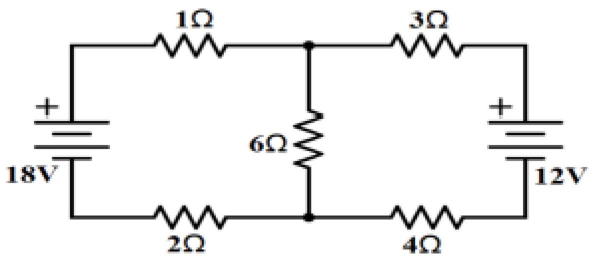
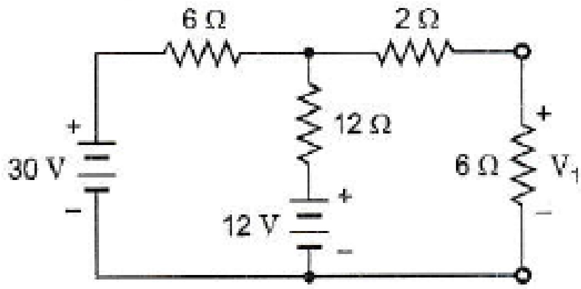
ABES Engineering College, Ghaziabad
B. Tech Even Semester Sessional Test-1

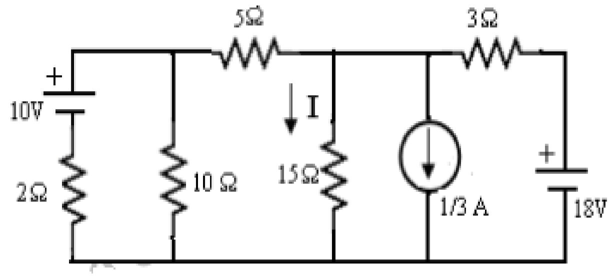
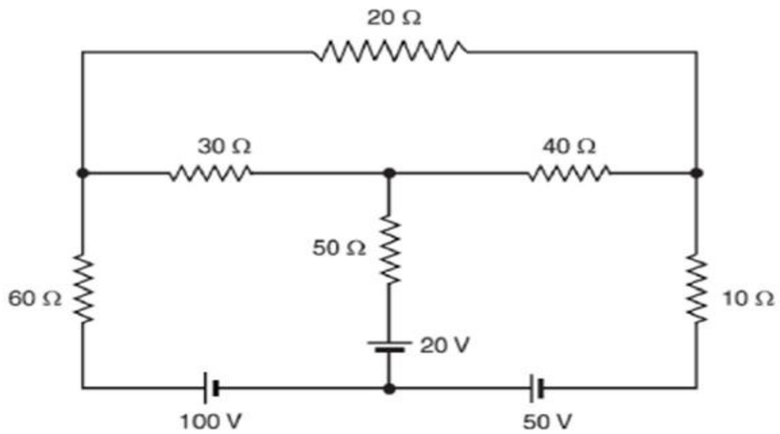
Printed Pages:
Session: 2023-24

Semester: 2nd
Course Code: BEE201
Course Name: Fundamentals of Electrical Engineering
Maximum Marks: 30

Roll No.:
Time: 1.15 Hrs.

Instructions:
1. **Attempt All sections.**
2. **If require any missing data, then choose suitably.**

Q. No.	Question	Marks	CO	KL	PI
	Section-A	**Total Marks : 20**			
1	**Attempt ANY ONE part from the following**				
a)	Explain the following with examples (i) Active and passive circuit elements (ii) Unilateral and bilateral circuit elements	**2.5 +2.5**	**CO1**	K2	2.1.2 2.1.3
b)	Differentiate the followings with V-I characteristics (i) Ideal and Practical Voltage source. (ii) Ideal and Practical Current source.	**2.5 +2.5**	**CO1**	K2	1.4.1
2	**Attempt ANY ONE part from the following**				
a)	Determine the current in 6Ω in the figure given below by using mesh or nodal analysis. 	5	**CO1**	K3	1.2.1 1.4.1
b)	Determine the voltage V_1 across 6Ω resistor using mesh or nodal analysis. 	5	**CO1**	K3	1.2.1 1.4.1
3	**Attempt ANY ONE part from the following**				
a)	Calculate the value of current I in 15Ω resistor in the figure given below by using nodal analysis	**10**	**CO1**	K3	1.2.1 1.4.1

					
b)	Calculate the value of current in 50Ω in the given figure using mesh analysis. 	**10**	**CO1**	K3	1.2.1 1.4.1
	Section-B	**Total Marks : 10**			
4	**Attempt ANY ONE part from the following**				
a)	Derive the expression for instantaneous power and average power for a pure resistance connected across single phase sinusoidal AC supply. Also draw the waveforms of instantaneous voltage, current and power.	**5**	**CO2**	K2	1.1.1 1.4.1
b)	Derive form factor and peak for a full wave rectified alternating voltage waveform.	**5**	**CO2**	K2	1.1.1 1.4.1
5	**Attempt ANY ONE part from the following**				
a)	A voltage v = 150 Sin l000t is applied across a series R.L-C circuit where R= 40 Ω, L =0.13 H and C = I0μF. (i) Compute the value of circuit current. (ii) Find voltage across inductor (iii) Find voltage across capacitor (iv) Power consumption and (v) power factor of circuit	**5**	**CO2**	K3	2.1.2 2.1.3
b)	Two impedances (8+j6) Ω and (2-j8) Ω are connected in parallel across 230V, 50Hz ac supply. Calculate the value of branch currents and supply current. Also find the value of power factor and real power of the circuit.	**5**	**CO2**	K3	2.1.2 2.1.3

CO Course Outcomes mapped with respective question
KL Bloom's knowledge Level (K1, K2, K3, K4, K5, K6)
K1-Remember, K2-Understand, K3-Apply, K4-Analyze, K5:Evaluate, K6-Create

Solution of Sessional Test -1

Q.1 (a)**Active and Passive Elements**: A Circuit element is said to be active if it is capable of delivering net power to the other elements when connected in a circuit. Ex: All sources voltage source and current source are considered as active elements.

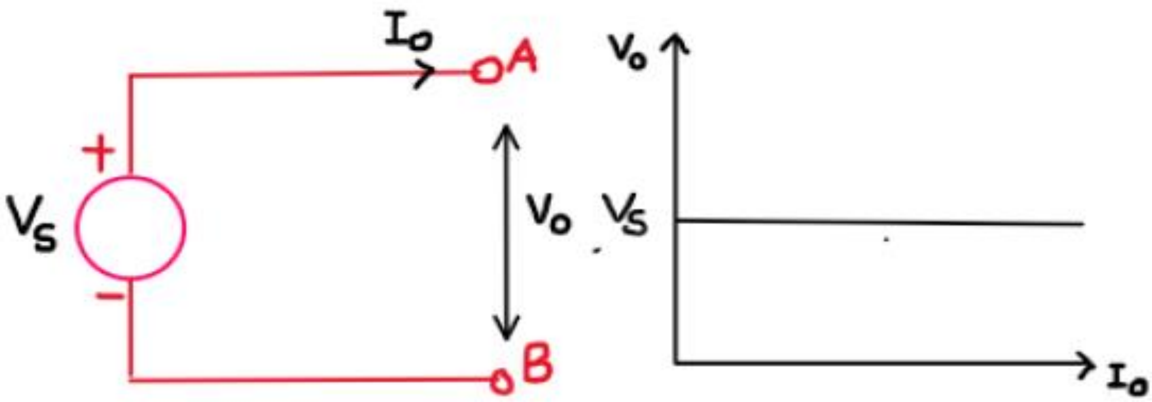
Passive circuit elements are those elements which are capable of consuming power when connected in a circuit. R, L and C are considered as passive elements

Unilateral and Bilateral Elements:

If the V-I relationship of an element depends on the direction of flow of current then, the element is called unilateral circuit element. Ex: Diode, Op-amp.

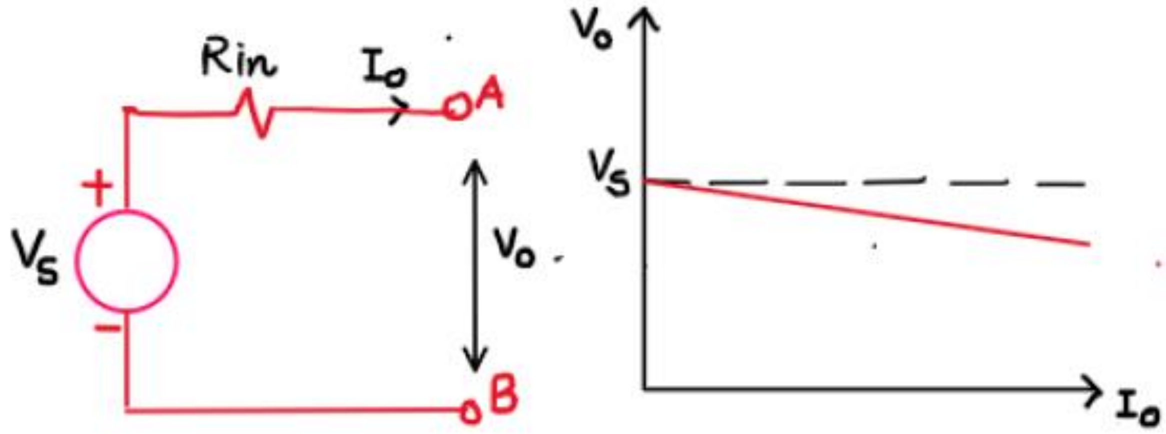
If the V-I relationship of an element is independent of the direction of flow of current then, the element is called bilateral circuit element. Ex: R, L and C

Q.1 (b) **Ideal and Practical Voltage Source** An ideal voltage source is a 2-terminal circuit element that maintains a constant terminal voltage no matter how much current is drawn from it. The internal resistance of ideal voltage source is zero.



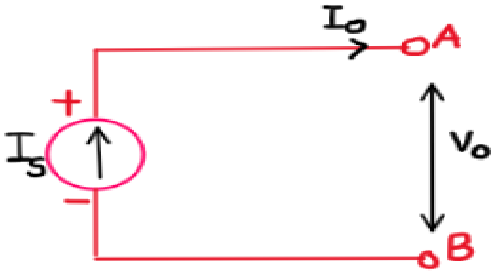
Symbol Characteristic

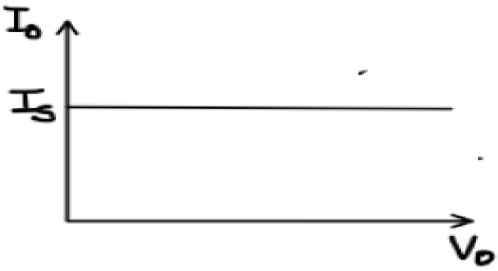
A practical voltage source consists of an ideal voltage source in series with an internal resistance (R_{in})



Symbol Characteristic

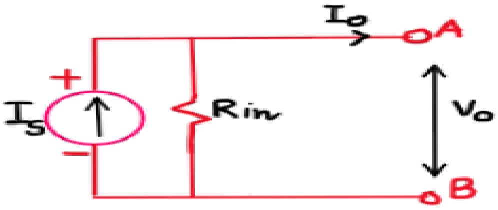
Ideal and Practical Current Source An ideal current source is a 2-terminal circuit element that maintains a constant current no matter how much voltage is exist across its terminals. The internal resistance of ideal current source is infinite.

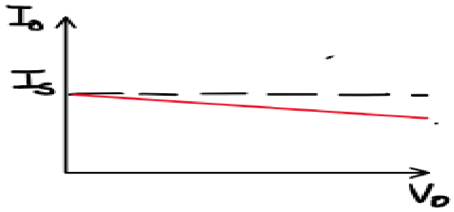




Symbol Characteristic

A practical current source consists of an ideal current source in parallel with an internal resistance.



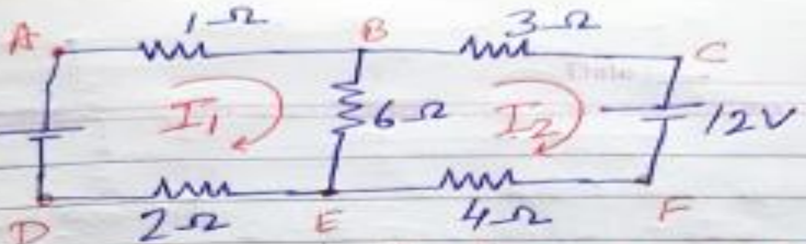


Symbol: Characteristic

Q2(a)

2(a)

Q:-



In loop ABEDA

$I_1 + 6(I_1 - I_2) + 2I_1 = 18$

$9I_1 - 6I_2 = 18$ — ①

In loop BCFEB

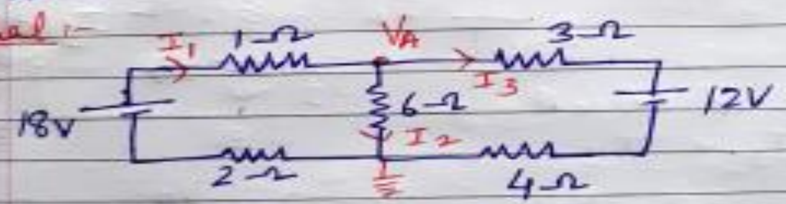
$3I_2 + 4I_2 + 6(I_2 - I_1) = -12$

$-6I_1 + 13I_2 = -12$ — ②

on solving we get $I_1 = 2\ A$ $I_2 = 0\ A$

Current in 6Ω $= (I_1 - I_2)$ B to E $= \boxed{2A}$ B to E

Nodal:-



By KCL At Node A:- $I_1 = I_2 + I_3$

$\Rightarrow \frac{18 - V_A}{3} = \frac{V_A}{6} + \frac{V_A - 12}{7}$

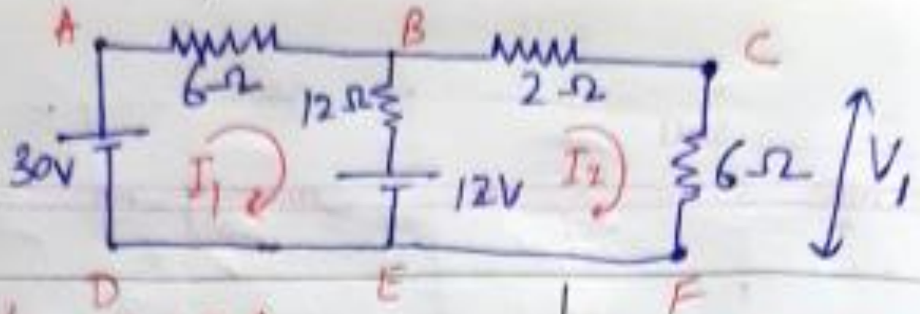
$252 - 14V_A = 7V_A + 6V_A - 72 \Rightarrow 27V_A = 324$

$\boxed{V_A = 12 \text{ Volts}}$

So Current In 6Ω $(I_2) = \frac{V_A}{6} = \frac{12}{6} = \boxed{2A}$

Q2(b)

Q2(b)



In loop ABEDA

$6I_1 + 12(I_1 - I_2) = 30 - 12$

$18I_1 - 12I_2 = 18$ — (i)

In loop BCFEB

$2I_2 + 6I_2 + 12(I_2 - I_1) = 12$

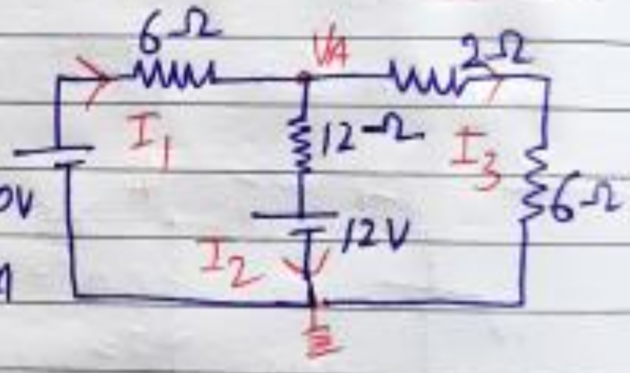
$-12I_1 + 20I_2 = 12$ — (ii)

on solving equation (i) & (ii)

$I_1 = 2.333A \quad I_2 = 2\ A$

So Voltage Drop in 6Ω = $6 \cdot I_2$ = 12 Volts

BY Nodal.



By KCL at Node A

$I_1 = I_2 + I_3$

$\Rightarrow \dfrac{30 - V_A}{6} = \dfrac{V_A - 12}{12} + \dfrac{V_A}{8}$

$\Rightarrow 240 - 8V_A = 4V_A - 48 + 6V_A$

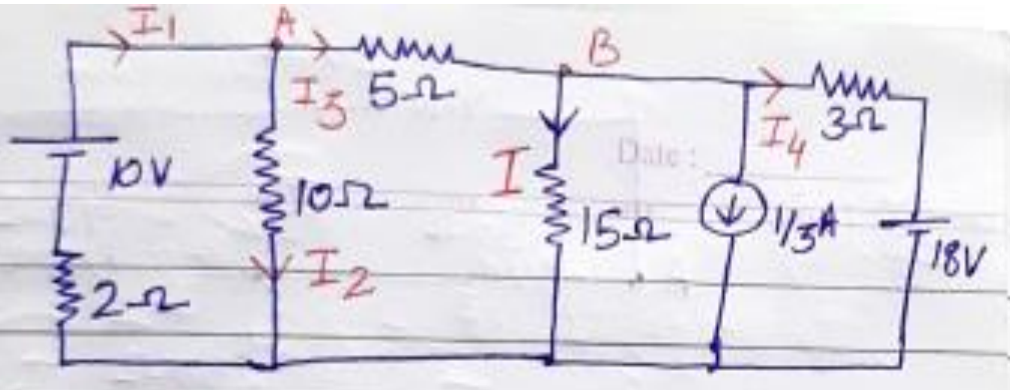
$18V_A = 288 \Rightarrow V_A = 16$ Volts

Current $I_3 = \dfrac{V_A}{8} = 2\ A$

Voltage Drop in 6Ω $(V_1) = 6 \cdot I_3 = \boxed{12 \text{ Volts}}$

Q3(a)

Q3(a)



At Node A

$$I_1 = I_2 + I_3$$

$$\frac{10 - V_A}{2} = \frac{V_A}{10} + \frac{V_A - V_B}{5}$$

$\Rightarrow$ $50 - 5V_A = V_A + 2V_A - 2V_B$

$8V_A - 2V_B = 50$ — (i)

At Node B :-

$$I_3 = I + \tfrac{1}{3} + I_4$$

$$\frac{V_A - V_B}{5} = \frac{V_B}{15} + \frac{1}{3} + \frac{V_B - 18}{3}$$

$\Rightarrow$ $3V_A - 3V_B = V_B + 5 + 5V_B - 90$

$3V_A - 9V_B = 85$ — (i)

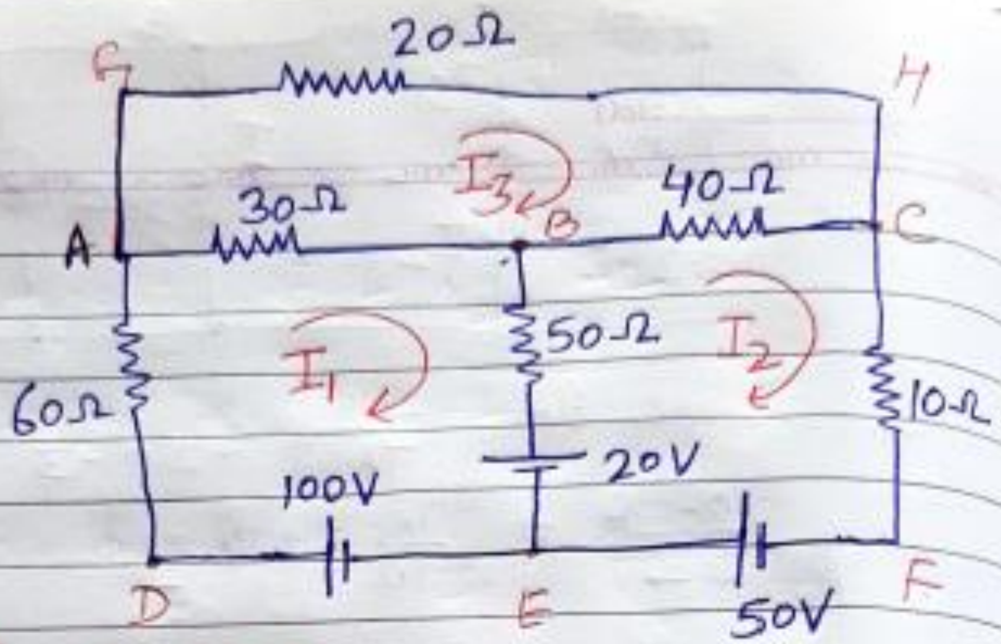
on solving $V_A = 9.394$ $V_B = 12.575$ Volts

Current in $15\Omega (I) = \frac{V_B}{15} = \frac{12.575}{15}$

$$\boxed{I = 0.838 \text{ A}}$$

Q3(b)

Q3 (b)



In loop ABEDA

$$60I_1 + 30(I_1 - I_3) + 50(I_1 - I_2) = 100 - 20$$

$$140I_1 - 50I_2 - 30I_3 = 80 \quad \text{— (i)}$$

In loop BCFEB

$$40(I_2 - I_3) + 10I_2 + 50(I_2 - I_1) = 20 + 50$$

$$-50I_1 + 100I_2 - 40I_3 = 70 \quad \text{— (ii)}$$

In loop AGHCBA

$$20I_3 + 40(I_3 - I_2) + 30(I_3 - I_1) = 0$$

$$-30I_1 - 40I_2 + 90I_3 = 0 \quad \text{— (iii)}$$

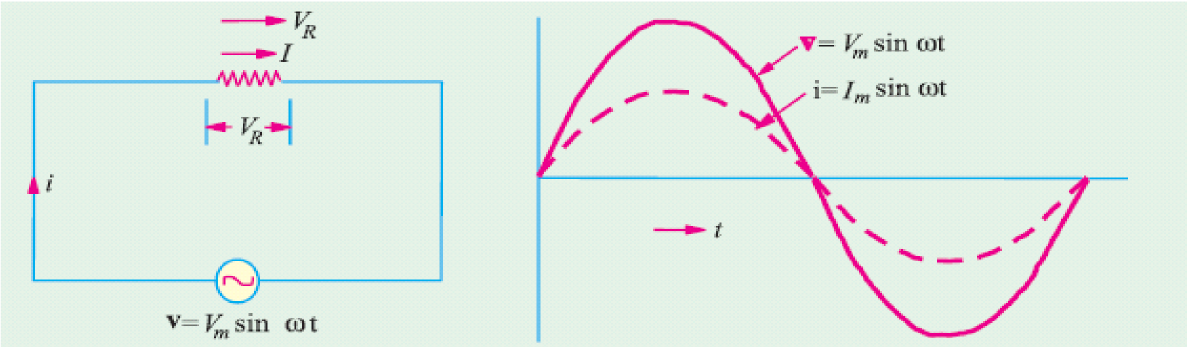
on solving we get

$I_1 = 1.649$, $I_2 = 2.1214$, $I_3 = 1.4925$ A

Current in 50 Ω = $(I_1 - I_2)$ B to E = -0.4724 B to E

$\boxed{= 0.4724 \text{ A E to B}}$

Q4(a)
CIRCUIT WITH PURE RESISTANCE ONLY



A pure resistance is that in which there is only a ohmic voltage drop. Consider a circuit having a pure resistance *R* as shown is figure above.. Let the instantaneous value of the alternating voltage applied be, $e = V_m \text{ Sin } \omega t$ The instantaneous value of current,

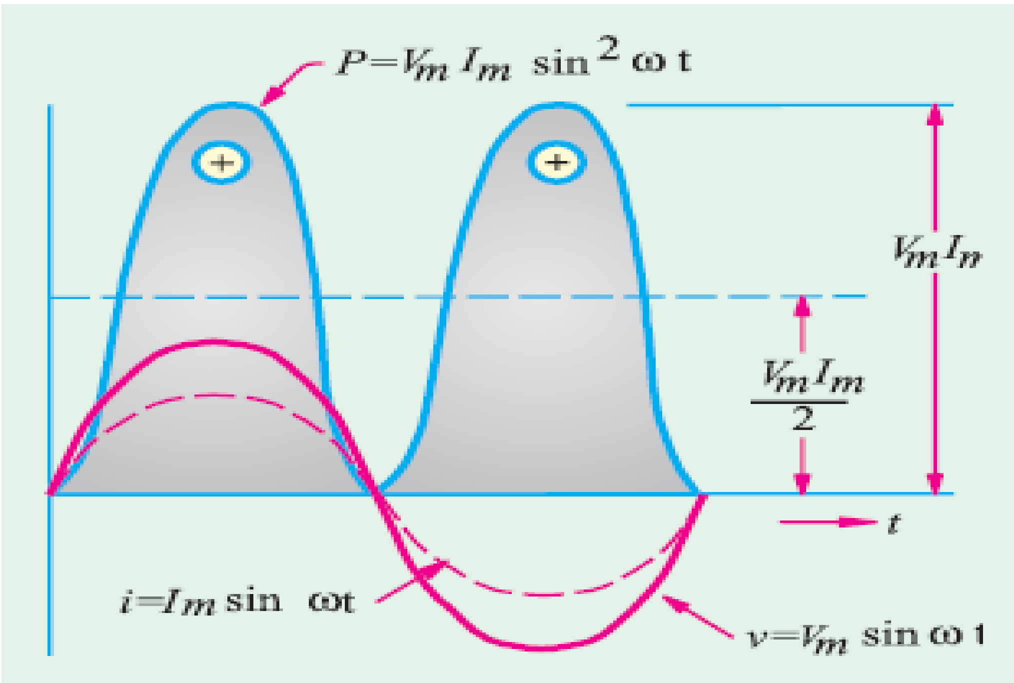
$$i = e/R = (V_m \text{ Sin } \omega t)/R . = I_m \text{ Sin } \omega t$$

Instantaneous Power

$$p = V_m \text{ Sin } \omega t * I_m \text{ Sin } \omega t = V_m I_m \text{Sin}^2 \omega t = \frac{V_m I_m}{2} - \frac{V_m I_m}{2} cos2\omega t .$$

Instantaneous power consists of a constant part $\frac{V_m I_m}{2}$ and a fluctuating part $\frac{V_m I_m}{2} cos2\omega t$ of frequency double that of supply. On taking average over complete cycle the fluctuating part reduces to zero and we get average Power

$$P = \frac{1}{2\pi}\int_0^{2\pi} ei\ d(\omega t) = \frac{V_m I_m}{2} \text{ watt or } V_{RMS} * I_{RMS} \text{ watt}$$



Wave diagram for resistive circuit

Q4(b)

Form factor of a Full wave rectifier:

For the full wave rectified voltage wave form shown in fig(2.6) the Average value is given by

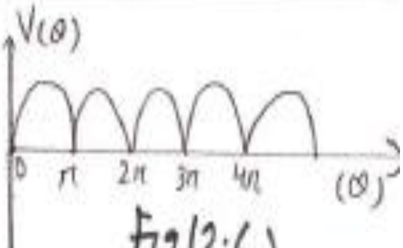


Fig (2.6)

The period of wave form is 0 to π
Sine function is followed over complete cycle

$$V_{Avg} = \frac{1}{\pi}\int_0^{\pi} V.d\theta = \frac{1}{\pi}\int_0^{\pi} V_m \sin\theta . d\theta$$

$$\Rightarrow V_{Avg} = \frac{V_m}{\pi}\Big[-\cos\theta\Big]_0^{\pi} \Rightarrow \boxed{V_{Avg} = \frac{2V_m}{\pi}} \quad \text{——} (i)$$

The RMS value is given by.

$$V_{RMS} = \sqrt{\frac{1}{\pi}\int_0^{\pi} V^2 d\theta} \Rightarrow V_{RMS}^2 = \frac{1}{\pi}\int_0^{\pi} V_m^2 \sin^2\theta . d\theta$$

$$V_{RMS}^2 = \frac{V_m^2}{2\pi}\int_0^{\pi}(1-\cos 2\theta).d\theta = \frac{V_m^2}{2\pi}\Big[\theta - \frac{\sin 2\theta}{2}\Big]_0^{\pi}$$

$$\Rightarrow V_{RMS}^2 = \frac{V_m^2}{2\pi} \times \pi \Rightarrow \boxed{V_{RMS} = \frac{V_m}{\sqrt{2}}} \quad \text{——} (ii)$$

So form factor of full wave rectified wave is given by

$$K_f = \frac{V_{RMS}}{V_{Avg}} \quad \text{using (i) \& (ii)} \Rightarrow \boxed{K_f = \frac{V_m/\sqrt{2}}{\frac{2V_m}{\pi}} = 1.11}$$

$$\text{Peak Factor } (K_P) = \frac{V_m}{V_{RMS}} = \frac{V_m}{V_m/\sqrt{2}} = \sqrt{2} = 1.4142$$

$$\boxed{K_P = 1.4142}$$

Q5(a)

Q5(a) $v = 150 \sin 1000t$, $R = 40\,\Omega$

$L = 0.13H \Rightarrow X_L = \omega L = 130\,\Omega$

$C = 10\mu F \Rightarrow X_C = \frac{1}{\omega C} = \frac{10^6}{1000 \times 10} = 100\,\Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{(40)^2 + (100-130)^2}$

$Z = 50\,\Omega$

Circuit Current $(I) = \frac{V_{RMS}}{Z} = \frac{150}{\sqrt{2} \times 50}$

$\boxed{I = 2.1213\ A}$

Voltage across Inductor $(V_L) = I \cdot X_L = 2.1213 \times 130$

$\boxed{V_L = 275.77 \text{ Volts}}$

Voltage across capacitor $V_C = I \cdot X_C = 2.1213 \times 100$

$\boxed{V_C = 212.13 \text{ Volts}}$

Power Factor of Circuit $\cos\phi = \frac{R}{Z} = \frac{40}{50}$

$\boxed{\cos\phi = 0.8 \text{ lagging}}$ $X_L > X_C$

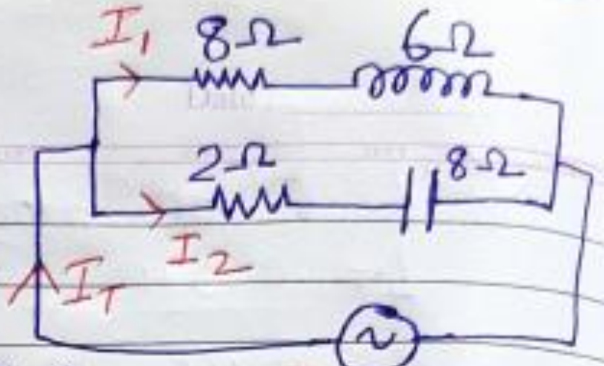
Power Consumption $= VI\cos\phi$

$= \frac{150}{\sqrt{2}} \times 2.1213 \times 0.8$

$\boxed{P = 180 \text{ watt}}$

Q5(b)

Q5(b)



230V, 50Hz

$Z_1 = 8+6j = 10\angle 36.87\ \Omega$

$Z_2 = 2-8j = 8.246\angle -75.96\ \Omega$

Current in Branch I $(I_1) = \dfrac{V}{Z_1} = \dfrac{230\angle 0^\circ}{10\angle 36.87}$

$\boxed{I_1 = 23\angle -36.87\ A = 18.40 - 13.8j\ A}$

Current in Branch 2

$I_2 = \dfrac{V}{Z_2} = \dfrac{230\angle 0^\circ}{8.246\angle -75.96} = \boxed{27.89\angle 75.96 A}$

$I_2 = 6.766 + 27.057j$

Net Current $I_T = I_1 + I_2$

$I_T = (18.4 - 13.8j) + (6.766 + 27.057j)$

$= 25.166 + 13.257j$

$\boxed{I_T = 28.44\angle 27.78\ A}$

Power Factor of Circuit $= \cos 27.78$

$\cos\phi = 0.8847$ leading

Power Consumption of Circuit $= VI\cos\phi$

$\boxed{P = 230 \times 28.44 \times 0.8847 = 5.787\ kW}$