B.E.(with Credits)-Regular-Semester 2012 - Mechanical Engineering Sem IV

ME403 - Mechanics of Material

P. Pages : 4 **GUG/W/16/3926**

Time : Three Hours * 4 0 4 1 * Max. Marks :80

Notes : 1. All questions carry equal marks.
2. Answer Q. 1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q. 6, Q. 7, or Q. 8, and Q. 9, or Q. 10.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of DDB by prof B.D. Shiwelkar is permitted.

1. a) Define Normal stress and bearing stress. **2**

b) An axial load on the shaft shown in fig (1-b) is resisted by collar at c, which is attached to the shaft and located on the right side of the bearing at B. Determine the largest value of P for the two axial forces at E and F so that bearing stress in the collar does not exceed an allowable bearing stress (σb) allow = 75 Mpa and Normal stress in the shaft does not exceed allowable tensile stress (σf) allow = 55 Mpa. **8**

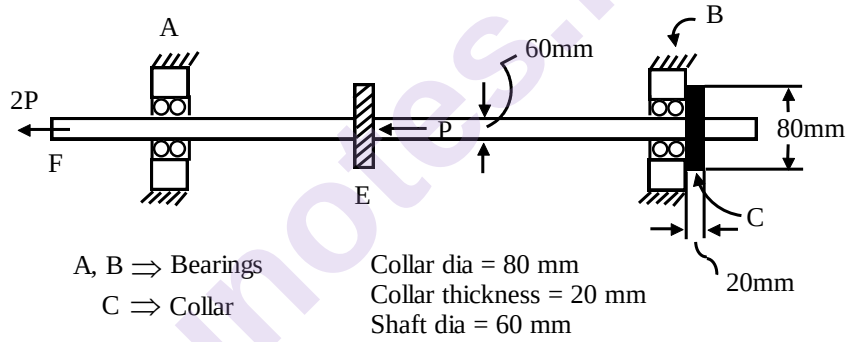


Fig. 1 (b)

c) A bar made of steel having Young's modulus of elasticity E = 200 x 10^9 Pa, is subjected to tensile load of 80 kN, as shown in Fig (1- c). **6**

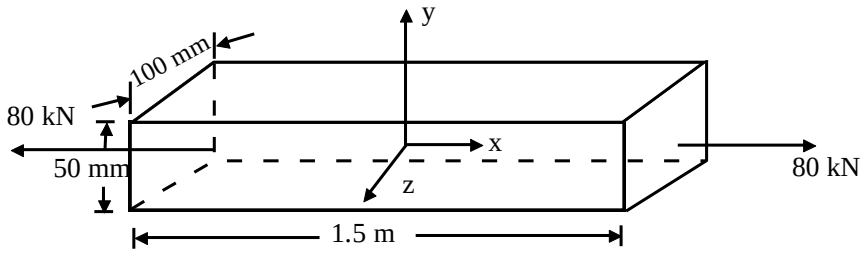


Fig. 1 (c)

Determine change in length (δx), change in breadth (δz) and change in height (δy) if the Poisson's ratio $\mu = 0.32$.

OR

2. a) Define lateral strain, longitudinal strain, and Poisson's ratio (μ) young's modulus of elasticity (E) and shear modulus of elasticity (G). Also state the relation between E, μ and G. **3**

b) An aluminium specimen shown in fig (2-b) has a diameter of do = 25 mm and gauge length Lo = 250 mm. If a force of 165 kN, elongates the gauge length 1.2 mm, determine modulus of elasticity (E). Also determine, by howmuch the diameter of specimen get contract. Take modulus of rigidity G = 26 Gpa. **8**

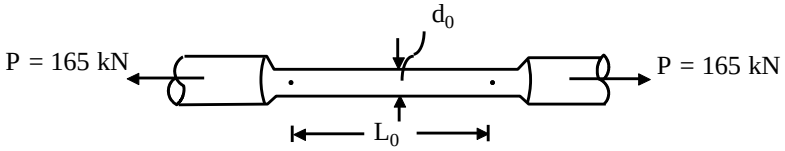


Fig. 2 (b)

c) The steel pipe is filled with concrete and subjected to compressive load of 80kN. Determine the stress in the concrete and steel due to loading. The pipe has outer dia. of 80 mm and inner dia. of 70 mm. Take E_{st} = 200 Gpa and E_c = 24 Gpa. **5**

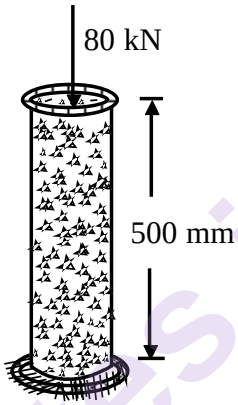
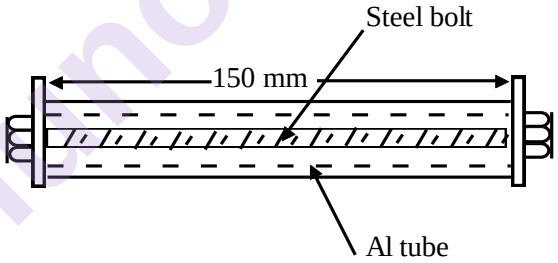


Fig. 2 (c)

3. a) An assembly of Aluminium tube and steel bolt as show in fig (3-a) is tightened will Nut. **8**



When initial temp of assembly is 15ºC, the bolt is stress free. If the temp of assembly is increased to 80ºC, Determine the stresses induced in tube and bolt.
Take

$\alpha_{bolt} = 12 \times 10^{-6} / ^\circ C$ and $E_{bolt} = 200$ Gpa.

$\alpha_{tube} = 23 \times 10^{-6} / ^\circ C$ $E_{tube} = 73$ Gpa.

b) A cantilever, circular rod of dia 50 mm and length 250 mm. is subjected to point load of 3kN and torque of 1 kN-m at its free end. **8**
Determine:

i) Maximum principal stress (σ_1)
ii) Minimum principal stress (σ_2) and
iii) Maximum shear stress (τ_{max}) at critical points.

OR

4. A simply supported beam ABCD, having total span of 10 m is supported at its ends A and D. It is subjected to point loads of 50 kN at B and 40 kN at C. It also carries UDL of 10 kN/m on span BC of 4 m. Draw shear force and Bending moment diagram for the beam. Find Max^m Bending moment and Locate point of contraflexure if any. Take AB = 2m, BC = 4m and CD = 4m. **16**

5. a) A cantilever beam of span 'L' is subjected to point load 'W' at its free end. Show that the maximum deflection at its free end is given by equation **8**

$$y_{max} = \frac{WL^3}{3EI}$$

where EI $\Rightarrow$ flexural rigidity of beam.

b) A simply supported beam ABCD, having span of 6m is supported at ends A and D. It carries UDL of 40 kN/m over its entire span. Find the deflection of beam at points B and C Take AB = 1m, BC = 3m and CD = 2m. Take EI = 17000 kN·m^2. **8**

OR

6. An overhung beam ABC of total span of 9m (with AB = 6m and BC = 3m) is supported at A and B and part BC is overhung. It carries UDL of 6 kN/m on part AB and point load of 10 kN at point C. Find deflection of beam at midpoint of AB and at C Also determine slope at point C. **16**

Take $E = 2 \times 10^5$ MPa and $I = 5 \times 10^8$ mm^4.

7. a) If the shaft of diameter 'D' is subjected to torque 'T', then show that torsional shear stress (τ_{xy}) induced in shaft is given by expression $\tau_{xy} = \frac{T}{z_p}$ **8**

where T $\Rightarrow$ Torque applied in N. M. and

Z_p = polar modulus for shaft c/s

$$= \frac{\pi}{16} D^3 \text{ in } m^3$$

b) If shaft of diameter 'D' is supported in bearings A and B, which are 2 m apart. It transmitts power 75kw at 200 rpm. It also carries pulley having weight of 200 N, at its center. Determine diameter of shaft required, if Max^m shear stress induced in shaft is limited to 60 MPa. **8**

OR

8. a) State the assumptions made in 'Euler's coloumn theory. **4**

b) A hollow CI coloumn whose O.D is 200mm and I. D is 160 mm is fixed at both ends. Length of column is 4.5m. Calculate safe load by Rankine formula. Take F. S = 4. Calculate slenderness ratio and ratio of Euler critical load to Rankine critical load **12**

Take $\sigma_c = 550$ MPa

$\alpha = 1/1600$ and

$E = 9.4 \times 10^4$ MPa

9. a) State the difference between Gradually applied load and impact load. **2**

b) Show that the instantaneous stress developed during axial impact load is twice the stress developed during gradually axial load. **6**

c) A weight of 10kN falls through a height of 50 mm on a collar rigidly attached to a lower end of vertical bar 3 m long having crossectional area 1000mm^2 **8**
Determine :
i) Instantaneous elongation induced in a bar in mm
ii) Instantaneous stress developed in a bar in MPa
Take E = 210 GPa.

OR

10. a) A shaft of diameter D = 75mm is supported in bearings and subjected to three torques at points A, B, C as shown in Fig (10-a) **8**

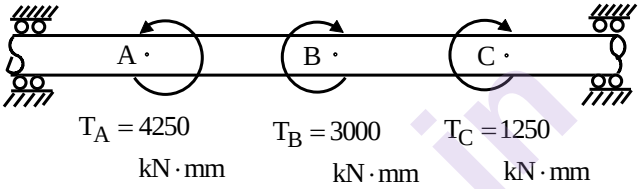


Fig. 10 (a)

Determine torsional shear stress developed at points P and Q.
i) Point P is at the outer surface of shaft.
ii) Point Q is at distance of 15mm from center of shaft

b) A Simply supported beam is made of timber that has allowable bending stress $(\sigma_b = 6.5\,\text{MPa})$. Determine its height (h) and breadth (b) if it is to be rectangular with $\left(\frac{h}{b}\right) = 1.25$ **8**

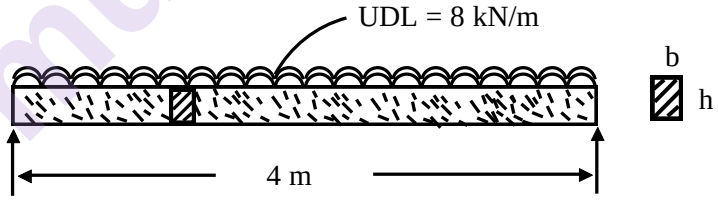


Fig. 10 (b)

The beam carries UDL of 8 kN/m over its whole span.

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