Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

1 a) Kirchhoff's Current Law states that in any electrical circuit, the algebraic sum of all the branch currents at any node or junction is always zero.

OR 2 marks

The sum of all currents leaving a junction is always equal to the sum of all the currents entering the junction.

1 b) Ideal Current Source is that current source which can deliver a constant amount of current irrespective of the value of the load resistance connected across its terminals. Specified by source value in Amperes. The internal resistance is infinite. 2 marks

1 c) Linear Network: A circuit or network whose parameters are always constant irrespective of variations in voltage or current is known as linear circuit or network (for example resistance). 1 mark

Active Network: When a network contains a source of energy, it is said to be an active network. 1 mark

1 d) Maximum power transfer theorem:-

A resistive load will draw maximum power from a network when the load resistance is equal to the resistance of the network as viewed from the output terminals (load terminals with load removed), with all energy sources removed and keeping only their internal resistances in respective places. 2 marks

OR

The power delivered to the load is maximum when load resistance R_L is equal to the Thevenin's resistance R_{th} of the network across the load terminals with load removed.

1 e) Phase difference:- Two alternating quantities are said to have a phase difference when they reach their zero and maximum values at different time instants. Measured in electrical radians or degrees. 1 mark

Time period:- It is the time (in seconds) required by an alternating quantity to complete its one cycle. 1 mark

1 f) Form factor:- The ratio of RMS value to average value. Its value is indicative of the shape of the waveform. 1 mark

Relation:- Form factor = RMS value/Average value 1 mark

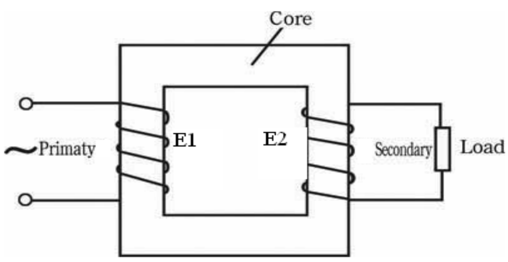
1 g) Phase Sequence:- The order in which the phase voltages of a 3-phase system attain their peak or maximum positive value is called the phase sequence of the system. 2 marks

1 h) $V_L = V_{ph}$, ½ mark

$I_L = \sqrt{3}\, I_{ph}$, ½ mark

$P = 3\, V_{ph} \times I_{ph} \times \cos\Phi$ **OR** $P = \sqrt{3}\, V_L \times I_L \times \cos\Phi$ 1 mark

1 i) Principle of working of single phase transformer:
Mutual induction between two circuits / coils (in ac circuits).
The circuits are linked by a common magnetic field produced in the electromagnetic core by one of the coils/circuits called as the primary winding while the other is the secondary to which the load is connected. The induced emf produced in the secondary winding feeds the load through the terminals of the secondary winding. 1 Mark



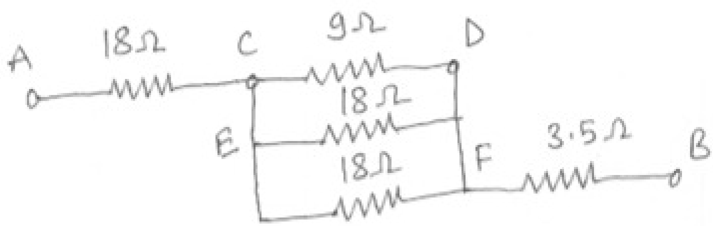
1 mark

1 j) Small DC current will flow through primary but emf will not be induced in transformer windings if primary is connected to 2 V DC. 1 Mark

Only at the instant of switching there might be a spike on the secondary side when the current changes suddenly (if the resistance of transformer is very low).

Justification: The transformer action is not possible with direct current of constant magnitude, as the flux produced by it is not alternating. Small current will flow through primary as the applied voltage (2 V) is very small as compared to the rated value (230 V). 1 Mark

1	k)	Function of commutator in d.c. motor:- The function of the commutator is to reverse the current in each conductor of the armature as it passes from one pole to another and thus to help the motor to develop a continuous and unidirectional torque.	2 Mark
1	l)	Two methods to reverse d.c. shunt motor:-	
		(1) By reversing of field terminals connections only.	1 Mark
		(2) By reversing of armature terminals connections only.	1 Mark
1	m)	Slip ring or Wound rotor induction motor is used for lifts.	1 Mark
		Reasons:	
		• High starting torque can be obtained by inserting external resistance in rotor circuit. • Speed can be controlled by varying external resistance in the rotor circuit.	½ mark each = 1 mark
1	n)	In an induction motor, it is impossible for the motor to run at synchronous speed. If it runs at synchronous speed, there will be no relative motion between the rotating magnetic field produced by the stator and the rotor conductors. As a result, there will be no induced e.m.f. and no current in the rotor conductors. Therefore, no torque will be produced. Actually, the speed of the motor adjusts itself so that the magnitude of the rotor current is just sufficient to produce a torque equal to that required by the rotor losses and the load if any, on the motor.	2 Marks
2	a)	Simplifying:	

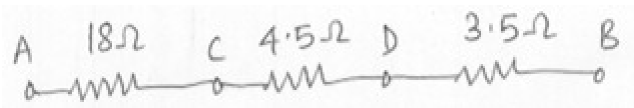


1 mark

Solve parallel resistances:

$1/R_{eq} = (1/9) + (1/18) + (1/18) = 2/9$ mho 2 marks

$R_{eq} = 4.5$ ohms.



Hence total resistance = 18 + 4.5 + 3.5 = 26 ohms 1 mark

2 b) **Statement:** Norton's theorem for dc networks states that any two-terminal active network containing electric sources and resistances when viewed from its output terminals, is equivalent to a constant current source and a parallel resistance (conductance).

The constant current (Norton equivalent current I_n) is equal to the current which flows through a short-circuit placed across the load terminals and the parallel resistance (Norton equivalent resistance R_n) is the resistance of the network measured between the load terminals with load disconnected & all the sources replaced with their internal resistances. 1 mark

Explanation:

Consider a network shown in fig. (a), in which it is desired to calculate the current flowing through the load resistance R. For calculating the value of Norton equivalent current I_n, short circuit the load resistance R as shown in fig. (b) and calculate the current through short circuit. Fig. (c) shows the circuit for calculating Norton's equivalent resistance R_n, in which the load is disconnected and all the sources are replaced by their internal resistances. 1 Mark

The Norton's equivalent circuit is shown in fig. (d) Hence the current through the load resistance $I = \frac{R_n}{R_n + R} I_n$

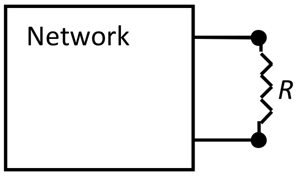


Fig. (a)

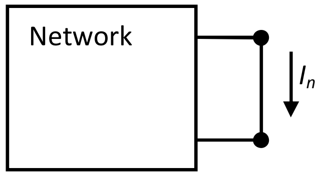


Fig. (b)

1 mark

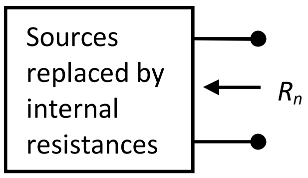


Fig. (c)

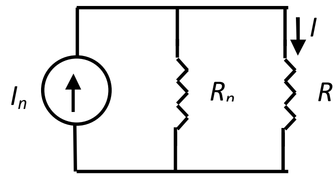


Fig. (d)

1 mark

2 c) **Impedance:-** Impedance is the combined effect of resistance (opposition) and reactance (inductive and capacitive) in alternating circuits. 1 Mark

Mathematically it is given by $Z = \sqrt{\{R^2 + (X_L - X_C)^2\}}$ (ohms).

Power factor:- It is the cosine of the angle between voltage and current, i.e., p.f.= cosΦ

OR

It is the ratio of resistance to impedance, i.e., p.f. = R/Z 1 Mark

OR

It is the ratio of active power to the Apparent power.

i.e., p.f. = Active power / Apparent power = kW/kVA.

Significance/importance of unity power factor in a.c. system:-

(1) For certain real power current is minimum.
(2) For given power lines more real power can be delivered. 2 Marks
(3) Resistive losses in the systems will be minimum, and efficiency will be maximum.
(4) An industrial consumer will be charged a penalty if the power factor is very low.

2 d) Advantages of 3φ a.c. system over 1φ a.c. system:-

(1) Output of 3φ machine is greater than that of 1φ machine of the same size. 1 mark each

(2) 3φ machine is smaller than 1φ machine of the same rating. pt; any four

(3) 3φ machine is lighter than 1φ machine of the same rating. points = 4 marks

(4) 3φ machine is cheaper than 1φ machine of the same rating.

(5) Output of 3φ machine is not fluctuating as in case of 1φ machine.

(6) 3φ transmission is economical for a given amount of power at given voltage over a given distance.

(7) 1φ motors are not self starting, 3φ motors are self starting.

(8) Power factor of 1φ motor is lower than that of a 3φ motor of the same output and speed.

2 e)

Sr. No.	Core type transformer	Shell type
1	The windings surround a considerable portion of core.	The core surrounds a considerable portion of the windings.
2	More suitable for high voltage transformers.	More economical for low voltage transformer.
3	Natural cooling is more effective, since the windings are distributed on two limbs.	Natural cooling is poor since the windings are placed on the central limb only.
4	It provides a single magnetic circuit.	It provides a double magnetic circuit.
5	When the coils are to be withdrawn for repairs, these can be easily withdrawn without dismantling large no. of laminations.	When the coils are to be withdrawn for repairs, a large number of laminations are to be dismantled.
6	As the windings are placed on the outer limbs, it provides poor mechanical protection to the windings.	As the windings are placed on the central limb, it provides better mechanical protection to the windings.

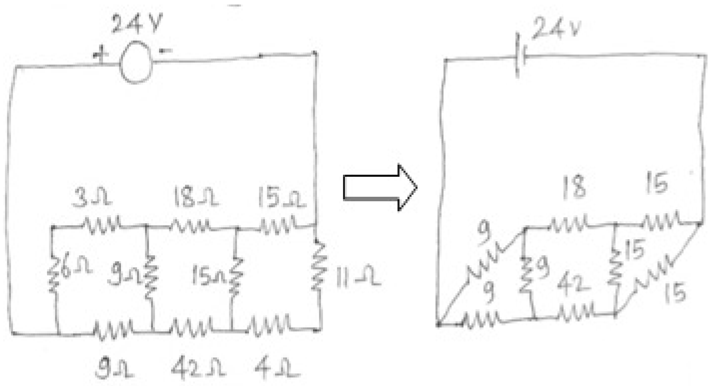
1 mark each pt; any four points = 4 marks

2 f) Compare squirrel cage and slip ring induction motor:-

Sr. No.	Points	Squirrel cage I.M.	Slip ring I.M.
1	Construction	Simple and robust	Less simple
2	Cost	Cheaper	Costlier
3	Starting	(i) star delta starter (ii) stator resistance starter (iii) Auto transformer starter	Rotor resistance starter
4	Starting torque	Low	High
5	Pull out torque	Greater	Less
6	Efficiency	More	Comparatively less
7	Speed control	Difficult	Easier
8	Maintenance	Less	More
9	Fire Hazards	Safe, as there are no rubbing contacts.	Risk of fire due to sparking at the brushes.

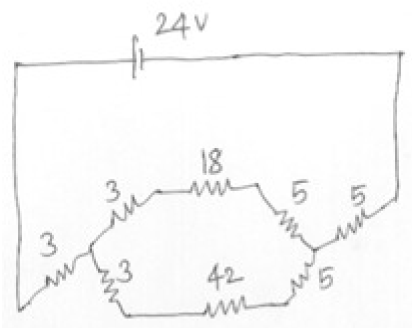
1 mark each pt; any four points = 4 marks

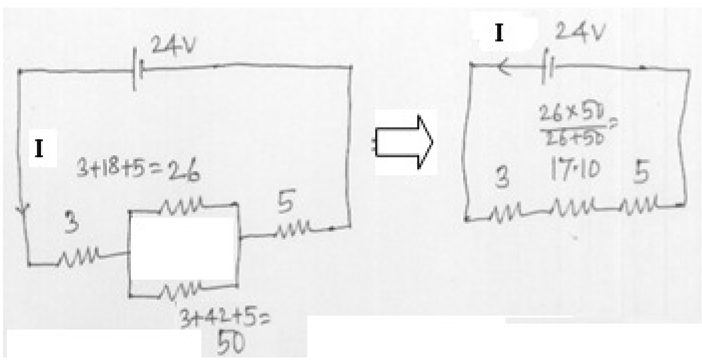
3 a) Simplify as below;



Convert symmetrical delta sections of 9 ohms and 15 ohms to equivalent star as

For delta of 9 ohms; equivalent star branch is (9 x 9)/(9 + 9 + 9) = 3 ohms; similarly for delta of 15 ohms equivalent star branch = 5 ohms. 1 mark





1 mark

1 mark

$I = 24/(3 + 17.10 + 5) = 0.956$ A.

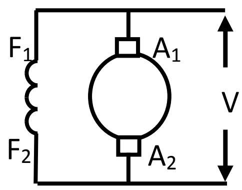
By division of current in parallel resistances, current through 42 ohms is

$I_{42} = I(26)/(26 + 50) = 0.327$ A 1 mark

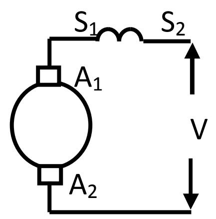
3 b) Significance of back emf in d.c. motor:-

- As the armature of the DC motor start rotating, the flux which is responsible for their rotation is cut and consequently an e.m.f. is induced in them in accordance with Faraday's law of electromagnetic induction.
- This e.m.f. always acts in opposition with the applied voltage (V) as per Lenz's law and therefore it is known as back e.m.f. (E_b) or counter e.m.f. 1 mark
- Since the back e.m.f. opposes the applied voltage across the armature, the net voltage acting in the armature circuit is the difference between the two (i.e. V-E_b). It is, this effective voltage which determines the value of armature current (I_a). 1 mark
- If R_a is the armature resistance, then from Ohm's law, $I_a = (V\text{-}E_b)/R_a$ amperes. 1 mark
- In the running condition, E_b is nearly equal to V. The internal resistance of the armature of a d.c. motor being very low, it is the back e.m.f. which mainly limits the armature current in the running condition of the motor. 1 mark

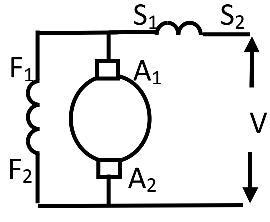
3 c) Classification of d.c. motors on the basis of winding connections:-
(1) DC Shunt motor, (2) DC Series motor and (3) DC Compound motor which is further classified into - (i) Long shunt compound motor and (ii) Short shunt compound motor 2 Marks



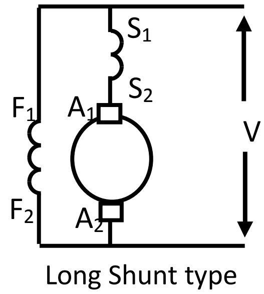
DC Shunt



DC Series



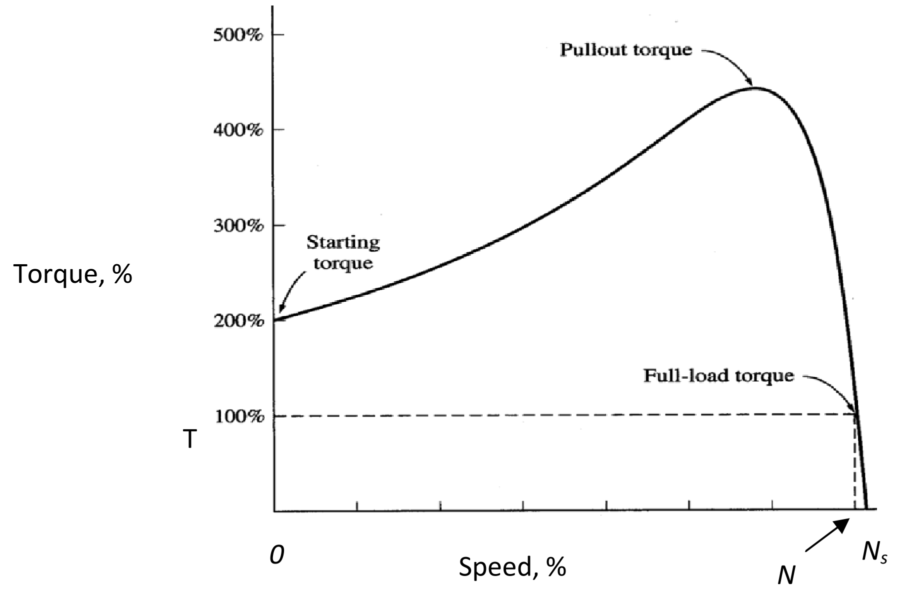
Short Shunt type
DC Compound



Long Shunt type
DC Compound

2 Marks

3 d) Torque Speed characteristics of 3Φ squirrel cage induction motor:-



Characteristics – 2 Marks

- In this diagram, T represents the nominal full load torque of the motor.
- In this case, the starting torque (at $N = 0$) is 2T.
- The maximum torque (pullout torque) is nearly equal to 4.5T.
- At full load, the motor runs at speed N.
- When mechanical load increases, motor speed decreases till the motor torque again becomes equal to the load torque.
- However, if the load torque exceeds the pullout torque, the motor will suddenly stop.

Explanation – 2 Marks

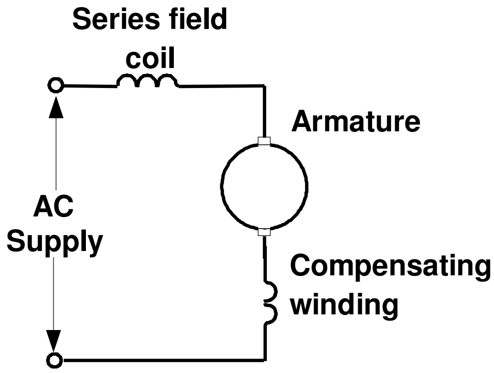
3 e) Working of universal motor with neat diagram:-

- Universal motor is one which operates both on AC and DC supply.
- Its principle of operation is the same as that of a DC series motor i.e. force is created on the armature conductors due to the interaction between the main field flux and the flux created by the current carrying armature conductors.
- The construction of AC series or universal motor is same as DC series motor. The main parts of this motor are – 1) Armature 2) Field poles and field winding 3) Compensating winding 4) Commutator

Working 2 Marks

and 5) Brushes

- When the motor is connected to an AC supply, it will rotate and exert unidirectional torque because the current flowing both in the armature and field reverses at same time.



Neat diagram 2 Marks

Schematic diagram of universal motor

3 f) Working of stepper motor:-

A stepper motor is electromechanical device which converts electronic pulses into proportionate mechanical step movement. In these motors, each step input causes the shaft to rotate through a certain number of degrees i.e. one step movement. A step is defined as the angular rotation in degrees produced by the output shaft when the motor receives a step input pulse. Construction and working of Permanent-Magnet (PM) type stator motor is given here.

2 Marks for construction and 2 Marks for working

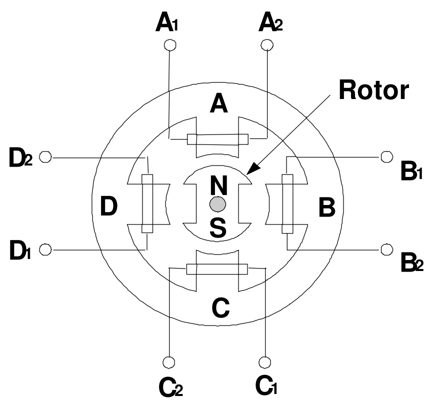
The permanent-magnet stepper motor operates on the reaction between a permanent-magnet rotor and an electromagnetic field produced by the stator. Fig. (a) shows the schematic representation of four phase, two pole permanent magnet stepper motor and fig, (b) shows its basic drive circuit. The stator of this type of motor is multipolar. In this case, the stator has four poles. Exciting coils A, B, C and D are wound around these poles. The rotor can be salient pole type or smooth cylindrical type and it has a permanent magnet mounted at each end. The rotor is made of ferrite material which is permanently magnetized.

When a steady DC signal is applied to one stator winding of PM stepper motor, the rotor makes a revolution of 90^0. This angle is called as step for

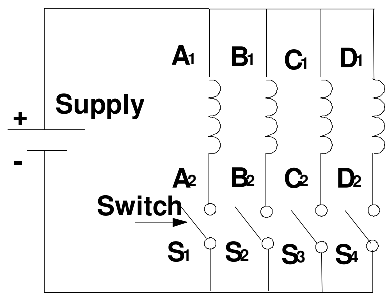
Note: There are many types of stepper motors, working of PM type stepper motor is given here. Full marks must be given for correct construction and each input voltage pulse. These steps are explained as below:

working of any type of stepper motor

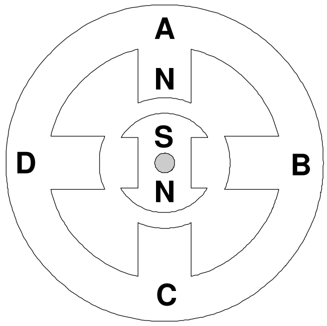
1) When the switch S_1 is closed, a pulse is applied to the phase A. Thus the torque is developed on the rotor and it rotates such that its magnetic axis gets aligned with the magnetic axis of the stator. The position of the rotor when phase A is excited is shown in fig. (c).
2) Now if phase A is disconnected and phase B is excited by closing the switch S_2. Then the rotor will further rotate through 90^0 in such a way that the magnetic axis of rotor again gets aligned with the magnetic axis of stator as shown in fig. (d). Here, if both the phases A and B are excited simultaneously, the rotor will rotate through 45^0 and will take a position between the stator poles A and B.
3) Similarly when phases C and D are excited sequentially, the rotor will every time rotate through 90^0 as shown in fig. (e) and (f).
4) Thus by giving pulses to the stator coils in a desired sequence, it is possible to control the speed and direction of the motor.



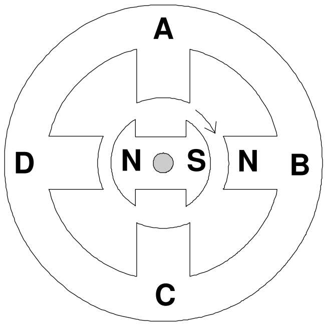
(a)



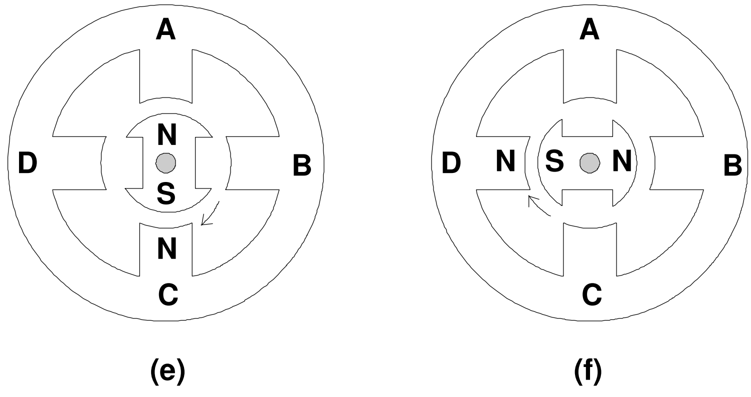
(b)



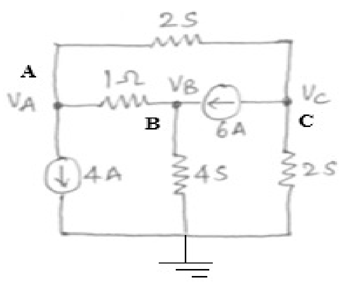
(c)



(d)



4 a) Mark nodes as A, B, C (& respective voltages) and ground as shown.



1 Mark

Apply Kirchhoff's current law at nodes A, B and C;

Node A:

$-4 = 3V_A - V_B - 2V_C$

Node B:

$-6 = V_A - 5V_B + 0V_C$

Node C:

$6 = 2V_A + 0V_B - 4V_C$

Three equations 1 Mark

For current through 4 S we require V_B only.

Solving simultaneously the above three equations we get $V_B = 0.55$ V. 1 Mark

Current through 4 S is

$= 4V_B = 4 \times 0.55$.

$= 2.2$ A. 1 mark

4 b) $X_L = 2\Pi f L = 2\Pi \times 50 \times 20 \times 10^{-3} = 6.28$ ohms. 1 mark

$Z = \sqrt{(R^2 + X_L^2)} = \sqrt{(10^2 + 6.28^2)} = 11.81$ ohms. 1 mark

Current I in the series circuit is

$= V/Z = 230/ 11.81 = 19.47$ A, 1 mark

Power factor = R/Z = 10/11.81 = 0.846 lag. 1 mark

4 c) Working of servo motor:-

Servo motors are mainly used for control applications. These motors look like the usual electric motors but these motors are not used for continuous energy conversion like industrial motors. Servomotors have high torque capabilities and used only for precise position or speed control. Their basic principle of operation is same that of other industrial motors. However, their construction, design and mode of operation are different. There are different types of servomotors. Two phase AC servomotor is explained here -

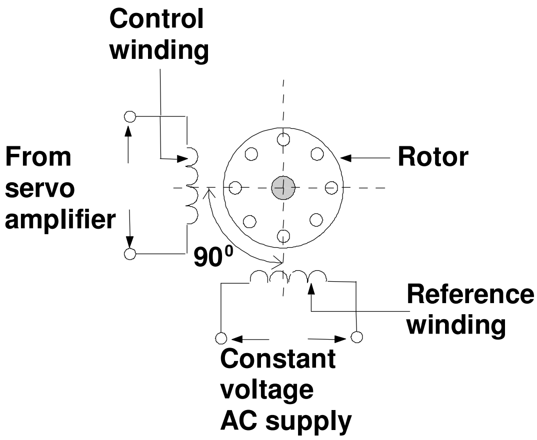
(There are many types of servo motors, working of two phase AC type servo motor is given here. Full marks must be given for correct construction and working of any type of servo motor)

Two phase AC servomotors: The stator of this motor carries two windings. These two windings are uniformly distributed and are displaced from each other by 90^0 electrical. One winding is called as the main or reference winding. This is supplied from a constant voltage ac supply. The other winding is called control winding. It is supplied with a variable control voltage of the same frequency which is obtained from servo amplifier. This voltage is 90^0 out of phase with respect to the voltage applied to the reference winding. This phase difference is necessary to obtain the rotating magnetic field. The schematic diagram of the two phase AC servomotor is shown in figure.

2 Marks for working

The rotor is usual squirrel cage type rotor. The rotor has small diameter and large length. Aluminium conductors are used as rotor bars to keep the rotor weight small. This reduces the inertia of the rotor. The rotor resistance is deliberately kept high to obtain the torque-speed characteristics as linear as possible.

The speed and torque of the motor is controlled by the magnitude of control voltage. The direction of rotation can be quickly reversed by reversing the phase difference between the reference and control voltage from leading to lagging.



2 Marks for construction incl. diagram

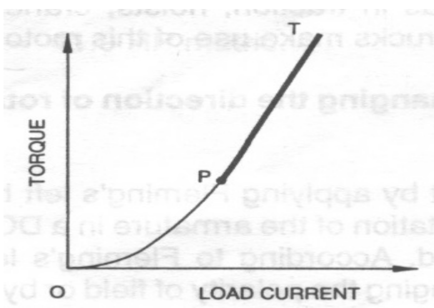
Schematic diagram of 2 phase AC servomotor

4 d) Torque Vs. Armature current (T/I_a) characteristics of d.c. series motor:-

- Torque 'T' is proportional to the armature current and field flux i.e. $T \alpha\ \phi I_a$ where ϕ is the series field flux and I_a is the armature current.
- In this case $\phi\ \alpha\ I_{se}$ which is proportional to I_a. $\therefore T\ \alpha\ I_a.I_a\ \alpha\ Ia^2$. Thus as the load increases, the torque increases according to square of the load current up to point 'P' and T/I_a curve is a parabola.
- Beyond the point 'P' the curve becomes a straight line and indicates that torque is proportional to the armature current only as field cores are saturated.

Characteristics – 2 Marks,

Explanation – 2 Marks



4 e) Working of 3 phase induction motor:-

- A 3-phase induction motor basically consists of a stator and a rotor separated by a uniform air gap.
- Stator carries three phase winding. When a three phase supply is fed to the stator winding, a magnetic field that rotates at synchronous

1 mark

speed is produced.

- The lines of force of the stator field cut the rotor conductors and an alternating emf is induced in these conductors. 1 mark
- As the rotor winding is equivalent to a short circuited winding, the emf generated in the rotor conductor circulates a current. 1 mark
- Thus a force will act upon the current carrying rotor conductor and the rotor will start to rotate in the direction of the rotating stator magnetic field. 1 mark

4 f)

- Single phase induction motor has distributed stator winding and a squirrel cage rotor. When the stator is fed from a single phase supply, it produces flux which is only alternating. It is not a synchronously rotating flux, as in the case of a three phase stator winding fed from three phase supply. 1 marks
- As the flux is an alternating or pulsating flux it cannot produce rotation of rotor. Thus a single phase motor is not self starting. 1 mark
- To overcome this drawback and make the motor self starting, it is temporarily converted into a two phase motor during starting period. For this purpose, the stator of a single phase motor is provided with an extra winding known as starting or auxiliary winding in addition to the main or running winding. 1 Marks
- Stator winding is arranged such that the phase difference between the currents in the two windings is very large. Hence, the motor behaves like a two phase induction motor. These two currents produce a rotating magnetic flux and hence make the motor self starting.

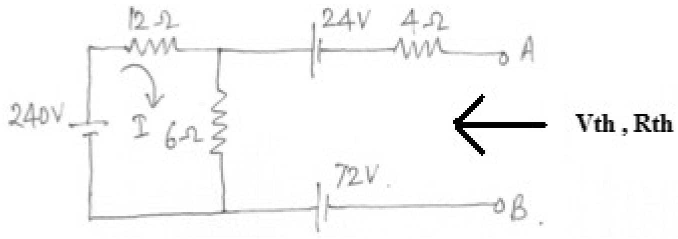
Types of commonly used single phase motors:-

(1) Resistance Split-Phase motors

(2) Capacitor Split-Phase motors - (i) Capacitor start motors, (ii) Permanent split or Single value capacitor motors and (iii) Capacitor start and run or Two value capacitor motors 1 Mark

(3) Shaded pole motors

5 a) Open circuit 8 ohm and convert 20 A current into equivalent voltage source = (20 x 12) 240 V, 12 ohms.



1 mark

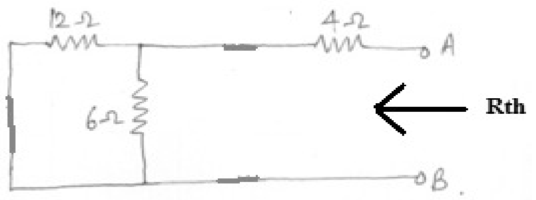
I = 240/(12 + 6) = 40/3 A.

$V_{th} = V_{A-B}$ = 72 + 6 x I – 24

= 72 + 6 x 40/3 – 24

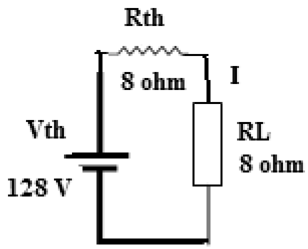
= 128 V. 1 mark

For R_{th} remove all sources and calculate as below 1 mark



1mark

R_{th} = 4 + (12 x 6)/(12 + 6) = 8 ohms.



1 mark

1 mark

Current through load of 8 ohm by thevenin's theorem is

$I = V_{th}/(R_{th} + R_L)$ 1 mark

= 128/(8 + 8) = 8 A. 1 mark

5 b) When connected across dc supply only resistance is offered hence resistance of the coil is

R = 12 / 6 = 2 ohms. 2 Marks

When across AC supply of 24 V, 50 Hz. again current = 6 A.

Hence impedance of coil = 24/6 = 4 ohms. 2 marks

But $Z = \sqrt{(R^2 + X_L^2)}$ which gives

$X_L = \sqrt{(Z^2 - R^2)} = (4^2 - 2^2)^{1/2} = 3.46$ ohms. 2 marks

Also $X_L = 2\,\Pi\, f\, L$ gives

$L = X_L / (2\,\Pi\, f) = 3.46/(2\,\Pi \times 50) = 0.011$ H 2 marks

5 c) There are two types of power losses in the transformer:-

(1) Copper losses and (2) Core or Iron losses

(1) Copper losses:- These losses represent the loss of power caused by the resistance of the windings (both, primary and secondary) due to the current flow through them. The power loss on this account is proportional to the square of the current flowing through the windings. Total copper loss = $I_1^2 R_1 + I_2^2 R_2$ 2 Marks

(2) Core or Iron losses:- These losses consist of hysteresis and eddy current losses caused by the alternating flux in the transformer core. 2 Marks

(a) Hysteresis loss:- This loss takes place in the transformer core because it is continuously subjected to rapid reversals of magnetization by the alternating flux.

(b) Eddy current loss:- This loss occurs due to the flow of eddy currents in the core.

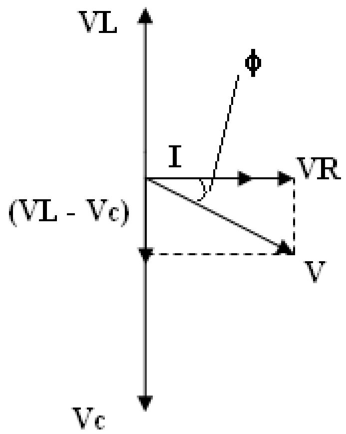
Copper losses occur in the primary and secondary windings of the transformer, and core or iron losses occur in the core of the transformer. Copper losses are minimized by using good winding material having lesser resistance, and core or iron losses are minimized by using silicon steel as core material and by using laminated construction for the core. 2 Marks

Transformer has efficiency more than 90 % because it is a static device, having no rotating part in it, therefore friction and windage losses are absent. 2 Marks

6 a) Assume voltage = 230 V, and frequency = 50 Hz, the standard in our country for single phase supply.

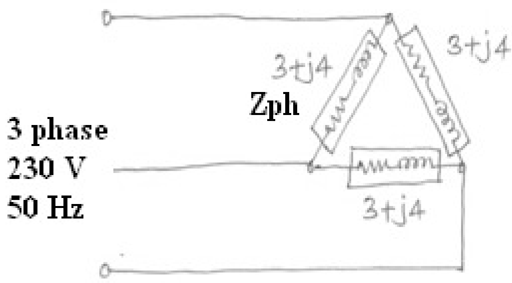
- $X_L = 2\,\Pi\, f\, L = X_L = 2\,\Pi \times 50 \times 25 \times {}^{10-3} = 7.85$ ohms. 1 mark
- $X_C = 1/(2\,\Pi\, f\, C) = 1/(2\,\Pi \times 50 \times 25 \times 10^{-6}) = 127.32$ ohms. 1 mark

- $Z = \sqrt{[R^2 + (X_L - X_C)^2]} = \sqrt{[25^2 + (7.85 - 127.32)^2]} = 122$ ohms. 1 mark
- Current = V/Z = 230/122 = 1.88 A. 1 mark
- Pf = R/Z = 25/122 = 0.2 lead as $X_C > X_L$. 1 mark
- Comment: capacitively reactive circuit current leads voltage drop. 1 mark
- Phasor diagram 2 marks



(Answers may vary depending on assumed frequency and voltage, full marks must be given if all the steps are correct)

6 b)



$Z_{ph} = \sqrt{[R_{ph}^2 + X_{Lph}^2]} = \sqrt{[3^2 + 4^2]} = 5$ ohm. 1 mark

Line voltage V_L = 230 V. 1 mark

Phase voltage $V_{ph} = V_L$ = 230 V (delta connection) 1 mark

Phase current $I_{ph} = V_{ph}/Z_{ph}$ = 230/5 = 46 A. 1 mark

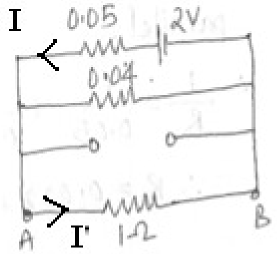
Line current $I_L = \sqrt{3}\, I_{ph} = \sqrt{3} \times 46 = 79.67$ A. 1 mark

pf = R/Z = 3 / 5 = 0.6 lag. 1 mark

Power consumed by each impedance = $V_{ph} I_{ph}$ pf = 230 x 46 x 0.6= 6348 W 1 mark

Total power (three phases) = $\sqrt{3}\, V_L I_L$. pf = √3x230x79.67x0.6 = 19043 W 1 mark

6 c) Keep inly 2 V source to determine current I' in 1 ohm,



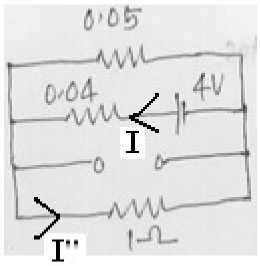
1 mark

I = 2/[0.05 + (0.04 x 1)/(1 + 0.04)] = 2/0.0885 = 22.6 A.

By division of current in parallel resistances;

I' = I(0.04)/(0.04 + 1) = (22.6 x 0.04)/(0.04 + 1) = 0.87 A 1 mark

Keeping only 4 V in circuit, determine I".

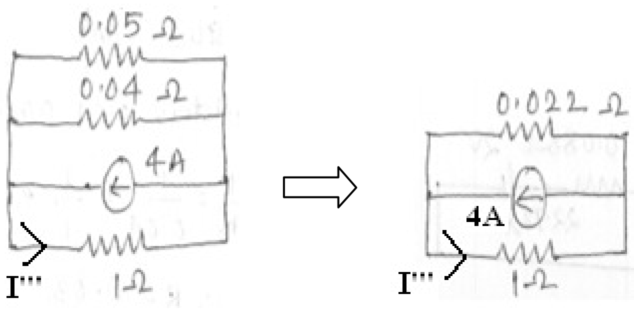


1 mark

I = 4/[0.04 + (0.05 x 1)/(1 + 0.05)] = 4/0.0876 = 45.65 A.

I" = I(0.05)/(0.05 + 1) = (45.65 x 0.05)/(0.05 + 1) = 2.17 A. 1 mark

Keeping only 4 A in circuit we determine I'",



1 mark

I'" = 4 (0.022)/(1 + 0.022) = 0.086 A 1 mark

By Superposition theorem the current in 1 ohm

= I' + I " + I '" = 0.87 + 2.17 + 0.086 = 3.126 A. 2 marks