

EEP3060

Power Engineering



Inductance and Capacitance Calculation

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1 Objective

To simulate the transmission line tower and determine the voltage regulation and efficiency.

2 Introduction

In this experiment, we analyze two transmission line towers with different load conditions using MATLAB Simulink.

3 Parameters of Transmission Line Towers

The parameters of the transmission line towers are as follows:

- Load: 45MW with a power factor of 0.8 lagging.
- Load: 495MW with a power factor of 0.8 lagging.

4 Circuit Diagrams for Part A

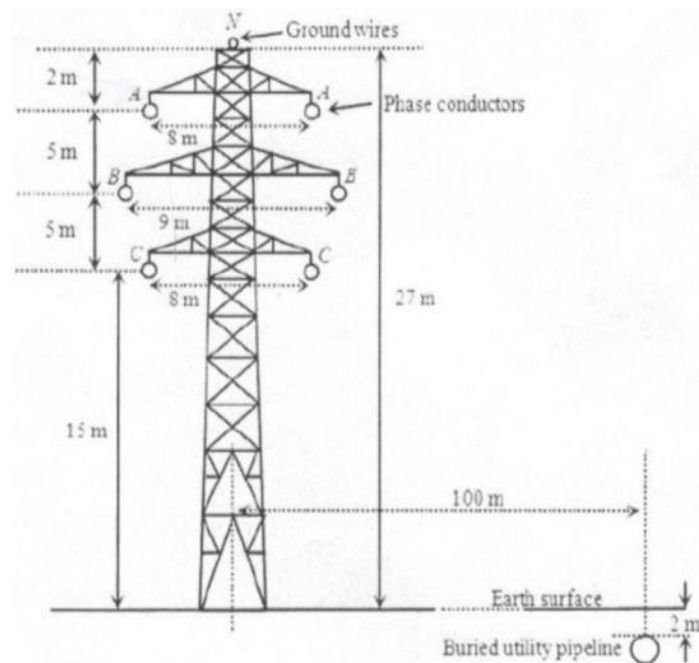


Figure 1: Tower A: 132KV Line, 160 KM Pheasant Conductor

4.1 MATLAB Simulink model of Tower A

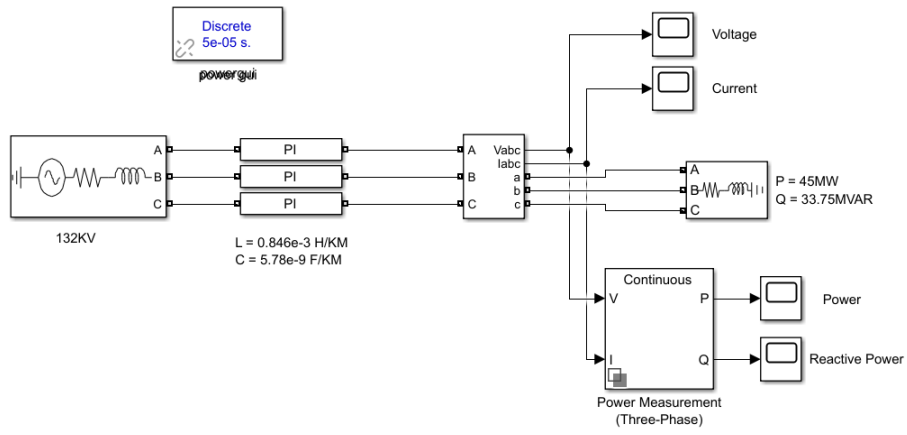


Figure 2: MATLAB Simulink model of Tower A

4.2 Conductor Details

Type	Diameter (mm)	Resistance (ohm/km)
Phase Conductors	31.63	0.05501
Shield Wires	12.60	0.642

Table 1: Conductor Specifications

4.3 Calculation for conductor A

Part A Load 45 MW & pf = 0.8 lag B22EE024

$P = 45 \text{ MW}$
 $S = \frac{45}{0.8} = 56.25 \text{ MVA}$
 $Q = 56.25 \times 0.6$
 $Q = 33.75 \text{ MVAR}$

Diagram showing conductors A₁, A₂, B₁, B₂, C₁, C₂ with dimensions 8m and 6m.

$d_{A_1 B_1} = d_{B_1 C_1} = d_{B_2 C_2} = 5.02 \text{ m}$ [using Pythagoras theorem]
 $d_{A_1 B_2} = d_{B_1 C_2} = d_{B_2 C_1} = 9.86 \text{ m}$
 $d_{A_1 C_1} = 10 \text{ m}$
 $d_{A_2 C_2} = 8 \text{ m}$

$D'_{AB} = \sqrt[4]{d_{A_1 B_1} \cdot d_{A_1 B_2} \cdot d_{A_2 B_1} \cdot d_{A_2 B_2}} \approx 7.035 \text{ m}$
 $D'_{BC} = \sqrt[4]{d_{B_1 C_1} \cdot d_{B_1 C_2} \cdot d_{B_2 C_1} \cdot d_{B_2 C_2}} \approx 7.035 \text{ m}$
 $D'_{CA} = \sqrt[4]{d_{A_1 C_1} \cdot d_{A_1 C_2} \cdot d_{A_2 C_1} \cdot d_{A_2 C_2}} \approx 8.944 \text{ m}$

$\therefore L = 2 \cdot 10^{-7} \ln \left(\frac{3 D'_{AB} D'_{BC} D'_{CA}}{(r e^{-1/4})^{1/2}} \right)$ [where $d = 31.63 \text{ mm}$ and $r = 15.815 \text{ mm}$]
 $L = 0.846 \times 10^{-3} \text{ H/km}$

now, $C = \frac{q}{2\pi} \ln \left[\frac{3 D'_{AB} D'_{BC} D'_{CA}}{\sqrt{r}} \right]$
 $C = 5.78 \times 10^{-12} \text{ F/m}$
 $C = 5.78 \times 10^{-9} \text{ F/km}$

as diameter of each conductor is given equal to 31.63 mm.

4.4 Results for conductor A

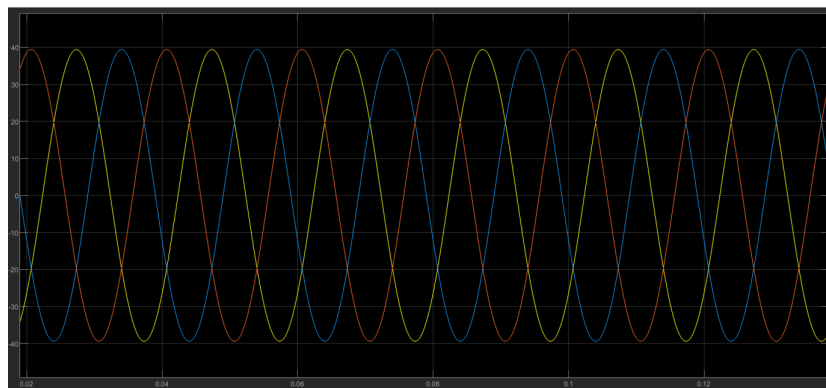


Figure 3: V(voltage)

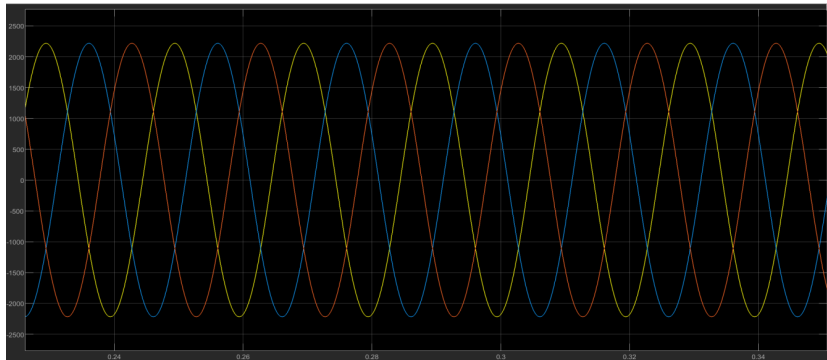


Figure 4: Current(A)

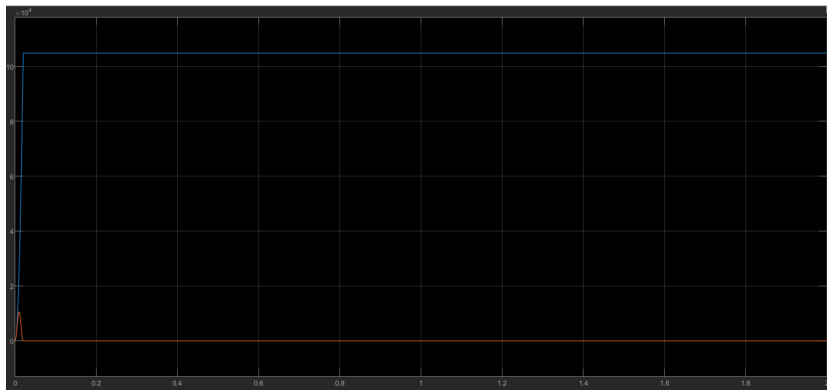


Figure 5: P(Active Power)

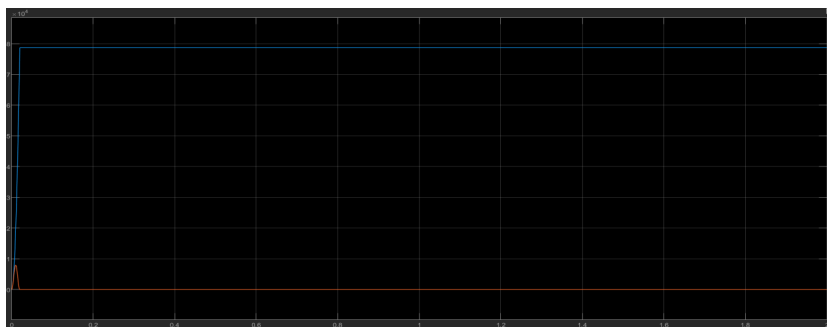


Figure 6: Q(Reactive Power)

5 Circuit Diagrams for Part B

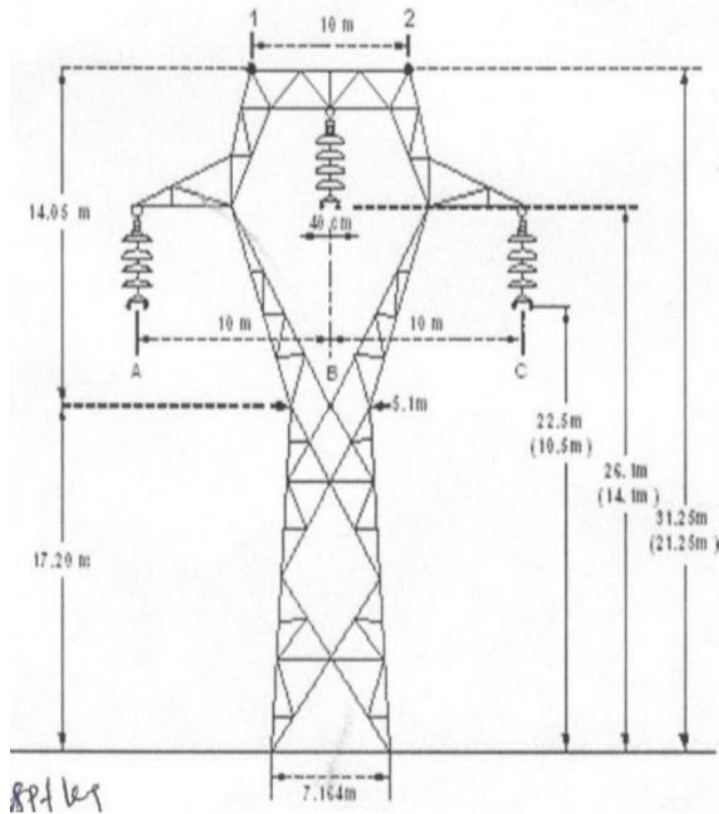


Figure 7: Tower B: 400KV Line, 160 KM

5.1 MATLAB Simulink model of Tower B

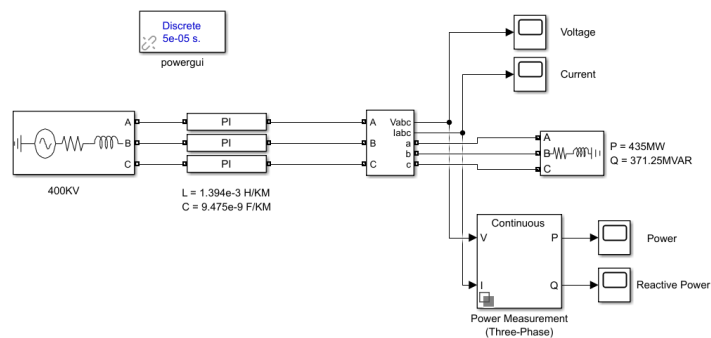


Figure 8: MATLAB Simulink model of Tower B

5.2 Calculation for conductor B

Part B Load 495 MW & PF = 0.8 lag B22EE024

Diagram showing three conductors A, B, and C. Conductor A is at the bottom left, B is at the top left, and C is at the bottom right. The distance between A and B is 10.62 m. The distance between A and C is 10 m. The distance between B and C is 10.62 m. The height of conductor B above conductor C is 3.5 m.

$D_{ab} = 10.62$
 $D_{bc} = 10.62$
 $D_{ac} = 20$

$\rightarrow P = 495 \text{ MW}$
 $S = \frac{495}{0.8} = 618.75 \text{ MVA}$
 $Q = 618.75 \times 0.6$
 $Q = 371.25 \text{ MVAR}$

$\rightarrow L = \frac{\mu}{2\pi} \ln \left[\frac{3 \sqrt{D_{ab} \cdot D_{bc} \cdot D_{ac}}}{r e^{1/4}} \right]$
 $L = 1.394 \times 10^{-3} \text{ H/km}$

$\rightarrow C = \frac{q}{2\pi} \ln \left[\frac{3 \sqrt{D_{ab} \cdot D_{bc} \cdot D_{ac}}}{r} \right]$
 $C \approx 9.475 \times 10^{-9} \text{ F/km}$

5.3 Results for conductor B

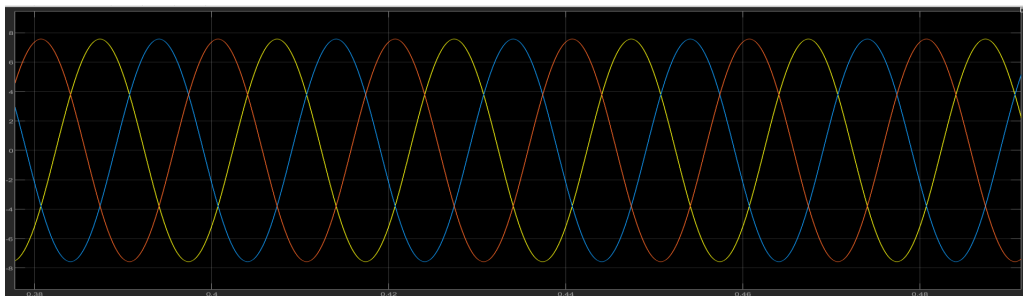


Figure 9: V(voltage)

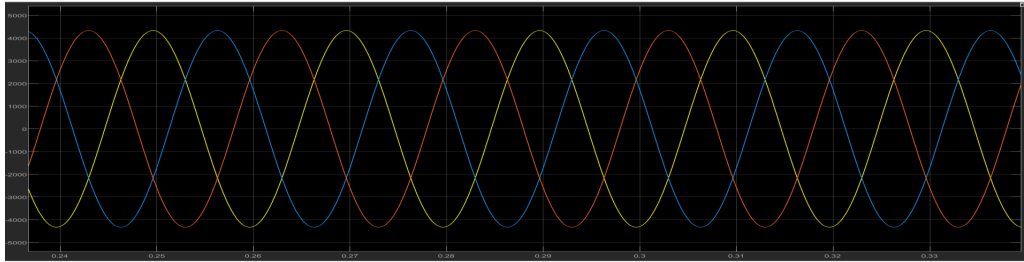


Figure 10: Current(A)

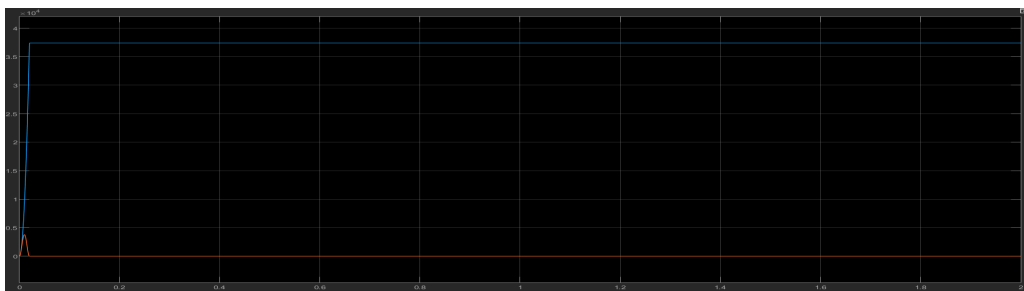


Figure 11: P(Active Power)



Figure 12: Q(Reactive Power)

6 Conclusion

Using MATLAB Simulink, we successfully analyzed the transmission line performance under different load conditions. The results provided insights into the voltage, current, active power, and reactive power for both transmission towers.