cImportant suggestions to examiners:

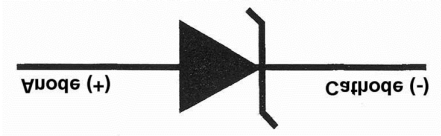
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 A)	**Attempt any Three of the following:** **12 Marks**
a)	**Define the following terms with their units E. M.F; current ; resistance and potential difference.**
Ans	**(i) EMF:** **(1 Mark)** It is the work done per unit charge which is the potential difference between the electrodes measured in volts. **OR** Mathematically, $V = \frac{W}{Q}$ **(ii) Current:** **(1 Mark)** It is defined as the movement of free electrons or flow of electrons inside a conducting material. It is denoted by I and measured in ampere. **OR** $I = Q/t$ Where, I = Average current in amperes , Q = Total charge flowing T = Time in seconds required for the flow of charge *Units* : – *coulomb* / sec. *or Amperes*. **iii) Resistance with their unit:** **(1 Mark)** It is defined as the opposition offered by a conductor to the flow of current. It is represented by R **OR** The formula for resistance is given by R= $\rho \times (l/a)$ OR R=V/I

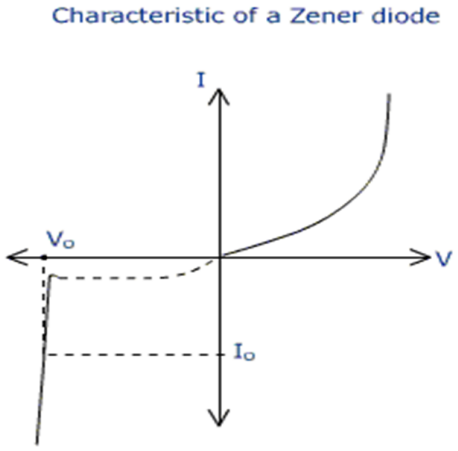
	Unit – ohm **iv) Potential difference:** **(1 Mark)** The **Potential difference** between two points is equal to the work done per unit of charge against a static electric field to move the test charge between two points and is measured in units of volts (a joule per coulomb).
b)	**State the various types of stepper motor. Give at least two applications of stepper motor.**
Ans	**Types of Stepper Motor:-** **(2 Mark)** 1) Variable Reluctance Motor 2) Permanent Magnet Motor **Applications of stepper motor-** **(Two application expected-1 Mark each)** 1. In Floppy disc drives. 2. In Computer printers. 3. In image scanners. 4. In compact Disc drives, etc.
c)	**Explain the purpose of colour code in the electrical circuit of an automobile.**
Ans	**Importance of colour coding in automobile wiring:** **(4 Mark)** Automobile wiring is complicated because of number of lamps and accessories for this color coding is necessary due to which wiring can easily identify for specific lamp and accessories and also it is easier during maintenance.
d)	**Define zener diode. Draw symbol and characteristics of zener diode.**
Ans	**Meaning of zener diode:** **(1 Mark)** Zener diodes are a special kind of diode which permits current to flow in the forward direction. What makes them different from other diodes is that Zener diodes will also allow current to flow in the reverse direction when the voltage is above a certain value. This breakdown voltage is known as the Zener voltage. In a standard diode, the Zener voltage is high, and the diode is permanently damaged if a reverse current above that value is allowed to pass through it. Zener diodes are designed in a way where the Zener voltage is a much lower value. There is a controlled breakdown which does not damage

the diode when a reverse current above the Zener voltage passes through a Zener diode.

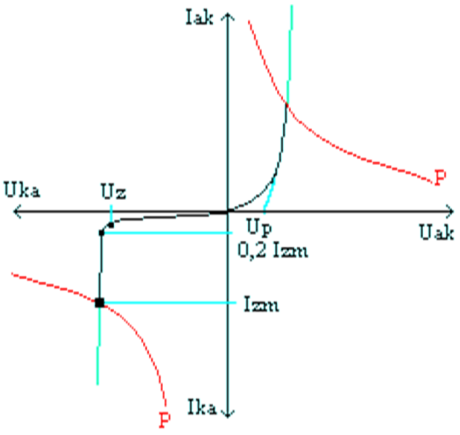
Symbol of zener diode :- **(1 Mark)**



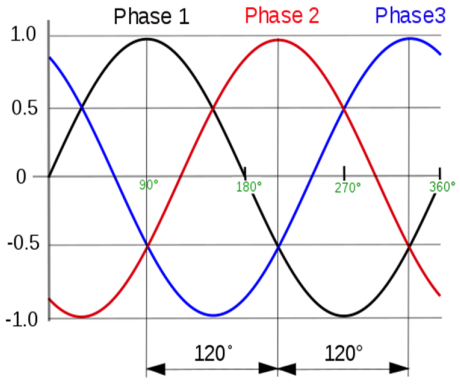
Characteristics of zener diode: **(1 Mark)**



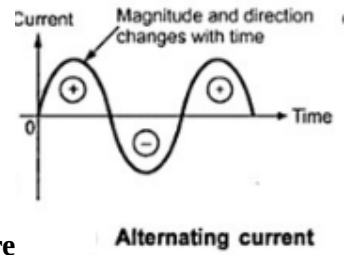
OR

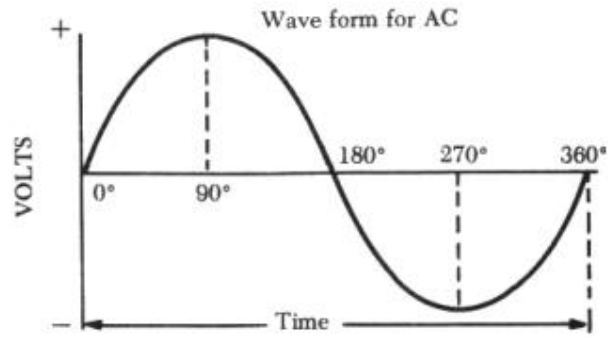


Q.1 B)	**Attempt any one of the following: 06 Marks**
a)	**Explain with neat sketch the generation of alternating current and voltage. Draw the graphical representation of generated A.C. EMF.**
Ans	**(Figure -2 Marks & Explanations- 2 Marks)**



OR **equivalent figure**





Explanation :-

Whenever there is a relative motion between the conductor and the magnetic field in which it is kept, an e.m.f. gets induced in the conductor.

The relative motion may exist because of movement of conductors with respect to magnetic field or movement of magnetic field with respect to conductor.

OR

When lines of magnetic force are cut by a conductor passing through them, voltage is induced in the conductor. The strength of the induced voltage is dependent upon the speed of the conductor and the strength of the magnetic field. If the ends of the conductor are connected to form a complete circuit, a current is induced in the conductor. The conductor and the magnetic field make up an elementary generator.

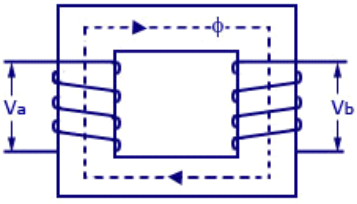
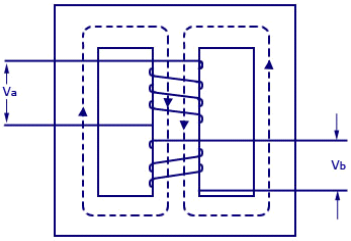
When the plane of the loop of wire is parallel to the magnetic lines of force, the voltage induced in the loop causes a current to flow .The voltage induced at this position is maximum, since the wires are cutting the lines of force at right angles and are thus cutting more lines of force per second than in any other position relative to the magnetic field.

b)	**What is positive return system and negative return systems? State the advantages of positive return system over negative return system in automotive wiring.**
Ans	**What is positive return system and negative return systems :-** It is nothing but return path for the current that has passed through the component. **Advantages of positive return system over negative return system in automotive wiring:** **Positive return system: ---------- (2 Marks)** 1. Tends to generate excessive system gain, noise, narrows bandwidth, and can cause oscillation. 2. Creates instability and tends to drive a system into its nonlinear region of operation. 3. Whereas negative feedback reduces system gain and increases bandwidth. Positive feedback increases system gain, narrows bandwidth, and becomes unstable. However, a system operating with positive feedback that hasn't gone into complete instability (oscillation), can be a very sensitive device with very high-gain amplifiers and sharp selectivity--super-regenerative radio receiver is a good example **Negative return system: ---------- (2 Marks)** 1. Tends to opposite excessive change (large amplitude) and wants to hold a system within a limited operating range. 2. In the case of an amplifier, it tends to reduce circuit gain and increase device operating bandwidth. 3. Tends to create system stability by ensuring linear operation.

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

a) **Compare core type transformer and shell type transformer ? (4 points)**

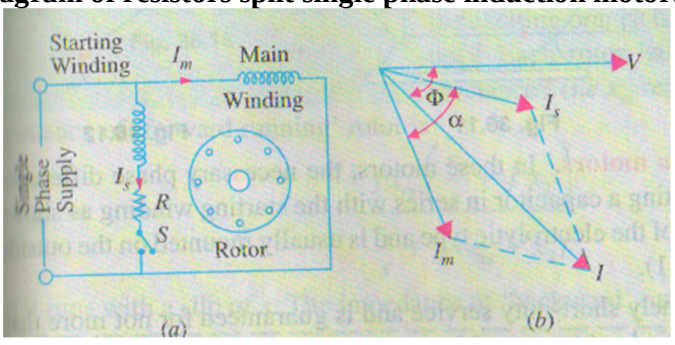
Ans: **(Any Four points expected each:1 Marks)**

S.No	Core Type Transformer	Shell Type Transformer
1.		
2.	The Winding surround the core	The core surround the windings
3.	Average length of the core is more	Average length of the core is less
4.	Magnetic Flux has only one continuous path	Magnetic Flux is distributed into 2 paths
5.	Suitable for high voltage & less output	Suitable for less voltage & high output
6.	Easy for repairs	Difficult for repairs
7.	Less in Weight	More in Weight
8.	Leakage flux are more	Leakage flux are less

b) **Explain with schematic diagram the working of resistance split phase single phase induction motor?**

Ans: **(Diagram: 2 Mark & Working: 2 Mark)**

Circuit diagram of resistors split single phase induction motor:



or equivalent figure

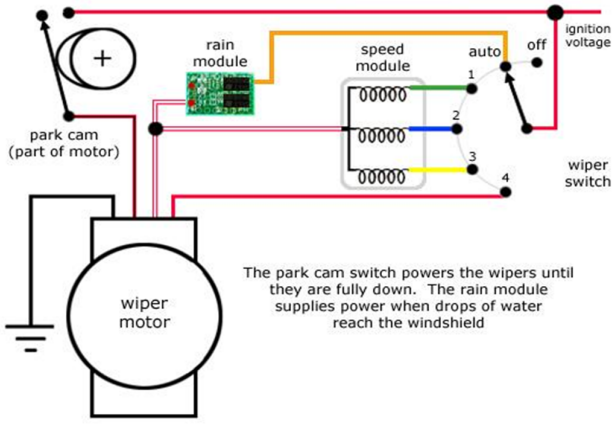
Construction and Working of resistance split phase induction motor:

- In resistors split phase I.M. shown in above figure ‘a’, the main winding has low resistance but high reactance whereas the starting winding has a high resistance, but low reactance.

- The resistance of the starting winding may be increased either by connecting a high resistance 'R' in series with it or by choosing a high-resistance fine copper wire for winding purpose**.**
- Hence as shown in fig. 'b' , the current I_S drawn by the starting winding lags behind the applied voltage V by a small angle whereas current I_m taken by the main winding lags behind V by a very large angle.
- Phase angle between I_S and Im is made as large as possible because the starting torque of a split-phase motor is proportional to sin α .
- A centrifugal switch S is connected in series with the starting winding and is located inside the motor.
- Its function is to automatically disconnected the starting winding from the supply when the motor has reached 70 to 80 per cent of its full load speed.

c) Explain with wiring diagram ; the working of windshield wiper.

Ans: **ii) Diagram of Windshield wiper:-** **(2 Marks)**



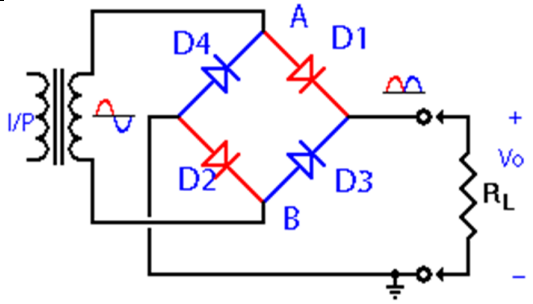
or any equivalent

Explanation:- **(2 Marks)**

The ignition switch supplies electrical power for the wiper motor. Current passes through the wiper control switch and then to the wiper motor. A speed control module may vary the voltage that reaches the motor on some models. Other types use different windings in the motor to control speed.

Within the wiper-motor is another switch, with voltage that bypasses the off-switch.

	The motor times this device with the full down position. Many use a cam to open the circuit when the motor achieves wiper parking. Turn off the wiper switch and current continues to flow through the park-switch, until the wipers are fully down.
d)	**Define the terms : Accuracy, precision resolution and reproducibility related to measurement system.**
Ans:	**(Each Definition : 1 Mark)** **i) Accuracy** – It is defined as the difference between the indicated value and the actual value. **OR** It is the closeness which an instrument reading approaches the true value of the quantity being measured. **OR** The degree of exactness of a measurement compared to the expected value. **ii) Precision** describes the reproducibility of the measurement. **OR** It is a measure of the reproducibility of the measurements that is given a fixed value of a quantity, precision of measure of the degree of agreement within a group of measurements. **OR** A measure of the consistency of measurements, i.e successive readings do not defer. **iii) Resolution:** The smallest to be distinguished magnitude from the measured value. **iv) Reproducibility:** Closeness of the agreement between the results of measurements of the same measurand carried out under changed conditions of measurement.
e)	**Describe with circuit diagram the working of bridge type full wave rectifier. Draw the wave form of input and output.**
Ans:	**(Circuit Diagram – 1 mark, Working – 2 marks, waveform – 1 mark)** **Bridge type full wave rectifier:**

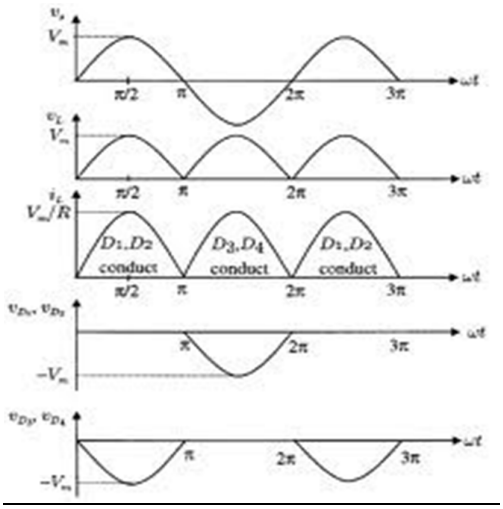


Working:-

The Bridge rectifier consists of a step down transformer, a rectifier circuit with four diodes and a load resistance RL .

- The 230 V ac input from mains is stepped down (reduced) using the step transformer.
- The reduced ac i.e. output of the secondary of the transformer is applied to the bridge circuit.
- The bridge consists of four diodes D1,D2,D3&D4, which offers full wave rectification. The diodes conduct in pair.
- During +ve half cycle of the ac input, point A is +ve& point B is –ve. Therefore diode D1 & D2 are forward biased and D3 & D4 are reverse biased. Therefore only D1 and D2 conduct and the current flows along the path " A-D1-RL-D2-B".
- During -ve half cycle of the ac input, point B is +ve& point A is –ve. D3 and D4 conduct while D1 & D2 remain reverse biased(off). Therefore the current follows following path" B-D3-RL-D4-A".
- In both the cases load resistance conducts in the same direction as shown in the above figure. Thus the ac signal gets converted into dc pulses.

The waveforms are as follows:-



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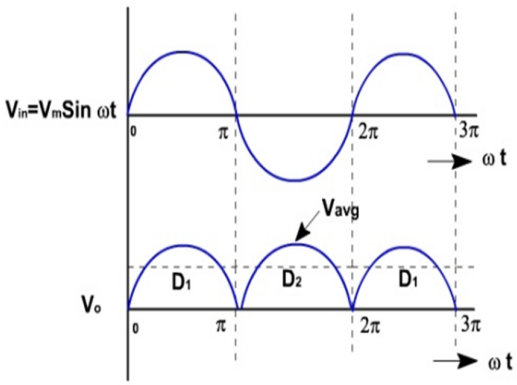
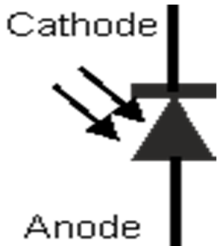
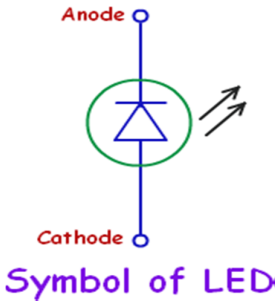
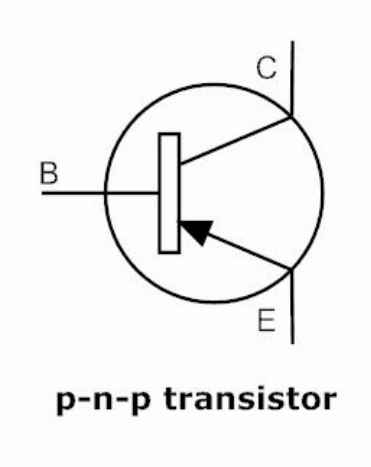
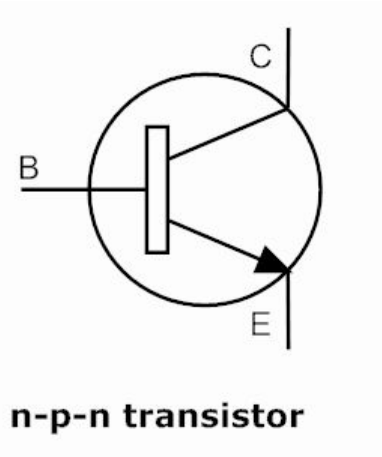


f)	**Draw the symbols of following Electronic Devices Photodiode ; LED ; PNP transistor and NPN transistor.**
Ans:	**(Each symbol – 1 Mark)** **Symbol of photodiode:** **Symbol of LED:**   **iii) PNP transistor :** **iv) NPN transistor :**  
Q.3	**Attempt any FOUR of the following:** **16 Marks**
a)	**State the Faraday's Laws of electromagnetic induction. Also state the magnetic effect of electric current.**
Ans:	**Faraday's law of electromagnetic induction:** **i) First Law: -** Whenever change in the magnetic flux linked with a coil or conductor , an emf is induced in it. **OR** Whenever a conductor cuts magnetic flux, an emf is induced in conductor. ----------**(1.5 Marks)** **ii) Second Law :-** The Magnitude of induced emf is directly proportional to (equal to) the rate of change of flux linkages.

$$e = \frac{-Ndt}{dt} d\phi$$

Where, N= Number of turn

$\frac{d\phi}{dt}$ = Rate of Change of flux ----------**(1.5 Marks)**

iii) Magnetic effect of electric current. **(1 Marks)**

Magnetic effect of electric current is one of the major effects of electric current in use, without the applications of which we **cannot have motors** in the existing world. A current carrying conductor creates a magnetic field around it, which can be comprehended by using magnetic lines of force or magnetic field lines.

b) i) State the various types D.C. motor .

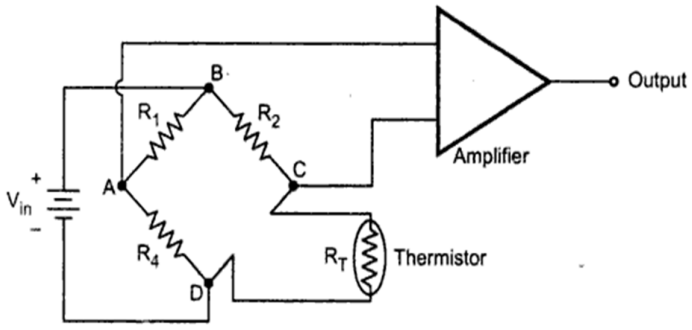
Ans: **The various types D.C. motor:-** **(2 Mark)**

i) DC Shunt Motor
ii) DC Series Motor
iii) DC Compound Motor: a) Short Shunt Compound Motor
b) Long short compound Motor

b) ii) Compare intrinsic semiconductor and extrinsic semiconductor (only two points).

Ans: **(Any Two point expected : 1 Mark each)**

Sr.No.	Parameter	Intrinsic Semiconductor	Extrinsic Semiconductor
1	**Purity**	Pure form of Semiconductor	Impure form of Semiconductor
2	**doping**	No doping (pure)	Doped with pentavalent or trivalent impurities
3	**Type**	Silicon & Germanium materials	N type & P type
4	**conductivity**	Conductivity very less	Conductivity increases with addition of impurity.

c)	**Define the transducers. State at least one transducer for the measurement of speed ; force and flow**
Ans:	**Meaning of Transducers :** **(1 Mark)** A device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa. OR We can define a transducer as an element which converts energy in one form to another form. **State at least one transducer for the measurement of speed ; force and flow:** **(Each Transducer : 1 Mark each)** 1. **Transducer for measuring speed-** tachometer 2. **Transducer for measuring force-** load cell 3. **Transducer for measuring Flow-** Ultrasonic , Orifice plate , Pitot tube ,
d)	**Explain with suitable diagram ; the measurement of temperature with the help of thermistor.**
Ans:	**Working principle of Thermistor:-** **(Figure : 2 Mark & Explanation: 2 Mark)**  Thermistors are one of the most commonly used devices for the measurement of temperature. The thermistors are resistors whose resistance changes with the temperature. The thermistors are made up of ceramic like semiconducting materials. They are mostly composed of oxides of manganese, nickel and cobalt having the resistivities if about 100 to 450,000 ohm-cm. Since the resistivity of the thermistors is very high the resistance of the circuit in which they are connected for measurement of temperature can be measured easily. As mentioned earlier the resistance of the thermistors decreases with the increase its temperature. The resistance of thermistor is

given by:

$R = R_o e^k$

$K = \beta(1/T - 1/T_o)$

Where, R is the resistance of the thermistor at any temperature T in ^oK (degree Kelvin)

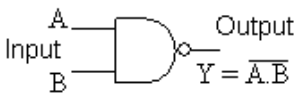
R_o is the resistance of the thermistors at particular reference temperature $T_o$in ^oKe is the base of the Naperian logarithms β is a constant whose value ranges from 3400 to 3900 depending on the material used for the thermistors and its composition.

The thermistor acts as the temperature sensor and it is placed on the body whose temperature is to be measured. It is also connected in the electric circuit. When the temperature of the body changes, the resistance of the thermistor also changes, which is indicated by the circuit directly as the temperature since resistance is calibrated against the temperature. The thermistor can also be used for some control which is dependent on the temperature.

e) Draw the symbol and write the truth table and logic expression of NAND gate.

Ans: **(Symbol - 1 Mark, truth table-2 Marks and logic expression-1Mark)**

symbol of NAND Gate



Truth Table for NAND Gate

INPUTS		OUTPUT
A	B	Y=A.B
0	0	1
0	1	1
1	0	1
1	1	0

logic expression of NAND gate

$Y = \overline{A.B}$

Q.4 A) Attempt any Three of the following: 12 Marks

a) A single phase 50Hz transformer has 300 primary turns and 750 secondary turns. The net cross-sectional area of the core is 64 square centimeter. If the primary induced e.m.f. is 440V find i) Maximum flux density in the core. ii) E.M.F. induced in the secondary.

Ans: Given Data - $f = 50\,Hz,\ N_1 = 300,\ N_2 = 750,\ A = 64\,cm^2,\ V_1 = 440\,V\quad B_m = ?\ \ E_2 = ?$

Step – I :- E.m.f. equation for primary side is given by : –

$E_1 = 4.44 \times f \times \phi_{max} \times N_1$ - ---------- **(1/2Mark)**

$440 = 4.44 \times 50 \times \phi_{max} \times 300$

$\phi_{max} = 6.606 \times 10^{-3}\ wb$

$\phi_{max} = 0.0066\ wb$ ---------- **(1Mark)**

Flux density is given by :–

$B_{max} = \frac{\phi_{max}}{A}$ ---------- ---------- **(1/2 Mark)**

$B_{max} = \frac{0.0066}{64 \times 10^{-4}}$ -

i) Peak value of flux density in the core = $B_{max} = 1.032\ wb/m^2\ or\ T$ ------- **(2Mark)**

Step – II emf on secondary side is given by :–

$E_2 = 4.44 \times f \times \phi_{max} \times N_2$

$E_2 = 4.44 \times 50 \times 0.0066 \times 750$

ii) EMF induced in the secondary winding= $E_2 = 1100\ V$ ---------- **(2Mark**

b) Define the following terms related to A.C. supply.
i) R.M.S. value ii) Form factor iii) Active power iv). Reactive power

Ans:

i) Meaning of R.M.S Value: **(1 Mark)**

The r.m.s value of an alternating current is that steady current (d.c) which when flowing through a given resistance for a given time produces the same amount of heat as produced by the alternating current when flowing through the same resistance for the same time. **OR**

∴ RMS Value = Form Factor × Average Value **OR**
RMS Value = 0.707× maximum value

iii) Form factor- **(1 Mark)**

It is defined as the ratio of its RMS value to its Average value.

iii) Active Power (P):- **(1 Mark)**

The active power is defined as the average power P_{avg} taken by or consumed by the given circuit**.**

$P = V.I.Cos\phi$ **Unit: -** Watt **OR** Kilowatt

iv) Reactive Power (Q):- **(1 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

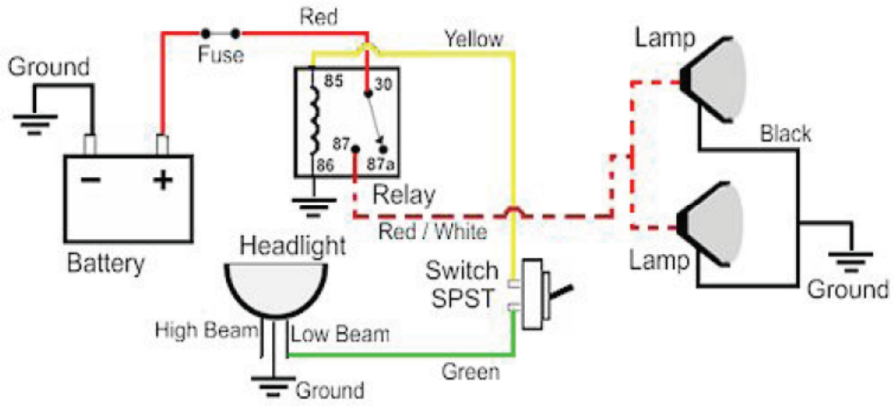
Q= V.I. sin ϕ

Units: - VAR **OR** KVAR

c) Draw the wiring diagram of : i) Headlight ii) Turn indicator

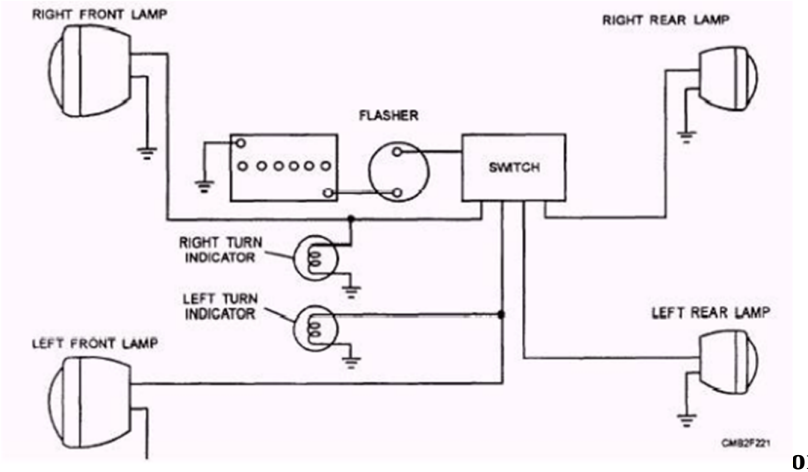
Ans:

i) Head light **(Diagram 2 Mark)**



or equivalent diagram

ii) Turn indicator: **(Diagram 2 Mark)**



or equivalent dia.

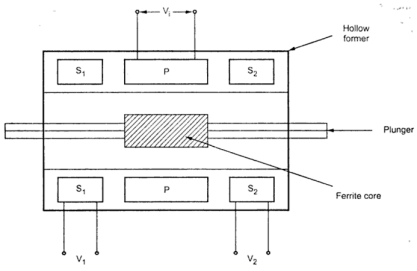
d)	**Explain with neat diagram the working of LVDT.**
Ans:	**Linear Variable Differential Transformer (LVDT):-**

(Figure: 2 Marks & Explanation: 2 Marks)

Linear Variable Differential Transformer (LVDT):-

It is the transducer most widely used to translate linear motion into electrical signals.

Construction-



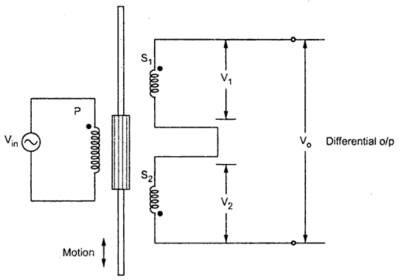
or equivalent dia.

P= primary winding

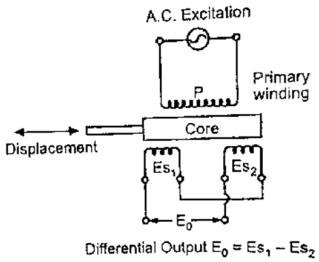
S1, S2= two secondary windings.

Working-

The secondary S1 and S2 are connected in series opposition so that voltages induced in each coil oppose each other. The electrical equivalent connection is shown below.



OR



or equivalent dia.

The position of movable core determines the flux linkage between the primary and each of the secondary windings.

Let V1= output of secondary S1

V2= output of secondary S2

Then V_O= V1-V2

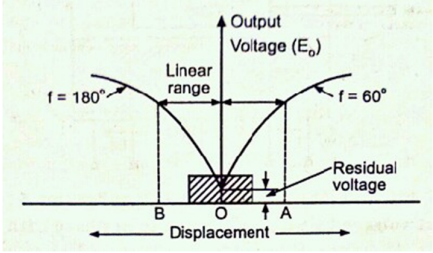
Case 1: when the core is at centre.

With the core in the centre, the induced voltages V1 and V2 in the secondary S1 and S2 are equal, since they oppose each other; the output will be zero volts.

Case 2: when core is displaced.

When the core is displaced from the null position, the induced voltage in the secondary towards witch the core has moved increases while that in other secondary decreases.

The phase difference between the output and input voltage changes by 180 degrees when the core moves through the null position. Therefore in actual measurement to determine positions uniquely, this phase change over is measured with phase sensitive detector.

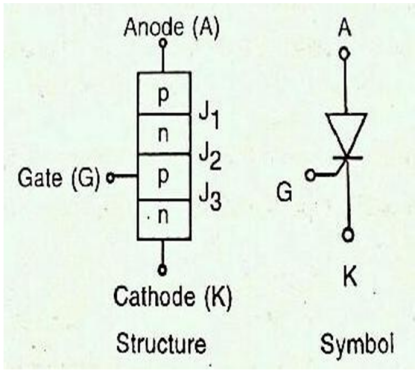


or equivalent dia.

Q.4 B)	**Attempt any Three of the following: 06 Marks**
a)	**Describe with neat sketches the symbol ; construction and working of SCR. Draw the V-I characteristics of SCR.**

Ans: **Allotted 2 Marks for diagram, 2 Marks for Working and 2 Marks for VI characteristics)**

Construction of S.C.R:–



or equiavlent figure

Working-

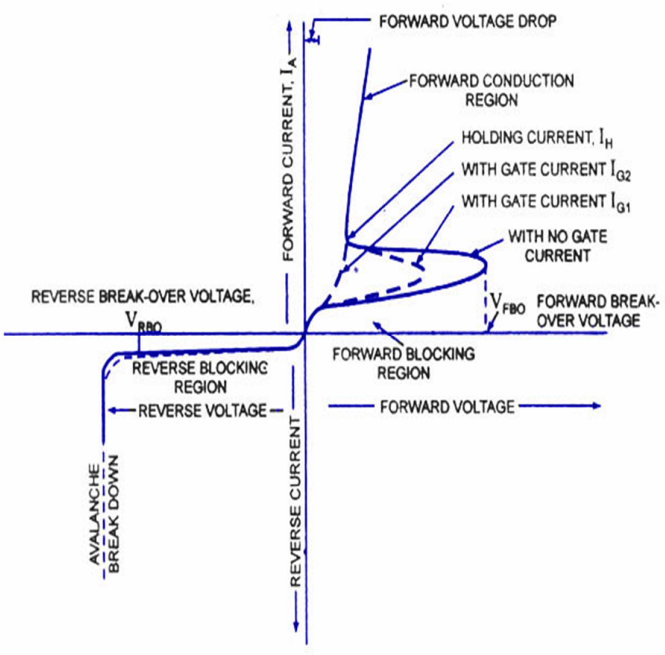
When the anode is made +ve w.r.t. cathode, the junctions J1 and J3 are

forward biased, whereas junction J2 is reverse biased. Due to this reverse biased junction J2, only small leakage current flows from anode to cathode. The S.C.R. is then said to be in forward blocking state.

With anode +ve w.r.t. cathode, if anode-to-cathode voltage is increased to a sufficient large value, the reverse biased junction J2 will break. The voltage at which it occurs is called forward break over voltage V_{BO}. The junctions J1 and J3 are already forward biased, hence results in free movement of carriers across all three junctions, resulting in large forward anode current. The S.C.R. is said to be in conducting state.

Without breakdown of junction J2, S.C.R. can be made ON by applying +ve voltage to gate w.r.t. cathode. Due to this, junction J3 is forward biased and conducts and gate current flows. Free movement of carriers (holes and electrons) across the junction J3 results in injection of holes into n-region and electrons into p-region. The injected electrons in p-region force this p-region to lose its identity as p-region because it was having holes as majority carriers but with injected electrons, it is having holes as well as electrons in majority. Therefore junction J2 now has majority electrons on both side and it is disappeared and S.C.R. is made ON.

VI characteristics :



V-I Characteristics of SCR

or equivalent figure

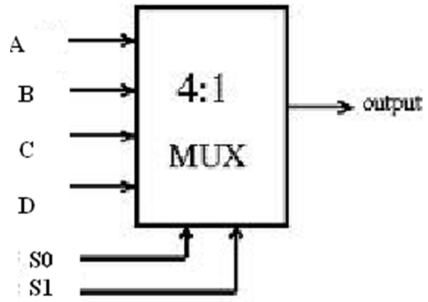
b) Describe the working principle with block/logic diagram of multiplexer (4:1) and demultiplexer (1 :4).

Ans:

Block/logic diagram of multiplexer (4:1)

(Figure-1 Mark, Truth Table-1 Mark & Operation- Mark)

Schematic Figure-



or equivalent dia.

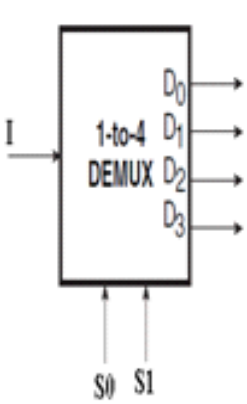
Truth Table:

S_0	S_1	Out
0	0	A
0	1	B
1	0	C
1	1	D

Operation of multiplexer (4:1):

Multiplexer has multiple inputs and one output. i.e. it accepts several data inputs and allows only one of them at a time. The routing of desired data input to output is controlled by select lines.

Block/logic diagram of demultiplexer (1 :4): **(1 Mark)**



I	Select		O/P			
	S0	S1	D0	D1	D2	D3
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	0	1

or equivalent dia.

Working- **(2 Mark)**

It accepts single input and distributes it over several outputs. The single input

should appear over which output line is decided by select lines.

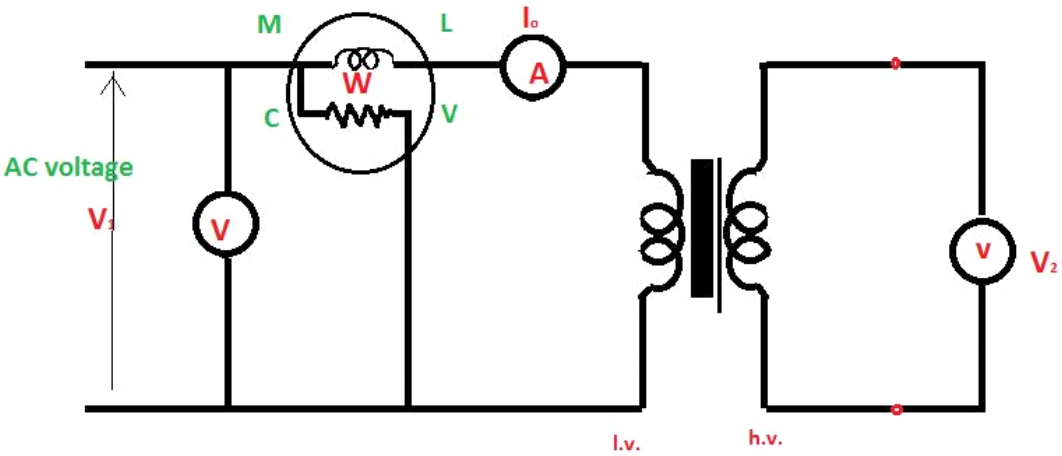
The relationship between select lines and output lines can be given by $2^m = n$

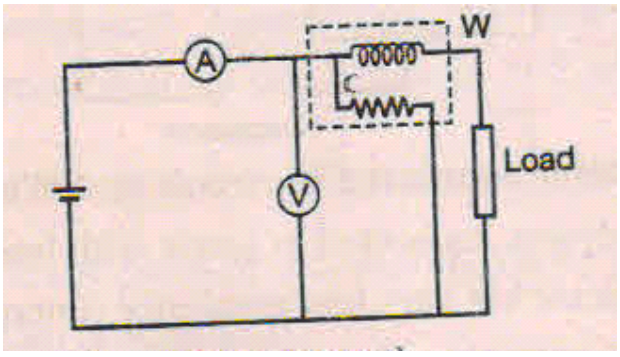
Where m = No. of select lines and n = No. of output lines.

Q.5 **Attempt any Four of the following:** **16 Marks**

a) **Draw the connection diagram showing the connection of voltmeter ; Ammeter and wattmeter in A.C. circuit with load.**

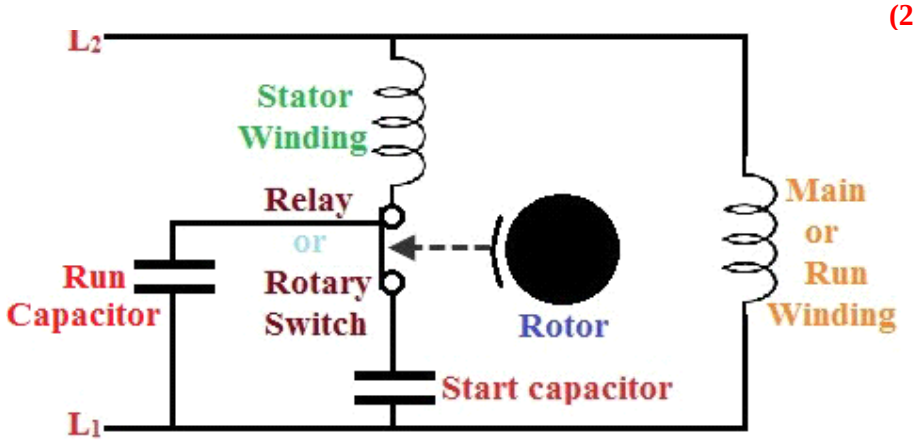
Ans: **Connection diagram showing the connection of voltmeter ; Ammeter and wattmeter in A.C. circuit with load:** **(4 Mark)**





or equivalent diagram

1. A : Ammeter (Measure Current)
2. V : Voltmeter (Measure Voltage)
3. W : Wattmeter (Measure Power

b)	**Why the single phase induction is not self starting motor ? Draw the circuit diagram for capacitor start induction run single phase induction motor.**
Ans:	**Reason for single phase induction motors are not self starting:** **(2 Mark)** ➢ When single phase AC supply is given to main winding it produces alternating flux. ➢ According to double field revolving theory, alternating flux can be represented by two opposite rotating flux of half magnitude. ➢ These oppositely rotating flux induce current in rotor & there interaction produces two opposite torque hence the net torque is Zero and the rotor remains standstill. ➢ Hence Single-phase induction motor is not self starting. **OR** **Single phase induction motor** has distributed stator winding and a squirrel-cage rotor. When fed from a single-phase supply, its stator winding produces a flux (or field) which is only alternating i.e. one which alternates along one space axis only. It is not a synchronously revolving (or rotating) flux as in the case of a two or a three phase stator winding fed from a 2 of 3 phase supply. Now, alternating or pulsating flux acting on a stationary squirrel-cage rotor cannot produce rotation (only a revolving flux can produce rotation). **That is why a single phase motor is not self-starting.** **Circuit diagram for capacitor start induction run single phase induction motor:** **(2 Mark)** 
c)	**What is wiring harness '? State its importance.**
Ans:	**Wiring harness:** **(2 Mark)** A **cable harness**, also known as a **wire harness**, **cable assembly**, **wiring assembly** or **wiring loom**, is an assembly of cables or wires which transmit signals or

	electrical power. The cables are bound together by straps, cable ties, cable lacing, sleeves, electrical tape, conduit, a weave of extruded string, or a combination thereof. **Importance of Wiring harness :** **(2 Mark)** Automobile wiring is complicated and critical to setup, with the help of harness time required for completion of wiring is less it easy to replace and maintain other accessories like audio, video or mobile can be setup inside the vehicle, with proper instructions it can be easily installed and replace safely.
d)	**What is the necessity of filter in rectifier circuit ? State the different types of filters.**
Ans:	**Necessity of Filter in rectifier circuit:-** **(2 Marks)** Filters are circuits which are used to remove unwanted AC components ie. Ripples from the output of rectifier. **OR** The output of rectifier circuit consists of a.c. ripples. The rectifier gives the output as d.c. + a.c. and not pure d.c (i.e. pulsating DC voltage). So as to get pure d.c. output, filter is necessary at the output side of rectifier. **Different types of filters:** **(2 Mark)** i) Shunt capacitor filter ii) Series inductor filter iii) LC Filter iv) CLC or π filter
e)	**Define the following terms related to dynamic characteristics of measuring system.** **i) Speed of response ii) Lag iii) Fidelity iv) Dynamic error**
Ans:	**Meaning following terms related to dynamic characteristics of measuring system:** **i) Speed of response** : **(1 Mark)** It is defined as the rapidity with which an instrument, responds to the changes in the measured quantity. **ii) Lag** : **(1 Mark)** It is defined as the retardation or delay, in the response of a system to the changes in the input.

iii) Fidelity: **(1 Mark)**

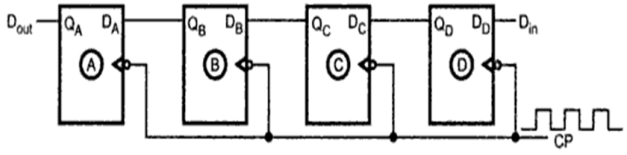
It is defined as the degree to which a measurement system is capable of faithfully reproducing the changes in input, without any dynamic error.

iv) Dynamic error: **(1 Mark)**

It is the difference between the true value of the quantity that is to be measured, changing with time and the measured value, if no static error is assumed.

f) Describe the working principle with general block diagram of shift register.

Ans: **Explanation of Shift Register:-** **(4 Mark)**



Working

We will illustrate the entry of the four bit binary number 1111 into the register, beginning with the left-most bit.

Initially, register is cleared. So

$Q_AQ_BQ_CQ_D = 0\,0\,0\,0$

a) When data 1 1 1 1 is applied serially, i.e. left-most 1 is applied as D_{in},

$D_{in} = 1$, $Q_AQ_BQ_CQ_D = 0\,0\,0\,0$

The arrival of the first falling clock edge sets the right-most flip-flop, and the stored word becomes,

$Q_AQ_BQ_CQ_D = 0\,0\,0\,1$

b) When the next negative clock edge hits, the Q_1 flip-flop sets and the register contents become,

$Q_AQ_BQ_CQ_D = 0\,0\,1\,1$

c) The third negative clock edge results in,

$Q_AQ_BQ_CQ_D = 0\,1\,1\,1$

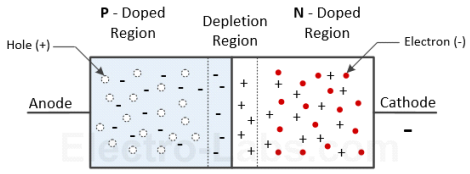
d) The fourth falling clock edge gives,

$Q_AQ_BQ_CQ_D = 1\,1\,1\,1$

Q.6 Attempt any Four of the following: 16 Marks

a)	**Describe the operation of P-N junction diode under forward and Reverse biasing condition.**
Ans:	**(2 Mark for construction , 2 Marks explanation)**

Construction of PN junction diode: -



or equivalent figure

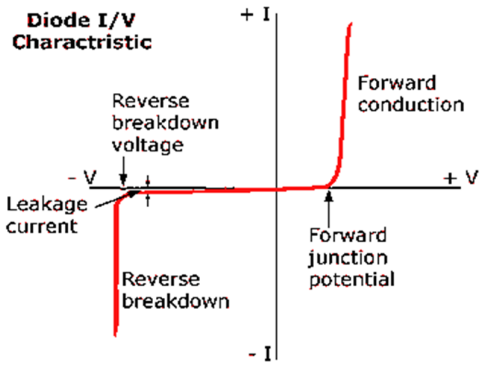
A P-N junction is formed at the boundary between a p-type and n-type semiconductor created in a single crystal of semiconductor by doping.

Working- **(2 Marks)**

In forward bias, the p-type is connected with the positive terminal and the n-type is connected with the negative terminal. With a battery connected this way, the holes in the P-type region and the electrons in the N-type region are pushed toward the junction. This reduces the width of the depletion zone. The positive charge applied to the P-type material repels the holes, while the negative charge applied to the N-type material repels the electrons. As electrons and holes are pushed toward the junction, the distance between them decreases. This lowers the barrier in potential. With increasing forward-bias voltage, the depletion zone eventually becomes thin enough that the zone's electric field cannot counteract charge carrier motion across the p–n junction, as a consequence reducing electrical resistance. The electrons that cross the p–n junction into the P-type material (or holes that cross into the N-type material) will diffuse in the near-neutral region. Therefore, the amount of minority diffusion in the near-neutral zones determines the amount of current that may flow through the diode.

Reverse-bias usually refers to how a diode is used in a circuit. If a diode is reverse-biased, the voltage at the cathode is higher than that at the anode. Therefore, no current will flow until the diode breaks down. Connecting the P-type region to the negative terminal of the battery and the N-type region to the positive terminal corresponds to reverse bias. Because the p-type material is now connected to the negative terminal of the power supply, the 'holes' in the P-type material are pulled away from the junction, causing the width of the depletion zone to increase. Likewise, because the N-type region is connected to the positive terminal, the electrons will also be pulled away from the junction. Therefore, the depletion region widens, and does so increasingly with increasing reverse-bias voltage. This increases the voltage barrier causing a high resistance to the flow of charge carriers, thus allowing minimal electric current to cross the p–n junction. The increase in resistance of the p–n junction results in the junction behaving as an insulator.

VI Characteristics:



or equivalent figure

b) Define the conductor and insulator. Compare between conductor and insulator.

Ans:

(i) Conductor : **(1 Mark)**

A conductor is an object or type of material that allows the flow of electrical current in one or more directions. It offers ideally 0Ω resistance. **OR** In terms of energy band diagram, conductor means valency band and conduction band are overlapping each other. Examples – Copper, ,Iron, Aluminium etc

(ii) Insulator :- **(1 Mark)**

Any material that exhibits high resistivity to electrical current is known as an insulator, such as rubber, plastic, or wood. **OR** In terms of energy band diagram, insulator means there is a large band gap present between valency band and conduction band.

Compare between conductor and insulator: **(Any Two expected: 1 Mark each)**

S.No	Conductor	Insulator
1	The conductivity of conductor is very high.	The conductivity of insulator is very low.
2	It has very low resistivity.	It has very high resistivity.
3	It has no forbidden gap.	It has large forbidden gap.
4	Conductor has positive temperature coefficient of resistance.	Insulator has negative temperature coefficient of resistance.
5	In conductor, both the effect of resistance and temperature are increases	In insulator, effect of resistance is decreases and effect of temperature is increases.
6	There is large number of electrons available for conduction.	There is small number of electrons available for conduction.
7	**Examples:** Metals, aluminium, copper.	Paper, Mica glass.

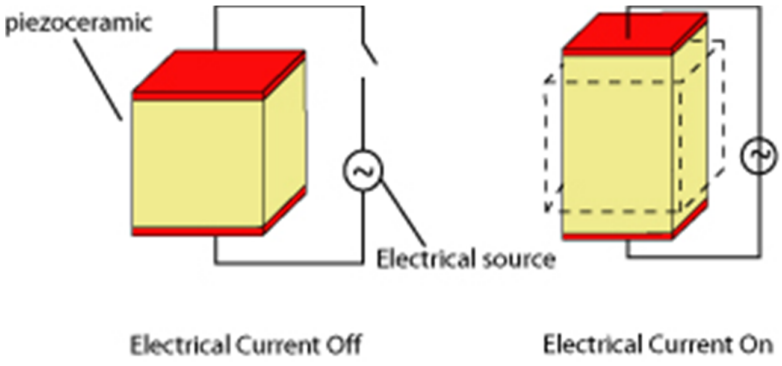
c) Compare the electrical instruments and mechanical instruments (4 points).

Ans: **(Any four point expected- 1 Mark each point)**

S.No.	Electrical Instrument	Mechanical Instruments
1	These instruments are used for rapid changes. Or sensitivity of the electrical instrument is more	These instruments are used for static & stable condition. Or sensitivity of the electrical instrument is less
2	They are able to record dynamic & transient condition.	They are unable to respond rapidly to measurement of dynamic & transient condition.
3	Instruments are consists of moving parts that are light in weight.	Instruments are consists of moving parts that are rigid, heavy & bulky.
4	Weight is less.	Weight is more.
5	It doesn't produce noise during measurement.	It produce noise & causes air pollution.
6	Rapidly indicates output.	Slowly indicates output.
7	Life of the electrical instrument is less	Life of the mechanical instrument is more

d) Explain the working of following transducers : i) Piezo electric transducer ii) Potentiometer.

Ans: **i) Piezo electric transducer:** **(Figure: 1 Mark & Explanation: 1 Mark)**



A **piezoelectric transducer / sensor** is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, strain or force by converting them to an electrical charge.

There are certain materials that generate electric potential or voltage when mechanical strain is applied to them or conversely when the voltage is applied to them,

they tend to change the dimensions along certain plane. This effect is called as the piezoelectric effect. Some of the materials that exhibit piezoelectric effect are quartz, Rochelle salt, polarized barium titanate, ammonium dihydrogen, ordinary sugar etc.

OR

The piezoelectric transducers work on the principle of piezoelectric effect. When mechanical stress or forces are applied to some materials along certain planes, they produce electric voltage. This electric voltage can be measured easily by the voltage measuring instruments, which can be used to measure the stress or force.

The physical quantities like stress and force cannot be measured directly. In such cases the material exhibiting piezoelectric transducers can be used. The stress or the force that has to be measured is applied along certain planes to these materials. The voltage output obtained from these materials due to piezoelectric effect is proportional to the applied stress or force. The output voltage can be calibrated against the applied stress or the force so that the measured value of the output voltage directly gives the value of the applied stress or force. In fact the scale can be marked directly in terms of stress or force to give the values directly.

ii) Potentiometer: **(Figure:1 Mark & Explanation: 1 Mark)**

or equivalent figure

Working:-

A Potentiometer consists of a track which provides the resistance path. Two terminals of the device are connected to both the ends of the track. The third terminal is connected to a wiper that decides the motion of the track. The motion of the wiper through the track helps in increasing and decreasing the resistance.

The track is usually made of a mixture of ceramic and metal or can be made of carbon as well. As a resistive material is needed, carbon film type variable resistors are mostly used. The track can be in both the rotary as well as straight versions. In a rotary track some of them may include a switch. The switch will have an operating shaft which can be easily moved in the axial direction with one of its ends moving from the body of variable resistor switch.

e) Describe the RS flip-flop and D flip-flop with its symbols and truth table.

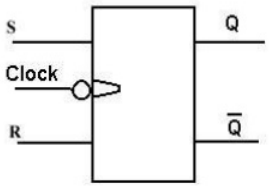
Ans:

RS flip-flop : **(2 Mark)**

The **SR flip-flop**, also known as a *SR Latch*, can be considered as one of the most basic sequential logic circuit possible. This simple flip-flop is basically a one-bit memory bistable device that has two inputs, one which will "SET" the device (meaning the output = "1"), and is labelled S and another which will "RESET" the device (meaning the output = "0"), labelled R.

Then the SR description stands for "Set-Reset". The reset input resets the flip-flop back to its original state with an output Q that will be either at a logic level "1" or logic "0" depending upon this set/reset condition

1) Symbol & Truth Table of RS flip flop : **(1.5 Marks)**



Symbol

(b) *SR* Flip-Flop

S	R	$Q(t+1)$	Operation
0	0	$Q(t)$	No change
0	1	0	Reset
1	0	1	Set
1	1	?	Undefined

Truth Table

2) Symbol & Truth Table of D flip flop : **(1.5 Marks)**

The D type flip-flop has one data input 'D' and a clock input. The circuit edge triggers on. The clock input. The flip-flop also has two outputs Q and Q' (where Q' is the reverse of Q).

D Flip-flop

Symbol

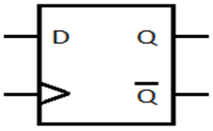


Table of truth:

clk	D	Q	$\overline{Q}$
0	0	Q	$\overline{Q}$
0	1	Q	$\overline{Q}$
1	0	0	1
1	1	1	0

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