EELE 354: Electric Power Applications

Homework 6: Transformers & Three-Phase Circuits

Assigned: Thursday, 11/19/2014

Due: Monday, 12/01/2014

The homework consists of several short-answer problems. The topics covered include single-phase transformers and three-phase circuit analysis. Some of these problems are well representative of those that might be asked on the test. Specifically, be able to answer the multiple choice problems and solution problems 1, 3, and 4. That said, being able to answer solution problems 2 is also good practice, but this problem discusses a center-tapped transformer which will not be on the test.

Please note that the solutions for HW6 are already posted. Work the problems and then correct your answers to receive full credit.

Multiple Choice Problems

Answer multiple choice problems 1 - 6 from Chapter 12 of your text.

Solution Problems

1. A single-phase transformer is used to convert a 480 V source to a 120 V source. The secondary output is used to power a lighting circuit that draws 10 A. Answer the following assuming an ideal transformer (100% efficient):

   (a) What is the turns ratio required of the transformer?

   (b) If the number of turns on the primary is 300, how many turns are on the secondary?

   (c) What is the current drawn on the primary?

   (d) If the lighting circuit is replaced by a 10 Ω load, what are the secondary and primary current draws?

2. **Note: A center-tapped transformer problem will not be on your test.** Figure 1 shows a schematic for a single-phase, center-tapped transformer used to convert a voltage of 4800 V to voltages of 120 V / 240 V. A center-tapped transformer is a standard transformer with an extra terminal connected to the very center of the secondary coil. If this terminal is grounded so that there is a 0 V reference at the center of the secondary coil, then two 120 V voltages and one 240 V voltages are available as shown in the diagram. The center-tap terminal is generally also connected to the neutral supplied to a load.

   For this problem, assume three loads require power. The first two loads are lighting circuits, which require for voltage 120 V, and draw 5 A of current, each. The third load, an electric range, requires the full 240 V and draws 10 A. Answer the following assuming an ideal transformer (100% efficient):

   (a) What is the turns ratio required of the transformer (make calculation based on 4800 V primary and 240 V secondary)?

   (b) In order to "balance" the load, one of the lighting circuit loads (120 V, 5 A) is connected to the top 120 V secondary (between X1 and Neutral), while the second is connected to the bottom 120 V secondary (between X2 and Neutral). Draw a schematic diagram showing these connections. Make sure to label the current of the two loads as I_1 and I_2.

   (c) Consider then, the **total** current on the neutral. What will it be?

   (d) If only the electric range load is connected (between X1 and X2), what is the primary current draw?

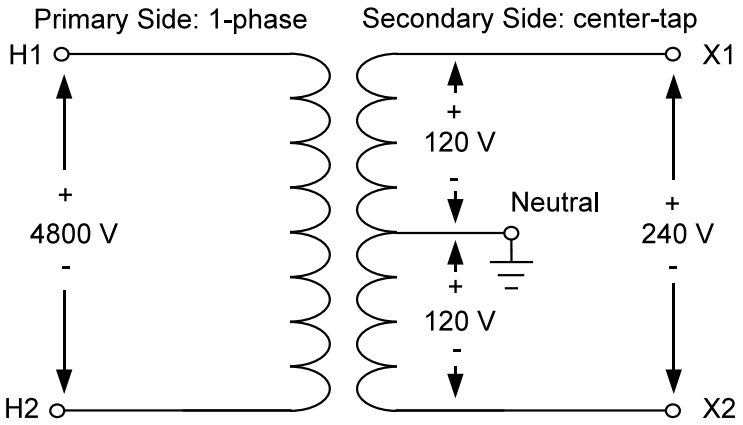

Figure 1: Center Tapped Transformer 2

3. A three-phase delta-configured power source with a phase voltage of 208 V is used to supply power to a three-phase wye-connected load. This load has a phase-impedance of 30 Ω and a power factor of 0.9, lagging. Determine the following quantities. Show work for full credit.

Variable Name	**Variable**	**Calculated Value**
Source phase voltage	$V_{source,phase}$	
Source line voltage	$V_{source,line}$	
Source phase current	$I_{source,phase}$	
Source line current	$I_{source,line}$	
Load phase voltage	$V_{load,phase}$	
Load line voltage	$V_{load,line}$	
Load phase current	$I_{load,phase}$	
Load line current	$I_{load,line}$	
Real power delivered to load	P	
Reactive power delivered to load	Q	
Total apparent power delivered to load	S	
Power factor	PF	

4. A three-phase wye-configured power source with a phase voltage of 480 V is used to supply power to a three-phase delta-connected load. This load requires a total apparent power of 10 kVA at a power factor of 0.75, lagging. Determine the following quantities. Show work for full credit.

Variable Name	**Variable**	**Calculated Value**
Source phase voltage	$V_{source,phase}$	
Source line voltage	$V_{source,line}$	
Source phase current	$I_{source,phase}$	
Source line current	$I_{source,line}$	
Load phase voltage	$V_{load,phase}$	
Load line voltage	$V_{load,line}$	
Load phase current	$I_{load,phase}$	
Load line current	$I_{load,line}$	
Real power delivered to load	P	
Reactive power delivered to load	Q	
Total apparent power delivered to load	S	
Power factor	PF	