Date: 9/30/2004

UNIVERSITY OF CALIFORNIA
Departments of Mechanical Engineering and Materials Science & Engineering

Prof. Ritchie

C-ME 124/C-MSE 113
Mechanical Behavior of Materials
Midterm Exam #1

Name: _____
SID No.:_____

No	Total Credit	Credit
1	40	
2	20	
3	40	

Problem 1

At your new job in Silicon Valley,your first task is to perform a safety evaluation of a pressure vessel.The vessel is spherical in shape with a diameter of 2m and will be used to store highly toxic pyrophoric Silane (SiH_4) gas.The vessel is stored outside the processing laboratory for safety reasons.If the container fails,most of Santa Clara county will perish.In your evaluation you must answer the following questions:

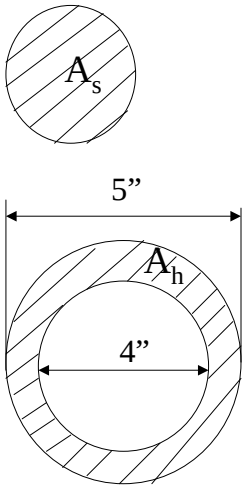
1..what internal pressure will cause first yielding in the 5mm thick walls if the vessel is made from a carbon steel(uniaxial tensile properties: E=210 GPa, σ_y=450 MPa,σ_u=560 MPa)?

2.What are the principal stresses and the maximum shear stress at the maximum operating pressure of 1800 kPa?

3.What is the factor of safety for the vessel(compare the maximum operating and yielding pressures)?

Problem 2

In the figure below, the solid shaft and the hollow shaft have the same cross-sectional area $A_s = A_h$.They are subject to the same torsional load $T_s = T_h$.If both shafts are made of the same material $G_s = G_h$,and have the same length, compare the Torsional Stiffness(T/ϕ) of the two shafts,where ϕ_s and ϕ_h are the angles of twist for the solid and hollow shafts respectively.



Problem 3

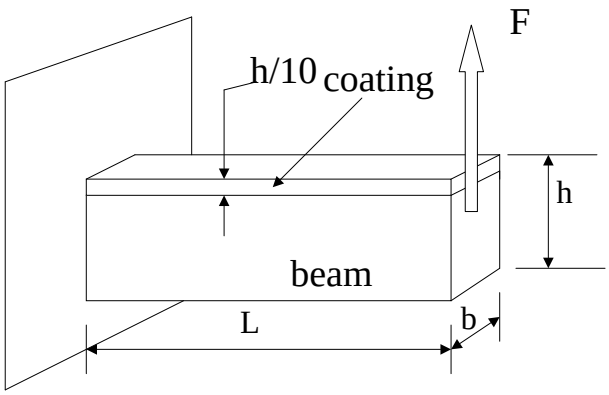
You are given the cantilever beam with a thin coating subject to the end load shown below.The beam is made of low carbon 1020 steel with a magnesium coating on the top surface.Assuming the beam can be considered a slender linear elastic beam,

1.Determine the location of the neutral axis.

2.Derive a general equation relating the deflection at the end of the beam to the applied force,F, and beam length L.

3.Assuming a beam length of 55 cm, what force is necessary to cause a 3 mm deflection?

Material Property	Low Carbon 1020 Steel	Magnesium
Yield Strength	300 MPa	145 MPa
Ultimate Strength	400 MPa	275 MPa
Young's Modulus	210 GPa	45 GPa
Shear Modulus	80 GPa	20 GPa
Poisson's Ratio	0.30	0.25



h=0.05m
b=0.025m