B.E. METALLURGICAL AND MATERIAL ENGINEERING
FIRST YEAR SECOND SEMESTER EXAM 2017

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

Answer any ***five*** questions.
All questions carry equal marks.

1. A steel bar of length 1.2 m tapers uniformly from a diameter of 4 cm to a diameter of 3.5 cm and carries an axial compressive load of 500 kN. Find the change in length of the bar, assuming E = 200 GPa, and deducing the necessary relation.

   If the maximum normal and shear stresses in a material are to be limited to 68.5 N/mm^2 and 54 N/mm^2 respectively, find the dimensions of a square section subjected to an axial tensile force of 200 kN.

2. Deduce the torsion formula in the form $\frac{T}{J} = \frac{G\theta}{l} = \frac{\tau}{r}$, assuming standard symbols, and stating necessary assumptions.

   A hollow circular shaft (external : internal diameter = 4:3) transmits 20 kW at 300 rpm. If G = 40 GPa, and the maximum shear stress is 40 MPa, find the torsional rigidity of the shaft.

3. Prove, stating necessary assumptions, that the neutral axis of a bent beam passes through the centroid of its cross-section.

   Sketch the shear force and bending moment diagrams for the beam shown in Fig A, marking important points.

4. A beam of span 1.5 m and cross-section 15 cm wide by 20 cm deep is simply supported at the ends and carries a point load at the centre. Find the safe value of this load if the allowable stresses are 7.5 N/mm^2 (longitudinal) and 0.7 N/mm^2 (shear).

5. Find the diameter of a vertical cylindrical gasoline tank made of 20 mm thick steel plate and subjected to a pressure of 1 MPa, if the allowable stress, factor of safety and joint efficiency are 240 MPa, 3 and 85% respectively.

   A circular bar of diameter 30 cm stretches by 0.03 mm in a length of 4.5 m under a tensile force of 120 kN. Find its critical buckling load when used as a column with one end fixed and the other free.

6. Determine the maximum deflection of a beam loaded and supported as shown in Fig B.

   Draw Mohr's circle for the stressed body shown in Fig C, and mark the principal stresses and their orientations on the diagram.

7. Deduce the relation between the elastic constants E, G and μ.

   Two steel springs (G = 83 GPa) attached in series support a load P. The number of turns, wire diameter (mm) and mean radius (mm) of the upper and lower springs are (12, 25, 100) and (10, 20, 75) respectively. If the maximum shearing stress in either spring must not exceed 200 MPa, find P.

8. Deduce any *two* of the following:

   i) Expression for the critical buckling load for a column with both ends pinned.

   ii) Equation of Mohr's circle for a body subjected to two mutually perpendicular principal tensile stresses of unequal intensities.

   iii) Differential equation of elastic line.

FIGURES

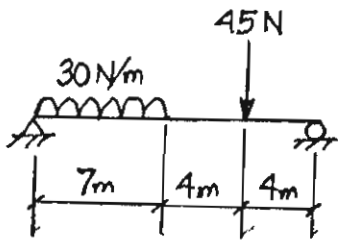

Fig A

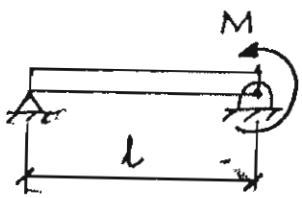

Fig B

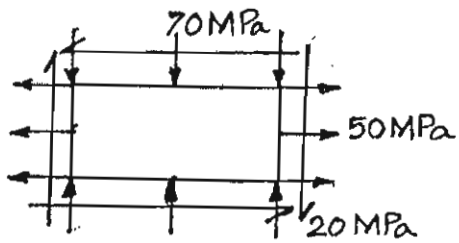

Fig C