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

PAPER ID : 4032 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. I) ODD SEMESTER THEORY EXAMINATION 2012-13

MECHANICAL ENGINEERING

Time : 3 Hours *Total Marks : 100*

Note :—*(1) Attempt* ***all*** *questions. Assume any missing data.*

(2) Steam tables and charts are allowed.

1. Attempt any **FOUR** parts of the following : **(4×5=20)**

(a) Define the following terms :—

(i) Thermodynamic Equilibrium.

(ii) Quasi static Process.

(b) A fluid system undergoes a non flow frictionless process following the pressure volume relation as $p = \frac{5}{V} + 1{\cdot}5$ where p is in bar and V is in m^3. During the process the volume changes from 0·15 m^3 to 0·05 m^3 and system rejects 45 kJ of heat. Determine :

(i) Change in internal energy.

(ii) Change in enthalpy.

(c) A domestic food refrigerator maintains a temperature of – 12°C. The ambient air temperature is 35°C. If heat leaks into the freezer at the continuous rate of 2 kJ/S determine the least power necessary to pump this heat out continuously.

(d) A heat pump operates between two identical bodies which are at temperature T_1 and cools one of the bodies to a temperature T_2 ($T_2 < T_1$). Prove that for this operation

the minimum work required by the heat pump is given by

$$W = C_p \left(\frac{T_1^2}{T_2^2} + T_2 - 2T_1 \right)$$

where C_p is the specific heat which is same for both the bodies.

(e) Explain the following terms relating to steam formation :

(i) Sensible heat of water.

(ii) Latent heat of steam.

(iii) Dryness fraction of steam.

(iv) Enthalpy of wet steam.

2. Attempt any **TWO** parts of the following : **(10×2=20)**

(a) In a constant volume 'Otto Cycle' the pressure at the end of compression is 15 times that at the start, the temperature of air at the beginning of compression is 38°C and maximum temperature attained in cycle is 1950°C. Determine :

(i) Compression ratio

(ii) Thermal Efficiency of the Cycle

(iii) Work done.

Take γ for air = 1·4.

(b) (i) Describe the different operations of Rankine cycle. Also derive the expression for its efficiency.

(ii) State the methods of increasing the thermal efficiency of a Rankine cycle.

(c) Explain the working of a two-stroke and four stroke S.I. Engines with the help of neat sketch.

3. Attempt any **TWO** parts of the following : **(10×2=20)**

(a) A roller of radius 200 mm and weight 1732 N is to be pulled over a curb of height 100 mm by a horizontal force P applied to the end of string wound tightly around the circumference of the roller. FInd the

magnitude of P required to start the roller move over the curb. Also find the least pull through the centre O the wheel to just turn the roller over the curb.

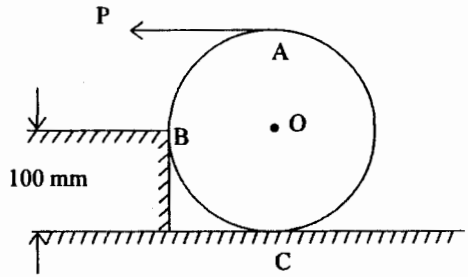

Fig. 1

(b) A ladder of length L rests against a wall, the angle of inclination being 45°. If coefficient of friction between the ladder and ground and that being ladder and wall be 0·5 each. What will be maximum distance on the ladder to which a man whose weight is 1·5 times the weight of the ladder may ascend before the ladder begins to slip.

(c) Derive the relation $\frac{T_1}{T_2} = e^{\mu\theta}$ for a flat belt drive.

4. Attempt any **TWO** parts of the following : **(10×2=20)**

(a) (i) Discuss the various types of beams and loading.

(ii) Derive the relation between load intensity, shear force and bending moment.

(b) Draw the SFD and BMD for the beam shown in Fig. 2 :

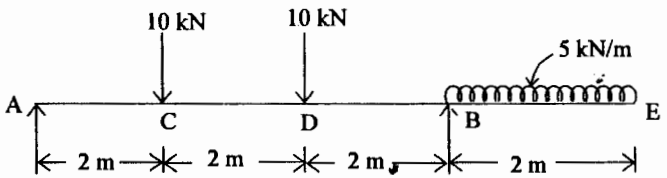

Fig. 2

Also locate the point of contraflexure.

(c) Find the forces in each member of the cantiliver truss as shown in Fig. 3.

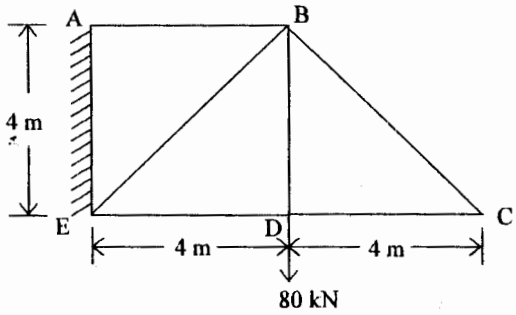

Fig. 3

5. Attempt any **FOUR** parts : **(5×4=20)**

(a) Derive the relationship between Young's modulus and modulus of rigidity.

(b) A steel bar 4 cm is section 3 m long is subjected to an axial pull of 128 kN. Taking E = 200 GN/m², calculate alteration in the length of the bar. Calculate also the amount of energy stored in the bar during the extension.

(c) The principal stresses at a point across two perpendicular planes are 75 MN/m² (tensile) and 35 MN/m² (Tensile). Find normal, tangential stresses and resultant stress and its obliquity on a plane at 20° with the major principal plane.

(d) Derive the bending equation :

$$\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}.$$

Also state the assumptions.

(e) A hollow shaft of diameter ratio 3/8 is required transmit 600 kW at 110 rpm, maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MN/m² and twist in a length of 3 m not to exceed 1·4°. Calculate the maximum external diameter satisfying these conditions.