ECE 526: On Campus Lab 3
Due: Session 29, April 27

Lab Objective
- Explore the effect of series capacitors on distance elements and line current differential elements
- Apply the principles of setting the distance elements and line current differential elements in SEL311L relay
- Learn the basic of using SEL-RTS (Relay Test System) to test the protective relays by playback COMTRADE files of fault data

The Power System Configuration

The simulated power system is configured as shown below, with two sources, two transmission lines and series capacitors in the first line. The system parameters as follows:

\[
V_S := 69.5 V \cdot e^{j\cdot0\text{deg}} \quad V_R := 69.5 V \cdot e^{j\cdot2.5\text{deg}}
\]

\[
Z_{S1} := j \cdot 1 \text{ohm} \quad Z_{\text{cap1}} := -j \cdot 0.8 \text{ohm} \quad Z_{1L1} := j \cdot 1 \text{ohm} \quad Z_{1L2} := j \cdot 1 \text{ohm} \quad Z_{R1} := j \cdot 0.4 \text{ohm}
\]

\[
Z_{S0} := j \cdot 3 \text{ohm} \quad Z_{\text{cap0}} := -j \cdot 0.8 \text{ohm} \quad Z_{0L1} := j \cdot 3 \text{ohm} \quad Z_{0L2} := j \cdot 3 \text{ohm} \quad Z_{R0} := j \cdot 1.2 \text{ohm}
\]

The Power System Configuration
Lab Procedure:

- Set SEL 311L relays at Bus S and Bus R to provide protection to line 1.
- Set Zone 1 of the line and time delayed back up Zone 2 of this line as well as the line current differential elements.
- For the setting of CT ratio and PT ratio: they are set as CTR = 200.0 and PTR = 200.
- Replay the COMTRADE files of SLG faults into SEL 311L relay using SEL-RTS (Relay Test System) for the following cases:

- **Case 1:** without series capacitors
  Suppose the SLG fault occurs at 10% of the way from bus 2 to bus 3. Test your settings and observe the response of the distance elements and line currents differential elements for this fault.

- **Case 2:** with series capacitors (50% of the line 1 impedance)
  Suppose the SLG fault occurs at 10% of the way from bus 2 to bus 3. Observe the response of the distance elements and line currents differential elements for this fault.

- **Case 3:** with series capacitors (80% of the line 1 impedance)
  For this case suppose the SLG fault occurs at 20% of the way from bus 1 to bus 2. Observe the response of the distance elements and the line currents differential elements for this fault. For distance elements, the COMTRADE files are provided for bus side and line side measurement.

- **Case 4:** with series capacitors (90% of the line 1 impedance)
  For this case suppose the SLG fault occurs at 20% of the way from bus 1 to bus 2 and the sending end source impedance is equal to $Z_{S1} = (j0.3)$ ohm. Observe the response of the distance elements and line currents differential elements for this fault. For distance elements, the COMTRADE files are provided for bus side and line side measurement.

**Report:**
1. Your report should list your relay settings.
2. Compare the response of distance elements versus the response of line current differential elements for each case.
3. Comment on your results and determine the challenges of using series capacitor in each case for distance elements and line current differential elements.