Homework #2
Due: 9/13/16

1. (20) In order to start thinking about your critical review paper, organize a proposed topic using the materials science and engineering paradigm (or the modified paradigm for a biological material). What are important factors to consider under "processing," "structure" and "properties"?

2. (20) (a) Write an algorithm to perform arbitrary stress transformations using Euler angles. From the initial stress tensor below, find the transformed stress tensor after each successive rotation about Euler angles of $\phi_1 = 60°$, $\Phi = 45°$, and $\phi_2 = 30°$. (b) Find the principal stresses and corresponding Euler angles.

$$\sigma = \begin{pmatrix} 10 & -3 & 0 \\ -3 & 10 & 0 \\ 0 & 0 & 20 \end{pmatrix} \text{ MPa}$$

3. (10) Recall the physical significance of Poisson's Ratio, ν_{ij}. What then is the physical significance of the coefficients of mutual influence, $\eta_{ij,i}$ and $\eta_{i,ij}$, that may occur in an anisotropic material? Think in terms of deformation and strain. A sketch may help explain your answer. What type of material structure could result in this type of behavior?

4. (50) Eq. 2.25 in Bowman is just a transformation of the compliance coefficients, S_{ij}.

   (a) Derive Young's Modulus for a cubic crystal (or isotropic material) in terms of the appropriate stiffness coefficients, C_{ij}.
   (b) Write an algorithm to find the rotation matrix, a_{ij}, from directional (Miller) indices [*hkl*].
   (c) Derive an equation similar to Eq. 2.25, only using the rotation matrix, a_{ij}, and stiffness coefficients, C_{ij}.
   (d) Compute the elastic moduli in the [100] and [111] directions for the bcc metals tungsten, molybdenum and iron, using both Eq. 2.25 and your equation. The answers should be the same!
   (e) Plot the elastic modulus for each metal as a function of the angle between the [100] and [010] poles on a stereographic projection. (Note that this plot will only be 2D, not 3D!)