## PROBLEM 1-7

**Statement:** Prepare an interactive computer program (using, for example, Excell, Mathcad, or TKSolver) from which the cross-sectional properties for the shapes shown in the inside front cover can be calculated. Arrange the program to deal with both *ips* and *SI* unit systems and convert the results between those systems.

**Solution:** See the inside front cover and Mathcad file P0107.

1. Rectangle, let:

$b := 3 \cdot in$ $\qquad$ $h := 4 \cdot in$

Area $\qquad A := b \cdot h \qquad A = 12.000 \cdot in^2$

$A = 7742 \cdot mm^2$

Moment about *x*-axis $\qquad I_x := \frac{b \cdot h^3}{12} \qquad I_x = 16.000 \cdot in^4$

$I_x = 6.660 \times 10^6 \cdot mm^4$

Moment about *y*-axis $\qquad I_y := \frac{h \cdot b^3}{12} \qquad I_y = 9.000 \cdot in^4$

$I_y = 3.746 \times 10^6 \cdot mm^4$

Radius of gyration about *x*-axis $\qquad k_x := \sqrt{\frac{I_x}{A}} \qquad k_x = 1.155 \cdot in$

$k_x = 29.329 \cdot mm$

Radius of gyration about *y*-axis $\qquad k_y := \sqrt{\frac{I_y}{A}} \qquad k_y = 0.866 \cdot in$

$k_y = 21.997 \cdot mm$

Polar moment of inertia $\qquad J_z := I_x + I_y \qquad J_z = 25.000 \cdot in^4$

$J_z = 1.041 \times 10^7 \cdot mm^4$

2. Solid circle, let:

$D := 3 \cdot in$

Area $\qquad A := \frac{\pi \cdot D^2}{4} \qquad A = 7.069 \cdot in^2$

$A = 4560 \cdot mm^2$

Moment about *x*-axis $\qquad I_x := \frac{\pi \cdot D^4}{64} \qquad I_x = 3.976 \cdot in^4$

$I_x = 1.655 \times 10^6 \cdot mm^4$

Moment about *y*-axis $\qquad I_y := \frac{\pi \cdot D^4}{64} \qquad I_y = 3.976 \cdot in^4$

$I_y = 1.655 \times 10^6 \cdot mm^4$

Radius of gyration about *x*-axis $\qquad k_x := \sqrt{\frac{I_x}{A}} \qquad k_x = 0.750 \cdot in$

$k_x = 19.05 \cdot mm$

Radius of gyration about $y$-axis $k_y := \sqrt{\dfrac{I_y}{A}}$ $k_y = 0.750 \cdot in$

$k_y = 19.05 \cdot mm$

Polar moment of inertia $J_z := \dfrac{\pi \cdot D^4}{32}$ $J_z = 7.952 \cdot in^4$

$J_z = 3.310 \times 10^6 \cdot mm^4$

3. Hollow circle, let:

$D := 3 \cdot in$ $d := 1 \cdot in$

Area $A := \dfrac{\pi}{4} \cdot \left(D^2 - d^2\right)$ $A = 6.283 \cdot in^2$

$A = 4054 \cdot mm^2$

Moment about $x$-axis $I_x := \dfrac{\pi}{64} \cdot \left(D^4 - d^4\right)$ $I_x = 3.927 \cdot in^4$

$I_x = 1.635 \times 10^6 \cdot mm^4$

Moment about $y$-axis $I_y := \dfrac{\pi}{64} \cdot \left(D^4 - d^4\right)$ $I_y = 3.927 \cdot in^4$

$I_y = 1.635 \times 10^6 \cdot mm^4$

Radius of gyration about $x$-axis $k_x := \sqrt{\dfrac{I_x}{A}}$ $k_x = 0.791 \cdot in$

$k_x = 20.08 \cdot mm$

Radius of gyration about $y$-axis $k_y := \sqrt{\dfrac{I_y}{A}}$ $k_y = 0.791 \cdot in$

$k_y = 20.08 \cdot mm$

Polar moment of inertia $J_z := \dfrac{\pi}{32} \cdot \left(D^4 - d^4\right)$ $J_z = 7.854 \cdot in^4$

$J_z = 3.269 \times 10^6 \cdot mm^4$

4. Solid semicircle, let:

$D := 3 \cdot in$ $R := 0.5 \cdot D$ $R = 1.5 \cdot in$

Area $A := \dfrac{\pi \cdot D^2}{8}$ $A = 3.534 \cdot in^2$

$A = 2280 \cdot mm^2$

Moment about $x$-axis $I_x := 0.1098 \cdot R^4$ $I_x = 0.556 \cdot in^4$

$I_x = 2.314 \times 10^5 \cdot mm^4$

Moment about $y$-axis $I_y := \dfrac{\pi \cdot R^4}{8}$ $I_y = 1.988 \cdot in^4$

$I_y = 8.275 \times 10^5 \cdot mm^4$

Radius of gyration about $x$-axis $k_x := \sqrt{\frac{I_x}{A}}$ $k_x = 0.397 \cdot in$

$k_x = 10.073 \cdot mm$

Radius of gyration about $y$-axis $k_y := \sqrt{\frac{I_y}{A}}$ $k_y = 0.750 \cdot in$

$k_y = 19.05 \cdot mm$

Polar moment of inertia $J_z := I_x + I_y$ $J_z = 2.544 \cdot in^4$

$J_z = 1.059 \times 10^6 \cdot mm^4$

Distances to centroid $a := 0.4244 \cdot R$ $a = 0.637 \cdot in$

$a = 16.17 \cdot mm$

$b := 0.5756 \cdot R$ $b = 0.863 \cdot in$

$b = 21.93 \cdot mm$

5. Right triangle, let:

$b := 2 \cdot in$ $h := 1 \cdot in$

Area $A := \frac{b \cdot h}{2}$ $A = 1.000 \cdot in^2$

$A = 645 \cdot mm^2$

Moment about $x$-axis $I_x := \frac{b \cdot h^3}{36}$ $I_x = 0.056 \cdot in^4$

$I_x = 2.312 \times 10^4 \cdot mm^4$

Moment about $y$-axis $I_y := \frac{h \cdot b^3}{36}$ $I_y = 0.222 \cdot in^4$

$I_y = 9.250 \times 10^4 \cdot mm^4$

Radius of gyration about $x$-axis $k_x := \sqrt{\frac{I_x}{A}}$ $k_x = 0.236 \cdot in$

$k_x = 5.987 \cdot mm$

Radius of gyration about $y$-axis $k_y := \sqrt{\frac{I_y}{A}}$ $k_y = 0.471 \cdot in$

$k_y = 11.974 \cdot mm$

Polar moment of inertia $J_z := I_x + I_y$ $J_z = 0.278 \cdot in^4$

$J_z = 1.156 \times 10^5 \cdot mm^4$