Name: Chris Anderson

SID: ▮▮▮▮▮▮

ME C85 / CE C30 Midterm 2 Exam

Final words of wisdom:

1. Read through the test before starting.

2. Be mindful of the time. 45 minutes will pass faster than you think.

3. At all costs, do not leave anything blank. You will not win if you do not play.

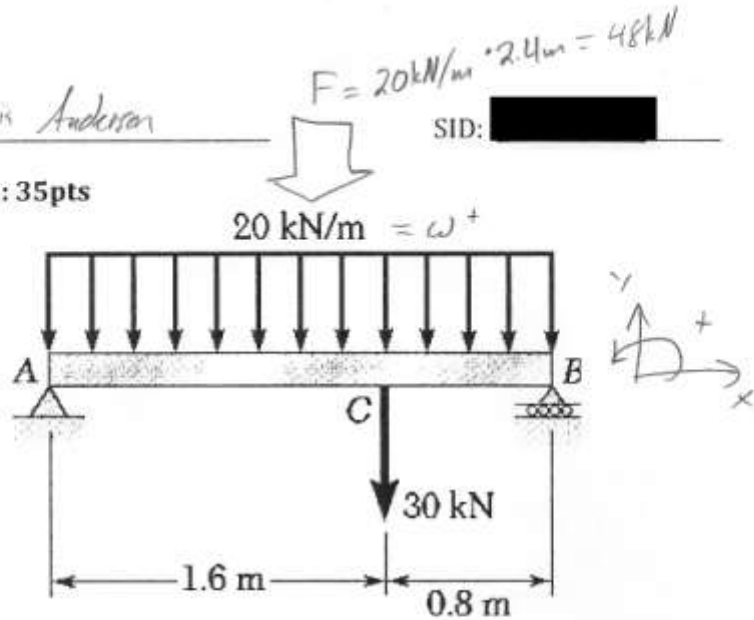4. Uphold academic integrity: don't cheat! The consequences are definitely not worth it.

Good luck!

	Scored Points	Possible Points
Problem 1	35	35
Problem 2	45	45
Problem 3	19	20
Total	99	100

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$F = 20kN/m \cdot 2.4m = 48kN$

PROBLEM 1: 35pts

$20 \text{ kN/m} = \omega^+$

A   C   B

30 kN

←— 1.6 m —→|← 0.8 m →

For the beam and loading shown, (a) sketch the shear force and bending moment diagrams (15pts each), and (b) calculate the maximum value of bending moment (5pts).

a.) $V(x)$ $V = A_y = 34kN$

$V = 26kN$
$x = 1.6m$

$\frac{\partial V}{\partial x} = -\omega$ $\frac{\partial M}{\partial x} = V$

$x = 2.4m$ $\Sigma M_A = 2.4(B) - 1.2(F) - 1.6(C) = 0$

$\rightarrow \boxed{B = 44 kN}$

$-V = -28kN$

$V = -B = -44kN$

$\Sigma F_y = 0 \rightarrow A + B - F - C = 0$

$A = F + C - B$

$M(x)$ M is a function of (x^2)

$\boxed{M = 27.8 kN \cdot m}$

$\boxed{A_y = 34 kN}$

$\Sigma F_x \rightarrow \boxed{A_x = 0}$

$\vec{A_y}$ F $\vec{B}$

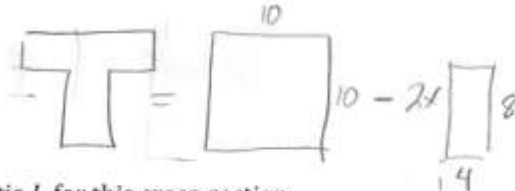A_x

C

Tensile
FBD

b.) $\boxed{M_{max} = 27.8 kN \cdot m}$

PROBLEM 2: 45 pts
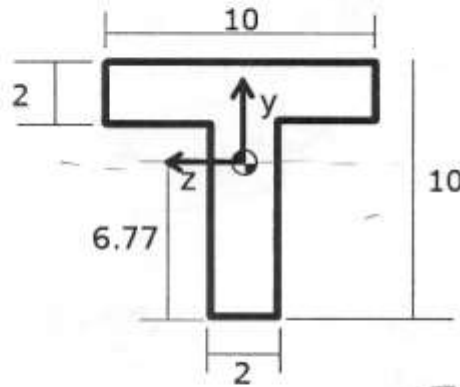
The figure shows the cross-section of a beam. All dimensions are in inches.

The centroid of the cross-section is located 6.77 inches from the bottom of the cross section, as shown.

A)   Calculate the moment of inertia I_z for this cross-section. (10 Points)   → (see back)

$$\boxed{314.22 \ in^4} \quad \uparrow \checkmark$$

B)   A pure bending moment M_z of magnitude 1000 lb-in is applied to the cross-section, generating compression above the neutral axis, and tension below.

Calculate the maximum values of the tensile and compressive stresses. (15 points)

$$\boxed{-10.27 \ psi} \ , \ \boxed{21.65 \ psi}$$

C)   The bending moment is removed. The same beam cross-section is now subject to a vertical shear force of 250 lb acting in the downwards.

Calculate the maximum shear force value of shear stress. Where does it occur? (20 points)

$$\boxed{18.34 \ psi}$$

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PROBLEM 2 cont'd   Par·A₂·Thm

a.)
$$I_z = \left[\frac{1}{12}(10)(10)^3 + 10^2(6.72-5)^2\right] - 2\left[\frac{1}{12}(4)(8)^3 + 4\cdot8(6.77-4)^2\right]$$

$$= 314.22 \text{ in}^4$$

b.)

$$\sigma = -\frac{My}{I} \qquad \sigma_{min} = \frac{M(10-6.77)in}{I_z} = \boxed{-70.27\,psi} \ (\text{max compressive})$$

$$\sigma_{max} = \frac{M(-6.77in)}{I_z} = \boxed{21.53\,psi} \ (\text{max tensile})$$

c.)
$$q = \frac{VQ}{I_z}$$

$$\tau = \frac{q}{t}$$

$$t = 2in$$

$$\rightarrow \boxed{\tau = 18.34\,psi}$$

$$\text{max } \overset{\tau}{V} \text{ at neutral axis}$$

Area above neut axis
thickness from n.A. to centroid of A
$$Q = \sum A_i \bar{y} = \pm \ 2\cdot10(9-6.77)$$
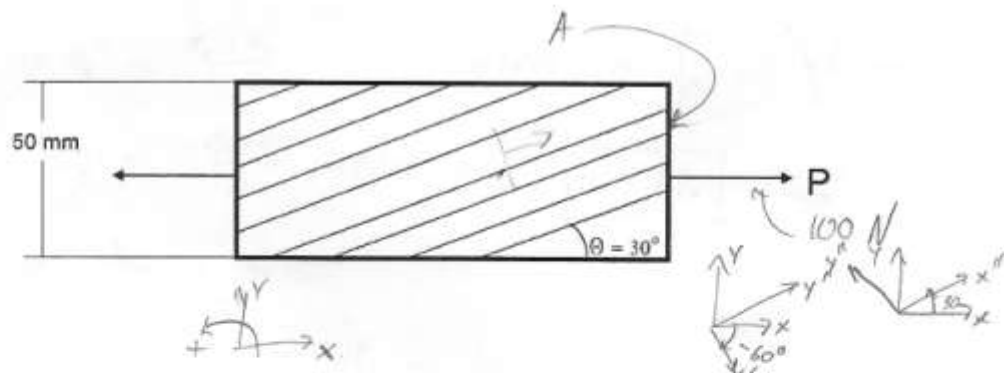$$+ (8-6.77)^2\cdot2\cdot\pi(8-6.77)/2$$

swert!

45/45

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Problem 3: 20 Pts

A 100 N tensile force, P, is applied to a block of wood. The wood has its grain oriented 30 degrees from the horizontal as shown. The height of the block is 50 mm and its depth is 20 mm (into the page).

A) What are the normal and shear stresses along a direction parallel to the grain? (10 pts)   See both next page

B) What are the normal and shear stresses along a direction perpendicular to the grain? (10 pts)

Problem 3, cont'd

b.) $\sigma_x = \frac{P}{A} = 100 \text{ kPa}$ $\sigma_y = 0$ $\theta = -60°$

$\tau_{xy} = 0$

$\rightarrow \sigma_x' = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos(2\theta) + 0 = \boxed{25 \text{ kPa}}$ (normal)

$\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2} \cdot \sin(2 \cdot \theta) + 0 = \boxed{43.3 \text{ kPa}}$ (shear)

a.) just change θ to $+30°$

$\rightarrow \sigma_x'' = \boxed{75 \text{ kN}}$ (normal)

$\rightarrow \tau_{x'y'}'' = \boxed{-43.3 \text{ kPa}}$ (shear)

-1 (shear is the same)

$\rightarrow$ I realized I did these backwards (according to Kenny) the new lettering reflects the correct answer