Answer the following questions for the circuit shown in **Figure 1**: [2+2+6]
i)Draw the circuit with the Independent Current Source Turned Off. ii)Draw the circuit with the Independent Voltage Source Turned Off. iii)Apply the Superposition Theorem, and find the value of I_R.

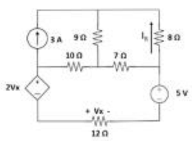
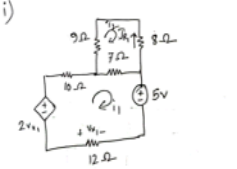


Figure 1.

i)



For mesh-1,

$$5 + 12i_1 - 2V_{x_1} + 10i_1 + 7(i_1 - i_2) = 0$$

$$\Rightarrow 5 + 12i_1 - 2(-12i_1) + 10i_1 + 7i_1 - 7i_2 = 0; \quad [\because V_x = -12i_1]$$

$$\Rightarrow 53i_1 - 7i_2 = -5 \ldots (1)$$

For mesh-2,

$$9i_2 + 8i_2 + 7(i_2 - i_1) = 0$$

$$\Rightarrow -7i_1 + 24i_2 = 0 \ldots (2)$$

Solving (1) and (2) we get,

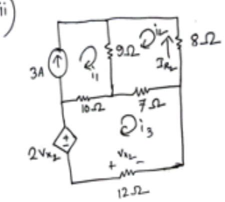
$$i_1 = -0.098A$$

$$i_2 = -0.0286A$$

$$I_{R_1} = -i_2$$

$$= 0.0286A$$

ii)



From mesh-1,

$$i_1 = 3$$

For mesh-2,

$$8i_2 + 7(i_2 - i_3) + 9(i_2 - 3) = 0$$

$$\Rightarrow 24i_2 - 7i_3 = 27 \ldots (1)$$

For mesh-3,

$$10(i_3 - 3) + 7(i_3 - i_2) + 12i_3 - 2V_{x_2} = 0$$

$$\Rightarrow 10i_3 - 30 + 7i_3 - 7i_2 + 12i_3 - 2(-12i_3) = 0; \quad [\because V_{x_2} = -12i_3]$$

$$\Rightarrow -7i_2 + 53i_3 = 30 \ldots (2)$$

$$i_2 = 1.3418A$$

$$i_3 = 0.7433A$$

$$I_{R_2} = -i_2 = -1.3418A$$

iii)

$$I_R = I_{R_1} + I_{R_2}$$

$$= 0.0286 - 1.3418$$

$$\therefore I_R = -1.3132A$$

Question 2: Answer all the questions. **(10 Marks)**

For the circuit shown in **Figure 2**, answer the following questions:

i) Determine the Thevenin equivalent circuit at the A-B terminal.

ii) For any value of R_L, what will be the maximum power delivered to this resistance?

iii) If R_L=1kΩ, then would maximum power be achieved? If not, then what should you do to achieve maximum power?

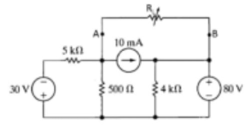
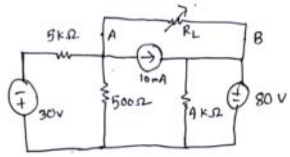
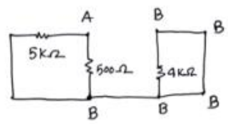


Figure 2.



For R_{TH},

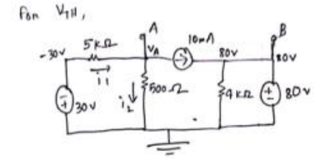


So, 5KΩ and 500Ω are in parallel.

$$\therefore R_{TH} = \left(\frac{1}{5000} + \frac{1}{500}\right)^{-1}$$

$$\therefore R_{TH} = 454.545\ \Omega$$

For V_{TH},



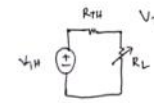
At V_A node,

$$i_1 = i_2 + 10\text{mA}$$

$$\Rightarrow \frac{-30 - V_A}{5000} = \frac{V_A}{500} + 10\times10^{-3}$$

$$\Rightarrow -30 - V_A = 10V_A + 50$$

$$\Rightarrow V_A = \frac{-80}{11}\ \text{V}$$



$$V_{TH} = V_A - V_B$$
$$= \frac{-80}{11} - 80$$
$$= -87.2727\text{V}$$

ii) Max power

$$P_{max} = \frac{V_{TH}^2}{4R_{TH}} = 4.18\ \text{W}$$

iii) P_{max} will not occur for $R_L = 1$ KΩ

Question 3: Answer all the questions **(10 Marks)**

Answer the following questions for the circuit shown in **Figure 3**: i)Determine Z_T. ii) Current, I. iii) Find the currents through 4 Ω and 3 Ω resistors. iv) Is the source voltage or the current, I leading in this circuit?	[3+2 +3+2]

Page **1** of **2**

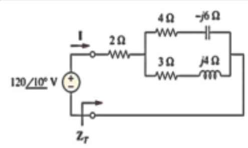
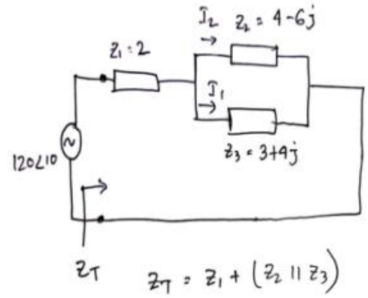


Figure 3.



$Z_T = Z_1 + (Z_2 \parallel Z_3)$

$= 6 \cdot 8302 + 1 \cdot 0943 j$

i) $\therefore Z_T = 6 \cdot 917 \angle 9 \cdot 103$

ii) $I = \dfrac{V}{Z_T} = \dfrac{120\angle 10}{6{\cdot}917\angle 9{\cdot}103} = 17 \cdot 3978 \angle 0{\cdot}8974$

iii) $I_1 = \dfrac{Z_2}{Z_2 + Z_3} \times I = 17 \cdot 183 \angle -39 \cdot 467^\circ$

$I_2 = \dfrac{Z_3}{Z_2 + Z_3} \times I = 11 \cdot 9145 \angle 69 \cdot 9729$

Current through 4Ω is I_2

" " 3Ω " I_1.

iv) $V = 120\angle 10^\circ = 120 \cos(\omega t + 10^\circ)$

$I = 17 \cdot 3478 \angle 0 \cdot 8974$

$= 17 \cdot 3978 \cos(\omega t + 0 \cdot 8974)$

So, V is leading.

Question 4: Answer all the questions. **(10 Marks)**

For the circuit shown in **Figure 4a**, determine I_m if the rms value of such current is 5A. Now, determine i_o and average real power absorbed by a 3-ohm resistor using **CDR** in the circuit shown in **Figure 4b** if the angular frequency is 100 rad/s in the circuit.	[6+2 +2]

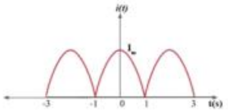


Figure 4a.

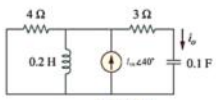


Figure 4b.

Q4: waveform

$-1 \leq t \leq 1, \quad I_m \cos(\pi t)$

$T = 2$

$f = 0.5$

$\omega = 2\pi f = \pi$

$$\text{RMS} = \sqrt{\frac{1}{T}\int i(t)^2\, dt}$$

$$5 = \sqrt{\frac{1}{2}\int_{-1}^{1} I_m^2 \cos^2(\pi t)\, dt}$$

$$\frac{1}{2}\int_{-1}^{1} 1 + \cos 2\pi t$$

$$\frac{1}{2}[1-(-1)] + \left[\frac{\sin 2\pi t}{2\pi}\right]_{-1}$$

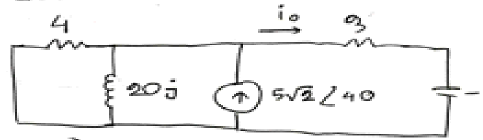
$$= 1$$

$$50 = I_m^2 \times 1$$

$$\boxed{I_m = 5\sqrt{2}}$$

AC ckt

$\omega = 100$



$j\omega L$

$\frac{1}{j\omega C}$

$(4 \parallel 20j) = 3.84 + 0.77j$

$$i_o = \frac{3.84 + 0.77j}{3.84 + 0.77j + 3 - 0.1j} \times 5\sqrt{2}\angle 40°$$

$$\boxed{i_o = 4.03\angle 45.744}$$

Considering I_m as ~~rms~~ peak value

$$\boxed{\text{Real } P_{avg} = \frac{1}{2}|I|^2 R = \frac{1}{2}\times(4.03)^2 \times 3 = 24.36\, W}$$