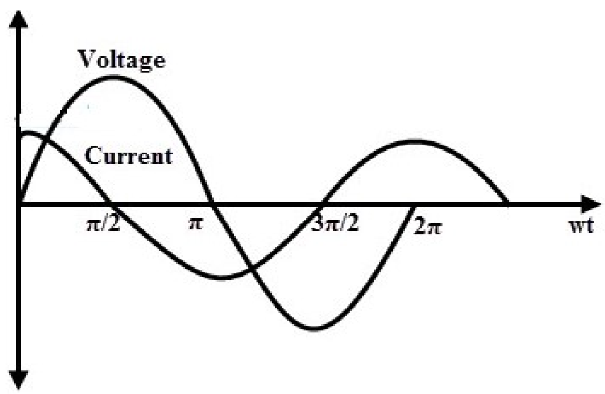
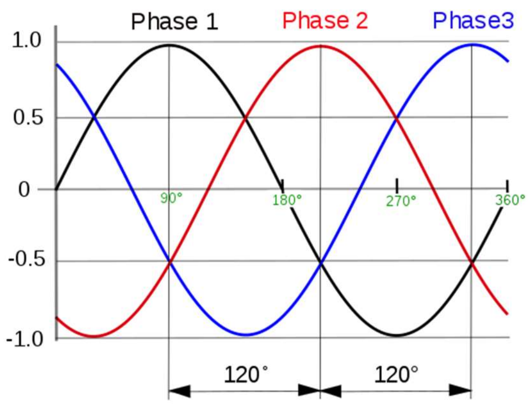
WINTER– 2018 Examinations

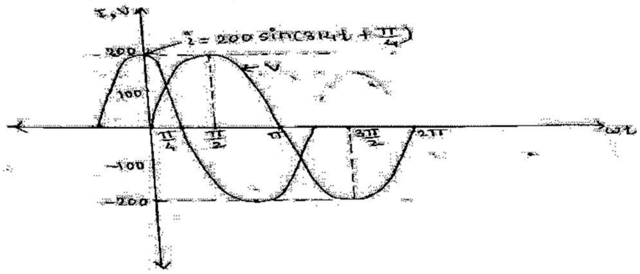
Important suggestions to examiners:

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 principle components indicated in a 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 some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	**Attempt any TEN of the following : 20 Marks**
a)	**Define terms frequency & time period related to A.C. quantity.**
Ans:	**1. Frequency:** **(1 Marks)** Number of cycles completed by an alternating quantity in one second is called 'Frequency'. $F = \frac{1}{t}\ Hz$ **2. Time Period:** **(1 Marks)** Time period of an alternating quantity is defined as the time required for an alternating quantity to complete one cycle
b)	**Draw the waveform of voltage & current of purely capacitive circuit.**
Ans:	**The waveform of voltage & current of purely capacitive circuit:** **(2 Marks)**  **or equivalent figure**

c)	**Draw the waveform of 3-ph a.c.-supply.**
Ans:	**Voltage waveform of a 3 phase supply with respect to time:** **(2 Mark)**  **or equivalent figure**
d)	**Define phase sequence.**
Ans:	**Phase sequence:** **(2 Mark)** The phase sequence is defined as the order in which all the phases attain there maximum positive values.
e)	**State Faraday's law of electromagnetic induction.**
Ans:	**First Law: -** Whenever change in the magnetic flux linked with a coil or conductor, an EMF is induced in it. **OR** Whenever a conductor cuts magnetic flux, an EMF is induced in conductor. **(1 Mark)** **Second Law: -** The Magnitude of induced EMF is directly proportional to (equal to) the rate of change of flux linkages. **(1 Mark)** $e = \frac{-N}{dt} d\varphi$
f)	**Define dynamically induced emf & statically induced emf.**
Ans:	**i) Dynamically induced emf:** **(1 Mark)** 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. $E = B\,l.\,v.\,\sin\theta$ volts

	ii) statically induced emf: **(1 Mark)** In the **Statically induced emf** flux linked with coil or winding changes (dΦ/dt) and coil or winding is stationary such induced emf is called Statically induced emf $E = - N (d\Phi/dt)$ **OR** Self-induced emf is the e.m.f induced in the coil due to the change of flux produced by linking it with its own turns. This phenomenon of self-induced emf $e \,\alpha \frac{dI}{dt} or \;\; e = L\frac{dI}{dt}$
g)	**State the working principle of transformer.**
Ans:	**Working Principle of Transformer: - --- (2 Marks)** ➢ The primary winding is connected to AC supply current starts flowing through primary winding. ➢ The primary current produces an alternating flux in the core. ➢ These flux gets linked with the secondary winding through the core ➢ The alternating flux will induce voltage into the secondary winding according to the faraday's laws of electromagnetic induction. **OR** A Transformer works on the principle of Faradays laws of electromagnetic induction. When their primary winding is connected to a.c. supply, a current flows through it. This current flowing through the primary winding produces an alternating magenetic flux .This flux links with secondary winding through the magenetic core & induces an emf in it according to the faraday's laws of electromagnetic induction
h)	**Define kVA rating of a transformer.**
Ans:	**Meaning of kVA rating of transformer:** **(2 Mark)** ➢ The amount of capacity of energy transferred is known as KVA rating of transformer. ➢ KVA Rating = $V_1 \; I_1 \; F.L \times 10^3 \;\; = V_2 \; I_2 \; F.L \times 10^3$
i)	**What changes should be done in supply system in order to reverse the direction of rotation of 3 ph I.M.**
Ans:	**(2 Mark)** By interchanging any two of the supply phase lines to the motor the direction of stator rotating field is reversed resulting in reversal of the rotor direction.

j)	**Define synchronous speed. Which speed is greater synchronous speed or slip speed ?**
Ans:	**i) Synchronous Speed:-** **(1 Mark)** It is speed at which rotating magnetic field rotates in induction motor. **OR** $$N_S = \frac{120\ f}{P}$$ Where, $N_S = Syncronous\ \ speed$ $f = Supply\ of\ \ frequency$ and $P = Number\ of\ Pole$ **Synchronous speed is greater** **(1 Mark)**
k)	**Draw the voltage and current waveform for following equation i = 200 sin (314 t + π/4). Also find I_M, & phase angle.**
Ans:	Given :- **i = 200 sin (314 t + π/4)**  **OR Equivalent figure--------(1mark)** 1) Im =200 amp--**(1/2 mark)** 2) Phase angle or **θ** = **π/4 OR 45^0**---**(1/2 mark)**
l)	**List any two applications of stepper motor & servo motor.**
Ans:	**i) Applications of stepper motor-** **(Two application expected-1 Mark)** 1.Suitable for use with computer controlled system 2. Widely used in numerical control of machine tools. 3. Tape drives 4. Floppy disc drives 5. Computer printers 6. X-Y plotters 7. Robotics 8. Textile industries 9. Integrated circuit fabrication 10. Electric watches

	11. In space craft's launched for scientific explorations of planets. 12. In the production of science friction movies 13 Automotive 14. Food processing 15. Packaging **ii) Applications of servo motor :** **(Two application expected: 1 Mark)** 1. Robotics 2. Conveyor Belts 3. Camera Auto Focus 4. Robotic Vehicle 5. Solar Tracking System 6. Metal Cutting & Metal Forming Machines 7. Antenna Positioning 8. Woodworking/CNC 9. Textiles 10. Printing Presses/Printers 11. Automatic Door Openers
m)	**What is the role of centrifugal switch in split phase motors?**
Ans:	**Role of centrifugal switch in split phase motors** **(2 Mark)** The centrifugal switch is used to disconnect the starting winding once the motor picks up speed after which the motor continues to run.
n)	**State the need of fuse.**
Ans:	**Need of Fuse:** **(2 Mark)** ➢ It is a protective device against over current, occurs due over load or short circuit. ➢ Fuse is a wire of short length or thin strip of material having low melting point

Q.2 Attempt any FOUR of the following : 16 Marks

a) Explain the concept of lagging & leading by waveform & mathematical equation in ac circuits.

Ans: **(Meaning - 2 Marks , Waveforms representation & Equation -2 Marks)**

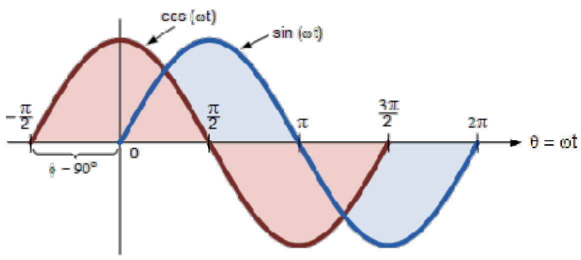
i) Leading AC Quantities:

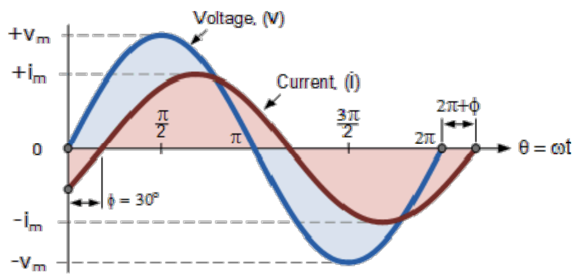
The quantity which attains the respective zero or peak value first, is called 'Leading Quantity'.

ii) Lagging AC Quantities:

The quantity which attains the respective zero or peak value later, is called 'Lagging Quantity'.

iii) Leading Phase difference waveform: **ii)Lagging Phase difference waveform**





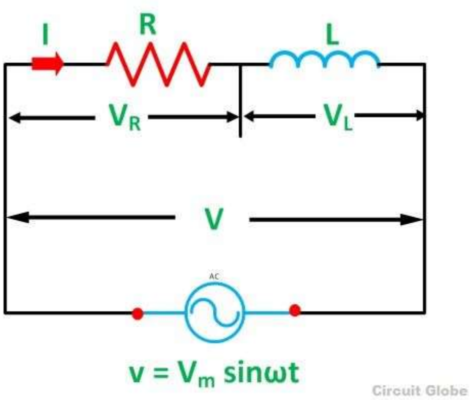
OR equivalent figure

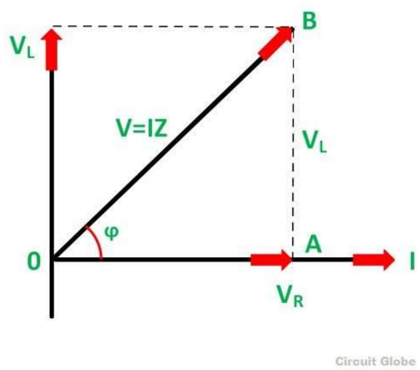
Leading	Lagging
1. Equation for voltage $V = V_m \sin \omega t$	1. Equation for voltage $V = V_m \sin \omega t$
2. Equation for current $I = I_m \sin (\omega t + \varphi)$	2. Equation for current $I = I_m \sin (\omega t - \varphi)$

b) Draw a circuit diagram for series R-L circuit. Also draw vector diagram & waveforms & write down expression for impedance.

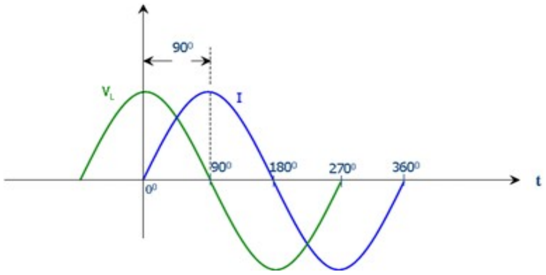
Ans: **(Diagram: 1 Mark, Phasor Diagram: 1 Mark, Waveform: 1 Mark , Equation : 1 Mark)**

1) Circuit diagram of RL circuit 2)Phasor diagram of RL series circuit

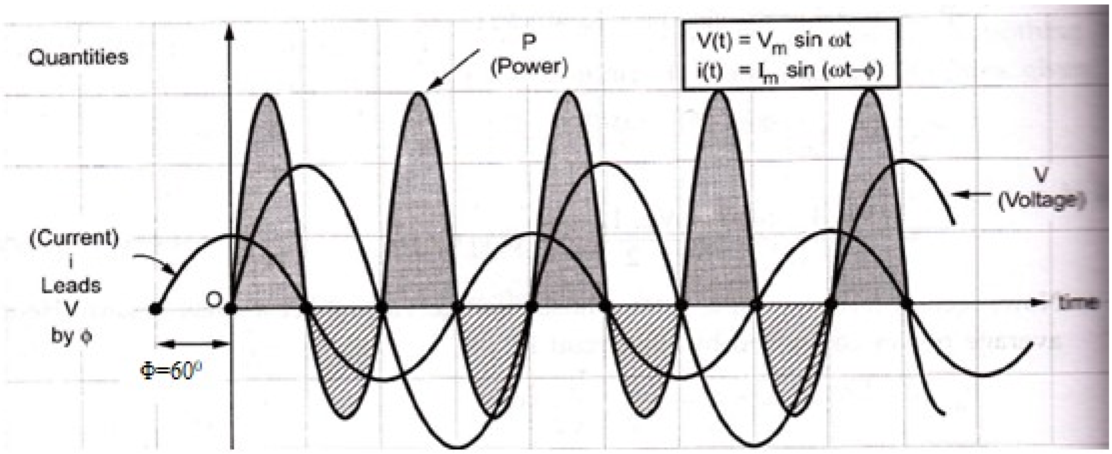




or equivalent diagram

	3) Waveforms  **or equivalent diagram** 1. Equation for voltage V= V_m sin ωt 2. Equation for current I = I_m sin (ωt- φ) **4) Impedance Z =** $\text{Im}\ pedance\ \ Z\ = \sqrt{(R)^2 + (X_L)^2}$
c)	**If a.c. current is represented by equation i = 25 sin (314t). Calculate rms value, average value, frequency & time period of current.**
Ans:	**Given data :** $i = 25 * \sin 314 * t$ ---------------- 1 Compare with standard current equation $I = I_m * \sin \omega * t$ **Step-I:- Average value of current**: $I_{avg} = 0.639 * 25$ ---------------------- (1/2 Mark) $I_{avg} = 15.975\ Amp$ ---------------------- (1/2 Mark) **Step-II:- To find RMS value of Current:** $I_{rms} = 0.707 * I_m$ ---------------------- (1/2 Mark) $I_{rms} = 0.707 * 25 = 17.675\ Amp$ ---------------- (1/2 Mark) **Step-III:- To find frequency**: $f = \frac{\omega}{2*\pi} = \frac{314}{2*\pi}$ ---------------------- (1/2 Mark) $\boldsymbol{f = 49.9746\ Hz \cong 50Hz}$ ---------------- (1/2 Mark) **Step-III:- To find time Period** $T = \frac{1}{f}$ ---------------------- (1/2 Mark) $T = \frac{1}{50}$ $T = 0.02 \sec or\ 20\ ms$ ---------------------- (1/2 Mark)

d)	**A circuit consist of a resistance of 4 ohm & inductance of 0.5 H & variable capacitance in series across a 100 V, 50 Hz supply. Calculate 1. value of capacitance to produce resonance 2. Voltage across capacitor 3. the Q-factor of the circuit.**
Ans:	Given:- R= 4Ω L= 0.5H V= 100v F= 50H_z $F_r = \frac{1}{2\pi\sqrt{LC}}$ ------------------------------**(1/2 mark)** $50 = \frac{1}{2\pi\sqrt{0.5C}}$ Squaring on both side $(50)^2 = \frac{1}{4\pi^2*0.5*C}$ $(50)^2 * 4\pi^2 = \frac{1}{0.5*C}$ $98696.0440 = \frac{1}{0.5*C}$ $C = \frac{1}{0.5*98696.0440}$ $C = 2.0264*10^{-5}$ Farad OR C = 20.2642 μFarad------------------------------**(1/2 mark)** $X_c = \frac{1}{2\pi FC}$ $= \frac{1}{2\pi*50*20.2642*10^{-6}}$ $X_c = 157.0799\Omega$------------------------------**(1/2 mark)** $I = \frac{V}{R}$ $= \frac{100}{4}$ I = 25 amp------------------------------**(1/2 mark)** $V_c = I*X_c$------------------------------**(1/2 mark)** $= 25*157.0799$ $V_c = 3926.9975v$------------------------------**(1/2 mark)** Quality factor $= \frac{1}{R}*\sqrt{\frac{L}{C}}$------------------------------**(1/2 mark)** $= \frac{1}{4}*\sqrt{\frac{0.5}{20.2642*10^{-6}}}$ Q.F. = 39.2699------------------------------**(1/2 mark)**

e)	**Equation for current and voltage in a circuit are given by V=Vm sin ωt , i = I_m sin (ωt + 60). State what type of circuit it is ? Draw waveform of voltage & current & power in the circuit.**
Ans:	**Type of circuit: ---(1 Mark)** Resistance, Capacitive circuit, (RC circuit) as current is leading voltage by 60^0. **Waveforms for Voltage, Current and Power:** **(Voltage: 1 Mark, Current: 1 Mark, Power: 1 Mark)**  **or Equivalent figure**
f)	**What is power factor ? State its significance. What is condition for unity power factor ?**
Ans:	**Definition of Power factor:** **(1.5 Mark)** Power factor is cosine of angle between voltage and current. **OR** $\cos\phi = R/Z$ **OR** Power factor is the ratio of active power to the apparent power $P.f = KW/KVA$ **Significance of Power factor: (Any two point expected)** **(1.5 Mark)** 1. P.F. increases current reduce so; cross section of conductor decreases hence its cost is educes. 2. P.F. increases current reduce so, cross section of conductor decreases hence weight decreases. So design of supporting structure becomes lighter. 3. Copper losses Decreases, Hence transmission efficiency increases. 4. Voltage drop reduces, hence voltage regulation becomes better 5. Handling capacity (KW) of each equipment increases as p.f. increases. 6. Less capacity (KVA) rating of equipment's are required so capital cost decreases.

	7. Cost per unit (KWH) decreases. **The condition for unity power factor:** **(1 Mark)** ➢ When cosine of angle between voltage and current **is zero.** **OR** ➢ When R = Z (Circuit is pure resistive circuit) OR ➢ When KW = KVA
Q.3	**Attempt any FOUR of the following :** **16 Marks**
a)	**A coil of resistance 10 ohm & inductance 0:1 H is connected in series. Calculate : (i) impedance (ii) current (iii) power factor iv) power consumed**
Ans:	**I= V/Z** **i) X_L =** $X_L=2\pi fL$ $= 2\pi\times50\times0.1$ $X_L= 31.4159\ \Omega$ **iii) Impedance Z =** $Impedance\ \ Z = \sqrt{(R)^2+(X_l)^2}$ -- **(1/2 Mark)** $\therefore Z = \sqrt{10^2 + (31.4159)^2}$ $\therefore \mathbf{Z = 32.9690\ \Omega}$-- **(1/2 Mark)** **iv) To Find Current=** $I = \frac{V}{Z}$-- **(1/2 Mark)** $I = \frac{230}{32.9690} = 6.9762\ Amp$ I= $6.9762\ Amp$ --- **(1/2 Mark)** **iii) power factor** $\cos\emptyset = \frac{R}{Z}$-- **(1/2 Mark)** $\cos\emptyset = \frac{10}{32.9690} = 0.3033$(lagging)-- **(1/2 Mark)**

Power Consumed P :

$\therefore P = V\ I\ Cos\ \phi$ -- **(1/2 Mark)**

$\boldsymbol{P = 230 * 6.9762 * 0.3033}$

$\boldsymbol{P = 486.6527\ Watt}$------- ----------------------------- **(1/2 Mark)**

b) **For the fig. I shown below. Find : (i) impedance (ii) nature of circuit (iii) power consumed.**

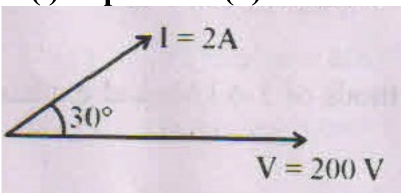


Fig. 1

Ans:

i) Impedance Z :

$Z = \frac{V}{I}$ --- **(1/2 Mark)**

$= \frac{200}{2}$

$\therefore \boldsymbol{Z = 100\ \Omega}$ − **(1/2Mark)**

ii) Power Factor :

$\therefore Cos\varphi = Cos\ (30)$ -- **(1/2 Mark)**

$\therefore Cos\ \varphi = 0.866\ leading$ -- **(1/2 Mark)**

iii) Power Consumed P :

$\therefore P = V\ I\ Cos\ \phi$ -- **(1/2 Mark)**

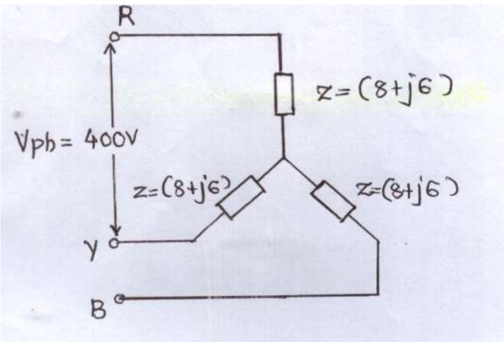
P = 200*2*0.866

P = 346.4101 Watt -- **(1/2 Mark)**

iv) Nature of Circuit : Capacitive -- **(1 Mark)**

c)	**Three impedances of (8 + j6) ohm each are connected in star to 3-Ph, 440 50 Hz balance a.c. supply. Calculate line & phase values of voltage & currents. & power consumed.**

Ans: **Solution:-**



or Equivalent fig.

i) line voltage V_L = 440 Volt

In Star connection $V_{Ph} = \frac{V_L}{\sqrt{3}}$

ii) Phase voltage V_{ph} = 440 Volt

$$V_{Ph} = \frac{440}{\sqrt{3}} = 254.034 \ \ volt$$ -- **(1 Mark)**

iii) Phase current (I_{ph}) ;

$$Phase\ current\ \ (I_{Ph}) = \frac{V_{Ph}}{Z_{Ph}}$$ ------------------------------------- **(1/2 Mark)**

$$Phase\ current\ \ (I_{Ph}) = \frac{254.034}{(8+j6)} = \frac{254.034}{10\ \angle 36.86}$$

$$Phase\ current\ \ (I_{Ph}) = 25.403\ \angle -36.86$$ --------------------------- **(1/2 Mark)**

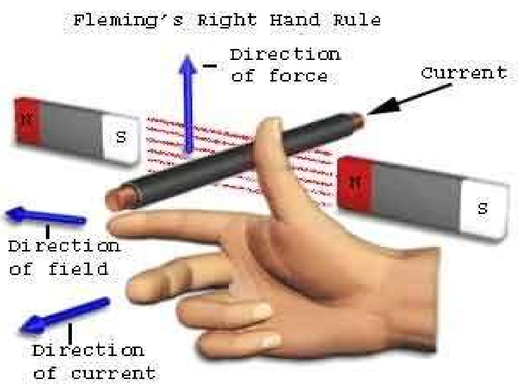
iv) Line current (I_{line}) ;

Phase current is equal to line current :-

$$\therefore Line\ \ current\ \ (I_L) = 25.403\ \angle -36.86$$ ------------------------------ **(1/2 Mark)**

v) Power factor.

$$\therefore\ \ Power\ \ \ factor\ = Cos\,\phi = Cos\ (-36.86)$$

	$\therefore\ Power\ \ factor = Cos\phi = 0.80\ \ lagging$ -------------------------------- **(1/2 Mark)** **vi) Power:** $P\ = 3 * V_{ph} * I_{ph} * \cos\theta$ ------------------------------------ **(1/2 Mark)** $P\ = 3 * 254.034 * 25.403 * 0.8$ $P\ = 15487.74\ watt$ ------------------------------------ **(1/2 Mark)**
d)	**What is phase sequence '? What is its physical significance'?**
Ans:	**Phase sequence:** **(2 Mark)** The phase sequence is defined as the order in which all the phases attain there maximum positive values. **Significance:** **(2 Mark)** ➢ If this sequence is reverses, then the direction of the motor gets reverses, which may cause temporary or permanent failure of motor ➢ If phase sequence is not proper then the process of synchronization of generators become difficult and improper
e)	**State and explain Fleming's Right hand rule & Lenz's law for deciding the direction induced emf.**
Ans:	**Fleming's Right Hand Rule:** **(2 Mark)** Arrange three fingers of right hand mutually perpendicular to each other, if the first figure indicates the direction of flux, thumb indicates the direction of motion of the conductor, then the middle finger will point out the direction of inducted current. **Explanation:**  In the arrangement shown in the figure, a conductor is moved up in the gap between two poles such that it cuts the magnetic lines of force (flux). According to Faraday's law of electromagnetic induction, an emf is induced in the conductor. The direction of this dynamically induced emf is given by Fleming's Right Hand rule. The first three fingers of right hand are stretched out such that they are perpendicular to each other. If the first finger points the direction of

	magnetic field from north pole to south pole, the thumb points the upward direction of motion of the conductor with respect to stationary magnetic field, then the middle (second) finger points the direction of emf induced in the conductor. **Lenz's law:** **Statement :** **(2 Mark)** The direction of induced emf produced due to the process of electromagnetic induction is always such that, it will set up a current to oppose the basic cause responsible for inducing the emf. **Explanation:** The mathematical representation is, $e = - N (d\Phi/dt)$, Where 'e' = Induced emf , N = No. of turns in coil, $d\Phi/dt$ = rate of change of flux where -ve sign indicates opposition to induced emf.
f)	**State the advantages of AC over DC.**
Ans:	**Advantages of AC over DC** **(Any Four Points expected : 1 Mark each)** 1) AC can be generated at high voltages. But DC cannot be generated at high voltages because sparking starts to occur at commutator at high voltages, due to which commutator may gets damaged. 2) High voltage AC generators are much simpler and economical than DC generators of the same range. It is because in AC generators there is no commutator which is costly part. 3) Alternating current can be stepped down with a static device called transformer. When voltage is stepped up current decreases to a small value. Small current produces less heat losses and power can be transmitted through a thin conductor. 4) AC transmission and distribution is more economical as line material (say copper, Aluminum etc.) can be saved by transmitting power at higher voltages. 5) At receiving station, voltages can be stepped down to the required value by using step down transformer. This is most important reason for generating and using electrical energy as AC. 6) For the same horse power as of DC motors, AC motors are economical, lighter in weight, require less space and require lesser attention in operation and maintenance. 7) AC can be converted to DC easily when and where required but DC cannot be converted to AC so easily and is not economical. 8) AC distribution efficiency is high. 9) Design of AC machine is easy and installation is less costly.

Q.4	Attempt any FOUR of the following : 16 Marks
a)	**Compare electric circuit & magnetic circuit on any four points.**
Ans:	**Compare Electric and Magnetic circuit:** **(Any Four Points expected : 1 Mark each)**

Sr.No	Electric Circuit	Magnetic Circuit
1	Path traced by the current is known as electric current.	The magnetic circuit in which magnetic flux flow
2	EMF is the driving force in the electric circuit. The unit is Volts.	MMF is the driving force in the magnetic circuit. The unit is ampere turns.
3	There is a current I in the electric circuit which is measured in amperes.	There is flux φ in the magnetic circuit which is measured in the weber.
4	The flow of electrons decides the current in conductor.	The number of magnetic lines of force decides the flux.
5	Resistance (R) oppose the flow of the current. The unit is Ohm	Reluctance (S) is opposed by magnetic path to the flux. The Unit is ampere turn/weber.
6	$R = \rho.\ l/a$. Directly proportional to l. Inversely proportional to a. Depends on nature of material.	$S = l/\ (\mu_0\mu_r a)$. Directly proportional to l. Inversely proportional to $\mu = \mu_0\mu_r$. Inversely proportional to a
7	The current I = EMF/ Resistance	The Flux = MMF/ Reluctance
8	The current density	The flux density
9	Kirchhoff current law and voltage law is applicable to the electric circuit.	Kirchhoff mmf law and flux law is applicable to the magnetic flux.

b)	**State the advantages of 3 phase system over 1 phase system.**
Ans:	**Advantages of 3-phase supply over 1-phase supply:**

(Any Four Points expected : 1 Mark each)

1. **Constant power output:** The power delivered by a three phase supply is constant and that of single phase supply is oscillating.
2. **Higher power:** For the same copper size output of 3 phase supply is always higher than single phase supply.
3. **Smaller conductor cross section:** For given power, cross section area of copper is smaller as compared to single phase.

	4. **Self starting capability:** Three phase motors are self-starting and single phase motors normally require a starter. 5. **Vibrations:** Three phase motors have less vibrations as compared to single phase motors.
c)	**State specification of isolation transformer. power transformer, pulse transformer & R.F. transformer.**
	Specifications of isolation transformer:- **(Any Two Points expected : 1 Mark)** ➢ Power rating, ➢ Input voltage range, ➢ Load regulation, ➢ Frequency of input, ➢ Efficiency, ➢ Insulation resistance , ➢ Ambient temperature , ➢ Operating humidity, ➢ Audible noise **Specifications of R.F. transformer:** **(Any Two Points expected : 1 Mark)** ➢ Power rating, ➢ Frequency in MHz, ➢ Power rating, ➢ Voltage, ➢ Current etc. **Pulse Transformer:** **(Any Two Points expected : 1 Mark)** ➢ Power rating, ➢ Core type ➢ Core material ➢ Pulse width ➢ Rise time ➢ Droop (%) ➢ Output voltage ➢ Output current ➢ Turns (primary/secondary) ➢ Inductance (primary/secondary)

	➢ Leakage inductance ➢ Coupling coefficient ➢ Efficiency (%) **Power Transformer** **(Any Two Points expected : 1 Mark)** ➢ Power rating, ➢ Power rating, ➢ Input voltage range, ➢ Load regulation, ➢ Frequency of input, ➢ Efficiency, ➢ Insulation resistance
d)	**A 3300 / 200 V. 100 kVA, 1-Ph transformer has 80 turns on secondary winding, calculate full load current in both the windings. flux & primary turns.**
Ans:	$V_I = 3300\,V$ $V_2 = 200\,V$ $N_I = ?$ $N_2 = 80$ $I_1 = ?$ $I_2 = ?$ **i) To Find full load Primary current I1:-** $I_1 = \frac{KVA \times 10^3}{V_1\ volt}$ -- **(1/2 Mark)** $I_1 = \frac{100 \times 10^3}{3300}$ $I_1 = 30.3030\ Amp$ -- **(1/2 Mark)** **ii) To Find full load Secondary I2:** $I_2 = \frac{KVA \times 10^3}{V_2\ volt}$ .... **(1/2 Mark)** $I_2 = \frac{100 \times 10^3}{200}$ $I_2 = 500\ Amp$ -- **(1/2 Mark)**

iii) Number of primary winding turns N_1:

$$\frac{V_2}{V_1}=\frac{N_2}{N_1} \quad \text{OR} \quad \frac{V_1}{V_2}=\frac{N_1}{N_2} \quad ,$$

$$N_1=\frac{V_1}{V_2}\times N_2$$ -- **(1/2 Mark)**

$$N_1=\frac{3300}{200}\times 80$$

$$N_1=1320 \ turns$$ -- **(1/2 Mark)**

iii) Maximum flux:

$$E_1=4.44\,\phi_m\ f\ N_1$$ -- **(1/2 Mark)**

$$\phi_m=\frac{E_1}{4.44\times f\times N_1}$$

$$\phi_m=\frac{3300}{4.44\times 50\times 1320}$$

$$\phi_m=0.01126\ Wb$$ -- **(1/2 Mark)**

e) **What are the various types of losses in transformer and explain.**

Ans: The various losses that occur in a transformer:

(Types of losses 2 Marks & Explanation 2 Marks)

1) Copper losses
2) Core or Iron losses:
   a) Hysteresis loss
   b) Eddy current loss

Explanation:

Iron Losses:

Iron losses are caused by the alternating flux in the core of the transformer as this loss occurs in the core it is also known as Core loss. Iron loss is further divided into hysteresis and eddy current loss.

Hysteresis Loss

	The core of the transformer is subjected to an alternating magnetizing force, and for each cycle of emf, a hysteresis loop is traced out. Power is dissipated in the form of heat known as hysteresis loss **Eddy Current Loss:** The circulating currents are called as eddy Currents. They will occur when the conductor experiences a changing magnetic field. As these currents are not responsible for doing any useful work, and it produces a loss (I^2R loss) in the magnetic material known as an Eddy Current Loss. **Copper Loss Or Ohmic Loss:** These losses occur due to ohmic resistance of the transformer windings. If I_1 and I_2 are the primary and the secondary current. R_1 and R_2 are the resistance of primary and secondary winding then the copper losses occurring in the primary and secondary winding will be ${I_1}^2R_1$ and ${I_2}^2R_2$ respectively. Therefore, the total copper losses will be $P_c = I_1^2R_1 + I_2^2R_2$ These losses varied according to the load and known hence it is also known as variable losses. Copper losses vary as the square of the load current.
f)	**Define regulation & efficiency of transformer. Which transformer will be said to be quality transformer : (i) transformer regulation 2% or 4%. (ii) transformer efficiency 89% or 92%**
Ans:	**i) Efficiency:-**It is the ratio of output power to the input power of the transformer. **(1 Mark)** **OR** $Transmission\ \ Efficency\ = \frac{Output\ \ power\ \ at\ receiving\ \ end}{Input\ \ power\ \ at\ sending\ \ end} \times 100$ - **ii) Voltage Regulation:** **(1 Mark)** Voltage regulation is nothing but voltage drop in transmission line expressed in % of receiving end voltage **OR** It is the change in terminal voltage from No Load to Full Load expressed in % of No Load voltage.

$$\% \text{ Regulation} = \frac{V2\ No\ Load - V2\ Full\ Load}{V2\ No\ Load} x100$$

Which transformer will he said to be a quality transformer one with regulation 2% or the other with regulation 4%: **(1 Mark)**

- 2% regulation is said to be better for a quality transformer.

Which transformer will he said to be a quality transformer one with transformer efficiency 89% or 92% **(1 Mark)**

- 92% **efficiency** is said to be better for a quality transformer.

Q.5	**Attempt any FOUR of the following :** **16 Marks**
a)	**Explain working principle of 3-ph I.M.**

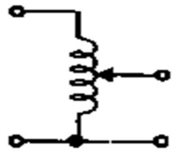
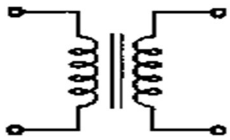
Ans: **(4 Marks)**

Working principle of 3-phase induction motor:

- When 3-phase stator winding is energized from a 3-phase supply, a rotating magnetic field is set up in air gap which rotates round the stator at synchronous speed Ns (= 120 f/P).
- The rotating field passes through the air gap and cuts the rotor conductors, which as yet, are stationary.
- Due to the relative speed between the rotating flux and the stationary rotor, e.m.f. are induced in the rotor conductors.
- Since the rotor circuit is short-circuited, currents start flowing in the rotor conductors.
- The current-carrying rotor conductors are placed in the magnetic field produced by the stator.
- Consequently, mechanical force acts on the rotor conductors.
- The sum of the mechanical forces on all the rotor conductors produces a torque which tends to move the rotor.
- In the same direction as the rotating field according to Lenz's law.

b) Compare auto-transformer & two winding transformer.

Ans: **(Any four points expected: Each point 1 Mark)**

S.No.	Points	Autotransformer	Two winding transformer
1.	**Symbol**		
2.	**Number of windings**	It has one winding	It has two windings
3.	**Copper saving**	Copper saving takes more as compared to two winding	Copper saving is less
4.	**Size**	Size is small	Size is large
5	**Cost**	Cost is low	Cost is high
6	**Losses in winding**	Less losses takes place	More losses takes place
7.	**Efficiency**	Efficiency is low	Efficiency is high
8.	**Electrical isolation**	There is no electrical isolation	Electrical isolation is present in between primary and secondary winding
9.	**Movable contact**	Movable contact is present	Movable contact is not present
11.	**Application**	Variac, starting of ac motors, dimmerstat.	Mains transformer, power supply, welding, isolation transformer

c) Explain the effect of change in rotor resistance on starting torque & maximum torque of induction motor.

Ans: **the effect of change in rotor resistance on starting torque & maximum torque of induction motor:** **(4 Marks)**

When rotor resistance increases, the starting torque also increases and vice versa When rotor resistance increases, the maximum torque condition occurs at higher values of slip keeping the magnitude of maximum torque unchanged

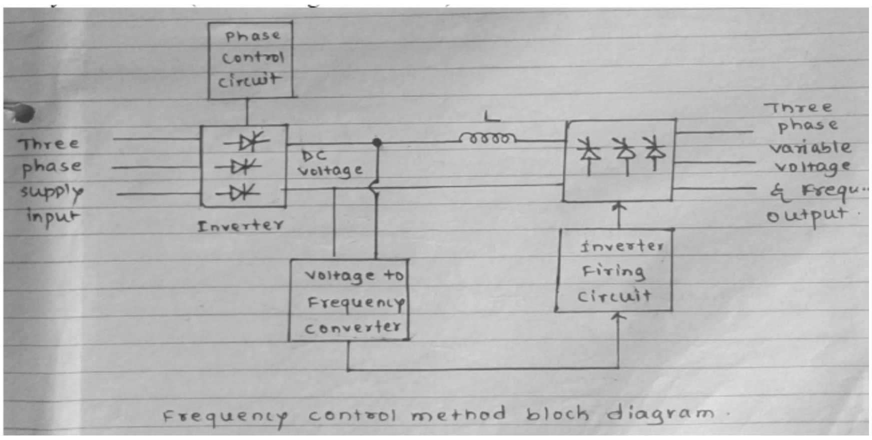
The maximum torque condition can be obtained at any required slip by changing rotor resistance.

d)	Give the various types of speed control methods of 3-ph 1.M. and explain any two methods.
Ans:	(List : 2 Marks & any two method explanation : 2 Marks)

Following methods to control the speed of 3 phase induction motor:

1) By Varying applied frequency (Frequency control)
2) By varying applied voltage (Stator voltage control)
3) Rotor resistance control.
4) By varying number of poles of the stator winding (Pole Changing)
5) By Voltage/ frequency control (V/f) method

1. by varying applied Frequency (Frequency control):



- The synchronous speed of an induction motor is given by $N_S = \frac{120 \times f}{P}$.
- It is clear from the equation that the speed of the induction motor can be changed by changing the frequency of the supply.
- The speed of the motor will increase if frequency increases and vice versa.
- Changing the frequency of supply to the motor is difficult. Therefore this method is only employed where the variable frequency alternator is available for the above purpose.

2. By varying applied voltage (Stator voltage control):

- This method is very easy but rarely used in commercial practice because a large variation of voltage produces a very small change in speed and much energy is wasted.
- In this method three resistances are inserted in series with the stator winding of the motor and the value of these resistances is varied by a common handle, so that equal resistances come in the stator circuit.
- For a particular load when voltage increases, speed of the motor also increases and vice-versa.

3. By rotor rheostatic control (Rotor Resistance control): For slip ring I.M. only

- In this method star connected external resistances (of continuous rating) are connected in the rotor circuit.
- The speed of the motor increases with the decrease of resistance in the rotor circuit.
- The change in speed is approximately inversely proportional to the external resistance connected in the rotor circuit.
- This method of the speed control is applied where a small variation of speed is required and the power wasted is not having great importance.

4. Pole Changing :

a) Speed control using two separate winding-

An induction motor stator is wound for fixed number of poles. The speed of the induction motor depends upon the number of poles for which stator is wound. If instead of one stator winding two independent windings are wound for a different number of poles then two definite speeds can be obtained. e.g. one winding for 4- pole and another winding for 8-poles them speeds can be achieved. Two windings are insulated from one another when any one of the winding is used, the other should be kept open circuited by the switch or kept star connected.

$$N_S = \frac{120 \times f}{P}$$

b) Speed control using consequent pole technique-

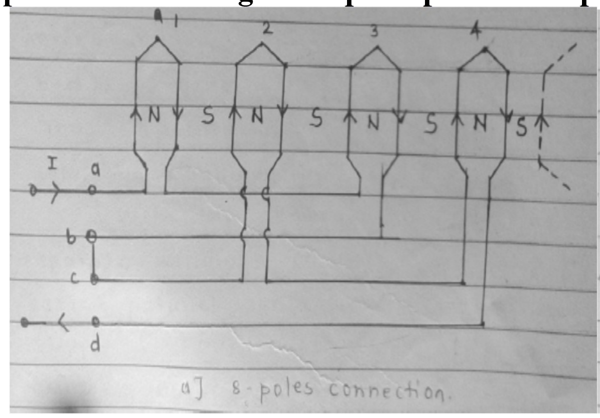


Fig (a)

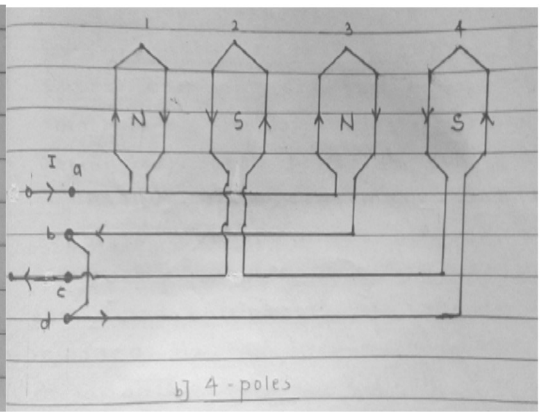


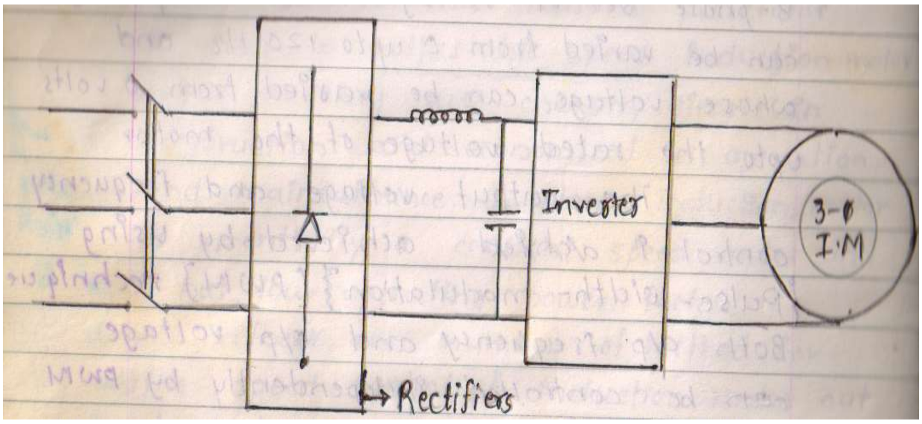
Fig (b)

This method is used for obtaining multispeed in squirrel cage induction motor. In this method only one winding is used and it is provided with some simple switching means (device), so that connections of coils with supply are changed and different number of poles is formed. This is explained as below-

- Above fig (a) shows developed winding diagram for one phase of balanced three phase winding.

- Coil-1 & c oil-3 are in series and they form one coil group while coil-2 & coil-4 connected in series to form another coil group. These two coil groups are connected in series such that all coils are magnetized in the same direction.
- Hence these coils form 4-North poles and 4-South poles. Thus this arrangement gives total 8-poles.
- If two coil groups are connected in series as shown in fig (b), there will be only 4- poles formed. Thus synchronous speed in this case will be doubled than first case.

5. By Voltage/ frequency control (V/f) method:



- If the ratio of voltage to frequency is kept constant, the flux remains constant.
- The maximum torque which is independent of frequency can be maintained approximately constant.
- However at a low frequency, the air gap flux is reduced due to drop in the stator impedance and the voltage has to be increased to maintain the torque level.
- This type of control is usually known as Volts/ Hertz or V/f control.
- A simple circuit arrangement for obtaining variable voltage and frequency is as shown in the above figure.

e)	**Explain the necessity of starter in induction motor. State any four starters used in 3 -ph I.M.**
Ans:	**Necessity of the starter in 3 phase I.M** :-- **(2 Mark)**

At the time of starting, slip s= 1, so the rotor resistance which depends on slip

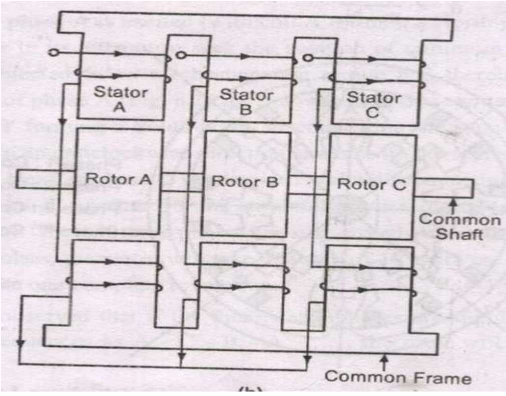
i.e. R2 (1-S)/S will be equal to "0",

i.e. rotor will act as short circuit.

Hence initially induction motor will draw heavy amount of current. Thus, a starter is needed in order to limit the starting current.

	After the motor has started at reduced starting current and hence reduced voltage, the connections are diverted towards the mains supply so that now, the motor can run at higher starting current and voltage. **Starters used in 3 -ph I.M:-- (Any Two Starters – 2 Mark)** 1. Direct ON-Line Starter (DOL) 2. Star Delta Starter 3. Soft Starter 4.Auto Transformer
f)	**What is the value of slip when 3-ph I.M. is in (1) stand still position (2) runs with synchronous speed ? Why 3-ph I.M. stops when it is made to run at synchronous speed?**
Ans:	**Stand still position (1 Mark)** Slip is maximum =1 **. This is one of the standstill condition of an I.M.** **Runs with synchronous speed (1 Mark)** Slip is minimum =0 **. This is one of an I.M runs with synchronous speed.** ➢ **3-ph I.M. is made to run at synchronous speed (2 Mark)** If rotor catches the synchronous speed of rotating magnetic field, (NS - N) i.e relative motion will be zero and rotor stops to rotate and therefore three phase induction motor can never run on synchronous speed.
Q.6	**Attempt any FOUR of the following : 16 Marks**
a)	**Explain working of stepper motor with neat diagram.**
Ans:	**Working Principle of stepper Motor- (2 Mark)** A stepper motor rotates through a fixed angular step in response to each input current pulse received by its controller. **Types of Stepper Motor :- (2 Mark)** 1) Variable Reluctance Motor 2) Permanent Magnet Motor

1) Variable Reluctance Motors:- **(Explanation not compulsory)**



or equivalent dia.

Working:-

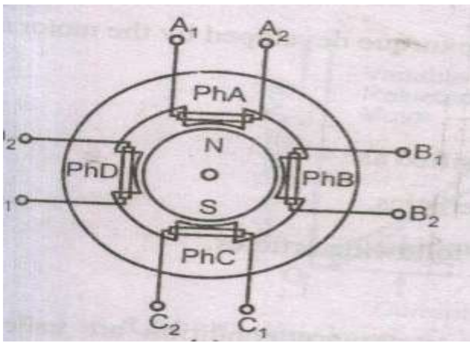
When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

Then phase 'B' is excited disconnecting supply of phase 'A' then rotor will move 30 anticlockwise directions. The Same process is repeated for phase 'C'

In this way chain of signals can be passed to get one revolution and direction can be also changed.

OR

2) Permanent Magnet Motor:-

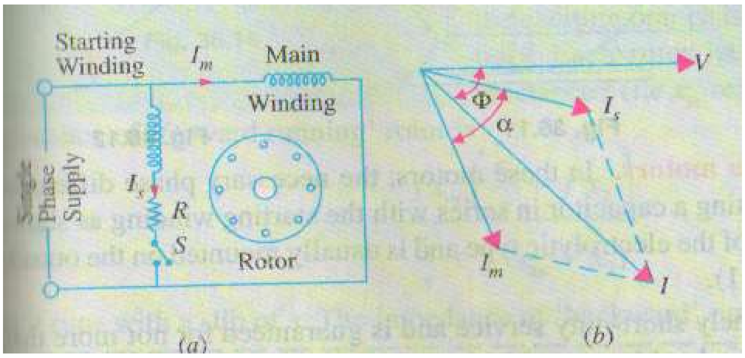


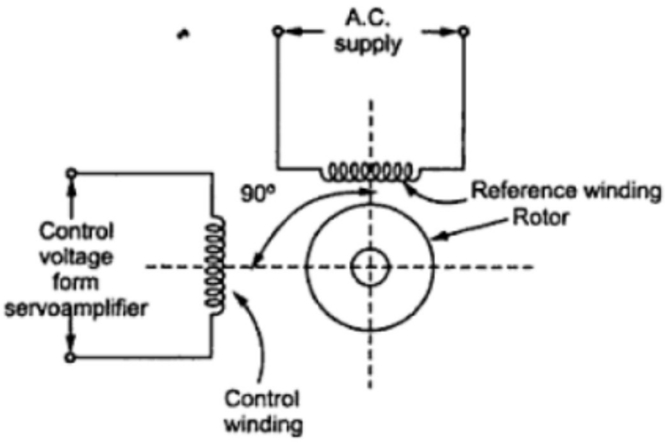
OR Equivalent Fig.

Working :-

If the phase is excited in ABCD, due to electromagnetic torque is developed by interaction between the magnetic field set up by exciting winding and permanent magnet.

Rotor will be driven in clockwise direction.

b)	**Draw circuit diagram of 1-ph resistance split phase induction motor & explain its working.**
Ans:	**Circuit diagram of resistance split single phase induction motor:** **(Figure : 2 Marks & Working : 2 Marks)**  **or equivalent figure** ➢ **Working of resistors split single phase induction motor:** To make a single phase induction motor self-starting, we should somehow produce a **rotating magnetic field**. This may be achieved by converting a single-phase supply into two-phase supply through the use of an additional winding. In a split phase induction motor, the additional winding is known as auxiliary winding or starting winding. ➢ Because of the high value of resistance in the starting winding, a phase shift of 30 to 40^0 is introduced in the current carried by starting and running windings. This creates rotating magnetic field and the motor starts running. ➢ A centrifugal switch S is connected in series with the starting winding ➢ It function is to automatically disconnected the starting winding from the supply when the motor has reached 70 to 80 per cent of its full load speed.
c)	**Which type of single phase induction motor is used in domestic ceiling fans. why ?**
Ans:	**(Choice of motor:-2 Marks & Explanation 2 Marks)** Capacitor start and run Single phase induction motors , also known as split phase induction motor are used in celling fan This motor gives silent or noise free operation, good starting and running torque and also a better power factor. And also due to their easy handling and repair, simple design, cost and efficiency. Single phase motor is the economical choice for domestic ceiling fans .

d)	**Draw a neat diagram of AC servo motor and give its operation.**
Ans:	**Diagram of AC servo motor :** **(Diagram : 2 Mark & Operation 2 Mark)**  **OR Equivalent figure** There are some special types of application of electrical motor where rotation of the motor is required for just a certain angle not continuously for long period of time. For these applications some special types of motor are required with some special arrangement which makes the motor to rotate a certain angle for a given electrical input (signal). Such motors can be ac or dc motors. When controlled by servo mechanisms are termed as servomotors. These consist of main and control winding and squirrel cage / drag cup type rotors. Vr is the voltage applied to the main or reference winding while Vc is that applied to control winding which controls the torque- speed characteristics. The 90^0 space displacement of the two coils/windings and the 90^0 phase difference between the voltages applied to them result in production of rotating magnetic field in the air gap due to which the rotor is set in motion. The power signals can be fed from servo amplifiers either to the field or armature depending upon the required characteristics.
e)	**Explain the necessity of earthing.**
Ans:	**Necessity of Earthing:** **(Any Four points expected - 4 Marks)** 1. To provide an alternative path for the leakage current to flow towards earth. 2. To save human life from danger of electrical shock due to leakage current. 3. To protect high rise buildings structure against lightening stroke. 4. To provide safe path to dissipate lightning and short circuit currents. 5. To provide stable platform for operation of sensitive electronic equipment's.

f)	**What is MCCB, ELCB. Megger ? Is fuse is necessary in wiring even if MCB or MCCB is connected?**
Ans:	**1. ELCB Means:** **(1 Marks)** Earth Leakage circuit breaker 2. **MCCB Means:** **(1 Marks)** Moulded Case circuit breaker **3. Megger:** **(1 Marks)** Megger is an instrument for measuring the resistance of electrical insulation. **4. Yes fuse is necessary in wiring even if MCB or MCCB is connected** **(1 Marks)**

---**END**---