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.

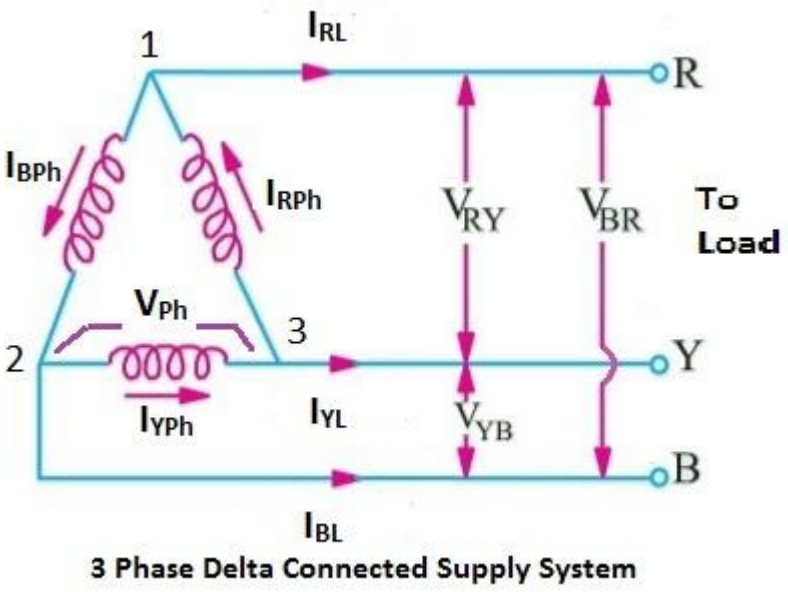
Q. No	Detailed Solution	MARKS Distribution
1	Attempt any TEN of the following	
1.a	List the stages of electrical power system i)Generation ii)Transmission iii)Distribution	For (i) and (ii) 1M For (iii) 1M
1.b	State working principle of PMMC type meters When a current carrying moving coil is placed in a magnetic field, a force is experienced on it and it is proportional to value of current flowing through it.	1M
1.c	State the applications of wattmeter and state the unit of power i) Applications of wattmeter:- To measure active power in DC and AC circuit ii) Unit of power:- Watt	1M 1M
1.d	List the main parts of DC machine	

	i)Stator parts:- 1)Yoke 2)Pole 3)Field coils ii)Rotor parts:- 1)Armature 2) Commutator 3)Brushes	1M 1M
1.e	Define the terms:- i)Transformation ratio ii)Voltage ratio i) Transformation ratio:- It is defined as the ratio of the secondary winding turns to the primary winding turns of a transformer. ii) Voltage ratio:- It is defined as the ratio of the secondary winding voltage to the primary winding voltage of a transformer.	 1M 1M
1.f	State the emf equation of a transformer E= 4.44 f N ϕm volt Where E= Induced emf in winding f = Frequency of AC supply source N = Number of turns of winding ϕm = Maximum value of magnetic flux linking with winding	 1M 1M
1.g	Define slip and write the formula to determine percentage slip. i)Slip:- It is the ratio of relative speed of rotor (difference between synchronous speed and rotor speed) to the synchronous speed of rotating magnetic field of stator. ii)Percentage slip =((NS – N)/ NS)*100 where NS = synchronous speed of rotating magnetic field of stator N = speed of rotor	 1M 1M
1.h	What is the function of MCCB and fuse i)MCCB:- It provide over current and short circuit protection (fault interruption function)in a power circuit with capacity up to 3KA and can also be used as a switch under normal working condition. ii)Fuse:- It provide protection against over current and short circuits.	 1M

		1M
1.i	State the purpose of earthing in electrical installation The purpose of earthing is to provide safety of operation of electrical equipment.(Both operator and equipment)	2M
1. j	State how you will reverse the direction of rotation of 3-phase induction motor. The direction of rotation of 3-phase induction motor is reversed by changing any two phases connections of motor terminals with supply terminals. The direction of rotation of 3-phase induction motor is reversed by Changing the phase sequence of supply.	2M
1.k	Why the starters are required in case of 3-phase I.M.? i)The starters are required in 3-phase I.M. to limit the heavy or large starting current drawn by the induction motor when directly switched on. ii)The large starting current produces large copper losses in motor that generates heat which can damage insulation of motor. iii)The large starting current produces heavy dip in supply voltage that can affect other equipment operating on it.	1M ½ M ½ M
1.l	Name any two electrical machines used in electro-agro system. i)Induction motor in mono block and centrifugal pumps ii)Electrical dryers for partial drying of grains use single phase induction motor iii)Small portable battery operated DC motor are used in sprayers.	Any two with 1M for each
Q-2	Attempt any FOUR of the following	
2.a	Draw delta connected 3-phase supply system. Mark line voltage and phase voltage, line current and phase current. Write power equation.	

2M

i)Delta connected 3-phase supply system diagram:-



3 Phase Delta Connected Supply System

ii) Marking of line voltage and phase voltage, line current and phase current.

Line Current = IRL, IYL, IBL

Phase Current = IRPh, IYPh, IBPh

Line Voltage = VRY, VYB, VBR

Phase Voltage = VPh (Voltage across terminal 1-2,2-3,3-1)

1M

iii)Power equation:-

Power(P) = $\sqrt{3}$ VL IL cosϕ Watt

Where,

VL = Line voltage in volt

IL = Line current in ampere

cosϕ = Power factor of load

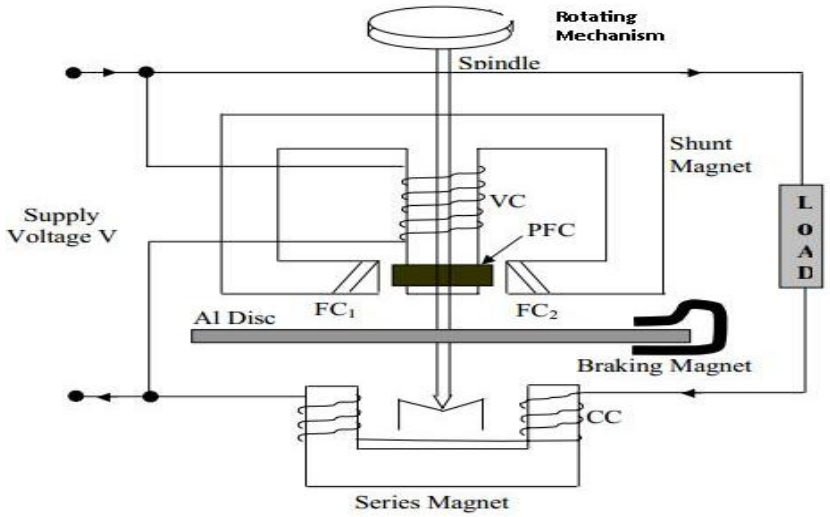
1M

2.b	Define RMS value of an AC quantity. Explain its practical significance. i)The RMS value of an AC quantity is that value of direct current which when flows through a circuit for a given period of time, produces same heat energy as when an AC quantity is applied to same circuit for the same time. ii)The practical significance:- The alternating quantity has an identical positive and negative half cycle. Normally the current or voltage is measured by the amount of heat that will be produced. The RMS value is the Root of Mean of Squares of quantity at different instant. It directly reflects the amount of heat produced by given AC quantity. So it is the RMS value of AC quantity that matters more as compared to average or maximum value.	2M 2M
2.c	An alternating voltage is mathematically expressed as:- $v = 141.42 \sin(157.08t + \pi/12)$ volt Find the maximum value, RMS value, frequency and periodic time. Solution:- The instantaneous value of alternating voltage is given by:- $v = Vm \sin(\omega t + \Theta)$ where, Vm = Maximum value of voltage ω = frequency of supply in radian Θ = phase difference angle Comparing the given equation with above equation ,we get i)Maximum value(Vm):- Vm = 141.42 volt ii) RMS value of voltage (Vrms):- $Vrms = Vm / \sqrt{2}$ volt $Vrms = 141.42/ \sqrt{2}$	1M

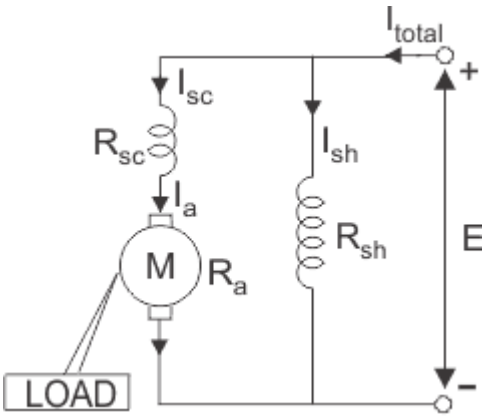
	Vrms = 100 volt iii) Frequency (f):- The relation between ω and f is given by $\omega = 2\pi f$ $f = \omega/2\pi$ $f = 157.08/ 2\pi$ f = 25 Hz iv) Periodic time(T):- T = 1/ f = 1/25 =0.04 T = 0.04 second	1M 1M 1M
2.d	A coil having resistance of 10 ohm and inductance of 0.2 H is connected across 100 volt, 50Hz AC supply. Calculate :- i)Reactance ii)Impedance iii)Current iv)Power consumed. Solution:- Given data:- 1)Resistance(R) = 10 ohm 2)Inductance(L)= 0.2 H 3)Voltage(V) = 100 VOLT 4)Frequency(f) = 50 Hz i)Reactance(XL):- $XL = 2\pi fL$ $XL = 2\pi*50*0.2$ XL = 62.832 ohm ii)Impedance(Z):- $Z = \sqrt{R^2 + X^2}$ $Z = \sqrt{10^2 + 62.832^2}$	1/2M 1/2M 1/2M

	$Z = \sqrt{100 + 3947.86}$ Z = 63.623 ohm iii)Current(I):- I = V/Z I = 100/63.623 I = 1.5718 Ampere iv)Power consumed(P):- $P = i^2 * R$ $P = (1.5718)^2 * 10$ P = 24.705 watt	1/2M 1/2M 1/2M 1/2M 1/2M
2.e	A balanced 3-phase star connected load is supplied from a 3-hase,400V,50Hz, Supply. The resistance per phase is 10 ohm. Find the value of of phase current, line current, power factor and total power consumed. Solution:- Given data:- 1)Resistance per phase(R) = 10 ohm 2)Line voltage (VL)= 400 Volt 3)Frequency = 50 Hz 4)Star connection For star connection line voltage and phase voltage are related by $VL = \sqrt{3} * VPh$ $400 = \sqrt{3} * VPh$ $VPh = 400/\sqrt{3} = 230.94$ volt i)Phase current(IPh):- IPh = VPh / RPh = 230.94/10	1/2M

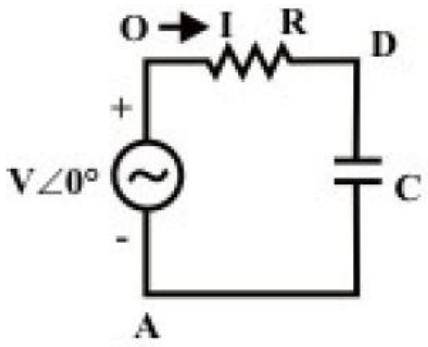
	IPh = 23.094 Ampere ii)Line current(IL):- IL = IPh IL = 23.094 Ampere iii)Power factor(cosϕ): As the circuit has no inductance or capacitance, it is pure resistive circuit. Hence Z=R=10 ohm cosϕ = R/Z=10/10=1.0 Power factor=1.0 iv)Power consumed(P):- P = $\sqrt{3}$ VL IL cosϕ Watt P = $\sqrt{3}$ *400*23.094*1.0 P = 16000 watt	1/2M 1/2M 1/2M 1/2M 1/2M 1/2M 1/2M
2.f	Draw a neat labelled diagram of single phase energy meter showing all its important parts. i)Diagram:- ii) Labelling:- VC= Voltage/ Pressure Coil PFC= Power Factor Compensator FC1 ,FC2 = Friction Compensator CC = Current Coil	3M 1M



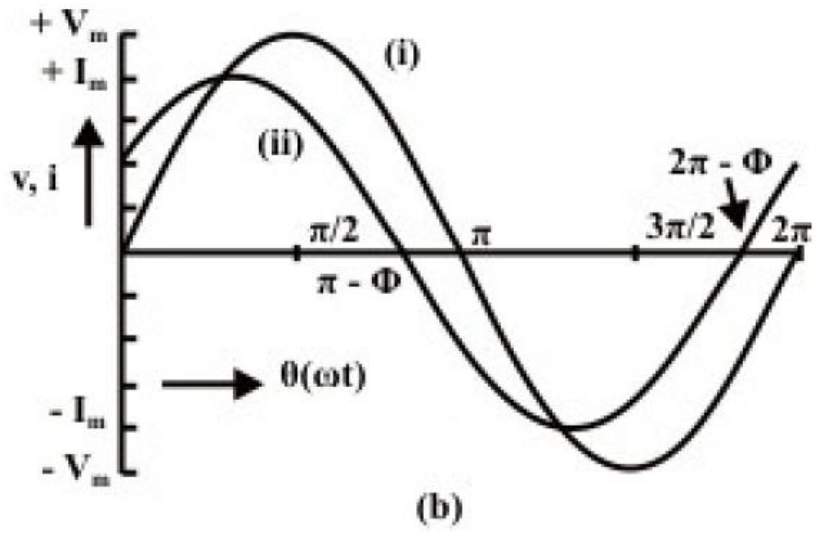
Single phase induction type energy meter

Q-3	Attempt any FOUR of the following:	Marks (16)
	a) Draw the schematic diagram of dc compound (long shunt) motor (04) Diagram:  Labeling: Rsc – Series field winding Rsh – Shunt field winding E or V – Applied voltage volt Ra- Armature resistance	02 Mark 02 Mark

	M- Motor Isc- Series field winding current Ish- Shunt field winding current	
	b) Single phase transformer has 350 primary and 1050 turns. The primary is connected to a 440 volt, 50 Hz supply. If the net cross-sectional area of core is 50 cm^2. Find: i) The maximum value of flux density in the core ii) The voltage induced in the secondary winding. Solution: N_1= 350 N_2= 1050 E_1= 400 v E_2 = ? A= 50 cm^2 = 0.005 m^2 *Formula:* $E1 = 4.44 f \varphi m N1$ volts But φ m = Bm x A Where- Bm = maximum flux density Wb/ m^2 A = cross-sectional area of core- m^2 $E1 = 4.44 \times f \times Bm \times A \times N1$ volts 400 = 4.44 x 50 x Bm x 0.005 x 350 Bm = 1.03 Wb/ m2 N1/N2 = E1/E2 E2 = (N2/N1) x E1 = 400x 1050/350	(04) Formulae 01 Mark 1.5 marks 1.5 Marks

	= 1200 Volt	
	c) Compare auto transformer with a two winding transformer on the basis of construction, efficiency, size, applications. **Auto transformer** 1) It has a single wing for input and output and these are electrical connected 2) Autotransformer copper loss in the common portion of the winding will be less, so efficiency will be slightly more 3) The autotransformer is lesser size than ordinary two winding transformer for the same rating 4) It is used in laboratory for variable supply and also used as starter **Two winding transformer** 1) Two winding transformer has two separate magnetically coupled coils with no electrical connection between them. 2) As it has two separate winding so copper loss is more hence efficiency will be less. 3) Two winding transformer is bigger in size than autotransformer for the same rating 4) It is used in power system to step up or step down the voltage level	(04) Each point has 1 mark 1x4= 04
	d) Draw and explain circuit diagram of R-C circuit <u>Circuit diagram</u>  (a)	(04) 01 Mark

Wave form



01 Mark

Explanation:

In a series circuit, the current is the same through both the resistor and the capacitor The resistor voltage is in phase with the current, and the capacitor voltage lags the current by 90

The impedance of a series RC circuit is determined by both the resistance (R) and the capacitive reactance (XC) (Z = R−jXC)

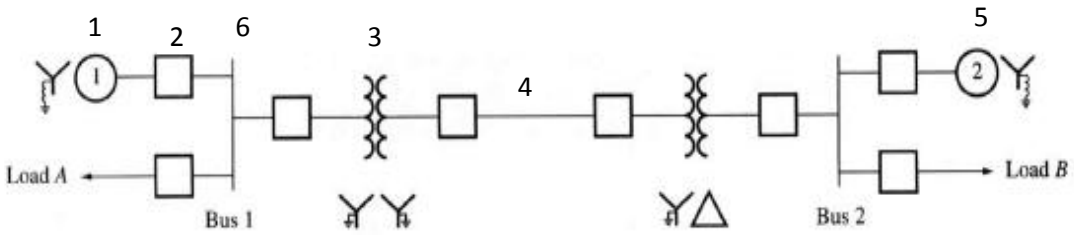
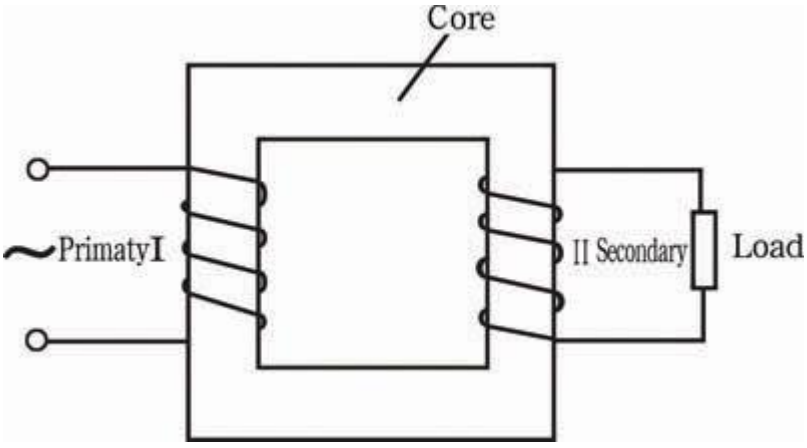
$$= R - j X_C = R - j\frac{1}{\omega C}$$

02 Mark

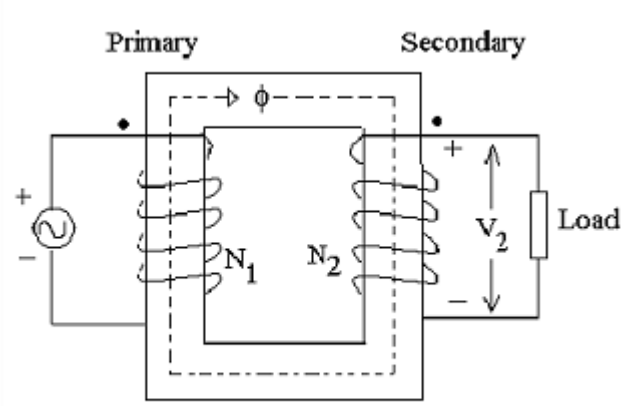
Note that the current leads the voltage by the angle φ , value as given above. In this case, the voltage phasor has been taken as reference phase, with the current phasor leading the voltage phasor by the angle, φ . This can be observed from diagram of waveforms. The power factor in this circuit is less than 1 (one), power is only consumed in the resistance, R, but not in the capacitance

e) Draw a single line diagram of electrical power system and label it. (04)

Diagram

	 Labeling: 1 &5 – Generators 2- Circuit Breaker 3- Transformer 4- Transmission line 6- Bus bar	Diagram 02 marks 02 Marks
	f) Explain the working principle of transformer and draw a neat labeled diagram of the same. Working Principle The working principle of transformer is depends upon Faraday's law of electromagnetic induction. Actually, mutual induction between two or more winding is responsible for transformation action in an electrical transformer. According to these Faraday's laws, "Rate of change of flux linkage with respect to time is directly proportional to the induced EMF in a conductor or coil". 	(04) 02 Mark 01 Mark

	As shown in above figure alternating current through the primary winding produces a continually changing flux or alternating flux that surrounds the winding. The secondary winding is nearer to the primary, obviously some portion of this flux will link with the secondary winding. According to Faraday's law of electromagnetic induction an EMF is induced in secondary winding. This emf is proportional to the rate of change of flux linkages and given by equation. $e = N. d\varphi/ dt$ volt Where, e is the induced emf in volt and φ is the flux linkages in Weber turn	01 Mark

Q-4	Attempt any FOUR of the following:	Mks (16)
	a) Derive the EMF equation of single phase transformer by first principle Diagram  Fig. 1 Let's say, N is number of turns in a winding, Φ_m is the maximum flux in the core in Wb. As per Faraday's law of electromagnetic induction, emf $e = N. d\varphi/ dt$ volt The magnetic flux φ set up in the core of a transformer when an alternating voltage is applied to its primary winding is also alternating and is sinusoidal. Let φ_m be the maximum value of the flux and f be the frequency of the supply. The time for	01 Mark 01

1 cycle of the alternating flux is the periodic time T, where

T = (1/*f*) seconds

The flux rises sinusoidally from zero to its maximum value in (1/4) cycle, and the time for (1/4) cycle is (1/4x *f*) seconds. Hence the average rate of change of flux = (φ_m /(1/4x*f*) 4x*f*xφm Wb/s, and since 1 Wb/s = 1 volt, the average e.m.f. induced in each turn = 4x *f x* φ_m volts. As the flux φ varies sinusoidally, then a sinusoidal e.m.f. will be induced in each turn of both primary and secondary windings. 01

For a sine wave,

Form factor = r.m.s. value / average value

= 1.11

Hence r.m.s. value = form factor x average value = 1.11 x average value Thus r.m.s. e.m.f. induced in each turn

= 1.11 x 4*f* φ_m volts

= 4. 4 *f* φ_m volts

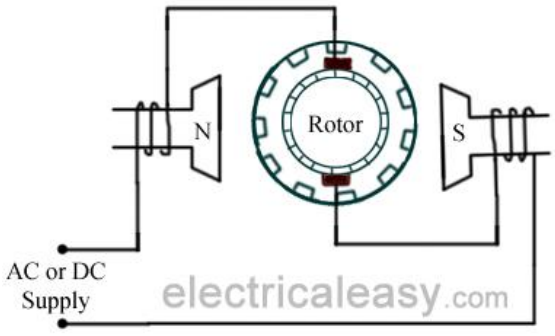
Therefore, r.m.s. value of e.m.f. induced in primary and secondary winding, 01

$E1 = 4.44\ f\ \varphi\ m\ N1$ volts

$E2 = 4.44\ f\ \varphi\ m\ N2$ volts

b) Explain the working principle of universal motor and state its two applications

Circuit diagram: 01 mark



Working principle:

A universal motor works on either DC or single phase AC supply. When the universal motor is fed with a DC supply, it works as a DC series motor. When current flows in the field winding, it produces an electromagnetic field. The same current also flows from the armature conductors. When a current carrying conductor is placed in an electromagnetic field, it experiences a mechanical force. Due to this mechanical force, or torque, the rotor starts to rotate. The direction of this force is given by Fleming's left hand rule.

02 Mark

The universal motors applications are

Any two

1) portable drills
2) hair dryers
3) grinders
4) table-fans
5) blowers
6) polishers
7) Kitchen appliances

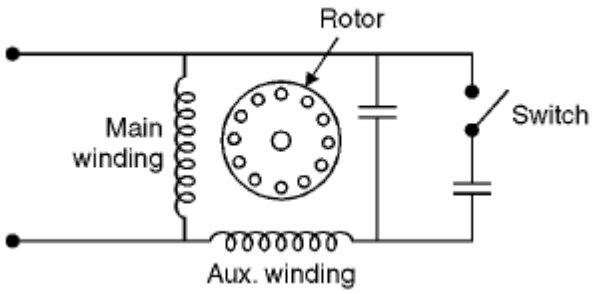
Appl.

01 Mark

c) Draw a neat diagram and explain working of capacitor start capacitor run single phase I.M.

Diagram

Circuit Diagram:



02 marks

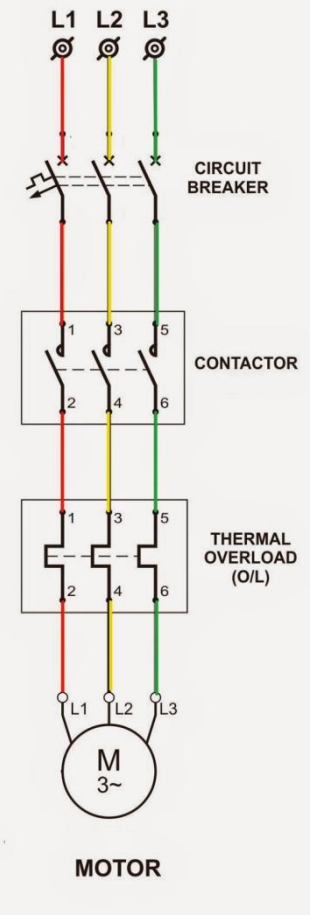
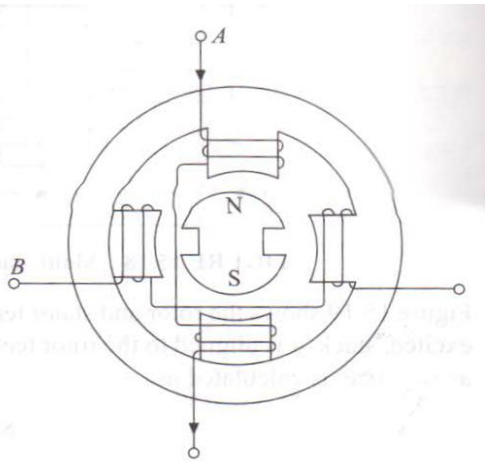
Working:

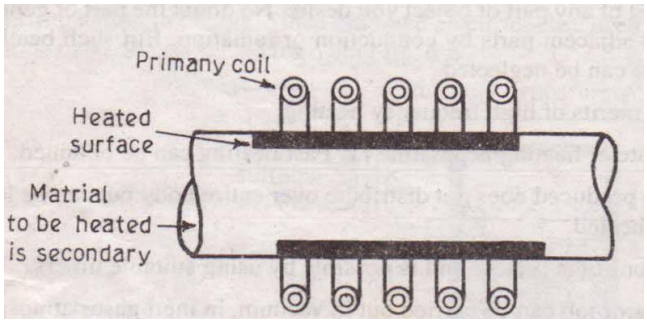
In this type of motor two capacitors are used with the auxiliary winding as shown in above diagram, one for starting an other during start and run, the starting and running performances are achieved are good.The small value capacitor are required for optimum running condition it is permanently connected in running winding and high value capacitor

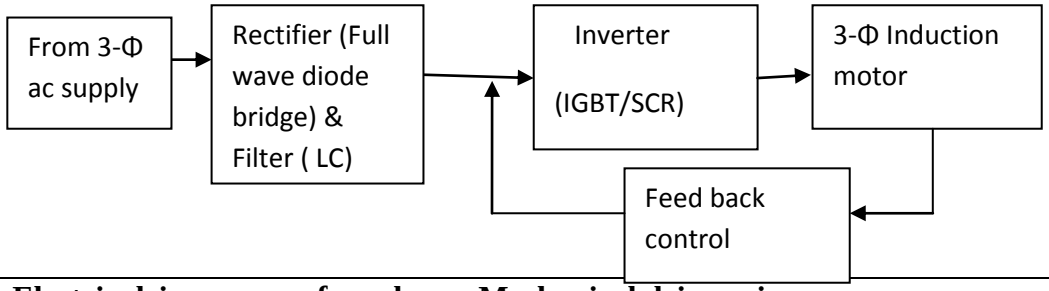
02 marks

	is connected parallel. This motor has two winding one is main winding and other is starting winding and both are displaced by the 90 degree electrical. When the single phase supply is applied to the winding the current through main winding and starting or running winding these currents are not exactly 90 degree apart. The permanent capacitor make these currents near about 90 degree. Due to the field interaction of these two winding torque is developed. When motor start then one low value capacitor get disconnect from circuit.	
	d) Explain any four factors to be considered while selecting a motor for a particular applications The factors considered while selections of motors are 1) Nature of the load : The load on the motor may be constant or variable according to the nature of load the motor selected for constant torque or variable torque 2) Speed Requirement: The application may required constant speed or variable speed according to this motor of constant speed or variable speed motor is selected. 3) Environmental condition: The plant condition means in chemical plant environment is explosive and hence the totally enclosed type motor is selected 4) Efficiency : In some application precise output required in that case high efficient motors are used. 5) Price : cost is one of the factor which consider in motor selection 6) Motor Duty Cycle: Some applications motor required for continuous operation and hence duty cycle of motor is also taken in to account in selection. 7) Temperature Ratings: It is important to use a consistent measure to compare the efficiency of one motor to another.	(04) Any for factor or each of 1 marks 1x4 =04
	e) A 3-phase , 4-pole, 50 Hz, IM works with a full load slip of 3 % Find: i) Synchronous speed ii) Actual speed of motor Solution: Synchronous speed Ns= 120 *f*/p Where *f* -frequency p- No of poles Ns = 120x 50/4 = 1500 rpm	(04) 01 mark 01 marks

	Slip = s = (Ns-Nr)/Ns = 1- Nr/Ns Ns- Synchronous speed Nr- Rotor or actual speed Nr = (1 - s) Ns Nr = (1 - 0.03) x 1500 = 1455 rpm	01 Marks 01 Marks
	f) State the types of an alternator. Which type of rotor is suitable for slow speed diesel engines? state reasons Types of alternator are as follows 1) Alternators are classified according to type of field system Stationary field system type Rotating field system type 2) Alternators can be classified into the following two types according to its rotor construction(shape of field system) Smooth cylindrical type alternator Salient pole alternator Salient pole alternator is suitable for slow/ low speed operation. As the speed of operation is low , salient pole type synchronous generators/ alternator are used because these allow better ventilation and also have other advantages over smooth cylindrical type rotor	(04) 01 Mark 01 Mark 01 Mark 01 Mark

Q.5 a)	Direct on Line starter for 3-phase induction Motor  Circuit diagram for DOL starter for 3-phase induction motor	4M Label 01 M Dig. 03 M
5 b)	**Working principle of Permanent type stepper Motor:**  	Dia 1M

	Two pole permanent magnet stepper motor -Operating principle of such motor is understand with the help of above diagram, where the rotor has two poles and stator has four poles. Since two stator poles are energized by one winding, the motor has two windings or phases marked as A and B. -When phase A is excited ,the rotor will aligned as shown in fig depends upon flux formation of stator ,here upper part of stator will be S pole and bottom part will be N pole. -If excitation is switched to phase B , the rotor will be moved by 90^0 where as the direction will be decided by the winding polarity and current direction. Here in clock wise direction.	3M
5-c)	**Induction Heating**  **Diagram of Induction Heating** **Principle:** -Induction heating is based upon the principle of current induced in the conducting material due to electromagnetic induction action which is similar to transformer action. -Consider a coil surrounding the conducting material to be heated i.e. charge as shown in the fig . The alternating current will set up flux in charge ,its value depends upon permeability of conducting material. This alternating flux as per Lenz's law will produce the current in the charge which is in opposite direction to the flow of current in the coil. -Coil act as primary and charge act as a secondary of transformer. The current induced in the Charge (secondary) is due to induction effect. The induced current in the charge produces heat proportional to i^2R ,where i is the induced current and R is resistance of the charge .This developed heat is useful for heating the charge. Since this heating is due to induced current in charge, it is called induction heating.	Dig. 1M 3M
5 d)	**Speed control of 3-phase induction motor by VFD:** **VFD** is a power electronics based device which converts a basic fixed frequency ,fixed voltage sine wave power to a variable frequency ,variable output voltage used to control speed of induction motor. It regulates the speed of three phase induction motor by controlling the frequency and voltage of power supplied to the motor.	

	As **Ns =** $\frac{120f}{p}$ since the no of pole is constant the speed Ns can be varied by continuously changing the frequency. It consist of three stages to control a 3 phase induction motor: (As shown in following Block diagram) i) **Rectifier and filter stage-** A full wave power based solid state rectifier converts 3 phase 50 Hz power from a standard 220V,440V to adjustable DC voltage. The system may include transformer for high voltage system. To get pure d.c. filters are used. ii) **Inverter stage**- Power electronics switches such as IGBT,SCR switch the DC power from rectifier ON and OFF to produce a current or voltage waveform at the required new frequency. Now days, PWM technique is also used because the current and voltage waveform at output in this technique is approximately sine wave. In above given electronics switches, Output frequency is adjusted by changing the no of pulses per half cycle or by varying the period of time cycle. Output voltage is varied by varying the gain of inverter. iii) **Control System**: Its function is to control output voltage of inverter to maintain constant ratio of voltage to frequency(V/f).It consist of an electronic circuit which receives the feedback information from the driven motor and adjust the output voltage or frequency to the desired values. **Block Diagram of VFD**: 	1M 1M 1M 1M
5 e)	**Electric drives are preferred over Mechanical drives since** i) Its operation are very simple ii) Performance and Speed control facility is easily available by using solid state devices such as SCR,IGBTs and microcontroller iii) It is comparatively clean and It is less noisy and pollution free iv) It is economical & more convenient	4 x1M
5 f)	**Electroplating:** Electroplating is defined as electrolytic process of depositing of one metal upon another metal. **Purpose:**	1M

	i) To protect the base metal from corrosion due to oxidation ii) To do plating of articles for decoration purpose iii) For repair work, For covering cheap metals by precious metals like gold, silver iv) One of the stage of manufacturing process **Operations involved in electroplating:** i) Cleaning of surface to be plated ii) Deposition of metal iii) Polishing the surface iv) Buffering	2M 1M
6 a)	-Welding is the process of joining metals of similar composition by heating them to a suitable temperature with or without application of pressure and addition of filler material -In **electric resistance welding** type heavy current is passed through the work piece and heat is developed by the contact resistance of job is utilized in welding them together. -In **electric arc welding** , arc is a electric discharge between one electrode and another electrode which may be a work piece. The arc current while flowing through air in the form of electrons bombards the atoms in air and produces ions. Such state of matter is almost plasma state and the temperature in that vicinity is around 3000^0 C to 4000^0 C, which is generally two to three times the melting point of generally used metals such as copper, iron etc. The electric arc effectively concentrate heat on the surfaces it is desired to joins.	1M 1.5 M 1.5 M
6b)	-To avoid electric accidents which may cause loss of human life, damage to equipments, machinery etc, Loss of production -To avoid fire due to electric reasons. -To avoid Electric shock. -To avoid Electric burns.	1M 1M 1M 1M
6c)		Any four points 4x1 M

Sr no	Incandescent Lamp	Fluorescent Lamp
1	Light output is affected by voltage fluctuations	Voltage fluctuations has comparatively low effect on light output as the variations in voltage are absorbed in the choke
2	Initial cost per lamp is quite low	Initial cost per lamp is more

	3	Luminous efficiency per watt increases with increase in applied voltage	Luminous efficiency increases with the increase in wattage and length of tube	
	4	Its brightness is more	Its brightness is less	
	5	No Stroboscopic effect	It has objectionable stroboscopic effect	
	6	Its normal working life is about 1000 hrs	The life of the fluorescent tube is about 7500 hrs.	
	7	Heat radiations are present due to high working temperature	Heat radiations are negligible due to low operating temperature	
	8	For the same light output a large number of lamps are required which results higher wiring cost	For the same light output ,less number of tubes are required and therefore wiring cost is comparatively low.	
	9	It gives light close to natural light therefore , objects are seen properly	It does not gives light close to natural light ,therefore colour rendering is defective	

6 d)	In domestic wiring, **Parallel connection** is preferred. All domestic equipments/appliances are design for 230 V, hence appliances are connected in parallel across a main supply **to get same voltage (i.e. 230 V)** as of main supply voltage across each.	2M 2M
6 e)	i) Totally Enclosed Non ventilated **(TENV):** This type is designed with totally enclosed to blocked the exchange of air between surrounded area and inside of the motor. But it is not fully enclosed because contaminated from outside could enter inside of motor through the seal of the shaft .The motor heat exchange through the enclosed by conduction process for small size .But for bigger size ,the frame designed with heavily ribbed to help dissipate heat more quickly. ii)**TEFC** (Totally enclosed fan cooled):Prevents the free exchange of air between the inside and outside the frame but does not make the frame completely air tight. A fan is attached to the shaft and pushes air over the frame during its operation to help in the cooling process. The ribbed frame is designed to increase the surface area for cooling purpose . iii) Explosion proof **(EXPL**):This is similar in design and appearance as TEFC type but for explosion proof enclosures are made from cast iron materials to stand from hazardous impact. iv) Totally enclosed Wash down **(TEWD)**: Designed to withstand high pressure wash downs or high humidity or wet or chemical environment.	1M 1M 1M 1M
6 f)	Importance of power factor improvement: i) For industrial and other big consumers has to pay electricity charges for his maximum	

	demand in kVA plus the unit consumed .If the consumer improves the power factor ,then there is a reduction in his maximum kVA demand (sinceM.D.in kVA = peak kW/cosΦ) and consequently there will be annual saving due to maximum demand charges. ii) Generating stations is as much concerned with power factor improvement as the consumer. The generators in a power station are rated in kVA but the useful output depends upon kW output. As station output is kW=kVA x cosΦ, therefore number of units supplied by it depends upon the power factor. The grater the power factor of the generating station ,the higher kwh it delivers to the system. **It leads the conclusion that improved power factor increases the earning capacity of the power station.** **Methods of power factor improvement:(Any four)** 1) By connecting capacitors in parallel with equipment operating at lagging power factor 2) By using synchronous condenser 3) By using phase advancers 4) Filter power factor improvement 5) Active boost power factor improvement	1M 1M Any 4, 2 M