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## Third Semester B.E. Degree Examination, Dec.2018/Jan.2019

### Strength of Materials

Time: 3 hrs.

Max. Marks: 80

**Note: Answer FIVE full questions, choosing one full question from each module.**

#### Module-1

- 1 a. Derive an expression for the elongation of a rectangular tapering bar subjected to an axial pull P. (08 Marks)
- b. A stepped bar is subjected to external loading as shown in Fig. Q1 (b). Determine the magnitude of axial force P such that net deformation in the bar does not exceed 02 mm. E for steel is 200 GPa and that for copper is 100 GPa. Larger diameter and smaller diameters are 40 mm and 15 mm respectively. (08 Marks)

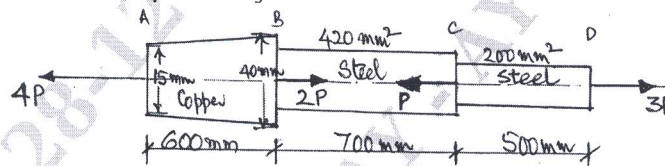


Fig. Q1 (b)

OR

- 2 a. Derive the relationship between modulus of elasticity (E), modulus of rigidity (C) and bulk modulus (K). (08 Marks)
- b. Two parallel walls 6 m apart are stayed together by a steel rod 25 mm diameter at a temperature of 80°C. Calculate the pull exerted by the steel rod when it is cooled to 20°C if, (i) the walls do not yield (ii) the walls yield together at two ends by 1.5 mm totally. Given:  $E = 2 \times 10^5 \text{ N/mm}^2$  coefficient of thermal expansion  $= \alpha = 11 \times 10^{-6} / ^\circ \text{C}$ . (08 Marks)

#### Module-2

- 3 a. Derive expression for principal stresses and their planes for a two dimensional stress system. (08 Marks)
- b. The state of stress in a two dimensionally stressed body is as shown in Fig. Q3 (b). Determine the principal planes, principal stresses, maximum shear stress and their planes. Schematically represent these planes on x-y coordinates: (08 Marks)

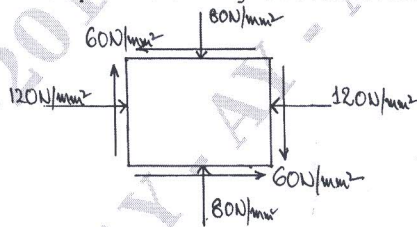


Fig. Q3 (b)

OR

- 4 a. Show that in the case of a thin cylindrical shell subjected to internal fluid pressure, the volumetric strain is equal to the sum of twice the hoop strain and longitudinal strain and also obtain expression for  $e_v = \frac{P.d}{2tE} \left[ \frac{5}{2} - \frac{2}{m} \right]$  with usual notations. (08 Marks)
- b. A thick cylinder of 250 mm internal diameter and 350 mm outer diameter contains a fluid at a pressure of 12 N/mm<sup>2</sup>. Determine the hoop stresses and radial stresses and draw a neat sketch showing the stress distribution across wall thickness. (08 Marks)

**Module-3**

- 5 a. Explain the different types of supports in beams with neat sketches. (06 Marks)  
 b. A overhanging beam with roller and hinged supports is as shown in Fig. Q5 (b). Draw bending moment and shear force diagrams for given loadings. (10 Marks)

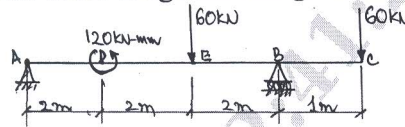


Fig. Q5 (b)

OR

- 6 a. Derive the relationship between intensity of loading, shear force and bending moment. (08 Marks)  
 b. Draw shear force and bending moment diagrams for a beam loaded as shown in Fig. Q6 (b). Indicate the point of inflexion and locate the points of contraflexure and also maximum bending moment. (08 Marks)

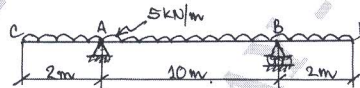


Fig. Q6 (b)

**Module-4**

- 7 a. Derive the bending stress equation,  $\frac{M}{I} = \frac{f}{y} = \frac{E}{R}$  with usual notations. (06 Marks)  
 b. A beam is of square cross section of sides 100 mm. If the permissible stress is  $70 \text{ N/mm}^2$ , find the moment of resistance of the beam section. Find whether there is any improvement in moment of resistance if the section is placed with one of the diagonals vertical. (10 Marks)

OR

- 8 a. Write a note on: (i) Effective length of columns (ii) Limitations of Euler's theory on columns. (08 Marks)  
 b. A hollow column of cast iron whose outside diameter is 200 mm has thickness of 20 mm. It is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate slenderness ratio and compare Euler's and Rankine's critical loads.

$$\text{Take critical stress} = \sigma_c = 550 \text{ N/mm}^2$$

$$\text{Rankine's constant} = \alpha = \frac{1}{1600}$$

$$\text{Elastic modulus} = E = 8 \times 10^4 \text{ N/mm}^2$$

(08 Marks)

**Module-5**

- 9 a. Derive the expression for torsion in circular shafts and state the assumptions. (08 Marks)  
 b. A solid shaft rotating at 500 rpm transmits 30 kW. Maximum torque is 20% more than mean torque. Allowable shear stress is 65 MPa, modulus of rigidity is 81 GPa and angle of twist in the shaft should not exceed  $1^\circ$  in 1 m length. Determine the suitable diameter. (08 Marks)

OR

- 10 a. Determine the ratio of power transmitted by a hollow shaft and a solid shaft when both have same weight length, material and speed. The diameter of solid shaft is 150 mm and external diameter of hollow shaft is 250 mm. (08 Marks)  
 b. (i) What is the significance and importance of theories of failure?  
 (ii) Explain the maximum principal stress theory (Rankine's) (08 Marks)

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