CMR INSTITUTE OF TECHNOLOGY		USN	

Internal Assesment Test –I

Sub:	Introduction to Electrical Engineering									Code:	22ESC142
Date:	19/01/2023	Duration:	90 mins	Max Marks:	50	Sem :	1st sem	Branch:	CS/EC		

Answer any FIVE FULL Questions

		Marks	CO	RBT
1 a)	State and explain Ohm's law, List out its limitation.	[4]	CO1	L1

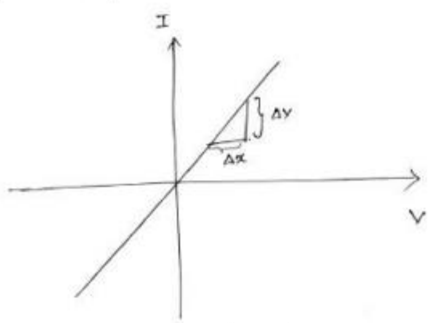
's law :-

The ratio of potential difference (V) between any two points on a conductor to the current (I) flowing between them is constant, provided the temperature of the conductor doesn't change.

$$\frac{V}{I} = \text{constant}$$
$$= R(\Omega)$$

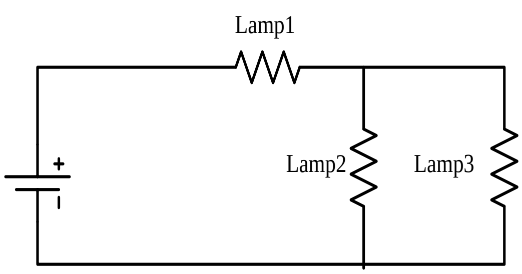
R - constant of proportionality
- resistance of the conductor.

Graphical representation of Ohm's law:



$$\text{Slope} = \frac{\Delta Y}{\Delta X} = \frac{I}{V} = \frac{1}{R} = G$$

where G is conductance (siemens) (℧).

<table>
<tr><td></td><td>Limitations - OHM'S LAW
1) It cannot be applied to non-linear devices like diodes, zener diodes, transistors, voltage regulator etc.
2) Ohm's law is applicable as long as tempe-rature and other physical parameters remains constant
3) It cannot be applied to complicated ckts having more no of branches and emf sources.
4) Not suitable for non-metallic conductors like silicon carbide, graphite etc.</td><td></td><td></td><td></td></tr>
<tr><td>b)</td><td>Three 60W 240V lamps are connected across a 240V power supply as shown in the figure. Calculate the i) Potential drop across each lamp
ii)Total power dissipated in the lamp.

</td><td>[6]</td><td>CO1</td><td>L3</td></tr>
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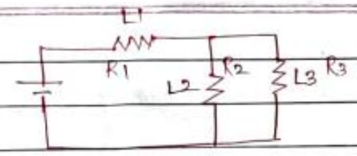
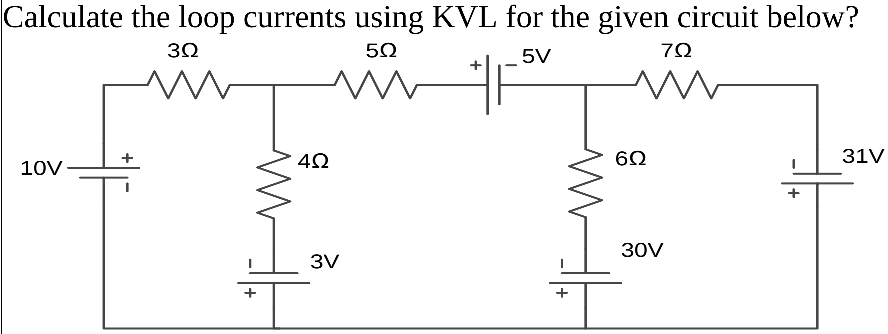
1 b)	 Given: Lamp Specification $P = 60W, \ V = 240V$ $R = \frac{V^2}{P} = \frac{240^2}{60} \Rightarrow 960\Omega$. Lamp Resistance $= 960\Omega$. Let R_1, R_2, R_3 be the resistance of each lamp. R_{eq} of the circuit $\Rightarrow R_1 + (R_2 \parallel R_3)$ $= 960 + 480 \Rightarrow 1440\Omega$. Supply / Source current I_1 (or) I_S $= \frac{V}{R_{eq}} = \frac{240}{1440} \Rightarrow 0.1667\ A$ Let I_2 and I_3 be the current through lamp 2 and lamp 3. Using current division, $I_2 = \frac{I_1 R_2}{R_2+R_3} \Rightarrow \frac{0.1667 \times 960}{(960+960)}$ $= 0.083\ A$. Simillarly $I_3 = 0.083\ A$. i) Potential drop across each lamp. W.K.T $V_1 = I_1 R_1 \Rightarrow 0.1667 \times 960 \Rightarrow 160.032\ V$. $\left.\begin{array}{l} V_2 = V_3 \\ \Rightarrow I_2 R_2 \\ \Rightarrow I_3 R_3 \end{array}\right\} \Rightarrow 0.083 \times 960 \Rightarrow 79.68\ V$. $\boxed{V_1 = 160.032V, \ V_2 = V_3 = 79.68V}$			
2 a)	Calculate the loop currents using KVL for the given circuit below?  	[6]	CO1	L3

<table>
<tr>
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<td>KVL @ loop 1:-
$10 - 3i_1 - 4(i_1 - i_2) + 3 = 0$
$10 - 3i_1 - 4i_1 + 4i_2 + 3 = 0$
$10 - 7i_1 + 4i_2 + 3 = 0$
$\boxed{-7i_1 + 4i_2 + 0i_3 = -13}$ − (1)

KVL @ loop 2:-
$-5i_2 - 5 - 6(i_2 - i_3) + 30 - 3 - 4(i_2 - i_1) = 0.$
$-5i_2 - 5 - 6i_2 + 6i_3 + 27 - 4i_2 + 4i_1 = 0.$
$\boxed{4i_1 - 15i_2 + 6i_3 = -22}$ − (2)

KVL @ loop 3:-
$-7i_3 + 31 - 30 - 6(i_3 - i_2) = 0.$
$-7i_3 + 1 - 6i_3 + 6i_2 = 0.$
$\boxed{0i_1 + 6i_2 - 13i_3 = -1}$ − (3).
Solving, $i_1 = 3.57A$; $i_2 = 3.01A$; $i_3 = 1.46A$.</td>
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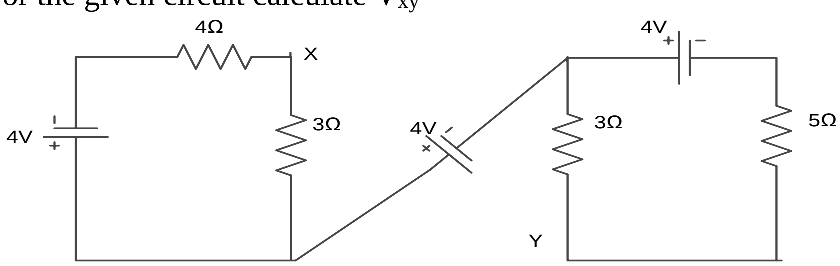
<td>b)</td>
<td>For the given circuit calculate V_{xy}

</td>
<td>[4]</td>
<td>CO1</td>
<td>L3</td>
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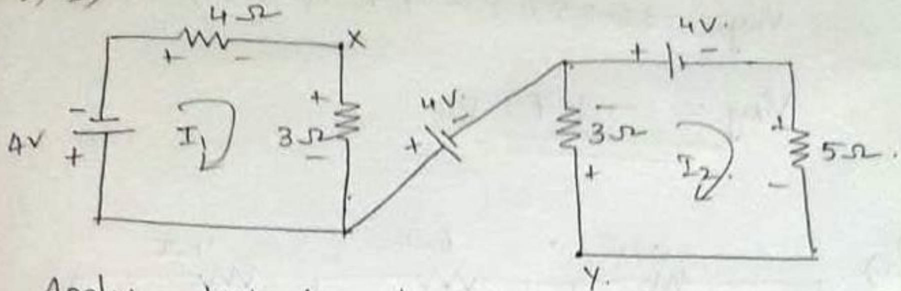
2) b)



Apply KVL for loop 1

$$-4 - 4(I_1) - 3I_1 = 0$$

$$-4 - 7I_1 = 0 \Rightarrow 7I_1 = -4$$

$$I_1 = \underline{\underline{-0.57\,A}}.$$

Apply KVL for loop 2

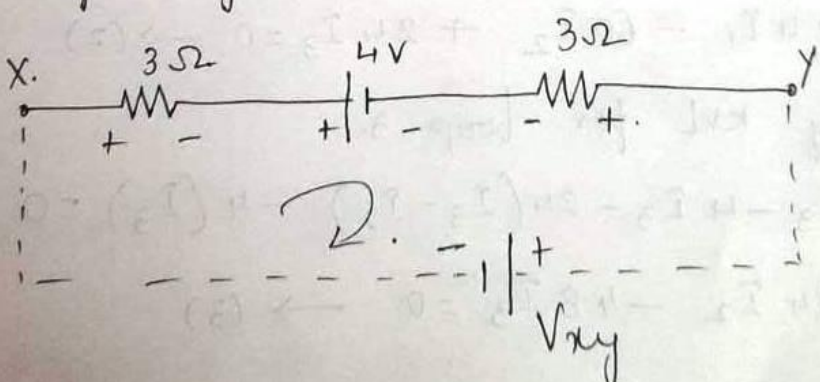
$$-4 - 5I_2 - 3I_2 = 0.$$

$$-4 - 8I_2 = 0 \Rightarrow 8I_2 = -4$$

$$I_2 = \underline{\underline{-0.5\,A}}.$$

To find V_{xy}

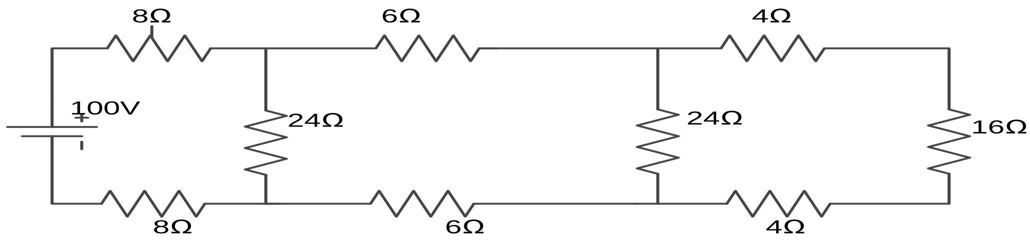
$$V_{xy} = V_y - V_x.$$

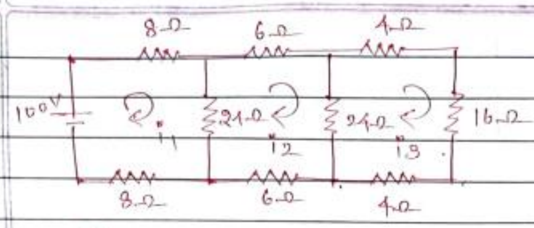


$$-3I_1 - 4 + 3I_2 - V_{xy} = 0.$$

$$V_{xy} = -3I_1 - 4 + 3I_2.$$

$$V_{xy} = -3.79V.$$

<table>
<tr>
<td>3 a)</td>
<td>Find the power dissipated in 16 ohm resistor.


3 a)


KVL @ L1,
$-8i_1 - 24(i_1 - i_2) - 8i_1 + 100 = 0$
$-8i_1 - 24i_1 + 24i_2 - 8i_1 = -100$
$\boxed{-40i_1 + 24i_2 + 0i_3 = -100}$ — (1)
KVL @ L2,
$-6i_2 - 24(i_2 - i_3) - 6i_2 - 24(i_2 - i_1) = 0$
$-6i_2 - 24i_2 + 24i_3 - 6i_2 - 24i_2 + 24i_1 = 0$
$\boxed{24i_1 - 60i_2 + 24i_3 = 0}$ — (2)
KVL @ L3,
$-4i_3 - 16i_3 - 4i_3 - 24(i_3 - i_2) = 0$
$-4i_3 - 16i_3 - 4i_3 - 24i_3 + 24i_2 = 0$
$\boxed{0i_1 + 24i_2 - 48i_3 = 0}$ — (3)
Solving above equations,
$i_1 = 3.57$ A
$i_2 = 1.78$ A
$i_3 = 0.89$ A.
Current through 16Ω resistor is i_3
∴ Power dissipated $= i_3^2 \times 16$
$= 0.89^2 \times 16$
$= 12.67$ W
$\boxed{P = 12.67 \text{ W}}$</td>
<td>[5]</td>
<td>CO1</td>
<td>L3</td>
</tr>
<tr>
<td>b)</td>
<td>Define and explain time period, frequency, amplitude, phase, phase difference.
Time Period:
The period is defined as the smallest time interval required by a wave to complete a wave cycle.
Frequency:</td>
<td>[5]</td>
<td>CO2</td>
<td>L1</td>
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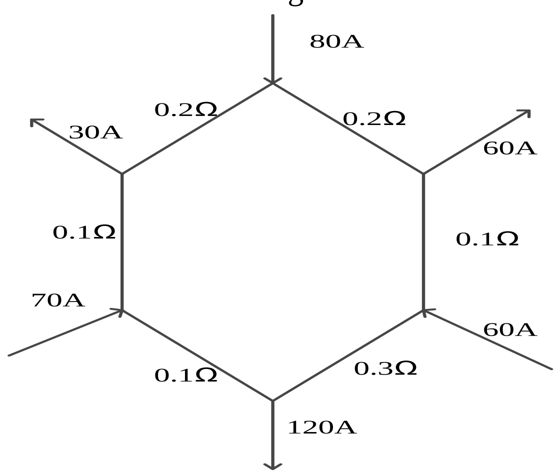
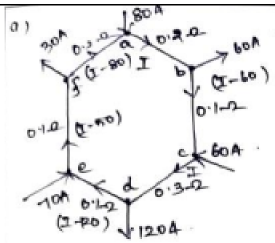
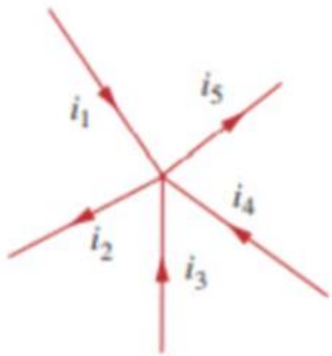
	The number of complete wave repetitions occurring in a unit time is referred as frequency. And ‘**f**’ is the denotion used for it. Consider the waveform representation given below. **Amplitude:** The **amplitude** of a periodic variable is a measure of its change in a single period . The amplitude of a non-periodic signal is its magnitude compared with a reference value. **Phase:** The phase of an alternating quantity is defined as the divisional part of a cycle through which the quantity moves forward from a selected origin. When the two quantities have the same frequency, and their maximum and minimum point achieve at the same point, then the quantities are said to have in the same phase. **Phase Difference:** The phase difference between the two electrical quantities is defined as the angular phase difference between the maximum possible value of the two alternating quantities having the same frequency.			
4 a)	For the given circuit , calculate current through all the branches  	[5]	CO1	L3

	a)  Let us assume current through branch ab, be I (A). Applying KCL at remaining nodes, the current through all other branches are written as follows $I_{ab} = I(A)$; $I_{bc} = (I-60)\,A$; $I_{cd} = I(A)$; $I_{de} = (I-120)\,A$ $I_{ef} = (I-50)\,A$; $I_{fa} = (I-80)\,A$. Apply KVL for the loop abcdefa, $-0.2I - 0.1(I-60) - 0.3I - 0.1(I-120) - 0.1(I-50)$ $- 0.2(I-80) = 0$. $-0.2I - 0.1I + 6 - 0.3I - 0.1I + 12 - 0.1I + 5 - 0.2I + 16 =$ $I - 39 = 0$ $\boxed{I = 39\,A}$. $I_{ab} = 39A$; $I_{bc} = 39-60 = -21A$; $I_{cd} = 30A$ $I_{de} = I-120 = 39-120 = -81A$; $I_{ef} = -11A$; $I_{fa} = -41A$.			
b)	State and explain Kirchhoff's Laws, as applied to D.C. Circuit. The current or voltage of any circuit branch can also be calculated using Kirchhoff's Law. These laws are valid in AC and DC networks at low frequencies. Kirchhoff's laws are classified into two types: • Kirchhoff's Current Law (KCL) • Kirchhoff's Voltage Law (KVL) **Kirchhoff's Current Law** Kirchhoff's current law is also known as Kirchhoff's First law or Kirchhoff's Law of the junction, but the most used term is Kirchhoff's Current Law or KCL. KCL is based on the law of conservation of charge. Kirchhoff's current law states that the algebraic sum of currents entering a node or a closed boundary equals zero.	[5]	CO1	L2

If there are N number of branches connected to a node and it is the current of the nth branch, then mathematically, KCL states,

$\sum_{n=1}^{N} i_n = 0$



Applying KCL to the above node,

$$-i_1 + i_2 - i_3 - i_4 + i_5 = 0$$

$$i_2 + i_5 = i_1 + i_3 + i_4$$

Current leaving=current entering

Kirchhoff's Voltage Law

Kirchhoff's Voltage Law is also known as Kirchhoff's Second law or KVL. KVL is based on the law of conservation of energy.

Kirchhoff's Voltage Law:

Kirchhoff's Voltage Law states that the algebraic sum of voltages around a closed path or loop in a circuit equals zero. If there are M number of voltages in a loop and V_m is the m^{th} voltage, then mathematically, KVL can be written as:

$\sum_{n=1}^{M} V_m = 0$

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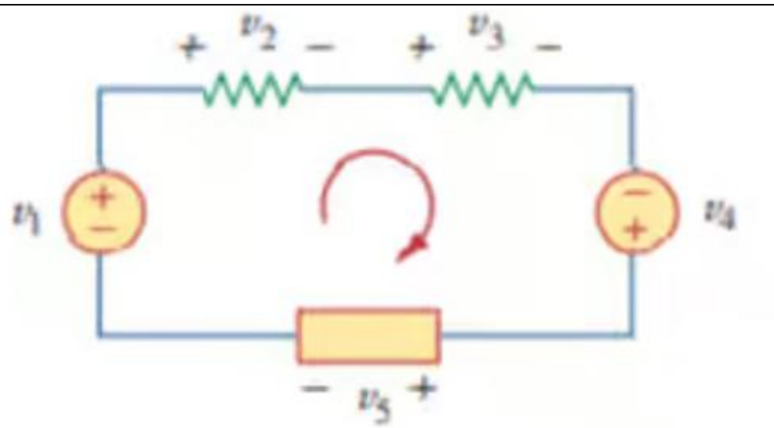
<td>

From the figure, KVL yields

$$-v_1 + v_2 + v_3 - v_4 + v_5 = 0$$

$$v_2 + v_3 + v_5 = v_1 + v_4$$</td>
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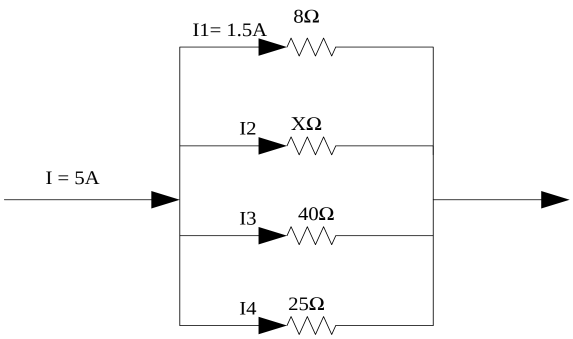
<tr>
<td>5</td>
<td>Calculate i) Current through each resistor ii) Unknown resistance x? iii) Req. iv) Power consumed.


</td>
<td>[10]</td>
<td>CO1</td>
<td>L3</td>
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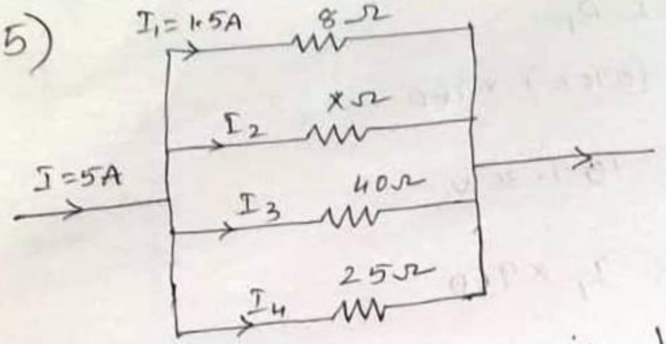
</table>

5)



Voltage drop across 8Ω is $V_{8\Omega} = I_1 \times 8$

$V_{8\Omega} = 12V.$

12V is Voltage across all $\parallel^{el}$ resistors.

i) $I_3 = \frac{V}{40} = 0.3A.$

$I_4 = \frac{V}{25} = 0.48A.$

$I = I_1 + I_2 + I_3 + I_4.$

$I_2 = I - (I_1 + I_3 + I_4)$

$= 5 - (1.5 + 0.3 + 0.48)$

$I_2 = 2.72A.$

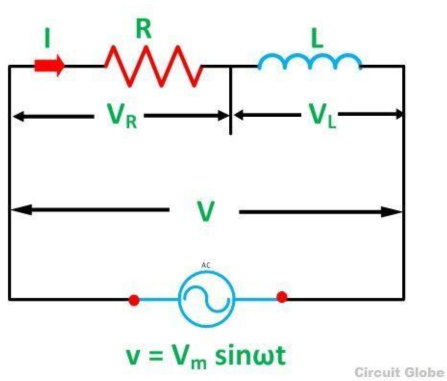
ii) $V = I_2 \times x \Rightarrow x = \frac{V}{I_2} = \frac{12}{2.72}$

$x = 4.4\Omega.$

iii) $\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{4.4} + \frac{1}{40} + \frac{1}{25}$

$R_{eq} = 2.39\Omega$

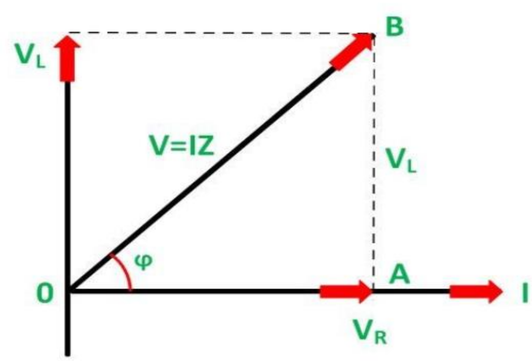
iv) $P = V \times I = 12 \times 5 = 60W$//

6a)	Define the RMS, average value, form factor and peak factor for a sinusoidal signal. **Average Value:** The average of all the instantaneous values of an alternating voltage and currents over one complete cycle is called **Average Value.**If we consider symmetrical waves like sinusoidal current or voltage waveform, the positive half cycle will be exactly equal to the negative half cycle. Therefore, the average value over a complete cycle will be **zero**. **RMS Value:** That steady current which, when flows through a resistor of known resistance for a given period of time than as a result the same quantity of heat is produced by the alternating current when flows through the same resistor for the same period of time is called **R.M.S** or effective value of the alternating current. **Peak Factor** is defined as the ratio of maximum value to the R.M.S value of an alternating quantity. The alternating quantities can be voltage or current. The maximum value is the **peak value** or the **crest value** or the amplitude of the voltage or current. **Form Factor:** The ratio of the root mean square value to the average value of an alternating quantity (current or voltage) is called Form Factor. The average of all the instantaneous values of current and voltage over one complete cycle is known as the average value of the alternating quantities.	[5]	CO2	L1
b)	Derive the expression for impedance in the case of series R-L and R-C circuits with relevant phasor diagrams. **RL series circuit:**  Where, • V_R – voltage across the resistor R • V_L – voltage across the inductor L	[5]	CO2	L2

- V – Total voltage of the circuit

Phasor Diagram of the RL Series Circuit

The phasor diagram of the RL Series circuit is shown below:



In right-angle triangle OAB

$V_R = I_R$ and $V_L = IX_L$ where $X_L = 2\pi fL$

$$V = \sqrt{(V_R)^2 + (V_L)^2} = \sqrt{(IR)^2 + (IX_L)^2}$$

$$V = I\sqrt{R^2 + X_L^2} \quad \text{or}$$

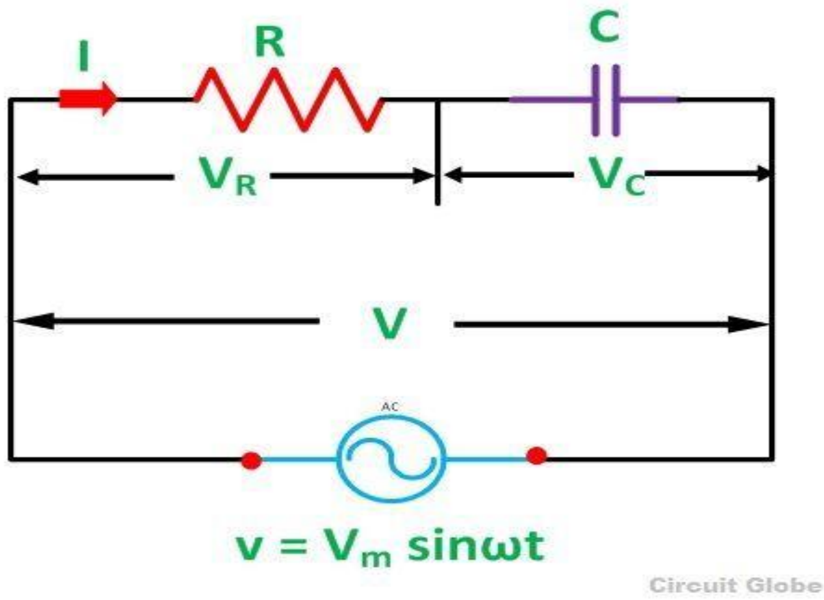
$$I = L = \frac{V}{Z}$$

$$Z = \sqrt{R^2 + X_L^2}$$

Where,

Z is the total opposition offered to the flow of alternating current by an RL Series circuit and is called impedance of the circuit. It is measured in ohms (Ω).

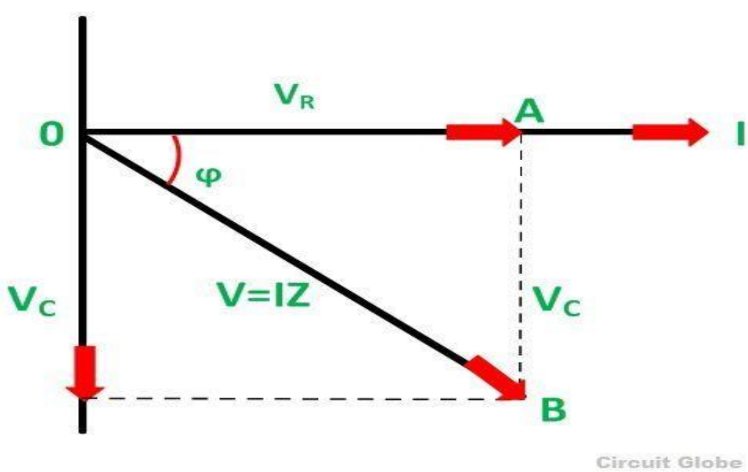
RC Series Circuit:



Where,

- V_R – voltage across the resistance R
- V_C – voltage across capacitor C
- V – total voltage across the RC Series circuit

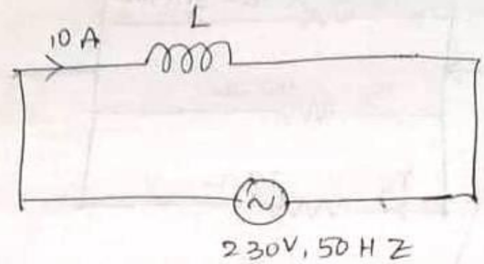
Phasor Diagram:



	In right triangle OAB, $$V = \sqrt{(V_R)^2 + (V_C)^2} = \sqrt{(IR)^2 + (IX_C)^2}$$ $$V = I\sqrt{R^2 + X_C^2} \qquad \text{or}$$ $$I = \frac{V}{\sqrt{R^2 + X_C^2}} = \frac{V}{Z}$$ Where, $$Z = \sqrt{R^2 + X_C^2}$$ Z is the total opposition offered to the flow of alternating current by an RC series circuit and is called **impedance** of the circuit. It is measured in ohms (Ω).			
7 a)	A pure inductive coil allows a current of 10A to flow from a 230V,50Hz supply. Calculate i) X_L ii) L and iii) Power	[4]	CO2	L3

$I_4 =$

7) a)



i) $\cancel{X_L = 2\pi}$

$X_L = Z = \frac{V}{I} = \frac{230}{10}$

$X_L = 23\ \Omega$

ii) $X_L = 2\pi f L$

$L = \frac{X_L}{2\pi f} = \frac{23}{2\pi \times 50}$

$L = 0.0732\ H$ (or) $73.2\ mH$

$P = V I \cos\phi = 230 \times 10 \times \cos 90^\circ$

~~P = 2300W~~

$[\phi = 90^\circ$ as pure Inductor$]$

$P = 0\ W$

7) b

i

b)	An alternating voltage (100+j60)V is applied to a circuit and current flowing through it is (-5+j10)A. Find (a) Impedance (b) Phase angle (c) Power factor and (d) Power. 4) b) $V = (100+j60)\ V \Rightarrow 116.62\angle 30.96$ $I = (-5+j10)\ A \Rightarrow 11.18\angle 116.56$ a) Impedance $Z = \frac{V}{I} \Rightarrow \frac{100+j60}{-5+j10}$ $= 0.8 - j10.4$ $= 10.43\angle -85.6$ b) Phase angle $\phi = \tan^{-1}\frac{X_L}{R}$ $\phi = \tan^{-1}\left(\frac{-10.4}{0.8}\right)$ $\phi = -85.60$ $\boxed{\phi = 85.60}$ c) Power factor: $\cos\phi = 0.0766$ d) Power $= VI\cos\phi \Rightarrow 116.62\times 11.18\cos\phi$ $= 116.62\times 11.18\times 0.0766$ $= 99.87\ W$	[6]	CO2	L3