STRENGTH OF MATERIALS
(MECH 2102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Toughness of a material signifies
(a) strength (b) softening
(c) brittleness (d) fatigue resistance.

(ii) Which one of the following properties cannot be evaluated by static tension test?
(a) Shear strength (b) Modulus of elasticity
(c) Ductility (d) Poisson's ratio.

(iii) The shear force at certain section of a beam is zero the corresponding bending moment at that section will be
(a) minimum (b) maximum
(c) zero (d) either minimum or maximum.

(iv) For a cantilever beam with transverse load at free end, the maximum bending stress is generated at
(a) free end (b) middle section
(c) any where in the beam (d) the fixed end.

(v) For a solid shaft of diameter d, the polar moment of inertia is _____
(a) $(\pi/32)\ d^4$ (b) $(\pi/64)\ d^4$ (c) $(\pi/32)\ d^3$ (d) $(\pi/32)\ d^2$

(vi) A structural member subjected to an axial compressive force is called
(a) beam (b) column (c) frame (d) strut.

(vii) Slenderness ratio of a column is defined as the ratio of its length to its
(a) least radius of gyration (b) least lateral dimension
(c) maximum lateral dimension (d) maximum radius of gyration.

(viii) If a part is constrained to move and heated, it will develop
(a) tensile stress (b) compressive stress
(c) shear stress (d) no stress.

(ix) Modulus of rigidity is defined as the ratio of
(a) longitudinal stress and longitudinal strain
(b) volumetric stress and volumetric strain
(c) lateral stress and lateral strain
(d) shear stress and shear strain

(x) In cantilever beam, slope and deflection at free end is _____
(a) zero (b) maximum
(c) minimum (d) none of the above.

Group – B

2. (a) A gap of 0.5 mm exist between the ends of the aluminium and steel rods at a temperature of 20°C as shown in Fig.1. If the temperature is raised to 100°C calculate.
(i) The stress in the bars
(ii) Change in length of each bar
$E_a = 0.75 \times 10^5$ N/mm^2 $A_a = 2000$ mm^2 $\alpha_a = 23 \times 10^{-6}$ per°C
$E_s = 1.9 \times 10^5$ N/mm^2 $A_s = 800$ mm^2 $\alpha_s = 17.3 \times 10^{-6}$ per°C

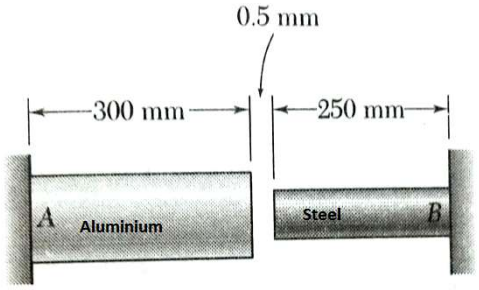

Fig.1

(b) Derive the expression for Volumetric Strain of isotropic homogeneous (i) rectangular bar, (ii) cylindrical rod. Assume suitable dimensions.

(6 + 2) + (2 + 2) = 12

3. (a) Two cylindrical rods, one of steel and other of brass, are joined at C and restrained by rigid supports at A and E. For the loading shown in Fig 2. and knowing E_s = 200 GPa and E_b = 105 GPa, determine (i) the reactions at A and E (ii) the deflection of point C.

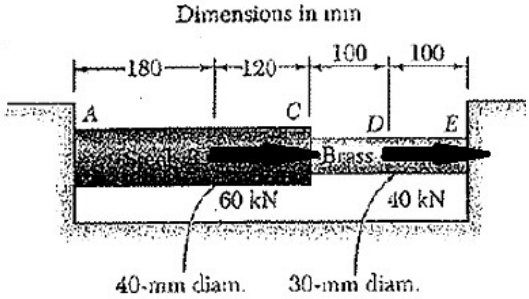

Fig.2

(b) Derive the relationship in between E and K in terms of ν. All the notations are carrying their usual meaning.

(3 + 4) + 5 = 12

Group – C

4. For the state of plane stress shown in Fig 3. Determine (i) the principal planes (ii) the principal stresses (iii) the maximum shearing stress and corresponding normal stress.

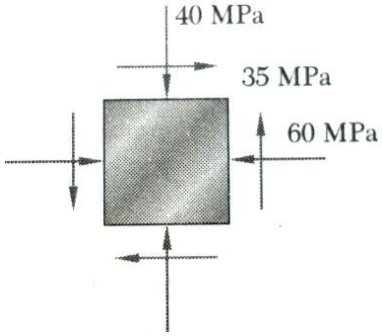

Fig.3

(4 + 4 + 2 + 2) = 12

5. (a) A cantilever of length 2 m carries a uniformly distributed load of 2500 N/m for a length of 1.25 m from the fixed end and a point load of 1000 N at the free end. If the section is rectangular 120 mm side and 240 mm deep, find the deflection at the free end. Take E = 10000 MPa.

   (b) A water main 80 cm diameter contains water at a pressure head of 100 m. If the weight density of water is 9810 N/m^3, find the thickness of the metal required for the water main. Give the permissible stress as 20 MPa.

7 + 5 = 12

Group – D

6. Draw the Shear Force and Bending Moment Diagrams for the timber beam and loading shown in Fig.4. Also determine the maximum normal stress due to bending.

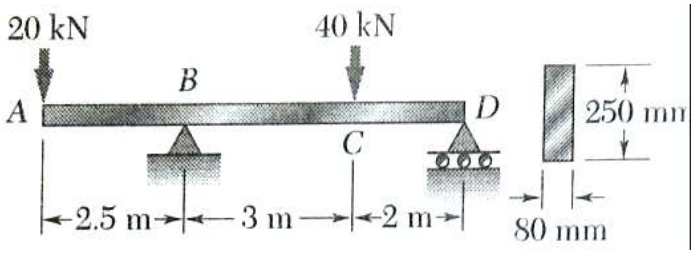

Fig.4

(5 + 5 + 2) = 12

7. Draw the Shear and Bending-Moment diagrams for the beam and loading shown in Fig 5.

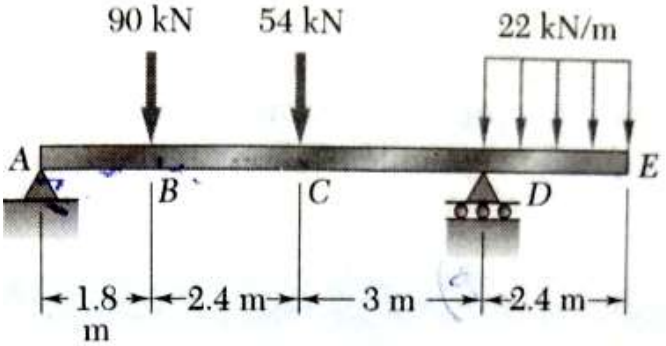

Fig.5

(6 + 6) =12

Group – E

8. (a) Prove that for a solid circular shaft $T/J = \tau/r = G\varphi/L$
Where T ,J , τ, r, G, φ, L has their usual meaning.
Also write the assumptions made.

(b) The torques shown in Fig.6. are exerted on pulleys A, B, C. Knowing that both shafts are solid and made of brass(G = 39 GPa), determine (a) shearing stress in shaft AB (b) shearing stress in shaft BC (c) the angle of twist between A and B (d) the angle of twist between A and C.

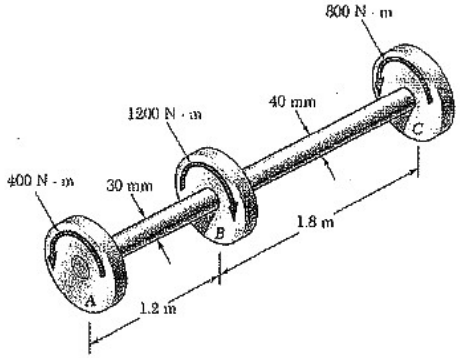

Fig.6

(3 + 2) + (3 + 2 + 1 + 1) = 12

9. (a) Write down the assumption made in Euler's Theory of Long Column.

(b) A horizontal beam ABC 2.4 m long is pinned to a support at C and supported by a vertical aluminium tube 3.0 m long as shown in Fig.7. The upper end of the tube is hinged to the beam while its lower end is firmly fixed. The beam carries a load of 300 kN at A. Find the thickness of the tube if its outer diameter is 120 mm. Allow a factor of safety of 2 with respect to Euler critical load. Take $E = 7.2 \times 10^4$ N/mm^2.

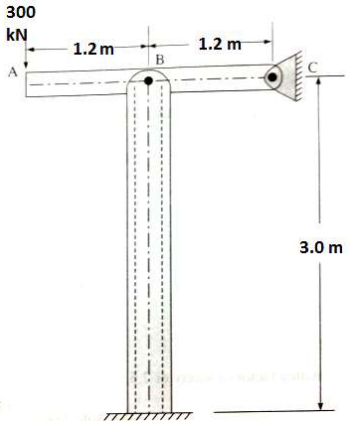

Fig.7

4 + (4 + 4) = 12

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ME	https://forms.gle/CHjwnUCNZfRDFSz89 Class code: kg42pvw