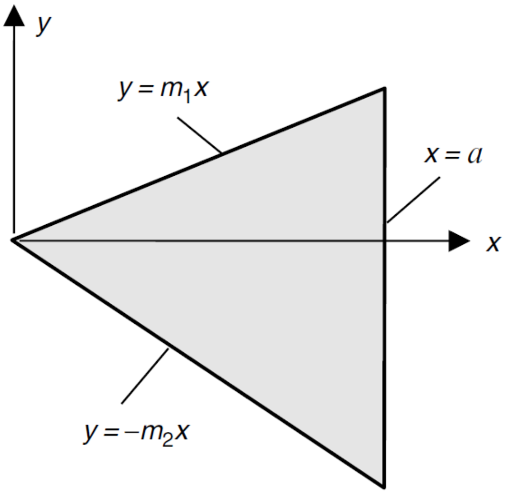
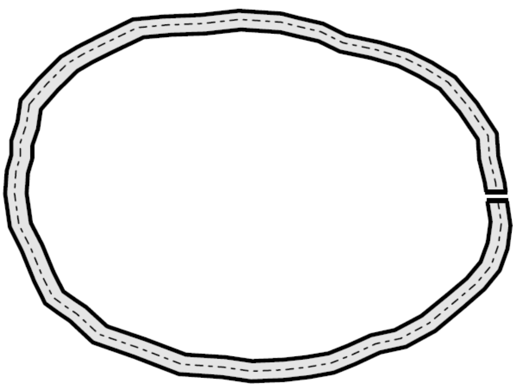
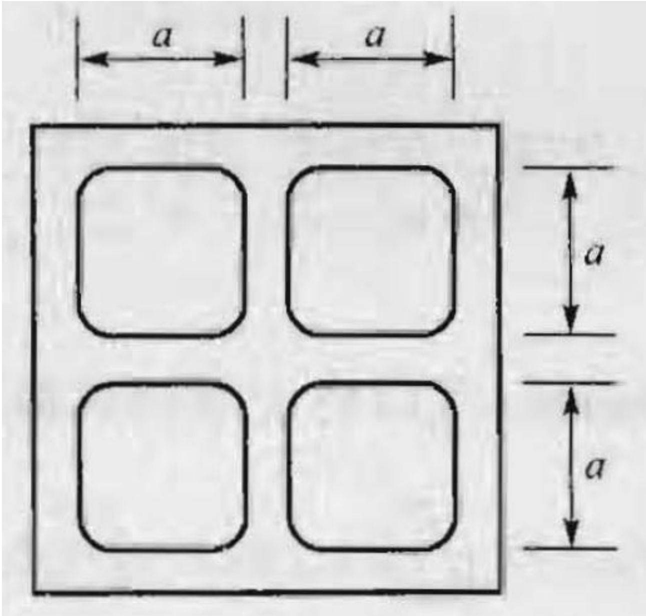
1. Consider the torsion of a bar of general triangular section as shown. Using the boundary equation technique, attempt a stress function solution of the form $\psi = K(x-a)(y-m_1x)(y+m_2x)$, where m_1, m_2, and a are geometric constants defined in the figure and K is a constant to be determined. Show that this form will be a solution to the torsion problem only for the case of an equilateral triangular section.



2. For identical applied torque, calculate and compare the stresses for a closed thin-walled section and the same section with a small cut. Justify that the closed tube has much lower stress and is thus much stronger.



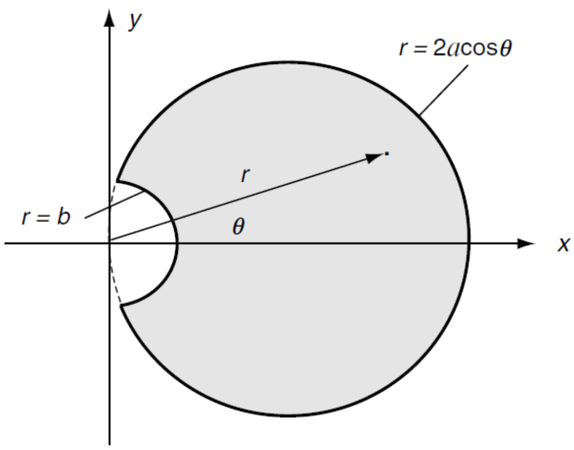
3. A closed thin-walled section shown below is subjected to twisting moment M. Determine the maximum shear stress and angle of twist per unit length. All wall thickness is δ.



4. A circular shaft with a keyway can be approximated by the section shown in the figure. Using the Boundary Equation Scheme, a trial stress function is suggested of the form

$$\psi = K\left(b^2 - r^2\right)\left(1 - \frac{2a\cos\theta}{r}\right)$$

where K is a constant to be determined. Show that this form will solve the problem and determine the constant K. Compute the two shear stress components in Cartesian coordinates. Further determine the resultant stresses on the shaft and keyway boundaries.



5. In the previous problem, determine the maximum values of the resultant stresses on the shaft and keyway boundaries. Next, make a plot of the stress concentration factor $(\tau_{\max})_{\text{keyway}}/(\tau_{\max})_{\text{shaft}}$ versus the ratio b/a over the range $0 \le b/a \le 1$. The stress concentration plot indicates that a small notch will result in a doubling of the stress in circular section under torsion.