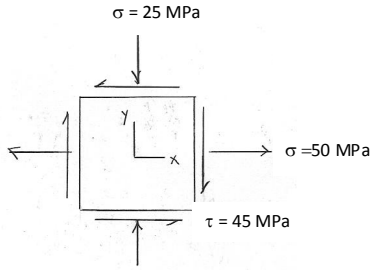
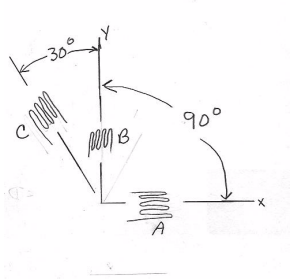
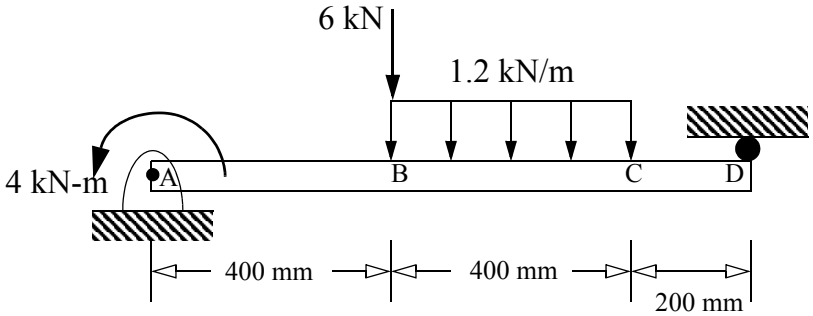
Final MEEM 2150 April 26th, 2010

1 The strain gages shown are mounted on a free surface in a region possessing the state of stress indicated. The gages are mounted on a material that has a modulus of elasticity of 150 GPa and Poisson's ratio $\nu = 0.29$. Determine the strains that would be indicated by gages *A* and *C*. (Note the *x* axes in both figures are parallel).

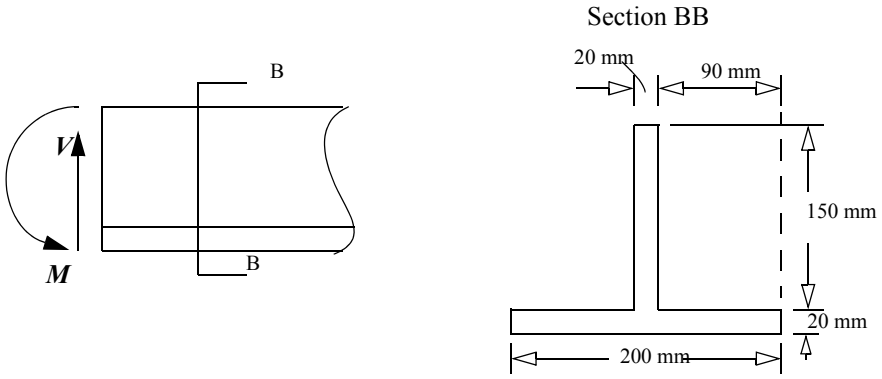




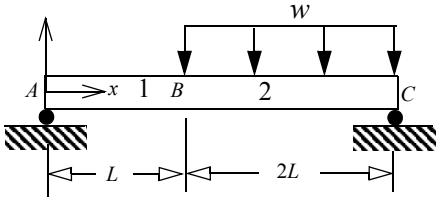
2 (a) Draw the shear force and bending moment diagram for the beam and loading shown. Clearly mark the numerical values at points A, B, C, D. What is the maximum bending moment and shear force?



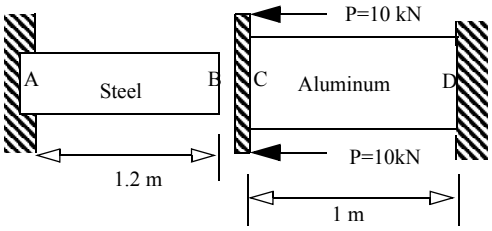
2 (b) The cross-section of the beam shown is subjected to a bending moment $\boldsymbol{M} = 21$ kN-m (about the cross-section's neutral axis) and a shear force $\boldsymbol{V} = 35$ kN in the directions shown. Determine the maximum compressive bending normal stress and the maximum bending shear stress acting on this cross-section.



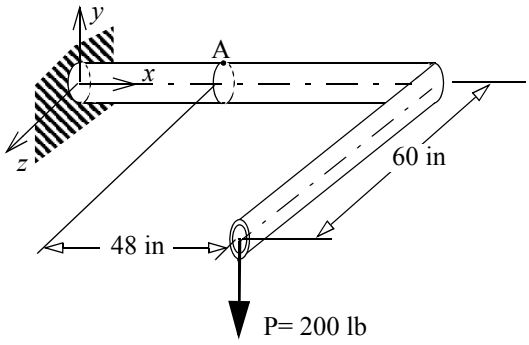
3 A beam under a uniform distributed load is shown. In terms of *E*, *I*, *x*, *L*, and *w*, write all the differential equations and all the conditions necessary for solving for the deflection as a function of *x* for any point in the beam. Use only the coordinate system shown. DO NOT INTEGRATE OR SOLVE.



4 An aluminum rod (E_{al} = 70 GPa) is and steel rod (E_{steel} = 210 GPa) are securely fastened to a rigid plate that does not rotate during the application of the load P. A gap of 0.5 mm exists between the rigid plate and the steel rod before the load is applied. The aluminum rod has a diameter of 20 mm and the steel rod has a diameter of 10 mm. Determine the movement of the rigid plate from the unloaded position.



5 A pipe with an outside diameter of 2.0 inch and wall thickness of 1/4 inch is loaded as shown. Determine the principal stresses and the maximum shear stress at point A. Points A is on the surface of the pipe at the top. (**Be methodical**)



ANSWERS

1. $\varepsilon_A =$ 381.7 μ ; $\varepsilon_C =$ 233.1 μ

2a. V_{max}= 7.792 N ; M_{max}= -4 kN-m

2b. σ_{comp} = 53.73 MPa (C) ; τ_{max} = 14.73 MPa

4. δ_C = 0.751 mm

5. σ_1 = 23.25 ksi (T) ; σ_2 = 5.371 ksi (C) ; τ_{max} = 14.3 ksi