Problem 1: Compute the principal stresses for a state of stress (expressed in an x-y coordinate system)

\[ \sigma = \begin{bmatrix} 5 & 1 \\ 1 & -1 \end{bmatrix} \).

Use an eigenvalue approach.

Problem 2: For the state of stress (expressed in an x-y coordinate system)

\[ \sigma = \begin{bmatrix} -2 & 1 \\ 1 & -1 \end{bmatrix} \]

one of the principal stresses is -2.618. Compute the principal direction (eigenvector) associated with that principal stress and show the direction and stress on a properly oriented element of material.

Problem 3: Derive the two-dimensional differential equation of equilibrium for the x-direction. Include a properly drawn and labeled figure of a differential element of material.
**Problem 4:** For the infinite plate shown below:

(a) Calculate the value of $\sigma_\theta$ at points A and B.
(b) Calculate the value of $\sigma_\theta$ for all points around the circumference of the hole.

Hint: Consider either the stress transformation equation or the result for principal directions.

**Problem 5:** For the cross section shown below, is the torsional constant (explain your answer):

\[
J > \frac{2}{3}at^3 + \frac{2}{3}bt^3 \\
J = \frac{2}{3}at^3 + \frac{2}{3}bt^3 \\
J < \frac{2}{3}at^3 + \frac{2}{3}bt^3
\]

**Problem 6:** Consider the plan strain problem below. Calculate the strain $\varepsilon_x$. Material properties are $E$, $G$, $\nu$. 