(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4039   Roll No. ☐☐☐☐☐☐☐☐☐☐☐

B.Tech.

SECOND SEMESTER EXAMINATION, 2005-2006

MECHANICAL ENGINEERING

Time : 3 Hours   Total Marks : 100

Note : (i)   *Attempt ALL questions.*

(ii)   *All questions carry equal marks.*

(iii) *In case of numerical problems assume data wherever not provided.*

(iv) *Use of STEAM TABLE and MOLLIER chart is allowed*

(v)   *Be precise in your answer.*

1. Attempt *any four* parts of the following :   (5x4=20)

(a) Define the terms, 'system', 'surroundings', 'boundary' and 'universe', as related to thermodynamics and distinguish between 'open', 'closed', and 'isolated' systems.

(b) State Zeroth Law of thermodynamics giving its practical importance, and explain, how this law can be used to establish equality of temperature of two bodies without bringing them in direct contact.

(c) State the First Law of thermodynamics as applied to closed systems and prove that for a non flow process, it leads to the energy equation, $Q = \Delta u + W$. Also explain the difference between a non flow and a steady flow process, in brief.

(d) The internal energy of a certain substance is expressed by the equation; $u = 3.62\,pv + 86$, where u is given in kJ/kg, p is in kPa and v is in m^3/kg. A system composed of 5 kg of this substance expands from an initial pressure of 550 kPa and a volume of 0.25 m^3/kg to a final pressure of 125 kPa, in a process in which pressure and volume are related by $pv^{1.2} =$ constant. If the expansion process is quasistatic, determine Q, Δu and W, for this process.

(e) State the Clausius and Kelvin Planck statements being used for second Law of thermodynamics. Further, define ; efficiency of a heat engine, COP of a refrigerator and COP of a heat pump, and show that : $(COP)_{Heat\ pump} = 1 + (COP)_{Refrigerator}$

(f) Describe a carnot cycle with the help of (P-V) and (T-S) diagrams, in brief. The temperature of the freezer of a domestic refrigerator is maintained at $-16°C$ whereas the ambient temperature is 35°C. If heat leaks into the freezer at a continuous rate of 2 kg/sec, what is the minimum power required to pump out this heat leakage from freezer, continuously ?

2. Attempt *any two* parts of the following : (10x2=20)

(a) With the help of (T - V) and (T - S) diagrams, explain the difference between, 'Wet', 'Dry saturated' and 'Superheated' steams and further show, as to how you can calculate their properties with the help of steam Tables and Mollier diagram ? 5 kg of steam is generated at a pressure of 10 bar from feed water at a temperature of 25°C. Starting from the basic principles and taking the help of steam tables only, calculate the Enthalpy and Entropy of steam, if :

  (i) Steam is dry and saturated

  (ii) Steam is superheated up to a temperature of 300°C. Take C_p for steam as 2.1 kJ/kg-K and C_p for water as 4.187 kJ/kg-K

(b) Which are the four basic components of a steam Power plant ? Draw a basic layout of a steam power plant and explain the working of a simple Rankine cycle with the help of (T - S) diagram. A steam power plant working on Rankine cycle, has a steam supply pressure of 20 bar and condenser pressure of 0.5 bar. If the initial condition of supply steam is dry and saturated, calculate the Carnot and Rankine efficiencies of the cycle, neglecting pump work.

(c) How can you define I.C. engines and how they are classified ? What is the basic difference between SI and CI engines ? Further explain the working of a 4 stroke S.I engine with the help of neat sketch.

3. Attempt *any two* parts of the following :

(a) Enumerate different laws of motion, discussing the significance of each of them. What do you understand by transfer of force to parallel position ? Also explain Varignon's Theorem of moments, in brief.

(b) What do you understand by Resultant of a Force system and which are the methods used for determining the resultant of coplanar concurrent force systems ? Four forces having magnitudes of 20N, 40N, 60N and 80N respectively, are acting along the four sides (1m each), of a square ABCD, taken in order, as shown in figure. Determine the magnitude and direction of the resultant force.
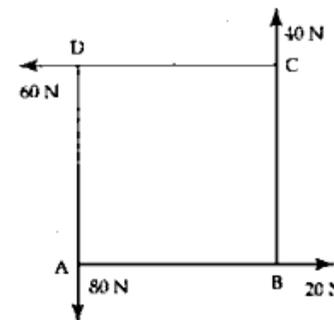

(c) What is the characteristic of frictional force ? Describe the Laws of coulomb friction, explaining the concept of Equilibrium of bodies involving dry friction.

A body of weight 500 N is pulled up along an inclined plane having an inclination of 30° with the horizontal. If the coefficient of friction between the body and the plane is 0.3 and the force is applied parallel to the inclined plane, determine the force required.

4. Attempt *any two* parts of the following : (10x2=20)

(a) Define a beam and classify different types of beams on the basis of support conditions and loadings. What do you understand by 'Shear force' and 'Bending-moment' and what is their importance in beam design ? What do you understand by statically determinate beams ?

(b) Explain, how shearing force and Bending moment diagrams are drawn for a beam. Also, draw the Shear Force and Bending Moment diagrams for the cantilever beam shown in figure :
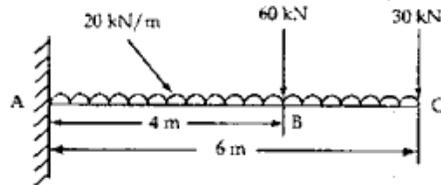
(c) Define a Truss and differentiate between Perfect, Deficient and Redundant Trusses. A truss having a span of 6 m, carries a load of 30 kN and is shown in figure. Find the forces in members, AB, AC, BC and AD.
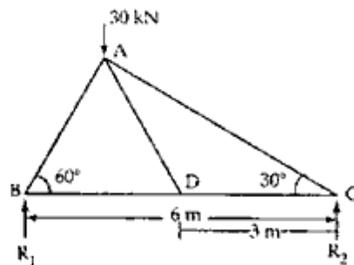
5. Attempt *any two* parts of the following : (10x2=20)

(a) (i) Define; stress, strain and elasticity and differentiate between normal stress and shear stress. Draw the stress - strain diagram for mild steel showing salient points on it.

(ii) A bar of 25 mm diameter is subjected to a pull of 60 kN. The measured extension over a gauge length of 250 mm is 0.15 mm and change in diameter is 0.004 mm. Calculate the modulus of elasticity, modulus of rigidity and Poisson's ratio.

(b) What do you understand by Principal planes and Principal stresses ? What is Mohr's circle ? Explain the construction of Mohr's circle and clearly indicate, how will you find out major principal stress, minor principal stress and maximum shear stress with the help of Mohr's circle.

(c) (i) What do you understand by Pure bending of beams and how it differs from simple bending ? Plot the variation of bending stress across the cross section; of a solid circular beam, a T section beam and a rectangular beam, indicating the salient features on it.

(ii) What do you mean by the terms ; Pure - Torsion and Torsional rigidity ?
A solid circular shaft is to transmit 160 kWat 180 rpm. What will be the suitable diameter of this shaft of permissible stress in the shaft material should not exceed 2×10^6 Pa. and twist per unit length should not exceed 2^6. Take G = 200 GPa.

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