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EE 4221

Hour Exam 2

November 9, 2017

Directions:

1. DO NOT START until told to do so.

2. There are 4 problems in this examination. All problems are equal valued.

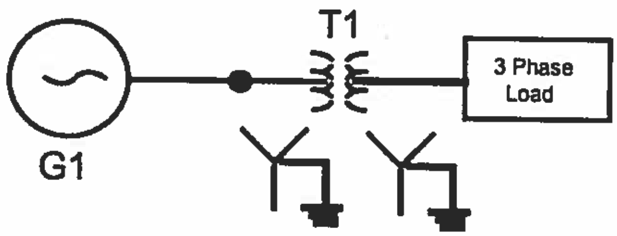
3. The correct answer is a necessary but not sufficient condition to receive full credit for a problem. You MUST show you work! Disorderly or illegible work cannot and thus will not be graded.

4. You are allowed use of an 8.5" x 11.0" formula sheet of your own design as a reference during the exam.

The exam duration is seventy-five minutes.

1. The simple three phase system shown below is comprised of the following elements:

Generator : Xg = 15% on a 15kV, 120MVA base
Transformer : Three phase bank Xt = 10 % on its ratings of 13.2kV/132kV, 100MVA
Load: Three 200Ω resistors connected in wye




A. Draw the p.u. reactance diagram, indicating all element values. Choose base values of 138kV and 100MVA at the load.

$V_{base_{load}} = 138kV$

$S_{base} = 100MVA$

$X_{T_1} = j0.1\left(\frac{132kV}{138kV}\right)^2 \frac{100MVA}{100MVA} = j0.0915$

$X_g = j0.15\left(\frac{15kV}{13.8kV}\right)^2 \left(\frac{100MVA}{120MVA}\right) = j\,0.1477$


B. If the voltage at the load is 138kV /0°, determine the magnitude of the generator current in actual amps.

$V_L = 138kV$

$Z_{base} = \frac{V_{base}^2}{S_{base}} = \frac{(138kV)^2}{100MVA} = 190.44$

$V_{gen_{pu}} = \frac{15kV}{13.8kV} = 1.087$

$Z_{pu} = \frac{Z_{actual}}{Z_{base}} = \frac{200}{190.44} = 1.05pu$

$I_{base_{gen}} = \frac{S_{base}}{V_{base_{gen}}} = \frac{100MVA}{13.8kV} = 7246$

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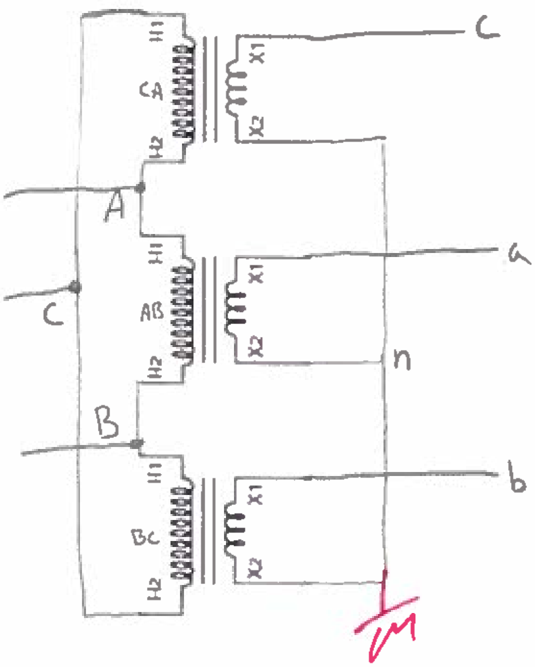
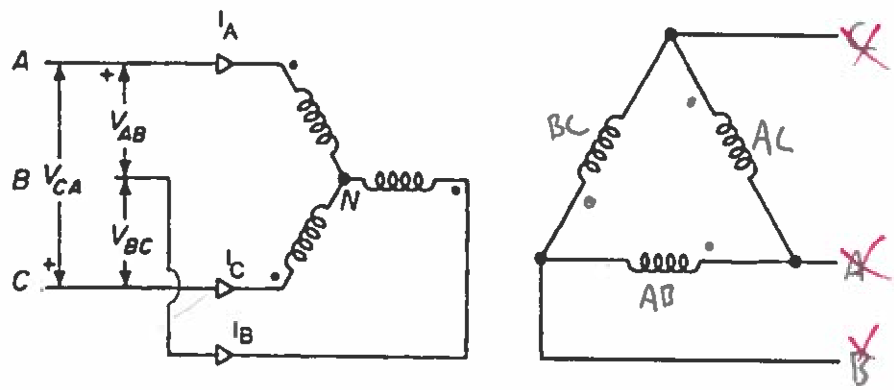
$I_{pu} = \frac{V_{pu}}{Z_{pu}} = \frac{1.087}{1.05} = 1.035$

$I_{actual_{gen}} = I_{pu} I_{base} = (1.035)(7246) = \cancel{\boxed{7501.04A}}$

2a. "Engineer" a three-phase transformer configuration utilizing the three single phase transformers shown below. Draw in the connections such that the high voltage side is connected in delta and low voltage side is in grounded wye. Also show the connections to the outside world i.e., lines "A", "B", "C", "a", "b" and "c"




2b. Add the polarity markings and identify the lines such that:
the delta side **leads** the wye side by 90°

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2c. The North American standard for wye/delta or delta/wye, three phase transformer connections states :

The line-to line voltages on the high side must ~~lag~~ lead the line-to-line low side voltages
(lead or lag)

by 30° degrees.

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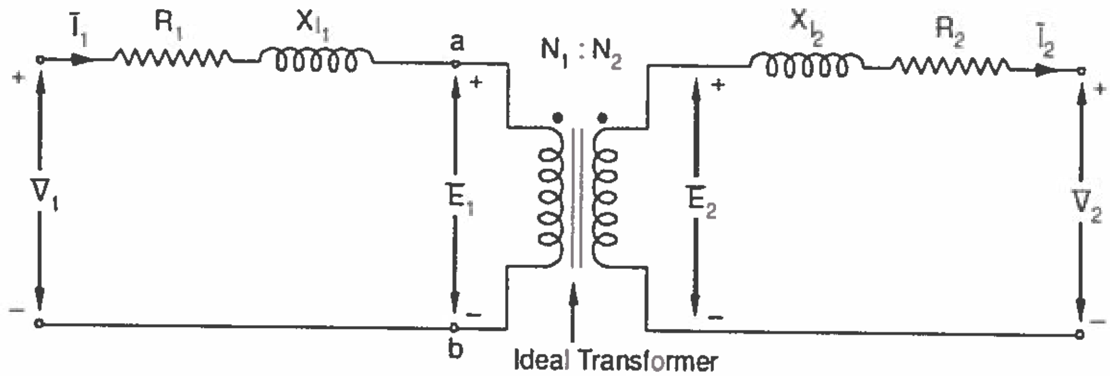
3. A 480V/120V, 60Hz, 6kVA single phase transformer has the following winding parameters:

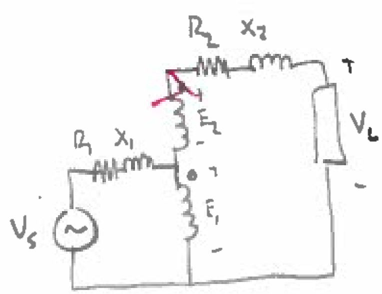
$Z_{480V\ winding} = 0.6 + j0.8\Omega$ $\quad\quad$ $Z_{120V\ winding} = 0.0375 + j0.050\Omega$




The transformer is to be connected as a 480V/360V autotransformer.

Draw the transformer connection required to implement the A-T configuration. Be sure to use polarity markings in your diagram. Also include a source and arbitrary load in your diagram.

$0.6 + j0.8 \left(\frac{120}{480}\right)^2 = 0.0375 + j.05$

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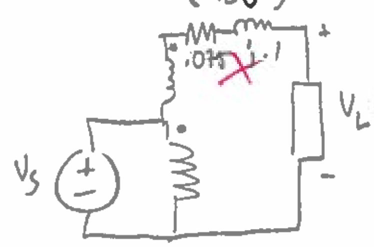


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$S_{AUTO\ TRANSFORMER}$ = ???

Determine the rated kVA for the autotransformer.

$I_{rated} = \frac{6kVA}{120V} = 50A$

$V_{rated} = (50A)(0.75 + j.1) = 37.5 + j5 = \boxed{37.83\angle 7.59^\circ}$

Given the autotransformer is driving a 15kVA load at a power factor of 0.8 lagging and the voltage at the load is 360/0° V, determine the source voltage/

$pf = 0.8$

$\theta = \cos^{-1}(0.8) = 36.87^\circ$

$V_L = 360\angle 0^\circ$

$I_L = \frac{15kVA}{360V} = 41.67$

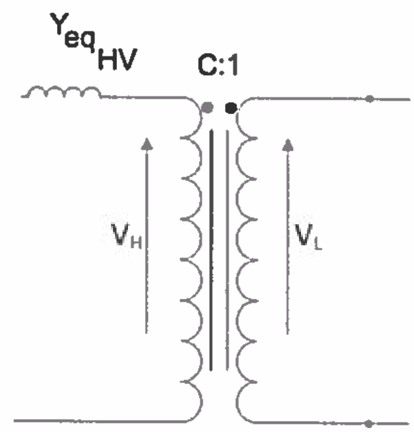
$E = V_L + I_L(0.075 + j.1) = 360\angle 0^\circ + (41.67)(0.075 + j.1) = 363.125 + j4.167 = 363.15\angle 0.657^\circ$

$V_S = \frac{E}{(1 \ldots)} = 345.83 + j3.97 = \boxed{348.86\angle 0.657^\circ}$

4. A three-phase transformer has nameplate data: 125kV/15.625kV, 60Hz, 100MVA, $X_T$ =6.4%

The transformer is put into service in a system with a base power of 100MVA,
Vbase(HV) = 100kV and Vbase (LV) = 10kV

Determine the values for $Yeq_{HV}$ and C that could be used to model to model the transformer when placed in this "off nominal turns" application. [You **do not** have to determine the pi equivalent parameters $y_{10}$, $y_{12}$ and $y_{20}$]




$$Z_{T_{LV}} = j0.064\left(\frac{15.625\text{kV}}{10\text{kV}}\right)^2\left(\frac{100\text{MVA}}{100\text{MVA}}\right) = j\,0.15625$$

$$Z_{T_{HV}} = j0.064\left(\frac{125\text{kV}}{100\text{kV}}\right)^2\left(\frac{100\text{MVA}}{100\text{MVA}}\right) = j\,0.1$$

$$Z_{T_{HV}} = c^2 \cdot Z_{T_{LV}} \rightarrow \boxed{c = 1.25}$$

$$Yeq_{HV} = \frac{1}{Zeq_{HV}} = \frac{1}{j0.15625} = \boxed{-j6.4}$$

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$Yeq_{HV}$ = ~~-j6.4~~

C = ~~1.25~~