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USN	1	C	R	1						

Internal Assesment Test I – March 2017

Sub:	BASIC ELECTRICAL ENGINEERING						Code:	15ELE25
Date:	27 / 03 / 2017	Duration:	90 mins	Max Marks:	50	Sem:	2	Section:	K, N & O

Note: Answer any five FULL Questions. Sketch figures neatly wherever required. Explain your notations explicitly and clearly. Answer to the point. Good Luck!

		Marks	OBE CO	OBE RBT
1 (a)	State and explain Ohm's Law. What are the limitations of Ohm's Law?	[06]	CO205.1	L2
(b)	Two batteries A and B connected in parallel supply a load of 2.5 Ω. The open circuit emf of battery A is 11.9 V and that of B is 12.1 V. Their internal resistances are 0.05 Ω and 0.053 Ω respectively. Determine the magnitude and direction of current in each battery and the total power supplied to the load.	[04]	CO205.1	L3
2 (a)	State Kirchoff's Voltage Law (KVL). Clearly give the sign conventions for emf-s and potential drops as used in KVL. Explain KVL with an example of an electrical network.	[06]	CO205.1	L2
(b)	Refer Fig. 2b. Find the potential of *X* w.r.t. the potential of Y.	[04]	CO205.1	L3
3 (a)	Refer Fig. 3a. Find all the branch currents and indicate them in the circuit diagram.	[06]	CO205.1	L3

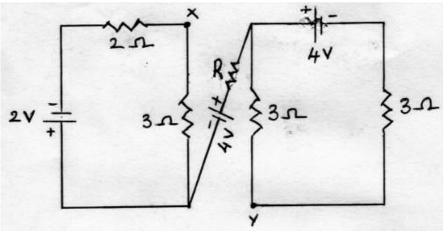

Fig. 2b

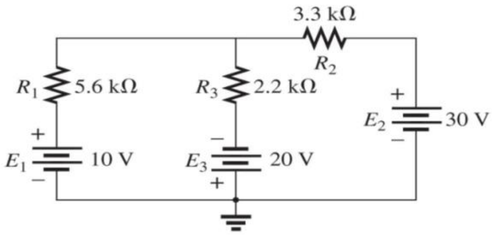

Fig. 3a

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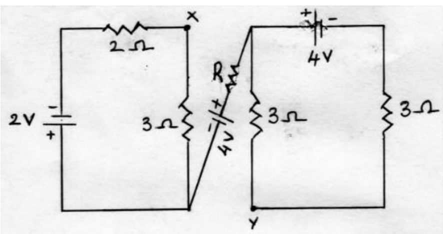
Fig. 2b

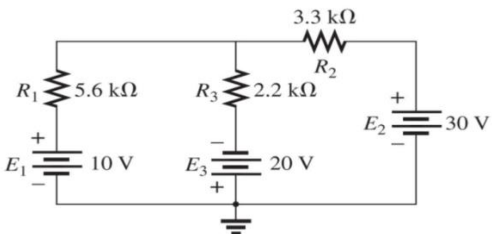
Fig. 3a

(b)	The domestic power load in a house comprises the following: 8 lamps of 100W each, 3 fans of 80W each, 1 refrigerator of 0.5HP, 1 heater of 1000W. (i) Calculate the total current taken from the supply of 230V. (ii) Calculate the energy consumed in a day, if on an average only a quarter of the above load persists all the time.	[04]	CO205.1	L3
4 (a)	What is “Dynamically induced emf”? Illustrate with an example. Derive an expression for such emf when a straight conductor is moving at an angle θ to a uniform magnetic field.	[06]	CO205.1	L3
(b)	A straight conductor of 1.15 m length moves with a uniform velocity of 20 m/s at 25º to a uniform field of density 0.9 T. Find the average emf induced across the ends of the conductor. If the conductor has resistance 1.4 Ω, find the average current in it.	[04]	CO205.1	L3
5 (a)	State and explain Faraday’s Laws of Electromagnetic Induction.	[06]	CO205.1	L2
(b)	A 15 cm long, 3.2 cm diameter air cored coil has 320 turns. Desired flux density in the core is 0.01 T. Find the coil current and the energy density of the magnetic field inside the core. If an iron core of relative permeability 850 is now inserted in the coil, for the same current as before, find the magnetic field, flux density and energy density in the core.	[04]	CO205.1	L3
6 (a)	State and explain Lenz’s Law.	[05]	CO205.1	L2
(b)	Coil A of 800 turns and Coil B of 700 turns have a coefficient of coupling of 0.4 between them. A current of 7 A in Coil A produces a flux of 48 mWb in it. Find (i) self inductance of Coil A with Coil B open circuited; (ii) flux linkage with Coil B; (iii) the emf in Coil B when the flux linking with it changes from 0 its full value in 1.5 ms; and (iv) the mutual inductance between the coils.	[05]	CO205.1	L3

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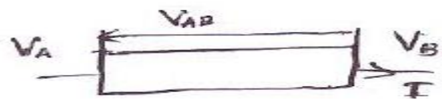
IAT-1 SOLUTION FOR SECTIONS (K,N,O)

1a.State and explain Ohm's law and mention its limitations.

Ohm's law:

The Current through a Conductor is propotional to the potential difference across its terminals. where temperature and physical parameters remained Constant.

Illustration :-



From the above figure, with Current I in a Conductor with terminals A & B from Ohm's law.

$$I \propto V_A - V_B$$

Where V_A & V_B are potential in A & B respectively

If. $V_{AB} = V_A - V_B$

$$I \propto V_{AB} \longrightarrow (1)$$

$V_A - V_B = V_{AB}$ is the potential of A w.r.t potential of B.

$$(1) \Longrightarrow I = C_1 V_{AB}$$

Where C_1 is Conductance

$$R = \frac{1}{C_1}$$

Then $$I = \frac{V_{AB}}{R}$$

$$V_{AB} = RI \longrightarrow (2)$$

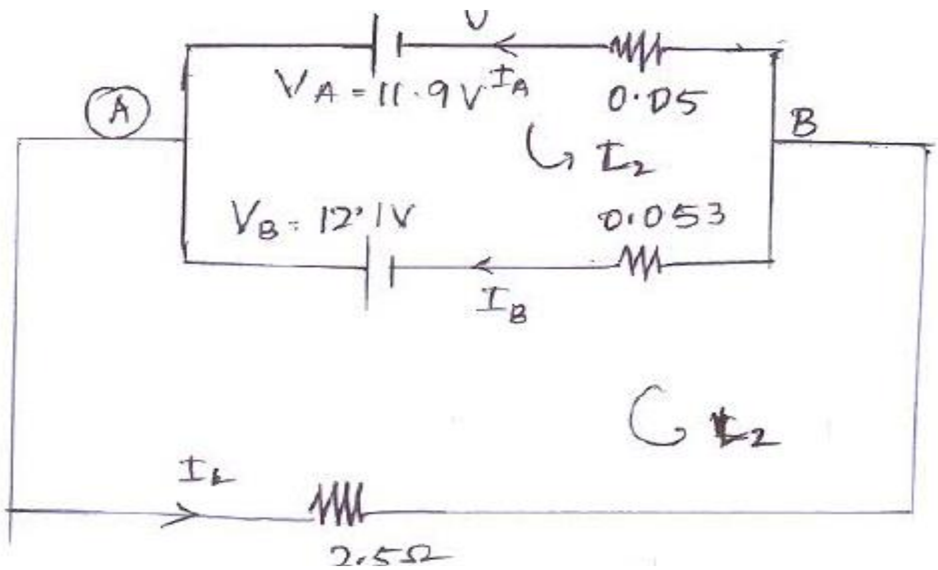
Limitations :

→ Ohm's law does not obey in high pressure & temperature

→ This law is applicable for devices like thermistor, electric arc etc.

1b. Two batteries *A* and *B* connected in parallel supply a load of 2.5 Ω. The open circuit emf of battery *A* is 11.9 V and that of *B* is 12.1 V. Their internal resistances are 0.05 Ω and 0.053 Ω respectively. Determine the magnitude and direction of current in each battery and the total power supplied to the load.

IAT-1 SOLUTION FOR SECTIONS (K,N,O)



Applying K.V.L for loop L1

$$(0.05)I_A - (0.053)I_B = V_A - V_B$$

$$(0.05)I_A - (0.053)I_B = 11.9 - 12.1$$

$$(0.05)I_A - (0.053)I_B = -0.2 \longrightarrow (1)$$

Applying K.V.L for loop L2

$$(0.053)I_B + (2.5)(I_A + I_B) = V_B$$

$$2.5I_A + 2.553I_B = 12.1 \longrightarrow (2)$$

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

Solving (1) & (2)

$I_A = 0.5A \quad I_B = 4.24 A$

$P_A = V_A I_A = (11.9)(0.5)$

$= 5.95 W$

$P_B = V_B I_B = (12.1)(4.24)$

$= 51.304 W$

$\therefore$ Total power $(P_A + P_B)$

$= 5.95 + 51.304$

$= 57.25 W$

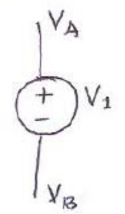
2a. State Kirchoff's Voltage Law (KVL). Clearly give the sign conventions for emf-s and potential drops as used in KVL. Explain KVL with an example of an electrical network.

KVL :

In a Closed loop electric network the algebraic Sum of emf is equal to the algebraic Sum of potential drops

Sign Conventions for emf

V_A



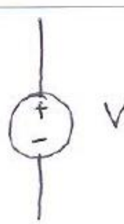
↑ Direction of traversal

$V_A = V_B = +V_1$

Gain potential

Traversal from −Ve to +Ve terminal of emf ⟹ +ve sign for emf

V_B



↓ Direction of traversal

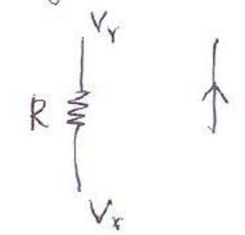
$-V_1$

fall in potential

Traversal from −Ve to positive terminal of emf ⟹ −ve sign for emf

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

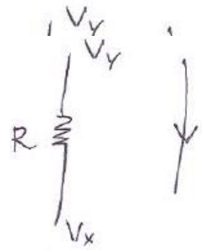
Sign Convention for potential drop



Direction of traversal | Potential drop is (+RI)

If designated direction of the current same as direction of traversal

⇒ potential drop get +ve sign



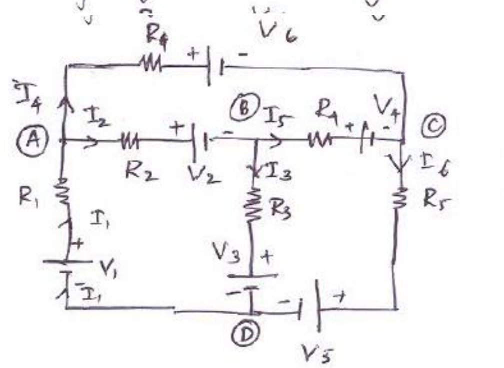
Direction of traversal | Potential drop is (−RI)

If disignated direction of current Opposite as direction of traversal

⇒ potential drop get −ve sign

Illustration for KVL

For the network in the given figure



Step 1:- Identify & label the nodes ABCD

Step 2:- Identify & mark branch Currents so as to follow KCL. I_1, I_2, I_3, I_4, I_5 & I_6

using KCL at node A $I = I_2 + I_4$

$I_4 = I_1 - I_2 \longrightarrow (1)$

at node B $I_4 + I_5 = I_6$

using (1) & (2) we get

$I_6 = (I_1 - I_2) + (I_2 - I_3)$

$I_6 = I_1 - I_3 \longrightarrow (3)$

at node D: $I_3 + I_6 = I_1$

Using (3) $I_3 + (I_1 - I_3) = I_1$

Conclusion :- In a network of n nodes, we require only (n-1) nodes to apply KCL

Step3: KVL to loop ABDA

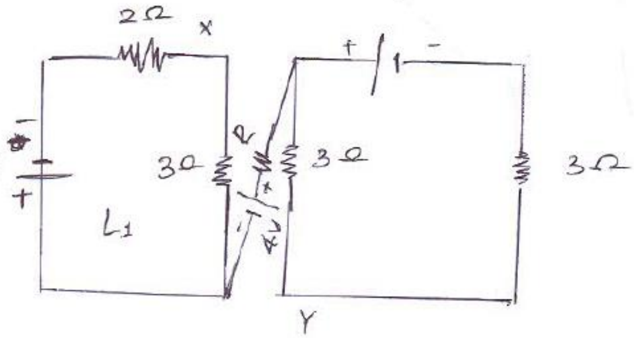
$-V_2 - V_3 + V_1 = R_2 I_2 + R_3 I_3 + R_1 I_1$

$R_1 I_1 + R_2 I_2 + R_3 I_3 = V_1 - V_2 - V_3$

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

2b.

Find the potential of X w.r.t potential of Y



The Current I in the Loop L_1 - I_1

$$I_1 = \frac{2}{2+3} = \frac{2}{5} = 0.4A$$

The Current in the Loop L_2

$$I_2 = \frac{4}{3+3} = \frac{4}{6} = 0.66A$$

The voltage V_{xy} is the voltage of point X with respect to point Y voltage, we start from Y and travers a path to X to find the total voltage

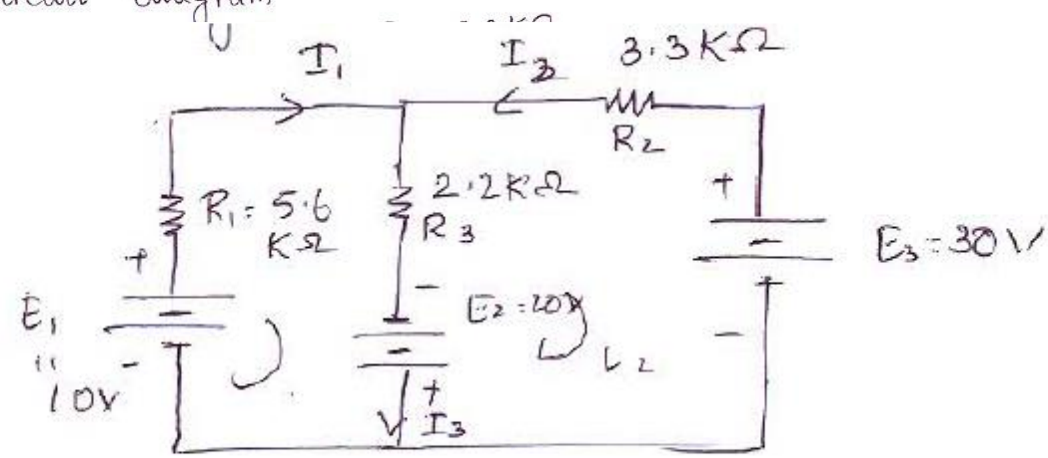
$$V_{xy} = 3I_2 - 4 - 3I_1$$

$$V_{xy} = 3(0.66) - 4 - 3(0.4)$$

$$= -3.22V.$$

3a.

Find all the branch Currents and indicate them in the Circuit diagram



IAT-1 SOLUTION FOR SECTIONS (K,N,O)

Applying K.C.L at node A $I_1 + I_2 = I_3$

Applying K.V.L to loop L1.

$$(5600)I_1 + (2200)I_3 = 30$$

$$(5600)I_1 + (2200)(I_1 + I_2) = 30$$

$$7800 I_1 + 2200 I_2 = 30 \longrightarrow (1)$$

Applying K.V.L to Loop L_2

$$(-3300)I_2 + (-2200)(I_3) = -30 - 20$$

$$(-3300)I_2 + (-2200)(I_1 + I_2) = -50$$

$$-2200 I_1 - 5500 I_2 = -50 \longrightarrow (2)$$

Solving (1) & (2) we get

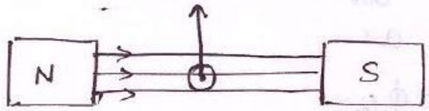
$I_1 = 1.4 mA$

$I_2 = 8.51 mA$

$I_3 = I_2 - I_1 = 7.11 mA$

4a.
What is Dynamically induced Emf? Illustrate with an Example. Derive an expression for such emf when a Straight Conductor is moving at an angle of θ to a uniform magnetic field.

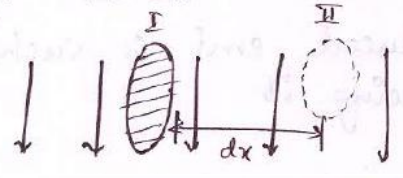
When the magnetic field is Stationary and the Conductor is in motion of the Emf induced is called dynamically induced emf.



IAT-1 SOLUTION FOR SECTIONS (K,N,O)

Example:

let us take a Conductor of length meters moving at right angles to a uniform magnetic field of B wb/m². with a velocity of 'v' m/s. let the Conductor move through a small distance 'dx' in 'dt' sec so, the area swept = $lx \cdot dx$



I^{st} position :

$e(t) = 0V$; i.e flux linking with the Conductor = 0

II^{nd} position :

As per faraday's law of EMI

$$e(t) = Bl \cdot \frac{dx}{dt}$$

$$= Blv$$

$$v = \frac{dx}{dt}$$

Suppose a Coil has N turns and flux through it change from an initial value of ϕ_2 weber in t sec.

Total flux linkage with each of the 'N' turns of the Coil is be $\phi_{(t)} = N\phi(t)$

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

By Faraday's 2nd law

$$|e(t)| \propto \frac{dN\phi}{dt} = N\frac{d}{dt}[\phi(t)] \longrightarrow (1)$$

we can write it as

$$|e(t)| = \frac{KNd\phi(t)}{dt}$$

if $K = 1$

$$|e(t)| = \frac{d\phi(t)}{dt}$$

where ϕ is in weber, t in seconds & 'e' in volts

4b.

A straight conductor of 1.15m length moves with a uniform velocity of 20m/s at 25° to a uniform field of density 0.9T. Find the average emf induced across the ends of the conductor. If the conductor has resistance 1.4Ω. Find average current in it.

$L = 1.15m$

$R = 1.4\Omega$

$V = 20m/s$

$\theta = 25°$

$B = 0.9T$

$$e = Blv\sin\theta$$

$$= 0.9 \times 1.15 \times 20 \times \sin(25°)$$

$$= 8.748V$$

Average Current

$$I = \frac{e}{R}$$

$$= \frac{8.748}{1.4}$$

$$= 6.248A$$

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

5a.

State & Explain i) Faradays law of electromagnetic

I^{st} law of EMI:

whenever the flux linking a coil (or) Circuit changes an emf is induced in it.

II^{nd} law of EMI:

The magnitude of the induced emf in a Coil is directly Propotional to the rate of Change of flux linkages

5b.

A 15cm Long 3.2cm diameter air cored Coil has 320 turns. Desired flux density in the Core is 0.01T. Find the Coil Current and energy density of the magnetic field inside the Core. If an iron Core relative permeability 850 is now inserted in the coil.

$L = 15 \times 10^{-2}$ m $\quad B = 0.01T \quad a = \pi r^2$

$r = 1.6 \times 10^{-2}$ m $\quad I = ? \quad = 8.04 m^2$

$N = 320 \quad \mu_r = 850$

$S = \frac{l}{\mu_0 \mu_r a} = \frac{15 \times 10^{-2}}{(4\pi \times 10^{-7})(850)(8.04)} = 17.46H$

$L = \frac{N^2}{S} = 5862.64H$

$\phi = B \cdot a = (0.01)(8.04) = 0.086 Wb \quad \phi = \frac{NI}{a} \quad I = \frac{\phi a}{N} = 2.02 mA$

$E = \frac{1}{2} L I^2 = \frac{1}{2}(5862.64)(2.02)^2 \times (10^{-3})^2$

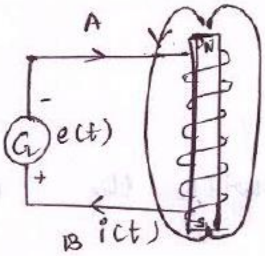
$= 0.012 J$

$\frac{dE}{dv} = \frac{LI^2}{2La} \Rightarrow \frac{dE}{dv} = 9.91 \times 10^{-3}$ J/m^3

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

6a. Lenz's law:

The direction of the induced emf is such that, it opposes the cause producing it



where,
i(t) is the current induced through the circuit
e(t) is the emf induced.

As per lenz's law, the direction of the induced current in the coil is such that it opposses the cause producing it

Here the cause is the motion of the magnet, therefore the induced current should flow in such a direction in the coil so that it develops polarities which opposes the motion of magnet.

$$\therefore e(t) = -N \frac{d}{dt}(\phi(t))$$

6b.

Coil A of 800 turns and Coil B 700 turns have co-efficient of coupling 0.4 between them, A current of 7A in coil A produces 48 mA in it. Find

i) Self inductance of coil A and coil B open circuited

$$L_1 = \frac{N_1 \phi_1}{I_1} = \frac{800 \times 48 \times 10^{-3}}{7}$$

$$L_1 = 5.48H$$

(iii) Emf in coil B when flux linkage changes from

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

(ii) Flux Linkage with Coil B

$$\phi_{12}(t) = K\phi_1(t)$$

$$\phi_{12}(t) = 0.4 \times 48 \times 10^{-3}$$

$$\phi_{12}(t) = 0.019\ Wb$$

0 to 4.5

$$e_{12}(t) = \frac{N_2 d\phi_{12}(t)}{dt}$$

$$= \frac{700 \times 0.019}{1.5 \times 10^{-3}}$$

$$= 8866.6\ V$$

iv) $M = \frac{N_2 \phi_{12}}{I_1} = \frac{700 \times 0.019}{7} = 1.9\ H$.

IAT-1 SOLUTION FOR SECTIONS (K,N,O)

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