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***Relations Between w, V, M***

$$\frac{dV}{dx} = -w(x), \qquad \frac{dM}{dx} = V$$

***Centroid***

$$\bar{x} = \frac{Q_y}{A} = \frac{\sum \bar{x}_i A_i}{\sum A_i}, \quad \bar{y} = \frac{Q_x}{A} = \frac{\sum \bar{y}_i A_i}{\sum A_i}$$

***Moments of Inertia***

$$I_x = \int y^2 dA, \quad I_y = \int x^2 dA$$

***Polar moment of inertia***

$$J_o = \int r^2 dA = I_x + I_y$$

***Product of inertia***

$$I_{xy} = \int xy dA$$

***Parallel-axis theorem***

$$I_x = I_{x_c} + Ad_1^2 \quad I_y = I_{y_c} + Ad_2^2$$

$$J_o = J_c + Ad^2 \quad I_{xy} = I_{x_c y_c} + Ad_1 d_2$$

***Transformation equations***

$$I_{x'} = \frac{I_x + I_y}{2} + \frac{I_x - I_y}{2}\cos 2\theta - I_{xy}\sin 2\theta$$

$$I_{y'} = \frac{I_x + I_y}{2} - \frac{I_x - I_y}{2}\cos 2\theta + I_{xy}\sin 2\theta$$

$$I_{x'y'} = \frac{I_x - I_y}{2}\sin 2\theta + I_{xy}\cos 2\theta$$

***Principal moments of inertia***

$$I_{1,2} = \frac{I_x + I_y}{2} \pm \sqrt{\left(\frac{I_x - I_y}{2}\right)^2 + I_{xy}^2},$$

$$\tan 2\theta = -\frac{2I_{xy}}{I_x - I_y}$$

***Axial Load***

$$\sigma = \frac{P}{A}, \quad \varepsilon = \frac{\delta}{L}$$

$$\delta = \frac{PL}{AE}, \quad \delta = \sum \frac{N_i L_i}{A_i E_i}, \quad \delta = \int_0^L \frac{N(x)dx}{A(x)E}$$

# Space for personal notes

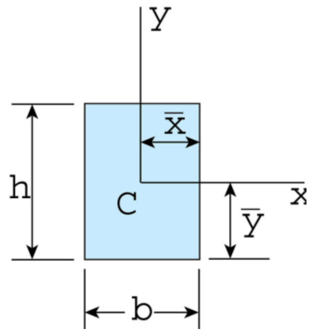
- You may include notes in this **BOXED** area **ONLY**
- The notes must be **hand-written** (no photocopies or computer print)
- You may include explanations/ diagrams
- You are **not permitted** to include **sample problems**

**TO BE SUBMITTED WITH THE EXAM**

NAME ______________________________ STUDENT ID ____________

**Geometric Properties of Some Plane Areas**

Rectangle (origin of axes at centroid)



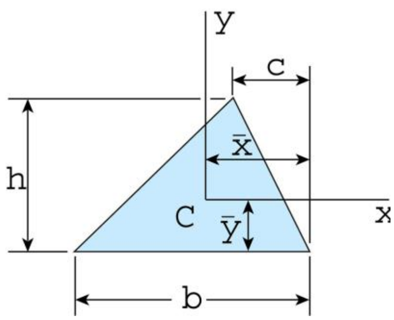

$$A = bh$$

$$\bar{x} = \frac{b}{2}, \quad \bar{y} = \frac{h}{2}$$

$$I_x = \frac{bh^3}{12}, \quad I_y = \frac{hb^3}{12}, \quad I_{xy} = 0$$

$$J_C = \frac{bh}{12}\left(h^2 + b^2\right)$$

Triangle (origin of axes at centroid)

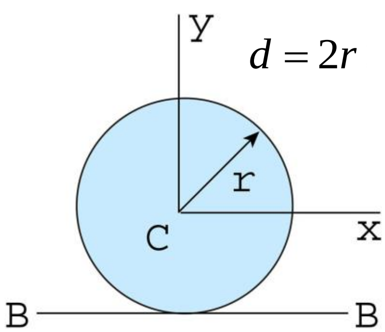



$$A = \frac{bh}{2}, \quad \bar{x} = \frac{b+c}{3}, \quad \bar{y} = \frac{h}{3}$$

$$I_x = \frac{bh^3}{36}, \quad I_y = \frac{bh}{36}\left(b^2 - bc + c^2\right), \quad I_{xy} = \frac{bh^2}{72}\left(b - 2c\right)$$

$$J_C = \frac{bh}{36}\left(h^2 + b^2 - bc + c^2\right)$$

Circle (origin of axes at centroid)

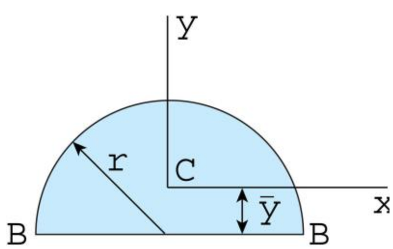



$$A = \pi r^2 = \frac{\pi d^2}{4}, \quad d = 2r$$

$$I_x = I_y = \frac{\pi r^4}{4} = \frac{\pi d^4}{64}, \quad I_{xy} = 0$$

$$J_C = \frac{\pi r^4}{2} = \frac{\pi d^4}{32}$$

Semicircle (origin of axes at centroid)




$$A = \frac{\pi r^2}{2}, \quad \bar{y} = \frac{4r}{3\pi}$$

$$I_x = \frac{\left(9\pi^2 - 64\right) r^4}{72\pi} \approx 0.1098 r^4, \quad I_y = \frac{\pi r^4}{8}, \quad I_{xy} = 0$$

$$I_{BB} = \frac{\pi r^4}{8}$$

**TO BE SUBMITTED WITH THE EXAM**