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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME3PCSOM **Max Marks: 100**
Course: Strength of Materials

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.

UNIT - I

1 a) A bar of thickness t tapers uniformly from a width of b_1 at one end to b_2 at other end over a length L. Obtain the expression for the change in length of the bar if it is subjected an axial force P. Deduce this expression for a bar of uniform width. **07**

b) For a solid subjected to uniform hydrostatic pressure p, $\sigma_x = \sigma_y = \sigma_z = -p$, write expression for volumetric strain/dilation. A steel cube is subjected to a hydrostatic pressure of 1.5 MPa. Because of this pressure the volume decreases to give a dilatation of -10^{-5}. The Young's modulus of the material is 200 GPa. Determine Poisson's ratio of the material and also the bulk modulus. **06**

c) A 12 meters long A36 Steel (E=200 GPa and $\alpha=12\times10^{-6}/^0C$) rails on a track are laid with a small gap between them to allow for thermal expansion as in fig 1c. Determine the required gap δ so that the rails just touch one another when temperature is increased from $T_1 = -29^0C$ to $T_2 = 32^0$ C. What would be the axial force if the temperature were to further rise to 43 ^{0}C ? The Cross-sectional area of each rail is 0.0033 m^2 **07**

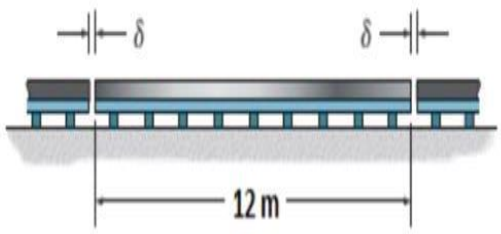

Fig 1c

OR

2 a) The state of plane stress at a failure point on the shaft is shown in Fig. 2a. Represent this stress state in terms of the principal stresses and directions. Also determine maximum shear stress and the normal stress on the plane of maximum shear stress and the directions of maximum shear stresses. **14**

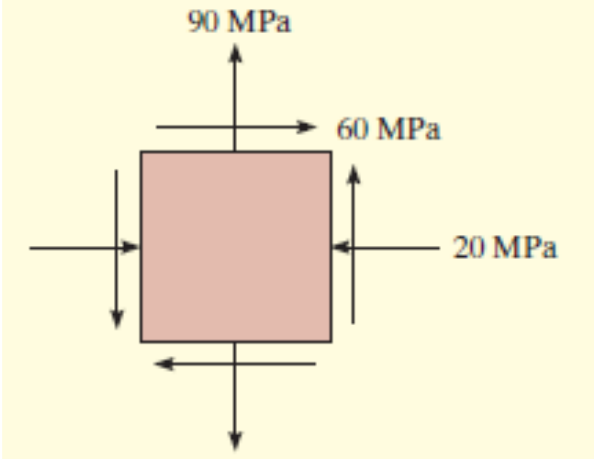

Fig. 2a

b) The assembly shown in Fig. 2b consists of an aluminium tube AB having a cross-sectional area of 400 mm^2. A steel rod having a diameter of 10 mm is attached to a rigid collar and passes through the tube. If a tensile load of 80 kN is applied to the rod, determine the displacement of the end C of the rod. Take E_{st} = 200 GPa, E_{al} = 70 GPa **06**

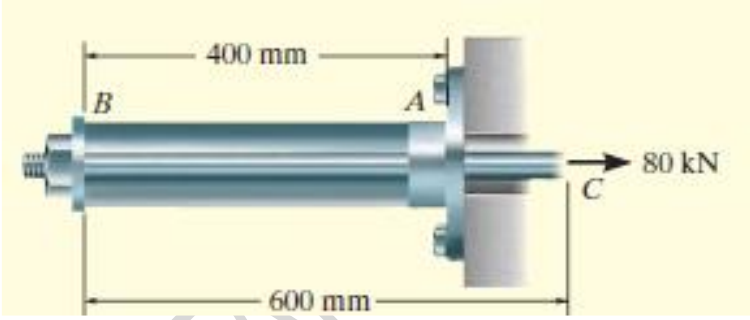

Fig. 2b

UNIT - II

3 a) Write relationship between rate of loading, shear force and bending moments. For a cantilever beam write SFD and BMD for the following cases **10**

i. End load 'F'
ii. UDL' w ' throughout
iii. Clockwise End moment 'M'
iv. Linearly varying load with w at fixed end and 0 at free end.

b) Draw the shear force and bending moment diagrams for a simply supported beam subjected to the loads as shown in fig3b. Also find the location of point of contraflexure. **10**

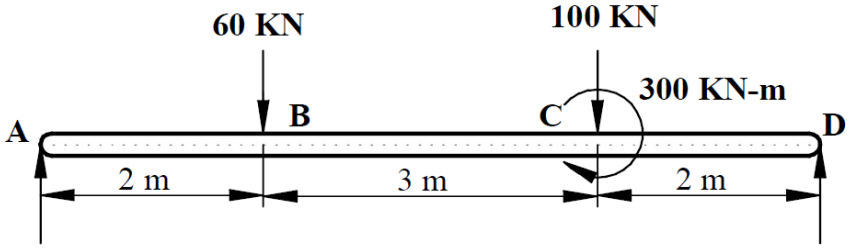

fig3b

UNIT - III

4 a) With usual notations, derive the Euler-Bernoulli bending equation of the form **10**

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

b) Determine the maximum shear stress acting at section a–a of the cantilevered strut shown in Figure Q4b **10**

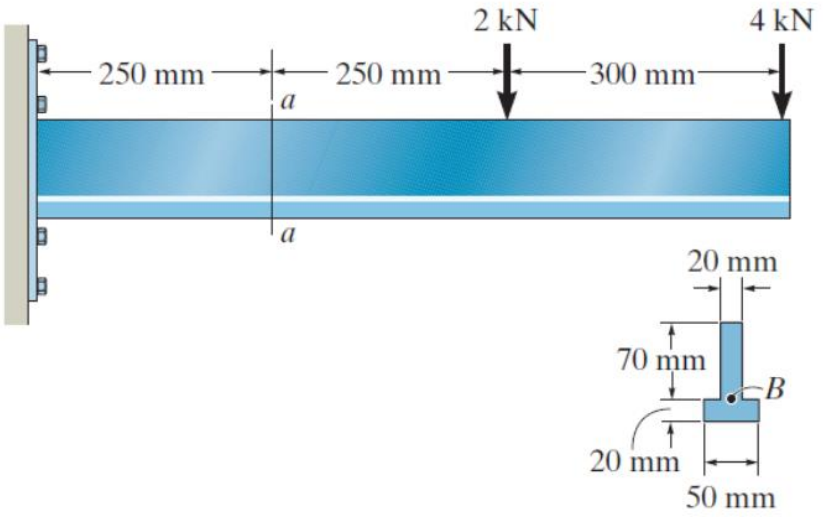

Figure Q4b

OR

5 a) The extruded beam shown in Fig. 5a is made of aluminium alloy having an allowable working stress in either tension or compression of 90 MPa. The beam is a cantilever, subject to a uniform vertical load. Determine the allowable intensity of uniform loading. **08**

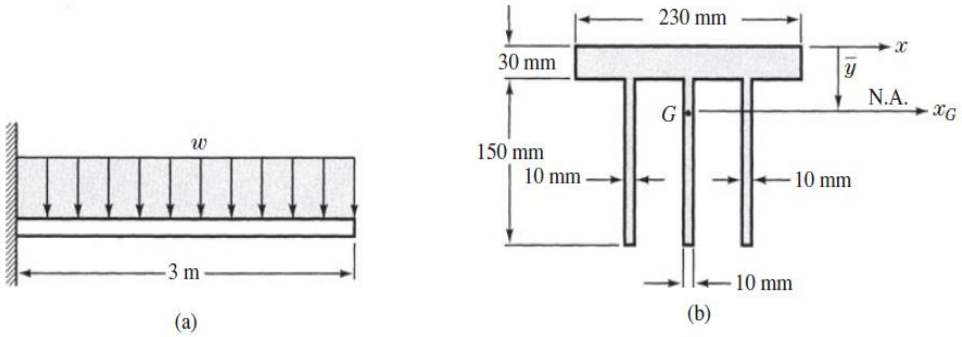

Fig 5a.

b) Determine the deflection and slope of the of a cantilever beam loaded with **12**

i. Point Load F at free end

ii. UDL of w throughout

What will be the deflection at free end for combination of above two cases

UNIT - IV

6 a) Stare assumptions and derive torsion equation for solid shaft. Also extend it to hollow shaft. **12**

b) Two wrenches are used to tighten the pipe as in fig 6b. If P = 300 N is applied to each wrench, determine the maximum torsional shear stress developed within region BC. The pipe has an outer diameter of 25 mm and inner diameter of 20 mm. Sketch the shear stress distribution **08**

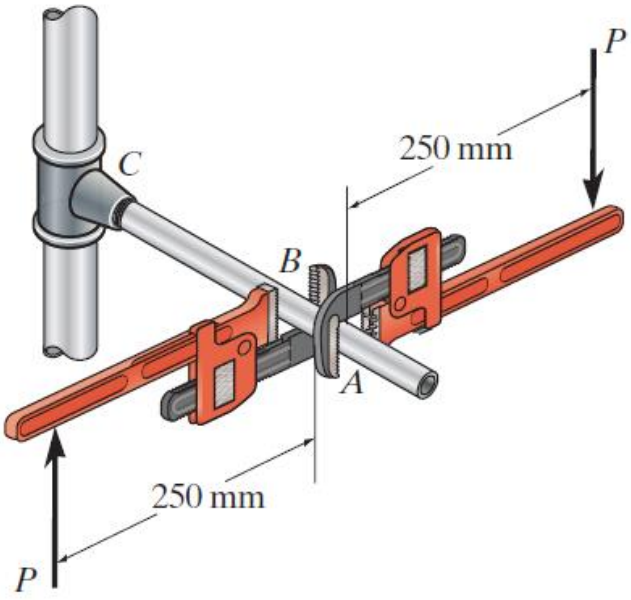

Fig.6b

UNIT - V

7 a) Derive Euler's expression for buckling load in a column fixed at one and free at other end. **10**

b) A thick cylinder of internal diameters of 500 mm is subjected to an internal pressure of 9 MPa. Taking allowable stress for the material of the cylinder as 40 MPa, determine: **10**

i. Wall thickness of the cylinder
ii. Hoop stress at outer radius and
iii. % error involved if thickness is calculated based on thin vessel theory

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