ECE 526: Homework #1

Due Session 6 (January 31)

1. A distance relay is installed at Bus 1 as indicated to protect the line from Bus 1 to Bus 2. Set zone 1 to protect 80% of the length of the line and zone 2 to protect 125% of the length of the line. The impedance values are in secondary ohms.

\[
\begin{align*}
Z_{L1} &= 5 \text{ ohm} / 85^\circ \\
Z_{S1} &= 2.5 \text{ ohm} / 85^\circ \\
Z_{S2} &= Z_{S1} \\
Z_{S0} &= 3Z_{S1} \\
Z_{R1} &= 2.5 \text{ ohm} / 85^\circ \\
Z_{R2} &= Z_{R1} \\
Z_{R0} &= 3Z_{R1}
\end{align*}
\]

CTR = \( \frac{800 \text{A}}{5 \text{A}} \) \hspace{1cm} PTR = \( \frac{345 \text{kV}}{120 \text{V}} \)

A. For an unfaulted condition, how much load current can flow (unity power factor as measured at the relay) from BUS 1 to BUS 2 without the zone 2 element picking up if the distance relay is a simple impedance relay? What if the power factor is 0.8 lagging? Assume BUS 1 has a voltage of 1.0 pu. Does it matter if power is going from BUS 1 to BUS 2 or from BUS 2 to BUS 1?

B. Repeat if a mho relay is used instead.

C. With the breaker at bus open calculate what the following mho elements will calculate for a SLG (AG) fault at 70% of the way down the line (AG, BG, CG, AB, BC, CA) if the fault resistance is zero. Plot your results against a mho circle. You can use a fault program to calculate the voltages and currents seen by the relay if you wish to do so. Repeat with Rf = 1 ohm and with Rf = 4 ohms. Repeat calculations for 3 phase, LL (BC) and DLG (BCG) faults. Do not do the fault resistance cases for the DLG fault.

D. Repeat part C if the circuit breaker is closed.