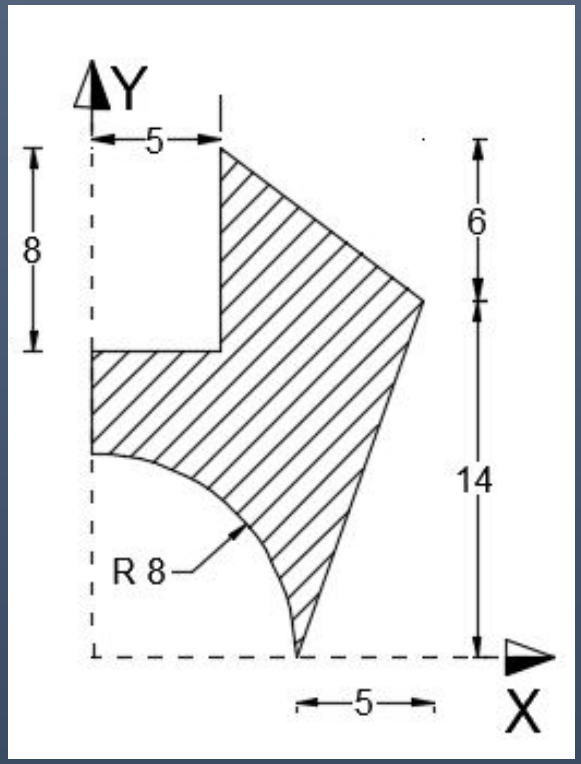
TUTORIAL – 7
(Additional problems)

1. Determine centroid of the shaded area shown in figure with respect to given reference axes. (units are in mm)



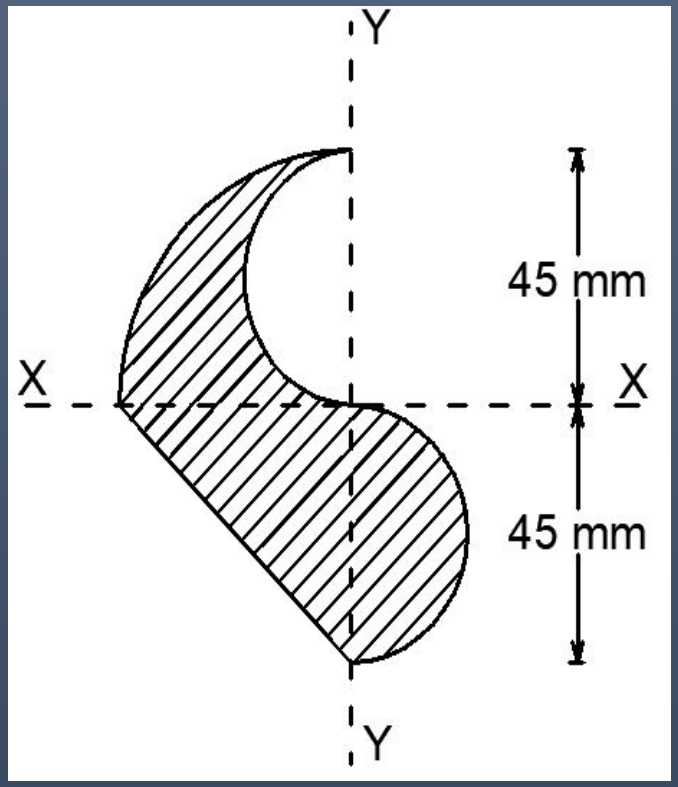
SOLUTION:

Shape	Area (mm^2)	$\bar{x}$ (mm)	$\bar{y}$ (mm)	$A\bar{x}$	$A\bar{y}$
	20X13 = 260 mm^2	6.5	10	1690	2600
	-8x5 = -40	2.5	16	-100	-640
	$-\frac{1}{2}$x8x6 = -24	10.33	18	-247.92	-432
	$-\frac{1}{2}$x5x14 = -35	11.33	4.67	-396.55	-163.45
	$-\pi R^2/4$ = -50.26	3.39	3.39	-170.38	-170.38

$\Sigma A = 110.74$ $\Sigma A\bar{x} = 775.15$ $\Sigma A\bar{y} = 1194.17$

$\bar{X} = 6.99$ mm $\bar{Y} = 10.78$ mm

2. Locate the centroid of shaded area with respect to the axes shown in the figure.(5 marks)

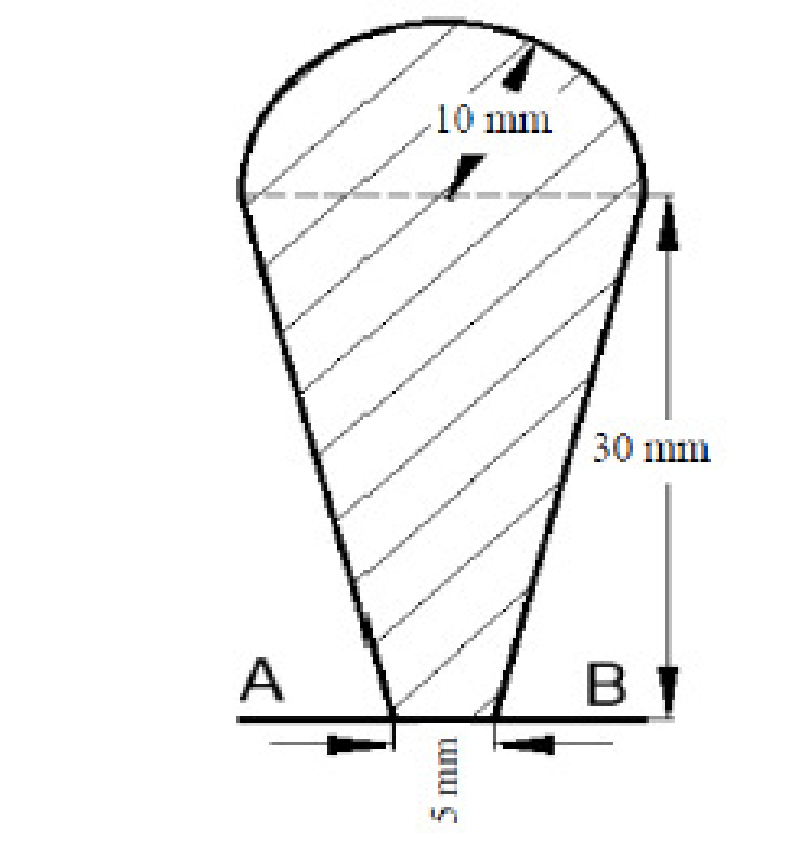


Shape	Area (mm^2)	x_i (mm)	y_i (mm)
I. Q. circle	$\frac{\pi \times 45^2}{4}$	$-\frac{4 \times 45}{3\pi}$	$+\frac{4 \times 45}{3\pi}$
	$= 1590.43$	$= -19.1$	$= 19.1$
II S. circle	$\frac{\pi \times 22.5^2}{2}$	$-\frac{4 \times 22.5}{3\pi}$	$+\frac{45}{2}$
	$= -795.22$	$= -9.55$	$= 22.5$
III Triangle	$\frac{1}{2} \times 45^2$	$-\frac{1}{3} \times 45$	$-\frac{1}{3} \times 45$
	$= 1012.5$	$= -15$	$= -15$
IV S. circle	$\frac{\pi \times 22.5^2}{2}$	$+\frac{4 \times 22.5}{3\pi}$	$-45/2$
	$= 795.22$	$= 9.55$	$= -22.5$
	2602.93		

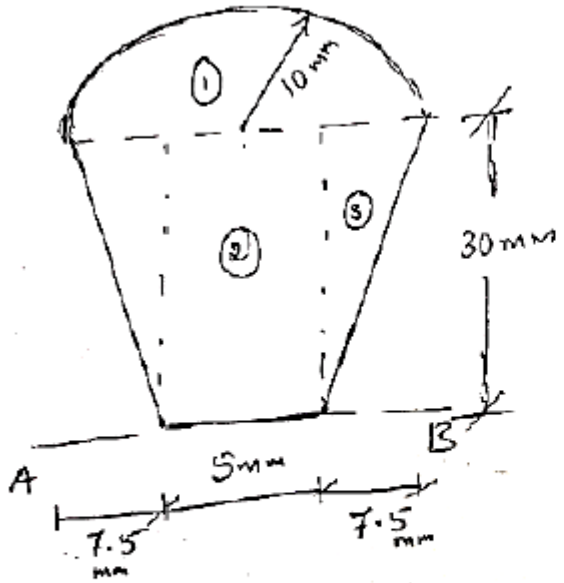
$$\bar{x} = \frac{\Sigma a_i x_i}{\Sigma a} = -11.67 \text{ mm}$$

$$\bar{y} = \frac{\Sigma a_i y_i}{\Sigma a} = 3.757 \text{ mm}$$

3. Determine the centroid of the hatched area with respect to axis AB



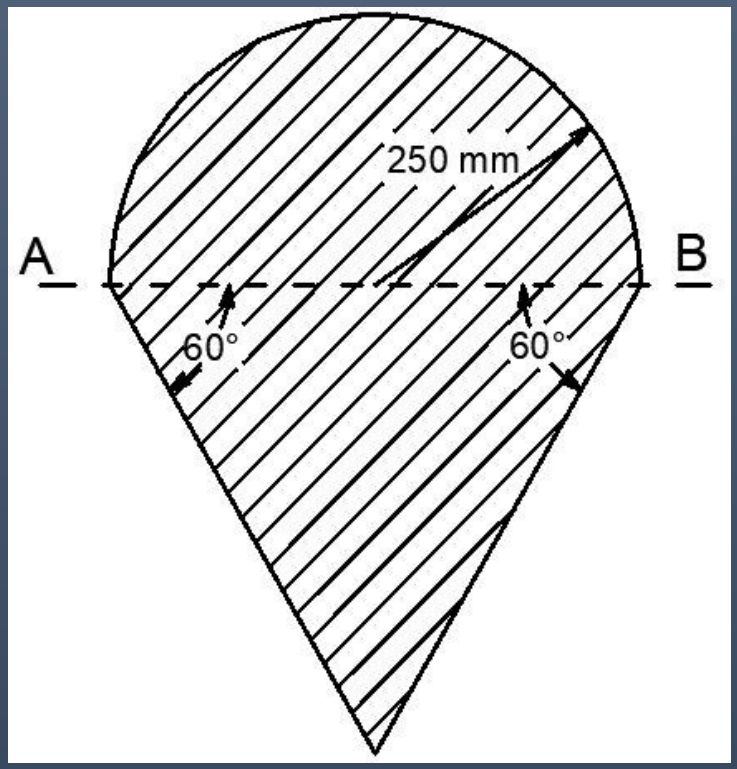
SOLUTION:

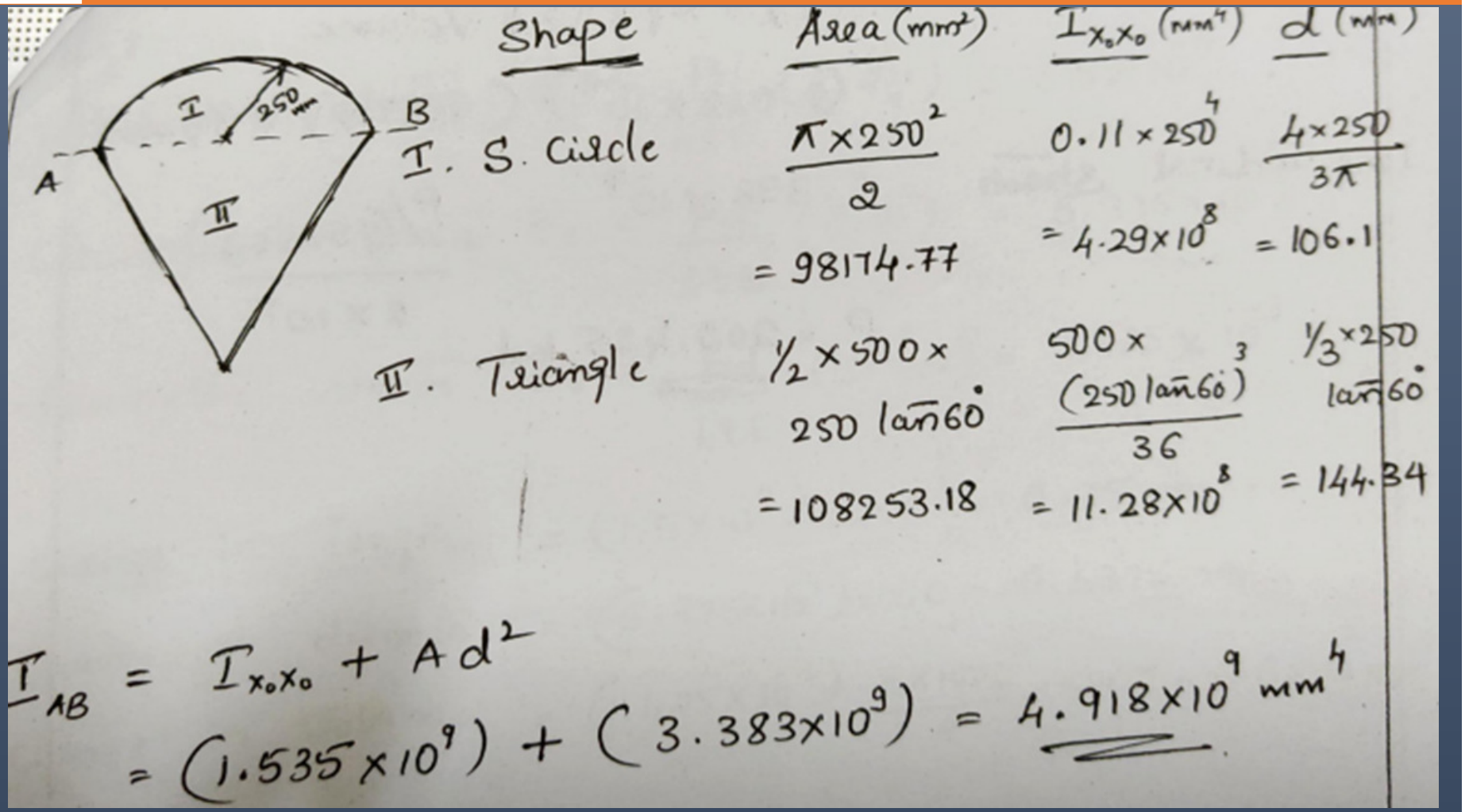


Shape	Area	$\bar{y}$	$a\bar{y}$
S. circle	$\frac{\pi \times 10^2}{2}$	34.244 mm	5379.03
Rectangle	5×30	15 mm	2250
Triangles	$2(\frac{1}{2} \times 7.5) \times 30$	20 mm	4500
	532.08		12129.03

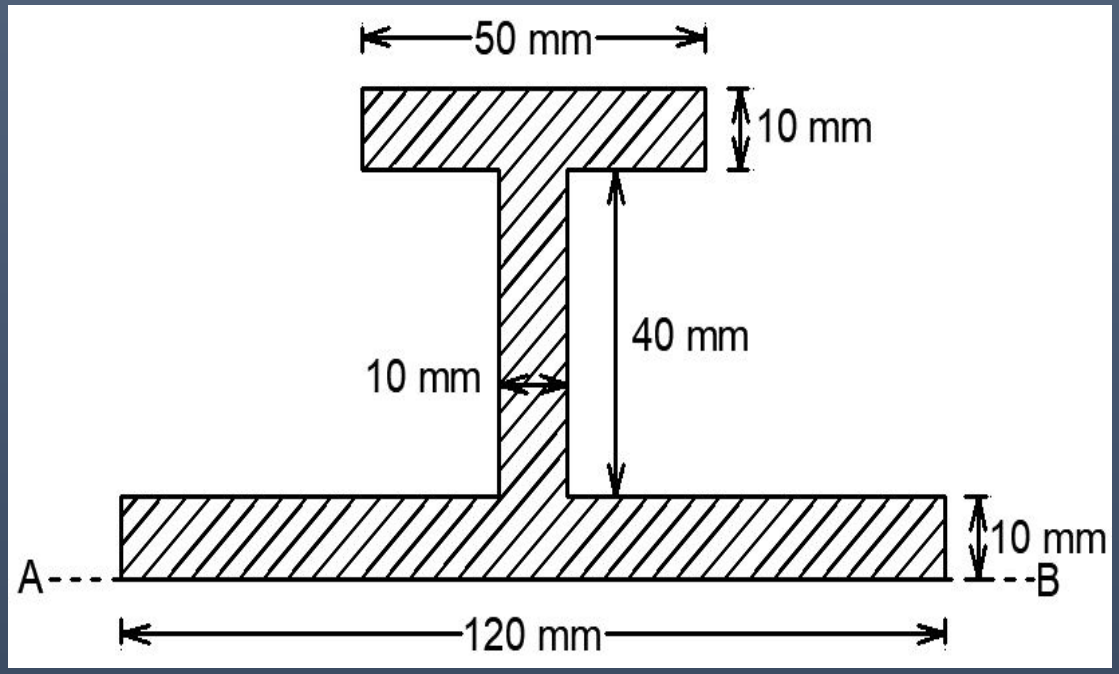
$$\bar{y} = \frac{12129.03}{532.08} = 22.8 \text{ mm} \quad (Y_2)$$

4. Determine moment of inertia of the shaded area shown in figure with respect to the given reference axis AB.



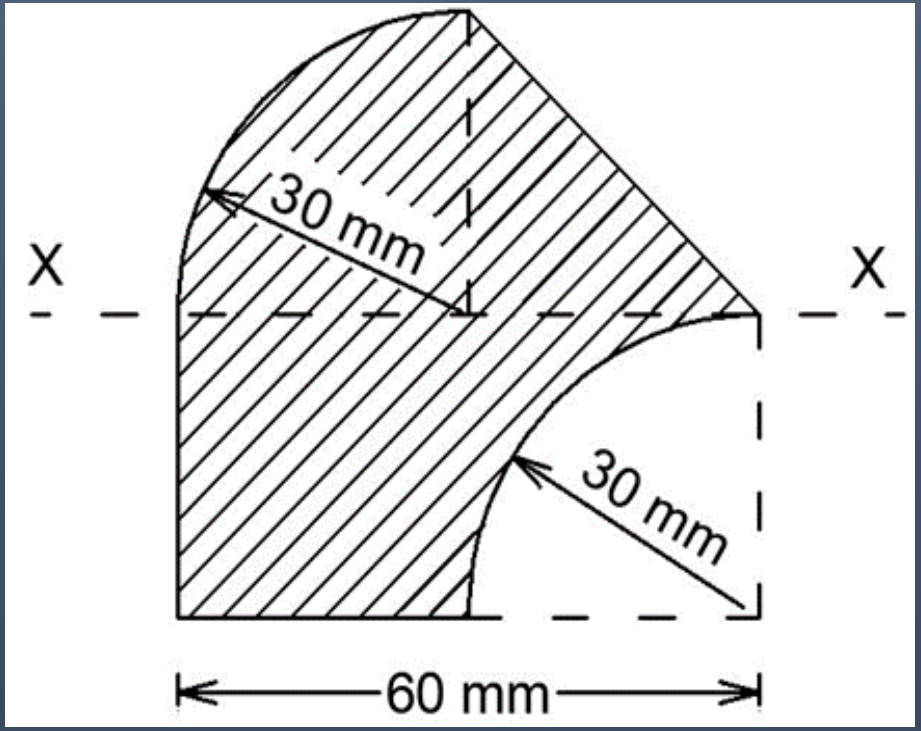


5. Determine the second moment of area for the hatched portion shown in figure with respect to given reference axis AB. (3 marks)



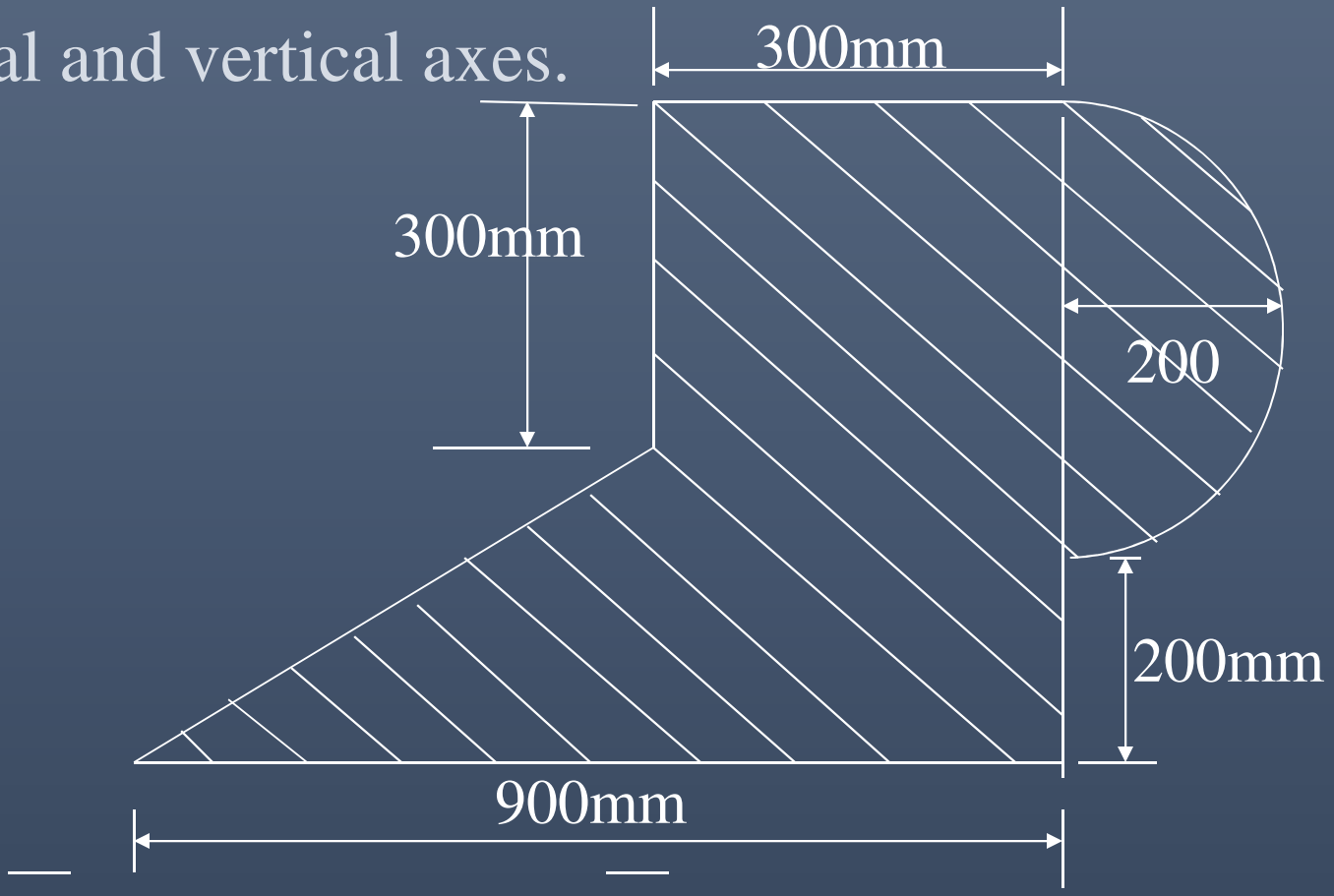
Ans: 1.97 x $10^6 mm^4$

6. Determine the second moment of area for the shaded area shown in the figure w.r.t given axis X-X.



Ans: 5.113 x $10^5 mm^4$

7. Determine second moment of area about centroidal horizontal and vertical axes.



[Ans: X = 99.7mm from A, Y = 265 mm
$I_{xx} = 10.29 \times 10^9 mm^4$, $I_{yy} = 16.97 \times 10^9 mm^4$]

8. Compute MI about vertical centroidal axis.

[Ans: X = 67.67mm , $I_{yy} = 3.783 \times 10^6 mm^4$]