2:45 - 3:45
Walker

MIT ID# (last four digits) _____

Unified Quiz 7M

December 16, 2004

- Put your MIT ID# (last four digits) on each page of the exam.
- Read all questions carefully.
- Do all work on that question on the page(s) provided. Use back of the page(s) if necessary.
- Show all your work, especially intermediate results. Partial credit cannot be given without intermediate results.
- Show the logical path of your work. Explain clearly your reasoning and what you are doing. *In some cases, the reasoning is worth as much (or more) than the actual answers*.
- Please be neat. It will be easier to identify correct or partially correct responses when the response is neat.
- Be sure to show the appropriate units. Intermediate answers and final answers are not correct without the units.
- Report significant digits only.
- Box your final answers.
- ***Calculators, handwritten "crib sheets", and Unified Handout #M-4 allowed.***

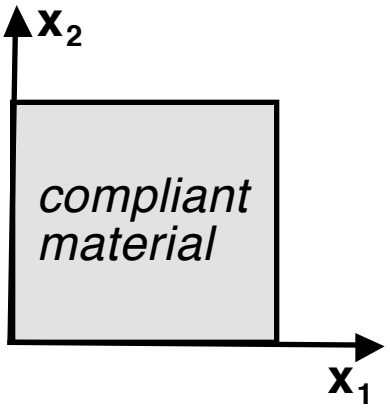
EXAM SCORING

#1M (25%)	
#2M (25%)	
#3M (25%)	
#4M (25%)	
FINAL SCORE	

MIT ID#
(last four digits) _____

PROBLEM #1M (25%)

A square slab of a very compliant material undergoes deformation such that the in-plane strain state has a constant strain in the x_1-direction of 5000 μstrain, no strain in the x_2-direction, and an *engineering* shear strain of 16,000 μstrain.



(a) Determine a two-dimensional displacement field/vector which corresponds to this strain state. Be as general as possible.

PROBLEM #1M (continued)

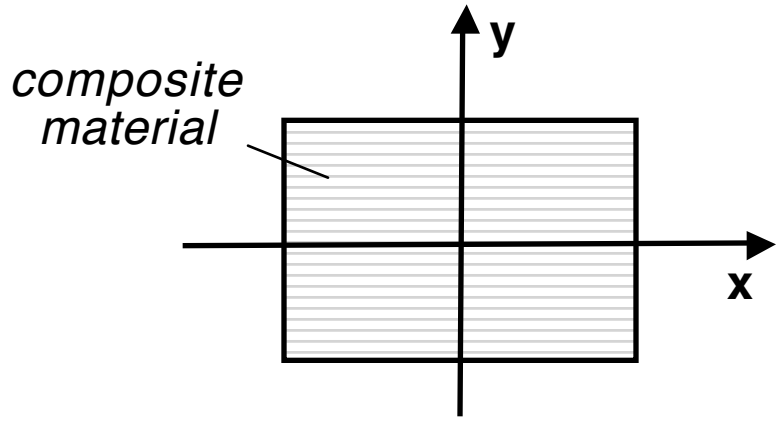
PROBLEM #1M (continued)

(b) The deformations are now increased by a factor of ten, how will the values of the in-plane strains change? Describe clearly. Use equations as necessary.

MIT ID#
(last four digits) _____

PROBLEM #2M (25%)

A rectangular slab of composite material (longitudinal modulus of 210 GPa) is loaded in a state of plane stress with a pure shear of magnitude τ



(a) Is it possible to find a transformed axis system in the x- y plane such that the slab is loaded only by normal stresses, σ_x and σ_y? If not, describe why not. If yes, describe why, determine the angle to the transformed axis system, and determine the relative values of the normal stresses.

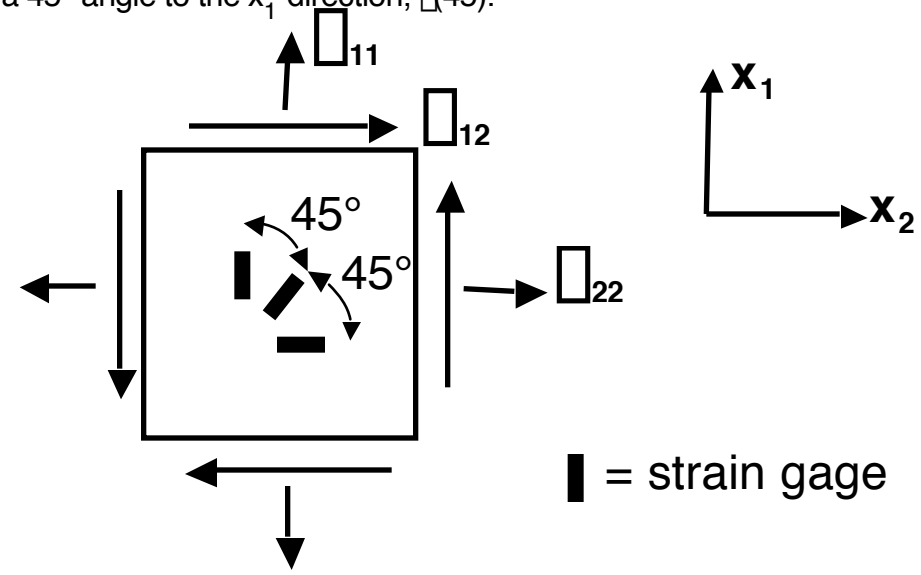
PROBLEM #2M (continued)

(b) Determine the principal stresses (**all three!**) for this stress state and their associated directions.

MIT ID#
(last four digits) _____

PROBLEM #3M (25%)

An *orthotropic* material has a general loading applied resulting in stresses of σ_{11}, σ_{22}, and σ_{12}, as indicated in the accompanying figure. The stresses are aligned with the main axes of the material. A three-gage strain gage rosette is placed on the material and aligned in such a way that the strain in the x_1-direction, ε_{11}, and in the x_2-direction, ε_{22}, are measured along with the strain at a 45° angle to the x_1-direction, $\varepsilon(45)$.



Can any of the engineering constants of this material be determined? If so, explain why and do so. If not, explain why not. Equations can be utilized in the explanations in either case.

PROBLEM #3M (continued)

MIT ID#
(last four digits) _____

PROBLEM #4M (25%)

In order of their importance (as best as possible), **list** the factors that contribute at lower levels of length scale to the material stiffness characterized at the macromechanical level. Clearly indicate the relative importance of each, the length scale at which they operate, and any associated limitations including the types of materials that are affected.

PROBLEM #4M (continued)