Homework #4
Due: 10/6/16

1. (30) A boron/aluminum composite has the following elastic properties:

boron fiber:	E = 380 GPa	G = 172 GPa	ν = 0.1
aluminum:	E = 68 GPa	G = 26 GPa	ν = 0.3

   Plot the effective moduli of the composite, (a) E_1, (b) E_2, and (c) G_{12}, versus the fiber volume fraction V_f using each of the following models: Voigt, Reuss, hybrid, and square fiber. (Show each model on the same plot for each engineering coefficient.)

2. (20) A "perfect bond" was assumed to exist between the reinforcement and matrix for each of the composite micromechanical models we discussed in class. What types of bonding would you expect to exist between a carbon or oxide fiber and polymeric matrix? If the fiber-matrix interfacial bond strength could be tailored, what changes would you expect in the mechanical properties of the composite and why? How might you tailor the interfacial bond strength?

3. (30) Using only the concepts taught in this class, find the effective elastic modulus of a three ply ("sandwich") laminate with fibers oriented in the loading direction on the top and bottom and a 45° layer in between. Each ply is an epoxy matrix reinforced with 60 vol% continuous graphite fibers. Assume the fibers and matrix themselves are isotropic with: E_f = 200 GPa, ν_f = 0.1, E_m = 3 GPa and ν_m = 0.3. Plot the elastic modulus of the laminate versus an angle of misorientation from the loading direction in the plane of the laminate. Compare this plot to that for a single ply.

4. (20) An epoxy matrix is reinforced with 50 vol% continuous carbon fibers. The ultimate tensile strength of the fibers and matrix is 350 MPa and 10 MPa, respectively. The shear strength of the matrix is 20 MPa. Plot the fiber, matrix shear, fiber-matrix separation and Tsai-Hill failure criteria on a plot of strength vs. fiber misorientation angle, ϕ.