ME108: Mechanical Behavior of Engineering Materials
Spring 2016 Midterm 1, 02/26/2016

This midterm is closed-book, closed-notes, except for the single page of notes that you have made. You will need a calculator. You will have 50 minutes to complete this exam. *Do not forget to state your assumptions, draw a coordinate system where needed and put a box around your answers.*

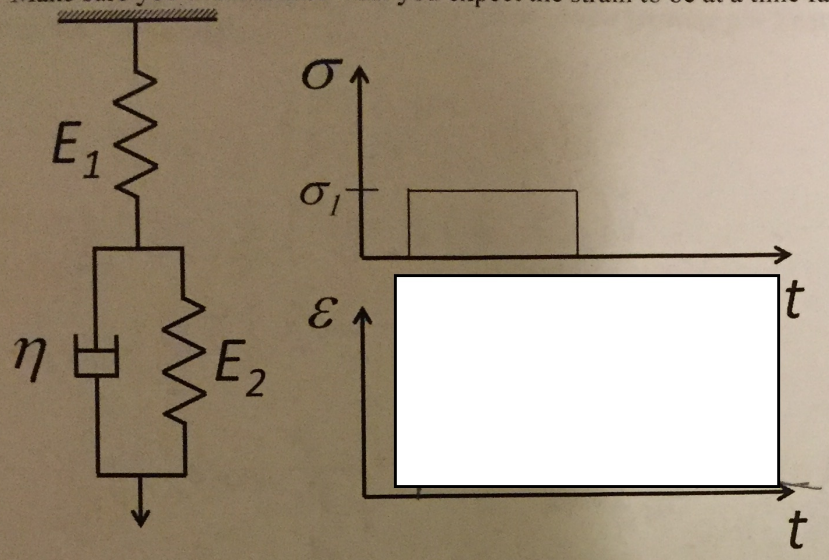
Problem 1 (25 points)

(a) A 2024-T4 aluminum bar with a circular cross-section was tested in tension to fracture with $\sigma_f = 400$ MPa. The initial diameter was 12.7 mm. The diameter after failure was 12.2 mm. What are $\bar{\sigma}_f$ and $\bar{\varepsilon}_f$?

(b) A 2024-T4 aluminum bar with a circular cross-section of diameter 25.4 mm is placed under a bending moment of 450 N-m. Will there be any yield as a result of this loading?

Problem 3 (25 points)

(a) *Using a solid line*, draw the expected strain response for the model and loading described below. Make sure you demonstrate what you expect the strain to be at a time far distant from the loading.



(b) For the polymer modeled in part (a), how would you expect the strain response to change if the molecular weight is increased? Using a dashed line, draw it on the strain-time plot above as well.

(c) A strip of polyvinyl chloride (PVC) tested at 25 °C and 50 mm/min can be represented by the Maxwell model. The polymer is loaded in tension at a deformation rate of 50 mm/min at 25 °C until the stress is 1.5 MPa. If the polymer is unloaded after being held at this load for 30 minutes, what is the strain at 1 hour after unloading?

Problem 4 (25 points)

A cylindrical pressure vessel made from AISI 1020 steel has length $l = 8$ m, diameter $d = 2$ m, and wall thickness $t = 10$ mm. This pressure vessel is placed under pressure $p = 2$ MPa. Show your calculations starting from 3D Hooke's law.

a) What is the change in length?

b) What is the change in diameter?

c) What is the change in wall thickness?

Problem 2 (25 points)

(a) Describe how bonding affects elastic modulus

(b) Calculate the radius of a chromium atom, given that Cr has a BCC crystal structure, a density of 7.19 g/cm^3, and an atomic weight of 52.0 g/mol.

(c) Give two methods that can be used to strengthen metals and describe why they work.