10:00 - 11: 00
32-141

MIT ID# (last four digits) ___________________________

Unified Quiz M1

March 5, 2008

<u>M - PORTION</u>

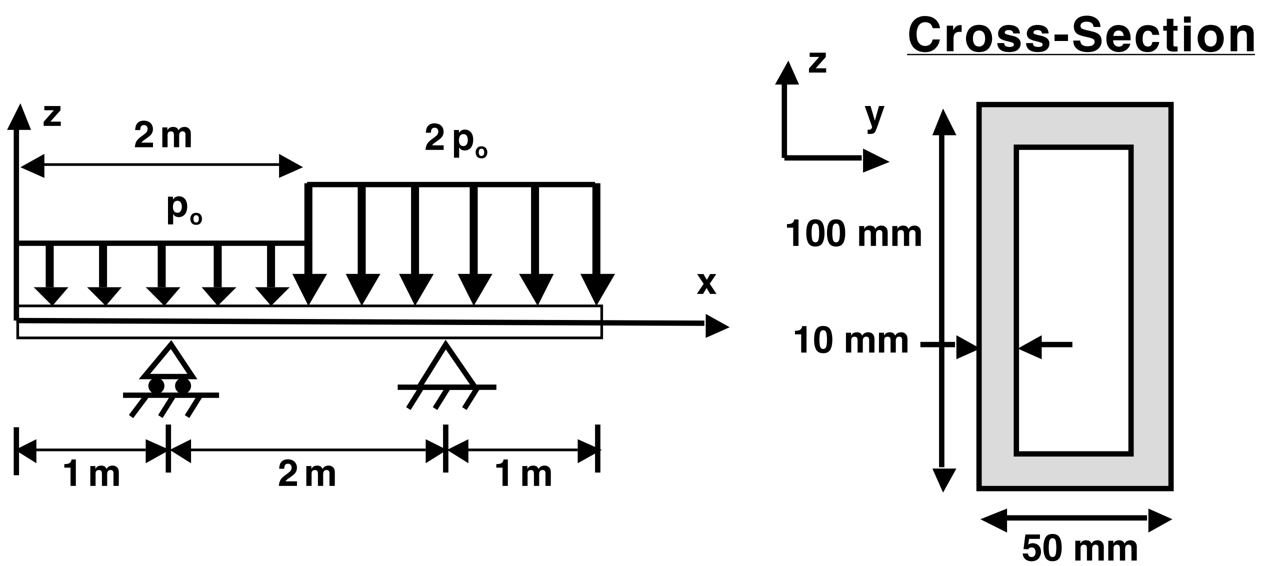
- Put the last four digits of your MIT ID # on each page of the exam.
- Read all questions carefully.
- Do all work on that question on the page(s) provided. Use back of the page(s) if necessary.
- Show all your work, especially intermediate results. Partial credit <u>cannot</u> be given without intermediate results.
- Show the logical path of your work. Explain <u>clearly</u> your reasoning and what you are doing. *In some cases, the reasoning is worth as much (or more) than the final answers*.
- Please be neat. It will be easier to identify correct or partially correct responses when the response is neat.
- Be sure to show the appropriate units throughout. Answers are not correct without the units.
- Report significant digits only.
- Box your final answers.
- ***Calculators are allowed.***
- ***Print-outs of Handouts "HO-M-8" and "HO-M-11" along with 2 sides of pages of handwritten material are allowed.***

EXAM SCORING

#1M (50%)	
#2M (50%)	
FINAL SCORE	

PROBLEM #1M (50%)

A 4-meter long steel beam (E = 200 GPa, ν = 0.3) is supported by a roller-pin configuration with a roller inboard 1 meter from one end and a pin 1 meter inboard from the other. The beam has a rectangular box cross-section with outer dimensions of 100 mm by 50 mm and a wall thickness of 10 mm. The beam is loaded by two constant load segments: p_o in intensity for the first half and double that for the second half. This overall configuration is shown in the accompanying figure.



(a) Sketch the shear force and bending moment resultant distributions as a function of position along the beam. Be sure to note the key values of each and their locations.

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PROBLEM #1M (continued)

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PROBLEM #1M (continued)

PROBLEM #1M (continued)

(b) Determine the x-location of the maximum axial stress (i.e. $\square_{xx}$).

(c) Determine the x-location of the maximum shear stress (i.e. $\square_{xz}$).

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PROBLEM #1M (continued)

(d) You need to reduce the maximum deflection by a factor of two and can do so by changing the wall thickness while keeping the outer box dimensions constant. Clearly indicate and explain the analysis needed to determine the new thickness. You can use and set up equations, but **do not** solve any resulting final equations.

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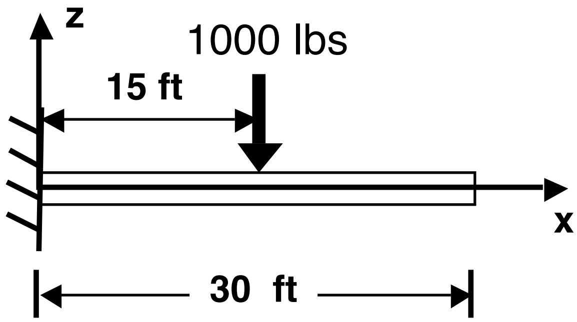
PROBLEM #1M (continued)

PROBLEM #1M (continued)

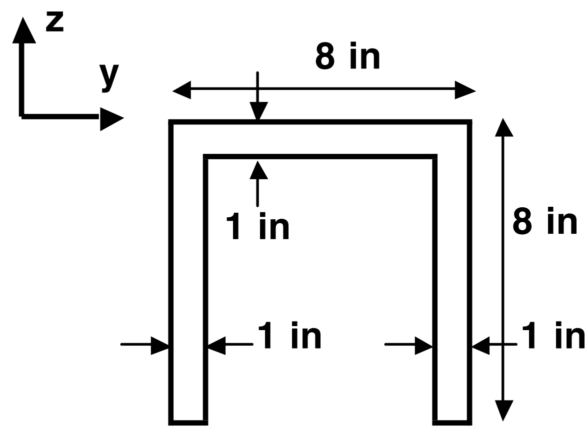
(e) How do the answers to parts (a), (b), (c), and (d) change if aluminum (E = 67 GPa ν = 0.3) is used rather than steel? Explain carefully.

PROBLEM #2M (50%)

A statically determinate beam has a C-shape cross-section with the dimensions and orientation as in the accompanying figure. The beam is cantilevered and is loaded by a mid-span downward bending load of 1000 pounds. The beam is 30 feet long and is made of titanium with a modulus of 15 Msi.



Cross-Section



(a) Determine the ratio of the maximum tensile axial stress to the maximum compressive axial stress (i.e. σ_{xx}). Indicate the location of these maximum stresses in the cross-sectional plane.

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PROBLEM #2M (continued)

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PROBLEM #2M (continued)

(b) Determine the location of the maximum value of the transverse shear stress, τ_{xz}, in the cross-sectional plane.

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PROBLEM #2M (continued)

(c) In addition to the bending load in the z-direction, the structural configuration is subjected to a tip tensile load in the x-direction of the same magnitude. Clearly explain if and how this affects the location of the maximum tensile axial stress, compressive axial stress, and transverse shear stress.