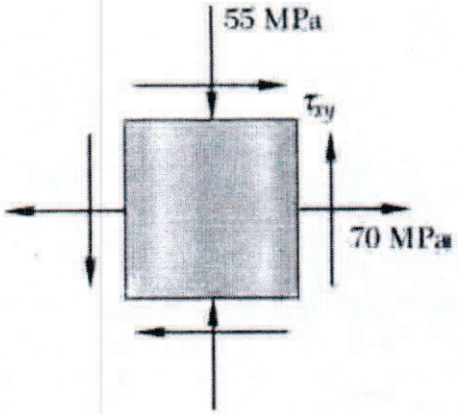
DEPARTMENT OF MECHANICAL ENGINEERING, IIT PATNA

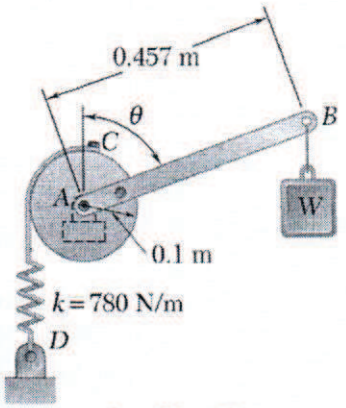
ME102 **Engineering Mechanics** **End-Semester Examination**

1. This is a closed book closed notes examination. Students are allowed to bring pen, pencil, geometry box and a calculator ONLY. Sharing of calculators is not allowed.
2. Carefully read the problems and in case of any missing data or confusion, please make suitable assumptions and solve the problem.
3. Draw clear FBD as appropriate.
4. All answers should be boxed and units should be mentioned.
5. All parts of a problem should be solved at one location together.

1. For the state of plane stress shown, determine (a) the largest value of τ_{xy} for which the maximum in-plane shearing stress is equal to or less than 82 MPa, (b) the corresponding principal stresses. **[6]**



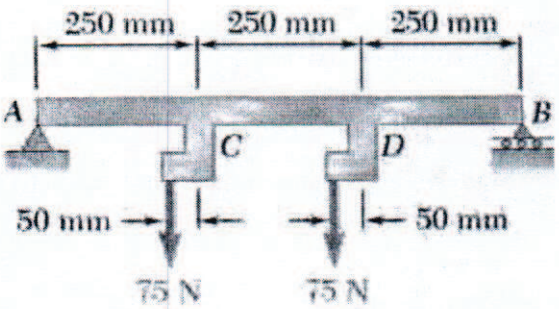
Problem 1



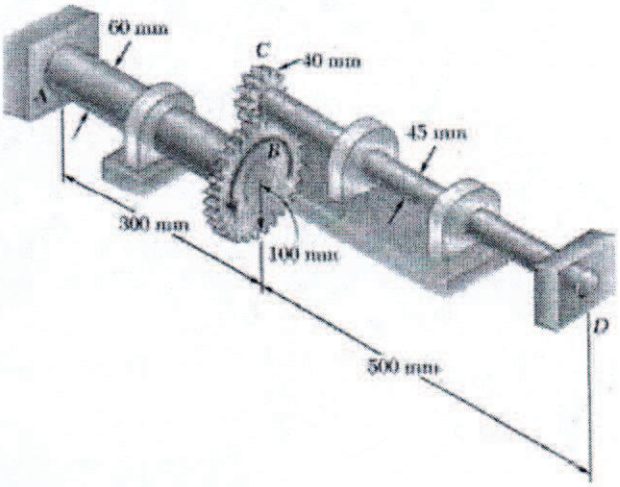
Problem 2

2. A block of weight W is hung from member AB as shown. Neglecting the weight of AB and knowing that the spring is unstretched when θ = 20°, determine the value of θ corresponding to equilibrium when W = 6.6 N. State whether the equilibrium is stable, unstable, or neutral. **[10]**

3. Draw the shear and bending-moment diagrams for the beam and loading shown, and determine the maximum absolute value (a) of the shear, (b) of the bending moment. **[8]**



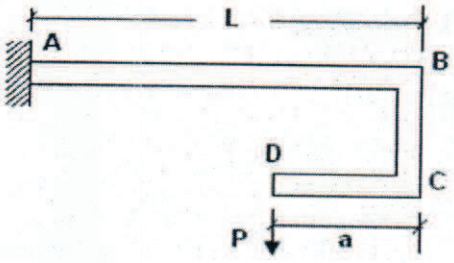
Problem 3



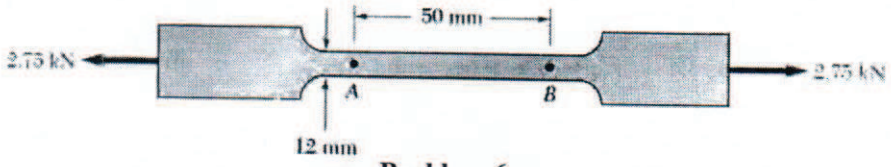
Problem 4

4. Ends A and D of two solid steel shafts AB and CD are fixed, while ends B and C are connected to gears as shown. Knowing that a 4-kN·m torque T is applied to gear B, determine the maximum shearing stress (a) in shaft AB, (b) in shaft CD. **[10]**

5. The cantilever beam AB has a bracket, BCD, attached to its free end (point B). A force P acts at the end of the bracket (point D). Find the expression for shear force and bending moment distribution along the length of the beam considering fixed end A as origin (x=0). Also, draw shear force and bending moment diagram. Here, $a<L$. **[8]**



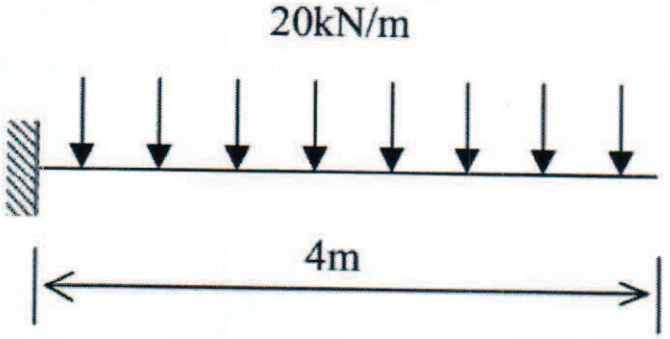
Problem 5

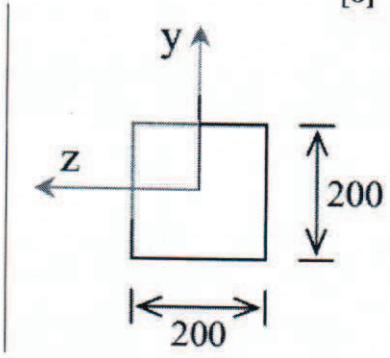


Problem 6

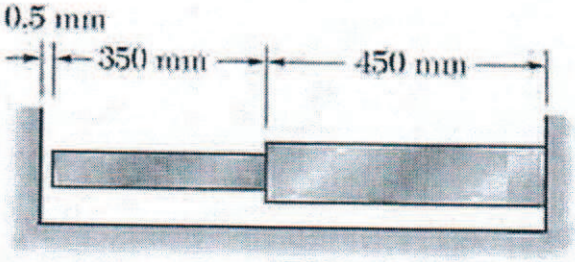
6. A 2.75 kN tensile load is applied to a test coupon made from 1.6-mm flat steel plate (E = 200 GPa, ν = 0.30), Determine the resulting change (a) in the 50-mm gage length, (b) in the width of portion AB of the test coupon, (c) in the thickness of portion AB, (d) in the cross-sectional area of portion AB. **[12]**

7. A cantilever beam of span 4m is subjected to a uniformly distributed load of 20 kN /m. Determine the maximum bending stresses in the beam for a square section with 200 mm side. (Note: Maximum bending moment occurs at fixed end) **[8]**





8. Determine: (a) the compressive force in the bars shown after a temperature rise of 82°C and (b) the corresponding change in length of the bronze bar. **[8]**



Bronze	Aluminum
$A = 1500\ \text{mm}^2$	$A = 1800\ \text{mm}^2$
$E = 105\ \text{GPa}$	$E = 73\ \text{GPa}$
$\alpha = 21.6 \times 10^{-6}/°\text{C}$	$\alpha = 23.2 \times 10^{-6}/°\text{C}$