22.314J – Spring 2004
Problem Set VI

Due 3/30/04

A. Show from first principles that the assumption of zero volumetric change during plastic deformation leads to the conclusion that Poisson's ratio has to equal 0.5. State your assumptions carefully.

B. A material is being tested for use as a fusion reactor first wall. The wall will be composed of tubes of an inner radius of 6mm and of a thickness of 3mm.. The one dimensional tensile creep tests indicate that at an average temperature of 700C the creep rate is given by $\dot{\varepsilon} = 10^{-9}\sigma\left(s^{-1}\right)$, where σ is MPa. The operating conditions in the reactor are expected to lead maximum (primary and thermal) stresses as follows:

$$\sigma_r = -5.0\ MPa \qquad \sigma_\theta = +345\ MPa \qquad \sigma_z = +195\ MPa$$

The average temperature of the first wall temperature = 500C and the yield Stress = 200MPa.

How long, at steady state operation, does it take to reach a plastic strain of 1%?