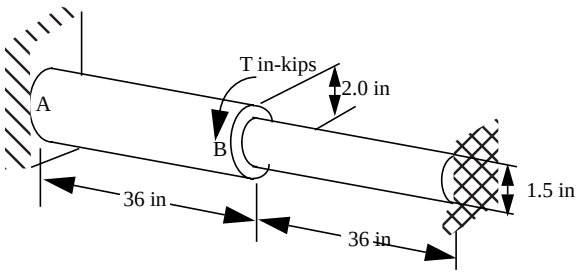
EM 342 **FINAL EXAM** **NAME:_____**

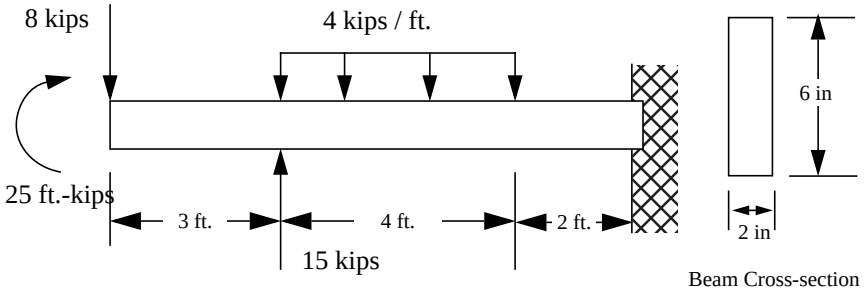
May 20th, 1997

1. At a point on the surface of a plane stressed region, measured strains reduce to the following: $\varepsilon_x = +450\ \mu$, $\varepsilon_y = -500\ \mu$, and $\gamma_{xy} = +200\ \mu$. The material on which the strains were measured has the following properties: E = 210 GPa and $\nu = 0.30$. Determine and *show on a sketch* (a) the stresses σ_x, σ_y, and τ_{xy}. (b) the principal stresses and the maximum shearing stress at the point.

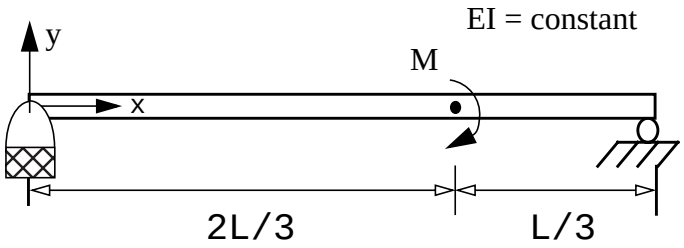
2. A steel (G_s = 12,000 ksi.) shaft is built into the walls at both ends as shown. Determine the maximum allowable torque T that can be applied, if the rotation at section B is to be limited to 0.09 rads and the maximum shear stress in the shaft is limited to 18 ksi



3. (a) Draw the shear force and bending moment diagram for the beam shown. (b) Determine the maximum bending normal stress and the maximum bending shear stress in the beam.



4. A beam has a moment applied as shown. Using the coordinate axis write down all the equations and all the conditions necessary to solve for the elastic curve i.e. displacement at any point on the beam. DO NOT INTEGRATE OR SOLVE FOR THE INTEGRATION CONSTANTS

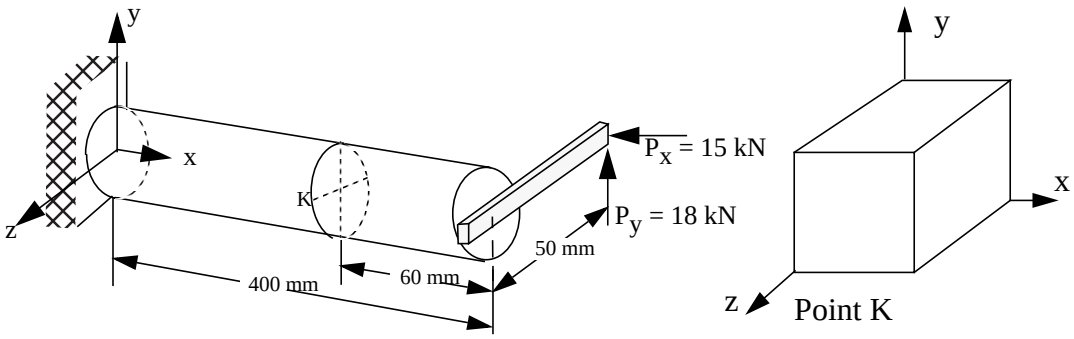


5. A solid circular shaft of 40 mm diameter is loaded as shown. Determine the normal and shear stress at point K in the x, y, and z coordinate system and show it on the cube. The geometric properties of the cross-section are as given.

$$A = 1.257(10^{-3})\ m^2$$

$$I = 0.1257(10^{-6})\ m^4$$

$$J = 0.2513(10^{-6})\ m^4$$



1. σ_x = 69.2 MPa (T); σ_y = 84.2 MPa (C) ; τ_{xy} = 16.15 MPa; σ_1 = 70.9 MPa (T), σ_2 = 85.9 MPa (C), τ_{max} = 78.4 MPa
2. T_{max} = 37.2 in-kips.
3. σ_{max}= 25 ksi (T) or (C); τ_{max}= 1.125 ksi
5. σ_{xx} = 107.4 MPa (T), τ_{xy} = -52.6 MPa