Problem 1

(5 points each) Short answer:

(i) Sketch a Mohr-Coulomb failure surface in the \( \pi \)-plane on the figure.

(ii) List two reasons why tensile strength is relatively unimportant in reservoir geomechanics.

1. Tensile strength of rocks is very low.
2. In situ stress at depth is always compressive.
(iii) On the figure below that schematically represents an extended leakoff-test.

Label the formation breakdown pressure and the fracture propagation pressure.
Problem 2

(30 points)

Given the following two Mohr's circles created with triaxial tests on a rock material:

\[
\begin{align*}
T &= \frac{340 - 140}{60 - 10} = \frac{200}{50} = 4 \\
S_1 &= 140 - (4)(10) = 100 \text{ MPa} \\
C_0 &= S_1 - n S_3 \\
\mu_f &= \frac{n-1}{2\sqrt{n}} = \frac{4-1}{2\sqrt{4}} = \frac{3}{4} = 0.75
\end{align*}
\]
Problem 3

(30 points) Given the geographical stress,

\[ S_G = \begin{bmatrix} 47.5 & -12.5 & 0 \\ -12.5 & 47.5 & 0 \\ 0 & 0 & 40 \end{bmatrix} \text{ MPa} \]

For a horizontal wellbore drilled along an azimuth oriented directly to the west, find the wellbore stress tensor, \( S_B \).

\[ \phi = 90^\circ \quad \theta = 270^\circ \]

Using code:

\[ S_B = \begin{bmatrix} 40 & 0 & 0 \\ 0 & 47.5 + 12.5 & 0 \\ 0 & 12.5 & 47.5 \end{bmatrix} \text{ MPa} \]