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18MR34

Third Semester B.E. Degree Examination, July/August 2022
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) Hook's law ii) Modulus of elasticity. **(04 Marks)**

b. A Steel bar of 1.5m length and uniform section of 500mm^2 is suspended vertically and loaded as shown in Fig Q1(b). Taking E = 2 × 10^{5}N/mm^2. Determine the total elongation of the bars neglecting the self weight of the bar.

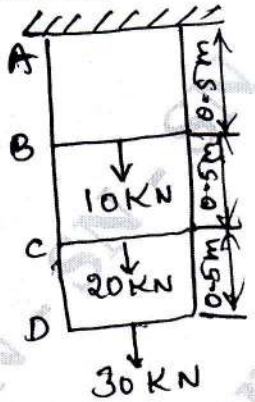

Fig Q1(b) **(08 Marks)**

c. Derive an expression for total elongation in an uniformly tapering rectangular bar section. **(08 Marks)**

OR

2 a. Define the following (i) Poisson's ratio (ii) Volumetric strain. **(04 Marks)**

b. A weight of 300kN is supported by a short concrete column of 250mm square section. The column is reinforced with 4 steel bars of cross sectional area 5500mm^2. Find the stresses in the steel and the concrete if $E_s = 15E_c$. If the stress in the concrete mast not exceed 4.5mN/m^2, what area of steel is required inorder that the column may support a load of 500kN. **(10 Marks)**

c. Derive an relation between Young's modulus, modulus of rigidity and bulk modulus. **(06 Marks)**

Module-2

3 a. A machine components to subjected to the stress as shown in Fig Q3(a). Find the normal and shearing stresses on the section AB inclined at an angle of 60° with X-X axis. Also find the resultant stress in the section.

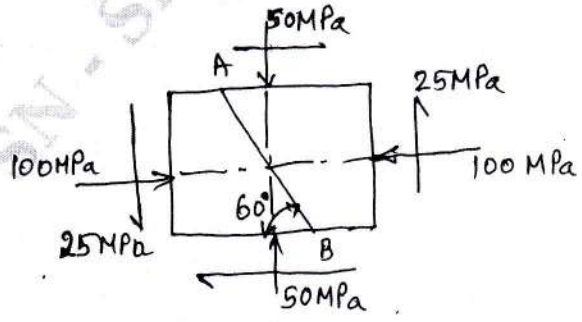

Fig Q3(a) **(10 Marks)**

b. The state of stress in a strained material is as shown in Fig Q3(b). Determine the normal, tangential and resultant stress on plane DE by Mohr's circle method. Also determine the direction of resultant stress.

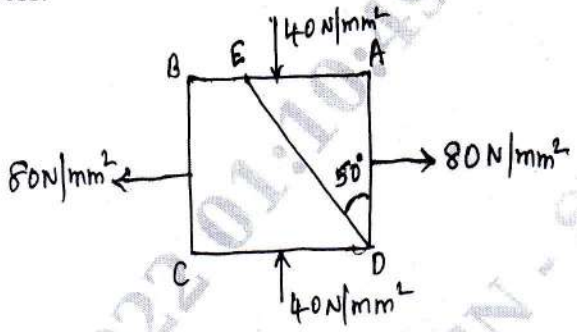

Fig Q3(b) **(10 Marks)**

OR

4 a. Form a thin cylindrical shell, the ℓ/d ratio is 3 and its initial volume is $20m^3$. The ultimate stress for the cylinder material is 200MPa. Determine the wall thickness, if it has to convey water under a head of 200mm. Take FOS as 2. **(10 Marks)**

b. Derive Lame's equation for radial and hoop stress in car of thick cylinder. **(10 Marks)**

Module-3

5 a. Sketch and explain different types of beams. **(06 Marks)**

b. A cantilever of length 2m carries a UDL of 10kN/m length over the cohol length and a point load of 5kN at the free end. Find the reaction at the fixed end and draw the SFD and BMD for the beam. **(14 Marks)**

OR

6 a. Explain the sign conventions for shear force and bending moment. **(05 Marks)**

b. Draw shear force and bending moment diagram for the beam shown in Fig Q6(b) making values at salient point.

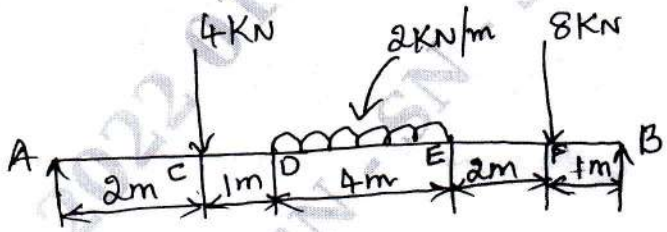

Fig Q6(b) **(15 Marks)**

Module-4

7 a. State the assumption made in Simple bending. **(05 Marks)**

b. Derive an bending equation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$. **(15 Marks)**

OR

8 a. The beam of symmetrical section and 200mm deep is simply supported over a span of 4m. Find the (i) UDL it may carry if the maximum bending stress is not to exceed $100N/mm^2$. (ii) Maximum bending stress if the beam carries a central load of 40kN. Take $I = 10 \times 10^6 mm^4$. **(10 Marks)**

b. A simply supported beam of I section carries a UDL 40kN/m run on entire span of beam length 10m. If I section has dimensions as shown in Fig Q8(b), determine the maximum stress produced due to bending.

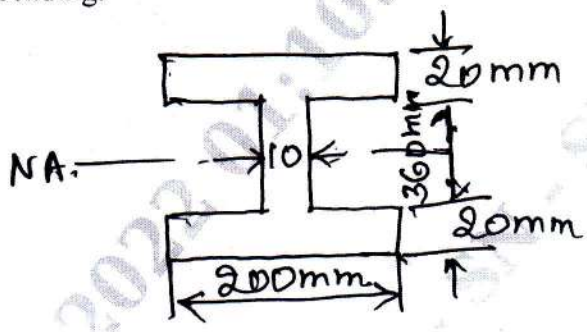

Fig Q8(b) **(10 Marks)**

Module-5

9 a. Derive an expression for comparison of torsional strength of hollow and solid shaft. **(08 Marks)**

b. A solid shaft rotating at 1000rpm transmits 50kW. Maximum torque is 20% more than the mean torque. Material of the shaft has the allowable shear stress of 50MPa and the modulus of rigidity 80GPa. Angle of shift in the shaft should not exceed 1° in 1m length. Determine the diameter of the shaft. **(12 Marks)**

OR

10 a. Derive an expression for Euler's crippling load for a column when both of its ends are fixed. **(10 Marks)**

b. A 1.5m long column has a circular cross section of 50mm diameter. One end of the column is fixed in direction and position and the other end is free. Taking FOS as 3 calculate the safe load using

i) Rankine's formula a taking yield stress 560N/mm^2 and $\alpha = \frac{1}{1600}$

ii) Euler's formula, taking E = 1.2 × 10^{5}N/mm^2. **(10 Marks)**

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