CBCS SCHEME

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17MT33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following :
i) Hooke's law
ii) Poisson's ratio
iii) Factor of safety
iv) Principle of superposition. **(04 Marks)**

b. A bar of uniform thickness 't' tapers uniformly from a width of b_1 at one end to b_2 at other end, in a length of 'L'. Find the expression for the change in length of the bar when subjected to an axial force P. **(08 Marks)**

c. Find the total elongation of the bar shown below. Take $E = 1.05 \times 10^5 N/mm^2$. **(08 Marks)**

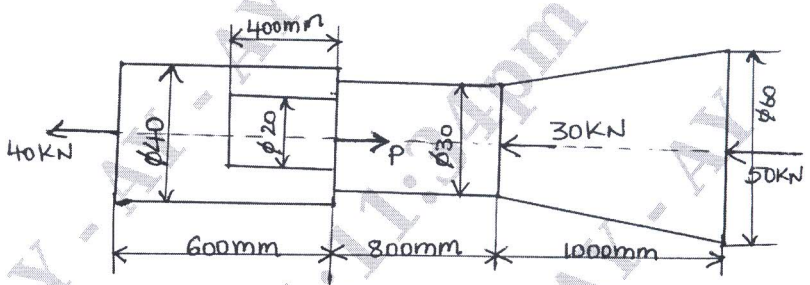

Fig.Q1(c)

OR

2 a. Derive the expression of volumetric strain due to three mutually perpendicular stresses. **(08 Marks)**

b. A solid steel bar 500mm long and 70mm diameter is placed inside aluminium tube having 75mm inside diameter and 100 mm outside diameter. The aluminium cylinder is 0.15mm longer than the steel bar. An axial load of 600kN is applied to the bar and the cylinder through rigid cover plates as shown below Fig.Q2(b). Find the stresses developed in steel bar and the aluminium tube. Assume $E_S = 210 kN/mm^2$ and $E_{Al} = 70 kN/mm^2$. **(12 Marks)**

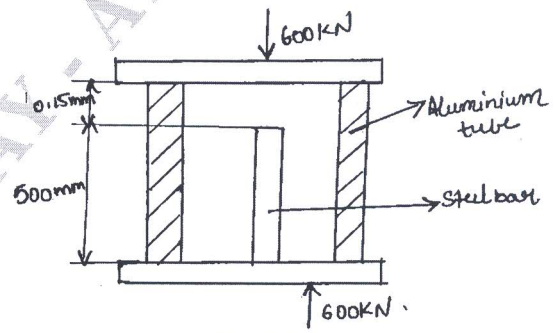

Fig.Q2(b)

Module-2

3 a. Derive the expression for a rectangular bar is subjected to two direct stresses σ_x and σ_y in two mutually perpendicular directions. Prove that the normal stress (σ_n) and shear stress (τ) on an oblique plane which is inclined at an θ with the axis of minor stress, are given by :

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta \text{ and } \tau = \frac{\sigma_x - \sigma_y}{2} \cdot \sin 2\theta .$$ **(08 Marks)**

b. A plane element is subjected to stresses as shown in Fig.Q3(b). Determine principal stress, maximum shear stress, their planes and normal stress on maximum shear plane. Sketch the planes. **(12 Marks)**

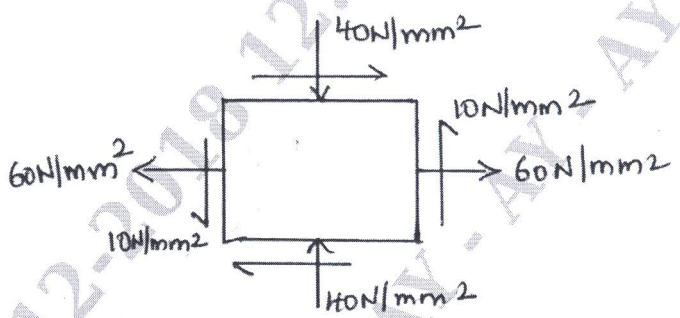

Fig.Q3(b)

OR

4 a. Define the principal stresses and principal planes. **(04 Marks)**

b. The state of stress in two dimensionally stressed body is shown in Fig. Q4(b). Determine the principal stresses, principal planes, maximum shear stress and their planes. Also draw the Mohr's cycle to verify the results obtained analytically. **(16 Marks)**

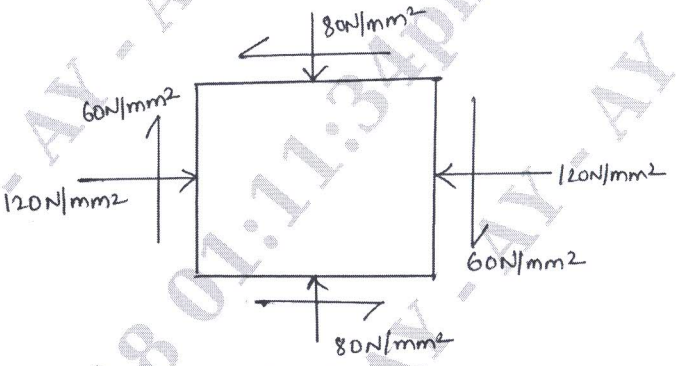

Fig.Q4(b)

Module-3

5 a. Explain the terms :
- i) Sagging bending movement
- ii) Hogging bending moment
- iii) Point of contrafluxture. **(06 Marks)**

b. Draw the shear force and bending moment diagram for the beam loaded as shown in Fig.Q5(b). Locate the point of contrafluxrue if any. **(14 Marks)**

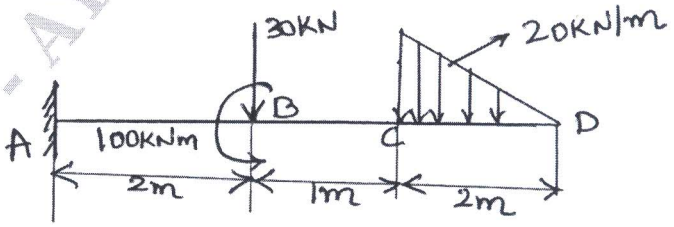

Fig.Q5(b)

OR

6 a. Define a Beam. Explain with simple sketches, different types of beams. **(04 Marks)**

b. Draw the shear force and bending moment diagram for the beam given in Fig.Q6(b). Locate the points of contrafluxure. **(16 Marks)**

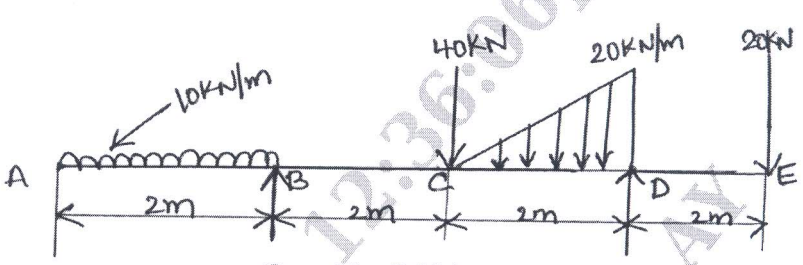

Fig.Q6(b)

Module-4

7 a. What are the assumptions made in theory of bending? **(04 Marks)**

b. Prove that $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations. **(08 Marks)**

c. A beam of an I-section consists of 180 mm × 15 mm flanges and a web of 280mm depth × 15mm thickness. It is subjected to a bending moment of 120 KNm and a shear force of 60kN. Sketch the bending stress distribution along the depth of the section. **(08 Marks)**

OR

8 a. Derive Euler Bernoulli equation for deflection. **(10 Marks)**

b. A simply supported beam [steel] having uniform cross-section is 14m span and is simply supported at its ends. It carries a concentrated load of 120kN and 80kN at two points 3m and 4.5m from the left and right end respectively. If the moment of inertia of the section is $160 \times 10^7 mm^4$ and E = 210GPa calculate the deflection of the beam at load points. **(10 Marks)**

Module-5

9 a. State the assumptions in the theory of pure torsion and derive the torsional equation of shear stress produced in a circular shaft subjected to torsion. **(08 Marks)**

b. Compare the weight, strength of hollow shaft of same external diameter as that of solid shaft. The inner diameter of hollow shaft is half the external diameter. Both the shafts have the same material, length. **(06 Marks)**

c. A hollow shaft having internal diameter 40% of its external diameter, transmits 562.5kW power at 100 rpm. Determine the internal and external diameter of shaft if the shear stress is not to exceed $60N/mm^2$ and the twist in a length of 2.5m should not exceed 1.3 degrees. The maximum torque being 25% greater than mean modulus of rigidity = $9 \times 10^4 N/mm^2$. **(06 Marks)**

OR

10 a. Define slenderness ratio and derive Euler's expression for buckling load for column with both ends hinged. **(10 Marks)**

b. A hollow CI column whose outside diameter is 200mm has a thickness of 20mm. It is 4.5m 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 the ratio of Euler's and Rankine's critical loads. Take $f_c = 550N/mm^2$, $\alpha = \frac{1}{1600}$ in Rankine's formula and $E = 9.4 \times 10^4 N/mm^2$. **(10 Marks)**

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