AEM 341: Exam 2 P Name:_____

28th March 2018 55 minutes 4 Pages Open book, Open notes, Calculator

100 total points **Read, think, plan, and then write.**

University of Alabama Academic Honor Pledge:

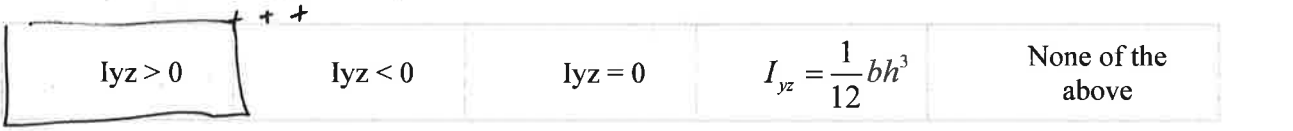
I promise or affirm that I will not at any time be involved with cheating, plagiarism, fabrication, or misrepresentation while enrolled as a student at The University of Alabama. I have read the Academic Honor Code, which explains disciplinary procedures that will result from the aforementioned. I understand that violation of this code will result in penalties as severe as indefinite suspension from the University.

Signature:_____ Date:_____

1. [10 pts] What is the sign (+,-, or zero) of Iyz for the following part around the given centroid?

$I_{yz} = \int yz\,dA$

$= \sum yz\,dA$



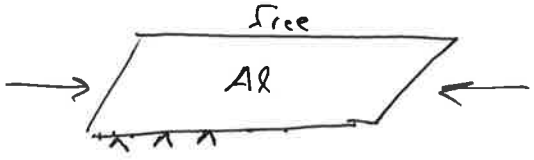
Iyz > 0	Iyz < 0	Iyz = 0	$I_{yz} = \frac{1}{12}bh^3$	None of the above

2. [10 pts] An applied load in the z-direction results in beam deflection in **only** the z-direction.

Always True	Always False	Only for a uniform load in z	True if Iyz=0	True if Iyz>0

3. [5 pts] Given a 4 x 8 foot piece of Al loaded in the 8 foot direction, which has the lowest buckling load?

4 Clamped	4 Simply Supported	3 simply supported + 1 free



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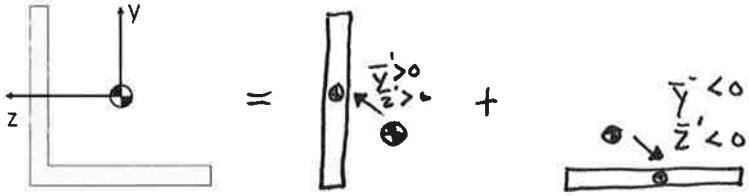
Signature:_____ Date:_____

1. [10 pts] What is the sign (+,-, or zero) of Iyz for the following part around the given centroid?

$I_{yz} = \sum \bar{y}'\bar{z}'A$

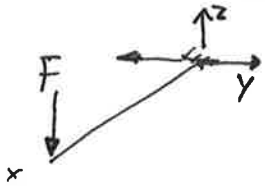
$+ + + = +$

$- - + = +$



Iyz > 0	Iyz < 0	Iyz = 0	$I_{yz} = \frac{1}{12}bh^3$	None of the above

2. [10 pts] An applied load in the z-direction ($= M_y$) results in beam deflection in **only** the z-direction.



Always True ×	Always False ×	Only for a uniform load in z ×	True if Iyz=0	True if Iyz>0

$\frac{d^2v}{dz^2} = \frac{(M_z - M_z^T)I_{yy}^* + (M_y + M_y^T)I_{yz}^*}{E_1\left(I_{yy}^* I_{zz}^* - I_{yz}^{*2}\right)}$

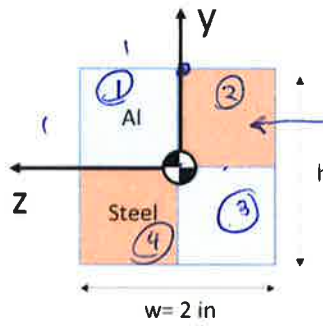
$M_y I_{yz}$ results in y deflection

3. [5 pts] Given a 4 x 8 foot piece of Al loaded in the 8 foot direction, which has the lowest buckling load?

4 Clamped	4 Simply Supported	3 simply supported + 1 free

See figure in Lesson 17 part 2

6. [25 pts] Determine the maximum axial stress for the following cross section. The part was heated +100 F with an applied load of Mz = 1000 lbf-in.



$P^T \neq 0$ $M_y^T = 0$ $M_z^T = 0$ $I_{y_0 z_0} = 0$

$I = \frac{1}{12} = 0.0833$

Part	$\frac{E}{E}$	A	$\bar{y}$	$\bar{z}$	$I_{y_0 y_0}$	$I_{z_0 z_0}$	$\frac{E}{E}(I_{y_0 y_0} + \bar{z}^2 A)$	$\frac{E}{E_1}(I_{y_0 z_0} + \bar{y}\bar{z}A)$
1	1	1	0.5	0.5	0.0833	...	.3333	.25
2	3	1	0.5	-0.5	...	...	1	-.75
3	1	1	-0.5	-0.5	...	...	0.3333	0.25
4	3	1	-0.5	0.5	...	0.0833	1	-0.75 // -1

$A^* = 8$

$I_{yy}^* = 2.6667 = I_{zz}^*$

$I_{yz}^* = -1$

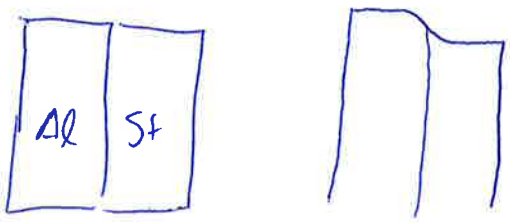
I_{yz}^*

$P^T = \sum E_i \alpha_i A_i \Delta T_i = (10\times10^6 \cdot 13\times10^{-6} \cdot 1 \cdot 100)2$ ① $(30\times10^6 \cdot 6\times10^{-6} \cdot 1 \cdot 100)2$ ② $= 62000$ lbf

$z=0$, $y=1$, Al

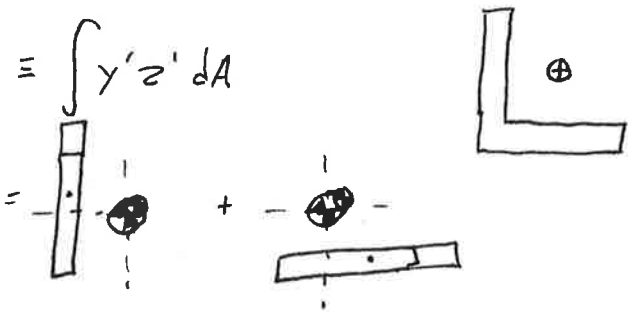
$\sigma_{xx} = \frac{1}{8}(0 + 62000) - 1 \cdot \left(\frac{1000 \cdot I_{yy}^*}{I_{yy}^* I_{zz}^* - I_{yz}^{*2}}\right) 1 = \frac{62000}{8} - \frac{1000 \cdot 2.667}{2.667^2 - 1} = \cancel{7.3}$ ksi

$-E\alpha\Delta T$ $-10\times10^6 \cdot 13\times10^{-6} \cdot 100 = -5.6$ ksi



1) Sign of I_{yz}

$$I_{yz} \equiv \int y'z'\,dA$$



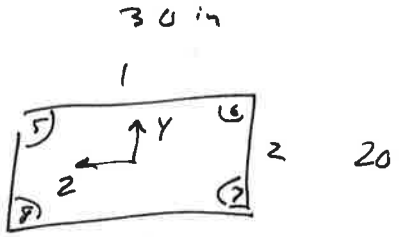
$\bar{y}\bar{z}A$	$\bar{y}\bar{z}A$	
+ + +	− − +	= +

2) True if $I_{yz} \neq 0$

3) 3 Simple + 1 Free

4) Estimate

$$A = \frac{\pi R^2}{4} = \frac{\pi}{4}$$



part	$\frac{E}{E}$	A	$\frac{E}{E}A$	$\bar{y}$	$\bar{z}$	$\bar{z}^2 A \frac{E}{E}$	$\bar{y}^2 A \frac{E}{E}$
1	1	3	3	10	0	0	300
2	1	2	2	0	-15	450	0
3	1	3	3	-10	0	0	300
4	1	2	2	0	15	450	0
5	3	$\pi/4$	$3/4\pi$	10	15	530	235.6
6	3	$\pi/4$	$3/4\pi$	10	-15	530	
7	3	$\pi/4$	$3/4\pi$	-10	-15	530	
8	3	$\pi/4$	$3/4\pi$	-10	15	530	
			19.4			3020	1542.5

Ignore I_{xy}, I_{zx}

$A^* = 19.4$

$I_{yy} = 3020$

$I_{zz} = 1542.5$

$\bar{y} = 0$ $\bar{z} = 0$

$I_{yz} = 0$

5) $M = pL$ $\quad \sigma_{xx} = \frac{My}{I} = \frac{pL \cdot h/2}{\frac{1}{12} 0.25 \cdot 2^3} = \frac{p \cdot 36 \cdot 1}{\frac{1}{12} 0.25 \cdot 8} = 216\,p$

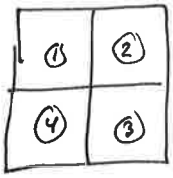
break $\quad \sigma_{xx} = 40 \times 10^3 = 216\,p \quad = 185$ lbf

Buckle

$$p = \frac{0.67\,h t^3}{l^2} \frac{E}{\sqrt{2(1+\nu)}}$$

$$= \frac{0.67 \cdot 2 \cdot 0.25^3}{36^2} \frac{10 \times 10^6}{\sqrt{2(1+.3)}} = 100 \text{ lbf}$$

6)



Part	E_i/E_c	A	$\frac{E_i}{E_c}A$	$\bar{y}$	$\bar{z}$	$I_{y_i y_i}$	$I_{z_i z_i}$	$\frac{E_i}{E_c}(I_{y_i y_i} + \bar{z}^2 A)$	$\frac{E_i}{E_c}(I_{z_i z_i} + \bar{y}^2 A)$
1	1	1	1	0.5	0.5	0.08333	0.08337	0.3333	←
2	3	1	3	0.5	-0.5	"	"	1.0	←
3	1	1	1	-0.5	-0.5	"	"	0.333	←
4	3	1	3	-0.5	+0.5	"	"	1.0	←
			8					2.6666	2.6666

$\frac{E_i}{E_c}(I_{y_i z_i} + \bar{y}\bar{z}A)$
0.25
-0.75
0.25
-0.25
-1.0

$$\sigma_{xx} = \frac{P^T}{E_i A} - \frac{E_i}{E_c}\left(\frac{M_z I_{yz} - M_y I_{zz}}{I_{yy} I_{zz} - I_{yz}^2} y + \frac{M_y I_{yz} - M_z I_{yy}}{I_{yy} I_{zz} - I_{yz}^2} z\right)$$

$$P^T = \left(10 \times 10^6 \cdot 13 \times 10^{-6} \cdot (100) \cdot 1\right) z + \left(30 \times 10^4 \cdot 6.5 \times 10^{-6} \cdot 100\right) \cdot 2$$

65000