UNIVERSITY OF BRITISH COLUMBIA
FACULTY OF APPLIED SCIENCE
DEPARTMENT OF MECHANICAL ENGINEERING

FINAL EXAMINATIONS, December 2009

MECH 360 – Mechanics of Materials

Duration: 2.0 hours.

Answer all four questions. They carry approximately equal marks. Additional marks will be assigned for orderly presentation of work.

This exam has 7 pages, printed double-sided. Please check that you have all pages. Write your name on all pages at the START of the exam.

Materials admitted: Pen, pencil, eraser, straightedge, non-programmable calculator, 2 formula sheets ONLY. No other items are permitted.

Turn off and put away all cell phones, pagers, alarms, etc. before starting the exam. Marks penalties may be assessed for any disturbances caused by such devices.

NAME:_____SIGNATURE:_____

SECTION:_____STUDENT NUMBER:_____

CANDIDATES MUST IMMEDIATELY STOP WRITING WHEN THE INVIGILATOR ANNOUNCES THE EXAM IS OVER.

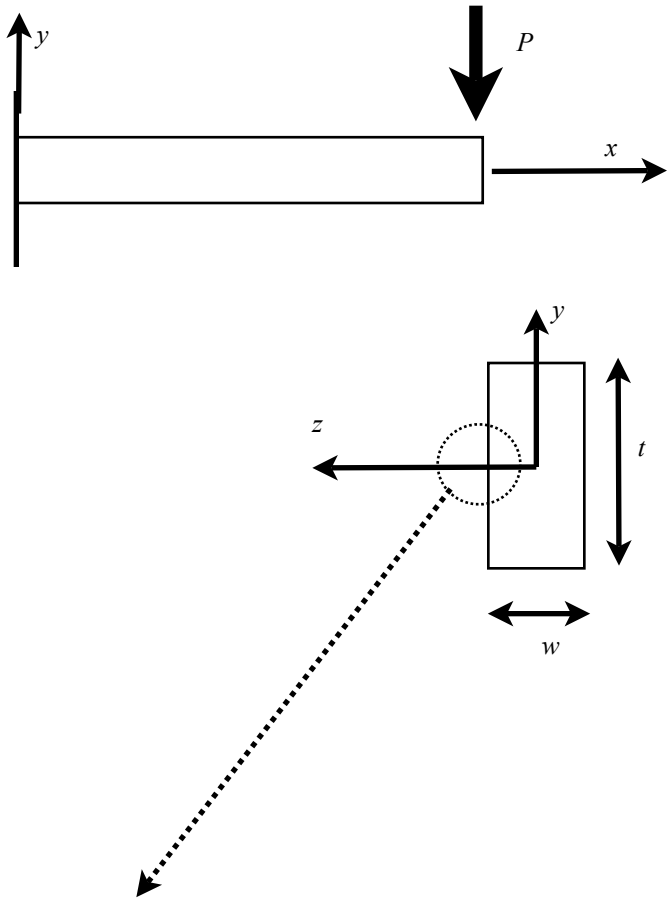
READ AND OBSERVE THE FOLLOWING RULES

1. Each candidate must be prepared to produce, upon request, a Library/AMS card for identification.
2. Candidates are not permitted to ask questions of the invigilators, except in cases of supposed errors or ambiguities in examination questions.
3. No candidate shall be permitted to enter the examination room after the expiration of one-half hour from the scheduled starting time, or to leave during the first half hour of the examination.
4. Candidates suspected of any of the following, or similar, dishonest practices shall be immediately dismissed from the examination and shall be liable to disciplinary action.
   - Having at the place of writing any books, papers or memoranda, calculators, computers, audio or video cassette players or other memory aid devices, other than those authorized by the examiners.
   - Speaking or communicating with other candidates.
   - Purposely exposing written papers to the view of other candidates. The plea of accident or forgetfulness shall not be received.
5. Candidates must not destroy or mutilate any examination material; must hand in all examination papers; and must not take any examination material from the examination room without permission of the invigilator.

Question	Score
1	
2	
3	
4	
Orderly Presentation	
TOTAL	

1. Short answer questions:

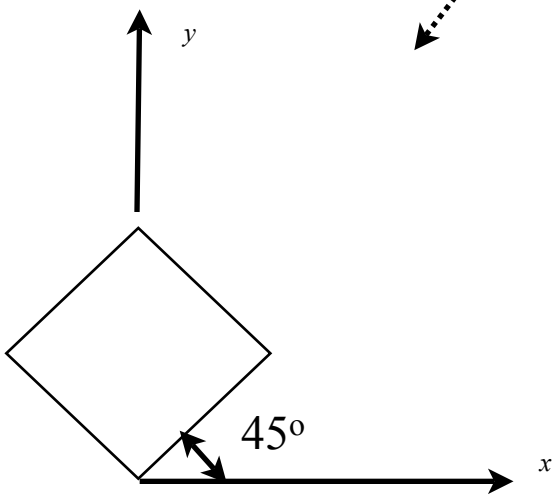
1(a) A cantilever beam (Young's Modulus ***E***, moment of inertia ***I***, cross section area ***A***, width ***w***, thickness ***t***) is under a transverse load ***P*** at its free end. The beam has a rectangular cross section. Axes *y* and *z* are axes of symmetry and pass through the centroid. An infinitesimal elements is taken from the center of the beam (y=0, Z=w/2), but is rotated at 45 degree angle



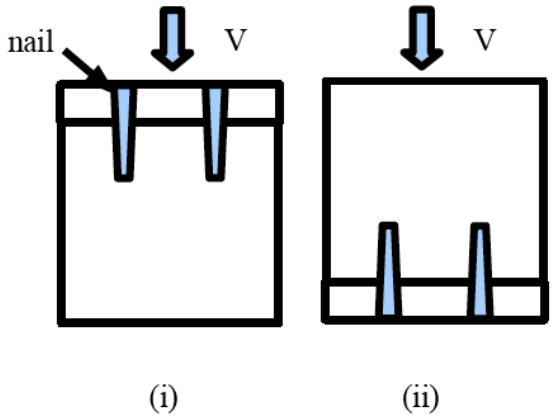
(i) Draw stress components on the element. what are the values (in terms of beam properties) of the stresses on the element?

(ii) will the value of the stresses change with the axial coordinate x, explain?

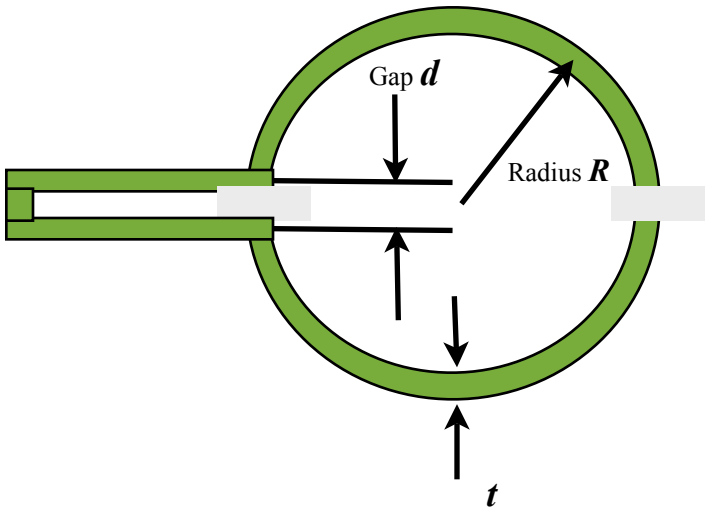
(iii) Is this a plane stress or plane strain problem, or both, or neither, explain.



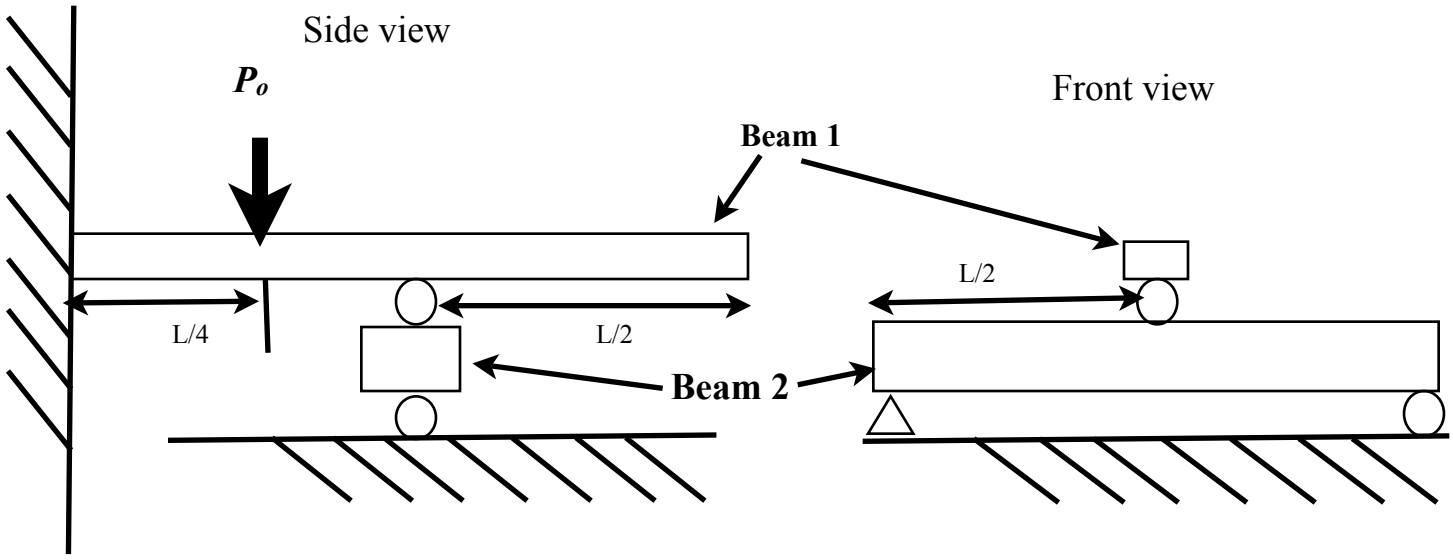
1(b) A cantilever beam with a built-up cross section is shown. A transverse load is applied on the free end of the beam but at two different directions. Do the nails experiences different shear stresses? if yes, which loading condition gives larger shear stresses to the nails.



1(c) A cantilever beam made of a thin-walled open section is shown below, the thickness is ***t***, The section contains two parts: (1) a circle (radius ***R***) ; and (2) two plates separated by a gap ***d***. Find the location of shear centre when ***d*** << ***t***



2. Two beams are stacking together through a pinned joints, and is forming 90 degree with respect to each other. Each beam has a length ***L,*** area ***A***, moment of inertia ***I***, Young's modulus ***E***. Beam 1 is fixed into the wall and all other supports are pinned joints. Find out the displacement at the free end of Beam 1.

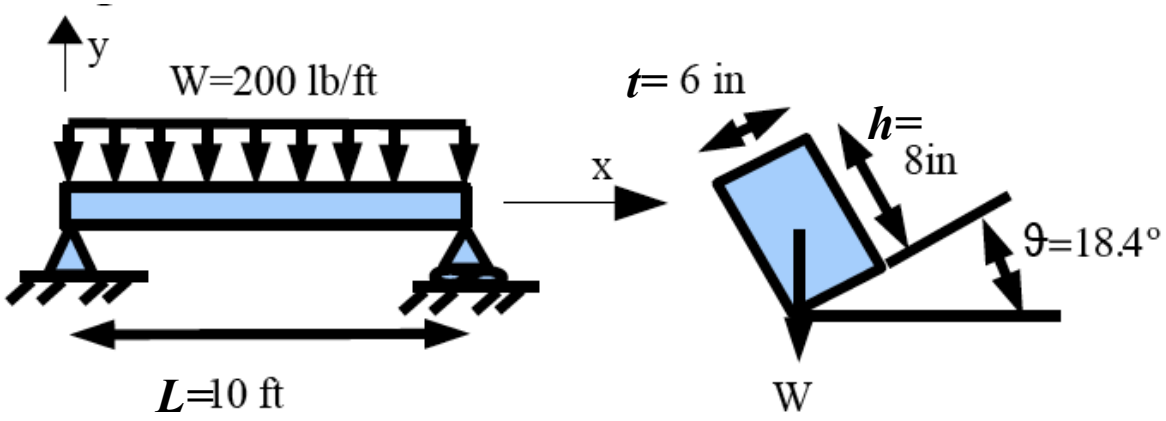


3. A simply-supported beam is deflected under its own weight, as shown below. The longitudinal axis of the beam is horizontal but the cross section is inclined at an angle ϑ to the horizontal. The load on the beam is uniform (W=200 lb/ft) that is assumed to act through the centroid of the beam.

(a) Locate at least two possible maximum stress points, rationalize your choice of points, and find the principal stresses for each points.

(b) Use Tresca Criterion to determine if the beam will fail if the yield stress, $\boldsymbol{\sigma_Y}$ is 700 Psi

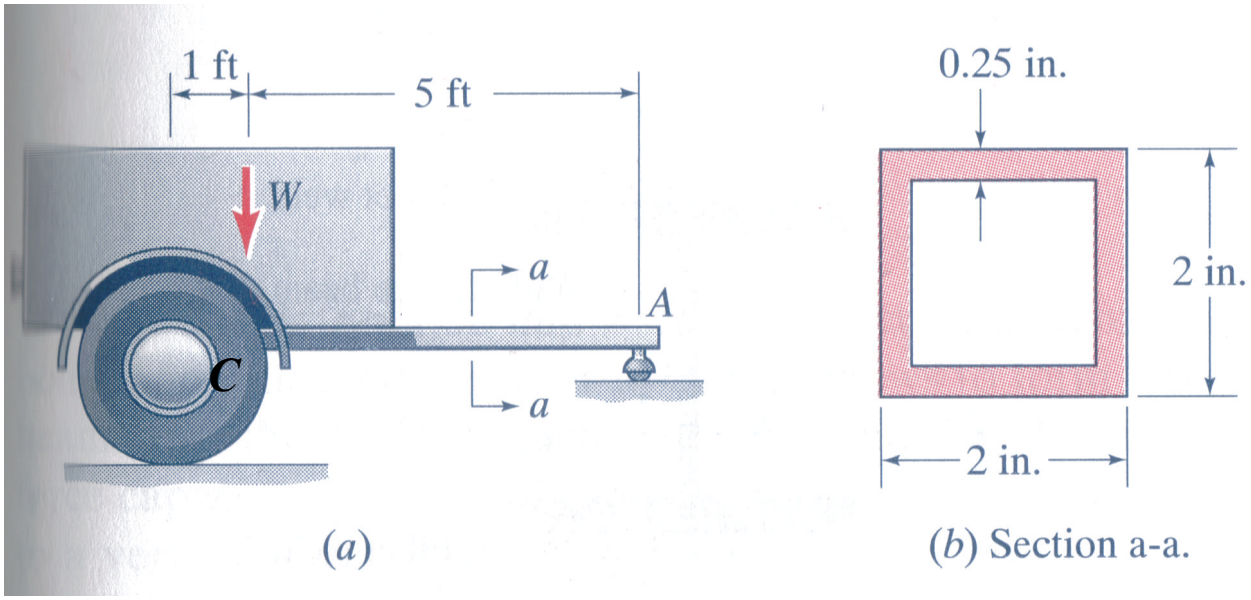
(c) if beam length $\boldsymbol{L}$ and height $\boldsymbol{h}$ are not assigned (i.e. they are variables), and the inclination angle ϑ is 0°. The remaining beam parameters stay the same. Find out the maximum ratio of L/h at which, failure will occur at the pinned supports first, when yielding occurs.



4. A trailer with support beam AC has a square box section as shown. Trailer hitch at point *A* is attached to a tow truck through a pin joint. Point C is attached to the axle of the trailer through a pin joint as well (not shown). Assume that the total weight of the trailer and its load is ***W***, and that its line of action is ***1ft*** forward of the axle of the trailer. Furthermore, assume that the tongue is effectively cantilevered from the trailer body at point *B* (assume built-in support at point *B).* The tongue AB material has a yield stress σ_Y=12 Ksi, *Poisson's ratio*=0.3, and Young's modulus=30×10^6 Psi. Determine the maximum allowable W for the following two conditions.

   (a) Trailer is resting.

   (b) Trailer is traveling at a velocity ***v of 100 km/hour,*** but has come to a complete stop within 0.5 seconds , assuming 50% of the kinetic energy is translated into beam AC's structural deformation in the axial direction. (ignore bending deformation caused by the inertial force). Gravitational acceleration ***g***=385.8 in/sec^2



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