RTU ROLL NO. ....

ARYA GROUP OF COLLEGES

I MID TERM EXAMINATION 2018-19 (I Sem.)

1FY3-08_Basic Electrical Engineering

BRANCH: Common to All

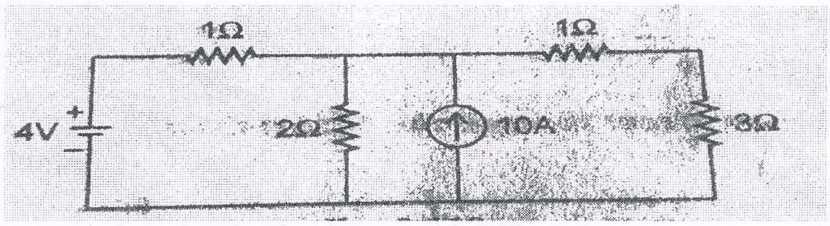
Max Marks:- 40 **Time:- 2 hrs.**

PART A (Attempt All)

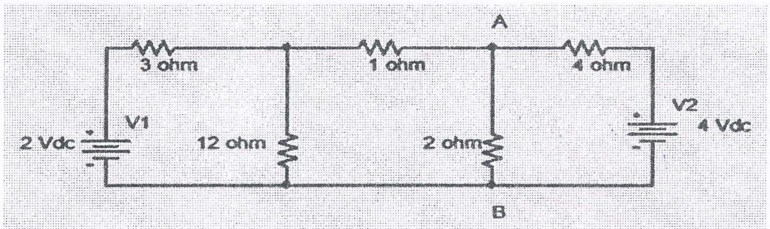
Q.1
(a) State and explain Ohm's Law and Faraday's law of electromagnetic induction.
(b) State and explain Kirchhoff's law.
(c) Mathematically, Prove the condition for maximum power transfer that is $R_L=R_S$. **5*2**
(d) Derive Average and RMS value of Sine wave.
(e) What is Resonance? What is the condition of resonance?

PART B (Attempt any Four)

Q.2
(a) State and explain Thevenin's Theorem with suitable example. Find current in 3ohm using Thevenin Theorem.



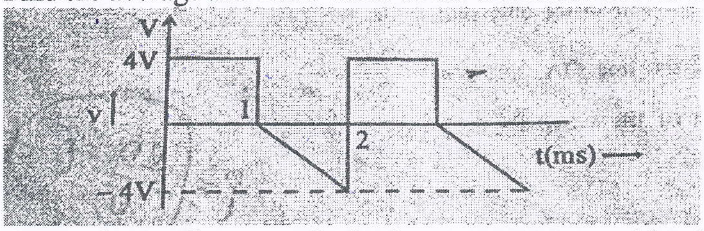
(b) Find current in branch AB using Superposition Theorem.



4*4

(c) A coil having a resistance of 3.5Ω and inductance of 0.07H is connected across 220V, 50Hz power supply. Find the value of current flow in the circuit and also find power factor.

(d) Find the average and RMS value of the waveform shown below:



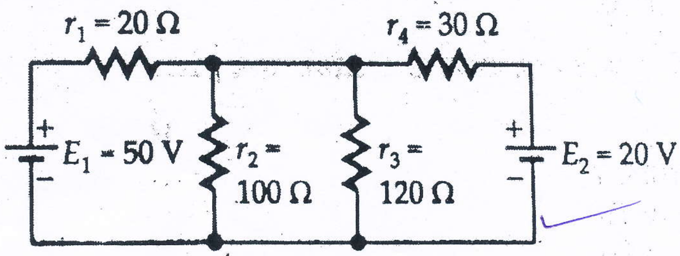
(e) Draw phasor diagram of a 3-phase star connected load and find the relationship between phase and line voltages and currents.

(f) Describe **RL series** circuit with **voltage triangle, Impedance Triangle and Power triangle.** What is **Resonance** in RLC circuit?

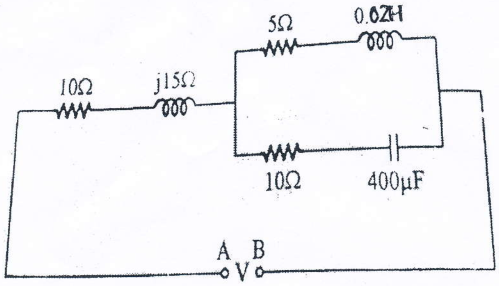
PART C (Attempt any Two)

Explain Node voltage method and Mesh current method with example.

Q.3 (a)



(b) In the circuit shown below, determine the voltage at a frequency of 50Hz to be applied across AB in order that current in the circuit drawn is 10A. 2*7



(c) Two coils A and B are connected in series across A 240V, 50Hz power supply. The resistance of coil A is 5Ω and inductance of B is 0.015H. If the input from the supply is 3KW and 2K VAR. Find the inductance of A and resistance of B. Also calculate the voltage across each coil.

PART A

Q. 1 (a) State and explain ohm's law & Faraday's law of electromagnetic induction.

Ans. Ohm's law —

Ohm's law states that the current flowing through conductor is directly proportional to the potential difference across them.

Mathematically, $\boxed{V \propto I}$

$$\frac{V}{I} = \text{Constant}$$

this constant is called R resistance, of conductor

$$\Rightarrow \boxed{\frac{V}{I} = R}$$

Faraday's law →

(1) Faraday's First Law —

it states that "whenever there is a change of flux linkage of a coil or conductor, an emf is induced in the coil or conductor."

(2) Faraday's second law — It states that " the magnitude of induced emf in

coil or conductor is directly proportional to the r
of change of flux linkage

$\Rightarrow$ $\boxed{e \propto \frac{d}{dt}(N\phi)}$

$\Rightarrow$ $e = K \frac{d}{dt}(N\phi)$

$\phi \rightarrow$ flux linkage of coil

$N \rightarrow$ no. of turns of coil

$K \rightarrow$ proportionality consta

(b) State and explain kirchoff's law.

Ans Gustav Robert kirchoff gave two important laws to solve the electrical circuits.

Kirchoff's Current law (KCL) —

KCL states that "in any electrical network the algebraic sum of all the currents at any n or junction is always zero."

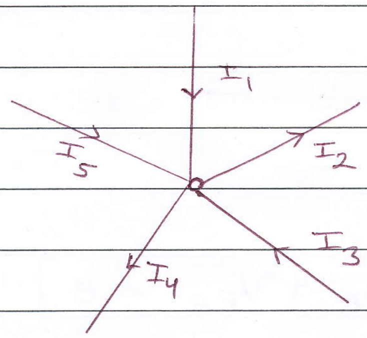
That is, at a node $\boxed{\sum_{i=1}^{N} I = 0}$

KCL can also be stated as "In any electrical cir at a node the sum of incoming current is always equal to the sum of outgoing currents

That is, at any node

$$\boxed{\Sigma \text{ incoming currents} = \Sigma \text{ outgoing currents}}$$

Example –



By KCL → $I_1 + I_3 + I_5 = I_2 + I_4$

OR $\boxed{I_1 - I_2 + I_3 - I_4 + I_5 = 0}$

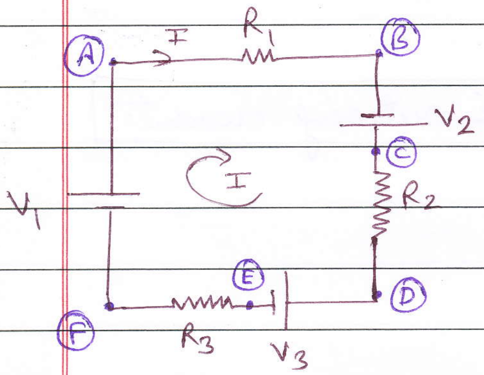
Kirchoff's Voltage Law (KVL) –

KVL states that " In a closed circuit or a mesh loop, the algebraic sum of all voltages (Voltage drop across resistances and battery or emf) is always

That is, around any closed path →

$$\Rightarrow \boxed{\sum_{i=1}^{N} V_i = 0}$$

Example —



By KVL in loop ABCDEFA —

$$\Rightarrow \boxed{V_{AB} + V_{BC} + V_{CD} + V_{DE} + V_{EF} + V_{FA} = 0}$$

$$\Rightarrow (-IR_1) + V_2 + (-IR_2) + (-V_3) + (-IR_3) + V_1 = 0$$

(c) Mathematically, Prove the condition for maximum power transfer that is $R_L = R_s$

Ans Consider a DC network source with a variable load resistance R_L as shown in figure —

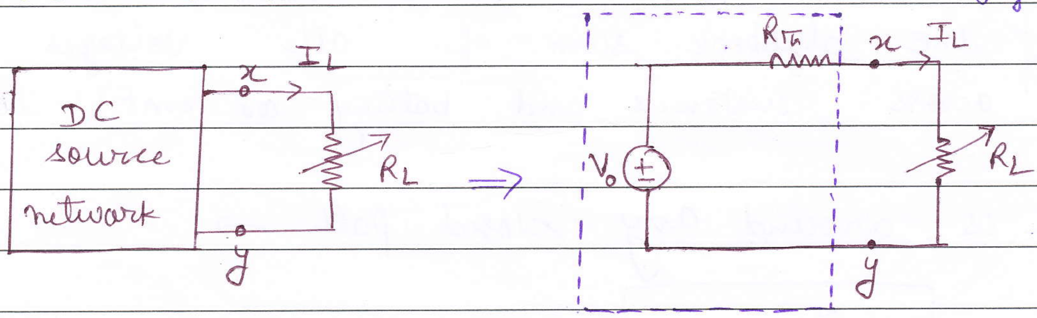


fig — load connected to DC network & its thevenin's equivalent

$$\text{Current } I_L = \frac{V_0}{R_{Th} + R_L}$$

Power delivered to load R_L →

$$P_L = I_L^2 R_L = \left(\frac{V}{R_{Th} + R_L}\right)^2 . R_L$$

Maximum power delivered by source when $\frac{dP}{dR_L} = 0$

so $$\frac{dP_L}{dR_L} = \frac{1}{[(R_{Th}+R_L)^2]^2} \times \left[(R_{Th}+R_L)^2 V_o^2 - V_o^2 R_L \frac{d}{dR_L}(R_{Th}+R_L)^2\right]$$

$$\frac{dP_L}{dR_L} = \frac{V_o^2 (R_{Th} - R_L)}{(R_{Th}+R_L)^3}$$

Putting $\frac{dP_L}{dR_L} = 0 \Rightarrow \frac{V_o^2 (R_{Th} - R_L)}{(R_{Th}+R_L)^3} = 0$

$$\Rightarrow R_{Th} - R_L = 0$$

$$\boxed{R_{Th} = R_L}$$

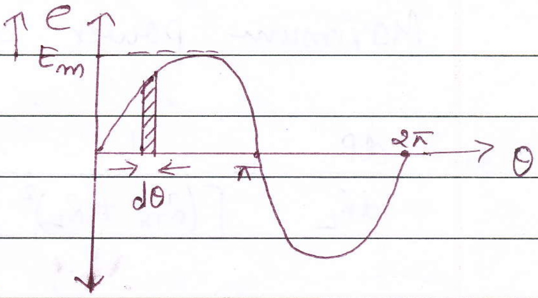
Hence, maximum power delivered when load resistance is equal to thevenin's equivalent resistance (R_{Th}) or source resistance (R_s).

(d) Derive Average and RMS value of sine wave.

Ans. — Average Value of AC Quantity —

By Analytical Method —

Consider a sine wave as shown —



equation given by →

$$e = E_m \sin\theta$$

An elementary strip of thickness $d\theta$ is shown as shaded region.

Area of strip → $dA = e\, d\theta$

Now, area of positive half cycle →

$$A = \int_0^{\pi} e \cdot d\theta = \int_0^{\pi} E_m \sin\theta \cdot d\theta = E_m [-\cos\theta]_0^{\pi}$$

$$A = 2E_m$$

Also, length of interval $= \pi - 0 = \pi$

So $$\boxed{E_{avg.} = \frac{2E_m}{\pi} = 0.637\, E_m}$$

ARYA INSTITUTE OF ENGINEERING & TECHNOLOGY, KUKAS, Jaipur

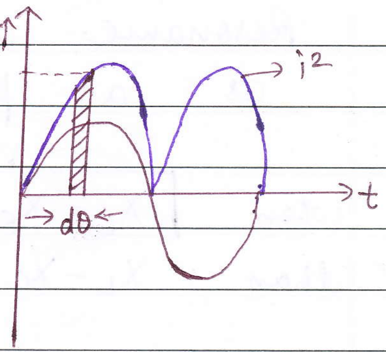
Lecture Notes

Branch : I year Sem. : I Sem Subject : BEE

Topic : Solution 2018-19 Unit PART-A Lecture No.

RMS Value of AC Quantity —

To find rms value, we find root of mean of square on alternating current, waveform for i, i^2 →



$$i = I_m \sin\theta$$

squaring both sides, $i^2 = I_m^2 \sin^2\theta$

consider an strip on I^2 wave, with thickness $d\theta$,

Area of this strip → $dA = i^2 \, d\theta$

Area over +ve half cycle $A = \int_0^{\pi} i^2 \cdot d\theta$

To find mean, divide it by length of positive cycle.

$$\text{mean} = \frac{\int_0^{\pi} i^2 \cdot d\theta}{\pi - 0}$$

Square root of this mean →

$$I_{rms} = \sqrt{\frac{\int_0^{\pi} i^2 \cdot d\theta}{\pi - 0}} = \frac{I_m}{\sqrt{\pi}} \int_0^{\pi} \sqrt{\sin^2\theta} \cdot d\theta = \frac{I_m}{2\pi} \int_0^{\pi} \left(\frac{1-\cos 2\theta}{2}\right)^{\frac{1}{2}}$$

⇒ $\boxed{I_{rms} = \frac{I_m}{\sqrt{2}}}$

Name of Lecturer : Vinny Sharma

(e) What is Resonance? What is the condition of resona[nce]

Ans Resonance $\longrightarrow$

Resonance is a condition when circuit behaves as a purely resistive circuit.

when $\boxed{X_L = X_C}$ $\leftarrow$ Condition of Resonance

than $X_L - X_C = 0$

so impedance becomes purely resistive.

since $Z = R + j(X_L - X_C)$ (in a series RLC ci[rcuit]

when $X_L - X_C \to 0$

$\boxed{Z = R}$ this impedance will be minimu[m]

& Current will be maximum at resonance

since $\boxed{I \propto \frac{1}{Z}}$

& power factor will be unity,

since $\boxed{\cos\phi = \frac{R}{Z} = \frac{R}{R} = 1}$

Part B

Q2.

Soln (a) Thevenin's Theorem :- Statement :-

"Any two terminal bilateral linear DC circuit can be replaced by an equivalent circuit consisting of a voltage source with a series resistance. The voltage source gives the open circuit voltage across the two terminals and the series resistance is the equivalent resistance of the network as seen from two terminals."

To, analyze the circuit following steps are followed :-

1.) Remove the load resistance mark the terminals A and B as open circuit.

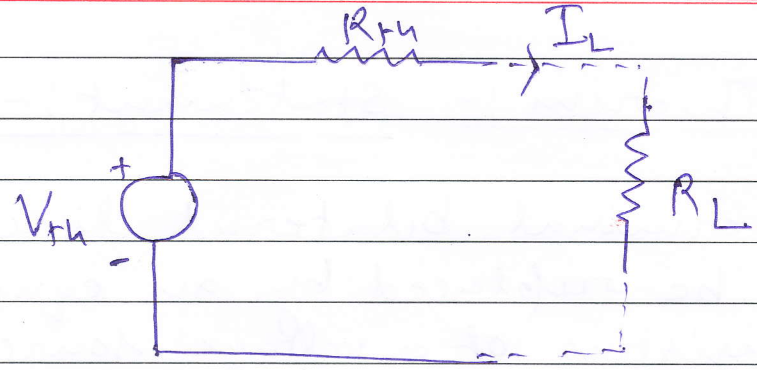
2.) Find open circuit voltage across open terminals Known as Thevenin's Voltage (V

3.) Find equivalent resistance as viewed from the open terminal AB by repl -cing all energy sources replaced wit their internal resistances.

4.) Obtain Thevenin's equivalent circuit as shown by placing V_{th} and R_{th}.

5.) Now, connect R_L back into circuit

5.) and find the current in circuit given as $\boxed{I_L = \frac{V_{th}}{R_{th} + R_L}}$

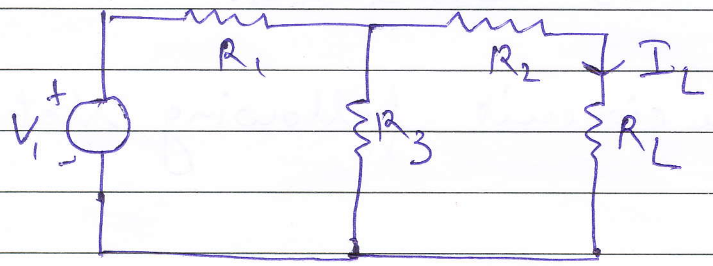


$$\boxed{I_L = \frac{V_{th}}{R_{th}+R_L}}$$

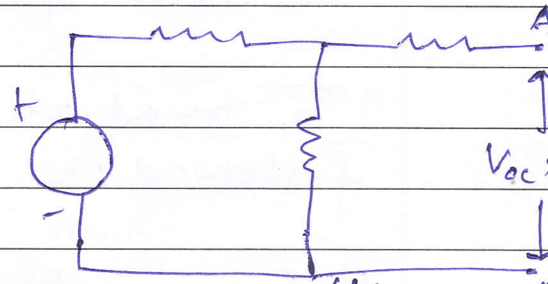
Thevenin's equivalent circuit

Example

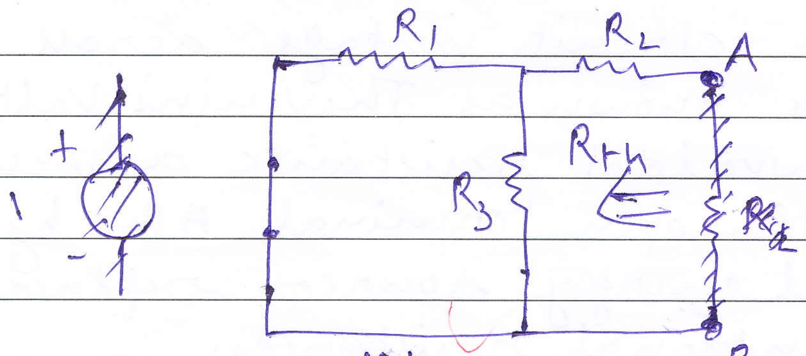
Consider a simple circuit as shown in figure where I_L is to be determined.



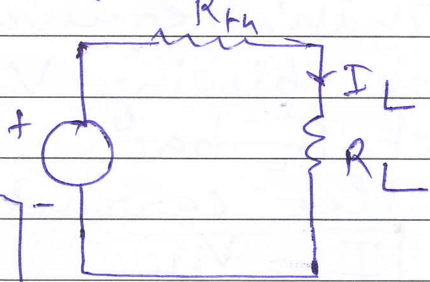
(a)



(b) Removing ~~Roa~~ R_{Load} (



(c)



(d)

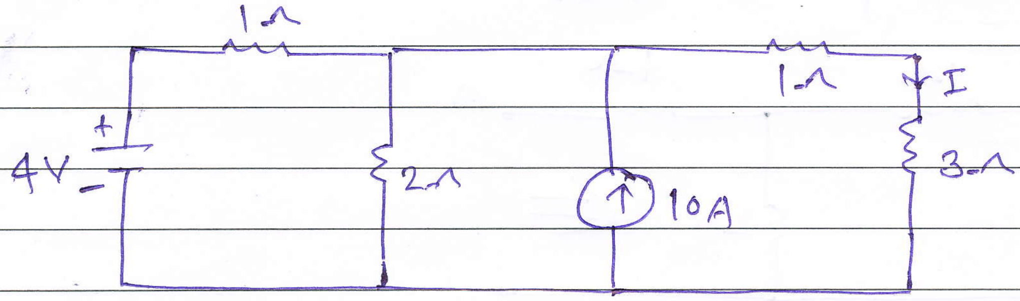
$$\boxed{I_L = \frac{V_{th}}{R_{th}+R_L}}$$

$$V_{oc} = V_{th} = \frac{V_1}{R_1+R_3} \times R_3$$

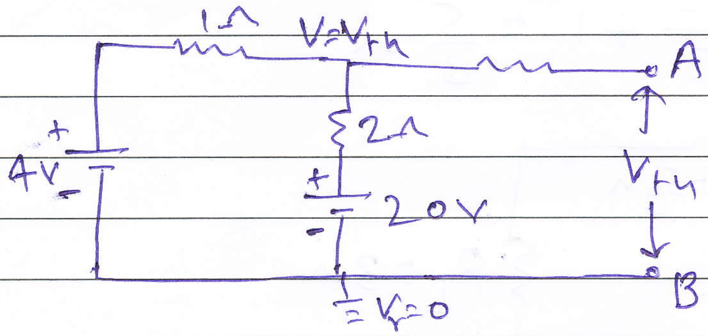
$$R_{th} = R_1 \parallel R_3 + R_2$$

$$= \frac{R_1 R_3}{R_1+R_3} + R_2$$

Numerical



Removing load $R_L = 3\Omega$ we get following circuit



Let V_{th} is open circuit Voltage

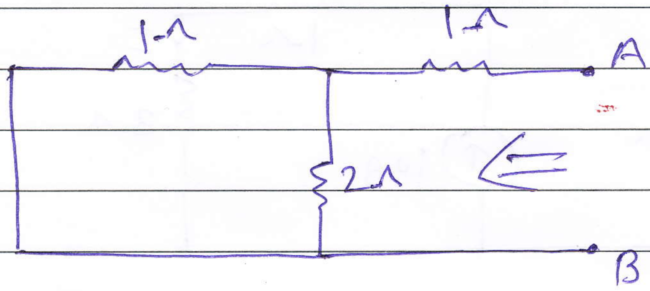
Applying nodal at V_{th} node

$$\frac{V_{th}-4}{1} + \frac{V_{th}-20}{2} = 0$$

$$\Rightarrow 2V_{th} - 8 + V_{th} - 20 = 0$$

$$\Rightarrow 3V_{th} = 28 \quad \Rightarrow \boxed{V_{th} = \frac{28}{3} V}$$

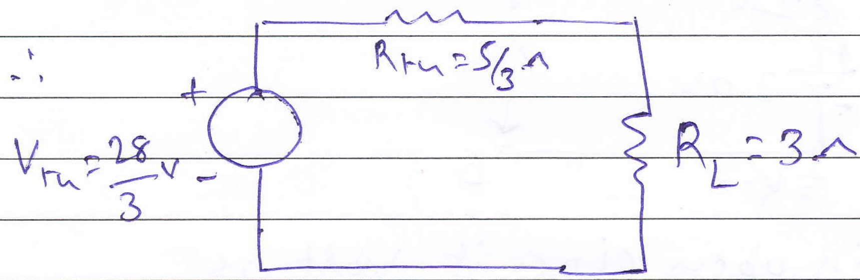
Now we find R_{th}.



Here we can see $1 // 2 + 1 = R_{th}$

Thus, $R_{th} = \frac{2}{3} + 1 = \frac{5}{3}\Omega$

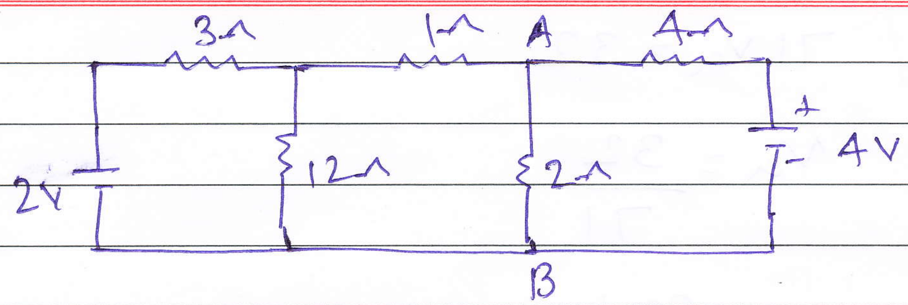
$\therefore$



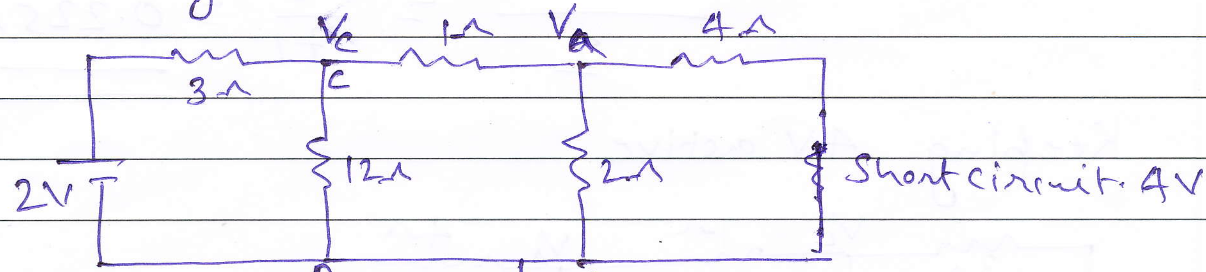
$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{28/3}{\frac{5}{3} + 3} \Rightarrow \frac{28/3}{14/3} A$$

$$\Rightarrow \boxed{I_L = 2A}$$

Solⁿ 2(b)



Keeping 2V source active.



fig(i)

Applying Nodal in fig(i)

$$\frac{V_c-2}{3}+\frac{V_c}{12}+\frac{V_c-V_a}{1}=0$$

$$\Rightarrow 17V_c-12V_a=8 \quad -(1)$$

Also,

$$\frac{V_a-V_c}{1}+\frac{V_a}{2}+\frac{V_a}{4}=0$$

$$\Rightarrow -4V_c+7V_a=0 \quad -(2)$$

Equation 1 × 4 and equation 2 × 17

we get, $68V_c-48V_a=32$

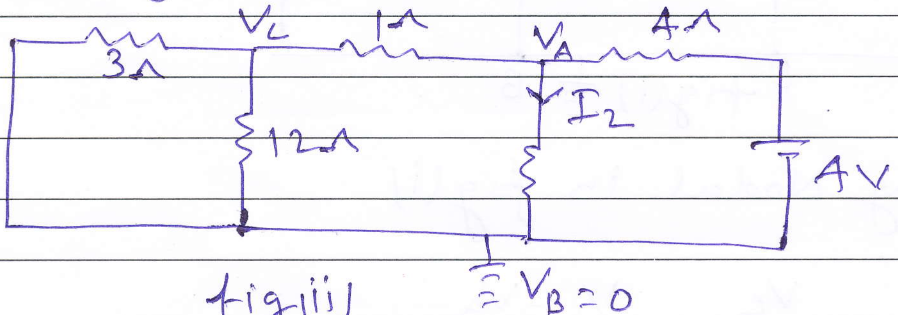
$$-68V_c+119V_a=0$$

we get $71 V_a = 32$

$$V_a = \frac{32}{71}$$

$$\therefore I_1 = \frac{32/71}{2} = \frac{16}{71} = 0.225 A$$

Keeping 4V active



fig(ii)

Applying KCL at Node V_c and V_a

$$\frac{V_a - V_c}{1} + \frac{V_a - 4}{4} + \frac{V_a}{2} = 0$$

$$\frac{4V_a - 4V_c + V_a - 4 + 2V_a}{4} = 0$$

$$-4V_c + 7V_a = 4 \quad \text{---(3)}$$

Also, $\dfrac{V_c}{3} + \dfrac{V_c}{12} + \dfrac{V_c - V_a}{1} = 0$

$$\Rightarrow \frac{4V_c + V_c + 12V_c - 12V_a}{12} = 0$$

$$\Rightarrow 17V_c - 12V_a = 0 \quad \text{—— (4)}$$

Eq.(3) × 17 and eq^n (4) × 4

$$-68V_c + 119V_a = 68$$

$$+68V_c - 48V_a = 0$$

$$71V_a = 68$$

$$\Rightarrow V_a = \frac{68}{71} \qquad \therefore I_2 = \frac{68}{71 \times 2} = \frac{34}{71} = 0.478\,A$$

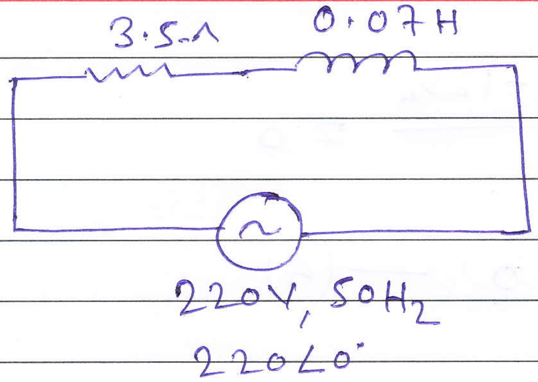
$$\therefore I = I' + I'' = I_1 + I_2$$

$$I = 0.225\,A + 0.478\,A$$

$$\boxed{I = 0.703\,A}$$

Part B

2/(C)



Here, $X_L = 2\pi f L$

$X_L = 2 \times \pi \times 50 \times 0.07$

$= 21.98\Omega$

$\therefore Z = 3.5 + j21.98 = 22.257 \angle 80.95^\circ$

$$I = \frac{220 \angle 0^\circ}{22.257 \angle 80.95^\circ} = 9.88 \angle -80.95^\circ$$

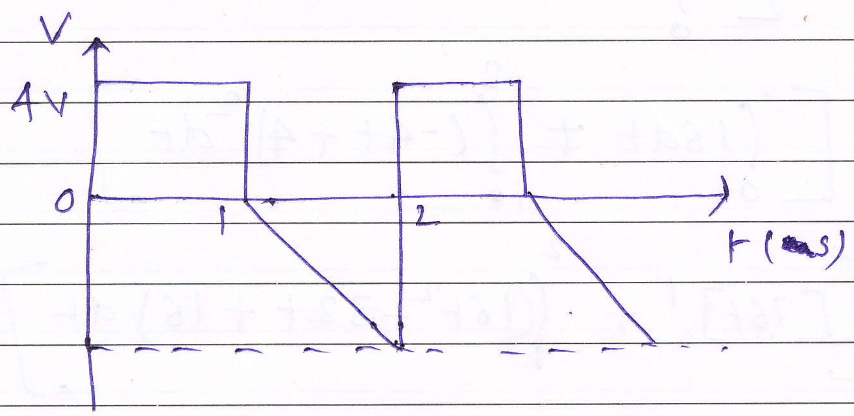
Here $\boxed{\phi = -80.95^\circ}$

$\therefore \cos\phi = \cos(-80.95^\circ) = 0.157$

Part B

2.) (d)

Sol^n



Sol^n The given wave is unsymmetrical

$v = 4 \quad \text{for } 0 \le t \le 1$

$v = -4t + 4 \quad \text{for } 1 \le t \le 2$

$$\therefore \quad V_{avg} = \frac{1}{2}\int_0^2 v\,dt = \frac{1}{2}\left[\int_0^1 v\,dt + \int_1^2 v\,dt\right]$$

$$= \frac{1}{2}\left[\int_0^1 4\,dt + \int_1^2 (-4t+4)\,dt\right]$$

$$= \frac{1}{2}\left[[4t]_0^1 + \left[\frac{-4t^2}{2} + 4t\right]_1^2\right]$$

$$= \frac{1}{2}\left[4 + (-8+8+2-4)\right]$$

$$\boxed{V_{avg} = 1 \text{ Volt}}$$

Also, RMS value of volage

$$V^2 = \frac{1}{2}\int_0^2 v^2 dt$$

$$V^2 = \frac{1}{2}\left[\int_0^1 16 dt + \int_1^2 (-4t+4)^2 dt\right]$$

$$= \frac{1}{2}\left[[16t]_0^1 + \int_1^2 (16t^2 - 32t + 16) dt\right]$$

$$= \frac{1}{2}\left[16 + \left[\frac{16t^3}{3} \cancel{+} - \frac{32t^2}{2} + 16t\right]_1^2\right]$$

$$= \frac{1}{2}\left[16 + 16/3\right]$$

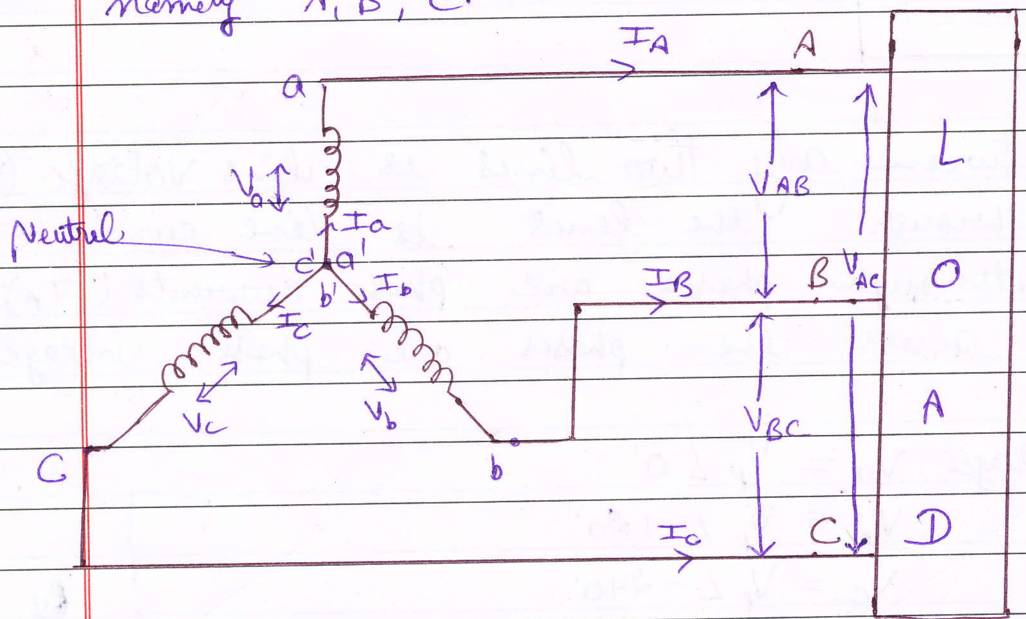
$$\Rightarrow V^2 = 10.667 \quad \Rightarrow V = \sqrt{10.667}$$

$$\boxed{V = 3.226 \text{ Volts}}$$

(e) Draw phasor diagram of a 3 phase star connecti[on] load and find the relationship between pha[se] & line voltages and currents.

Ans Star Connection –

In star connection, the low potential point of a[ll] the coils are joined together. Comon point is neutral of supply system Remaining 3 term[inals] (high potential point) used to transmit power [to] loads using three wires which are called lines namely A, B, C.



Relation b/w line voltage & current Phase Voltage –

from connection diagram –

$V_{AB} = V_a - V_b = V_a + (-V_b)$

$V_{BC} = V_b - V_c = V_b + (-V_c)$

$V_{CA} = V_c - V_a = V_c + (-V_a)$

$$\Rightarrow |V_{AB}|^2 = |V_a|^2 + |-V_b|^2 + 2|V_a||-V_b| \cos 60^\circ$$

since, load is balanced →

$$|V_{AB}| = |V_{BC}| = |V_{CA}| = V_L$$

$$|V_a| = |V_b| = |V_c| = V_p$$

$$\therefore \quad |V_L|^2 = V_p^2 + V_p^2 + 2|V_p|^2 \cos 60^\circ$$

$$V_L^2 = 2V_p^2(1+\cos 60^\circ)$$

$$V_L = 2V_p \cos 30^\circ$$

$$\boxed{V_L = \sqrt{3}\, V_p}$$

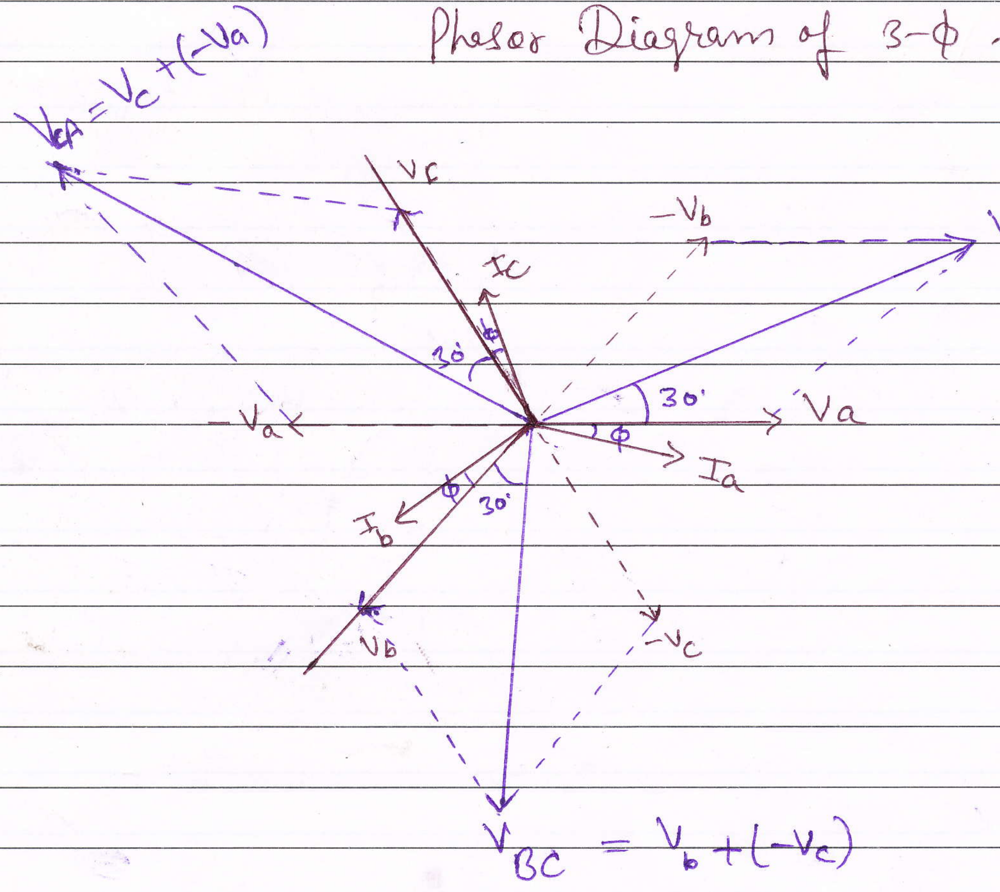
The Voltages between any two lines is line voltage (V_L).
The current through the lines is line current (I_L)
The current through phases are phase currents (I_p).
The voltages across the phases are phase voltages (

thus phase voltages $V_a = V_p \angle 0^\circ$
$V_b = V_p \angle -120^\circ$
$V_c = V_p \angle -240^\circ$

& line voltages, $V_{AB} = \sqrt{3}\, V_p \angle 30^\circ$
$V_{BC} = \sqrt{3}\, V_p \angle -120 + 30^\circ$
$V_{CA} = \sqrt{3}\, V_p \angle -240^\circ + 30^\circ$

By Phasors

Phasor Diagrams of 3-ϕ star connection



Relation b/w line current and phase current —

It can be seen from diagram (connection diagram) that currents that flow through phases also flow through lines. So, line current and phase currents are same.

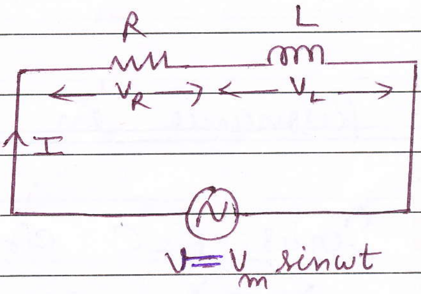
$$I_A = I_a = I_p \angle 0° - \phi$$
$$I_B = I_b = I_p \angle -120° - \phi$$
$$I_C = I_c = I_p \angle -240° - \phi$$

ϕ is power factor angle of load.

(f) Describe RL series circuit with voltage triangle, impedance triangle, power triangle. What is resonance in RLC circuit?

Ans Series RL circuit →

Consider a resistance of R ohms, inductance L henry connected in series as shown —



By kirchoff's law —

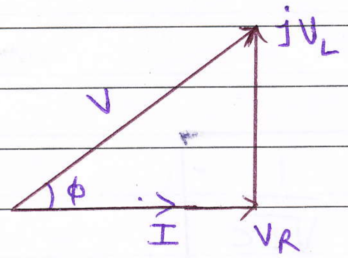
$$\Rightarrow \boxed{V = V_R + jV_L} \quad \text{—— (1)}$$

$$\Rightarrow V = IR + jIX_L$$

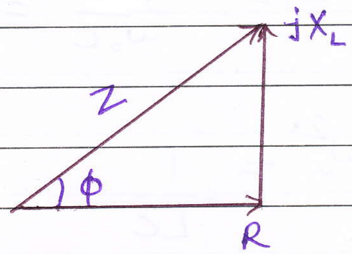
$$\Rightarrow \frac{V}{I} = R + jX_L$$

$$\Rightarrow \boxed{Z = R + jX_L} \quad \text{—— (2)}$$

Angle ϕ is the power factor angle.



Voltage Triangle



Impedance Triangle

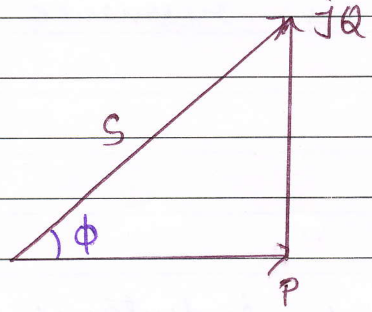
by multiplying I in both sides, at eqn (1) →

$$V = V_R + jV_L$$

$$VI = V_R I + jV_L I$$

$$\Rightarrow VI = I^2R + j\, I^2X_L \qquad \left(\text{when } V_R = IR, \; V_L = IX_L\right)$$

$$\Rightarrow \boxed{S = P + jQ}$$



Power Triangle

$S \rightarrow$ Apparent power (VA)

$P \rightarrow$ Active power (W)

$Q \rightarrow$ Reactive Power (VAR)

Resonance in Series RLC Circuit :-

Series RLC circuit is said to be in resonance a[...] $X_L = X_C$ or inductive reactance equal to capacit[...] reactance, so net impedance is purely resistive.

To determine resonant frequency (ω_0); put reactance [...] $\boxed{X = (X_L - X_C) = [...]}$

$$\Rightarrow \omega_0 L - \frac{1}{\omega_0 C} = 0$$

$$\Rightarrow \omega_0^2 = \frac{1}{LC} \Rightarrow \boxed{\omega_0 = \frac{1}{\sqrt{LC}}}$$

$$\Rightarrow \boxed{f_0 = \frac{1}{2\pi\sqrt{LC}}}$$

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Lecture Notes

Branch : Ist Year Sem. : IInd. Subject : Solution

Topic : Part (C) Solⁿ (a) Unit Part C Lecture No.

Part(C) (a)

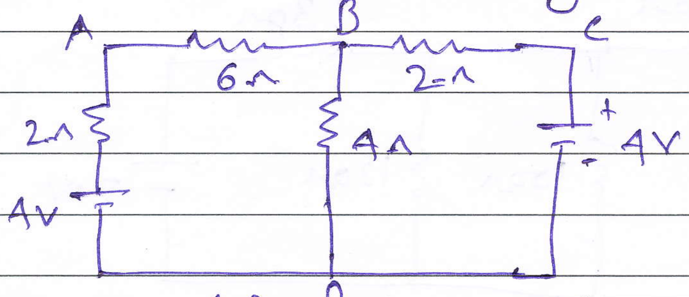
Node voltage Method:-

Node voltage method is based on Kirchoff's Current Law (KCL) and computes all node voltages. The voltages at different independent nodes are assumed where one of these nodes is taken as reference node.

The steps to apply nodal analysis.

1.) Convert voltage source to current source wherever possible.
2.) Identify unknown nodes and reference node.
3.) Assume Voltage $V_1, V_2, \ldots V_n$ of N nodes in the circuit.
4.) Write KCL equation for each node a
5.) Solve the equations to find node voltage and find current in any branch.

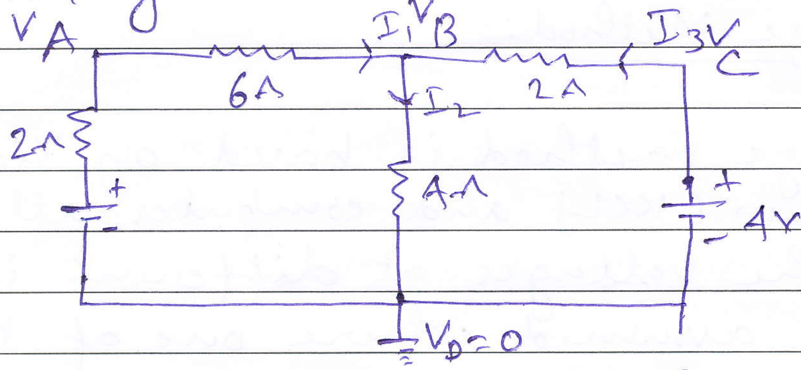
Example :



Finding current in 6Ω using Nodal Analysis

Solⁿ Let us take node D as reference node.

Applying KCL at node B



Applying KCL at node B

$$I_1 + I_3 = I_2$$

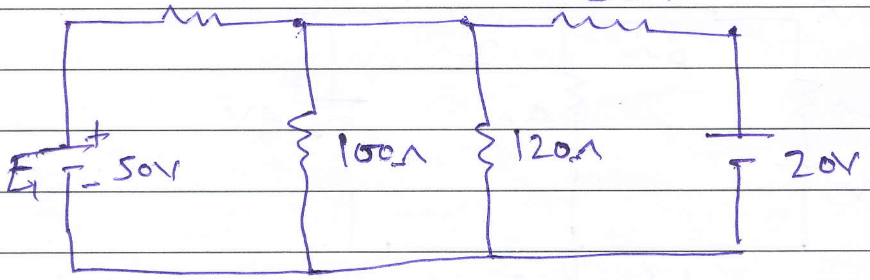
$$\frac{4-V_B}{8} + \frac{4-V_B}{2} = \frac{V_B - V_D}{4}$$ As $V_D = 0$ Ref. Nod

$$\Rightarrow 7V_B = 20 \quad \text{or} \quad V_B = \frac{20}{7}\ \text{V}$$

∴ Current through 6Ω resistance is

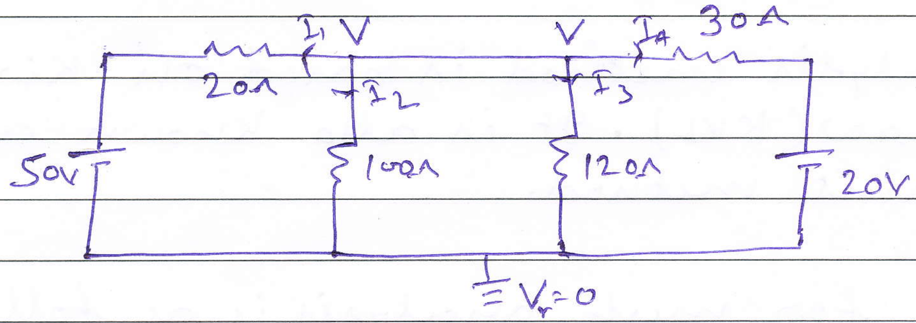
$$I_1 = \frac{4-V_B}{8} = \frac{4-\frac{20}{7}}{8} = \frac{\frac{8}{7}}{8} = \frac{1}{7}\ \text{A}$$

Numerical



To find current in 100Ω and 120Ω

Here, we apply Nodal analysis.



Let Node Voltage 'V' is Unknown. Applying

$$\frac{V-50}{20} + \frac{V}{100} + \frac{V}{120} + \frac{V-20}{30} = 0$$

$$\Rightarrow \frac{30V - 1500 + 6V + 20V - 400}{60} = 0$$

$$\Rightarrow 61V - 1900 = 0$$

$$V = \frac{1900}{61} = 31.14\ V$$

$$\Rightarrow I_1 = \frac{31.14-50}{20} = -0.94\ A$$

$$I_2 = \frac{31.14}{100} = 0.3114\ A$$

$$I_3 = \frac{31.14}{120} = 0.2595 A$$

$$I_4 = \frac{31.14-20}{30} = 0.37 A$$

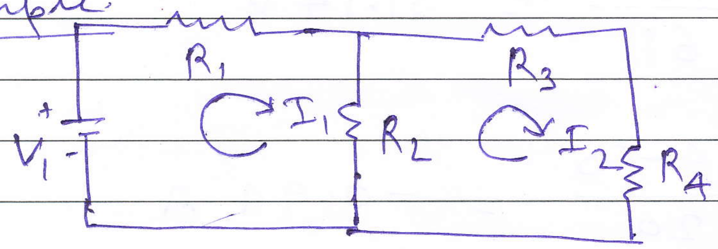
Mesh Analysis :-

Mesh analysis method is based on Kirchoff's Voltage Law (KVL). It is also known as loop current method.

The steps for mesh analysis is as follows :-

i) Convert ~~co~~ current source to voltage source
ii) Identify all the meshes and assume mesh currents in any direction (clockwise or anticlockwise). For convenience flow mesh currents in clockwise.
iii) Write KVL for each ~~mesh~~ mesh. When more than one mesh current flows through a circuit element, algebraic sum of currents should be considered.
iv) Solve equations to determine currents

Example



Mesh currents are I_1 and I_2. So, Mesh equations

loop 1 :- $V_1 - I_1 R_1 - (I_1 - I_2) R_2 = 0$ —(1)

loop 2 :- $(I_2 - I_1) R_2 - I_2 R_3 - I_2 R_4 = 0$ —(2)

Solving (1) & (2) we get I_1 & I_2.

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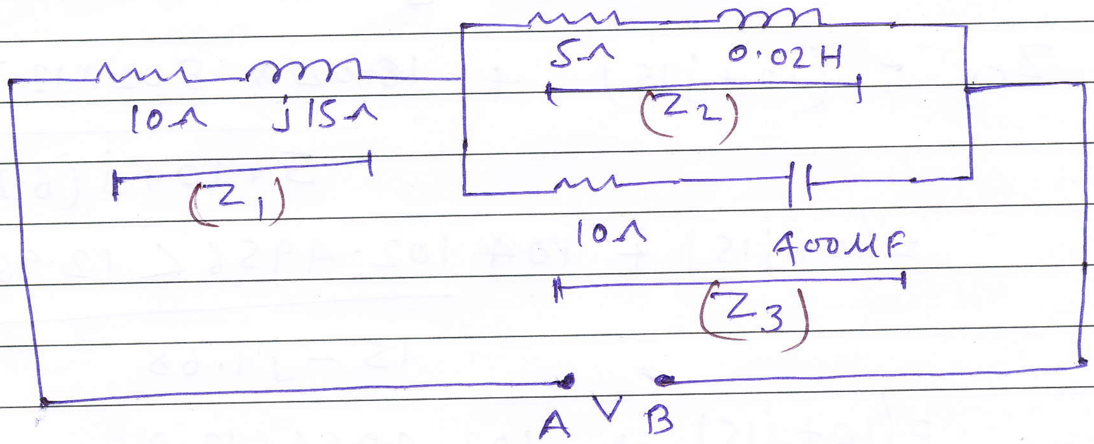
Lecture Notes
Branch : Part C (b) Sem. : I sem Subject : BEE
Topic : Solutions Midterm I Unit PART – C Lecture No.

Part (C)

(b) Given $f = 50Hz$, current drawn $I = 10A$



* We have to find Voltage V across A & B So

Here $L = 0.02H$ $\Rightarrow X_L = 2\pi f L = 2 \times 3.14 \times 50 \times$
$= j6.28\Omega$

also, $C = 400\mu F$ $\Rightarrow X_C = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.14 \times 50 \times 40}$

$X_C = \frac{1}{0.1256} = -j7.96\ \Omega$

Now we can write

$Z_1 = 10 + j15 = 18.02 \angle 56.30°$

$Z_2 = 5 + j6.28 = 8.02 \angle 51.47°$

$Z_3 = 10 - j7.96 = 12.78 \angle -38.51°$

Now, we can see in the circuit

Name of Lecturer : Vikram.

$$Z_{eq} = Z_1 + \frac{Z_2 \times Z_3}{Z_2 + Z_3}$$

$$\Rightarrow Z_{eq} = (10 + j15) + \frac{\cancel{18.02\times}\ 8.02 \times 12.78 \angle 51.47-}{5 + 10 + j(6.28 - 7.96)}$$

$$= (10 + j15) + \frac{\cancel{102.4}\ 102.4956 \angle 12.96^\circ}{15 - j1.68}$$

$$= (10 + j15) + \frac{102.4956 \angle 12.96}{15.093 \angle -6.390}$$

$$Z_{eq} = (10 + j15) + 6.79 \angle 19.35^\circ$$

$$= (10 + j15) + (6.40 + j\,2.24)$$

$$= 16.40 + j17.24$$

$$= 23.79 \angle 46.43^\circ \ \Omega$$

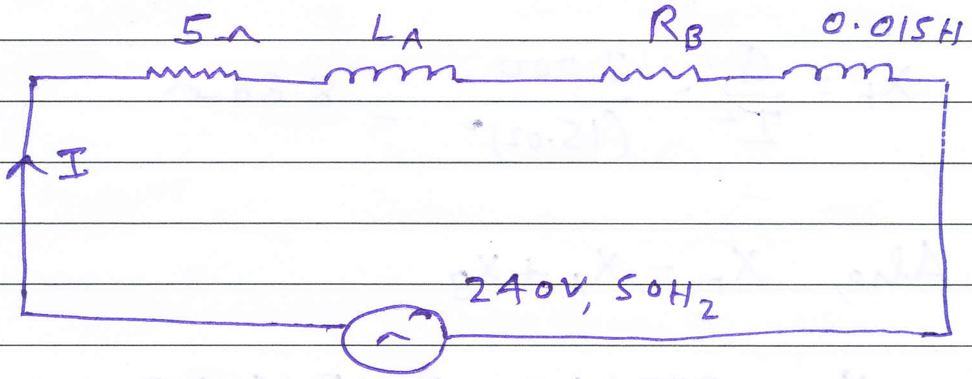
As we know

$$V = I \times Z_{eq} = 10 \times 23.79 \angle 46.43^\circ$$

$$= \underline{237.9 \angle 46.43^\circ \text{ Volts.}}$$

Thus Voltage across A and B is 237.9 V in magnitude..

Part (C)
Sol 1 (C)



Active Power $P = 3000\,W$

Reactive Power $Q = 2000\,VAR$

$\therefore$ Apparent Power $S = \sqrt{P^2+Q^2}$

$\Rightarrow S = \sqrt{(3000)^2+(2000)^2} = 3605.55\,VA$

Also $S = VI$

$\Rightarrow I = \frac{S}{V} = \frac{3605.55}{240} = 15.02\,A$

Active Power $P = I^2 R_{eq}$

$\therefore R_{eq} = \frac{P}{I^2} = \frac{3000}{(15.02)^2} = 13.3\,\Omega$

$R_B + 5 = 13.3\,\Omega$ $\therefore R_B = (13.3 - 5)\,\Omega = 8.3$

Also, Reactive Power $Q = I^2 X_t$

$$X_T = \frac{Q}{I^2} = \frac{2000}{(15.02)^2} = 8.86\,\Omega$$

Also, $X_T = X_A + X_B$

$$X_B = 2\pi f L = 2 \times 3.14 \times 50 \times 0.015 =$$

So, $X_A = 4.15\,\Omega$

Also, $$L_A = \frac{4.15}{2\pi f} = 0.0132\ H$$

The, impedance of coil A,

$$Z_A = R_A + jX_A = 5 + j4.15 = 6.49\angle 39.69^\circ$$

So, The voltage drop across coil A is,

$$\underline{\underline{V_A}} = IZ_A = 15.02 \times 6.49\angle 39.69 = \underline{97.48\angle 39.}$$

The impedance of coil B,

$$Z_B = R_B + jX_B = 8.3 \times j(2\pi \times 50 \times 0.015)$$

$$= 8.3 \times j4.71 = 9.54\angle 29.57^\circ\ V$$

So, The voltage drop across coil B is

$$\underline{\underline{V_B}} = IZ_B = 15.02 \times 9.54\angle 29.57$$

$$= \underline{143.29\angle 29.57^\circ\ V}$$