INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR
B.E. 4th Semester (Met & Min) Final Examination, May 2014
Strength of Materials (AM – 405)

Full Marks: 70   **Time: 3 hrs**

i) Notations used carry their conventional senses.

FIRST HALF
(Answer Question No. 1 and any TWO from the rest)

1. Choose the correct alternative: [5×1]

a) Maximum value of bending moment of a simply supported beam of length l subjected to uniformly distributed load of intensity w per unit length over its full span is (i) $wl^2/4$, (ii) $w^2l/4$, (iii) $wl/4$, (iv) $wl^2/8$.

b) For a simply supported beam subjected to uniformly distributed load over its entire length the relationship between shear force (V) and bending moment (M) is given by (i) $\frac{dV}{dx} = M$, (ii) $\frac{dM}{dx} = V$, (iii) $\frac{dM}{dV} = x$, (iv) $\frac{dx}{dM} = V$.

c) The maximum compressive stress due to bending in a simply supported beam loaded with u.d.l. over its entire length occurs in (i) top-most fiber, (ii) fiber passing through neutral axis, (iii) bottom-most fiber, (iv) 2/3 rd of the depth from top.

d) The total angle of twist ϕ for a circular shaft of length l subjected to a torque T is given by i) $\frac{TG}{lJ}$, (ii) $\frac{Tl}{GJ}$, (iii) $\frac{JG}{lT}$ and (iv) $\frac{Tl}{rJ}$.

e) The unstable end condition for a long column is (i) hinge-fixed, (ii) hinge-hinge, (iii) fixed-free, (iv) hinge-free.

2. A hollow steel shaft is to have outside diameter 2 times of its inside diameter. Calculate the proper outside diameter of the shaft if it has to transmit a power of 200 hp at 300 rpm with working stress in shear is 70 MPa.   [15]

3. What is the core section of a short column? A short column is having a cross section of 250 m.m. × 300 m.m. Find out the shape and dimension of the core section of the short column and show it with a neat sketch of the column cross section.   [15]
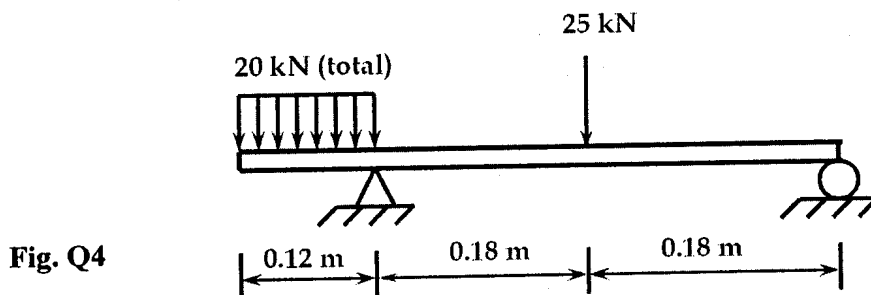

Fig. Q4

4. For the loaded beam **(Fig. Q4)**, draw the shear force and bending moment diagrams mentioning the values at important points. Also find the point of contra-flexure, if any.   [15]

5. A T-shaped beam with the flange at the top has the following dimensions. Flange width 200 mm, flange depth 50 mm, web depth 200 mm and web width 50 mm, the overall depth of the section being 250 mm. The simply supported beam is loaded in such a way that the developed bending moment at the mid span level is 100 N-m (positive). Calculate the values of the maximum compressive and tensile bending stresses in the beam.   [15]

6. Derive the expression of shear stress due to bending as $\tau = \dfrac{V(A\bar{y})}{Ib}$, where the symbols carry usual meaning. *[5]*

7. The shear force acting on a beam of I-section with unequal flanges is 50 kN. The dimensions are: top flange 200 x 50, bottom flange 130 x 50, web 200 x 50. Compute the shear stress at the NA of the section and also draw the shear stress distribution diagram across the section showing values at salient points. *[15]*

8. A steel tube of 30 mm external diameter and 20 mm internal diameter encloses a copper rod of 15 mm diameter to which it is rigidly joined at each end. If at a temperature of 10° C there is no longitudinal stress, compute the stresses in the rod and the tube when the temperature is raised to 200° C. consider $E_S = 2.1 \times 10^5$ N/mm^2, $E_C = 1 \times 10^5$ N/mm^2, $\alpha_C = 18 \times 10^{-6} / ^\circ$ C, $\alpha_S = 11 \times 10^{-6} / ^\circ$ C. *[15]*

9. At a point in a thin-walled pressure vessel, stresses in x and y directions are -450 MPa and 240 MPa respectively. Find the normal stress and shear stress on a plane which makes an angle 35^0 to the positive x-direction. Find also the maximum shear stress and the plane on which it acts. *[15]*

10. A simply supported beam of length L carries a triangularly varying distributed load, zero at left end and w at right end. Find the equation of deflection curve and maximum deflection. *[15]*