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

With effect from June 2010

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<th>Code</th>
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** Theory paper of 4 hours duration.
*** The term work marks of seminar shall be as mentioned in the syllabus

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

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<td>Lectures 4 hrs/week</td>
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<td>Practical 2 hrs/week</td>
<td>Term work 50 Marks</td>
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Section I

1 Shafts, Keys and Couplings
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
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
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
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
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
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

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

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Section I

1 **Concepts and Mechanism of Heat Flow**

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.

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**

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**

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**

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 Lambert’s 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**

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**

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
7. Determination of emissivity of a test surface
8. Determination of Stefan Boltzmann constant
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 :

10. Incopera and DeWitt, Fundamental of Heat and Mass transfer, John Wiley Inc.
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**Section I**

1. **Friction Clutches, Brakes & Dynamometers**
   
   **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**
   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, radius of curvature and undercutting, Kinematically equivalent system, Jump phenomenon.
   Introduction to advanced cam curves.

3. **Gyroscopes and Introduction to Governors**
   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**
   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**
   **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**
   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

2. Beven T., ”Theory of Machines”, Longman Publication
9. Dr.V.P.singh,”Theory of machine”, Dhanpatrai and son.
10. C.S.Sharma & kamlesh Purohit,” Theory of machine 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

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,

2 Productivity and Work study
Productivity: Definition and Types, Kinds of Productivity measures, productivity improvement methods.

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.

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.

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

6 Technology Strategy
Concepts, types, key principles, framework for formulating technology strategy, technology forecasting: techniques and application, Technology Diffusion and
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:

6. ILO, Introduction to work study
8. Curie R.M.& Faraday, work study
10. Arnold J.R. – Introduction to materials management, prentice Hall India Ltd.
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
Trapezoidal rule, Simpson’s Rules (1/3rd, 3/8th), 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

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

Teaching Scheme

Practical 2 Hrs/ Week

Examination Scheme

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

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<tr>
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<td>Question/ Answer</td>
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- 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

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Section I

1 Rolling Contact Bearings  
Types of rolling contact bearings, static and dynamic load carrying capacities, Striebeck'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

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
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 clutches, 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

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**

**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:

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

1 Measurement Standard & Comparators
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
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
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
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 Total Quality Management
Quality function deployment, SS, Kaizen, Kanban, JIT, Poka yoke, QMS (ISO 9000, TS 16949, ISO 14000, Quality audit); TPM, FMECA, FTA; Zero defects.

6 Statistical quality control
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.
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
2. A. W. Judge, “Engineering Precision Measurements”, Chapman and Hall
5. Galyer J.F & Shotbolt C.R. Metrology for engineers.

Reference Books : Quality Control
10. Francis T. Farago, Mark A. Curtis, “Handbook of dimensional measurement”,
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

1 Introduction to Turbo Machinery
Impulse momentum principle and its applications. Force exerted 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
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
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
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
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
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.
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

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

Teaching Scheme  
Lectures  4 hrs/week  
Practical  2 hrs/week  

Examination Scheme  
Theory  100 Marks  
Term work  50 Marks

Section I

1 Introduction to Sensors and Transducers  
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  
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  
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  
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  
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  
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.

2. Calibration of Thermocouples/ RTD.
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.
14. Study of Data acquisition system.
15. Study of switches & relays

**Text Book**


**Reference Books**

5. HMT, Mechatronics, HMT.
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
1 Fundamentals of Refrigeration
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
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
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
Introduction, psychrometric terms, use of psychrometric chart, psychometric processes,
adiabatic saturation temperature, evaporative cooling, chemical air dryers: solid and
liquid desiccants, by-pass factor of coil, efficiency of coil, adiabatic mixing of two air
streams, concept of SHF, RSHF, GSHF, ERSFH, 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
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: CO₂; smoke, ozone injection
Installation, testing, and maintenance, and trouble shooting of 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 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
9. ASHRAE & ISHRAE Handbook
10. Anantanarayan, Basic of Refrigeration and Air Conditioning, Tata McGrawHill Publications
11. Roger Legg, Air conditioning systems: Design, Commissioning and maintenance
University of Pune, Pune  
T. E. (Mechanical) Part II  (2008 Course)  
311052 WORK SHOP PRACTICE II  

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<th>Teaching Scheme</th>
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<td>Practical</td>
<td>Term work</td>
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<tr>
<td>2 Hrs/ Week</td>
<td>50 Marks</td>
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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.