1. For the given loading on the truss shown, which of the following set of members ARE zero-force members? (a) AF, EI (b) DH, BG (c) FK, IO (d) CG, CH

2. The \( y \)-coordinate of the centroid of semielliptical area, \( \bar{y} \), is \( \frac{4b}{3\pi} \). The area of the semielliptical shape is \( \frac{\pi ab}{2} \). What is the \( x \)-coordinate of the centroid, \( \bar{x} \), of quarter-elliptical area? (a) \( \frac{2a}{3\pi} \) (b) \( \frac{4a}{3\pi} \) (c) \( \frac{4a}{3} \) (d) \( \frac{2a}{3} \)

3. What is the maximum bending moment for the beam and loading shown? (a) \( \frac{w_0L^2}{96} \) (b) \( \frac{w_0L^2}{72} \) (c) \( \frac{w_0L^2}{48} \) (d) \( \frac{w_0L^2}{36} \)

4. A spring of constant 15 kN/m connects \( C \) and \( F \) of the linkage shown. Neglecting the weight of the spring and linkage, determine the force in the spring when a vertical downward 120-N force is applied at points \( E \) and \( F \). (a) 120 N (b) 180 N (c) 240 N (d) 60 N.
5. A stepped shaft of solid circular cross section is held against rotation at the ends. If the allowable shear stress is 70 MPa, what is the allowable torque $T$ that may be applied to the shaft at C?

![Shaft Diagram]

Problem 5.

6. A cube of granite with sides of length $a = 50$ mm is tested in a laboratory under triaxial stress. Strain gages mounted on the faces of the blocks record the following strains: $e_x = -620 \times 10^{-6}$ and $e_z = -250 \times 10^{-6}$. Calculate the following quantities: (a) the normal stresses $\sigma_x$, $\sigma_y$, and $\sigma_z$ acting on the $x$, $y$, and $z$ faces of the element; (b) the maximum shear stress $\tau_{max}$ in the material; (c) the change $\Delta V$ in volume of the block; and (d) the total strain energy $U$ stored in the block. (Assume the $E = 60$ GPa, $\nu = 0.25$) (10%)
11. Solve the following differential equations.
   
   (a) \((2x^3 - xy^2 - 2y + 3)dx - (x^2 + 2x)dy = 0\)  \((5\%)\)

   (d) \(y'' + 2y' + y = xe^{-x}\)  \((5\%)\)

12. Solve the initial value problem (10%)
   \(y'' + 3y' + 2y = f(t);\quad y(0) = 0,\quad y'(0) = 1\)

   In which  \(f(t) = \begin{cases} 
   1, & 0 < t < 1 \\
   0, & \text{otherwise} 
   \end{cases}\)

13. The governing differential equation for the deflection of a uniform beam is
   \[ E I y^{(4)} = -q(x). \]
   (A) Find the general solution of the differential equation. (3%)
   (B) What are the boundary conditions for the beam shown in the figure? (3%)
   (C) Find the elastic curve \(y(x)\) for the uniform beam shown. (3%)
   (D) Determine the slope at \(O\). (3%)
   (E) Determine the maximum deflection. (3%)

![Diagram of a uniform beam with a load at one end and a deflection at the other.](Problem 13.)