# ED 305, Quiz #2, Oct 13 2009

Instructions

1. If something is not clear, come up and ask in a soft voice; do **not** discuss amongst yourselves.

2. Time limit is 50 minutes.

3. This is an open-notes test. You may refer only to your class notes (including worked homework solutions).

4. Cheating of any sort will not be tolerated; you will receive zero credit and may face additional consequences.

Questions

1. Consider biaxial loading of an isotropic, linear-elastic material such that $\sigma_{11} = -\sigma$, $\sigma_{22} = \sigma$. (4)
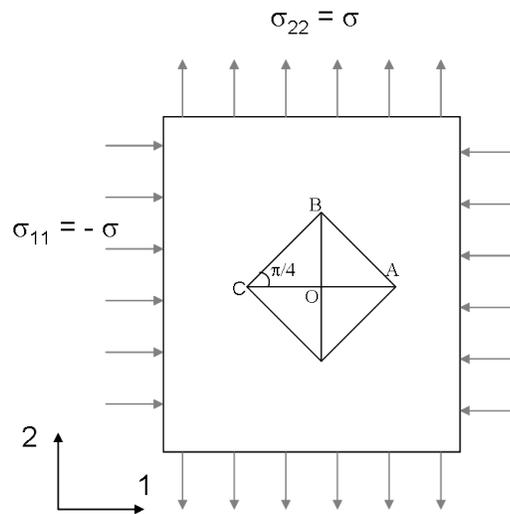
By considering the deformation of a square of material oriented 45° to the original axes, show that one can derive the following relationship between the elastic constants:

$$\mu = \frac{E}{2(1+\nu)}$$

2. A rod of square cross-section of side 20 mm is subjected to a uniaxial load of 40 kN. An identical rod is also subjected to the same load, but is kept immersed in a pressurized fluid of 50 MPa pressure.

    (a) What is the maximum shear stress in the two cases? (1)

    (b) If the yield stress of the material in uniaxial tension is 400 MPa, what is the fluid pressure required to cause yielding, according to the Tresca criterion? (1)

3. Uniaxial tensile and fully-reversed fatigue tests on an unknown metal established the ultimate strength and endurance limit to be 1200 MPa and 550 MPa respectively. Will a rod made of this material fail in fatigue if subjected simultaneously to a static stress of 600 MPa and oscillating stresses whose total range is 700 MPa? (2)

4. A smooth cylindrical specimen is to be tested in fully reversed bending at a plastic strain amplitude of 0.001. The following is the available material data:

$$E = 205 GPa, \quad \sigma_{TS} = 1.85 GPa, \quad \epsilon_f = 0.7$$

Compute a **conservative** estimate of the number of cycles to failure. State your assumptions and justifications clearly. (2)