Name: _____ ECE 3600 homework TL2 Due: Sat, 4/5/25 e2xt

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?

more on next page ---->

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.

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 line-voltage if the line is supplying rated voltage and apparent power at 0.90 PF lagging.

f) This part asks for the voltage regulation, a number of dubious value given it's dependance on the power factor of the load. You can read more on p. 469 of your textbook, but no answer is required here.

g) What is the efficiency of the transmission line for the conditions in (e)?

h) 9-13 What is the "power angle", δ ?

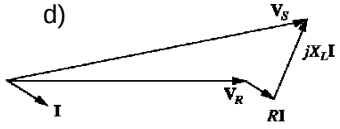
3. 9-12 If the series resistance and shunt admittance of the transmission line in Problem 9-11 are ignored, what would the value of the angle δ be at rated conditions and 0.90 PF lagging?

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

Answers

1. a) $426.7 \cdot \text{A} \angle -36.87 \cdot \text{deg}$ $123.2 \cdot \text{kV} \angle -4.98 \cdot \text{deg}$
   b) $4.98 \cdot \text{deg}$ c) 0.849
3. $21.8 \cdot \text{deg}$ 4. $443\ \text{kV} \angle 12.0^o$ $1375\ \text{A} \angle 18.56^o$

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



   e) $111.8 \cdot \text{kV} \cdot \sqrt{3}$
   f) no ans. required. $41.6 \cdot \%$
   g) $89.4 \cdot \%$
   h) $18.74 \cdot \text{deg}$