Indian Institute of Technology Delhi

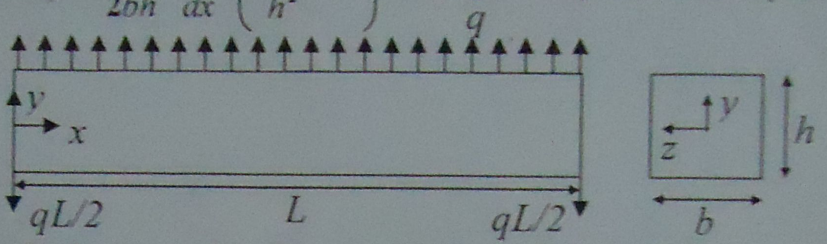
Minor I: Second Semester: 2014-15

Course: Mech. of Solids and Fluids, APL105 **Date:** 17 Feb 2015 **Dur.:** 1 Hr (1.00-2.00 PM)

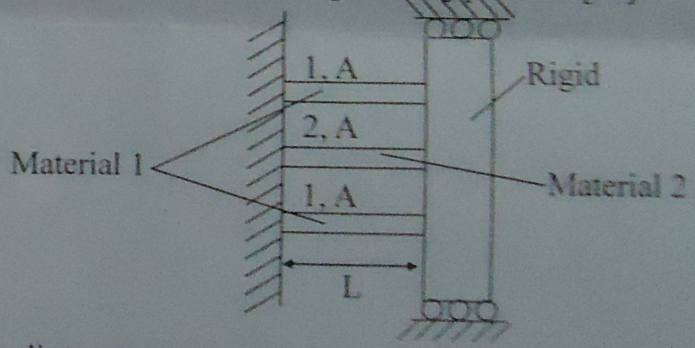
Note: Answer all the questions. Marks are indicated against each question.

Q. 1: At a point in a body of elastic isotropic material (E = 200 GPa, ν = 0.3), state of stress is given by: σ_{xx} = 100 MPa, σ_{yy} = 80 MPa, σ_{zz} = -40 MPa, $\tau_{xy} = \tau_{yz} = \tau_{zx} = 0$. Determine the **shear strain** on an octahedral plane passing through the point. [5]

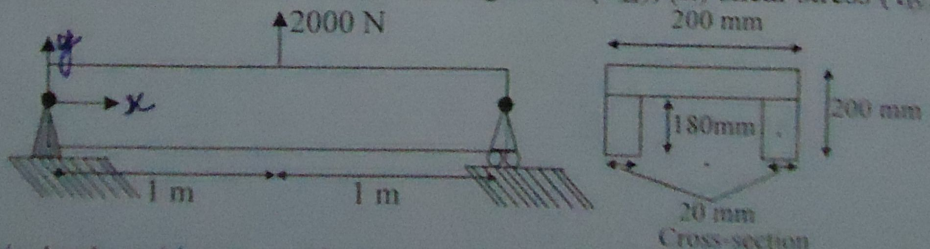
Q. 2: For a beam of rectangular cross-section under plane state of stress ($\sigma_{zz} = \tau_{yz} = \tau_{zx} = 0$), σ_{xx} and τ_{xy} are given by: $\sigma_{xx} = -\dfrac{12 M_z y}{bh^3}$; $\tau_{xy} = \dfrac{3}{2bh}\dfrac{dM_z}{dx}\left(\dfrac{4y^2}{h^2} - 1\right)$. Using the equations of equilibrium, derive the expression for σ_{yy}. [5]



Q. 3: For the system shown, the bar materials have unequal coefficient of thermal expansion and Young's modulli: $\alpha_1 = \alpha$, $\alpha_2 = 2\alpha$, $E_1 = E$ and $E_2 = 2E$. Material 1 is elastic-perfectly plastic (yield stress = σ_Y) and Material 2 is elastic for the range of loading considered. The system is assembled at temperature T = 0 with no stress in the bars, then the assembly is heated to $T = 3\sigma_Y/E\alpha$ and finally cooled to T = 0. Find the residual stresses developed in the bars due to heating-cooling process. *[10]*



Q. 4: For the beam shown, calculate maximum (i) bending stress (σ_{xx}), (ii) shear stress (τ_{xy}). [20]



Q. 5: A thin cylindrical tube with open ends (mean radius = R, thickness = h, length = L, Young's modulus = E, Poisson's ratio = ν, coefficient of thermal expansion = α) just fits between two smooth rigid walls at room temperature. If the tube is heated by ΔT above room temperature and subjected to internal pressure p, derive an expression for the contact pressure between rigid walls and tube. [10]

Q. 6: A component is subjected to loads which produce the following stress field in a region where an oil hole must be drilled: σ_{xx} = 10 MPa, σ_{yy} = 10 MPa, σ_{zz} = 10 MPa, τ_{xy} = 20 MPa, τ_{yz} = 10 MPa and τ_{zx} = 10 MPa. Determine the direction cosines of maximum tensile stress direction in the region. [10]