ENEL 472 Design Project

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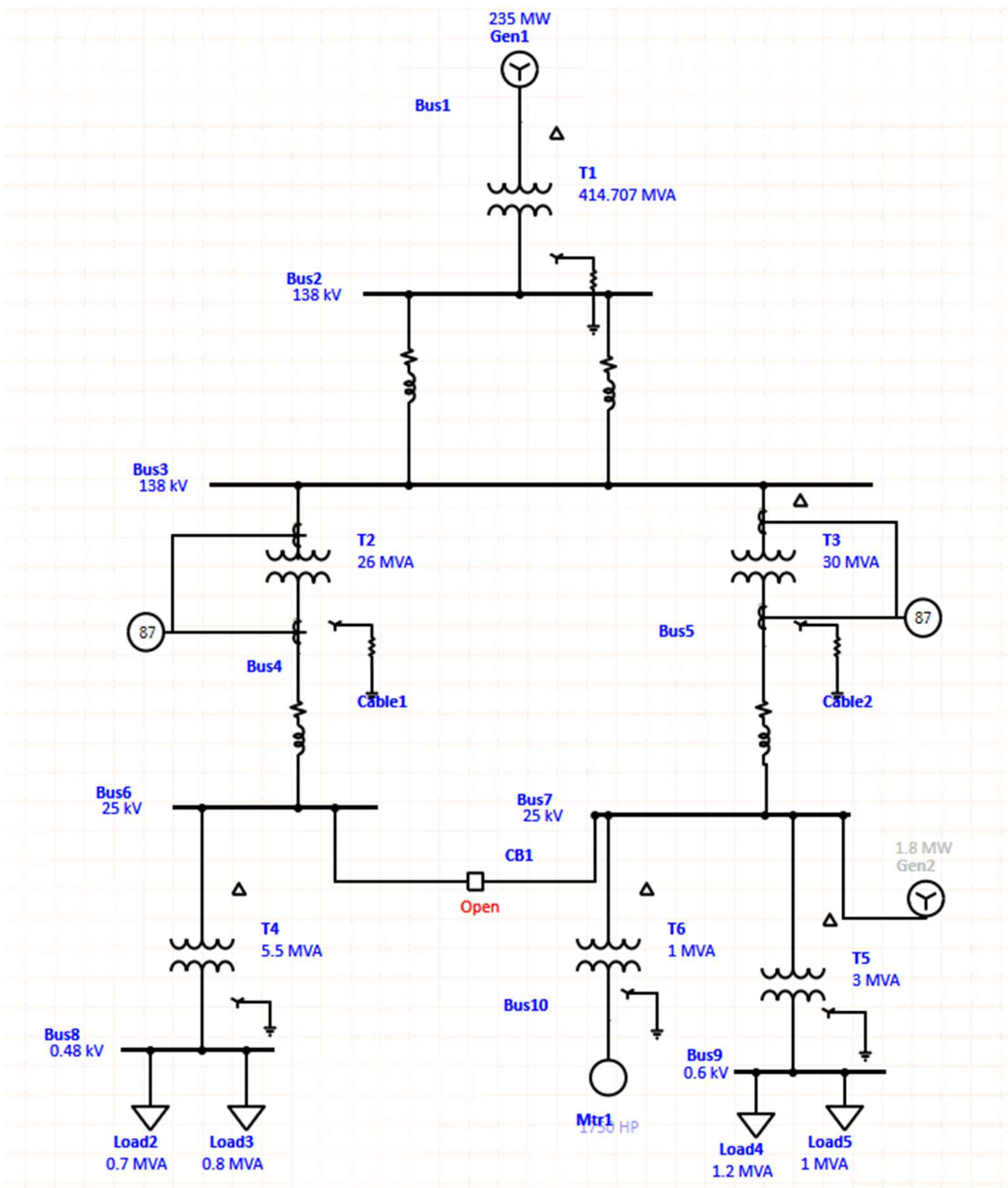
Produce Single Line Diagram – ETAP:



Refer to ETAP folder

Calculate Transmission line parameters Pos, Zero Sequence:

Positive Sequence: Z1 = 0.47244 + j0.565496 Ohm per km
Zero Sequence: Zo = 0.65 + j1.59699 Ohm per km

Equations used from Network Protection and Automation Guide

Page 5-17, Eq 5.12 :

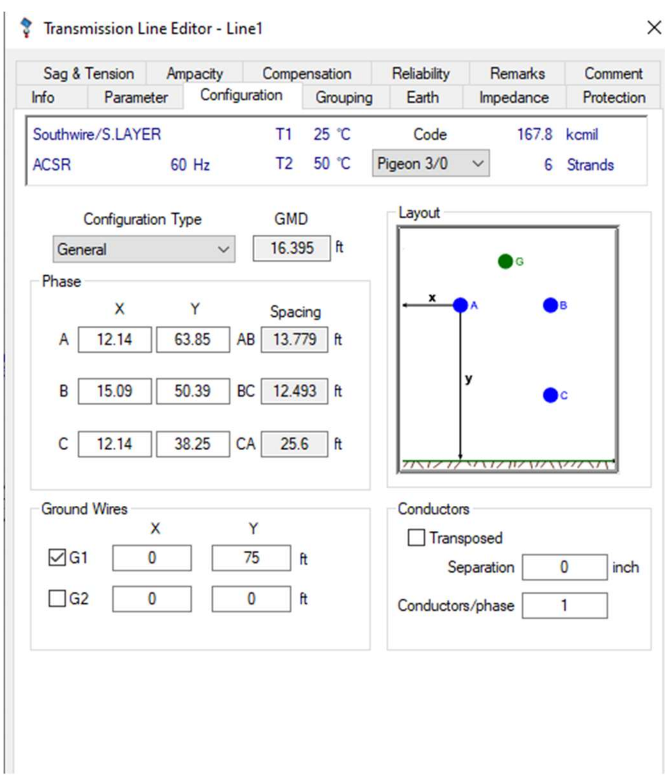
$$Z_1 = Z_2 = R + j0.0029 f \log_{10} \frac{D}{dc}$$

$$Z_0 = R + 0.00296 f + j0.00869 f \log_{10} \frac{D_e}{\sqrt[3]{dcD^2}}$$

Refer to Hand Calculations*

Specify Tx Lines L1 and L2:

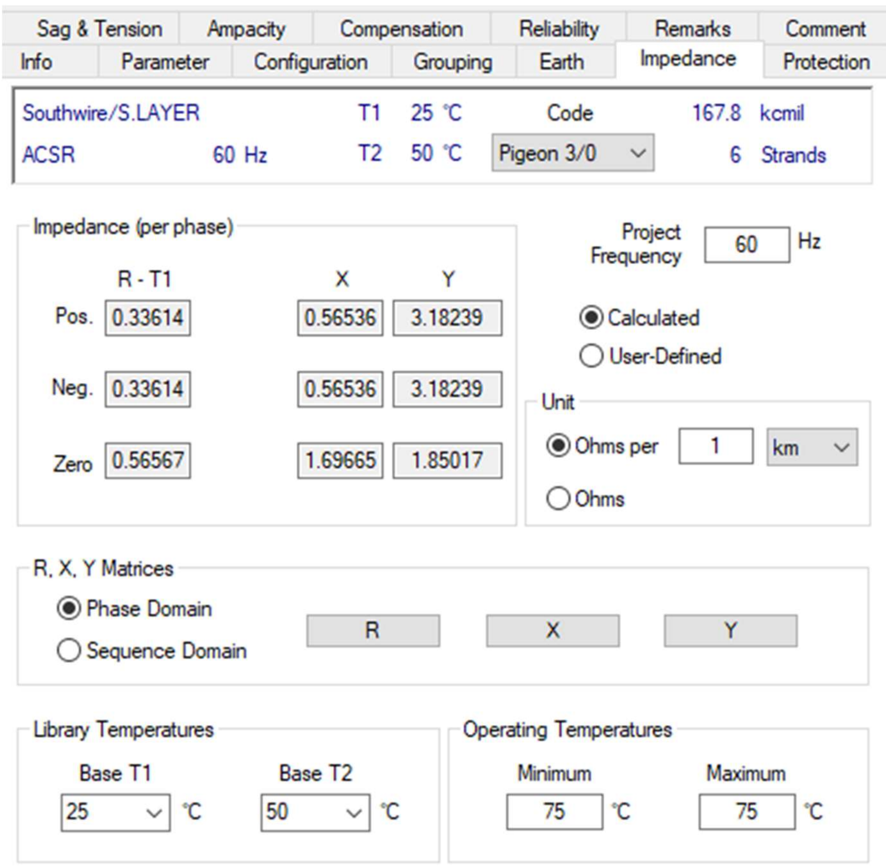
Configuration of Tx Lines was completed from the diagram (Double Circuit 138kV) in the project handout:



Used Pigeon (3/0 AWG) from the Southwire ACSR table (on urcourses).

Refer to Second Last Row

Code Word	Size (AWG or kcmil)	Strand-ing (Al/Stl)	Diameter (ins.)				Weight Per 1000 ft. (lbs.)			Content (%)		Rated Strength (lbs.)	Resistance OHMS/1000 ft.		Allowable Ampacity (Amps)
			Individual Wires Al	Individual Wires Stl	Steel Core	Complete Cable	Al	Stl	Total	Al	Stl		DC @ 20°C	AC @ 75°C	
Turkey	6	6/1	.0661	.0661	.0661	.198	24	12	36	67.88	32.12	1190	.641	.806	105
Swan	4	6/1	.0834	.0834	.0834	.25	39	18	57	67.87	32.12	1860	.403	.515	140
Swanate	4	7/1	.0772	.103	.103	.257	39	28	67	58.1	41.9	2360	.399	.519	140
Sparrow	2	6/1	.1052	.1052	.1052	.316	62	29	91	67.9	32.1	2850	.254	.332	184
Sparate	2	7/1	.0974	.1298	.1298	.325	62	45	107	58.12	41.88	3460	.251	.338	184
Robin	1	6/1	.1181	.1181	.1181	.354	78	37	115	67.88	32.12	3550	.201	.268	212
Raven	1/0	6/1	.1327	.1327	.1327	.398	99	47	145	67.89	32.11	4380	.159	.217	242
Quail	2/0	6/1	.1489	.1489	.1489	.447	124	59	183	67.88	32.12	5310	.126	.176	276
Pigeon	3/0	6/1	.1672	.1672	.1672	.502	156	74	230	67.87	32.13	6620	.100	.144	315
Penguin	4/0	6/1	.1878	.1878	.1878	.563	197	93	291	67.88	32.12	8350	.0795	.119	357



The ETAP Positive Real value is different from my calculated value because of the temperature at which ETAP has calculated its Resistive values. ETAP used 25 degrees C, while my hand calculations used the ACSR Resistance value is at AC 75 degrees C. The Positive Reactive values are nearly identical when comparing the ETAP value to my hand calculated on.

As for the Zero Impedence, my calculated value does not match the ETAP value because the ground wire has a different conductor core radius than the ASCR wire. Another reason is due to the ground wire being a completely different wire in ETAP than the one used for the hand calculations.

Design Differential Protection T2 and T3:
This task has been postponed for ENEL 482*

Test Differential Protection T2 or T3:
This task has been postponed for ENEL 482*

Specify Protection:
This task has been postponed for ENEL 482*

Hand verification of Fault Currents:
Refer to Hand Calculations
All equations and methods were used from ENEL 472 lecture notes 2020

Bus 2 Fault 3 Phase: IAf = 1.08673 kA ∠ -67.09 °
Bus 3 Fault 3 Phase: IAf = 30.6613 kA ∠ -76.109 °
Bus 5 Fault 3 Phase: IAf = 58.46522 kA ∠ -84.96 °
Bus 6 Fault 3 Phase: IAf = 32.07514 kA ∠ -86.63 °

The fault values above are all hand calculated, and the magnitudes are very similar to the ETAP fault values.

For the next section refer to ETAP Fault Reports
ETAP 3 Phase Bus 2 Fault = 1.034 kA ∠ -56.6 °
ETAP 3 Phase Bus 3 Fault = 3.029 kA ∠ -69.53 °
ETAP 3 Phase Bus 5 Fault = 58.337 kA ∠ -79.69 °
ETAP 3 Phase Bus 6 Fault = 31.155 kA∠ -81.12 °

Cable Selection:
The reason why I selected the [KERITE Mag. Code: 350AWG/kcmil 3/C CU] cable for both C1 and C2 was because this cable can handle the total load current if Bus 4 or Bus 3 is faulted.

Protective Measures:

For the Transmission Lines, I used the 1.5x rule for the allowable ampacity via the combined Primary FLA of Transformers 2 and 3.

For the Cables, I used the 1.5x rule for the allowable ampacity via the 200% Primary FLA as Transformer 4. Further explaining the Cable Selection task; if there is a fault on either Bus 3 or 4, a cable should be able to handle the load from both busses for there to be no stoppage in system operation.

Extra Notes:

The differential protections in my ETAP single line are there for the next class of ENEL 482. This way I can recollect on where I have left off. This also applies to the HV Circuit Breaker between Bus 3 and Bus 4.