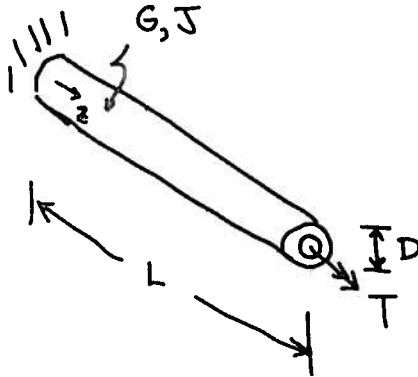


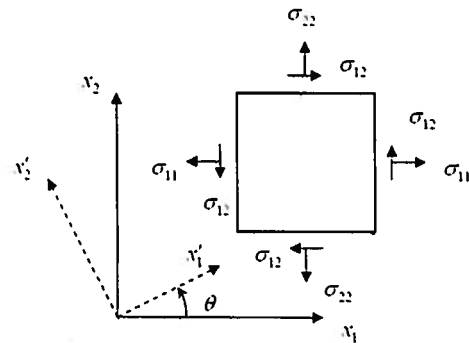
MAE Solid Mechanics Ph.D. Qualifier (Tuesday, May 21, 2013)

Solve all **four** of the following problems. Maximum score for each problem is 25 pts.

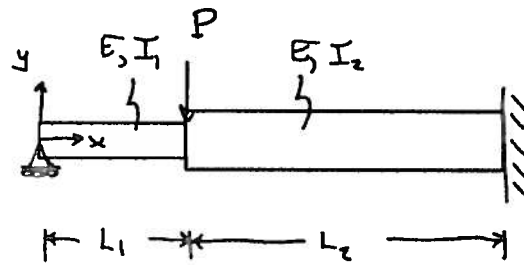
Q1. Consider the prismatic aluminum tube of length $L = 0.75$ m under the action of an applied torque $T = 200$ N-m at the end $z = L$, as shown in the diagram. The outer diameter of the tube is specified as $D = 6$ cm, while the thickness is $h = 10$ mm. If the maximum allowable shear stress is $\tau_{\max} = 100$ MPa, determine the factor of safety for the current design. Assume an elastic modulus $E = 70$ GPa and Poisson ratio $\nu = 0.33$.



Q2. A state of plane stress at a point in a turbine disk is given by $\sigma_{11} = 0$, $\sigma_{22} = 2\sigma_o$, $\sigma_{12} = -\sigma_o$. Determine the principal stresses and principal directions at that point and sketch your results on a properly oriented material block.



Q3. Consider the stepped beam, shown in the diagram to the right, under the action of the concentrated load P . Formulate the equations that could be used to find the rotation of the beam at the roller support at $x = 0$. Please note that you do not need to solve these equations.



Q4. Consider the structure idealized as three springs connected in series and restrained by the walls at A and D , as shown in the diagram. The stiffness of the two outer springs is k , while the center spring has stiffness $2k$. Meanwhile, forces P and $2P$ are applied at locations B and C , respectively. Determine the reaction forces at A and D .

