Question 1: Answer all the questions. **(10 Marks)**

Use the superposition theorem to **determine** the value of V_x for the circuit shown in **Figure 1**. Also, the 8-ohm resistor absorbs power from both independent sources. **Analyze** the circuit and **determine** which independent source in this circuit supplies most of the power to the 8-ohm resistor. [8+2] CO3

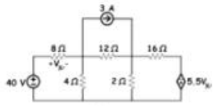
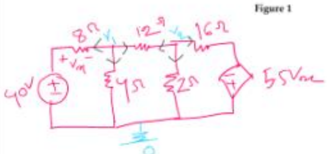


Figure 1



Node V_1; $\dfrac{(V_1-0)-40}{8}+\dfrac{V_1-0}{4}+\dfrac{V_1-V_2}{12}=0$

$\Rightarrow \dfrac{3V_1-120+6V_1+2V_1-2V_2}{24}=0$

$\Rightarrow 11V_1-2V_2-120=0 \cdots$ (i)

Node, V_2; $\dfrac{V_2-V_1}{12}+\dfrac{V_2-0}{2}+\dfrac{(V_2-0)+5.5V_x}{16}=0$

$\Rightarrow \dfrac{4V_2-4V_1+24V_2+3V_2+16.5V_m}{48}=0$

$\Rightarrow 31V_2-4V_1+16.5V_x=0$

Here. $V_x=V_1-40$;

$\Rightarrow 31V_2-4V_1+16.5(V_1-40)=0$

$\Rightarrow 31V_2-4V_1+16.5V_1-660=0 \cdots$

$\Rightarrow 12.5V_1+31V_2=660 \cdots$ (ii)

Solving (i) (ii);

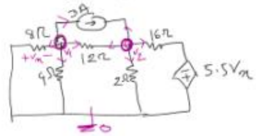
$V_1=13.77\text{ V}$ $V_2=15.73\text{ V}$

$\therefore V_x' = V_1-40$

$=(13.77-40)\text{ V}$

$=-26.23\text{ V}$

Again;



node;-1; $\dfrac{V_1}{8}+\dfrac{V_1}{4}+\dfrac{V_1-V_2}{12}+3=0$

$\Rightarrow \dfrac{3V_1+6V_1+2V_1-2V_2+72}{24}=0$

$\Rightarrow 11V_1-2V_2+72=0 \cdots$ (i)

node-2; $\dfrac{V_2-V_1}{12}+\dfrac{V_2}{2}+\dfrac{(V_2-0)+5.5V_x}{16}-3=0$

$\Rightarrow \dfrac{4V_2-4V_1+24V_2+3V_2+16.5V_x-144}{48}=0$

$\Rightarrow 31V_2-4V_1+16.5V_x=144$

here; $V_x=V_1$

$31V_2-4V_1+16.5V_1=144$

$\Rightarrow 12.5V_1+31V_2=144 \cdots$ (ii)

solving; (i)(ii); $V_1=-5.31\text{ V}$ $V_2=6.78\text{ V}$

$V_x''=V_1$ $\therefore V_x''=-5.31$

$V_x=V_x'+V_x''$

$=(-26.23-5.31)\text{ V}$

$=-31.54\text{ V}$. Ans:

'Power absorsord;

- in 8 Ohm;

$P=\dfrac{(V_x)^2}{R}$

$=\dfrac{(-31.54V)^2}{8}$

$=\dfrac{994.77}{8}$

$=124.34$ Watt.

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

For the circuit shown in **Figure 2**, answer the following questions: [4+3+3] CO3

i) **Determine** the **Thevenin equivalent** circuit at the **a-b** terminal.

ii) Suppose, your friend suggests that if you connect a **20V-40W** bulb across **a-b** terminal, then you will get maximum bulb intensity. Is he right? If not, then **calculate** the resistance of the bulb that would get maximum intensity.

iii) **Determine** the maximum power delivered to the bulb that would be connected across the **a-b** terminal.

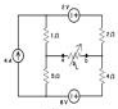
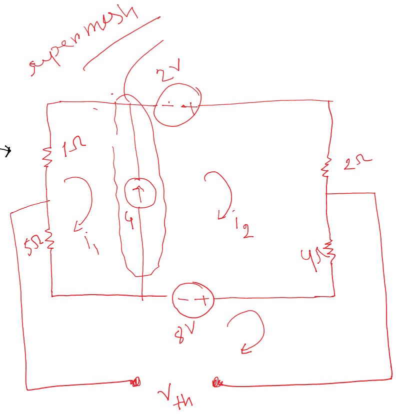
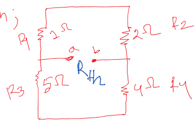


Figure 2

Simplying



for Rth;



$R_{th} = (R_1 + R_2) \,||\, (R_3 + R_4)$

$\Rightarrow (1+2) \,||\, (5+4)$

$\Rightarrow 3 \,||\, 9$

$= \frac{3 \times 9}{3+9}$

$= \frac{27}{12} = 2.25\ \Omega.$

KVL onto Supermesh;

$6i_1 - 2 + 6i_2 + 8 = 0$

$6i_1 + 6i_2 - 6 = 0$

$i_1 + i_2 = 1 \text{ --- (i)}$

eqn of supermesh; $i_1 + 4 = i_2$

$\Rightarrow i_1 - i_2 = -4 \cdots \text{(ii)}$

Solving (i)(ii),

$i_1 = -1.5 \quad i_2 = 2.5$

KVL onto V_{th};

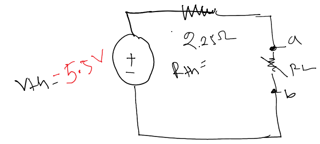
$\Rightarrow 5i_1 - 8 + 4i_2 + V_{th} = 0$

$\Rightarrow 5(-1.5) - 8 + 4(2.5) + V_{th} = 0$

$\Rightarrow -7.5 - 8 + 10 + V_{th} = 0$

$\Rightarrow -15.5 + 10 + V_{th} = 0$

$\Rightarrow V_{th} = 5.5V$



(ii)

We, know, $R_L = R_{th}$

20V − 40W; in a−b terminal;

$P = \frac{V^2}{R}$

$\Rightarrow R = \frac{V^2}{P} = \frac{(20)^2}{40} = 10$

So, $10 \neq 2.25\Omega$

so, my frind is not correct;

(iii) $P_{max} = \frac{(V_{th})^2}{4R_{th}} = \frac{(5.5)^2}{4 \times 2.25}$

$= \frac{30.25}{9}$

$= 3.36$ watt.

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

For the circuit shown in **Figure 3**, where $v_g(t) = 247.49\cos(1000t + \pi/4)$ [3+3+2+2] CO4

i) **Determine** the total impedance of the circuit.

ii) **Determine** the current through the 100Ω resistor using the current division rule.

iii) **Determine** the voltage $V_{ab}(t)$ using VDR.

iv) **Determine** by how much degree the voltage, $V_{ab}(t)$ is leading the source voltage, $v_g(t)$.

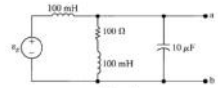
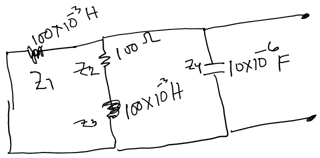


Figure 3

$$v_g(t) = 247.49\cos(1000t + \pi/4)$$
$$= 247.49\cos(1000t + 45^\circ)$$

(i)

$Z_{eq} = ?$

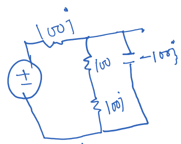


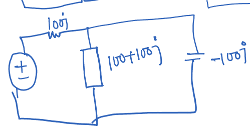
$Z_1 = j\omega L = j \times 1000 \times 100\times10^{-3}$
$= 100j\ \Omega$

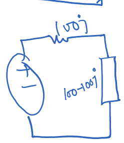
$Z_2 = 100\Omega$

$Z_3 = 100j\,\Omega$

$Z_4 = \frac{1}{j\omega C} = -j\left(\frac{1}{1000\times10\times10^{-6}}\right)\Omega$
$= -100j\,\Omega$



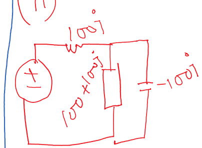




$\frac{(100+100j)\times(-100j)}{100+100j-100j}$
$= 100 - 100j$

$Z_{eq} = 100j + 100 - 100j$
$= 100\Omega$.

(ii)



$I = \frac{V}{Z_{eq}}$
$= \frac{247.49\angle 45^\circ}{100}$
$= 1.75 + 1.75j$

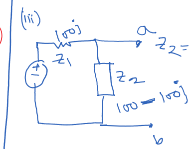
Current throw, 100 Ω;

CDR; $i = \left(\frac{-100j}{100+100j-100j}\right)(1.75+1.75j)$

$= 1.75 - 1.75j$

$\Rightarrow 2.47\angle -45^\circ$ A.

(iii)



$Z_2 = (100+100j) \parallel (-100j)$
$= \frac{(100+100j)\times(-100j)}{(100+100j-100j)}$
$= 100 - 100j$

$V_g = 247.49\angle 45^\circ$

VDR, $V_{ab} = \left(\frac{Z_2}{Z_2+Z_1}\right)V_g$

$= \left(\frac{100-100j}{100-100j+100j}\right) 247.49\angle 45^\circ$

$= 350$ V. $\Rightarrow 350\angle 0^\circ$

(iv)

$V_{ab}(t) = 350\cos(1000t + 0^\circ)$

$V_g(t) = 247.49\cos(1000t + 45^\circ)$

V_g is leading on V_{ab}; 45°.

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

Answer the following questions for the circuit shown in **Figure 4 (a-b)**: [5+5]

i) **Calculate** the rms value of the periodic voltage shown in **Figure 4a**. **CO4**

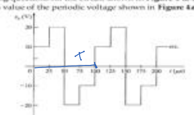


Figure 4a

ii) Now, **use** this rms value as the maximum amplitude of the sinusoidal voltage source in the circuit shown in Figure 4b. **Determine** $i_0(t)$ and average real power absorbed by the 2-ohm resistor in the circuit. The angular frequency is 100 rad/s in the circuit.

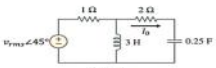


Figure 4b

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

Here, T = 100.

(i) $v_n = \begin{cases} 10 & 0 < t < 25 \\ 20 & 25 < t < 50 \\ -20 & 50 < t < 75 \\ -10 & 75 < t < 100 \end{cases}$

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

$$= \frac{1}{100}\int_0^{25} 100\,dt + \int_{25}^{50} 400\,dt + \int_{50}^{75} 400\,dt + \int_{75}^{100} 100\,dt$$

$$\frac{1}{100}\left(100[t]_0^{25} + 400[t]_{25}^{50} + 400[t]_{50}^{75} + 100[t]_{75}^{100}\right)$$

$$= \frac{1}{100}\left\{(100\times 25) + 400\times 25 + 400\times 25 + 100\times 25\right\}$$

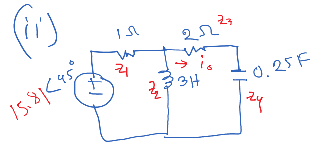
$$= \frac{1}{100}\left[2500 + 10000 + 10000 + 2500\right]$$

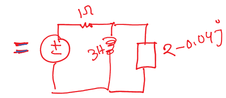
$$= \frac{25000}{100}$$

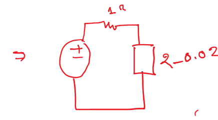
$$V_{rms}^2 = 250$$

$$V_{rms} = \sqrt{250} = 15.81\,V.$$

(ii)







$\omega = 100$

$z_4 = \frac{1}{j\omega C} = \frac{1}{100\times 0.25}\cdot -j = -0.04j$

$z_2 = j\omega L = j\times 100\times 3 = 300j$

$z_3 + z_4$ are series. $2-0.04j$

$z_2 \parallel (z_3+z_4)$

$$= \frac{300j \times (2-0.04j)}{300j + 2 - 0.04j} = 2-0.02j$$

$z_{eq} = 1 + 2 - 0.02j = 3-0.02j$

$$I = \frac{V}{z_{eq}} \Rightarrow \frac{15.81\angle 45°}{3-0.02j} \Rightarrow 3.70+3.75j$$

find, i_0, using CDR,

$$i_0 = \left(\frac{3H}{(2-0.04j)}\right) 3.70+3.75j$$

$$= \left(\frac{300j}{2-0.04j}\right) 3.70+3.75j$$

$i_0 = -573.37 + 543.53j$

• Aver: real power

$$P = \frac{1}{2}|i_0|^2 \cdot R$$

$$= \frac{1}{2}(-573.37)^2 \times 2$$

$= 328753.1569$ watt

Ans: