WINTER – 2016 Examinations
Model Answer
Subject Code: 17404 :Electrical Engineering

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given importance (Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure/figures drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer (as long as the assumptions are not incorrect).

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept

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1	**Attempt any <u>TEN</u> of the following:**	**20**

1 a) Define :
i) Maximum Value
ii) RMS Value of ac supply
Ans:
i) Maximum Value :- The maximum or peak value attained by an alternating quantity during positive or negative half cycle, is called maximum value or peak value.
ii) RMS Value of ac supply :- The effective or RMS value of an alternating current is that value of the steady current or DC current required to produce the same amount of heat as produced by the alternating current when flowing through the same resistance and for the same time.

1 mark each

1 b) State one application for each of PMMC and MI meters.
Ans:
   i) PMMC: DC voltmeter, DC ammeter, Galvanometer.
   ii) MI :- AC/DC voltmeter, AC/DC ammeter

1mark each for any 1 application

1 c) State one application of clip on meter.
Ans:
Clip-on meter is used to measure the High value AC current without breaking the circuit Or without opening the circuit.

2 marks

1 d) State two applications of DC shunt motor.
Ans:
Applications of DC shunt motor:
1) Lathe machines
2) drilling machines
3) milling machines
4) Printing machinery
5) Paper industry
6) centrifugal and reciprocating pumps
7) blowers 8)fans

1mark each (any two)

1 e) State the transformation ratio.
Ans:
Transformation ratio is defined as the ratio of secondary emf to primary emf.
                        Or
It is the ratio of secondary turns to primary turns.
                        Or
It is the ratio of primary current to secondary current.
Mathematically,
Transformation ratio $K = \frac{E2}{E1} = \frac{N2}{N1} = \frac{I1}{I2}$

2 marks

1 f) State principle of transformer**.**
Ans:
Principle of Transformer:
Transformer works on the principle of electromagnetic induction. When the primary winding is connected to ac supply, applied alternating voltage circulates an

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alternating current through it. This current flowing through the primary winding produces an alternating magnetic flux. This alternating flux links with secondary winding through the magnetic core & induces an emf in it according to the faraday's laws of electromagnetic induction (mutual induction).

2 marks

1 g) Define Slip of Induction Motor.
Ans:
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.

1 mark

$Slip = (N_S - N) / N_S$
where , N_S = synchronous speed, N = speed of rotor

1 mark

1 h) State the Principle of energy conservation.
Ans:
Principle of energy conservation:
The law of conservation of energy states that the total energy of an isolated system remains constant—it is said to be conserved over time. Energy can neither be created nor destroyed; rather, it transforms from one form to another. The transformation of energy is from forms provided by nature to any other forms that can be used by humans. As the total amount of energy in nature is limited, it is essential to conserve it, so that its use can be prolonged. The energy saved leads to saving in cost, avoid pollution due to burning of fuels, greenhouse gases and avoid harmful effects on all livings on earth.

2 marks

1 i) Name any two safety tools used in industry for electrical wiring.
Ans:
Safety tools used in industry for electrical wiring :

1) Hand gloves	2) Goggles	3) Rubber mats
4) Fire extinguishers	5) Danger notice plates	6) Search lights
7) Safety shoes or Gumboots	8) Ear plugs	9) Fall arresters
10) Life line rope	11) Safety helmets	12) Safety belts
13) Safety mask	14) Fire buckets	15) First aid box
16) Insulating stick or discharge rod		

1 mark for each (any two tools)

1 j) State how direction of 3 phase induction motor can be reversed.
Ans:
The direction of rotation of 3-phase induction motor is reversed by Changing the phase sequence of supply.

2 marks

OR

The direction of rotation of 3-phase induction motor is reversed by inter-changing any two phase connections of motor terminals with supply terminals.

1 k) State classification of single phase induction motor.
Ans:
Classification of single phase induction motor:
1) Split phase induction motor,
2) Capacitor-Start, Induction- Run induction motor
3) Capacitor-Start, Capacitor-Run induction motor
4) Shaded Pole Induction Motor

1 mark each (any two)

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1 l) State any two factors for selection of motors as drive.
Ans:
Factors for selection of motor for electric drives:
1)Type of drive:- individual or group
2)Electrical supply:-whether it is AC or DC,1phase or 3 Phase
3) Nature of the load: constant or variable.
4) Speed Requirement: constant speed or variable speed operation.
5) Environmental condition: the condition of surroundings in plant. Explosive etc.
6) Efficiency: for precise output requirement high efficient motors are used.
7) Cost.
8) Motor Duty Cycle: continuous or intermittent operation.

1 mark each
(any two)

2 **Attempt any FOUR of the following:** **16**

2 a) Define terms related to ac supply i) Cycle ii) frequency iii) period iv) amplitude
Ans:-
  i) **Cycle :-** A complete set of variation in an alternating quantity, which is repeated at regular interval of time, is called a cycle.
     OR
     A complete set of positive and negative values of an alternating quantity, which is repeated at regular interval of time, is called a cycle.
  ii) **Frequency :-** Number of cycles completed by an alternating quantity in one second is called as frequency. It's unit is cycles/second or hertz.
  iii) **Period :-** The time taken by an alternating quantity to complete one cycle is called its time period or period. It's unit is second.
  iv) **Amplitude :-** A maximum value or peak value attained by an alternating quantity during positive or negative half cycle is called as its amplitude.

1 mark each

2 b) Calculate: i) Reactance   ii) impedance
          iii) current   iv) phase angle
for the circuit shown below.

Ans:

  i)   Inductive Reactance $X_L = 2\pi f L = 2 \times \pi \times 50 \times 0.1 = 31.41\Omega$
  ii) Impedance $Z = \sqrt{(R^2 + XL^2)} = \sqrt{(23^2 + 31.41^2)} = 38.93 \, \Omega$
  iii) Current $I = \dfrac{V}{Z} = \dfrac{230}{38.93} = 5.90 \, A$
  iv) Phase angle $\emptyset = cos^{-1}\dfrac{R}{Z} = cos^{-1}(23/38.93) = 53.78^0$

1 mark for
each bit.

2 c) The current flowing in a circuit is i = 28.28 sin (314t - $\frac{\pi}{6}$)

Calculate: i) amplitude,   ii) rms current,   iii) frequency,   iv) phase difference
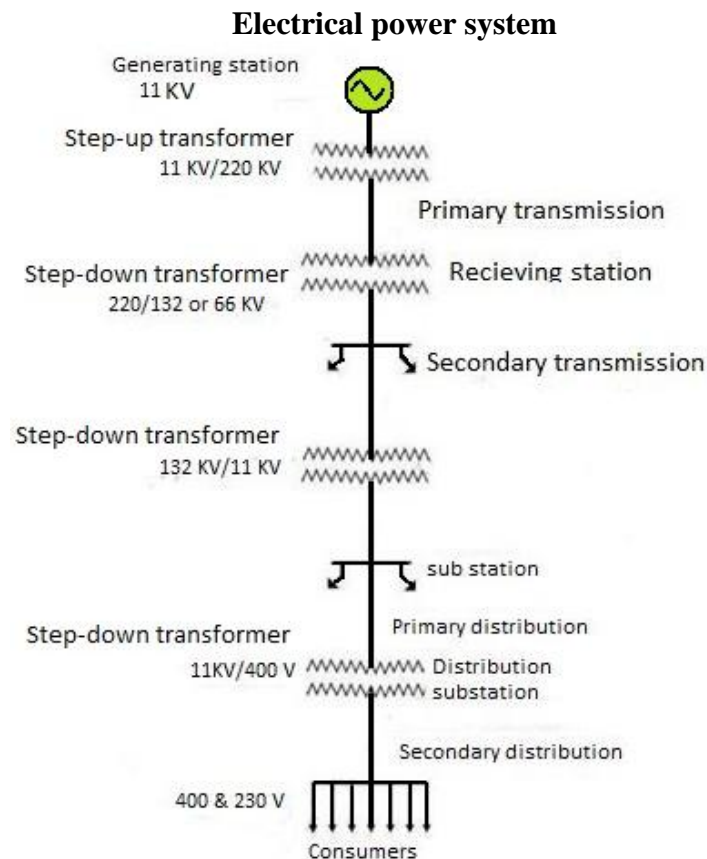**Ans:**
On comparing with standard form $i = I_{max} \sin(\omega t - \emptyset)$ we get

     i)   Amplitude = I_{max} = 28.28 A.

     ii)   RMS Current $I_{rms} = \frac{I_{max}}{\sqrt{2}} = \frac{28.28}{\sqrt{2}} = 20$ A.

     iii)   Angular frequency ω = 2πf

           ∴ Frequency $f = \frac{\omega}{2\pi} = \frac{314}{2\pi} = 50$ Hz

     iv)   Phase difference $\emptyset = \frac{\pi}{6} = \frac{180°}{6} = 30°$

(1mark for each bit)

2 d) Draw a neat single line diagram of electrical power system.
Ans:

Electrical power system

Neat labeled diagram 4 marks

Partially labeled 2 to 3 marks

Unlabeled 1 to 2 marks

(proper voltages other than shown in fig. also be considered)

Or Equivalent figure

2 e) State any four advantages of 3 phase system over single phase system**.**
Ans:
Advantages of 3-phase system over 1-phase system: -
1. **More output:** For the same size, output of poly-phase machines is always higher than single phase machines.
2. **Smaller size:** For producing same output, the size of three phase machines is always smaller than that of single phase machines.

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3. **More power is transmitted:** It is possible to transmit more power using a three phase system than single phase system.

4. **Smaller cross-sectional area of conductors:** If the same amount of power is to be transmitted then the cross-sectional area of the conductors used for three phase system is small as compared to single phase system.

5. **Better power factor:** Power factor of three phase machines is better than that of single phase machines.

6. **Three phase motors are self- starting:** The three phase ac motors are self-starting, while single phase induction motor are not.

1 mark each (any four points)

2 f) Draw a neat labelled diagram of PMMC meter.
Ans:

PMMC Meter
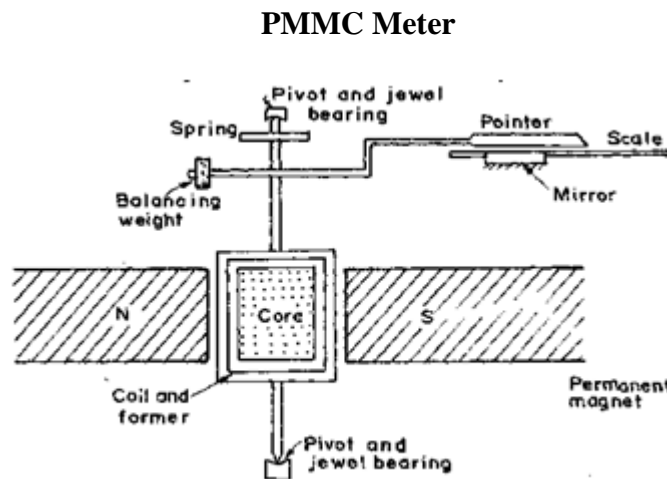
Neat labeled diagram 4 marks

Partially labeled 2 to 3 marks

Unlabeled 1 to 2 marks

3 **Attempt any FOUR of the following:** **16**

3 a) Draw speed torque curve of d.c. series motor. Also state its two apllications.
Ans:
Speed-torque curve of d.c. series motor:
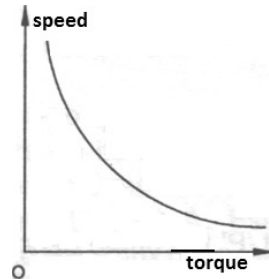
2 marks for Characteristics.

Applications:
  1. Crane   2. Hoist   3. Elevator   4. Lift   5. Traction applications

1mark each for any two applications

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3 b) Derive the equation of induced emf in a transformer .
       Ans:
       EMF Equation of Transformer:
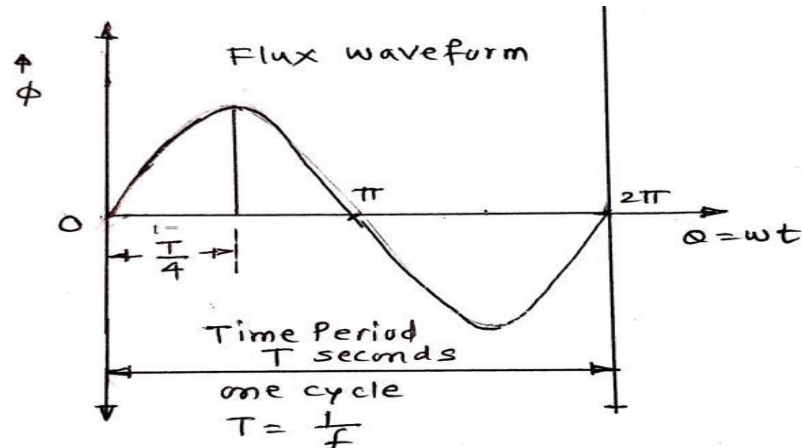
1 mark

Let N_1 be the no. of turns of the primary winding.
     N_2 be the no. of turns of the secondary winding.   1 mark
     $\emptyset m$ be the maximum value of the flux in wb.
     f be the frequency of supply in Hz.
By first principle**:**
     Maximum value of flux is reached in time t = T/4 = 1/(4f)
     Average rate of change of flux $=\emptyset m$/t $=\emptyset m$/1/(4f)=4$\emptyset mf$ wb/sec.   1 mark
     According to Faraday's law of electromagnetic induction,
     Average emf/turn induced =Average Rate of change of flux =4$\emptyset mf$
     Form factor =1.11 for sinusoidal quantity.
     RMS value of emf/turn =1.11×$Average\ value$ = 4.44$\emptyset mf$ volt
     RMS value of emf in primary winding = E_1 = 4.44 $\emptyset mf N_1$ volt   1 mark
     Similarly,
     RMS value of emf in secondary winding E_2 = 4.44 $\emptyset mf N_2$ volt

(Alternate method also be considered)

3 c) Draw a neat labelled diagram of autotransformer and state its any two applications.
       Ans:
       Autotransformer:
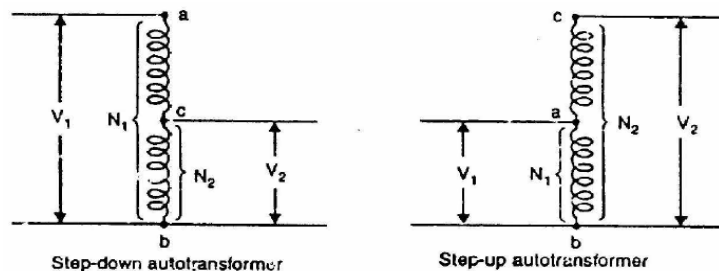
2 marks (any
one figure)

1 mark each
(any two)

Applications: 1) As Variac   2) Used as Starter   3) As Dimmerstat
                4) As Power Transformer in transmission when volt ratio is near 1.

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3 d) A coil having resistance 6Ω and reactance 8Ω is connected across 230V, 50Hz a.c. supply. Calculate i) inductance ii) impedance iii) current iv) active power
Ans:

$$i) \; Reactance \; X_L \; = \; 2\pi f L$$
$$\therefore Inductance \; L \; = \; X_L/2\pi f = \frac{8}{(2 \; x\pi \; x \; 50)} \; = \; 0.02547 \; henry$$

1 mark for each bit

$$ii) \; Impedance \; Z \; = \; \sqrt{(R^2 \; + \; X_L^2)} \; = \; \sqrt{(6^2 \; + \; 8^2)} \; = \; 10\Omega.$$
$$iii) \; Current \; I = \frac{V}{Z} = \; 230/10 \; = \; 23 \; A.$$
$$iv) \; Active \; power \; P \; = \; VIcos\emptyset \; = \; 230 \; \times \; 23 \; \times \; \frac{6}{10} \; = \; 3174 \; watts$$

3 e) An alternating current is given by equation $i = 10\sqrt{2} \; sin \; 314 \; t$.
Calculate:
        i) Average Value   ii) instantaneous value of I at t = 5 millisec.
Ans:
i) Average Value:
        I_{av} = (2/ π) I_m = (2/3.14)10√2 = 9.00 A.

2 marks

ii) I at t = 5 millisec
        $\therefore$ i = 10√2 sin(314×0.005) = 14.14 amp.

2 marks

3 f) Draw an experimental setup for direct loading of single phase, 230/115v, 50Hz, 1 kVA transformer with proper ranges of meters.
Ans:
Direct loading of Single phase transformer:
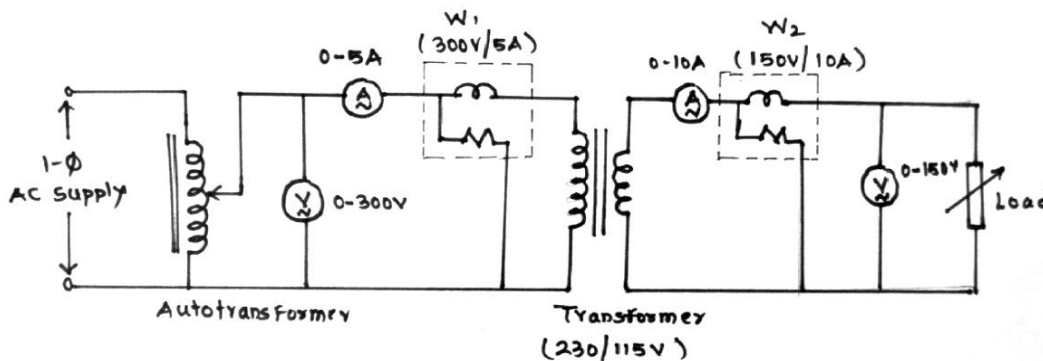
2 marks for setup

2 marks for meter ranges

4   Attempt any <u>FOUR</u> of the following: 16

4 a) Define efficiency & voltage regulation of a transformer. Also state their formulae.
Ans:-
Efficiency:
It is defined as the ratio of the output power to the input power of transformer.
                % Efficiency = (output power/input power) x 100   OR
                % Efficiency = (output power/(output power+ losses)) x 100
Regulation:
The change in secondary voltage of transformer from no load to full load expressed as a fraction or percentage of no load voltage (or Full load voltage), keeping primary

1mark for each definition
+
1 mark for each formula

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voltage constant, is called as regulation.

% Regulation$_{dowm}$ = {(V_{NL}-V_{FL})/V_{NL}}x 100   OR

% Regulation$_{up}$ = {(V_{NL}-V_{FL})/V_{FL}}x 100

4 b)   State two applications of each: i) Universal motor   ii) Stepper motor.
       Ans:-

    i)   Applications of Universal motor: | 1 mark each

    1) portable drills   2) hair dryers   3) grinders   4) mixers | for any two

    5) table-fans   6) blowers   7) polishers   8) Kitchen appliances | applications

    ii) Applications of Stepper motor:

    1) Floppy disc drives   2) Computer printers   3) image scanners | 1 mark each

    4) CD drives   5) Electric clocks   6) solar power systems | for any two

    7) robotics   8) CNC machine   9) Control systems | applications

    10) Biomedical applications   10) XY recorder 11) plotters

4 c)   Draw block diagram of variable frequency drive (VFD) for speed control of three
       phase induction motor.
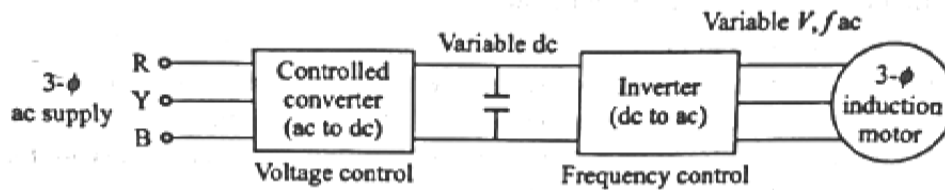
       Ans:

Neat labeled Diagram 4 marks Partially labeled 2 to 3 marks Unlabeled 1 to 2 marks

OR Equivalent figure

4 d)   State types of enclosures of electric drives.
       Ans:

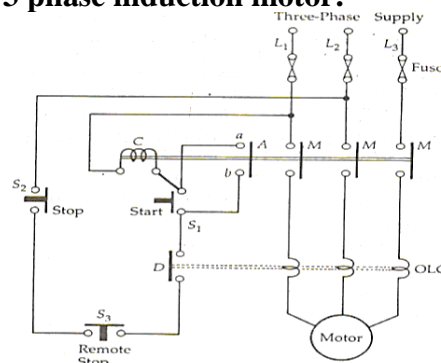   **Types of enclosures of Electric Drives:** | 1 mark each

       1) Screen protected   2) Open type   3) Protected type | (any 4 types)

       4) Totally enclosed   5) Drip-proof type   6) Pipe ventilated type

       7) Flame proof type   8) Explosion proof   9) Splash proof.

4 e)   Draw a neat labeled circuit diagram of 'Direct on-line' starter of 3 phase induction
       motor.

       Ans:

       Direct on-line starter of 3 phase induction motor:

Neat labeled Diagram 4 marks

Partially labeled 2 to 3 marks

Unlabeled 1 to 2 marks

Or Any Equivalent fig.

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4 f) State working principle of universal motor with the help of diagram.
**Ans:-**
Working Principle of Universal motor :
It is modified **DC series** motor which can work on AC as well as DC supply. According to basic motor principle, whenever a current carrying conductor is placed in magnetic field, force is exerted on it. In Universal motor, when supply is given, the current flows through both field and armature winding. The magnetic field is produced by the field current. The current carrying armature conductors are in this magnetic field, so there is production of force or torque on the armature conductors and motor rotates. The force is directly proportional to the product of main flux and armature current.

$$F \text{ (or torque)} \ \alpha \ (flux)x(Armature \ current)$$

They have nearly same operating characteristic for both AC and DC supply.

2 marks for working principle
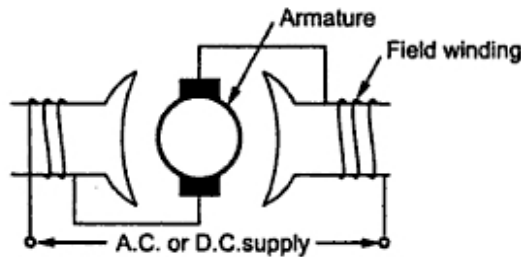
2 marks for diagram

5 **Attempt any FOUR of the following:** **16**

5 a) State working principle and applications of servo motor.
Ans:
Working Principle of Servo Motor:
Basically servo motor is made up of DC motor, which is controlled by a potentiometer and some gears. Its angle of rotation is controlled by the duration of applied pulse to its control circuit. The input current to the motor is automatically adjusted, and according to this the motor moves and correct the position. The working is similar to other electromagnetic motors. Servo motor is used in feedback control systems.

2 Marks for working principle

Servomotor applications :-
1) CNC machines
2) Machine Tool (Metal Cutting)
3) Machine Tool (Metal forming)
4) Antenna Positioning
5) Packaging
6) Woodworking
7) Textiles
8) Printing
9) Robotics
10) Portable drilling
11)Process control

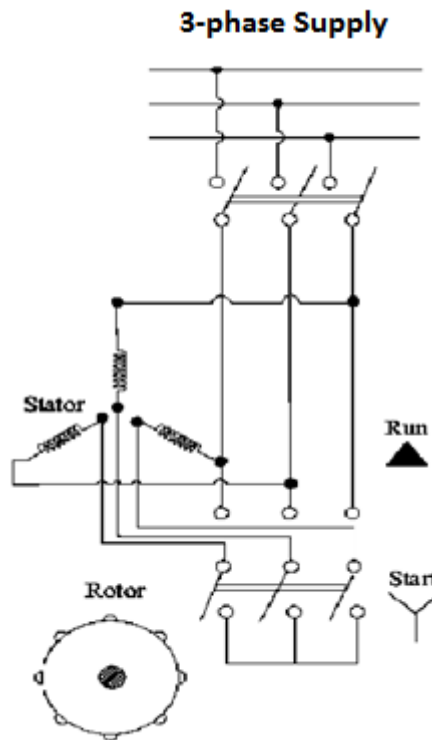1 mark each for any two applications

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5 b)   Draw a circuit diagram of star-delta starter for three phase induction motor.
        Ans:
        Star-delta starter for three phase induction motor:

Neat labeled
Diagram 4
marks
Partially
labeled
2 to 3 marks
Unlabeled 1
to 2 marks

OR Equivalent Fig.

5 c)   State different types of electric welding methods. State working principle of any one
        method.
        Ans :-
        Methods of electric welding :
        1. Resistance welding   1 mark for
            i   Butt welding   each type
            ii   Spot welding   (any two)
            iii Seam welding
            iv   Projection welding

        2. Arc Welding
            i   Carbon arc welding
            ii   Metal arc welding

Working Principle :-   2 marks for
Resistance welding: Heavy current is passed through the work piece and heat is   any one
developed by the contact resistance of job is utilized in welding them together.   principle
Arc welding: Arc is an electric discharge between one electrode and another which (Any other
may be a work piece. The arc current while flowing through air in the form of   than given
electrons bombards the atoms in air and produces ions. Such state of matter is almost type also
plasma state and the temperature in the vicinity is around 3000 to 4000 ^{0}C, which is considered)

generally 2 to 3 times the melting point of general metals such as copper, iron etc. The electric arc effectively concentrate heat on the surfaces it is desired to join.

5 d) A three phase, four pole, 50Hz induction motor runs at 1440 rpm at full load. Calculate slip and rotor current frequency.

Ans:

i) Slip $s = \dfrac{Ns - N}{N}$ since $Ns = \dfrac{120f}{P} = \dfrac{120 \times 50}{4} = 1500$ rpm   1 mark

$\therefore\ \ s = \dfrac{1500 - 1440}{1500} = 0.04$ or 4%   1 mark

ii) Rotor current frequency $= f_r = s \times f = 0.04 \times 50 = 2$ Hz   2 marks

5 e) State which electric motors are generally used in electro agro systems with reason.

Ans:

1) 3 phase induction motor is used in electro agro system for water pumping from wells as 3 phase ac supply is easily available, cost of induction motor is less, maintenance free being rugged construction, long life.

2) 1phase induction motor is used for domestic electro agro systems as 1 phase ac supply is easily available for domestic purpose, repair is simple and easily available.

1 mark for each motor (2 marks)
1 mark for each reason (2 marks)

5 f) Suggest electric motors for i) traction ii) crane iii) lathe machine iv) domestic fan.

Ans:-

i) Traction :- DC Series motor
iii) Crane :- DC Series motor
iv) Lathe machine :- 3 phase Induction motor or DC shunt motor
v) Domestic fan :- 1 phase induction motor

1 mark each

6 **Attempt any <u>FOUR</u> of the following:**

6 a) State advantages of electric heating over other types of heating methods. (Any four advantages).

Ans:

Advantages of Electric Heating:

1. Clean operation: no formation of ash or smoke, hence operation is clean.
2. No pollution: no production of flue gases, smoke, ash, dust etc. hence no pollution.
3. Temperature control is easy: no. of heating elements can be turned on and off manually or automatically, hence temperature control is easy.
4. Uniform heating:
5. Less attention: It requires less attention as compared to other heating methods.
6. Economical: It does not require large space and storage accessories, therefore capital and running cost of electrical heating is less.
7. High utilization efficiency: The losses are less, hence utilization efficiency is high.
8. High temperature: Very high temperature can be attained.
9. Quick heating: Time required for electric heating is comparatively less.
10. Large scale production: It is used for large scale production.
11. Bad conductor of heat and electricity can be heated like plastic.

1 mark each (any four advantages)

6 b) State necessity of earthing.

Ans:

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Necessity of earthing:

1. Earthing is grounding the body of the electrical equipment to avoid the hazards due to leakage current. If the leakage current keeps circulating in the body of the equipment, it might result in electrical shocks
2. Earthing is necessary for better voltage regulation and protection from surges and lightning strikes.
3. To provide safe path to dissipate lightning and short circuit currents.
4. To provide stable platform for operation of sensitive electronic equipment.

1 mark for each point

6 c) State types of tariffs and describe any one of them.
Ans:
Types of tariffs:
i)   Simple tariff
ii)   Flat rate tariff
iii)   Block rate tariff
iv)   Two part tariff
v)   Three part tariff
vi)   Maximum demand tariff
vii)   Power factor tariff

1 mark for each of any two

Explanation :-
Simple Tariff: In this type of tariff, rate per unit is fixed. The rates will not vary with type of consumers, so it is very simple tariff to understand for consumers.
Flat rate Tariff: In this type of tariff different types of consumers are charged at different rates i.e. the flat rate for light and fan load is less than that for power load.
Block rate Tariff: In block rate tariff, the first block of energy (say first 100 units) is charged at lower rates and succeeding blocks of energy (i.e 101 to 300 units, 301 to 500 units etc.) are charged at progressively higher rates.
Two Part Tariff: The total charge to be made to the consumer is split in to two components mainly Fixed charge and running charge.
Total Energy charge= a x kW + b x kWh, where a= charge per kW of maximum demand and b = Charge per kWh or unit of energy consumed.

2 marks for any one type explanation

6 d) State functions of
i) MCB   ii) ELCB   iii) fuse   iv) Switch
Ans :
   i)   **MCB:** Provide short circuit protection & over load protection to electrical loads.
   ii)   **ELCB:** Provides protection by detecting the unsafe magnitudes leakage currents flowing to earth and disconnecting the supply to the circuit.
   iii) **Fuse:** Provides short circuit & occasionally over current protection depending on its size and related circuit rating.
   iv)   **Switch**: Make and break the electrical connection to the load manually.

1 mark each

6 e) With proper reason suggest type of enclosure for electric drives used in coal mines.
Ans:
Flame-proof type of enclosure for electric drives is used in coal mines.
Reason: - Coal mines are very hazardous, prone to flame and explosions. Under such conditions, flame proof type are safer to use in coal mines. Flame-proof motors are

2 marks for type

2 marks

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designed to withstand any explosions or flames produced within them (due to arcs, sparks, or flashes) without igniting the surrounding flammable gases or vapors.   for reason

6 f)   Describe any one fire extinguishing method.

Ans:

(i)   Carbon Dioxide Extinguishing Systems

This type is the most suitable & widely recommended one for electrical fires. Carbon dioxide (CO_2) extinguishers are normally Class C extinguishers. Before using, Switch off the supply immediately so that the source for the fire to get sustained is isolated using proper insulated hand gear/foot gear . To use the extinguisher, pull the pin near the handle, point the horn at the base of the fire, and hold down the handle. As the flames shrink, continue spraying until the fire is fully extinguished.

4 marks for neat explanation

(ii)   Dry chemical extinguisher

The Dry Powder (or Dry Chemical) charged fire extinguisher is a multipurpose fire extinguisher and can be used on wide variety of fires. They are used on electrical fires but leave a residue that may be harmful to sensitive electronics. They work by chemical reaction with the fire causing the particles to expand chemically inhibiting combustion and expelling the oxygen thereby smothering the flames.

2 marks for Partial explanation