Name *(Print)*____

(Last) *(First)*

ME 323 - Mechanics of Materials
Exam # 2

November 4, 2015

6:30 – 7:30 PM

Instructions:

Circle your lecturer's name and your class meeting time.

Krousgrill	Gonzalez	Ghosh	Zhao
11:30AM-12:20PM	12:30-1:20PM	2:30-3:20PM	4:30-5:20PM

Begin each problem in the space provided on the examination sheets. If additional space is required, use the yellow paper provided.

Work on one side of each sheet only, with only one problem on a sheet.

Write your name on every sheet of the exam.

Please remember that for you to obtain maximum credit for a problem, you must present your solution clearly.

Accordingly,

- coordinate systems must be clearly identified,
- free body diagrams must be shown,
- units must be stated,
- write down clarifying remarks,
- state your assumptions, etc.

If your solution does not follow a logical thought process, it will be assumed that it is in error.

When handing in the test, make sure that ALL SHEETS are in the correct sequential order.

Remove the staple and restaple, if necessary.

Prob. 1 ____________________

Prob. 2 ____________________

Prob. 3 ____________________

Total ____________________

ME 323 Examination #2 **Name** ____________________

November 4, 2015 **Instructor** (circle) Krousgrill 11:30AM-12:20PM | Gonzalez 12:30-1:20PM | Ghosh 2:30-3:20PM | Zhao 4:30-5:20PM

PROBLEM NO. 1 (35 points max.)

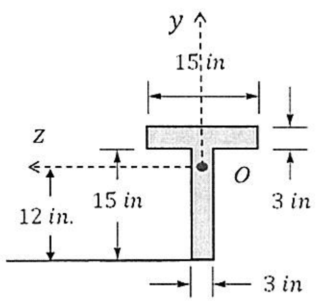
A structural 'T' section is used as a cantilever beam (AC) to support a distributed load of 1 kip/ft and a point load of 50 kips as shown below.

(a) Draw the *shear force*, V(x), and *bending moment*, M(x), diagrams for the beam

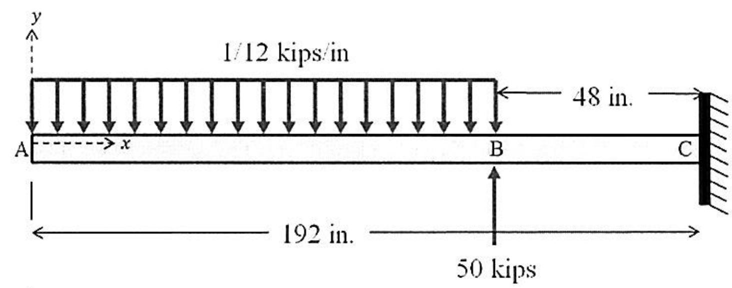
(b) Determine the location (x,y) and magnitude of maximum *tensile* flexural stress.

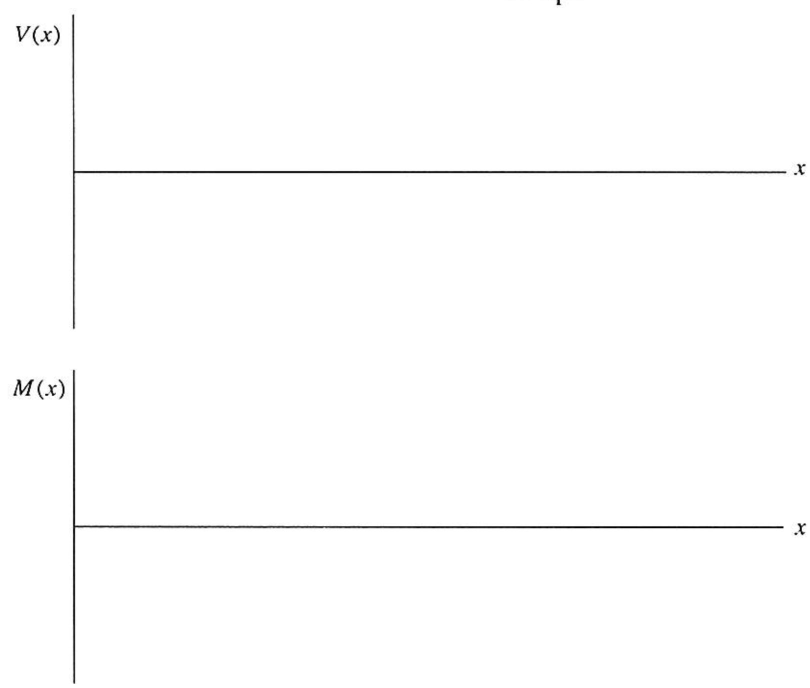
(c) Determine the location (x,y) and magnitude of maximum *compressive* flexural stress.

Please use the coordinate system already provided in the figures. The centroid O and the area moment of inertia are shown in the figure.



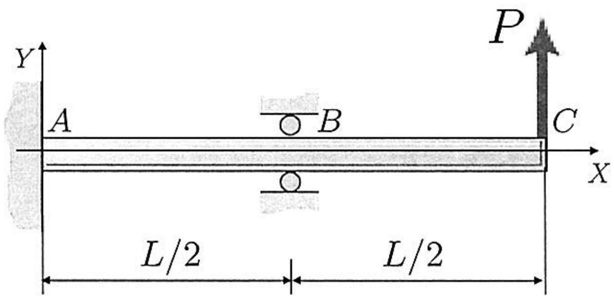
$I_z = 2700\ in^4$





PROBLEM NO. 1 (continued)

PROBLEM NO. 2 (35 points max.)

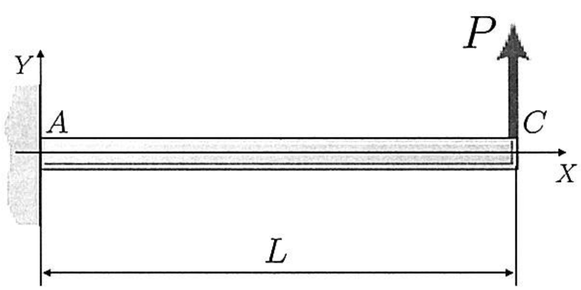


The cantilever beam ABC shown in the figure is fixed to a rigid wall at A and is supported by a roller at B. The beam is loaded by a concentrated force P located at C. Determine the value of the reaction R_B at support B using the superposition method and following the procedure described below.

(a) Explain whether the problem is statically determinate or statically indeterminate.

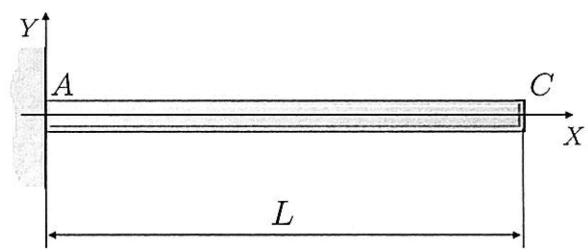
(b) The problem is broken down into two statically determinate sub-problems. Sub-problem I is shown below on the left-hand side, together with an expression for the corresponding deflection $v_I(x)$.
Draw the loading conditions of sub-problem II on the beam depicted on the right-hand side. These loading conditions must be such that the reaction at B can be determined by superposition of sub-problems I and II.

Sub-problem I:



$$v_I(x) = \frac{Px^2}{6EI}(3L - x) \qquad x \in [0, L]$$

Sub-problem II:



$$v_{II}(x) = \cdots$$

(c) Solve for the deflection $v_{II}(x)$ of sub-problem II using an integration method.

(d) Write the compatibility equation(s) relevant to the superposition method (that is the boundary conditions and/or continuity conditions that are not automatically satisfied by the sub-problems).

(e) Solve for the reaction R_B at support B.

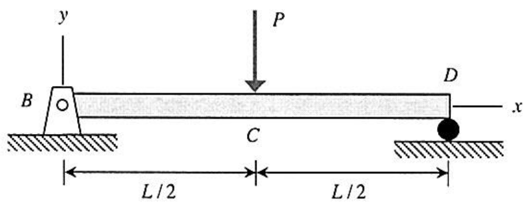
PROBLEM NO. 2 (continued)

PROBLEM NO. 2 (continued)

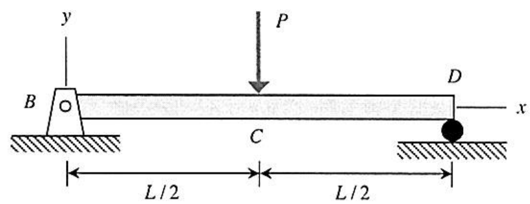
ME 323 Examination #2 **Name** ______________________

November 4, 2015 **Instructor** (circle) Krousgrill 11:30AM-12:20PM / Gonzalez 12:30-1:20PM / Ghosh 2:30-3:20PM / Zhao 4:30-5:20PM

PROBLEM NO. 3 – Part A (6 points max.)



Beam (i) - STEEL



Beam (ii) - ALUMINUM

Beams (i) and (ii) shown above are identical, except that Beam (i) is made up of steel, and Beam (ii) is made up of aluminum. Note that $E_{steel} > E_{aluminum}$.

Let $\left(|\sigma|_{max}\right)_i$ and $\left(|\sigma|_{max}\right)_{ii}$ represent the maximum magnitude of flexural stress in Beams (i) and (ii), respectively. Circle the correct relationship between these two stresses:

a) $\left(|\sigma|_{max}\right)_i > \left(|\sigma|_{max}\right)_{ii}$

b) $\left(|\sigma|_{max}\right)_i = \left(|\sigma|_{max}\right)_{ii}$

c) $\left(|\sigma|_{max}\right)_i < \left(|\sigma|_{max}\right)_{ii}$

Let $\left(|\tau|_{max}\right)_i$ and $\left(|\tau|_{max}\right)_{ii}$ represent the maximum magnitude of the xy-component of shear stress in Beams (i) and (ii), respectively. Circle the correct relationship between these two stresses:

a) $\left(|\tau|_{max}\right)_i > \left(|\tau|_{max}\right)_{ii}$

b) $\left(|\tau|_{max}\right)_i = \left(|\tau|_{max}\right)_{ii}$

c) $\left(|\tau|_{max}\right)_i < \left(|\tau|_{max}\right)_{ii}$

Let $\left(|\delta|_{max}\right)_i$ and $\left(|\delta|_{max}\right)_{ii}$ represent the maximum magnitude of deflection in Beams (i) and (ii), respectively. Circle the correct relationship between these two deflections:

a) $\left(|\delta|_{max}\right)_i > \left(|\delta|_{max}\right)_{ii}$

b) $\left(|\delta|_{max}\right)_i = \left(|\delta|_{max}\right)_{ii}$

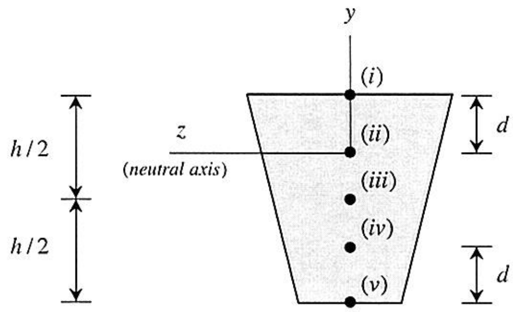
c) $\left(|\delta|_{max}\right)_i < \left(|\delta|_{max}\right)_{ii}$

ME 323 Examination #2 **Name** ______________________________

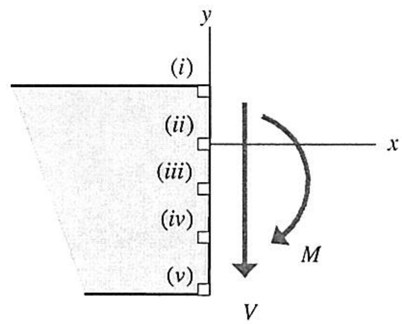
November 4, 2015 **Instructor** (circle)

Krousgrill	Gonzalez
11:30AM-12:20PM	12:30-1:20PM
Ghosh	Zhao
2:30-3:20PM	4:30-5:20PM

PROBLEM NO. 3 – Part B (10 points max.)



cross section of beam



SIDE view of beam

A shear force V and bending moment M act at a cross section of a trapezoidal cross-sectioned beam. Consider the five points (i), (ii), (iii), (iv) and (v) on the beam cross section, as shown above. *Match up the state of stress at each of these five points with the stress elements (a) through (o) shown below.* If you choose "(o) NONE of the above", provide a sketch of the correct state of stress for your answer.

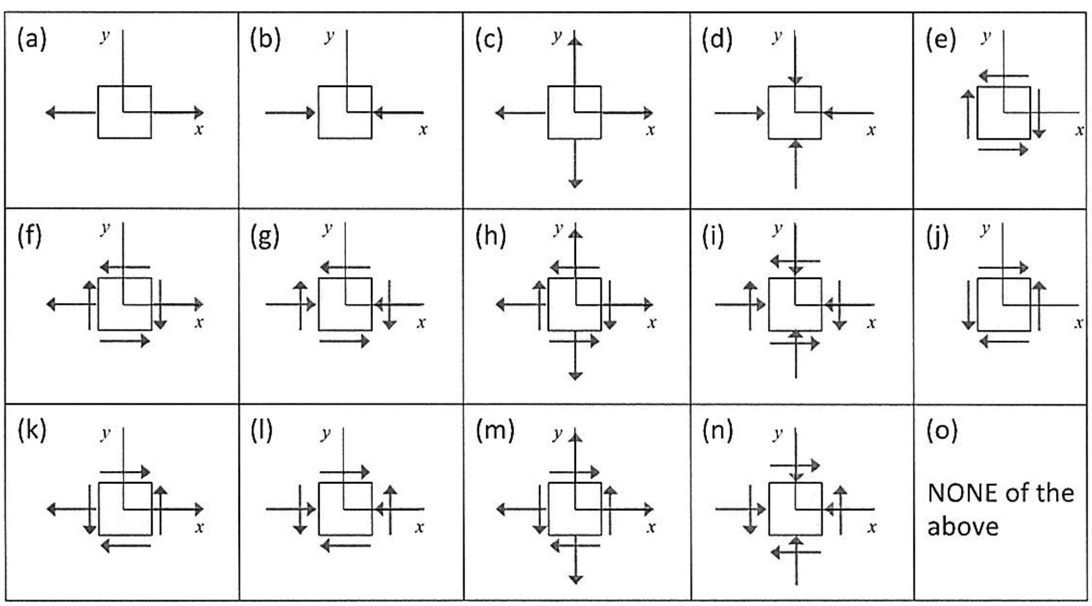
The state of stress at point (i) is________________

The state of stress at point (ii) is ________________

The state of stress at point (iii) is ________________

The state of stress at point (iv) is ________________

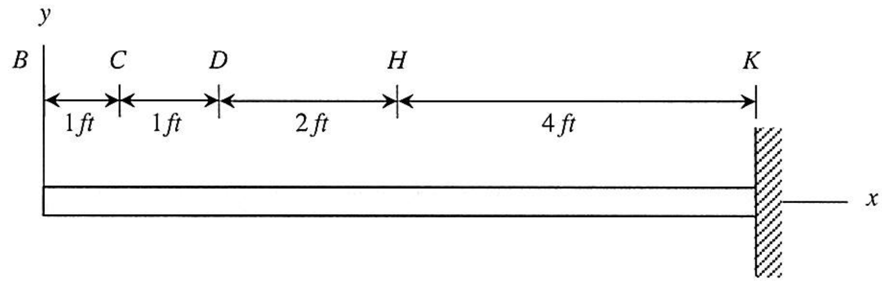
The state of stress at point (v) is ________________

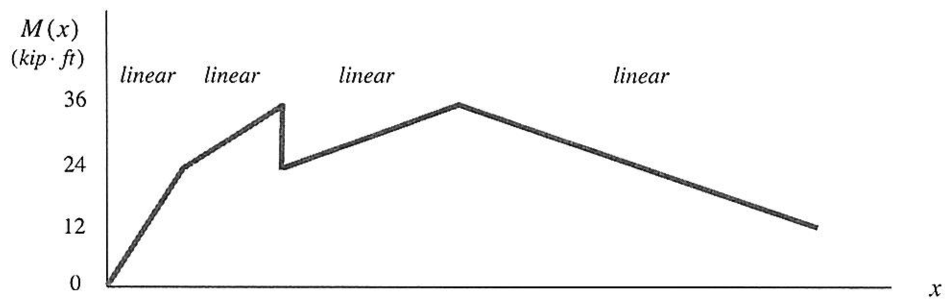


ME 323 Examination #2 **Name** ______________________

November 4, 2015 **Instructor** (circle) Krousgrill 11:30AM-12:20PM Gonzalez 12:30-1:20PM Ghosh 2:30-3:20PM Zhao 4:30-5:20PM

PROBLEM NO. 3 – Part C (7 points max.)





The cantilevered beam is loaded with concentrated moments and concentrated forces. This loading is unknown; however, the bending moment diagram for the beam is known and provided above.

a) Determine the maximum value of the magnitude of *internal shear force* V in the beam.

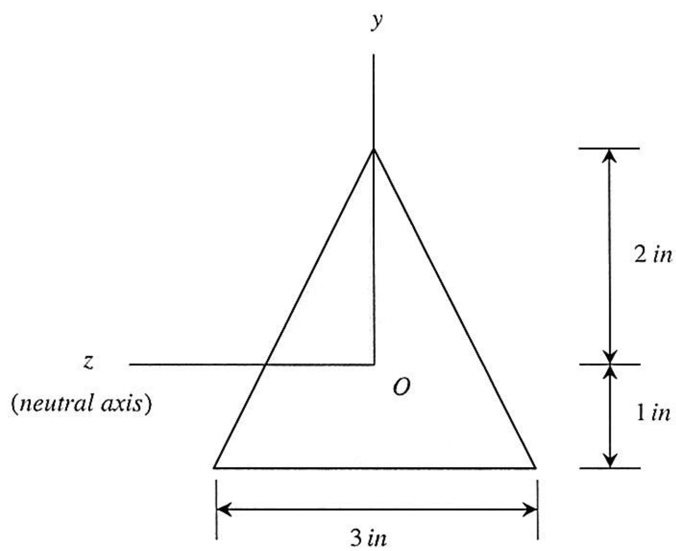
b) If the beam has a square cross section with a cross-sectional area of $A = 2\,ft^2$, determine the maximum value of the magnitude of *shear stress* τ_{xy} in the beam?

ME 323 Examination #2 **Name** ________________________________

November 4, 2015 **Instructor** (circle)

Krousgrill 11:30AM-12:20PM	Gonzalez 12:30-1:20PM
Ghosh 2:30-3:20PM	Zhao 4:30-5:20PM

PROBLEM NO. 3 – Part D (7 points max.)



At a given location along a beam, it is known that a shear force of $V = 4$ *kips* acts in the y-direction on the beam's triangular cross section. Determine the *shear stress* at O on the cross section of the beam.