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BioE 102 Fall 2013
Midterm #2

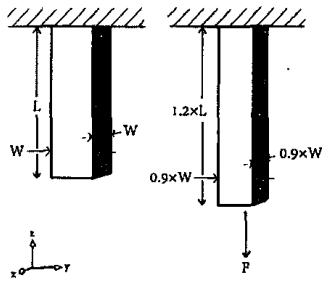
Instructions: Please write legibly; write your name and SID on the upper right corner of each page.

1. Hook's Law

Consider the transverse isotropic beam shown below. Unloaded, the beam has a length, L and width W. In tension under the force F, the beam is stretched to a length of 1.2×L and width 0.9×W (represented in the diagram below). **A.** Calculate all normal strains and use these to calculate the relevant Poisson's ratio. **B.** Solve for the σ_{zz} in terms of F and W and use this value to solve for the relevant elastic modulus.

You may assume linear-elastic behavior

(Hint: At equilibrium, the area that the force, F, acts over may be different than the area at rest.)



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2. **Pressure Vessels**

You're grilling a hotdog and the heat from the grill is causing the internal gasses to expand, creating an internal pressure. You can model the hotdog as a 12cm long cylinder with a diameter of 2cm and two spherical caps with a casing that is a mere 0.05cm thick. A fully cooked hotdog will have an internal pressure of 3.2MPa. **A.** Calculate the normal stresses on the surface of the hotdog on both the spherical ends and the cylindrical center. **B.** The hotdog will break open if a normal stress surpasses 150MPa or a shear stress surpasses 26MPa. Determine if the hotdog will break open before it is fully cooked.

You may neglect external pressures and assume linear elastic behavior.

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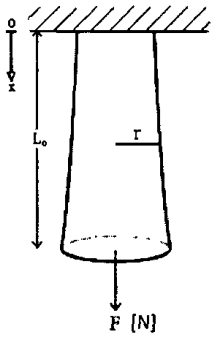
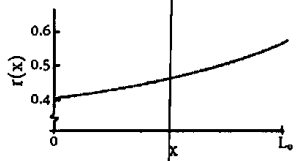
3. Extension

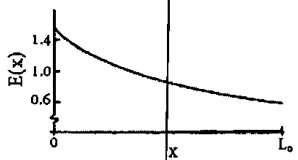
A force is applied on a beam with circular cross-section as shown below. Both the radius and the Young's modulus of the beam are functions of x. **A.** What is the total deformation, δ, of the beam under the applied force? **B.** If you were to use strain gauges to measure the strain along this beam, at what location x would you measure the largest strain in the x direction?

You may neglect any strain due to Poisson's ratio and assume linear elastic behavior





$$r(x) = \sqrt{\frac{1}{\left(2 - \frac{x}{L_0}\right)\pi}}\, r_0 \quad [\text{m}]$$



$$E(x) = \frac{1}{\left(\frac{x}{L_0} + \frac{2}{3}\right)} E_0 \quad [\text{Pa}]$$