NAME:

_____

ME 270 – Fall 2012 **Group No.: _____**

Examination No. 3 - Makeup

Please review the following statement:

I certify that I have not given unauthorized aid nor have I received aid in the completion of this exam.

Signature: _____

INSTRUCTIONS

Begin each problem in the space provided on the examination sheets. If additional space is required, use the white lined paper provided to you.

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

Each problem is worth 20 points.

Please remember that for you to obtain maximum credit for a problem, it must be clearly presented, i.e.

- The coordinate system must be clearly identified.
- Where appropriate, free body diagrams must be drawn. These should be drawn separately from the given figures.
- Units must be clearly stated as part of the answer.
- You must carefully delineate vector and scalar quantities.

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

When handing in the test, please make sure that all sheets are in the correct sequential order and make sure that your name is at the top of every page that you wish to have graded.

Instructor's Name and Section:

Sections: J. Silvers E. Nauman K.M. Li

Problem 1 _____

Problem 2 _____

Problem 3 _____

Total _____

NAME: _____

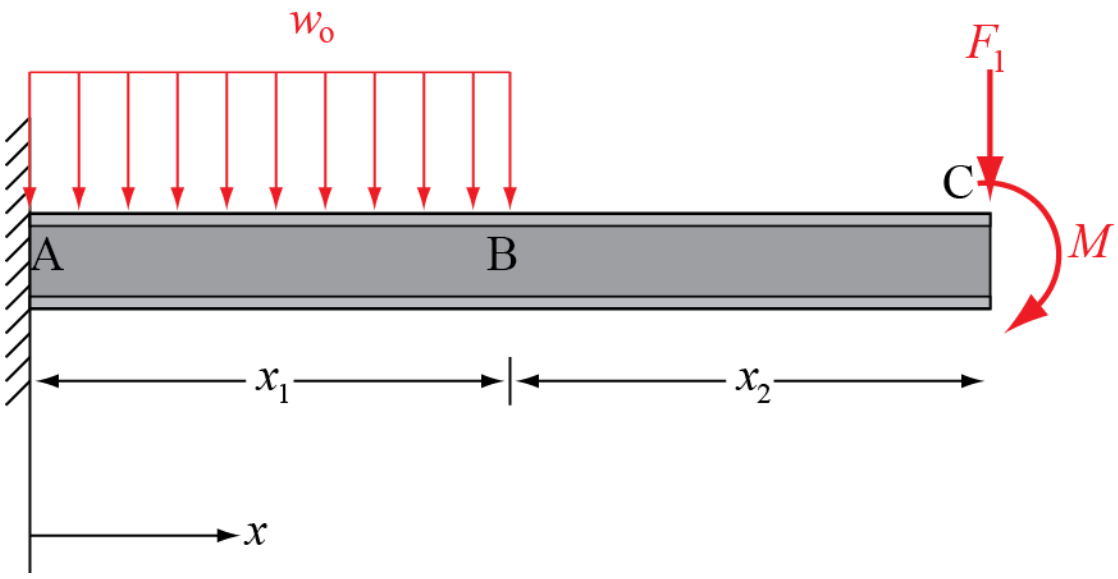
Problem 1:

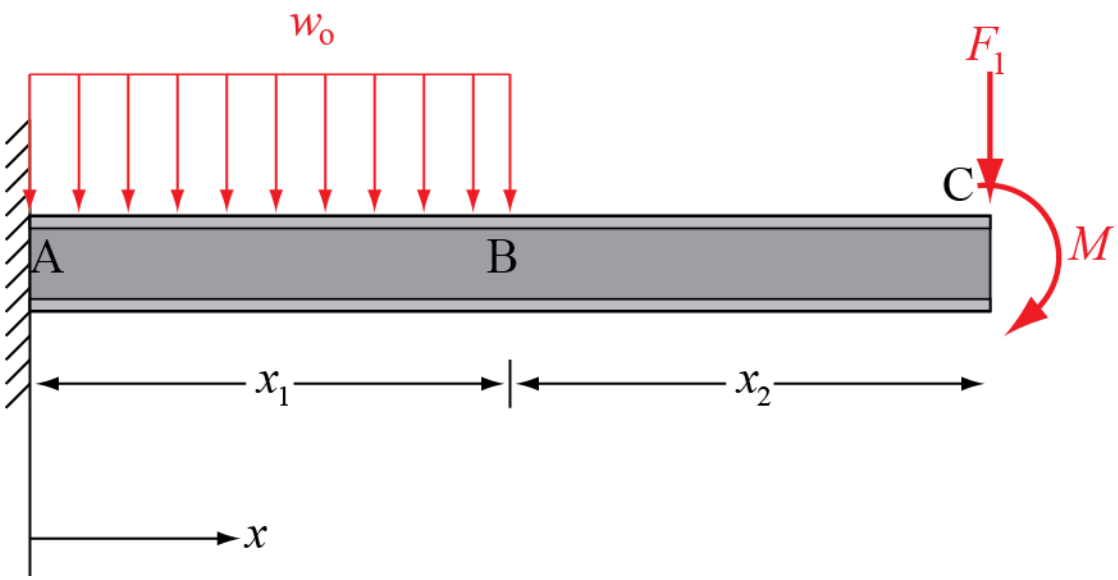
1a (4 points) For the beam shown below, calculate the reactions at the wall if M = 10 kN*m, F_1 = 5 kN, x_1 = 2 m, x_2 = 2 m, and w_0 = 250 N/m.

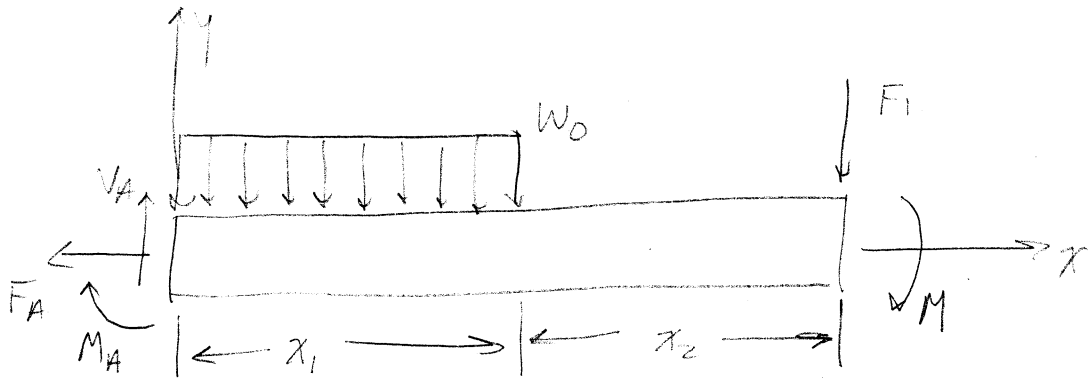
1b (7 points) On the following page, draw the shear force diagram, labeling maxima and minima.

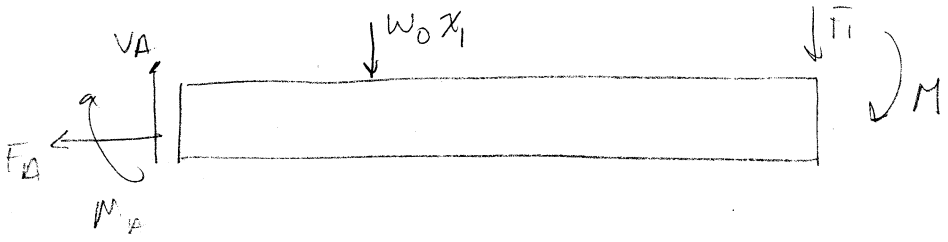
1c (7 points) On the following page, draw the moment diagram right below the shear force diagram, labeling the maxima and minima.

1d (2 points) Identify (if any) points where pure bending exists.




w_o
F_1
C
A
B
M
x_1
x_2
x





$$\Sigma \vec{M}_{/A} = \vec{0}$$

$$-M_A - (w_0 x_1)\frac{1}{2}x_1 - (x_1 + x_2)F_1 - M = 0$$

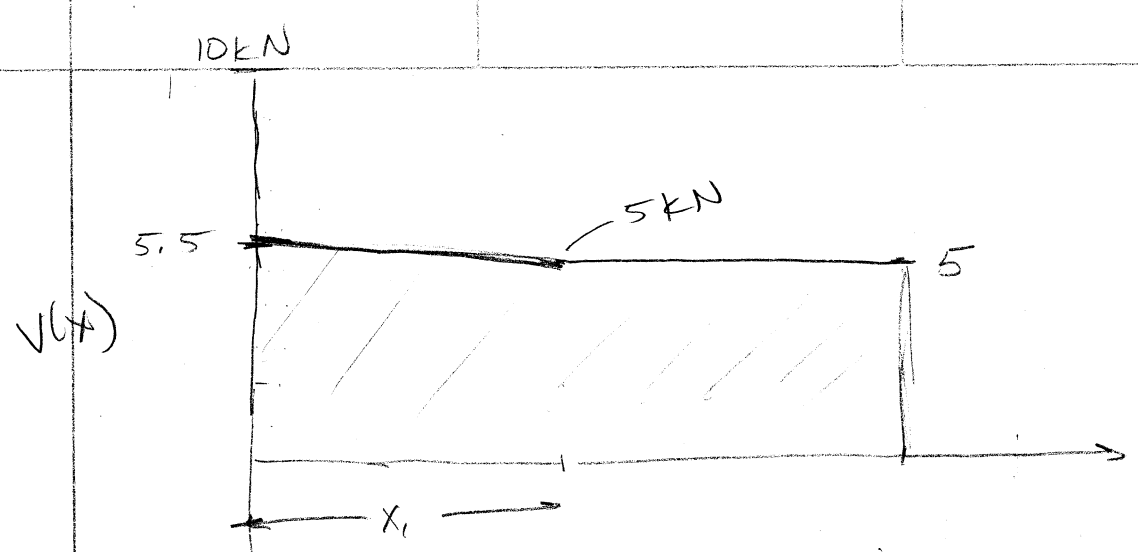
$$M_A = -\frac{1}{2}w_0 x_1^2 - (x_1 + x_2)F_1 - M = -30.5\ kN.m$$

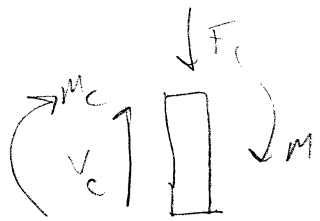
$$\Sigma \vec{F} = \vec{0}$$

$$\hat{i}: \quad -F_A = 0$$

$$\hat{j}: \quad V_A - w_0 x_1 - F_1 = 0$$

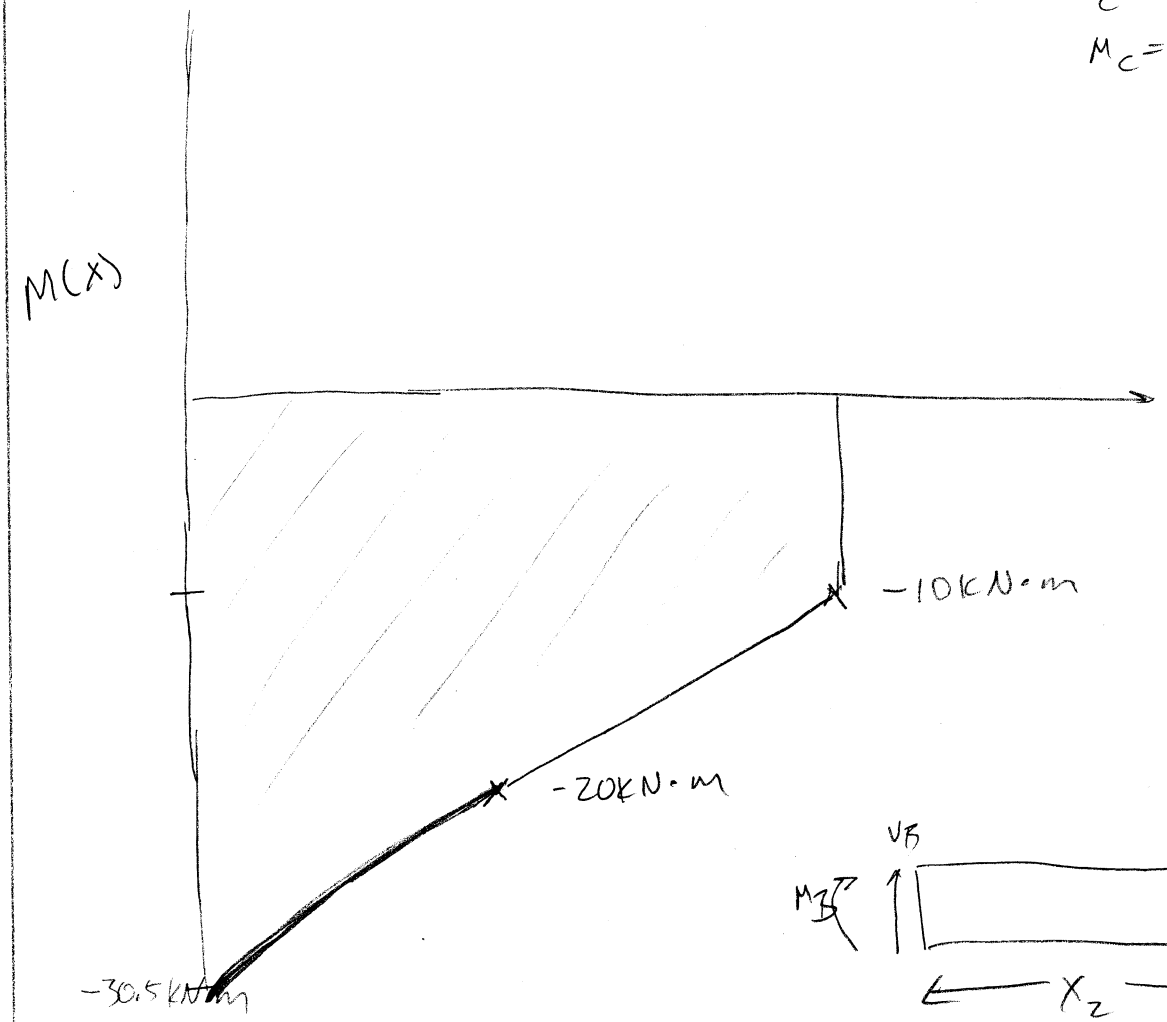
$$V_A = w_0 x_1 + F_1 = 5.5\ kN$$





$V_C = F_1$

$M_C = -M$



There are no points of pure bending.

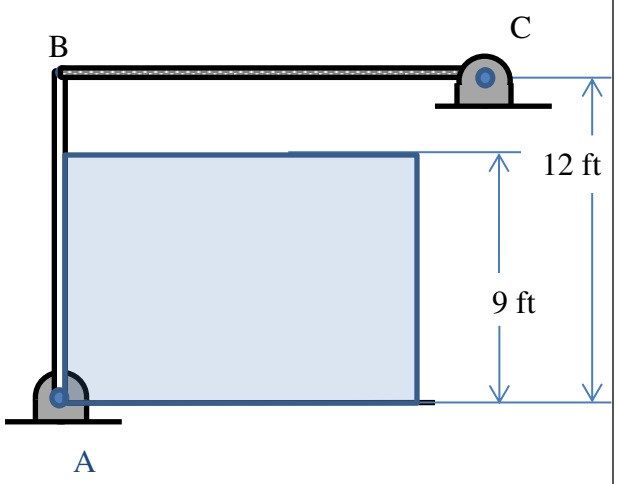
$V_B = F_1$

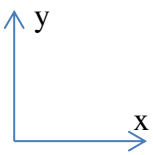
$-M_B - M - X_2 F_1 = 0$

$M_B = -M - X_2 F_1$

Name (last, first)_____

Problem #2 Version 3



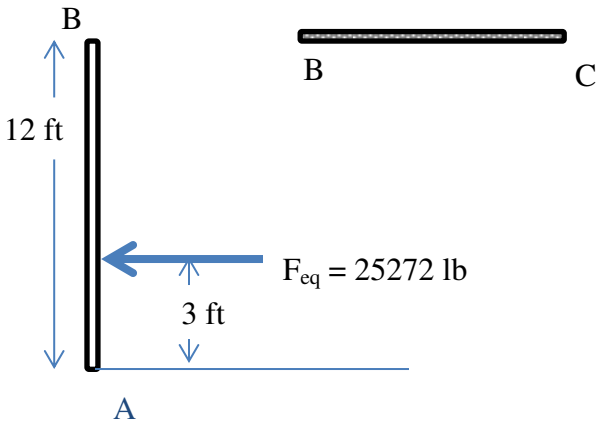


The structure is subjected to a hydrostatic load as shown. The distance out of the paper is 10 feet. The mass of the members is negligible when compared to applied load. BC is a two-force member.

The modulus of elasticity (**E**) is 21×10^6 psi for all members
Poisson's Ratio $\vartheta = 0.40$ for all members.
The cross-sectional area of member BC is 0.15 in^2
Please place your answers in the box provided.
Remember units! Coordinate axis is provided for this problem.
ALL steps of your work must be shown to earn credit.

a. The hydrostatic load has been calculated and replaced by an equivalent load (F_{eq}=25272 lb) at the proper height (3 feet). It is shown on the FBD. Please complete the free-body diagram on the figure provided (4 points)
b. Determine the reactions at A. (3 points).
c. Determine the load carried by member BC and circle whether it is in tension or compression (4 points)
d. Determine the axial stress σ_{BC} in member BC (3 points)
e. Determine the axial strain ε_x in BC (3 points)
f. Determine the strain in the y-direction ε_y for BC (3 points)

a.



b. **Reactions at A**_____

c. Load BC _____ tension or compression (circle one)

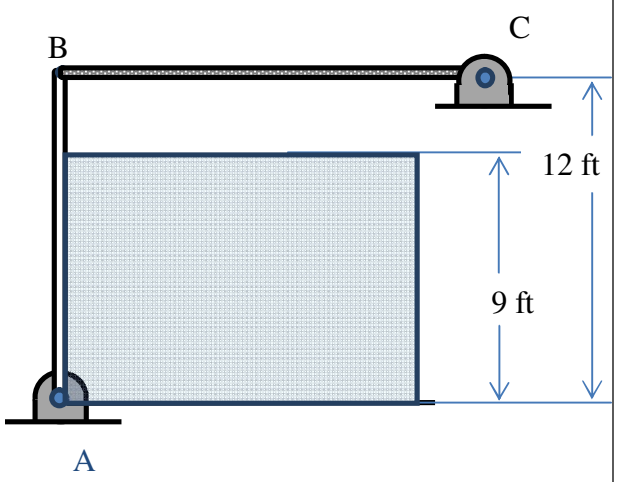
d. σ_{BC} _____

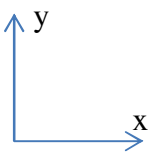
e. ε_x in member BC _____

f. ε_y in member BC _____

Name (last, first)_____

Problem #2 Version 3





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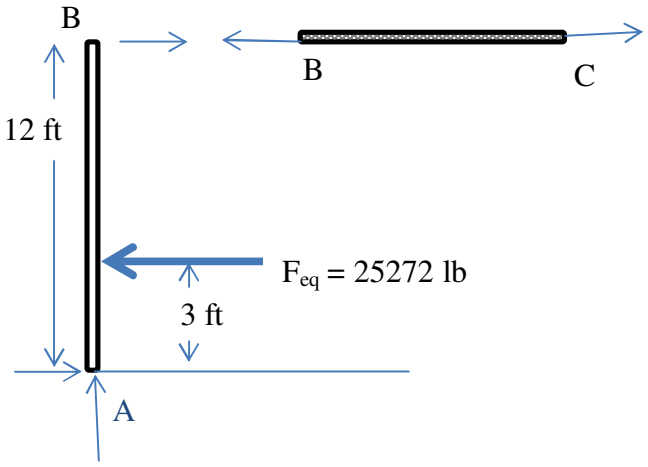


b. **Reactions at A** **Ax= 18954-lb Ay=0**

c. Load BC 6318 lb **tension** or compression (circle one)

d. σ_{BC} 42120 psi

e. ε_x in member BC 0.00201 in/in

f. ε_y in member BC - 0.000802 in/in

$\Sigma = 0 = -12 + 3 * 25272 = 0$

$= 6318 -$

$= 25272\text{-}6318 = 18954$ lb

$\sigma BC = 6318/0.15 = 42120$ psi

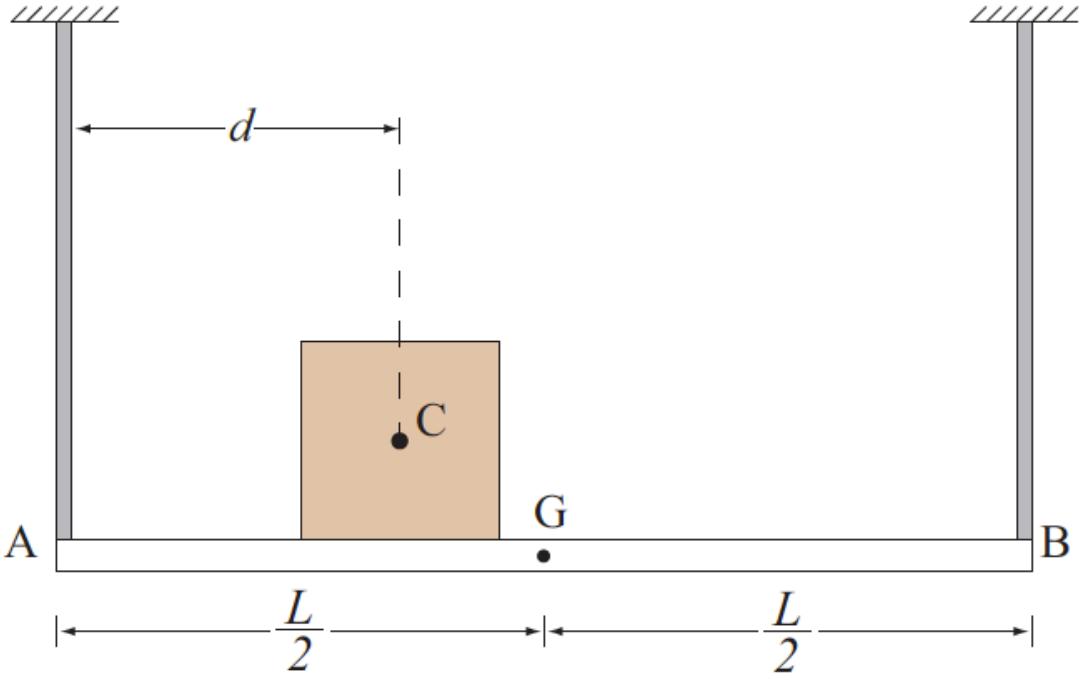
$\varepsilon x = 42120/21000000 = 0.002006$

$\varepsilon y = -0.4 * 0.002006 = -0.000802$

Problem 3A (8 points)

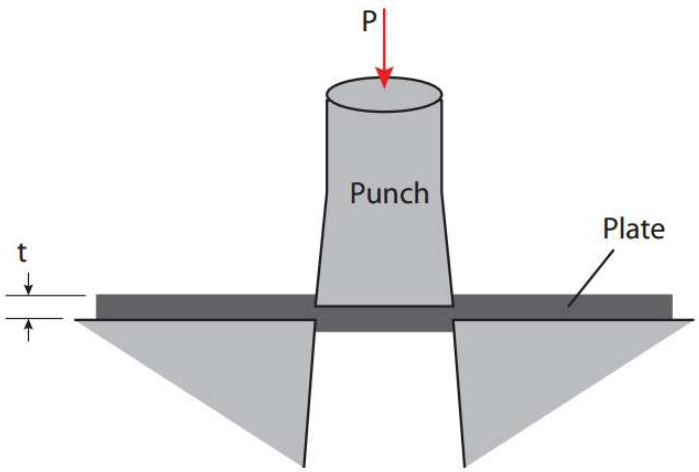
A rigid beam AB having a length of L = 2 m is supported by two identical rods having diameters of D = 2 cm that act as two force members. This beam in turn supports a crate having a weight of W = 500 N with its center of mass at C. The weights of the beam and rods are to be considered negligible compared to the crate.

You may assume that d = 0.5 m. Calculate the forces in rods A and B. What is the corresponding axial or normal stress in each one? If they each have a modulus of elasticity, E = 10,000 MN/m^2, what is the axial strain in each rod?



Problem 3B (4 points)

Estimate the force *P* required to punch out circular blanks 8 cm diameter from a plate 4 mm thick. Ultimate shear stress can be taken as 300 MN/m^2. (1 MN = 1×10^6 N).

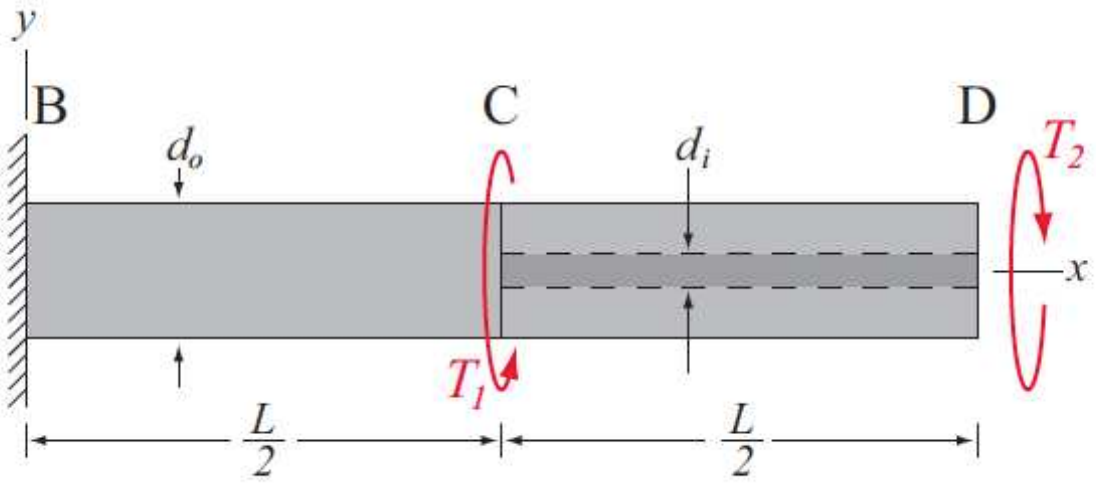


***P* = _____**

Problem 3C (8 points)

A shaft is made up of a solid circular section between B and C (of radius d_o), and a hollow circular section between C and D (of outer radius d_0 and inner radius d_i). Concentrated torques T_1 and T_2 are applied at locations C and D, respectively. End B of the shaft is built into a fixed support.

For the case shown below, you may assume that $T_1 = 0$. Calculate the internal torque in region BC and CD if T2 = 50 kN*m. Then determine the maximum shear stress in each region if, d_o = 7 cm, d_i = 3 cm, and L = 500 cm.



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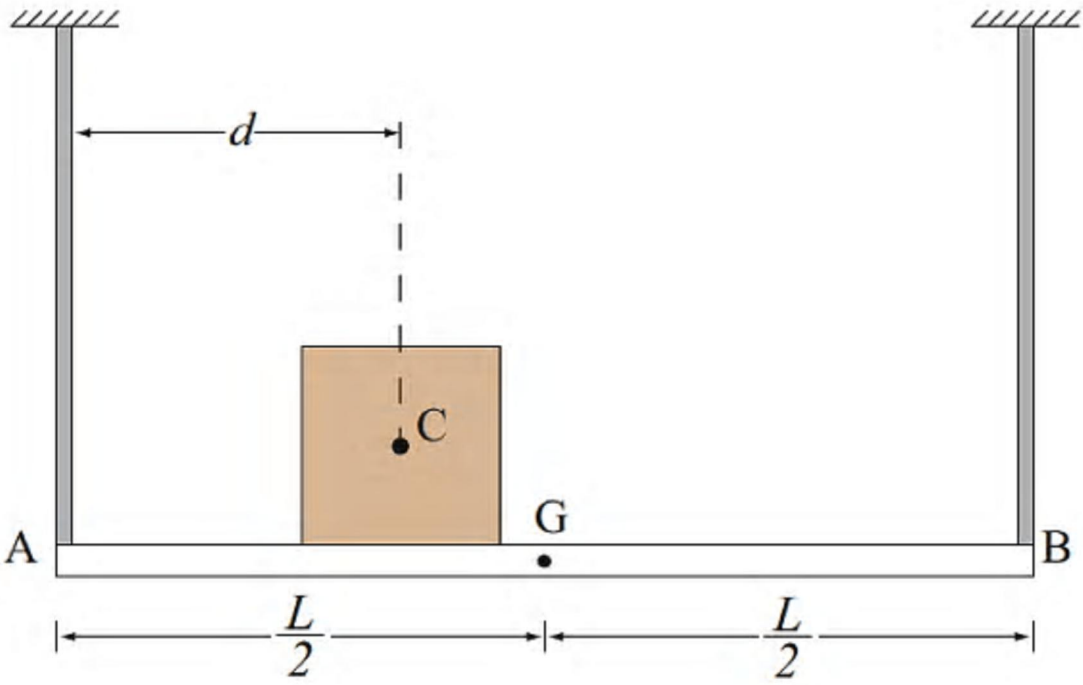
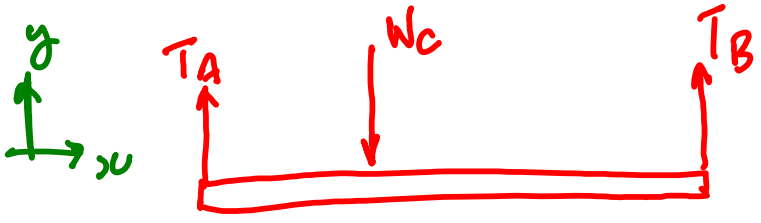


FBD



$\Sigma M_{@A} = 0$

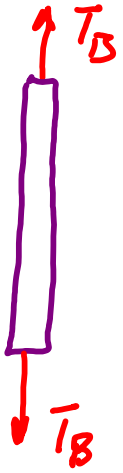
$\Rightarrow T_B \times 2 = W_C (1 - 0.5)$

$\therefore T_B = \frac{500N \times 0.5}{2}$

$= 125N$

$\Sigma F_y = 0 \Rightarrow T_A = W_C - T_B = 375N$

$A = \pi D^2/4 = 3.1415926 \times 10^{-4} m^2$



$$\sigma_A = \frac{T_A}{A} = \frac{375}{3.1415 \times 10^{-4}}$$

$$= 1.19 \times 10^6 \ N/m^2$$

$$= \underline{1.19 \ MN/m^2}$$

$$\varepsilon_A = \frac{\sigma_A}{E}$$

$$= \frac{1.19 \ MN/m^2}{1 \times 10^4 \ MN/m^2}$$

$$= \underline{1.19 \times 10^{-4}}$$

$$\sigma_B = \frac{T_B}{A} = \frac{125}{3.1415 \times 10^{-4}}$$

$$= 3.98 \times 10^5 \ N/m^2$$

$$= \underline{0.398 \ MN/m^2}$$

$$\varepsilon_B = \frac{\sigma_B}{E}$$

$$= \frac{0.398 \ MN/m^2}{1 \times 10^4 \ MN/m^2}$$

$$= \underline{3.98 \times 10^{-5}}$$

Problem 3B (4 points)

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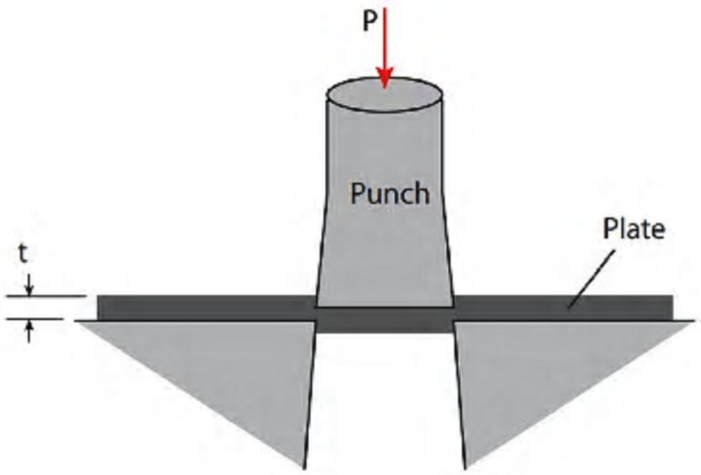

$d = 8\ cm = 8 \times 10^{-2} m$

$t = 4\ mm = 4 \times 10^{-3} m$

$A = \pi d = \pi \times (8 \times 10^{-2}) \times (4 \times 10^{-3}) m^2$

$= 1.0053 \times 10^{-3} m^2$

$P = \sigma_z \times A$

$= 300 \times 10^6 \times 1.0053 \times 10^{-3} N$

$= 301593 N$

$= 302 kN$

P = 302 kN

Problem 3C (8 points)

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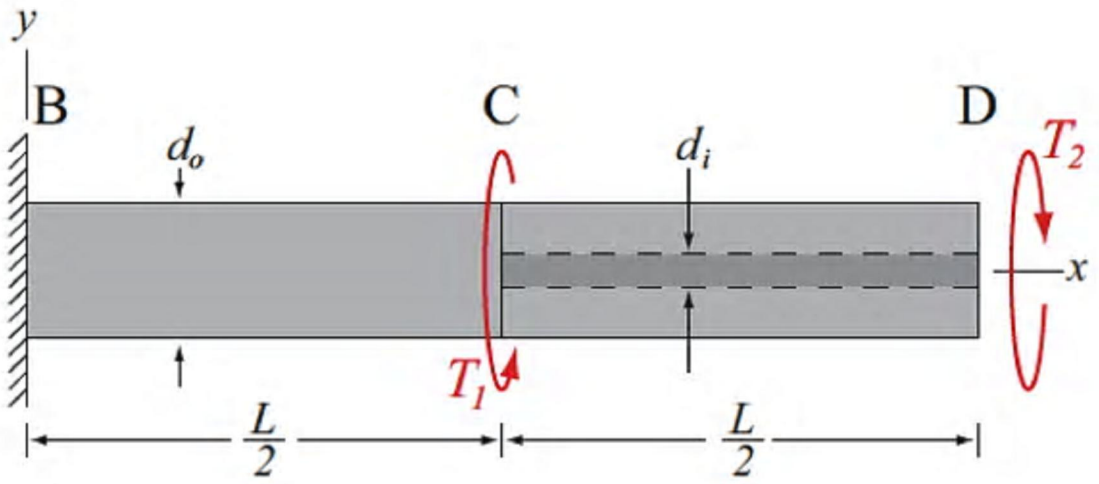

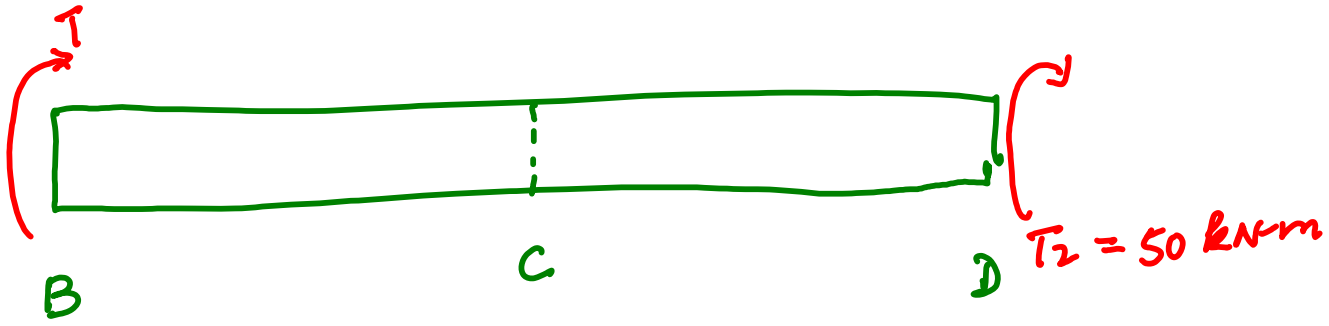

$\Sigma M = 0 \Rightarrow T_2 + T = 0$

i.e. $T = -T_2 = -50\ kN\text{-}m$

$J_{BC} = \frac{1}{2}\pi d_o^4$ [radius $= d_o$]

$= \frac{1}{2}\pi \times 0.07^4\ m^4$

$= 3.77148 \times 10^{-5}\ m^4$

Name: _____

$$(\tau_{max})_{BC} = \frac{T_2 d_o}{J_{BC}} = \frac{50 \times 0.07}{3.77148} \frac{kN}{m^2}$$

$$= 92.8 \ MN/m^2$$

$$J_{CD} = \frac{1}{2}\pi (d_o^4 - d_i^4)$$

$$= \frac{1}{2}\pi (0.07^4 - 0.03^4)$$

$$= 3.6442 \times 10^{-5} \ m^4$$

$$(\tau_{max})_{CD} = \frac{T_2 d_o}{J_{CD}} = \frac{50 \times 0.07}{3.6442 \times 10^{-5}} \frac{kN}{m^2}$$

$$= 96.0 \ MN/m^2$$

If d_o = radius = 0.035 & $d_i = 0.015$ are used

$$J_{BC} = 2.35718 \times 10^{-6} \ m^4$$

$$(\tau_{max})_{BC} = \frac{50 \times 0.035}{2.35718 \times 10^{-6}} \frac{kN}{m^2} = 742 \ MN/m^2$$

& $J_{CD} = 2.27765 \times 10^{-6} \ m^4$

$$(\tau_{max})_{CD} = \frac{50 \times 0.035}{2.27765 \times 10^{-6}} \frac{kN}{m^2} = 768 \ MN/m^2$$