ENGINEERING MECHANICS - STATICS

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DISTRIBUTED FORCES

Session- 10

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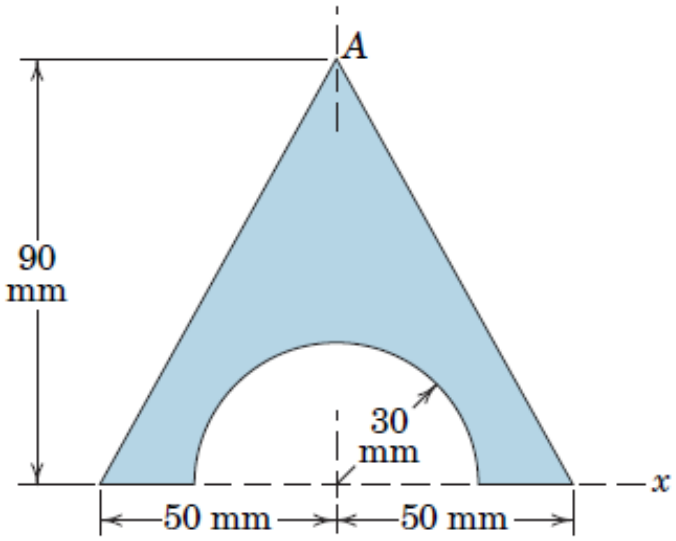
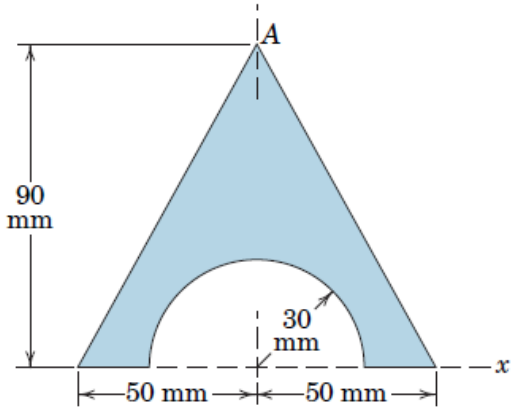
Moment of Inertia: Numerical

Problem A/42 Calculate the moment of inertia of the shaded area about the x-axis.



Moment of Inertia: Numerical

SOLUTION:



Moment of inertia of the shaded area about the x-axis:

$$I_x = \begin{pmatrix} MI\ of\ a\ triangle\ about \\ x - Axis \end{pmatrix} - \begin{pmatrix} MI\ of\ a\ Semicircle \\ about\ x - Axis \end{pmatrix} ----- (1)$$

$$MI\ of\ a\ triangle\ about\ x - axis = \frac{bh^3}{12}$$

Here,

$$b = 10\ mm\ \&\ h = 90\ mm$$

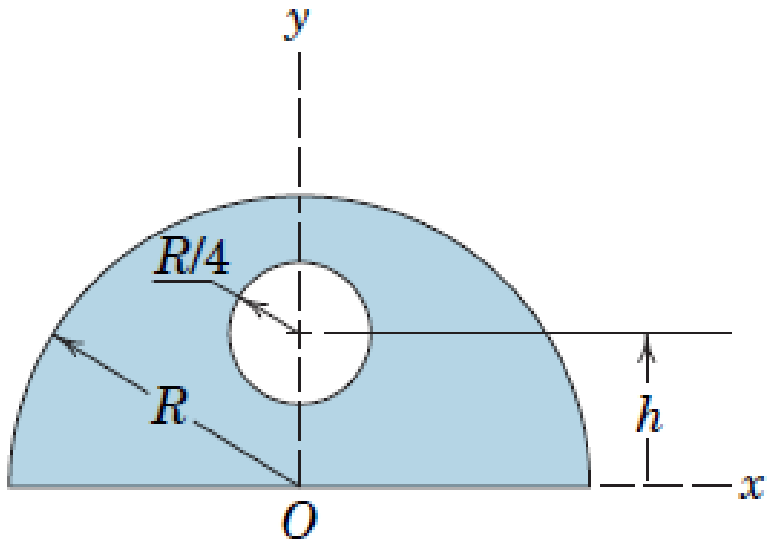
$$MI\ of\ a\ semicircle\ about\ x - axis = \frac{\pi R^4}{8}$$

Here, $R = 30\ mm$

Substituting in equation (1)

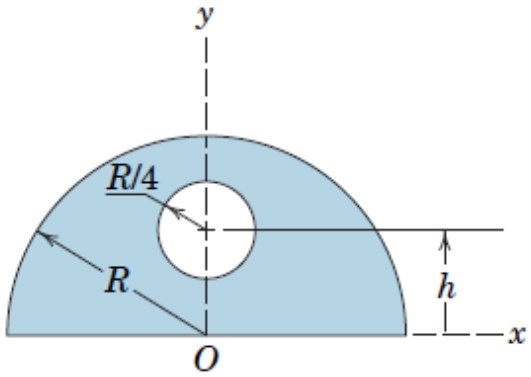
$$I_x = \left(\frac{100\ (90)^3}{12}\right) - \frac{\pi(30)^4}{8} = 5.756\ X\ 10^6\ mm^4$$

Problem A/44. The variable h designates the arbitrary vertical location of the center of the circular cutout within the semicircular area. Determine the area moment of inertia about the x-axis for (a) h =0 and (b) h = R/2.



Moment of Inertia: Numerical

SOLUTION:



Case (a) h=0

Moment of Inertia of shaded area about x-axis=

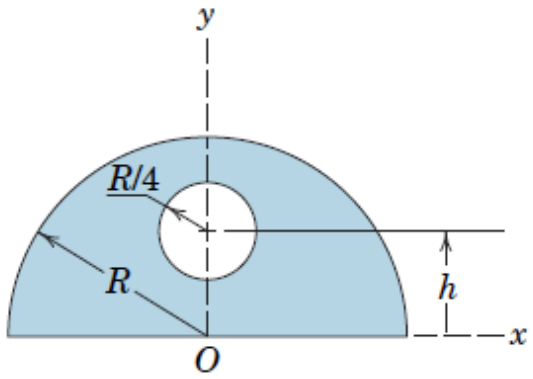
I_x =(MI of a semicircle about x-axis) – (MI of a circle about x-axis)

$$I_x = \left(\frac{\pi R^4}{8}\right) - \left(\frac{\pi \left(\frac{R}{4}\right)^4}{8}\right)$$

$$I_x = \left(\frac{\pi R^4}{8}\right) - \left(\frac{\pi (R)^4}{(4^4)(8)}\right)$$

$$\boxed{I_x = 0.3911R^4}$$

Moment of Inertia: Numerical



Case (b) h= R/2

Moment of Inertia of shaded area about x-axis= I_x =(MI of a semicircle about x-axis) – (MI of a circle about x-axis)

$$I_x = \left(\frac{\pi R^4}{8}\right) - (\bar{I} + Ad^2)$$

$$I_x = \left(\frac{\pi R^4}{8}\right) - \left(\frac{\pi R^4}{4} + \left(\frac{\pi R^2}{2}\right)h^2\right)$$

$$I_x = \left(\frac{\pi R^4}{8}\right) - \left(\frac{\pi\left(\frac{R}{4}\right)^4}{4} + \left(\frac{\pi\left(\frac{R}{4}\right)^2}{2}\right)\left(\frac{R}{2}\right)^2\right)$$

$$I_x = \left(\frac{\pi R^4}{8}\right) - \left(\frac{\pi R^4}{4^5} + \left(\frac{\pi (R)^2}{(4^2)2}\right)\left(\frac{R}{2}\right)^2\right)$$

$$\boxed{I_x = \left(\frac{\pi R^4}{8}\right) - \left(\frac{\pi\ 17\ R^4}{1024}\right) = 0.341R^4}$$

THANK YOU

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