Take Home Exam I: Elasticity

## Assigned: Sunday 02/13/2022

## Due (as pdf by email) 02/27/2022 (in two weeks)

•All questions carry equal weight.

•You may submit your answers in one of two ways:

1. For typed answers: as a .docx file (as is) or converted into a pdf file. (DO NOT SEND GOOGLE DOC)

For handwritten answers: Please scan as images, and group together into one pdf file. Or you may hand them manually to my office (ECME-212)

## HW 01.1

Explain (in a brief paragraph) why such a heavy machine is used to test very small samples.

## HW 01.2

•Write down the principal stresses and principal strains in a simple uniaxial test.

•Now separate the stress tensor into (i) hydrostatic and (ii) shear components.

## HW 01.3

Further in HW 01.2, show that the first corresponds only to volume change, and the second to shape change at constant volume.

## HW 01.4

Further in Question 01.2:

Using the accepted definitions of the Youngs Modulus, E, the Poission's Ratio, , the shear modulus, G,and the Bulk Modulus, B, show at



## HW 01.5

Describe an experiment with an Instron to determine (i) the shear modulus and (ii) the bulk modulus of an "isotropic" material.

## HW 01.6

Show the magnitudes of the shear stress in the Mohr Circle for the following cases (using arbitrary units)  
(i) both principal stresses are equal to 5 units  
(ii) one of them is +2, and the other is +10  
(iii) one of them is -2 and the other is -10

## HW 01.7

In the water molecule the oxygen and hydrogen bond has mixed covalent and ionic character. Explain (qualitatively) how this type of bonding creates a molecule with a significant dipole moment (assume that the dipole moment of a "+" and a "-" charge spaced by a distance, "x", is related to the product of the magnitude of the charge(s) and "x").

## HW 01.8

Write a 100 word essay (with one or two figures) on sp2 and sp3 hybridization of orbitals in carbon, and how this leads to graphite and diamond structure.

## HW 01.9

In class we derived the following equation

 (1)

with the assumption that the force displacement curve is a sine wave with the force going to zero when the displacement is equal to one half of the interatomic distance ()

Re-derive Eq. (1) with the condition that the force goes to zero at  where .

Sketch a rough graph for the ratio  vs.  (assuming ) to show whether the ratio increases or decreases with alpha.

## HW 01.10

Derive the equation for the Youngs Modulus of a transversely aligned fiber composite to be

 

where the elastic modulus appears in the denominator(s) and teh volume fraction of the fibers in the numerator(s).