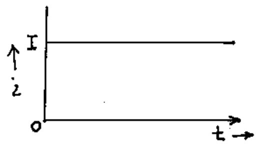
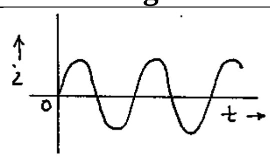
Important Instructions to examiners:

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 FIVE of the following: 10**

1 a) Write any two differences between direct current and alternating current.
**Ans:**
**Differences Between Direct current and Alternating current:**

| Particulars | Direct Current | Alternating Current |
|---|---|---|
| 1. Waveform |  |  |
| 2. Definition | It is the current whose magnitude and direction do not change with respect to time. | It is the current whose magnitude and direction continuously changes with respect to time. |
| 3. Use of transformer | Not possible | Possible |
| 4. Design of machines | Complicated | Simple |
| 5. Frequency | Zero | It is 50 Hz or 60 Hz depending upon country. |
| 6. Obtained from | Battery, Cell and DC Generator | Alternator |
| 7. Passive parameters | Resistance only | Resistance, Inductance, Capacitance. |
| 8. Applications | DC machines, HVDC system, electroplating, Battery charging, Traction. | AC machines, Domestic and industrial supply. |

1 Mark for each of any two points = 2 Marks

1 b) Define-
(i) Node
(ii) Loop for a DC circuit
**Ans:**
**i) Node:** A point or junction at which two or more elements of network are connected is called as node. 1 Mark
**ii) Loop:** A closed path for flow of current in an electrical circuit is called loop. 1 Mark

1 c) Define dielectric strength for a capacitor.
**Ans:**
**Di-electric Strength for a capacitor:**
The voltage which a dielectric material can withstand without breaking down (without losing its dielectric property) is called as dielectric strength. 2 Marks

1 d) An iron ring of mean circumference 80 cm is uniformly wound with 500 turns of wire and carries 0.8A. Find the magnetic field strength.
**Ans:**
Magnetic field strength $H = NI/\ell = 500 \times 0.8 / 80 \times 10^{-2} = 500$ AT/m 2 Marks

| | | | |
|---|---|---|---|
| 1 | e) | Define magnetic flux density. State its unit.<br>**Ans:**<br>**Magnetic flux density (B):** It is the magnetic flux per unit area measured at right angles to the flux path. Its unit is weber/$m^2$ or tesla(T). | 1 Mark for definition & 1 Mark for its unit |
| 1 | f) | Define the term – statically induced emf.<br>**Ans:**<br>**Statically induced emf:**<br>The emf induced in coil or conductor when conductor is stationary and flux linked with it changes with respect to time then it is known as statically induced emf. | 2 Marks |
| 1 | g) | A coil of 500 turns is linked with a flux of 25 mwb, when carries a current of 12.5A. Calculate the value of self-inductance.<br>**Ans:**<br>**Self-Inductance:**<br>$L = N\Phi / I = 500 \times 25 \times 10^{-3} / 12.5 = 1$ H | 2 Marks |
| **2** | | **Attempt any THREE of the following:** | **12** |
| 2 | a) | List any four types of resistors. Give one application of each.<br>**Ans:**<br>**Types of resistors with their applications:**<br>**i) Carbon composition resistor**: Potential divider, welding control circuits, power supplies, H. V. and high impulse circuits as switching spark circuits, radio/TV receiver circuit, biasing circuits of transistor, amplifier circuits, zener voltage regulator.<br>**ii) Metal film resistor**: Transmitter circuits, Oscillator, telecommunication circuits, testing circuits, measurement circuits, audio amplifier circuits, Modulator and De-modulator circuits.<br>**iii) Wire wound resistor**: Power amplifiers, Zener voltage regulators, radio / TV receiver circuit, High power resistance in DC power supplies, measurement circuits.<br>**iv) H V Ink Film type resistor**: C R O circuits, Radar, medical electronics.<br>**v) Carbon film resistors:** used for electronic circuits<br>**vi) Cermet resistors:** used in printers, automotive, computers, cell phones & battery chargers. | Any 4 resistors with one application = 4 Marks |
| 2 | b) | Find current through 1Ω resistance of Figure No.1 using Kirchhoff's laws. | |

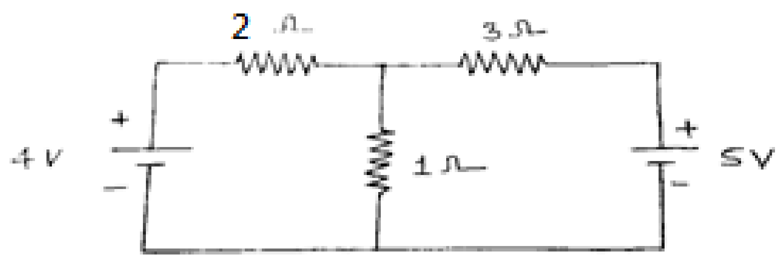
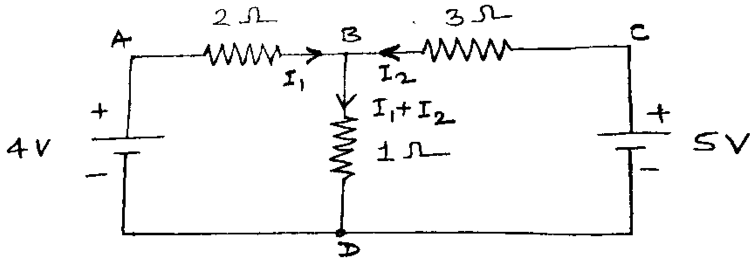



Fig. No. 1

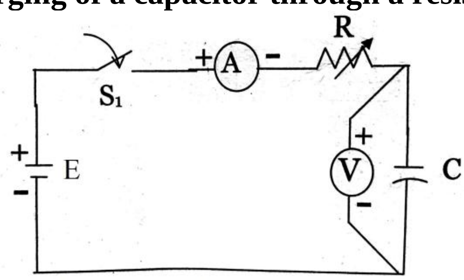
**Ans:**
Mark the currents on the diagram.




1 Mark

Write KCL and KVL based equations
Consider loop ABDA,
$(-2)I_1 - 1(I_1 + I_2) + 4 = 0$
$\therefore 3I_1 + I_2 = 4$ ……………………… (1)
Consider loop BCDB,
$(3)I_2 - 5 + 1(I_1 + I_2) = 0$
$\therefore 1I_1 + 4I_2 = 5$ ……………………… (2)
Solving simultaneous equations
$\therefore \boldsymbol{I_2 = 1.0\ A}$ ……………………………… (3) 1Mark
Substituting $eq^n$ (3) in $eq^n$ (1), we get
$3I_1 + 1 = 4$
$\therefore \boldsymbol{I_1 = 1\ A}$ ……………………………… (4) 1Mark
Final answer
The current through 1Ω resistance is,
$= I_1 + I_2 = +1 + 1$
$\therefore$ **2 $A$ flowing from B to D** 1Mark

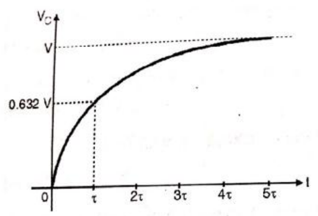
2 c) Draw a practical set-up to plot charging and discharging curves of a capacitor through a resistor. Draw the curves.
**Ans:**
**Practical set-up to plot charging of a capacitor through a resistor:**



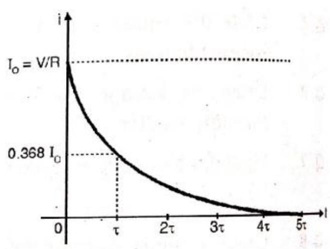

Practical setup to plot Charging Curve of Capacitor

1 Mark

**Charging curves of a capacitor:**



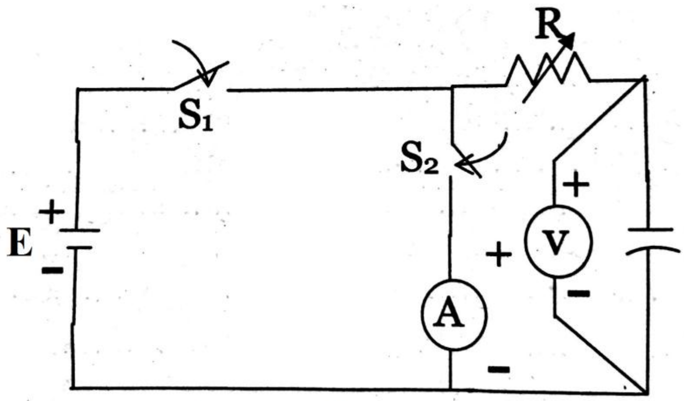

Variation in capacitor voltage while charging




Variation in capacitor current while charging

1 Mark

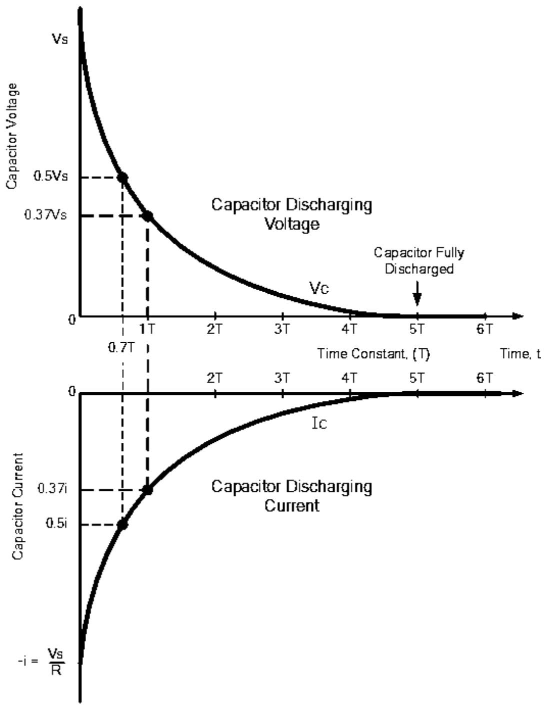
**Practical set-up to plot dis-charging of a capacitor through a resistor with curves:**




Experimental setup to plot Discharging Curve of Capacitor

1 Mark

**Discharging curves of a capacitor:**




1 Mark

2 d) When a voltage of 220 V is applied to a coil with resistance of 50Ω, produces 5mWb of flux. If the coil has 1000 turns, find inductance of coil and energy stored in the magnetic field.

**Ans:**

Current in the coil I= V/R = 220/50 = 4.4 A — 1 Mark

Inductance of coil $L = \frac{N\emptyset}{I} = \frac{1000\times5\times10^{-3}}{4.4} = 1.136H$ — 1 Mark

Energy stored in the magnetic field — 2 Marks

$E = \frac{1}{2}L\,I^2 = \frac{1}{2}\times 1.136\ \times\ 4.4^2 = 10.996\,J \cong$ 11 joules

**3 Attempt any THREE of the following:** **12**

3 a) A device stores 500J and releases in the form of current of 40A in the duration of 15 msec. Find the terminal voltage.

**Ans:**

Energy stored $E = VIt$ — 4 Marks

$$V = \frac{E}{It} = \frac{500}{40 \times 15 \times 10^{-3}} = 833.33V$$

3 b) List any two effects of electric current. Give one example of each.

**Ans:**

**Effects of electric current:**

**i) Heating effect:** It is utilized in Electric iron, Water heater, Hot plates, Electric lamp, Electric cooker, Hair dryer, Room heater, Electric oven, Electric furnace, Electric fuse, Electric heat treatment process etc.

**ii) Magnetic effect:** It is utilized in Electric motor, Electric bell, Electromagnet, Measuring instrument, Alternator, Various electric appliances, Electric hoist etc.

**iii) Chemical effect:** It is utilized in Electro-plating, Battery charging, Electro-refining, Fuel cells, Production of chemicals, Electro-typing, Electrolytic process etc.

2 Marks for One effect with an example = 4 Marks

3 c) State and explain Ohm's law.

**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.

OR — 4 Marks

As long as physical conditions (such as dimensions, pressure and temperature) are constant, the current flowing through the conductor is directly proportional to the potential difference or voltage applied across it.

$V \alpha I$ Or $I \alpha V$

i. e. $V = R I$ Or $I = V/R$

where, R = constant of proportionality, called as the resistance of the conductor.

3 d) Three capacitors 15µf, 18µf and 12µf are connected in a circuit. Find equivalent capacitance when they are connected in –

1) Series
2) Parallel

**Ans:**

**Value of equivalent capacitance:**

Given: $C_1$= 15µF, $C_2$=18 µF, $C_3$= 12µF

i) For Series combination of capacitors:

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

$= (1/15)+( 1/18)+( 1/12)$

$1/C_s = 0.0666+0.0555+0.0833$

$1/C_s = 0.2054$ — 2 Marks

$\therefore C_s = 4.868$ µF

ii) For parallel combination of capacitors: 2 Marks

$$Cp = C_1 + C_2 + C_3 = 15 + 18 + 12 = 45\ \mu F$$

**4 Attempt any THREE of the following: 12**

4 a) Define – resistance and resistivity. State relationship between them. Give one material having high resistivity.

**Ans:**

**Resistance and Resistivity:**

**Resistance:** It is the opposition offered by the conductor to the flow of current. 1 Mark

**Resistivity:** It is property of the substance by virtue of which it opposes to the flow of current passing through it.

The resistance of a specimen piece of material having unit length and unit cross sectional area is known as resistivity of that material. 1 Mark

**OR**

Specific resistance or resistivity is defined as the resistance between the opposite faces of a meter cube of the material.

**Relationship between Resistance and Resistivity:**

Resistance = $R = \rho\ (\ell / a)\ \ \Omega$ 1 Mark

where, $\rho$ = Resistivity of material in $\Omega$-m.

$\ell$ = length of conductor in m.

a = cross sectional area of conductor in $m^2$.

**Material having high resistivity:** 1 Mark

Mica, Nichrom, Rubber, Glass, Plastic Porcelain, Dry wood, Insulating material etc.

4 b) Define following networks

(i) Active
(ii) Passive
(iii) Unilateral
(iv) Bilateral.

**Ans:**

**i) Active network:** Active network is one which contains at least one source of e.m.f. or energy, is called active network.

**ii) Passive network:** Passive network is one which does not contain any source of e.m.f. or energy in it, is called passive network. 1 Mark for each = 4 Marks

**iii) Unilateral network:** If the characteristic (response or behavior) of network dependents on the direction of flow of current through its elements, then the network is called as a unilateral network.

**iv) Bilateral Network:** If the characteristic (response or behavior) of network is independent of the direction of current through its elements, then the network is called as a bilateral network.

4 c) Find resistance $R_{AB}$ from Figure No. 2

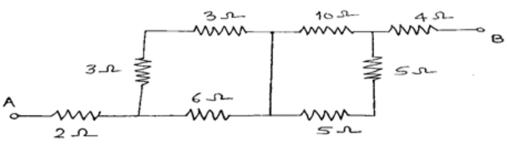
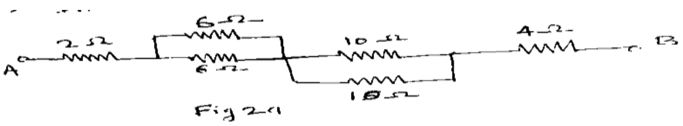



Fig. No. 2

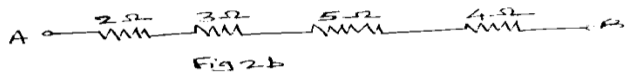
**Ans:**

i) In figure No.2 two 3Ω & two 5 Ω resistances are in series and circuit reduces to figure 2a — 1 Mark

ii) In figure No.2a two 6Ω & two 10 Ω resistances are in parallel and circuit reduces to figure 2b — 1 Mark




1 Mark




iii) From figure 2b — 1 Mark
$R_{AB}$ = 2+ 3+ 5+ 4 =14 Ω

4 d) Derive the expression for energy stored in a capacitor with the help of neat diagram.

**Ans:**

**Energy stored in Capacitor:**

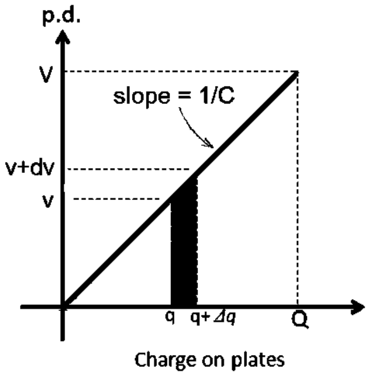
Let C be the capacitance of a capacitor in farad.
$v$ be the potential difference across capacitor in volt at a particular instant.
q be the charge on the capacitor at that instant.

Therefore, potential difference $v = \frac{q}{C}$ or charge $q = Cv$

When the potential difference across capacitor is $v$ and if small amount of charge $dq$ is shifted from one plate to other, the voltage is changed by $dv$. Therefore, $dq = C.dv$ — 1 Mark for diagram

The work done in shifting a small charge dq against P. D. of $v$ volt is given by,

$$dW = v.dq = \left(\frac{q}{C}\right)dq \quad \text{OR} \quad dW = v.dq = v.C.dv$$ — 1 Mark




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

Therefore, total energy stored by the capacitor is given by, — 1 Mark

$$E = \text{work done } W = \int dW = \int\left(\frac{q}{C}\right)dq = \frac{1}{2C}q^2$$

$$= \frac{1}{2}C\left(\frac{q}{C}\right)^2 = \frac{1}{2}Cv^2 \quad \text{joules}$$

OR

$$W = \int dW = \int Cv\,dv = \frac{1}{2}Cv^2 \quad \text{joules}$$ — 1 Mark

4 e) List any three types of capacitor. Give one application of any one type.

**Ans:**

**Types of capacitors and their applications:** — Any three types 1 Mark each

i) Air capacitors: Radio tuning applications, Antenna tuning, RF matching networks, MRI medical scanners.

ii) Paper capacitors: High voltage and high current applications.

iii) Mica capacitors: High frequency tuned circuits, such as filters and oscillators. — Application of any one type 1 Mark = 4 Marks

iv) Ceramic Capacitors: Tone compensation, Automatic volume control filtering, Antenna coupling, Resonant circuit, Volume control RF bypass, lighting ballasts.

v) Electrolytic capacitors: Reduce voltage fluctuations in various filtering devices, In input and output smoothing to filter if DC signal is weak with AC component, For noise filtering or decoupling in power supplies, For coupling signals between amplifier stages, To store energy in flash lamps.

vi) Film Capacitor: A/D converters, Filters, snubber circuits, In DC link circuits.

vii) Glass capacitors: High power amplifier, Filters, R-F oscillator, Energy storage, Power factor correction, High voltage capacitors, Power electronic filters.

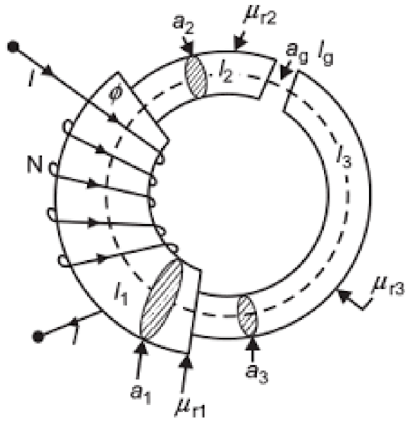
viii) Polycarbonate capacitor: Filters, Timing and precision coupling circuits, Switching power supplies, AC applications to avoid corona.

**5 Attempt any TWO of the following: 12**

5 a) Draw a neat sketch of series magnetic circuit. State value of reluctance for both series and parallel magnetic circuit. Name each term used in them.

**Ans:**

**Series magnetic circuit:**




2 Marks for diagram

**Value of reluctance for series magnetic circuit:**

$S=S_1+S_2+S_3$ 1 Mark

**Value of reluctance for parallel magnetic circuit:**

$$\frac{1}{S} = \frac{1}{S_1} + \frac{1}{S_2} + \frac{1}{S_3}$$ 1 Mark

**Terms used:**

N= Number of Turns on magnetic circuit.
S= Equivalent reluctance of magnetic circuit.
$S_1$, $S_2$, $S_3$= Reluctance of first, second, third part of magnetic circuit.
$l_1$, $l_2$, $l_3$= Length of first, second, third part of magnetic circuit.
$\mu_{r1}$, $\mu_{r2}$, $\mu_{r3}$= Relative permeability of first, second, third part of magnetic circuit.
$a_1$, $a_2$, $a_3$= Cross-sectional area of first, second, third part of magnetic circuit.
$l_g$ = Length of air gap.
$a_g$ = Cross-sectional area of air gap.
I = Current through magnetizing coil of magnetic circuit.
ϕ = Flux through series magnetic circuit.

2 Marks for terms

5 b) An iron ring of mean circumference 0.8 m is uniformly wound with 400 turns of wire. It carries 1.6A and produces a flux density of 1.1 T. Find permeability of the material.

**Ans:**

Given data: $l$ = 0.8 m, N =400 turns, I = 1.6 A, B = 1.1 tesla — 2 Marks for H

$H = NI/l = 400 \times 1.6/0.8 = 800$ AT/m — 1 Mark for eq$^n$ of B

$B = \mu_0 \mu_r H$ therefore $\mu_r = B/(\mu_0 H)$, $\mu_0 = 4\pi \times 10^{-7}$ — 1 Mark for $\mu_r$

Relative permebility of iron ring:

$\mu_r = 1.1/(4\pi \times 10^{-7} \times 800) =$ **1094.19**

$\mu = \mu_0 \times \mu_r = 4\pi \times 10^{-7} \times 1094.19 = \mathbf{1.375 \times 10^{-3}\ H/m}$ — 2 Marks

5 c) Define any three laws related to electromagnetic induction. Write use of each law.

**Ans:**

**Faraday's laws of electromagnetic induction:**

**First law**: Whenever a conductor cuts the magnetic flux, an emf is induced in it.

**OR**

Whenever a changing magnetic flux links with the conductor, an emf is induced in the conductor.

**Use:** Generator principle, Alternator principle.

**Second law:** The magnitude of induced EMF in the conductor is directly proportional to rate of change of flux linkages.

**Use:** To find magnitude of induced emf in Generator, To find magnitude of induced emf in Alternator

**Fleming's Right Hand Rule:**

Stretch out the first three fingers of your right hand such that they are mutually perpendicular to each other, *align* first finger in direction of magnetic field, thumb in direction of motion of conductor with respect to magnetic field, *then* the middle finger will give the direction of induced emf in conductor.

**Use:** Fleming's right hand rule is used for finding the direction of dynamically induced emf.

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

**Use:** Lenz's law used for finding the direction of statically induced emf.

**Fleming's Left Hand Rule:**

Stretch out the first three fingers of your left hand such that they are mutually perpendicular to each other, *align* first finger in direction of magnetic field, middle finger in direction of current *then* the thumb will give the direction of force acting on conductor.

**Use:** Fleming's left hand rule is used for finding the direction of force acting on current carrying conductor when placed in magnetic field.

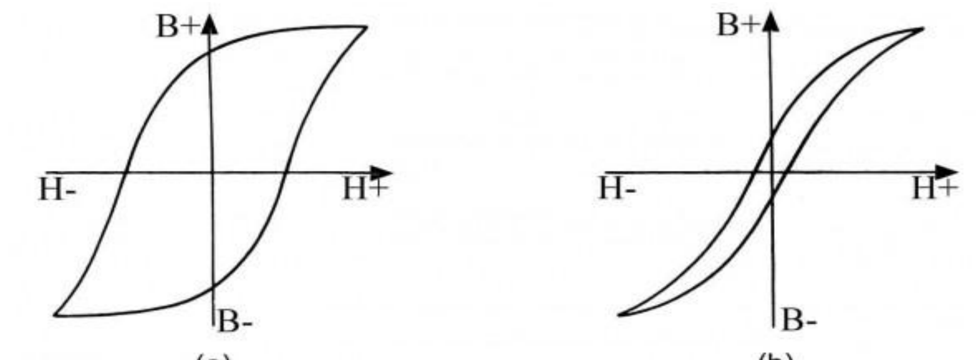
2 Marks for each of any 3 laws with one use of each = 6 Marks

**6 Attempt any <u>TWO</u> of the following: 12**

6 a) Draw hysteresis shapes for following materials-

(i) Permanent magnet
(ii) Steel alloy
(iii) plastic

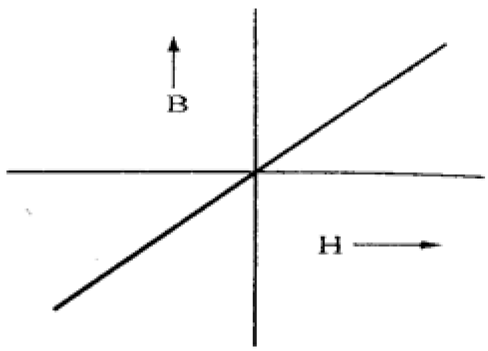
**Ans:**




(a) (b)

.

2 Marks for each shape




( c)

(a) For Permanent magnet
(b) For Steel alloy
(c) For Plastic

6 b) Related to inductor state
(i) any two types
(ii) any two applications
(iii) expression for self and mutual indutance

**Ans:**

**i) Types of inductors & their applications:**

Any two types = 2Marks
Any two applications = 2Marks

**1) Iron core inductors:** Used in Low frequency applications such as filter choks, amplifires

**2) Air core inductors:** Used in high frequency applications such as oscillators, RF amplifires, Radio and TV receivers.

**3) Ferrite core inductors:** Used in high frequency upto 100MHz applications such as oscillators, RF amplifires, Radio and TV receivers, signal genrators.

**ii) Expression for self indutance**

$$L = N\frac{d\emptyset}{di} \quad \text{OR} \quad L = \frac{N\emptyset}{I} \quad \text{OR} \quad L = \frac{N^2}{S}$$

1 Mark

where, L is the coefficient of self-inductance,
N is the no. of turns of coil,
d∅ is the change in the flux,
di is the change in current,
S is the reluctance of magnetic path,
. I is the current flowing in the coil,

**iii) Expression for mutual indutance:**

$$M = N_2 \frac{d\phi_{12}}{di_1} \quad \text{OR} \quad M = \frac{N_2 \phi_{12}}{I_1} \quad \text{OR} \quad M = \frac{N_1 N_2}{S}$$ 1 Mark

where, M is the coefficient of mutual inductance,
$N_1$ is the no. of turns of coil 1,
$N_2$ is the no. of turns of coil 2,
$d\phi_{12}$ is the change in the flux produced by coil 1 and linking with coil 2,
$di_1$ is the change in current in coil 1,
S is the reluctance of magnetic path
$I_1$ is the current flowing in the first coil.

6 c) Two coils A of 1000 turns and B of 1200 turns are such that 60% of flux produced by A links with B. A current of 4A in coil A produces a flux of 0.05 Wb and in coil B of 0.075 Wb. Find

(i) $L_1$ (ii) $L_2$ (iii) M (iv) K

**Ans:**

i) Inductance of Coil A: 1 Mark

$$L_1 = \frac{N_1 \phi_1}{I_1} = \frac{1000 \times 0.05}{4} = 12.5\ H$$

ii) Inductance of Coil B: 1 Mark

$$L_2 = \frac{N_2 \phi_2}{I_2} = \frac{1200 \times 0.075}{4} = 22.5\ H$$

iii) Mutual Inductance 1 Mark

$$M = K\sqrt{L_1 L_2} = 0.6\sqrt{12.5 \times 22.5} = 10.06\ H$$

iv) Coefficient of coupling 1 Mark

$$K = \frac{\phi_{12}}{\phi_1} = 0.6$$

where, $\phi_1$ is the flux produced by coil 1
$\phi_{12}$ is the flux produced by coil 1 and linking with coil 2