

Block B: AC circuits

Q1. Problem 4.49

For the circuit shown in Figure P4.49, the current $i_s(t) = I_0 \cos(\omega t + 30^\circ)$, $I_0 = 13\text{mA}$, $\omega = 1000 \frac{\text{rad}}{\text{s}}$, and the value of the capacitance C is $0.5\mu\text{F}$.

Find:

- The phasor notation for the source current.
- The impedance of the capacitor.
- The voltage across the capacitor, showing all the passages and using phasor notation only.

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Figure P4.49

Q2. Problem 4.50*(modified)

- For the circuit shown in Figure P4.50, find the current $i_3(t)$. Given that

$$i_1(t) = 141.4 \sin(\omega t + 135^\circ) \text{mA},$$

$$i_2(t) = 50 \cos(\omega t + 53.13^\circ) \text{mA}, \quad \omega = 377 \frac{\text{rad}}{\text{s}}.$$

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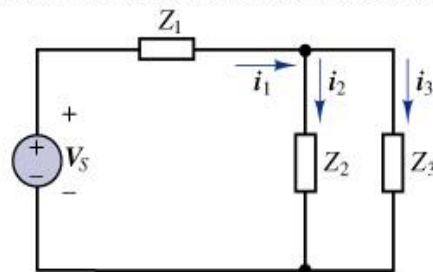


Figure P4.50

- If Z_1 is an resistor R in series with an inductor L where $R=50\Omega$ and $L=12.5\text{mH}$, determine the phase voltage V_{Z1} across Z_1 , and its corresponding voltage $v_{Z1}(t)$ in time domain.

Q3. Problem P4.51* (modified)

For the circuit shown in Figure 5.51, determine the current through Z_3 if

- $V_{S1} = V_{S2} = 170 \cos(377t) \text{ V}$;
- $V_{S1} = 170 \cos(377t) \text{ V}$ and $V_{S2} = 170 \cos(1000t) \text{ V}$;
- Please comment whether a change in the value of Z_1 or Z_2 will affect the answer in part (a) and (b) or not. Justify your answer.

Given that $Z_3 = 17 \angle 11^\circ \Omega$

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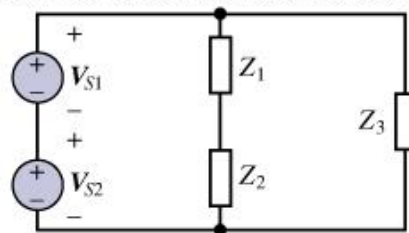


Figure P5.51

Q4. Problem 4.52

Given that the values of the impedance in the circuit shown in Figure P4.52 are $Z_s = (13000 + j\omega 3) \Omega$, $R = 120 \Omega$, $L = 19 \text{ mH}$, $C = 220 \text{ pF}$, determine the frequency such that the current I_i and the voltage V_o are in phase.

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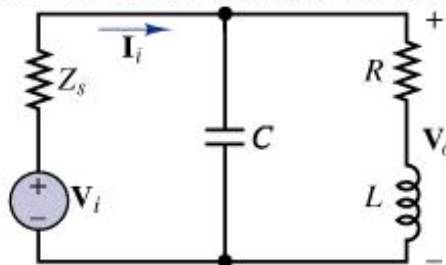


Figure 4.52

Q5. Problem 4.53

For the circuit shown in Figure P4.53, determine the current supplied by the source. Given that the values of the impedance, $R_s = 50\Omega$, $R_c = 40\Omega$, $L = 20\ \mu\text{H}$, $C = 1.25\ \text{nF}$, and the voltage applied to the circuit shown in Figure P4.53, $v_s(t) = V_0 \cos(\omega t + 0^\circ)$ $V_0 = 10\ \text{V}$, $\omega = 6\ \text{M}\frac{\text{rad}}{\text{s}}$.

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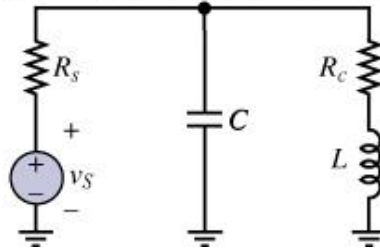


Figure P4.53

Q6. Problem P4.54* (modified)

- a) Determine the current in the circuit shown in Figure P4.54.

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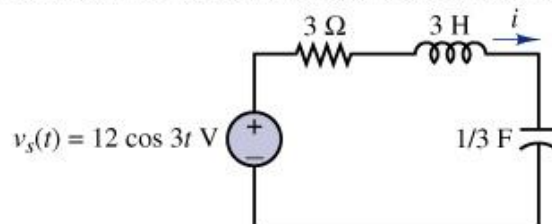


Figure P4.54

- b) If the frequency, ω , of the source is variable, determine at which frequency in rad/s such that the current i is maximum. Under this situation, calculate also the phasor voltage across the 3H inductor and 1/3F capacitor respectively. What can you observe?

Hint: maximum current occurs at which the equivalent impedance seen by the source v_s is resistive. Do you know why? You can use the previous finding to explain it.

Q7. Problem P4.57* (modified)

Determine the voltage V_2 of the circuit shown in Figure P4.57. It is given that the frequency of the source is 2 rad/s . Calculate also the current through the 6 H inductor and its power dissipation. What is the physical meaning if you find the answer (power dissipation) is a purely imaginary value?

Note: the source magnitude is in rms.

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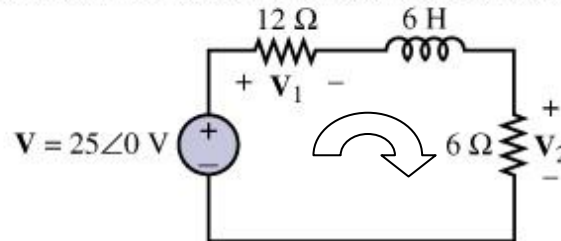


Figure P4.57

Q8. Problem P4.66

- Find the equivalent impedance Z_L shown in Figure P4.66(a), as seen by the source, if the frequency is 377 rad/s
- If we want the source to see the load as completely resistive, what value of capacitance should we place between the terminal a and b as shown in Figure P4.66(b)?

Hint: Find an expression for the equivalent impedance Z , and then find C so that the phase angle of the impedance is zero.

- What is the actual impedance that the source sees with the capacitor included in the circuit?

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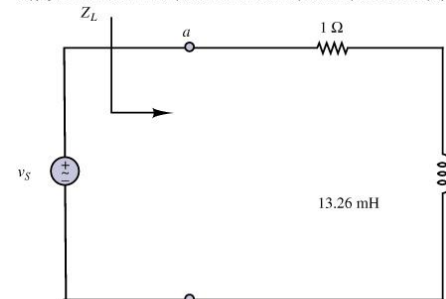
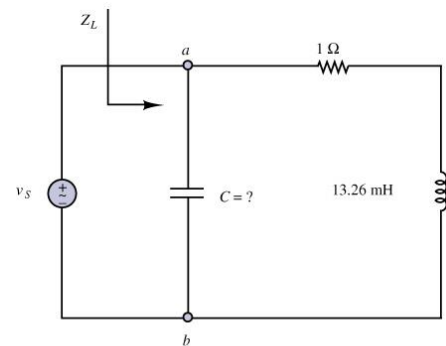


Figure 4.66 (a)



(b)

Q9. Problem P6.1**Find:**

- The frequency response for the circuit of Figure P6.1.
- Plot magnitude and phase of the circuit using a linear scale for frequency.
- Repeat part b., using semilog paper or otherwise
- Plot the magnitude response using semilog paper with magnitude in dB.

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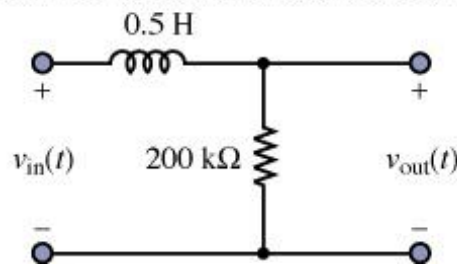


Figure P6.1

Hint: you can use MATLAB to help you to plot the graph.

Sample program to plot part (d):

```
f=linspace(0,10e6,100); %prepare 100 points between the range
H=abs((1+6.25e-12.*f.^2).^-1); %calculate the magnitude response
P=-atan(2.5e-6.*f)*180/pi; %calculate the phase response in deg
subplot(2,1,1);plot(f,H,'b');grid; %plot magnitude graph
title('Magnitude Response');
ylabel('Magnitude (absolute)');
subplot(2,1,2);plot(f,P,'r');grid; %plot phase graph
title('Phase Response');
ylabel('Phase (degree)');xlabel('Frequency (rad/s)');
```

Q10. Problem P6.3**Find:**

- The frequency response for the circuit of Figure P6.3.
- Plot magnitude and phase of the circuit using a linear scale for frequency.
- Repeat part b., using semilog paper.
- Plot the magnitude response using semilog paper with magnitude in dB.

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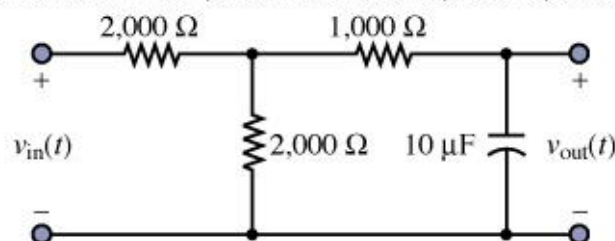


Figure P6.3

Q11. Problem P6.4

Given: $R_1=500\Omega$, $R_2=1000\Omega$, $L=2H$, $C=100\mu F$

Find:

- The frequency response for the circuit of Figure P6.4.
- Plot magnitude and phase of the circuit using a linear scale for frequency.
- Repeat part b., using semilog paper.
- Plot the magnitude response using semilog paper with magnitude in dB.

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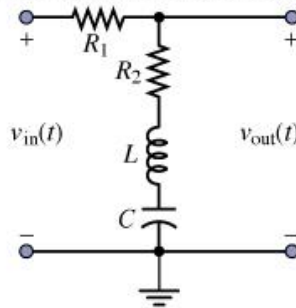


Figure P6.4

Q12. Problem P6.12

Compute and plot the frequency response function for the circuit shown in Figure 6.12 using semilog in frequency with magnitude in dB (Bode Plot).

Given that $R_1 = 100\Omega$; $R_L = 100\Omega$; $R_2 = 50\Omega$; $C = 80\text{ nF}$

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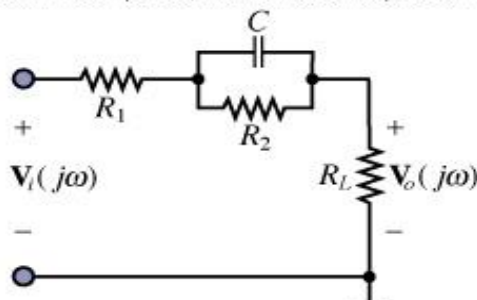


Figure P6.12

Q1.

a) $13\angle 30^\circ \text{ mA}$ b) $2\angle -90^\circ \text{ k}\Omega$ c) $26\angle -60^\circ \text{ V}$

Q2.

a) $i_3(t) = 92.17 \cos(\omega t + 40.60^\circ) \text{ mA}$
 b) $7.1\text{V}\angle 50.38^\circ$

Q3.

a) $20\angle -11^\circ \text{ A}$
 b) $i_3(t) = 10 \cos\left(377 \frac{\text{rad}}{\text{s}} \cdot t - 11^\circ\right) + 10 \cos\left(1000 \frac{\text{rad}}{\text{s}} \cdot t - 11^\circ\right) \text{ A}$
 c) NO

Q4.

$$489.1\text{k} \frac{\text{rad}}{\text{s}}$$

Q5.

$$i_s(t) = 22.22 \cos(\omega t + 0^\circ) \text{ mA}$$

Q6.

$$i(t) = 1.4 \cos(\omega t - 69.4^\circ) \text{ A}$$

1 rad/s; j6V (inductor); -j6V (capacitor)

Q7.

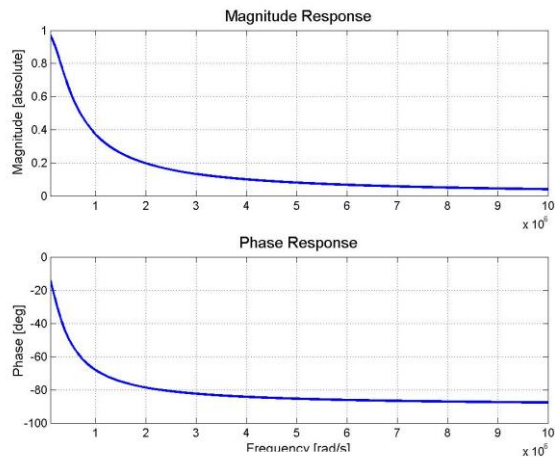
$$6.93\angle -33.7^\circ \text{ V} \quad 1.156\angle -33.7^\circ \text{ A} \quad -j16\text{VAr}$$

Q8.

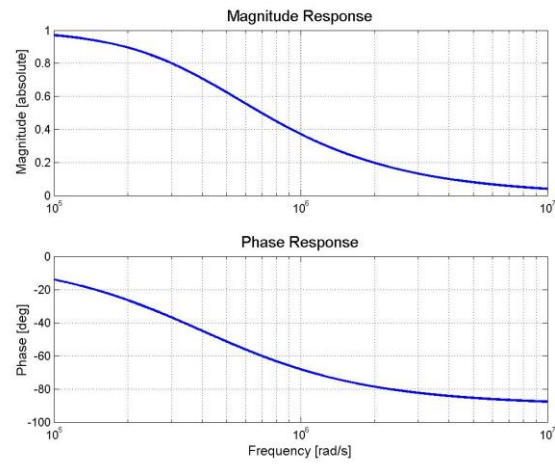
$$1+j5 \Omega \quad 5101.1\mu\text{F} \quad 26\Omega$$

Q9.

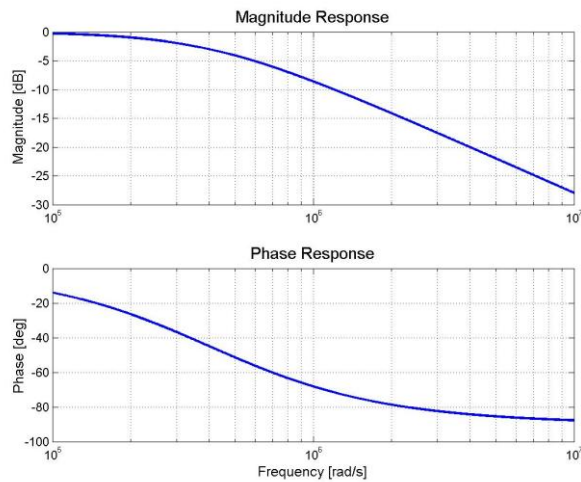
(a) Magnitude Response $\frac{1}{\sqrt{1 + 6.25 \times 10^{-12} \omega^2}}$; Phase Response $-\arctan(2.5 \times 10^{-6} \omega)$



(b)



(c)

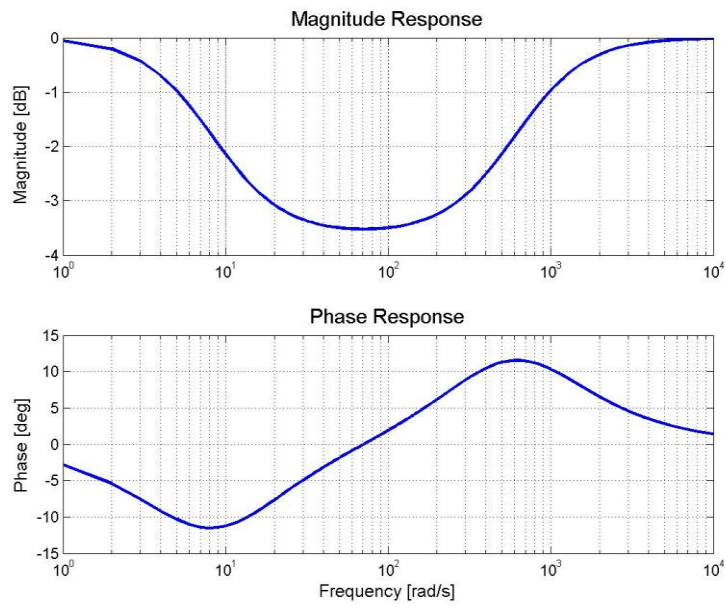


(d)

Q10. Magnitude response: $\frac{0.5}{\sqrt{1 + 4 \times 10^{-4} \omega^2}}$

Phase response: $-\arctan(0.02\omega)$

Q11. $\frac{v_{out}}{v_{in}}(j\omega) = \frac{1 - 0.0002\omega^2 + j(0.1)\omega}{1 - 0.0002\omega^2 + j(0.15)\omega}$



Q12.
$$H_v[j\omega] = \frac{R_L}{R_1 + R_2 + R_L} \frac{1 + j\omega R_2 C}{1 + j \frac{[R_1 + R_L] \omega R_2 C}{R_1 + R_2 + R_L}}$$

