BRAC University

Department of Electrical & Electronic Engineering
Assignment 1a, Summer 2025
EEE/ECE203: Electrical Circuits II

Total Marks: 100

Q1. [20 marks]

Obtain the rms values of the waveforms shown in the Fig. 1a and 1b.

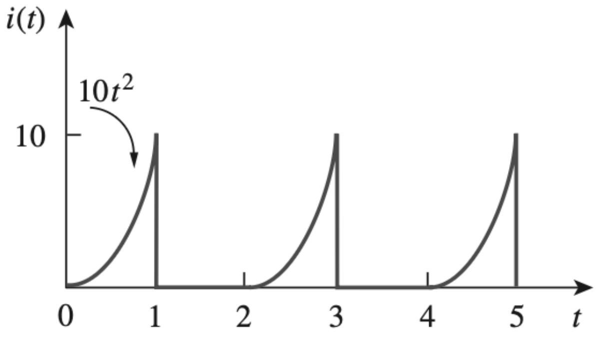


Figure 1a

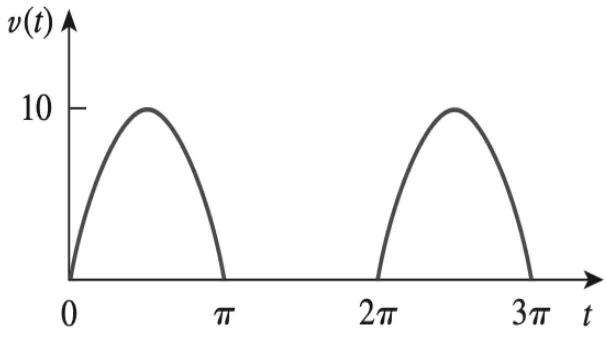


Figure 1b

Q2. [20 marks]

For the network in Fig. 2:

a. Find the total impedance $\mathbf{Z}_T$.
b. Find the source current $\mathbf{I}_s$ in phasor form.
c. Find the currents $\mathbf{I}_1$ and $\mathbf{I}_2$ in phasor form.
d. Find the voltages $\mathbf{V}_1$ and $\mathbf{V}_{ab}$ in phasor form.
e. Find the average power delivered to the network.
f. Draw the phasor diagram.

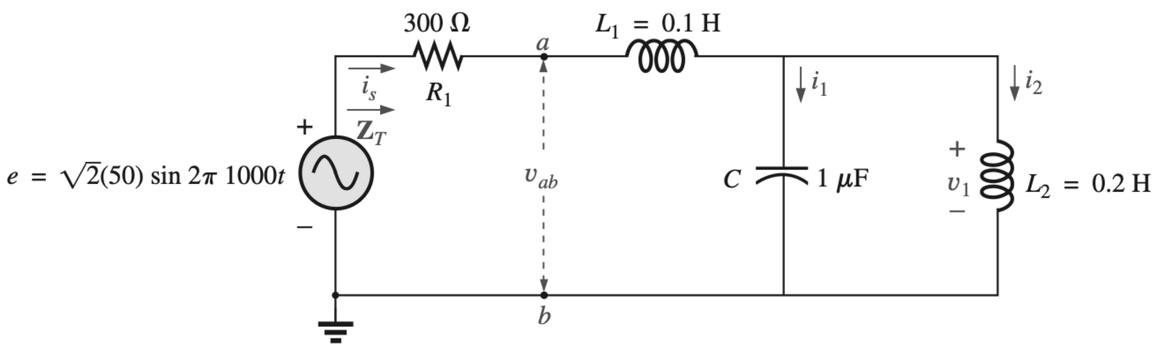


Figure 2

Q3. [20 marks]

For the network of Fig. 3:

a. Find the total impedance $\mathbf{Z}_T$.
b. Find the voltage $\mathbf{V}_1$, $\mathbf{V}_2$, and $\mathbf{V}_3$ in phasor form.
c. Find the current $\mathbf{I}_1$ in phasor form.
d. Find the source voltage $\mathbf{V}_s$ in phasor form.
e. Find the average power delivered to the network.
f. Draw the phasor diagram.

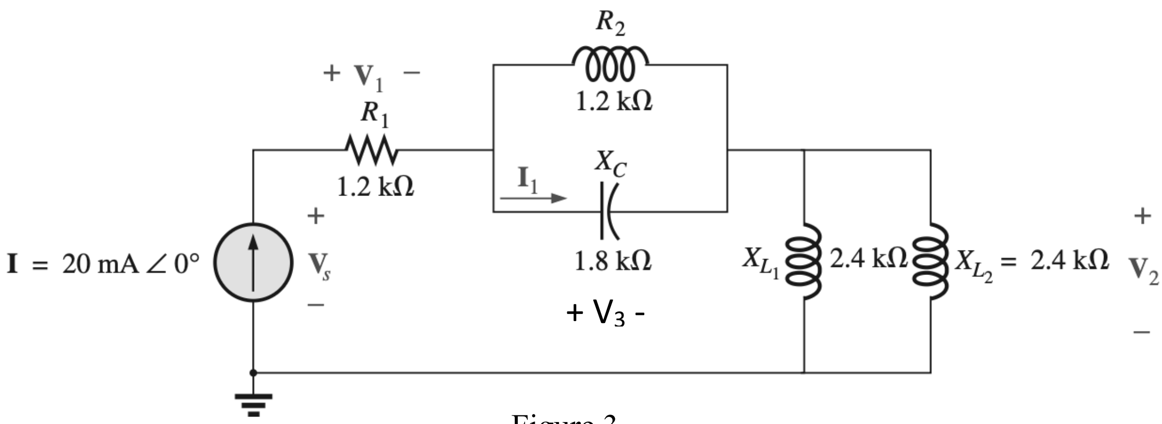


Figure 3

Q4. [10 marks]

Find the instantaneous power supplied by the source in the network in Fig. 4.

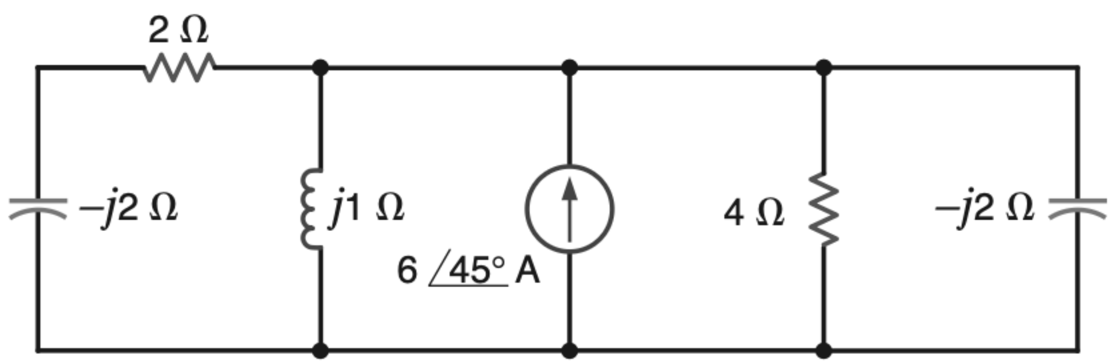


Figure 4

Q5. [10 marks]

Find the impedance, Z, for the network in Fig. 5.

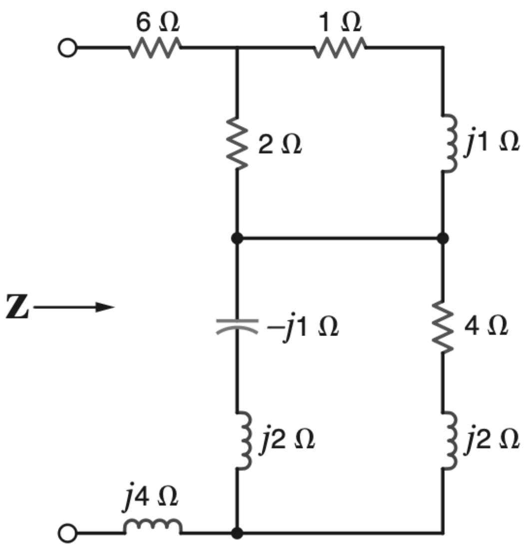


Figure 5

Q6. [10 Marks]

Find $v_x(t)$ for the circuit shown in Fig. 6.

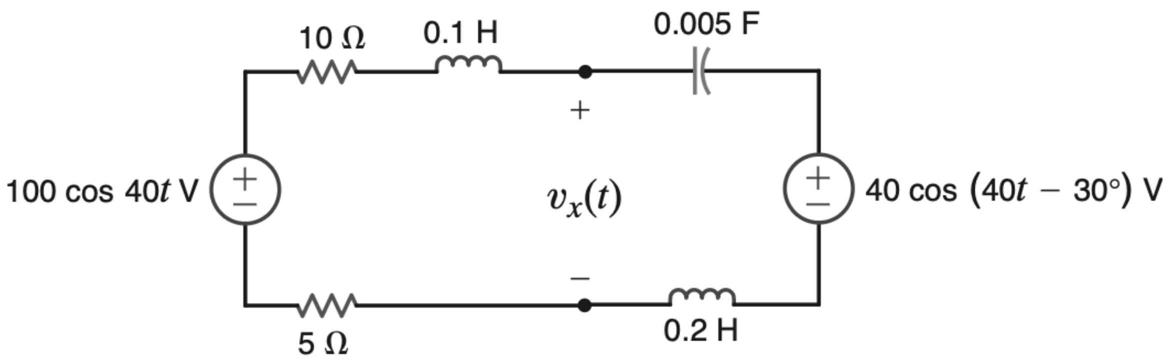


Figure 6

Q7. [10 Marks]

Find the phase relationship between the following waveforms:

(a) $v(t) = 2\ \cos(\omega t - 30°),\ i(t) = 5\ \sin\ (\omega t + 60°)$
(b) $v(t) = -4\ \cos(\omega t +\ 90°),\ i(t) = -2\ \sin\ (\omega t + 10°)$

EEE 203

Assignment 1 a.

Name: Souvik Barman Ratul

ID : 24121205

Section: 06

Ans to the Q. No-1

figure 1a ⇒

$$i_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$$

$$\Rightarrow i_{rms} = \sqrt{\frac{1}{5}\left[\int_0^1 (10t^2)^2 dt + \int_2^3 (10t^2)^2 dt + \int_4^5 (10t^2)^2 dt\right]}$$

$$= \sqrt{\frac{1}{5}\left[\frac{100}{5}\left[t^5\right]_0^1 + \frac{100}{5}\left[t^5\right]_2^3 + \frac{100}{5}\left[t^5\right]_4^5\right]}$$

$$= \sqrt{\frac{1}{5}\left[20\times(1^5-0) + 20\times(3^5-2^5) + 20(5^5-4^5)\right]}$$

$$= \sqrt{\frac{1}{5}\left[20 + (20\times 211) + (20\times 2101)\right]}$$

$$\doteq 96.187\,A$$ Ans

figure 1b,

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

$$\Rightarrow \sqrt{\frac{1}{3\pi}\left[\int_0^{\pi} (10\sin t)^2 dt + \int_{2\pi}^{3\pi} (10\sin t)^2 dt\right]}$$

$$\Rightarrow \sqrt{\frac{1}{3\pi}\left[\int_0^{\pi} 100\sin^2 t\,dt + \int_{2\pi}^{3\pi} 100\sin^2 t\,dt\right.}$$

now,

$$\int 100\sin^2 t\,dt = 100\int \frac{1}{2}(1-\cos 2t)\,dt$$

$$= 100\times\frac{1}{2}\times\left[\int dt - \int \cos 2t\,dt\right]$$

$$= 50.t - 50.\frac{\sin 2t}{2}$$

$$= 50t - 25\sin 2t$$

$$\therefore \int_0^{\pi} 100\sin^2 t\,dt = 50\left[t\right]_0^{\pi} - 25\left[\sin 2t\right]_0^{\pi} = 50\pi$$

$$\int_{2\pi}^{3\pi} 100\sin^2 t\,dt = 50\left[t\right]_{2\pi}^{3\pi} - 25\left[\sin 2t\right]_{2\pi}^{3\pi} = 50\pi$$

now,

$$V_{rms} = \sqrt{\frac{1}{3\pi}\left[\int_0^{\pi} 100\sin^2 t\,dt + \int_{2\pi}^{3\pi} 100\sin^2 t\,dt\right]}$$

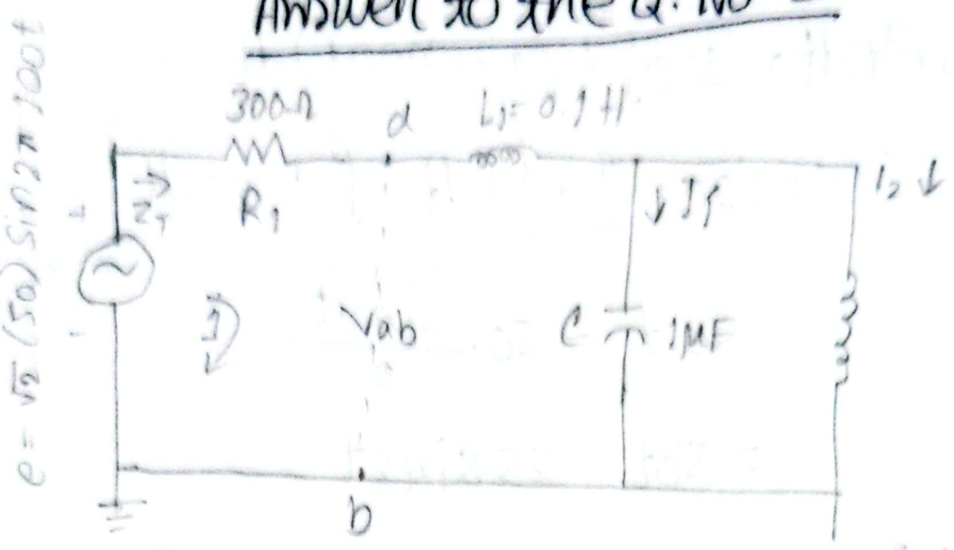
$$= \sqrt{\frac{1}{3\pi}\left[50\pi + 50\pi\right]}$$

$$= \sqrt{\frac{1}{3\pi}(100\pi)}$$

$$= 5.77\ V$$

Ans

Answer to the Q. No-2



$Z_{R_1} = 300\angle 0°$, $E = 50\sqrt{2}\angle 0°$

$Z_C = \dfrac{1}{2\pi \cdot 1000 \cdot 1\times 10^{-6}}\angle -90° = 159.155\angle -90°$

$Z_{L_1} = \dfrac{2\pi \cdot 1000 \times 0.1}{1}\angle 90° = 628.319\angle 90°$

$Z_{L_2} = \dfrac{2\pi \times 1000 \times 0.2}{1}\angle 90° = 1256.637\angle 90°$

$Z_1 = \dfrac{Z_C \cdot Z_{L2}}{Z_C + Z_{L2}} = 182.23\angle -90°$

$Z_T = Z_1 + Z_{R_1} + Z_{L_1} = 537.58\angle 56.07°$

$i_s = \dfrac{E}{Z_T}$

$= \dfrac{50\sqrt{2}\angle 0°}{537.58\angle 56.07°} = 0.131\angle -56.07°$

Applying KVL at loop 1 $\Rightarrow$

$-e + V_{R_1} + V_{ab} = 0$

$\Rightarrow V_{ab} = e - V_{R_1}$

$\Rightarrow V_{ab} = 50\sqrt{2}\angle 0^\circ - \{(0.131\angle -56.07) \times (300\angle 0^\circ)\}$

$\Rightarrow V_{ab} = V_a = 58.67\angle 33.76^\circ$

now,

$V_a - V_e = i_s Z_{L_1}$

$\Rightarrow V_e = V_a - i_s Z_{L_1}$

~~$\Rightarrow$~~

$\Rightarrow V_e = 58.67\angle 33.76^\circ - \{(0.131\angle -56.07) \times (628.319\angle 90^\circ)\}$

$V_e = 23.64\angle -145.65^\circ$

$V_e = V_1 = 23.64\angle -145.65^\circ$

now,

a) Total impedence $Z_T = 537.58\angle 56.07^\circ$

b) $I_s = 0.131\angle -56.07^\circ$

c) $I_1 = \frac{V_e}{Z_C} = \frac{23.64\angle -145.65^\circ}{159.154\angle -90^\circ}$

$= 0.1485\angle -55.65^\circ$

$$I_1 = \frac{V_c}{Z_{L1}} = \frac{23.64\angle -145.65^\circ}{1256.637\angle 90^\circ} = 0.0188\angle 124.35^\circ$$

d] $V_1 = 23.64\angle -145.65^\circ$

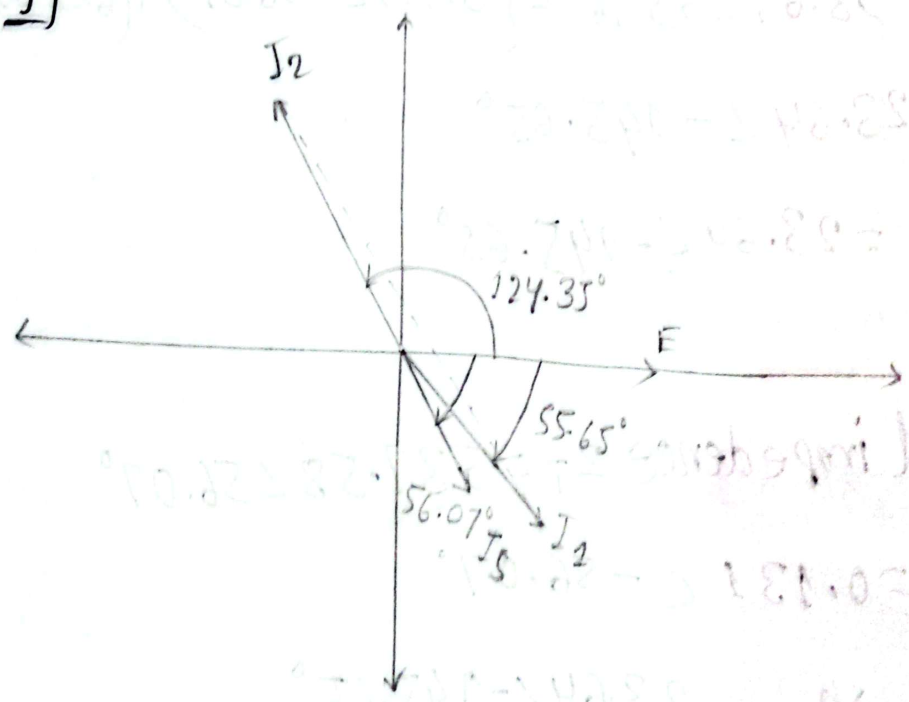
$V_{ab} = 58.67\angle 33.76^\circ$

e] $$P_{av} = \frac{V_m . I_m}{2} \cos(\theta_v - \theta_i)$$

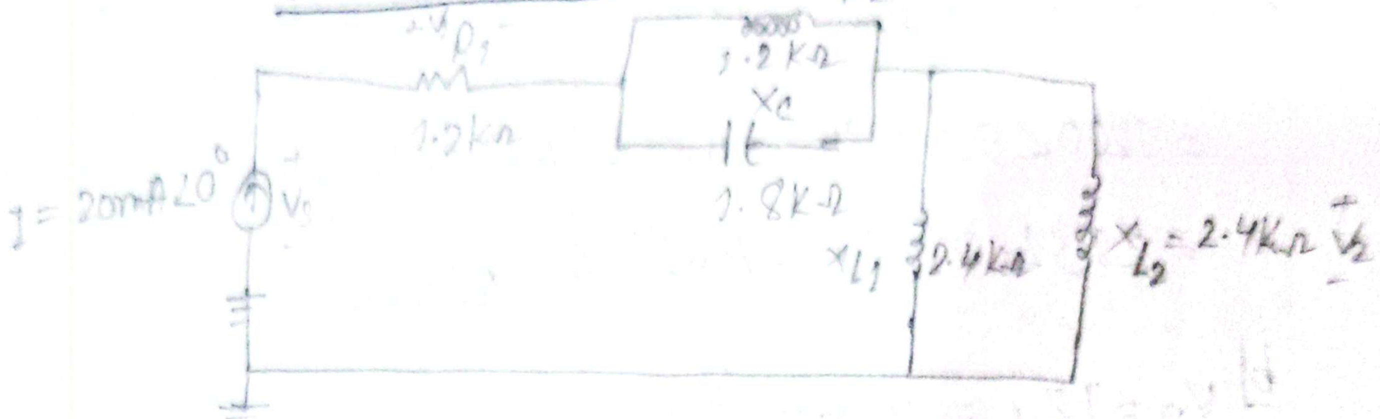
$$= \frac{50\sqrt{2} \times 0.131}{2} \cos(0 + 56.07^\circ)$$

$$= 2.585 \text{ watt}$$

f]



Ans to the Q. NO-3



$Z_{R_1} = 1200\angle 0^\circ \Omega$, $Z_{R_2} = 1200 \angle 0^\circ \Omega$

$Z_C = 1800\angle -90^\circ \Omega$, $Z_{L_1} = 2400 \angle 90^\circ \Omega$

$Z_{L_2} = 2400\angle 90^\circ \Omega$

Z_{L_1} and Z_2 are in parallel.

$$Z_{P1} = \frac{Z_{L1} \cdot Z_{L2}}{Z_{L_1} + Z_{L2}} = \frac{2400\angle 90^\circ \times 2400\angle 90^\circ}{2400\angle 90^\circ + 2400\angle 90^\circ}$$

$$= 1200 \angle 90^\circ \Omega$$

Z_{R_2}, Z_C are in parallel.

$$Z_{P2} = \frac{Z_{R2} \cdot Z_C}{Z_{R2} + Z_C} = \frac{1200\angle 0^\circ \times 1800\angle -90^\circ}{1200\angle 0^\circ + 1800 \angle -90^\circ}$$

$$= 998.46 \angle -33.0^\circ \Omega$$

Z_{P1}, Z_{P2} and Z_{R_1} are in series.

a) $Z_T = Z_{P1} + Z_{P2} + Z_{R1}$

$= 1200\angle 90° + 998.46\angle -33.69° + 1200\angle 0°$

$= 2131.089\angle 17.65°\ \Omega$ Ans

b) $V_2 = IZ_1 = 20\times 10^{-3}\angle 0° \times 1200\angle 90°$

$= 24\angle 90°$ V. Ans

$V_3 = IZ_2 = 20\times 10^{-3}\angle 0° \times 998.46\angle -33.69°$

$= 19.96\angle -33.69°$ Ans

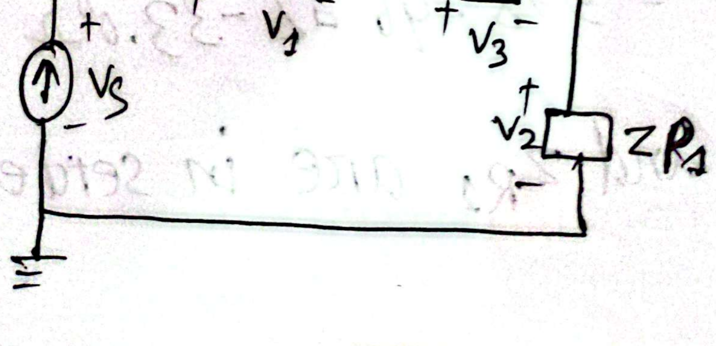
$V_1 = IZ_{R1} = 20\times 10^{-3}\angle 0° \times 1200\angle 0°$

$= 24\angle 0°$ V Ans

c) $I_1 = \dfrac{V_3}{Z_C} = \dfrac{19.96\angle -33.69°}{1800\angle -90°}$

$= 0.011\angle 56.31°$ Ans

d)



Applying KVL,

$$-V_s + V_1 + V_3 + V_2 = 0$$

$$\Rightarrow V_s = V_1 + V_2 + V_3 = 0$$

$$= 24\angle 0^\circ + 24\angle 90^\circ + 19.96\angle -33.69^\circ$$

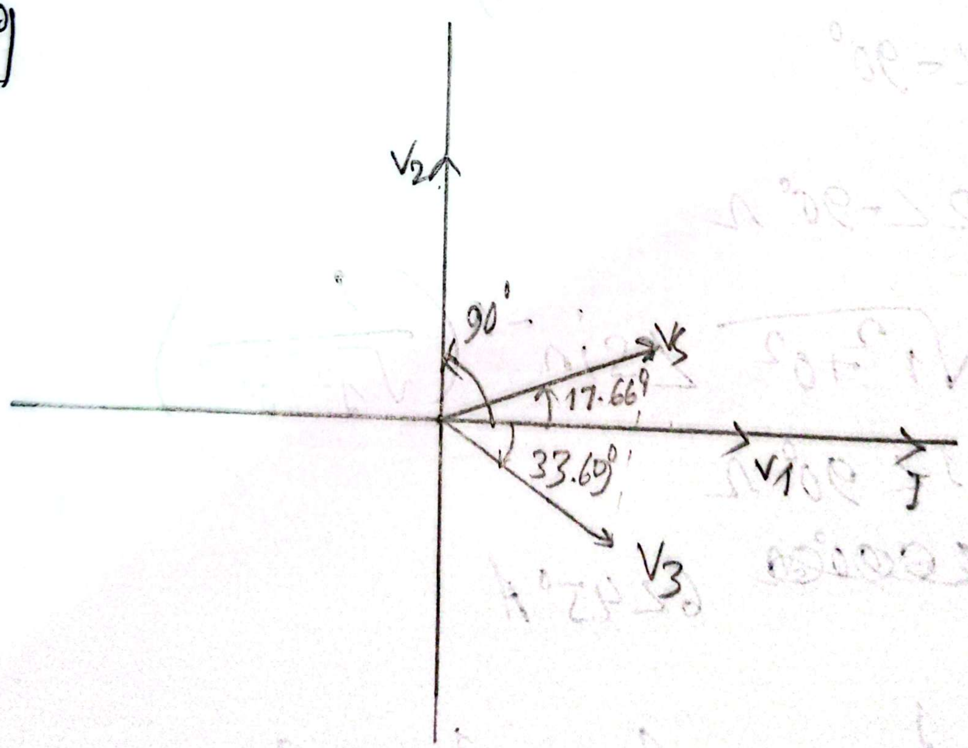
$$= 42.616\angle 17.66^\circ \text{ Ans}$$

e) $P_{av} = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i)$

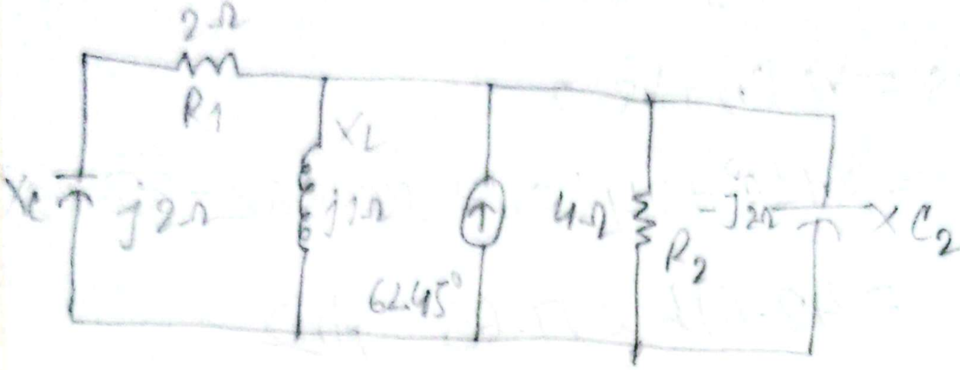
$$= \frac{42.616 \times 0.02}{2} \cos(17.66^\circ - 0^\circ)$$

$$= 0.41 \text{ watt.}$$

f)



Ans to the Q. No-4



$Z_{R2} = 4\angle 0°$, $Z_R = 2\angle 0°\ \Omega$

$X_{C_1} = -j2\Omega$. $X_L = j1\Omega$

$Z_{C_1} = \sqrt{0^2+(-2)^2}\ \angle \sin^{-1}\left(\frac{-2}{\sqrt{0^2+(-2)^2}}\right)$

$= 2\angle -90°$

$Z_{C_2} = 2\angle -90°\ \Omega$

$\therefore Z_L = \sqrt{1^2+0^2}\ \angle \sin^{-1}\left(\frac{1}{\sqrt{1^2+0^2}}\right)$

$= 1\angle 90°\ \Omega$

$I = 6\angle 45°\ A$

now,

$$\frac{1}{Z_T} = \frac{1}{Z_{R_1}+Z_{C_1}} + \frac{1}{Z_L} + \frac{1}{Z_{R_2}} + \frac{1}{Z_{C_2}}$$

$$\frac{1}{Z_T} = \frac{1}{2\angle 0° + 2\angle -90°} + \frac{1}{1\angle 90°} + \frac{1}{4\angle 0°} + \frac{1}{2\angle -90°}$$

$$Z_T = \frac{1}{0.56\angle -26.57^\circ}\ \Omega$$

$$= 1.79\angle 26.57^\circ\ \Omega$$

$$V = IZ_T = 6\angle 45^\circ \times 1.79\angle 26.57^\circ\ \Omega$$

$$= 10.74\angle 71.57\ V$$

$$i(t) = 6\sin(\omega t + 45^\circ)$$

$$v(t) = 10.74\sin(\omega t + 71.57^\circ)$$

now.

$$P(t) = i(t)\,v(t) = 6\sin(\omega t + 45^\circ) + 10.74\sin(\omega t + 71.57^\circ)$$

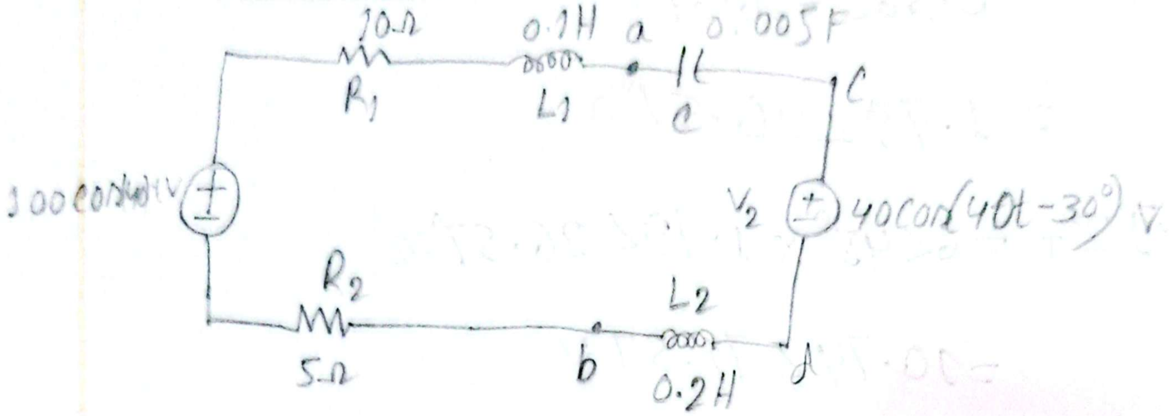
$$\Rightarrow P(t) = 64.44 \times \frac{1}{2} \times \left[\cos(\omega t + 45^\circ - \omega t - 71.57^\circ) - \cos(\omega t + 45^\circ + \omega t + 71.57^\circ)\right]$$

$$\Rightarrow P(t) = 32.22\left[\cos(-26.57) - \cos(2\omega t + 116.57^\circ)\right]$$

$$= 28.82 - \cos(2\omega t + 116.57^\circ)$$

Ans

Ans to the Q. NO-6



$Z_{R_1} = 10\angle0°$, $Z_{R_2} = 5\angle0°$, $Z_{L_1} = 40\times0.1\angle90°$
$= 4\angle90°\,\Omega$

$Z_{L_2} = 40\times0.2\angle90°$
$= 8\angle90°$, $Z_c = \frac{1}{40\times0.005}\angle-90°$
$= 5\angle-90°$

$V_1 = 100\angle0°\,V$, $V_2 = 40\angle-30°\,V$

Applying KVL

$-V_1 + Z_{R_1}I + Z_{L_1}I + Z_cI + V_2 + Z_{L_2}I + Z_{R_2}I = 0$

$\Rightarrow I(Z_{R_1} + Z_{L_1} + Z_c + Z_{L_2} + Z_{R_2}) = V_1 - V_2$

$\Rightarrow I \times (16.55\angle25.02°) = 68.35\angle17.01°$

$I = 4.13\angle-8.01°$

Applying KVL around loop-1,

$-V_1 + V_{R_1} + V_{L_1} + V_{ab} + V_{R_2} = 0$

$\Rightarrow V_x = V_1 - V_{R1} - V_{L1} - V_{R2}$

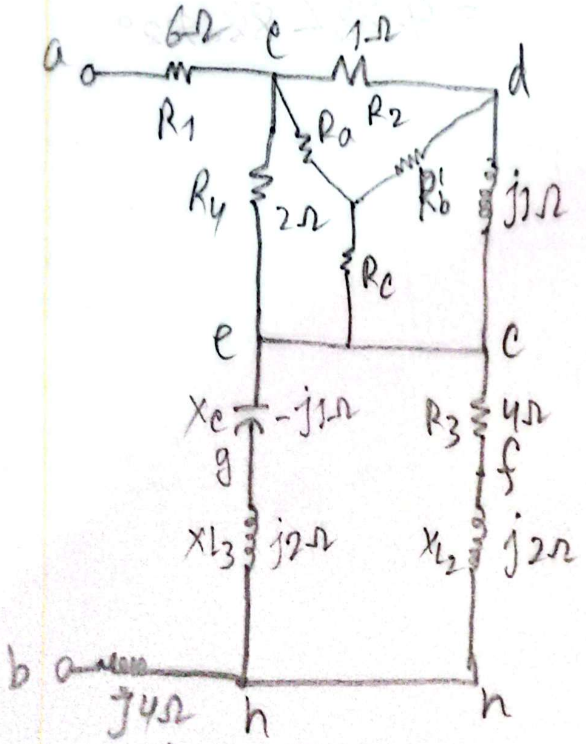
$\Rightarrow V_x = 100\angle 0^\circ - (10\angle 0^\circ) \times (4.13\angle -8.01^\circ) - (4\angle 90^\circ)(4.13\angle -8.01^\circ)$

$- (5\angle 0^\circ)(4.13\angle -8.01^\circ)$

$= 37.17\angle -12^\circ$

$v_x(t) = 37.17 \cos(40t - 12^\circ)$ Ans

Ans to the Q. No-5



$Z_{R1} = 6\angle 0^\circ\ \Omega$

$Z_{R2} = 1\angle 0^\circ\ \Omega$

$Z_{R3} = 4\angle 0^\circ\ \Omega$

$Z_{R4} = 2\angle 0^\circ\ \Omega$

$Z_C = \sqrt{0^2 + (-1)^2}\ \angle \sin^{-1}\left(\frac{-1}{\sqrt{0^2+(-1)^2}}\right)$

$\Rightarrow Z_C = 1\angle -90^\circ$

$Z_{L1} = 1\angle 90^\circ\ \Omega$

$Z_{L2} = 2\angle 90^\circ\ \Omega$

$Z_{L3} = 2\angle 90^\circ\ \Omega$

$Z_{L4} = 4\angle 90^\circ\ \Omega$

Z_C and Z_{L3} are in series $Z_{S1} = Z_C + Z_{L3} = 1\angle 90° \Omega$

Z_{R3} and Z_{L2} are in ~~parall~~ $\parallel$ $Z_{S2} = Z_{R3} + Z_{L2}$

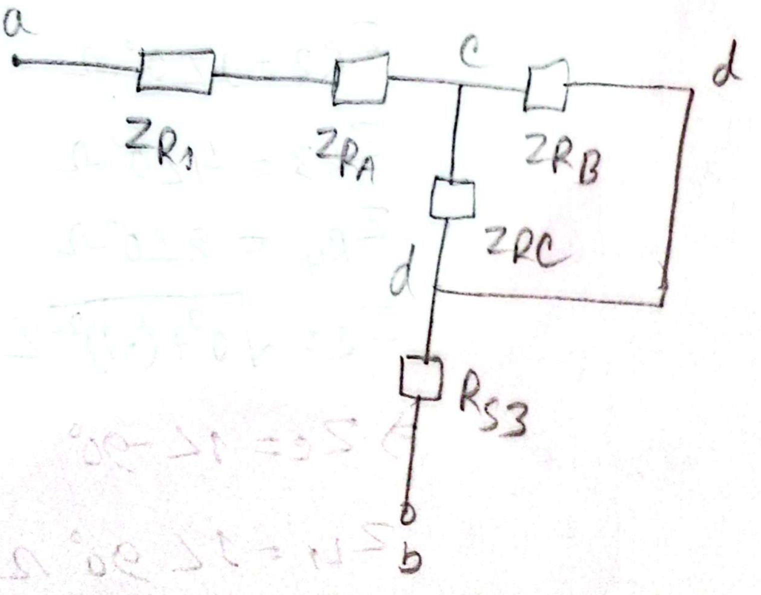
$= 4.47\angle 26.57° \Omega$

Z_{S1} and Z_{S2} are in parallel $Z_{P1} = \dfrac{Z_{S1} \times Z_{S2}}{Z_{S1} + Z_{S2}}$

$= 0.89\angle 79.69°$

Z_{P1} and Z_{L4} are in series $Z_{S3} = Z_{P1} + Z_{L4}$

$= 4.88\angle 88.122°$



$Z_{RA} = \dfrac{Z_{R2} \times Z_{R4}}{Z_{R2} + Z_{R4} + Z_{L1}} = 0.63\angle -18.435° \Omega$

$Z_{RB} = \dfrac{Z_{R2} \times Z_{L1}}{Z_{R2} + Z_{R4} + Z_{RL1}} = 0.32\angle 71.57° \Omega$

Z_{R}

$$ZRC = \frac{ZR_4 * ZRL_1}{ZR_2 + ZR_4 + ZR_1} = 0.63\angle 71.57^\circ\,\Omega$$

ZR_1 and ZRA are in series,

$$ZS4 = ZR_1 + ZRA = 6\angle 0^\circ + 0.63\angle -18.435^\circ$$
$$= 6.60\angle -1.73^\circ\,\Omega$$

ZRC and $ZR3$ are in parallal.

$$ZP3 = \frac{ZRC \times ZRB}{ZRC + ZRB} = \frac{0.63\angle 71.57^\circ \times 0.32\angle 71.57^\circ}{0.63\angle 71.57^\circ + 0.32\angle 71.57^\circ}$$
$$= 0.21\angle 71.57^\circ\,\Omega$$

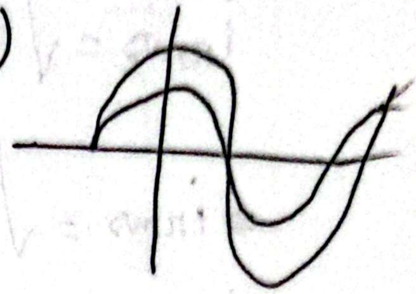
now,

$ZP3$, $ZS3$ and $ZS4$ are in series,

$$Z_T = Z_{P3} + Z_{S3} + ZS4 = 0.22\angle 71.57^\circ + 4.88\angle 88.122^\circ$$
$$+ 6.60\angle -1.73^\circ$$
$$= 8.4\angle 35.60^\circ\,\Omega \quad \text{Ans}$$

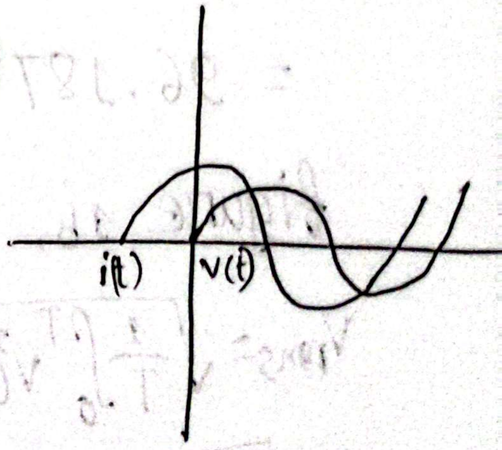
Answer to the Q. NO-07.

a)
$$v(t) = 2\cos(\omega t - 30^\circ)$$
$$= 2\,\overset{\sin}{\cancel{\cos}}(\omega t - 30^\circ + 90^\circ)$$
$$= 2\,\overset{\sin}{\cancel{\cos}}(\omega t + 60^\circ)$$
$$i(t) = 5\sin(\omega t + 60^\circ)$$



$i(t)$ and $v(t)$ are in phase.

b)
$$v(t) = -4\cos(\omega t + 90^\circ)$$
$$= -4\sin(\omega t + 90^\circ - 90^\circ)$$
$$= -4\sin(\omega t + 0^\circ)$$
$$i(t) = -2\sin(\omega t + 10^\circ)$$



$v(t)$ lags $i(t)$ by 10°

$i(t)$ leads $v(t)$ by 10°