Indian Institute of Technology, Kharagpur

End Semester Examination, 2016

Mechanical Engineering Department

Subject: Mechanics of Solids **Subject No. : ME 31013**

Full Marks : 50 Time : 3 Hrs

Adopt appropriate assumption or data if it is necessary.

1. (a) Show that in case of bending of curved beam, the neutral axis is not a centroidal axis and it lies above the centroidal axis. (3+2)

(b) For the curved beam shown in Fig. 1, determine the maximum tensile stress in section **a-a**. Consider **P** = 30kN. In Fig. 1 all dimensions are in mm. (5)

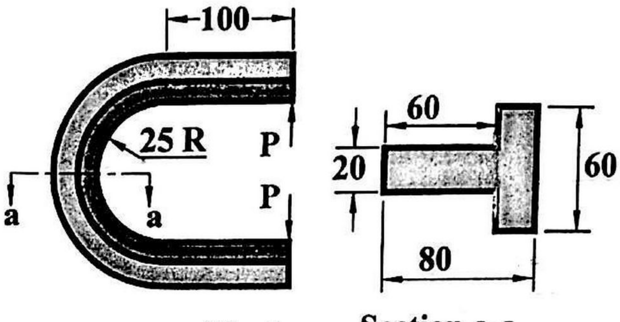

Fig. 1 **Section a-a**

2. A disc of inner radius **a** and outer radius **b** is fitted on a solid shaft of radius r_0 ($r_0 > a$). If the assembly of the shaft and the disc rotates, prove that the radial interference at the interface between the shaft and the disc at any rotating speed ω is given by

$$\delta = \frac{\rho(1-\upsilon)\omega^2}{4E}(r_0^3 - a^3) - \frac{3+\upsilon}{4E}\rho\omega^2 ab^2 + r_0 - a. \quad (6)$$

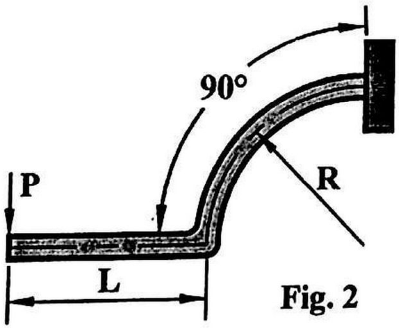

Fig. 2

3. A prismatic homogeneous isotropic beam is vertically loaded as shown in Fig. 2. The plane of the beam is also vertical. Determine the horizontal and vertical displacements at the at the point of application of the force **P**. (8)

4. Using virtual work principle derive the governing equation and boundary conditions for the buckling of the column as shown in Fig. 3 and determine the critical buckling load. (10)

5. A semi-infinite homogenous, isotropic and prismatic beam rested on an elastic foundation of modulus **k** is loaded with a uniformly distributed load **q** per unit length and a point force **F** as shown in Fig. 4. Derive the solution for the deflection of the beam. Also determine the location of the maximum bending moment and its magnitude. (5+3+2)

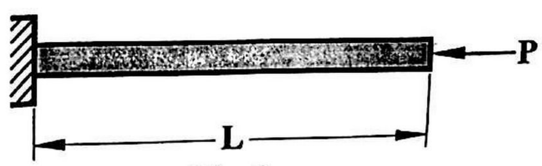

Fig. 3

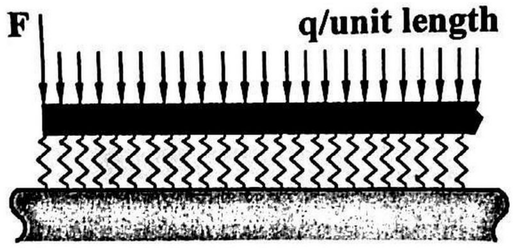

Fig. 4

6. (a) Show that the design using Tresca's failure theory is more conservative than that using von Mises' theory. (4)

(b) The octahedral shear stress at a point in a solid body is 1.247 MPa. Determine the von Mises stress at the same point. (2)