Temperature Relations, Plane stress, plane strain and axisymmetric problems, Strain energy, Total potential energy, Essential and natural boundary conditions

2 1D and 2D Elements Subjected to In-plane Loads **8**

Finite element modeling - Node, Element, different types of element – spring, bar, truss, beam, frame, plane stress/strain (CST element) and axi-symmetric elements, Coordinate systems – global, local and natural coordinate systems, Order of element, internal and external node/s, Degrees of freedom, primary and secondary variables, shape functions – linear and quadratic, properties of shape functions.

Calculation of elemental stiffness matrix and load vector (mechanical and thermal load) using Potential energy (PMPE)

Transformation matrix – 2D truss and plane frame, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Numbering system to reduce bandwidth, Boundary conditions – elimination method and penalty approach, Multipoint constraints, Symmetric boundary conditions, Stress calculations

3 Isoparametric Elements and Formulations: **10**

Coordinate mapping - Natural coordinates, Area coordinates (for triangular elements), Global coordinate systems for 1D and 2D linear and higher order elements (Lagrangean and serendipity elements). Terms Isoparametric, super parametric and subparametric. Convergence requirements – patch test, Uniqueness of mapping - Jacobian matrix.

Formulation of element equations (stiffness matrix and load vector). Numerical integration (full and reduced integration)

FE Discretisation- higher order elements vs. refined mesh (p vs h refinements), submodel, substructure

Section II

4 1D Steady State Heat Transfer Problems **8**

Introduction, steady state heat transfer – 1D and 2D heat conduction and convection
Governing differential equation, boundary conditions, formulation of element.

5 Dynamic Considerations (Undamped Free Vibration): **8**

General dynamic equation of motion, Formulation for point mass and distributed masses – Consistent and lumped element mass matrices for bar element, truss element, beam element, CST element, axisymmetric triangular element, quadrilatateral element and frame element

Generalized eigenvalue problem, Evaluation of eigenvalues and eigenvectors, Applications to bars, stepped bars, and beams.

6 Computer Implementation of the Finite Element Method: 10

Pre processing: model definition – nodal coordinates, element connectivity, material and element type and property definitions, type of analysis (static/modal), loading and boundary conditions.

Meshing techniques - free and mapped meshing, Quality checks – aspect ratio, warp angle, skew, jacobian, distortion, stretch, included angle, taper

Processing: Element level calculations, Equation assembly, Equation solver (sparse solvers, factorization, numerical/computational issues)

Post Processing: strain and stress recovery (integration and nodal points), interpretation of results (results validation and data interpretation) and design modification

Term Work:

The term work shall consist of record of any three from 1 to 4* and any three from 5 to 8** assignments of the problems based on following topic:

1 Computer program for 1-D temperature analysis
2 Computer program for stress analysis 2-D truss subjected to plane forces
3 Computer program for modal analysis 1-D beam (simply supported or cantilever beams)
4 Computer program for frames subjected to transverse forces and moments
5 Static stress concentration factor calculation for a plate with center hole subjected to axial loading in tension using FEA software.
6 2D Forced convection problem using FEA software.
7 Modal analysis of any machine components using FEA software.
8 Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.

(*1. Students can write the program in any of the programming language (i.e., Fortran, C, C++, Matlab, Python, VB)
2. Minimum number of elements considered should be 10
3. Comparison of the results of the program with analytical or existing FEA software(Abaqus, Ansys, Msc-Nastran, Optistruct/Radioss, Comsol-Multiphysics) should be done)

(** 1. Students should do convergence study for all assignment problems.
2. Use different element types from element library
3. If possible use submodel/symmetry option.)

Text Books:

1. Bhavikatti S. S. Finite element analysis, New Age International Publishers
2. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India.
3. Liu G. R. and Quek S. S. The Finite Element Method – A Practical Course, Butterworth-Heinemann, 2003.
4. Lakshiminarayana H. V. Finite Element Analysis (Procedures in Engineering), University Press, 2004.
5. Chandrupatla T. R., Finite Element Analysis for Engineering and Technology, University Press, 2009.
6. Seshu P. Text book of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.
7. Y. M. Desai, T. L. Eldho and A. H. Shah; 'Finite Element Method applications in Engineering', Pearson Education

Reference Books:

1 Bathe K. J., Finite Element Procedures, Prentice-Hall of India (P) Ltd., New Delhi.
2 Fagan M. J., Finite Element Analysis, Theory and Practice, Pearson Education Limited
3 Cook R. D., Finite Element Modeling for Stress Analysis, John Wiley and Sons Inc, 1995
4 Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
5 S. Moaveni Finite element analysis, theory and application with Ansys –
6 Asghar Bhatti, Fundamental Finite Element Analysis and Applications, John Wiley and Sons Inc, 2005
7 David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill Education Pvt. Ltd.
8 Daryl Logan, First Course in the Finite Element Method, Cengage Learning India Pvt. Ltd.
9 Zienkiewicz O. C., Taylor R. I., The Finite Element Method, Butterworth-Heinemann
10 Carlos A. Introduction to Finite Element Methods, Felippa
11 G. Lakshmi Narasaiah, Finite Element Application, BS Publications
12 Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402049 C ROBOTICS

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	50 Marks

Section - I

Unit 1 **08**

Introduction:- Basic Concepts, Three laws of Robotics, Robot anatomy, Classification, structure of robots, point to point and continuous path robotic systems. Robot performance- resolution, accuracy, repeatability, dexterity, compliance, RCC device, Socio – economic aspects of robotisation

Unit 2 **08**

Robot Grippers:- Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper systems including Mechanical, Hydraulic and Pneumatic systems.
Robotic Sensors:- Characteristics of sensing devices, Classification, Selection and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

Unit 3 **10**

Drives:- Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems,
Control Systems :- Types of Controllers, Introduction to closed loop control, second order linear systems and their control, control law of partitioning, trajectory-following control, modeling and control of a single joint, Present industrial robot control systems and introduction to force control.

Section - II

Unit 4 **10**

Kinematics :- Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods.
Velocities and Static forces in manipulators: Motion of the manipulator links, Jacobians, singularities, static forces, Jacobian in force domain.
Dynamics: - Introduction to Dynamics , Trajectory generations , Manipulator Mechanism Design

Unit 5 **8**

Machine Vision System :- Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques , Noise reduction methods, Edge detection, Segmentation.
Robot Programming : Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages : Introduction to various types such as RAIL and VAL II …etc, Features of each type and development of languages for recent robot systems.

Unit 6 **8**

Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI.

Simulation: - Need of Simulation, Tools and Techniques of Simulation
Associated Topics in Robotics:- Economical aspects for robot design, Safety for robot and associated mass, New Trends and recent updates in robotics, International Scenario for implementing robots in Industrial and other sectors. Future scope for robotisation.

Term Work
Practical: Journal must contain detailed report of any five of the following practical, essentially with one demonstration, one gripper design and an industrial visit.

1. Demonstration of Cartesian/ cylindrical/ spherical robot.
2. Demonstration of Articulated/ SCARA robot.
3. Virtual modeling for kinematic and dynamic verification any one robotic structure using suitable software.
4. Design, modeling and analysis of two different types of grippers.
5. Study of sensor integration.
6. Two program for linear and non-linear path.
7. Study of robotic system design.
8. Setting robot for any one industrial application after industrial visit.

Text Books:

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 2004

2. K.S. Fu, R.C. Gonzales, C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1987.

3. Shimon Y. Nof , Handbook of Industrial Robotics , , John Wiley Co, 2001.

4. Groover M. P., Wiess M., Nagel R. N. and Odery N. G. Industrial Robotics- Technology, Programming and Applications, McGraw Hill Inc. Singapore 2000.

5. Shah S. K., Introduction to Robotics, Tata McGraw Hill International, 2008.

6. Mittal R. K. and Nagrath J. J. Robotics and control, Tata McGraw Hill, New Delhi

Reference Books:

1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 2002.
2. Niku, Saeed B. Introduction to Robotics – Analysis, Systems Applications, Pearson Education Inc. New Delhi.
3. Mataric M. J., The Robotic Primer, University Press, 2009.

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402049D ADVANCED AIR CONDITIONING AND REFRIGERATION

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks
Practical	2 Hrs/Week	Term work	50 Marks

Section I

1 Vapour compression cycle **8**

Theoretical and actual cycle; subcritical and transcritical cycle, Multi-pressure refrigeration system: individual and multiple expansion valve with individual and multi-tage compression, HP, LP receiver, pumped circulation system, presentation of cycle on P-h and T-s chart, ammonia-CO2 cascade cycle, secondary refrigerant systems.

Defrost methods for sub-zero applications

Methods of defrosting: manual and auto, water, electric, hot gas, re-evaporator coils, defrosting: multiple evaporator systems, reverse cycle defrosting, vapor defrosting

2 Refrigeration equipments **10**

Compressor: Characteristic curves, rating and selection, capacity control, Factors affecting compressor capacity, applications.

Condensers: Types, air cooled natural and forced, water cooled and evaporative, PHE, rating and selection

Cooling tower: Principle of operation with psychrometric chart, straight line law, types, selection.

Evaporator: DX Evaporator, Flooded evaporator, pumped circulation, PHE, evaporator capacities, circulating flow direction.

Metering devices: Theory: concept of adiabatic and diabatic flow, choking of tube, types of metering devices, capillary tubes, TEV, electronic expansion valve, orifice tube, low side and high side float

3 Safety Controls **8**

HP/LP and Oil pressure failure control, Thermal overload protection for hermetic motors, reduced voltage protection, motor over current protection, adjustable speed drives, variable frequency drives, flow failure switches, safety valves, purge valves, level controller

Operating Control

Solenoid valve, regulating valves, IAQ controls

Section II

4 Applied Psychrometry **8**

New ASHRAE Comfort Chart, inside design conditions and outside design conditions, cooling and heating load calculation, methods: ETD, TF, CLTD/CLF method, hourly analysis, ECBC and star rating for unitary products.

5 Air Conditioning Applications **10**

Pharmaceutical, textile, hospitals, theaters, IT centers: design considerations.

Heat Pumps

Introduction, different heats pump Circuits, Analysis of heat pump cycles, working fluid for heat pumps, heat pumps Heating and heating-cooling purposes, performance of heat pumps, Controls for heat pumps.

6 Cryogenics **8**

Introduction, Figure of Merit, Limitations of VCS for the production of low temperatures, Joule-Thompson effect, Liquefaction of gases such as N2, He, Properties of cryogenic fluid, cryogenic formulation

Insulation: Types and materials

Term Work

The term work shall consist of a record based on following experiments;

1. Determination of cooling load of air conditioning system (simple case study)
2. Study of installation/operation/maintenance practices for refrigeration systems
3. Determination of refrigeration load in cold storage
4. Visit to any refrigeration or air conditioning plant (compulsory) and write the report on it
5. Development of Process and Instrumentation diagram for cold storage plant

Reference books

1. Arora C P, Refrigeration and Air Conditioning, Tata McGraw Hill
2. Dossat Ray J., Principal of Refrigeration, S.I. Version, Wiley Eastern Limited, 2000
3. Manohar Prasad, Refrigeration and Air-conditioning, Wiley Eastern Limited, 1983
4. Stocker W.F. and Jones J.W., Refrigeration and Air-conditioning, McGraw Hill International editions 1982
5. Threlkeld J.L., "Thermal Environmental Engineering, Prentice Hall Inc. New Delhi
6. ASHRAE and ISHRAE Handbook
7. Anantnarayan, Basic of Refrigeration and Air Conditioning, Tata McGrawHill Publications
8. Roger Legg, Air conditioning systems: Design, Commissioning and maintenance
9. Shan Wang, Handbook of Refrigeration and Air Conditioning, McGrawHill Publications
10. Wilbert Stocker, Industrial Refrigeration, McGrawHill Publications
11. Keith Harold, Absorption chillers and Heat Pumps, McGrawHill Publications
12. ASHRAE, Air Conditioning System Design Manual, IInd edition, ASHRAE

University of Pune, Pune
B E (Mechanical) Part II (2008 Course)
402050A INDUSTRIAL HEAT TRANSFER EQUIPMENTS

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks

Section I

1 Double pipe heat exchanger **08**

Thermal and hydraulic design - inner pipe - annulus, Hairpin heat exchanger - base inner tube - finned inner multi tubes- parallel and series arrangements, pressure drop, constructional features

2 Shell and tube heat exchanger: **10**

Basic components - shell - tube bundles - baffles - types and geometry. Design procedure - preliminary estimation of size, pressure drop and heat transfer calculations - shell and tube sides - Kern method - bell - Delaware method. Design of heat exchangers by TEMA and ASME Standards.

3 Compact heat exchangers **08**

Compact heat exchangers - types - constructional features, heat transfer and pressure drop calculations - finned plate and tube. Automotive radiators. Extruded tube type, sprayed heat exchanger, dimple heat exchangers, wrap around heat exchangers.

Gasketed, semi-welded, welded, brazed plate heat exchangers - constructional features - plate pack and frame - operational characteristics - flow arrangement, heat transfer and pressure drop calculation, performance analysis.

Section II

4 Condensers and Evaporators **10**

Shell and tube condensers - horizontal & vertical types - design and operational consideration, plate condensers, air cooled and direct contact types, condenser for refrigeration, evaporative condensers. Applications to cryogenics.

Evaporation for refrigeration & air conditioning - chillers.

5 Cooling Towers **08**

Types - basic relation - heat balance and heat transfer - characteristics, effects of - packing - geometry, design of cooling towers, spray design, selection of - pumps, fans, Testing, maintenance, visit to cooling tower.

6 Heat pipes **08**

structures - applications - basic relations - performance characteristics - effects of working fluid and operating temperature, wick - selection of material - pore size (basic concepts only)

Cooling of electrical and electronic components

Cooling of chips, PCBs, Computers, Logic chips etc., Electrical transformers, Panel boards, Electric motors.

Reference Books:

1. Yonous A Cengel, Heat transfer: A Practical Approach, McGraw Hill
2. Donald Q. Kern, Process Heat Transfer, McGraw Hill Publications
3. TEMA Standards
4. S. P. Sukhatme, Textbook of Heat Transfer, 4th edition, Universities Press
5. G. Walkar, Industrial Heat Exchangers: A Basic Guide, Hemisphere Publications
6. Holger Martin, Heat Exchangers, CRC Press
7. Hewitt G, Shires G, Bolt T, Process Heat Transfer, CRC Press, Florida
8. Kalvin C Silverstein, Design Technology of Heat Pipes for cooling and Heating of Heat Exchangers, CRC
9. Eduardo Cao, Heat Transfer in Process Engineering: Calculations and Design, McGraw Hill Publications
10. Saunders E. A., Heat Exchangers, Selection, Design and Construction, New York: Logman Scientific and Technical

11. Hill G. B., Pring E. J, Osborne P. D., Cooling Tower: Principles and Practice, 3ed edition, Butterworth-Heinemann

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B E (Mechanical) Part II (2008 Course)
402050B MANAGEMENT INFORMATION SYSTEM

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks

Section I

1 Introduction **8**

Management, Information system. Role of Management Information System (MIS), Information as a strategic resource, MIS-support to the management, Organizational structure, MIS-organization, system- types of system, MIS-as a system

2 Decision Making **8**

Concept, process, behavioral decision making, organizational decision making, MIS and decision making. Building blocks of information system-Input, output, models, technology, database and control blocks. System development life cycle (SDLC) and its approach.

3 Decision support system (DSS) **10**

Concept, group DSS, knowledge based expert system

Database management system (DBMS): Distributed data management, data mining and warehousing, system requirement specifications, charting tools- data flow diagrams, E-R diagrams.

Section II

4 System implementation **10**

Modern software design techniques, verification and validation, methods, performance of software systems, software matrix and models, software standards, introduction to Capability maturity model (CMM), and quality management in software organization

5 System testing and security issues **8**

Software testing, review, walkthrough and inspection, testing approaches, software reliability, errors, faults, repairs and availability, reliability and maintenance.

6 Application **8**

Application in Manufacturing sectors- Personnel management, financial management, production management, material management, marketing management, supply chain management

Case study on 3600 Feedback, E-Enterprise management

Reference Books:

1. Waman S. Jawadekar, Management Information System 4/e.
2. O'Brien J. A., Management Information System 4/e.
3. Burch and Gruditski, Information system-Theory and practice 5/e.
4. Ian Sommerville, Software Engineering 6/e.
5. Turban E., Leidner P., et. al., Information Technology for Management 6/e.
6. Laudon and Laudon, Management Information System11/e

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B E (Mechanical) Part II (2008 Course)
402050C RELIABILITY ENGINEERING

Teaching Scheme		**Examination Scheme**	
Lectures	4 hrs/week	Theory	100 Marks

Section I

1 Fundamental concepts of Reliability **8**

Reliability definitions, failure, failure density, failure Rate, hazard rate, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), maintainability, availability, pdf, cdf, safety and reliability, quality, cost and system effectiveness, life characteristic phases, modes of failure, areas of reliability, quality and reliability assurance rules, product liability, importance of reliability.

2 Probability theory and System Reliability **10**

Set theory, laws of probability, total probability theorem, probability distributions -binomial, normal, Poisson, lognormal, Weibull, exponential, standard deviation, variance, skew-ness coefficient, series, parallel, mixed configuration, k- out of n structure, analysis of complex systems- enumeration method, conditional probability method, delta-star method for conditional probability analysis, cut set and tie set method, node removal matrix method, Redundancy, element redundancy, unit redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy.

3 System reliability Analysis **8**

Reliability allocation or apportionment, reliability apportionment techniques - equal apportionment, AGREE, ARINC, feasibility of objectives apportionment, dynamic programming apportionment, reliability block diagrams and models, reliability predictions from predicted unreliability, minimum effort method.

Section II

4 Maintainability and Availability **8**

Objectives of maintenance, types of maintenance, maintainability, factors affecting maintainability, system down time, availability - inherent, achieved and operational availability, reliability and maintainability trade-off, maintainability tools and specific maintainability design considerations, reliability centered maintenance

5 Failure Mode, Effects and Criticality Analysis **10**

Failure mode effects analysis, severity/criticality analysis, FMECA examples, RPN, Ishikawa diagram for failure representation, fault tree construction, basic symbols development of functional reliability block diagram, fau1t tree analysis, fault tree evaluation techniques, minimal cut set method, minimal tie set method, Delphi methods, Monte Carlo evaluation.

6 Strength based Reliability **8**

Safety factor, safety margin, stress strength interaction, design of mechanical components and systems, material strengths and loads, reliability testing and reliability growth testing, Markov modeling and analysis, mechanical and human reliability accelerated life testing, Highly Accelerated Life Testing (HALT) and highly accelerated stress Screening.

Reference Books

1. L.S.Srinath, Reliability Engineering, EWP , 3rd Edition 1998
2. Roy Billinton and Ronald N Allan , Reliability Evaluation of Engineering Systems, Springer, 2007
3. Roger D Leitch , Reliability Analysis for Engineers, An Introduction, Oxford University Press, 1995
4. S S. Rao, Reliability Based Design, Mc Graw Hill Inc. 1992
5. Bryan Dodson, Dennis Nolan, Reliability Engineering Handbook, Marcel Dekker Inc, 2002
6. E.E.Lewis, " Introduction to Reliability Engineering,' John Wiley and Sons.
7. B.S.Dhillon, Maintainability , Maintenance and Reliability for Engineers, CRC press.
8. Basu S.K, Bhaduri , Terotechnology and Reliability Engineering, Asian Books Publication
9. Alessandro Birolini, Reliability Engineering Theory and Practice, Springer