

**Third Semester B.E. Degree Examination, Dec.2017/Jan.2018**  
**Mechanics of Materials**

Time: 3 hrs.

Max. Marks:100

**Note: Answer FIVE full questions, selecting at least TWO questions from each part.**

**PART - A**

- 1 a. Define : (i) Elasticity (ii) Poisson's ratio (iii) Hooke's law (iv) Principle of superposition. (04 Marks)
- b. Prove that deformation in a uniform bar due to self weight is equal to half the deformation due to the force equal to its self weight. (06 Marks)
- c. A stepped bar is subjected to forces as shown in Fig. Q1 (c). Find the maximum value of P that will not exceed a stress in steel of 140 MPa, in aluminium of 90 MPa or in bronze of 100 MPa. (10 Marks)

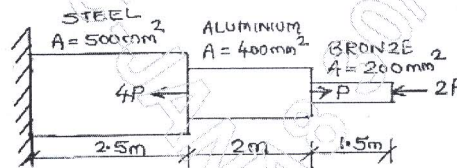


Fig. Q1 (c)

- 2 a. Define : (i) Volumetric strain (ii) Modulus of rigidity (02 Marks)
- b. Derive relation  $E = 3K(1 - 2\mu)$  between Young's modulus (E), bulk modulus (K) and Poisson's ratio ( $\mu$ ). (08 Marks)
- c. A steel tube of 30 mm external diameter and 20 mm internal diameter encloses a copper rod of 15 mm diameter to which it is rigidly joined at each end. If, at a temperature of  $10^\circ\text{C}$  there is no longitudinal stress, calculate stresses in rod and tube when the temperature is raised to  $200^\circ\text{C}$ . Take E for steel and copper as  $2.1 \times 10^5 \text{ N/mm}^2$  and  $1 \times 10^5 \text{ N/mm}^2$  respectively. The value of  $\alpha$  for steel and copper is given as  $11 \times 10^{-6} / ^\circ\text{C}$  and  $18 \times 10^{-6} / ^\circ\text{C}$  respectively. (10 Marks)
- 3 a. Show that sum of the normal stresses on any two planes at right angles in a general two dimensional stress system is constant. (06 Marks)
- b. Sketch the Mohr's circle for the following cases: (04 Marks)

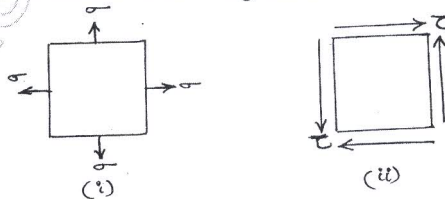


Fig. Q3 (b)

- c. A point in a strained material is subjected to the stresses as shown in Fig.Q3 (c). Evaluate principal stresses and locate principal planes. Sketch the planes. (10 Marks)

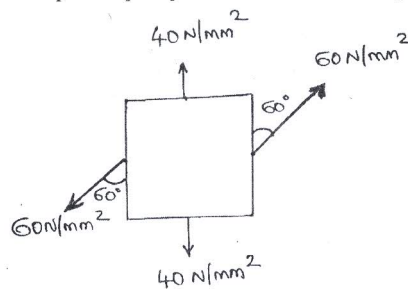


Fig. Q3 (c)

- 4 a. Derive the expressions for circumferential and radial stresses in the wall of thick cylinder (Lame's equation). (10 Marks)  
 b. The maximum stress produced by a pull in a bar of length 1 m is  $150 \text{ N/mm}^2$ . The bar details are given in Fig. Q4 (b). Calculate strain energy stored in the bar if  $E = 200 \text{ GPa}$ . (10 Marks)

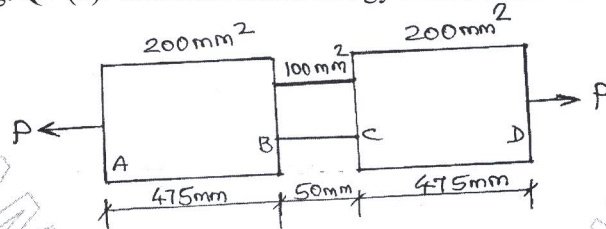


Fig. Q4 (b)

**PART - B**

- 5 a. Derive an expression to establish a relationship between the intensity of load  $W$ , shear force  $F$  and bending moment  $M$  in the beam. (06 Marks)  
 b. A beam 8 m long is simply supported at two points and loaded with concentrated loads, two UDL and a couple as shown in Fig. Q5 (b). Draw SF and BM diagrams. (14 Marks)

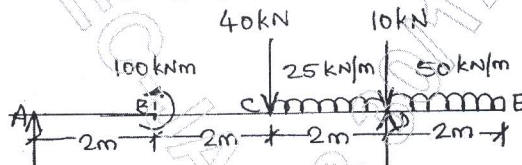


Fig. Q5 (b)

- 6 a. Prove that the maximum shear stress is 1.5 times the average shear stress in a beam of rectangular cross section. (06 Marks)  
 b. A T-shaped cross section of a beam of flange  $200 \text{ mm} \times 50 \text{ mm}$  and web  $200 \text{ mm} \times 50 \text{ mm}$  is subjected to a bending moment of  $15 \text{ kNm}$  and a shear force of  $10 \text{ kN}$  at a particular section. Draw the bending stress and shear stress distribution diagrams across the section. Indicate values at salient points. (14 Marks)

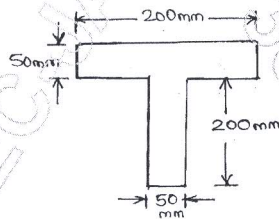


Fig. Q6 (b)

- 7 a. Derive an expression  $EI \frac{d^2y}{dx^2} = M$ , with usual notations. (08 Marks)  
 b. A Cantilever of length 3 m and cross section  $150 \text{ mm}$  width and  $300 \text{ mm}$  in depth is loaded as shown in Fig. Q7 (b). Take  $E = 2.1 \times 10^5 \text{ N/mm}^2$ . Calculate maximum slope and maximum deflection. (12 Marks)

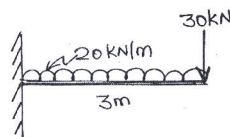


Fig. Q7 (b)

- 8 a. State at least 4 assumptions made in the Euler's theory of columns, and derive an expression for Euler's formula for a column when both ends are fixed. (10 Marks)  
 b. A hollow shaft of diameter ratio  $\frac{3}{5}$  is required to transmit  $700 \text{ kW}$  at  $110 \text{ rpm}$ . The maximum torque being 12% greater than the mean. The shearing stress is not exceed  $60 \text{ MPa}$  and twist in the length of 3 meters not to exceed  $1^\circ$ . Calculate the minimum external diameter. Take  $G = 0.8 \times 10^5 \text{ MPa}$ . (10 Marks)

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