WINTER – 2016 Examinations

Model Answer

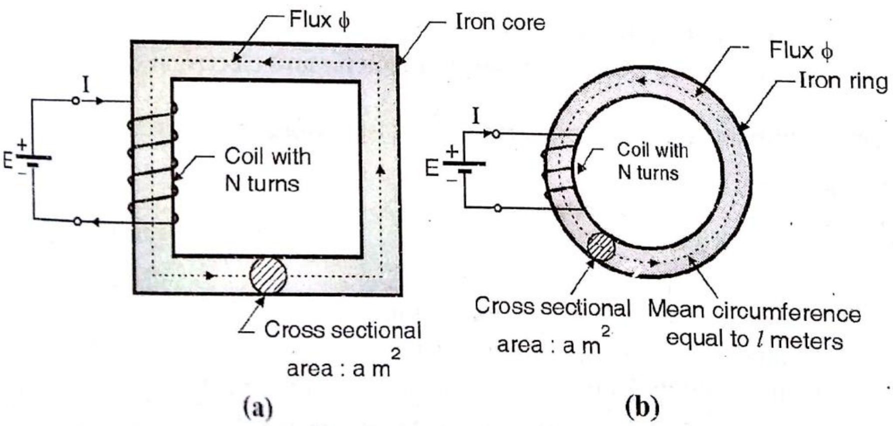
Subject: 17214: Fundamentals of Electrical Engineering

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 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/figures 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 (as long as the assumptions are not incorrect).
6) In case of some questions credit may be given by judgment 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

WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering

1	**Attempt any TEN of the following:**	**20**
1 a)	**Define active circuit and passive circuit** **Ans:** **Active circuit:** Active Circuit is one which contains at least one source of e.m.f. or energy, is called active circuit. **Passive Circuit:** Passive Circuit is one which does not contain any source of e.m.f. or energy in it, is called passive circuit.	1 mark for each
1 b)	Define resistance. Also write down its formula. **Ans:** **Resistance(R) :** It is defined as the opposition offered by conductor to electric current. It is measured in ohm (Ω) and represented by R. The resistance R is given by $R = \sigma\ l/a\ \Omega$. where, R = Resistance of material (Ω) σ = Specific resistance or resistivity (Ω-m) l = length of conductor (m) a = area of conductor (m^2)	1mark for definition 1 mark for formula
1 c)	A capacitor of 12μF is connected across a battery of 6 volt. Determine energy stored in this capacitor. **Ans:** Given : $C = 12\ \mu F = 12 \times 10^{-6}$ F, v = 6 Volt The energy stored in capacitor is given by , $E = \frac{1}{2}Cv^2$ $E = \frac{1}{2} \times 12\times 10^{-6}\times (6^2) = 2.16 \times 10^{-4}$ J	1 mark for formula 1 mark
1 d)	Draw simple magnetic circuit. **Ans:** **Simple magnetic circuit:**	Any one diagram 2 marks for labeled diagram or 1 mark for unlabeled diagram



Simple magnetic circuits

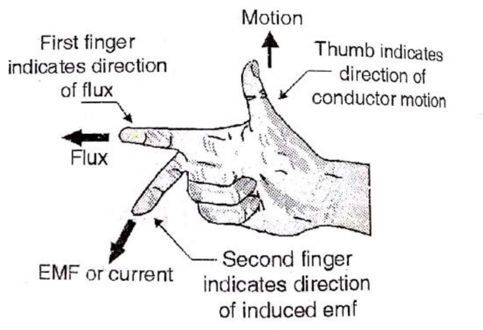
WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering

1 e) State Fleming's right hand rule with diagram.

Ans:

Fleming's right hand rule:

Fleming's right hand rule states that, stretch out the first three fingers of your right hand such that they are mutually perpendicular to each other, if the forefinger (first finger) indicates the direction of magnetic field, thumb indicates the direction of motion of conductor, then middle finger gives the direction of induced e.m.f. and hence current in the conductor.



1 mark for statement + 1 mark for figure = 2 marks

1 f) Define:

(i) Self-induced e.m.f.

(ii) Mutually induced e.m.f.

Ans:

(i) **Self-induced e.m.f.:** The e.m.f. induced in a coil due to the change of its own flux linked with it, is called self-induced e.m.f.

(ii) **Mutually induced e.m.f.:** The e.m.f. induced in a coil due to the changing current in the neighbouring coil, is called mutually induced e.m.f.

1 mark for each definition.

1 g) State any two properties of insulating materials.

Ans:

(i) Resistivity should be very high.

(ii) It should be water resistant.

(iii) It should not contain impurities.

(iv) It should not be affected chemically and not corroded easily.

(v) Its resistance should not drop under high voltage and high temperature.

(vi) It should be mechanically strong (tensile strength should be more).

(vii) It should not be porous.

1 mark for each of any two

1 h) State Ohm's law for electric circuit.

Ans:

Ohm's Law:

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

i.e. V α I or V = RI, where R= constant of proportionality called resistance of the conductor.

2 marks for correct statement

1 i) Two resistance of 6 Ω each are connected in parallel. Find equivalent resistance.

Ans:

The equivalent resistance of parallel circuit is given by ,

$R_T = \frac{R_1 R_2}{R_1+R_2} = \frac{6\times6}{6+6} = 3\ \Omega$.

1 mark for formula
1 mark for answer

WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering

1 j) Define :
(i) Dielectric strength
(ii) Breakdown voltage

Ans:

(i) **Dielectric strength:** The voltage which a dielectric material can withstand without breaking down (without losing its dielectric property) is called its dielectric strength. It is represented by kV/mm or kV/cm.
e.g. dielectric strength of air is @ 30 kV/cm or 3 kV/mm. — 1 mark for each definition

(ii) **Breakdown Voltage:** The voltage at which the dielectric material breaks down (Start conducting or is no longer an insulator) for a specified thickness, is its breakdown voltage.

1 k) State the relation for energy stored in a capacitor.

Ans:

The energy stored in capacitor is given by, — 1 mark for equation

$$E=\frac{1}{2}Cv^2=\frac{1}{2}Qv=\frac{1}{2}\frac{Q^2}{C} \text{ joules}$$

where, C is the capacitance in farad, — 1 mark for terms
Q is the charge on capacitor in coulomb.
v is the voltage across capacitor in volt

1 l) Define ampere hour efficiency and watt hour efficiency.

Ans:

Ampere-Hour Efficiency:

Ampere-Hour-efficiency of a battery is defined as the ratio of the output of a battery in amp-hr during discharging to the input amp-hr of battery during charging. — 1 mark

$$\eta_{AH}=\frac{amp-hrs\ during\ discharge}{amp-hrs\ during\ charge}=\frac{I_d\,T_d}{I_c\,T_c}$$

where, I_d be the discharge current ,
T_d be the time of discharge,
I_c be the charging current,
T_c be the time of charging.

Watt-Hour Efficiency:

The ratio of the output of a battery measured in watt- hour, to the input required to restore the initial state of charge under specified conditions, is called Watt-hr efficiency. — 1 mark

$$\eta_{WH}=\frac{Watt-hrs\ during\ discharge}{Watt-hrs\ during\ charge}=\frac{I_d\,T_d v_d}{I_c\,T_c v_c}=\eta_{AH}\frac{v_d}{v_c}$$

where, v_d be the average potential difference (Voltage) of battery during discharge,
v_c be the average potential difference (Voltage) of battery during charging.

1 m) State the relationship between permeability of free space and relative permeability of air.

Ans:

Permeability of free space $\mu_o = 4\pi \times 10^{-7}$H/m — 1 mark

Relative permeability of air μ_r = 1.

$$\mu_r=\frac{\mu}{\mu_o}$$

Since μ_r = 1, the permeability of air will be $\mu = \mu_o = 4\pi \times 10^{-7}$H/m — 1 mark

WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering

1 n) Compare dry cell and liquid cell (any two points)

Ans:

Particulars	Dry Cell	Liquid cell
Principle of operation	Irreversible chemical action	Reversible chemical action
Cost	Lower	Higher
Life	Lower	Higher
Maintenance	Very low maintenance	Maintenance required at regular intervals

1 mark for each (Any 2 points)

2 Attempt any FOUR of the following: 16

2 a) In a circuit containing resistance of 60 Ω connected across a voltage sources of 20 V and current is allowed to pass for 50 sec. Calculate:

(i) Work done in Joules
(ii) Heat energy produced in kcal

Ans:

(i) Work done in joules = $\frac{v^2t}{R} = \frac{20\times20\times50}{60} = 333.3$ joules — 2 marks

(ii)Heat energy produced in kcal H = $\frac{1}{4200}\left(\frac{v^2t}{R}\right) = \frac{1}{4200}\left(\frac{20^2\times50}{60}\right) = 0.07936$ kcal — 2 marks

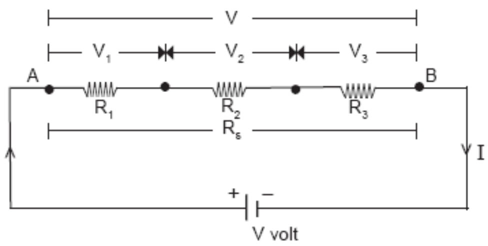
2 b) Derive the expression for equivalent resistance when three resistances are connected in series.

Ans:

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.

$R_s = R_1 + R_2 + R_3$

When a no. of resistances are connected in series, the total resistance is equal to the sum of individual resistances.

1 mark for individual voltage equations + 1 mark for voltage equation + 1 mark for V/I equation + 1 mark for equivalent resistance

2 c) Find equivalent resistance between terminal A and B shown in Figure No.1

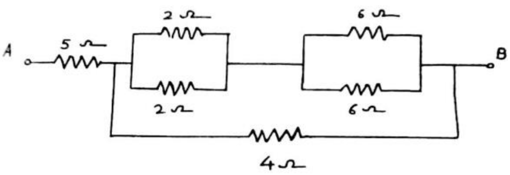
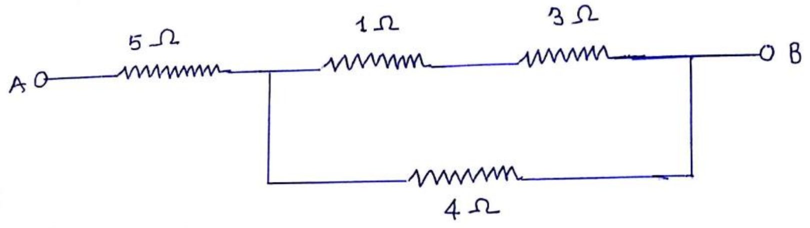


Fig. No. 1

WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering

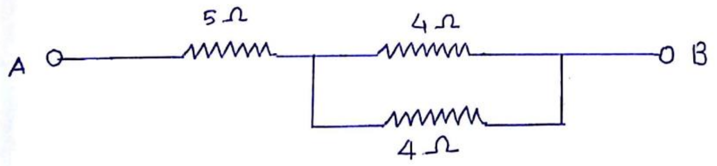
Ans:
As shown in Fig. No. 1, two 2 Ω resistances are connected in parallel. Therefore there equivalent resistance will be, $\frac{2*2}{2+2} = 1\Omega$.
Similarly two 6 Ω are connected in parallel. Therefore there equivalent resistance will be, $\frac{6*6}{6+6}$ = 3 Ω .Now the circuit becomes as shown in figure (a).



[fig. a.]

1 mark

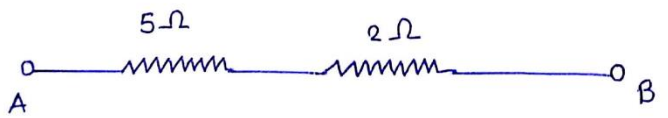
Here resistance of 1 Ω and 3 Ω are in series. Therefore there equivalent resistance will be 1 Ω + 3 Ω = 4 Ω as shown in fig. (b)



[fig. b.]

1 mark

Now two resistances of 4 Ω are in parallel.
There equivalent resistance will be $\frac{4*4}{4+4} = 2\ \Omega$.
Circuit becomes as shown below:



1 mark

Now 5 Ω and 2 Ω resistance are in series, there equivalent resistance between terminals A and B will be 5 Ω + 2 Ω = 7 Ω .

1 mark

2 d) Derive an expression for the capacitance of parallel plate capacitor with medium partly air.

Ans:
As shown in figure, the medium consists partly air parallel sided dielectric slab of thickness't' and relative permittivity $\in_r$. The electric flux density D = Q/A is the same in both media. But electric intensities are different.

$E_1 = \frac{D}{\epsilon o \epsilon r}$ ……………………….. in the dielectric medium — 1 mark

$E_2 = \frac{D}{\epsilon o}$ ……………………….. in the air — 1 mark

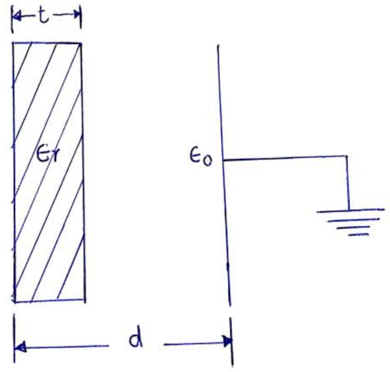
P.D. between plates,

$V = E_1.t + E_2(d - t)$ 1 mark

$= \frac{D}{\epsilon o \epsilon r} \times t + \frac{D}{\epsilon o} \times (d - t)$

$= \frac{D}{\epsilon o} \left(\frac{t}{\epsilon r} + d - t\right)$

$= \frac{Q}{\epsilon o A} \left[d - \left(t - \frac{t}{\epsilon r}\right)\right]$



$\therefore \frac{Q}{V} = \frac{\epsilon o.A}{\left[d - \left(t - \frac{t}{\epsilon r}\right)\right]}$

$\therefore$ Capacitance $C = \frac{Q}{V} = \frac{\epsilon o.A}{\left[d - \left(t - \frac{t}{\epsilon r}\right)\right]}$ 1 mark

2 e) A coil has resistance of 3.146 Ω at temperature of 40°C and 3.767 at 100°C. Find resistance of coil at 0°C and temperature coefficient of resistance at 40°C.

Ans:

The resistance at t°C is given by, $R_t = R_0 (1 + t.\alpha_0)$

$\therefore R_{100} = 3.767 = R_0 (1 + 100\ \alpha_0)$ …………………..(i)

$\therefore R_{40} = 3.146 = R_0 (1 + 40\ \alpha_0)$ ……………………(ii) 1 mark

Take ratio, $\frac{3.767}{3.146} = \frac{(1 + 100\ \alpha 0)}{(1 + 40\ \alpha 0)}$

$\therefore$ $\boldsymbol{\alpha_0 = 0.00379}$ 1 mark

Substituting in eq. (i),

$3.767 = R_0 (1 + 100 \times 0.00379)$

The resistance of coil at 0°C is,

$\boldsymbol{R_0 = 2.732\Omega}$ 1 mark

Now, the resistance temperature coefficient at t°C is given by, $\alpha_t = \frac{\alpha_0}{1 + t \times \alpha_0}$

$\therefore$ The resistance temperature coefficient at 40°C is

$\therefore \alpha_{40} = \frac{\alpha_0}{1 + 40 \times \alpha_0} = \frac{0.00379}{1 + 40 \times 0.00379} = \frac{1}{304}$ per °C

$= 3.289 \times 10^{-3}$ per °C

= **0.003289 /°C** 1 mark

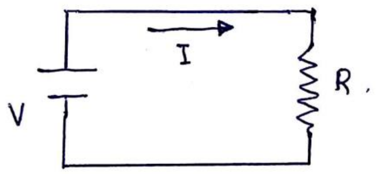
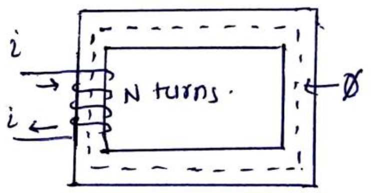
2 f) Compare electric circuit and magnetic circuit on any four points.

Ans:

Sr. No.	Electric circuit	Magnetic circuit
1	Current: Flow of electrons through conductor is current. It is measured in ampere.	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 volt.	MMF: It is driving force for flux, measured in A-T.
3	Resistance: It is opposition of conductor to current, measured in ohms.	Reluctance: It is opposition offered by magnetic path to flux, measured in A-T/Wb.
4	Resistance is directly proportional to length of	Reluctance is directly proportional to length of magnetic path.

1 mark for each of any four points

WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering

	conductor	
5	For electric circuit we define the conductivity.	For magnetic circuit we define permeability.
6	Electric circuit is closed path for current.	Magnetic circuit is closed path for magnetic flux.
7	For electric circuit, I = EMF/Resistance	For magnetic circuit ϕ = MMF/Reluctance.
8	Voltage = IR	MMF= ϕ S
9	Resistivity	Reluctivity
10		

Dissimilarities between Electric and magnetic circuit.

Sr. No.	Electric Circuit	Magnetic circuit
1.	Electric current flows	Flux does not actually flow.
2.	Energy is needed continuously for the flow of current	Energy is only needed for establishment of field (flux).
3.	Current cannot pass through the insulator	Flux can pass through almost all things including air.
4.	Electrical insulator is available.	Magnetic insulator does not exist.

3 Attempt any FOUR of the following: 16

3 a) Find the equivalent capacitance of series parallel combination of capacitance shown in Fig. no. 2

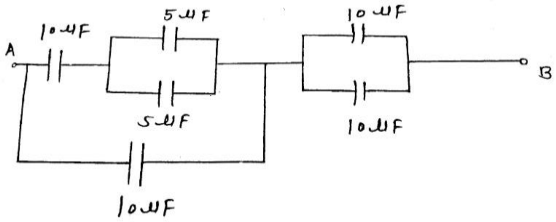
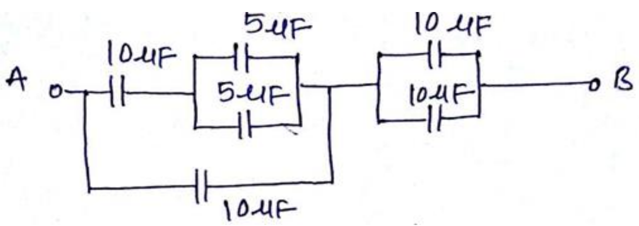


Fig. No. 2

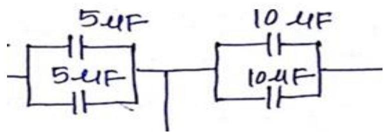
Ans:



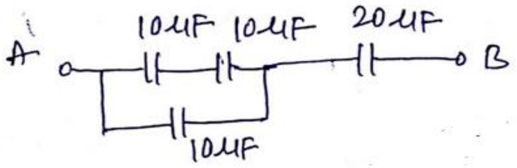
Equivalent capacitance of parallel combination of 5μF and 5μF
=5+5 =10 μF

also equivalent capacitance of parallel combination of 10µF and 10µF

=10+10 = 20 µF 1mark

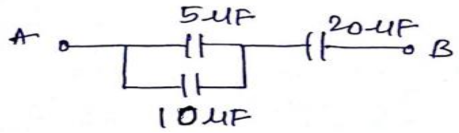


The circuit is simplified as below



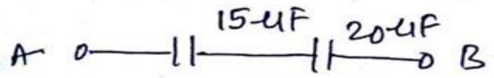
Equivalent capacitance of series comination of 10 µF and 10 µF

= (10×10)/(10+10) =5 µF 1mark



Equivalent capacitance of parallel combination of 5 µF and 10 µF

=5+10=15 µF 1mark



Equivalent capacitance of series combination of 15 µF and 20 µF

= (15×20)/(15+20)

= 8.57 µF

Equivalent capacitance **C_{AB} = 8.57 µF** 1mark

3 b) Convert given voltage source of Fig. no. 3 into equivalent current source and given current source of Fig. no. 4 into equivalent voltage source.

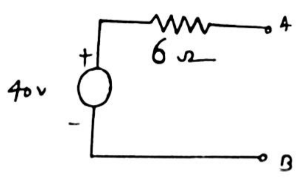


Fig. No. 3

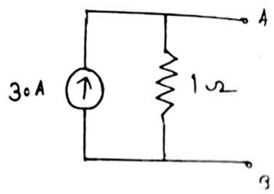
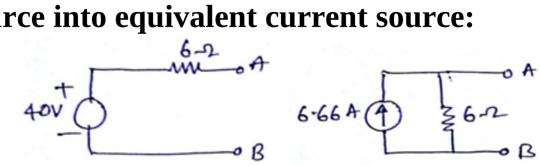


Fig. No. 4

Ans:

Convert voltage source into equivalent current source:

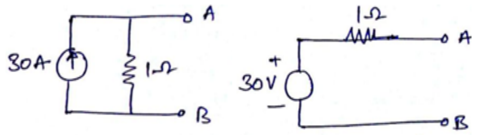


Current source magnitude I = V/R = 40/6=6.66 A 1 mark

Shunt internal resistance $R_I = R_V = 6\ \Omega$ 1 mark

Convert current source into qeuivalent voltage source:

WINTER – 2016 Examinations
Model Answer
Subject: 17214: Fundamentals of Electrical Engineering



Voltage Source magnitude V = I×R = 30×1 = 30 V — 1 mark
Series internal resistance $R_V = R_V = 1\ \Omega$ — 1 mark

3 c) Define the following terms related to circuit:
- (i) Bilateral Network
- (ii) Node
- (iii) Loop
- (iv) Branch

Ans:

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

(ii) Node: - A point in electric circuit at which different branches meet.

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

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

1 mark for each definition = 4 marks

3 d) Find current flowing through 10 Ω resistance shown in Fig. no. 5 using Kirchhoff's law.

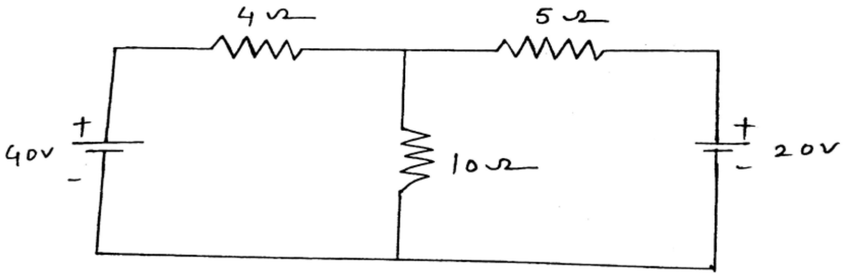
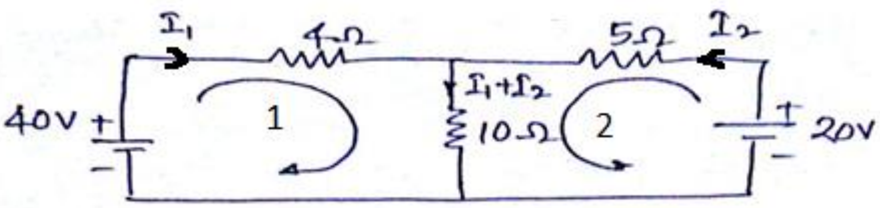


Fig. No. 5

Ans:



Apply KVL for loop 1:

$4I_1+10(I_1+I_2)=40$

$4I_1+10I_1+10I_2=40$

$14I_1+10I_2=40$……………………….Eq.(1) — 1Mark

Apply KVL for loop 2:

$5I_2+10(I_1+I_2)=20$

$5I_2+10I_1+10I_2=20$

$10I_1+15I_2=20$……………………Eq.(2) 1Mark

Multiplying eq. (1) by 15 and multiplying eq. (2) by 10, we get

$210I_1+150I_2=600$……………………Eq.(3)

$100I_1+150I_2=200$……………………Eq.(4)

Subtracting eq. (4) from eq. (3),

$110I_1=400$ $\therefore I_1=3.635$ A 1Mark

Substituting I_1 in eq. (2),

$36.35+15I_2=20$ $\therefore I_2=-1.09$ A

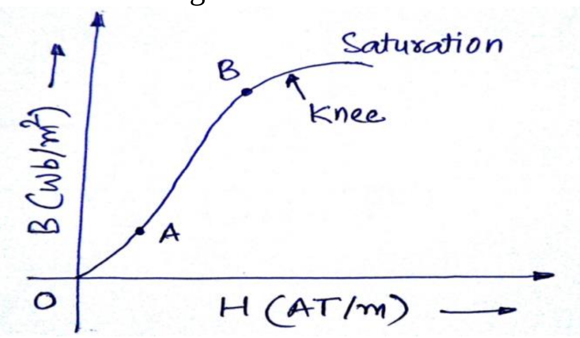
$\therefore$ Current through 10 Ω resistance is $(I_1+I_2)=3.635-1.09=2.545$ A 1Mark

3 e) Explain B-H curve for magnetic material. With the help of diagram, explain the concept of leakage flux, useful flux and fringing.

Ans:

B-H curve for magnetic material:

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: 1Mark



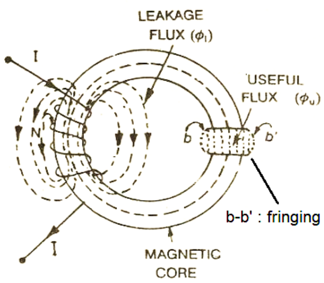
The B-H curve can be described by dividing it into 3 regions.

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.

Concept of leakage flux, useful flux and fringing:



Leakage flux: Some flux while passing through the magnetic circuit, leaks through the air surrounding the core. This flux is called as leakage flux. 1Mark

Useful flux:- The flux in the air gap which is actually utilized for various purposes depending upon the application is called as useful flux 1Mark

Fringing: When the magnetic flux passing or crossing an air gap tends to bulge outwards the iron ring, this effect is called as "Fringing". 1Mark

4 Attempt any FOUR of the following: 16

4 a) Convert delta connected network shown in Fig. no. 6 into equivalent star.

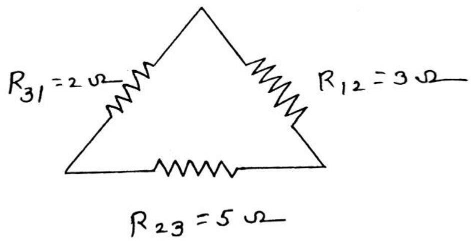
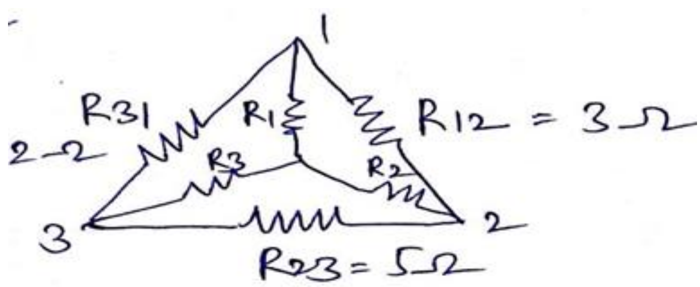


Fig. No. 6

Ans:



1 mark for diagram

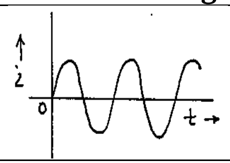
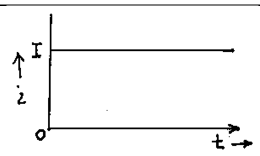
$R_1 = R_{12} \times R_{31}/(R_{12}+R_{23}+R_{31}) = 3\times2/(3+5+2) = 0.6\ \Omega$ 1 mark

$R_2 = R_{12} \times R_{23}/(R_{12}+R_{23}+R_{31}) = 3\times5/(3+5+2) = 1.5\ \Omega$ 1 mark

$R_3 = R_{23} \times R_{31}/(R_{12}+R_{23}+R_{31}) = 5\times2/(3+5+2) = 1\ \Omega$ 1 mark

4 b) Compare alternating and direct current.

Ans:

Particulars	Alternating Current	Direct Current
Waveform		
Definition	It is the current whose magnitude and direction continuously changes with respect to time.	It is the current whose magnitude and direction do not change with respect to time.

1 mark for each of any four points

Use of transformer	Possible	Not Possible
Distribution efficiency	High	Low
Design of machines	Simple	Complicated
Generation	Mostly by electromechanical energy conversion	Mostly by electrochemical energy conversion and also by conversion of AC to DC using converters
Applications	AC machines, Domestic and industrial	DC machines, electroplating, HVDC system, battery charging

4 c) Define the following terms:

i) Magnetic flux density,
ii) Reluctance,
iii) Magneto-motive force,
iv) Permeance.

Ans:

(i) **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).

(ii) **Reluctance:** It is the opposition offered by magnetic path to flux. It is measured in AT/wb.

(iii) **Magnetic Motive Force (MMF):** It is defined as the entity (quantity or force) that sets up or creates magnetic flux in a magnetic circuit. It is the product of the number of turns and the current in the coil (MMF = NI). Its unit is Ampere (A) OR ampere-turns

(iv) **Permeance:** It is the property of magnetic circuit due to which it permits the magnetic flux to set up through it and it is reciprocal of reluctance. Permeance = 1/ Reluctance. Unit: weber/ampere.

1 mark for each definition
Units are not expected

4 d) State Kirchhoff's current law and explain with neat diagram.

Ans:

Kirchhoff's current law:

It states that in any electric network, at any node or junction, the algebraic sum of currents is zero.

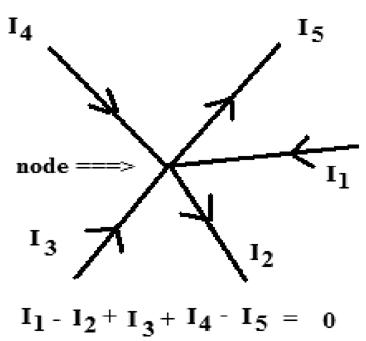
i.e. At a node $\sum I = 0$

OR

At any node or junction in an electric circuit, the total incoming current is equal to the total outgoing current.

i.e. $I_1 - I_2 + I_3 + I_4 - I_5 = 0$

Incoming current towards the junction (node) is considered as plus (positive) and current leaving the junction (node) is considered as minus (negative).



2 marks for statement
+
2marks for explanation with diagram

4 e) The capacitance of capacitor formed by two parallel plates each of 200 cm^2 area

separated by dielectric of thickness 4 mm is 0.0004 μF. Voltage of 20,000 volt is applied to the capacitor. Calculate:

i) Total charge on plates
ii) Electric flux density.

Ans:

Given Data: $A=200\ cm^2 = 200\times10^{-4}\ m^2$, $d = 4\ mm = 4\times10^{-3}\ m$,
$C=0.0004\ \mu F = 0.0004\times10^{-6}\ F$, $V= 20000\ V$

(i) $Q = CV= 0.0004\times10^{-6}\times 20000 = \mathbf{8\times10^{-6}\ C = 8\ \mu C}$ — 2 marks

(ii) $B = Q/A= 8\times10^{-6}/200\times10^{-4} = \mathbf{0.0004\ C/m^2}$ — 2 marks

4 f) A mild steel ring of 30 cm circumference has cross sectional area of 6 cm^2 and winding of 500 turns. Air gap is cut of 1 mm in magnetic circuit. A current of 4 A produces a flux density of 1 Tesla in air gap. Find

i) Total ampere turns
ii) Relative permeability of steel

Ans:

Given data: l = 30cm = 0.3m, $a = 6\ cm^2 = 6\times10^{-4}\ m^2$, N =500 turns,
I = 4 A, B =1 tesla air gap =1mm = 1×10^{-3} m

(i) Amp-turns = N×I = 500×4 = **2000 AT** — 2 marks

(ii) $H = NI/l = 500\times4/0.3 = 6666.66$ AT/m
$B = \mu_0\ \mu_r H$ therefore $\mu_r = B/(\mu_0 H)$, $\mu_0 = 4\pi\times10^{-7}$
Relative permebility of steel
$\mu_r = 1/(4\pi\times10^{-7}\times6666.66)$= **119.366** — 2 marks

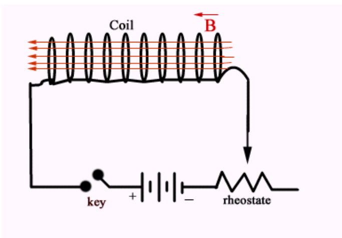
5 Attempt any FOUR of the following: 16

5 a) Derive expression for energy stored in magnetic field of a coil.

Ans:

The energy is stored in magnetic field when current increases and return back when the current decreases.

At instant 't' seconds after closer of switch (Refer Fig.), let the current be 'I' amperes. If current increases by di amperes in dt seconds, then e.m.f. induced in the coil, — 1 mark



$e = -L\ (di/dt)$ volts — 1 mark

The e.m.f. opposes the current and energy drawn from the source.
Component of applied voltage to neutralize the induced e.m.f. = - e volts.
Therefore Energy absorbed by the magnetic field during dt seconds
= Power x Time = (-e) i dt = L (di/dt) x i x dt = L i di joules — 1 mark

Hence total energy absorbed by the magnetic field when current increases from 0 to I amperes

$$E = L\int_0^I i\,di = L(\frac{1}{2}i^2)_0^I = \frac{1}{2}LI^2$$

$\therefore$ E = ½ L I^2 joules — 1 mark

5 b) Calculate the inductance and energy stored in magnetic field of air cored coil of 250 cm long, 50 cm diameter and wound with 4000 turns and carrying current of 10 A.

Ans:

Given**:** l = 250 cm = 2.5 m, d = 50 cm = 0.5 m, N = 4000 turns, I = 10A

i) Inductance:

Magnetizing force H = $\frac{NI}{l} = \frac{4000\times10}{2.5}$ = 16000 AT/m.

Reluctance, $S = \frac{l}{\mu_0\times\mu_r\times a}$

Now $\mu_0 = 4\pi\times10^{-7} H/m$ μ_r = 1, a = $\pi r^2 = \pi\frac{d^2}{2} = \pi\frac{0.5^2}{2}$ = 0.196 m^2

$S = \frac{2.5}{4\pi\times10^{-7}\times1\times0.196}$ = 1.01502 × 10^7 AT/wb

$\therefore$ Inductance $L = \frac{N^2}{S} = \frac{4000^2}{1.01502\times10^7} = 1.576\ H$ — 2 marks

ii) Energy stored in magnetic field: — 2 marks

E = ½ L I^2 = ½ × 1.576 × 10^2 = 78.8 joules.

5 c) Air core coil has 500 turns and diameter of 30 cm and cross sectional area 3 cm^2. Calculate:

i) Inductance of coil
ii) Emf induced in coil if current of 2A is reversed in 0.04 sec.

Ans:

Given:- d = 30cm = 0.3m, N = 500 turns, air cored coil $\therefore \mu_r$= 1
a = 3cm^2 = 3 × 10^{-4} m^2

Inductance of coil $L = \frac{N^2}{S}$ But $S = \frac{l}{\mu_0\times\mu_r\times a}$

$\therefore L = \frac{N^2\times\mu_0\times\mu_r\times a}{l} = \frac{(500)^2\times4\pi\times10^{-7}\times1\times3\times10^{-4}}{\pi\times0.3}$ = 0.1 × 10^{-3} H — 2 marks

Induced emf
di= 2 - (-2) = 4A, dt = 0.04sec
$\therefore e = L\frac{di}{dt}$ = 0.1 × 10^{-3} × $\frac{4}{0.04}$ = 0.01 Volt — 2 marks

5 d) What is amorphous metal material? Give any three properties of amorphous metal.

Ans:

Amorphous metal:

The amorphous is metal alloy which differ in crystalline structure. The atoms are arranged in random configuration. — 1 mark

Properties of amorphous metal:

1) Thermal conductivity of amorphous metal is lower than that of crystalline

metal.

2) High magnetic susceptibility with low coercivity and high electrical resistance which contribute to low losses. — 1 mark for each of any 3 points
3) High resistance which leads to low eddy current losses.
4) The tensile strength is almost that of high grade titanium.
5) They are true glasses, which mean that they soften and flow upon heating, which allows easy processing.
6) The alloy does not undergo shrinkage on solidification, which helps in bones attachments.

5 e) State and explain Faraday's law of electromagnetic induction.

Ans:

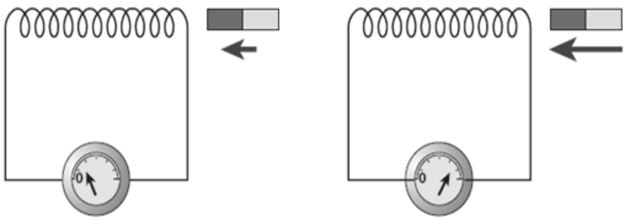
Faraday's laws of electromagnetic induction:

First law: — 2 marks for statements

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

Second law:

The magnitude of EMF induced in the conductor depends on rate of change of flux linking with the conductor.



2 marks for explanation

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 e.m.f. is as follows:
- $|e| \ \alpha$ (change in flux)/(time in which it occurs)

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

5 f) Define following terms:

i)Cycle,
ii) Frequency,
iii)Amplitude,
iv) Time period

Ans:

i) **Cycle**: Each repetition of complete set of changes undergone by the alternating quantity is called as cycle.
OR
A complete set of positive and negative values of an alternating quantity.

ii) **Frequency (f):** The number of cycles completed by an alternating quantity in one second is known as its frequency.

iii) **Amplitude:** The maximum value attained by alternating quantity during its positive or negative half cycle, is called as its amplitude.

iv) **Time period (T):** It is time in seconds required for an alternating quantity to complete its one cycle.

1 mark for each term = 4 Marks

6 Attempt any FOUR of the following: 16

6 a) Describe the laws for finding direction of induced e.m.f.

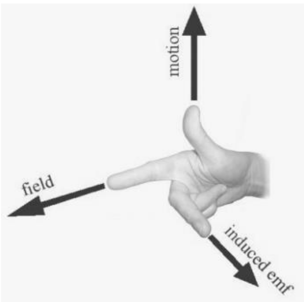
Ans:

The direction of statically induced e.m.f. is given by **Lenz's law.**

Lenz`s Law: It states that the direction of an induced e.m.f. is such that it always opposes the cause that produces it. 2 marks

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

Flemings Right hand rule:



Fleming's right hand rule states that arrange first three fingers of your right hand mutually perpendicular to each other, in such way that forefinger (first finger) showing the direction of magnetic field, thumb indicating the direction of motion of conductor with respect to magnetic field, then second (middle) finger gives the direction of induced e.m.f., hence current in the conductor. 2 marks

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

Ans:

Steps to carry out the maintenance of lead acid batteries:

1) Keep the container surface dry by using dry cloths.
2) Tighten the terminal connections.
3) Battery should not be discharged below a minimum voltage.
4) Never keep battery in discharged condition.
5) Check the specific gravity of the electrolyte and maintainn it by adding distilled water.
6) Electrolyte level should be maintained above the electrodes.
7) Battrey should not be overcharged.
8) Charge battrey at specific rate.
9) During initial charging use fresh electrolyte.
10) Avoid overcharging and short circuit of plates.

Any eight point ½ mark each = 4 Marks

WINTER – 2016 Examinations

Model Answer

Subject: 17214: Fundamentals of Electrical Engineering

6 c) Distinguish between HRGO and CRGO on any four points.

Ans:

Sr. No.	HRGO	CRGO
1	Hot rolled grain oriented steel	Cold rolled grain oriented steel
2	Grain orientation is obtained by hot rolling to obtain soft steel to facilitates machining process.	Grain orientation is obtained by cold rolling so facilitates easy flux passing so that less magnetising force is required.
3	Magnetising current required is slightly more.	Magnetising current required is less.
4	Used in instrument core etc.	Used in Transformer core, Machine cores etc.
5	Less cost	More cost

Any four points 1 mark each = 4 marks

6 d) State necessity of series connection and parallel connection of batteries.

Ans:

Necessity of series connection of batteries:

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 voltage is equal to the sum of individual battery voltages.

$$V_L = V_1 + V_2 + V_3 + V_4$$

2 marks

Necessity of parallel connection of batteries:

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.
3. The parallel connected batteries together supply the required load current depending on their internal resistances (they have identical e.m.f.s).
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.

2 marks

6 e) List four examples of insulating material and explain any two.

Ans:

Examples of insulating materials:

- **i) Solid:** Ceramic, Porcelain, Mica, Glass, Rubber, Resinous, Fibers
- **ii) Liquid:** Synthetic, Mineral etc.
- **iii) Gaseous:** Hydrogen, Air, Nitrogen, Sulphur-hexa-fluoride

Any 4 examples ½ marks each = 2 marks

a)Porcelain:

Porcelain is widely used material in electric fields. In mineral form it can mix with water and when it is wet it can be easily shaped. After backing it becomes water resistant and acquires mechanical strength. Porcelain is made from china clay and quartz. Its compression strength is 5000 kg/cm^2 and tensile strength is 400 kg/cm^2. Specific weight is 2.3 to 2.5 gm/cm^2. It is water and heat resistant but at a very high

temperature it deteriorates sharply.
Its resistivity is high. Chemical effect on it negligibly small.
Use: it is mostly used for making different types of insulators, bushings, oil C.B., disconnecting switches, Arresters, plugs, fuses, bodies and mounting plates.

b)Glass:
It is manufactured by fusing silica (sand), alkali (potash, soda), and base (lead oxide or lime). Properties of glass depend on the composition and heat treatment. Its compression strength is 6000 to 21000 kg/cm^2 and tensile strength is 100 to 300 kg/cm^2. Specific weight is 2 to 8.1 gm/cm^2. Silica has high insulating properties, high heat resistant and hydraulic strength. Explanation any two materials 1 mark each
Uses: As dielectric in capacitors, Light and electron tubes, filament support, Various kinds of insulating supports, antennas, bushings etc.

c)Mica:
Mica is mineral substance obtained from earth, requires no thermal and chemical process and can directly be used. Its resistance is very high and mechanical strength is also very high. It is moisture resistant, heat resistant, also has good elasticity. At high temperatures it retains its electrical and mechanical properties.
Uses: Insulation in commentator, insulators in heating equipments, also used in stator and rotor windings of electric machines.

d)Varnishes:
These are solutions of certain materials like resins, bitumen, drying oils and some base. When thin film of varnish is applied on the solid surface it dries up and forms hard film. It has high insulating properties and low hygroscopicity.
Uses: Insulation in electric field, transformer stampings, armature, pole stampings.

6 f) Based on temperature withstanding ability, classify insulating material.

Ans:

class	**Temperature withstanding ability in ^{0}C**	**Materials**
Y	90	Cotton, silk paper and similar organic materials neither impregnated nor immersed in any oil, rubber, PVC.
A	105	Impregnated paper, silk, cotton, polyamides resins
C	120	Enameled wire insulations on base of polyvinyl formal, polyurethane and epoxy resins, molding etc.
B	130	Inorganic materials (mica, fibre, glass, asbestos) impregnated with varnish and other compounds
F	155	Mica, polyester, epoxide varnishes with a high heat resistance
H	180	Composite materials on mica, fiber, glass and asbestos bases, impregnated with silicon rubber except other rubber compounds
C	Above 180	Mica, ceramics, glass, Teflon, quartz, etc.

Any four types with temperature range & materials expected 1 Mark each