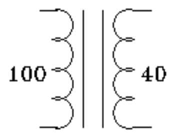
ECE 3600 homework # 9 Due: Tue, 10/6/09

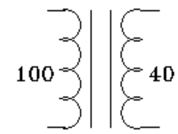
1. 5.7 A 500/200-V, 30-kVA transformer is reconnected as a 700/500-V autotransformer. Compute the new kVA rating of the device.

2. Show connections to the following 100/40-V, 200-VA transformers to get the voltage ratios desired. Compute the new VA rating of each connection.

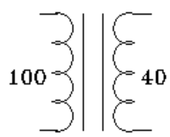
   a) 140/40 V



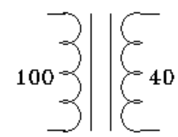
   b) 140/100 V



   c) 60/40 V



   d) 60/100 V

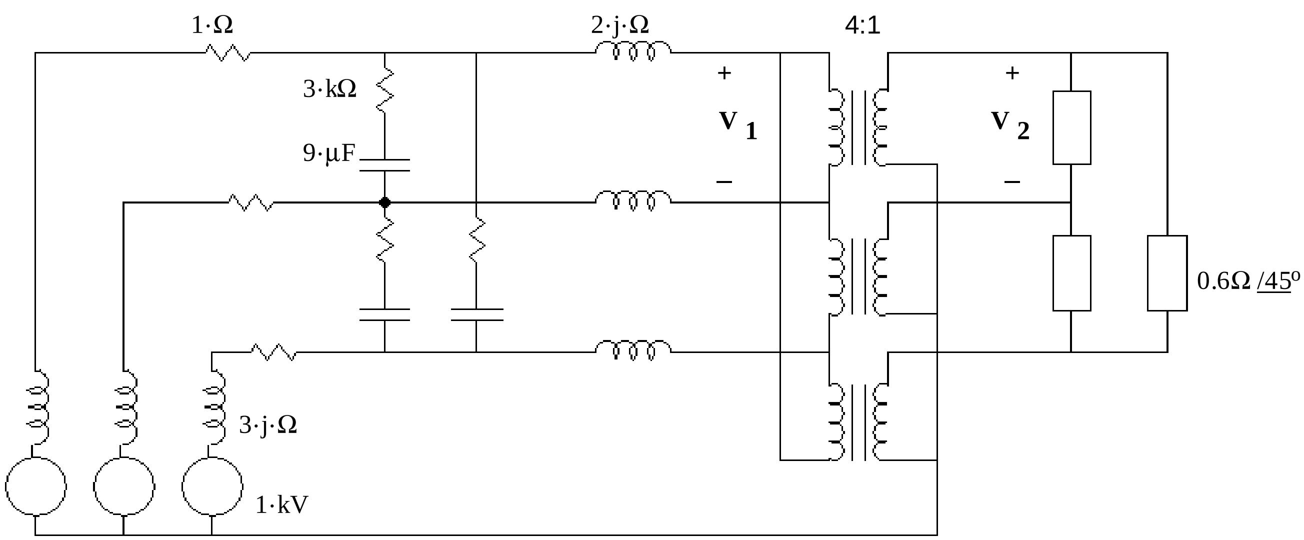


3. 5.8 The terminals of a 500/200-V transformer can be interconnected in four different ways, two of which will result in a 700/500-V autotransformer. Assume that you have interconnected the windings in the wrong way, but that you believe that you did it the right way. In other words, you think that you have a 700/500-V autotransformer when in fact you have something else. As you now connect the “700-V terminals” of your device to a 700-V source, you expect to obtain 500-V between what you presume to the “500-V terminals.” To your surprise you get an entirely different voltage.

   a) What voltage do you get?

   b) What will happen to your transformer with this kind of treatment?

4. a) Draw a per-phase drawing of for the balanced 3-phase, 60-Hz system shown. You may neglect phase issues introduced by Y-Δ and Δ-Y connections. You may need to modify the turns ratio of the transformer to reflect Y-Δ and Δ-Y connections. Be sure to show values of the source, passive components and turns ratio on your drawing.



V a V b V c

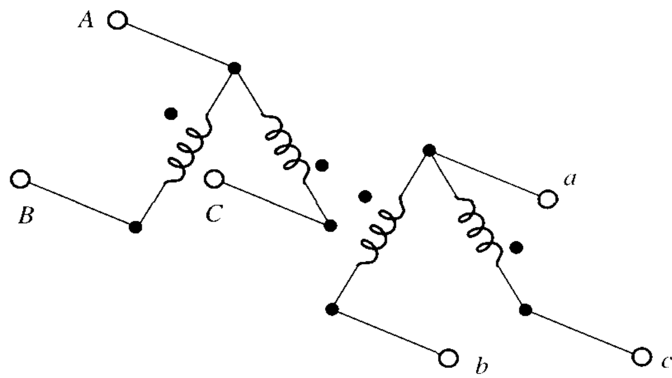
b) Find $\frac{V_1}{V_2}$ incuding phase angle

It is easy to see how to transform three-phase power with the use of three single-phase transformers, but there are two ways to transform three-phase power using only two single-phase transformers. The next two problems investigate these methods. In them, we will transform 480 V three phase to 240 V three phase; hence, the transformers have a turns ratio of 2:1. Hint: In both figures, the geometric orientation hints of the phasor relationships.

5. The configuration shown is called the “open-delta” or "V" connection, for obvious reasons. Identical 2:1 transformers are used.

   a) Show that if ABC is 480-V balanced three phase, abc is 240-V balanced three-phase. Consider the ABC voltages to be a three-phase set and prove the abc set is three-phase.

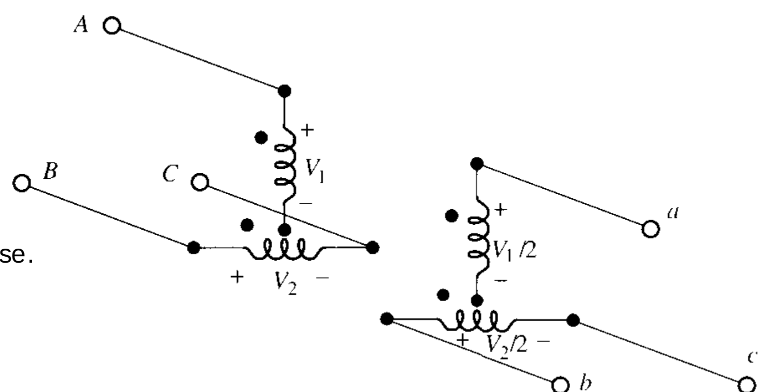
   b) If the load is 30 kVA, find the required kVA rating of the transformers to avoid overload. [You can solve this independent of part a)]



6. 1.22. The configuration shown is called the "T" connection. For this connection, the 2:1 transformers are not identical but have different voltage and kVA ratings. The bottom transformer is center-tapped so as to have equal, in-phase voltages for each half.

   a) Find the voltages V_1 and V_2 to make this transform 480-V to 240-V balanced three-phase.

   b) If the load is 30 kVA, find the required kVA rating of each transformer to avoid overload.



7. A phase-shifting transformer has a complex turns ratio of $\mathbf{t} := 4 \cdot e^{j \cdot 20 \cdot deg}$ = 4 /20°

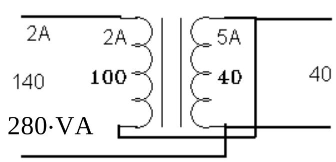
   It has a series impedance of $\mathbf{Z_S} := (0.05 + j \cdot 0.6) \cdot \Omega$

   Find the admittance matrix of this tranformer (see p 6-16 in the text).

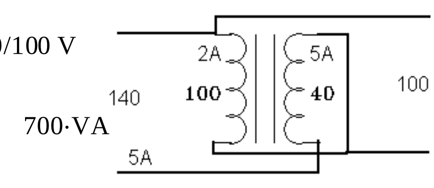
Answers

1. $105 \cdot kVA$

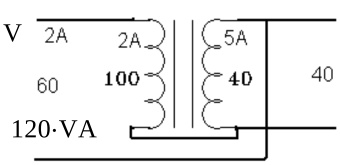
2. a) 140/40 V



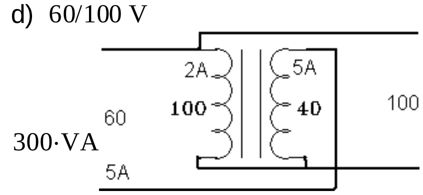
b) 140/100 V



c) 60/40 V



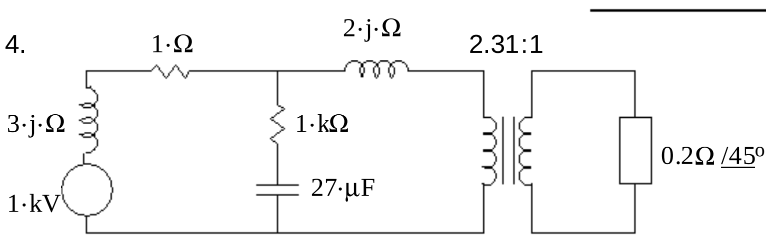
d) 60/100 V



3. a) $1167 \cdot V$

   b) The smoke gets out

4.



b) 2.309 / -30°

5. a) Calculate $\mathbf{V_{bc}}$ from the other two voltages and show that it has the correct magnitude and correct phase angle.

   b) $17.3 \cdot kVA$ per transformer, $34.6 \cdot kVA$ for both

6. a) $415 \cdot 7 \cdot V$ $480 \cdot V$ b) $15 \cdot kVA$ $17.3 \cdot kVA$ $32.3 \cdot kVA$ for both

7. $\begin{pmatrix} 0.138 - 1.655 \cdot j & 0.109 + 0.401 \cdot j \\ -0.174 + 0.377 \cdot j & 8.621 \cdot 10^{-3} - 0.103 \cdot j \end{pmatrix} \cdot \frac{1}{\Omega}$