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 FIVE :** **10 Marks**
a)	**Define reluctance and flux density.**
Ans:	**i) Reluctance (s) :-** **(1 Marks)** Reluctance is the property of the substance which opposes the creation of flux in it. **ii) flux density:-** **(1Mark)** Magnetic flux is passing perpendicularly per unit area is called magnetic flux density. $B = \varphi / A\, Wb/m^2$ $B = Magnetic\ density$ $\varphi = flux$ $a = Area$
b)	**Define frequency and time period.**
Ans:	**(i) Frequency :** ----------**(1 Mark)** The total number of cycles per second. **ii) Time period:** ----------**(1 Mark)** The time (in sec) required by an alternating quantity to complete its one cycle is known as time period.
c)	**State units for active power, relative power, apparent power.**
Ans:	**i) Active Power (P):-** **(1/2 Mark)** The active power is defined as the average power Pavg taken by or consumed by the given circuit**.** $P = V.I.Cos\phi$ **Unit: -** Watt **OR** Kilowatt

ii) Reactive Power (Q):- **(1/2 Mark)**

The reactive power is defined as the product of voltage and current (V, I) and sine of angle between voltage (V) and current (I) i.e. ϕ

Q= V.I. sin ϕ

Units: - VAR **OR** KVAR

iii) Apparent power (s):- **(1 Mark)**

Apparent power is defined as the product of rms values of voltage (v) and current (I) it is given by

S=V.I **Units: -** VA **OR** KVA

d) Define phase sequence in three phase system.

Ans: The order in which the voltages in the three phase supply reach their maximum positive values is called phase sequence. **(2 Mark)**

e) List different types of DC motors.

Ans: **Types of DC Motor :-** **(2 Mark)**

i) DC Shunt Motor

ii) DC Series Motor

iii) DC Compound Motor:

a) Short Shunt compound motor
b) Long short compound motor

Or

a) Cumulative compound DC motor
b) Differential compound DC motor

f) Select suitable single phase motor for each of the following :
(i) Fan (ii) Home Mixer

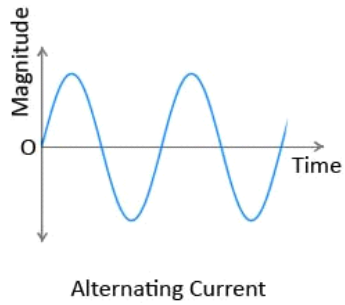
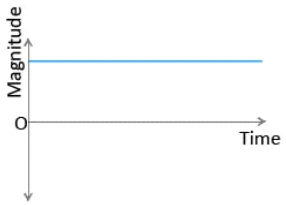
Ans: (i) Motor required for fan: Capacitor start induction motor (ceiling fan) **(1 Mark)**
(ii) Home mixer: Universal motor. **(1 Mark)**

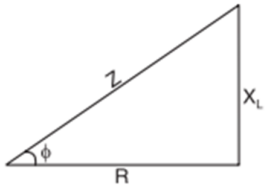
g) State main difference between ELCB and MCB.

Ans: **(2 Mark)**

Point	ELCB	MCB
	ELCB operates on leakage current i.e. difference between Phase and neutral current and it is used to disconnect the circuit when there is earth leakage.	MCB operates on phase current. It is used to disconnect the circuit when there is over load/short circuit condition.

Q.2	**Attempt any THREE :**	**12 Marks**
a)	**Explain dynamically induced EMF and statically induced EMF.**	
Ans:	**i) Dynamically induced emf:** **(2 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.** **(2 Mark)** In the Statically induced emf flux linked with coil or winding changes ($d\Phi/dt$) and coil or winding is stationary such induced emf is called Statically induced emf $E = - N\ (d\Phi/dt)$	
b)(i)	**Differentiate AC and DC quantity w.r.t. time varying waveform.**	
Ans:	**Differentiate DC supply with AC supply:** **(2 Mark)**	

S.No.	Points	AC Supply	DC Supply
1.	Wave form	 Alternating Current	 Direct Current

b)(ii)	**Explain impedance triangle.**
Ans:	**(2 Mark)** Impedance triangle is a vector representation of resistance, reactance and impedance of AC circuit. It is a right angled triangle in which perpendicular sides represent resistance and reactance and hypotenuse represents impedance. 

c) (i) Write any two difference between each of the following :
(i) Step up transformer and step down transformer.

Ans: **Step up transformer and step down transformer** **(Any two points 2 Mark)**

S.No.	Step-up transformer	Step-down transformer
1.	No of turns of secondary windings are greater than primary	No of turns of secondary are smaller than primary.
2	Secondary voltage is greater than primary	Secondary voltage is smaller than primary.
3	Secondary current rating is less than primary current rating	Secondary current rating is greater than primary.

c) (ii) ii) Balanced load and unbalanced load in three phase system.

Ans: **Balanced load and unbalanced load in three phase system** **(Any two points 2 Mark)**

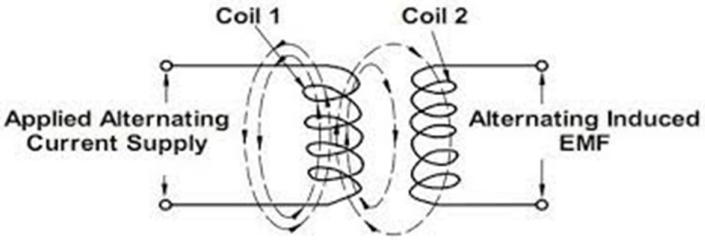
Sr. No.	Balanced load	Unbalanced load
1.	All three phase current and line currents are equal	All three phase current and line currents are not equal
2	Neutral current is zero if the load is three phase four wire	Neutral current is not zero if the load is three phase four wire
3	Phase displacement between phase voltage and phase current of all three phases is equal	Phase displacement between phase voltage and phase current of all three phases is not equal

d) Explain working principle of three phase induction motor.

Ans: **(4 Mark)**

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.

	➢ These rotor current produces flux ➢ According to faradays law of electromagnetic induction torque is produced due to interaction between stator and rotor flux ➢ Which tends to move the rotor.so rotor starts rotating ➢ In the same direction as the rotating field according to Lenz's law.
Q.3	**Attempt any THREE :** **12 Marks**
a)	**Describe Fleming's right hand rule and left hand rule.**
Ans:	**1) 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, and then the middle finger will point out the direction of induced current. **2) Left hand rules:** **(2 Mark)** According to Fleming's left hand rule if we stretch the thumb, the center finger and the middle finger of our left hand such that they are mutually perpendicular to each other. If the center finger gives the direction of current and middle finger points in the direction of magnetic field then the thumb points towards the direction of the force or motion of the conductor.
b)	**Describe working principle of a transformer.**
Ans:	**working principle of a transformer:** **(4 Marks)**  **Working Principle: -** ➢ The primary winding is connected to AC supply an ac current starts flowing through it. ➢ The AC primary current produces an alternating flux in the core. ➢ This Changes flux gets linked with the secondary winding through the core ➢ The varying 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 law of electromagnetic induction. When their primary winding is connected to a.c supply, applied alternating voltage circulates an alternating current through it.

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

c) Classify three phase induction motor and compare them on any four points.

Ans:

Classify three phase induction motor : **(2 Marks)**

1. Squirrel cage I.M
2. Slip ring 3-Ph I.M

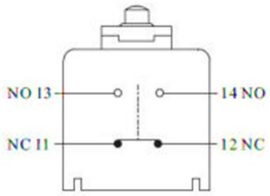
Comparison : **(Any four points each 1/2 Mark, Total 2 Marks)**

S.No	3-phase squirrel cage I.M	Slip ring 3-Ph I.M
1	Rotor is in the form of bars	Rotor is in the form of 3-ph winding
2	No slip-ring and brushes	Slip-ring and brushes are present
3	External resistance cannot be connected	External resistance can be connected
4	Small or moderate starting torque	High Starting torque
5	Starting torque is of fixed	Starting torque can be adjust
6	Simple construction	Completed construction
7	High efficiency	Low efficiency
8	Less cost	More cost
9	Less maintenance	Frequent maintenance due to slip-ring and brushes.
10	Size is compact for same HP	Relatively size is larger
11	Speed control by stator control method only	Speed can be control by stator & rotor control method

d) Explain concept of Limit switch and float switch.

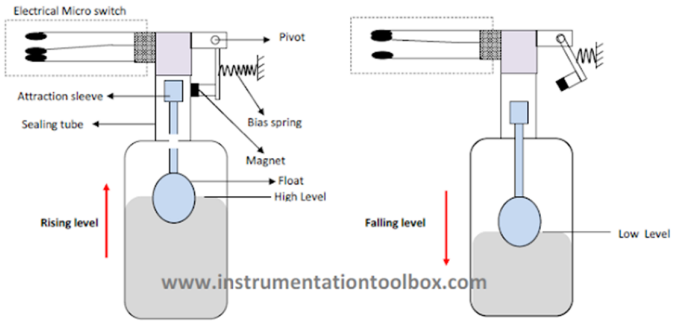
Ans: **i) Limit switch:-** **(2 Marks)**

Limit switch is a contact type switch device which is used to detect position of an object. It has a spring loaded lever and a micro switch. The micro switch consists of set of contacts (NO and NC). When the target object is near to limit switch, the lever is pressed. It operates the microswitch and contact positions are changed.



ii) Float switch:- **(2 Marks)**

Float switch is a contact type switching device which is used to detect level of fluid in tank. It has float and a micro switch. The float rests on the fluid surface. As the level is increased, float moves upward and microswitch is operated and contact positions are changed. When the float move downward the microswitch is released and contacts return to their normal condition.



Q.4 **Attempt any THREE :** **12 Marks**

a) **Compare electric circuit and magnetic circuit on any four points.**

Ans: **Compare Magnetic and Electric circuit:**

(Any Four Point expected : 1 Mark each, total 4 Marks)

S.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.	$S = l/ (\mu_0 \mu_r a)$. Directly proportional to l. Inversely

	Inversely proportional to a. Depends on nature of material.	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) Identify material used for each of the following parts of DC motor : Winding, Armature, Brush, Pole

Ans: **Material used for DC motor** **(Any four points each 01 Marks)**

Sr.No	Parts of DC motor	Material used
1.	Winding	Cooper or Aluminum
2.	Armature	Thin silicon steel stamping
3.	Brush	Carbon or graphite
4.	Pole	Thin silicon steel stamping

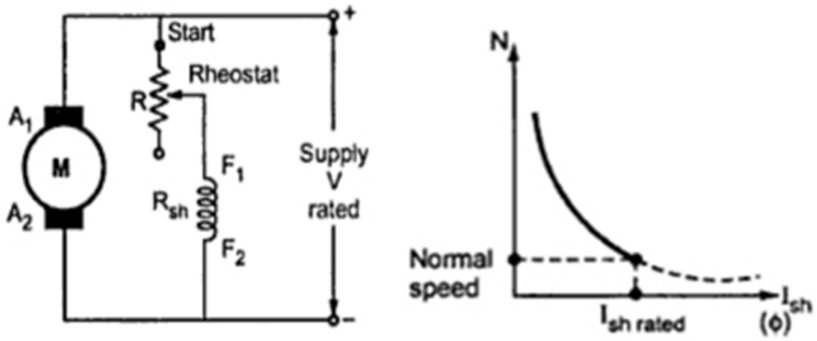
c) Explain with diagram field control method of speed of DC shunt motor.

Ans: **(Diagram 2 Marks Explanation 2 Marks)**

The characteristic equation for dc shunt motor is given by

$N \propto \frac{E_b}{\phi}$ and $V = E_b - I_a R_a$

From above equations, dc shunt motor speed *N* is inversely proportional to flux. By decreasing field current the speed can be increased above normal speed. This is field control of dc shunt motor.

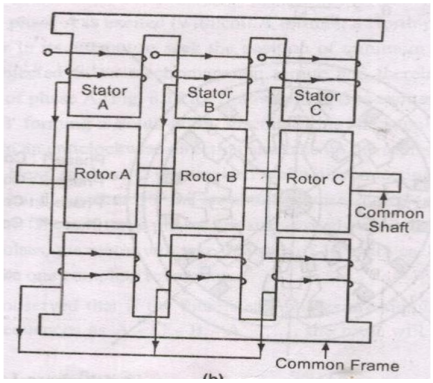


d)	**Explain basic principle of working or stepper motor.**

Ans:

1) Variable Reluctance Motors:

(Any one type expected: Explanation - 2 Mark & Diagram 2 marks)



or equivalent dia.

Working:-

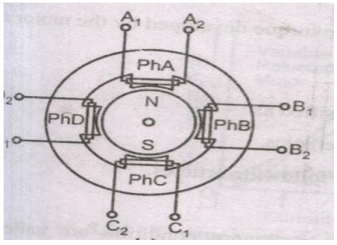
When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A.

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 dia.

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.

e)	**Explain need of earthing of electrical equipment's or machines.**
Ans:	**Need of earthing of electrical equipment's or machines:** **(Any Four point are expected: 1 Mark each, Total 4 Marks)** 1. Earthing provides protection to the electrical machinery due to leakage current. 2. Earthing provides protection to Tall Building & structure against lightening stroke 3. Earthing is protects human from shocks. 4. To provide an alternative path for the leakage current to flow towards earth. 5. To save human life from danger of electrical shock due to leakage current. 6. To provide safe path to dissipate lightning and short circuit currents. 7. To provide stable platform for operation of sensitive electronic equipment's.
Q.5	**Attempt any TWO :** **12 Marks**
a)	**Calculate each of the following for a sinusoidal voltage source having equation v = 400 sin** $\left(314\,t\frac{\pi}{6}\right)$ **volt. (i) Maximum value (ii) Frequency (iii) Time period v) Phase (v) RMS voltage (vi) Form factor.**
Ans:	$v = 400\sin(314t - \frac{\pi}{6})$ Comparing the above equation with $v = V_m \sin(\omega t - \theta)$ i) Maximum value = 400V **(1 Marks)** ii) Frequency = f $\frac{314}{2\times\pi}$ =50Hz **(1 Marks)** iii) Time period = 1/f = 20mS **(1 Marks)** iv) Phase = 30^0 **(1 Marks)** v) RMS voltage = $\frac{V_m}{\sqrt{2}}$ =400/1.414=282.88 **(1 Marks)** vi) Form Factor = 1.11 **(1 Marks)**

b) **Calculate current per phase, total active power, total reactive power for a circuit shown in fig. 1.**

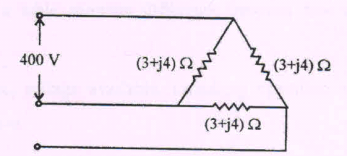


Fig. 1

Ans:

Current per phase = Vph/Zph **(1 Marks)**

Zph= 5

Curent per phase = 400 /5 = 80 A **(1 Marks)**

Power factor of load = R/Z= 3/5=0.6

Active power =

$$Z_{ph} = 5\Omega$$

$$I_{ph} = 400/5 = 8A$$

$$P_{ACTIVE} = 3V_{PH}I_{PH}COS\phi \quad \textbf{(1 Marks)}$$

$$= 3\times 400\times 80\times (3/5)$$

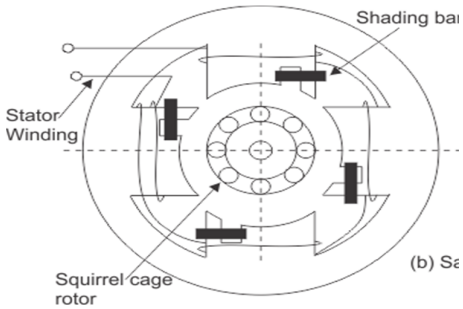
$$= 57.6kW \quad \textbf{(1 Marks)}$$

$$Q_{REACTIVE} = 3V_{PH}I_{PH}SIN\phi \quad \textbf{(1 Marks)}$$

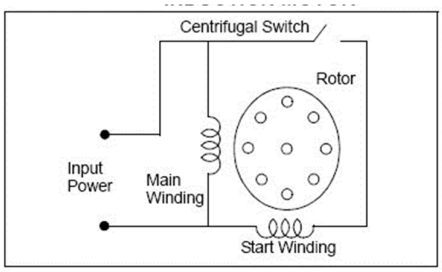
$$= 3\times 400\times 80\times (4/5) = 76.8kVAr \quad \textbf{(1 Marks)}$$

c) **Sketch schematic diagram for each of the following :**
(i) Shaded pole motor (ii) Split phase motor (iii) Universal motor (iv) Capacitor start induction run (v) Capacitor start capacitor run (vi) Permanent capacitor

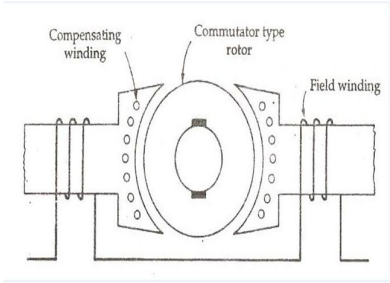
Ans: **i) Shaded pole motor** **(1 Marks)**



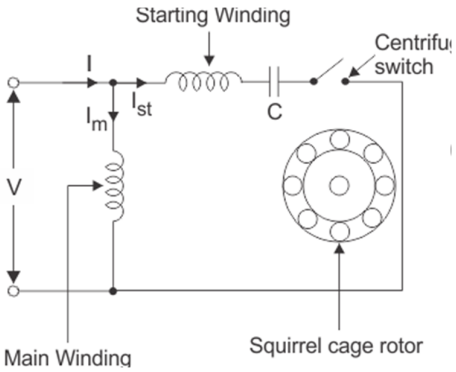
ii) Split phase motor **(1 Marks)**



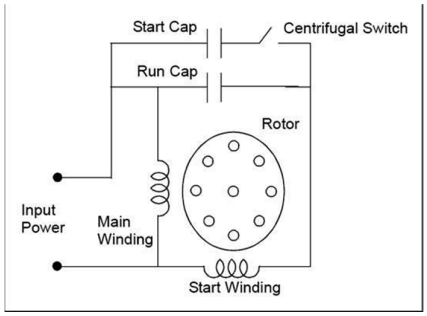
iii) Universal motor: **(1 Marks)**



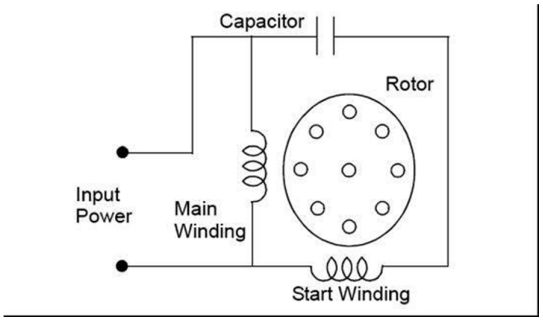
iv) Capacitor start induction run ; **(1 Marks)**



v) Capacitor start – capacitor run : **(1 Marks)**



vi) Permanent capacitor motor **(1 Marks)**



Q.6	**Attempt any TWO :** **12 Marks**
a)	**Calculate power factor. Impedance, current. Active power, Reactive power. Apparent power for the circuit shown in fig. 2.**

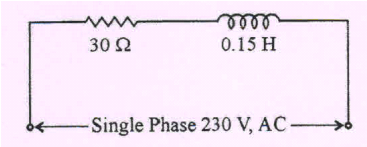


Fig. 2

Ans:

X_L =

$X_L = 2\pi fL$

$= 2\pi \times 50 \times 0.15$

$X_L = 47.12\ \Omega$

Impedance $Z = \sqrt{R^2 + (X_L - Xc)^2}$----------**(1/2 Mark)**

$Z = \sqrt{30^2 + (47.12 - 0)^2} = 55.85\ \Omega$

$Z = R + jXL$

$Z = 55.85 \angle 57.51\ \Omega$ ---------- **(1/2 mark)**

To Find Current=

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

$$I = \frac{230}{55.85 \angle 57.51} = 4.11 \angle -57.51\ amp$$

I=4.11Amp ---------- **(1/2 Mark)**

Active Power:

$P = V * I * \cos\emptyset$ ---------- **(1 Mark)**

$P = 230 * 4.11 * 0.53$

$P = 501.00\ watt$ ---------- **(1 Mark)**

Ractive Power:

$P = V * I * \sin\emptyset$ ---------- **(1 Mark)**

$P = 230 * 4.11 * 0.84$

$P = 797.34\ var$ ---------- **(1 Mark)**

b) Write any two applications for each of the following :
(i) Servo-motor (ii) Brushless DC motor (iii) Stepper motor

Ans: **Applications as follows**

(i) Servo motor:- : **(Any Two points - 2 Marks)**

1) Position control systems
2) CNC machines
3) Robotic hands

(ii) **Brushless dc motor** **(Any Two points - 2 Marks)**

1) Electric vehicles
2) Electronic toys
3) Position control systems
4) Industrial automation

(iii) **Stepper motor** **(Any Two points - 2 Marks)**

1) Printers
2) CNC machines
3) Robotic hands
4) Valve control mechanisms

c) Prepare a table showing difference between fuse and MCB on following points : cost, size, ratings available, switching operation after fault, maintenance, application.

Ans: **(Any Six points each point - 1 Marks)**

Sr.No	POINTS	FUSE	MCB
1	**cost**	Fuse is cheap	MCB is costly
2	Size	Fuse small size	MCB large size
3	Ratings	Fuse rating is in Amperes	MCB rating is also in Amperes but its available in selected current ratings like 1A,2A, 5A,25A
4	Switching operation	Fuse wire is melted and the circuit is broken	In MCb there is bimetallic strip which bends and operates the trip circuit to disconnect load from supply.
5	Maintenance	Fuse requires replacement	MCB is a resettable protection
6	Appplication	short circuit protection	Overload and short circuit protection

----------**END**----------