Problem 1: For the stress matrix shown below:
   a) Show the stress using properly directed arrows on a square element of material.
      Indicate coordinate system
   b) Compute the principal stresses using an eigenvalue approach
   c) For the case of plane stress, what is the third principal stress?

\[ \sigma = \begin{bmatrix} -2 & -3 \\ -3 & 1 \end{bmatrix} \]

Problem 2: For the stress matrix shown below the principle stresses are 1.7 and 5.3. Compute the principal direction (eigenvector) corresponding to the principal stress 1.7 and show the principal stresses on a properly oriented element.

\[ \sigma = \begin{bmatrix} 5 & 1 \\ 1 & 2 \end{bmatrix} \]

Problem 3: For the infinite plate with a circular hole shown below:
   a) Determine the state of stress around the hole \((r = a)\).
   b) For plane strain, what is the out of plane stress.
**Problem 4:** For the Z-section shown below:

a) Compute $J$

b) List the geometric parameters in order of importance in determining the warping constant $C_w$. That is, if you wanted to increase $C_w$, which parameters would give you the most increase in $C_w$ for a given parameter increase.

![Diagram of Z-section](image)

**Problem 5:** For which cross sections shown below is the expression

$$J = \sum \frac{1}{3} \text{(width)} \times \text{(thickness)}^3$$

valid.

- a)
- b)
- c)
- d)
- e)
- f)
- g)
**Problem 6:** Consider the solution for the contact patch radius \(a\) between two spheres in contact as given below. Determine the expression for the size of the contact patch when \(E_1 \to \infty\) and \(r_2 \to 0\).

\[ a = 0.88 \left[ \frac{P(E_1 + E_2)r_1r_2}{E_1E_2(r_1 + r_2)} \right]^{1/3} \]

**Problem 7:** Consider the uniform distributed load applied to an infinite half space as shown below. Develop an expression for the stress \(\tau_{xy}\) at any point in the solid.

Useful solution:

\[ \tau_{xy} = -\frac{2P}{\pi} \frac{x^2y}{(x^2 + y^2)^2} \]