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10ME/AU34

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)**

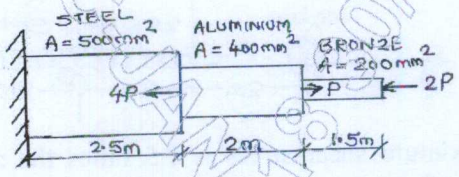

Fig. Q1 (c)

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 (μ). **(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°C there is no longitudinal stress, calculate stresses in rod and tube when the temperature is raised to 200°C. Take E for steel and copper as 2.1×10^5 N/mm^2 and 1×10^5 N/mm^2 respectively. The value of α for steel and copper is given as 11×10^{-6} /° C and 18×10^{-6} /° 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)**

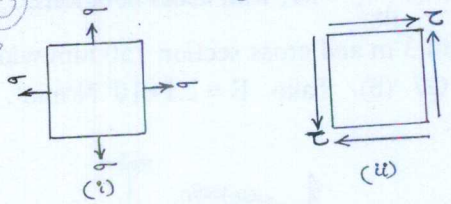

Fig. Q3 (b)

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)**

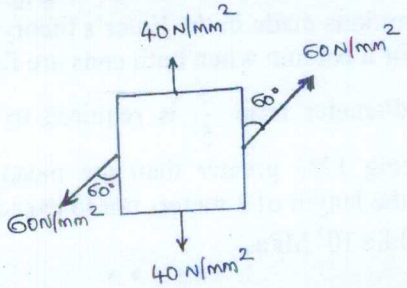

Fig. Q3 (c)

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 N/mm^2. The bar details are given in Fig. Q4 (b). Calculate strain energy stored in the bar if E = 200 GPa. **(10 Marks)**

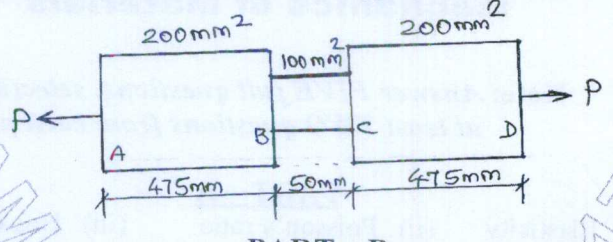

Fig. Q4 (b)

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)**

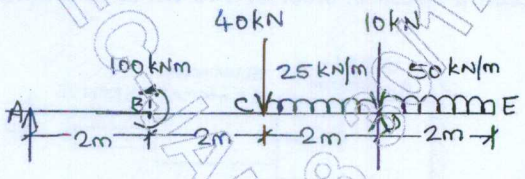

Fig. Q5 (b)

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 200mm × 50mm and web 200mm × 50mm is subjected to a bending moment of 15 kNm and a shear force of 10 kN at a particular section. Draw the bending stress and shear stress distribution diagrams across the section. Indicate values at salient points. **(14 Marks)**

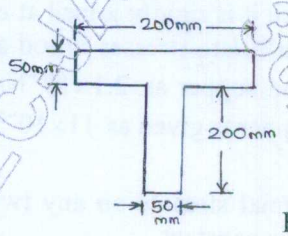

Fig. Q6 (b)

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 mm width and 300 mm in depth is loaded as shown in Fig. Q7 (b). Take $E = 2.1\times10^5$ N/mm^2. Calculate maximum slope and maximum deflection. **(12 Marks)**

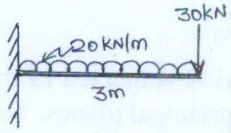

Fig. Q7 (b)

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 kW at 110 rpm. The maximum torque being 12% greater than the mean. The shearing stress is not exceed 60 MPa and twist in the length of 3 meters not to exceed 1°. Calculate the minimum external diameter. Take $G = 0.8\times10^5$ MPa. **(10 Marks)**

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