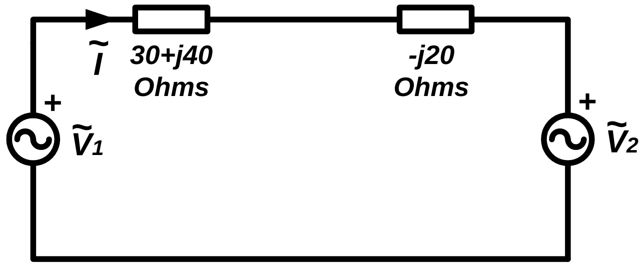
ECET 3000

Electrical Principles – Exam II **Sample Problems**

Instructions: This exam is **closed book** except for one, 8½"x11" sheet of handwritten notes that may NOT contain any numerically-solved problems.

Problem #1) Given the following (steady-state) AC circuit:



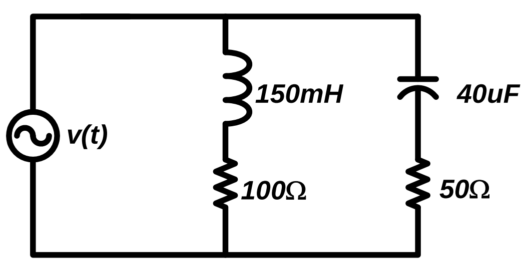
$\tilde{V}_1 = 120\angle 0°$ volts

$\tilde{V}_2 = 60\angle -30°$ volts

Write out the Kirchhoff's Voltage Law (KVL) equation that could be used to solve the current $\tilde{I}$, expressing the voltages across the impedances based on the direction of the current $\tilde{I}$ as shown, and use the equation to determine the phasor current $\tilde{I}$.

$\tilde{I} =$ ________________________ A

Problem #2) Given the following (steady-state) AC circuit:



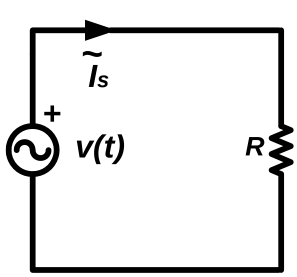
$v(t) = \sqrt{2} \cdot 24 \cdot \sin(\omega \cdot t + 45°)$

$f = 60\ Hz$

Express all of the loads in their impedance form and then determine the impedance seen by the source if the entire network is simplified into a single complex impedance expressed in "rectangular" form.

$Z_{eq} =$ ________________ **Ω**

Problem #3) Given the following circuit:



$v(t) = \sqrt{2} \cdot 120 \cdot \sin(\omega \cdot t + 20°)$ volts $f = 60$ Hz

$R = 30\ \Omega$

a) Determine the ***current*** $\tilde{I}_S$ in ***phasor form***,

b) Rewrite the ***current*** value as a ***function of time*** [i.e. – $i_S(t)$]

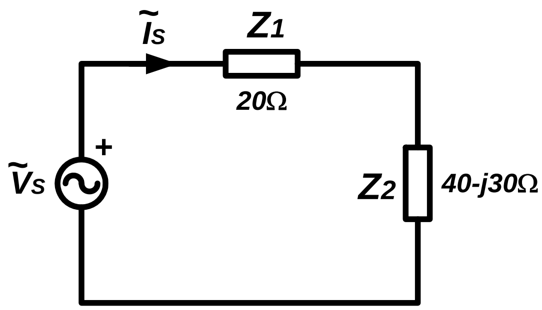
c) Determine the ***Real*** (***average) power*** consumed by the resistor.

$\tilde{I}_S =$ ________________________ A

$i_S(t) =$ ________________________ A

$P_R =$ ________________________ W

Problem #4) Given the following (steady-state) AC circuit:



$\tilde{V}_S = 120\angle 0°$ volts

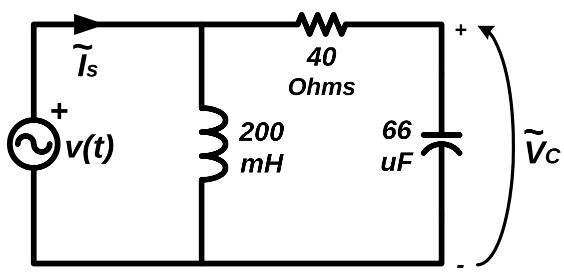
Determine the source current $\tilde{I}_S$, the complex power produced by the source, S_{source}, and the complex power, S_2, consumed only by the impedance Z_2.

$\tilde{I}_S =$ ______________________ **A**

$S_{source} =$ ______________________

$S_2 =$ ______________________

Problem #5) Given the following (steady-state) AC circuit:



$v(t) = \sqrt{2} \cdot 24 \cdot \sin(\omega \cdot t + 60°)$

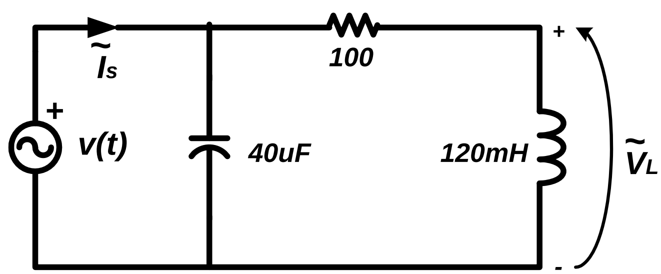
$f = 60\ Hz$

Determine the ***source current*** $\tilde{I}_S$ and the capacitor voltage $\tilde{V}_C$, both in RMS phasor form.

$\tilde{I}_S =$ ______________________ **A**

$\tilde{V}_C =$ ______________________ **V**

Problem #6) Perform a steady-state AC analysis of the circuit shown below in order to determine the source current, $\tilde{I}_S$, and the voltage across the inductor, $\tilde{V}_L$, both in RMS phasor form.



$v(t) = \sqrt{2} \cdot 10 \cdot \sin(\omega t)$

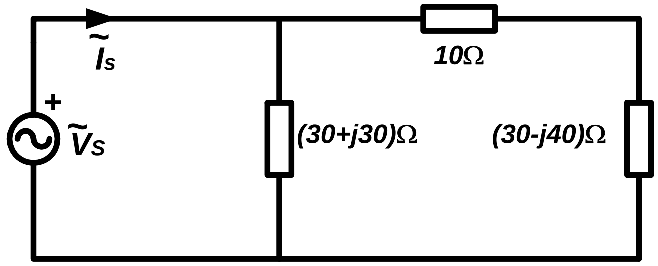
$\omega = 2\pi \cdot f$

$f = 60\ Hz$

$\tilde{I}_S =$ ______________________ A

$\tilde{V}_L =$ ______________________ V

Problem #7) Given the following (steady-state) AC circuit:



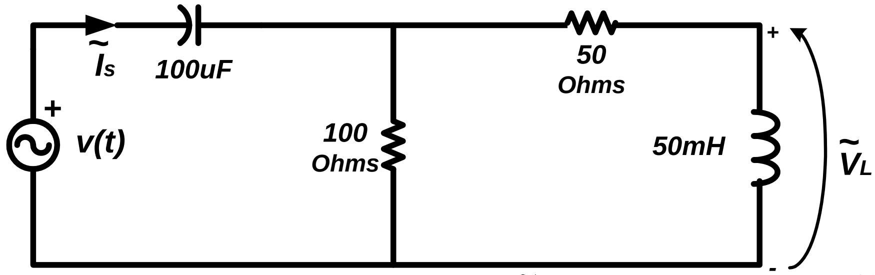
$\tilde{V}_S = 240\angle 0°$ volts

Determine the ***source current*** $\tilde{I}_S$ (expressed in "polar" form) and the ***complex power*** consumed by the 10Ω impedance S_{10} (expressed in "rectangular" form).

$\tilde{I}_S =$ ______________________________ **(A)**

$S_{10} =$ ______________________________

Problem #8) Given the following (steady-state) AC circuit:



$v(t) = \sqrt{2} \cdot 60 \cdot \sin(\omega t - 45°)$

$\omega = 2\pi \cdot f = 1000 \ {}^{rad}/_{sec}$

a) Determine the ***source current*** $\tilde{I}_S$ and the ***inductor voltage*** $\tilde{V}_L$, both in "polar" form.

b) Determine the ***total complex power*** supplied by the source to the circuit (in "rectangular" form).

$\tilde{I}_S =$ ______________________________ **(A)**

$\tilde{V}_L =$ ______________________________ **(V)**

$S_{Source} =$ ______________________________

Problem T/F) Specify whether each of the statements are **TRUE** or **FALSE**.

__________ The ***real power*** consumed by an ideal capacitive load will always be zero.

__________ Given a circuit containing both an AC voltage source and a ***resistor***, the magnitude of the ***impedance*** of the resistor will increase if the frequency of the source is increased.

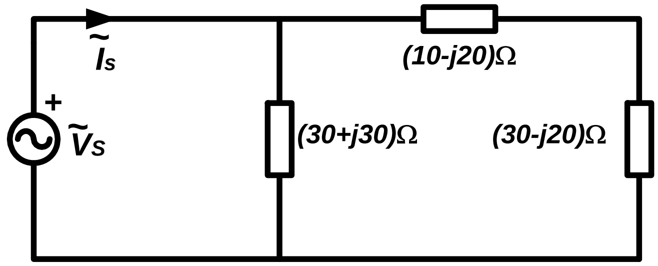
__________ Given a circuit containing both an AC voltage source and an ***inductor***, the magnitude of the ***impedance*** of the inductor will increase if the frequency of the source is increased.

__________ Given a circuit containing both an AC voltage source and an ***capacitor***, the magnitude of the ***impedance*** of the capacitor will increase if the frequency of the source is increased.

__________ A ***purely resistive load*** will consume no reactive power.

__________ When connected to an AC voltage source, the ***power supplied to a resistor*** (as a function of time) varies at a frequency that is 2x greater than that of the applied source voltage.

Problem #9) Given the following (steady-state) AC circuit:



$\tilde{V}_S = 240\angle 0°$ volts

Determine the ***source current*** $\tilde{I}_S$ in phasor form and the ***real power*** consumed by the (30+j30)Ω impedance.

$\tilde{I}_S =$ ______________________________ **(A)**

$P_{(30+j30)} =$ ______________________________ **(W)**

True/False-2) Specify whether each of the statements are **TRUE** or **FALSE**.

__________ A positive, purely "imaginary" impedance relates to a ***capacitive load***.

__________ Given an AC (purely sinusoidal) voltage source, the ***RMS voltage magnitude*** of the source is $\sqrt{2}$ times greater than the peak value of the source voltage.

__________ The magnitude of the ***impedance*** of a specific capacitor will be greater when it is connected to a 60Hz voltage source compared to when it is connected to a 50Hz voltage source.

__________ The ***impedance*** of a resistor will increase as the source frequency increases.

__________ When expressed in ***phasor form***, a sinusoidal voltage source's magnitude and phase angle are shown but the frequency of the source is not.

__________ When connected to an AC voltage source, the ***power*** (rate of energy transfer) as a function of time to a resistor fluctuates at a frequency that is 2x the frequency of the applied source voltage.

__________ The magnitude of the impedance of a capacitor supplied by an AC source will decrease as the source frequency increases.

__________ Given an AC voltage source, the ***RMS magnitude*** of the source is $\sqrt{2}$ times greater than the peak value of the source voltage.

__________ The ***reactive power*** supplied by an AC source to a purely resistive load will always be zero.

__________ The ***real power*** supplied to a +j10Ω inductive reactance will be equal to the real power supplied to a -j10Ω capacitive reactance if they are connected to the same AC voltage source.

1) $120\angle 0° - (30 + j40)\cdot\tilde{I} - (0 - j20)\cdot\tilde{I} - 60\angle -30° = 0$

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2) $Z_{eq} =$ **59.7-j21.5** Ω

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3) $\tilde{I}_S =$ **4∠+20º** A $\quad i_S(t) =$ **√2(4)sin(ωt+20º)** A $\quad P_R =$ **480** W

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4) $\tilde{I}_S =$ **1.789∠+26.565º** A $\quad S_{source} =$ **192 – j96** $\quad S_2 =$ **128 – j96**

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5)

$\tilde{I}_S = 0.3\angle 56.5°\ amps$

$\tilde{V}_C = 17\angle 15.1°\ volts$

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6)

$\tilde{V}_L = 4.12\angle 65.7°\ volts$

$\tilde{I}_S = 0.14\angle 53.76°\ amps$

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7)

$\tilde{I}_S = 7.07\angle -8.13°\ amps$

$S_{10} = 180 + j0$

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8) $\tilde{I}_S = 1.455\angle -59.04°$ amps, $\quad \tilde{V}_L = 46.02\angle 12.53°$ volts, $\quad S_{source} = 84.7 + j21.1$

T/F)

True

False

True

False

True

True

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9) $\tilde{I}_S = 7.07\angle -8.13°$ amps, $P_{(30+j30)} = 960$ watts

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True/False-2) Specify whether each of the statements are **TRUE** or **FALSE**.

False A positive, reactance value relates to a ***capacitive load***.

False Given an AC (purely sinusoidal) voltage source, the ***RMS voltage magnitude*** of the source is $\sqrt{2}$ times greater than the peak value of the source voltage.

False The magnitude of the ***impedance*** of a specific capacitor will be greater when it is connected to a 60Hz voltage source compared to when it is connected to a 50Hz voltage source.

False The ***impedance*** of a resistor will increase as the source frequency increases.

True When expressed in ***phasor form***, a sinusoidal voltage source's magnitude and phase angle are shown but the frequency of the source is not.

True When connected to an AC voltage source, the ***power*** (rate of energy transfer) as a function of time to a resistor fluctuates at a frequency that is 2x the frequency of the applied source voltage.

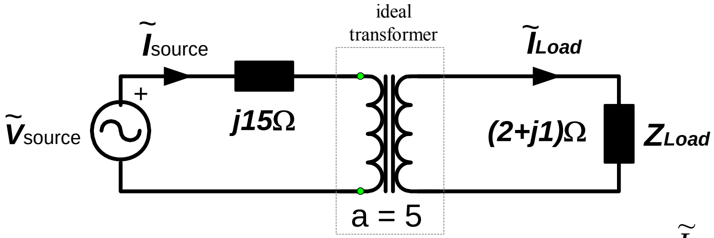
True The magnitude of the impedance of a capacitor supplied by an AC source will decrease as the source frequency increases.

False Given an AC voltage source, the ***RMS magnitude*** of the source is $\sqrt{2}$ times greater than the peak value of the source voltage.

True The ***reactive power*** supplied by an AC source to a purely resistive load will always be zero.

True The ***real power*** supplied to a +j10Ω inductive reactance will be equal to the real power supplied to a -j10Ω capacitive reactance if they are connected to the same AC voltage source.

Problem #10) Determine the ***source current*** and the ***load current*** in the following circuit that contains an ideal transformer with a turns ratio $a = 5$.



$\tilde{V}_{source} = 120\angle 0°\ volts$

$\tilde{I}_{source} =$ ________________________________ **(A)**

$\tilde{I}_{Load} =$ ________________________________ **(A)**

Problem #11) A balanced, positive-sequence, 3Φ source having phase voltage $\tilde{V}_a = 80\angle 0°$ volts is used

to supply a Y-connected load, each phase of which has the impedance $Z_Y = 8 - j6\,\Omega$.
The ***line current*** flowing out of phase "**a**" of the source is $\tilde{I}_a = 8\angle 36.9°$ amps. Specify all of the ***phase*** and ***line voltages*** of the source along with all of the ***line currents*** flowing in the system.

$\tilde{V}_a =$ ______**80∠0°**______ **V** $\tilde{V}_{ab} =$ ________________________ **V**

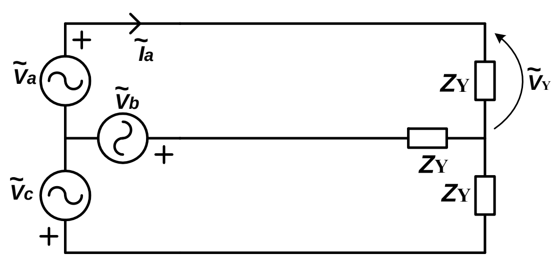
$\tilde{V}_b =$ ________________________ **V** $\tilde{V}_{bc} =$ ________________________ **V**

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

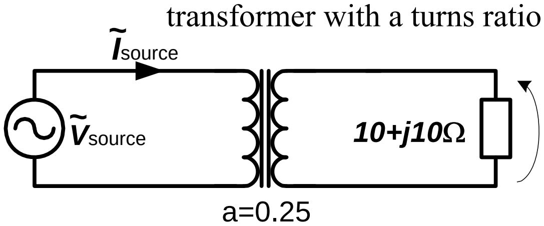
$\tilde{I}_a =$ ________________________ **A**

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

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



Problem #12) Determine the ***source voltage and current*** in the following circuit that contains an ideal transformer with a turns ratio $a = 0.25$



$120\angle 0°$ volts

$\tilde{V}_{source} =$ ________________________________ **(V)**

$\tilde{I}_{source} =$ ________________________________ **(A)**

Problem #13) Specify whether each of the statements are **TRUE** or **FALSE**.

__________ Under ***"no-load"*** conditions (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 a transformer.

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

__________ Given a source connected to a transformer having an effective turns ratio a=10, the magnitude of the **primary voltage** will be 10x larger than the magnitude of the secondary voltage.

__________ A "step-up" transformer will have a **turns ratio** that is greater than one ($a > 1$).

__________ The winding with the smaller number of turns will be the **low-voltage winding** in a transformer.

__________ The magnitudes of the phase voltages of a Y-connected, balanced, 3Φ source are $\sqrt{2}$ times larger than the magnitudes of the source's line voltages.

__________ Under ***"no-load"*** conditions (i.e. – the secondary winding remains "open-circuited"), an **ideal transformer** will have no voltage across its secondary winding.

Problem #14) A balanced, positive-sequence, three-phase source has a line voltage $\tilde{V}_{bc} = 60\angle 0°$ 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** $\tilde{V}_{bc} =$ __________ **$60\angle 0°$** __________ **V**

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

10) $\tilde{I}_{Source} = 1.874\angle -38.66°\ amps$ $\tilde{I}_{Load} = 9.37\angle -38.66°\ amps$

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11)

$\tilde{V}_a = 80\angle 0°\ volts$ $\tilde{V}_{ab} = 138.6\angle 30°\ volts$

$\tilde{V}_b = 80\angle -120°\ volts$ $\tilde{V}_{bc} = 138.6\angle -90°\ volts$

$\tilde{V}_c = 80\angle -240°\ volts$ $\tilde{V}_{ca} = 138.6\angle -210°\ volts$

$\tilde{I}_a = 8\angle 36.9°\ amps$

$\tilde{I}_a = 8\angle -83.1°\ amps$

$\tilde{I}_a = 8\angle -203.1°\ amps$

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12) $\tilde{V}_{Source} = 30\angle 0°\ volts$ $\tilde{I}_{Source} = 33.94\angle -45°\ amps$

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13) __**True**__ Under ***"no-load"*** conditions (i.e. – the secondary winding remains "open-circuited"), an ideal transformer will have no current in the primary winding.

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

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

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

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

__**True**__ The coil with the largest number of turns will be the high-voltage coil in an ideal transformer.

__**False**__ An "ideal transformer" will function with either an AC or a DC applied voltage.

__**True**__ There is no phase angle change from primary to secondary voltage across an ideal transformer.

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

__**True**__ 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**__ Given a source connected to a transformer having an effective turns ratio a=10, the magnitude of the **primary voltage** will be 10x larger than the magnitude of the secondary voltage.

__**False**__ A "step-up" transformer will have a **turns ratio** that is greater than one ($a > 1$).

__**True**__ The winding with the smaller number of turns will be the **low-voltage winding** in a transformer.

__**False**__ The magnitudes of the phase voltages of a Y-connected, balanced, 3Φ source are $\sqrt{2}$ times larger than the magnitudes of the source's line voltages.

__**False**__ Under ***"no-load"*** conditions (i.e. – the secondary winding remains "open-circuited"), an **ideal transformer** will have no voltage across its secondary winding.

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14)

$\tilde{V}_a$ **= 34.64∠+90° V** $\tilde{V}_{ab}$ **= 60∠+120° V**

$\tilde{V}_b$ **= 34.64∠–30° V** $\tilde{V}_{bc}$ **= 60∠0° V**

$\tilde{V}_c$ **= 34.64∠–150° V** $\tilde{V}_{ca}$ **= 60∠–120° V**