Winter – 2017 Examinations

Model Answer **Subject Code: 17214 (FEE)**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner should assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given importance (Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner should give credit for any equivalent figure/figures drawn.

5) Credits to be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer (as long as the assumptions are not incorrect).

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept

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1	**Attempt any <u>TEN</u> of the following:**	**20**
1 a)	Define: i) Ampere ii) Volt **Ans:** **i) Ampere:** One ampere current is said to be flowing through a conductor /wire if at any section of it, one coulomb of charge passess in one second. It is the unit of current. **ii) Volt**: A body is said to have an electric potential of one volt if one joule of work is required to transfer a charge of one coulomb to the body. It is the unit of potential difference.	1 Mark for each definition
1 b)	Write definition of ''Branch'' and ''Node'' related to electric circuit. **Ans:** **i) Branch:** A part of an electric network which lies between two junctions or nodes is known as branch. **ii) Node:** A point or junction where two or more elements of the network are connected together is called as node.	1 Mark for each definition
1 c)	Define conductance and state its unit**.** **Ans:** **Conductance:** In DC circuit, the reciprocal of resistance of a conductor is called its conductance. $G = 1/R$ In AC circuit, the real part of admittance is called as conductance. If impedance $Z = R+jX$, then admittance $Y= G-jB$ and conductance $G = R/(R^2+X^2)$ **OR** Conductance is the inducement to the flow of current. The unit of conductance is mho (℧) or siemens.	1 Mark for definition 1 Mark for unit
1 d)	Explain the following terms: (i) Unilateral circuit (ii) Non-linear circuit. **Ans:** **i) Unilateral circuit:** If the characteristic, response or behavior of circuit dependents on the direction of flow of current through its elements, then the circuit is called as a unilateral circuit. e.g. networks containing elements like diodes, transistors, thyristors etc. **ii) Non-linear circuit:** A circuit whose parameters changes with voltage or current are called as non-linear circuit. **OR** The circuit which does not obey Ohm's law is called as non-linear circuit. e .g. circuit containing , CFL, TV circuit, UPS etc. **OR** The circuit whose terminal voltage-current relationship is not linear, is called non-linear circuit.	1 Mark for each bit
1 e)	What do you understand by the term capacitance? What is its unit? **Ans:** **Capacitance:** The capacity of a capacitor to store electric charge is known as its capacitance.	

The capacitance of a capacitor is defined as the ratio of the charge Q stored on its either plates to the potential difference V between the plates. 1 Mark

The capacitance is expressed as, C = Q/V 1 Mark

The unit of capacitance is farad.

1 f) Define permeability. What is the value of permeability of free space?

Ans:

Permeability: Permeability of a material is its ability to permit the magnetic flux to set up through it. 1 Mark

The permeability of free space is $\mu_o = 4\pi \times 10^{-7}$ H/m. 1 Mark

1 g) What is permanent magnet and electromagnet?

Ans:

Permanent magnet:

A permanent magnet is an object made from a material that is magnetized and creates its own persistent magnetic field. As the name suggests, a permanent magnet is 'permanent'. This means that it always has a magnetic field and will display a magnetic behavior at all times. 1 Mark for each bit

Electromagnet:

An electromagnet is an object having a coil of wire wrapped around a core of ferromagnetic material like steel, which acts as a magnet when an electric current passes through the coil. If the current is interrupted, the magnetism is lost.

1 h) Define co-efficient of coupling.

Ans:

Coefficient of coupling (k):

It is defined as the ratio of actual mutal inductance present between two coils to the maximum possible value. 1 Mark for definition

If L_1 and L_2 are coefficients of self inductances of two coils having mutual inductance 'M' between them then the coefficient of coupling between these coils is given by: $k = M/\sqrt{(L_1L_2)}$ 1 Mark for equation

OR

The fraction of magnetic flux produced by the current in one coil that links with the other coil is called **coefficient of coupling** between the two coils.

$$k = \phi_{12}/\phi_1$$

where, ϕ_1 is the total flux produced by coil 1,

ϕ_{12} is the flux (out of ϕ_1) linking with coil 2

1 i) What are insulating material?

Ans:

Insulating material: Insulating material is that which offers very high resistance to the flow of current through it. 2 Marks

1 j) State two types of inductors and give their applications.

Ans:

Types of inductors:

i) Air cored inductor
ii) Iron cored inductor
iii) Ferrite cored inductor

Air cored inductor: These are used for high frequency application e.g. Radio sets, wave traps, Induction heaters etc.
Iron cored inductor: These are basically used for low frequency applications such as filters, chokes, amplifiers and other d.c. applications.
Ferrite cored inductor: These are used for many high frequency applications such as carrier telephony, domestic television receivers, domestic radio receiver, wide band pulse transformers, oscillators, signal generators, high frequency amplifiers, etc.

1 Mark for each of any two types with application = 2 Marks

1 k) State any four properties of conducting materials.

Ans:

Electrical properties of conductivity materials:

i) Low resistivity.
ii) Low temperature coefficient of resistance.
iii) High conductivity.
iv) Low heat dissipation.

Mechanical properties of conductivity materials:

i) High mechanical strength to withstand stress and strain.
ii) Malleable to fabricate easily.
iii) Ductile for wire drawing.
iv) Elastic in nature.

Chemical properties of conductivity materials:

i) Adequate resistant to corrosion.
ii) Low oxidation.

½ Mark for each of any four = 2 Marks

1 l) Define the following terms:

(i) Reluctance (ii) MMF.

Ans:

i) **Reluctance:** The opposition offered by magnetic circuit to establish magnetic flux in it, is called as "Reluctance". Its unit is AT/weber.

ii) **MMF:** It is the force that drives magnetic flux through magnetic circuit. It is measured in amp-turns.

1 Mark for each definition

2 Attempt any <u>FOUR</u> of the following: **16**

2 a) How to convert practical current source into practical voltage source? Draw equivalent voltage source for given circuit shown in Fig. 1.

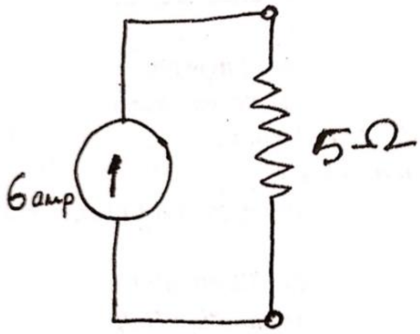
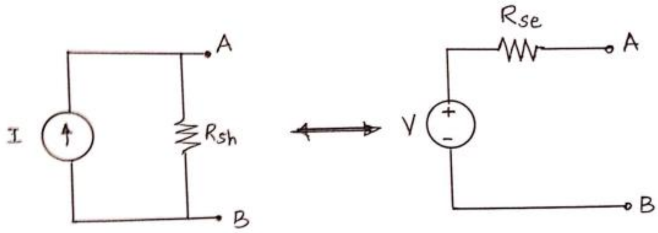


Fig. 1

Ans:

Conversion of practical current source into practical voltage source:



Practical current source can be converted to equivalent voltage source & vice versa.

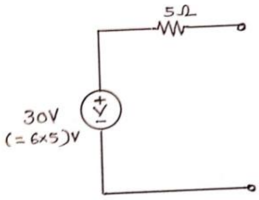
R_{sh} and R_{se} are internal resistance of sources. The equivalent voltage source is given by,

$$V = I \times R_{sh}$$ 2 Marks

And internal resistance of voltage source is given by,

$$R_{se} = R_{sh}$$

Equivalent voltage source for circuit of fig. 1:



2 Marks

2b) A silver coil has a resistance of 3.7 Ω at 42°C and 4.2 Ω at 100°C. Find the resistance at 0 °C and the temperature-coefficient of resistance at 40°C.

Ans:

The resistance at t°C is given by standard equation $R_t = R_0 (1 + t.\alpha_0)$ 1 Mark for equations (i) and (ii)

$\therefore R_{100} = 4.2 = R_0 (1 + 100\ \alpha_0)$ …………………..(i)

$\therefore R_{42} = 3.7 = R_0 (1 + 42\ \alpha_0)$ ……………………(ii)

Take ratio, $\frac{4.2}{3.7} = \frac{(1+100\ \alpha_0)}{(1+42\ \alpha_0)}$, solving it we get,

$\therefore$ **α_0 = 0.00258 /°C** 1 Mark for α_0

Substituting in eq. (i),

$4.2 = R_0 (1 + 100 \times 0.00258)$

The resistance of coil at 0°C is, 1 Mark for R_0

R_0 = 3.34Ω

Now, the resistance temperature coefficient at t°C is given by, $\alpha_t = \frac{\alpha_0}{1 + t \times \alpha_0}$

$\therefore$ The resistance temperature coefficient at 40°C is

$\therefore \alpha_{40} = \frac{\alpha_0}{1+40\times\alpha_0} = \frac{0.00258}{1+40\times 0.00258} = 2.33\times10^{-3}$ per °C 1 Mark for α_{40}

= **0.00233 /°C**

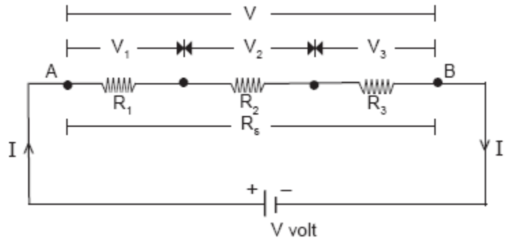
2c) Derive equivalent resistance for series and parallel circuit containing three resistances.

Ans:

Equivalent resistance for series circuit containing three resistances:

Consider three resistances R_1, R_2 and R_3 ohms connected in series across a battery of V volts as shown in the figure. There is only one path for current I i.e. current is same throughout the circuit. By ohms law, the voltages across the various

resistances are:
$V_1 = IR_1$; $V_2 = IR_2$; $V_3 = IR_3$
Now $V = V_1 + V_2 + V_3$
$= IR_1 + IR_2 + IR_3$
$= I(R_1 + R_2 + R_3)$ or



2 Marks

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

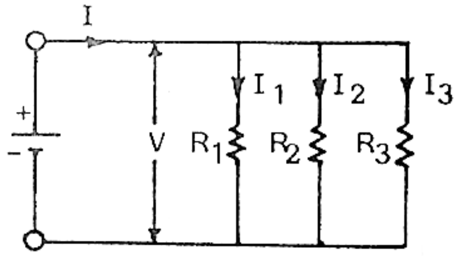
But $\frac{V}{I}$ is the total resistance R_s between points A and B.

R_s is called the total or equivalent resistance of the three series resistances.

$\therefore \mathbf{R_s = R_1 + R_2 + R_3}$

When a ‘n’ no. of resistances are connected in series, the total resistance is equal to the sum of ‘n’ individual resistances.

Equivalent resistance for parallel circuit containing three resistances:



Consider three resistances R_1, R_2 and R_3 ohms connected in parallel across a battery of V volts as shown in figure. The total current I divides into three parts: I_1 flowing through R_1, I_2 flowing through R_2 and I_3 flowing through R_3. The voltage across each resistance is the same and there are as many current paths as the number of resistances.

By ohms law the current through each resistance is $I_1 = \frac{V}{R_1}$; $I_2 = \frac{V}{R_2}$; and $I_3 = \frac{V}{R_3}$

Now $I = I_1 + I_2 + I_3 = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$ 2 Marks

$= V \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right]$ or

$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

But V/I is equivalent resistance R_P of parallel resistances so that

$I/V = 1/R_P$

$\mathbf{\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

When ‘n’ number of resistances are connected in parallel, reciprocal of total resistance is equal to the sum of the ‘n’ reciprocals of the individual resistances.

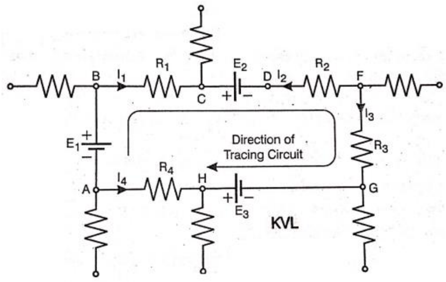
2 d) State and explain Kirchhoff’s voltage law with suitable example.

Ans:

Kirchhoff’s Voltage Law (KVL):

It states that, in any closed path in an electric circuit, the algebraic sum of the emfs and products of the currents and resistances is zero.

i.e $\Sigma E - \Sigma IR = 0$ or $\Sigma E = \Sigma IR$



2 Marks for statement

1 Mark for example

OR

It states that, in any closed path in an electrical circuit, the total voltage rise is equal to the total voltage drop.

i.e Voltage rise = Voltage drop

e.g. Referring to the circuit, by KVL we can write,

$(E_1 - E_2 + E_3) = (I_1R_1 - I_2R_2 + I_3R_3 - I_4R_4)$

Sign convention:

While tracing the loop or mesh, the voltage rise is considered as positive and voltage drop is considered as negative.

1 Mark for sign convention

2 e) Find current through 5Ω resistance using Kirchhoff's law of Fig.2.

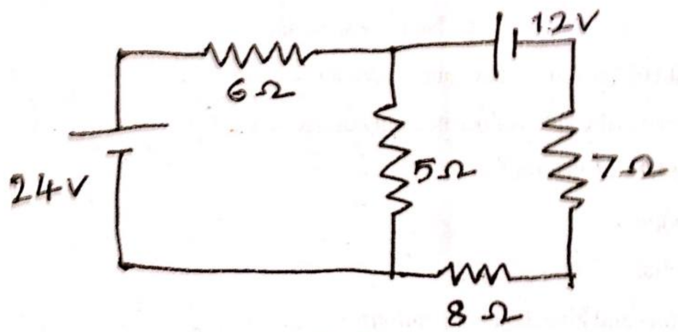
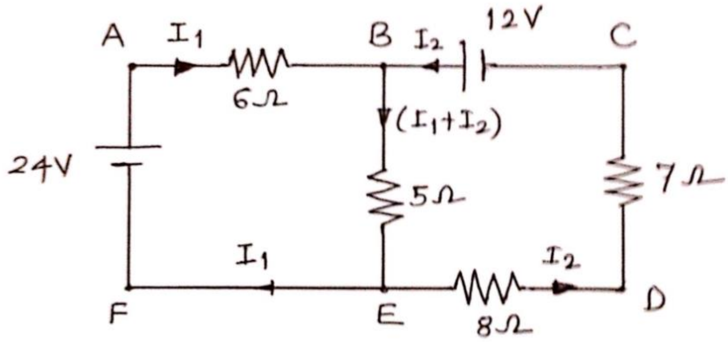


Fig. 2

Ans:

Current through 5Ω resistance using Kirchhoff 's laws:



Apply KVL for loop ABEFA :

$-6I_1 - 5(I_1 + I_2) + 24 = 0$ OR

$11I_1 + 5I_2 = 24$ ……………………Eq.(1)

1 Mark for Eq. (1)

Apply KVL for loop BCDEB :

$-12 + 7I_2 + 8I_2 + 5(I_1 + I_2) = 0$ OR

$5I_1 + 20I_2 = 12$ ……………………Eq.(2)

1 Mark for Eq. (2)

Multiplying eq. (1) by 5 and multiplying eq. (2) by 11, we get

$55 I_1+25 I_2 = 120$……………………………Eq.(3) 1 Mark for steps

$55 I_1+220 I_2 = 132$……………………………Eq.(4)

Subtracting eq. (4) from eq. (3),

$-195 I_2 = -12$ $\therefore I_2 = 0.0625$ A

Substituting I_1 in eq. (2),

$5 I_1+ 20\times0.0625 = 12$ $\therefore I_1= 2.15$ A

$\therefore$ Current through 5 Ω resistance is I = (I_1+ I_2) = 2.15 + 0.0625 1 Mark for I

I= 2.2125 A

2 f) State Faraday's law of Electromagnetic Induction and explain.

Ans:

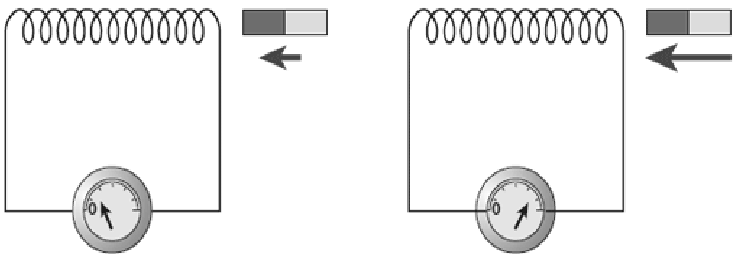
Faraday's laws of electromagnetic induction:

First law:

When a conductor cuts or is cut by the magnetic flux, an EMF is induced in the conductor. 2 Marks for statements

Second law:

The magnitude of EMF induced in the conductor depends on rate of change of flux linking with the conductor or rate of cutting the flux by the conductor.



Explanation:

- A stationary coil is placed near a movable permanent magnet and galvanometer is connected across the coil to measure current flowing through it. 2 Marks for explanation
- As magnet is moved closer to or away from the coil, the galvanometer starts showing deflection.
- The magnitude of the current through the coil is zero when both coil & magnet are stationary and direction of coil current depends on the direction of movement of the magnet.
- The expression of induced e.m.f. is as follows:
- $|e| \ \alpha$ (change in flux)/(time in which it occurs)
  $e = N (d\Phi /dt)$ volts
- When the movement of magnet is slow, the flux linking the coil changes slowly and lower emf is induced which results in lower current as shown by the galvanometer.
- When the movement of magnet is fast, the flux linking the coil changes at faster rate and high emf is induced which results in higher current as shown

by the galvanometer.

3 Attempt any FOUR of the following: **16**

3a) Explain briefly the factors affecting the capacitance of capacitor.

Ans:

Factors affecting the capacitance of capacitor:

The capacitance of a capacitor is given by, 1 Mark for equation

$$C = \frac{\epsilon_0 \epsilon_r A}{d}$$

i) **Area of Plates**: Greater the area (A) of capacitor plates, more is the value of capacitance and vice versa. 1 Mark for each of three factors = 3 Marks

ii) **Thickness of dielectric:** Smaller the thickness (d) of dielectric, more is the value of capacitance and vice versa.

iii) **Relative permittivity of dielectric:** Greater the relative permittivity (ϵ_r) of dielectric material more is the value of capacitance and vice versa.

3b) State the equation:

i) Voltage across capacitor while charging and discharging.

ii) Current in capacitor while charging and discharging.

Ans:

i) Voltage across capacitor while charging and discharging:

Voltage across capacitor while charging:

$$v_c = V(1 - e^{-\frac{t}{\tau}})$$

Voltage across capacitor while discharging: 1 Mark for each voltage equation = 2 Marks

$$v_c = V\, e^{-\frac{t}{\tau}}$$

where, V is the maximum voltage to which capacitor can charge and

τ = RC = Charging or discharging time-constant of the circuit.

ii) Current across capacitor while charging and discharging:

Current in capacitor while charging: 1 Mark for each current equation = 2 Marks

$$i_c = I_0 e^{-\frac{t}{\tau}}$$

Current in capacitor while discharging:

$$i_c = -\, I_0 e^{-\frac{t}{\tau}}$$

where, I_0 is the maximum current at instant t = 0

τ = RC = Charging or discharging time-constant of the circuit.

3c) Find the value of capacitance, charge and energy stored if plate area is 500cm^2 and thickness of insulation is 1.6mm, capacitor is connected across 120 volt.

Ans:

Given data:

Area of plates A= 500 cm^2 = 500 ×10^{-4} m^2

Distance between plates, d = 1.6 mm = 1.6 ×10^{-3} m

Supply voltage, V= 120V.

i) **Capacitance**, $C = \frac{\epsilon 0 \epsilon r\, A}{d}$ farad 1 Mark

Assuming $\epsilon r = 1$

(Examiners are requested to award the marks for proper assumption)

$$C = \frac{8.854\times10^{-12}\times1\times500\times10^{-4}}{1.6\times10^{-3}} = 276.6875\times10^{-12}\ \text{F}$$ 1 Mark

C = 276.69 pF

ii) **Charge**, Q = CV

$= 276.6875\times10^{-12}\times120$ 1 Mark

$Q = 33.2025\times10^{-9}$ C

iii) **Energy stored** $E = \frac{1}{2}cv^2$

$= \frac{1}{2}\times276.6875\times10^{-12}\times120^2$ 1 Mark

E = 1.9921 µJ

3 d) Calculate the value of equivalent capacitance of the Fig.3

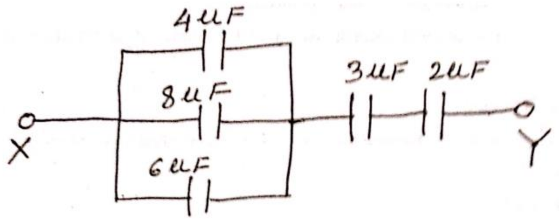


Fig. 3

Ans:

Value of equivalent capacitance:

i) For parallel combination: $C_p = C_1 + C_2 + C_3$ 1 Mark

$= 4 + 8 + 6$

$C_p = 18$ µF 1 Mark

ii) For Series combination between X and Y 1 Mark

$1/C_s = (1/C_1)+(1/C_2)+(1/C_3)$

$= (1/18)+(1/3)+(1/2)$

$1/C_s = 0.05556+0.33333+0.5$

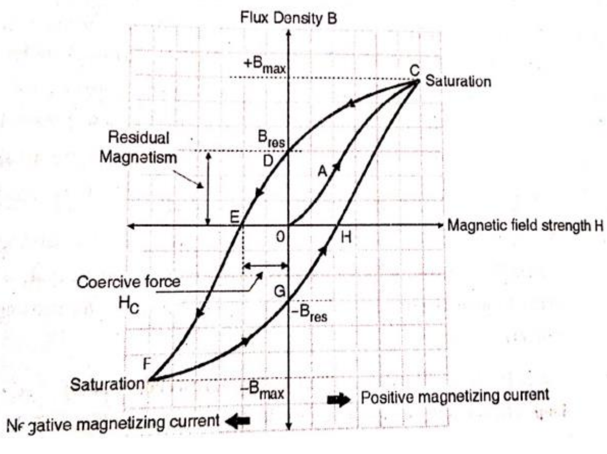
$1/C_s = 0.88889$

$\therefore C_s = 1.125$ µF 1 Mark

3 e) Draw hysteresis loop. Explain how it is plotted.

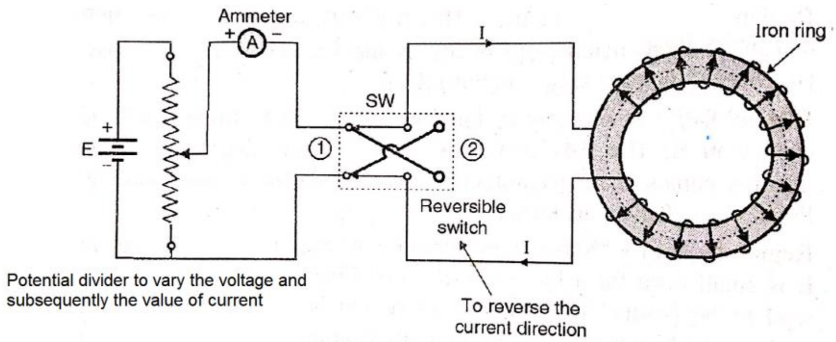
Ans:

Hysteresis loop of magnetic material:



1 Mark

The circuit arrangement for plotting the hysteresis loop is shown in figure given below. The electromagnetic part consists of a coil wound on the iron ring. The current direction can be reversed using reversible switch as shown. The magnitude of current is changed by varying the potential divider resistance. Magnetic ring is subjected to a cycle of magnetization and demagnetization for both the directions of the current. Then it is found that flux density B in the ring lags behind the applied magnetizing force H. The graph of flux density B versus magnetizing force H plotted for one magnetic reversal is called hysteresis loop. Meaning of hysteresis is to lag behind. 1 Mark



Set-up to plot the hysteresis curve

2 Marks

OR any equivalent set-up

3 f) Explain briefly the various electric characteristics of battery.

Ans:

Terminal voltage (V_T): The voltage available across the terminals of battery after connecting the load is called terminal voltage (V_T)

Internal resistance (R_i): The resistance within the source that causes a drop in the source voltage when load current flows, is called internal resistance.

AH efficiency:

Ampere-hour efficiency of a battery is defined as the ratio of the output of battery in amp-hour during discharging to the input amp-hour of battery during charging.

$$\eta_{Ah} = \frac{amp - hours\ during\ discharge}{amp - hours\ during\ charge}$$

1 Mark for each characteristics = 4 Marks

Watt – Hr efficiency :

The ratio of the output of a battery, measured in Watt-hours, to the input required to restore the initial state of charge, under specified conditions, is called Watt-hour efficiency.

$$\eta_{Wh} = \frac{watt\ hours\ during\ discharge}{watt\ hours\ during\ charge}$$

4 Attempt any <u>FOUR</u> of the following: 16

4 a) Explain Ohm's Law for magnetic circuit.

Ans:

Ohm's Law for magnetic circuit:

i) Ohm's law in case of magnetic circuits can be stated as, the Magnetic flux (Φ) developed in the circuit is directly proportional to Magneto-motive-force MMF

ii) The relation is similar to Ohm's law for electric circuit and can be formed by replacing Electro motive force (EMF) with MMF, Electric Current (I) with Magnetic Flux (Φ) and resistance (R) with reluctance (S).

iii) The relation can be expressed as follows:

Flux(Φ)=MMF(N.I)/ Reluctance(S)

where, S is Reluctance of the magnetic circuit.
N is the number of turns of coil.
I is the current flowing through coil.

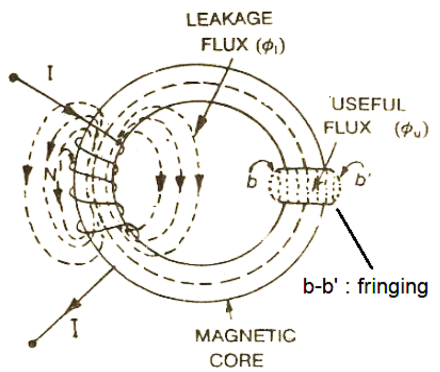
iv) The above equation strongly resemblance to Ohm's law of electric circuit as **Current(I) = EMF(V)/Resistance(R),** hence called as Ohm's Law for magnetic circuit. **OR Equivalent Explanation.**

1 Mark for each point = 4 Marks

4 b) Describe the concept of leakage flux, useful flux and fringing with neat diagram.

Ans:

Concept of leakage flux, useful flux and fringing:



1 Mark

Leakage flux: Some flux while passing through the magnetic circuit, leaks through the air surrounding the core. This flux is called as leakage flux. 1 Mark

Useful flux: The flux in the air gap which is actually utilized for various purposes depending upon the application is called as useful flux 1 Mark

Fringing: When the magnetic flux passing or crossing an air gap then it tends to bulge outwards the iron ring, this effect is called as "Fringing". 1 Mark

4 c) An iron ring of 20 cm in diameter, 10 cm^2 in cross sectional area is wound with 250 turns for the flux density of 1.2 wb/m^2 and permeability of 600, find:

i) Reluctance
ii) Flux
iii) MMF
iv) Current for excitation

Ans:

Given data :

A $=10\ cm^2 = 10 \times 10^{-4}\ m^2$,
No. of turns, N = 250,
Flux Density B = $1.2 wb/m^2$,
$\mu r = 600$
Diameter d = 20 cm = 20×10^{-2} m
Hence length of magnetic circuit = $\ell = \pi d = \pi \times 20 \times 10^{-2} = 0.6283$ meter

i) Reluctance (S):

$\therefore$ Reluctance of ring (S) = $\dfrac{l}{\mu_0 . \mu_r . a}$ 1 Mark for each bit = 4 Marks

$$= \frac{0.6283}{4\times\pi\times10^{-7}\times600\times10\times10^{-4}}$$

S = 833308.75 AT/Wb

ii) Flux (ϕ):

Flux Density B = 1.2wb/m^2 = ϕ/A

Flux ϕ = B × A= 1.2 ×10 × 10^{-4} =1.2×10^{-3} =**1.2 mWb**

iii) MMF:

$\therefore$ MMF = Flux × Reluctance

= 1.2 × 10^{-3} × 833308.75

= **1000 AT**

iv) Current for excitation (I):

Magnetizing current / Current for excitation:

$\therefore$ MMF = N × I

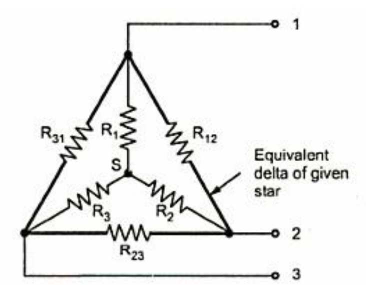
$\therefore$ I = MMF / N

= 1000 / 250

= **4 A**.

4 d) Three resistance are connected in star their values 8Ω,10Ω and 6Ω. Determine its equivalent delta circuit.

Ans:



1 Mark

In star connection values of resistances are

R_1 = 8 Ω, R_2 = 10 Ω, R_3 = 6 Ω

Converting the star network into delta

$R_{12} = (R_1 R_2 + R_2 R_3 + R_3 R_1) / R_3 = 31.33\ \Omega$ 1 Mark

$R_{23} = (R_1 R_2 + R_2 R_3 + R_3 R_1) / R_1 = 23.5\ \Omega$ and 1 Mark

$R_{31} = (R_1 R_2 + R_2 R_3 + R_3 R_1) / R_2 = 18.8\ \Omega$. 1 Mark

4 e) Explain the following terms:
i) Flux density
ii) Magnetic field strength.
State the relation between the two terms.

Ans :

i) Flux density (B): It is magnetic flux per unit area measured at right angles to the flux path and it is denoted by B. Its unit is tesla or weber/m^2. — 1 Mark

Flux Density B = (Flux Φ) / (Area A)

ii)Magnetic field strength (H): The force experienced by a unit north pole placed at any point in magnetic field is known as magnetic field strength at that point. Its unit is newtons per weber or amperes per meter. — 1 Mark

Relation between flux density and magnetizing force (field strength) is given by, — 1 Mark

$$B = \mu_0 \mu_r H$$

where, μ_0 is Permeability of free space &

. μ_r is Relative permeability of magnetic material — 1 Mark

4 f) Classify magnetic materials and explain in brief.

Ans:

Classification of magnetic materials:

1)Paramagnetic materials
2)Diamagnetic materials
3)Ferromagnetic materials

1 Mark for classification

a. **Paramagnetic materials**: The relative permeability of such materials is very less but positive (slightly greater than 1) so these materials cannot be magnetized and not suitable to carry the flux from one place to the other. In their case, the individual atomic di-poles are oriented in a random fashion. Following are the paramagnetic materials: magnesium, molybdenum, lithium, Aluminium, Titanium, Platinum. — 1 Mark

b. **Diamagnetic materials:** These materials have relative permeability slightly less than one. Such materials are magnetized opposite to the direction of the external field and due to this they are pushed out of regions of the highest field intensity. So diamagnetic materials are not useful in magnetic applications. Most elements in periodic table, including Copper, Silver and Gold fall in this category. — 1 Mark

c. **Ferromagnetic materials:** Relative permeability of ferromagnetic material is very large. These materials are very easily magnetized and used as conductors of magnetic flux from one place to other. These materials are characterized by the presence of parallel alignment of permanent magnetic dipole moments in a single direction. In the ferromagnetic materials the magnetization arises spontaneously i.e. in the absence of external magnetic field. Following are the ferromagnetic materials: Iron, Cobalt, Nickel. — 1 Mark

5 Attempt any FOUR of the following **16**

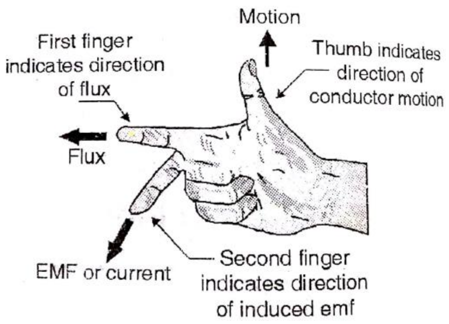
5 a) Explain in brief the concept of statically induced and dynamically induced emf. Give e.g. of each.

Ans:

Concept of statically induced emf: The emf induced in coil or conductors without any relative motion between it and magnetic field is called statically induced emf. When conductor is stationary and flux linking with it changes, the emf induced is — 2 Marks

known as statically induced emf.
e.g. Emf induced in transformer windings.
Concept of dynamically induced emf: The emf induced in coil or conductors due to relative motion between it and magnetic field, is called dynamically induced emf. When a conductor is moved in the magnetic field produced by fixed poles, it cuts the flux and emf is induced in it. This emf is dynamically induced emf. 2 Marks
e.g. Emf induced in generators, alternator.

5b) Explain Fleming's Right hand rule and Lenz's law.
Ans:
Fleming's Right hand rule:



2 Marks

Fleming's right hand rule states that stretch out the first three fingers of your right hand such that they are mutually perpendicular to each other. If the forefinger (first finger) indicates the direction of magnetic field, thumb indicates the direction of motion of conductor with respect to magnetic field, then middle (second) finger gives the direction of induced emf and hence current in the conductor.

Lenz's law:
The direction of induced emf due to the process of electromagnetic induction is such that, it always sets up a current to oppose the basic cause responsible for inducing the emf.
The mathematical representation is, e = - N (dΦ/dt) 2 Marks
Explanation: If a bar magnet with its N pole facing the coil is brought close to the coil, due to the relative motion between the coil and the magnet, there is a change in flux linkage with the coil. An emf is induced in the coil and current I starts flowing. This current produces its own magnetic field The direction of this current is such that it produces an N Pole on the side of the coil it faces.
As N-pole produced by the coil is close to the N pole of magnet, there is a force of repulsion between the two and this will oppose the magnet coming closer to the coil. Thus the induced emf produces current in such way that it opposes the cause behind its own production.

5c) State and explain in short the factors affecting the self-inductance of coil.
Ans:
Factors affecting the self-inductance of coil: 1 Mark for each of four factors = 4 Marks
Self-inductance is given by equation: $L = \frac{N^2}{S}$ & $L = \frac{\mu_0 \mu_r a\, N^2}{l}$

i) **Number of turns (N)**: Anything that affects the magnetic field, also affects the inductance of coil. Thus an increase in number of turns of coil causes an increase in the self-inductance of coil.

ii) **Relative permeability (μ_r) of material surrounding the coil**: As permeability increases, inductance also increases.

iii) **Cross sectional area (a) of core**: By increasing cross sectional area, the self-inductance can be increased.

iv) **Length of core (ℓ)**: By decreasing length if core, self-inductance can be increased.

5 d) The field winding of D.C. generator is wound with 910 turns and has resistance of 30Ω. When the voltage is 125 volts, the magnetic flux linking the coil is 0.007 wb. Calculate the self-inductance of the coil and the energy stored in the magnetic field.

Ans:-

Given Data: N=910 turns, R=30Ω, V=125 volts, ϕ = 0.007wb

i) We have, Inductance $L = \frac{N\phi}{I}$ henry — 1 Mark

Current in coil, I= $\frac{125}{30}$= **4.16A.** — 1 Mark

L= $\frac{910\times0.007}{4.16}$ = **1.53 H** — 1 Mark

ii) Energy stored , E= $\frac{1}{2}LI^2 = \frac{1}{2} \times 1.53 \times (4.16)^2 = 13.23\ joule$ — 1 Mark

5 e) State various effects of electric current and explain any one.

Ans:

Heating effect : — 2 Marks for effects

When an electric current flows through a conductor, the flow of electron is opposed by the resistance of conductor and heat is produced.

Joules law of heating. $H = I^2Rt$

It is utilized in electric irons, water heaters, Hot plates, electric lamps etc.

Chemical effect :

Whenever a DC current is passed through a chemical solution, the solution is decomposed into its constituent substances. — 2 marks for any one explanation

It is utilized in the electrolytic processes such as electro-plating, electro-refining, in production of different chemicals etc.

Magnetic Effect:

Whenever a conductor carries electric current, the magnetic field is produced. If the conductor is a straight conductor, the magnetic field is produced round the conductor itself. If the conductor is in the form of coil or winding (solenoid) wound over the core, the magnetic field is produced in the core.

5 f) With a neat circuit, show the current division in two parallel resistance, R_1 and R_2 in terms of total current.

Ans:

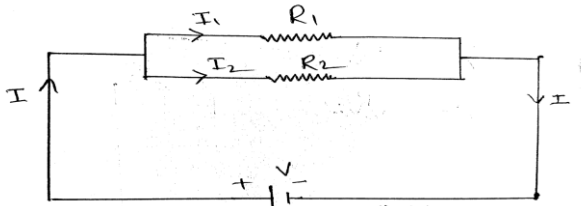


fig. current division — 1 mark for diagram

Consider two parallel resistances R_1 and R_2 as shown in fig. Let I be the total current.

The equivalent resistance is, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R_{eq}} = \frac{R_2+R_1}{R_1R_2}$$

$$R_{eq} = \frac{R_1R_2}{R_1+R_2}$$

1 mark for equivalent resistance

Now,

$$V = I \times R_{eq}$$

$$V = I \times \frac{R_1R_2}{R_1+R_2}$$

Now current through R_1, $I_1 = \frac{V}{R_1} = I \times \frac{R_2}{R_1+R_2}$

1 mark each for I_1 and I_2

current through R_2, $I_2 = \frac{V}{R_2} = I \times \frac{R_1}{R_1+R_2}$

This is the current division formula

6 Attempt any <u>FOUR</u> of the following: 16

6 a) What are the different methods of charging batteries? Draw a neat circuit diagram of any one and explain.

Ans:-

There are two methods of charging of batteries:

1) Constant current method
2) Constant voltage method

1 Mark for methods

1) **Constant current method**:
   - In this method, the charging current is kept constant by varying the supply voltage to overcome the increased back emf.
   - If a charging booster is used the current supplied by it by adjusting its excitation.
   - It charged on a d.c supply connected in the circuit.
   - The value of charging current should be so chosen that there is no excessive gassing during final stages of Charging the cell temperature should not exceed 45°C.
   - This method takes a comparatively longer time.

1 Mark for circuit diagram
2 marks for explanation (any one)

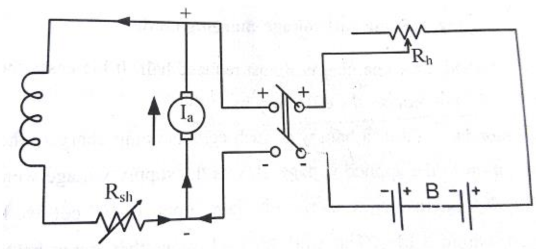


Fig.1. Constant current charging method

2) **Constant voltage charging method:**
   - In this method the charging voltage is held constant throughout the charging process.
   - The charging current is high in the beginning when the battery is in

discharged condition drops off as the battery picks up charge resulting in increased back e.m.f.

- This is the common method of charging used in battery shops and in automotive equipment.
- In this method time of charging is almost reduced to half.

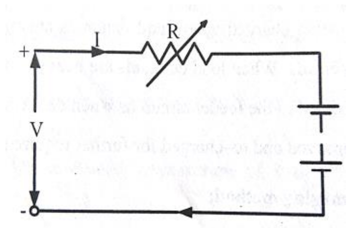


Fig.2. Constant voltage charging method

6 b) Explain the maintenance of lead acid battery.

Ans:-

Maintenance of lead acid battery:

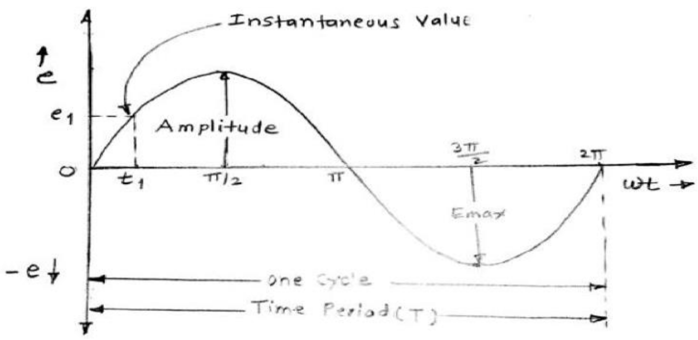
1) Keep the container surface dry by using dry cloths.
2) Tighten the terminal connections.
3) Battery should not be discharged below a minimum voltage.
4) Never keep battery in discharged condition.
5) Check the specific gravity of the electrolyte and maintain it by adding distilled water.
6) Electrolyte level should be maintained above the electrodes.
7) Battery should not be overcharged.
8) Charge battery at specific rate.
9) During initial charging use fresh electrolyte.
10) Avoid overcharging and short circuit of plates.

½ Mark for each of any eight points = 4 Marks

6 c) Draw the graphical representation of alternating E.M.F. or current. Show the following parameters in the same.

i) Cycle
ii) Time period
iii) Amplitude.

Ans:-



1 Mark for Graph

1 Mark for labeling of each = 3 Marks

6d) Compare copper and aluminium.

Ans:-

Sr. No.	Copper	Aluminium
1.	Resistivity is less	Resistivity is more
2.	More weight	Low weight
3.	Mechanically strong	Mechanically weaker
4.	Specific Gravity high	Specific Gravity Low
5.	Welding & soldering is easy	Difficult to weld & solder
6.	Affected chemically	Oxidizes when open
7.	Does not break when bend	Breaks when bend
8.	Tensile strength is double of that of aluminum	Tensile strength is half of that of copper
9.	Used for winding	Used for overhead lines

1 Mark for each of any four points = 4 Marks

6e) Explain the mechanical properties of insulating materials.

Ans:-

i) **Mechanical strength**: Mechanical strength depends on temperature and humidity.
   a) Temperature: High temperature badly affects the mechanical strength of insulating material. While selecting material precautions should be taken that it should withstand high temperature.
   b) Humidity: Non-hygroscopic materials should be selected, humidity badly affects mechanical strength.

ii) **Viscosity**: Viscosity is important in liquid dielectrics used in varnishes for impregnation. Low viscosity liquids are more mobile and helpful in transmission of heat by circulation.

iii) **Porosity**: High porosity insulating materials will increase the moisture holding capacity, which is harmful for insulating material, hence porosity is undesired.

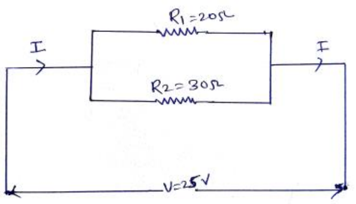
iv) **Solubility:** In some cases, the insulation can be applied only after dissolving, it in some solvent.

v) **Mouldability**: In manufacturing solid insulating material should have property of easy moulding and machined into required shape and size.

1 Mark for each of any four properties = 4 Marks

6f) Two resistors are connected in parallel, $R_1 = 20\Omega$ and $R_2 = 30\Omega$, the voltage is 25 volt. Calculate the current that flows through each resistor and total current drawn by the circuit.

Ans:



1 Mark for equivalent resistance

1 Mark for total current

The current that flows through R_1 is given by $I_1 = V/R_1 = 25/20 =$ **1.25A**

Similarly, the current that flows through R_2 is given by $I_2 = V/R_2 = 25/30 =$ **0.833A**

Total current drawn by circuit $I = I_1 + I_2 = 1.25 + 0.833 =$ **2.0833A**

1 Mark each for each current