B.E. METALLURGICAL AND MATERIAL ENGINEERING
FIRST YEAR SECOND SEMESTER EXAM 2018

STRENGTH OF MATERIALS **Time : Three hours** **Full Marks : 100**

Answer any ***five*** questions.

All questions carry equal marks.

1. Derive an expression for the elongation of a uniform rod of length L due to its own weight, if the weight density and modulus of elasticity of its material are γ and E respectively.

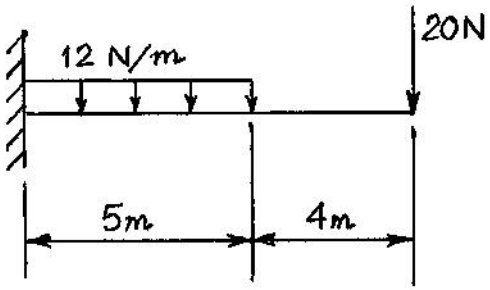
   A rod of length 1.3m and diameter 12 mm is rigidly fixed at the ends and is pre-stressed by a tensile load of 12 kN. Calculate the residual stress in the rod when the temperature is increased by 25^0C, if E = 205 GPa and $\alpha = 1.6 \times 10^{-5}$ /^{0}C.

2. Find the minimum diameter of a solid shaft carrying a torque of 12 kN m, if the allowable stress is 90 MPa and the maximum angle of twist is 3^0 per metre length. G = 85 GPa.

   Derive, stating assumptions, an expression for the spring constant of a close coiled helical spring.

3. Derive relations between shear force, bending moment and loading intensity of beams.

   Sketch the shear force and bending moment diagrams for the beam shown below.

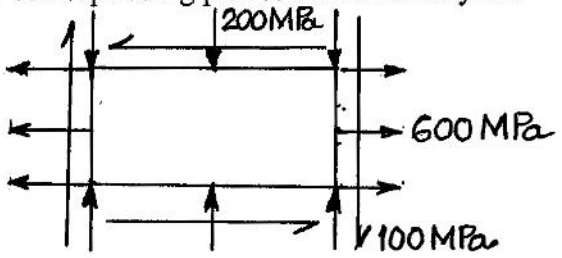


4. A beam of rectangular cross-section (depth : breadth = 2:1) has a span of 3 m and carries a uniformly distributed load of 5000 N/m and a concentrated load of 1200 N at the middle of the span. If the permissible longitudinal bending stress is 120 MPa, find the depth of the cross-section.

   The average shear stress at a section of a simply supported rectangular beam of width 120 mm and depth 250 mm is 0.5 MPa. Calculate the shear stress at a point on the section 5 cm above the neutral axis.

5. A cylindrical pressure vessel of diameter 1 m and length 2 m is subjected to an internal pressure of 2 MPa. If the circumferential stress is limited to 42 MPa and the longitudinal stress to 28 MPa, find the minimum thickness required, assuming a factor of safety of 2.5.

   Draw Mohr's circle for the state of stress shown below. Mark the maximum and minimum shear forces on the diagram, and indicate the corresponding planes on which they act.



6. The maximum deflection of a prismatic structural member of length 4.2 m simply supported at the ends and subjected to a force of 150 N at the middle is 5.3 mm. Find the flexural rigidity of the member, deducing the necessary relation.

   What will be Euler's critical load for the above member when used as a column with both ends pinned?

7. Prove any *two* of the following:

   a) For uniaxial tension or compression, the sum of normal stresses on complementary planes is a constant.

   b) The shear stress at any point in the cross-section of a solid shaft under torsion is proportional to the distance of the point from the longitudinal axis of the shaft.

   c) The neutral axis of a bent beam passes through the centroid of its cross section.