Registration No. : | | | | | | | | | | |

Total number of printed pages – 4

B. Tech.
PCME 4202

Third Semester Examination – 2010

MECHANICS OF SOLIDS

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the followings : 2×10

   (a) State and briefly explain Saint Venant's principle.

   (b) What do you mean by Statically Indeterminate problems ? Briefly explain with an example.

   (c) What is the purpose of wire winding of thin cylinders ?

   (d) What is volumetric stress ? Give an example.

   (e) Sketch the BMD of a simply supported beam subjected to a moment M at its mid-span.

   (f) How can you use the Mohr's stress circle ?

   (g) Why the depth of a beam of rectangular cross section is always kept more than its width ? Discuss with an example.

   (h) What do you mean by torsional stiffness ?

   (i) What do you mean by Section modulus and what is its significance ?

   (j) What do you mean by Composite Beams ? Give an example.

2. (a) What do you mean by modulus of resilience ? 2

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(b) A bar of elastic material is subjected to a direct compressive stress of σ_1 in the longitudinal direction. Suitable lateral compressive stress σ_2 is applied along other two lateral directions to limit the net strain in each of the lateral directions to half the magnitude that would be under σ_1 acting alone. Find the magnitude of σ_2 and the net strain in the longitudinal direction. 8

3. (a) A steel tube of 35 mm outer diameter and 30 mm inner diameter encloses a gun metal rod of 25 mm diameter and is rigidly joined at each end. If at a temperature of 40°C there is no longitudinal stress, determine the stresses developed in the rod and the tube when the temperature of the assembly is raised to 240 °C. Take, 5

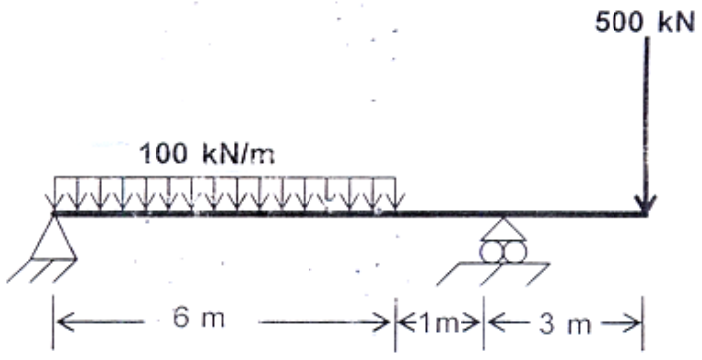
$\alpha_{steel} = 11 \times 10^{-6} / {}^{0}C$, $\alpha_{gun\ metal} = 18 \times 10^{-6} / {}^{0}C$,

$E_{steel} = 205$ GPa, $E_{gun\ metal} = 91.5$ GPa.

Also find the increase in length if the original length of the assembly is 1 m.

(b) A piece of material is subjected to two perpendicular tensile stresses of 100 MPa and 60 MPa. Determine the plane on which the resultant stress has maximum obliquity with the normal. Also find the resultant stress on this plane. 5

4. For the beam loaded and supported as shown in Figure 1, draw the shear force and bending moment diagrams. Find the position and magnitude of maximum bending moment and locate the point of contra-flexure if any. 10



(Figure 1)

5. (a) The cross section of the beam shown in Figure 1 above is a symmetric T-section having a flange of 24 cm × 2 cm and web of 2 cm × 20 cm. Draw the bending stress distribution diagram at a section where the maximum bending moment occurs. 6

(b) For a beam with circular cross section, show that $\tau_{max} = (4/3)\ \tau_{mean}$, where τ_{max} is the maximum shear stress induced due to bending and τ_{mean} is the average shear stress at the section due to the shear force associated with bending. 4

6. (a) A simply supported beam of 10 m length carries a point load of 100 kN and a pure moment of 100 kNm at 3 m and 7 m respectively from the left end. Find the slopes at the simply supported ends and the deflection under the point load. Also find the position and magnitude of maximum deflection. Take E = 210 GPa and I = 80 × 10^6 mm^4. 6

(b) A close coiled helical spring absorbs 72 Nm of energy when compressed through 60 mm. There are 08 coils in the spring. The coil diameter is 10 times the wire diameter. Find the diameters of the coil and the wire and the maximum shear stress. Take G = 82 GPa. 4

7. (a) A cylindrical shell 2.5 m long which is closed at its ends has an internal diameter of 1 m and a wall thickness of 12 mm. Calculate the circumferential and longitudinal stresses induced and also the change in dimensions of the shell if it is subjected to an internal pressure of 1.8 MN/m^2. Take E = 200 GN/m^2 and Poisson's ratio (μ) = 0.25. 5

(b) A solid circular shaft and a thin-walled circular tube made of the same material and having the same weight are stressed in torsion to the maximum shear stress τ. What is the ratio of the amounts of strain energy stored in the two shafts ? 5

8. (a) Show that the core of the circular cross-section for a short strut under eccentric loading is circular and find its radius if d is the diameter of the section. 5

(b) A steel bar of rectangular cross-section 2.5 cm × 5 cm is to be used as a column with pinned ends. What is the shortest length l for which Euler's equation applies if E = 210 GPa and the proportional limit $\sigma_{p.l.}$ = 210 MPa. Also calculate the critical compressive stress for the column, if it is 120 m long. 5