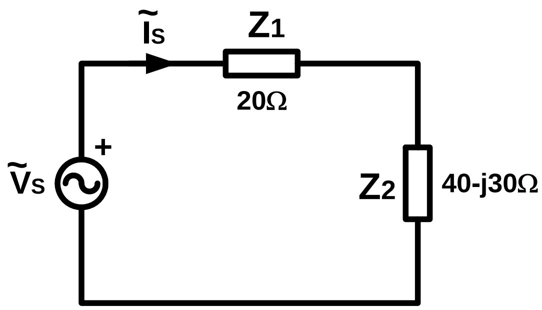
ECET 2111

Circuits II – Exam II **Sample Problems_____**

Instructions: Show all of your work… no credit will be given for illegible or illogical work, or for final answers that are not justified by the work shown. This exam is closed book except for one 8½"x11", single sheet of handwritten notes that may NOT contain any numerically-solved problems.

Note – Express all **voltages** & **currents** as phasors written in "**polar**" form (I.e. – $100\angle 45°$ **or** $100e^{\frac{\pi}{4}rad}$) and all **impedances** & **complex powers** as complex numbers in "**rectangular**" form. (I.e. – $80+j60$)

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



$\tilde{V}_S = 120\angle 0°$ volts

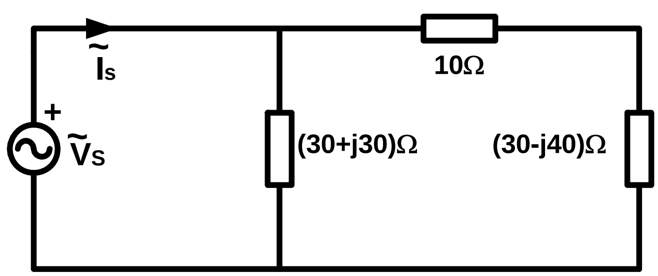
Determine the **source current** $\tilde{I}_S$, the **complex power produced by the source**, S_{source}, and the **complex power,** S_2**, consumed only by the impedance Z2**.

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

$S_{source} =$ ______________________

$S_2 =$ ______________________

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



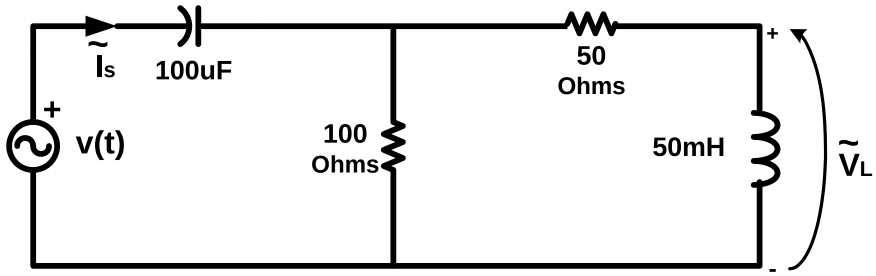
$\tilde{V}_S = 240\angle 0°$ volts

Determine the **source current** $\tilde{I}_S$ and the **complex power** consumed by the 10Ω impedance S_{10}.

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

$S_{10} =$ ______________________

Problem #3) 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 #4) 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**

Problem #5) A balanced, positive-sequence, 3Φ source with a phase voltage $\tilde{V}_a = 80\angle 0°$ volts is used to supply a Y-connected load, each phase of which has the impedance $Z_Y = 8 - j6\,\Omega$.

Specify all of the **phase** and **line voltages** of the source along with all of the **line currents** flowing in the system.

$\tilde{V}_a =$ ____________**$80\angle 0°$**____________ **V** $\tilde{V}_{ab} =$ ______________________________ **V**

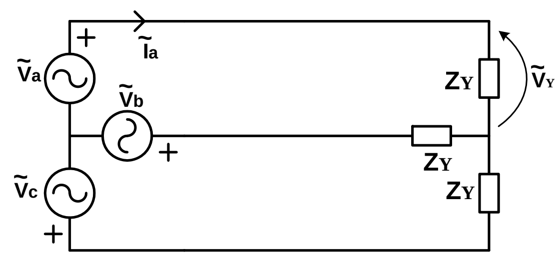
$\tilde{V}_b =$ ______________________________ **V** $\tilde{V}_{bc} =$ ______________________________ **V**

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

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

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

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



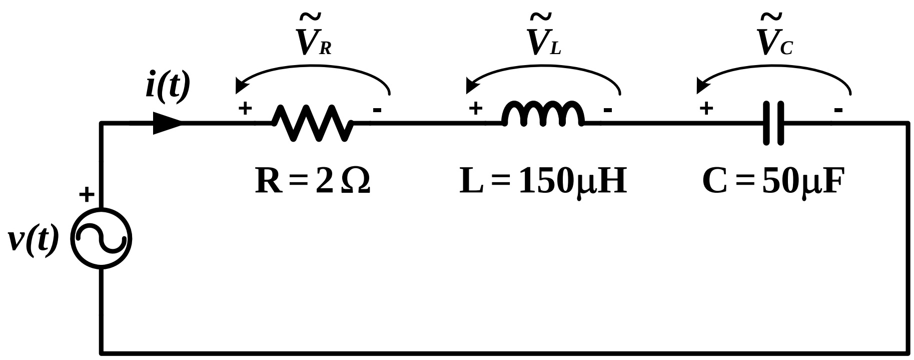
Problem #6) Determine the **decibel** ratios (out/in) of the following:

a) P_{out} = 200mW and P_{in} = 10mW
b) P_{out} = 45mW and P_{in} = 135mW
c) V_{out} = 50mV and V_{in} = 500mV
d) V_{out} = 20V and V_{in} = 1V

Problem #7) Convert the following dBm values to **power** values expressed in **mW**:

a) –3dBm
b) +20dBm

Problem #8) Given the following **series-resonant** RLC circuit that is supplied by a variable-frequency source:



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

a) Determine the **resonant frequency** f_o, the **quality factor** Q, the **cutoff frequencies** f_1 and f_2, and the **bandwidth** BW of the circuit.
b) Determine the **maximum (RMS) current magnitude** $I_{\max}$ that can flow in the circuit and the **maximum power** $P_{\max}$ that can be supplied to the resistor.
c) Determine the **current magnitude** I_{co} that will flow in the circuit and the **power** P_{co} that will be supplied to the resistor at the cutoff frequencies.

a) f_o = ______________________ **(Hz)**

Q = ______________________ **(V)**

f_1 = ______________________ **(Hz)**

f_2 = ______________________ **(Hz)**

BW ______________________ **(Hz)**

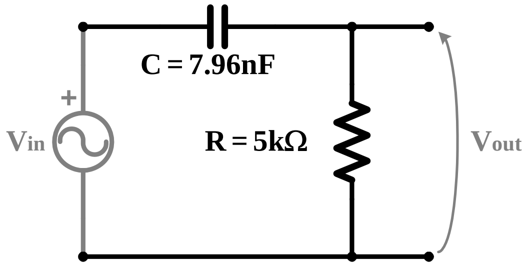
b) $I_{\max}$ = ______________________ **(A)**

$P_{\max}$ = ______________________ **(W)**

c) I_{co} = ______________________ **(A)**

P_{co} = ______________________ **(W)**

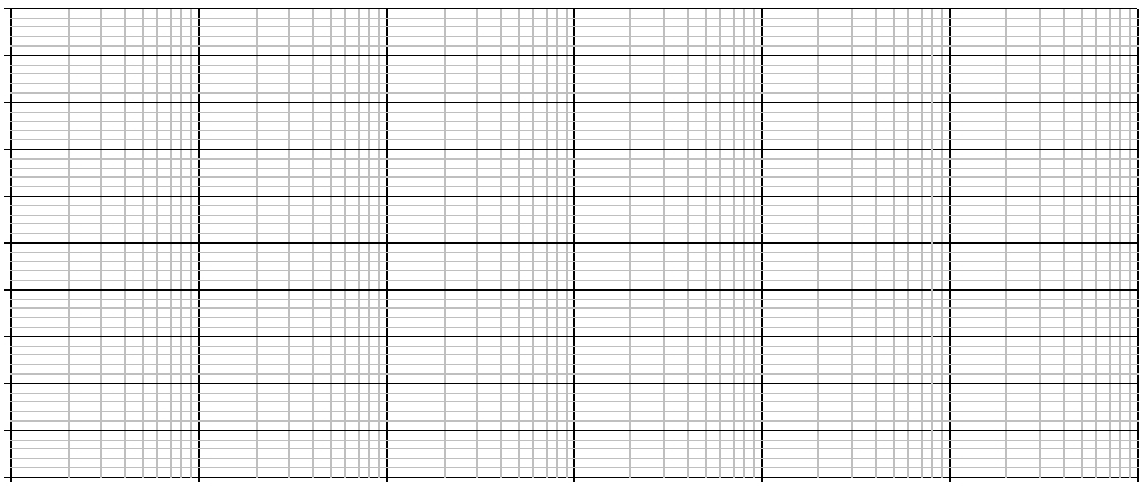
Problem #9) Given the following RC filter circuit that is supplied by a variable-frequency source:

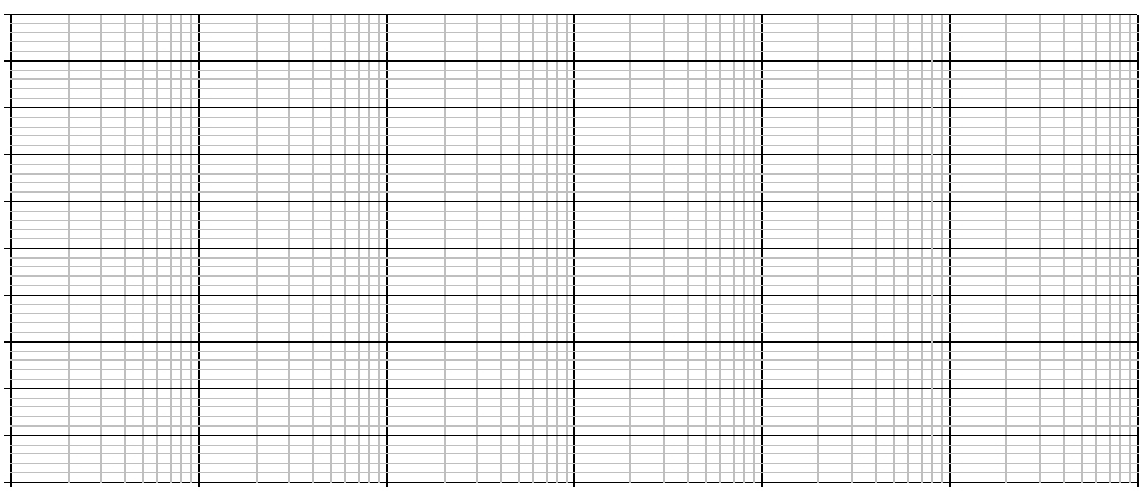


a) Determine the **cutoff frequency** f_c of the filter.

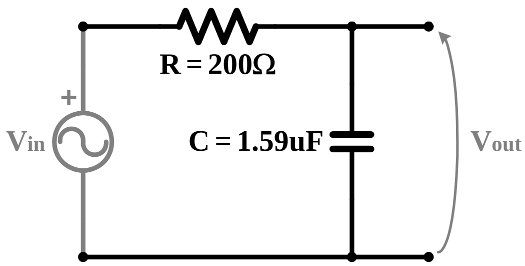
b) Sketch the **Idealized Bode Plot** of the **decibel voltage gain** for the circuit.

c) Sketch the **Idealized Bode Plot** of the **phase response** for the circuit





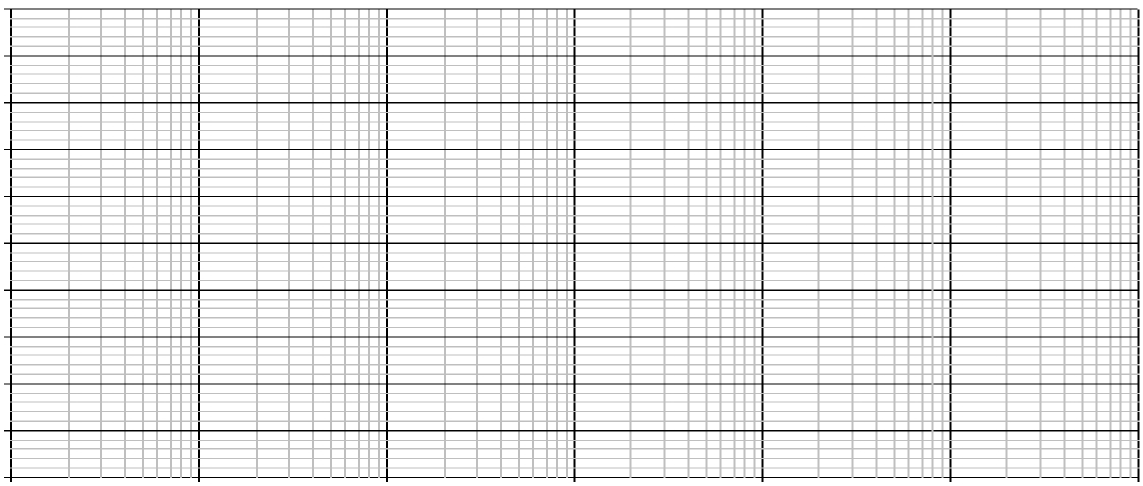
Problem #10) Given the following RC filter circuit that is supplied by a variable-frequency source:

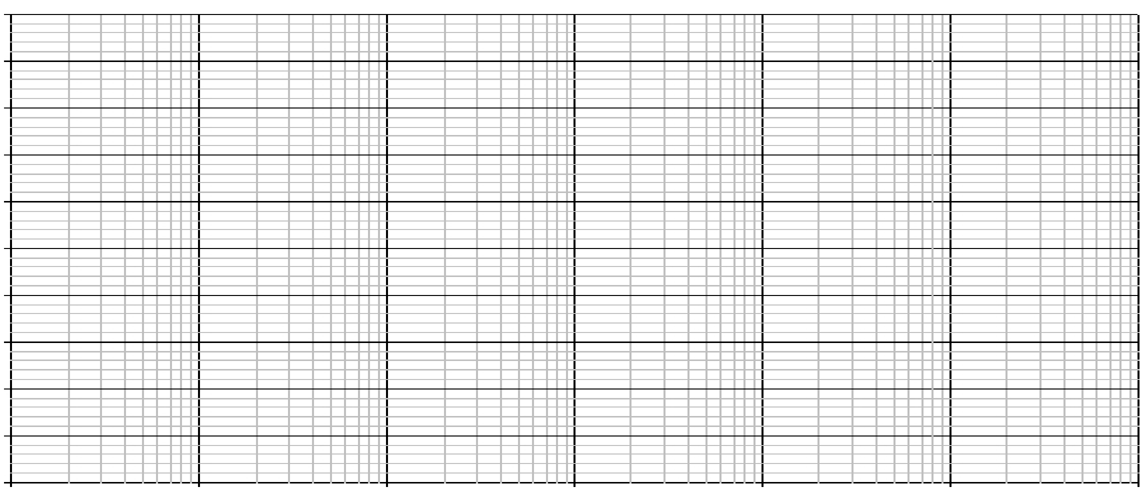


a) Determine the **cutoff frequency** f_c of the filter.

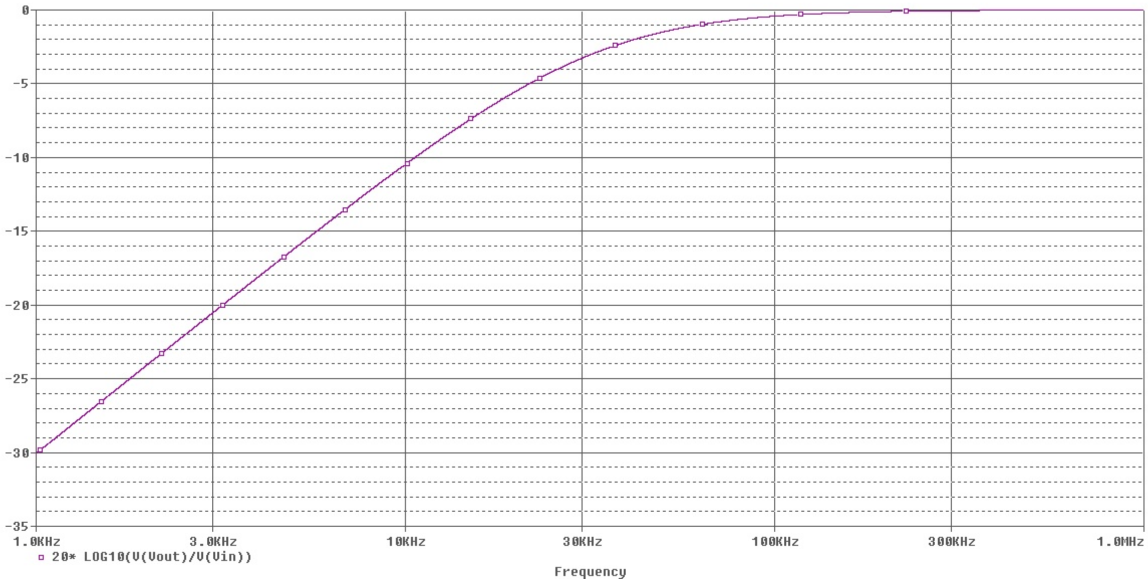
b) Sketch the **Idealized Bode Plot** of the **decibel voltage gain** for the circuit.

c) Sketch the **Idealized Bode Plot** of the **phase response** for the circuit





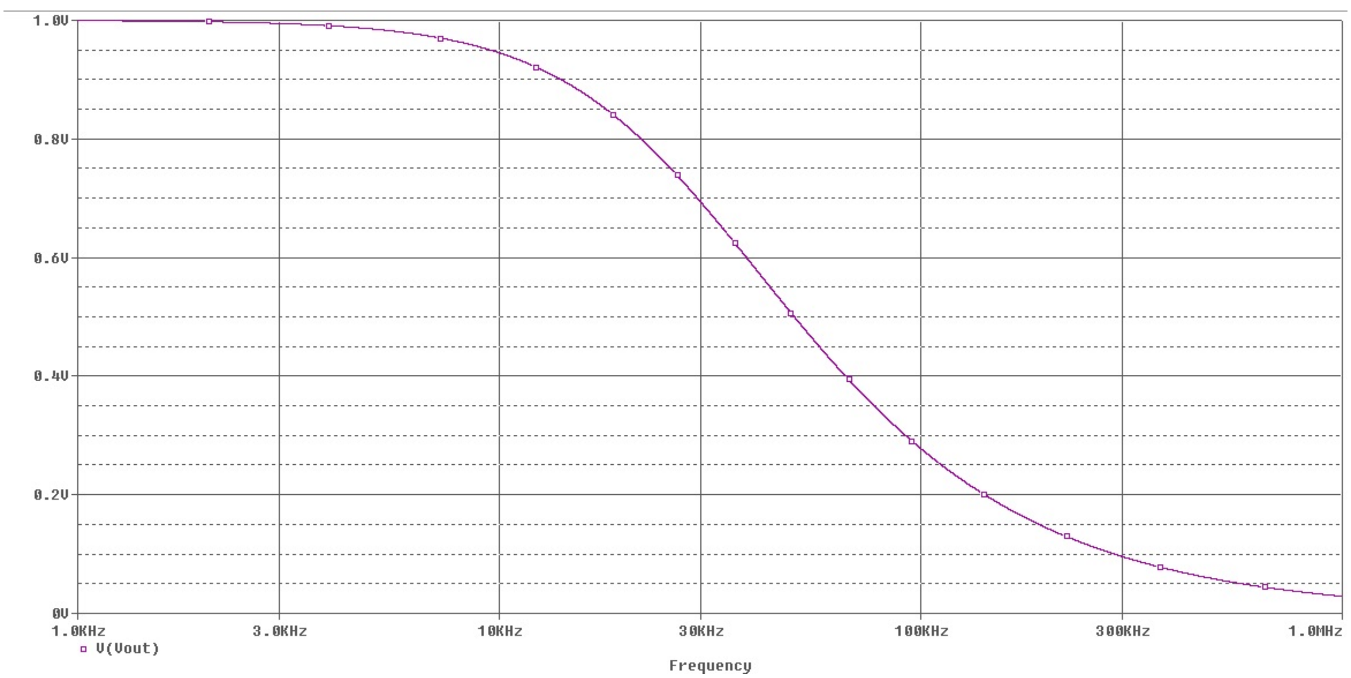
Problem #11) Given the following plot of the **decibel voltage gain** of a filter circuit:



a) Specify the **type** of filter circuit.

b) Determine the **cutoff frequency** f_c of the filter.

Problem #12) Given the following plot of the **output voltage** of a filter circuit:

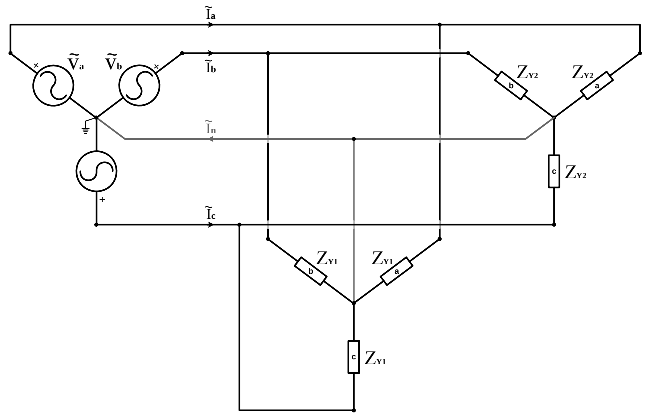


a) Specify the **type** of filter circuit.

b) Determine the **cutoff frequency** f_c of the filter.

Problem #13) A balanced, positive-sequence, 3Φ source with a phase voltage $\tilde{V}_a = 120\angle 0°$ volts is used to supply a two 3Φ Y-connected loads, the first of which has the impedance $Z_{Y1} = 40 + j40\,\Omega$ per phase and the second of which has the impedance $Z_{Y2} = -j80\,\Omega$ per phase.

Determine the **phase current** flowing through ***phase-a*** of each load, $\tilde{I}_{a1}$ and $\tilde{I}_{a2}$, the **line current** $\tilde{I}_a$ flowing out of the source, the **complex power** consumed by each of the 3Φ loads, S_{Y1} and S_{Y2}, and the total **complex power** produced by the 3Φ source, S_{source}.



$\tilde{I}_{a1}$ = ________________________ **(A)**

$\tilde{I}_{a2}$ = ________________________ **(A)**

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

S_{Y1} = ________________________

S_{Y2} = ________________________

S_{source} = ________________________

True/False Questions

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

__________ 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 ***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.

__________ 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.

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

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2)
$\tilde{I}_S = 7.07\angle -8.13°\ amps$
$S_{10} = 180 + j0$

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

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4)
$\tilde{V}_a$ = **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**

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5)
$\tilde{V}_a = 80\angle 0°\ volts$ $\tilde{V}_{ab} = 138.6\angle 30°\ volts$
$\tilde{V}_b = 80\angle -120°\ volts$ $\tilde{V}_{bc} = 138.6\angle -90°\ volts$
$\tilde{V}_c = 80\angle -240°\ volts$ $\tilde{V}_{ca} = 138.6\angle -210°\ volts$
$\tilde{I}_a = 8\angle 36.9°\ amps$
$\tilde{I}_a = 8\angle -83.1°\ amps$
$\tilde{I}_a = 8\angle -203.1°\ amps$

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6)
$+13dB$
$-4.77dB$
$-20dB$
$+26dB$

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7)
$0.5mW$
$100mW$

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8)
a)
$f_o = 1838Hz$
$Q = 0.0866$
$f_1 = 1061Hz$
$f_2 = 3183Hz$
$BW = 2122Hz$

b)
$I_{max} = 30A$
$P_{max} = 1800W$

c)
$I_{co} = 21.2A$
$P_{max} = 900W$

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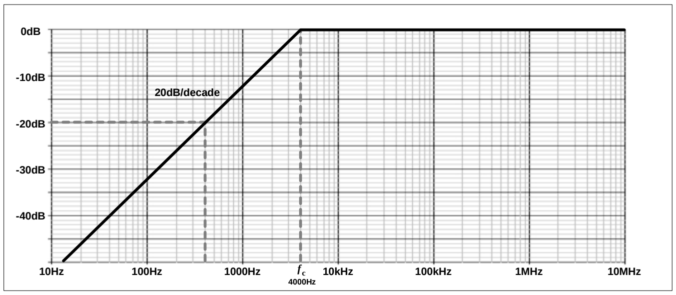
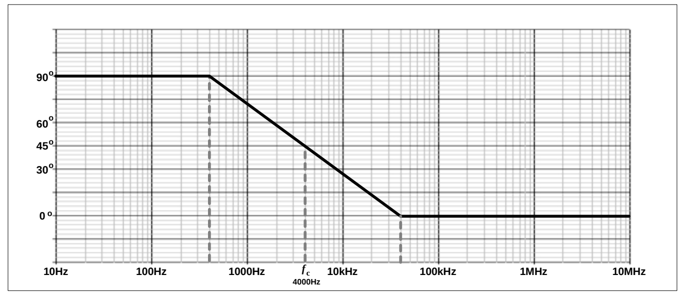
9) $f_c = 4000Hz$





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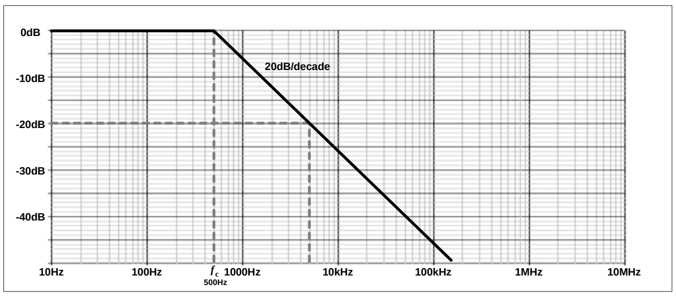
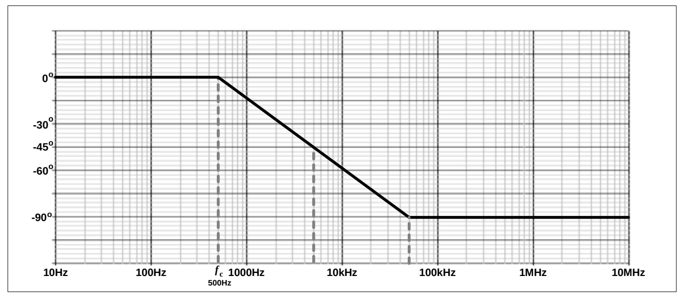
10) $f_c = 500Hz$





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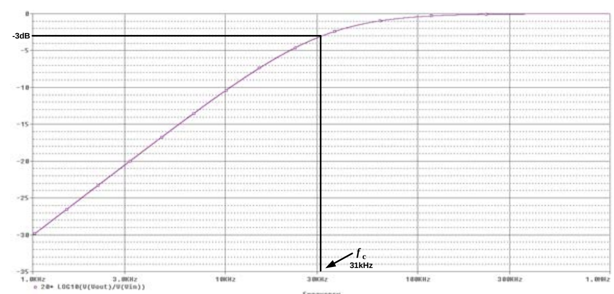
11) $f_c \approx 31kHz$

High Pass Filter



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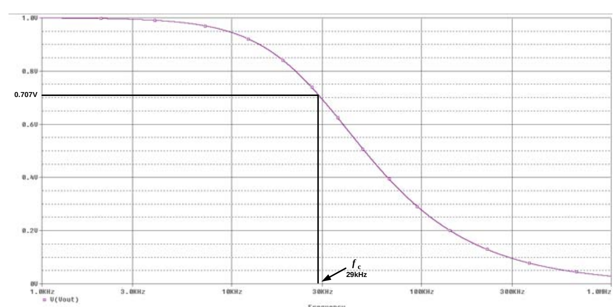
12) $f_c \approx 29kHz$

Low Pass Filter



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13)

$\widetilde{I}_{a1} = 2.121\angle -45°\ amps$ $\qquad S_{Y1} = 180 + j180$

$\widetilde{I}_{a2} = 1.5\angle 90°\ amps$ $\qquad S_{Y2} = 0 - j180$

$\widetilde{I}_{a} = 1.5\angle 0°\ amps$ $\qquad S_{source} = 180 + j0$

T/F) **True, True, True, False**