

## ECE 3600 Exam 2 given: Fall 08

(The space between problems has been removed.)

### WITH ANSWERS

Look at the **bold** numbers the rest are for material no cover this time, but may help to study for final.

### Write Legibly!

This part of the exam is **Closed book, Closed notes, No Calculator.**

(30 pts) Questions If I can't read what you've written or you answer is ambiguous, I'll assume you don't know.

1. For a transmission line, what is the "Surge Impedance"?

Don't give me a mathematical expression, tell me what it means.

2. For a transmission line, what does 2 SIL mean?

3. What is the most important reason to use the per-unit method to analyze a power system?

4. a) List the bases of a per-unit system.

b) When analyzing a power system, which, if any, of these bases should be constant throughout the system?

c) Which, if any, of these bases is changes from place to place throughout the system?

d) What, if anything, can cause these bases to be different from place to place throughout the system?

5. Name 3 requirements of a power system.

6. a) Name the three types of busses used in the power-flow problem.

b) Under your answers above, list the assumed knowns for each bus. List magnitudes and phase angles separately.

7. This was your HW 14, problem 1

This part of the exam is open book, open notes. You MUST show work to get credit. Show the correct units

1. (27 pts) A 138 kV transmission line is 180 km long and has the following line parameters.  $S := \text{siemens}$

$$\text{len} := 220 \cdot \text{km} \quad R := 0.1 \cdot \frac{\Omega}{\text{km}} \quad \omega L := 0.5 \cdot \frac{\Omega}{\text{km}} \quad G := 0 \cdot \frac{S}{\text{km}} \quad \omega C := 2.8 \cdot 10^{-6} \cdot \frac{S}{\text{km}}$$

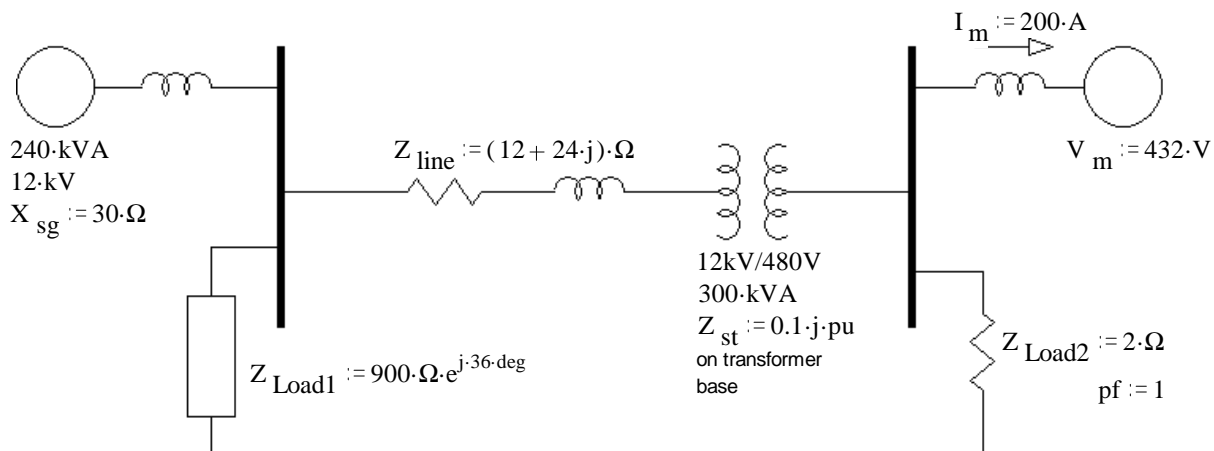
a) Choose the most appropriate model for this transmission line and draw it, including the impedance and/or admittance value(s).

b) A source is connected to one end of the line and a load is connected to the other end. The line voltage at the load is 130 kV  $\angle 0^\circ$ . The power delivered to the 3-phase load is 60 MW at unity power factor. Find the line current  $I_L$  (not  $I_S$ ) in any form and the line voltage at the source, magnitude and phase. You may add to the drawing above if it helps. (Remember, line voltage means  $V_{LL}$ .)

c) Express this load in terms of SIL

2. This problem was given to you as part of Exam 1 study material

3. (15 pts) A one-line, per-phase diagram is shown below. Starting with the generator on the left, select the most reasonable bases and draw a per-phase, per-unit diagram. Include pu values for all the components you can.



4. (16 pts) A 60 Hz, 4-pole, 3-phase synchronous generator supplies 90 kW of power to a 4 kV bus.

The synchronous reactance is 50  $\Omega$ /phase. The generator emf is 3 kV. Find the following.

a) The power angle,  $\delta$ .

b) The total reactive power generated.

c) Find a new magnitude of the generator emf so that  $Q := 45 \cdot \text{kVAR}$

## Answers

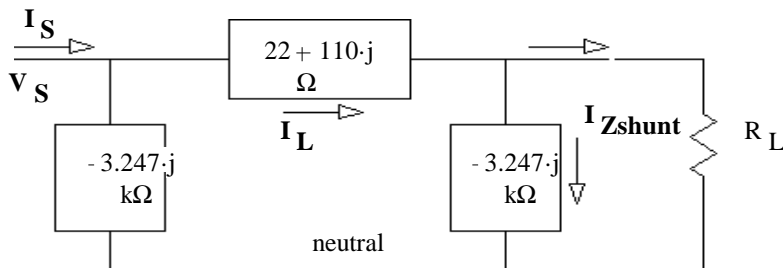
### Questions

1. If you load a transmission line with an impedance whose magnitude equals the surge impedance, then the transmission line Q will be 0, and it will neither lose or gain voltage across its length (except ohmic losses).
2. SIL is the "Surge Impedance Loading". A load of 2 SIL draws twice the VAs as the SIL. The magnitude of the load impedance is half the surge impedance.
3. Transformers. They cause impedance transformations which are easier to handle in the per-unit system.
4. a)  $S_{\text{base}}$      $V_{\text{base}}$      $I_{\text{base}}$      $Z_{\text{base}}$   
b)  $S_{\text{base}}$   
c)  $V_{\text{base}}$      $I_{\text{base}}$      $Z_{\text{base}}$   
d) Transformers
5. 3 of these 4  
1. The power generation meets the demand.  
2. Bus voltages are within limits.  
3. Generators operate within their real and reactive power limits.  
4. Transformers and transmission lines are not overloaded.

6. <u>Slack bus or Swing bus</u>	<u>Generator, Voltage controlled or PV bus</u>	<u>Load bus or PQ bus</u>
$ V $	P	P
$\angle V = 0^\circ$	$ V $	Q

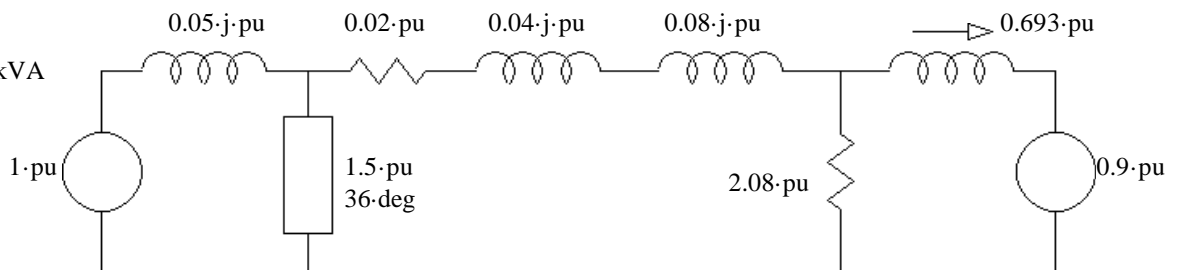
### Problems

1. a)



- b)  $(266.5 + 23.1j) \cdot A$   
 $145.2 \cdot kV \angle 20.88^\circ$   
c) 1.5 SIL

3. If  $S_{\text{base}} := 240 \cdot kVA$



4. a) 12.5-deg    b) 85.8-kVAR    c) 2713-V