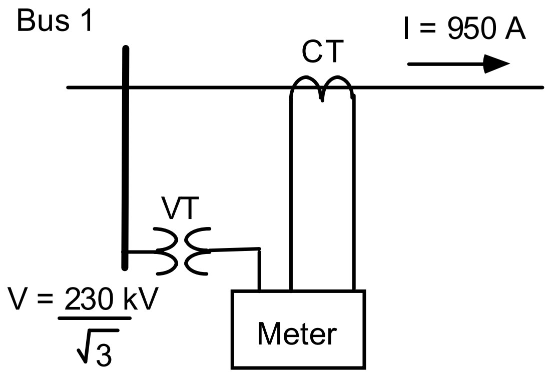
CS/ECE 444/544: Homework #1

Due: Session 9 (February 8)

The 60 Hz line current on the transmission line below is 950 A RMS at an angle φ_i = -13 degrees, and the line to neutral bus voltage is (230/SQRT(3)) kV RMS at an angle φ_v = 5 degrees.



The current transformer ratio is 1000:5 and the voltage transformer ratio is 230,000:120

Complete the following steps:

1. Calculate the secondary (scaled) values of the RMS voltage and current

2. Calculate the real power transfer using in primary values and secondary values using the equation below. ***544 students:*** If they don't match, comment on why that is the case.

$$P_{3ph} = 3 \cdot |V_{LN}| \cdot |I| \cdot \cos(\phi_v - \phi_i)$$

3. Plot the secondary values of *v(t)* and *i(t)* versus time for one 60 Hz cycle (you don't have to use Mathcad you can use Matlab, write your own program, or use a spreadsheet.

4. Plot the output versus time for an analog-to-digital (A/D) converter applied to the current waveform from part 3 for the following options. Assume 8 samples per 60 Hz cycle.

   a) You have a 4 bit A/D where the most significant bit is a sign bit (MSB). Use the signed magnitude to represent the negative number (0 is positive and 1 is negative). In your plot, simply put the negative number below zero. Assume full scale for you're A/D converter is -7A to + 7A. Compare your result to the original waveform.

   b) Repeat part a) with the full scale range changed to -35A to +35A.

   c) Repeat parts a) and b) with a 5 bit A/D (again, MSB is the sign bit).

5. **CS and ECE 544 students only**: Plot the output versus time for an analog-to-digital (A/D) converter applied to the voltage waveform from part 3 for the following options. Assume 8 samples per 60 Hz cycle.

a) You have a 4 bit A/D where the most significant bit is a sign bit (MSB). Use the signed magnitude to represent the negative number (0 is positive and 1 is negative). In your plot, simply put the negative number below zero. Assume full scale for you're A/D converter is -150V to + 150V.

b) Repeat 5 a) with a 5 bit A/D (again, MSB is the sign bit) and the same full scale

c) Calculate the RMS current magnitudes for problem 4 parts a) and c) and compare with your original magnitudes. Use the following formula (you will need to break the intergral over the the flat line segments)

$$I_{RMS} = \sqrt{\frac{1}{T}\cdot\int_0^T \left(i(t)^2\right) dt}$$