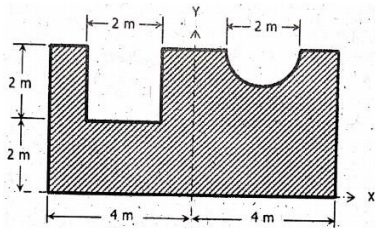


PRINCIPLE OF STEEL DESIGN

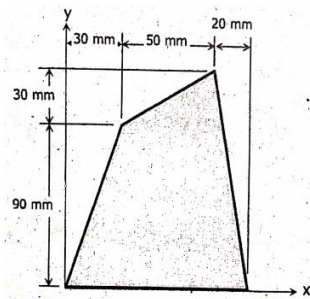
CHAPTER 1 - INTRODUCTION AND PROPERTIES OF SECTION

PROBLEM SET NO. 1:

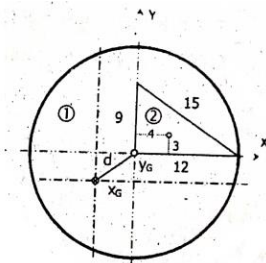
1. Locate the centroid of the shaded area shown in the figure and determine the area of the Plane in mm^2 :



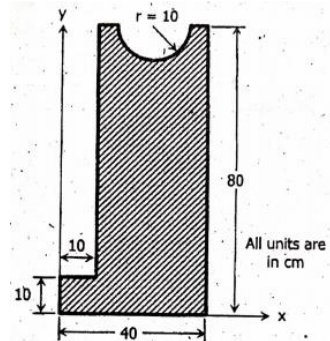
2. Determine the following based on the figure:
 - a. Area of the Plane in Square Millimeters
 - b. X-Coordinate of the centroid
 - c. Y-Coordinate of the centroid
 - d. Moments of inertia I_x and I_y .
 - e. Polar moment of inertia J_G and J_o .



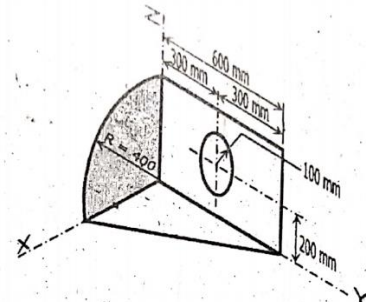
3. A circular piece of tin 24 cm in diameter has a triangular hole 9 cm by 12 cm by 15 cm. The Vertex of the triangle at the intersection of the 9-cm and 12-cm sides is at the center of the circle. How far is the centroid of the area to the center of the circle?



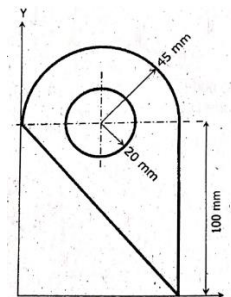
4. Determine the x and y coordinates of the shaded area shown below.



5. For the shaded surface shown in the figure, determine the following:
 - a. The area of the surface, in square millimeters.
 - b. The X-Coordinate of the Centroid in mm.
 - c. The Z-coordinate of the centroid in mm.



6. For the shaded area shown, determine the following:
 - a. Area of the shaded portion in square mm.
 - b. X-coordinate of the centroid of the area in mm.
 - c. Moment of inertia of the composite area with respect to the X-axis in mm^4

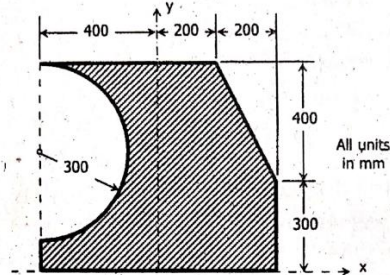


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CHAPTER 1 - INTRODUCTION AND PROPERTIES OF SECTION

7. For the shaded area shown, determine the following:

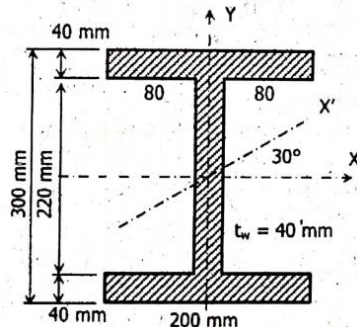
- Area of the shaded portion in square mm.
- X-coordinate of the centroid in mm.
- Y-coordinate of the centroid in mm.



8. A tee section is made up of 30mm x 150 mm flange and a 30 mm x 160 mm web. Determine the properties of the section.

9. For the section below:

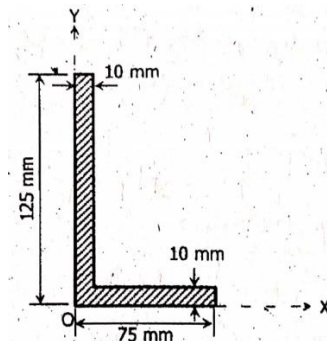
- Determine the moment of inertia with respect to the X-axis.
- Determine the moment of inertia with respect to the Y-axis.
- Determine the moment of inertia with respect to the X'-axis.



10. A certain area has the following properties: $I_x = 40 \times 10^6 \text{ mm}^4$; $I_y = 100 \times 10^6 \text{ mm}^4$, and $I_{xy} = 40 \times 10^6 \text{ mm}^4$. Determine the maximum and minimum moments of inertia, and the angle that the axis of maximum moment of inertia makes with the x-axis.

11. For the angular section shown in the figure, determine the following:

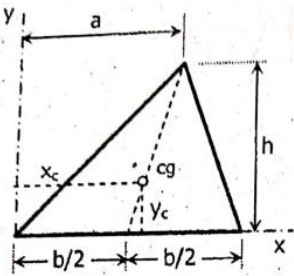
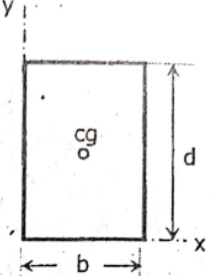
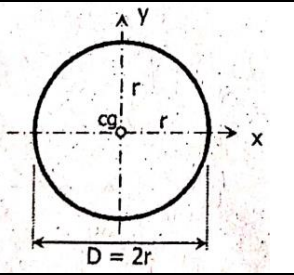
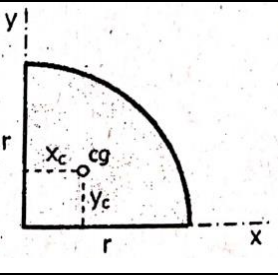
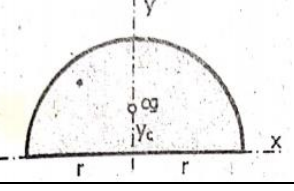
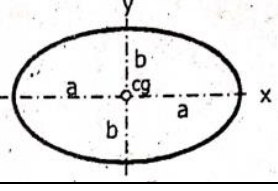
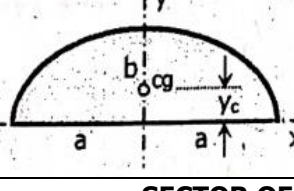
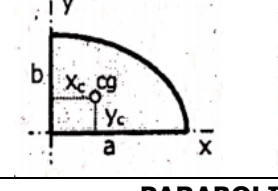
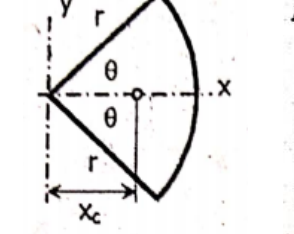
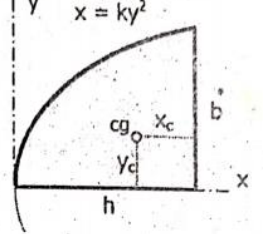
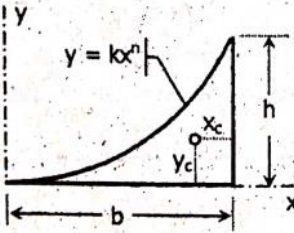
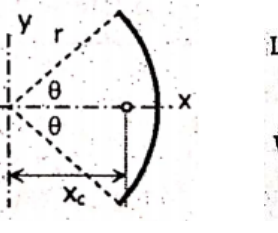
- Location of the centroid from the X and Y-axes.
- Centroid moments of inertia I_{gx} and I_{gy} .
- Moments of inertia I_x and I_y .
- Polar moment of inertia J_O and J_O .
- Maximum and minimum moments of inertia about the axes and its rotation through O.
- Moment of Inertia about an axis through O making an angle of 20° with the horizontal.



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CHAPTER 1 - INTRODUCTION AND PROPERTIES OF SECTION

Properties of Common Geometric Shapes

TRIANGLE	RECTANGLE
 $x_c = \frac{a+b}{3} \quad y_c = h/3$ $\text{Area} = \frac{1}{2} b h$ $I_x = \frac{bh^3}{12} \quad I_{gx} = \frac{bh^3}{36}$	 $\text{Area} = bd$ $I_x = \frac{bd^3}{3} \quad I_y = \frac{db^3}{3}$ $I_{gx} = \frac{bd^3}{12} \quad I_{gy} = \frac{db^3}{12}$
CIRCLE	QUARTER CIRCLE
 $\text{Area} = \pi r^2 = \frac{1}{4} \pi D^2$ $I_{gx} = I_{gy} = \frac{\pi r^4}{4} = \frac{\pi D^4}{64}$	 $\text{Area} = \frac{1}{4} \pi r^2$ $x_c = y_c = \frac{4r}{3\pi}$ $I_x = I_y = \frac{\pi r^4}{16}$ $I_{gx} = I_{gy} = 0.055r^4$
SEMICIRCLE	ELLIPSE
 $\text{Area} = \frac{1}{2} \pi r^2$ $y_c = \frac{4r}{3\pi}$ $I_x = I_{gy} = \frac{\pi r^4}{8}$ $I_{gx} = 0.11 r^4$	 $\text{Area} = \pi a b$ $I_{gx} = \frac{\pi ab^3}{4}$ $I_{gy} = \frac{\pi ba^3}{4}$
HALF ELLIPSE	QUARTER ELLIPSE
 $\text{Area} = \frac{1}{2} \pi ab$ $y_c = \frac{4b}{3\pi}$ $I_x = \frac{\pi ab^3}{8} \quad I_{gx} = 0.11 ab^3$ $I_{gy} = \frac{\pi ba^3}{8}$	 $\text{Area} = \frac{1}{4} \pi ab$ $x_c = \frac{4a}{3\pi} \quad y_c = \frac{4b}{3\pi}$ $I_x = \frac{\pi ab^3}{16} \quad I_y = \frac{\pi ba^3}{16}$ $I_{gx} = 0.055ab^3 \quad I_{gy} = 0.055ba^3$
SECTOR OF A CIRCLE	PARABOLIC SEGMENT
 $\text{Area} = \frac{1}{2} r^2 (2\theta) = r^2 \theta$ $x_c = \frac{2}{3} \frac{r \sin \theta}{\theta}$ $I_x = \frac{r^4}{4} (\theta - \frac{1}{2} \sin 2\theta)$ $I_y = \frac{r^4}{4} (\theta + \frac{1}{2} \sin 2\theta)$	 $\text{Area} = \frac{2}{3} bh$ $x_c = \frac{2}{5} h \quad y_c = \frac{3}{8} b$ $I_x = \frac{2}{15} hb^3 \quad I_y = \frac{2}{7} bh^3$
SPANDREL	SEGMENT OF ARC
 $\text{Area} = \frac{1}{n+1} bh$ $x_c = \frac{1}{n+2} b$ $y_c = \frac{n+1}{4n+2} h$	 $\text{Length of arc} = r(2\theta) = 2r\theta$ $x_c = \frac{r \sin \theta}{\theta}$ $\text{When } \theta = 90^\circ \text{ (semicircle)}$ $x_c = \frac{2r}{\pi}$