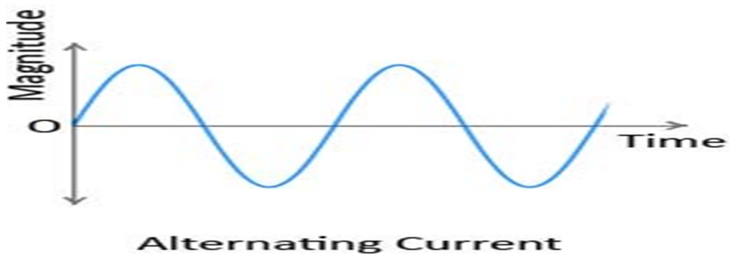
Important suggestions to examiners:

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 principle components indicated in a 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 some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 A	**Attempt any TEN of the following : 20 Marks**
a)	**Define potential difference and give its unit.**
Ans:	**Potential Difference:** **(1 Mark)** Potential difference between two points is defined as the work done to transfer unit positive charge from one point to other. **OR** The difference in electric potentials of two charged bodies is called potential difference. **Unit of Potential Difference:** Volts **(1 Mark)**
b)	**Define i) Power ii) Energy.**
Ans:	**i) Power:** **(1 Mark)** The rate of doing work done is known as power. Its unit is watt **ii) Energy:** **(1 Mark)** The total work done in the given time is known as energy. Its unit is KWH
c)	**Draw the waveform of direct current and alternating current.**
Ans:	**i) Waveform of Direct current (DC)** : **(1 Mark)**  or **equivalent figure**

ii) Waveform of Alternating current (AC): **(1 Mark)**



or **equivalent figure**

d) Define unilateral and bilateral circuit.

Ans:

i) Unilateral circuit: **(1 Mark)**

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) Bilateral Circuit: **(1 Mark)**

If the characteristic of circuits (response or behavior) is independent of the direction of current through its elements in it, then the circuit is called as a bilateral circuit e. g. circuits containing elements like resistances, inductances and capacitances.

e) Compare series and parallel circuit in terms of voltage and current.

Ans: **Comparison for series and parallel circuits:** **(Any Two point expected: 1 Mark each)**

S.No.	Series circuits	Parallel circuits
1	Only ONE path for current to flow in a closed circuit	Number of path for current to flow in a closed circuit
2	Current remains the SAME in all parts of the circuit	Current is DIFFERENT through each branch of the circuit
3	Voltage is DIFFERENT across each component	Voltage remains the same across each component of the circuit

f) State KVL as applied to DC circuit.

Ans: **Kirchhoff's Voltage Law (KVL):** **(2 Mark)**

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 $\Sigma E = \Sigma IR$ 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
g)	**What is capacitance? State its unit.**
Ans:	**Capacitance:** **(Meaning: 1 Mark & Unit : 1 Mark)** 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. The capacitance is expressed as, $C = Q/V$ The unit of capacitance is farad.
h)	**State the values for permeability of free space and relative permeability of air.**
Ans:	**i) Values for permeability of free space:** $\mu_o = 4\pi\times10^{-7}$ H/m. **(1 Mark)** **ii) Values for relative permeability of air :** $\mu_r = 1$. **(1 Mark)**
i)	**Write one application of each: i) Permanent Magnet ii) Electromagnet**
Ans:	**ii) Applications of Permanent Magnet:** **(Any one application expected:1 Mark)** 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. **ii) Applications of Electromagnet:** **(Any one application expected:1 Mark)** Cranes, Motors, Generators, Transformers, Electromagnetic Relays, Circuit breakers, Traction, Measuring instruments, Electrical Bell etc.

j) **State Fleming's Right Hand Rule.**

Ans: **1) Fleming's Right Hand Rule:** **(2 Mark)**

Arrange three fingers of right hand mutually perpendicular to each other, if the first figure indicates the direction of flux, thumb indicates the direction of motion of the conductor, and then the middle finger will point out the direction of induced current.

k) **State the meaning of 'A' and 'B' type insulating materials.**

Ans: Table not compulsory but content need to be covered **(Each Meaning : 1 Mark)**

S.No.	Class	Temperature ^{0}C	Materials
1	**A**	**105 ^{0}C**	Impregnated paper , silk, cotton
2	**B**	**130 ^{0}C**	Inorganic materials like mica, glass, asbestos impregnated with varnish

l) **Write the equation of ac voltage.**

Ans: **Equation of ac voltage:** **(2 Mark)**

$$v = V_m \sin(\omega t)$$

Where, v=instantaneous value of voltage in volt

V_m= Maximum value of voltage in volt

m) **List any four application of lead acid battery.**

Ans: **Applications of lead acid battery:** **(Any Four point expected: 1/2 each : Total : 2 Mark)**

i) As standby units in the distribution network

ii) In the uninterrupted power supplies

iii) In the telephone system

iv) In the railway signaling

v) In the battery operated vehicles

vi) In the automobiles for starting and lighting

n) **State Ohm's law for electric circuit.**

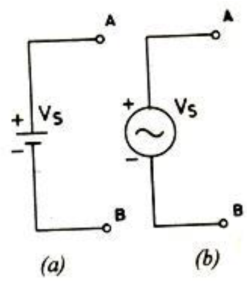
Ans: **Ohms Law:** -- **(State-1 Mark & Equation-1 Mark)**

The current flowing through a solid conductor is directly proportional to the difference of potential across the conductor. & inversely proportional to its resistance provided the temperature remains constant.

	Equation:- i.e $I \; \alpha \; V \quad \therefore \frac{V}{I} \; constant \; \therefore I = \frac{V}{R}$ $or \; \therefore V = I.R. \quad or \quad R = \frac{V}{I}$ **Where** R is constant called as resistance, V=voltage and I = Current
Q.2	**Attempt any FOUR of the following : 16 Marks**
a)	**A copper coil has a resistance of 12.7 ohms at 18°C and 14.3 ohms at '50°C. Find :** **i) Temperature co-efficient of resistance at 0°C ii) Resistance of coil at 0°C**
Ans:	The resistance at t^0C is given by : $R_1 = 12.7$ ohm $t_1 = 18^0$C $R_2 = 14.3$ ohm $t_1 = 50^0$C **i) Temperature co-efficient of resistance at 0°C** $R_2 = R_1[1+\alpha_1(t_2 - t_1)]$ -- **(1 Marks)** $14.3 = 12.7[1+\alpha_1(50-18)]$ $\frac{14.3}{12.7} = [1+\alpha_1(32)]$ $1.125 - 1 = [\alpha_1(32)]$ $0.125 = [\alpha_1(32)]$ $\alpha_{18} = 3.93 \times 10^{-3} /^0 C$ t_1 at = 18^0C: $\alpha_t = \frac{\alpha_0}{1+\alpha_0 t}$ $\alpha_{18} = \frac{\alpha_0}{1+\alpha_0 18}$ $3.93 \times 10^{-3} = \frac{\alpha_0}{1+\alpha_0 18}$ $3.93 \times 10^{-3} + \alpha_0(0.708) = \alpha_0$ $3.93 \times 10^{-3} = \alpha_0 - (0.708)\,\alpha_0$ $3.93 \times 10^{-3} = \alpha_0(1-0.708)$ $3.93 \times 10^{-3} = \alpha_0(0.929)$

	$\alpha_0 = \frac{3.93\times10^{-3}}{0929}$ $R_{TC}\ \ at\ \ 0^0C \quad \alpha_0 = 4.23\times10^{-3}\ /^0\ C$ ------------------------ (1 Marks) **ii) Resistance of coil at 0°C:** $R_t = R_0\ (1+\alpha_0\ \text{t})$ --- (1 Marks) $12.7 = R_0\ (1+4.23\times10^{-3}(18-0)$ $12.7 = R_0\ (1.07)$ $R_0 = \frac{12.7}{1.07}$ $R_0 = 11.80\ \ \Omega$ -- (1 Marks)
b)	**List any four types of resistance. Give one application of each.**
Ans:	**Types of resistance and their applications:** **(Any Four Types & expected : 1 Mark each)** 1**. Carbon composition resistance;** Application: Potential divider, welding control circuits, power supplies, hv. and high impulse circuits as switching spark circuits. 2. **Wire wound resistance**: Application : Power amplifiers 3. **Film type resistance**: Application: medical instruments. 4. **Carbon film resistance**: Application : Amplifier 5. **Metal film resistance**, Application: Oscillator, telecommunication circuits, testing circuits, measurement circuits, audio amplifier circuits.
c)	**Define 'Ideal voltage source' and 'Practical voltage source'. Draw the symbol for each.**
Ans:	**i) Ideal voltage source:** **(1 Mark)** A voltage source whose terminal voltage always remains constant for all values of output current, is known as an ideal voltage source. It has zero internal resistance.

Symbol of Ideal Voltage Source:- **(1 Mark)**

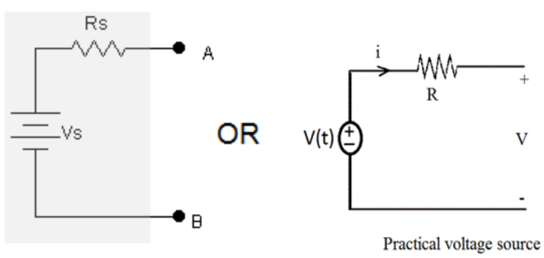


or equivalent

ii) Practical voltage source: **(1 Mark)**

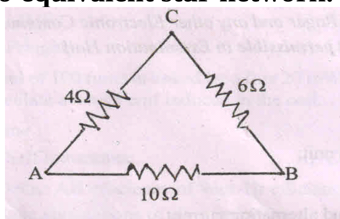
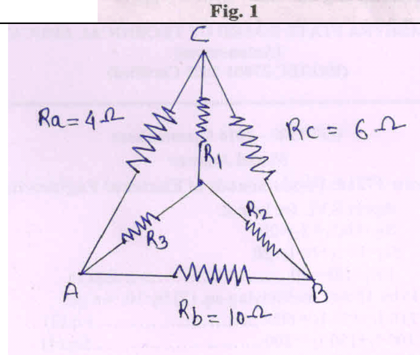
A voltage source whose terminal voltage falls with the increase in the output current due to the voltage drop in the internal resistance.

Symbol of Practical Voltage Source: **(1 Mark)**



or equivalent

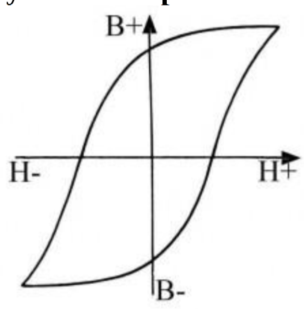
d)	**Define the terms : i) Node ii) Branch iii) Loop iv) Mesh**
Ans:	**i) Node:** **(1 Mark)** A point or junction where two or more elements of the network are connected together is called as node. **ii) Branch:** **(1 Mark)** A part of an electric network which lies between two junctions or nodes is known as branch. **iii) Loop:** **(1 Mark)** Any closed path in an electric circuit where each element or branch is traversed only once. **iv) Mesh:** **(1 Mark)** A set of branches forming a closed path (same as loop) in an electric circuit. **OR** A loop that does not contain any other loop inside

e)	**Convert the network of fig. 1 into equivalent star network.**  Fig. 1
Ans:	 ------------------------ **(1 Mark)** $R_1 = \frac{R_c \times R_a}{(R_c + R_b + R_a)}$ $R_1 = \frac{6 \times 4}{(6+10+4)}$ $R_1 = 1.2\ \Omega$ --- **(1 Mark)** $R_2 = \frac{R_c \times R_b}{(R_c + R_b + R_a)}$ $R_2 = \frac{6 \times 10}{(6+10+4)}$ $R_2 = 3\ \Omega$ --- **(1 Mark)** $R_3 = \frac{R_b \times R_a}{(R_c + R_b + R_a)}$ $R_3 = \frac{10 \times 4}{(6+10+4)}$ $R_3 = 2\ \Omega$ --- **(1 Mark)**

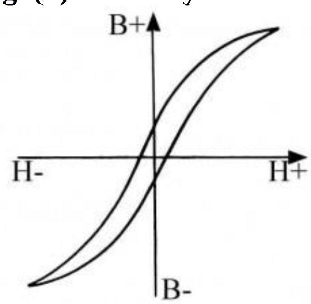
f) **Draw Hysteresis loop for Hard steel and soft steel. Also write one application of each material.**

Ans: **(Each Figure : 1 Mark)**

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



(a)



(b)

Application of Hard steel: **(1 Mark)**

- Fig. (a) Shows hysteresis loop for hard steel. Such materials are used for producing permanent magnets. Such a hysteresis loop represents a large residual flux & hence large coercive force.

Application of Soft steel: **(1 Mark)**

- Fig. (b) Shows hysteresis loop for Soft steel. Residual flux & coercive force are less. Hence material can be used for making the electromagnets.

Q.3 **Attempt any FOUR of the following :** **16 Marks**

a) **Find the current flowing through 5 ohm resistor using Kirchhoff's laws in Fig.2.**

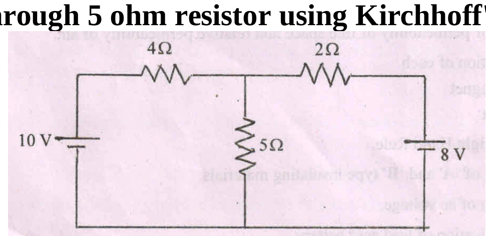
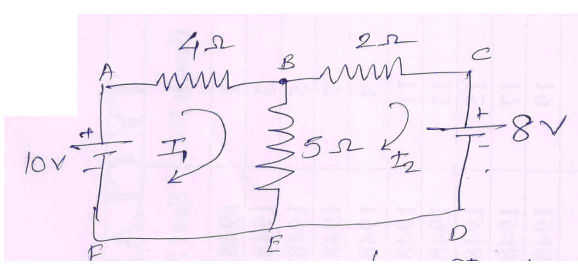


Fig. 2

Ans:



Apply KVL for loop ABEFA :

$-4I_1 - 5(I_1 - I_2) + 10 = 0$ --- **(1/2 Mark)**

$-4I_1 - 5I_1 + 5I_2) + 10 = 0$

$-4I_1 - 5I_1 + 5I_2) = -10$ ………………………Eq.(1)

Apply KVL for loop BCDEB :

$-2I_2 - 8 - 5(I_2 - I_1) = 0$

$-2I_2 - 8 - 5I_2 + 5I_1) = 0$

$5I_1 - 7I_2 = 8$………………………Eq.(2) -------------------------- **(1/2 Mark)**

Multiplying eq. (1) by 7 and multiplying eq. (2) by 5, we get

$-63I_1 + 35I_2 = -70$……………………………Eq.(3)

$25I_1 - 35I_2 = 40$……………………………Eq.(4)

Adding eq. (3) & eq. (4),

$-63I_1 + 35I_2 = -70$……………………………Eq.(3)

$+\underline{25I_1 - 35I_2 = 40}$……………………………Eq.(4)

$-38I_1 = -30$ -- **(1/2 Mark)**

$$I_1 = \frac{-30}{-38}$$

I_1 = 0.7894 Amp --- **(1 Mark)**

Substituting I_1 in eq. (2),

$5(0.7894) - 7I_2 = 8$ --- **(1/2 Mark)**

$-7I_2 = 8 - 3.94$

$-7I_2 = 4.05$

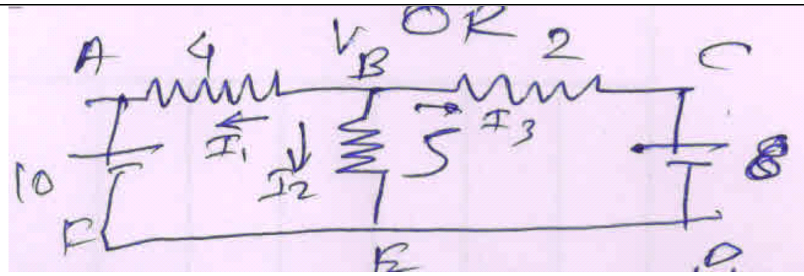
$$I_2 = \frac{4.05}{-7}$$

$I_2 = -0.579$ *Amp* -- **(1 Mark)**

$\therefore$ **Current through 5 Ω resistance is I =** $(I_1 - I_2) = 0.7894 - (-0.579)$

I= 1.36 Amp

OR



Apply KCL at node B :

$$I_1 + I_2 + I_3 = 0$$ -- **(1 Mark)**

$$\frac{V_B - 10}{4} + \frac{V_B}{5} + \frac{V_B - 8}{2} = 0$$

$$\frac{V_B}{4} - \frac{10}{4} + \frac{V_B}{5} + \frac{V_B}{2} - \frac{8}{2} = 0$$

$$V_B\left(\frac{1}{4} + \frac{1}{5} + \frac{1}{2}\right) = \frac{8}{2} + \frac{10}{4} = 0$$

$$0.95\,V_B = \frac{6.5}{0.95}$$

$$V_B = 6.84 \ \ volt$$ -- **(1 Mark)**

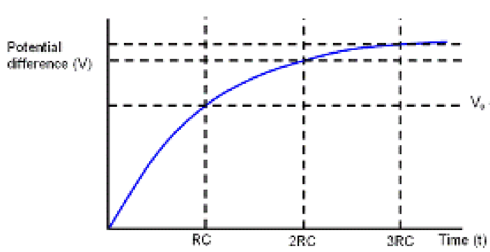
Current in 5 ohm :

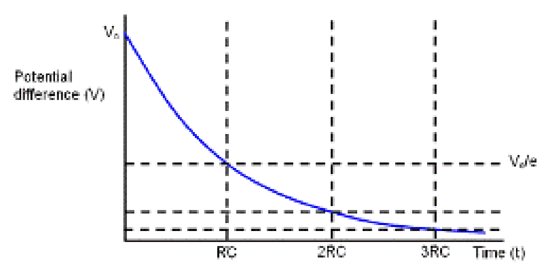
$$I_2 = \frac{V_B}{5} = \frac{6.84}{5}$$

$$I_2 = 1.36 \ \ Amp$$ -- **(2 Mark)**

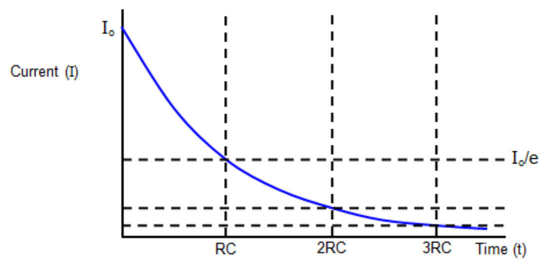
b) **Draw the voltage and current curves during charging and discharging of a capacitor.**

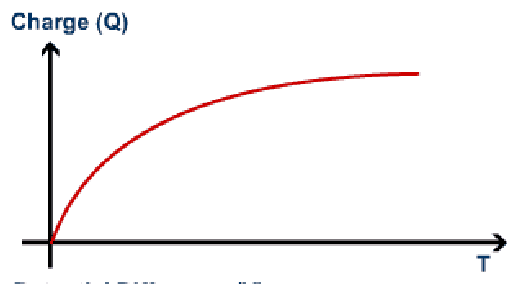
Ans: **i) Voltage curves during charging and discharging of a capacitor:** **(2 Marks)**





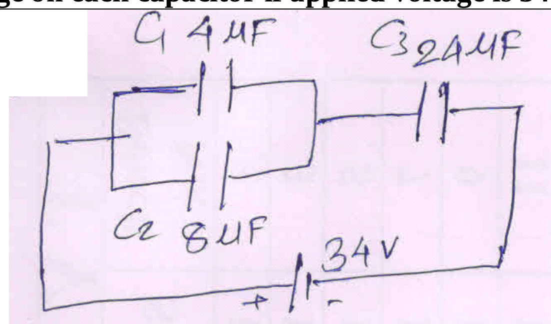
ii) Current curves during charging and discharging of a capacitor: **(2 Marks)**





c) **Two capacitor of 4 microfarad and 8 microfarad are connected in parallel combination is connected in series with a capacitor of 24 microfarad. Find i) Total capacitance ii) Total charge iii) Charge on each capacitor if applied voltage is 34 volts.**

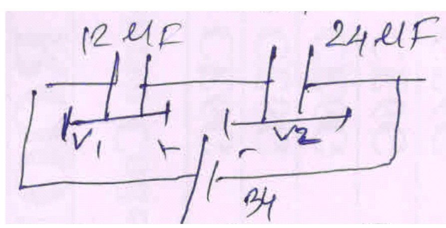
Ans:



i) Total Capacitance : 4 μF & 8 μF are connected in parallel

C_{eq} = 4+18

C_{eq} = 12 μF -- **(1/2 Marks)**



: 12 μF & 24 μF are connected in Series

$$\frac{1}{C_{eq}} = \frac{1}{12} + \frac{1}{24}$$

$$C_{eq} = 8\ \mu F$$

Total Capacitance : 8 μF --- **(1/2 Marks)**

ii) Total Charge φ : Total capacitance (C) x Voltage (v)

$$\varphi = (C) \times (v)$$

$$\varphi_{total} = 8 \times 10^{-6} \times 34$$

Total Charge φ_{total} = 2.72 x 10^{-4} coulomb -------------------------------------- **(1/2 Marks)**

iii) Charge on each capacitor if applied voltage is 34 volts :

Total Charge for 12 µF & 24 µF will be same = 2.72 x 10^{-4} C

$$V_1 = \frac{\varphi}{12\mu F} = \frac{2.72\times10^{-4}}{12\times10^{-6}}$$

$V_1 = 22.66\ volt$ --- **(1/2 Marks)**

$$V_2 = \frac{\varphi}{24\mu F} = \frac{2.72\times10^{-4}}{24\times10^{-6}}$$

$V_2 = 11.33\ volt$ --- **(1/2 Marks)**

Charge on each capacitor:

$\varphi_1 = C_1 V_1 = 4\times10^{-6}\times22.66$

$\varphi_1 = 9.064\times10^{-5}\ C$ --- **(1/2 Marks)**

$\varphi_2 = C_2 V_1 = 8\times10^{-6}\times22.66$

$\varphi_2 = 1.81\times10^{-4}\ C$ --- **(1/2 Marks)**

$\varphi_3 = C_3 V_2 = 24\times10^{-6}\times11.33$

$\varphi_3 = 2.71\times10^{-4}\ C$ --- **(1/2 Marks)**

d) **Calculate equivalent resistance R_{xy} in following in fig. 3.**

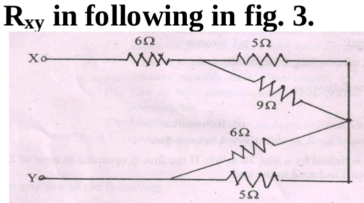
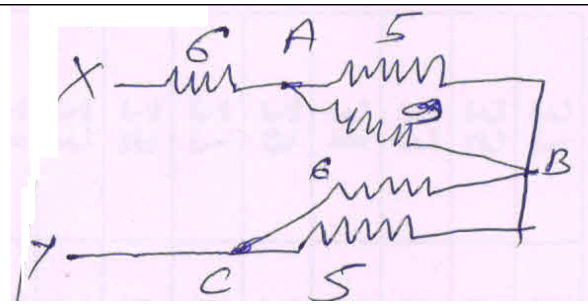


Fig. 3

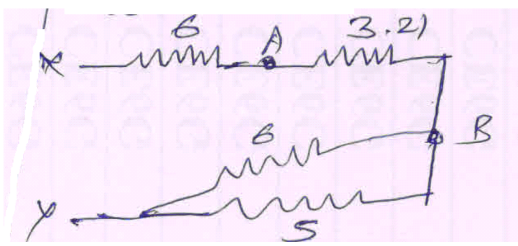
Ans:



Two resistance 5 ohm and 9 ohm are in parallel

$\therefore equivalent\ resistance\ R_{eq} = \dfrac{5 \times 9}{5+9}$ -- **(1/2 Marks)**

$\therefore equivalent\ resistance\ R_{eq} = 3.21\,\Omega$ -------------------------------------- **(1/2 Marks)**

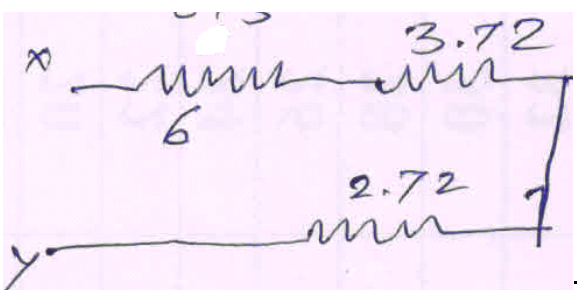


-- **(1/2 Marks)**

Two resistance 5 ohm and 6 ohm are in parallel

$\therefore equivalent\ resistance\ R_{eq} = \dfrac{6 \times 5}{6+5}$ -- **(1/2 Marks)**

$\therefore equivalent\ resistance\ R_{eq} = 2.72\ \Omega$ ----------------------------------- **(1/2 Marks)**



--- **(1/2 Marks)**

$\therefore\ R_{XY} = 6 + 3.72 + 2.72$

$\therefore\ R_{XY} = 12.44\ \Omega$ --- **(1 Mark)**

e)	**Four capacitors have capacitance of 3 μF, 5 μF. 8 μF and 10 μF. Find the total capacitance when they are connected in i) series ii) parallel.**

Ans: Given Data :

C_1 = 3 µF, C_2 = 5 µF, C_3 = 8 µF and C_4 = 10 µF connected series & parallel

i) Total capacitance in Series combination: **(2 Marks)**

$$\frac{1}{C_S}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\frac{1}{C_4}$$

$$\frac{1}{C_S}=\frac{1}{3}+\frac{1}{5}+\frac{1}{8}+\frac{1}{10}$$

$$\frac{1}{C_S}=0.333+0.2+0.125+0.1$$

$$\frac{1}{C_S}=0.758$$

$$C_{series}=1.319\ \mu F$$

ii) Total capacitance in Parallel combination: **(2 Marks)**

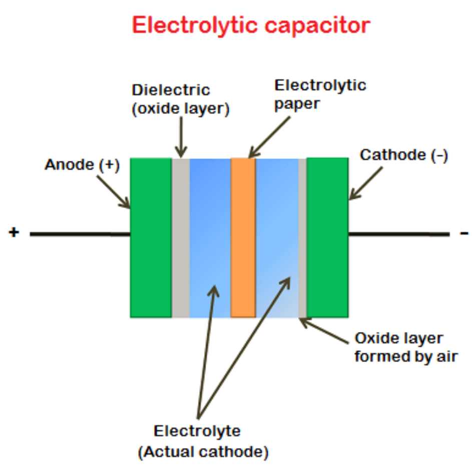
Total capacitance (C_P) = C_1+ C_2+ C_3 + C_4 as capacitors are in parallel

C_P = 3 + 5 + 8 +10

C_P = **26 µF**

f)	**Explain the electrolytic capacitor with neat diagram.**

Ans: **Diagram of electrolytic capacitor:** **(Diagram ; 2 Marks & Explanation: 2 Marks)**



OR

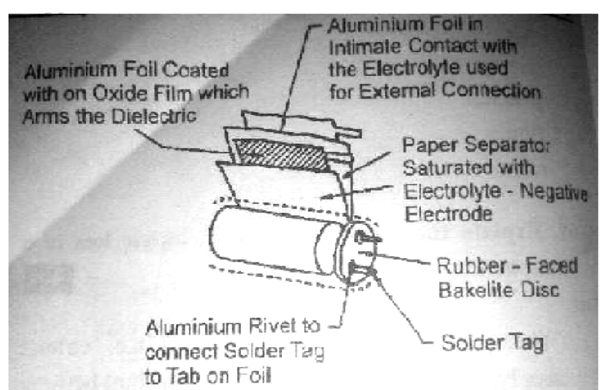
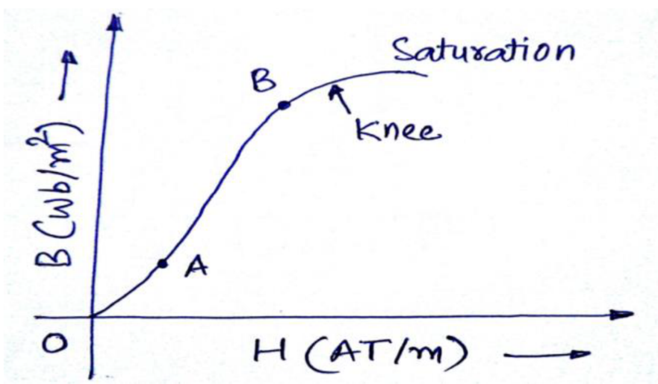


Fig. Electrolytic copacitor

	Explanation: ➢ In an electrolytic capacitor, two sheets of aluminum foil, separated by a fine gauges soaked in an electrolyte rolled up and encased in an aluminum or ceramic or plastic tube. ➢ The aluminum oxide is dielectric. The electrolytic capacitors can be used only for DC and should be connected with correct polarity. ➢ The electrolytic capacitors have the advantages of small size and low cost. ➢ The range of capacitor is from around 1 μF to 200 μF and working voltage up to 400 volt DC. ➢ Their main field of applications is in electronic circuit and filters circuits.
Q.4	**Attempt any FOUR of the following : 16 Marks**
a)	**Explain B-H curve of magnetic material.**
Ans:	**B-H curve of magnetic material:** **(Diagram ; 2 Marks & Explanation: 2 Marks)**

The B-H curve is the graphical representation of relation between flux density (B) and applied field strength (H), with H plotted on the x-axis and B plotted on the y-axis. Typical B-H curve is as shown in figure below:



The B-H curve can be described by dividing it into 3 regions.

- **Region OA:** For zero current, H = 0 and B is also zero. The flux density B then increases gradually as the value of H is increased. However B changes slowly in this region.
- **Region AB:** In this region, for small change in H, there is large change in B. The B-H curve is almost linear in this region.
- **Region beyond B:** After point B, the change in B is small even for a large change in H. Finally, the B-H curve will tend to be parallel to X axis. This region is called as saturation region.

b) **Compare between electric and magnetic circuit.**

Ans: **Compare Magnetic and Electric circuit:**

(Any Four Point expected : 1 Mark each, total 4 Marks)

S.No	Electric circuit	Magnetic circuit
1	Path traced by the current is known as electric current.	The magnetic circuit in which magnetic flux flow
2	EMF is the driving force in the electric circuit. The unit is Volts.	MMF is the driving force in the magnetic circuit. The unit is ampere turns.
3	There is a current I in the electric circuit which is measured in amperes.	There is flux φ in the magnetic circuit which is measured in the weber.
4	The flow of electrons decides the current in conductor.	The number of magnetic lines of force decides the flux.
5	Resistance (R) oppose the flow of the current. The unit is Ohm	Reluctance (S) is opposed by magnetic path to the flux. The Unit is ampere turn/weber.
6	$R = \rho. l/a$. Directly proportional to l. Inversely proportional to a. Depends on nature of material.	$S = l/ (\mu_0\mu_r a)$. Directly proportional to l. Inversely proportional to $\mu = \mu_0\mu_r$. Inversely proportional to a
7	The current I = EMF/ Resistance	The Flux = MMF/ Reluctance
8	The current density	The flux density
9	Kirchhoff current law and voltage law is applicable to the electric circuit.	Kirchhoff mmf law and flux law is applicable to the magnetic flux.

c) **An iron ring with mean length of 60 cm is uniformly wound with 250 turns of wire. Calculate the value of flux density if a current of 2A flows through a wire. Assume μ_r = 500 for iron.**

Ans: **Given data:**

$L = 60$ cm $= 60 \times 10^{-2}$m $N = 250$ $I = 2A$ & $\mu_r = 500$

Value of flux density:

$$B = \mu_0 \; \mu_r \; H$$ ---**(1 Mark)**

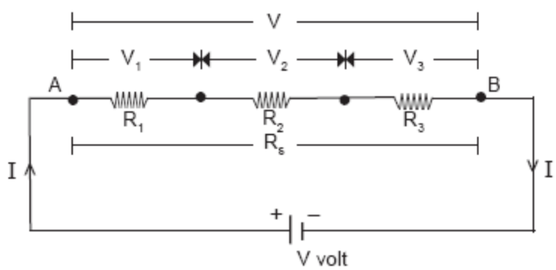
$$B = \mu_0 \; \mu_r \frac{N\,I}{l}$$

$$B = 4\pi \times 10 - 7 \times 500 \times \frac{250 \times 2}{60 \times 10^{-2}}$$

$$Flux\ density \;\; B = 0.523 \;\; tesla \;\; or\ wb / m^2$$ ------------------- **(3 Mark)**

d)	**Derive the expression for equivalent resistance when there resistances are connected in series**
Ans:	**Equivalent resistance for series circuit containing three resistances:** **(4 Marks)**

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

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.

e)	**State and explain Lenz's law.**
Ans:	**Lenz's law:** **(2 Marks)**

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, $e = - N (d\Phi/dt)$

Explanation: **(2 Marks)**

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.

f) Give classification of insulating materials on the basis of state of material and give one application of each.

Ans: **Classification of insulating materials and application of each:** **(4 Marks)**

S.No	Classification of Insulating material	State of material (Anyone expected)	Application (Anyone expected)
1	**Solid insulating materials**	Wood, rubber, plastic, PVC, glass, porcelain, mica, Polypropylene film etc.	Terminal boards, Switch board, casing capping, Spacers, Slot wages, Insulation paper for transformers, capacitors and cables, Sleeves in heating devices, Flexible cables & wires, Panel boards, Switchgears, Electrical heating & cooling equipments, lamp holders, switches and plug sockets
2	**Liquid insulating materials**	Transformer oil, condenser oil, (both are mineral oils), synthetic insulating oil etc.	Switchgears, Circuit breakers, DC capacitors, cables and Transformers
3	**Gaseous insulating materials**	Hydrogen, SF6, Nitrogen, Air.	Switchgears, gas pressures cables, circuit breakers, generator cooling systems and X-ray apparatus

Q.5	Attempt any FOUR of the following : 16 Marks
a)	**Prove that L = N^2/S. Where N = Number of turns S = Reluctance.**

Ans: Prove that L = N^2/S : **(4 Marks)**

$$L = \frac{N\phi}{I}$$ ------------------------------------ equation No.1

Ohms Law of magnetic circuit:

$$\phi = \frac{MMF}{Reluctance}$$

$$\phi = \frac{MMF}{S}$$

$$\therefore\ MMF = N \times I$$

$$\phi = \frac{N \times I}{S}$$ ------------------------------------ equation No.2

Subsisting equation No. 2 in equation No.1 :

$$L = \frac{N \times N \times I}{I \times S}$$

$$L = \frac{N^2}{S}\ Henry$$ ------- Hence proved

OR

L = (N x Φ) / I

But, Φ = (m.m.f.) / Reluctance

$\therefore$ Φ = (N x I) / S

$\therefore$ L = (N / I) [(N x I) / S]

$\therefore$ L = N^2 / S Henry……. Hence proved

b) Compare Dry cell and liquid cell.

Ans: **Comparison between Dry cell and Liquid Cell:** **(Each Point: 1 Mark)**

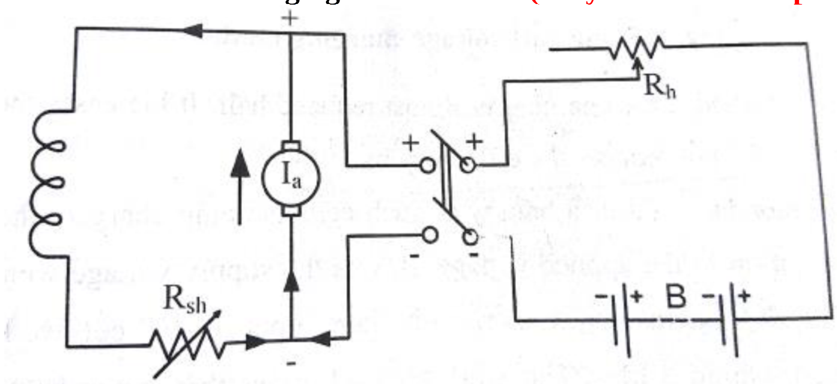
S.No	Particulars	Dry cell	Liquid cell
1	Principal of operation	Irreversible chemical action	Reversible chemical action
2	Cost	Lower	Higher
3	Life	Lower	Higher
4	Maintenance	Very low maintenance	Maintenance required regular intervals

c)	**What are the different methods of charging batteries? Explain any one of them.**
Ans:	**There are two methods of charging of batteries:** **(2 Marks)**

1) Constant current method

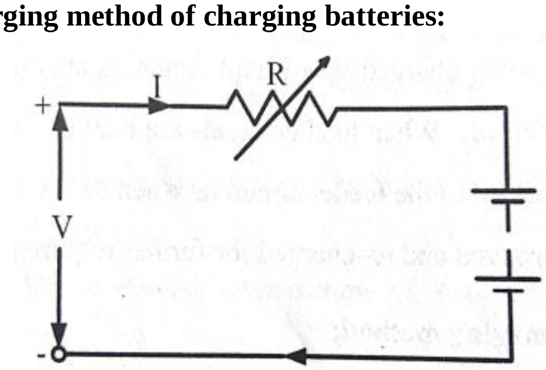
2) Constant voltage method

1) Constant current method of charging batteries: **(Any one method expected: 2 Marks)**



- 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.

2) **Constant voltage charging method of charging batteries:**



- 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.
d)	**Define : i) Amplitude ii) Frequency iii) Time period iv) Angular velocity related to a.c.**
Ans:	**i) Amplitude:** **(1 Mark)** The maximum value of attained by alternating quantity is called amplitude **(ii) Frequency :** **---(1 Mark)** The total number of cycles per second. **iii) Time period:** **---(1 Mark)** The time (in sec) required by an alternating quantity to complete its one cycle is known as time period. **iv) Angular velocity: ---(1 Mark)** The frequency of an alternating quantity expressed in electrical radians per second, is known as Angular velocity **OR** In AC cycle, rate of change of angle ωt with respect to time, is known as angular velocity
e)	**State the application of following materials : i) CRGO Silicon Steel ii) HRGO Silicon Steel iii) Amorphous metal iv) Bronze**
Ans:	**Applications of CRGO Silicon Steel**: **(Any one application expected :1 Mark)** 1) Manufacturing distribution and power transformer cores. 2) Manufacturing cores of audio transformers, ballast transformers, specialty transformers. 3) Manufacturing cores of large transformers, generators and motors. 4) Manufacturing stator and rotor of waterwheel generators. 5) Manufacturing stator and rotor of turbo generators **ii) Applications of HRGO Silicon:** **(Any one application expected :1 Mark)** 1) Manufacturing cores of small rating transformers 2) Manufacturing cores of small rating induction motors 3) Manufacturing water-wheel generators 4) Manufacturing turbo generators

	iii) Applications of Amorphous metal: **(Any one application expected :1 Mark)** 1) Making nanocomposites for field electron emission devices. 2) Manufacturing cores of high efficiency distribution transformers 3) Manufacturing cores of special transformers 4) Manufacturing magnetic sensors 5) Magnetomotive sensors **iv) Applications of Bronze:** **(Any one application expected :1 Mark)** 1) Making brush holders 2) Making knife switch blades 3) Making current carrying springs, bushings. 4) For extremely longer spans of overhead transmission lines, phosphor bronze conductors are used. 5) Cadmium bronze is used for making commutator segments and contact wires.
f)	**What is coefficient of coupling? Explain in brief.**
Ans:	**Coefficient of coupling (k):** **(Meaning : 2 Mark & Explanation: 2 Marks)** ➢ It is defined as the ratio of actual mutual inductance present between two coils to the maximum possible value. ➢ 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: $k = M/\sqrt{(L_1L_2)}$ **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 **OR** It is a measure of the portion of flux produced by a coil linking another coil. It is defined as (K)

the ratio of actual mutual inductance (M) present between the coils C_1 and C_2 to the maximum possible value of M. OR it is the fraction of the total flux produced by current in a coil that links the other coil

Explanation of coefficient of coupling:

Mathematical expression for coefficient of coupling is

$$K = M / M_{max}$$

But, $M_{max} = \sqrt{(L_1 L_2)}$

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

- The maximum value of K is 1 which represents the coupling of all flux produced by one coil with the other coil
- Corresponding to K = 1 the value of mutual inductance will be maximum and it is given by, $M_{max} = \sqrt{(L_1 L_2)}$ Corresponding to K = 1
- The coupling between the two coils is said to be a tight coupling if K = 1 and the coupling is called as loose coupling if K is less than one.
- The coefficient of coupling is also called as Magnetic coupling Coefficient.

Q.6	**Attempt any FOUR of the following :**	**16 Marks**
a)	**Define : i) MMF ii) Reluctance iii) Fringing iv) Leakage flux**	

Ans:

i) MMF: **(1 Marks)**

It is the force that drives magnetic flux through magnetic circuit. It is measured in amp-turns.

ii) Reluctance (s) :- **(1 Marks)**

Reluctance is the property of the substance which opposes the creation of flux in it.

iii) Fringing: **(1 Marks)**

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”.

iv) Leakage flux: **(1 Marks)**

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

b)	**A coil of 100 turns is linked by a flux 20 mWb. If the flux is reversed in time of 2 m sec. Calculate average emf induced in the coil.**
Ans:	Given Data: N = 100, $\phi_1 = 200\, mwb = 20\times10^{-3}\ wb \quad t = 2m\sec = 2\times10^{-3}\ \sec$ **Average emf induced in the coil:** $Avg\ induced\ emf\ = -N\dfrac{d\phi}{dt}$ -- **(1 Mark)** $d\phi = 20\times10^{-3} - 20\times10^{-3}$ $d\phi = -40\times10^{-3}\ wb$ ------------------------------------ **(1 Mark)** $Avg\ induced\ emf\ e = \dfrac{-100(-40\times10^{-3})}{2\times10^{-3}}$ $Avg\ induced\ emf\ e = 2000\ volt$ - -- **(2 Mark)**
c)	**Define :i) Self inductance ii) Coefficient of self induction**
Ans:	**i) Self-inductance**: **(2 Marks)** It is the property by virtue of which a coil opposes change in current flowing through it by inducing an emf in it such that its effect is to circulate current (induced current) that produces a magnetic field which opposes the change in the field. **OR** **Equation for self-inductance:** $L\dfrac{d\phi}{di} \quad OR \quad L = \dfrac{d\phi}{I} \quad OR \quad L = \dfrac{N^2}{S}$ where, L is the coefficient of self-inductance, N is the no. of turns of coil, dØ is the change in the flux, di is the change in current, S is the reluctance of magnetic path. **ii) Coefficient of self induction:** **(2 Marks)** 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. **OR**

	$L \frac{N\frac{d\phi}{dt}}{\frac{di}{dt}}$ $N = \frac{di}{dt}$ $N = \frac{\phi}{I}$ It is expressed in henry.
d)	**i) Define AH efficiency of Watt-Hr efficiency of a battery.** **ii) State applications of storage batteries.**
Ans:	**i) Definition** of **AH efficiency of Watt-Hr efficiency of a battery:** **AH efficiency:** **(1 Mark)** 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. $\eta_{AH} = \frac{amp\ \ hours\ during\ discharge}{amp\ \ hours\ during\ Charge}$ **OR** **Watt – Hr efficiency :** **(1 Mark)** 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. **OR** $\eta_{Wh} = \frac{Watt\ \ hours\ during\ discharge}{Watt\ \ hours\ during\ Charge}$ **ii) Applications of storage batteries:** **(Any Four expected: 1/2 mark each, Total 2 Mark)** 1) Broadcasting stations. 2) Transmission and distribution substations. 3) Telephone and telegraphic services. 4) Emergency lighting for hospitals, shops, banks etc. 5) Automobiles. 6) Solar street lights 7) Railway signaling system 8) UPS systems 9) Marine and submarine applications
e)	**Give the properties and application of following materials :i) mica ii) rubber**
Ans:	**i) Mica:** **Properties of Mica:** **(Any one properties expected: 1 Marks)** 1. It has very high resistance 2. It is heat resistant, moisture resistant, it has good elasticity and is fire proof.

3. It retains its electrical and mechanical properties even at very high temperature.

Applications of Mica: **(Any one properties expected: 1 Marks)**

1. It is used in commutator, insulators in electric heating units.
2. It is used for binding armature winding .
3. Mica papers are used in rotor winding, turbo generator

ii) Rubber:

Properties of Rubber: **(Any one properties expected: 1 Marks)**

1. Rubber is moisture repellent and possesses good insulating properties.
2. Its specific resistance around is 10^{17} ohm/cm
3. Vulcanized rubber is more resistant, mechanically strong and tough, elastic and can withstands high temperature.
4. It can be affected chemically.
5. It has low heat resistance.

Applications of Rubber: **(Any one properties expected: 1 Marks)**

1. It is extensively used as insulation on wires, cables etc.

f) State the temperature with standing capacity of following class-insulating material class Y, class A, class B, class E. Also state two examples for each.

Ans: **(Each Point : 1 Mark)**

S.No	Class of Insulating material	Temperature withstanding capacity ^{0}C	Examples
1	Class ‘Y’	90^0C	Cotton, Silk paper and similar organic materials neither impregnated nor immersed in oil, rubber, PVC
2	Class ‘A’	105^0C	Impregnated paper, Silk, cotton and polyamides resins
3	Class ‘B’	130^0C	Inorganic materials (mica, fiber, glass, asbestos) impregnated with varnish and other compounds
4	Class ‘E’	120^0C	Cotton fabric, synthetic resin enamels. Paper laminates and Powder plastics

--END--