Diploma in Engineering: Summer – 2015 Examinations

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) Give relation between resistance and resistivity. State SI unit of both.

1 a) Ans:

Resistance, $R = \rho (l / a) \quad \Omega$ — 1mark

Where, ρ = Resistivity of material
l = length of conductor
a = area of conductor.

Unit of resistance is ohm (Ω) & resistivity is ohm-meter (Ω.m). — 1mark

1 b) Two resistances of 10 Ω each are connected in parallel. Find the equivalent resistance.

1 b) Ans:

Equivalent resistance $R = (R_1 R_2)/(R_1 + R_2)$ — 1 Mark

$= 5\Omega$. — 1 mark

1 c) Write any four application of heating effect of electric current.

1 c) Ans:

Application of heating effect of electric current: — ½ mark each any four = 2 marks

1) Electric Iron
2) Electric Heater
3) Toaster
4) Electric Kettle
5) Oven
6) Furnace.
7) Hair dryers.

1 d) Define unilateral and bilateral circuit.

1 d) Ans:

Unilateral circuit: If for a circuit the characteristics, (response or behavior) is dependent on the direction of current through elements in it, then the network is called as a unilateral circuit. e. g. networks containing elements likes diodes, transistors etc. — 1 mark

Bilateral circuit: If the characteristics, (response or behavior) is independent on the direction of current through its elements in it, then the network is called as a bilateral circuit. e. g. networks containing elements like resistances, inductances and capacitances. — 1 mark

1 e) Write two uses of Electrolytic capacitor.

1 e) Ans: — 1 mark each any two = 2 marks.

- Small single phase motor starting applications.
- Filter circuits.
- Electronic circuits.(students may give names of individual electronic circuits as amplifiers etc.)

1 f) Define M. M. F. and give its SI unit.

1 f) Ans:
Magnetic Motive Force (MMF): - It is defined as the entity (quantity or force) that sets up or creates magnetic flux in a magnetic circuit. 1 mark

It is the product of the number of turns and the current in the coil (MMF = N I).
Its unit is Ampere (A) OR Ampere-turns. 1 mark

1 g) State the values for permeability of free space and relative permeability of air

1 g) Ans:
Permeability of free space $\mu_O = 4\pi \times 10^{-7}$ H/m. 1 mark

Relative permeability of air $\mu_R = 1$ 1 mark

1 h) List two types of induced emfs.

1 h) Ans:
i) Statically induced emf.
ii) Dynamically induced emf.
iii) Mutually induced emf.

1 mark each = 2 marks

1 i) Give meaning of CRGO and HRGO silicon steel.

1 i) Ans:
CRGO silicon steel: Cold Rolled Grain Oriented silicon steel (the sheets of silicon steel are manufactured by the process of cold rolling to get an orientation of the grains (magnetic property) which help to create flux with minimum reluctance or set up flux easily using lower MMF (silicon content in the steel may vary from 3 to 5%). 1 mark

HRGO silicon steel: Hot Rolled Grain Oriented silicon steel (the sheets of silicon steel are manufactured by the process of hot rolling (soft condition), to get an orientation of the grains (magnetic property) which help to create flux with minimum reluctance or set up flux easily using lower MMF. (silicon content in the steel may vary from 3 to 5%). 1 mark
These are used for electromagnetic cores.

1 j) Differentiate between two types of statically induced emf.

1 j) Ans:

Self induced emf	Mutually induced emf
Induced in a coil due to own current changes of the coil	Due to current changes in (linking) neighboring coil/conductor
Counter emf of self induction	Counter emf of mutual induction
e = -L(di/dt), L = coefficient of self inductance	e = -M(di/dt), M = = coefficient of mutual inductance.

Any 2 points 1 mark each = 2 marks

1 k) State meaning of A and B type insulating materials.

1 k) Ans:
Table not compulsory but content need to be covered — 1 mark each class = 2 marks

Class	Temperature ^{O}C	Materials
A	105	Impregnated paper , silk, cotton
B	130	Inorganic materials like mica, glass, asbestos impregnated with varnish

1 l) Define frequency for a sine wave. Give SI unit.

1 l) Ans:
Frequency (f): It is defined as the number of cycles (repetitions) completed by sinusoidal quantity in unit time which normally one second. — 1 mark
SI unit: Hertz (Hz). — 1 mark

2 Attempt any FOUR of the following: — 16

2 a) An immersion heater is rated as 250V, 1000W. Calculate resistance and current through it. Determine the bill for using it for 10 hours at a rate of Rs 2 per unit.

2 a) Ans:
Resistance $R = V^2 / P = (250)^2 / 1000 = 62.5\ \Omega$. — 1 mark

Current $I = V/R = 250/62.5 = 4$ A. — 1 mark

Energy consumed in 10 hrs = 1000 (W) x 10 (hrs) = 10000 Wh = 10 kWh. — 1 mark

Energy charges incurred: (no. of kWh x rate per unit) = 10 x 2 = Rs 20/- — 1 mark

2 b) List four types of resistors. Give one application of each.

2 b) Ans: **Types of resistors and their applications:**

1. Carbon composition resistor; Application : Potential divider, welding control circuits, power supplies, hv. and high impulse circuits as switching spark circuits.
2. Wire wound resistor; Application : Power amplifiers
3. Film type resistor, Application : medical instruments.
4. Carbon film resistor, Application : Amplifier
5. Metal film resistor, Application : Oscillator, telecommunication circuits, testing circuits, measurement circuits, audio amplifier circuits.

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

2 c) Calculate resistance R_{AB} of figure 1.

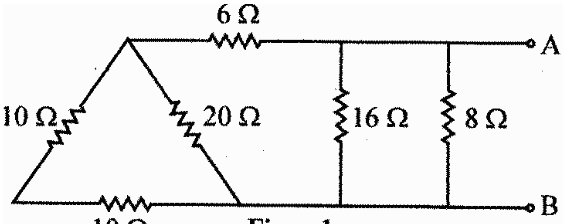
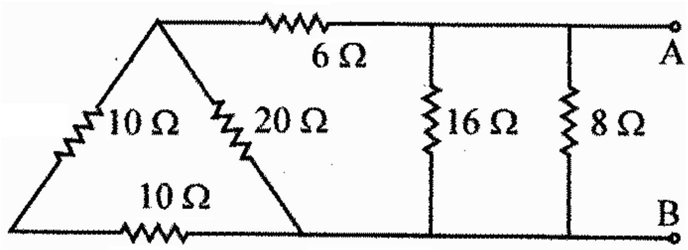


Fig. – 1

2 c) Ans:



10 Ω in series with 10 Ω gives 10 + 10 = 20 Ω. 1 mark

This 20 Ω is in parallel with 20 Ω gives equivalent of (20 x 20)/(20+20) = 10 Ω. 1 mark

The above obtained 10 Ω is in series with 6 Ω to give 10+6 = 16 Ω.

This 16 Ω is in parallel with 16 Ω of (16 x 16)/(16+16) = 8 Ω. 1 mark

The above obtained 8 Ω is in parallel with 8 Ω to give equivalent resistance of

R_{AB} = (8 x 8)/(8+8) = 4 Ω. 1 mark

2 d) Define the terms:
(i) Node, (ii) Branch, (iii) Loop, (iv) Mesh.

2 d) Ans:
(i) Node: - A point in electric circuit at which different branches meet. 1 mark

(ii) Branch: - A part of an electric network which lies between two junctions or nodes is known as branch. 1 mark

(iii) Loop: Any closed path in an electric circuit where each element or branch is traversed only once . 1 mark

1 mark

(iv) Mesh: 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.

2 e) Find current flowing through 5 Ω resistor using Kirchoff's Laws at fig – 2.

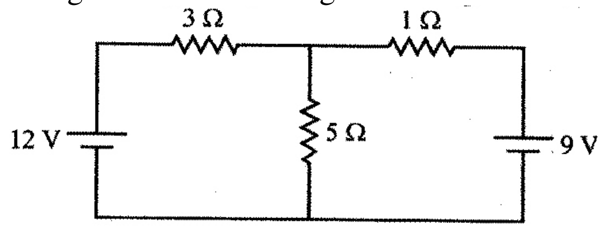
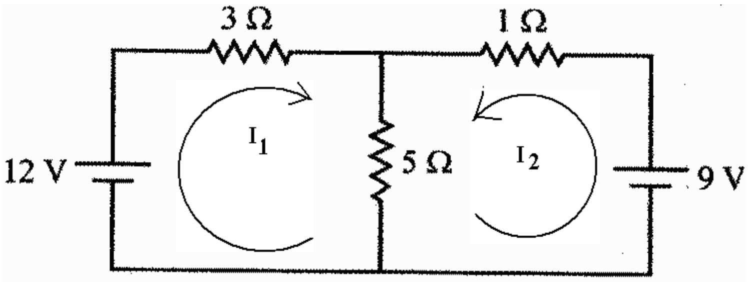


Fig. – 2

2 e) Ans:



Applying KVL:
Loop 1:

$12 = 8\,I_1 + 5\,I_2$
$9 = 5\,I_1 + 6\,I_2$ 1 mark

Solving these simultaneously

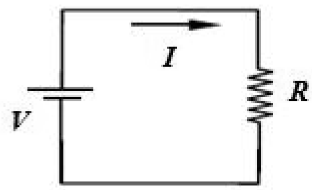
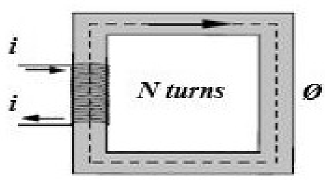
$I_1 = (12 \times 6 - 9 \times 5)/(8 \times 6 - 5 \times 5) = 27/23$
$= 1.17$ A. 1 mark

$I_2 = (8 \times 9 - 12 \times 5)/(8 \times 6 - 5 \times 5) = 12/23$
$= 0.52$ A. 1 mark

Required current $= I_1 + I_2$
$= 1.69$ A. 1 mark

2 f) Give comparison between electric & magnetic circuits.

2 Ans:

Point	Electric circuit:	Magnetic circuit
Diagram		
Basic quantity	Electrical charge Q (coulomb)	Magnetic pole
Field strength	E (Newtons/coulomb)	H (A/m)
Flux density	D (coulomb/m^2)	B (Tesla or Weber/m^2)
Property	(dielectric)Permittivity ϵ	(magnetic) Permeability μ

1 mark each any four = 4 marks

Relation	$D = \epsilon E$	$B = \mu H$
Applied quantity	Voltage 'V' (volts)	MMF = Ø S (amperes)
Set up quantity	Current 'I' (amperes)	Flux 'Ø' (webers)
Opposition to set up quantity	Resistance $R = \rho l/a$ ohms.	Reluctance $S = l/(\mu A)$ amperes/weber
Relation	V = I R (volts)	MMF = Ø S (amperes)
Measure of ease for set up quantity	Conductance G = 1/R (Siemens)	Permeance P = 1/S (webers/ampere)

OR

	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.
5	For electric circuit we define the conductance.	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	Current is actual flow of elctrons	Flux is direction of force- Nothing flows between N pole and S pole.
9	Current does not pass through air.	Flux can pass through air also.

3 Attempt any FOUR of the following: 16

3 a) The parallel plates of a capacitor each 460 cm^2 area are seperated by a distance of 2.2 mm using a dielectric material of permittivity 4.5. Calculate the capacitance and charge on each plate if voltage across plates is 415 V.

3 a) Ans:

Given 'A' = 460 cm^2 = 460 x 10^{-4} m^2, d = 2.2 mm = 2.2 x 10^{-3} m, $\epsilon_r = 4.5$.

$\epsilon_o = 8.854 \times 10^{-12}$ F/m.

$C = \epsilon_o \epsilon_r A/d$ 1 mark

$= (8.854 \times 10^{-12} \times 4.5 \times 460 \times 10^{-4})/(2.2 \times 10^{-3})$

$= 8331 \times 10^{-13}$ F = 833.1 pF. 1 mark

$Q = C\ V$ 1 mark
$= 8331 \times 10^{-13} \times 415 = 3457365 \times 10^{-13} = 0.3457365\ \mu C$ 1 mark

3 b) Define the terms (i) breakdown voltage (ii) Dielectric Strength. State any four factors which affect the dielectric strength.

3 b) Ans:
(i) Breakdown voltage: the voltage at which the dielectric material breaks down (starts conducting or is no longer an isulator) for a specified thickness is its breakdown voltage. It is normally specified for thicknesses of 2.5 mm, 4 mm. (kV for specified thickness. (1 mark

(ii) Dielectric Strength: The voltage which a dielectric material can withstand without breaking down (without losing its dielectric property) for 1 minute. (kV for specified thickness). 1 mark)

OR **OR**

Breakdown voltage: Above the dielectric strength E_{ds} , the dielectric between conducting surfaces (eg. capacitor) becomes conductive. The voltage at which this occurs is called the breakdown voltage (V_{bd}) of the device, and is given by the product of the dielectric strength and the separation between the conducting surfaces. (1 mark

Dielectric Strength: The dielectric strength of an insulating material is defined as the ability of the insulating medium to resist its breakdown when large voltage is applied across it. 1 mark)
Its unit is volts per meter (V/m).

and

Factors affecting dielectric strength:

1) Temperature: higher temperature leads to lowering of the strength.
2) Impurity content: impurity content leads to lowering of the strength.
3) Moisture content leads to lower strength.
4) Aging leads to lowering of the strength.
5) Heavy mechanical stresses lead to lower dielectric strength.

½ mark each any four = 2 marks

3 c) Compare dry cell & lead acid battery on the basis of principle of operation, maintenance, life, cost.

3 c) Ans:

Point	Dry cell	Lead acid battery	
Principle of operation	Irreversible chemical action.	Reversible chemical action.	1 mark
Maintenance	Very low maintenance (only cleaning if exposed)	Required at regular intervals (such as maintaining the specific gravity of the solution, cleaning)	1 mark
Life	Lower (no recharging)	Higher (recharging done)	1 mark
Cost	Lower	Higher	1 mark

3 d) State relation for energy stored in a capacitor.
A capacitor of 850 μF is charged to a voltage of 120 V. Calculate the energy stored by the capacitor.

3 d) Ans:

$E = ½ CV^2 = ½ QV = ½ Q^2C$ (Joules) 2 marks

$E = (850 \times 10^{-6} \times 120^2)/2 = 6.12$ Joules. 2 marks

3 e) Define (i) Magnetic field strength (ii) Magnetic flux density (iii) Permeability, give relation between them.

3 e) Ans:
(i) Magnetic field strength (H): It is the magnetomotive force acting per unit length of the magnetic flux path also called as the magnetic field strength. (SI unit ampere per metre) 1 mark

(ii) Magnetic flux density (B): It is the magnetic flux per unit area measured at right angles to the flux path. (SI unit webers/m^2 or tesla) 1 mark

(iii) Permeability (μ): the measure of the magnetic property by virtue of which the flux (flux density) is set up when a magnetic field strength is applied to a material. 1 mark

Relation: B = μH 1 mark

3 f) Find equivalent capacitance C_{AB} of fig 3 (all values are in μF)

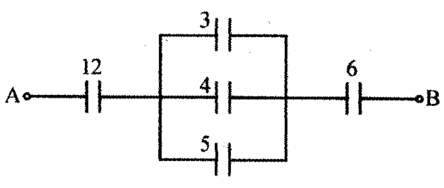
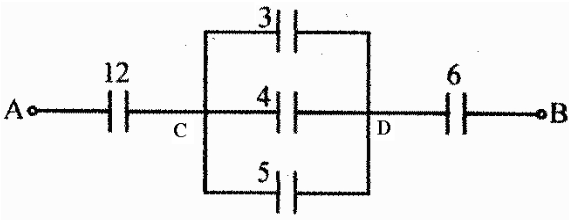


Fig. – 3

3 f) Ans:



The three capacitances of 3, 4 & 5 units are in parallel to yield an equivalent capacitance of C_{CD} = 3+4+5 = 12 units between C and D. 1 mark

C_{AB} = resultant of series combination of C_{AC}, C_{CD} and C_{DB}.

$1/C_{AB} = [(1/C_{AC}) + (1/ C_{CD}) + (1/C_{DB})]$ 1 mark

Hence

$C_{AB} = [(1/C_{AC}) + (1/ C_{CD}) + (1/C_{DB})]^{-1}$

$= [(1/12) + (1/ 12) + (1/6)]^{-1}$ 1 mark

= 3 μF 1 mark

4 Attempt any FOUR of the following: 16

4 a) Convert the network of Fig 4 into equivalent star network.

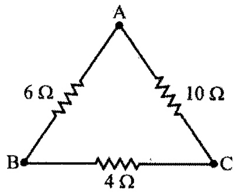
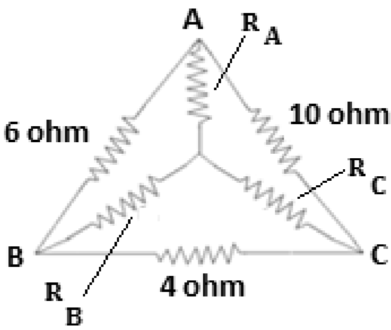


Fig. – 4

4 a) Ans:

Conversion of given circuit into equivalent star:



$R_A = (R_{AB} * R_{AC}) / (R_{AB} + R_{BC} + R_{CA})$ 1 mark

$= (6*10) / (6+4+10)$

= 3 ohm 1 mark

$R_B = (R_{AB} * R_{BC}) / (R_{AB} + R_{BC} + R_{CA})$

$= (6*4) / (20)$

= 1.2 ohm.

1 mark

$R_C = (R_{BC} * R_{AC}) / (R_{AB} + R_{BC} + R_{CA})$
= (4*10) / (20)
= 2 ohm

1 mark

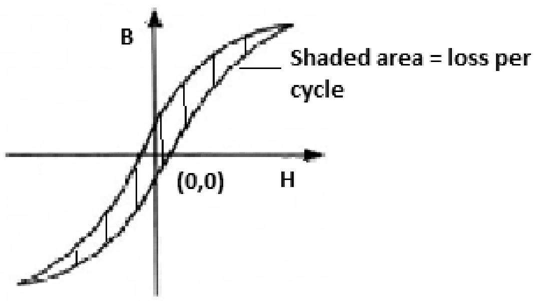
4 b) Describe the concept of magnetic hysteresis & hysteresis loss.

4 b) Ans:

Magnetic hysteresis:

When a magnetic material is subjected to cycle of magnetization and de-magnetization, it is found that flux density (B) in the material lags behind applied magnetization force (H). This phenomenon is known as magnetic hysteresis.

2 marks



Hysteresis loss: due to presence of magnetic hysteresis a fraction of the applied power to the magnetic circuit is lost in the form of heat. This energy loss is given by the area under the hysteresis loop shown shaded above.

2 marks

4 c) List any four conducting materials and give one application of each in electrical equipment or machines.

4 c) Ans:

i) Copper: Windings of machines, insulated wires/conductors, low voltage power cables, bus bars, HV cables.

(½ mark material + ½ mark for one application each)

ii) Aluminum: Line conductor of OH lines (ACSR), busbars, domestic wirings, rotor bars of squirrel cage induction motors.

(iii) Bronze: Phospher bronze for brush holders, knife switch blades, current carrying springs, bushings, sliding contact parts, connecting strips, commutator segments.

(iv) Iron/steel: Earthing conductor.

Any four = 4 marks

(v) Lead-tin alloy: fuse wires.

(vi) Brass: contacts of switches, starters, rheostats, CBs.

(vii) Carbon/graphite: brushes, terminals.

4 d) An iron ring of mean length 60 cm is uniformly wound with 250 turns of wire. Calculate the value of flux density if current of 2 A flows the wire. Assume $\mu_r = 500$ for iron.

4 d) Ans:
N= 250 turns, I = 2 A, l = 60 cm = 0.6 m, $\mu_r = 500$.

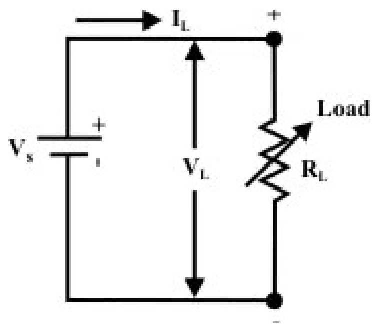
$H = NI/l$ — 1 mark
$= (250 \times 2)/(0.6) = 833.33$ A/m. — 1 mark

$B = \mu_o \mu_r H$ — 1 mark
$= 4\pi \times 10^{-7} \times 500 \times 833.33 = 0.5235$ T — 1 mark

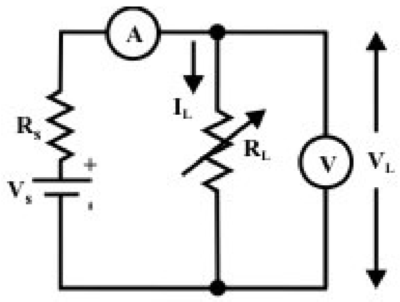
4 e) Draw circuit for ideal and practical voltage source. Convert a 20 V voltage source with 2.5 ohm internal resistance into equivalent current source. — 6

4 e) Ans:

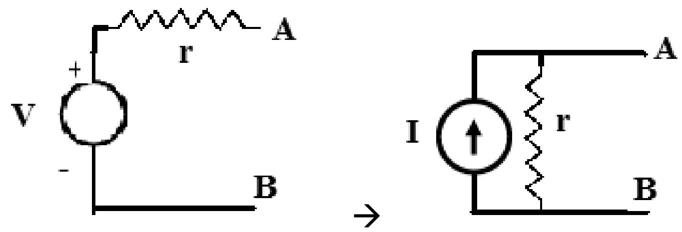
Ideal voltage source:



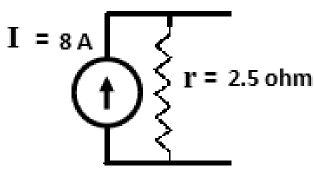
Practical voltage source



1 mark each = 2 marks for figures



In the equivalent current source : I = V/r = 20/2.5 = 8 A, and
r = 2.5 ohm or g= 1/2.5 = 0.4 mho. — 1 mark



1 mark

4 f) Give four applications each of i) Permanent magnet ii) Electromagnet.

4 f) 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

Any four ½ mark each = 2 marks

(other valid points may be evaluated accordingly)

Applications of electromagnet:

1) As Field and armature in DC Machine.
2) In cores of solenoid valves.
3) In cores of electromechanical relays.
4) In electromagnetic circuits of all AC Machines
5) Electrical measuring instruments.
6) Cores of transformers.

Any four ½ mark each = 2 marks

5 Attempt any FOUR of the following: 16

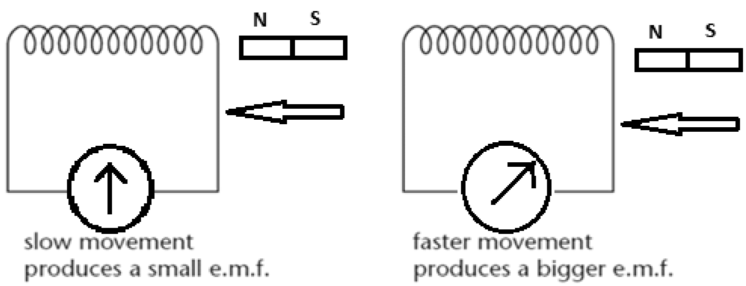
5 a) State & explain Faradays of Electromagnetic induction.

5 a) 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. 1 mark

2nd law: The magnitude of EMF induced in the coil depends on rate of change of flux linking with coil. 1 mark



Explanation with figure 2 marks.

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.
- 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| α (change in flux)/(time in which it occurs)
  $|e| = |N\ (d\Phi/dt)|$ volts.

5 b) Compare series and parallel connection of resistances (4 points).

5 b) Ans:

Comparison between series and parallel DC circuit: 1 mark for each point.

	Series circuit	Parallel circuit
1	$I_T = I_1 = I_2 = I_3 =$ (current same)	$V_T = V_1 = V_2 = V_3 =$ (voltage same)
2	$V_T = V_1 + V_2 + V_3 + \ldots$	$I_T = I_1 + I_2 + I_3 + \ldots$
3	$R_T = R_1 + R_2 + R_3 + \ldots$	$G_T = G_1 + G_2 + G_3 +$
4	$I_T = V_1 / R_1 = V_2 / R_2 = V_3 / R_3$	$V_T = I_1/G_1 = I_2/G_2 = I_3/G_3 =$

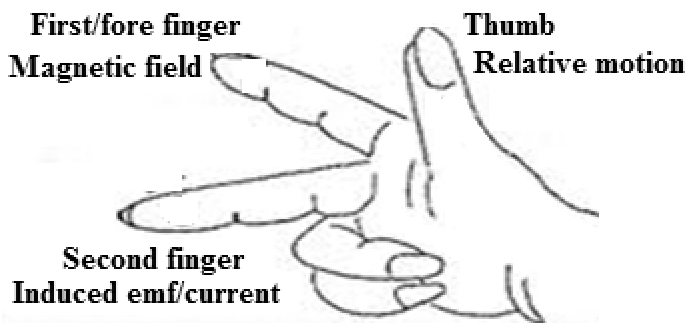
5 c) Describe the laws for finding direction of induced emf.

5 c) Ans:

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) points in the direction of magnetic filed, thumb points in the direction of relative motion of conductor with respect to magnetic field (at right angles to it)), then the second (middle) finger gives the direction of induced emf & hence current in the conductor. 2 marks (fig not compulsory)

Fleming's right hand rule generally used in all types of generators.



Lenz's Law :

Statement: The direction of induced emf produced due to the process of electromagnetic induction is always such that, it will set up a current to oppose the basic cause responsible for inducing the emf.

The mathematical representation is, $\mathbf{e = - N\ (d\Phi/dt)}$ 1 mark

Explanation :

If a bar magnet with its N pole facing the coil is brought close to the coil, due to the relative motion between the coil and the magnet, there is a change in flux linkage with the coil. An emf is induced in the coil and current I starts flowing. This current produces its own magnetic field The direction of this current is such that it produces

1 mark (other

and N Pole on the side of the coil it faces. valid explanation may be assessed)

As N-pole produced by the coil is close to the N pole of magnet, there is 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.

5 d) A field winding has resistance of 220 ohm at 25 ^{O}C, find resistance of the winding at (i) 0^{O} C (ii) 50 ^{O}C. take $\alpha_o = 0.004\ /^{o}C$.

5 d) Ans:
R_1 = 220 ohm, t_1 = 25 ^{O}C, t_2 = 50^{o}C. $\alpha_o = 0.004/^{o}C$.

$R_O = R_1/(1 + \alpha_o t_1)$ 1 mark
$= 220/(1+0.004x25)$
= 200 ohm. 1 mark

R_2 = resistance at 50^{o}C

$R_2 = R_O(1 + \alpha_o t_2)$ 1 mark
$= 200(1+0.004 x50)$
= 240 ohm. 1 mark

5 e) Define (i) self inductance (ii) mutual inductance (iii) coefficient of coupling. State relation for coefficient of coupling.

5 e) Ans:
(i) **Self inductance:** It is property by virtue of which a coil opposes change in current flowing through itself by inducing an emf in it such that its effect is to circulate a current (induced current) that produces a magnetic field which opposes the change in the field. Coefficient of self inductance L (unit: Henry) 1 mark
Self Induced emf: = e = - L(di/dt)) Volts.

(ii) **Mutual inductance:**
Mutual Inductance: - The ability of the coil 1 having changing current to induce an EMF in a neighbouring coil 2 is due to the property of mutual inductance. Measured in Henry. 1 mark
Mutually induced emf $e_{21} = -M\ (di_1/dt)$, where, e_{21} = emf in coil 2due to change in current i_1 in coil 1, M = coefficient of mutual inductance between coils 1 & 2.

(iii) **Coefficient of coupling:**
It is the fraction of the flux produced by a coil (1st coil) that links another coil (2nd coil) to produce mutually induced emf in the 2nd coil. 1 mark
Coefficient of coupling between two coils with coefficient self inductances L_1 & L_2; coefficient of mutual inductance = M is given by

$K = M/\sqrt{(L_1 L_2)}$. 1 mark

5 f) A conductor of 1.5 m length moves at right angle in a uniform magnetic field of flux density 1.2 Tesla with a velocity of 100 m/s. Calculate the value of induced emf in the conductor. If the conductor moves at an angle of 30 ^{O} with direction of field. Calculate the value of the induced emf.

5 f) Ans:
B= 1.2 T, l = 1.5 m, v = 100 m/s.

Induced emf 'e' = B l v sinθ (V) — 1 mark

I. $\theta = 90^{O}$
e = 1.2 x 1.5 x 100sin90^{o}
= 180 V. — 1 mark

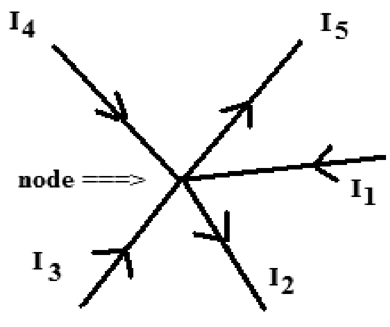
II. $\theta = 30^{O}$
e = 1.2 x 1.5 x 100sin30^{o} — 1 mark
= 90 V. — 1 mark

6 Attempt any FOUR of the following: 16

6 a) State and explain KCL.

6 a) Ans:
Kirchhoff's current law:
It states that in any electric network at any node or junction the algebraic sum of currents is zero. — 1 mark

i..e $\sum I = 0$ i. e $I_1 - I_2 + I_3 = 0$. — 1 mark



$I_1 - I_2 + I_3 + I_4 - I_5 = 0$

Labeled fig 2 marks, unlabeled 1 mark.

6 b) List the number of steps to be carried out for maintenance of Lead- acid batteries.

6 b) Ans: — 1 mark each any four points = 4 marks
1) Clean the container surface of dust, dirt, moisture, or any other deposits.
2) Regularly check and tighten the terminal connections.
3) Apply petroleum jelly on freshly cleaned terminals to avoid corrosion.
4) Check and top up electrolyte level when needed.
5) Charge battery at specific rate given by manufacturer only.

6) Battery should not be discharged below a minimum voltage.
7) Battery terminals should not get shorted during use/maintenance.
8) During initial charging use fresh electrolyte.
9) Confirm that the cells are in proper shape while carrying out maintenance.
10) Ensure that the location of batteries is not congested but dry & airy.

6 c) With the help of neat sketch explain how sinusoidal emf is generated using simple AC generator.

6 c) Ans:

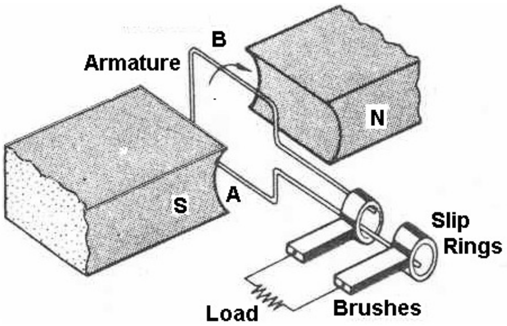
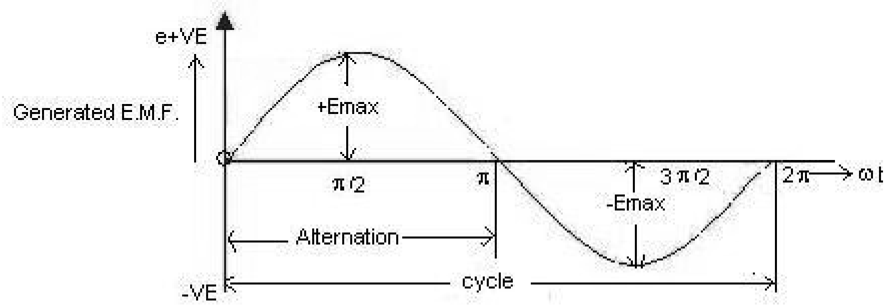


Figure or equivalent diagram 1 mark



Waveform 1 mark.

The induced emfs are produced in each conductor A & B as given by Faraday's Laws of electromagnetic induction. The emfs are opposite in direction in A & B. At the slip rings the total emf is twice of emf in one conductor as they are connected in series addition to sum the emfs. If e = emf in one conductor = B l v sinΘ (Volts).
The total emf will be 2e = 2B l v sinΘ (Volts). 1 mark

As the conductors rotate between the pole faces their induced emfs alternate between the maximums under the N pole and S pole as shown in the waveform where ωt is the angle of rotation in terms of the electrical angle. 1 mark

6 d) Classify insulating materials on the basis of state of material. Give two examples of each.

6 d) Ans:
Solid, Liquid & Gaseous insulating materials. 1 mark

1) Solid insulating materials: wood, rubber, plastic, PVC, glass, porcelain, mica, polypropylene film etc. 1 mark (any two)
2) Liquid insulating materials: transformer oil, condenser oil, (both are mineral oils), synthetic insulating oils. 1 mark (any two)

3) Gaseous insulating materials: Hydrogen, SF_6, Nitrogen, Air. 1 mark (any two)

6 e) Describe the necessity of series connection and parallel connection of batteries.

6 e) Necessity of series connection:

1. The batteries are available with some specific terminal voltages. e. g. 6V, 12V, 24V, 48V etc.
2. If we want to have some terminal voltage other than these standard ones, then series connected batteries are necessary to get the required voltage (. 2 marks
3. The load voltage is equal to the sum of individual voltages of batteries between the terminals across which the voltage is needed.
   $V_L = V_1 + V_2 + V_3 + V_4$.

Necessity of parallel connection:

1. The batteries are available with specific current capacities.
2. To obtain higher current capacities batteries need to be connected across each other such that their similar polarity terminals are connected together. 2 marks
3. The parallel connected batteries together supply the required load current depending on their internal resistances (they have identical emfs).
4. $I_T = I_1 + I_2 + I_3 + I_4 + \ldots\ldots$. is the total current capacity available when batteries of capacities I_1, I_2, I_3, I_4 ……. are connected in parallel all having identical emfs.

6 f) Distinguish between paramagnetic & ferromagnetic materials on any four points

6 f) Ans:

Point	Paramagnetic materials	Ferromagnetic materials
Relative permeability (μ_r)	Very low positive value, slightly greater than one.	Very large values ranging from 400 to 1200 etc.
Reluctance	High	Very low.
Magnetization	Require large MMF or cannot be magnetized.	Require low MMF, can be easily magnetized.
Atomic dipoles orientation	Very random even with high field strength.	Easy parallel alignment with very low magnetizing current.
Examples	Copper, Aluminum, Titanium, Platinum, Oxygen	Iron, Nickel, Cobalt.

1 mark each any four points = 4 marks.