Arch 314
Structures I

Fall 2025 Recitation 004

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TAUBMAN COLLEGE

Recitation 004

Welcome to session 8!

- Final Report
- Quick Recap of this week's lecture
- Homework Review (#11 Moment of Inertia)
- Lab: Moment of Inertia

Feel free to ask questions anytime

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Bridge

Due Dates:

- ~~Preliminary Report - 10.10~~
- ~~Bridge Testing - 11.03~~
- **Final Report* - 11.25**
  (right before Thanksgiving break)

*Make sure to refer to the **scoring rubric and final report guidelines** on Structures website to see what you need to include + how GSI's will grade your paper!

FINAL REPORT REQUIREMENTS	150	
Preliminary Design Development	**20**	
How initial (preliminary) bridge design was developed	4	
How initial (preliminary) member sizes were chosen	4	
Why bridge design was or was not adjusted from preliminary design	4	
Why member sizes were or were not adjusted from preliminary design	4	
Discussion of how pre-analysis of initial bridge impacted the final design	4	
Revised Bridge Design Analysis	**50**	
Internal axial force calculations/modeling (with proper design loading indicated) (Dr. Frame acceptable)	10	
Derivation of member cross-sectional areas from axial forces	10	
Member size selection from available stock	4	
Est. weight calculation of bridge - including members, glue & fasteners	6	
Method of joints/sections calculation for at least 1 joint (@ reaction is usually easiest based on truss geometry, but could be done elsewhere)	10	
Member crushing calculations/check (show work) using $F'_c=P/A$	4	
Prediction of capacity of bridge and mode of failure	6	
Illustration of Tested (Revised from Preliminary) Design	**20**	
Cross-section of bridge	4	
Elevation(s) of bridge	4	
Dimensions and units labeled in elevation and cross-section	4	
Member sizes labeled (with dimensions)	4	
Member stresses labeled (with units)	4	
Testing Results	**30**	
Weight and height of bridge	5	
Capacity of bridge	5	
Observations of testing	6	
Description of mode of failure	5	
Images of failure	5	
Following the guidelines	4	
Post-Testing Analysis	**30**	
Comparison of testing with predicted capacity and modes of failure	10	
Discussion of discrepancies between results	10	
Suggested improvements for future designs with reasoning discussed	10	
FINAL GRADE	**250**	

Up to 20 pts may be withheld for a lack of clarity or professional quality. **8.5"x11" PAPER ONLY!**

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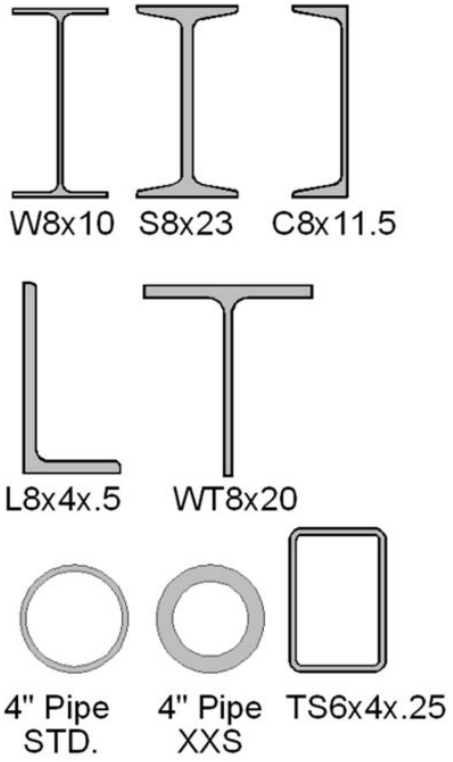
Lecture: Cross-Sectional Properties (11/5)

ARCHITECTURE 314
STRUCTURES I

Cross-Sectional Properties of Structural Members

Resultant of Parallel Forces
Center of Gravity
Centroid of Area
First Moment of Area
Second Moment of Area
(Moment of Inertia)
Radius of Gyration



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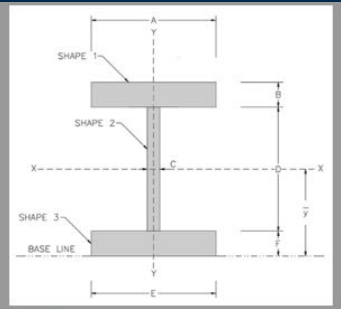
HW #11: Moment of Inertia

11. Moment of Inertia

Use the Parallel Axis Theorem to find the moments of inertia about both the x-x and y-y axes of the compound section.



DATASET: 1 -2- -3-

Dimension A	4 IN
Dimension B	4 IN
Dimension C	1 IN
Dimension D	7 IN
Dimension E	8 IN
Dimension F	4 IN

Your answer was correct.
You scored 5 points.

#	Question	Your Response	Correct Answer	Score
1	x-x Moment of Inertia of shape 1 about its own centroid (Ixx)	21.33 IN^4	21.3333 IN^4	5
2	x-x Moment of Inertia of shape 2 about its own centroid (Ixx)	28.583 IN^4	28.5833 IN^4	5
3	x-x Moment of Inertia of shape 3 about its own centroid (Ixx)	42.667 IN^4	42.6667 IN^4	5
4	Summation of x-x Moments of Inertia of all shapes (SUM Ixx)	92.5803 IN^4	92.5833 IN^4	5
5	Distance from the centroid of shape 1 to the centroid of the whole shape	7.1 IN	7.1 IN	5
6	Distance from the centroid of shape 2 to the centroid of the whole shape	1.6 IN	1.6 IN	5
7	Distance from the centroid of shape 3 to the centroid of the whole shape	3.9 IN	3.9 IN	5
8	2nd Moment of area 1 about centroid of whole shape x dist. to centroid (Ad^2)	806.56 IN^4	806.56 IN^4	5
9	2nd Moment of area 2 about centroid of whole shape x dist. to centroid (Ad^2)	17.92 IN^4	17.92 IN^4	5
10	2nd Moment of area 3 about centroid of whole shape x dist. to centroid (Ad^2)	486.72 IN^4	486.72 IN^4	5
11	Summation of moments of areas times distances to centroid (SUM Ad^2)	1311.2 IN^4	1311.2 IN^4	5
12	Moment of Inertia about the x-x axis for the whole shape (Ix)	1403.78 IN^4	1403.78 IN^4	5
13	y-y Moment of Inertia of shape 1 about its own centroid (Iyy)	21.33 IN^4	21.3333 IN^4	5
14	y-y Moment of Inertia of shape 2 about its own centroid (Iyy)	0.583 IN^4	0.583333 IN^4	5
15	y-y Moment of Inertia of shape 3 about its own centroid (Iyy)	170.67 IN^4	170.667 IN^4	5
16	Summation of y-y Moments of Inertia of all shapes (SUM Iyy)	192.58 IN^4	192.583 IN^4	5
17	Moment of Inertia about the y-y axis for the whole shape (Iy)	192.58 IN^4	192.583 IN^4	5

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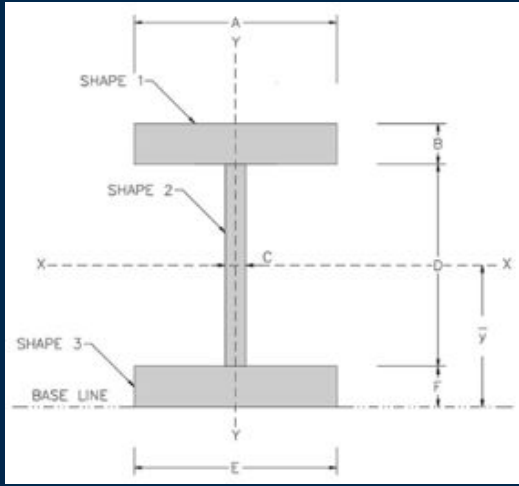
HW #11: Moment of Inertia

DATASET: 1	-2-	-3-
Dimension A		4 IN
Dimension B		4 IN
Dimension C		1 IN
Dimension D		7 IN
Dimension E		8 IN
Dimension F		4 IN



Collect some basic data

	Area ($A = b \times h$)	Distance (d)	I_2 for xx Area × Distance (Ad)
Shape 1	$4" \times 4" = 16 in^2$	$\frac{B}{2} + D + F = 13"$	$Ad_1 = A \times d = 16 \times 13 = 208 in^3$
Shape 2	$1" \times 7" = 7 in^2$	$\frac{D}{2} + F = 7.5"$	$Ad_2 = A \times d = 7 \times 7.5 = 52.5 in^3$
Shape 3	$8" \times 4" = 32"$	$\frac{F}{2} = 2"$	$Ad_3 = A \times d = 32 \times 2 = 64 in^3$
SUM	$\Sigma A = 55$	/	$\Sigma Ad = 324.5$

$$y = \frac{\Sigma Ad}{\Sigma A} = \frac{324.5}{55} = 5.9"$$

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HW #11: Moment of Inertia

DATASET: 1	-2-	-3-
Dimension A		4 IN
Dimension B		4 IN
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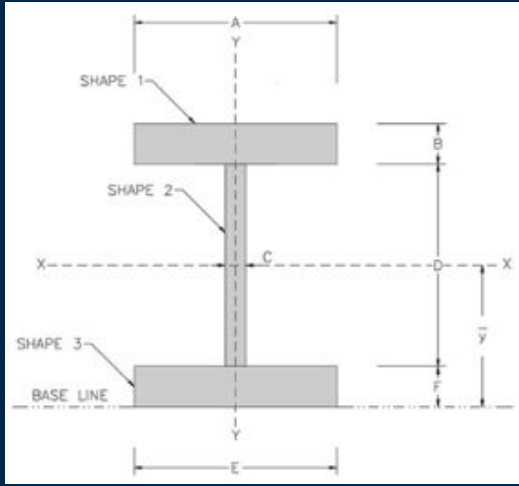
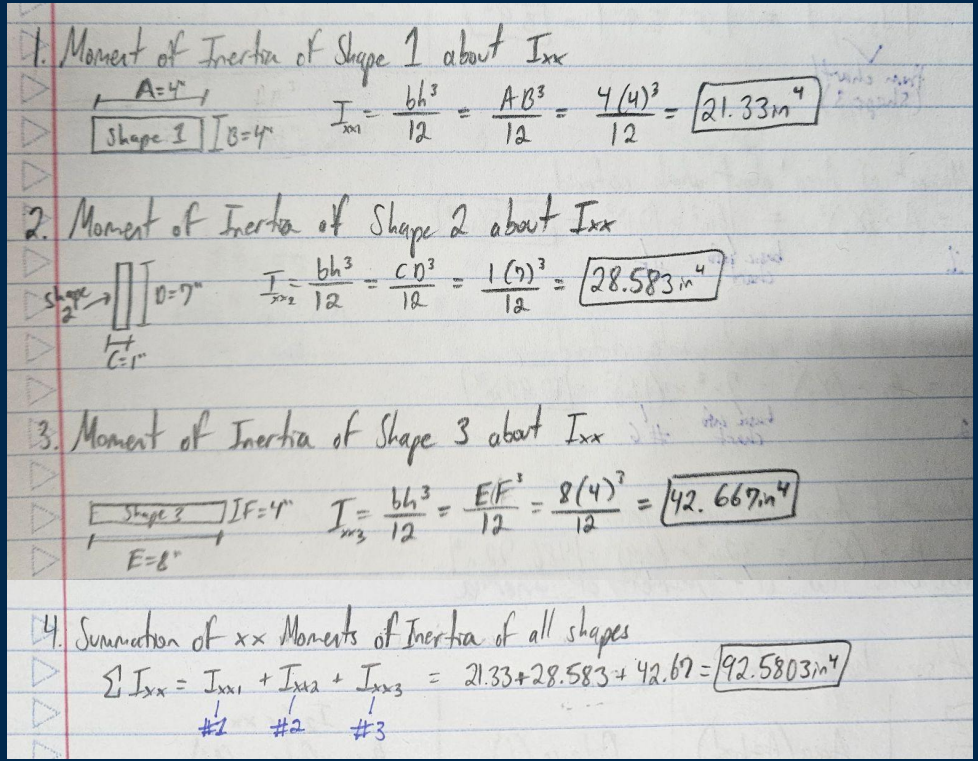
Dimension D		7 IN
Dimension E		8 IN
Dimension F		4 IN





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HW #11: Moment of Inertia

DATASET: 1	-2-	-3-
Dimension A		4 IN
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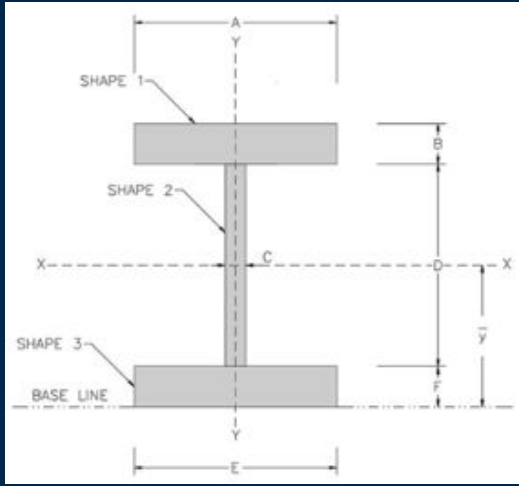
Dimension D		7 IN
Dimension E		8 IN
Dimension F		4 IN



Refer to basic data chart!

5. Distance from centroid of shape 1 to centroid of whole shape

$X_1 = |d_1 - y| = |13" - 5.9"| = \boxed{7.1"}$

d_1 from chart we made! (Shape 1)

6. Distance from centroid of shape 2 to centroid of whole shape

$X_2 = |d_2 - y| = |7.5" - 5.9"| = \boxed{1.6"}$

d_2 from chart! (Shape 2)

7. Distance from centroid of shape 3 to centroid of whole shape

$X_3 = |d_3 - y| = |2" - 5.9"| = \boxed{3.9"}$

d_3 from chart! (Shape 3)

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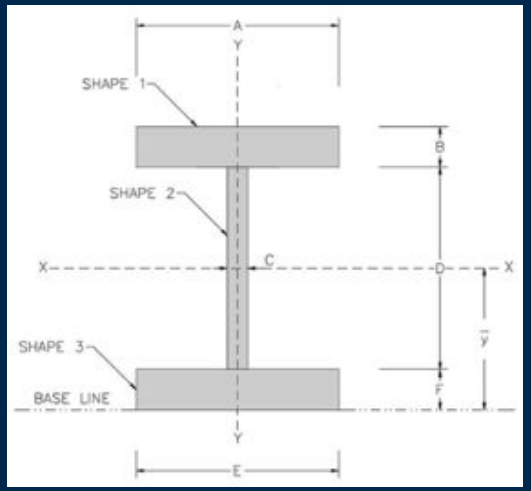
HW #11: Moment of Inertia

DATASET: 1	-2-	-3-
Dimension A		4 IN
Dimension B		4 IN
Dimension C		1 IN
Dimension D		7 IN
Dimension E		8 IN
Dimension F		4 IN



8. 2nd Moment of Area 1 about whole centroid

$I_2 = A_1 \times (X_1)^2 = 16in^2 \times (7.1)^2 = \boxed{806.56in^4}$

SHAPE 1 — basic info chart — #5

9. 2nd Moment of Area 2 about whole centroid

$I_2 = A_2 \times (X_2)^2 = 7in^2 \times (1.6)^2 = \boxed{17.92in^4}$

SHAPE 2 — basic info chart — #6

10. 2nd Moment of Area 3 about whole centroid

$I_2 = A_3 \times (X_3)^2 = 32in^2 \times (3.9)^2 = \boxed{486.72in^4}$

SHAPE 3 — basic info chart — #9

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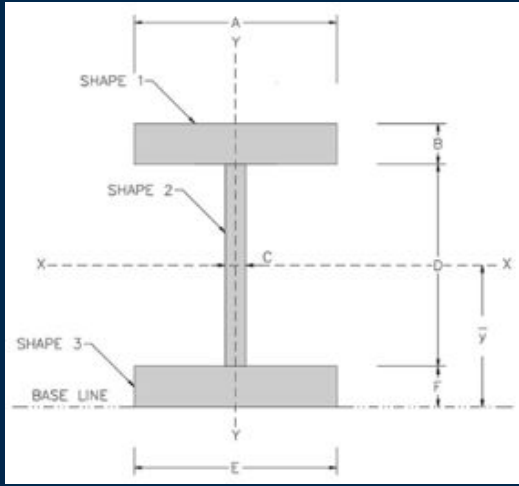
HW #11: Moment of Inertia

DATASET: 1	-2-	-3-
Dimension A		4 IN
Dimension B		4 IN
Dimension C		1 IN
Dimension D		7 IN
Dimension E		8 IN
Dimension F		4 IN



11. Summation of moments of areas × distances to centroid

$\Sigma I_x = A_1(X_1)^2 + A_2(X_2)^2 + A_3(X_3)^2$ (#8, #9, #10)

$= 806.56 in^4 + 17.92 in^4 + 486.72 in^4$

$= \boxed{1311.2 in^4}$

12. Moment of Inertia about the x-x axis for whole shape

$I_x = \Sigma I_{xx} + \Sigma I_x$ (#4, #11)

$= 92.5803 in^4 + 1311.2 in^4$

$= \boxed{1403.78 in^4}$

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HW #11: Moment of Inertia

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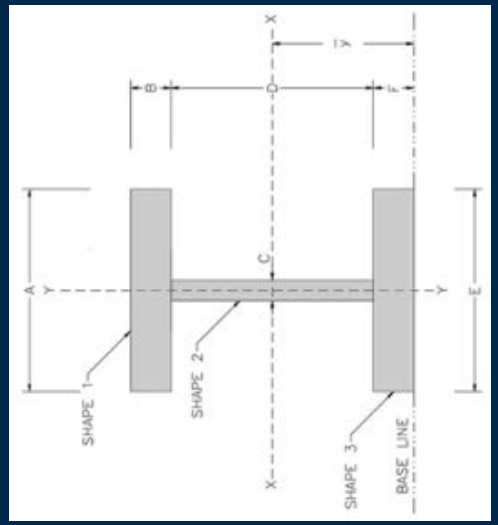
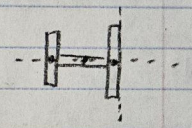


#13-17 → chart for visualization

	Area = b×h	Distance (d)	I_2 for yy: Area × distance (Ad)
SHAPE 1 (A, h=4", b=4")	4" × 4" = 16 in²	0	16" × 0 = 0
SHAPE 2 (D, h=1", b=7")	7" × 1" = 7 in²	0	7 × 0 = 0
SHAPE 3 (E, F, h=8", b=4")	4" × 8" = 32 in²	0	32 × 0 = 0
	ΣA = 55	↓	ΣI_2 = 0

* This column does not change...

* Because the centroid of all shapes is on one line (axis), distance = 0 and therefore Ad = 0



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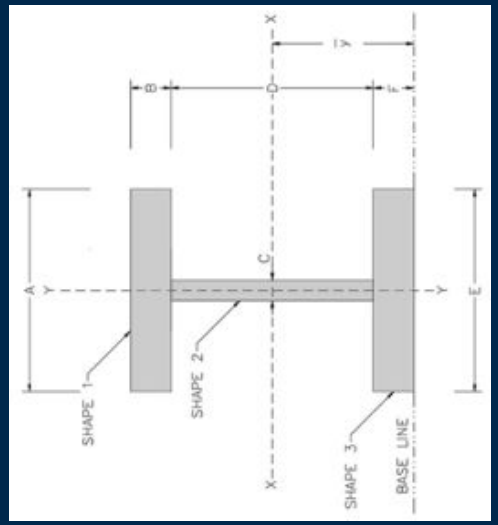

13. Moment of Inertia of Shape 1 about I_{yy}

$$I_{yy_1} = \frac{bh^3}{12} = \frac{BA^3}{12} = \frac{4"(4")^3}{12} = 21.33\ in^4$$

14. Moment of Inertia of Shape 2 about I_{yy}

$$I_{yy_2} = \frac{bh^3}{12} = \frac{DC^3}{12} = \frac{7"(1")^3}{12} = 0.583\ in^4$$

15. Moment of Inertia of Shape 3 about I_{yy}

$$I_{yy_3} = \frac{bh^3}{12} = \frac{FE^3}{12} = \frac{4"(8")^3}{12} = 170.67\ in^4$$

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HW #11: Moment of Inertia

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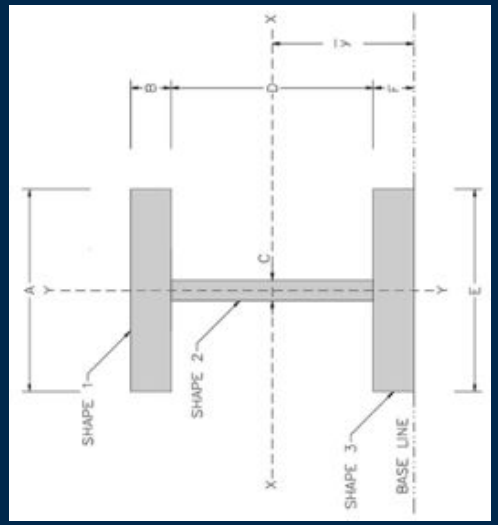

16. Summation of yy Moments of Inertia

$\Sigma I_{yy} = I_{yy_1} + I_{yy_2} + I_{yy_3}$ (#13, #14, #15)

$= 21.33 in^4 + 0.583 in^4 + 170.67 in^4$

$= \boxed{192.58 in^4}$

17. Moment of Inertia about yy axis for the whole shape

$\Sigma I_y = \Sigma I_{yy} + \Sigma I_2$

$= 192.58 in^4 + 0$ (#16) — chart!

$= \boxed{192.58 in^4}$

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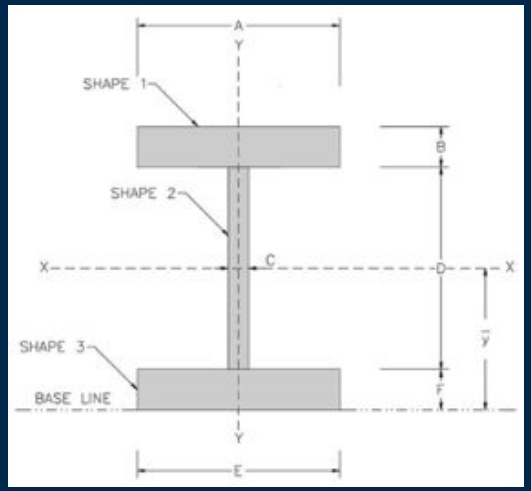
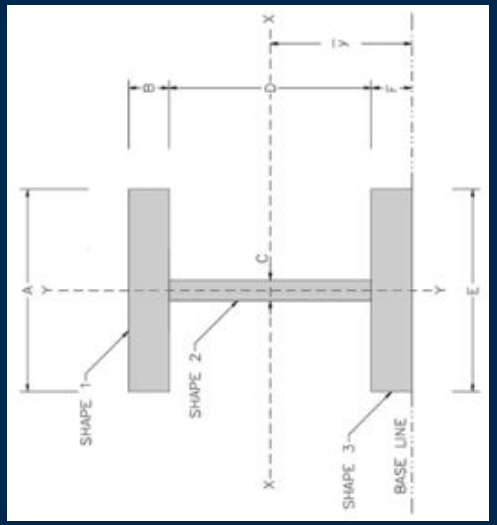
HW #11: Moment of Inertia



x-x axis



y-y axis

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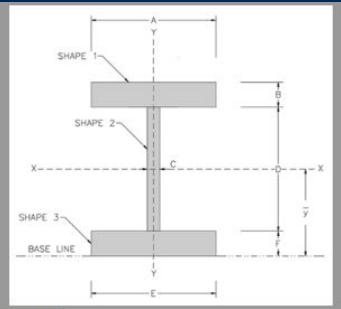

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Dimension E	8 IN
Dimension F	4 IN

Your answer was correct.
You scored 5 points.

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LAB!

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