Unified Engineering Problem Set **Lectures: M21, M22, M23 (part)**
Week 14 Fall, 2007 **Units: M3.2**

M14.1 ***(15 points)*** The compliance tensor is a key part of the overall set of stress-strain relationships. Let's explore these ties to the three-dimensional compliance tensor in the following way:

(a) Write out, in full, the tensorial version of the three-dimensional compliance relations for the complete anisotropic case. Group the components of the compliance tensor into the three groups (as done for the elasticity tensor in the lecture notes).

(b) Reduce these compliance relations to the orthotropic case and relate the engineering constants to the components of the compliance tensor for this case.

(c) For the orthotropic case, **show** how to relate the engineering constants back to the components of the elasticity tensor, using the results of (a) and (b), as appropriate. (**Do not** get final component-by-component relations.)

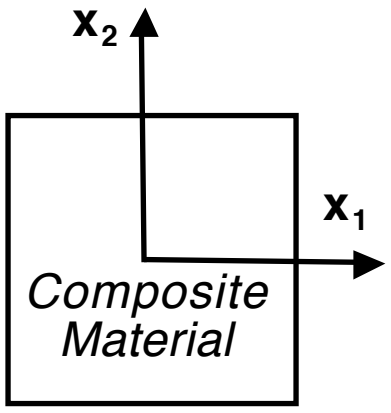
M14.2 ***(15 points)*** A composite material is made with woven fibers in multiple directions and with a polymer matrix. A set of three experiments are performed on this composite material. The stresses applied in each case are noted and various strains measured. Note that the strain gage in the 1-direction broke during Experiment A and no readings were obtained. The stresses and strains for the three experiments are:

Experiment A

$\sigma_{11} = 200$ MPa
$\sigma_{22} = 200$ MPa
$\varepsilon_{22} = 3500$ μstrain

Experiment B

$\sigma_{11} = 600$ MPa
$\varepsilon_{11} = 7800$ μstrain
$\varepsilon_{22} = -2250$ μstrain



Experiment C

$\sigma_{12} = 150$ MPa
$\gamma_{12} = 3400$ μstrain

NOTE: Any stresses or strains not specified are equal to zero, except that related to gage failure in Experiment A. Also, all strains are tensorial.

(a) Determine the in-plane engineering constants (all possible) and characterize the stress-strain behavior of the material.

(b) If possible, determine what the broken strain gage along the 1-direction in Experiment A should have read. If not possible, explain why it is not possible.

(c) Determine as many components of the compliance tensor as possible and put this in matrix form.