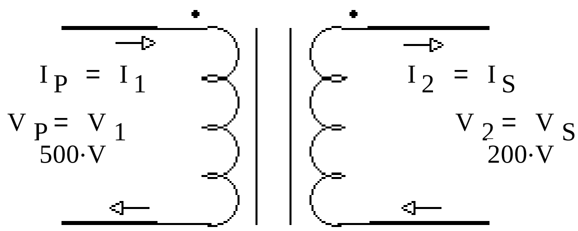
ECE 3600 homework 9 Autotransformers & 3-phase Transformers c

Name_____________________________

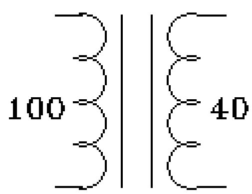
1. 5.7 A 500/200-V, 30-kVA transformer is reconnected as a 700/500-V autotransformer. Compute the new kVA rating of the device.

Normal 500/200-V transformer

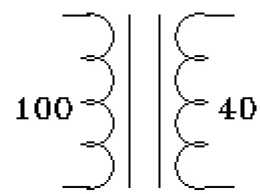


2. Show connections to the following 100/40-V, 200-VA transformers to get the voltage ratios desired. Compute the new VA rating of each connection.

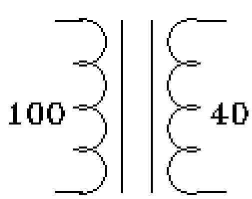
a) 140/40 V



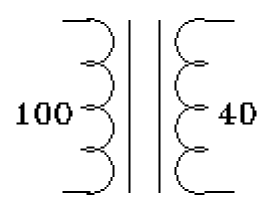
b) 140/100 V



c) 60/40 V

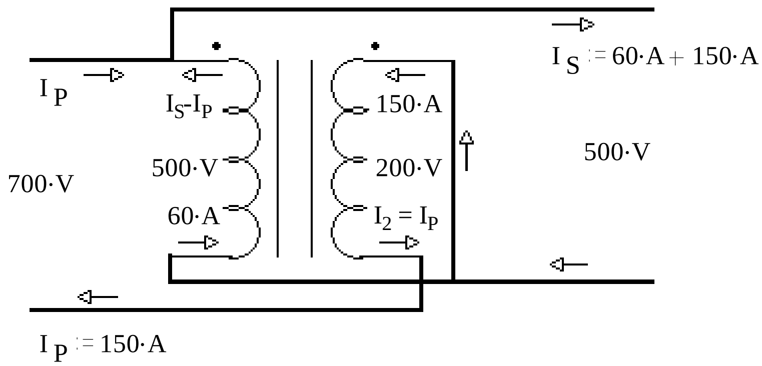


d) 60/100 V

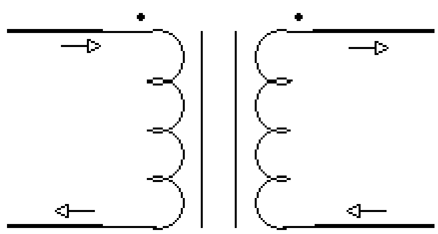


3. 5.8 The terminals of a 500/200-V transformer can be interconnected in four different ways, two of which will result in a 700/500-V autotransformer. Assume that you have interconnected the windings in the wrong way, but that you believe that you did it the right way. In other words, you think that 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.

500/200-V, 30-kVA transformer reconnected CORRECTLY as a 700/500-V autotransformer at maximum voltages and currents:



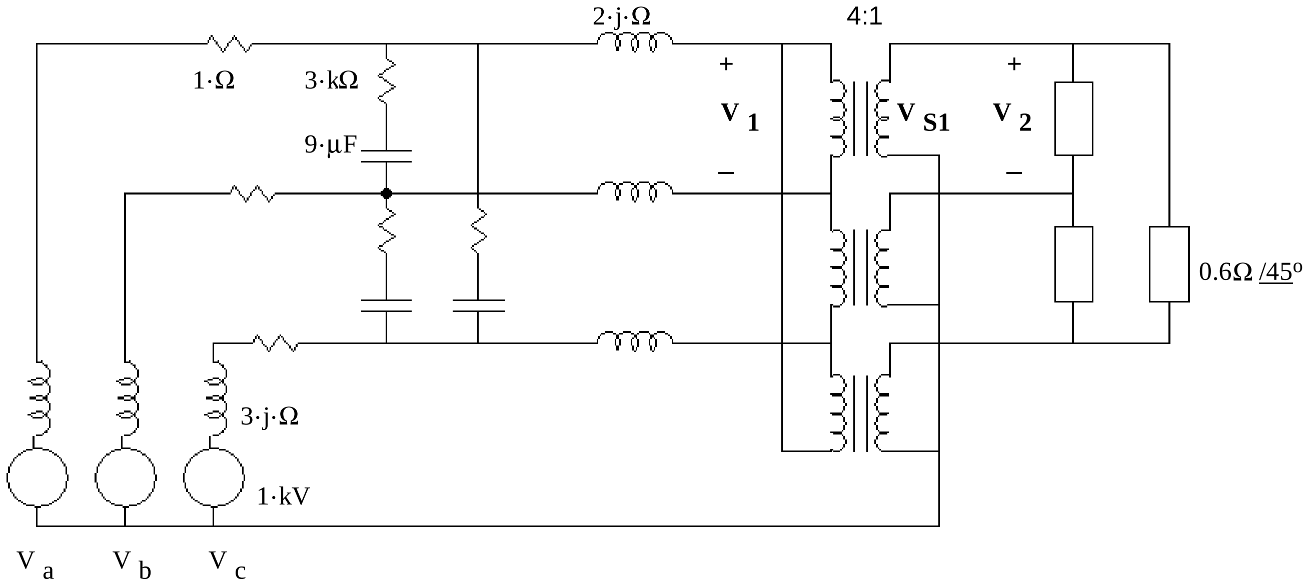
Show a possible INCORRECT connection:



a) What voltage do you get?

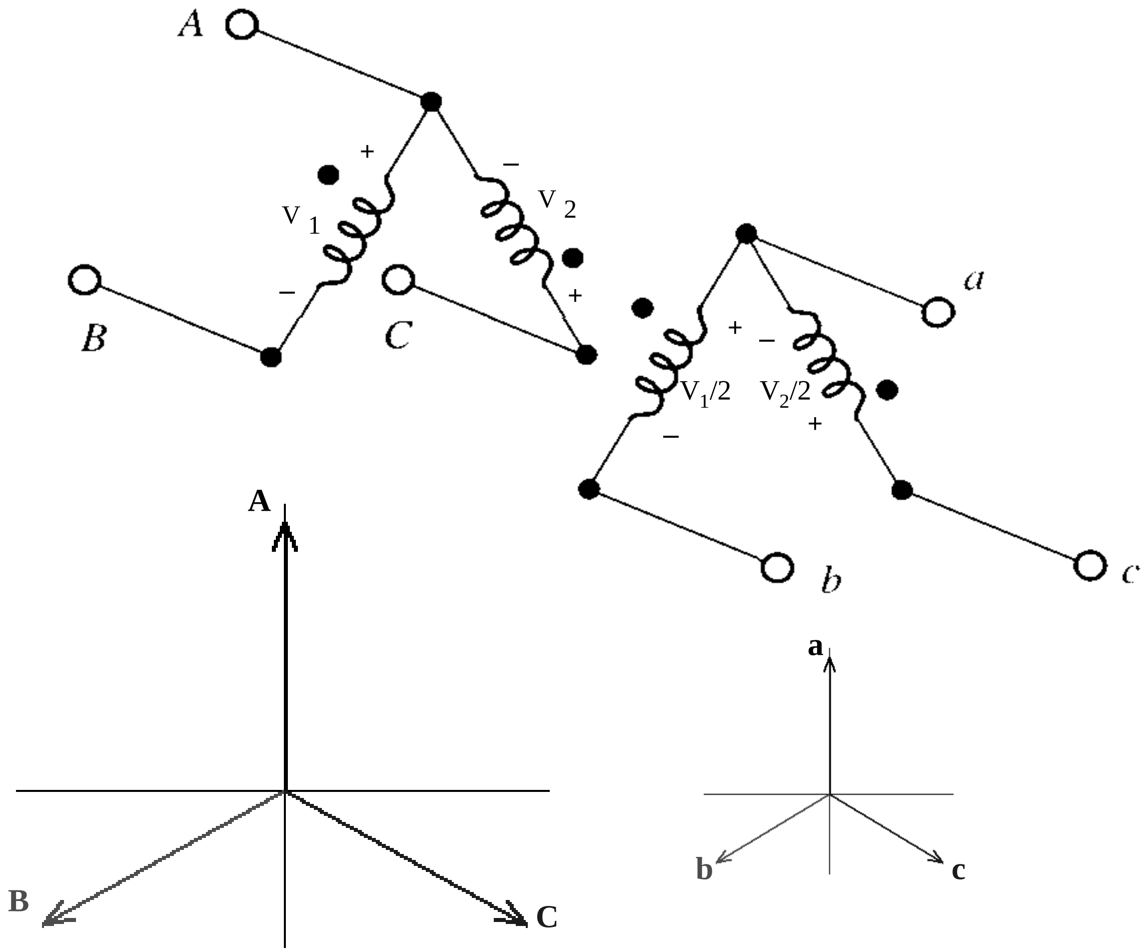
b) What will happen to your transformer with this kind of treatment?

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.



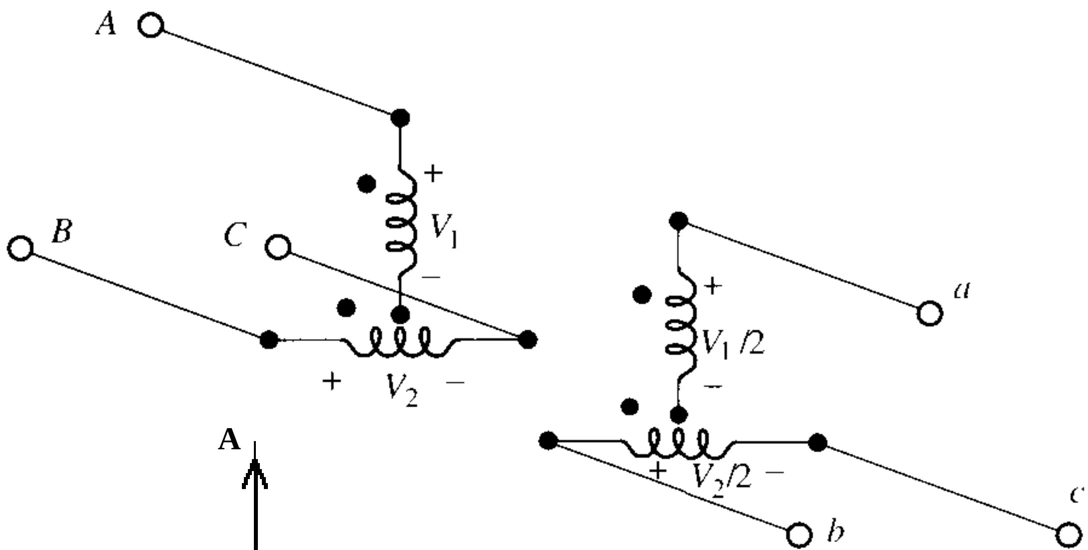
b) Find $\frac{\mathbf{V_1}}{\mathbf{V_2}}$ incuding phase angle Modify turns ratio to reflect Δ-Y transformer connection

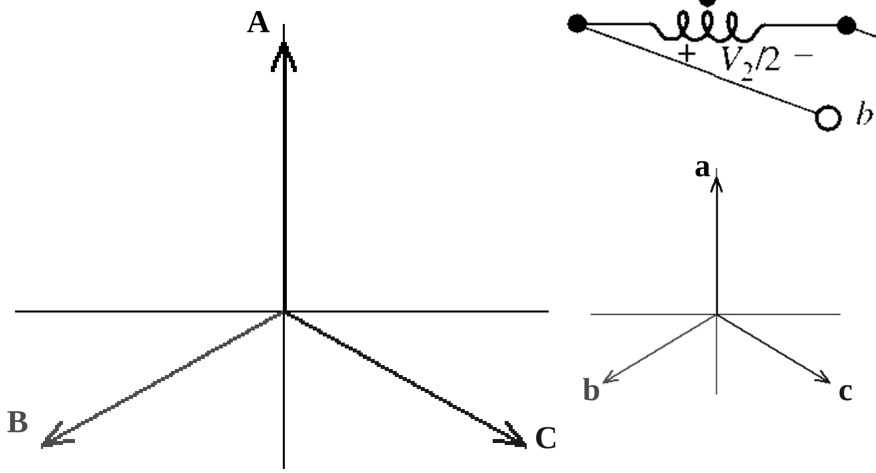
5. The configuration shown is called the “open-delta” or "V" connection, for obvious reasons. Identical 2:1 transformers are used.
   a) Show that if ABC is 480-V balanced three phase, abc is 240-V balanced three-phase. Consider the ABC voltages to be a three-phase set and prove the abc set is three-phase.



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. 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) 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 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 /20º

   It has a series impedance of $\mathbf{Z_S} := (0.05 + j \cdot 0.6) \cdot \Omega$ $\quad \mathbf{Y_S} := \dfrac{1}{\mathbf{Z_S}} =$

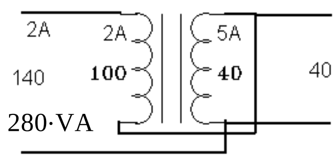
   Find the admittance matrix of this tranformer
   (see the last page of the transformer notes).

$$\begin{bmatrix} \mathbf{Y_S} & -\dfrac{\mathbf{Y_S}}{\mathbf{t}} \\ -\dfrac{\mathbf{Y_S}}{\overline{\mathbf{t}}} & \dfrac{\mathbf{Y_S}}{(|\mathbf{t}|)^2} \end{bmatrix} = \begin{bmatrix} \quad & \quad \\ \quad & \quad \end{bmatrix} \frac{1}{\Omega}$$

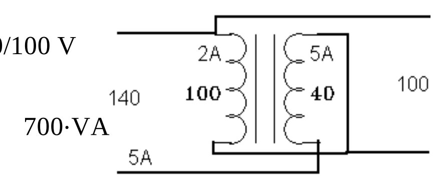
Answers

1. $105 \cdot kVA$

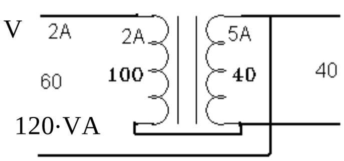
2. a) $140/40\ V$



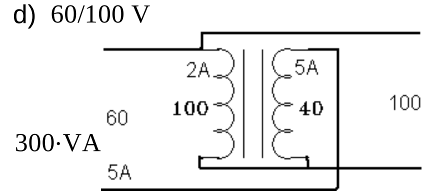
b) $140/100\ V$



c) $60/40\ V$



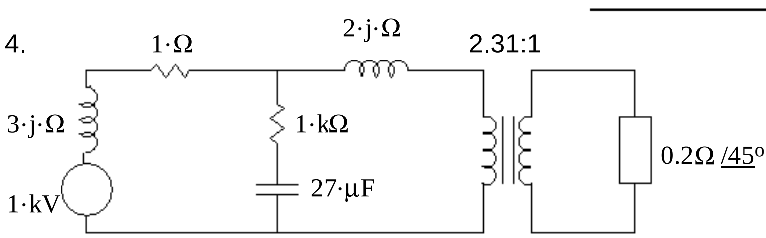
d) $60/100\ V$



3. a) $1167 \cdot V$

   b) The smoke gets out

4.



b) 2.309 / -30º

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) $415 \cdot 7 \cdot V$ $\quad 480 \cdot V$ $\quad$ b) $15 \cdot kVA$ $\quad 17.3 \cdot kVA$ $\quad 32.3 \cdot kVA$ for both

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