USN :

CMR Institute of Technology, Bangalore
DEPARTMENT OF PHYSICS
I - INTERNAL ASSESSMENT

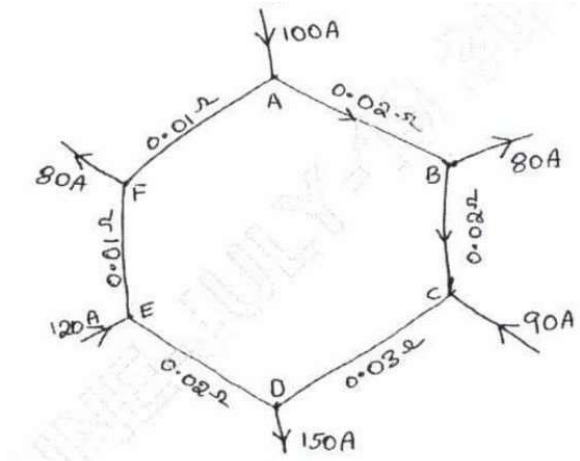
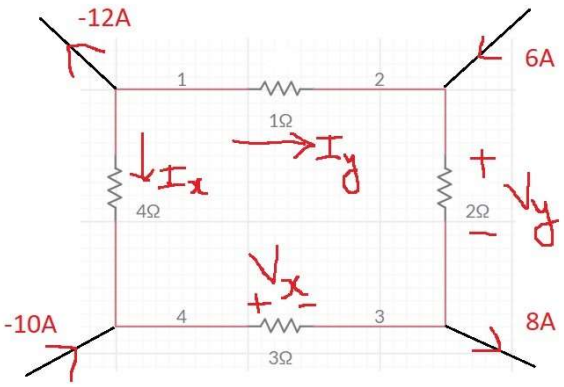
Semester: 2-CBCS 2018
Subject: BASIC ELECTRICAL ENGINEERING (18ELE23)
Faculty: Ms Nithara P V

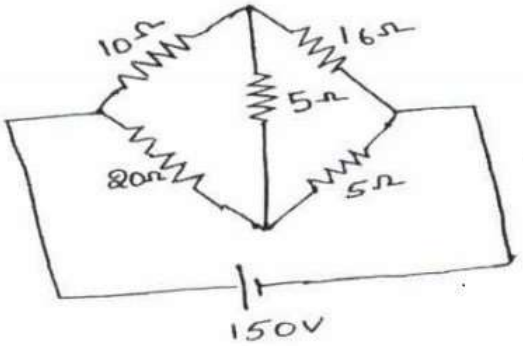
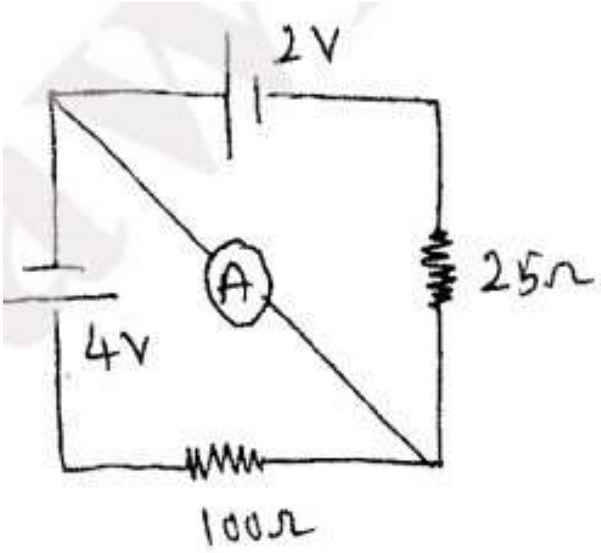
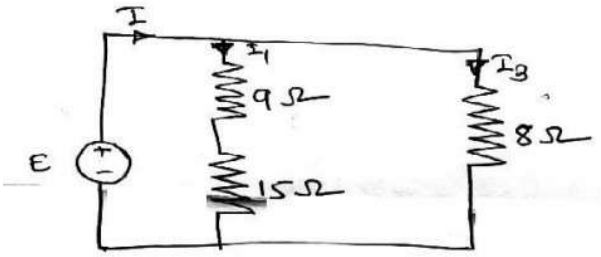
Date: 24 Jun 2021
Time: 02:15 PM - 03:45 PM
Max Marks: 50

Instructions to Students :

Answer Any FIVE FULL Questions

Answer any 5 question(s)

Q.No			Marks	CO	BT/CL
1	a	State and explain ohm's law with an illustration. List its limitations.	4	CO1	
	b	A DC circuit comprised two resistors R1 of value 30Ω and R2 of unknown value. The R1 and R2 are connected in parallel, together with the third resistor R3 of the value 6Ω connected in series with the parallel group. The P.D across R3 is 84V. If the total power in the circuit is 4312W, Calculate i) The value of R2 ii) The applied voltage to the ends of the whole circuit, and iii) The current in each resister.	6	CO1	
2	a	For the sinusoidal signal, Define a) Cycle b) Time period c) Phase difference, and d) Form factor e) Peak factor.	5	CO1	
	b	The instantaneous values of two alternating voltages are represented respectively by $v1(t)=2\sin 5t+30°$ Volts and $v2(t)=\sin 5t+60°$ Volts. Derive an expression for the instantaneous value of (i) the sum (ii) the difference of these voltages.	5	CO1	
3	a	Determine the currents in various branches of the given network. 	5	CO1	
	b	Determine Vx, Vy, Ix, Iy. 	5	CO1	
4	a	Define RMS Value of Alternating current, show that Its value is proportional to the maximum value.	5	CO1	
	b	The equation for an AC voltage as $V=0.04\sin 2000t+60°$ Volts. Determine the frequency, angular frequency, instantaneous voltage when t=160μs. What is the time represented by a $60°$ phase angle?	5	CO1	
5	a	Two 12V batteries with internal resistance 0.2Ω and 0.25Ω respectively are joined in parallel and a resistance of 1Ω is placed across the terminals. Find the current supplied by each battery.	5	CO1	
	b	State and Explain Kirchoff's laws as applied to an electric circuit.	5	CO1	

6	a	For the bridge circuit shown in Fig. Calculate current in all the branches and power supplied by the source. 	5	CO1	
	b	Explain the generation of single-phase AC induced emf with a suitable diagram.	5	CO1	
7	a	For the network shown in Fig. determine current flow in the Ammeter “A” having a resistance of 10Ω. 	5	CO1	
	b	For the network shown in Fig. determine I1, I3, E, and I. If the voltage across 9Ω resistor is 27V. 	5	CO1	

18ELE23 – SCHEME & SOLUTIONS

INTERNAL ASSESSMENT – I

1(a) Sol

State and Explain Ohm's law, and its limitations.

Ohm's law: - States that the current passing through a conductor (or) circuit is directly proportional to the potential difference applied across the ends of the conductor and inversely proportional to the resistance of the conductor at constant temperature ⟶ (2M)

Equation, $\boxed{V = IR}$ ⟶ (1M)

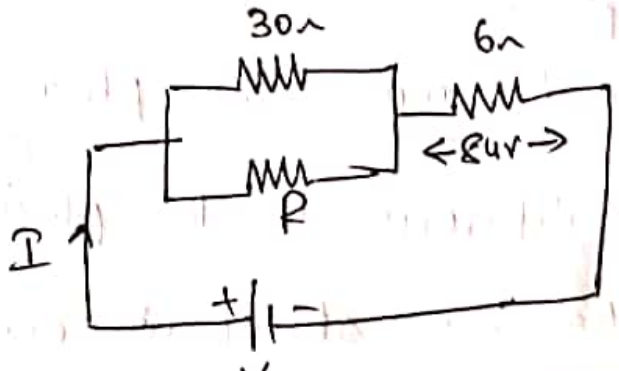
limitations ① not applicable when temperature is not constant (1M)

② not applicable to non-linear circuits & devices

③ not applicable to non-metallic conductors

(b)

Given $P = 4312\ W$



$I_{6\Omega} = \frac{V}{R}$

$= \frac{84}{6} = \underline{14A}$ (1M) (1M)

$P = I^2R \Rightarrow 4312 = (14)^2 R_T$, $R_T = \frac{4312}{196} = 22\Omega$ (1M)

$\frac{30 \times R_2}{30+R_2} + 6 = 22 \Rightarrow R_2 = 34.28\Omega$ ——— (1M)

$I_{30\Omega} = 7.46A$

$I_{34\Omega} = 6.53A$ (3M)

$I_{6\Omega} = 14A$

2 (5) **Definitions:** (1) **cycle:** A cycle is a series of events that are repeated in the same order (or) (1M)

when a wave-form reaches a complete set of positive & negative value is called a cycle.

(2) **Time period:** The time taken in seconds by an alternating quantity to complete one cycle is known as time period

(3) **phase difference:** The phase difference can be defined as the difference in the phase when two alternating quantities are starting (or) ending with respect to time

(4) form factor $= \frac{\text{RMS Value}}{\text{AVG Value}} = 1.11$

⑤ **Peak factor:**

$$P.f = \frac{\text{Max. Value}}{\text{RMS Value}} = 1.412$$

⑥ $v_1(t) = 2\sin(5t+30^\circ)$, $v_2(t) = \sin(5t+60^\circ)$

polar form of V_1 & V_2 is $V_1 = 2\angle 30^\circ$, $V_2 = 1\angle 60^\circ$

$$\text{Sum} = V = V_1 + V_2 = 2\angle 30^\circ + 1\angle 60^\circ \quad (1M)$$

polar to cartesian coordinates $= 2\cos 30^\circ + j2\sin 30^\circ + \cos 60^\circ + j\sin 60^\circ$

$$= 1.732 + j + 0.5 + j0.866$$

$$= 2.232 + j1.866$$

$$V \equiv 2.91\angle 39.9^\circ \quad (2M)$$

$$\therefore v(t) = 2.91\sin(5t + 39.9^\circ) \longrightarrow (2M)$$

3a

Apply KCL & KVL to the loop

$$-0.02I - 0.02(I-80) - 0.03(I+10) - 0.02(I-140) - 0.01(I-20) - 0.01(I-100) = 0$$

$$\boxed{I = 48.18A} \quad - 2M$$

$AB = 48.14A$

$BC = -31.8A$

$CD = 58.15A$

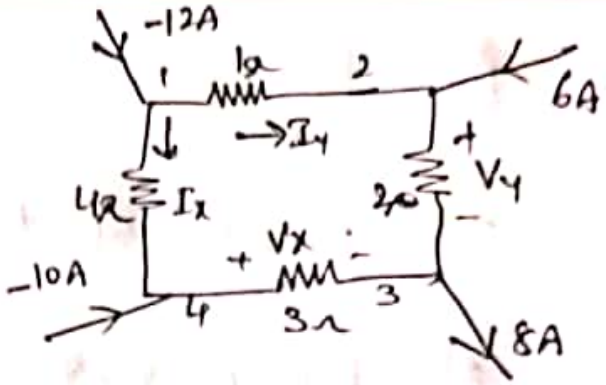
$DE = -91.82A$

$EF = 28.18A$

$FA = -51.82A$

} — 3M

3b



Apply KVL

$(I_y \times 1) + 2(I_y + 6) + 3(I_y - 2) + 4(I_y - 12) = 0$

$10I_y + 12 - 6 - 48 = 0$

$10I_y = 42 \Rightarrow \boxed{I_y = 4.2\,A}$

$V_y = 2 \times (I_y + 6) = 2(4.2 + 6)$

$\boxed{V_y = 20.4\,V}$

$V_x = 3 \times (I_y - 2) = 3 \times (4.2 - 2) = 6.6\,V$

$\boxed{V_x = 6.6\,V}$

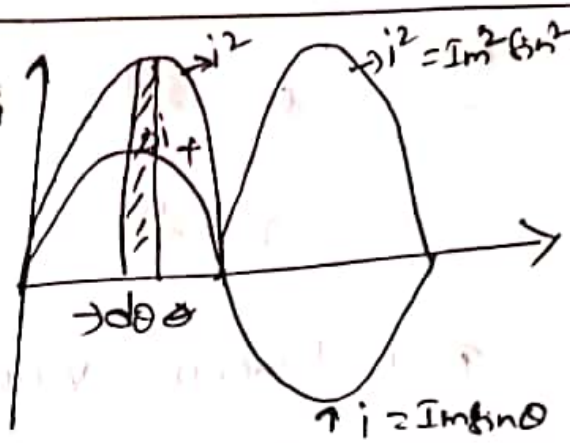
$I_x = -(I_y - 12) = -(4.2 - 12) = \boxed{I_x = 7.8\,A}$

4g

RMS: An AC current is the current which when passed through a given resistance for a given time, produces same heat as produced by flow of one ampere of DC current through the same resistance for the same time. (2M)

derivation:

$i = I_m \sin\theta \rightarrow (1)$



Area of first half cycle of the squared wave $= \int_0^{\pi} i^2 d\theta \rightarrow (2)$

$$\text{Area} = \int_0^{\pi} (I_m \sin\theta)^2 \cdot d\theta$$

$$= \int_0^{\pi} I_m^2 \sin^2\theta \, d\theta$$

$$= I_m^2 \int_0^{\pi} \sin^2\theta \cdot d\theta$$

$$= I_m^2 \int_0^{\pi} \left[\frac{1 - \cos 2\theta}{2}\right] d\theta$$

$$= \frac{I_m^2}{2} \int_0^{\pi} 1 - \cos 2\theta \, d\theta$$

$$= \frac{I_m^2}{2} \left[\theta - \frac{\sin 2\theta}{2}\right]_0^{\pi}$$

$$\frac{I_m^2}{2} \left[(\pi - 0) - \left(\frac{\sin 2\pi - \sin 0}{2}\right)\right]$$

$$= \frac{I_m^2}{2} \left(\pi - (0 - 0)\right)$$

$$= \frac{I_m^2 \pi}{2}$$

$$\therefore \text{RMS of } I = \sqrt{\frac{\text{Area of first half cycle squared}}{\text{Base}}}$$

$$= \sqrt{\frac{I_m^2 \cdot \pi}{2\pi}} = \sqrt{\frac{I_m^2}{2}} = \frac{I_m}{\sqrt{2}}$$

$$\boxed{I_{rms} = 0.707 \, I_m}$$

4b Given $\omega = 2\pi f = 2000$ rad/sec

$$f = \frac{\omega}{2\pi} = \frac{2000}{2\pi} = 318.3 \text{ Hz} \quad (1M)$$

Instantaneous value @ $t = 160\mu s$ is

$$V = 0.04 \sin(2000 \times 160 \times 10^{-6} + 60^\circ) V$$

$$= 0.04 \sin(0.32 \text{ rad} + 60^\circ) V$$

$$= 0.04 \sin\left(0.32 \times \frac{180}{\pi} + 60^\circ\right) V$$

$$= 0.04 \sin(18.3^\circ + 60^\circ) V$$

$$= 0.0392 V$$

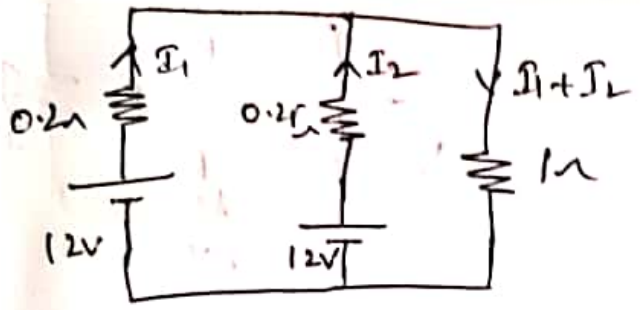
$$\boxed{V = 39.2 \text{ mV}} \quad (2M)$$

(c) Time period, $T = 1/f = \frac{1}{318.3} = 3.14 ms$ — (1M)

@ 60°, $t = \frac{60^\circ}{360^\circ} \times 3.14 ms = 0.52 ms$ (1M)

5a

59



(1M)

Apply KVL & form the loops (2M)

Solving the two loop equations (1M)

$I_1 = 6A$ (1M)

$I_2 = 4.8A$

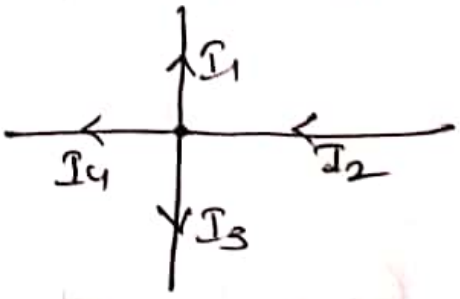
55 **Kirchoff's Laws:** ① Kirchoff's current law

② Kirchoff's Voltage Law

⇒ The sum of currents entering the circuit of a node is equal to the sum of the currents leaving the node

$$-I_1 + I_2 - I_3 - I_4 = 0$$

$$I_1 + I_3 + I_4 = I_2$$

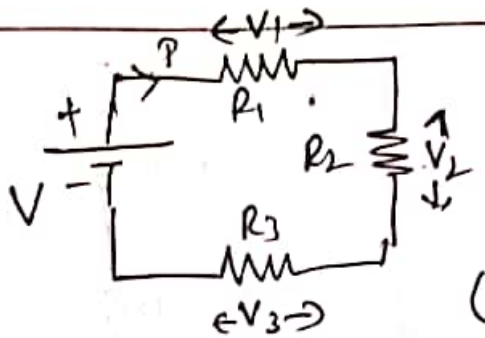


(2.5M)

⇒ In a closed circuit the sum of the P.D's across the resistors plus Emf's is equal to zero.

$V = I_1R_1 + I_2R_2 + I_3R_3$

$\boxed{V = V_1 + V_2 + V_3}$



(2.5M)

6a

Apply KVL to the loops

$-I_1 + 10 - 8(I_1 - I_2) - 20I_1 = 0$

$38I_1 - 8I_2 - 20I_3 = 0 \rightarrow (1)$

loop2:

$-I_2 \times 15 - 5(I_2 - I_3) - 8(I_2 - I_1) = 0$

$-15I_2 - 5I_2 + 5I_3 - 8I_2 + 8I_1 = 0$ (2M)

$-8I_1 + 28I_2 - 5I_3 = 0 \rightarrow (2)$

loop3:

$-20I_1 - 5I_2 + 25I_3 = -150 \rightarrow (3)$

Solving (1) & (2) & (3)

$I_1 = 8A$ (1M)

$I_2 = 4.67\ A$ (1M)

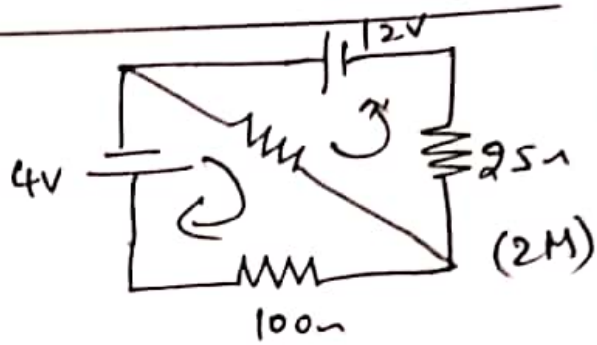
$I_3 = 13.3\ A$ (1M)

6b

Generation of sinusoidal voltage:

Explanation of faraday's law of electromagnetic induction with diagram. (5M)

7a



Apply KVL to the loops (2M)

$-110I_1 - 10I_2 - 4 = 0 \rightarrow ①$

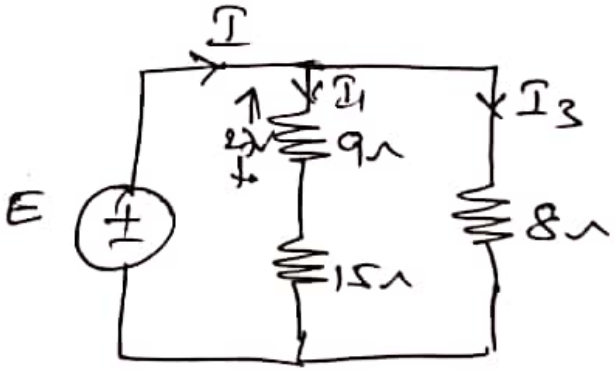
$-10I_1 + 35I_2 - 2 = 0$ (1M)

Solving ① & ② $I_1 = -0.04A$ (1M)

$I_2 = -0.06A$ (1M)

$I_1 - I_2 = -0.04 + 0.06 = \underline{0.02A}$ (1M)

7b



$I_1 = \frac{V}{R}$

$I_1 = \frac{27}{9} = \underline{3A}$ (2M)

$\boxed{I_1 = I_2 = \underline{3A}}$

$V_{15\Omega} = IR \Rightarrow V_{15\Omega} = 45V$

$V_{8\Omega} = 27 + 45 = \underline{72V}$ $\therefore \boxed{E = 72V}$ (1M)

$I_3 = 72/8 = 9A$ $\boxed{I_3 = 9A}$ (1M)

$\boxed{I = 12A}$ (1M)