Winter – 2014 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 mark

1 a) Define resistance. Also write the formula for the same in terms of physical constants.

Soln:

Resistance: It is property of a substance by virtue of which it opposes current through it. 1 mark

Resistance, R = ρ (l / a) (unit is ohms denoted by Ω)

Where, ρ = Resistivity of material 1 mark

l = length of conductor

a = area of conductor.

1 b) State Ohm's law for electric circuits.

Soln:

Ohm's law: As long as physical conditions of a conductor are constant (dimensions, pressure and temperature) the potential difference between any two points in the conductor is directly proportional to current between them. 1 mark

PD "V" α current "I". or V = I R. (R = constant of proportionality called as the resistance of the conductor) 1 mark

1 c) Write the names of any three resistors and write down one application of each

Soln:

Types of resistors:

- Carbon composition: used as potential divider, Radio/TV receivers, Amplifiers.
- Wire wound resistors: used in Zener voltage regulator, Power amplifiers, Radio/TV receivers, Low/high frequency applications.
- Metal film resistors: used for military applications, Modulators, Demodulators.
- Carbon film resistors: used for military applications
- Cermet resistors: used in printers, automotive, computers, cell phones & battery chargers.
-

1 resistor ½ mark, two resistors 1 mark, Any 3 resistors with application 2 marks

1 d) What is terminal voltage explain in brief.

Soln:

Terminal Voltage:

- The voltage available at the terminals of sources (which is less than EMF). 1 mark

- For battery $V_T = E - I\,r$. hence the terminal voltage of sources depends upon the load current drawn at its terminals. Higher the load current lower will be the terminal voltage. hence sources with lower internal resistances are normally preferred. 1 mark

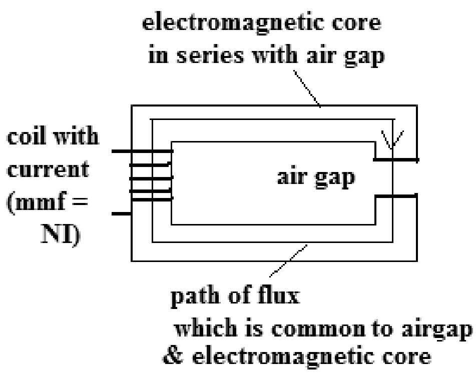
1 e) What is capacitance? What is its unit?
Soln:
Capacitance: The capacitance is defined as the property of dielectrics to store the electric energy in form of charge on conductors between which the dielectric mediums are placed. 1 mark

- Capacitance C α'ϵ'
- C α A
- C α 1/d.

Where ϵ = permittivity of the dielectric, A = area of conductor surface and d = separation between the conducting surfaces
Its unit is Farad (F). 1 mark

1 f) Define magnetic circuit. Also draw a simple series magnetic circuit.
Soln:
Magnetic circuit: it is a closed path in which magnetic flux (Φ) is set up. 1 mark

Series magnetic circuit:



1 mark (alternative figure may also be awarde marks)

1 g) Define M. M. F. and reluctance of magnetic circuit.
Soln:
Magnetic Motive Force (MMF): - It is defined as the force that sets up or creates magnetic flux in a closed magnetic circuit. 1 mark
It is given by the product of the current through a coil and number of turns of the coil.
Reluctance (S) : -
The property of opposition offered by magnetic circuit to magnetic flux in it is called as "Reluctance". It is denoted by letter "S" 1 mark

1 h) What is self inductance? What is its unit?
Soln:
Self Inductance: It is property of coil to oppose any change in current flowing through it.
Also: property by virtue of which emf is induced in it when its own current changes. 1 mark

Its unit is Henry (H). 1 mark

1 i)	Write any two examples for solid insulating materials. Also give one application for each material. Soln: **Solid Insulating materials:** 1. Porcelain: used for HV, EHV and UHV insulators, bushings, disconnecting switches, arrestors, guy insulators, mount fuses etc. 2. Mica: used in commutator segments, electric iron, insulators in heating units, traction motors, hydroelectric generators etc. 3. Glass: used for insulators in very high voltage and above applications. 4. Bakelite: used for machine/motor terminal plates to mount live terminals, control panels etc.	Names of any two insulators = 1 mark. Application of each one = 1 mark. Other eg. Valid
1 j)	What is mean by co-efficient of coupling? Write an expression for the same. Soln: **Co-efficient of coupling(K)**: It is defined as the ratio of actual mutual inductance (M) present between two coils A & B to the maximum value of M.	1 mark
	Co-efficient of coupling(K) = $M/M_{MAX} = \frac{M}{\sqrt{L1\ L2}}$ Where M = mutual inductance (M) present between the coils A & B L_1 = self indutance of coil A L_2 = self indutance of coil B. $\sqrt{(L_1L_2)}$ = max. possible mutual inductance between the coils. OR	1 mark
	It is the portion of flux produced by one coil that links another nearby coil.	1 mark
	Hence it is Co-efficient of coupling(K) = $\frac{\text{Ø}ab}{\text{Ø}a} = \frac{\text{Ø}ba}{\text{Ø}b}$	1 mark
	$Ø_a$ & $Ø_b$ are fluxes produced by coils A and B independently; $Ø_{ab}$ is flux produced by coil A linking coil B; $Ø_{ba}$ is portion of flux produced by coil B linking coil A.	
1 k)	State any two electrical and any two mechanical properties of high- conductivity materials. Soln: **Electrical properties:** 1. Resistivity must be low 2. Temperature coefficient of resistance must be low. 3. Resistivity must be low. 4. Electrical energy dissipated in the form of heat must be low.	½ mark each any two = 1 mark
	Mechanical properties: 1. It should have sufficient elasticity. 2. Easy to work on. 3. It should be ductile. 4. It should withstand stress & strains, should posses high mechanical strength.	½ mark each any two = 1 mark

1 1) Give any two applications of electro magnets.
Soln:
Applications of electromagnets: (easy magnetisation with low currents)
1. Produce required magnetic flux in DC generators
2. Magnetic cores of field & armature winding in DC motors.
3. In solenoid valves.
4. In electromechanical relays.
5. Cores of AC machines.
6. Lifting of heavy loads.
7. Measuring instruments.

Any two application 1 mark each = 2 marks

2 Attempt any four: 16

2 a) Convert the given voltage sources of fig 1 and fig 2 into equivalent current sources.

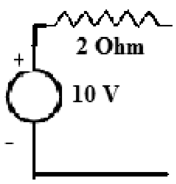
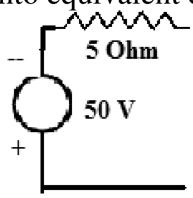
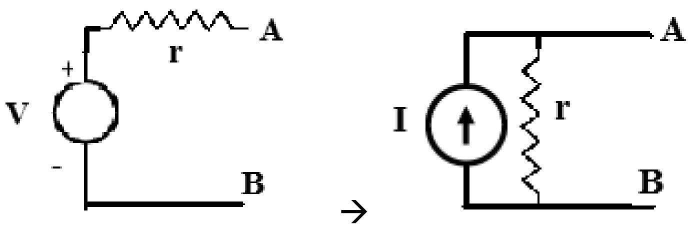
Fig no 1: 

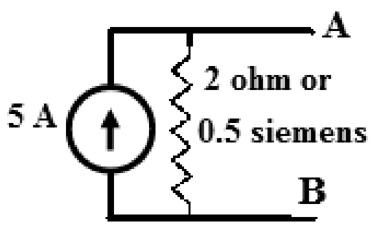
Fig no 2: 

Ans:
Steps to transform Voltage source to Current source:
1) Calculate equivalent current source as the short circuit current through the voltage source terminals: (I = V / r) 1 Mark
2) The Shunt Resistance of current source: (Rsh= r) or source conductance g = 1/r. 1 Mark
3) Draw the equivalent source.



For given figures 1 & 2 calculate as below;

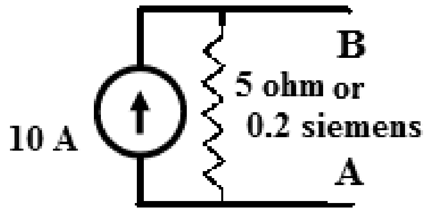
Figure 1:
Equivalent current source I: I = V/r = 10/2 = 5 A and (source conductance ‘g’ = 1/r) = ½ = 0.5 mho or also r = 2 ohm.



1 mark

Figure 2:
Equivalent current source I: I = V/r = 50/5 = 10 A. and source conductance ‘g’ = 1/r

= 1/5 = 0.2 mho or also r = 5 ohm.



1 Mark

2 b) Given: $R_1 = 12.7\ \Omega$, $t_1 = 18^0$ C, $R_2 = 14.3\ \Omega$ and $t_2 = 50^0$ C.

Sol^n :

i) Temperature coefficient of resistance at 0^oC:
$R_1 = R_O(1 + \alpha_o t_1)$ & $R_2 = R_O(1 + \alpha_o t_2)$ from which by taking ratio of the two expressions we get,
$R_2/R_1 = (1 + \alpha_o t_2)/(1 + \alpha_o t_1)$, 1 mark
$14.3/12.7 = (1 + 50\ \alpha_o)/(1 + 18\ \alpha_o)$, which gives
$\therefore\ \alpha_0 = 0.004237\ /^0C = 4.237 \times 10^{-3}\ /^0C$
$\therefore$ TCOR α_0 at 0^0 C $= 4.237 \times 10^{-3}\ /^0C$. 1 mark

ii) Resistance of coil at 0^oC:
$R_O = R_1/(1 + \alpha_o t_1)$
$= 12.7/(1 + 0.004237 \times 18)$
$= 11.8\ \Omega$.
OR
Resistance of coil at 0^oC:
$R_O = R_2/(1 + \alpha_o t_2)$
$= 14.3/(1 + 0.004237 \times 50)$ 1 mark
$= 11.8\ \Omega$

iii) Temperature coefficient of resistance at 18 ^oC:
By definition of TCOR:

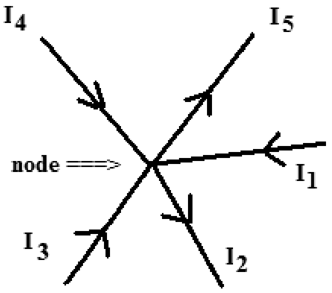
$\alpha_1 = [(R_O - R_1)/R_1] \times 1/(0 - t_1)$
$= [(11.8 - 12.7)/12.7] \times 1/(-18)$
$= 0.003937\ /\ ^OC = 3.937 \times 10^{-3}/^OC$

OR

$\alpha_1 = [(R_2 - R_1)/R_1] \times 1/(t_2 - t_1)$
$= [(14.3 - 12.7)/12.7] \times 1/(32)$
$= 0.003937\ /\ ^OC = 3.937 \times 10^{-3}/^OC$ 1 mark

2 c) State and explain Kirchoff's laws with suitable illustrations.
Sol^n:
Krichhoff's current law : - It states that in any electric network at any node or junction the algebric sum of currents is zero. 1 mark

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

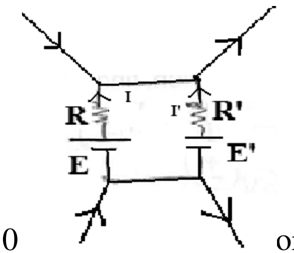


1 mark

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

ii) Kirchhoff's voltage law : - It states that in algebraic sum of the e.m.f. is equal to the algebraic sum of voltage drops (I.R.) across each part of the circuit. 1 mark

i.e. $\sum$ e.m.f. = $\sum$ I.R

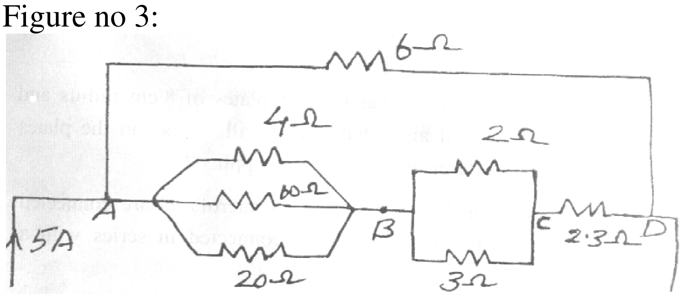


1 mark

i.e (E – E') + (- IR + I' R') = 0 or (E – E') = (IR - I' R')

2 d) Find equivalent resistance of the circuit shown in figure no.3. If the total current taken by the circuit is 5 amperes, what is the current through 2 ohm resistance?

Figure no 3:

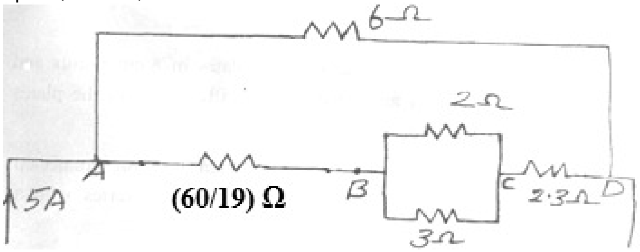


Ans:

We work out the equivalent resistance of 4 Ω, 60 Ω, and 20 Ω between A and B as follows:

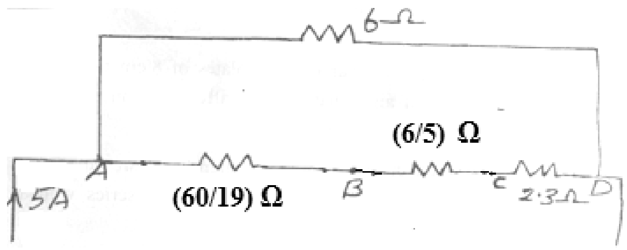
$$\frac{1}{Req} = \frac{1}{4} + \frac{1}{60} + \frac{1}{20} = \frac{19}{60}$$ ½ mark

Hence R_{eq} = (60/19) Ω



Next equivalent resistance between B and C is =

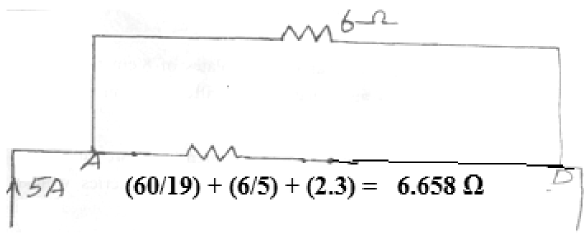
$$\frac{3x\ 2}{3+2} = \frac{6}{5}\ \Omega$$



The equivalent resistance of series resistances between A and D will be

½ mark

$$= \frac{60}{19} + \frac{6}{5} + 2.3 = 6.658\ \Omega$$



This is in parallel with resistance of 6 ohms, hence total equivalent resistance between A and D

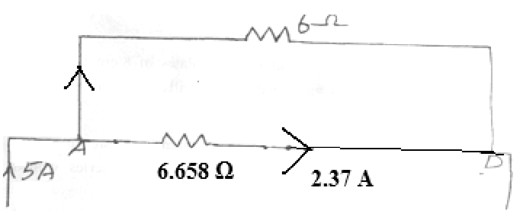
$$= \frac{6.658\ x\ 6}{6.658\ +\ 6} = 3.156\ \Omega$$

1 mark

The current of 5 A gets divided between 6 Ω and 6.658 Ω in inverse proportion to their values and hence current in the lower branch of 6.658 Ω between A & D is,

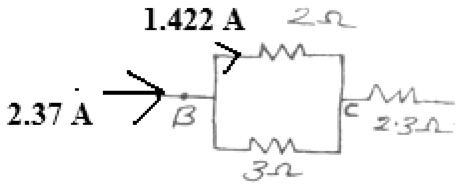
$$\frac{5\ x\ 6}{6.658\ +\ 6} = 2.37\ A$$

1 mark



This current of 2.37 A gets divided again between 2 Ω and 3 Ω as follows for the current in the 2 Ω to be as follows,

$$\frac{2.37\ x\ 3}{(3+2)} = 1.422\ A$$



1 mark

hence current in 2 ohms = 1.422 A.

2 e) Find the current in each branch of the circuit shown in figure no 4 using Kirchhoff's Laws.

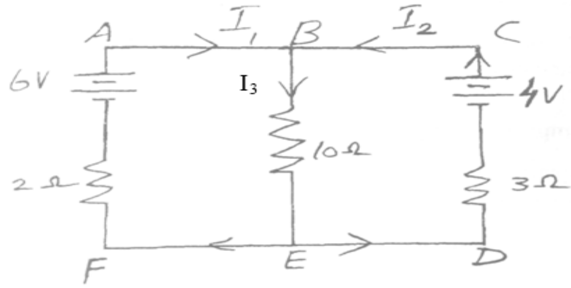


Figure no 4:

Loop ABEFA: by KVL,

$6 - 2I_1 - 10I_3 = 0$

$\therefore\ 2I_1 + 10I_3 = 6$

Or $I_1 + 5\ I_3 = 3$ ----------------------- (1)

In loop CBEDC: by KVL,

$4 - 3I_2 - 10I_3 = 0$

$\therefore\ 3I_2 + 10I_3 = 4$ -------------------------(2)

But, By KCL,

$I_3 = I_1 + I_2$ -------------------------(3)

Substituting for I_3 in equation (1)

$I_1 + 5(\ I_1 + I_2) = 3$

$\therefore\ 6I_1 + 5I_2 = 3$ ------------------------(4)

And substituting for I_3 in equation (2)

$3I_2 + 10(I_1 + I_2) = 4$

$\therefore\ 10\ I_1 + 13\ I_2 = 4$ --------------------------- (5)

Correct equations (4) and (5) = 1 Mark

Solving equations (4) and (5), we get

$\therefore I_1 = 0.679$ A and 1 Mark

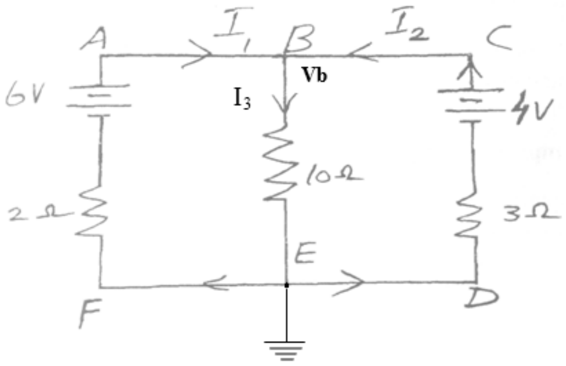
$I_2 = -\ 0.214$ A 1 Mark

And $I_3 = I_1 + I_2$ 1 Mark

$= 0.679 + (-\ 0.214) = 0.465$ A

OR

Students may also solve by assuming node voltage at B as V_b and grounding node E as follows:



Applying KCL at B:

$$\frac{(6 - Vb)}{2} + \frac{(4 - Vb)}{3} - \frac{Vb}{10} = 0$$

$$\frac{3}{1} + \frac{4}{3} - \frac{5Vb}{6} - \frac{Vb}{10} = 0$$

From which we have

$V_b = 4.64$ V. 1 mark

Then $I_1 = ((6 - Vb))/2 = 0.68$ A 1 mark

$I_2 = ((4 - Vb))/3 = - 0.2133$ A 1 mark

And $I_3 = V_b/10 = 4.64/10 = 0.464$ A 1 mark

2 f) What are the factors affecting hysteresis loss? How will you minimise this loss?

Sol^n:

Hysteresis loss is given by: $P_h = K_h (B_{max})^{1.6}.f. V$ (watts)

Factors affecting hysteresis loss: ½ mark each any four = 2 marks

1) Area of the hysteresis loop (loss per cycle α area of loop).
2) Maximum flux density of the alternating flux used in the electromagnetic circuit, (hysteresis loss α B_m^x, where 'x' > 1).
3) Frequency of the , alternating flux used in the electromagnetic circuit, (hysteresis loss α f).
4) Quality of the electromagnetic core material used (K_h) such as stalloy etc.
5) Volume 'V' of the electromagnetic core used.

These losses can be reduced by

1) Using good electromagnetic core materials such as stalloy or similar ones that have very thin hysteresis loops. 1 mark

2) Using field strengths that produce lower maximum flux densities.
3) Using lower frequency supply where ever possible.
4) Avoiding un-necessary higher volumes of core construction.

½ mark each any 2 = 1 mark.

3 a) Derive expression for capacitance of the parallel plate capacitor with medium partly air.

Sol^n: this is a composite capacitor wherein the partly air medium may be of two types as shown below; **case I and case II** (students are expected to derive any one)

Case I:

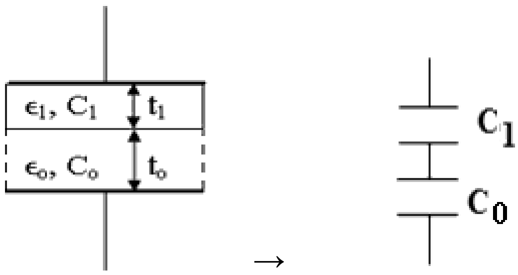


Fig I →

Figure 1 mark

As seen in the figures suffix 'o' is for air and '1' is for any other valid dielectric medium in both figures.

C_O and C_1 are in series. 'A' (in m^2) is area of plates. Thicknesses as shown are in metres.

For air $C_O = \epsilon_o A/t_o$ and for other medium $C_1 = \epsilon_1 A/t_1$. 1 mark

The equivalent capacitance is = 1 mark

$$\frac{(Co\ C1)}{(Co + C1)}$$

$$= \frac{\left(\left(\epsilon o \frac{A}{to}\right)\left(\epsilon 1 \frac{A}{t1}\right)\right)}{\left(\left(\epsilon o \frac{A}{to}\right) + \left(\epsilon 1 \frac{A}{t1}\right)\right)} = \frac{(\epsilon o\ \epsilon 1)A}{(\epsilon o\ t1 + \epsilon 1 to)}\ F$$ 1 mark

OR

Case II: (refer fig II)

The effect is equivalent to parallel connected capacitors:

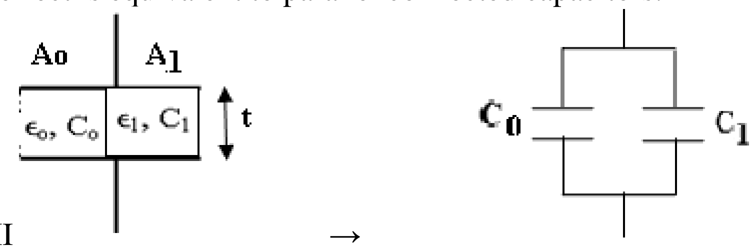


Fig II →

Figure 1 mark

As seen in the figures suffix 'o' is for air and '1' is for any other valid dielectric medium.

C_O and C_1 are in parallel hence equivalent capacitance is = $(C_O + C_1)$

For air $C_O = \epsilon_o A_o /t$ and 1 mark

for other medium $C_1 = \epsilon_1 A_1 /t$,

A_O & A_1 are areas of air and other medium sections. 1 mark

$$(C_O + C_1) = \left(\frac{\epsilon o\ Ao}{t} + \frac{\epsilon 1\ A1}{t} \right) F$$ 1 mark

3 b) What is dielectric strength? What is its unit? Also define breakdown voltage.

Sol^n:

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). 1 mark

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

$V_{bd} = E_{ds}$ d, where ‘d’ is the separation. 1 mark

3 c) A parallel plate capacitor has circular plates of 8 cm radius and 1.0 mm seperation of air. What charge will appear on the plates if a potential difference of 100 V is applied?

Sol^n:

For given capacitor charge Q = C V, where C= capacitance in farads = $(\in r.\in o.A)/d$, (where $\in o$ = permittivity of free space, $\in r$ = relative permittivity of air wrt to free space = 1, A = area of plates in m^2 and ‘d’ = separation between plates in ‘m’).

Here $\in o = 8.854 \times 10^{-12}$ F/m. 1 mark

As plates are circular;

$A = \pi R^2 = \pi \times (0.08)^2 = 0.02\ m^2$

d = 0.001 m. 1 mark

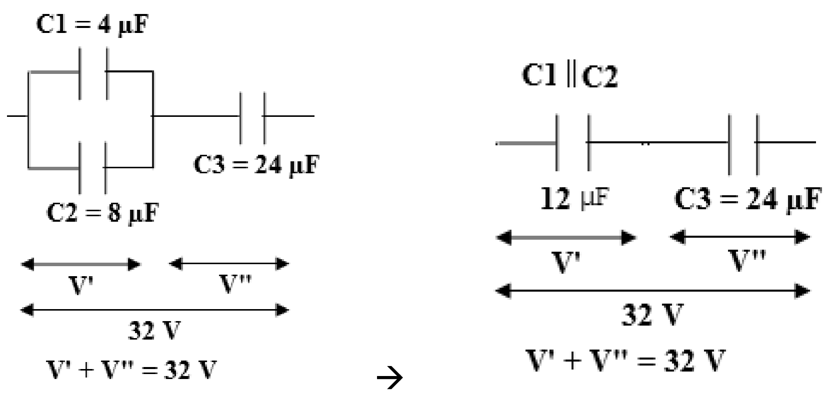
Hence by formula $C = (8.854 \times 10^{-12} \times 0.02)/(0.001) = 1.7708 \times 10^{-10}$ F. 1 mark

$Q = CV = 1.7708 \times 10^{-10} \times 100 = 1.7708 \times 10^{-8}$ C. is the charge appearing on the plates. 1 mark

3 d) Two capacitors of 4μF and 8μF are in parallel and this combination is connected in series with a capacitor of 24μF. Find

(i) Total capacitance,
(ii) Total charge and
(iii) Charge on each capacitor if applied voltage is 32 V.

Sol^n:



(i) Total capacitance = $C_T = (C_1 \parallel C_2)$ in series with C_3

=

$$(C1 + C2)x\frac{C3}{C1 + C2 + C3} = (4 + 8)\frac{(24)}{(4 + 8 + 24)}$$

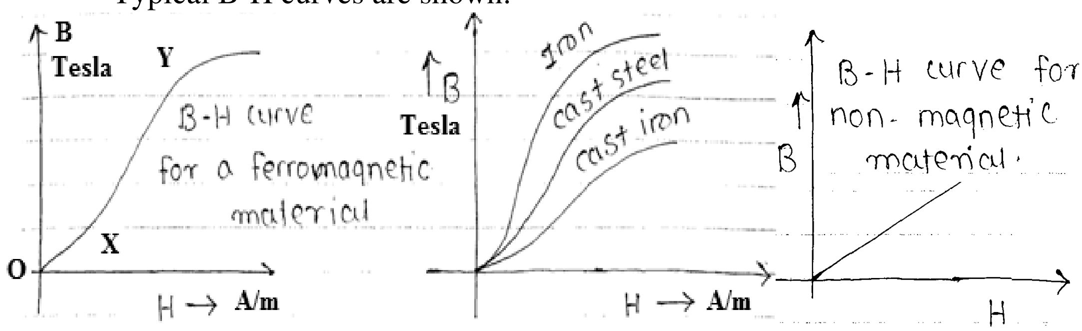
= 8 µF 1 mark

(ii) Total charge: (total capacitance) x (total applied voltage across combination)
= C_T x V_T = 8 µF x 32 V
= 256 µC 1 mark

(iii) Charge on each capacitor:
We calculate voltages V' and V" as follows;
Charge on 12 µF is 256 µC (same as 24 µF) as it is in series; hence voltage across 12 µF,
V'= Q/C = (256 µC) /(12 µF) = 21.33 V and that on 24 µF is
V" = (256 µC) /(24 µF) = 10.67 V.

a) Charge on 4µF = C_1 V' = 4 µF x 21.33 V = 85.32 µC 1 mark
b) Charge on 8µF = C_2 V' = 8 µF x 21.33V = 170.64 µC and
c) Charge on 24µF = C_3 V" = 24 X 10.67 = 256 µC. 1 mark

3 e) What is B-H curve? Draw the nature of graph and explain it in brief.
Sol^n:
B-H curve: The B-H curve is the graphical representation of relation between flux density (B) and applied field strength (H), with independent variable 'H' plotted on the X-axis and dependent variable 'B' plotted on the Y-axis. 1 mark
Typical B-H curves are shown:



1 mark

Description of the B-H curve:
The B-H curve can be described by dividing it into 3 regions.

- **Region OX**: 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. 1 mark
- **Region XY**: 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 Y**: After point Y, 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. 1 mark

3 f) Give any four important steps to be followed while doing battery maintenance.

Sol^n:

Steps in battery maintenance:

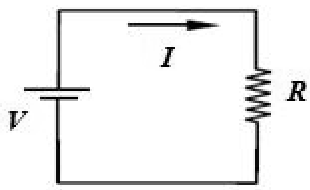
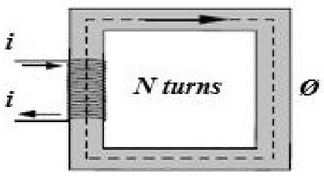
1) Keep the battery container surface dry.
2) Tighten the terminal connections.
3) Battery should not be over charged.
4) Maintain the electrolyte solution level by adding distilled water only.
5) Maintain the specific gravity and check after every 3 months.
6) Never keep the battery in discharged condition for long periods.
7) Never discharge the battery below the minimum voltage.
8) Avoid any activity that will lead to short circuiting of the terminals.

1 mark each any four = 4 marks.

4 Attempt any FOUR of the following: 16

4 a) Compare electric circuit with magnetic circuit on any four important points.

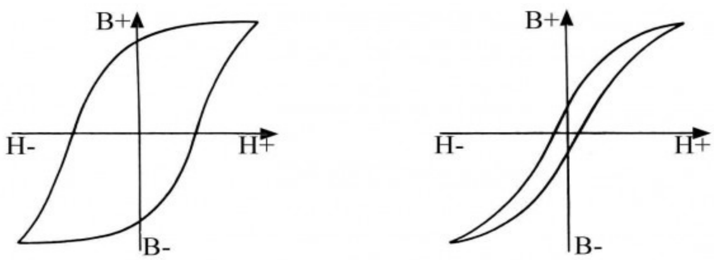
Soln:

Parameter	Electric circuit:	Magnetic circuit
Schematic representation		
Applied force (quantity)	Voltage 'V' (volts).	MMF (AT or amperes)
Circulating path quantity	Current 'I' (amperes)	Flux 'Ø' (webers)
Degree of Opposition	Resistance R = ρl/a ohms.	Reluctance S = l/(μA) amperes/weber
Equation for parameters	V = I R (volts)	MMF = Ø S (amperes)
Degree of ease	Conductance G = 1/R (Siemens)	Permeance P = 1/S (webers/ampere)
Energy requirement	Energy is required to produce current & to maintain it.	Energy is required to produce flux But not for its maintenance.

1 mark each any four = 4 marks

4 b) Draw Hysteresis loop for Hard steel And Cast steel. Also write one application of each material.

Soln:



(a) (b)

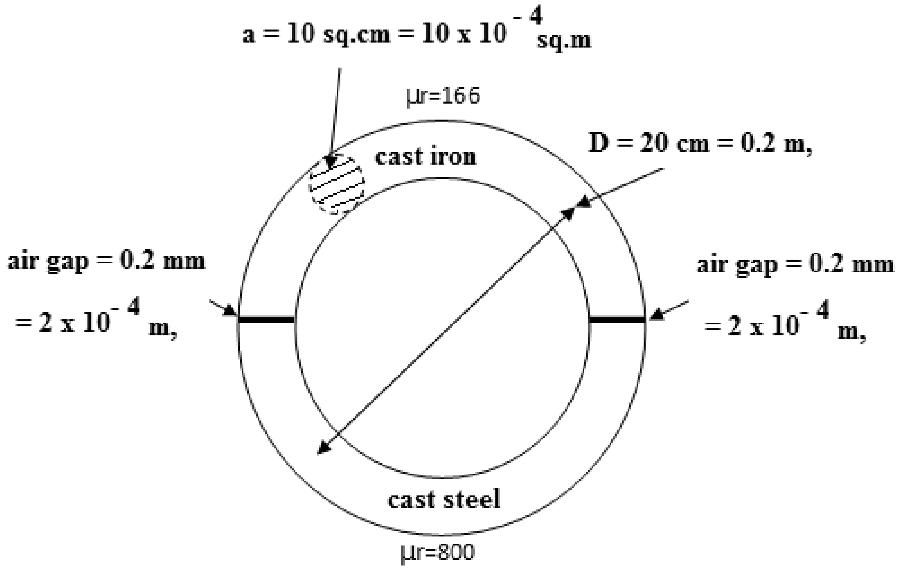
2 marks

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. 1 mark

Fig. (b) Shows hysteresis loop for cast steel. Residual flux & coercive force are less. Hence material can be used for making the electromagnets. 1 mark

4 c) A ring has a mean diameter of 20 cm and a cross sectional area of 10 cm^2 and is made up of semi-circular sections of cast steel and cast iron, each joint having a reluctance equal to an air gap of 0.2 mm. Find the ampere turns required to produce a flux of 6×10^{-4} Weber in the magnetic circuit. The relative permeability of cast steel is 800 and of cast iron is 166.

Soln:



$a = 10\ cm^2 = 10 \times 10^{-4}\ m^2$, $\Phi = 6 \times 10^{-4}$ Wb.

As both sections are semi circular, length of cast steel (L_{CS}) and length of cast iron (L_{CI})are

$L_{CS} = L_{CI} = \pi D/2 = \pi \times 0.2/2 = 0.314$ m.

Each joint is having reluctance of air gap length

$L_G = 0.2\ mm = 0.2 \times 10^{-3}\ m = 2 \times 10^{-4}\ m$

Reluctance of cast steel $S_{CS} = L_{CS} / (\mu_O\ \mu_r\ a)$,

$= 312500$ AT/Wb

Reluctance of cast iron $S_{CI} = L_{CI} / (\mu_O\ \mu_r\ a)$,

$= 1506024$ AT/Wb 1 mark

Reluctance at one joint $S_G = L_G / (\mu_O\ a)$,

$= 159155$ AT/Wb.

Total reluctance for the two joints will be double = 318310 AT/Wb 1 mark

Total reluctance of series circuit, $S_T = S_{CS} + S_{CI}\ 2S_G$
$= 2136834$ AT/Wb — 1 mark

Total ampere turns required MMF = $\Phi \times S_T$
$= 6 \times 10^{-4} \times 2136834 = 1282$ AT. — 1 mark

4 d) Connect the three resistances 32 Ω, 40 Ω and 48 Ω in star and determine its equivalent delta circuit.

Soln: Diagram:

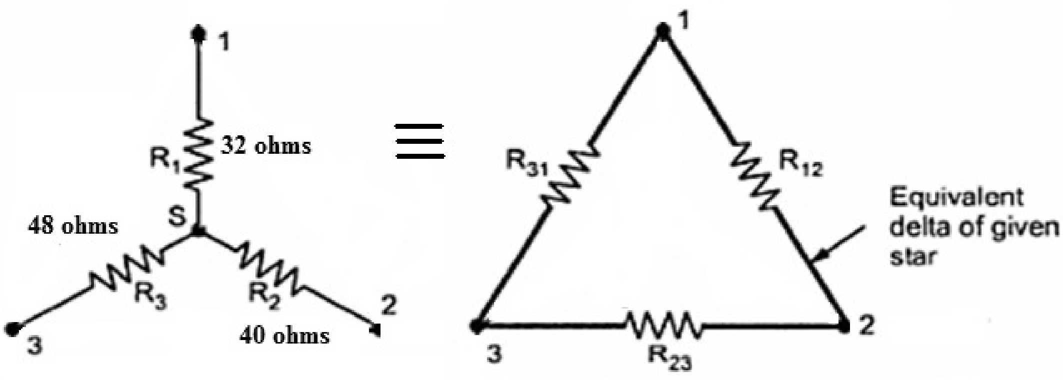


Diagram 1 mark

Converting the star network in delta

$R_{12} = (R_1 R_2 + R_2 R_3 + R_3 R_1) / R_3 = 98.66\ \Omega$

$R_{23} = (R_1 R_2 + R_2 R_3 + R_3 R_1) / R_1 = 148\ \Omega$

$R_{31} = (R_1 R_2 + R_2 R_3 + R_3 R_1) / R_2 = 118.4\ \Omega$

For each correct formula ½ mark and ½ mark for value

Total = 4 marks

4 e) What is fringing? What are the effects of magnetic fringing? How will you reduce its effects?

Soln:

Fringing :-

The magnetic flux crossing an air gap in its electromagnetic path tends to bulge outwards as shown in figure; this effect is called as "Fringing". This occurs due to repulsion between parallel flux lines.

Effects:-Due to the fringing the effective cross sectional area of the air gap increases and hence the useful flux density in the air gap decreases. The fringing gives effect of increase in the length of the air gap as flux lines travel larger distance.

Reduction: - Fringing can be reduced by making the air gap as narrow as possible.

Definition 1 mark, effects 1mark & reduction 1 mark

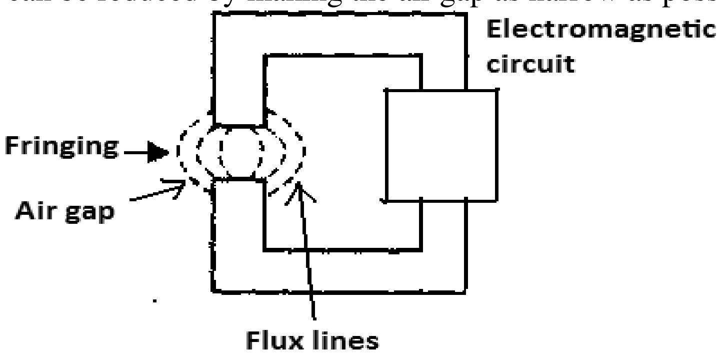


Diagram 1 mark

4 f) Write down any four examples for Gaseous insulating materials with one application of each. .

Soln: **Gaseous insulating materials**:

- Air: used in transformer, motors, circuit breakers, switches. 1 mark each = 4 marks
- Hydrogen: used in generators, motors.
- Nitrogen: used in transformers & machines.
- Sulfur-hexafluoride: used in circuit breakers, metal enclosed switchgear

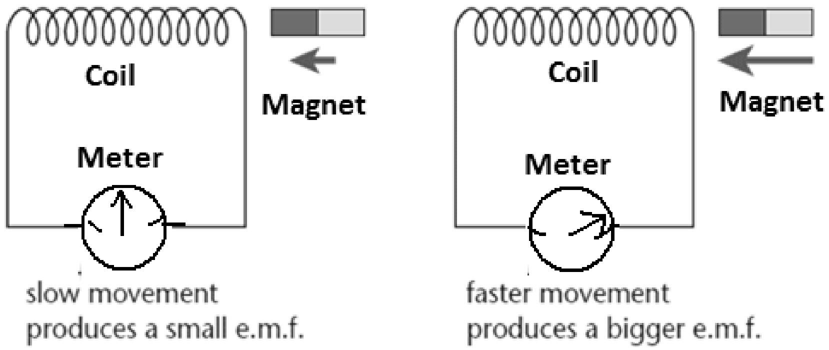
5 Attempt any FOUR of the following: 16

5 a) State and explain Faraday's laws of electromagnetic induction

Soln: Faraday's laws of electromagnetic induction:

1st law: When a conductor cuts or is cut by the magnetic flux, an EMF is generated in the conductor. Statement 2 marks

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



explanation 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:
- $|e| \propto$ (change in flux)/(time in which it occurs)

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

5 b) Define:

1. Statically induced emf
2. Dynamically induced emf

Write the names of electrical equipments in which these two types of emf one induced.

Soln:

Statically induced emf.: The emf induced in coil. By changing the current in coil itself or in the near by coil such emf is known as "Statically induced emf." 1 mark

Used in Transformers, Choke coil. 1 mark

Dynamically induced emf :

If flux linking with a particular conductor is brought about by moving the coil in stationary field or by moving the magnetic field w. r. t to stationary conductor. Then the e. m. f. induced in coil or conductor. Is known as "Dynamically induced e. m. f. — 1 mark

Used in AC Generators, DC Generators. — 1 mark

5 c) Calculate the inductance and energy stored in the magnetic field of an air-cored solenoid 50 cm long, 5 cm in diameter and wound with 1000 turns, if it is carrying a current of 5 amperes. State Fleming's right hand rule. Where is it applicable?

Soln:

d = diameter of coil = 5 cm = 5×10^{-2} m,

Length of magnetic circuit 'l' = 50 cm = 0.5 m.

But for air $\mu_r = 1$, $a = \pi (d/2)^2 = 0.001963$ sq m

Reluctance, $S = l/(\mu_O \mu_r A)$

$= 202693509$ AT/Wb

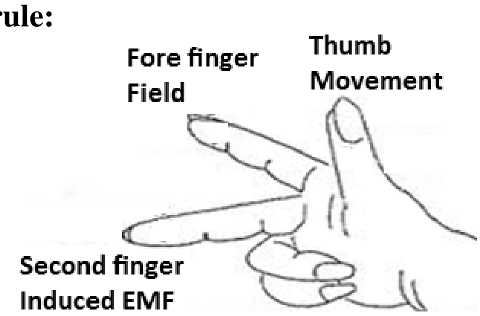
Inductance $L = N^2 / S = 1000^2 / (202693509) = 0.004934$H — 1 mark

Energy stored,

$E = \frac{1}{2} L I^2$

$= 0.0617$ Joules. — 1 mark

Flemings Right hand rule:



1 mark

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

Fleming's right hand rule is applied in dynamo, generators, motors for direction of induced emf and induced currents.

5 d) Write down any four advantages of A.C. over D.C.

Soln: Advantages of A.C. over D.C.

1. Generation is easy as lesser components are needed. — 1 mark
2. Design & manufacture of AC machines is simpler. — each any 4
3. Related circuit components and their installation is less costly. — = 4 marks
4. Distribution efficiency is high.
5. It is possible to use a transformer due to which transmission and distribution of power becomes easier and cheaper.

5 e) Give any three important properties of:

1. Series circuit
2. Parallel circuit

Soln: **Series circuits:**

1. The current in each resistor is same. — 1 mark

2. The total voltage V applied across the series resistive circuit is the sum of voltage drop across the individual resistors i.e. $V = V_1 + V_2 + V_3 + V_4$ — each any two = 2 marks
3. Equivalent resistance $R_T = R_1 + R_2 + R_3$

Parallel circuits:

1. The voltage across each resistor is same. — 1 mark
2. The total current I is the sum of currents through the individual resistors i.e. $I = I_1 + I_2 + I_3 + I_4$ — each any two =
3. Equivalent resistance R_T is determined by, $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$ — 2 marks

6 Attempt any FOUR of the following: 16

6 a) Explain constant voltage charging of battery using a DC generator.

Soln:

Constant voltage charging :

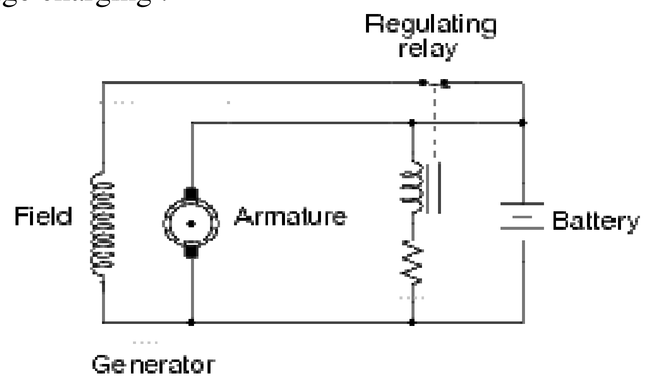


Diagram 2 marks

description 2 marks

other equivalent methods may also be assessed

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

Charging current in the beginning is high due to low terminal voltage. Of the battery. The charging current becomes very small when the cells are fully charged. The regulating relay controls the charging by controlling the field circuit.

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

6 b) Explain the necessity of series connection of batteries.

Soln: — 1 mark for each step = 4 marks max.

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 or parallel combination of batteries are necessary.
3. The series connection of batteries is necessary to increase the terminal voltage.
4. The load terminal voltage is equal to the sum of individual battery voltages. $V_L = V_1 + V_2 + V_3 + V_4$

6 c) Define the following terms as related to a. c. circuits:

1) Cycle, 2) Frequency, 3) Time period, 4) Amplitude

Soln:

1. **Cycle:** In an ac waveform, each repetition consisting of one positive and one identical negative part is called as one cycle.
2. **Frequency (f):** It is defined as the number of cycles completed by an

alternating quantity in one second.

3. **Time period(T):** It is defined as the time taken in seconds by the waveform of ac quantity to complete one cycle.
4. **Amplitude:** The maximum value or peak value of an ac quantity is called as its amplitude. Denoted as I_m, V_m etc.

1 mark each = 4 marks

6 d) Write down the values of relative permeability for Dia, Para and Ferro magnetic materials. Also write one example for each type.

Soln:

1. **Diamagnetic materials:** The relative permeability of these materials is slightly less than one. e. g. Hydrogen, Bismuth. — 1 mark
2. **Paramagnetic materials:** The relative permeability (μ_r) of such materials is very less but positive. Slightly greater than one. e. g. Copper, Aluminum, Titanium, Platinum, Oxygen. — 2 marks
3. **Ferromagnetic materials:** The relative permeability of ferromagnetic materials is large. e. g. Iron, Nickel, Co, Gd. Normally in the ranges above 150 or so and can go up to 1200 or greater. — 1 mark

6 e) What is amorphous metal? Write down any two properties and any one application of this metal.

Soln:

Amorphous metal: Amorphous refers to the materials that do not possess a particular structure. The amorphous metal alloys differ in crystalline structure. The atoms are arranged in random configuration. — 1 mark

Properties:

1) Core loss is very less(about ¼ that of silicon steel)
2) The requirement of magnetizing current is very less.
3) The temperature rise is less.

1 mark any two = 2 marks

Application: This material is used for transformer core, small high frequency electronic transformers etc. — 1 mark

6 f) Define the following terms as related to electric circuits:
1. Linear circuit, 2. Active network, 3. Mesh and 4.Unilateral circuit.

Soln:

1. **Linear circuit:** A circuit whose parameters (such as resistances, capacitances, inductances etc. are always constant irrespective of changes in time, voltage or current is known as linear circuit.
2. **Active networks:** A network containing one or more sources of electric energy is an active network.
3. **Mesh: -** A mesh is a set of branches, forming a closed path in a network.
4. **Unilateral circuit:** If the characteristics, response or behavior is dependent on the direction of current through its elements in it, then the network is called as a unilateral circuit. e. g. networks containing elements likes diodes, transistors etc.

1 mark each = 4 marks