Duke University
Edmund T. Pratt, Jr. School of Engineering

EGR 75 Summer 2010
Test II
Michael R. Gustafson II

Name (please print)_____

In keeping with the Community Standard, I have neither provided nor received any assistance on this test. I understand if it is later determined that I gave or received assistance, I will be brought before the Undergraduate Conduct Board and, if found responsible for academic dishonesty or academic contempt, fail the class. I also understand that I am not allowed to speak to anyone except the instructor about any aspect of this test until the instructor announces it is allowed. I understand if it is later determined that I did speak to another person about the test before the instructor said it was allowed, I will be brought before the Undergraduate Conduct Board and, if found responsible for academic dishonesty or academic contempt, fail the class.

Signature:_____

Instructions

First - please turn **off** any cell phones or other annoyance-producing devices. Vibrate mode is not enough - your device needs to be in a mode where it will make no sounds during the course of the test, including the vibrate buzz or those acknowledging receipt of a text or voicemail.

Please be sure to put each problem on its own page or pages - do *not* write answers to more than one problem on any piece of paper and do not use the back of a problem for work on a *different* problem. You will be turning in each of the problems independently. This cover page should be stapled to the front of Problem 1.

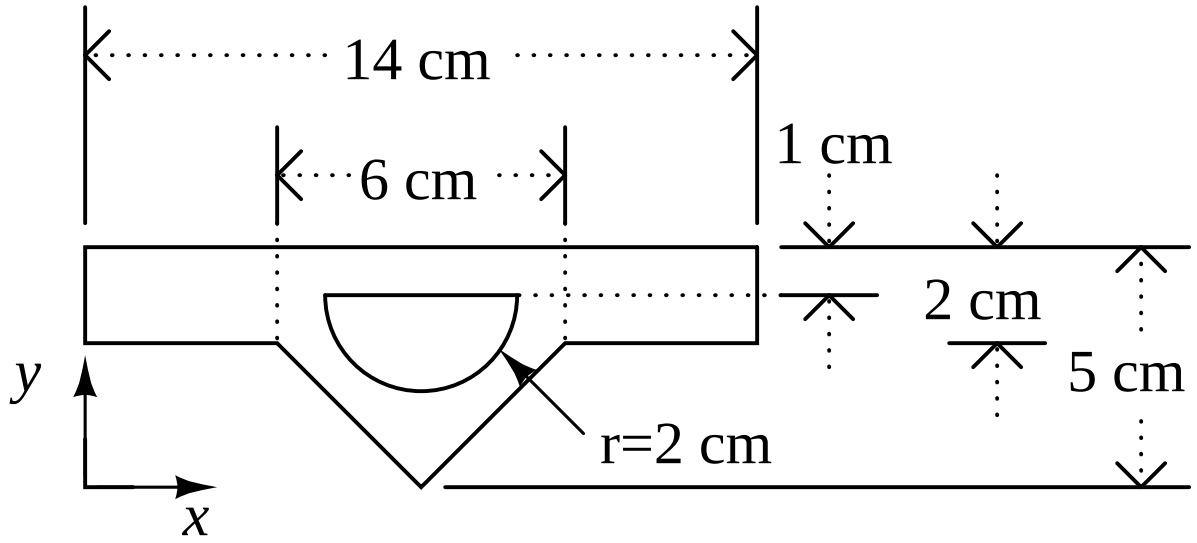
Make sure that your name *and* NET ID are *clearly* written at the top of *every* page, just in case problem parts come loose in the shuffle. Make sure that the work you are submitting for an answer is clearly marked as such. Finally, when turning in the test, individually staple all the work for each problem and place each problem's work in the appropriate folder.

Note that there may be people taking the test after you, so you are not allowed to talk about the test - even to people outside of this class - until I send along the OK. This includes talking about the specific problem types, how long it took you, how hard you thought it was - really anything. Please maintain the integrity of this test.

Name (please print):
Community Standard (print ACPUB ID):

Problem I: [20 pts.] Geometric Properties

A specialized (and symmetric) beam has a semi-circular hole drilled along its length so that it can be mounted on a semi-circular rods. The cross section of the resulting beam is:



(1) *Clearly* demonstrate the process of determining the x and y location of the centroid. Once calculated, draw a * at approximately that location on the drawing. Be sure to also indicate where you chose the origin.

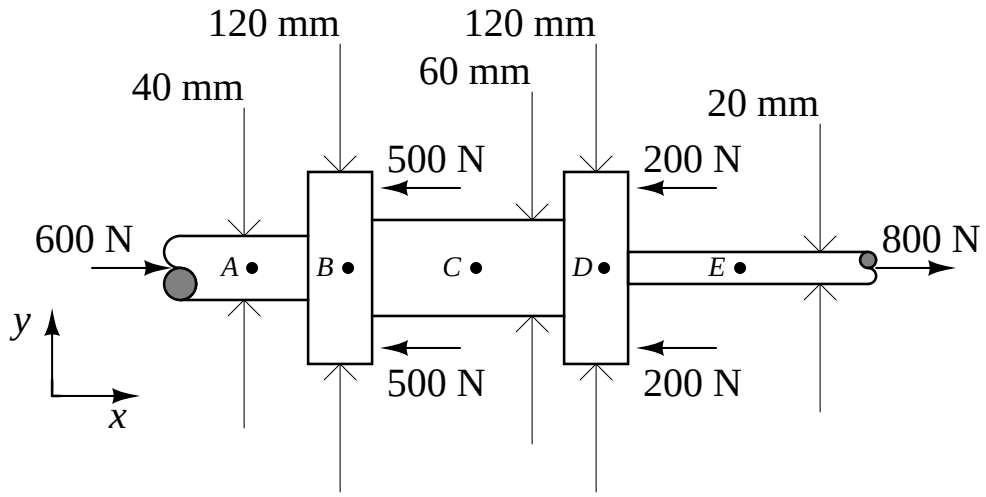
(2) *Clearly* demonstrate the process of determining the area moment of inertia in the x direction about an axis directed through the centroid of the object (this is sometimes listed as $\bar{I}_{x'}$ in the book where x' denotes an x-axis through the centroid of the object). You may assume that you have calculated the centroid above correctly.

(3) *Clearly* demonstrate the process of determining the area moment of inertia in the x direction about an axis directed through the bottom of the object. You may assume that you have calculated the two quantities above correctly.

Name (please print):
Community Standard (print ACPUB ID):

Problem II: [20 pts.] Normal Stress and Strain

A double thrust bearing is loaded as follows:



(1) Determine the normal force and average normal stress developed at points B and C in the bearing. Be sure to include a free-body diagram and state whether the stress represents tension or compression. Note that each section is circular and that the diameters are given.

(2) For location C *only*, sketch the state of stress of a differential volume element located in this section.

(3) The section containing location E is originally 150 mm long; after loading, this section is 150.1 mm long. Calculate the average normal strain in the x direction for this section.

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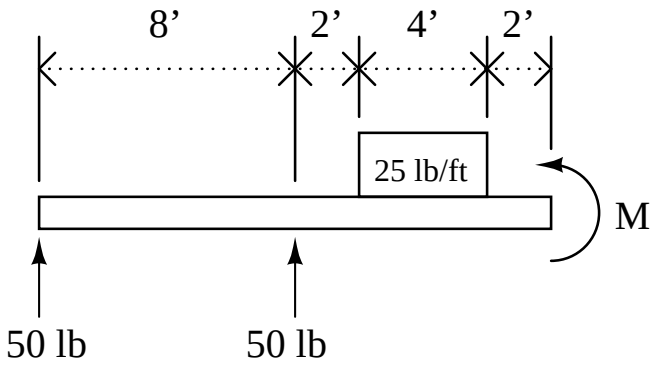
Problem III: [20 pts.] Shear and Bending Diagrams

A beam is loaded as follows:



Note that there is a 100 pound box that represents a distributed load of 25 lb/ft. You may neglect the weight of the beam.

(1) Calculate the moment M applied to the right end of the beam for the beam to be in equilibrium.

(2) Draw the shear and bending diagrams for the beam. Be sure to clearly indicate all zero-crossings as well as all local maxima and minima in the latter two diagrams.

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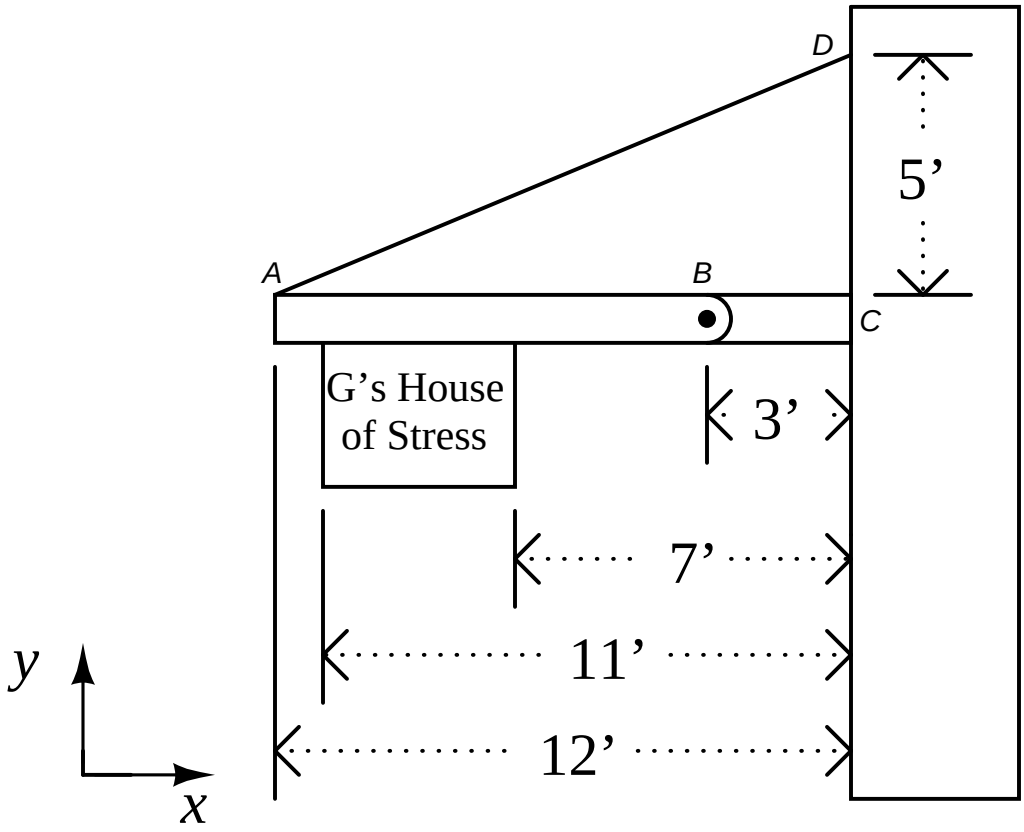
Problem IV: [40 pts.] Design

On a busy street in a town near you, a restaurant has a deployable sign advertising its specials. A short beam (BC)is fixed to a wall; a single-shear connection at B is used to pin the short beam to a long beam (AB). The long beam is held in place by a steel cable (AD). The sign is attached to the long beam by several rivets. This arrangement is depicted below:



The sign itself is made of steel and weighs 180 lb which causes a distributed load of 45 lb/ft on the long beam for the 4' the sign is riveted to the beam. The beams holding up the sign are made of the same steel and contribute a distributed load of 15 lb/ft along the entire length of each of the beams. The weight of the connecting pin and the support wire may be ignored. Also ignore any moments about the in the x-direction caused by asymmetry.

(1) Determine the reaction of the wall at C.

(2) Determine the minimum diameter of the cable AD if $\tau_{\max}$=8 ksi and $\sigma_{\max}$=12 ksi.

(3) Given that the pin at B is in single-shear, determine the minimum diameter of the pin if $\tau_{\max}$=15 ksi and $\sigma_{\max}$=30 ksi.

(4) The cross-sectional area of each of the beams AB and BC is 4 in^2. If the maximum allowable normal stress for the beam material is 18 ksi, determine the factor of safety of this aspect of the design. That is, determine the ratio of the maximum *allowable* normal stress to the maximum normal stress developed in the beam.

Note - for any of the above portions, if you feel you are unable to calculate a value because you are unable to complete an intermediate step, list the variables you would need in order to complete the analysis and present the relevant equations using those symbols.