Exercises

1.

A 300 km 500 kV three-phase 50 Hz transmission line has distributed positive sequence inductance and capacitance of 0.801 μH/m and 14.07 pF/m respectively. The resistance may be neglected.

(a) Calculate the parameters of the exact 50 Hz equivalent Π network of the transmission line.

(b) For the line on open circuit, with the sending end voltage of 500 kV calculate:

(i) the reactive power generated by the line.

(ii) the receiving end voltage.

(iii) the megavar rating of a shunt compensating reactor at the receiving end, which would make the receiving end voltage equal to the sending end voltage.

(c) Calculate the wave impedance loading in megawatts at 500 kV. What is the significance of this figure?

(d) If the sending end and receiving end voltages are 525 kV and 475 kV respectively, calculate:

(i) the maximum real power in megawatts that can be transmitted

(ii) the corresponding receiving end load in megavars.

2.

The Red Cliffs – Broken Hill 220 kV transmission line is 283 km long and has the following positive sequence parameters:

$$L = 0.995\ \mu\text{Hm}^{-1}, \quad C = 11.57\ \text{pFm}^{-1}, \quad R = 73.2\ \mu\Omega\text{m}^{-1}$$

(a) Determine the exact equivalent Π circuit and compare with the nominal Π representation.

(b) Calculate:

(i) voltage, current and complex power at the sending end when the line supplies 50 MW and 0 Mvar at the receiving end at 220 kV.

(ii) open circuit voltage at the receiving end, assuming sending end voltage remains at the value in (i).

(c) Calculate the wave impedance loading in megawatts at nominal voltage, neglecting line resistance.

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3.

A 765 kV three-phase line is 650 km long, and has positive phase sequence values of inductance and capacitance of 0.877 μH/m and 12.81 pF/m respectively, and negligible resistance. It is desired to energise the line at 765 kV 60 Hz at the sending end while the receiving end is open.

(a) How many megavars would the line produce?

(b) Assuming the answer (a) is outside the capability of the available generators, we wish to overcome the problem by connecting equal shunt reactors to both ends of the line. What is the required megavar rating of each reactor to reduce the overall megavar generation to zero?

(c) Under the conditions of (b), what would be the magnitude of the mid-line voltage?

(d) We consider the result (c) unacceptable, and decide to install three reactors, one at each end, and one at mid-line, to obtain line voltages of 765 kV at the three locations. What would be the rating of each reactor?