Analysis of electrical power and energy systems

Practical session 3

5 October 2020

1 The transmission line[1]

1. The parameters for a 500-kV transmission system with bundled conductors are as follows: $Z_c = 258\Omega$ and $R = 1.76 \times 10^{-2}\Omega$/km. Calculate the value for the Surge Impedance Loading SIL and the percentage power loss in this transmission line if it is 300 km long and is loaded to its SIL.

2. The 500-kV line of type described in Problem 1 is a short-length line, 80 km long. It is loaded to three times its SIL. Calculate the power loss in this line as a percentage of its loading.

3. Consider a 300-km long, 345-kV transmission line that has parameters similar to those described in Table 1. Assume its receiving-end voltage $V_R = 1.0$ pu. Plot the voltage ratio V_S/V_R as a function of P_R/SIL, where P_R is the unity power factor load at the receiving end. P_R/SIL varies in a range from 0 to 3.

Table 1: Approximate transmission line parameters with bundled conductors at 60 Hz.

Nominal voltage (kV)	R (Ω/km)	ωL (Ω/km)	ωC (μS/km)
230	0.06	0.5	3.4
345	0.04	0.38	4.6
500	0.03	0.33	5.3
765	0.01	0.34	5.0

4. A 200 km long 345-kV line has the parameters given in Table 1. Neglect the resistance. Calculate the voltage profile along this line if it is loaded to

   (a) $1.5 \times SIL$

   (b) $0.75 \times SIL$

   and the receiving end is held at the voltage of 1 per unit.

2 Solutions

1. $SIL = 969$ MW, power loss = 2.05%

2. $SIL = 969$ MW, power loss = 1.64%

[1] Exercises 4.3, 4.4, 4.7 and 4.10 of Ned Mohan's book "Electric power systems, a first course"