



# ENGINEERING MECHANICS

## - STATICS

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# ENGINEERING MECHANICS - STATICS

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## DISTRIBUTED FORCES

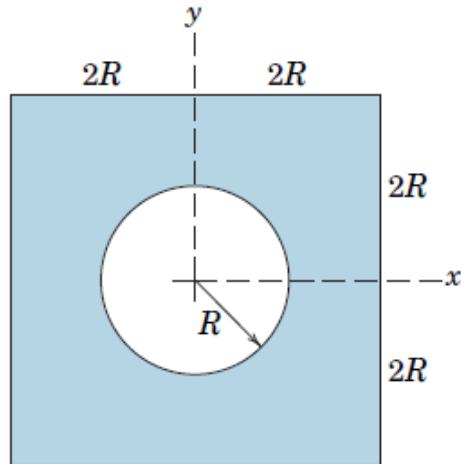
**Session- 9**

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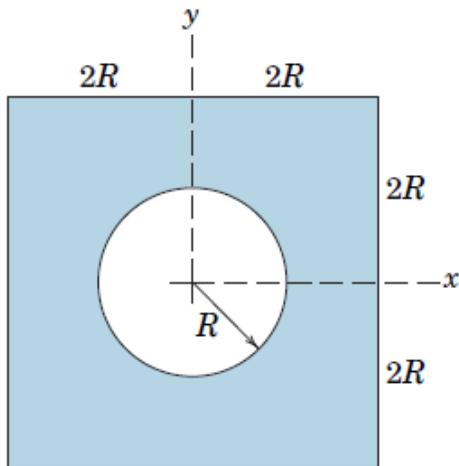
## Moment of Inertia: Numerical

**Problem A/35.** Determine the moment of inertia about the x-axis of the square area without and with the central circular hole.



## Moment of Inertia: Numerical

SOLUTION:



**Moment of inertia about the x-axis of the square area without central circular hole:**

$$I_x = \frac{bh^3}{12}$$

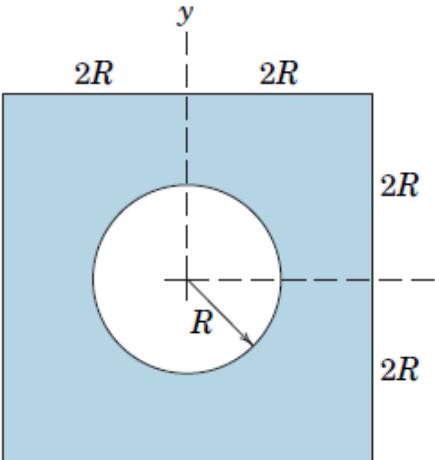
Here,

b= 4R, h=4R

$$I_x = \frac{(4R)(4R)^3}{12} = 21.33R^3$$

$$I_x = 21.33R^3$$

## Moment of Inertia: Numerical



**Moment of inertia about the x-axis of the square area with central circular hole:**

$$I_x = \left( MI \text{ of a square lamina } \atop \text{about } x - \text{Axis} \right) - \left( MI \text{ of a circle about } \atop x - \text{Axis} \right)$$

$$I_x = \left( \frac{bh^3}{12} \right) - \left( \frac{\pi r^4}{4} \right)$$

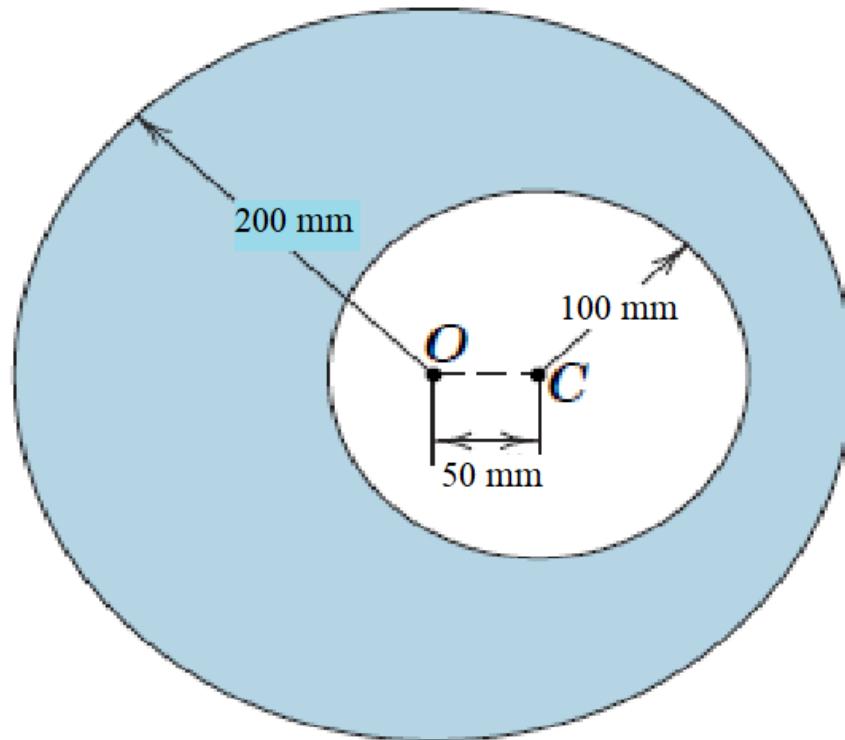
Here,

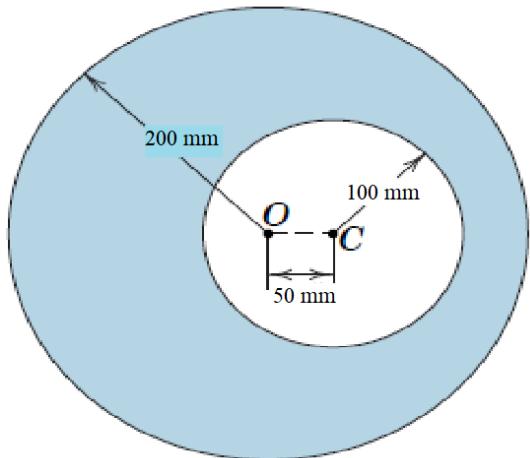
$$b=4R, h=4R \text{ & } r=R$$

$$I_x = \left( \frac{(4R)(4R)^3}{12} \right) - \left( \frac{\pi R^4}{4} \right) = 20.55 R^4$$

$$I_x = 20.55 R^4$$

**Problem A/39.** Calculate the polar radius of gyration of the shaded area about the center O of the larger circle.



**SOLUTION:**

**Polar Radius of Gyration of the shaded area about the Center "O":  $K_z$**

$$K_O = \sqrt{\frac{I_z}{A}} \quad \text{Here, } I_z \text{ is PMI of the shaded area about point "O" \& } A \text{ is shaded area.}$$

$$I_z = I_x + I_y \quad \text{Here } I_x, I_y \text{ are the MI of the shaded area about } x \text{ and } y - \text{axis}$$

$$I_x = \left( \begin{matrix} \text{MI of a larger circle} \\ \text{about } x - \text{Axis} \end{matrix} \right) - \left( \begin{matrix} \text{MI of a smaller circle about} \\ x - \text{Axis} \end{matrix} \right) \cdots \cdots (1)$$

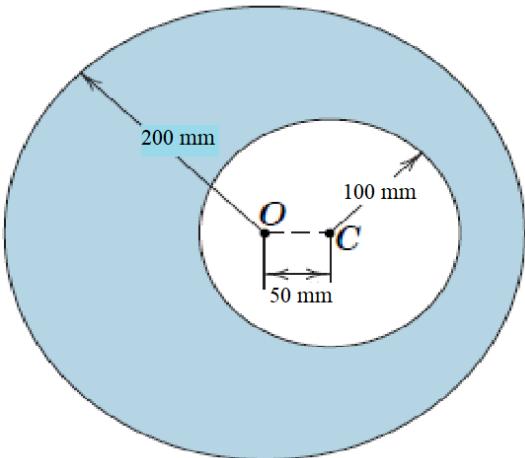
$$\text{MI of a larger circle about } x - \text{axis} = \frac{\pi R^4}{4} \quad \text{here } R = 200\text{mm}$$

$$\text{MI of a smaller circle about } x - \text{axis} = \frac{\pi R^4}{4} \quad \text{here } R = 100\text{mm}$$

Substituting in equation (1)

$$I_x = \left( \frac{\pi 200^4}{4} \right) - \left( \frac{\pi 100^4}{4} \right) = (12.566 \times 10^8) - (0.7854 \times 10^8) = 11.78 \times 10^8 \text{ mm}^4$$

## Moment of Inertia: Numerical



$$I_y = \left( MI \text{ of a larger circle } \atop \text{about } y\text{-Axis} \right) - \left( MI \text{ of a smaller circle about } \atop y\text{-Axis} \right) \quad \dots \dots (2)$$

$$MI \text{ of a larger circle about } y\text{-axis} = \frac{\pi R^4}{4} \text{ here } R = 200\text{mm}$$

$$\begin{aligned} MI \text{ of a smaller circle about } y\text{-axis} &= \bar{I}_y + Ad^2 \\ &= \frac{\pi R^4}{4} + \frac{\pi R^2}{2} d^2 \text{ here } R = 100\text{mm}, d = 50\text{mm} \end{aligned}$$

Substituting in equation (2)

$$I_y = \left( \frac{\pi 200^4}{4} \right) - \left( \left( \frac{\pi 100^4}{4} \right) + (\pi 100^2)(50)^2 \right) = (12.566 \times 10^8) - (1.57 \times 10^8) = 10.99 \times 10^8 \text{ mm}^4$$

$$I_z = I_x + I_y = 11.78 \times 10^8 + 10.99 \times 10^8 = 22.775 \times 10^8 \text{ mm}^4$$

$$A = (\pi 200^2) - (\pi 100^2) = \pi 30000 \text{ mm}^2$$

$$K_z = \sqrt{\frac{I_z}{A}} = \sqrt{\frac{22.775 \times 10^8}{\pi 30000}} = 155.45 \text{ mm}$$

$K_z = 155.45 \text{ mm}$



**THANK YOU**

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