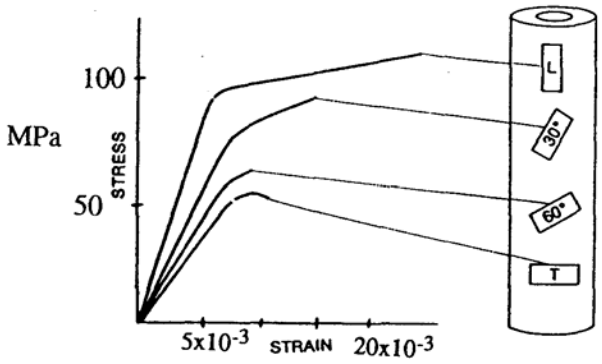
EN3 Advanced, 2010

Statics HW 4, due Nov 11th, 2010

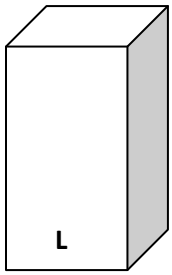
Problem 1: Strength and stiffness are important mechanical properties of bone. The anisotropic behavior of cortical (dense) bone specimens from a human femoral shaft tested in tension in four directions is shown below:



a. Estimate the stiffness of the specimens tested in each of the above directions. Do you think that the relative magnitudes of your answers make sense? Explain.

b. Which specimen shows the greatest strength in terms of energy storage (note: you do not need to calculate a numerical answer)? Explain whether this answer makes sense.

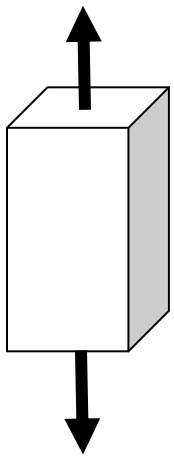
c. Consider only the longitudinal bone specimen as shown below.



$V = 16cm^3$

It is found experimentally that a change in length of 0.02 cm corresponds with a strain of $5x10^{-3}$. Using the data from the graph above, determine the force necessary to cause this change in length.

Problem 2: An experiment was used to determine the elastic modulus of a soft tissue, like the human heart. A specimen of cross-section 8x2 mm^2 was prepared for the test. Two lines were marked on the specimen at a fixed distance apart. The specimen was then subjected to tensile loading, and the length between the marked sections was measured electronically. The following data was obtained:



Applied Force, *F* [Newtons]	**Measured Gage Length, *l* [mm]**
0	10.000
0.544	10.091
0.799	10.126
1.105	10.167

a. Plot the stress strain data from this experiment.

b. Compute the Young's Modulus (E) for the soft tissue. What does this value describe in terms of the mechanical properties of the tissue? Compare this value to the following reported Young's modulus values:

Material	**Young's Modulus (GN/m^2)**
Stainless Steel	190-200
Rubbers	0.01-0.1
Titanium	116
Polyetherurethane	0.04-0.05
Polylactic-co-glycolic Acid	0.01-0.03
Silica Glass	94
Nylon	2-4

c. Which material is the best choice for your replacement tissue?