

SOLUTION (Comprehensive examination 2016-17)

Mechanics of Solids (PART -A)

Ans: 1

Rigid Beam ACB Rotates through angle ' θ ' to close the gap

$$\tan \theta = \frac{BE}{AB} = \frac{\delta_c}{AC} \quad \text{Where } \delta_c = \text{deflection of CD due to close the gap}$$

$$\Rightarrow \delta_c = \frac{0.08 \times 1.5 \times 10^{-3}}{0.40} = 3 \times 10^{-4} \text{ m} \quad (1)$$

Again $\delta_c = \frac{F_{CD} L_{CD}}{E A_{CD}} \Rightarrow F_{CD} = \frac{200 \times 10^9 \times 3 \times 10^{-4} \times 3 \times 10^{-4}}{0.25} = 753.6 \text{ N} \quad (2)$

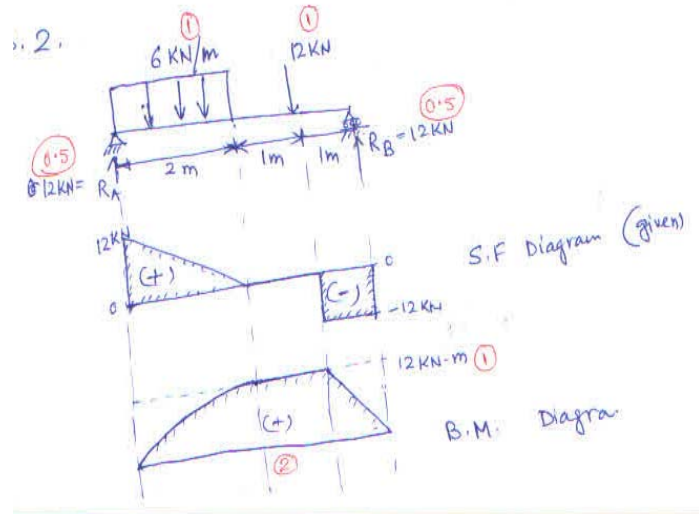
Where $A_{CD} = \frac{\pi}{4} \times (2 \times 10^{-3})^2 = 3.14 \times 10^{-6} \text{ m}^2$

F.B.D of ACB

$$\sum M_A = 0 \Rightarrow 0.08 \times F_{CD} = (0.40 - x) W$$

$$\Rightarrow x = 92.72 \text{ mm} \quad (1)$$

Ans:2



Ans 3

3.3

$$\sum M_x = 0$$

$$T_{AB} = 300 \times 0.25 = 75 \text{ N-m} \quad (1)$$

$$T_{BC} = 300 \times 0.25 - 300 \times 0.25 = 0 \Rightarrow T_{BC} = 150 \text{ N-m} \quad (1)$$

Maximum Shear Stress

$$I_P = \frac{\pi}{2} [0.0125^4 - 0.01^4] = 22.642 \times 10^{-9} \text{ m}^4$$

$$(\tau_{max})_{AB} = \frac{T_{AB} \cdot r_{max}}{I_P} = \frac{75 \times 0.0125}{22.642 \times 10^{-9}} = 41.4 \text{ MPa} \quad (1)$$

$$(\tau_{max})_{BC} = \frac{T_{BC} \cdot r_{max}}{I_P} = \frac{150 \times 0.0125}{22.642 \times 10^{-9}} = 82.8 \text{ MPa} \quad (1)$$

Min Shear Stress

$$(\tau_{AB})_{r=0} = \frac{T_{AB} \cdot r_{min}}{I_P} = 33.1 \text{ MPa}$$

$$(\tau_{BC})_{r=0} = 66.2 \text{ MPa}$$

AB Portion

BC Portion

Ans 4

$$I = \frac{\pi}{64} (d_2^4 - d_1^4) = \frac{\pi}{64} (40^4 - 30^4) = 85902.9 \text{ mm}^4 \quad (1)$$

$$P_{cr} = \frac{20.2 EI}{L^2} \quad (\text{For fixed-pinned end condition})$$

$$= \frac{20.2 \times 200 \times 10^9 \times 85902.9 \times 10^{-12}}{(2.1)^2} = 78.69 \text{ kN} \quad (1)$$

$$P_a = \frac{P_{cr}}{F.S} = \frac{78.69}{3} = 26.23 \text{ kN} \quad (1)$$

$$\sum F_y = 0 \Rightarrow P_a + 2T \cos \theta = 0 \quad (1)$$

$$T = -\frac{P_a}{2 \cos \theta}$$

$$\cos \theta = \frac{2.1}{\sqrt{2.1^2 + 2.1^2}} = 0.7241 \quad (1)$$

$$= -\frac{26.23}{2 \times 0.7241} = 18.11 \text{ kN} \quad (1)$$

Ans 5

5.

$$\sigma_x = 400 \mu, \sigma_y = 0$$

$$\tau_{xy} = -400 \mu \Rightarrow \frac{\tau_{xy}}{2} = -200 \mu$$

$$C = (200 \mu, 0)$$

$$\text{Radius of Mohr's Circle} = \sqrt{200^2 + 200^2} = 283 \mu \quad (1)$$

$$\sigma_A = OC + R = 483 \mu \quad (22.5^\circ \text{ from } x\text{-axis})$$

$$\sigma_B = OC - R = -83 \mu$$

Orientation of Principal Plane $\theta = 22.5^\circ$ from x -axis (1)

$$\theta = \tan^{-1} \frac{200}{200} = 45^\circ$$

$$\text{Maximum shear strain} = \gamma_{max} = 2R = 566 \mu \quad (1)$$