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 may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more 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 may give credit for any equivalent figure drawn.

5) Credits may 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.

6) In case of some questions credit may be given by judgement 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.

1 **Attempt any *TEN* of the following:** 20

1 a) Define 'electric Potential' and 'potential difference'.

1 a) Ans:
Electric Potential: Electric potential at a point is defined as work done in bringing unit positive charge from infinity to that point. OR 1 mark
The capacity of the any charged body to do the work is called as "Electric potential"
Potential Difference: Potential difference between two points is defined as the work done to transfer unit positive charge from one point to other. OR 1 mark
The difference in electric potentials of two charged bodies is called potential difference.

1 b) State Ohm`s law applied to an electric circuit and write the mathematical expression for it.

1 b) Ans:
Ohm's law: As long as physical conditions (such as dimensions, pressure and temperature) are constant, the potential difference or voltage applied across the conductor is directly proportional to current flowing through it. 1 mark
i.e $V \alpha I$ or $V = R I$ 1 mark
where R = constant of proportionality, called as the resistance of the conductor

1 c) State KCL and KVL as applied to D. C. circuits.

1 c) Ans:

i) **Kirchhoff's current law**: - It states that in any electrical circuit, at any node or junction, the algebraic sum of currents is equal to zero. 1 mark

i..e $\sum I = 0$

ii) **Kirchhoff's voltage law**: - It states that in any closed circuit or mesh, the algebraic sum of all the emfs and the voltage drops (IR) is equal to zero. 1 mark

i.e. $\sum emf + \sum IR = 0$

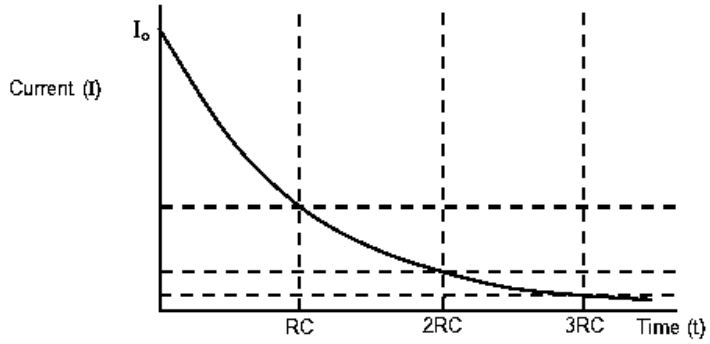
1 d) Releted to electric circuits, define:
i) Node ii) Branch

1 d) Ans:
i) Node: A point in an electric circuit at which two or more branches meet. 1 mark
ii)Branch: A part of an electric network which lies between two junctions or nodes. 1 mark

1 e) Draw the nature of charging current of a capacitor and write the expression for it.

1 e) Ans:
The expression for charging current of a capacitor:

$i = I_0 (e^{-t/RC})$ 1 mark



1 mark

1 f) With reference to magnetic circuit define:
i) Reluctance,
ii) Ampere turns (AT).

1 f) Ans:

Reluctance (S) : -

The property of opposition offered by magnetic circuit to establish magnetic flux in it is called as "Reluctance". It is denoted by letter "S". 1 mark

Ampere-Turn (AT) : -

It is the product of current I through a coil and number of turns N of the coil. It is the magneto-motive force (MMF) which sets up the magnetic flux in the magnetic circuit. 1 mark

∴ Amp–turns = I x N

1 g) State any two applications each for
-Permanent magnet
-Electromagnet

1 g) Ans:

Applications of Permanent magnet:
1) Field of DC motors
2) Tacho-generators
3) In stepper motors.
4) Field of two wheeler and car dynamo
5) In magnetic therapy
6) In magnetic compass.
7) Speedometers
8) Telephones
9) Microphones
10) Earphones
11) PMMC instrument.

Any two ½ mark each = 1 mark

Applications of electromagnet:
1) As Field and armature in DC Machine.
2) In cores of solenoid valves.
3) In cores of electromechanical relays.

Any two ½ mark each = 1 mark

4) In electromagnetic circuits of all AC Machines
5) Electrical measuring instrument.
6) Cores of transformers.

1 h) Define 'coefficient of self- induction' and 'coefficient of mutual- induction'.

1 h) Ans:

Coefficient of self- induction: Coefficient of self- induction of a coil is defined as the ratio of the electromotive force produced in a coil by self-induction to the rate of change of current producing it. 1 mark

$$L = N\Phi / I$$

It is expressed in henry.

Coefficient of mutual- induction: It is defined as the ratio of the electromotive force produced in a coil by mutual-induction to the rate of change of current in another coil producing it. 1 mark

$$M = N_2\Phi_1 / I_1 = N_1\Phi_2 / I_2$$

It is also expressed in henry.

1 i) State two applications for each of 'Air cored inductors' and 'Iron cored inductors'.

1 i) Ans:

Air cored inductors: These are used for high frequency application e.g. Radio sets, wave traps, Induction heaters etc. 1 mark

Iron cored inductors: These are basically used for low frequency applications such as filters, chokes, amplifiers and other D C applications 1 mark

1 j) State the law used to determine the direction of :
- Statically induced emf
- Dynamically induced emf.

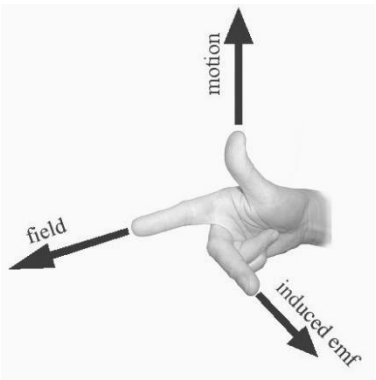
1 j) Ans:

The direction of statically induced emf is given by Lenz's law.

Lenz`s Law: It states that the direction of an induced emf is such that it always opposes the cause that produces it. 1 mark

The direction of dynamically induced emf is given by Fleming's Right hand rule.

Flemings Right hand rule:



Fleming's right hand rule states that arrange first three fingers of your right hand mutually perpendicular to each other, in such way that forefinger (first finger) showing the direction of magnetic filed, thumb indicating the direction of motion of conductor, then second (middle) finger gives the direction of induced emf hence current in the conductor. 1 mark

1 k) With reference to alternating current define- amplitude, cycle, frequency and time.

1 k) Ans:

1. **Amplitude:** The maximum value or peak value of an ac quantity is called as its amplitude. It is denoted by I_m, V_m etc.
2. **Cycle:** A complete set of variation of an alternating quantity which is repeated at regular interval of time is called a "cycle". OR
   In an ac waveform, each repetition consisting of one positive and one identical negative part is called as one cycle.
3. **Frequency (f):** It is defined as the number of cycles completed by an alternating quantity in one second.
4. **Time (Time period)(T):** It is defined as the time taken in seconds by an alternating quantity to complete one cycle.

½ mark for each definition

1 l) State any two materials used for current conduction and two materials used as insulating material in electrical appliances.

1 l) Ans:

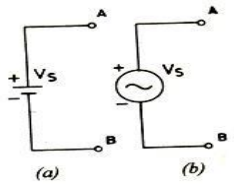
1. Materials used for current conduction: Silver, Copper Aluminum, Steel, Brass, Bronze. — Any two 1 mark
2. Materials used as insulating material: Mica, Polyvinyl chloride (PVC), rubber, Glass, Paper, Porcelain etc. — Any two 1 mark

2 Attempt any FOUR of the following: 16

2 a) Define 'Ideal voltage' source and 'Practical voltage' source. Draw the symbol for each.

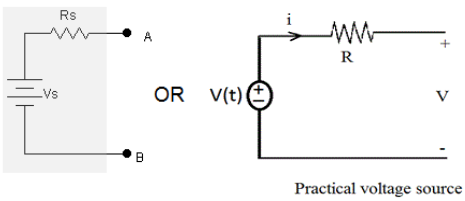
2 a) Ans:

i**) Ideal voltage source:** A voltage source whose terminal voltage always remains constant for all values of output current. 1 mark



Any one(a or b) 1 mark

ii) Practical voltage source: A voltage source whose terminal voltage falls with the increase in the output current due to the voltage drop caused by internal resistance. 1 mark



Practical voltage source

1 mark

2 b) State one application for each

- Carbon composition resistor
- Metal film resister

- Wire wound resistor
- H V Ink film resistor.

2 b) Ans:

1. **Carbon composition resistor**: Potential divider, welding control circuits, power supplies, H. V. and high impulse circuits as switching spark circuits, radio/ TV receiver circuit.
2. **Metal film resistor**: Oscillator, telecommunication circuits, testing circuits, measurement circuits, audio amplifier circuits.
3. **Wire wound resistor**: Power amplifiers, zener voltage regulators, radio/ TV receiver circuit.
4. **H V Ink Film type resistor**: C R O circuits, Radar, medical electronics.

1 mark for each point. Any 4 points (other valid Appl. to be considered)

2 c) Write the expression for 'equivalent resistance' and 'voltage division' when 3 resistances are connected in series.

2 c) Ans:

Equivalent resistance for series combination

$$R = R_1 + R_2 + R_3$$

1 mark

Voltage division Formula

$$V = IR_1 + IR_2 + IR_3$$

1 mark

$$V = V_1 + V_2 + V_3$$

Voltage across $R_1 = V_1 = V\frac{R_1}{R_1+R_2+R_3}$

Voltage across $R_2 = V_2 = V\frac{R_2}{R_1+R_2+R_3}$

Voltage across $R_3 = V_3 = V\frac{R_3}{R_1+R_2+R_3}$

2 marks

2 d) State the diffrance between and example for:

i) Linear circuit and non-linear circuit.

ii) Unilateral circuit and Bi-lateral circuit.

2 d) Ans:

i) a)**Linear circuit : -** A circuit whose parameters are always constant irrespective of changes in voltage or current is known as a "Linear circuit." The v-i characteristic of the circuit is linear. e.g Circuit with Bulb,Heater.

b) **Non Linear circuit : -** A circuit whose parameters change with voltage or current as called "Non-linear circuit." For such circuits, v-i characteristic is non-linear. e.g Circuit with CFL, TV, UPS etc.

ii) a) **Unilateral circuit:** If the characteristic response or behavior of circuit dependents on the direction of current through its elements, then the circuit is called as a unilateral circuit. e. g. networks containing elements likes diodes, transistors, thyristors etc.

b) **Bi-lateral circuit**:- It is that circuit whose characteritic response or behavior is independent of the direction of current flowing through its elements. e.g. Transmission line, circuits containing only resistor etc.

1 mark each for definition & valid example

2 e) Three capacitor's having capacitances 3µF, 5 µF and 7 µF respectively are connected in a circuit. Determine the equivalent capacitance when they are connected in-
i) Series
ii) Parallel.

2 e) Ans:
Given: C1= 3µF, C2= 5 µF , C3= 7 µF

i) For Series combination:

$1/Cs = (1/C1)+(1/C2)+(1/C3)$ 1 mark

$1/Cs = (1/3)+(1/5)+(1/7)$

$1/Cs = 0.33+0.2+0.142$

$1/Cs = 0.672$

$Cs = 1.48$ µF 1 mark

ii) For parallel combination:

$Cp = C1 + C2 + C3$ 1 mark

$Cp = 3 + 5 + 7$

$Cp = 15$ µF 1 mark

2 f) Derive the expression for energy stored in capacitor. Also draw discharging curves of capacitor.

2 f) Ans:
Energy stored in Capacitors:

Let C be capacitance of a capacitor in farad.

'v' be potential difference across capacitor in volt

Let q be charge on capacitor at an instant t

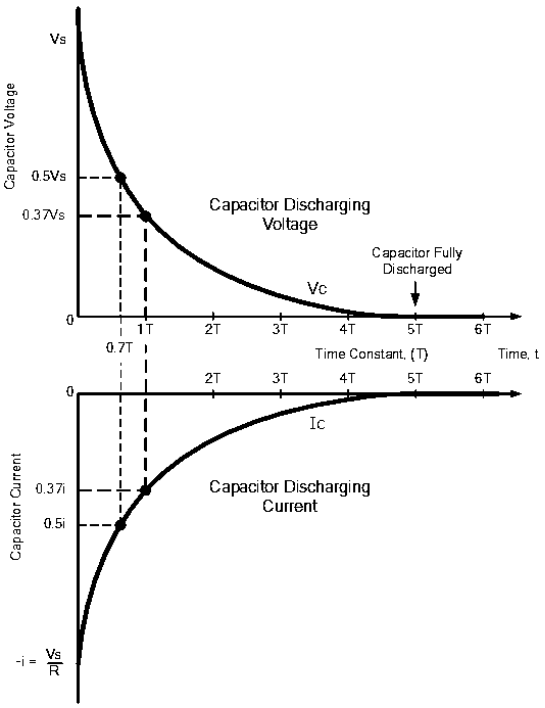
Therefore, Potential, $v = q / C$, $\therefore q = C\,v$

The work done in shifting a small charge dq against P. D. of 'v' volts is

$dW = v \times dq = v\, d(C\,v) = C\,v\,dv$

The work done is stored as potential energy in the electrostatic field by the capacitor.

Therefore, total energy stored by the capacitor



Derivation 3 marks

Curves 1 mark

E = work done $W = \int dW = \int_0^v C\,v\,dv = \frac{1}{2} C\,v^2$ joules.

3 Attempt any FOUR of the following: 16

3 a) State following effects of electric current and state two appilcations of each:
- Heating effect

- Chemical effect

3 a) Ans:

i) Heating effect : -

When an electric current flows through a conductor, the flow of electron is opposed by the resistance of conductor and heat is produced. 1mark for each effect

Joules law of heating.

$$H \alpha I^2Rt$$ 1 mark for two applications of each

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

ii) Chemical effect:

Whenever a DC current is passed through a chemical solution, the solution is decomposed into its constituent substances.

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

3 b) The rating of electric geyser is 250 V, 3 kW. How much current does it take and what is its hot resistance? Also calculate the energy consumed by it in one hour.

3 b) Ans:

Resistance $R = V^2/P = (250)^2 / 3000 = 20.83\ \Omega$ 1 marks

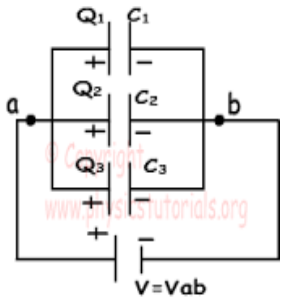
Current $I = V/R = 250/20.83 = 12$ A 1 marks

Energy consumed in 1 hr = 3000 (W) x 1 (hrs) = 3000 Wh = 3 kWh = 3 units 2 marks

3 c) Derive the expression for equivalent capacitance when three capacitors are connected in parallel.

3 c) Ans:.

Consider three capacitors having capacitances C_1, C_2 and C_3 farad respectively, connected in parallel across V volts.



Diag. 1 mark

In parallel connection, voltage across each capacitor is same with diffrent charge

$Q = Q_1 + Q_2 + Q_3$ 1 mark

$Q = C_1V + C_2V + C_3V$

$Q/V = C_1 + C_2 + C_3$

since $Q/V = C_T$ = Equivalent capacitance of parallel combination, 1 mark

$C_T = C_1 + C_2 + C_3$ 1 mark

3 d) Descibe the concept of 'breakdown voltage' and 'dielectric strength'.

3 d) Ans:

(i) Breakdown voltage: The voltage at which the dielectric material breaks down (Start conducting or is no longer an insulator) for a specified thickness is its breakdown voltage. 2 marks each

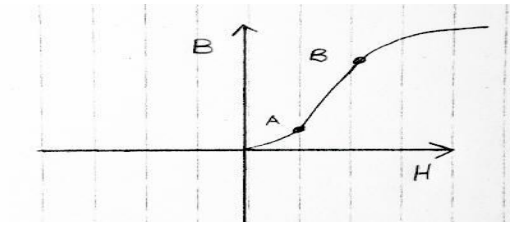
(ii) Dielectric Strength: The voltage which a dielectric material can withstand without

breaking down (without losing its dielectric property) is called its dielectric strength. It is represented by kV/mm or kV/cm.e.g dielectric strength of air is @ 30kV/cm or 3kV/mm.

3 e) Draw B-H curve for magnetic material and State its nature. Also draw hysteresis loop for hard steel and soft steel.

3 e) Ans:

B-H curve for magnetic material:

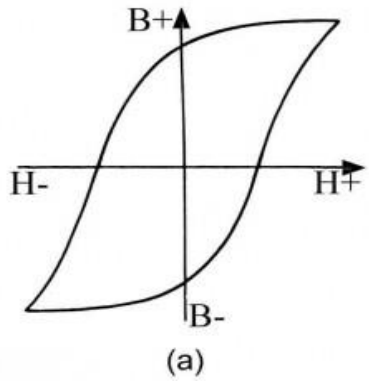


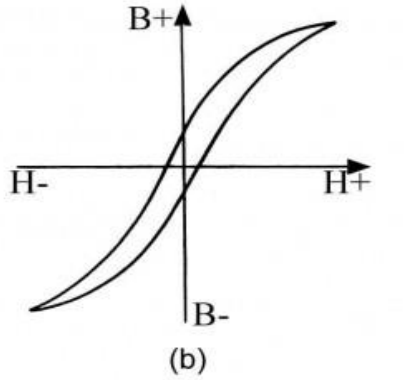
The B-H curve is concave up for low flux desities upto point A, for medium flux densities, it becomes straight (AB), for heigher flux densities curve concaves down (after point B) Then almsot becomes flat i.e. saturation occures.

Valid diagram 1 Mark

1 mark

Fig. (a) Shows hysteresis loop for hard steel.
Fig. (b) Shows hysteresis loop for soft steel.





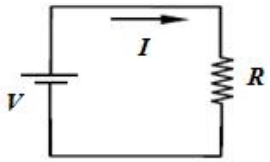
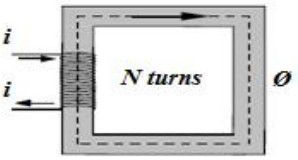
1 mark for each valid figure of H-loop

3 f) List out similarities (any four) between electric circuit and magnetic circuit.

3 f) Ans:.

Sr. No.	Electric circuit	Magnetic circuit
1	Current: flow of electrons through conductor is current, it is measured in amp.	Flux: lines of force through medium from N pole to S pole form flux. It is measured in weber.
2	EMF: It is driving force for current, measured in volts.	MMF: It is driving force for flux, measured in amp-turn.
3	Resistance: It is opposition of conductor to current, measured in ohms	Reluctance: It is opposition offered by magnetic path to flux measured in AT/wb.
4	Resistance is directly proportional to length of conductor.	Reluctance is directly proportional to length of magnetic path.

1 mark for each of any four points

5	For electric circuit we define the conductivity.	For magnetic circuit we define permeability.
6	Electric circuit is closed path for current.	Magnetic circuit is closed path for magnetic flux.
7	For electric circuit I = EMF/resistance	For magnetic circuit Φ= MMF/reluctance
8	Voltage = IR	M M F = Φ S
9	Resistivity	Reluctivity
10		

4 Attempt any FOUR of the following: 16

4 a) With the help of diagram, describe the concept of 'leakage flux', 'useful flux' and fringing.

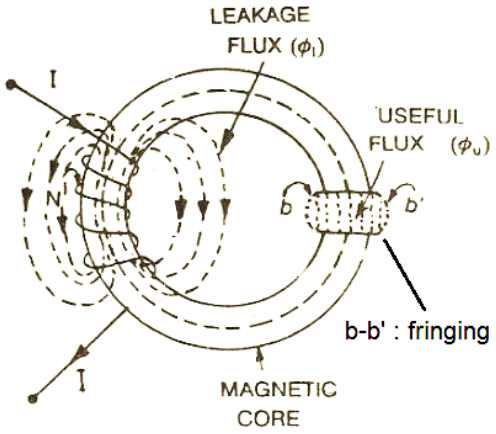
4 a) Ans:

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 tends to bulge outwards the iron ring, this effect is called as "Fringing". 1 mark



valid Diagram 1 mark

4 b) Iron ring of mean circumference 80 cm is uniformly wound with 550 turns of wire. Calculate value of flux density when a current of 1.1 amp would produce in the ring. Assume $\mu_r = 1400$.

4 b) Ans:

Given; $l = 80 \text{ cm} = 80 \times 10^{-2}$ m, N = 550, $\mu_r = 1400$, I= 1.1 A

$H = NI / l = 550 \times 1.1 / 80 \times 10^{-2} = 756.25$ AT/ m 2 marks

$B = \mu_0 \mu_r H = 4\pi \times 10^{-7} \times 1400 \times 756.25 = 1.33$ Wb/ m^2 — 2 marks

4 c) State the difference between 'self-induced e.m.f.' and 'mutual induced e m f'. Also state the expression for 'coefficient of coupling' and 'equivalent inductance' when two inductances are connected in series.

4 c) Ans:

Sr. No	Self induced emf	Mutual induced e m f
1	Induced in a coil due to own current changes of the coil	Due to current changes in (linking) neighboring coil/conductor
2	Counter emf of self induction	Counter emf of mutual induction
3	e = -L(di/dt), L = coefficient of self inductance	e = -M(di/dt), M = coefficient of mutual inductance.

1 mark for each point max. two points

Coefficient of coupling(K):

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

1 mark

$$K = M/\sqrt{(L_1.L_2)}$$

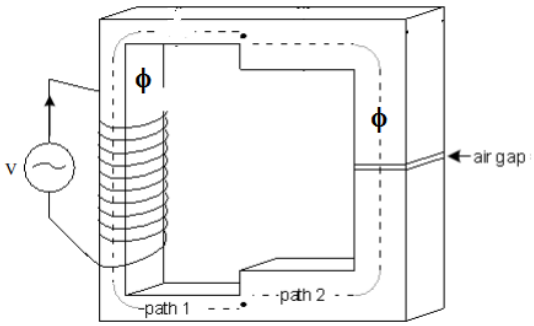
Equivalent inductance when two inductors connected in series: 1 mark

$L_T = L_1 + L_2 \pm 2M$

4 d) With the help of labeled diagram explain the concept of 'series magnetic circuit' and 'parallel magnetic circuit'.

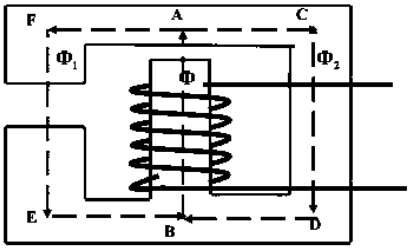
4 d) Ans:

i) **Series magnetic circuit:** When different magnetic material having different lengths, cross sectional areas and permeability's are connected one after another in which same flux is established in different sections, then it is called series magnetic circuit. 1 mark



Valid figure 1 mark

ii) **Parallel magnetic circuit:** Magnetic circuit which has more than one path for magnetic flux is called as parallel magnetic circuit. Reluctances are in parallel. Total flux, $\Phi = \Phi_1 + \Phi_2$ 1 mark



Valid figure
1 mark

4 e) With reference to storage batteries, define the terms:
- Terminal voltage
- Internal resistance
- Amp hour capacity
- Watt – hr efficiency.

4 e) Ans:

Terminal voltage(V_T): The voltage available across the terminals of battery after connecting the load is called terminal voltage (V_T) 1 mark

Internal resistance(r): The resistance within the source that causes a drop in the source voltage when load current flows, is called internal resistance. 1 mark

Amp hour capacity (AH capacity): It is the product of a constant discharge current and the time duration beyond which the battery voltage falls below a final discharge voltage level. 1 mark

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-hr efficiency. 1 mark

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

4 f) List out the steps to carry out the maintenance of storage batteries.

4 f) Ans:

Steps to carry out the maintenance of storage batteries:

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 maintainn it by adding distilled water.

6) Electrolyte level should be maintained above the electrodes.

7) Battrey should not be overcharged.

8) Charge battrey at specific rate.

9) During initial charging use fresh electrolyte.

2pts-1mark
4 pts-2marks
5pts-3marks
More than 5pts 4 marks

10) Avoid overcharging and short circuit of plates.

5 Attempt any FOUR of the following: 16

5 a) State the comparison between series and parallel circuits. (Any four points).

5 a) Ans:

Sr No	Series circuit	Parallel circuit
1	Total $V_T = V_1 + V_2 + V_3$	Total current $I_T = I_1 + I_2 + I_3$
2	Common current $I = I_1 = I_2 = I_3$	Common voltage $V = V_1 = V_2 = V_3$
3	Resultant resistance $R_T = R_1 + R_2 + R_3$	Resultant conductance $G_T = G_1 + G_2 + G$
4	$I = (V_1/R_1) = (V_2/R_2) = (V_3/R_3)$	$V = (I_1/G_1) = (I_2/G_2) = (I_3/G_3)$

1 mark Each point.

5 b) Determine the equivalent delta circuit of the following circuit. Refer Figure No. 1

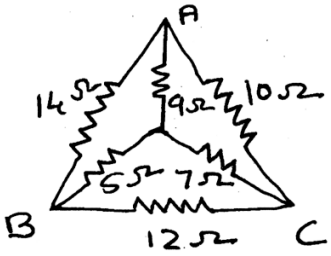


Fig. No. 1

5 b) Ans:

Step 1: Converting Inner Star into equivalent Delta

$$R_{AB} = R_A + R_B + \frac{R_A R_B}{R_C}$$

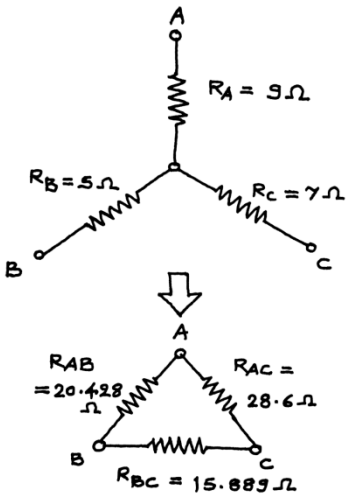
$$R_{AB} = 9 + 5 + \frac{9 \times 5}{7} = 20.428\ \Omega$$

$$R_{BC} = R_B + R_C + \frac{R_B R_C}{R_A}$$

$$R_{BC} = 5 + 7 + \frac{5 \times 7}{9} = 15.889\ \Omega$$

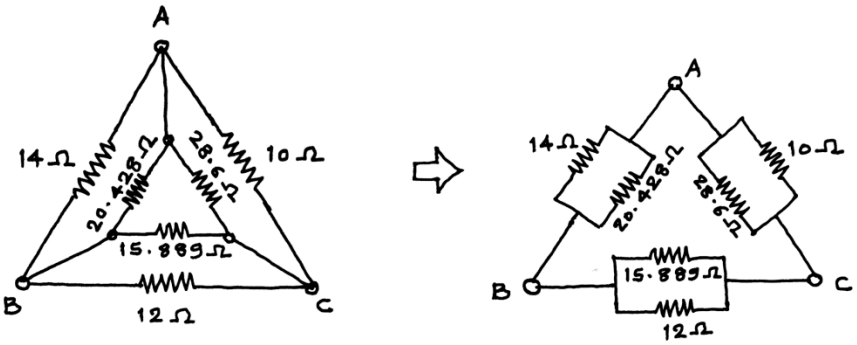
$$R_{CA} = R_C + R_A + \frac{R_C R_A}{R_B}$$

$$R_{CA} = 7 + 9 + \frac{7 \times 9}{5} = 28.6\ \Omega$$



2 marks

Step 2: Modified Network



1 mark

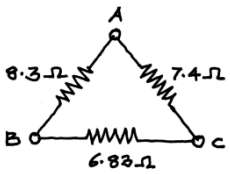
1 mark

Step 3: Solving Parallel Combinations

Resistance between AB $= \frac{14 \times 20.428}{14+20.428} = \frac{285.992}{34.428} = 8.3\ \Omega$

Resistance between BC $= \frac{12 \times 15.889}{12+15.889} = \frac{190.668}{27.889} = 6.836\ \Omega$

Resistance between CA $= \frac{10 \times 28.6}{10+28.6} = \frac{286}{38.6} = 7.4\ \Omega$



5 c) State and explain Faraday's first law and second law of electromagnetic induction.

5 c) Ans: **Faraday's laws of electromagnetic induction:**

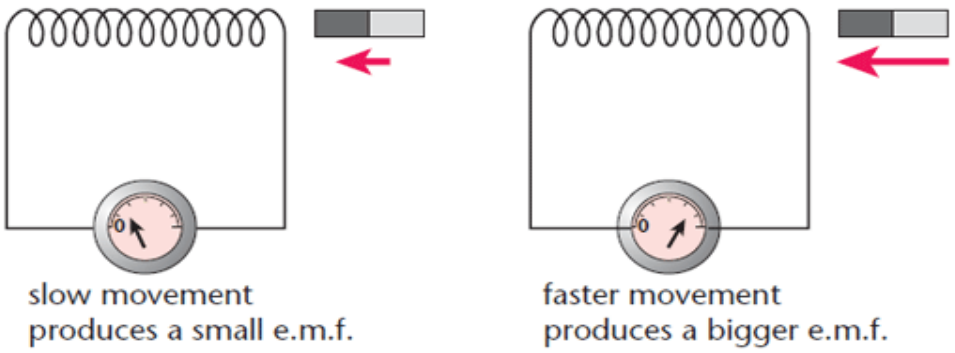
1st law: When a conductor cuts or is cut by the magnetic flux, an EMF is induced in the conductor.

2nd law: The magnitude of EMF induced in the coil depends on rate of change of flux linking with coil.

1 mark for each

Explanation:

- A stationary coil is placed near a movable permanent magnet and galvanometer is connected across the coil to measure current flowing through it.
- As magnet is moved closer to or away from the coil, the galvanometer starts showing deflection.



explanation 2 marks

- 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 emf is as follows:
  $|e| \alpha$ (change in flux)/(time in which it occurs)
  $e = N (d\Phi /dt)$ volts.

5 d) A magnetic flux of 0.4 mWb passing through a coil of 1200 turns is reversed in 0.1 second. Determine the average value of self-induced emf.

5 d) Ans:

N = 1200, initial flux $\Phi_1 = 0.4$ mWb $= 0.4 \times 10^{-3}$ Wb,
final flux $\Phi_2 = -0.4 \times 10^{-3}$ Wb, time of reversal t = 0.1 sec — 1 mark

We know that

e = N |(average rate of change of flux w.r.t time)| — 1mark

$e = N|(\Phi_2 - \Phi_1)|/t$, — 1 mark

$e = 1200 \times |[(-0.4 \times 10^{-3} - 0.4 \times 10^{-3})]| / 0.1$

e = 9.6 V

$\therefore$ Average induced emf in the coil = 9.6 V — 1mark

5 e) State the classification of 'conducting material' and 'magnetic material' with two examples for each.

5 e) Ans:

A)Classification of conducting materials:

1. **High conductivity materials:** Copper, aluminum
2. **Low conductivity materials:** Nichrome, manganese, tungsten, Eureka, Platinum.

B) Classification of magnetic materials:

1. **Paramagnetic materials:** The relative permeability (μ_r) of such materials is very less but positive. Slightly greater than one. e. g. Copper, Aluminum, Titanium, Platinum, Oxygen.
2. **Diamagnetic materials:** The relative permeability of these materials is slightly less than one. e. g. Hydrogen, Bismuth.
3. **Ferromagnetic materials:** The relative permeability of ferromagnetic materials is large. e. g. Iron, Nickel, Co, Gd.

Classification and two examples 1 mark each

5 f) State the temperature withstanding capacity of following class- Insulating material class Y, class A, class B, class E. Also state two examples for each.

5 f) Ans:

Sr. No.	Class	Limiting temp. in ^{O}C	Materials
1	Y	90	Cotton, silk paper, press board, wood.
2	A	105	Impregnated paper , silk, cotton
3	B	130	Inorganic materials like mica, glass, asbestos impregnated with varnish
4	E	120	Cotton fabric, synthetic resin enamels, paper laminates, powder plastics.

½ mark each for Temp. limit

½ mark each for two valid example

6 Attempt any FOUR of the following: 16

6 a) Explain the constant voltage charging of a battery.

6 a) Ans:

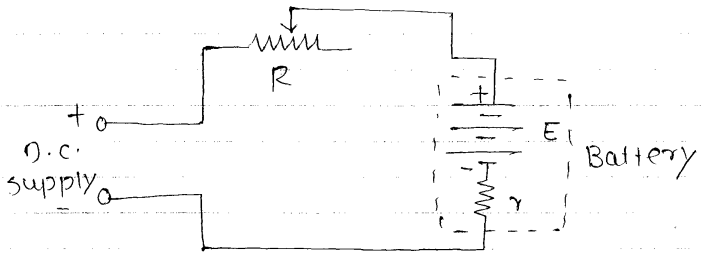


Diagram 2 marks

Constant voltage charging :

In this method, charging voltage is kept constant throughout the charging.

Charging current in the beginning is high due to low terminal voltage of the battery.

The charging current is very small when the cells are fully charged.

This method has advantage that the time required for charging is almost reduced to half as compared to constant current method.

Description 2 marks

The charging cunt (I) can be calculated by

$$I = \frac{V - E_b}{R_t}\ amp$$

Where,

E_b = back e.m.f.

V = supply voltage

R_t = R + r

= external series resistance + internal resistance.

6 b) List out the precautions to be taken while charging of lead- acid battery

6 b) Ans:

precautions to be taken while charging of lead- acid battery:

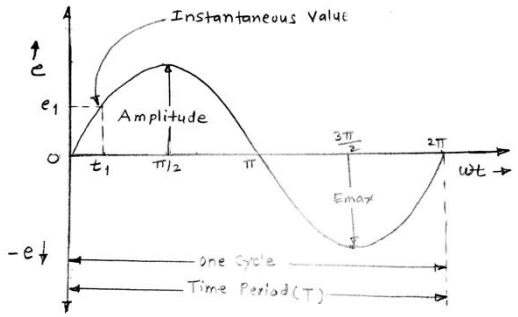
1) Never keep the battery in the circuit and connect for external charging if it is not

designed so.
2) While disconnecting / removing a battery first disconnect the negative terminal.
3) While connecting to charger, ensure that it is turned off.
4) Keep the charging voltage and current at levels specified by the maintenance manual.
5) The charge rate also depends on the external conditions such as temperature etc. so take care of the fact and set the rate.
6) Fast charging must be done with full supervision.
7) Inspect the electrolyte level and top up, if needed, else charging will not be of much use.
8) Never wear hanging jewellery while near a charging battery.
9) Do not keep tools etc on batteries.
10) Do not splash any liquids on the batteries, near the charger etc.

2pts-1mark
4 pts-2marks
5pts-3marks
More than 5pts 4 marks

6 c) Draw a labeled sinusoidal emf generated by a. c. generator and indicate cycle, time period, amplitude and instantaneous value.

6 c) Ans:



1 mark each Quantity Shown on waveform

6 d) Define Paramagnetic; Diamagnetic and Ferromagnetic material and amorphous metal

6 d) Ans:

1. **Paramagnetic materials:** The relative permeability (μ_r) of such materials is very less but positive and slightly greater than one. e. g. Copper, Aluminum, Titanium, Platinum, Oxygen.
2. **Diamagnetic materials:** The relative permeability of these materials is slightly less than one. e. g. Silver, Gold, Copper, Zinc, Lead, Hydrogen, Bismuth.
3. **Ferromagnetic materials:** The relative permeability of these materials is large. e. g. Iron, Nickel, Co.
4. **Amorphous metal:** Amorphous refers to the materials that do not possess a particular structure.

1 mark for each

The amorphous metal alloys differ in crystalline structure. The atoms are arranged in random configuration.

6 e) Determine the current through 6 Ω resistor shown in figure No. 2 using KVL.

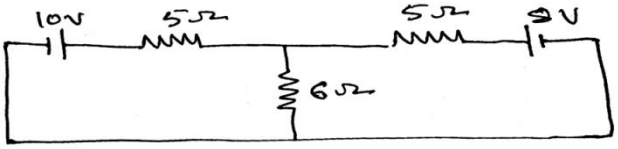
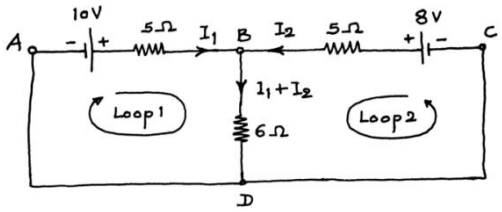


Fig. No. 2

6 e) Ans:



The branch currents are marked as shown in the figure.

Applying KVL to Loop 1: ABDA, the voltage equation is,

Figure 1mark

$$10 - 5I_1 - 6(I_1 + I_2) = 0$$
$$-11I_1 - 6I_2 = -10$$
$$11I_1 + 6I_2 = 10 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Applying KVL to Loop 2: CBDC, the voltage equation is,

$$8 - 5I_2 - 6(I_1 + I_2) = 0$$
$$-6I_1 - 11I_2 = -8$$
$$6I_1 + 11I_2 = 8 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Multiplying Eq. (1) by 6 and Eq.(2) by 11, we get,

$$6 \times (11I_1 + 6I_2 = 10) \ldots\ldots\ldots\ldots\ldots\ldots (3)$$
$$11 \times (6I_1 + 11I_2 = 8) \ldots\ldots\ldots\ldots\ldots\ldots (4)$$
$$66I_1 + 36I_2 = 60 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$
$$66I_1 + 121I_2 = 88 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

and then taking subtracting Eq.(5) from Eq.(6), we get

$$85I_2 = 28$$
$$\therefore\ I_2 = \frac{28}{85} = \mathbf{0.3294\ A}$$

1 mark

Substituting I_2 into Eq.(2), we get

$$6I_1 + 11(0.3294) = 8$$
$$6I_1 + 3.6235 = 8$$
$$6I_1 = 4.3765$$
$$I_1 = \frac{4.3765}{6} = \mathbf{0.7294\ A}$$

1 mark

The current through 6 Ω resistor I is (I_1+I_2),

$$I = I_1 + I_2 = 0.3294 + 07294 = \mathbf{1.0588\ A}$$

1 mark

The current through 6 Ω resistor is 1.0588 A

6 f) Calculate equivalent resistance R_{ab} in following Figure No. 3

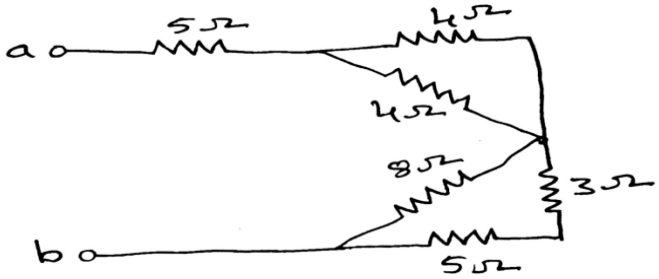
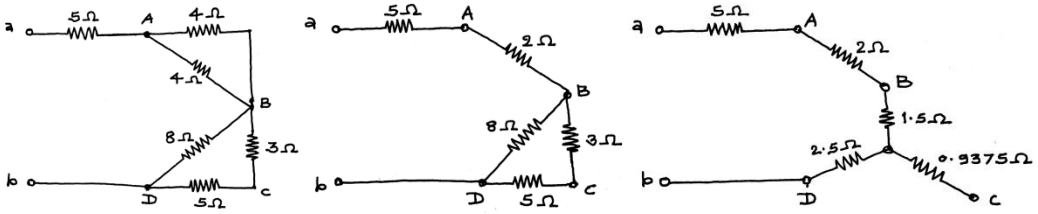


Fig. No. 3

6 f) Ans:



1 mark

Two 4 Ω resistors between A and B are in parallel, their equivalent resistor

$\frac{4\times4}{4+4} = \frac{16}{8} = 2\ \Omega$ 1 mark

Converting delta network formed by 8 Ω, 3 Ω and 5 Ω into an equivalent star,

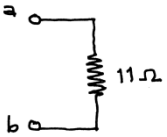
$R_B = \frac{R_{BC}R_{DB}}{R_{BC}+R_{CD}+R_{DB}} = \frac{3\times8}{3+5+8} = 1.5\ \Omega$

Similarly,

$R_C = \frac{R_{BC}R_{CD}}{R_{BC}+R_{CD}+R_{DB}} = \frac{3\times5}{3+5+8} = 0.9375\ \Omega$ 1 mark

$R_D = \frac{R_{CD}R_{DB}}{R_{BC}+R_{CD}+R_{DB}} = \frac{5\times8}{8+5+3} = 2.5\ \Omega$

The simplified network is shown in the figure,



$R_{ab} = 5 + 2 + 1.5 + 2.5 = 11\Omega$ 1 mark