(vii) Point of contraflexure of a beam is defined as the point where
(a) shear force is maximum
(b) bending moment is maximum
(c) shear force changes its sign
(d) bending moment changes its sign.

(viii) Maximum deflection in a cantilever beam of length l carrying a load p at its end will
(a) $pl^3/3EI$ (b) $pl^2/8EI$ (c) $pl^3/32EI$ (d) $pl^2/4EI$.

(ix) Which of the following is the largest allowable diameter of a 3 m long steel rod (G = 77 GPa) if the rod is to be twisted through 30° without exceeding a shearing stress of 80 MPa?
(a) 17.85 mm (b) 11.9 mm (c) 5.95 mm (d) 8.9 mm.

(x) The Rankine's formula holds good for
(a) short columns (b) long columns
(c) both short and long columns (d) weak columns.

Group - B

2. (a) A bar system is loaded as shown in Fig. 1. Determine. (i) the reaction of the lower support, and (ii) the stresses in the bar. Take E=205 GPa.

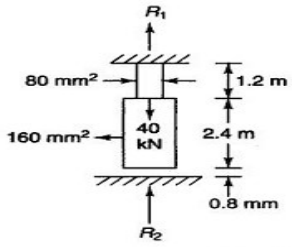

Fig. 1

(b) A uniformly tapered rod, as shown in Fig. 2, is held between two rigid supports at room temperature. The rod is made of steel with E = 200GPa and coefficient of thermal expansion is 12 X $10^{-6}/^0$C. Find out the maximum stress induced in the rod if temperature is raised by 30^0C.

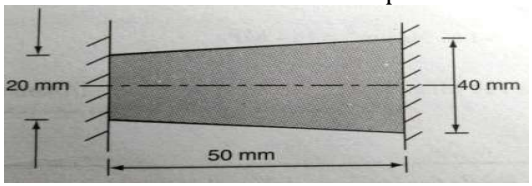

Fig. 2

6 + 6 = 12

MPa. Also determine the torque if the solid shaft is replaced hollow shaft of the same mass and of 90 *mm* inner diameter.

(b) Determine the critical load P_{cr} and the equation of the buckled for an ideal column with ends fixed against rotation (see Fig. solving the differential equation of the deflection curve.

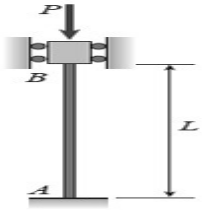

Fig. 6

(2 + 2) + 8

9. (a) The torques shown in Fig. 7, are exerted on pulleys A, B, C. Knowir both shafts are solid and made of brass(G = 40 GPa), dete (a) shearing stress in shaft AB (b) shearing stress in shaft BC (angle of twist between A and B (d) the angle of twist between A ar

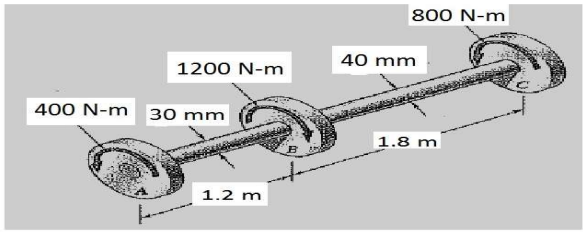

Fig. 7

(b) An aluminum tube AB of circular cross section has a guided supp the base and is pinned at the top to a horizontal beam suppor load Q = 200 *kN* (see figure 8). Determine the required thickne the tube if its outside diameter d is 200 *mm* and the desired fac safety with respect to Euler buckling is n = 3.0. (Assume E = 72 G

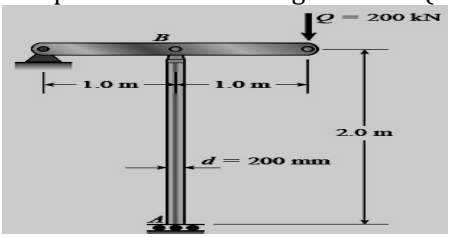

Fig. 8

6 + 6

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) If the radius of a wire is doubled, then its Young's modulus will be
(a) doubled (b) halved
(c) become four times (d) remain unchanged.

(ii) The shape of the bending moment diagram over the length of a beam, carrying a uniformly distributed load is always
(a) parabolic (b) linear
(c) circular (d) cubical.

(iii) The ratio of elongations of a conical bar and that of a prismatic bar of the same length due to its own weight is
(a) 1/5 (b) 1/2 (c) 1/3 (d) 1/4.

(iv) Radius of the Mohr's circle signifies
(a) major principal stress (b) minor principal stress
(c) maximum shear stress (d) none of the above.

(v) Hoop stress of a thin cylinder of diameter *d* and thickness *t* subjected to pressure *p* will be
(a) *pd/2t* (b) pd/4t (c) *4p/td* (d) 2p/td.

(vi) The shear stress at any section of a shaft of radius r is maximum
(a) at the top of the surface
(b) at the centre of the section
(c) at a distance r/2 from the centre
(d) at a distance 3r/4 from the centre.

3. (a) Three wires of the same material and cross-section support a rigid bar which further supports a weight of 5 kN as shown in Fig. 3. The length of the wires is 5 m, 8 m and 6 m in order. The spacing between the wires is 2 m and weight acts at 1.6 m from the first wire. Determine the load carried by each wire.

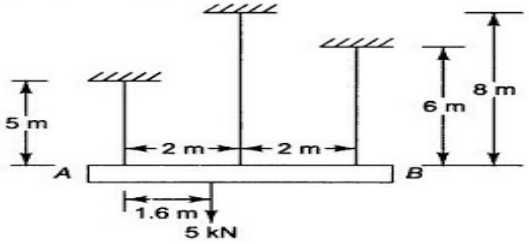

Fig. 3

(b) (i) A bar of 30 *mm* diameter is subjected to a pull of 60 *kN*. The measured extension on a gauge length of 200 *mm* is 0.08 *mm* and the change in diameter is 0.004 *mm*. Calculate the Poisson's ratio and the values of the three moduli.

(ii) Define: Modulus of resilience and toughness.

7 + (3 + 2) = 12

Group - C

4. (a) Direct stresses of 160 MPa tensile and 120 MPa compressive exist on two perpendicular planes at a certain point in a body. They are also accompanied by shear stresses on the planes. The greatest principal stress at the point due to these is 200 MPa. (i) What must be the magnitude of the shearing stresses on the planes? (ii) Draw the Mohr's circle and find out the maximum shear at the point.

(b) Using moment area method find out the deflection of a simply supported beam of span l, carrying a point load W at mid span.

(3 + 5) + 4 = 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 1000N 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 hollow cylindrical drum 600 *mm* in diameter has a thickness of 10 *mm*. If the drum is subjected to an internal air pressure of 3 N/mm^2, determine the longitudinal and circumferential strain (Take E = 200 *GPa* and Poisson's ratio is 0.3).

8 + 4 = 12

B.TECH/ME/3RD SEM/MECH 2102/2016

3. (a) Three wires of the same material and cross-section support a bar which further supports a weight of 5 kN as shown in Fig. The length of the wires is 5 m, 8 m and 6 m in order. The sp between the wires is 2 m and weight acts at 1.6 m from the first Determine the load carried by each wire.

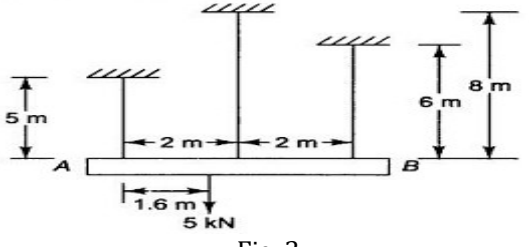

Fig. 3

(b) (i) A bar of 30 *mm* diameter is subjected to a pull of 60 *kN* measured extension on a gauge length of 200 *mm* is 0.08 *mm* the change in diameter is 0.004 *mm*. Calculate the Poisson's and the values of the three moduli.

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(3 + 5) +

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(b) A hollow cylindrical drum 600 *mm* in diameter has a thickness *mm*. If the drum is subjected to an internal air pressure of 3 *N*, determine the longitudinal and circumferential strain (Take *E* *GPa* and Poisson's ratio is 0.3).

8 +

Group - D

6. (a) Draw the S.F. and B.M. diagram for the overhanging beam carrying loads as shown in Fig. 4. Locate the point of contraflexure, if any, uniformly distributed and concentrated.

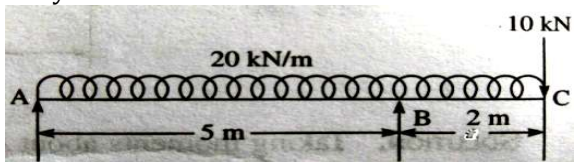

Fig. 4

(b) Show that for a beam of rectangular section, the maximum shear stress is 1.5 times the average stress.

8 + 4 = 12

7. (a) An I–section shown in Fig. 5 is simply supported over a span of 12 m. If the maximum permissible bending stress is 80 N/mm^2, what concentrated load can be carried at a distance of 4 m from one support?

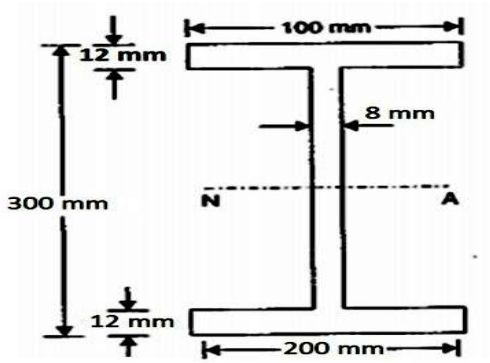

Fig. 5

(b) Write short note on pure bending of beam.

OR

Define slenderness ratio of a column and show the variation of compressive stress induced in a column with the above ratio.

9 + 3 = 12

Group - E

8. (a) Determine the torque which may be applied to a solid shaft of 90 *mm* outer diameter without exceeding an allowable shearing stress of 75

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Group - D

6. (a) Draw the S.F. and B.M. diagram for the overhanging beam ca loads as shown in Fig. 4. Locate the point of contraflexure, i uniformly distributed and concentrated.

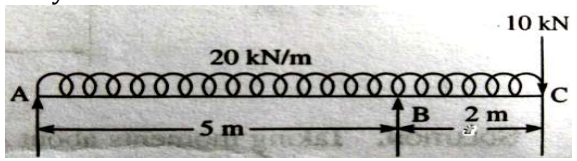

Fig. 4

(b) Show that for a beam of rectangular section, the maximum stress is 1.5 times the average stress.

8 +

7. (a) An I–section shown in Fig. 5 is simply supported over a span of If the maximum permissible bending stress is 80 N/mm^2, concentrated load can be carried at a distance of 4 m fror support?

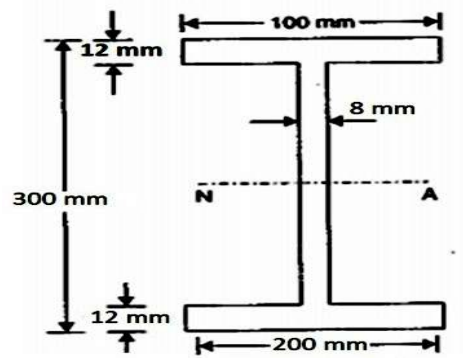

Fig. 5

(b) Write short note on pure bending of beam.

OR

Define slenderness ratio of a column and show the variati compressive stress induced in a column with the above ratio.

9 +

Group - E

8. (a) Determine the torque which may be applied to a solid shaft of 9 outer diameter without exceeding an allowable shearing stress