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.

Q.1.

A. Attempt any six of the following: **12M**

a) Define loop and node in a network.

(Each definition – 1M)

Loop: It is a closed path in a circuit in which no element or node is encountered more than once

Node: It is a junction in a circuit where two or more circuit elements are connected together. For two nodes to be different, their voltages must be different.

b) State Faraday's laws of electromagnetic induction.

(First law – 1M; Second law – 1M)

Faraday's First Law of Electromagnetic Induction: It states that whenever magnetic flux linked with a circuit changes, an emf is always induced in it.

OR

Whenever a conductor cuts magnetic flux, an emf is induced in that conductor.

Faraday's Second Law of Electromagnetic Induction: It states that the magnitude of induced e.m.f. is equal to the rate of change of flux linkages.

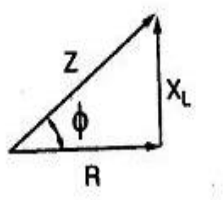
c) Define RMS value of AC quantity.

Correct Definition – 2M

R.M.S. (Root Mean Square) value of an AC quantity is equal to the DC quantity that is required to produce the same amount of heat as produced by the AC quantity, provided the resistance and time for which these currents flow are identical. The relation between the RMS value and Peak value can be defined for current as given below.

$I_{rms} = 0.707\ I_m$

d) Draw impedance triangle for series R-L circuit.
Correct diagram – 2M



e) State the types of transformer depending on their construction.

Each type – 1M
Transformers are of 2 types based on the construction as
1. Core Type
2. Shell Type

f) Define voltage ratio for 1Φ transformer.
(Correct Definition – 2M)
Voltage Ratio of a single phase transformer is defined as the ratio of primary voltage to secondary voltage
Voltage Ratio = $\frac{PrimaryVolatge\ (V1)}{Seconaryvolatge\ (V2)}$

g) Define statically induced emf.
Correct Definition – 2M
In statically induced e.m.f., the conductor or the coil remains stationary and flux linked with it is changed by simply increasing or decreasing the current producing this flux. (as in transformers). Statically induced e.m.f. can be mutually induced or self induced.

h) Give classification of fuses.

Any two – 1M each
Different types of fuses are,
1. Semi enclosed or rewirable type
2. Totally enclosed or cartridge type
3. Dropout fuse
4. Expulsion fuse
5. H.R.C fuse
6. Striker fuse
7. Switch fuse

i) State Lenz's law.

Correct Definition – 2M

Lenz's law: This law gives the direction of the induced e.m.f. The direction of the induced e.m.f. produced during electromagnetic induction is such that it sets up current opposing the basic cause that produced it. The Minus sign in the below equation signifies Lenz's Law.

$$e = -N\frac{d\Phi}{dt}$$

B. Attempt any two of the following: 8M

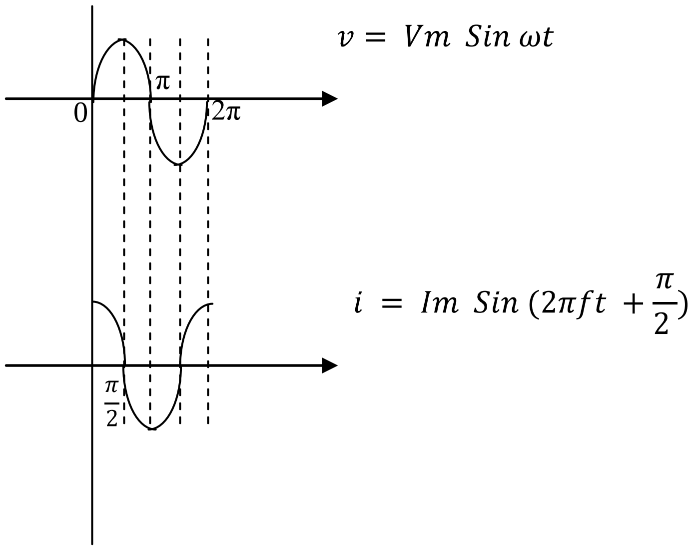
a) Write the equations of instantaneous values of voltage and current through a pure capacitor. Draw the waveforms of voltage and current.
(Each equation – 1M; Each Waveform – 1M)

Equations for instantaneous values of voltage and current through a pure capacitor:
Instantaneous voltage,
$v = Vm\ Sin\,\omega t = Vm\ Sin 2\pi f t$

Instantaneous current,

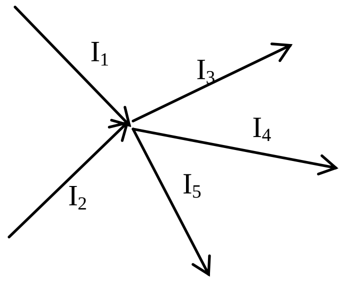
$i = Im\ Sin\,(2\pi f t + \frac{\pi}{2})$

Waveforms:



b) State KCL and KVL with the help of suitable example.

KCL (Kirchhoff's Current Law): 2M
It states that in any electrical network, the algebraic sum of the currents meeting at a point (or junction) is zero.
i.e., total current leaving a junction = total current entering that junction.
For example,



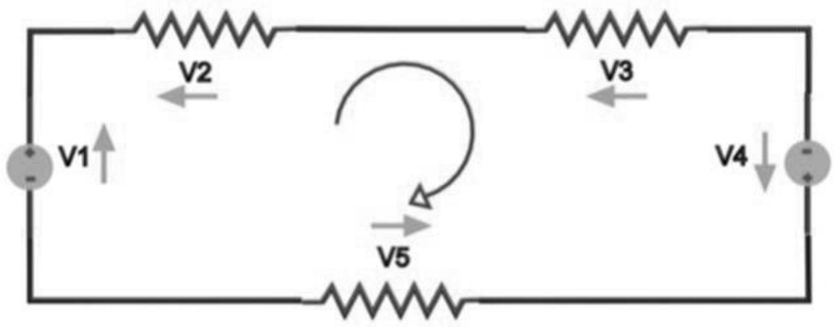
In the above example, $I_1 + I_2 = I_3 + I_4 + I_5$

KVL (Kirchhoff's Voltage Law): 2M
It states that, in any closed circuit, the algebraic sum of the e.m.f's and products of the currents and resistances is zero.

OR

It states that, in any electrical circuit, the algebraic sum of voltages in a loop or mesh is equal to zero.

For example,



Applying KVL,
$-v1+v2+v3-v4+v5=0.$
Note: Any other example may also be considered.

c) Calculate the current flowing through each resistor by loop current method for the circuit.

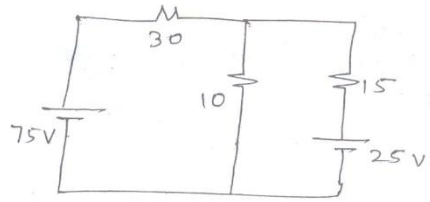
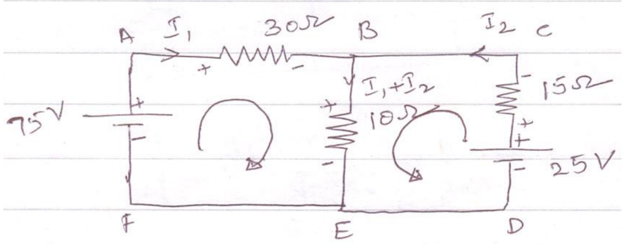


Fig. (i)



Loop ABEFA,

Apply KVL
$75-30I_1-10(I_1+I_2)=0$
$30I_1+10I_1+10I_2=75$
$40I_1+10I_2=75$---------(i) **(2M)**

Loop CBEDC,
Apply KVL
$25-15I_2-10(I_1+I_2)=0$
$15I_2+10I_1+10I_2=25$------(ii)

Solving (i) & (ii)
Multiply (ii) by 4
$40I_1+10I_2=75$
$40I_1+100I_2=100$
$90I_2=25$ **(1M)**
$I_2=25/90=0.28A$

$40I_1+10I_2=75$
$40I_1+10(0.28)=75$
$I_1=1.8A$
Current through 30Ω=1.8A
15Ω=0.28A **(1M)**
10Ω=2.08A

Q.2. Attempt any four of the following: 16M

a) Define (i) RMS value and (ii) Average value of an a.c.
(Each Definition 2M)

R.M.S. (Root Mean Square) value of an AC quantity is equal to the DC quantity that is required to produce the same amount of heat as produced by the AC quantity, provided the resistance and time for which these currents flow are identical.

OR

The effective or root mean square (RMS) value of a periodic signal is equal to the magnitude of a DC signal which produces the same heating effect as the periodic signal when applied across a load resistance.

The relation between the RMS value and Peak value can be defined for current as given below.

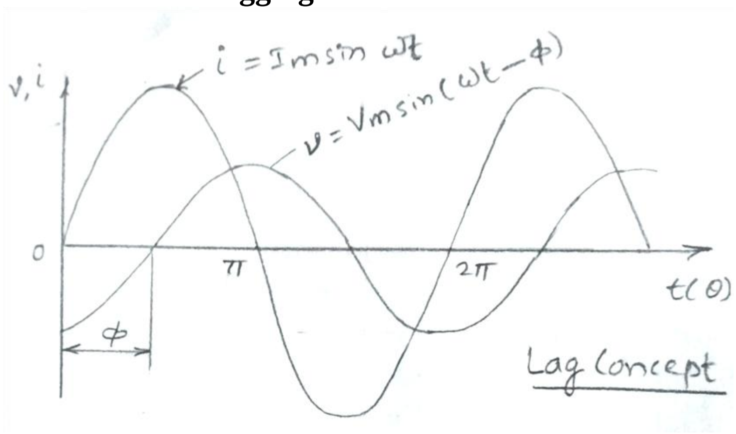
I_{rms}= 0.707 I_m

Average Value of an AC quantity is equal to the average of all the instantaneous values over a period of half cycle.

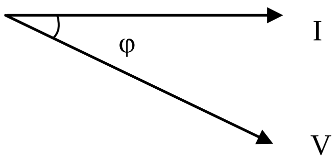
Average Value = 0.637 * Peak value

b) Draw waveform and phasor representation for lagging and leading ac quantities.
(Each Waveform 1M; Each Phasor 1M))

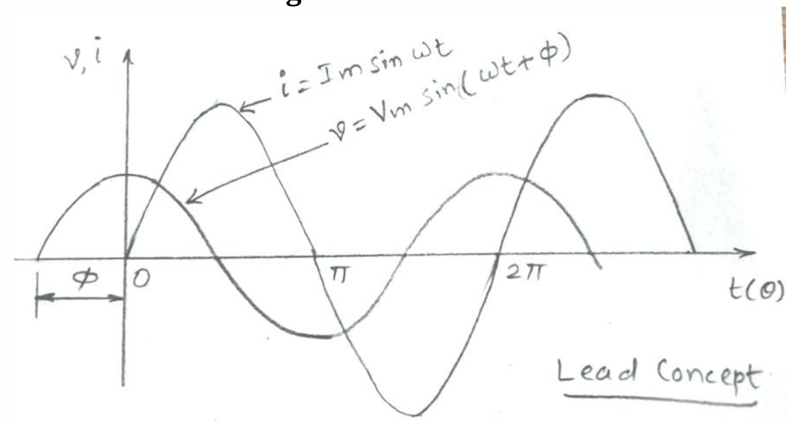
Waveform for Lagging:



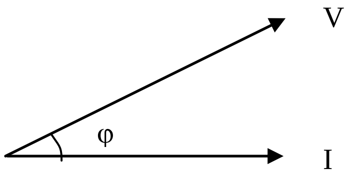
Lagging Phasor Represenation: Voltage (V) lagging current (I) by angle Φ



Waveform for leading



Leading Phasor Representaion:Voltage (V) leading current (I) by angle Φ



c) **Calculate amplitude, RMS value, time period and phase angle for $e=100\sin(314t+30^o)$**
(Each term calculation -1M)

Given,

$e = 100 \text{ Sin } (314t + 30^o)$
This is of the form,
$e = V_m \text{ Sin } (\omega t + \varphi)$
Therefore,

i. **Amplitude V_m = 100volts**

ii. **RMS value** = V_{rms} = $0.707\ V_m$

= 0.707 * 100 = 70.7volts

iii. **Time period :-**

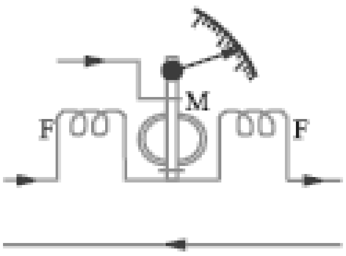
$\omega = 2\pi f$
$314 = 2 * \pi * f$
Therefore, $f = \dfrac{314}{2 * \pi}$ = 49.97Hz.
Time Period = $\dfrac{1}{f} = \dfrac{1}{49.97} =$ **0.02 Sec**

iv. **Phase Angle** = 30^o

d) Draw the connection diagram for measurement of 1Φ power using Dynamometer type wattmeter.

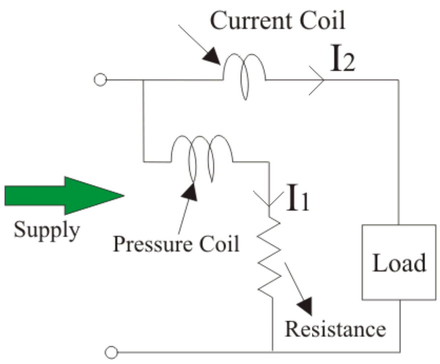
Correct diagram – 4M

Note: any diagram with fixed coils and moving coils with needle may be considered.

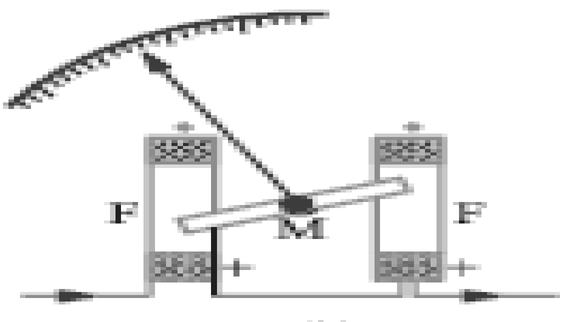


Where F = Fixed Coil; M – Moving Coil

OR

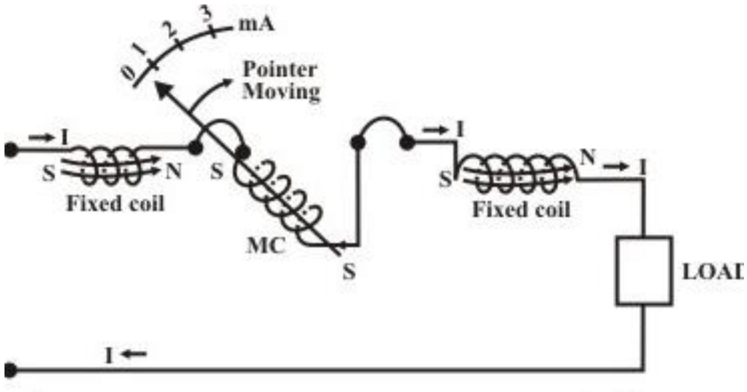


OR

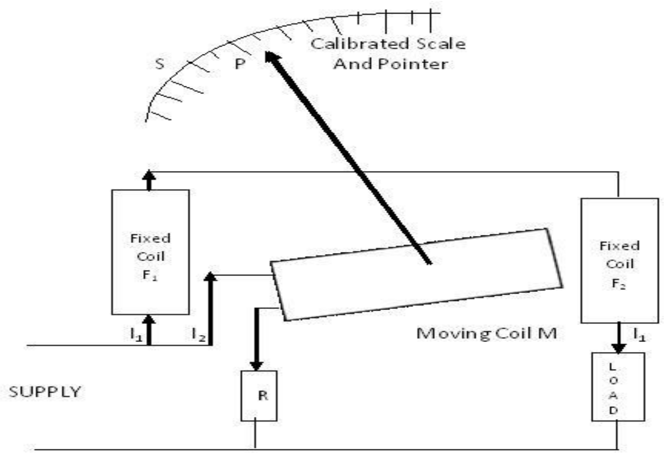


Where F = Fixed Coil; M – Moving Coil

OR

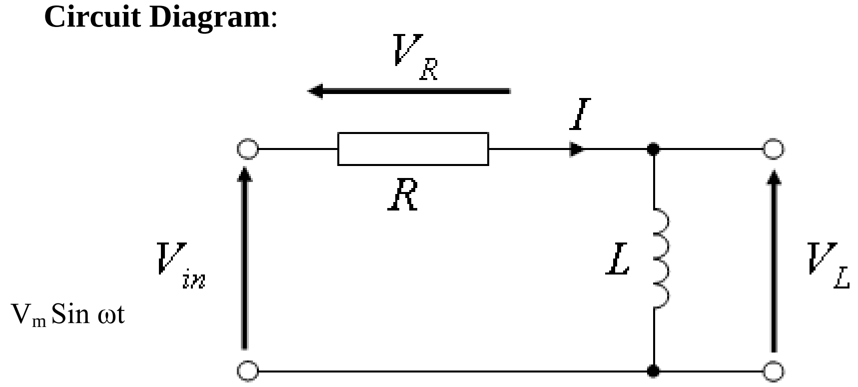


OR

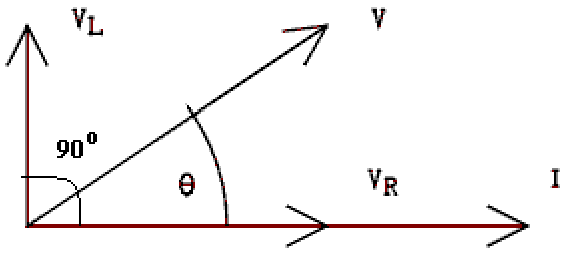


e) Draw series RL circuit indicating all voltages and current and hence draw phasor diagram for the same.
Circuit Diagram – 1M; Correct labeling: 1M; Phasor Diagram – 2M

Circuit Diagram:



Phasor Diagram:

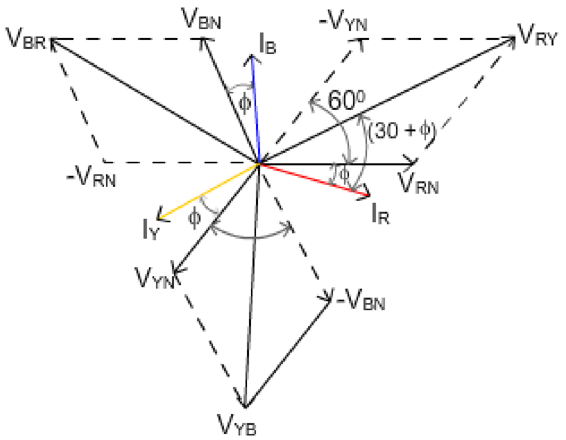


f) State 4 advantages of 3Φ circuit over 1Φ circuit.
(Any 4 each 1M)
Advantages of three phase supply system over single phase system.

Single Phase system	**Three phase system**
Voltage low(230V)	Voltage high(415V)
For same capacity single phase machine occupies more space.	Size of machines to produce same output is smaller.
Motors working on single phase are not self starting	Motor are self starting
Transmission efficiency is low	Transmission efficiency is high
Power delivered to the load fluctuates and falls to zero three time during each cycle	Power delivered to load is the same at any instant.
Used in domestic, small power applications	Used in industrial large power applications

Q.3. Attempt any four of the following: 16M

a) Prove the relationship between line and phase voltage for balanced star connected load with the help of phasor diagram.
(Equation 2M, Diagram 2M)



Voltage Relation:
Where
V_{RY}= V_{YB} =V_{BR} =Line voltages =V_L
V_{RN}=V_{YN} =V_{BN} =Phase voltages =V_{ph}

Consider first the two terminals (or line) R an Y. as voltage between the lines is equal to the phasor difference between the two corresponding phase voltage,

$V_{RY} = V_{RN} - V_{YN}$

Applying KVL between the lines R and Y

$V_{RY} - V_{RN} + V_{YN} = 0$

$V_{RY} = V_{RN} - V_{YN}$

Applying KVL between the lines Y and B
$V_{YB} = V_{YN} - V_{BN}$

Similarly applying KVL between the lines B and R
$V_{BR} - V_{BN} + V_{RN} = 0$
$V_{BR} = V_{BN} - V_{RN}$

$$\text{Magnitude of } V_{RY} = \sqrt{V_{RN}^2 + V_{YN}^2 + 2V_{RN}.V_{YN}\cos 60^\circ}$$

$$= \sqrt{V_{RN}^2 + V_{YN}^2 + 2V_{RN}.V_{YN}\cdot {}^1\!/_2}$$

$$= \sqrt{V_{RN}^2 + V_{YN}^2 + 2V_{RN}.V_{YN}}$$

$$But\, V_{RN} = V_{YN} = V_{ph.}$$

$$V_{RY.} = V_L$$

$$V_{RY} = \sqrt{V_{ph}^2 + V_{ph}^2 + 2V_{ph.}V_{ph}}$$

$$= \sqrt{3}.V_{ph.}$$

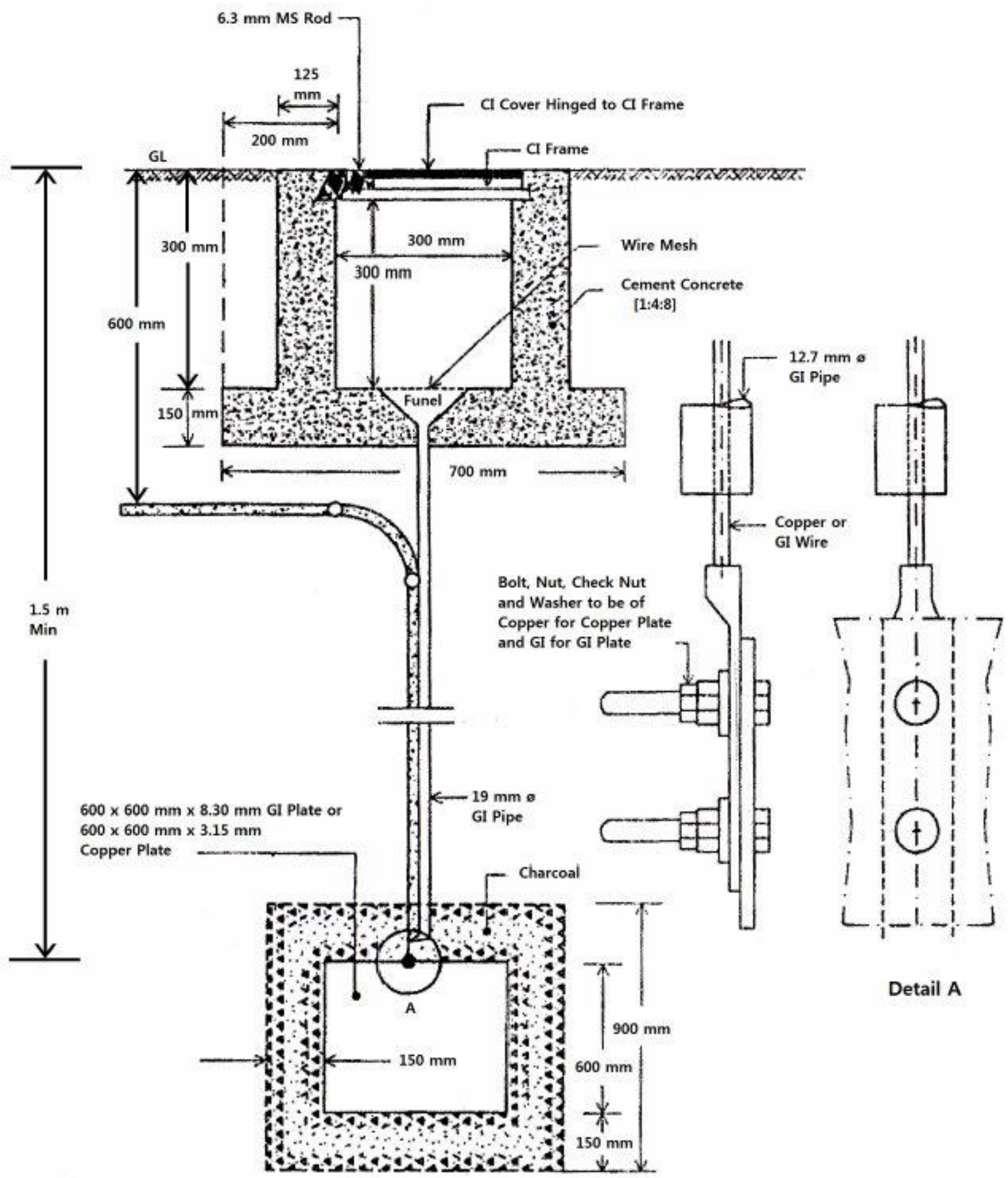
$$\therefore V_{ph.} = \frac{V_{RY}}{\sqrt{3}} = \frac{V_L}{\sqrt{3}}$$

Similarly
$V_{YB} = \sqrt{3}\, V_{ph}$
$V_{BR} = \sqrt{3}\, V_{ph}$
$V_{YB} = V_{BR} = V_L$
$V_L = \sqrt{3}\, V_{ph}$

Line Voltage=$\sqrt{3}(\boldsymbol{phase\ Voltage})$

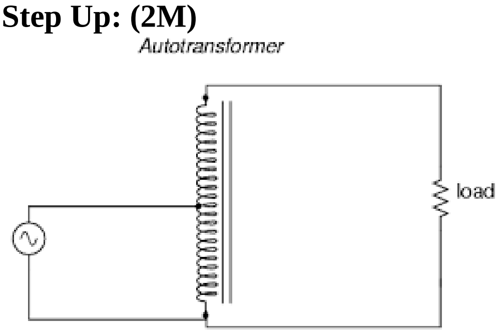
It should be noted that there is a phase displacement of 30^0 between them.

b) Draw neat sketch of plate earthing.
(labeled Diagram 4M)

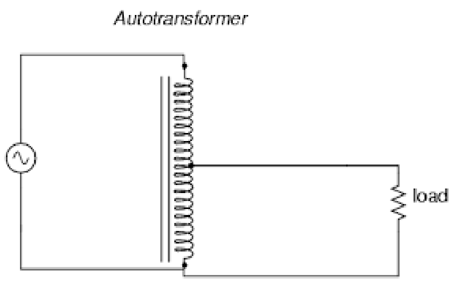


c) Draw connection diagram for step up and step down autotransformer.

Step Up: (2M)

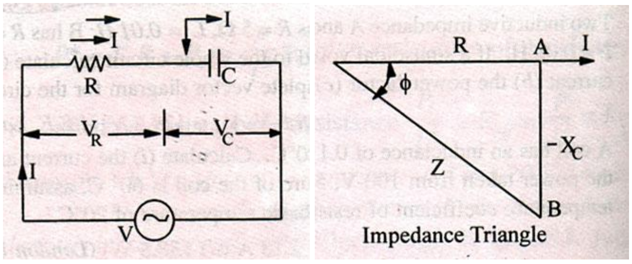


Step down : (2M)



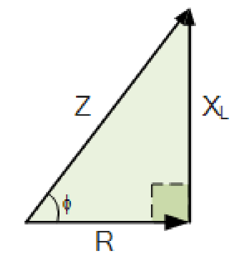
d) Draw the impedance triangle for series RL and RC circuit.

Impedance triangle for RC series: (2M)



Impedance Triangle

Impedance triangle for RL series (2M)



Impeadance Triangle

$$Z = \sqrt{R^2 + X_L^2}$$

$$\tan\Phi = \frac{X_L}{R}$$

$$\sin\Phi = \frac{X_L}{Z}$$

$$\cos\Phi = \frac{R}{Z}$$

e) A choke coil is connected across 230 V, 50 Hz supply. The power consumed by the coil is 960 W and current is 8amp. Calculate circuit constants (R and L).

Given:

v=230V, f=50Hz, P=960W, I=8amp

Impedance=V/I=230/8=28.75Ω

Effective resistance:

$P=I^2R$

$960=8^2R$

$\therefore \boldsymbol{R = 15\Omega} ------ \text{(2M)}$

***Reactance*:**

$X_L = \sqrt{Z^2 - R^2}$
$= \sqrt{28.75^2 - 15^2}$
$\therefore \boldsymbol{X_L = 24.52}\Omega$

Inductance:

$$L = \frac{\boldsymbol{X_L}}{2\pi f}$$

$$L = \frac{24.52}{2 \times 3.14 \times 50}$$

$\therefore \boldsymbol{L = 0.078H ------(2M)}$

Circuit constants (R=15Ω),(L= $\boldsymbol{0.078H}$)

f) Three similar coil each having a resistance of 20Ω and inductance of 0.05 H are connected in star to a 3Ǿ, 400 V, 50 Hz supply. Calculate

i. Line currents
ii. Total power absorbed.
Given:
R=20Ω , L=0.05H, V=400V, f=50Hz

i. Line currents: (2M)

$\boldsymbol{X_L} = 2\pi f L$
$\boldsymbol{X_L} = 2 \times 3.14 \times 50 \times 0.05$
$\therefore \boldsymbol{X_L = 15.7}\Omega$
$\boldsymbol{V_L = 400V}$

$$\boldsymbol{V_{PH} = \frac{400}{\sqrt{3}}} (\because \boldsymbol{star\ connection})$$

$$\boldsymbol{V_{PH} = 230.94V}$$

Impedance:

$$Z_{PH} = \sqrt{R^2 + {X_{L_{PH}}}^2}$$

$$Z_{PH} = \sqrt{(20^2 + (15.7)^2)}$$

$$\boldsymbol{Z_{PH} = 25.43\Omega}$$

Phase current:

$$I_{PH} = \frac{V_{PH}}{Z_{PH}}$$

$$I_{PH} = \frac{230.94}{25.43}$$

$$\therefore \boldsymbol{I_{PH} = 9.08A}$$

As circuit is connected in star connection, Relation between Phase and line current is,

$$\boldsymbol{I_{PH} = I_L}$$

$$\therefore \boldsymbol{Line\ current\ I_L = 9.08A}$$

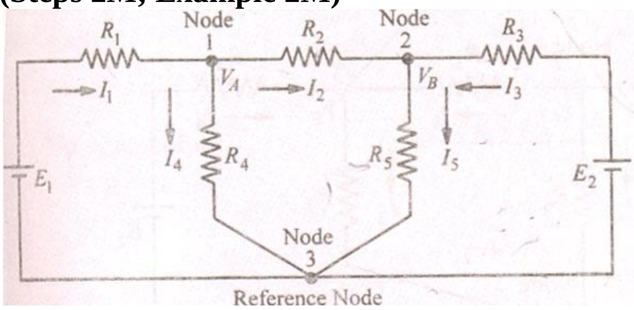
ii. Total Power absorbed: (2M)

$$Power = \sqrt{3}.V_L.I_L \cos\emptyset$$
$$\cos\emptyset = R/Z = 20/25.43 = 0.7865$$
$$P = \sqrt{3}\times 400\times 9.08\times 0.7865$$
$$= 4947.72W$$
$$\therefore \boldsymbol{P = 4.9477KW}$$

Line current = 9.08A, Total power absorbed P= 4.9477KW

Q.4. Attempt any four of the following: 16M

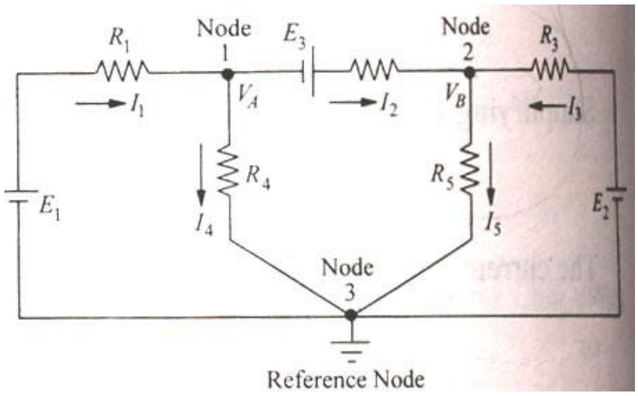
a) Write the steps of Nodal voltage method with suitable example.
(Steps 2M; Example 2M)



First Case:
For the node 1, the following current equation can be written the help of KCL.

$$I_1 = I_4 + I_2$$
$$I_1R_1 = E_1 - V_A$$
$$\therefore I_1 = (E_1 - V_A)/R_1$$
$$I_4 = \frac{V}{R_4}\ also, I_2R_2 = V_A - V_B\ \because (V_A > V_B) --- (i)$$
$$I_2 = \frac{V_A - V_B}{R_2}$$
$$subsituting\ these\ values\ in\ Equation\ (i) above, we\ get,$$
$$\frac{E_1 - V_A}{R_1} = \frac{V}{R_4} + \frac{V_A - V_B}{R_2}$$

$$simplifying\ the\ above, we\ have$$
$$V_A\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_4}\right) - \frac{V_B}{R_2} - \frac{E_1}{R_1} = 0 ------(ii)$$
$$the\ current\ equation\ for\ node\ 2\ is\ I_5 = I_2 + I_3$$
$$or\quad \frac{V_B}{R_5} = \frac{V_A - V_B}{R_2} + \frac{E_2 - V_B}{R_3}$$
$$or\ V_B\left(\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_5}\right) - \frac{V_A}{R_2} - \frac{E_2}{R_3} = 0$$



Second case:
For node 1

$I_1 - I_4 - I_2 = 0$ *or* $I_1 = I_4 + I_2$ as per KCL

$$I_1 = \frac{E_1 - V_A}{R_1}; I_2 = \frac{V_A + E_3 - V_B}{R_2}; I_4 = \frac{V_A}{R_4}$$

$$\frac{E_1 - V_A}{R_1} = \frac{V_A}{R_4} + \frac{V_A + E_3 - V_B}{R_2}$$

$$V_A\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_4}\right) - \frac{E_1}{R_1} - \frac{V_B}{R_2} + \frac{E_3}{R_2} = 0 ----(i)$$

For node 2

$I_2 + I_3 - I_5 = 0$ *or* $I_2 + I_3 = I_5$ as per KCL

$$I_2 = \frac{V_A + E_3 - V_B}{R_2}; I_3 = \frac{E_2 - V_B}{R_3}; I_5 = \frac{V_B}{R_5}$$

$$\frac{V_A + E_3 - V_B}{R_2} + \frac{E_2 - V_B}{R_3} = \frac{V_B}{R_5}$$

$$V_B\left(\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_5}\right) - \frac{E_2}{R_3} - \frac{V_A}{R_2} - \frac{E_3}{R_2} = 0$$

Example *Using Node voltage method, find the current in the 3Ω resistance for the network shown in Fig.*

Solution. As shown in the figure node 2 has been taken as the reference node. We will now find the value of node voltage V_1. Using the technique developed in Art. 2.10, we get

$$V_1\left(\frac{1}{5}+\frac{1}{2}+\frac{1}{2}\right)-\frac{4}{2}-\left(\frac{4+2}{5}\right)=0$$

The reason for adding the two battery voltages of 2 V and 4 V is because they are connected in additive series. Simplifying above, we get V_1 = 8/3 V. The current flowing through the 3 Ω resistance towards node 1 is $= \frac{6-(8/3)}{(3+2)} = \frac{2}{3}$ A

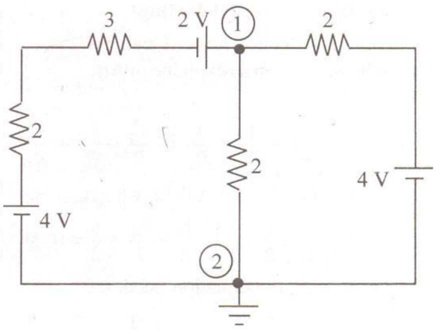


Fig.

Alternatively

$$\begin{aligned} \frac{6-V_1}{5}+\frac{4}{2}-\frac{V_1}{2} &= 0 \\ 12-2V_1+20-5V_1 &= 0 \\ 7V_1 &= 32 \end{aligned}$$

Also

$$\begin{aligned} \frac{6-V_1}{5}+\frac{4-V_1}{2} &= \frac{V_1}{2} \\ 12-2V_1+20-5V_1 &= 5\,V_1 \\ 12V_1 &= 32;\ V_1 = 8/3 \end{aligned}$$

b) Define the following terms:

i. Magnetic flux: (1M)

Total number of line of force in any particular magnetic field is called magnetic flux. Unit of magnetic flux is weber.

ii. Reluctance: (1M)

It is the name given to that property of a material which opposes the creation of magnetic flux in it. It measures the opposition offered to the passage of magnetic flux through a material and is analogous to resistance in an electric circuit even in form. Their unit is AT/Wb.

$$reluctance = \frac{l}{\mu A} = \frac{l}{\mu_0 \mu_r A}$$

iii. Inductance: (1M)

The property of an electric conductor or circuit that causes an electromotive force to be generated by a change in the current flowing. It is denoted by Land unit is Henry(H)

iv. Capacitance: (1M)

The capacitance of a capacitor is defined as “the amount of charge required in creating a unit p.d. between its plates.

$$C = \frac{Q}{V} = \frac{charge}{potential\ difference}$$

c) Define the following:

i. Power factor: (1M)

Power factor: The cosine of phase angle between current and voltage of the circuit is called Power factor.

p.f. = cos Φ

OR It is the factor by which apparent power is multiplied to obtain the active (true) power.
ORIt is also defined as the ratio of true (or active or real) power to the apparent power.
OR It is the ratio of resistance to impedance i.e. R/Z.

ii. **Apparent power: (1M)**
It is given by the product of r.m.s values of applied voltage and circuit current.

$$\therefore S = VI = (IZ)\ ,I = I^2Z\ volt - amperes(VA)$$

iii. **Phasor diagram: (1M)**

The diagram in which different alternating quantities (sinusoidal) of the same frequency are represented by phasors with their correct phase relationship is known as phasor diagram.

iv. **Reactive power: (1M)**
It is the power developed in the reactance of the circuit. It is given by the product of r.m.s values of applied voltage and circuit current and sine of phase angle between V and I.

d) Calculate R_{AB} for the circuit of fig (ii) by y/Δtransformation.
(Correct Calculation 4M)

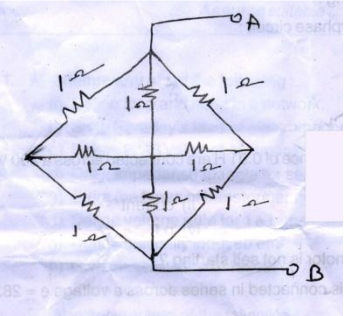
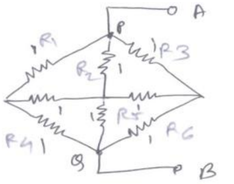


Fig. (ii)



As shown in fig, one End of Resistors R_1, R_2 & R_3 are connected to Node P. And R_4, R_5 & R_6 are connected to Q. Hence star connection is formed.

So, Applying star to Delta conversion,

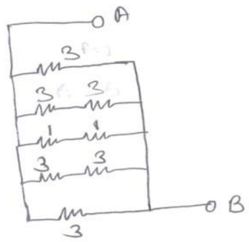
$$R_{12} = \frac{R_1 \cdot R_2 + R_2 \cdot R_3 + R_3 \cdot R_1}{R_3}$$

$$\frac{1+1+1}{1} = \frac{3}{1} = 3\,\Omega$$

Same formula applied for R_{23}, R_{31}, R_{45}, R_{56}, R_{46}

$R_{23} = 3\,\Omega$, $R_{31} = 3\,\Omega$, $R_{45} = 3\,\Omega$, $R_{56} = 3\,\Omega$, $R_{46} = 3\,\Omega$

circuit is,

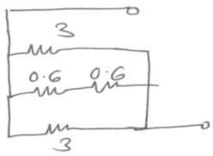


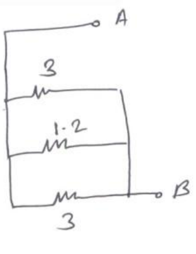
Parallel.

$3 \| 1 \| 3$

$3 \| 1 \| 3$

Resistors are in Parallel, By solving them we get,

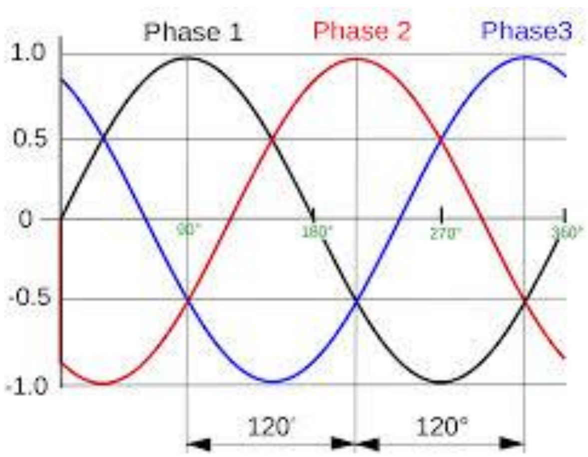




$\therefore R_{AB} = 3 \| 1.2 \| 3$

$$\boxed{\therefore R_{AB} = 0.66\,\Omega}$$

e) Draw the waveform representation of three phase a.c.
(Labeled diagram 4M)



f) Explain resonance in series RLC circuit.

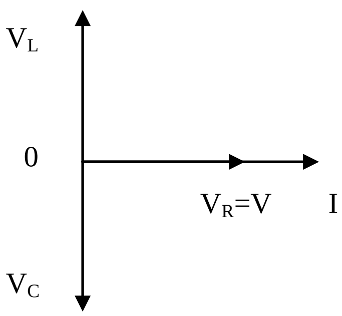
A R-L-C series circuit is said to be in electrical resonance when its net reactance is 0 i.e. Inductive reactance (X_L) = Capacitive reactance (X_C) and hence power factor of the circuit becomes unity. The frequency at which it happens is known as resonant frequency.

(2M)

The conditions under which resonance occurs in R-L-C series circuit are – **(2M)**

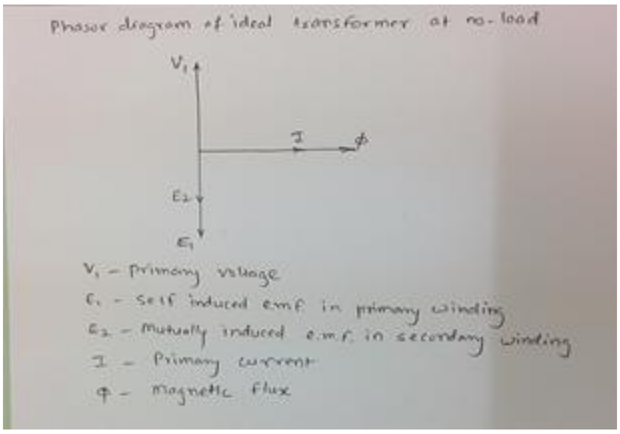
a) $X_{L=}$ X_c Hence Z = R (Minimum)
ii) Power factor is unity
iii) Voltage and current in R-L-C circuit are in phase with each other
iv) Current is Maximum
v) Power absorbed by the circuit is maximum.

Phasor Diagram (Optional)



Q.5. Attempt any four of the following: 16

a) Draw the phasor diagram for an ideal transformer.
(Correct diagram with nomenclature 4M)



b) Define efficiency and regulation of transformer. Write the condition for maximum efficiency.

(Each definition – 1 1/2 Marks and condition 1 mark)

i) Efficiency: It is the ratio of output power to the input power of transformer. It is expressed in terms of percentage.

Efficiency (ή) = $\frac{Output\ power}{Input\ power}$ x 100

$= \frac{Output\ power}{output\ power+losses}$ x 100

$= \frac{Outpur\ power}{Output\ power+Pi+Pc}$ x 100

Where Pi = Iron loss, Pc=Copper loss of Transformer

ii) **Voltage Regulation of transformer:** The ratio of the change in Secondary Terminal Voltage from No load to full Load (VFL) to no load voltage.(VNL)

So % Voltage Regulation $= \frac{V_{NL}-V_{FL}}{V_{NL}}$ x 100

Where V_{NL} = No Load Secondary voltage, V_{FL} = Full Load Secondary voltage

The condition for maximum efficiency : Pcu = Pi
Copper loss is equal to iron loss.

c) Write two applications of each motor:
i. Shaded pole motor
ii. Universal motor.

i. **Shaded pole motor: (2 marks)**

Small fans, toy motors, hair dryers, ventilators, electric clocks, record players, motorized valves, gramophones, photocopying machines, recording instruments, advertising displays etc. **(Any two)**

Applications of Universal motor: **(2 marks)**
Domestic appliances like vacuum cleaners, food mixers, sewing machines, portable drilling machines, coffee grinders, electric shavers, mechanical computing machines etc. **(Any two)**

d) State 2 advantages and 2 disadvantages of 1Φ autotransformer.

Advantages of 1 Φ autotransformer: (Any two- 2 marks)
1) As only one winding is used the copper required for the transformer is very less.
2) The size and hence the cost is reduced as compared to the conventional transformer.
3) The losses taking place in the winding are reduced hence efficiency is higher as compared to the conventional transformer.
4) Due to reduced resistance the voltage regulation is better than the conventional transformer.

Disadvantages of 1 Φ autotransformer: (Any two- 2 marks)
1) There is no electrical isolation between the primary and secondary windings.
2) If the common part of the winding breaks (open circuited) then the transformer action is lost and full primary voltage appears across secondary.
3) It has a low impedance hence if secondary winding is short circuited, then a large current will flow on secondary side.

e) Compare fuse and MCB of the basis of
i. Service
ii. Operation
iii. Safety
iv. Cost

FEATURES	MCB	FUSE
Service	Can be reused after successful operation	Needs replacement after it is blown away once
Operation	MCB trips off in case of excessive load (works on bimetal expansion or induced magnetism)	Fuse melts/fuses in case of excessive load (due to increase in temperature)
Safety	More safe than fuse	Less safe as compared to MCB
Cost	Relatively costlier than fuse	Relatively cheaper than MCB

f) Write 4 steps for handling shock victims.

Steps : (any 4 – 04 marks)

i) Determine whether the victim is breathing. If the victim is not breathning, you must apply artificial ventilator (respirations) without delay.

ii) lay the victim face up. The feet should be about 12 inches higher than head. Chest or head injures require the head to be slightly elevated.

iii) If there is vomiting or if facial injuries have occurred which cause bleeding into throat, the victim should be placed on the stomach with head turned to and side and 6 to 12 inches lower than the feet.

iv) Keep victim warm. Keep the victim covered with one or more blankets depending upon weather conditions.

v) Small amount of warm salt water, tea or coffee should be used.

Q.6. Attempt any four of the following: 16

a) Define the following for polyphase circuit.

a. **Balanced load**
b. **Unbalanced load**
c. **Balanced supply**
d. **Unbalanced supply**

Define the following for polyphase circuit:

(1 mark for each)

Balanced load: If all phase impedances of the three phase load are exactly identical in respect of magnitude and their nature, then it is called a Balanced three phase load.

Unbalanced load: If all phase impedances of the three phase load are not identical in respect of magnitude and their nature, then it is called a Balanced three phase load.

Balanced supply: A three phase supply in which the three phase voltages have equal magnitude, same frequency but have a phase difference of 120^0 between each othe is called a balanced supply.

Unbalanced supply: A three phase supply in which the three phase voltages do not have equal magnitude, same frequency and a phase difference of 120^0 between each other is called unbalanced supply.

b) A resistance of 10Ω and inductance of 0.01 H are connected across a 230V, 50 Hz ac supply. Find

i. **Impedance**
ii. **Current**
iii. **Power**
iv. **P.f.**

Given: $R = 10\,\Omega$, $L = 0.01\,H$, $V = 230V$, $f = 50\,Hz$

$$X_L = 2\pi f L = 2\pi \times 50 \times 0.01 = 3.141\,\Omega$$

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{(10)^2 + (3.141)^2}$$

$$\boxed{Z = 10.48\,\Omega}$$

$$I = \frac{V}{Z} = \frac{230}{10.48} = 21.95 \text{ Amp.}$$

$$\boxed{I = 21.95\ A}$$

$$\cos\phi = P.F. = \frac{R}{Z} = \frac{10}{10.48} = 0.954$$

$$\boxed{P.f. = 0.954\ (\text{lagging})}$$

$$\text{Power} = P = VI\cos\phi = 230 \times 21.95 \times 0.954$$

$$\boxed{P = 4816.269 \text{ watts}}$$

c) Explain why 1Φ induction motor is not self starting?

(Explanation – 4 marks)

When single phase a .c. supply is given to single phase stator winding magnetic field produced at the stator is alternating, pulsating or fluctuating in nature and not rotating. Hence torque produced at starting is equal to zero.
If the rotor is given manually push either is clockwise or in anticlockwise direction, it gives torque in that direction and starts rotating in that direction. Hence winding 1 Φ induction motor is not self starting

OR

When single phase AC supply is given to main (stator) winding it produces a magnetic field which is alternating, pulsating or fluctuating in nature and not rotating.

- According to double field revolving theory, alternating flux can be represented by two opposite rotating flux of half magnitude.
- These oppositely rotating flux induce current in rotor & there interaction produces two opposite torque hence the net torque is Zero and the rotor remains standstill.

Hence Single-phase induction motor is not self starting.

d) A resistance and capacitor is connected in series across a voltage e= 282 sin314t and i= 28.2sin(314t+π^0/3).
Calculate:
- **i. RMS value of voltage and current.**
- **ii. Value of R and C.**

Given: $e = 282 \sin 314t$

$i = 28.2 \sin\left(314t + \frac{\pi}{3}\right)$

$\phi = \frac{\pi}{3} = 60^\circ \quad \therefore \cos\phi = 0.5$

$E_{rms} = 0.707\, E_m = 0.707 \times 282 = 199.37$ Volts

$I_{rms} = 0.707\, I_m = 0.707 \times 28.2 = 19.94$ Amps

$Z = \frac{V}{I} = \frac{199.37}{19.94} = 9.998 \simeq 10\,\Omega$

$\cos\phi = \frac{R}{Z} \quad \therefore R = Z\cos\phi = 10 \times 0.5 = 5\,\Omega$

$Z = \sqrt{R^2 + X_C^2} \quad \therefore X_C = \sqrt{Z^2 - R^2} = 8.66\,\Omega$

$C = \frac{1}{2\pi f X_C} = \frac{1}{2\pi \times 50 \times 8.66} = 3.675 \times 10^{-4}\, f$

$E_{rms} = 199.37$ Volts ——— ($\frac{1}{2}$ M)

$I_{rms} = 19.94$ Volts ——— ($\frac{1}{2}$ M)

$R = 5\,\Omega$ ——— (1 M)

$C = 3.675 \times 10^{-4}\, f$. ——— (2 M)

e) A 50 KVA, 6600/250 V, 1 Φ transformer has 52 secondary turns. Find.

i. No. of primary turns.

ii. Full load primary and secondary currents.

Given, $V_1 = 6600 V$, $V_2 = 250 V$. $KVA = 50$,

No. of Secondary turns = 52

(i) No. of Primary turns :- —— (2M)

We know that, $\frac{E_1}{E_2} = \frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\therefore \frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\therefore N_1 = N_2 \times \frac{V_1}{V_2}$, $N_1 = 52 \times \frac{6600}{250}$

$\boxed{\therefore N_1 = 1373}$

(ii) Full load Primary And Secondary Currents → (2M)

1 KVA = 1000 VA.

KVA = 50 V, $V_1 = 6600 V$, we get

$I_1 = \frac{KVA \times 1000}{V_1}$ $\left(\because KVA = \frac{V_1 I_1}{1000} \right)$

$I_1 = \frac{50 \times 1000}{6600}$, $\boxed{\therefore I_1 = 7.57 A}$

Simillarly, full load secondary current.

$I_2 = \frac{KVA \times 1000}{V_2}$

$I_2 = \frac{50 \times 1000}{250} = 200 A.$

or

$I_2 = I_1 \times \frac{V_1}{V_2} = 7.57 \times \frac{6600}{250} = 200 A$

OR

$I_2 = I_1 \times \frac{N_1}{N_2}$ = $I_2 = 7.57 \times \frac{1373}{52} = 200 A$

$\therefore (1) Number\ of\ primary\ turns = N_1 = 1373$

$(2) Full\ load\ primary\ current (I_1) = 7.57A$

$(3) full\ load\ secondary\ current (I_2) = 200A$

f) Define the following related to a.c.

i. Frequency
ii. Cycle
iii. Time period
iv. Amplitude.

(1 mark for each definition)

i) Frequency: the number of cycles completed by an A.C. quantity in one second is known as frequency. Its unit is Hertz (Hz) or Cycles / sec.

ii) Cycle: In an A.C. waveform, any repetition consisting of one positive and one identical negative part is called a cycle of the waveform.

iii) Time Period: It is defined as the time taken in seconds by an A.C. quantity to complete one cycle. After every 'T' seconds, the cycle repeats itself.

iv) Amplitude : The maximum value or peak value of an A.C. quantity is called its amplitude. (V_m or I_m)