(vii) For a Column having one end fixed and other end free possess minimum critical load for buckling P_{cr} is

(a) $P_{cr} = \frac{\pi^2 EI}{4L^2}$ (b) $P_{cr} = \frac{\pi^2 EI}{L^2}$

(c) $P_{cr} = \frac{4\pi^2 EI}{L^2}$ (d) none of these.

(viii) Maximum deflection of simply supported beam with a central point load W is

(a) $Wl^3/4EI$ (b) $Wl^3/8EI$

(c) $Wl^3/24EI$ (d) $Wl^3/48EI$.

(ix) Euler's formula holds good only for

(a) short columns (b) long columns

(c) both short and long columns (d) weak columns.

(x) The expression for total angle of twist of a circular cross section bar having cross sectional polar moment of inertia 'J', length 'L' and Modulus of rigidity 'G' subjected to torque 'T' is

(a) $\frac{TL}{GJ}$ (b) $\frac{TJ}{GL}$ (c) $\frac{GJ}{TL}$ (d) none of these.

Group – B

2. (a) A circular steel bar ABCD, rigidly fixed at A and D is subjected to axial loads of 50 kN & 100 kN at B and C as shown in figure below. Find the loads shared by each part of the bar and the displacements of the points B and C. Take E_{steel} = 200 GPa. 50kN and 100 kN loads act at points B and C respectively. Refer to the following figure 1.

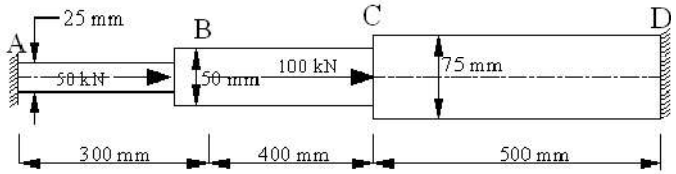

Figure 1

(b) Prove that the deformation of a body due to its self weight is equal to half of the deformation, if the same body is subjected to a direct load equal to the weight of the body.

(3 + 4) + 5 = 12

3. (a) A rigid steel plate is supported by three concrete posts having 10 cm × 10 cm cross-section as shown in the figure 2. By accident the middle post is 0.05 cm shorter than the other two before load *P* applied. Find safe value of load *P* if the working stress for the concrete in compression is 200 kg/cm² and the modulus of elasticity $E_c = 12(10)^4$ kg/cm².

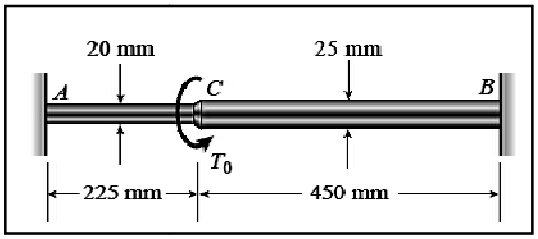

Figure 5

(b) A closed coiled helical spring has a stiffness of 10 N/mm. Its l when fully compressed, with adjacent coils touching each ot 400 mm. the modulus of rigidity of the spring is 8×10^4 N/mm².

(i) Determine the wire diameter and the mean coil diameter i ratio = 1/10.

(ii) If the gap between any two adjacent coils is 2 mm, maximum load can be applied before the spring becomes i.e., adjacent coils touch?

(iii) What is the corresponding maximum shear stress in the spr

6 + (2 + 2 + 2

9. (a) Derive the expression for Critical Load of a column fixed at the and pinned at the top (as shown in figure 6).

Consider here —

- Modulus of rigidity of the column material is 'E'.
- Moment of Inertia of the column cross-section 'I'.

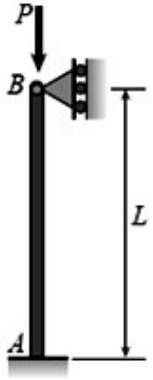

Figure 6

(b) A horizontal beam ABC 1.8 m long is pinned to a support at supported by a pin ended vertical steel column 1.75 m long as s in the figure 7. The column is of square section of side 50 mm.

on the critical load of the column, find the safe load Q that can be applied at A with a factor of safety of 2. Take E = 2 × 10^5 N/mm^2.

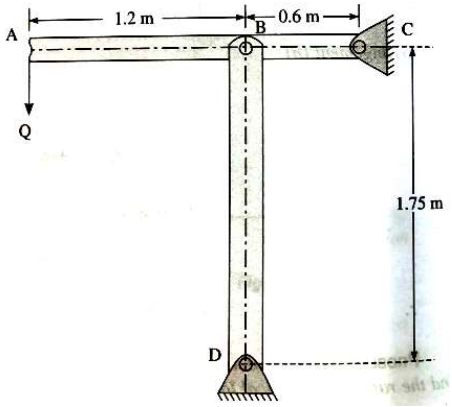

Figure 7

7 + 5 = 12

STRENGTH OF MATERIALS
(MECH 2102)

Time Allotted : 3 hrs **Full Mark**

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 practica

Group – A
(Multiple Choice Type Questions)

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

(i) The Young's modulus, when the radius of wire stretched by a l halved, will be
(a) unaffected (b) doubled
(c) halved (d) quadrupled.

(ii) For incompressible material, the maximum value of Poisson's ratio
(a) 0.20 (b) 0.3 (c) 0.5 (d

(iii) The materials which exhibit same elastic properties in all dire are called
(a) Homogeneous (b) Isotropic
(c) Isentropic (d) Inelastic.

(iv) When a body is subjected to a direct tensile stress (σ) in one then normal stress on an oblique section of body inclined at an a to the normal of the section is given by
(a) $\sigma \sin^2\theta$ (b) $\sigma \cos^2\theta$
(c) $\sigma \sin 2\theta$ (d) $\sigma \cos 2\theta$.

(v) In Mohr's circle radius is taken as
(a) $\frac{\sigma_x - \sigma_y}{2}$ (b) $\frac{\sigma_x + \sigma_y}{2}$
(c) $\sqrt{\frac{(\sigma_x - \sigma_y)^2}{2} + \tau_{xy}^2}$ (d) $\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

(vi) Contra-flexture point is one where
(a) bending moment is zero (b) shearing force is
(c) bending moment changes sign (d) shearing force is maxi

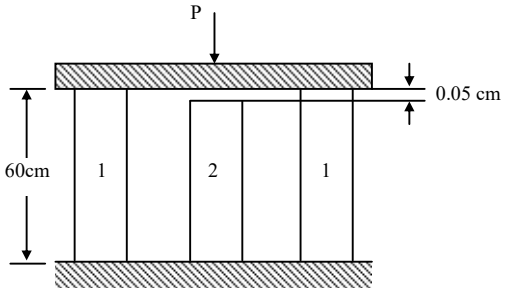

Figure 2

(b) A reinforced concrete circular section of 50,000 mm² cross sectional area carries 6 reinforcing bars whose total area is 500 mm². Find the safe load, the column can carry, if the concrete is not to be stressed more than 3.5MPa. Take modular ratio for steel and concrete as 18.

6 + 6 = 12

Group – C

4. (a) A machine component is subjected to the stresses a shown in figure 3. Draw Mohr's circle and find the normal and shearing stresses on the section inclined at an angle of 60^0 with horizontal axis. Also find the resultant stress on the section.

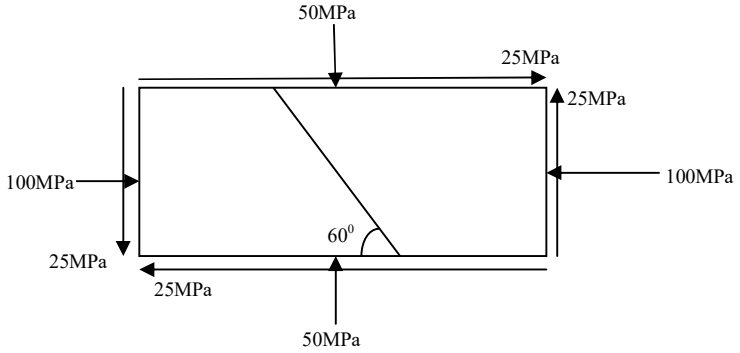

Figure 3

(b) Deduce the relation between the longitudinal and circumferential stresses in a thin pressure vessel.

7 + 5 = 12

5. (a) A simply supported beam of span 3 m is subjected to a central load of 10 kN. Find the maximum slope and deflection of the beam. Take $I = 12 \times 10^6\,mm^4$ and E = 200 GPa.

(b) A cantilever beam of length L carries a uniformly distributed load of W/unit over the entire length. Find the deflection at the free end by moment area method, using the following values.
$L = 2\text{ m}, w = 20\text{ kN/m}, E = 200\,\text{GPa}, I = 10^8\,mm^4$

6 + 6 = 12

Group – D

6. (a) Construct shear force and bending moment diagrams for the simply supported beam with overhangs, loaded (w per unit length) as shown in the figure 4.

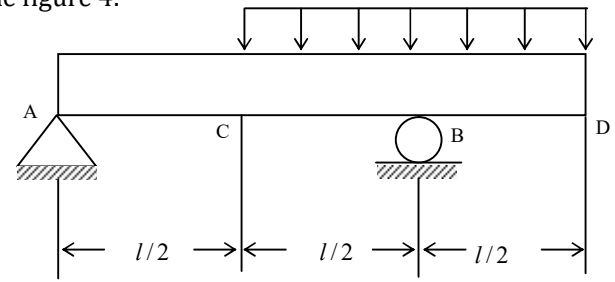

Figure 4

(b) A rectangular beam 20 mm deep is simply supported over a span of 2 m. Find the uniformly distributed load, the beam can carry if the bending stress is not to exceed 30 MPa. Take I for the beam as $8 \times 10^6\,mm^4$.

7 + 5 = 12

7. (a) Define shear force and bending moment.

(b) A cantilever beam of 1 m long carries a gradually varying load, zero at the free end to $w kN/m$ at the fixed end. Draw Bending Moment and Shear Force diagrams for the beam.

(c) Explain over hanging and continuous beam.

2 + 6 + 4 = 12

Group – E

8. (a) A stepped shaft ACB having solid circular cross sections with two different diameters is held against rotation at the ends (see figure 5). If the allowable shear stress in the shaft is 43 MPa, what is the maximum torque (T_0) that may be applied at section C?