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15ME/MA34

Third Semester B.E. Degree Examination, July/August 2021
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions.

1 a. Explain in brief, the terms 'stress' and its types, and 'strain' and its types. **(06 Marks)**

b. For a laboratory tested specimen, the following data were obtained:
Diameter of the specimen = 25 mm
Length of the specimen = 300 mm
Extension of specimen under a load of 15 kN = 0.045 mm
Load at yield point = 127.65 kN
Maximum load = 208.6 kN
Length of specimen after failure = 375 mm
Neck diameter at failure = 17.75 mm
Determine: (i) Young's modulus (ii) Yield point stress (iii) Ultimate stress
(iv) Percentage elongation (v) Percentage reduction in area **(10 Marks)**

2 a. A uniformly tapering circular bar having smaller diameter d_1 and larger diameter d_2 at the two ends is subjected to a pull of P. If the length of the bar is 'L', find the total deformation in the bar. **(08 Marks)**

b. A stepped bar with varying cross sections is subjected to forces as shown in Fig.Q2(b) below:

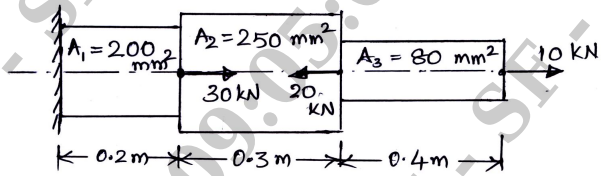

Fig.Q2(b)

Determine the net deformation in the bar if the Young's modulus of bar material is 2×10^5 N/mm^2. **(08 Marks)**

3 a. When a certain thin walled tube is subjected to internal pressure and torque, the stresses in the tube wall are (i) 120 MPa (tensile – x direction) , (ii) 60 MPa (tensile – y direction), (iii) complimentary shear stress of 90 MPa in the directions of (i) and (ii).
Find the normal and tangential stress on the two planes which are equally inclined to stresses in (i) and (ii). **(08 Marks)**

b. At a point in a bracket, the stresses on two mutually perpendicular planes are 35 MPa (tensile) and 15 MPa (tensile). The shear stress across these planes is 9 MPa. Find the magnitude and direction of the resultant stress on a plane making an angle of 40° with the plane of first stress. Find also, the normal and tangential stress on the plane. Use Mohr's circle method. **(08 Marks)**

4 a. A thin cylinder of diameter 'd', wall thickness 't' and length 'L' is subjected to an internal fluid pressure of 'p'. Find the equations for circumferential and longitudinal stresses induced in the cylinder material. Draw neat sketches wherever necessary. **(08 Marks)**

b. A pipe of 400 mm internal diameter and 100 mm wall thickness carries a fluid at a pressure of 80 MPa. Calculate the maximum and minimum hoop stresses across the section. Also, sketch the distribution of radial and hoop stresses across the thickness of the cylinder. **(08 Marks)**

5 a. What is a beam? With neat sketches, explain briefly the types of beams and the loads they carry. **(08 Marks)**

b. A cantilever beam 2m long carries a UDL of 1.5 kN/m over the entire span. It also carries a point load of 2 kN at a distance of 0.5 m from the free (right) end. Draw the SFD and BMD of the beam. **(08 Marks)**

6 a. Derive the differential equation of deflection (Euler-Bernoulli). List the assumptions made in the derivation. **(08 Marks)**

b. A uniform I - section beam is 5m long and carries a UDL of 83 kN/m on its entire span. The I - section is 100 mm wide and 150 mm deep. The thickness of flanges is 25 mm each and the web thickness is 12 mm. If the beam is simply supported, determine the bending stress in the beam. **(08 Marks)**

7 a. Derive torsion equation using suitable notations. Draw neat sketches wherever necessary. **(10 Marks)**

b. Determine the diameter of a steel shaft which will transmit 90 KW of power at 160 rpm. The maximum shear stress induced is 60 MPa. Find also the length of the shaft if the twist in the shaft must not exceed 1° over the entire length. Take G = 80 GPa. **(06 Marks)**

8 a. A column of length ℓ, having its moment of inertia as I and Young's modulus E carries a compressive load of P. If the column is hinged at both the ends, find the Euler's buckling load equation for the column. **(08 Marks)**

b. A 1.5 m long, circular C/S column of 50 mm diameter has one of its ends fixed in direction and position while the other end is free. Taking a factor of safety of 3, calculate the safe load the column can carry using:

(i) Rankine formula, with yield stress as 560 N/mm^2 and constant $\alpha = \frac{1}{1600}$.

(ii) Euler's formula, taking $E = 1.2 \times 10^5$ N/mm^2. **(08 Marks)**

9 a. A stepped bar of 1 m length is subjected to an axial pull such that the maximum tensile stress is equal to 150 MPa. Calculate the strain energy stored in the bar if E = 200 GPa. [Refer Fig.Q9(a)]

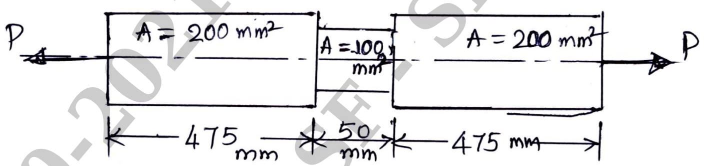

Fig.Q9(a) **(08 Marks)**

b. Find an expression for the strain energy due to bending of a beam of length 'L', simply supported at the ends and carrying a UDL of W/unit length over its entire length. The beam is of constant cross-section throughout its length having flexural rigidity as EI. **(08 Marks)**

10 a. In a metallic body, the principal stresses are +35 MPa and −95 MPa, the third principal stress being zero. The elastic limit stress in simple tension as well as in simple compression is equal and is 220 MPa. Find the factor of safety based on the elastic limit if the criterion of failure for the material is the maximum principal stress theory. **(08 Marks)**

b. A mild steel shaft 120 mm diameter is subjected to a maximum torque of 20 kN-m and a maximum bending moment of 12 kN-m at a particular section. Find the factor of safety according to maximum shear stress theory if the elastic limit in simple tension is 220 MN/m^2. **(08 Marks)**

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