AEM 341: Exam 2 B Name: O'Neill

28th March 2018 55 minutes 3 Pages Open book, Open notes, Calculator

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

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Signature:_____ Date:_____

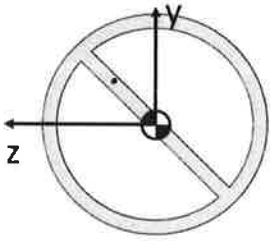
1. [10 pts] What is the sign (+,-, or zero) of Iyz for the following part around the given centroid?

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

+ + +

− − +

+



Iyz > 0	Iyz < 0	Iyz = 0	$I_{yz} = \pi r^3 t$	None of the above

2. [10 pts] An applied load in the z-direction can result in beam tip **rotation** about x, y and z.

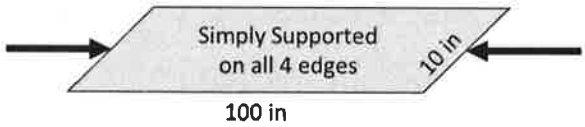
True	False	Only for a uniform load in z	True only if Iyz=0 x	True only if Iyz>0 x

3. [10 pts] Why do spacecraft and aircraft use stringers and longerons? Discuss from a stress and buckling perspective.

We want light structures. Thus, thin walled structures with

- stringers for additional MoI
- Stringers for increasing the buckling load.

4. [35 pts] Will the flat panel shown below **break** or **buckle** first? The Al beam has a length of 100 inches, a width of 10 inches, and a thickness of 0.125 inches. The ultimate stress (i.e. break) is 40 ksi.



Buckling

$k = 3.62$ at $a/b = 10$

$$P = t b K E \left(\frac{t}{b}\right)^2$$

$$\sigma = K E \left(\frac{t}{b}\right)^2 = 3.62 \cdot 10 \times 10^6 \text{ psi} \cdot \left(\frac{0.125}{10}\right)^2$$

$$= 5.6 \text{ ksi} < 40$$

Buckles

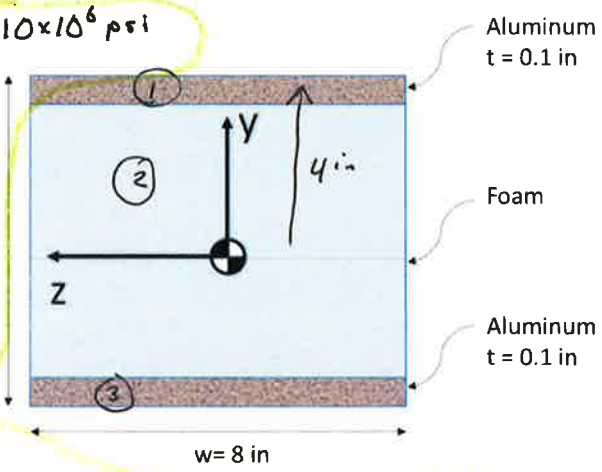
~~wrong type~~ of bucklin
-~~0~~ -15

wrong type of breakin
-15

wrong BCs of buckin
-10

right answer
+5

5. [35 pts] Determine the axial stress **on the top of the upper Al skin** for the cross section below. The part has an applied load of Mz = $50 \cdot 10^3$ lbf-in and is heated +100 F. The foam's modulus of elasticity is 4 ksi. The foam's coefficient of thermal expansion is $1.0 \cdot 10^{-5}$ 1/F.



DRAWING NOT TO SCALE

Fast way: Foam is inconsequential $4 ksi << 10 \times 10^6$ psi

$I_{zz} = \bar{y}^2 A \cdot 2$ (only considering Al parts!)

$= 4^2 \cdot 0.1 \cdot 8 \cdot 2 = 25.6$ in^4

$\sigma = \frac{-My}{I} = \frac{-50000 \text{ lbf-in} \mid 4 \text{ in}}{25.6 \text{ in}^4} =$

$\sigma = -7.8$ ksi

Thermal is dominated by Al, so ignore!

Slower way (lumped)

part	E/E	A	$\bar{y}$	z°	$E/E(I_{zz_o} + \bar{y}^2 A)$
1	1	0.8	4		12.8
2	0.0004	60.8	0		0
3	1	0.8	-4		12.8
		$A^* = 1.62$			$I_{zz} = 25.6$

$P^T = E \alpha \Delta T A_i$

$= 10 \times 10^6 \cdot 13 \times 10^{-6} \cdot 100 \cdot 8 \cdot 0.1 \cdot 2$

$+ 4000 \cdot 1 \times 10^{-5} \cdot 100 \cdot 8 \cdot 7.8$

21049.6 lbf

$\sigma_{xx} = \frac{E}{E}' \frac{21049.6}{1.62} - \frac{50000 \cdot 4 \text{ in}}{25.6} - 10 \times 10^6 \cdot 13 \times 10^{-6} \cdot 100$

$12993 - 7.8 - 13000$

$\sigma_{xx} = -7.8$ ksi

I_{zz}^* Alternative $= 62725$

$A^* = 4062.4$

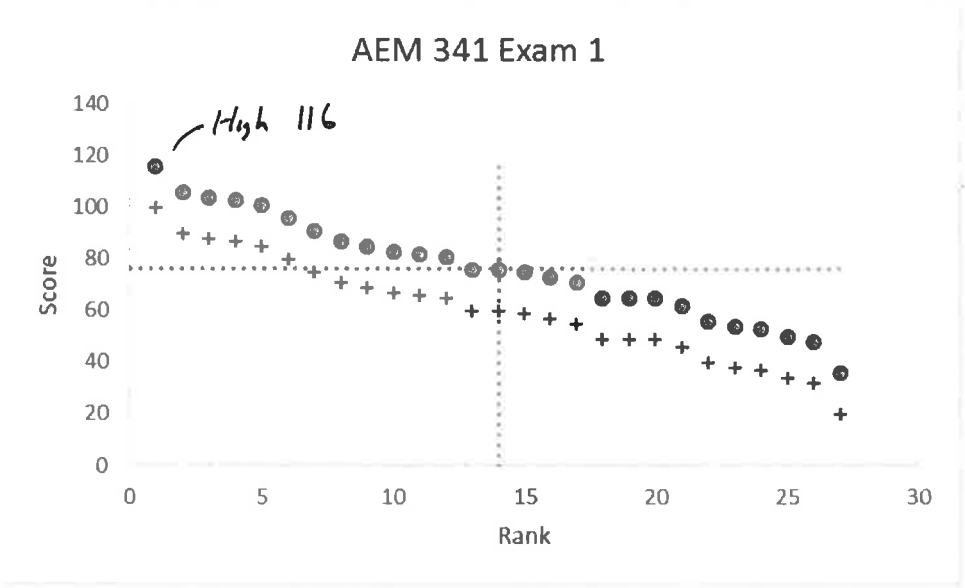
Very slow method

part	E/E	A	$\bar{y}$	$I_{z_o z_o}$	$E/E(I_{z_o z_o} + \bar{y}^2 A)$
1	1	0.8	3.95	0.000667	12.48
2	0.0004	60.8	0	316.4	0.126
3	1	0.8	-3.95	0.000667	12.48
					25.09

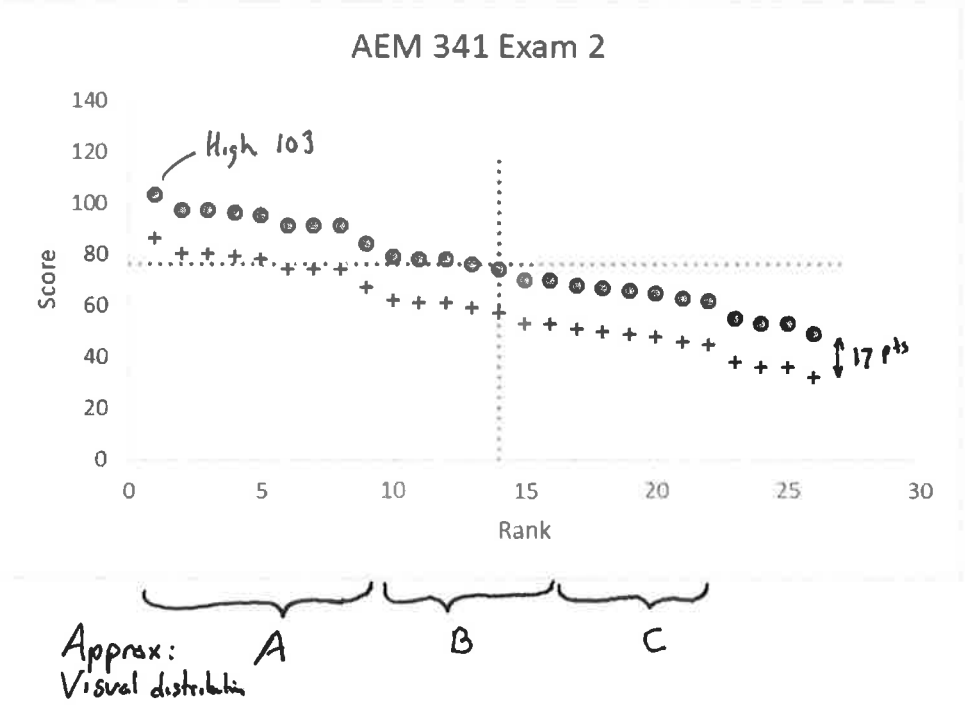
$\sigma_{xx} = 12993 - \frac{50000 \cdot 4}{25.09} - 13000$

-7.98 ksi

E/E	+2
I_{yy_o}, $I_{z_o z_o}$	+1
$\bar{y}$	+1
$E \alpha \Delta T$	+3
A^*	+5
P^T	+5
I_{zz}^*	+5
σ_{xx}	+10



Avg 60
Shifted +16
$Avg_{shifted}$ = 76.3



Avg 59
Shifted +17
$Avg_{shifted}$ = 76

Approx: Visual distribution