

23W-EC ENGR-10-LEC-1 Hw #5

SANJIT SARDA

TOTAL POINTS

91.5 / 100

QUESTION 1

Problem 1 6 pts

1.1 a 2 / 2

✓ - 0 pts *Correct*
- 2 pts incorrect

1.2 b 2 / 2

✓ - 0 pts *Correct*
- 2 pts incorrect

1.3 c 2 / 2

✓ - 0 pts *Correct*
- 2 pts incorrect

QUESTION 2

Problem 2 4 pts

2.1 a 2 / 2

✓ - 0 pts *Correct*
- 2 pts incorrect

2.2 b 2 / 2

✓ - 0 pts *Correct*
- 2 pts incorrect

QUESTION 3

Problem 3 10 pts

3.1 (a) 4 / 4

✓ - 0 pts *Correct*
- 2 pts incorrect
- 0.5 pts small calculation error

3.2 (b) 2 / 3

- 0 pts *Correct*
✓ - 1 pts *partially incorrect*
- 2 pts incorrect

3.3 (c) 3 / 3

✓ - 0 pts *Correct*
- 2 pts incorrect

QUESTION 4

4 Problem 3 10 / 10

✓ - 0 pts *Correct*
- 3 pts incorrect V_o
- 3 pts incorrect I

QUESTION 5

5 Problem 4 10 / 15

- 0 pts *Correct*
✓ - 5 pts I_N incorrect
- 5 pts V_c incorrect
- 3 pts didnt calculate the final answer
- 1 pts small calculation error in V_C and I_N

- 15 pts missing

QUESTION 6

Problem 5 15 pts

6.1 a 4 / 5

- 0 pts Correct

✓ - 1 pts *incorrect sign*

- 2 pts incorrect answer

- 5 pts missing

6.2 b 5 / 5

✓ - 0 pts Correct

- 3 pts didnt convert diagram to two impedance in parallel

- 2 pts incorrect or missing too much steps that lead to did not get the final correct answer

- 0.5 pts small calculation error

- 5 pts missing

6.3 c 4 / 5

- 0 pts Correct

✓ - 1 pts *wrong direction*

- 5 pts missing answer

QUESTION 7

7 Problem 6 10 / 10

✓ - 0 pts Correct

- 5 pts Incomplete transformation leading to incorrect answer

- 1 pts small calculation error

- 10 pts missing

QUESTION 8

Problem 7 20 pts

8.1 a 6 / 6

✓ - 0 pts Correct

- 6 pts missing

8.2 b 3 / 3

✓ - 0 pts Correct

- 2 pts incorrect

- 3 pts missing

8.3 c 5.5 / 6

- 0 pts Correct

✓ - 0.5 pts *calculation error*

- 3 pts incorrect

- 6 pts missing

8.4 d 5 / 5

✓ - 0 pts Correct

- 2 pts method is incorrect leading to wrong ω

- 5 pts missing

QUESTION 9

9 Problem 8 10 / 10

✓ - 0 pts Correct

- 5 pts Wrong method leading to wrong answer

- 2 pts correct method but got the wrong answer

- 10 pts missing answer

ECE 10 HW5

$$2\pi = 360 \quad \pi = 180$$

$$\sin t = \cos\left(\frac{\pi}{2} - t\right)$$

$$= \cos\left(t + \frac{3\pi}{2}\right)$$

①

$$\textcircled{a} x(t) = -2\sin(100\pi t - 135^\circ)$$

$$= 2\sin(135^\circ - 100\pi t)$$

$$= 2\sin\left(\frac{3\pi}{4} - 100\pi t\right)$$

$$= 2\cos\left(-\frac{3\pi}{4} + \frac{2\pi}{4} + 100\pi t\right)$$

$$= 2\cos\left(-\frac{\pi}{4} + 100\pi t\right)$$

$$= 2\cos(100\pi t - \pi/4)$$

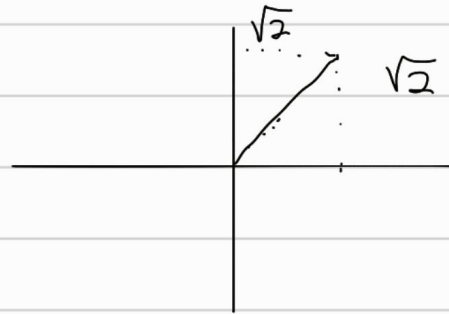
$$\therefore X = 2e^{j\pi/4}$$

$$\textcircled{b} x(t) = 12\sin(100\pi t + 135^\circ) + 5\cos(100\pi t + 60^\circ)$$

$$12\sin\left(100\pi t + \frac{3\pi}{4}\right) + 5\cos\left(100\pi t + \frac{\pi}{3}\right)$$

$$= 12\cos\left(100\pi t + \frac{\pi}{4}\right) + 5\cos\left(100\pi t + \frac{\pi}{3}\right)$$

$$\therefore X = 12e^{j\pi/4} + 5e^{j\pi/3}$$



③ DNE

1.1 a 2 / 2

✓ - 0 pts Correct

- 2 pts incorrect

ECE 10 HW5

$$2\pi = 360 \quad \pi = 180$$

$$\sin t = \cos\left(\frac{\pi}{2} - t\right)$$

$$= \cos\left(t + \frac{3\pi}{2}\right)$$

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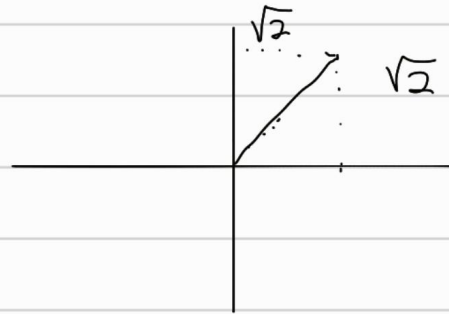
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$$\therefore X = 12e^{j\pi/4} + 5e^{j\pi/3}$$



③ DNE

1.2 b 2 / 2

✓ - 0 pts Correct

- 2 pts incorrect

ECE 10 HW5

$$2\pi = 360 \quad \pi = 180$$

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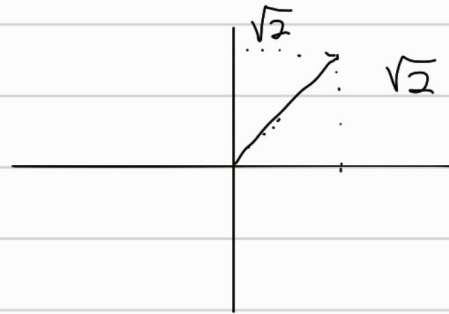
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$$= 12\cos\left(100\pi t + \frac{\pi}{4}\right) + 5\cos\left(100\pi t + \frac{\pi}{3}\right)$$

$$\therefore X = 12e^{j\pi/4} + 5e^{j\pi/3}$$



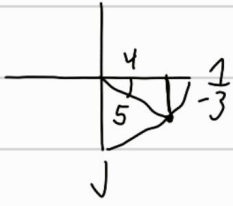
③ DNE

1.3 C 2 / 2

✓ - 0 pts Correct

- 2 pts incorrect

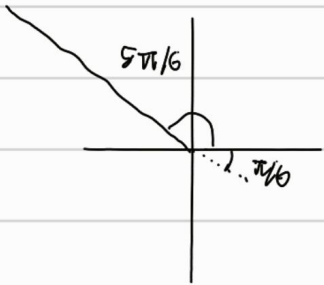
② a) $x = 4 - j3$ $\omega = 70 \text{ K rad/s}$



$$= 4\cos(\omega t) - 3\sin(\omega t)$$

$$= 4\cos(70000t) - 3\sin(70000t)$$

⑥ $-8e^{-j\pi/6}$, $\omega = 100 \text{ rad/s}$



$$x = 8e^{5\pi/6}$$

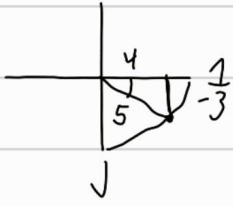
$$x(t) = 8\cos(100t + 5\pi/6)$$

2.1 a 2 / 2

✓ - 0 pts Correct

- 2 pts incorrect

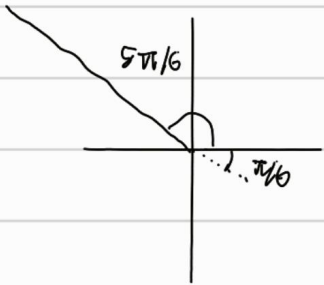
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$$x = 8e^{5\pi/6}$$

$$x(t) = 8\cos(100t + 5\pi/6)$$

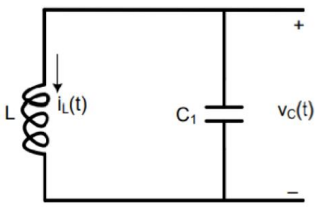
2.2 b 2 / 2

✓ - 0 pts Correct

- 2 pts incorrect

3

a



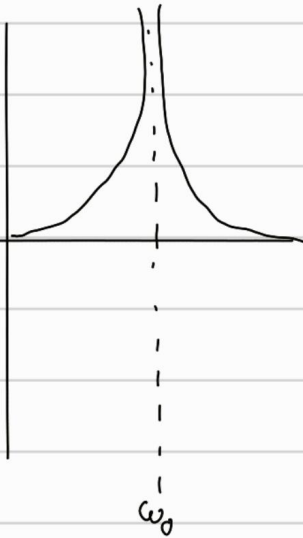
$$Z_L = j\omega L \quad Z_C = \frac{1}{j\omega C}$$

$$\therefore Z_{eq} = Z_L \parallel Z_C = \left(\frac{1}{j\omega L} + j\omega C \right)^{-1} = \left(\frac{1 + j\omega C j\omega L}{j\omega L} \right)^{-1} \\ = \frac{j\omega L}{1 - \omega^2 LC}$$

b

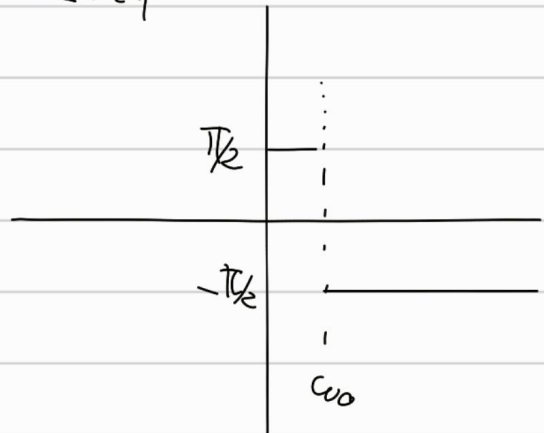
Magnitude

$|Z_{eq}|$



Phase

$\angle Z_{eq}$



$$\omega = \frac{1}{\sqrt{LC}} = 4 \text{E}9 \text{ rad/s}$$

$$\therefore f = \frac{\omega}{2\pi} = 6.37 \text{E}6 \text{ Hz}$$

3.1 (a) 4 / 4

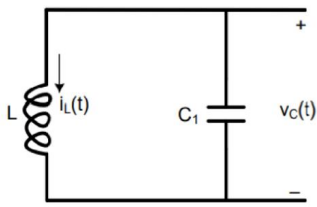
✓ - 0 pts Correct

- 2 pts incorrect

- 0.5 pts small calculation error

3

a



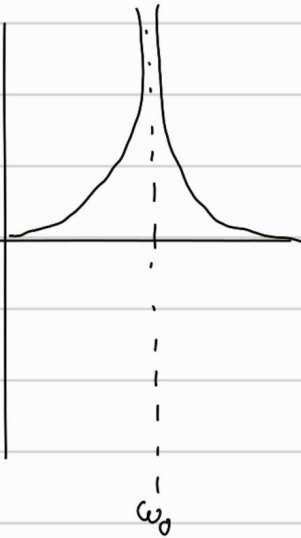
$$z_L = j\omega L \quad z_C = \frac{1}{j\omega C}$$

$$\therefore z_{eq} = z_L \parallel z_C = \left(\frac{1}{j\omega L} + j\omega C \right)^{-1} = \left(\frac{1 + j\omega C j\omega L}{j\omega L} \right)^{-1} \\ = \frac{j\omega L}{1 - \omega^2 LC}$$

b

Magnitude

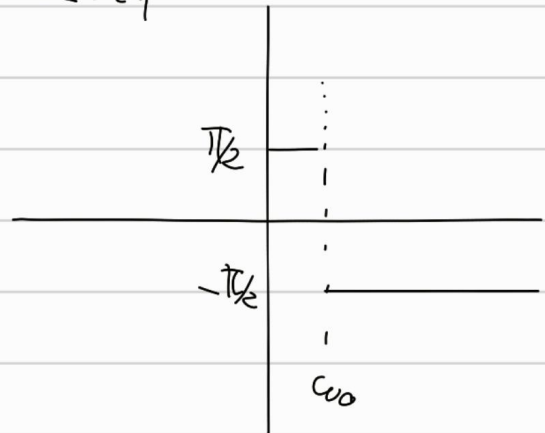
$|z_{eq}|$



Phase

$\angle z_{eq}$

ω



$$\omega = \frac{1}{\sqrt{LC}} = 4 \text{E}9 \text{ rad/s}$$

$$\therefore f = \frac{\omega}{2\pi} = 6.37 \text{E}6 \text{ Hz}$$

3.2 (b) 2 / 3

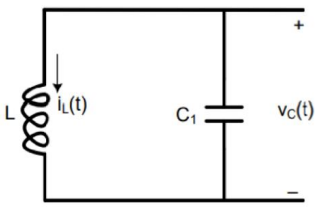
- 0 pts Correct

✓ - 1 pts *partially incorrect*

- 2 pts incorrect

3

a



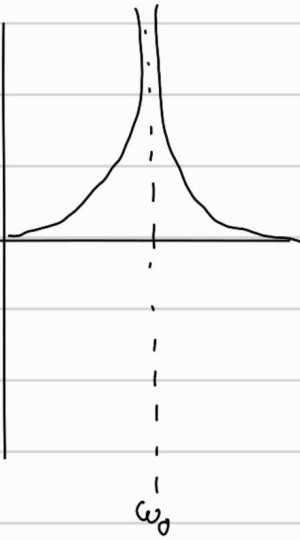
$$Z_L = j\omega L \quad Z_C = \frac{1}{j\omega C}$$

$$\therefore Z_{eq} = Z_L \parallel Z_C = \left(\frac{1}{j\omega L} + j\omega C \right)^{-1} = \left(\frac{1 + j\omega C j\omega L}{j\omega L} \right)^{-1} \\ = \frac{j\omega L}{1 - \omega^2 LC}$$

b

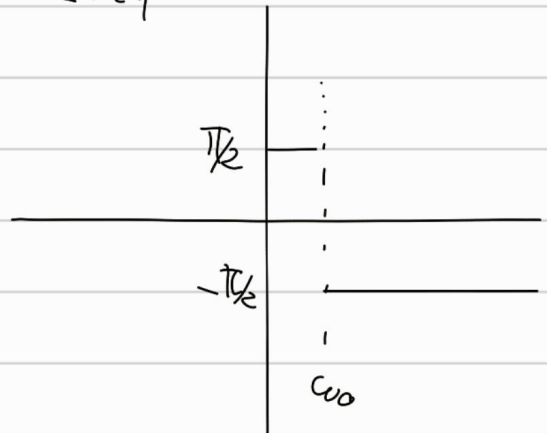
Magnitude

$|Z_{eq}|$



Phase

$\angle Z_{eq}$



$$\omega = \frac{1}{\sqrt{LC}} = 4 \text{E}9 \text{ rad/s}$$

$$\therefore f = \frac{\omega}{2\pi} = 6.37 \text{E}6 \text{ Hz}$$

3.3 (c) 3 / 3

✓ - 0 pts Correct

- 2 pts incorrect

(4)

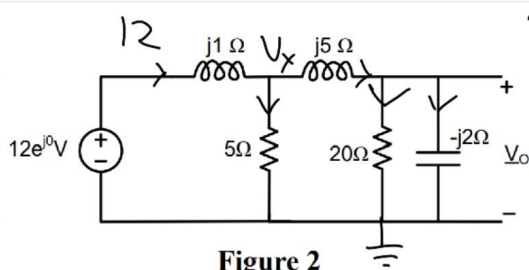


Figure 2

$$V = \frac{1}{j\omega C} I$$

$$V = (j\omega L) I$$

$$12 = V_x + V_o$$

$$\frac{12 - V_x}{j} = \frac{V_x}{5} + \frac{V_x - 6}{5j}$$

$$\frac{V_x - V_o}{j5} = \frac{V_o}{20} + \frac{V_o}{-j2} \quad \therefore \frac{V_x - V_o}{5j} = V_o \left(\frac{1}{20} + \frac{10j}{2} \right)$$

Solving, $V_x = 8.8 - 1.5j \text{ V}$
 $V_o = -5.85 \text{ V}$

$$Z_{eq} = \left(\left(\left((-j2)^{-1} + 20^{-1} \right)^{-1} + 5j \right)^{-1} + 5^{-1} \right)^{-1} + j$$

$$\therefore Z_{eq} = \frac{205 + 451j}{146}$$

$$\therefore I = \frac{V}{R} = \frac{12 \angle 0^\circ}{205 + 461j} = 1.5 - 3.2j \text{ A}$$

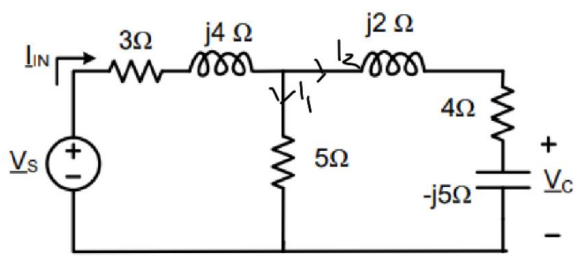
4 Problem 3 10 / 10

✓ - 0 pts Correct

- 3 pts incorrect Vo

- 3 pts incorrect I

5



$$I_n = I_1 + I_2$$

$$V_s - 3I_n - 4jI_n - 5I_1 = 0$$

$$5I_1 - 2jI_2 - 4I_2 - -5jI_2 = 0$$

$$\therefore V_s = (3 + 4j)I_n + 5I_1$$

$$\therefore 5I_1 = (7 + 4j)I_2$$

Solving for I_n, I_1, I_2 ,

$$I_n = \frac{198}{145} - \frac{114}{145}j = 0.55 - 0.62j \text{ A}$$

$$V_c = -5jI_2 = -5j(I_n - I_1) = -0.83 - 4.07j \text{ V}$$

5 Problem 4 10 / 15

- 0 pts Correct

✓ - 5 pts I_N incorrect

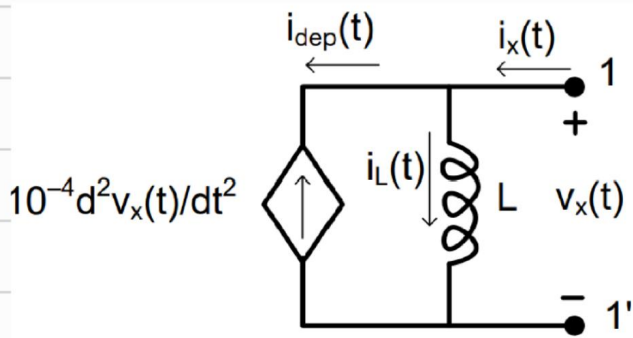
- 5 pts V_c incorrect

- 3 pts didn't calculate the final answer

- 1 pts small calculation error in V_C and I_N

- 15 pts missing

⑥



$$Z_L = 10 \cdot 10 \cdot j = 100j$$

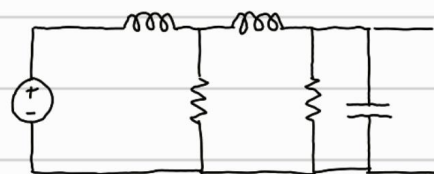
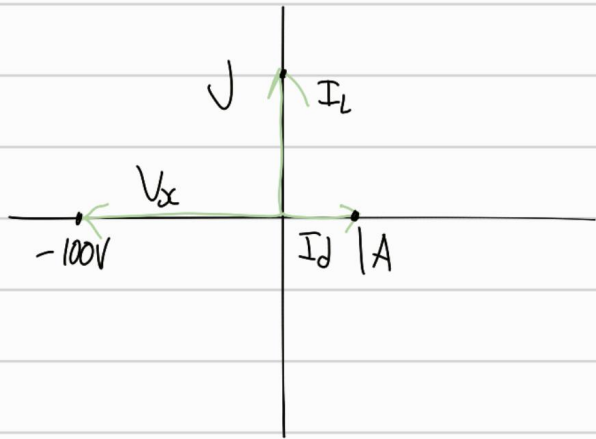
$$-I_d = j^2 \omega^2 10^{-4} V_x$$

① $\therefore -I_d = -100 \cdot 10^{-4} V_x \therefore I_d = 10^{-2} V_x$

② $V = IZ \therefore V_x = I_d \cdot Z \therefore V_x = 10^{-2} V_x Z \therefore Z = 100 \Omega$

$$Z_{eq} = (100^{-1} + (100j)^{-1})^{-1} = 50 + 50j$$

③ $V_x = -100V, I_L = jA, I_d = 1A$



6.1 a 4 / 5

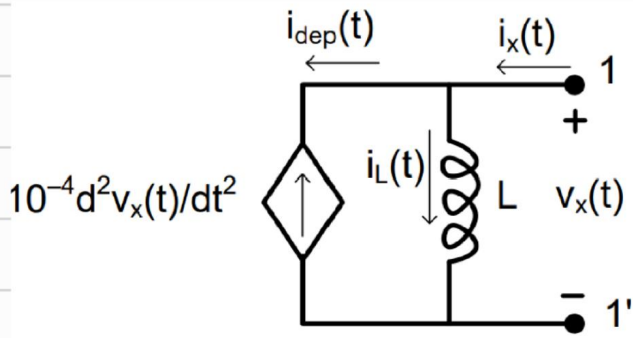
- 0 pts Correct

✓ - 1 pts *incorrect sign*

- 2 pts incorrect answer

- 5 pts missing

⑥



$$Z_L = 10 \cdot 10 \cdot j = 100j$$

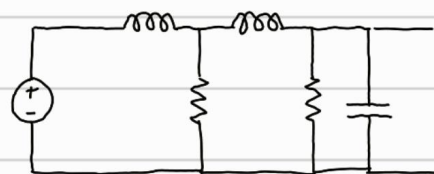
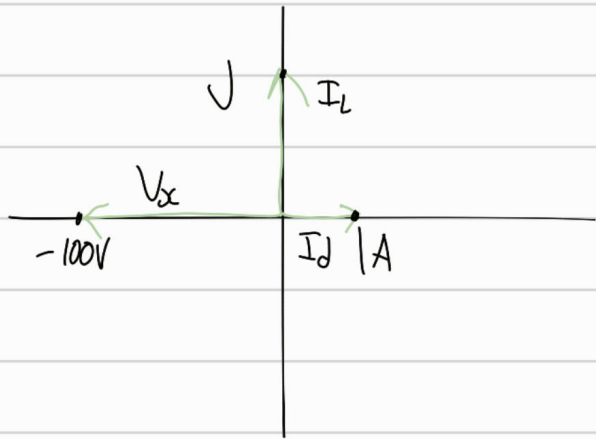
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① $\therefore -I_d = -100 \cdot 10^{-4} V_x \therefore I_d = 10^{-2} V_x$

② $V = IZ \therefore V_x = I_d \cdot Z \therefore V_x = 10^{-2} V_x Z \therefore Z = 100 \Omega$

$$Z_{eq} = (100^{-1} + (100j)^{-1})^{-1} = 50 + 50j$$

③ $V_x = -100V, I_L = jA, I_d = 1A$

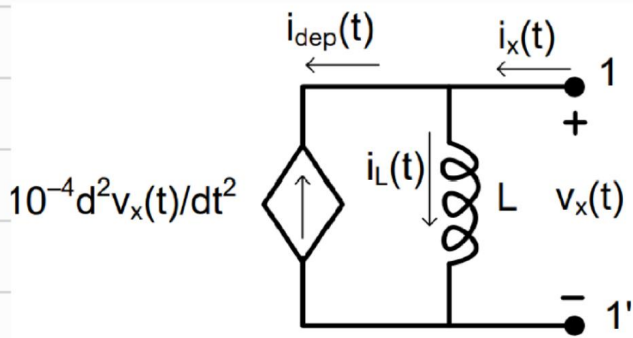


6.2 b 5 / 5

✓ - 0 pts Correct

- 3 pts didnt convert diagram to two impedance in parallel
- 2 pts incorrect or missing too much steps that lead to did not get the final correct answer
- 0.5 pts small calculation error
- 5 pts missing

⑥



$$Z_L = 10 \cdot 10 \cdot j = 100j$$

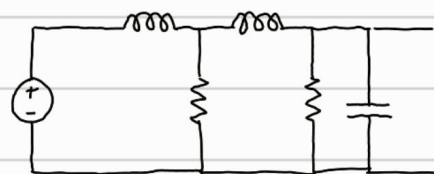
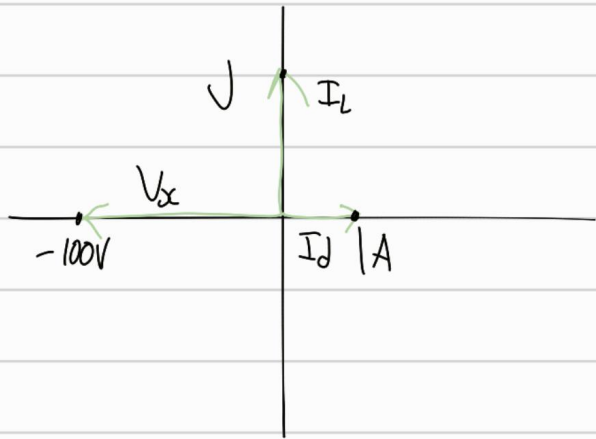
$$-I_d = j^2 \omega^2 10^{-4} V_x$$

① $\therefore -I_d = -100 \cdot 10^{-4} V_x \therefore I_d = 10^{-2} V_x$

② $V = IZ \therefore V_x = I_d \cdot Z \therefore V_x = 10^{-2} V_x Z \therefore Z = 100 \Omega$

$$Z_{eq} = (100^{-1} + (100j)^{-1})^{-1} = 50 + 50j$$

③ $V_x = -100V, I_L = jA, I_d = 1A$



6.3 C 4 / 5

- 0 pts Correct

✓ - 1 pts *wrong direction*

- 5 pts missing answer

7

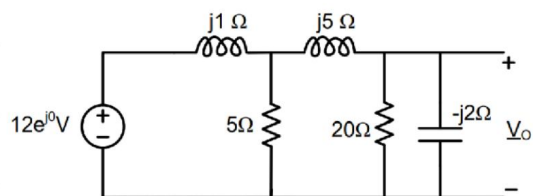
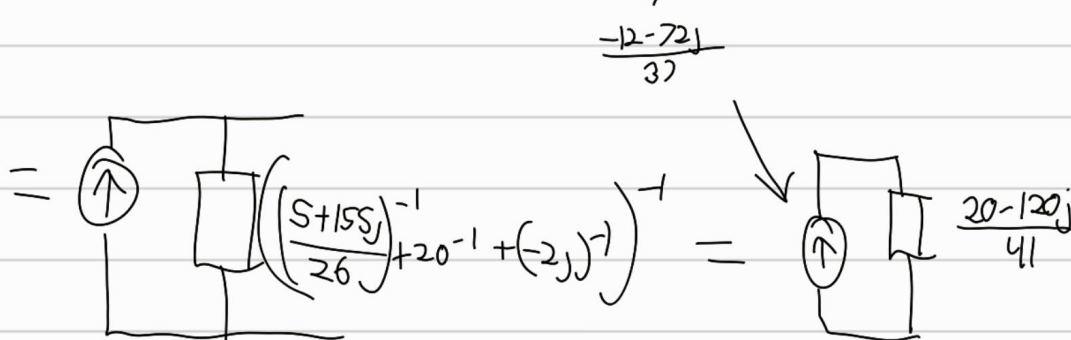
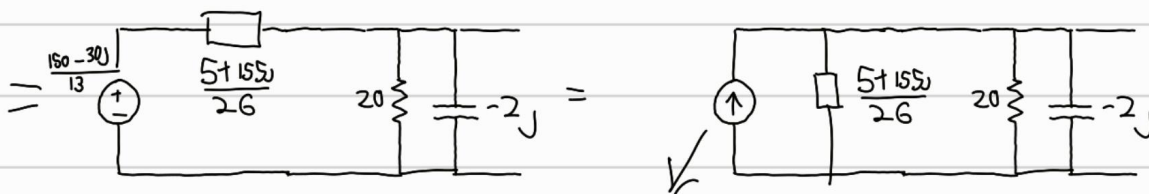
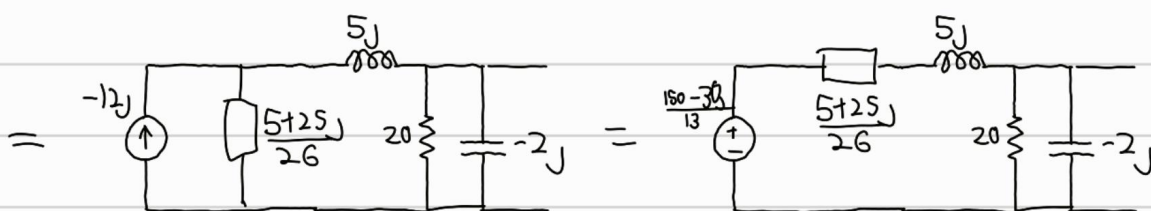
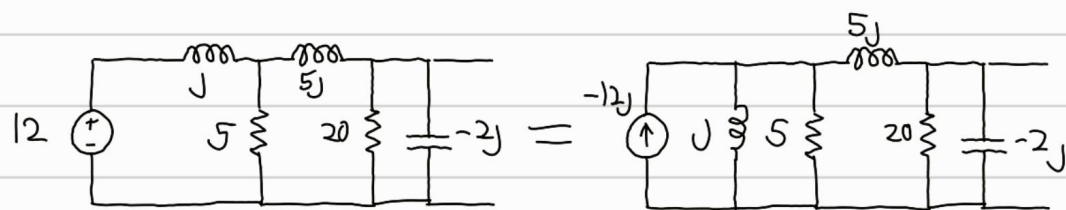


Figure 2



$$\therefore V = IZ$$

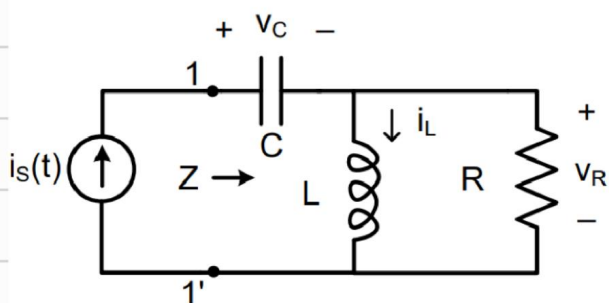
$$= \frac{-240}{41} = -5.85$$

7 Problem 6 10 / 10

✓ - 0 pts *Correct*

- 5 pts Incomplete transformation leading to incorrect answer
- 1 pts small calculation error
- 10 pts missing

8



$$Z_{eq} = Z_L \parallel Z_R + Z_C = \frac{Z_L Z_R}{Z_L + Z_R} + Z_C = \frac{Z_L Z_R + Z_C (Z_L + Z_R)}{Z_L + Z_R}$$

$$Z_L = j10^{-9} \omega$$

$$Z_R = 10$$

$$Z_C = \frac{-j}{\omega} \cdot 10^{12}$$

$$\therefore Z_{eq} = \frac{j\omega C (j\omega L + j\omega C R + j\omega L R)}{j\omega L + R}$$

$$(a) = \boxed{\frac{-\omega^2 LC + j\omega R(C+L)}{j\omega L + R}}$$

(b) $\omega < 10 \text{ rad/s}$, $Z_{eq} = -100j + \frac{10j}{j+10}$ \therefore the load is capacitive
Since $\text{Im}[Z_{eq}] = -10000/101$

(c) $i_s(t) = 2 \cos(10^{10} t - \pi/6)$ $\therefore I_s = 2e^{-j\pi/6} = \sqrt{3} - j$

$$V_C = -10j I_s = -10 - 10\sqrt{3}j = 20e^{-\frac{2\pi}{3}}$$

$$I_L = \frac{1}{1+j} I_s = \frac{\sqrt{3}-j}{1+j} = \frac{\sqrt{3}-1}{2} - \frac{\sqrt{3}+1}{2}j = \sqrt{2} e^{-\frac{5\pi}{12}j}$$

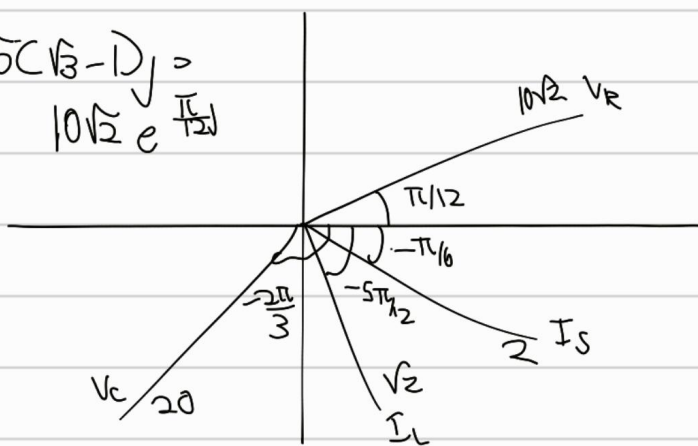
$$V_R = 10j I_L = 5C(\sqrt{3}+1) + 5C(\sqrt{3}-1)j = 10\sqrt{2} e^{-\frac{\pi}{12}j}$$

$$Z_{eq} = \frac{\omega^2 L^2 R}{R^2 + (\omega L)^2}$$

$$+ j \left(\frac{\omega L R^2}{R^2 + (\omega L)^2} - \frac{1}{\omega C} \right)$$

\therefore Resistive (a)

$$\frac{\omega L R^2}{R^2 + (\omega L)^2} = \frac{1}{\omega C}$$

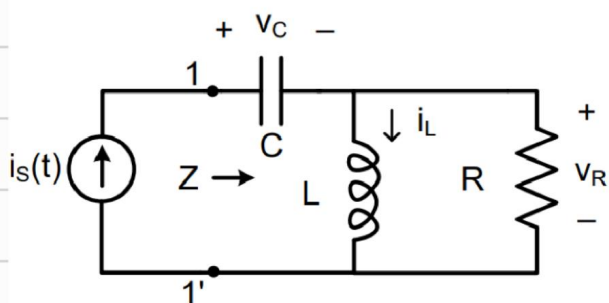


8.1 a 6 / 6

✓ - 0 pts Correct

- 6 pts missing

8



$$Z_{eq} = Z_L \parallel Z_R + Z_C = \frac{Z_L Z_R}{Z_L + Z_R} + Z_C = \frac{Z_L Z_R + Z_C (Z_L + Z_R)}{Z_L + Z_R}$$

$$Z_L = j10^{-9} \omega$$

$$Z_R = 10$$

$$Z_C = \frac{-j}{\omega} \cdot 10^{12}$$

$$\therefore Z_{eq} = \frac{j\omega C (j\omega L + j\omega C R + j\omega L R)}{j\omega L + R}$$

$$(a) = \boxed{\frac{-\omega^2 LC + j\omega R(C+L)}{j\omega L + R}}$$

(b) $\omega < 10 \text{ rad/s}$, $Z_{eq} = -100j + \frac{10j}{j+10}$ \therefore the load is capacitive
Since $\text{Im}[Z_{eq}] = -10000/101$

(c) $i_s(t) = 2\cos(10^{10}t - \pi/6)$ $\therefore I_s = 2e^{-j\pi/6} = \sqrt{3} - j$

$$V_C = -10j I_s = -10 - 10\sqrt{3}j = 20e^{-\frac{2\pi}{3}}$$

$$I_L = \frac{1}{1+j} I_s = \frac{\sqrt{3}-j}{1+j} = \frac{\sqrt{3}-1}{2} - \frac{\sqrt{3}+1}{2}j = \sqrt{2} e^{-\frac{5\pi}{12}}$$

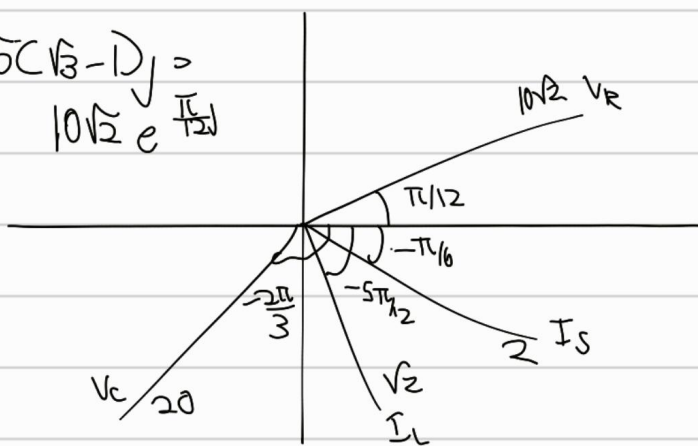
$$V_R = 10j I_L = 5C(\sqrt{3}+1) + 5C(\sqrt{3}-1)j = 10\sqrt{2} e^{-\frac{\pi}{12}}$$

$$Z_{eq} = \frac{\omega^2 L^2 R}{R^2 + (\omega L)^2}$$

$$+ j \left(\frac{\omega L R^2}{R^2 + (\omega L)^2} - \frac{1}{\omega C} \right)$$

\therefore Resistive (a)

$$\frac{\omega L R^2}{R^2 + (\omega L)^2} = \frac{1}{\omega C}$$



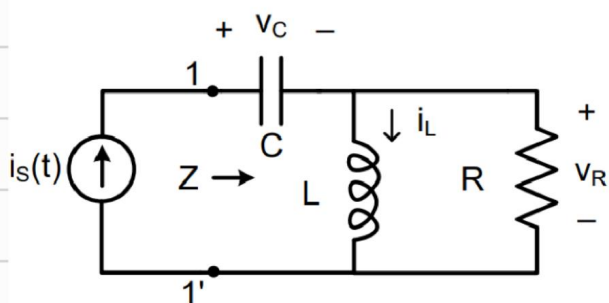
8.2 b 3 / 3

✓ - 0 pts Correct

- 2 pts incorrect

- 3 pts missing

8



$$Z_{eq} = Z_L \parallel Z_R + Z_C = \frac{Z_L Z_R}{Z_L + Z_R} + Z_C = \frac{Z_L Z_R + Z_C (Z_L + Z_R)}{Z_L + Z_R}$$

$$Z_L = j10^{-9} \omega$$

$$Z_R = 10$$

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$$\therefore Z_{eq} = \frac{j\omega C (j\omega L + j\omega C R + j\omega L R)}{j\omega L + R}$$

$$(a) = \boxed{\frac{-\omega^2 LC + j\omega R(C+L)}{j\omega L + R}}$$

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Since $\text{Im}[Z_{eq}] = -10000/101$

(c) $i_s(t) = 2\cos(10^{10}t - \pi/6)$ $\therefore I_s = 2e^{-j\pi/6} = \sqrt{3} - j$

$$V_C = -10j I_s = -10 - 10\sqrt{3}j = 20e^{-\frac{2\pi}{3}}$$

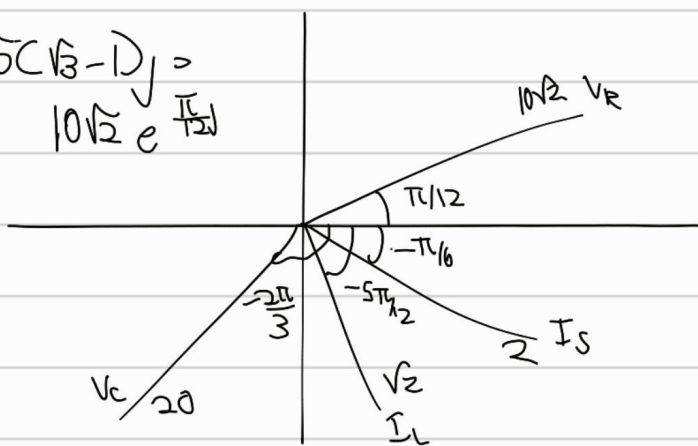
$$I_L = \frac{1}{1+j} I_s = \frac{\sqrt{3}-j}{1+j} = \frac{\sqrt{3}-1}{2} - \frac{\sqrt{3}+1}{2}j = \sqrt{2} e^{-\frac{5\pi}{12}}$$

$$V_R = 10j I_L = 5(\sqrt{3}+1) + 5(\sqrt{3}-1)j = 10\sqrt{2} e^{j\frac{\pi}{12}}$$

$$Z_{eq} = \frac{\omega^2 L^2 R}{R^2 + (\omega L)^2} + j \left(\frac{\omega L R^2}{R^2 + (\omega L)^2} - \frac{1}{\omega C} \right)$$

\therefore Resistive (a)

$$\frac{\omega L R^2}{R^2 + (\omega L)^2} = \frac{1}{\omega C}$$



8.3 C 5.5 / 6

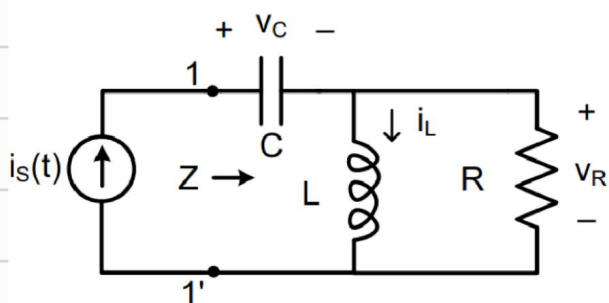
- 0 pts Correct

✓ - 0.5 pts *calculation error*

- 3 pts incorrect

- 6 pts missing

8



$$Z_{eq} = Z_L \parallel Z_R + Z_C = \frac{Z_L Z_R}{Z_L + Z_R} + Z_C = \frac{Z_L Z_R + Z_C (Z_L + Z_R)}{Z_L + Z_R}$$

$$Z_L = j10^{-9} \omega$$

$$Z_R = 10$$

$$Z_C = \frac{-j}{\omega} \cdot 10^{12}$$

$$\therefore Z_{eq} = \frac{j\omega C (j\omega L + j\omega C R + j\omega L R)}{j\omega L + R}$$

$$(a) = \boxed{\frac{-\omega^2 LC + j\omega R(C+L)}{j\omega L + R}}$$

(b) $\omega < 10 \text{ rad/s}$, $Z_{eq} = -100j + \frac{10j}{j+10}$ \therefore the load is capacitive
Since $\text{Im}[Z_{eq}] = -10000/101$

(c) $i_s(t) = 2 \cos(10^{10} t - \pi/6)$ $\therefore I_s = 2e^{-j\pi/6} = \sqrt{3} - j$

$$V_C = -10j I_s = -10 - 10\sqrt{3}j = 20e^{-\frac{2\pi}{3}}$$

$$I_L = \frac{1}{1+j} I_s = \frac{\sqrt{3}-j}{1+j} = \frac{\sqrt{3}-1}{2} - \frac{\sqrt{3}+1}{2}j = \sqrt{2} e^{-\frac{5\pi}{12}}$$

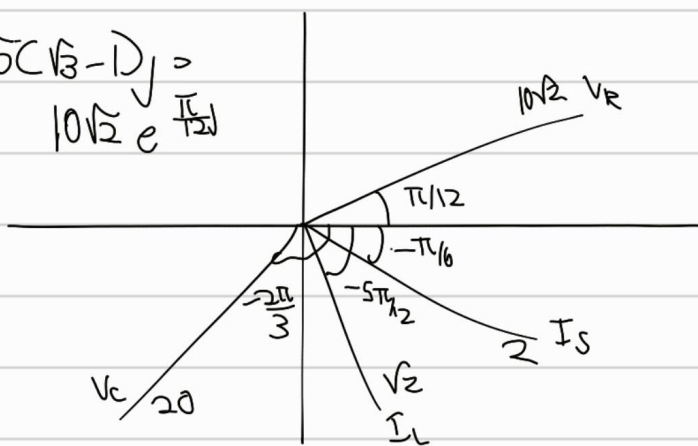
$$V_R = 10j I_L = 5(\sqrt{3}+1) + 5(\sqrt{3}-1)j = 10\sqrt{2} e^{j\frac{\pi}{12}}$$

$$Z_{eq} = \frac{\omega^2 L^2 R}{R^2 + (\omega L)^2}$$

$$+ j \left(\frac{\omega L R^2}{R^2 + (\omega L)^2} - \frac{1}{\omega C} \right)$$

\therefore Resistive (a)

$$\frac{\omega L R^2}{R^2 + (\omega L)^2} = \frac{1}{\omega C}$$



$$\therefore \frac{\omega^2}{R^2 + (\omega L)^2} = \frac{1}{LCR^2}$$

$$\therefore \omega^2 = \frac{R^2 + \omega^2 L^2}{LCR^2}$$

$$\therefore \omega^2 \left(\frac{LCR^2 - L^2}{LCR^2} \right) = \frac{R^2}{LCR^2}$$

$$\therefore \omega^2 = \frac{R^2}{LCR^2 - L^2} \quad \therefore \omega = \omega_0$$

\therefore It becomes purely resistive @ $\omega = \omega_0$

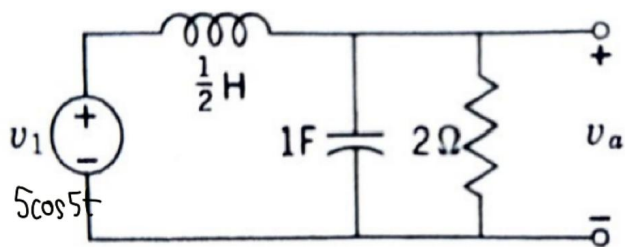
8.4 d 5 / 5

✓ - 0 pts Correct

- 2 pts method is incorrect leading to wrong ω

- 5 pts missing

9



$$Z_B = \left(\left(\frac{1}{5j} \right)^{-1} + 2^{-1} \right)^{-1} = \frac{2-20j}{101}$$

$$V_a = \frac{5Z_B}{Z_B + \frac{5}{2}} = \frac{-920-100j}{2141} = 0.43e^{-3j}$$

9 Problem 8 10 / 10

✓ - **0 pts** *Correct*

- **5 pts** Wrong method leading to wrong answer
- **2 pts** correct method but got the wrong answer
- **10 pts** missing answer