1. Let us assume that the resistance of the studied transmission line is 0Ω. Theoretical maximum power flow through the line is achieved when the angle difference between line ends is δ = 90° and voltage in both ends is constant 1.0 pu. Maximum power flow is P_{max} = 1.0 pu.
   a) Prove that reactive power losses in the line are 2.0 pu.
   b) Prove that voltage in the middle of line is \(\frac{\sqrt{2}}{2}\) pu.

2. Figure 1 represents 300 km long transmission line where voltage on both ends is U_1 = U_2 = 400 kV and power flow through line is P = 700 MW. Calculate how large series capacitor needs to be connected in the middle of the line in order to have Q_1 = Q_2 = 0. Parameters of the line are x = 0.33 Ω/km, b = 3.57 μS/km.

   ![Figure 1](image)

3. Generator produces P = 80 MW active- and Q = 0 reactive power. Connection point voltage on the high voltage side of the transformer is \(U = 115\) kV and network short-circuit power is \(S_k = 1000\) MVA when voltage is 115 kV. How much the connection point voltage will change if a reactor (\(U_n = 120\) kV, \(Q_n = 60\) Mvar) is connected to same point?

   ![Figure 2](image)

4. A Generator (300 MVA, 23 kV) is feeding power through a transformer (330 MVA, 23/230 kV, Δ-Y connected, taps on Δ-side, leakage reactance 11 %) to a load (240 MVA, power factor 0.9_{in}, 230 kV). The generator is maintaining the voltage on the high voltage side of the transformer at nominal.
   a) Determine generator active and reactive power when transformer ratio is 1:1∠30°
   b) Determine generator active and reactive power when transformer ratio is 1:1.05∠30°