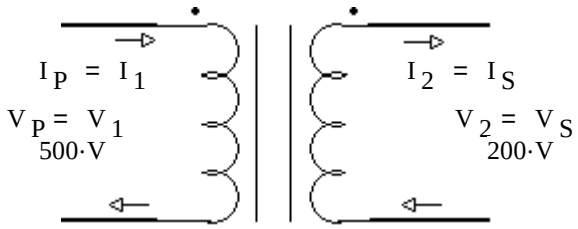
Autotransformers & 3-phase Transformers

c

Name_____ ECE 3600 homework 9 Due: Sat, 2/8/25

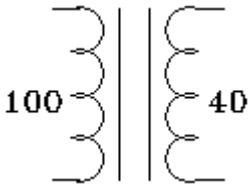
1. 5.7 A 500/200-V, 30-kVA transformer is reconnected as a 700/500-V autotransformer. Compute the new kVA rating of the device.

Normal 500/200-V transformer

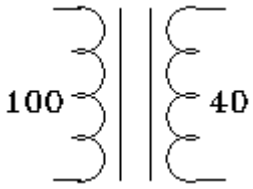


2. Show connections to the following 100/40-V, 200-VA transformers to get the voltage ratios desired. Compute the new VA rating of each connection.

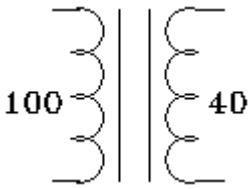
a) 140/40 V



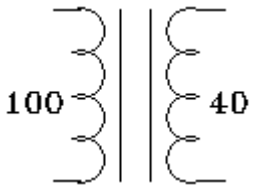
b) 140/100 V



c) 60/40 V

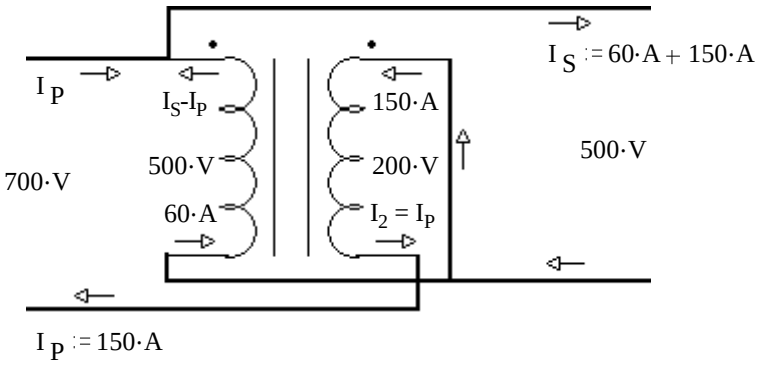


d) 60/100 V

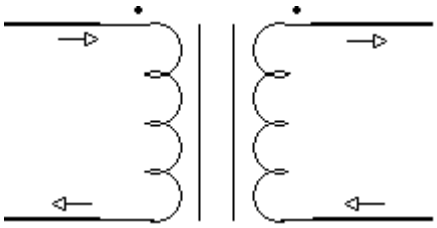


3. 5.8 The terminals of a 500/200-V transformer can be interconnected in four different ways, two of which will result in a 700/500-V autotransformer. Assume that you have interconnected the windings in the wrong way, but that you believe that you did it the right way. In other words, you think that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



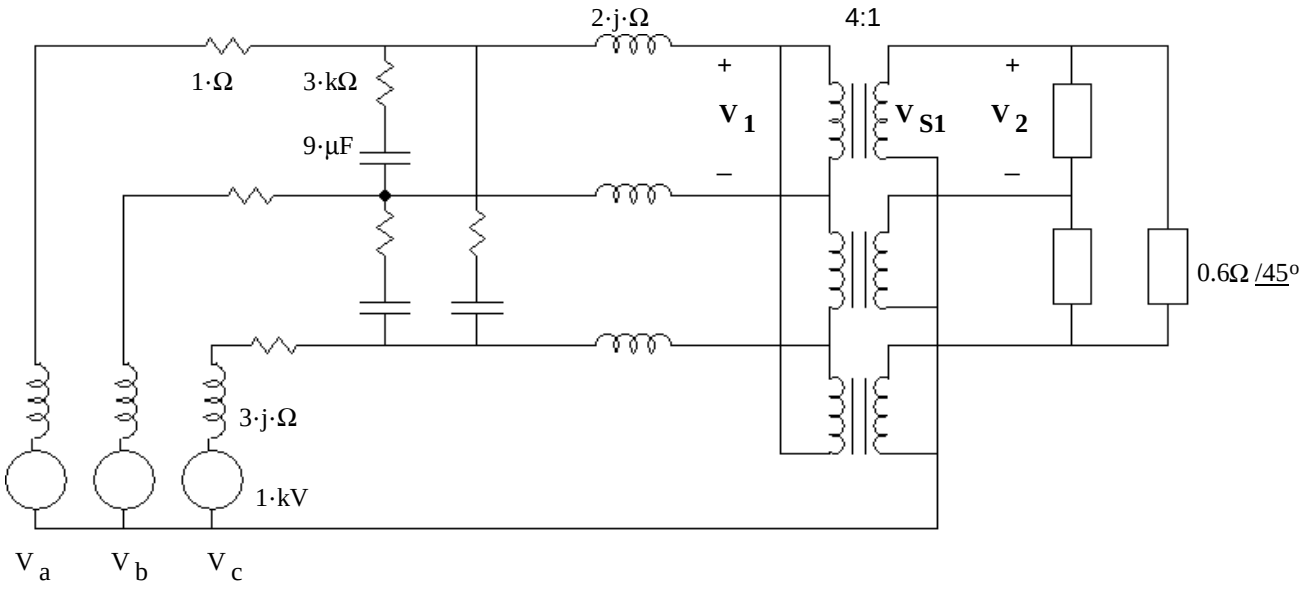
Show a possible INCORRECT connection:



a) What voltage do you get?

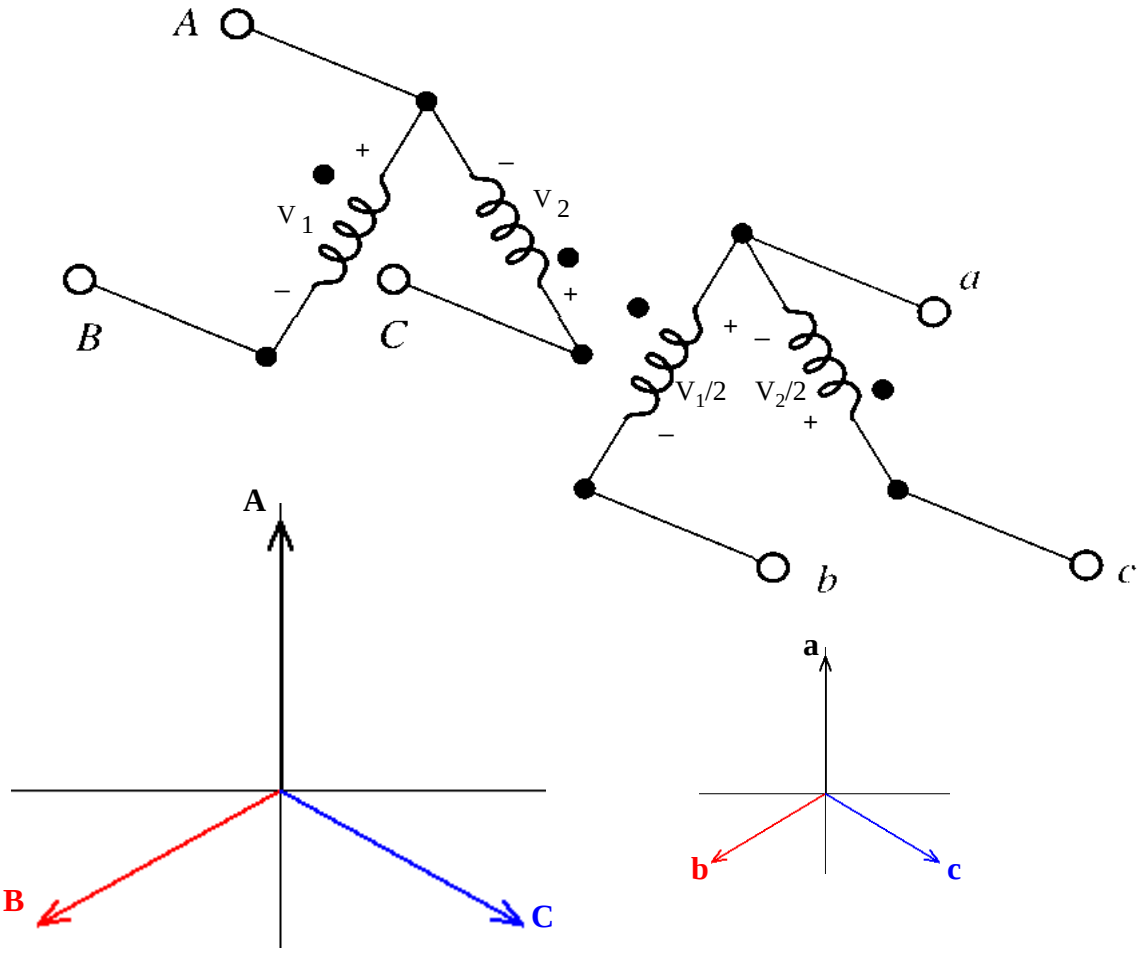
b) What will happen to your transformer with this kind of treatment?

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.



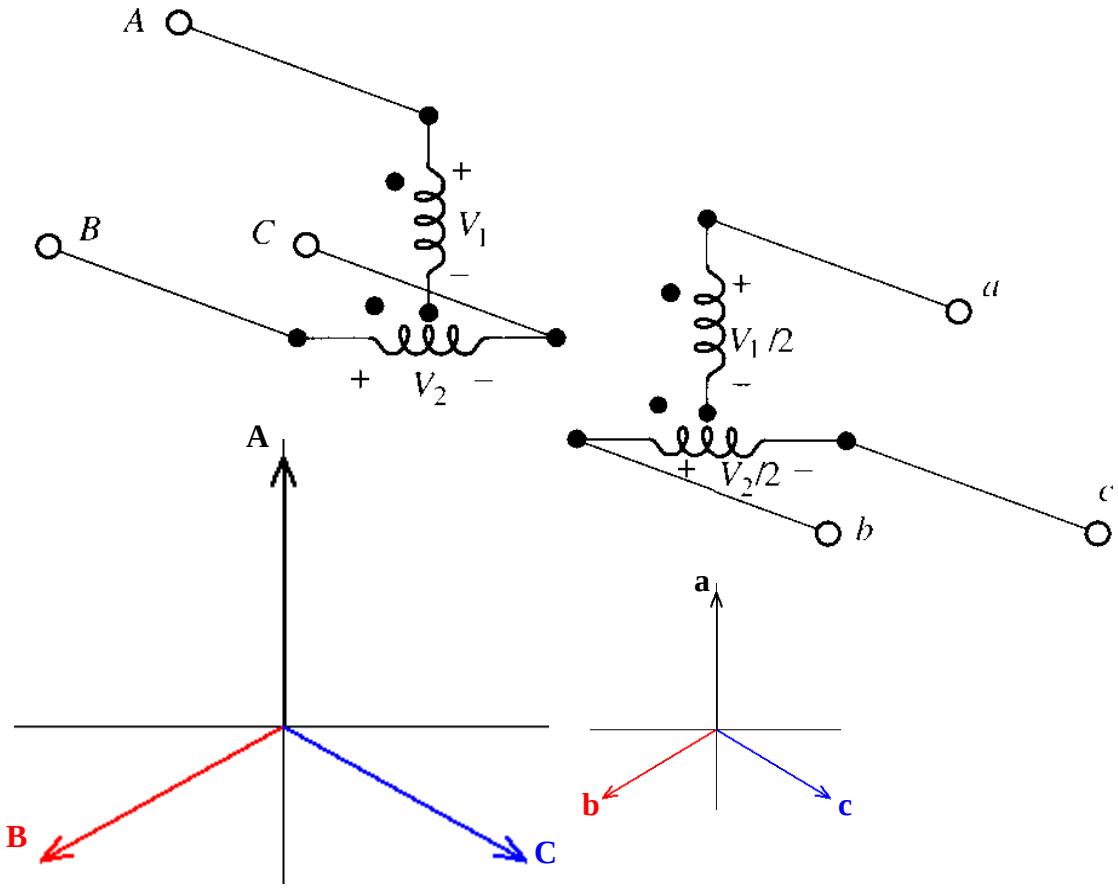
b) Find $\frac{\mathbf{V_1}}{\mathbf{V_2}}$ incuding phase angle Modify turns ratio to reflect Δ-Y transformer connection

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 $\mathbf{t} := 4 \cdot e^{j \cdot 20 \cdot deg} = 4 \angle 20^{o}$

   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 the last page of the transformer notes).

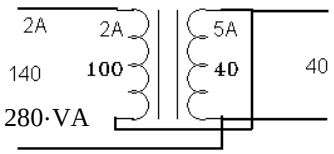
$$\mathbf{Y_S} := \frac{1}{\mathbf{Z_S}} =$$

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

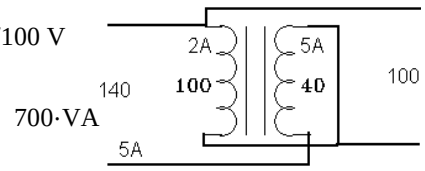
Answers

1. 105·kVA

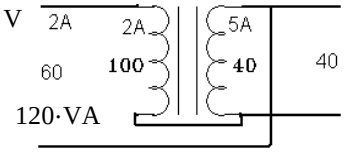
2. a) 140/40 V



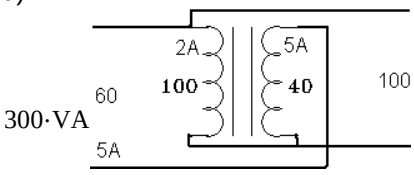
b) 140/100 V



c) 60/40 V



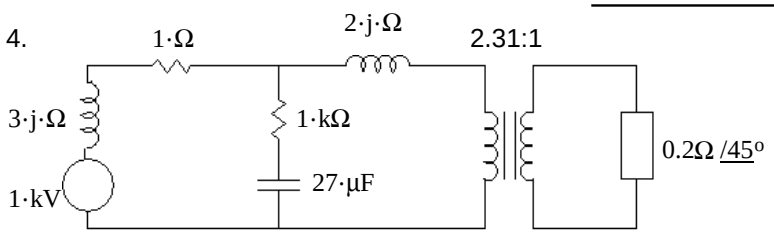
d) 60/100 V



3. a) 1167·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·kVA per transformer, 34.6·kVA for both

6. a) 415·7·V 480·V b) 15·kVA 17.3·kVA 32.3·kVA for both

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