Total Pages—4

(Set-Q_1)

B.Tech-3rd(Civil)
Mechanics of Materials

Full Marks : 70

Time : 3 hours

Answer any **six** questions including **Q. No. 1**

The figures in the right-hand margin indicate marks

Assume any suitable data required

1. Explain the following : 2×10

   (*a*) Complementary shear stress

   (*b*) Modulus of rigidity

   (*c*) Hooke's law

   (*d*) Slenderness ratio

   (*e*) Principal stress theory

   (*f*) Maximum shearing stress theory

(Turn Over)

(*g*) Difference between yield stress and proof stress

(*h*) Biaxial bending

(*i*) Castigliano's lst theorem

(*j*) Roller support.

2. A rigid bar AB of length $L = 1600$ mm is hinged to a support at A and supported by two vertical wires attached at points C and D such that $AC = 500$ mm and $AD = 1200$ mm. Both the wires have same cross sectional area of 16 mm^2 and made of the same material having Young's modulus of 200 GPa. The wire at C has a length of 400 mm and that at D has 800 mm. Determine the tensile stresses in the wires and downward displacement at point B of the bar when a load of 1 kN is suspended at B. 10

3. What is meant by principal stress ? At a point on the surface of a machine, the material is in plane stress with $\sigma_x = 1600$ MPa, $\sigma_y = -800$ MPa and $\tau_{xy} = 600$ MPa. Calculate the principal stress and its orientation with respect to X axis. 10

4. An element of material in plane strain is subjected to strains $\varepsilon_x = 480 \times 10^{-6}$, $\varepsilon_y = 70 \times 10^{-6}$ and $\gamma_{xy} = 480 \times 10^{-6}$. Determine the strains for an element oriented at 75° with the X axis, the principal strain and maximum shear strain. 10

5. A hollow steel shaft ACB 1500 mm long has its outside diameter 50 mm and inside diameter 40 mm. It is held against rotation at ends A and B. It has a vertical arm at C ($AC = 900$ mm) whose length is 400 mm and it is attached at its mid point to the horizontal shaft. Horizontal forces are applied at the ends of the arm trying to rotate the shaft. Determine the allowable value of the force if permissible shear stress in the shaft is 55 N/mm^2. 10

6. A simply supported bridge girder beam AB of 12 m span supports a uniform load of q kN/m that includes the weight of the girder. The girder section is I shaped with the flanges 450 mm wide and 25 mm deep and the web is 1800 mm deep and 25 mm thick. Calculate the maximum permissible load q that the girder can carry if the allowable bending stress is 90 N/mm^2. 10

7. A cylindrical tank with hemispherical heads is constructed of steel sections that are welded circumferentially. The tank diameter is 1·2 m, the wall thickness is 20 mm and the maximum internal pressure is 1800 kN/mm^2. Determine the maximum tensile stress in the heads and in the cylindrical part of the tank. Also find the tensile stress acting perpendicular to the welded joints. 10

8. Two hollow tubular members AB and BC are pinned together at B and are hinged to supports at A and C such that a triangular shape ABC is formed. The distance between A and C is 7·0 m and the angles formed by AB and BC with the horizontal is 40° and 55° respectively. Determine the critical vertical load at pin B for the system. The tubes have outside diameter 100 mm, wall thickness 6 mm and Young's modulus of 2×10^5 N/mm^2. 10