University of Pune, Pune
B. E . (Mechanical) Sandwich 2008 Course Structure
(w.e.f. July – 2011)

Semester I

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME				
		Lect.	Pract/ Dwg	Paper	TW	Oral	Pr	Total
402061	Machine & Computer Aided Design**	4	2	100	25	50	-	175
402042	Dynamics of Machinery*	4	2	100	25	50	-	175
402062	Industrial Hydraulics & Pneumatics	4	2	100	25	50	-	175
402063	Elective II	4	2	100	50	-	-	150
402064	Elective III	4	-	100	-	-	-	100
402065	Mechanical Engineering Lab Practice	-	2	-	25	50	-	75
Total of First Term		**20**	**10**	**500**	**150**	**200**	**-**	**850**

Semester II

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME				
		Lect.	Pract/ Dwg	Paper	TW	Oral	Pr	Total
402066	Elective IV (Self study)	-	-	100	-	-	-	100
402067	Technical Paper Presentation	-	-	-	-	50	-	50
402068	Industrial In-plant Training & Project	-	30	-	200	100	-	300
Total of First Term		**-**	**30**	**100**	**200**	**150**	**-**	**450**

* Common to B.E. Mechanical Course
** Theory paper of 4 hour duration.

Code No.	Elective II	Code No.	Elective III
402063 A	Refrigeration & Air-conditioning	402064 A	Automobile Engineering
402063 B	Computational Fluid Dynamics	402064 B	Operations Research
402063 C	Finite Element Method	402064 C	Robotics

Code No.	Elective IV
402066 A	Costing & Cost Control
402066 B	Machine Tool Design
402066 C	Energy Management & Industrial Pollution

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402061: Machine and Computer Aided Design

Teaching Scheme:
Lectures: 4Hours/ Week
Practical: 2 Hours/Week

Examination Scheme:
Paper : 100 Marks
Term Work : 25 Marks
Oral : 50 Marks

Section I

Unit I

Bevel gears

Straight tooth bevel gear terminology and geometric relationship-formative Number of teeth-force analysis Design criteria of bevel gears.-Beam and wear strengths-Dynamic tooth load-Effective load- Design of straight tooth bevel gears. Selection of materials for bevel gears. Introduction to design of spiral bevel gears and hypoid gears and comparison with straight tooth bevel gears. Lubrication and mounting of bevel gears. Bearing reactions. Types of failure in bevel gears.

Worm Gears

Worm and worm gear terminology and geometrical relationship-Types of worm and worm gears. Standard dimensions-force analysis of worm gear drive-friction in worm gears, efficiency-worm and worm wheel materials-strength and wear ratings of worm gears-Thermal consideration in worm gear drive-Design of worm gear drive as per IS 7443.Types of failures in worm gearing. Methods of lubrication and selection of bearings.

Unit II

Thick and thin cylinders

Thin cylindrical and spherical vessels -Lame's equation-Clavarino's and Birnie's equations-Design of hydraulic and pneumatic cylinders- Autofrettage and compound cylinders- Gasketed flanged joints in cylindrical 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-Corrosion, erosion and protection of vessels, stresses induced in pressure vessels, materials of construction. Thickness of cylindrical and spherical 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.

Unit III

Statistical consideration in design

Frequency distribution – Histogram and frequency polygon – Normal distribution – Units of measurement of central tendency and dispersion – Standard variable – population combinations – Design and natural tolerances –Design for assembly- Statistical analysis of tolerances – Mechanical reliability and factor of safety.

Design for manufacture (DFM)

General principles of design for manufacture and assembly (DFM & DMFA). Principles of design of castings and forgings – Design for machining – Design for powder metallurgy – Design for welding.

Aesthetic and ergonomic considerations in design of products

Basic types of product forms – Designing for appearance – Shape, features, materials and finishes, proportions symmetry, contrast etc. – Morgan's colour code. Ergonomic considerations - Relation between Man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipments using ergonomic and aesthetic design principles.

Section II

Unit IV

Material Handling System

Design of belt and chain conveyors-- Power requirement, selection of belt and chain, design of tension take up unit, idler pulley.

Optimum design

Objectives of optimum design- Johnson's Method of Optimum Design (MOD).Adequate and optimum design. Primary, Subsidiary and limit equations-Optimum design with normal specifications of simple machine elements like tension bar, transmission shaft.

Unit V

Finite Element Analysis : Basic Concepts

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

One Dimensional Problems

Finite Element Modelling, Coordinate and Shape function, Potential Energy Approach, Galerking Approach, Assembly of Global Stiffness Matrix & Load Vector, Properties of Stiffness Matrix , Finite Element Equations, Quadratic Shape Function, Temperature Effects .

Two-Dimensional Problems

Using Constant Strain Triangles.-Introduction, Finite Element Modelling, Constant Strain Triangle, Problem Modelling & Boundary Conditions.

2D Isoparametric Elements and Numerical Integration

Introduction, Four Node Quadrilateral, Numerical Integration, Higher Order Elements

Unit VI

Computer Aided Manufacturing

Introduction to NC, CNC & DNC. NC Programming –Machine Tool Coordinate System, Machine Zero, Job Zero, Cutter Programming, Tool offsets, Programming Steps, NC Programming Languages, G-codes & M-codes.

Automation

Concepts of Automation, Types of Automation, Computer Integrated Manufacturing, Advantages and Limitations of Automation, Automation Strategies in Manufacturing Industries, Flexible Manufacturing System (FMS), Types of FMS, Machining Centres.

Term Work:

Term work shall consist of two parts:

Part-1:

'One' design project, consist of two imperial size sheets-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 tolerance should be specified so as to make it working drawing. A design giving all necessary calculations of the design of components and assembly should be submitted in a separate file. The topics for design project are as follows:

1. Design of bevel gear box.
2. Design of worm gear box.
3. Design of pressure vessels

Part-2:

'Two' assignments based on the following topics:

1. Stress and deflection analysis of any Mechanical component consisting of 2-D or 3-D elements using finite element analysis package.
2. Programming and Manufacturing of one job on CNC lathe or CNC Milling machine.

Note: A separate file is to be submitted which includes design calculations for part-1 and assignments of part-2.

References:

1. Shigley J.E. and Mischke C.R. – Mechanical Engineering Design McGraw Hill Publication Co.Ltd.
2. Spotts M.F. and Shoup T.E.-"Design of Machine Elements"- Prentice Hall International.
3. Bhandari V.B. – "Design of Machine Elements" Tata -McGraw Hill Publication Co.Ltd.
4. William C. Orthwein – "Machine Components Design"-west Publishing Co. and Jaico Publishing House.
5. Black P.H. and O. Eugence Adams-"Machine Design McGraw Hill Book Co. Inc
6. 'Design Data" – P.S.G. College off Technology, Coimbtore.
7. Juvinal R.C.- " Fundamentals of Machine Components Design" – John Wiley and Sons.
8. Hall A.S., Holowenko A.R. and Laughlin H.G.- "Theory and Problems of Machine Design"-Schaum's outline series.
9. I.S.2825- code for unfired pressure vessels.
10. Johnson R.C.-"Mechanical design Synthesis with optimisation applications"-Von-Nostrand-Reynold Publications.
11. IS 7443-Method for load rating of worm gears.
12. Industrial Design in Engineering – Edited by charles H.Flurscheim : Springer-verlag Publication
13. Dieter G.E., Engineering Design, McGraw Hill Inc.
14. Rudenko.' Material Handling Equipment',M.I.R.Publishers Moscow.
15. Mulani I.G., 'Belt Conveyors'.
16. Ray T.K.,'Mechanical Handling and Materials', Asian Books Pvt.Ltd.
17. Ibrahim Zeid – 'CAD/CAM - Theory and Practice' Tata McGraw Hill Publishing Co.

18. Chandrupatla T.R. and Belegunda A.D. – ‘Introduction to finite elements in engineering’ – Prentice Hall of India.
19. Segerling L.J. – ‘Applied finite elements analysis’ John Wiley and Sons.
20. Rao P.N., Introduction to CAD/CAM Tata McGraw Hill Publishing Co.
21. Groover M.P.- ‘Automation, production systems and computer integrated manufacturing’ – Prentice Hall of India

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402062: Industrial Hydraulics and Pneumatics

Teaching Scheme:
Lectures: 4Hours/ Week
Practical: 2 Hours/Week

Examination Scheme:
Paper : 100 Marks
Term Work : 25 Marks
Oral : 50 Marks

Section I

Unit I

Introduction to fluid power

Fluid power system, Components, Advantages, Applications. Comparison of hydraulic, pneumatic, electrical and mechanical systems. Power transmission at static and dynamic states. Fluid power terminology.

Fluid power basics

Pascal's Law. Hydraulic fluids, Properties, Selection, Additives. Seals, Seal material, Compatibility of seal with fluids. Fluid conductors and fittings. Pressure, Flow and Temperature measurements, Basics of fluid flow in pipelines. Sources of oil contamination and contamination control.

Unit II

Hydraulic Pumps

Introduction, Pumping theory, Pump classification, Principle of working and constructional details of Gear pumps, Vane pumps, Piston pumps, etc. Cavitations and Aeration. Power and efficiency calculations, characteristics curves. Pump performance ratings.

Hydraulic Power unit

Types of power units, Reservoir assembly, Constructional details, Pressure switches, Temperature switches. Design of Hydraulic Power Unit. Selection of Hydraulic power unit, Selection of pump, Filter, Motor, Reservoir, Necessary piping, Heat exchanger, etc.

Unit III

Control Valves

Graphic symbols for fluid power systems. Check valve. Types and Classification of fluid power control valves. Necessity of pressure control, directional control and flow control. Manual, Mechanical and Pilot operated direction control valves. Servo valves. Proportional valves. Cartridge valves.

Accumulators and Intensifier

Types, Construction and working of accumulator and intensifier. Charging of accumulator, Selection / design procedure, Applications.

Section II

Unit IV

Actuators

Linear and Rotary. Vane, Gear, Rotary piston type hydraulic motors. Methods of control of acceleration, deceleration. Types of cylinders and mountings. Calculation of piston velocity,

thrust under static and dynamic applications, considering friction, inertia loads. Design considerations for cylinders.

Industrial Circuits

Simple reciprocating, Regenerative, Meter in, Meter out, Bleed off, Sequencing, Synchronization, Transverse & feed, Fail safe, Counter balance, Actuator locking, Unloading , Motor breaking, Automatic reciprocating circuits, Circuits for Riveting machine, Hydraulic press, Injection moulding machine, Copy turning attachment, Hydraulic clamps, Hydraulic jack, Dumper, Forklift etc.

Unit V

Pneumatics

Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compressors. (ii) Types of filters, regulators, lubricators, mufflers, dryers. (iii) Pressure regulating valves, (iv) Direction control valves, (v) Speed regulating – Methods used in Pneumatics. (vi) Pneumatic actuators-rotary, reciprocating, (vii) Basic pneumatic circuits, (viii) Application of pneumatics in low cost Automation and in industrial automation, (ix) Pneumatic clamp calculations.

Unit VI

System Design

Design of hydraulic / pneumatic circuit for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Refer manufacturer's catalogues.).

Term Work:

Term work shall consist of following Experiments, Demonstrations, Industrial visit and Design report.

(Minimum Eight):

1. Trial on Gear / Vane / Piston pump and plotting of performance characteristics.
2. Study of Direction / Pressure / Flow control valves and systems using them.
3. Regenerative system: Measurement of actual speed and load.
4. Design of accumulator for any known application.
5. Study and Demonstration of hydraulic system (Hydraulic press, Injection moulding machines, etc.)
6. Experiments of pneumatics using Shuttle valve / Quick exhaust valve / Twin pressure valve.
7. Study and development of Electro-hydraulic / Electro-pneumatic systems.
8. Testing of any hydraulic or pneumatic component.
9. Industrial visit to study compressed air generation and distribution system / Hydraulic or Pneumatic components manufacturing unit.
10. Design report of a hydraulic or pneumatic system using manufacturer's catalogue.

References:

1. Hydraulics and Pneumatics, Andrew A. Parr, Elsevier Science & Technology Books.
2. Fluid Power with application, Anthony Esposito, Pearson Prentice Hall.
3. Hydraulic and Pneumatic for Production, Harry L. Stewart, Industrial Press Inc.
4. Hydraulics and Pneumatics, S. Ilango, V. Soundararanjan, Prentice Hall India.
5. Basic fluid power, Pease, Dudley A., Prentice hall.
6. Fluid Power Design Handbook, Yeaple, CRC Press.
7. Industrial hydraulics, John J. Pippenger, Tayler Gregory Hicks, McGraw-Hill.
8. Oil Hydraulic Systems: Principles and Maintenance, Majumdar, Tata McGraw Hill.
9. Pneumatic Systems: Principles and Maintenance, S. R. Majumdar, Tata McGraw Hill.
10. Graphical symbols for fluid power systems, IS 7513: 1974, ISO 1219: 1976

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402063 (A): Refrigeration and Air-Conditioning
(Elective II)

Teaching Scheme:		**Examination Scheme:**	
Lectures	**: 4 Hours/Week**	**Paper**	**: 100 Marks**
Practical	**: 2 Hours/Week**	**Term work**	**: 50 Marks**

Section I

Unit I

Methods of Refrigeration: Evaporative refrigeration, Refrigeration by expansion of air, steam jet refrigeration system, Pulse tube, vortex tube, heat pipe, thermoelectric refrigeration, magnetic refrigeration, solar refrigeration system.

Air Refrigeration Systems: Necessity of air-craft refrigeration, simple air cooling system, boot-strap system, reduced ambient system, regenerative system, concept of DART.

Unit II

Refrigerants: Desirable properties of refrigerants, classification of refrigerants, Nomenclature of refrigeration, alternative refrigerants for CFC's and HCFC's, Montreal Protocol and Kyoto Protocol, Green house effect, ozone depletion Potential (ODP) Global Warming Potential(GWP),Total equivalent warming impact(TEWI), Concept of green building, Refrigerant piping & design, Lubricants in refrigeration systems, Selection of refrigerants, Recovery ,Recycling & Reclaiming of refrigerants

Unit III

Multi Pressure Systems: Introduction, multistage compression, two stage compression with flash gas removal, with liquid intercooler, complete two stage compression system multiple evaporator systems, cascade systems

Vapour Absorption System: Introduction, simple vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption system, selection criteria of refrigerant-absorbent mixture, water ammonia system, Electrolux refrigerator, lithium bromide absorption system, comparison between VCC and VAC.

Section II

Unit IV

Air- Conditioning Systems: Definition, factors, equipment used, classification, all air system, all water system, air water system, unitary and central air conditioning, infiltration and ventilation loads, concept of SHF,RSHF,GSHF,ERSHF,ADP,

Introduction to industrial & automobile air conditioning system

Unit V

Refrigeration & Air Conditioning Controls: Basic elements of control, Detecting Elements, Actuating elements, Electric motors & controls, Controls in refrigeration equipment, Controlling room conditions at partial loads, Induction system

Ducts: Introduction, classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct, friction losses, dynamic losses, air flow through simple duct system, equivalent diameter, methods for determination of duct size, equal friction, velocity reduction, static regain method.

Unit VI

Food preservation: Necessity, Causes of food spoilage, Methods of food preservation, Food preservation by refrigeration, Commercial refrigerators for food preservation, Cold storages, Methods of food freezing, Design consideration of cold storages, Transport refrigeration, Marine refrigeration

Introduction to Cryogenics: Introduction, limitation of vapour compression systems for the production of low temperature, liquefaction of hydrogen,linde system, Claude system, liquefaction of hydrogen, liquefaction of helium, application of cryogenics.

Term Work:

The term shall consist of record of minimum six experiments from the followings.

1. Trial on vapour absorption refrigeration test rig
2. Demonstration of psychometric processes using air washer
3. Cooling load estimation of air conditioning plant
4. Refrigeration load estimation of cold storage
5. Study & demonstration of refrigerant compressors
6. Study of control elements
7. Study of installation, charging & maintenance of refrigeration system
8. Visit to any refrigeration and air-conditioning component manufacturing plant

References:

1. Arrora and Domkundwar: Refrigeration and airconditioning, Dhanpatrai and Company.
2. C P Arrora: Refrigeration and Airconditioning, Third edition Tata McGraw Hill.
3. Dossat Ray J.," Principal of refrigeration"S.I. Version,Wiley Eastern Limited, 2000.
4. Manohar Prasad,"Refrigeration and Air-conditioning",Wiley Eastern Limited, 1983.
5. Ballaney P.L." Refrigeration and Air-conditioning'Khanna Publishers, New Delhi, 1992.
6. Khurmi R.S. and Gupta J.K., "Refrigeration and Air-conditioning"Eurasia publishing house (P) Ltd.,New Delhi, 1994.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402063 (B): Computational Fluid Dynamics
(Elective II)

Teaching Scheme:		**Examination Scheme:**	
Lectures	**: 4 Hours/Week**	**Paper**	**: 100 Marks**
Practical	**: 2 Hours/Week**	**Term work**	**: 50 Marks**

Section I

Unit I

Introduction to CFD ,Impact of CFD with examples, flow modeling using finite control volume-finite and infinitesimal control volumes, concept of substantial derivatives, divergence of velocity, basic governing equations in integral and differential forms-conservation of mass, momentum and energy, CFD application related to engineering.

Iterative methods for matrix inversion, direct methods for banded matrices, conjugate gradient and preconditioned conjugate gradient algorithms.

Unit II

Numerical solution of ordinary differential equations-2^{nd} order initial value problem, implicit and semi-implicit methods, shooting method for 2 point boundary value problem. Finite difference – discretization, consistency, explicit and implicit methods, errors and stability analysis, 1^{st} order wave equation, stability of hyperbolic and parabolic equations, fundamentals of fluid flow modeling, the upwind scheme, artificial viscosity.

Unit III

Grid generation- introduction, grid with appropriate transformation, matrices and Jacobins, stretched grids, adaptive grids, some modern developments in grid generation, unstructured meshes.

Finite difference applications in convective heat transfer- thermally developing fluid flow inside 2-D channels and a circular pipe.

Section II

Unit IV

Heat conduction in 1 and 2 dimensional steady state and transient with explicit, implicit and semi-implicit schemes, algorithm, and flow chart for 2-D transient case. MacCormack method and its applications to compressible flows, stability criteria, and quasi 1-D CFD solution of subsonic-supersonic isentropic nozzle flow using MacCormak's technique, extension to general 2-D flows.

Unit V

Solution of Navier-Stokes equation for incompressible flows using MAC and SIMPLE algorithm, staggered grid, MAC formulation, formulation of flow problem with the SIMPLE algorithm.

Unit VI

Finite volume method, continuity equation- model of finite control volume fixed in a space, moving with the fluid. Model of infinitesimally small element fixed in a space, moving with the flow, momentum and energy equations. Integral verses differential form of equations.

Term Work:

List of practical

1. Introduction to CFD
2. Creating 2D and 3D geometries.
3. Mesh generation
4. Problem formulation and solution
5. Laminar pipe flow problem
6. Turbulent pipe flow problem
7. Flat plate boundary layer problem
8. Forced convection over a flat plate problem
9. Compressible flow in a nozzle problem
10. Flow over an airfoil

Note: 1 to 4 practical's are compulsory and from 5 to 10 any 4 to be conducted
Software packages: GAMBIT, FLUENT 6.2/6.3, CFX, Star CCM, ANSYS CFX

References:

1. Computational fluid flow and heat transfer, K Murlidhar & T Sundarranjan, Narosa Publishing House.
2. Computational fluid dynamics- the basics with applications, John D Anderson Jr.-McGraw Hill.
3. Computational fluid dynamics- T J Chung, Cambridge University press.
4. Numerical computation of internal and external flows. Vol-1 and 2, Charles Hirsh Wiley.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402063 (C): Finite Element Method
(Elective II)

Teaching Scheme:		**Examination Scheme:**	
Lectures	**: 4 Hours/Week**	**Paper**	**: 100 Marks**
Practical	**: 2 Hours/Week**	**Term work**	**: 50 Marks**

Section I

Unit I

Introduction to Finite Element Method

Introduction to Solid Mechanics.

Introduction to Finite Difference Method (FDM), Finite Element Method (FEM), Finite Volume Method (FVM), Classical Governing Differential Equations.

General FEM process.

Analysis of Spring System – Derivation of system matrix (Direct Method), Numbering Schemes, Assembly of Stiffness Matrices and Solution.

Variational Methods and Principle of Virtual Work.

Potential Energy, The Raylegh-Ritz Method, The Galerkin Method, Principle of Virtual work.

Sources of errors in FEM.

Unit II

One-Dimensional Problems

One-D Bar Element – Discretization, Numbering, Coordinates and Linear Shape Functions,The Potential energy approach and Galerkin Approach. The global stiffness matrix,Boundary Conditions (Penalty and Elimination Methods), Effect of Temperature, Quadratic shape functions.

Truss Element – Local and Global Coordinates. Analysis of 2 – D truss, Concept of symmetric truss, Analysis of skewed support. Analysis of 3 – D truss.

Unit III

Two-Dimensional Problems

Constant strain triangle (CST) – Analysis of Linear and Quadratic CST Element. Plane stress, Plane strain Concepts.

Analysis of Linear Rectangular Element.

Isoparametric Elements – Mapping of Cartesian to Natural coordinate system, formulation of Plane Quadrilateral Element.

Section II

Unit IV

Beams and Frames

Introduction to Beams and frames. Coordinate systems, Element Formulation and Stiffness Matrices, Loads and Boundary Conditions assembly.

Unit V

Steady state Heat Transfer Problem

Heat Transfer Problems – Governing equations. One Dimensional Heat Conduction Analysis, Problems on 1 – D Conduction in thin fins.

Two Dimensional Heat Conduction Analysis.

Unit VI

Introduction to non-linear and Dynamic Analysis. Introduction to other scalar field problems – Torsion, Model, Fatigue, Crash and NVH Analysis.

Introduction to Commercial FEA software.

Term Work:

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

1. Stress and deflection analysis of 2 – D / 3 – D trusses using finite element package.
2. Stress and deflection analysis of any Mechanical component consisting of 2-D or 3-D elements using finite element package.
3. Stress and deflection analysis of any Mechanical component having Plain stress / Plain strain concept using finite element package.
4. Stress and deflection analysis of any Mechanical component having symmetry concept using finite element package.
5. Stress and deflection analysis of Beam and Frames.
6. Thermal analysis of two dimensional problems.
7. Thermal analysis of three dimensional problems.
8. Model Analysis of any Mechanical Component.
9. Case study on Fatigue/Crash/NVH Analysis.

References:

1. Chandrupatla T.R. and Belegunda A.D. – 'Introduction to finite elements in engineering' – Prentice Hall of India.
2. Daryl Logan – 'First Course in the Finite Element Method' – Cengage Learning India Pvt. Ltd.
3. David V. Hutton – 'Fundamentals of Finite Element Analysis' – Tata McGraw-Hill Education Pvt. Ltd.
4. Nitin S Gokhale, Sanjay S Deshpande, Sanjeev V Bedekar, Anand N Thite – 'Practical Finite Element Analysis' – Finite To Infinite, India
5. J.N. Reddy – 'An Introduction to the Finite Element Method' – Tata McGraw-Hill Education Pvt. Ltd.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402064 (A): Automobile Engineering
(Elective III)

Teaching Scheme:
Lectures : 4 Hours/Week

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Automotive chassis system

Layout with reference to prime location, frame, constructional details, material testing of frames, integrated body construction, resistance to motion, air resistance, rolling resistance, gradient resistance, requirement of engine power.

Unit II

Transmission system

Clutch: Types of clutches, Single plate clutch, Multiplate clutch, Centrifugal clutch, Diaphragm spring clutch, clutch plate, lining material.

Gear Box: Function of various resistances, tractive effort, performance curve, power required for acceleration and gradability, selection of Gear ratio, sliding mesh gear box, constant mesh gear box, synchromesh gear box, epycyclic gear box, fluid flywheel & torque converter, overdrive gears, semi-automatic gear box.

Drive line study: effect of driving thrust and torque reaction, hotskiss drive, torque tube drive, radius rod, propeller shafts, universal joints, final drive and types, double reaction final drive, axles: two speed rear axles, rear axle construction, and differential drive.

Unit III

Automotive Systems

Steering: Front axle types, steering geometry, steering linkages, steering linkages, steering gear box turning radius, wheel wobble & shimmy, power assisted steering mechanism. (Steering characteristics, steering gear box)

Wheels & types: Wheels, purpose, requirement wheel alignment & wheel balancing (Center point steering, cornering force slip angle, scrub radius)

Tyres: - Function, types of tyres & its construction, static & rolling properties of pneumatic tyres, tubeless tyres.

Suspension system: Types, factors inlating ride comfort, suspension springs leaf spring, coil & torsion bar springs, springs material, shock absorbers, independent suspension, rubber, pneumatic hydroelastic suspension, self leveling, hydrogas suspension.

Braking system: Types of brakes, constructional details, materials, braking torque developed by leading & trailing shoes, disc brake theory, brake actuation system, factors affecting brake performance, power assisted brakes.

Automobile Air Conditioning System

Introduction of Air Conditioning System: Classification Layout, Central /unitary air conditioning systems, component like compressors, evaporator, condenser, expansion devices, fan blowers, heating systems, Automotive heater, types of heater systems a/c protection engine,

Load analysis: Outside & Inside design consideration, factors effect of a/c load on engine performance.

Air Distribution system: Distribution duct system, sizing, supply/return duct type of grills, diffuser, and ventilation.

Section II

Unit IV

Vehicle maintenance and garage practice

Maintenance, Servicing of auxiliaries: Cooling system service, Anti corrosion additives, anti-freezing solutions, Dry & wet lines, Petrol & diesel system maintenance, Lubrication system services, Chassis lubrication, Suspension system, Servicing of brake systems, Maintenance of steering systems, Wheel balancing, Wheel alignment, Maintenance of tyres, servicing & reconditioning.

Unit V

Automobile safety & lighting

Introduction: Active & passive safety, Characteristics of vehicle structures, Optimization of vehicle structures crash worthiness, Types of crash/roll over. Pedestrian Safety & Ergonomics: Importance of ergonomics in automotive safety, locations of controls. Anthropometry: Human impact tolerances, Determination of injury thresholds, Servicity index, study acceptable tolerances. Vehicle Safety Systems: Types of safety belt- Head s restraints, air bags- Use of energy absorbing systems- Impact protection from steering controls, Types of seats- Importance of bumpers,- damagablity criterion in bumper designs- Type of safety glass & their requirements reaword field of vision automobiles, Type of rear view mirror & their assessment, Warning devices- Hinges & lathes. Automotive Lighting & Light Sensing Devices:- Automotive lamps, types, design, construction, material & performance, Lighting signaling devices such as stop lamp, number plate lamp, rear position lamp, direction indicator lamp, reverse lamp, reflex reflector, position lamp. New technology in automotive lightning- Gas Discharge Lamp, LED, Adoptive Front Lighting system (AFLS), Daylight Running Lamps(DRL).

Unit VI

Automobile Electronics

Fundamental of Automotive Electronics, Microprocessor applications in automobiles, Components for engine management systems.

Sensors & Actuators: Introduction, basic sensors arrangement, Type of sensor, Oxygen sensors, Cranking sensor, Positioning sensors, positioning sensors, engine cooling water pump, engine oil pressure V, fuel metering sensors, vehicle speed sensors detonation sensors, stepper motor-relays. Basic electronic engine control, Digital engine control system, vehicle motion control system, further automotive electronics system, digital cruise control, electronic antilock braking system.

References:

1. Advance Vehicle Technology; Hein Heister.
2. Automotive Engines- Hebert E. Ellinger.
3. P. M. Heldt Automobile Chassis, NK.
4. P'Luckin.G Automobile Chassis- Design & Calculations.
5. William F. Milliken, et al "Chassis Design" Maurice Delay.
6. Paul Lung " Automotive Air Conditioning " C B S Publisher & Distribution Delhi.
7. Prasad, Priya Belwafa Jamel "Vehicles Crashworthiness & Occupant Protection of American Iron & Steel Institute, USA."
8. Jullin Happian- Smith ' An Introduction to Modern Vehicle Design' SAE 2002.
9. Edward A, "Lamp & Lighting" Hodder & Stoughton, London, 1993.
10. Keitz H. A. E. "light Calculations & Measurements" Macmillan, 1971.
11. Willim B Ribbens., et al "Understanding Automotive Electronics, Butterworth - Heineman Publication, Woburn.
12. Automobile Engines – James D. Halderman, chase D.M.tchell by poorson Education.
13. Devadas Shetty, Rechard A. Kolk " Mechatronics System Design" ce by PWS publishing company, New Delhi.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402064 (B): Operations Research
(Elective III)

Teaching Scheme: **Examination Scheme:**
Lectures : 4 Hours/Week **Paper : 100 Marks**

Section I

Unit I

Introduction to Operations Research and its History. Management Application of Operations Research. Mathematical Models in Operation Research. Linear Programming –Introduction, Formulation, Graphical Solution, Representation in Standard Form, Simplex Methods, Duality and Sensitivity Analysis.

Unit II

Transportation Problem – Introduction, Formulation, Basic Methods of Solving Transportation Problem, Optimization Methods Like UV Methods and Stepping Stone Methods. Duality in Transportation Problem, Transship Methods as an Extension of Transportation. Assignment Problem, Hungarian Methods to Solve Assignment Problem. Travelling Salesman as an Extension of Assignment Problem.

Unit III

a) Inventory Models: Introduction, Cost Involved in Inventory Problems, Terminology, Concepts of E.O, Q. in Various Deterministic Models and Simple Probabilistic Model Such as Instantaneous Demand Without Set up Cost, Service Level, ABC Analysis.

b) Sequencing Models: Scheduling and Sequencing, Assumptions in Sequencing Models, Processing 'n' jobs on 'm' Machines, Processing of Two Jobs on n Machines with Each Having Different Processing Order.

Section II

Unit IV

a) Games Theory : Introduction, Minimax and Maximin Principle, Solution of Game with and without Saddle Point, Solution by Dominance, Solution by Graphical Method, m x n size Game Problem, L.P. Method, Approximation Method, Bidding Problems.

b) Replacement Analysis: Replacement of Capital Equipment that Deteriorates with time, value Remains the same during the period and it Changes With Constant Rate During the Period, Replacement of items that Fail Completely.

Unit V

Queuing theory: Introduction to Queuing Theory -Basis Structure, Terminology and Applications. Queuing Models M/M/1: ∞/FEFO, M/M/S: ∞/FIFO, MCSR.
Simulation-Monte Carlo simulation.
Introduction to Non-Linear Programming, Integer Programming, Dynamic and Goal Programming

Unit VI

Network Analysis: Introduction Bar and Milestone Charts, Fundamentals of PERT and CPM Networks, Fulkerson's Rule, Time estimates in PERT and CPM critical Path, Probability of Project Completion in schedule time, Types of Slack and Float.
Network Crashing, Resource Leveling and Load Smoothing.

Text books:

1. Quantitative Techniques in management by N.D.Vora,Tata Mcgrawhill publication Ltd.
2. Operations Research by H. Taha,Prentice Hall of India Pvt.Ltd.
3. Operations Research by Hira Gupta,S.Chand and co.Ltd.2008
4. Operations Research by J.K.Sharma,Mcmillan India Ltd.Delhi

References:

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. Ravinran, Phillips & Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey, ISBN: 978-81-265-1256-0.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402064 (C): Robotics
(Elective III)

Teaching Scheme: **Examination Scheme:**
Lectures : 4 Hours/Week **Paper : 100 Marks**

Section I

Unit I

Introduction: Basic concepts, Definitions and Three laws of Robotics, Robot Anatomy, Classification of Robots on different basis, Performance Parameters, Socio-Economic aspects of Robotisation, Safety, Maintenance and Quality aspects in Robotics, Recent trends in Robotics.

Unit II

Grippers: Different types, Guidelines for design of Robotic Grippers, Force analysis of Mechanical, Pneumatic and Hydraulic Grippers.
Sensors: Different types of sensors such as Position, Velocity, Acceleration, Force, Torque, Vision etc., Characteristics & Classifications of sensory devices, Need for Sensors.

Unit III

Drives: Different types, Hydraulic, Pneumatic and Electric Drives, Comparison of Drive systems and their advantages and limitations.
Control systems: Different types of Controllers (e.g. PD & PID feedback etc.), Trajectory planning, Introduction to Closed loop control, second order linear system, Modeling and Control of Single Joint, Introduction to Force control.

Section II

Unit IV

Kinematics: Forward and Inverse kinematics, Homogenous transformation, Denavit-Hartenberg parameters, Kinematics redundancy, Kinematics calibration, Velocity mapping and static force analysis.
Dynamics: Introduction to Dynamics, Acceleration of Rigid body, Singularities, Euler's equation, Newton-Euler's dynamic formulation, Lagrangian formulation of manipulator dynamics,

Unit V

Transmission Systems: Basic Motion Conversion Systems, Efficient power transmission for robotic systems, Concepts and related terms of power transfer
Modeling of Robotic Systems: Solid Modeling for robots by using simulation softwares
Vision System for Robotics: Image Acquisition, Masking, Sampling, Image Processing Techniques, Noise Reduction Methods, Edge Detection, Segmentation

Unit VI

Robot Programming: Methods of Programming, Walk Through & Lead Through programming,
Robot Programming Languages: Introduction to various types of Robotic programming Languages, Salient Features and recent updates in programming
AI: Introduction to Artificial Intelligence, AI Techniques, Need and applications of AI
Futuristic topics of Robotics: MEMS, SWARM, Telesurgery, Service Robots…etc.

Text Books:

1. Introduction to Robotics (Mechanics and Control), John J. Craig, Addison-Wesley, 2nd Edition
2. Robotics: Control, Sensing, Vision and Intelligence, K.S. Fu, R.C. Gonzales, C.S.G. Lee, McGraw-Hill International, 1987.
3. Industrial Robotics: Technology, Programming and Applications, Mikell P. Groover et. al. McGraw-Hill International, 1986.
4. Robotics and Control, R.K.Mittal, J.Nagrath, Tata McGraw-Hill International, 2003.
5. Introduction to Robotics, S.K.Saha, Tata McGraw-Hill International, 2008.

References:

1. Handbook of Industrial Robotics, Shimon Y. Nof, John Wiley co. 2001.
2. Robotic Engineering: An Integrated Approach, Richard D. Clafter, Thomas A. Chemielewski Michael Negin, Prentice Hall India, 2002.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part I (2008 Course)
402065: Mechanical Engineering Lab Practice

Teaching Scheme:
Practical: 2 Hrs/Week

Examination Scheme:
Term Work : 25 Marks
Oral : 50 Marks

The term work shall consist of minimum 'six' of the following experiments and presented it in the form of journal.

1. Trial on Diesel power plant to determine the following characteristics :
    a) Plant efficiency vs. load.
    b) Total fuel consumption vs load.
    c) Rate of energy input vs. load, and
    d) Heat rate and incremental Heat rate vs. load.

2. Study report on visit to one of the plants listed below :
    a) Steam power plant.
    b) Gas turbine power plant.
    c) Nuclear power plant.
    d) Hydro power plant.

3. The load estimation of unitary Air conditioning system.
4. Energy audit of a department/section of any industrial process plant.
5. Study of automobile systems such as transmission, suspension braking, instrumentation etc.
6. Study of steam turbines: types of steam turbines, constructional details of impulse and reaction turbines.

7. Study of steam turbine systems:
    a) Methods of governing
    b) Emergency trip gear mechanism and
    c) Extraction pressure regulation system.

8. Dismantling and assembly of I.C.Engine.

9 Design of experimentation.

10 Trial on subsonic air nozzle to determine:
    a) Variation of pressure along the length of the nozzle.
    b) Discharge co-efficient and discharge Mach Number.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part II (2008 Course)
402066 (A): Costing and Cost Control
(Elective IV) (Self study)

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Introduction: Significance for Engineers. Limitations of Financial Accounting, Corporate Objective – profitability. Elements of Cost – Material, Labor, Equipment, Overheads.

Unit II

Cost Classification: Direct – Indirect, Variable – Fixed, Controllable – Uncontrollable, Overhead classification.

Unit III

Overheads – Allocation, Apportionment. Basis for Overhead Apportionment, Budgets and budgetary Control.

Section II

Unit IV

Joint products and by-products : Segregation of the joint expenses. Process Costing.

Unit V

Cost-Volume Profit Relationship: Assumptions. Break-even Point Concept. Contribution. Application in decision making.

Unit VI

Special Techniques: Standard Costing, Marginal Costing, Activity Based Costing.

References:

1. C. B. Gupta: Fundamentals of Business Accounting, Sultan Chand & Co.,
2. Samualson P. A. Economics, McGraw Hill International,
3. Bhar B. K., Costing
4. Prasad N. K., Cost Accounting, Book Syndicate Pvt. Ltd.,
5. Collin Durry, Management and Cost Accounting, English Language Book Society, London.

University of Pune, Pune
B. E. (Mechanical) Sandwich Part II (2008 Course)
402066 (B): Machine Tool Design
(Elective IV) (Self study)

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Drives

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.

Stepless drives

Design considerations of Stepless drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking,

Unit II

Design of Machine Tool Structures

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

Unit III

Design of Guideways and Power Screws

Functions and types of guideways, design criteria and calculation for slideways, design of hydrodynamic, hydrostatic and aerostatic slideways, Stick-Slip motion in slideways. Design of power screws: Distribution of load and rigidity analysis.

Section II

Unit IV

Design of Spindles and Spindle Supports

Design of spindle and spindle support using deflection and rigidity analysis, analysis of anti-friction bearings, preloading of antifriction bearing.

Unit V

Dynamics of machine tools

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.

Unit VI

Advances in Machine Tool Design

Design considerations for SPM, NC/CNC, and micro machining, Retrofitting, Recent trends in machine tools, Design Layout of machine tool using matrices.

Text Books:

1. N.K. Mehta, “Machine Tool Design”, Tata McGraw Hill, ISBN 0-07-451775-9.
2. A. 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) Sandwich Part II (2008 Course)
402066 (C): Energy Management and Industrial Pollution
(Elective IV) (Self study)

Examination Scheme:
Paper : 100 Marks

Section I

Unit I

Energy crisis, finite fossil reserves, Need and importance of energy conservation and management, Commercial and non commercial energy sources, energy security, energy strategy for the future, Energy consumption patterns in Globle and Indian industry,
Electrical Systems- Electricity tariff, Load management, demand side management, energy efficient motors, power factor improvement, Energy efficient lighting, variable Speed drive, Energy efficient illumination

Unit II

Energy Audit – need, types of energy audit and methodology, understanding energy costs, benchmarking and energy performance, plant energy performance, fuel and energy substitution, energy audit instruments, Sankey diagram, heat balance for boiler, energy audit instruments
Methods of financial analysis simple payback period, Time value of money (Future value, Net present value), return on investments (ROI) , Internal rate of return (IRR)

Unit III

Energy conservation opportunities in different sectors, Energy conservation in boilers and steam system, various types of steam traps and their selection, condensate recovery systems, Insulating materials and refractories, Economic thickness of insulation
Energy conservation in pumps, compressed air system, HVAC and refrigeration system and fans

Section II

Unit IV

Man and environment, Energy problem, Industrial pollution emissions – solids ,liquids and gases, pollution control aspects, fossil fuel related pollutants in the environment, Global environmental issues- Ozone layer depletion, Global warming, loss of biodiversity, acid rain. Emission reduction- emission trading, Joint implementation, CDM (Clean Development Mechanism)

Unit V

Environmental impacts of industrial pollution, Air pollution – sources of emission and their classification, air pollution laws and standards, air pollution control methods
Sources and classification of water pollutants, Types of water pollutants and their effects, water pollution laws and standards, waste water treatment
Noise pollution, Thermal pollution, Marine water pollution

Unit VI

Waste minimization, waste minimization techniques, solid waste management- causes, effects and control measures of industrial wastes, sources of industrial wastes, E- waste, Incineration. Waste heat recovery and cogeneration for pollution control.
Sustainable development, Environmental Impact Assessment (EIA)

References:

1. P. H. Henderson, India- The Energy Sector, Oxford University press
2. D. A. Ray, Industrial Energy Conservation, Pergamon Press
3. Callaghan, Energy Conservation
4. Energy Conservation related books published by National Productivity Council (NPC)
5. C. S. Rao, Environmental pollution control- Engineering, New age international publication
6. Anindita Basak, Environmental Studies, Pearson Education

University of Pune, Pune
B. E. (Mechanical) Sandwich Part II (2008 Course)
402067: Technical Paper Presentation

Examination Scheme:
Oral: 50 Marks

A Technical paper presentation is expected to be on a state-of-the-art technical topic related to Mechanical Engineering but outside the syllabus. The report and its presentation is based on material, mainly collected and analyzed from the latest research papers from reputed national and international technical journals. (Minimum 3 research papers are to be submitted along with report).

Report	Number of pages 15 to 20 (Soft copy and 1 hardcopy) Excluding a) Title b) Certificate c) Acknowledgement d) Abstract e) Index f) References. (Web site names should not be mentioned)
Text	Font size – 12 Font type – Times New Roman Spacing – 1.5
Binding	Spiral Binding
Page size	A 4
Internal assessment	One mid term presentation by the student on the topic
Examination	Two examiners, one internal and one external examiner. External examiner is from Academics (Other University) / Research Institutes. Marks are equally divided between Report and Presentation / Oral. Presentation – Maximum 10 minutes, Question/Answer- Maximum 5 minutes

University of Pune, Pune
B. E. (Mechanical) Sandwich Part II (2008 Course)
402068: Industrial In-Plant Training & Project

Teaching Scheme:
½ Hours /Week/Student

Examination Scheme:
Oral : 100 Marks
Term work : 200 Marks

Duration of training in industry: 6 Months

GENERAL GUIDELINES

TO THE INSTITUTIONS RUNNING MECHANICAL ENGINEERING (SANDWICH) DEGREE COURSE
AND
TO THE STUDENTS OPTED FOR SANDWICH COURSE

INDUSTRIAL IN-PLANT TRAINING

Students shall undergo industrial in-plant Training for the period of 6 months in an industrial establishment and spend about 8 weeks for observational training and solving minimum 3 assignments given by the organization. The remaining period shall be utilized for Project. Students are expected to analyze the problems systematically and offer suggestions/concluding remarks.

The training/assignments may be related to following areas:

1. Machines/process diagnostics.
2. Quality Assurance, quality improvement management.
3. Production planning and control, productivity improvement.
4. Costing and cost control, value engineering study.
5. Material inspection and movement, material management and control.
6. Inventory Control, stores, facility planning.
7. Improvement in tool layout, tool selection, machine selection.
8. Maintenance of m/s and maintenance of plants, house keeping, safety precaution.
9. Plant layout, machine layout for minimum travel of the job, man and machine movement study time and motion study problems.
10. Computer based information study for stores, purchase, wastage of material, in process material planning and scheduling, assembly, storage of finish products, dispatch etc.
11. Placing a purchase order for inland/foreign goods.
12. Import-export procedures.
13. Improvement of human skills, productivity.
14. Incentive schemes, labour laws, factory acts.

Student shall submit the report based on the assignments and training.

PROJECT

Students shall take up suitable project suggested by industry. The scope of the project shall be such as to complete it within the time schedule.

Project may be of the following types:

1. Manufacturing/Fabrication of a proto-type machine including selection, concept, design, material, manufacturing the components, assembly of components. Testing and performance evaluation.
2. Improvement of existing machine/equipment/process.
3. Design and fabrication of Jigs and fixtures, dies, tools, special purpose equipment. Inspection gauges, measuring instruments for automats.
4. Computer aided design, analysis of components such as stress analysis.
5. Problems related Productivity improvements.
6. Problems related value engineering.
7. Problems related material handling systems.
8. Energy audit of a departmental or section in an organization/plant, Industrial waste and its control.
9. Design of a test rig for performance evaluation of machine device.
10. Product design and development.
11. Detail cost estimation of products.
12. Analytical evaluation and experimental verification of any mechanical engineering problems encountered.
13. Quality systems and management.
14. Low cost automation.

Student shall submit a detailed report based on his project work.

The reports on (1) Industrial In-plant Training and (2) Project should be submitted separately. The oral examination will be jointly taken on the In-plant Training and Project and shall be based on the term work submitted, and jointly conducted by an internal and an external examiner from industry. Equal weightage will be given to (1) Industrial In-plant Training and (2) Project.