B. Tech-3rd(ME)

Mechanics of Deformable Solids

Full Marks : 50

Time : $2\frac{1}{2}$ hours

Answer **all** questions

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

1. Answer *all* questions : 2×5

(*a*) Derive the relationship between elastic constants E and K, where symbols have their usual meaning.

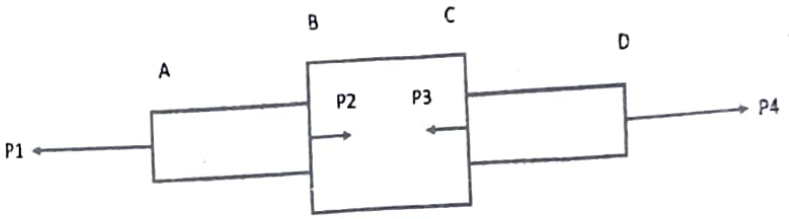
(*b*) Draw the Mohr's Circle for a member under pure shear stress.

(*c*) What do you understand by point of inflection ? Explain with neat skectch.

(d) Compare the resistance to torsion of a hollow circular shaft to that of solid shaft if the inside diameter of the hollow shaft is two third of the external diameter and the two shafts have the same material and weight and of equal length.

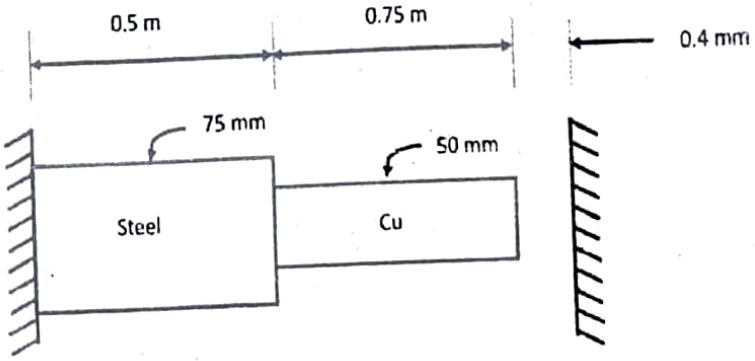
(e) Explain about two different end conditions for column and their respective equivalent length.

2. A member ABCD is subjected to point loads P1, P2, P3 and P4 as shown. Calculate the force P2 necessary for equilibrium if P1 = 45 kN, P3 = 420 kN, P4 = 120 kN. Determine the total elongation of the member assuming the modulus of elasticity to be 2.05×10^5 N/mm^2. The length and cross sectional area of AB, BC and CD are 1000 mm, 500 mm, 800mm and 500 mm^2, 2000 mm^2, 1200 mm^2 respectively. 8



Or

A rod consists of two parts that are made of steel and copper as shown in figure below. The elastic modulus and coefficient of thermal expansion for steel are 200 GPa and 11.7×10^{-6} per °C respectively and for copper 70 GPa and 21.6×10^{-6} per °C respectively. If the temperature of the rod is raised by 50°C, determine the forces and stresses acting on the rod. 8



3. Calculate the change in diameter, change in length and change in volume of a thin cylindrical shell of 100 cm diameter, 1 cm thick and 5 m long when subjected to an internal pressure of 3 N/mm^2.
Take $E = 2 \times 10^5$ N/mm^2 and $\mu = 0.3$. 8

Or

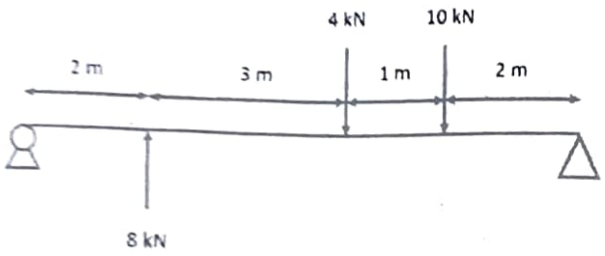
The maximum normal stress and the maximum shear stress analyzed for a shaft of 150 mm diameter under combined bending and torsion were found to be 120 MN/m^2 and 80 MN/m^2, respectively. Find the bending moment and torque to which the shaft is subjected. If the maximum shear stress be limited to 100 MN/m^2, find by how much the torque can be increased if the bending moment is kept constant. 8

4. The stresses in two perpendicular planes through a point in a body are 100 MPa and 50 MPa along with a shear stress of 30 MPa. Using Mohr's circle, determine (*i*) The magnitude and direction of Principal stresses (*ii*) The plane of maximum shear stress. Validate your answer with analytical method. 8

Or

A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 rpm. Determine the maximum internal diameter if the maximum stress in the shaft is not to exceed 60 N/mm^2. 8

5. Draw the shear force and bending moment diagram of a beam 5m long is simply supported at the ends as shown in figure below. 8



Or

A simply supported beam of span of 6 m is subjected to a load 150 kN and an anti-clockwise moment of 100 kN-m both at the centre of the span. Calculate the shear force and bending moment at critical points and draw the shear force and bending moment diagram. 8

6. A closed coil helical spring has a maximum load of 50 N and maximum shear stress induced is 100 MPa. The spring constant is 60 N/m in compression. If the solid length (coils touching) of the spring is 60 mm, determine the wire diameter and the coil diameter. Take G = 32 GPa. 8

Or

Find the shortest length of a hinged steel column having a rectangular cross section 600 mm × 100 mm, for which the elastic Euler formula applies. Take yield strength and modulus of elasticity value for steel as 250 MPa and 200 GPa respectively. 8