You must submit a complete set of solutions to the following problems that shows all of the steps required to achieve the correct answers. Your solutions should appear in the numerical order of the homework problems, and should be written one-sided on blank paper that is stapled to the back of this handout. Place all of your final answers in the blanks provided with each problem statement.

Problem #1) A balanced, positive-sequence, three-phase (3Φ) voltage source has phase voltage $\tilde{V}_a = 240\angle{+30°}$ volts. Specify all of the other ***phase voltages*** and ***line voltages*** of the source.

$\tilde{V}_a =$ **240∠+30°** **V** $\tilde{V}_{ab} =$ ____________ **V**

$\tilde{V}_b =$ ____________ **V** $\tilde{V}_{bc} =$ ____________ **V**

$\tilde{V}_c =$ ____________ **V** $\tilde{V}_{ca} =$ ____________ **V**

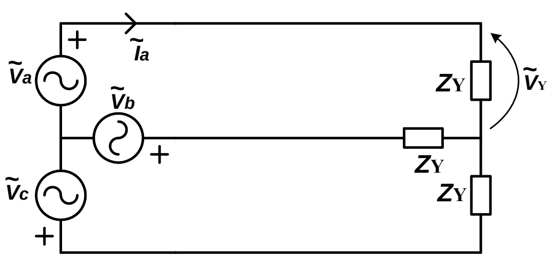
Problem #2) A balanced, positive-sequence, three-phase source has a line voltage $\tilde{V}_{bc} = 480\angle{-15°}$ volts; Specify all of the other ***phase voltages*** and ***line voltages*** of the source:

$\tilde{V}_a =$ ____________ **V** $\tilde{V}_{ab} =$ ____________ **V**

$\tilde{V}_b =$ ____________ **V** $\tilde{V}_{bc} =$ **460∠-15°** **V**

$\tilde{V}_c =$ ____________ **V** $\tilde{V}_{ca} =$ ____________ **V**

Problem #3) A 3Φ source having a phase voltage $\tilde{V}_a = 120\angle 0°\ volts$ is used to supply a 3Φ, Y-connected load, each phase of which has the impedance $Z_Y = 12 + j5\Omega$. Determine the complete set of ***line currents*** and the ***total complex power*** supplied by the source to the 3Φ load.



$\tilde{I}_a =$ ____________ **A**

$\tilde{I}_b =$ ____________ **A**

$\tilde{I}_c =$ ____________ **A**

$S_{3\Phi} =$ ____________

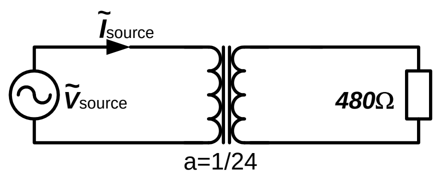
Problem #4) Repeat problem #3, but this time for a 3Φ source having a phase voltage $\tilde{V}_a = 120\angle 135°\ volts$

$\tilde{I}_a =$ ____________ **A** $\tilde{I}_c =$ ____________ **A**

$\tilde{I}_b =$ ____________ **A** $S_{3\Phi} =$ ____________

Problem #5) If the ideal transformer has turns ratio ***a* = 1/24** as connected, determine the ***source current*** $\tilde{I}_{source}$, the ***load voltage*** $\tilde{V}_{load}$, the ***load current*** $\tilde{I}_{load}$, and the ***input impedance*** Z_{in} of the transformer.

$6\angle 0°\ volts$



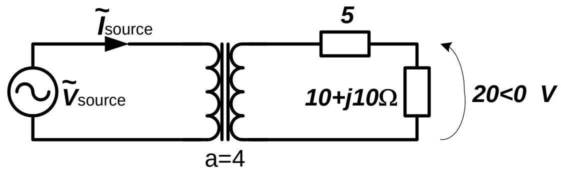
$\tilde{I}_{source} =$ ____________ **A**

$\tilde{V}_{load} =$ ____________ **V**

$\tilde{I}_{load} =$ ____________ **A**

$Z_{in} =$ ____________ **Ω**

Problem #6) Determine the ***source voltage*** $\tilde{V}_{source}$, the ***source current*** $\tilde{I}_{source}$**,** and the ***complex power*** S_{source} produced by the source if the voltage across the (10+j10)Ω complex load is **20∠0°** volts as shown in the figure. Also, determine the ***input impedance*** Z_{in} of the transformer.



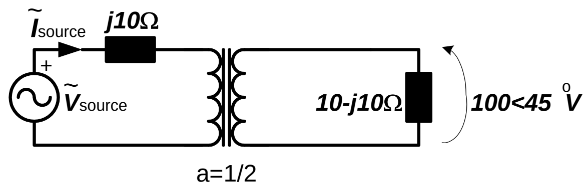
$\tilde{V}_{source} =$ ______________________ **V**

$\tilde{I}_{source} =$ ______________________ **A**

$S_{source} =$ ______________________

$Z_{in} =$ ______________________ **Ω**

Problem #7) Determine the ***source voltage***, $\tilde{V}_{source}$, the ***source current***, $\tilde{I}_{source}$, and the ***real power***, P_{load}, consumed by the (10-j10)Ω complex load impedance in the following circuit.



$\tilde{V}_{source} =$ ______________________ **V**

$\tilde{I}_{source} =$ ______________________ **A**

$P_{load} =$ ______________________ **W**

TRUE/FALSE QUESTIONS

__________ At ***"no-load"*** (i.e. – the secondary winding remains "open-circuited"), an **ideal transformer** will have no current in the primary winding.

__________ The **rated current** for the primary winding of a step-down transformer will be less than the rated current for the secondary winding.

__________ The magnitude of the currents in the primary and secondary coils of an "ideal" transformer will also have the **same ratio** as the magnitudes of the voltages across the primary and secondary coils.

__________ The effective **turns ratio** of a transformer is dependent on the winding to which the source is connected.

__________ The **rated current** for a transformer's winding is the maximum current that can flow continuously in that winding without damaging the transformer.

__________ The winding with the largest number of turns will be the **high-voltage winding** in an ideal transformer.

__________ An **ideal transformer** will function with either an AC or a DC applied primary voltage.

__________ Although their magnitudes may differ, the **phase angles** of the primary and secondary voltages of an ideal transformer must be equal.

__________ The **turns ratio** of a transformer is often specified by the ratio of the rated primary voltage compared to the rated secondary voltage.

__________ If the primary coil of a transformer has fewer turns than the secondary coil, then the secondary side will be the **high-voltage side** of the transformer.

True True False True True True False True True True

ECET 3000 Homework #4 — NUMERICAL ANSWERS

1)

$\tilde{V}_a =$ **240∠+30°** V $\tilde{V}_{ab} =$ **416∠+60°** V

$\tilde{V}_b =$ **240∠ -90°** V $\tilde{V}_{bc} =$ **416∠ -60°** V

$\tilde{V}_c =$ **240∠ +150°** V $\tilde{V}_{ca} =$ **416∠-180°** V

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2)

$\tilde{V}_a =$ **265.6∠+75°** V $\tilde{V}_{ab} =$ **460∠+105°** V

$\tilde{V}_b =$ **265.6∠ -45°** V $\tilde{V}_{bc} =$ **460∠ -15°** V

$\tilde{V}_c =$ **265.6∠ -165°** V $\tilde{V}_{ca} =$ **460∠-135°** V

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3)

$\tilde{I}_a =$ **9.23∠-22.6°** A

$\tilde{I}_b =$ **9.23∠-142.6°** A

$\tilde{I}_c =$ **9.23∠+97.4°** A

$S_{3\Phi} =$ **3067 + j1278**

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4)

$\tilde{I}_a =$ **9.23∠112.4°** A

$\tilde{I}_b =$ **9.23∠-7.6°** A

$\tilde{I}_c =$ **9.23∠-127.6°** A

$S_{3\Phi} =$ **3067 + j1278**

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5)

$\tilde{I}_{source} =$ **7.2∠0°** A

$\tilde{V}_{load} =$ **144∠0°** V

$\tilde{I}_{load} =$ **0.3∠0°** A

$Z_{in} =$ **0.833** Ω

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6)

$\tilde{V}_{source} =$ **102<-11.3º** V

$\tilde{I}_{source} =$ **0.354<-45º** A

$S_{source} =$ **30+j20**

$Z_{in} =$ **240+j160** Ω

$$\tilde{I}_S = \frac{20\angle 0^\circ}{10 + j10} = 1.414\angle -45^\circ \text{ amps}$$

$$\tilde{E}_S = \tilde{I}_S \cdot (5 + 10 + j10) = \tilde{I}_S \cdot (15 + j10) = 25.5\angle -11.3^\circ \text{ volts}$$

$$\tilde{V}_{Source} = \tilde{E}_P = \tilde{E}_S \cdot a = (25.5\angle -11.3^\circ) \cdot 4 = 102\angle -11.3^\circ \text{ volts}$$

$$\tilde{I}_{Source} = \tilde{I}_P = \frac{\tilde{I}_S}{a} = \frac{1.414\angle -45^\circ}{4} = 0.354\angle -45^\circ \text{ amps}$$

$$Z_{in} = a^2 \cdot Z_{secondary} = a^2 \cdot (15 + j10) = (240 + j160)\,\Omega$$

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7)

$\tilde{V}_{source} =$ **111.8∠161.6°** V

$\tilde{I}_{source} =$ **14.14∠90°** A

$P_{load} =$ **500** W

$$\tilde{I}_S = \frac{100\angle 45^\circ}{10 - j10} = 7.07\angle 90^\circ \text{ amps} \qquad \tilde{I}_P = \frac{\tilde{I}_S}{a} = \frac{7.07\angle 90^\circ}{\frac{1}{2}} = 14.14\angle 90^\circ \text{ amps}$$

$$\tilde{E}_S = 100\angle 45^\circ \text{ volts} \qquad \tilde{E}_P = \tilde{E}_S \cdot a = (100\angle 45^\circ) \cdot \tfrac{1}{2} = 50\angle 45^\circ \text{ volts}$$

$$\tilde{V}_{Source} = \tilde{E}_P + \tilde{I}_P \cdot (j10) = 50\angle 45^\circ + (14.14\angle 90^\circ) \cdot (j10) = 111.8\angle 161.6^\circ \text{ volts}$$

$$\tilde{I}_{Source} = \tilde{I}_P = 14.14\angle 90^\circ \text{ amps}$$

$$P_{load} = E_S \cdot I_S \cdot cos(\theta_S) = (100) \cdot (7.07) \cdot (0.707) = 500 \text{ watts}$$