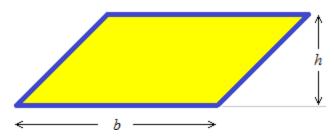**ENGI 3425 Mathematics for Civil Engineering 1**
Problem Set 9 Questions
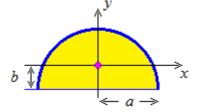**(Section 8.4 – Second Moments)**

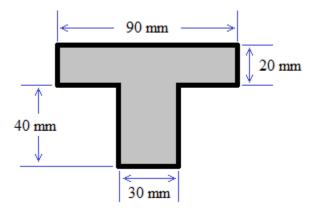1. Find the second moment of area I_x of this parallelogram about its centroid.

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2. Verify that the second moments of area for a semicircle of radius a, whose base is parallel to the x-axis, about its centroid are
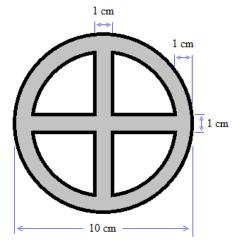
$$I_x = \frac{\pi a^4}{8}\left(1 - \frac{64}{9\pi^2}\right) \quad \text{and} \quad I_y = \frac{\pi a^4}{8}$$

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3. Find the second moment of area of this T-shaped cross section about its centroid.

4.   A metal wheel of radius 5 cm has four support spokes, has uniform thickness and density
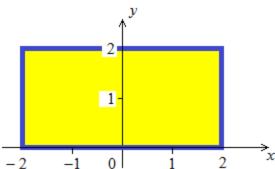   and has the shape shown here.

      Find the approximate second moments of area of this wheel about its centroid.

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5.   Related concepts to first and second moments of area are first moment of mass and
      moment of inertia.   In the case of bodies of uniform density there is no practical
      difference between these pairs of concepts: the centre of mass is at the same location as
      the centroid.

      However, when the density is not constant, the centre of mass (the balance point) can be
      in a different location from the centroid (the geometric centre).

      The rectangle shown below has a surface density $\sigma = 3y$ kg m^{-2}.

      (a) Find the location of its centroid.
      (b) Find the second moments of area around the centroid.
      (c) Find the second moments of area around the origin of the coordinate system shown.
      (d) Find the location of its centre of mass.
      (e) Find the moments of inertia around the centre of mass.
      (f) Find the moments of inertia around the origin of the coordinate system shown.