B. E. ELECTRICAL ENGINEERING EXAMINATION, 2017
(1st Year, 2nd Semester)
STRENGTH OF MATERIALS

Time: Three Hours **Full Marks: 100**

Any missing data may be assumed with suitable justification
For question Q6a, the figure should be drawn in graph paper
PARTS OF THE SAME QUESTION MUST BE ANSWERED TOGETHER

ANSWER ANY FIVE QUESTIONS

Q1. **[10+10]**

(a) In order to have a uniform stress distribution across the cross-section of a prismatic slender member under the action of an axial force, find the location of the point of application of the external force.

(b) A uniform and homogenous rigid rectangular bar (**Fig. Q1b**) of 2.0 m length has a weight of 5.0 kN. The bar is supported by means of two massless rods having cross-sectional areas 50 mm^2 for rod 1 and 100 mm^2 for rod 2. Both these rods are of made of same material for which Young's modulus of elasticity can be assumed as 200 GPa. Initially, before the application of the load, the bar was horizontal. Find the location of the 10.0 kN force (denoted by distance x in the figure) for the cases so that (i) equal stresses are developed in the rods, and (ii) the bar remains perfectly horizontal even under the application of the force P_0.

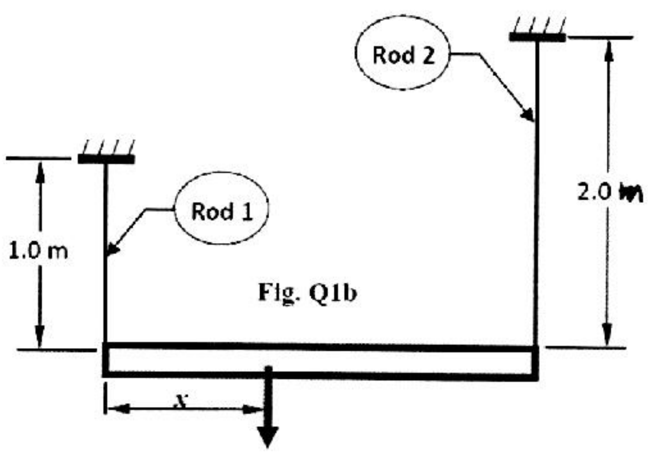

Fig. Q1b

Q2. **[6+10+4]**

(a) For a slender homogeneous bar under uniaxial loading, find the inclination of the plane of maximum shear stress developed and the corresponding maximum value.

(b) For the composite bar made of bronze and aluminum (**Fig. Q2b**), a 0.5 mm gap exists when the temperature is 20°C. Determine the temperature at which the normal stress in the aluminum bar will be equal to -90 MPa. For bronze bar: A=1500 mm^2, E =105 GPa, α =21.6×10^{-6}/°C; For aluminum bar: A=1800 mm^2, E =73 GPa, α =23.2×10^{-6}/°C.

(c) What do you mean by single shear? Explain with an example.

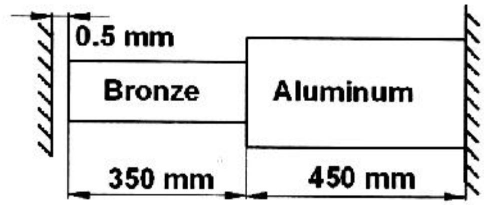

Fig. Q2b

Q3. **[10+10]**

(a) A hollow shaft is to transmit 250 kW at a frequency of 30 Hz. Knowing that the shear stress must not exceed 50 MPa, calculate the diameters of the shaft for which the ratio of the inner diameter to the outer diameter is 0.75.

(b) Two close-coiled helical springs wound from the same wire but with different mean coil radii are coaxially assembled as shown in **Fig. Q3b** and compressed between rigid plates at their ends. Calculate the maximum shear stress induced in each spring if the wire diameter=12 mm and P=500 N. The mean coil diameters for the outer and inner springs are 100 mm and 75 mm respectively.

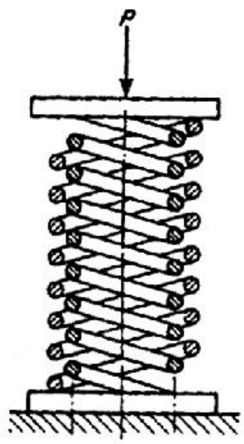

Fig. Q3b

Q4. **[12+6+2]**

(a) For beam loaded as shown in **Fig. Q4a**, draw the complete shear force and bending moment diagrams.

(b) For the beam shown in Fig. **Q4a**, determine the maximum normal stress developed at section C, and also the maximum shear stress developed for the entire beam.

(c) What do you mean by point of contraflexure?

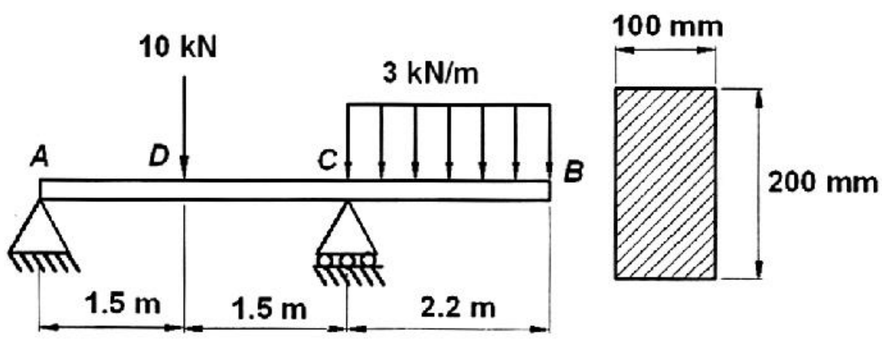

Fig. Q4a

Q5. **[10+10]**

(a) A prismatic and homogeneous cantilever beam is subjected to uniformly distributed load of intensity ω for its entire span L. Derive the equation of the elastic curve. Also find the maximum deflection and maximum slope.

(b) Derive Euler's critical load for the fundamental mode of a fixed-fixed column of length L. Take EI=constant for the column.

Q6. **[10+10]**

(a) Fig. Q6a shows a differential bi-axial stress element. Draw Mohr's circle for stresses of the element [should be drawn in graph paper and in scale]. Using Mohr's circle, (i) find the principal stresses and the corresponding principal planes, (ii) find the stress components on a plane, which is 45^0 counterclockwise from the x-plane. Show the principal stresses on a properly rotated element in body plane.

(b) A thin-walled cylinder of thickness t and mean radius r, with closed ends, is subjected to a constant internal pressure p. Derive the expressions of circumferential and longitudinal stresses developed in the cylinder.

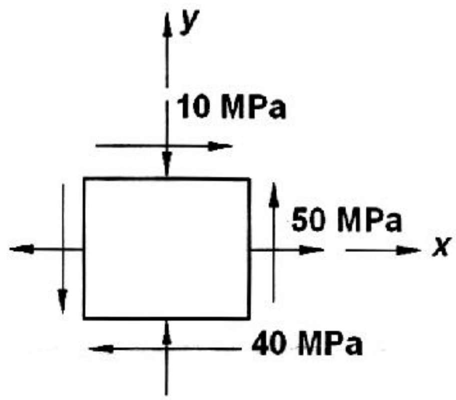

Fig. Q6a

Q7. Answer any four. **[5×4]**

(a) For a prismatic homogeneous bar of weight W, Young's modulus E, length L and cross sectional area A, find the elongation due to self-weight.

(b) Prove the relationship: $V = \frac{dM}{dx}$, where V and M are shear force and bending moment respectively.

(c) Explain the fact that an I-section beam is more economical than a rectangular cross section beam of the same cross sectional area.

(d) What do you mean by *torsional rigidity* and *flexural rigidity*?

(e) Derive and explain critical compressive stress.

(f) Draw and explain the stress-strain diagram of mild steel.

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