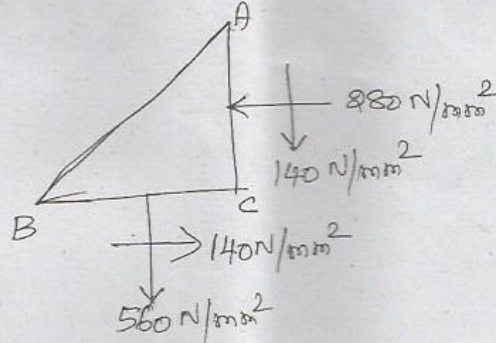




PART B — (5 × 13 = 65 marks)

11. (a) A tension bar 5 m long is made up of two parts, 3 metre of its length has a cross-sectional area of  $10\text{cm}^2$  while the remaining 2 m has a cross-sectional area of  $20\text{cm}^2$ . An axial load of 80 kN is gradually applied. Find the total strain energy produced in the bar and compare this value with that obtained in a uniform bar of the same length and having the same volume when under the same load. Take  $E = 2 \times 10^5 \text{ N/mm}^2$ .
- Or
- (b) State and prove Maxwell's reciprocal theorem.
12. (a) A fixed beam AB of length 6 m carries point loads of 160 kN and 120 kN at a distance of 2 m and 4 m from the left end A. Find the fixed end moments, support reaction, and also draw B.M and S.F. diagrams.
- Or
- (b) Draw the S.F and B.M diagram of a continuous beam ABC of length 10 m which is fixed at A and is supported on B and C. The beam carries a uniformly distributed load of 2 kN/m length over the entire length. The spans AB and BC are equal to 5 m each.
13. (a) Derive an expression for crippling load when one end of the column is fixed and the other end is force.
- Or
- (b) Determine the maximum and minimum hoop stress across the section of a pipe of 400 mm internal diameter and 100 mm thick, when the pipe contains a fluid at a pressure of 8  $\text{N/mm}^2$ . Also sketch the radial pressure distribution and hoop stress distribution across the section.
14. (a) At a point in a strained material, on plane BC there are normal and shear stresses of  $560 \text{ N/mm}^2$  and  $140 \text{ N/mm}^2$  respectively. On plane AC, perpendicular to plane BC, there are normal and shear stresses of  $280 \text{ N/mm}^2$  and  $140 \text{ N/mm}^2$  respectively as shown in Fig. below, Determine the following :
- (i) Principal stresses and location of the planes on which they act.
- (ii) Maximum shear stress.



Or



- (b) According to the theory of maximum shear stress, determine the diameter of a bolt which is subjected to an axial pull of 9 kN together with a transverse shear force of 4.5 kN. Elastic limit in tension is  $225 \text{ N/mm}^2$ , factor of safety = 3 and Poisson's ratio = 0.3.

15. (a) A beam of T-section (flange :  $100 \text{ mm} \times 20 \text{ mm}$ ; web :  $150 \text{ mm} \times 10 \text{ mm}$ ) is 2.5 metres in length and is simply supported at the ends. It carries a load of 3.2 kN inclined at  $20^\circ$  to the vertical and passing through the centroid of the section. If  $E = 200 \text{ GN/m}^2$ , calculate :
- (i) Maximum tensile and compressive stress
  - (ii) Position of the neutral axis.

Or

- (b) Derive the value of ' $h^2$ ' for a triangular section of a curved bar.

PART C — (1 × 15 = 15 marks)

16. (a) Explain the following :
- (i) Principle of virtual work. (5)
  - (ii) Castigliano's theorems. (5)
  - (iii) Strain energy due to torsion. (5)

Or

- (b) Explain the following :
- (i) The failure of short columns under compression. (7)
  - (ii) Distortion energy theories. (8)