T. E. (Mechanical) Structure (2008 Course)

With effect from June 2010

Code	Subject	Teaching Scheme		Examination Scheme				
		L	P/D	P	TW	Or	Pr	Total
	Semester I							
302041	Machine Design - I **	4	2	100	50			150
302042	Heat Transfer	4	2	100			50	150
302043	Theory of machines II	4	2	100		50		150
302044	Industrial Engineering & Technology Management	4		100				100
302045	Computer Oriented Numerical Methods	4	2	100			50	150
302046	Seminar ***		2		50			50
	Total of First Semester	**20**	**10**	**500**	**100**	**50**	**100**	**750**
	Semester II							
302047	Machine Design II **	4	2	100		50		150
311048	Metrology & Quality Control	4	2	100	25			125
302049	Turbo Machines	4	2	100		50		150
302050	Mechatronics	4	2	100	50			150
302051	Refrigeration & Air Conditioning	4	2	100	25			125
311052	Workshop Practice II		2		50			50
	Total of Second Semester	**20**	**12**	**500**	**150**	**100**		**750**

** Theory paper of 4 hours duration.

*** The term work marks of seminar shall be as mentioned in the syllabus

Legend :

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

University of Pune, Pune
T E (Mechanical) Part I (2008 Course)
302041 MACHINE DESIGN - I

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

Section I

Hrs

1 **Shafts, Keys and Couplings** 10

Shafts: Transmission shaft, shaft design on the basis of strength and torsional rigidity, A.S.M.E. code for shaft design, shaft design based on lateral rigidity, Castigliano's Theorem

Keys: Design of sunk, saddle, tangent, Kennedy and round keys, design of splines.

Couplings – Muff coupling, flange coupling and flexible bushed pin coupling.

2 **Power Screws** 8

Forms of threads, multiple start screws, torque analysis with square and trapezoidal threads, self-locking screw, collar friction torque, design of power screw with square and trapezoidal threads, design of screw jack and C-clamp Design.

3 **Threaded and Welded Joints** 8

Threaded joints:

Basic types of screw fastenings, cap screws and set screws, bolts of uniform strength, locking devices, I.S.O. metric screw threads, bolts under tension, eccentrically loaded bolted joint in shear, eccentric load perpendicular and parallel to axis of bolt, eccentric load on base plate, torque requirement for bolt tightening, selection of standard fasteners, design of a turn buckle.

Welded joints:

Welding symbols, advantages and limitations of welded joints, butt and fillet welds, stresses in butt and fillet welds, strength of butt, parallel and transverse fillet welds, axially loaded unsymmetrical welded joints, eccentric load in plane of welds, welded joints subjected to bending and torsional moments.

Section II

4 **Design of Flywheel** 10

Fundamental equation of motion, torque analysis, Significance of turning moment diagram for input and output shaft, Fluctuation of speed & energy, disk and rimmed flywheels, stresses in flywheel rim and arms, design of disc and rimmed flywheels for various applications, standard dimensions of flywheels.

5 **Mechanical Springs** 8

Types, applications and materials for springs, stress and deflection equations for helical compression springs, style of ends, Design of helical and tension springs, springs in series and parallel, concentric helical springs, helical torsion springs, multi-leaf spring (Theoretical Treatment only) Shot peening.

6 **Belt and Rope Drives** 8

Belt drive:

Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition, selection of flat and V belts from manufacturer's catalogue, belt tensioning methods, relative advantages and limitations of flat and V belts, construction and applications of timing belts.

Wire ropes:
Construction of wire ropes, lay of wire ropes, stresses in wire rope, selection of wire ropes, rope drum construction and design.

Term Work

Term work shall consist of:

1. TWO design projects based on above units. Each design project shall consist of two half imperial (A2) size sheets: one involves assembly drawing with a part list and overall dimensions and 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 in a separate file.

   Design projects should be in the form of 'Design of Mechanical System' comprising of machine elements covered in the syllabus. Design data book shall be used wherever necessary to achieve selection of standard components.

2. Four home assignments based on above units.

Recommendation

One design project drawings should be done manually and one using any CAD software

Reference Books

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. Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
5. Willium C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
6. "Design Data",P.S.G. College of Technology, Coimbatore.
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.

University of Pune, Pune
T E (Mechanical) Part I (2008 Course)
302042 HEAT TRANSFER

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

Section I

1 **Concepts and Mechanism of Heat Flow** 10

Steady and unsteady state heat transfer, Modes of heat transfer, their physical mechanism, Laws of heat transfer, thermal conductivity, variable thermal conductivity, heat transfer coefficients, isotropic and an-isotropic materials, insulating materials. electrical analogy of heat transfer

Three dimensional heat conduction equation in Cartesian coordinates and its reduction to Fourier, Poisson and Laplace equations. Three Boundary conditions (temperature, heat flux and convection).Three dimensional heat conduction equations in cylindrical and spherical coordinates (no derivation) and its reduction to one dimensional form.

2 **One dimensional steady state heat conduction** 8

without heat generation in plane and composite wall, hollow cylinder, hollow sphere, thermal contact resistance, critical thickness of insulation on cylindrical and spherical bodies

One dimensional steady state heat conduction with uniform internal heat generation in plane wall, cylinder and sphere.

3 **Extended Surfaces** 8

Types of fins, governing equation for constant cross sectional area fins, solution for infinitely long, short and adequately long (with insulated end) fins. Fin efficiency, fin effectiveness, overall fin effectiveness.

Unsteady state heat conduction: Biot number, Fourier number, time constant and response of thermocouple, validity and criteria of lumped system analysis,

Section II

4 **Thermal Radiation** 10

Physics of radiation, Black body radiation, Spectral and total emissive power, real and gray surfaces, Stefan Boltzmann law, Radiation laws- Planks, Wiens, Kirchoff's and Lamberts cosine law, irradiation and radiosity, Surface absorption, reflection and transmission, emissivity, Radiation view factor, theorems of view factor, radiation heat exchange between two black and diffuse gray surfaces, gas radiation, ray tracing and energy balance method, radiation shield

5 **Principle of Heat Convection** 8

Mechanism of natural and forced convection, local and average heat transfer coefficients, convection boundary layers: velocity and temperature, dimensionless numbers and their physical significance, laminar and turbulent flow over bodies, flow inside circular and non-circular ducts, natural convection over bodies, use of empirical correlations for forced and natural convection

6 **Condensation and Boiling** 8

Film wise, drop wise condensation, types of boiling, pool boiling curve and forced boiling phenomenon (No numerical treatment)

Heat Exchangers: Classification of heat exchangers, temperature distribution in

parallel, counter flow arrangement, condenser and evaporator, overall heat transfer coefficient, fouling factor, Log-mean temperature difference method and NTU-effectiveness method of analysis for rating and sizing of heat exchangers, Design criteria, practical applications of heat exchangers, introduction to heat transfer augmentation techniques.

Introduction to heat pipe

List of experiments

Any Eight Experiments (1-10) and one assignment (11-13) from the following list

1. Determination of thermal conductivity of metal rod
2. Determination of thermal conductivity of insulating powder
3. Determination of thermal conductivity of composite wall
4. Determination of heat transfer coefficient in natural convection
5. Determination of heat transfer coefficient in forced convection
6. Determination of temperature distribution, fin efficiency in natural / forced convection.
7. Determination of emissivity of a test surface
8. Determination of Stefan Boltzmann constant
9. Determination of equivalent thermal conductivity of heat pipe.
10. Study of pool boiling phenomenon and determination of critical heat flux.
11. Determination of log-mean temperature difference, overall heat transfer coefficient and Effectiveness of heat exchanger in parallel and counter flow arrangement
12. One assignment to solve transient heat transfer problem using Heisler and Grober charts
13. One assignment on steady state heat transfer by using any software (preferably CFD)/ finite difference method

Reference Books :

1. J.P. Holman, Heat Transfer, VII Edition, McGraw Hill
2. Yunus A. Cengel, Heat Transfer –A Practical Approach, Tata McGraw Hill
3. M. M. Rathore, Engineering Heat and Mass Transfer, 2nd Edition, Laxmi Publications, New Delhi.
4. D. S. Kumar, Heat And Mass Transfer, S.K.Kataria & Sons,Delhi.
5. P. K. Nag, Heat Transfer, Tata Mcgraw Hill Publishing Company Ltd.,New Delhi.
6. Sukhatme S. P, A Text Book On Heat Transfer (1989) , III rd Edition, Orient Longmans Ltd., New Delhi.
7. Chapman A.J., Fundamentals of Heat Transfer, IV th Edition. John Wiley Inc.
8. M. Thirumalseshwar, Fundamentals of Heat and Mass Transfer, Pearson Education.
9. Suryanarana N. V., Engineering Heat Transfer, Prenam International, Mumbai
10. Incropera and DeWitt, Fundamental of Heat and Mass transfer, John Wiley Inc.
11. Ozisik M. N., Heat Transfer - A Basic Approach, McGraw Hill New York.
12. Kothandandarman C.P, Heat Transfer Data Book, New Age (I), New Delhi.

University of Pune, Pune
T E (Mechanical) Part I (2008 Course)
302043 THEORY OF MACHINES -II

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

Section I Hrs

1 **Friction Clutches , Brakes & Dynamometers** 10

Friction :

Friction and types of friction, laws of friction, Friction in turning pairs, Friction circle, Friction axis, Friction in 4 bars and single slider crank mechanism.

Friction clutches :

Pivot and Collar friction, Plate clutches, Cone clutch, Centrifugal clutch, Torque transmitting capacity.

Brakes & dynamometers :

Different types of brakes, Shoe brakes, External and internal shoe brakes, Block brakes, Band brakes, Band and block brakes, Braking torques, Different types of absorption and transmission type dynamometers.

2 **Cam & Followers** 8

Types of cams and followers, analysis of standard motions to the follower, determination of cam profiles for given follower motions, analysis of cams with specified contours-circular arc cam, tangent cam, eccentric cam, Methods of control : pressure angle, rdius of curvature and undercutting, Kinematically equivalent system, Jump phenomenon. Introduction to advanced cam curves.

3 **Gyroscopes and Introduction to Governors** 8

Gyroscopes, concept of gyroscopic action, gyroscopic couple, effect of gyroscopic couple on ship, aeroplanes, and vehicles.

Introduction to Governors, Types centrifugal governor (Watt, Porter, and Hartnell governor only), controlling force, governor effort and governor power with numerical treatment, sensitivity, stability, isochronism and hunting, friction, insensitiveness. (No Numerical Treatment)

Section II

4 **Kinematics of Spur Gears** 10

Classification and applications of gears, terminology of gearing, law of gearing, velocity of sliding, conjugate action, forms of teeth, path of contact, arc of contact, interference, undercutting, methods to avoid interference and undercutting, effect of centre distance variation, friction between gear teeth.

5 **Kinematics of Helical, Bevel and Worm Gears** 8

Helical gears :

Terminology, virtual number of teeth, torque transmitted, spiral gears - terminology and efficiency.

Worm gears & bevel gears :

Terminology, geometrical relationships, tooth forces, torque transmitted.

6 **Inertia of Geared systems and Gear Trains** 8

Inertia of gear systems, types of gear trains - simple, compound, reverted and epicyclic gear trains, analysis of epicyclic gear trains, torque on sun and planet gears, compound epicyclic gear trains, bevel epicyclic gear trains.

Term Work

The term work shall consist of any **eight** of the following experiments :

1. To measure torque transmitting capacity of a friction clutch.
2. To measure the power transmitted by the dynamometer or power absorbed by the brake.
3. To verify the cam jump phenomenon.
4. To draw cam profiles for various types of follower motions.
5. To determine the characteristic curves for centrifugal governor and to find its coefficient of insensitiveness and stability.
6. To study various types of gearboxes such as: Industrial gear box, Synchromesh gearbox, Differential gearbox, or PIV gearbox.
7. To draw conjugate profile for any general type of gear tooth.
8. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using model.
9. To measure transmitted torque and holding torque of a epicyclic gear train.

Reference Books

1. Hannah and Stephans, “Mechanics of Machines”, Edward Arnolde Publication.
2. Beven T ,” Theory of Machines”, Longman Publication
3. Shigley J. E. and Uicker, J J, “Theory of Machines and Mechanisms”, International Edition, MacGraw Hill Inc.
4. Ballaney P. L. “Theory of Machines”, Khanna Publications.
5. Jagdish Lal , “Theory of Machines “, Metrapolitan Book Co. Pvt. Ltd. N. Delhi.
6. Khurmi, R. S. and Gupta, J. K.” Theory of Machines”, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
7. A. Ghosh Malik, “Theory of Mechanism and Machines”, East-West Pvt. Ltd.
8. S.S.Ratan “Theory of machine”,Tata McGrawHill .
9. Dr.V.P.singh,”Theory of machine”, Dhanpatrai and son.
10. C.S.Sharma & kamlesh Purohit,” Theory of machine and mechanism”,PHI.
11. David H. Myszka, ”Machines and Mechanism”, PHI..

University of Pune, Pune
T. E. (Mechanical) Part I (2008 Course)
302044 INDUSTRIAL ENGINEERING & TECHNOLOGY MANAGEMENT

Teaching Scheme		**Examination Scheme**	
Lectures	4 Hrs/ Week	Theory	100 Marks

Section I

		Hrs
1	**Management Science** Basic concepts and functions of management, Contribution of Taylor and Fayol to scientific management, Motivation and Control, Maslow's hierarchy of needs, Vroom's expectancy theory, Leadership Styles, Contingency theory, Managerial grid. **Plant Locations, Layout and material Handling** Location: Importance and factors affecting plant location, Single and Multi-facility location problems, Layout: Need, Importance, Objectives and Principles of good plant layout, Types of layout and applications, Material Handling: Objectives, functions, principles of material handling, Types of material handling equipment and selection,	8
2	**Productivity and Work study** Productivity: Definition and Types, Kinds of Productivity measures, productivity improvement methods. Work Study: Introduction, Techniques of work study, Method study – procedure, recording techniques, Principles of motion economy, Micro-motion analysis, Work measurement – Time study, work/ activity sampling, Predetermined motion time standards, Job evaluation and Merit rating – Procedure and Methods.	8
3	**Production Planning and Inventory Control** Introduction, Functions of PPC, Forecasting models – moving average, exponential smoothing, Capacity planning, aggregate production planning – cost computation for pure and mixed strategies. Inventory control – Purpose, types, functions, basic EOQ, safety stock inventory control systems (Numerical treatment), selective control of inventory ABC, FMS, VED. Project Management: PERT/ CPM, Cost accounting and control, elements of cost, depreciation, method for calculating depreciation, break even analysis, standard costing, variance analysis, zero based budgeting.	10

Section II

4	**Technology Management** Concept and meaning of technology, evolution and growth of technology, role and significance of management and technology, impact of technology on society and business, forms of technology, process technology, and product technology. Competitive advantages through new technologies: Product development,- from scientific breakthrough to marketable product – role of government in technology development. Linkage between technology, development and competition, managing research and development (R& D) Managing intellectual property.	8
5	**Technological Forecasting and Assessment** Exploratory: Intuitive, extrapolation, growth curves, technology monitoring, normative: relevance tree, morphological analysis, mission flow diagram Technology Assessment: Technology choice, Technological leadership and follower ship, technology acquisition, meaning of innovation and creativity, innovation management	8
6	**Technology Strategy** Concepts, types, key principles, framework for formulating technology strategy, technology forecasting: techniques and application, Technology Diffusion and	10

Absorption: Rate of diffusion, innovation time and innovation cost, speed of diffusion, Project Management in adoption and implementation of new technologies, technology transfer process (IPR)

Reference Books:

1. Tarek Khalli, 'Management of Technology' McGraw-Hill. New Delhi.
2. V K Narayanan, 'Managing Technology and Innovation for Competitive Advantage', Pearson Education Asia
3. Gaynor, 'Handbook Of Technology Management', Mcgraw Hill,
4. Dinesh seth, Subhash C. Rastogi, 'Global management solutions – Cleanage learning
5. S.N.Chary, 'Production & Operation Management,' Tata McGraw Hill, New Delhi.
6. ILO, Introduction to work study
7. Khanna O.P. - Industrial Engg.& management, Dhanpatrai publications, New Delhi
8. Curie R.M.& Faraday, work study
9. Bewoor A. K., 'Production planning control' Satya Publication, New Delhi, 2004.
10. Arnold J.R. – Introduction to materials management, prentice Hall India Ltd.
11. Gopalkrishnan, "Materials Management," John Wiley Publications,
12. L. C. Jhamb, "Materials Management," Everest Publications

University of Pune, Pune
T. E. (Mechanical) Part I (2008 Course)
302045 COMPUTER ORIENTED NUMERICAL METHODS

Teaching Scheme		**Examination Scheme**	
Lectures	4 Hrs/ week	Theory	100 Marks
Practicals	2 Hrs/week	Practical	50 Marks

Section I

1 **Roots of Equations and Numerical Integration** 8

Newton Raphson method, Modified Newton Raphson method, and Successive approximation method.

Trapezoidal rule, Simpson's Rules ($1/3^{rd}$, $3/8^{th}$), Gauss Quadrature Method- 2 point, 3 point, Double integration – Trapezoidal rule, Simpson's 1/3th rule.

2 **Interpolation and Differentiation** 8

Lagrange's Interpolation, Newton's interpolation – Forward, Backward, Hermit Interpolation, Spline Interpolation- cubic, inverse interpolation, extrapolation. Differentiation.

3 **Simultaneous Equations** 10

Gauss Elimination Method, partial pivoting, Thomas algorithm for tridiagonal matrix, Gauss-seidal method, Gauss-seidal method with relaxation,

Section II

4 **Curve Fitting and errors** 8

Least square technique- straight line, quadratic equation, power equation, exponential equation.

Errors and approximations

5 **Numerical Solutions of ODE** 8

Taylor series method, Euler Method, Modified Euler Method, Runge Kutta Methods- second order and fourth order, Predictor-corrector method, simultaneous equations.

6 **Finite difference methods** 10

Introduction to finite difference method, Boundary value problems of exact differential equations limited to second order only, PDEs- Parabolic – explicit, Crank Nicholson method, Hyperbolic equations , and Elliptic equations.

List of Assignments:

1. Program on **Roots of Equations**
2. Program on **Numerical Integration**
3. Program on **Interpolation**
4. Program on **Simultaneous Equations**
5. Program on **Curve Fitting**
6. Program on **ODE**
7. Program on **Finite difference methods**
8. One assignment on all above topics using any suitable Solver

Note: All the assignments should be completed using any suitable solver.

Guidelines to conduct the Practical Exams.

1. One program on Unit No 1.
2. Any one program from unit 2 to 6 option within unit

Reference Books

1. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 4/e, Tata McGraw Hill Editions, 2002, ISBN 0-07-047437-0
2. Dr. B. S. Garewal, Numerical Methods in Engineering and Science, 7/e, Khanna Publishers, ISBN 81-74009-205-6
3. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientist, 2/e, Tata Mc-GrawHill Publishing Co-Ltd, 2008, ISBN 0-07-064853-0,
4. M. K. Jain, S R K Iyengar, R K Jain, Numerical Methods for Scientific and Engineering Computations, 5/e New Age International Publishers ISBN 13 978-81-224-2001-2008
5. Gerold/ Wheatley, Applied Numerical Analysis, 6/e, Pearson Education Asia, 2002 ISBN 81-7808-567-4
6. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Ltd, New Delhi, ISBN 10: 0-07-0643419-X

University of Pune, Pune
T. E. (Mechanical) Part I (2008 Course)
302046 SEMINAR

Teaching Scheme		**Examination Scheme**	
Practical	2 Hrs/ Week	Term work	50 Marks

Topic

The seminar topic may be

- Mechanical Engineering.
- Based on Interdisciplinary subjects.
- Recent trends in engineering field.

The topic should be based on recent research paper published in recent international Conference and/ or engineering journal and/ or articles published in print media. .

Seminar Load:

Maximum five students shall work under one faculty of department. Each student should have different seminar topic and its presentation. In case more than one student is working on the same topic, then their scope of seminar must be distinct.

Seminar Term Work:

Seminar report should be of 15 to 20 pages. The seminar report must be spiral bound. For standardization of the seminar reports the following format should be strictly followed.

- Page size : Trimmed A4
- Top Margin : 1.00 Inches
- Bottom Margin : 1.32 Inches
- Left Margin : 1.5 Inches
- Right Margin : 1.0 Inches
- Para Text : Font - Times New Roman; 12 point
- Line Spacing : 1.5 Lines
- Page Numbers : Right aligned and in footer. Font Times New Roman; 12 point
- Headings : New Times Roman, 14 point, Boldface
- Certificate : All students should attach standard format of Certificate as described by the Department.
- The entire seminar should be documented as one chapter. References should have the following format
  For Books:
  1. “Title of Book”; Authors; Publisher; Edition;
  For Papers:
  1. “Title of Paper”; Authors; Conference Details; Year.

Marks

1.	Seminar Review	10
2.	Seminar Report	15
3.	Presentation	15
4.	Question/ Answer	10

- Mid semester review must be taken to ensure that all the students have concluded the topic and must be evaluated for 10 Marks
- All students have to present their seminars individually in front of the panel of faculty members of department.
- Examination will be conducted by two internal examiners (among the approved teachers only) appointed by the Principal of the concerned college.
- Schedule of seminar presentation must be displayed on notice board at least two weeks in advance.

University of Pune, Pune
T E (Mechanical) Part II (2008 Course)
302047 MACHINE DESIGN II

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

Section I Hrs

1 **Rolling Contact Bearings** 8

Types of rolling contact bearings, static and dynamic load carrying capacities, Stribeck's equation, equivalent bearing load, load-life relationship, selection of bearing life, selection of rolling contact bearings from manufacturer's catalogue, taper roller bearing, design for cyclic loads and speed, bearing with probability of survival other than 90%, lubrication and mounting of bearings, preloading of rolling contact bearings, types of failure in rolling contact bearings – causes and remedies, selection of oil seals for shafts, selection of bearings for different applications like automotive IC engines, wheels and steering.

2 **Sliding Contact Bearings** 10

Lubricating oils:

Properties, additives for mineral oils, selection of lubricants, properties and selection of bearing materials.

Hydrodynamic lubrication:

Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, Two dimensional Reynolds equation, theory of infinitely long and infinitely short journal bearing, Sommerfield number, Raimondi and Boyd method, temperature rise, parameters of bearing design, length to diameter ratio, unit bearing pressure, radial clearance and minimum oil film thickness.

3 **Design for Fluctuating Loads** 8

Stress concentration - causes & remedies, fluctuating stresses, fatigue failure, S-N curve, endurance limit, notch sensitivity, endurance strength modifying factors, reversed stresses, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg and Goodman diagram, fatigue design of components under combined stresses such as shafts, bolts and springs (Only theoretical treatment for bolted joints).

Section II

4 **Design of Friction Clutches and Brakes**

Friction clutches, classification and selection of friction clutches, torque transmitting capacities, design of single plate, multi plate, cone and centrifugal clutche4s, types of friction materials, their advantages, limitation and selection criterion, concept of temperature rise in clutch operation.

Brakes Energy absorbed by brake, design consideration in pivoted block brakes and long shoe, internal expanding shoe brake, disk brake, temperature rise in brake operation.

5 **Design of Spur and Helical Gears** 8

Introduction

Classification of gears, selection of types of gears, desirable properties and selection of gear materials, standard gear tooth systems, modes of gear tooth failures methods of gear lubrication

Spur gears

Number of teeth and face width, constructional details of gear wheel, force analysis, beam strength (Lewis) equation, velocity factor, service factor, load concentration factor, effective load on gear, wear strength (Buckingham's) equation, estimation of module based on beam and wear strength, estimation of dynamic tooth load by velocity factor and Buckingham's equation.

Helical gears

Transverse and normal module, virtual no of teeth, force analysis, beam and wear strengths, effective load on gear tooth, estimation of dynamic tooth load by velocity factor and Buckingham's equation.

6 **Design of Bevel and Worm Gears** 10

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 by velocity factor and Buckingham's equation, effective load, design of straight tooth bevel gears, selection of materials for bevel gears, introduction to spiral bevel gears and hypoid gears and comparison with straight tooth bevel gears, mounting of 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 drives, friction in worm gears and its efficiency, worm and worm-wheel material, strength and wear ratings of worm gears, thermal consideration in worm gear drive, types of failures in worm gearing, methods of lubrication

Term work :

Term work shall consist of "TWO" design projects:

1. First design project will consist of one imperial size sheet, involving assembly and detailed drawing of a clutch and brake assembly.
2. Second design project will be based on gears, which shall consist of two imperial size sheets – one involving assembly drawing and other details. The assembly drawing should include the part list and overall dimensions, and details should consist of individual components, manufacturing tolerances, surface finish symbols, and geometric tolerances should be specified so as to make it working drawing. Design report giving all necessary calculations of the design of the components and assembly should be submitted in the separate file.

Design data book shall be used extensively for the selection of the components.

The oral examination shall be based on the above term work.

Recommendations

1. As far as possible, preference should be given to prepare drawing sheet of first design project using any CAD software and drawing sheets of the second design project should be drawn manually.
2. A study visit to industry may be arranged to see the manufacturing of machine elements and assemblies during the semester. During the visit, the students are expected to visit design office to see design and drafting aids. A report of this visit can be included in the term work.

Reference Books :

1. Shigley J.E. and Mischke C.R, "Mechanical Engineering Design", Tata McGrow Hill.
2 Spott's M.F. and Shoup T.E, "Design of Machine elements", Prentice Hall International.
3. Bhandari V.B, "Design of machine elements",Tata McGrow Hill Public Co. Ltd., (Second Edition).
4. Black P.H. and O. Eugene Adams,"Machine Design" , McGrow Hill Book Co. Ltd.
5. William C. Orthwein ,"Machine Components Design", West-Pub. Co. an Jaico Pub. House.
6. "Design Data" ,P.S.G. College of Technology, Coimbatore.
7. Juvinal R.C, "Fundamentals of Machine Components Design" ,John Wiely and Sons.
8. Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum's outline series.

University of Pune, Pune
T E (Mechanical) Part II (2008 Course)
311048 METROLOGY & QUALITY CONTROL

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

Section I Hrs

1 **Measurement Standard & Comparators** 8

Measurement Standard – Principles of Engineering Metrology, line end, wavelength, Types and sources of error, alignment, Temperature, Plastic deformation, Accuracy precision, Slip gauges & gauges block, Linear and Angular measurement (Sine bar, Sine centre, Auto collimator, Angle décor Dividing Head), Calibration

Comparator- Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).

Checking of geometrical forms, machine tool alignment test: Lathe, Drilling, Milling.

2 **Interferometer** 8

Interferometer- Principle, NPL Interferometer, Flatness measuring of slip gauges, Parallelism, Laser Interferometer

Surface Finish Measurement- Surface texture, measuring surface finish by Stylus Probe, Tomlinson & Taly-surf, Analysis of surface traces: Methods

Design of Gauges- Types of gauges, limits, fits, tolerances, Taylor's principle.

3 **Metrology of Screw Thread** 10

Measurement of thread form- Minor, Major, effective, Flank angle, Types & effect of screw threaded error, Floating Carriage Micrometer.

Gear Metrology- Gear error, Gear measurement: Gear tooth Vernier, constant chord, base tangent, Rolling, Profile Projector, Tool maker's microscope.

Advancements in Metrology- Co-ordinate measuring machine, Universal measuring machine, Laser in metrology, Automatic inspection system, Online-Offline inspection machine vision.

Section II

4 **Introduction to Quality and Quality Tools** 8

Deming's PDCA,PDSA cycles & Juran Trilogy approach, Quality Statements, Cost of quality & value of quality, Seven Quality Tools: check sheet, flow chart, Pareto analysis, cause & effect diagram, scatter diagram, Brain storming; Quality circle; Concurrent engineering; Malcom Balbridge national quality award.

5 T**otal Quality Management** 8

Quality function deployment, 5S, Kaizen, Kanban, JIT, Poka yoke, QMS (ISO 9000, TS 16949,ISO 14000, Quality audit); TPM, FMECA, FTA; Zero defects.

6 **Statistical quality control** 10

Statistical quality control- Statistical concept, Frequency diagram, Concept of variance analysis, control chart for variable & attribute, Process capability, statistical process control, Concept of Six sigma: DMAIC.

Acceptance Sampling : Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: comparison, calculation of sample size, AOQ, Probability of Acceptance.

Term Work

A] Experiments (Any Eight)

1. Determination of Linear/ Angular dimensions of a part using precision/non precision measuring instruments.
2. Precision Angular Measurement using Sine bar/Sine center, Autocollimator/ Angle Dekkor.
3. Machine tool Alignment Test on any two machine like- Lathe, Milling, Drilling.
4. Measurement of screw threads using Floating carriage Micrometer.
5. Measurement of gear tooth thickness by gear tooth Vernier Caliper/ Constant chord/ Span micrometer.
6. Measurement of circularity/Roundness using mechanical comparator.
7. Calibration of dial gauge using Dial calibration Tester.
8. Interferometer- Study of surfaces using optical flat.
9. Study & applications of profile projector & Tool maker's microscope.
10. Inspection of Production job by Statistical process control.

B] Assignments- At least two assignments based on Syllabus of quality control
C] Industrial visit Report on study of metrology subject.

Reference Books : Metrology

1. Hume K.J. - Engineering Metrology Mascdonald Publications
2. A. W. Judge, "Engineering Precision Measurements", Chapman and Hall
3. Jain R.K. – Engineering Metrology, Khanna Publication.
4. Narayana K.L. Engineering Metrology.
5. Galyer J.F & Shotbolt C.R. Metrology for engineers.
6. I. C. Gupta, "Engineering Metrology", Dhanpatrai Publiartions
7. Kulkarni V. A. and Bewoor A. K., "Metrology and Measurements", Tata McGraw Hill Co. Ltd.

Reference Books : Quality Control

8. Juran J. M., "Quality Handbook", McGraw Hill Publications.
9. Grant S.P., "Statistical Quality Control", Tata McGraw hill Publication.
10. Francis T. Farago, Mark A. Curtis, "Handbook of dimensional measurement",
11. Harrison M., Wordsworth, Stefeen Godfrey, "Modern Methods for Quality Control and Improvement", Willy Publication.
12. K. J.. Hune and G. H. Sharp, "Practical Metrology", Macdnald Publications
13. ASTME, "Handbook of Industrial Metrology", Prentice Hall of India Ltd.

University of Pune, Pune
T E (Mechanical) Part II (2008 Course)
302049 TURBO MACHINES

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

Section I Hrs

1 **Introduction to Turbo Machinery** 8

Impulse momentum principle and its applications. Force excreted on fixed plate, moving flat plate and curved vanes, series of plates, velocity triangles and their analysis, work done equations, efficiency.

Impulse Water Turbines

Pelton wheel – construction, principle of working, velocity diagrams and analysis, design aspects governing and performance characteristics, specific speed.

2 **Reaction Water Turbines** 8

Classifications, Francis and Kaplan Turbine, constructional features, velocity diagrams and analysis, draft tubes – types and analysis, cavitation, causes and remedies, performance characteristics and governing, specific speed.

3 **Steam Turbines** 10

Steam nozzles- Equation for velocity and mass flow rate (No Derivation) types and applications.

Classification, constructional details, compounding of steam turbines, velocity diagrams and analysis of impulse and reaction Turbines.(single and multistage), governing, performance characteristics, with numericals

Section II

4 **Gas Turbines** 8

Theory and fundamentals of Gas Turbine, principle and classification, Joules Cycle, assumptions for simple Gas Turbines, cycle analysis, compounding of gas turbine, work ratio, closed and semi closed cycles Gas turbine plant, aviation power plants, turbofan, turboprop, turbojet (with numerical treatment)& rocket .

5 **Rotary Pumps** 8

Classification, components of centrifugal pumps, various terms associated with centrifugal pump, various heads, velocity triangles and their analysis, effect of outlet blade angle, cavitation, NPSH, Thomas cavitation factor, priming of pumps, installation, specific speed and pump classification, performance characteristics of centrifugal pump. Axial thrust, maintenance, troubles and remedies, series and parallel operation of pumps, system resistance curve, water hammer problem in pumping system.

6 **Centrifugal Compressor** 10

Centrifugal Compressor : Construction, flow process on T-S Diagram, velocity diagram and Euler's work, slip factor and its effect on work input, actual work input, dimension parameters, pre-whirl losses, surging, choking, stalling characteristics.

Axial Compressor : Construction, velocity triangles and its analysis, dimensionless parameters, pressure rise and aerodynamic force in flow with and without friction, stalling characteristics. Introduction to Fans and blowers, introduction to hydraulic coupling and torque converter.

List of Experiments

1. Verification of momentum principle.
2. Study and trial on Pelton wheel and plotting of operating/main characteristics.
3. Study and trial on any one reaction turbine and plotting of operating/main characteristics.
4. Study and trial on centrifugal pump and plotting of operating characteristics.
5. Study of non conventional pumps.
6. Trial on centrifugal air compressor / rotary air compressor.
7. Visit to hydropower / steam / Gas turbine power plant.
8. Visit to pumping station.
9. Design of pumping system, installation using manufacturer catalogue.
10. Study of Nozzles.

Notes

1. Eight experiments from above list should be performed out of which at least four trails should be conducted.
2. Data from any one trial performed should be analyzed by using any suitable software.

Reference Books

1. Modi. P. N & Seth. S. N. "Hydraulics Fluid Mechanics and Machinery", Standard Book House, New Delhi.
2. V. P. Vasandani, "Theory of Hydraulic Machinery", Khanna Publishers, Delhi.
3. Dr. J. Lal, "Hydraulic Machines", Metropolitan Book Co. Pvt. Ltd Delhi.
4. Karrasik, "Hand Book of Pumps", Tata Mc Graw Hills Ltd. New Delhi.
5. R Yadav, " Steam & Gas Turbines" Central Pub., Allahabad.
6. J K Jain, Gas Turbine Theory and Jet Propulsion" Khanna Pub., New Delhi.
7. Cohen, Rogers, " Gas Turbine theory", Longman Publications.
8. GopalKrishnan, " A Treatise on Turbomachines", Scitech Publications, Chennai (India).
9. Kadambi V. & Prasad M., " Turbo Machinery", New Age International Publication, New Delhi.
10. D.S. Kumar "Fluid Machines and Fluid Power Engineering", Katariya publication.

University of Pune, Pune
T E (Mechanical) Part II (2008 Course)
302050 MECHATRONICS

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

Section I

1 **Introduction to Sensors and Transducers** 8

Introduction to Mechatronics, Measurement systems, Static characteristics, Classification of Transducers and Sensors,
Basic Divider Circuits, Bridge Circuits, filters
Level measurement, strain measurement: Strain Gauge Principles, types, strain gauge circuits, Load Cells, Temperature Compensation,.
Temperature measurement : Thermister, RTD, Thermocouples

2 **Mechanical Sensors** 8

Displacement & Position Sensors: Potentiometric Sensor, Capacitive and Inductive Sensors, Variable Reluctance Sensors, Linear Variable Differential Transformers
Motion Sensors: Translational and Rotary Optical Encoders, Tachometers with output signal as electrical quantity

3 **Converters and Controller Fundamentals** 8

Data Acquisition system: concept of sampling, sample & hold operation, analog to digital converters, digital to analog converters.
Introduction to SCADA & its application
System Models: Mathematical models, introduction to mechanical, electrical, fluid and thermal systems. Rotational and transnational systems, Basic concepts of transfer function.

Section II

4 **Controller Principles** 10

Control Systems: Types of control system, Open loop, closed loop systems, transfer functions, feed back and feed forward control systems and their applications
Process Characteristics: Process equation, Process load, Error, Variable range, Control Parameter Range, Dead time.

5 **Controller Modes** 8

Continuous Controller Modes: Proportional Controller, Integral Controller, Derivative Controller, with mathematical equations, advantages, disadvantages and applications.
Composite Controller Modes: Proportional, Proportional + Integral (PI), Proportional + Derivative (PD), Proportional + Integral + Derivative (PID) Controllers, with simple numerical treatment.

6 **Discrete State Process Control** 8

Relay Controllers and Ladder Diagrams: Ladder Diagram Elements, and Ladder Diagram Examples.
Programmable Logic Controllers : Relay sequencers, PLC Programming Concepts, logic, basic structure, input/ output processing, timers, internal relays and counters, shift resisters, ladder diagram and programming, selection of PLCs,
Case studies of Mechatronics with different applications like washing machine, dish washer, bottle filling plant, elevator, building automation.

List of Experiments

Minimum of 10 experiments from the following; out of which experiment no. 12 is compulsory, four shall be from serial no. 1 to 5, three from serial no. 6 to 11 and two from 13 to 17. Record of experiments and assignments shall be submitted in the form of journal.

1. Calibration of flow meters.
2. Calibration of Thermocouples/ RTD.
3. Study of Load Cells.
4. Study of various types of actuators.
5. Displacement measurement/ level measurement.
6. Verification of P, P+I, P+D, P+I+D control actions.
7. Study of XY position control systems.
8. Study of linear conveyor control system.
9. Study of rotary table positioning systems.
10. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application.
11. Study of A/D and D/A converters.
12. Study of Flip Flops and Timers.
13. Study of Application of Op – Amp circuits.
14. Study of Data acquisition system.
15. Study of switches & relays

Text Book

1. Johnson C. D., Process Control Instrumentation Technology, Prentice Hall of India Pvt Ltd., New Delhi.

Reference Books

1. Doebelin E. O., Measurement System – Application and Design, Tata McGraw Hill Publications Ltd, New Delhi.
2. Bolton W. , Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering, Pearson – Education (Singapore) Pte. Ltd.
3. Rangan C. S., Sarma G. R., Mani V. S., Instrumentation – Devices and Systems, Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Histand B. H., Alciatore D. G., Introduction to Mechatronics and Measurement Systems.
5. HMT, Mechatronics, HMT.
6. Mahalik N. P., Mechatronics – Principles, concepts and applications, Tata McGraw Hill Publishing Company Ltd, New Delhi.
7. Kolk R. A., Shetty D., Mechatronics Systems Design, Vikas Publishing Manual Delhi.

University of Pune, Pune
T E (Mechanical) Part II (2008 Course)
302051 REFRIGERATION AND AIR-CONDITIONING

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

Section I Hrs

1 **Fundamentals of Refrigeration** 8

Review to the thermodynamic processes: isothermal, isentropic, polytropic, and throttling processes, its presentation on P-h & T-s thermodynamic charts, behavior of working fluids during phase change.

Need of refrigeration and its applications in comfort, industrial, food processing and food chain.

Reversed Carnot cycle with air and vapour, simple vapour compression cycle and basic simple system, deviations of practical VCC from Carnot cycle.

Miscellaneous methods of refrigeration: Air refrigeration: Bell Coleman and Reverse Brayton cycle, vortex tube, thermoelectric, magnetic refrigeration, ultrasound Refrigeration.

2 **Vapour Compression System** 10

Vapour compression system with accumulator, receiver, suction line heat exchanger**,** effect of operating parameters on performance of VCC, practical VCC.

Vapour Absorption System

Introduction, simple vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption system, selection criteria of refrigerant-absorbent pair, water ammonia system, lithium bromide absorption system, comparison between VCC and VAC, Cycles used in absorption refrigeration: single effect, double effect

3 **Refrigerants** 8

Desirable properties of refrigerants, classification of refrigerants, secondary refrigerants, alternative refrigerants, Ozone Depletion Potential (ODP) Global Warming Potential (GWP), atmospheric life, Total Equivalent Warming Impact (TEWI), refrigerant: recovery, reclaim, recycle and recharge

Multi Pressure Systems

Introduction, need of multistage system, intermediate pressure, two stage compression with flash gas removal and liquid intercooler, HP, LP receivers, single compressor with multiple evaporator: individual and multiple expansion valves, individual compressors with compound compression and flash intercooling, pumped circulation system, cascade system: application and thermodynamic evaluation

Section II

4 **Psychrometry** 10

Introduction, psychometric terms, use of psychometric chart, psychometric processes, adiabatic saturation temperature, evaporative cooling, chemical air driers: solid and liquid desiccants, by-pass factor of coil, efficiency of coil, adiabatic mixing of two air streams, concept of SHF, RSHF, GSHF, ERSHF, ADP (numerical on psychrometric calculations on simple AC system design with return air systems), concept of infiltration and ventilation.

Human comfort, effective temperature, ASHRAE comfort chart, factors influencing human comfort, indoor air quality requirements, ventilation requirements.

5 **Refrigeration System components** 8

Working principle, classification, application: compressors, condensers, evaporators,

expansion devices and controls

Air- Conditioning Systems

Definition, system: layout and components, classification: summer; winter and all year AC systems, all air system; all water system; air water system; variable refrigerant flow and variable air volume systems, unitary and central air conditioning.

Air Conditioning System components

Operating principle, basic construction and types: Air Handling Unit, Fan Coil Unit, dampers, filters, supply and return grills, sensors: CO_2; smoke, ozone injection

Installation, testing, and maintenance, and trouble shooting of system.

6 **Ducts** 8

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 of duct system design: equal friction, velocity reduction, static regain method (numerical on duct system design)

Fans in air conditioning applications: fan laws, types of fans, basic selection method

Food Preservation

Concept and need of cold chain, cold storages, control and modified atmosphere (CA/MA) storages, precooling, blast freezers, IQF, plate freezers, spiral freezers.

Term Work

The term shall consist of record of minimum eight experiments from the followings

1. Test on vapour compression test rig
2. Test on air conditioning test rig
3. Test on ice plant test rig
4. Test on vapour absorption test rig
5. Trial on heat pump
6. Determination of cooling load of air conditioning system (simple case study)
7. Study of installation/operation/maintenance practices for refrigeration systems
8. Determination of refrigeration load in cold storage (case study/visit)
9. Visit to any refrigeration or air conditioning plant (compulsory) and write the report on it
10. Thermal analysis of refrigeration cycle using computer program

Reference Books

1. Arora and Domkundwar, Refrigeration and Airconditioning, Dhanpatrai and Company, New Delhi
2. Arora C P, Refrigeration and Air Conditioning, 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
7. Stocker W.F. and Jones J.W., Refrigeration and Air-conditioning, McGraw Hill International editions 1982
8. Threlkeld J.L., 'Thermal Environmental Engineering, Prentice Hall Inc. New Delhi
9. ASHRAE & ISHRAE Handbook
10. Anantnarayan, Basic of Refrigeration and Air Conditioning, Tata McGrawHill Publications
11. Roger Legg, Air conditioning systems: Design, Commissioning and maintenance
12. Sapali S.N., Refrigeration and Air Conditioning, PHI Learning Pvt. Ltd., New Delhi

University of Pune, Pune
T. E. (Mechanical) Part II (2008 Course)
311052 WORK SHOP PRACTICE II

Teaching Scheme		**Examination Scheme**	
Practical	2 Hrs/ Week	Term work	50 Marks

Each Candidate is required to complete and submit the following

Part A : One composite job consisting of machining of components covering operations on Lathe, Drilling, Milling machines and essentially consisting of Thread Assembly.

Part B : Demonstration/ Job on CNC machine which should consist of Step Turing and Taper Turning Operations

Part C : One job on Milling machine consisting of Gear Cutting operations

Journal should contain detailed process sheets of above jobs.