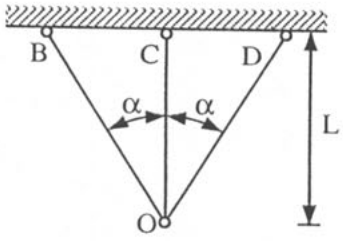
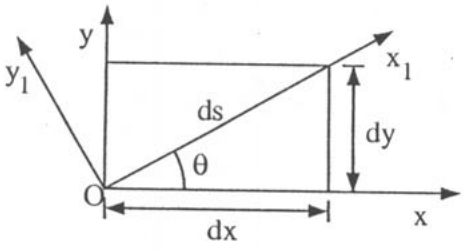
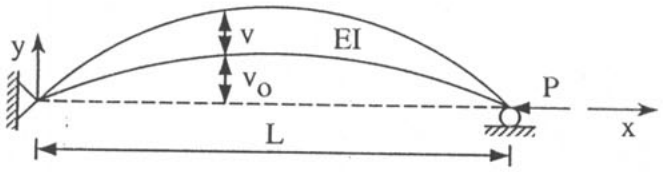
1. The three-bar truss as shown has no initial stress at temperature t_o. Bar OC is made of steel with A_s, E_s and α_s as the cross-sectional area, the modulus of elasticity and the thermal expansion coefficient. Bars OB and OD are made of copper with A_c, E_c and α_c as the cross-sectional area, the modulus of elasticity and the thermal expansion coefficient. If the temperature of the bar system is raised from t_o to t, find the axial forces in all the bars. (Note $\alpha_c > \alpha_s$). (20%)



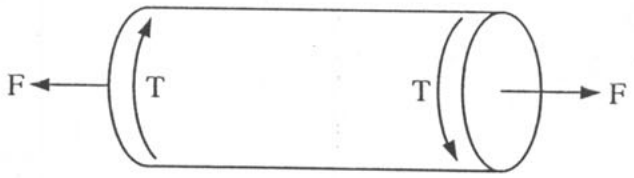


2. Draw appropriate deformation shapes of a plane strain element subjected to ε_x, ε_y, γ_{xy} separately and derive the following strain transformation equation: (20%)
$$\varepsilon_{x1} = \varepsilon_x \cos^2\theta + \varepsilon_y \sin^2\theta + \gamma_{xy} \sin\theta\cos\theta$$

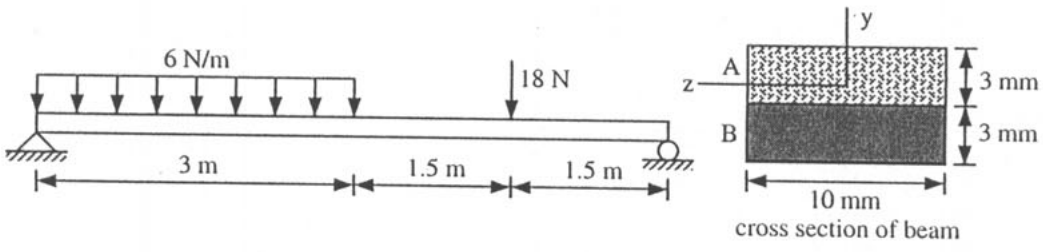
3. A simply supported column has an initial deflection $v_o(x) = a \sin(\pi x/L)$. If an axial compressive force P is applied to the column, an additional lateral deflection v(x) will be generated. (i) Set up the differential equation in terms of v(x) for the column. (ii) Solve the differential equation and obtain the expression for v(x). (iii) Find the critical buckling load P_{cr} of the column. (20%)



4. A cylindrical tank with flat ends is loaded by torques T = 500 N-m and tensile forces F. The tank has radius r = 50 mm and wall thickness t = 3 mm. The internal pressure of the tank is p = 3.5 MPa. If the allowable tensile stress and allowable inplane shear stress in the wall of the cylinder are σ_{allow} = 70 MPa and τ_{allow} = 10.7 MPa, what is the maximum permissible value of the forces F? (20%)



5. A simply supported beam composed of two materials A and B is subjected to loads as shown. Assume the moduli of elasticity of these two materials are E_A = 196 GPa and E_B = 105 GPa. Calculate the maximum normal stresses (in absolute values) in these two materials. (20%)



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