6th Semester

BTME 601 DESIGN OF MACHINE ELEMENTS -II

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. Transmission Drives

Belt and rope drives: Basics, Characteristics of belt drives, selection of flat belt, Design of Flat belt, V-belt and rope (steel wire), Design of the pulley for the same

Chain Drives: Basics, Roller chains, polygonal effect, power rating, selection of chain

Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, terminology of spur, helical, bevel, worm and worm wheel, Design of spur, helical, straight bevel gears, worm and worm wheel

2. Bearings

Slider: Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design

Roller: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of roller and slider bearing

3. Design of Flywheel

Introduction, Energy stored in a flywheel, stresses in a rim, design considerations

4. Springs

Types; end styles of helical compression spring; stress and deflection equation; surge in spring; nipping of leaf spring; Design of close-coil helical spring and multi leaf spring

5. Clutches

Design of contact clutches i.e. plate, multi-disc, cone and centrifugal clutches.

6. Brakes

Design of band, disc, block with shoe and internal expanding brakes.

Books

a. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill

b. Robert C. Juvinall Fundamentals of machine component design, JohnWiley Eastern
c. V.K Jadon, Analysis and design of machine elements, I.K. International
d. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill
e. S.S Jolly, Design of machine elements-II, Dhanpat Rai and Co.

Following is the list of sample tutorial problems for design practice to be given to the students:

1. Find an assembly containing the belt and pulley mechanism and do the complete design calculations and then justify the existing design.

2. Design a transmission system involving the chain drives / gear drives by specifying inputs, and then justify design.

3. Design completely a hydrodynamic journal bearing and specify its suitability by using heat balance equation.

4. Select a suitable roller bearing for a particular application.

5. Design flywheel for industrial application and suggest its suitability.

6. Design springs for automobile application by specifying conditions and constraints.

7. Design a clutch and brakes of an automobile and justify its suitability.

Note:1 Design data book compiled by PSG college of Engg. & Tech., Coimbatore is allowed in examination.

Note: 2 Guide lines regarding paper setting:

Part A- 10 questions of 2 marks each. All compulsory.

Part B- There will be 6 questions of 10 marks each. Candidate will be required to attempt any four questions.

BTME-602 HEAT TRANSFER

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. Introduction:

Concept of heat transfer, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Different modes of heat transfer - conditions, convection, and radiation.

2. Conduction:

Fouier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Three-dimensional general conduction equation in rectangular, cylindrical and spherical coordinates involving internal heat generation and unsteady state conditions. Derivation of equations for simple one dimensional steady state heat conduction from three dimensional equations for heat conduction though walls, cylinders and spherical shells (simple and composite), electrical analogy of the heat transfer phenomenon in the cases discussed above. Influence of variable thermal conductivity on conduction through simple cases of walls / cylinders and spheres. Equivalent areas, shape factor, conduction through edges and corners of walls and critical thickness of insulation layers on electric wires and pipes carrying hot fluids. Internal generation cases along with some practical cases of heat conduction like heat transfer through piston crown, through under-ground electrical cables/Hot fluid pipes etc and case of nuclear fuel rod with and without cladding. Introduction to unsteady heat transfer, Newtonian heating and cooling of solids; definition and explanation of the term thermal diffusivity. Numerical.

3. Theory of Fins:

Concept of fin, classification of fins and their applications. Straight fins of uniform cross-section; e.g. of circular, rectangular or any other cross-section). Straight fins with varying cross-sectional area and having triangular or trapezoidal profile area. Circumferential fins of rectangular cross-section provided on the circumference of a cylinder. Fin performance: fin effectiveness and fin efficiency, total fin effectiveness, total fin efficiency. Optimum design of straight fin of rectangular and triangular profile area. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement. Numerical.

4. Convection:

Free and forced convection. Derivation of three-dimensional mass, momentum and energy conservation equations (with introduction to Tensor notations).

Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Theory of dimensional analysis and its application to free and forced convective

heat transfer. Analytical formulae for heat transfer in laminar and turbulent flow over vertical and horizontal tubes and plates. Numerical.

Newton's law of cooling. Overall coefficient of heat transfer. Different design criterion for heat exchangers. Log mean temperature difference for evaporator and condenser tubes, and parallel and counter flow heat exchangers, Calculation of number and length of tubes in a heat exchanger effectiveness and number of transfer units(NTU); Numerical.

5. Convection with Phase Change (Boiling and Condensation):

Pool boiling, forced convection boiling, heat transfer during pool boiling of a liquid. Nucleation and different theories of nucleation, different theories accounting for the increased values of h.t.c. during nucleate phase of boiling of liquids; different phases of flow boiling (theory only), Condensation, types of condensation, film wise condensation on a vertical and inclined surface, Numerical.

6. Radiation:

Process of heat flow due to radiation, definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies, Plank's law of nonchromatic radiation. Kirchoff's law and Stefan Boltzman's law. Interchange factor. Lambert's Cosine law and the geometric factor. Intensity of Radiation (Definition only), radiation density, irradiation, radiosity and radiation shields. Derivation formula for radiation exchange between two bodies using the definition of radiosity and irradiation and its application to cases of radiation exchange between three or four bodies (e.g. boiler or other furnaces), simplification of the formula for its application to simple bodies like two parallel surfaces, concentric cylinders and a body enveloped by another body etc. Error in Temperature measurement by a thermocouple probe due to radiation losses.

Books:

1. Frank P. Incropera and David P. De Witt, Fundamentals of Heat and Mass transfer, John Wiley
2. P.S. Ghoshdastidar, Heat Transfer, Oxford Press
3. D.S. Kumar, Fundamentals of Heat and Mass Transfer, SK Kataria & Sons (6^{th}/7^{th} Edition)
4. A.J. Chapman, Heat Transfer, McGraw Hill Book Company, New York.
5. J.P. Holman, Heat Transfer, Tata McGraw-Hill Publishing Company Ltd.(Special Indian Edition).
6. Yunus A.Cengel, Heat and Mass Transfer, Tata McGraw Hills Education Private Ltd (Special Indian Edition).
7. Eckert & Drake, Heat and Mass Transfer, McGraw Hill Book Company, New York.

BTME 603 FLUID MACHINERY

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. General Concepts:

Impulse momentum principle; jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted, work done and efficiency of jet.

Basic components of a turbo machine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid and the type of fluid etc. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes.

2. Pelton Turbine:

Component parts and operation; velocity triangles for different runners, work output; Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions

3. Francis and Kaplan Turbines:

Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks, Electro- Mechanical governing of turbines

4. Centrifugal Pumps:

Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump - suction, delivery and manometric heads; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems, causes and remedies.

5. Similarity Relations and Performance Characteristics:

Unit quantities, specific speed and model relationships, scale effect; cavitation and Thoma's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting

6. Reciprocating Pumps:

Components parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Air vessels

7. Hydraulic Devices and Systems:

Const., operation and utility of simple and differential accumulator, intensifier, fluid coupling and torque converter, Air lift and jet pumps; gear, vane and piston pumps, Hydraulic Rams

Books:

1. R.L. Daughaty, Hydraulic Turbines, McGraw Hill

2. Jagdish Lal, Hydraulic Machines by Metropolitan Book Co

3. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,

4. K. Subramaniam, Hydraulic Machines, Tata Mc Graw Hill

5. R.K. Purohit., Hydraulic Machines, Scientific Publishers

BTME-604 STATISTICAL AND NUMERICAL METHODS

Internal Marks: 40 **External Marks: 60** **Total Marks: 100**

1. Data, its Arrangements and Measures:

Introduction: Data, Data Array; Frequency Distribution Construction and Graphic representation. Mean, median, mode and standard deviation.

2. Probability and Probability Distributions:

Introduction: Definition probability and Probability Distribution; Conditional probability; Random variables, Poisson, Normal and Binomial distributions.

3. Sampling and Sampling Distributions:

Introduction: Fundamentals of Sampling, Large samples, small samples; Normal sampling distributions; Sampling distribution of the means, t-Distribution, F-Distribution, Chi-square Distribution.

4. Errors in Numerical Calculations:

Errors and their analysis, general error formula, errors in a series approximation

5. Solution of Algebraic and Transcendental Equations:

Bisection method, iteration method, Method of false position,, Newton -Raphson method, solution of systems of non linear equations.

6. Interpolation Method:

Finite difference, forward, backward and central difference, Difference of polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's general interpolation formula, interpolation by iteration.

7. Numerical Differentiation and Integration:

Numerical differentiation, maximum and minimum values of a tabulated function; Numerical Integration-trapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only)

8. Solution of Linear Systems of Equations:

Gauss Elimination method (fall and banded symmetric and unsymmetric systems), Gauss Jordon method. Eigen value problems (Power method only).

9. Numerical solution of ordinary and partial differential equations:

Solution by Taylor's series, Prediction -correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods. Finite difference approximation to derivatives, Solution to Laplaces equation- Jacobi's method, Gauss -Siedel method.

Note: The students are required to develop computer programs (using any high level language) for different Numerical Methods as part of assignment work.

Books:

1. S. S. Sastry, Introductory methods of numerical analysis by: Prentice Hall of India

2. V. RajaRaman, Computer Oriented Numerical Methods-

3. S.D. Conte, Cari De Boor, Elementary Numerical Analysis, Mc Graw Hill.

4. B. Cornahn, Applied Numerical Methods, John Wiley.

5. Richard I. Levin, S. David., Rubin Statistics for Management, Pearson.

BTME 605 HEAT TRANSFER LAB.

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

A. Two to three students in a group are required to do one or two practicals in the form of Lab. Project in the topic/s related to the subject matter and in consultation with teacher. The complete theoretical and experimental analysis of the concerned topic is required to be performed (including design and fabrication of new experimental set up, if required, or modifications/retrofitting in the existing experimental set ups). The following topics can be taken as reference:-

1. Determination of thermal conductivity of:

   - a solid insulating material by slab method

   - powder materials by concentric spheres method / or by some transient heat transfer technique

   - a metal by comparison with another metal by employing two bars when kept in series and / or in parallel under different boundary conditions

   - Liquids by employing thin layer

2. Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept:

   a) along the direction of flow

   b) perpendicular to the direction of flow

   c) inclined at an angle to the direction of flow

3. To plot the pool boiling curves for water and to determine its critical point

4. Determination of heat transfer coefficient for

   i) film condensation ii) drop-wise condensation

5. Determination heat transfer coefficient by radiation and hence find the Stefan Boltzman's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.

6. Determination of shape factor of a complex body by an analog technique.

7. To plot the temperature profile and to determine fin effectiveness and fin efficiency for

   i) A rod fin when its tip surface is superimposed by different boundary condition like.

a) Insulated tip

b) Cooled tip

c) Temperature controlled tip

ii) Straight triangular fins of various sizes and optimization of fin proportions

iii) Circumferential fins of rectangular/triangular section

B. Each student is required to use Finite Difference Method for analysis of steady state one dimensional and two dimensional conduction problems (Minimum two problems one may be from the Lab. Project) such as conduction through plane/cylindrical/spherical wall with or without internal heat generation, heat transfer through fins, bodies with irregular boundaries subjected to different boundary conditions.

BTME 606 FLUID MACHINERY LAB

Internal Marks: 30 **External Marks: 20** **Total Marks: 50**

1. Determination of various efficiencies of Hydraulic Ram

2. To draw characteristics of Francis turbine/Kaplan Turbine

3. To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance

4. To draw the characteristics of Pelton Turbine

5. To draw the various characteristics of Centrifugal pump

6. Determine the effect of vane shape and vane angle on the performance of centrifugal fan/Blower

7. A visit to any Hydroelectric Power Station