

ECE 3600 homework # TL1

d

Answer the following questions in your textbook, starting on p.488.

- 9-3 What factors influence the inductance of a transmission line?
- 9-4 Suppose that there are two transmission lines using a single conductor per phase, and that the conductors in the two transmission lines are identical (same material and same diameter). If one transmission line is rated at 345 kV and the other one is rated at 238 kV. which transmission line is likely to have the highest inductance? Why?
- 9-5 Suppose someone asked you to evaluate a proposal for an underwater power cable between North Carolina and the Bahamas. What would you say about the probability of success of this proposal? Why?
- 9-6 What line lengths are generally considered to be short transmission lines? Medium-length transmission lines? Long transmission lines?
- 9-9 What happens to the receiving end voltage as the load on a transmission line is increased if the load has a lagging power factor? Sketch a phasor diagram showing the resulting behavior.
- 9-11 What happens to the receiving end voltage as the load on a transmission line is increased if the load has a leading power factor? Sketch a phasor diagram showing the resulting behavior.
- 9-12 What is the significance of the angle δ between V_S and V_R in a transmission line?

Problems

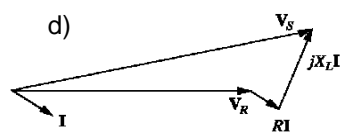
1. A 230 kV transmission line is 70 km long and has line parameters shown in Table 4.1 (handout). $|V_{SLL}|$ is 230 kV. Assume the phase angle of V_S is 0° and that the source sees a pf = 0.8, lagging.
 From Table 4.1: $r := 0.055 \Omega/\text{km}$ $x := 0.489 \Omega/\text{km}$ $y := 3.373 \cdot 10^{-6} \text{ S/km}$ Assume: $g := 0 \text{ S/km}$
 - a) Use the short-length model to find I_R and V_R if the source is loaded to 170 MVA (as calculated for the line).
 - b) What is the angle δ ?
 - c) What is the power factor of the load?

Solve the following problems in your textbook, starting on p.489.

2. 9-11 A 138 kV, 200 MVA, 60 Hz, three-phase, power transmission line is 100 km long, and has the following characteristics: $r := 0.103 \Omega/\text{km}$ $x := 0.525 \Omega/\text{km}$ $y := 3.3 \cdot 10^{-6} \text{ S/km}$
 - a) What is per phase series impedance and shunt admittance of this transmission line?
 - b) Should it be modeled as a short, medium, or long transmission line?
 - d) Sketch the phasor diagram of this transmission line when the line is supplying rated voltage and apparent power at a 0.90 power factor lagging.
 - e) Calculate the sending-end voltage if the line is supplying rated voltage and apparent power at 0.90 PF lagging.
 - f) What is the voltage regulation of the transmission line for the conditions in (e)?
 - g) What is the efficiency of the transmission line for the conditions in (e)?
- h) 9-13 What is the "power angle", δ ?
 Original problem statement: If the series resistance and shunt admittance of the transmission line in Problem 9-11 are not ignored, what would the value of the angle δ be at rated conditions and 0.90 PF lagging?
3. 9-12 If the series resistance and shunt admittance of the transmission line in Problem 9-11 are ignored, what would the value of the angle δ be at rated conditions and 0.90 PF lagging?
4. A 765 kV transmission line is 200 km long and has line parameters shown in Table 4.1, p.4-10. Use the medium-length model to find V_S and I_S if the line is loaded to 1800 MVA and $|V_{RLL}|$ is 770 kV. Assume the phase angle of V_R is 0° and assume load pf = 1.

Table 4.1: $r := 0.013 \Omega/\text{km}$ $x := 0.339 \Omega/\text{km}$ $y := 4.988 \cdot 10^{-6} \text{ S/km}$

Answers

1. a) $426.7 \text{ A} \angle -36.87\text{-deg}$ $123.2 \text{ kV} \angle -4.98\text{-deg}$ 2. a) $(10.3 + j \cdot 52.5) \cdot \Omega$ d)  e) 111.8 kV
 b) 4.98 deg c) 0.849 j·0.00033·S f) 40.3 %
 b) medium g) 89.3 %
 3. 21.8 deg h) 18.74 deg
 4. 443 kV $\angle 12.0^\circ$ 1375 A $\angle 18.56^\circ$