Name: _____ ECE 3600 homework TL2 ext

1. If the voltage at the receiving-end of a transmission line is too low, what can the power company do at the receiving-end to raise the voltage?

2. If the voltage at the receiving-end of a transmission line is too high, what can the power company do at the receiving-end to lower the voltage?

3. Why and/or where are HVDC used?

4. What is the purpose of phase-shifting transformers?

   Where are they often found?

5. 9-12 What is the significance of the angle δ between $\mathbf{V_S}$ and $\mathbf{V_R}$ in a transmission line?

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Problems

1. A $230\ \text{kV}$ transmission line is $70\ \text{km}$ long and has line parameters shown in "Transmission Line typical Values" table in "Transmission Line Notes" handout (p6). $|\mathbf{V_{SLL}}|$ is $230\ \text{kV}$. Assume the phase angle of $\mathbf{V_S}$ is 0^o and that the source sees a $\text{pf} = 0.8$, lagging.

   From Table: $r := 0.055\ \Omega/\text{km}$ $x := 0.489\ \Omega/\text{km}$ $y := j\cdot\left(3.373\cdot 10^{-6}\right)\ \text{S/km}$ Assume: $g := 0\ \text{S/km}$

   a) The source provides $170\ \text{MVA}$ at 0.8pf (lagging) to the source end of the transmission line. Use the short-length model to find $\mathbf{I_R}$ and $\mathbf{V_R}$.

   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. **ECE 3600 homework TL2 p3**

2. 9-11 A 138 kV, 200 MVA, 60 Hz, three-phase, power transmission line is 100 km long, and has the following characteristics:

$$r := 0.103 \cdot \frac{\Omega}{km} \qquad x := 0.525 \cdot \frac{\Omega}{km} \qquad y := j \cdot \left(3.3 \cdot 10^{-6}\right) \cdot \frac{S}{km} \qquad len := 100 \cdot km$$

a) What is per phase series impedance and shunt admittance of this transmission line?

Series impedance:

Shunt admittance:

Shunt impedance:

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 ?

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?

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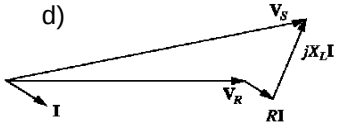
4. A 765 kV transmission line is 200 km long and has line parameters shown in Table 4.1, p.4-10. Use the medium-length model to find $\mathbf{V_S}$ and $\mathbf{I_S}$ if the line is loaded to 1800 MVA and $|\mathbf{V_{RLL}}|$ is 770 kV. Assume the phase angle of $\mathbf{V_R}$ is 0^o and assume load pf = 1.

Answers

1. a) 426.7·A / - 36.87·deg 123.2·kV / - 4.98·deg
   b) 4.98·deg c) 0.849
3. 21.8·deg 4. 443 kV /12.0° 1375 A /18.56°

2. a) $(10.3 + j \cdot 52.5) \cdot \Omega$ $j \cdot 0.00033 \cdot S$
   b) medium
   d) 

   e) 111.8·kV
   f) 40.3·%
   g) 89.3·%
   h) 18.74·deg

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