B.Tech-3rd (PE)

Mechanics of Materials

Full Marks : 50

Time : 2.30 hours

Answer **all** questions.

The figures in the right-hand margin indicate marks.

Symbols carry usual meaning.

1. Answer *all* questions : 2×5

(*a*) Labeling the salient points, draw the engineering and the true stress-strain curves for ductile materials.

(*b*) What do you mean by temperature stresses ? Explain.

(*c*) What is Mohr's stress circle ? How it is useful in the solution of stress analysis problems.

(*Turn Over*)

(*d*) Explain 'Section Modulus' and 'Moment of Resistance'. What is their significance ?

(*e*) What is Macaulay's Method ? How it differs from the double integration method ?

2. (*a*)

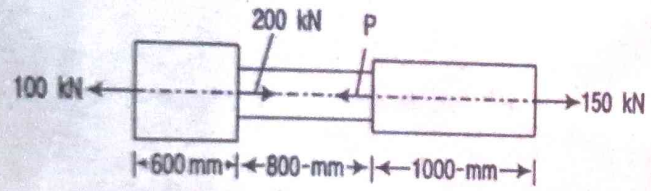

Figure 1

Determine the force *P* required for equilibrium of the bar as shown in Figure 1. The diameters of the rod at first, middle and last segments are 30, 25 and 30 mm respectively. Assume $E = 200$ GPa. 4

(*b*) A reinforced concrete column 250mm × 250 mm in section is reinforced with 8 bars of 16 mm diameter steel bars. The column carries an axial load of 350 kN. Find the stresses induced in concrete and steel. Find also the loads carried by concrete and steel. Assume Es = 18 Ec. 4

Or

A steel rod of 16 mm diameter and 3 m length passes through a copper tube of 50 mm external diameter and 40 mm internal diameter and of the same length as shown in Figure 2. The tube is closed at each end with the help of 30 mm thick steel plates which are tightened by nuts till the length of the copper tube is reduced by 0.6 mm. The temperature of the whole assembly is then raised by 56 °C. Determine the stresses in the steel and copper before and after the temperature rise. Es = 210 GPa, Ec = 100 GPa, $\alpha_s = 12 \times 10^{-6}$/°C and $\alpha_c = 17 \times 10^{-6}$/°C. 8

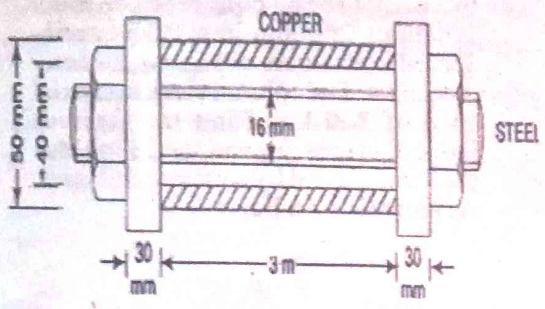

Figure 2

3. The normal stresses at a point in an elastic material are 100 MPa tensile and 60 MPa compressive. Determine, principal stresses, the position of principal planes, maximum shear stress, and its plane both analytically and graphically. 8

Or

For the two-dimensional stress systems as shown in Figure 3 determine, the principal stresses, principal planes, maximum shear stress and the planes

of maximum shear stress by both analytically and using Mohr's circle method. 8

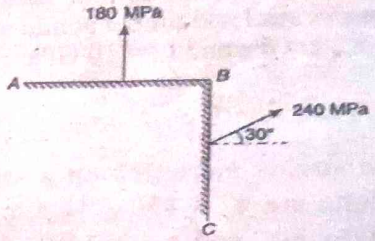

Figure 3

4. (*a*) An axial load of 56 kN is applied to a bar of 36 mm diametre and 1 m length. The extension of the bar is measured to be 0.265 mm whereas the reduction in diameter is 0.003 mm. Calculate the Poisson's ratio and the value of the three moduli. 4

(*b*) A timber of section 500 mm × 500 mm is reinforced by securing two steel plates of 500 mm × 10 mm size at the

top and bottom surfaces. The composite section is used as a beam of 6 m span and is loaded with a uniformly distributed load of 80 kN/m run. Determine the maximum bending stress in steel and timber at mid span. Es = 200 GPa and Et = 10 GPa. 4

Or

(*a*) The strains measured on a strain rosette are $\varepsilon_0 = 450 \times 10^{-6}$, $\varepsilon_{60} = -600 \times 10^{-6}$ and $\varepsilon_{120} = 150 \times 10^{-6}$. Determine the principal stresses and their directions. E = 200 GPa and Poisson's ratio = 0.3. 4

(*b*) A solid shaft transmits torque of 15 kN m and bending moment of 10 kN m. The yield stress of the shaft is 240 MPa with factor of safety 2. Find the diameter of the shaft using (*i*) Maximum normal stress theory, (*ii*) Maximum shear stress theory. 4

5. Deduce the relationship between rate of loading, shear force and bending moment. A wooden beam 10 m long, 360 mm deep and 300 mm wide is simply supported and loaded with a uniformly distributed load throughout the span. Find the maximum load it can carry if the maximum intensity of stress is 60 MPa. 8

Or

Draw the SFD and BMD showing the position of the point of contra flexure if any for the overhanging beams as shown in Figure 4. 8

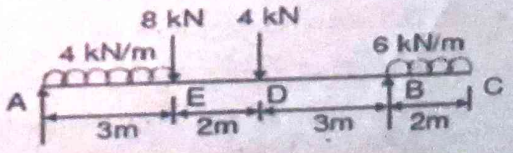

Figure 4

6. (*a*) Derive the 'Pure bending equation' stating the requisite assumptions. 4

(*b*) What do you mean by 'Flitched Beam' ? Develop a relation for moment of resistance for such beam. 4

Or

(*a*) Deduce the Torsion Equation stating the assumptions made. 4

(*b*) A beam of length 8 m is simply supported at its ends and carries two points loads of 68 kN and 48 kN at a distance of 1 m and 4 m, respectively from the left support. Find

(*i*) Deflection under each load,

(*ii*) Maximum deflection, and

(*iii*) The point at which maximum deflection occurs.

Given $E = 210$ GPa and $I = 180 \times 10^6$ mm^4. 4