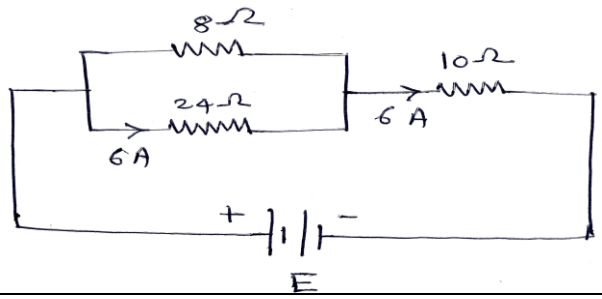
Important Instructions to examiners:

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

1. A) Attempt any FIVE of the following :	**20**
a) Define following terms:	**4**
Answer: (1 marks each) i. **E.M.F.:** It is the force which creates potential difference across the terminals, by a source of electrical energy, to produce an electric current in a circuit. ii. **Current:** It is defined as the rate of transfer of electric charge per unit time or current is flow electrons. iii. **Resistance:** It is a property of substance by virtue of which it opposes the flow current through it. iv. **Potential Difference:** The potential difference between two points, say A and B, is a measure of the energy used by one coulomb in moving from A and B.	
b) Two resistances of 8 Ω and 24 Ω respectively are connected in parallel. Another resistance of 10 Ω is connected in series with this combination. Calculate respective voltages which should be applied across the whole circuit : **i) to pass 6 A through 10 Ω resistance and ii) to pass 6 A current 24 Ω resistance.**	**4**
Answer:  	1

i) Voltage across, 10Ω resistance = 6A × 10Ω $V_1 = 60\ V$. ii) Voltage across, 24Ω resistance = 6A × 24Ω $V_2 = 144\ V$ iii) voltage applied across Whole circuit, $E = V_1 + V_2$ $= 60 + 144$ $E = 204\ V$	1 1 1
c) Define the following terms: **i) Magnetic flux** **ii) Magnetic flux density, state their units.**	**4**
Answer: **(Note: Definition 1 Marks & Unit 1 marks each)** (i) **Magnetic flux:** The total number of lines of force in any particular magnetic field is called magnetic flux. Its unit is weber (w). (ii) **Magnetic flux density:** The flux per unit area in a plane at right angles to the flux is known as flux density. Its unit is tesla (T).	2 2
d) Define the following terms related to A.C. quantity. **i) instantaneous value** **ii) waveform** **iii) time period** **iv) frequency**	**4**
Answer: (1 mark each) (i) **Instantaneous Value:** The value of an alternating quantity at any instant is called instantaneous value. (ii) **Waveform:** The shape of the curve obtained by plotting the instantaneous value against time. (iii) **Time period:** The time taken in seconds to complete one cycle of an alternating quantity is called time period. (iv) **Frequency:** Number of cycles completed in one second is called frequency.	4

e) Compare conductor and insulator for four points **4**

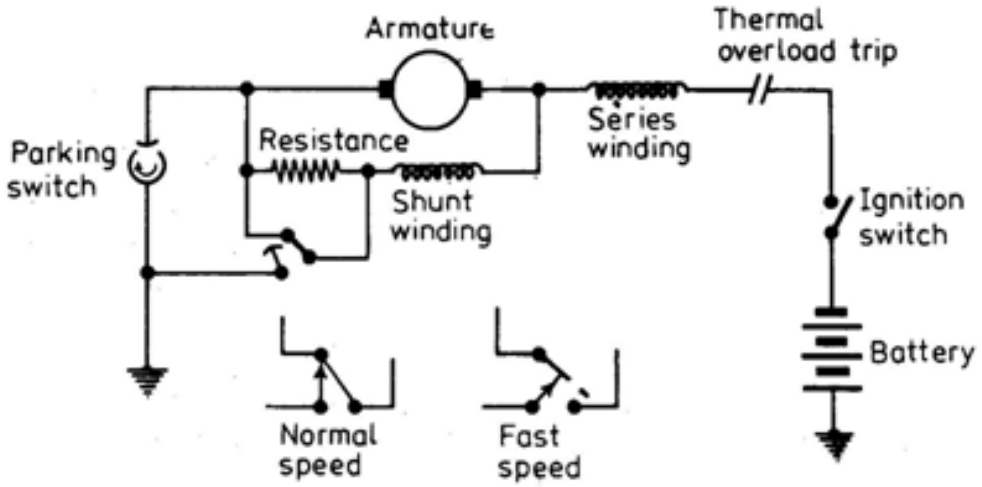
Answer: (1 Mark each point) 4

Sr.no	Conductor	Insulator
1	Materials through which current can flow	Materials through which current cannot flow
2	Materials of which conductivity is high	Materials of which conductivity is very low
3	Materials of which, resistivity is low	Materials of which, resistivity is high
4	Conductors have positive temperature coefficient of resistance	Insulators have negative temperature coefficient of resistance

f) Draw wiring diagram of wind shield wiper. Describe how the speed of the wiper is adjusted. **4**

Answer: (Wiring diagram -2 marks & description – 2marks)

Wiring diagram of wind shield wiper:



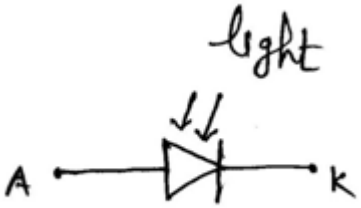
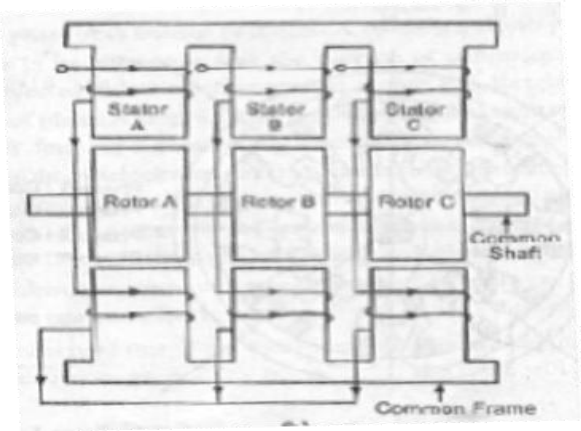
2

Fig. of Wind shield wiper

As shown in fig., DC compound wound motor is used for circuit of wiper, showing normal & fast speed operation positions. When switch position is on **Normal Speed Position**, series circuit of Resistance & shunt winding is in parallel with armature of motor. For this position motor gives normal speed.

When switch position is on **Fast Speed Position**, only shunt winding is in parallel with armature of motor. For this position motor gives fast speed. 2

The motor shaft is connected to blade through mechanical linkage with reduction gear box.

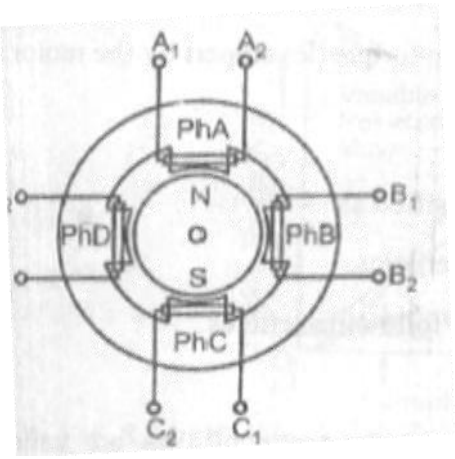
g) Draw symbols of photodiode and LED. Write two application of each	**4**
Answer: (Symbol -1 Mark each & Two Applications – 1 Mark each) **Symbol of Photo diode:**  Symbol- Photodiode **Applications of Photodiode:** 1) It is used in Alarm circuits. 2) It is used in Counter circuit. **Symbol of LED:**  Symbol- LED **Applications of LED:** 1) It is used in opto couplers. 2) It is used in 7 segment displays.	2 2
2. Attempt any TWO of the following :	**16**
a) State the principle on which stepper motor works. Draw a sketch of a stepper motor to indicate various parts of the motor.	**8**
Answer: **(Principle of working – 2 marks, Sketch of any one type of Stepper motor- 6 marks)** **Stepper Motor: -** A stepper motor is basically an electromagnetic transducer or an incremental actuator which converts digital pulse inputs into output shaft motion. The essential property of stepper motor is its ability to translate switched excitation into precisely defined increment of output shaft motion. **Variable Reluctance Motors** 	8

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 unit 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 direction. The same process is repeated for phase 'C'

In this way chain of signals can be passed to get revolution and direction can be also changed.

2. Permanent Magnet motor:-



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.

b) Write principle working and application of resistance split phase motor. **8**

Answer: (Sketch – 3 marks, Explanation – 3 marks & application – 2 Marks) 3

Working Principle of resistance split phase motor:

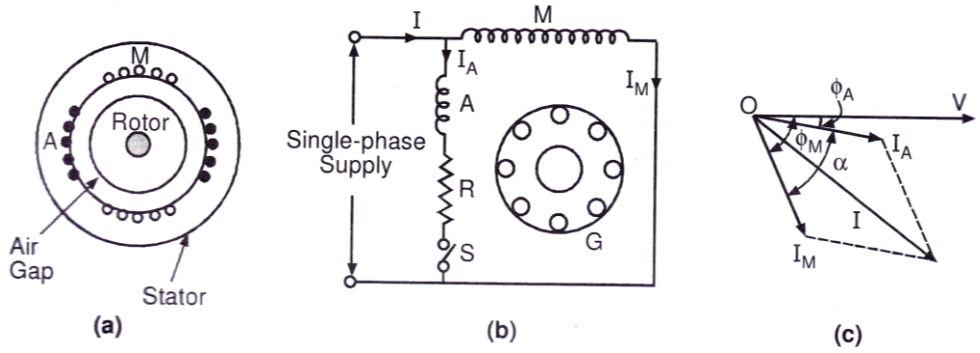


Fig. Resistance split phase motor.

Fig (a) Shows the motor schematically and Fig (b) shows its connection diagram.

The auxiliary winding along with the series resistor (R) connected across the main winding. Instead of connecting externally such a high resistance in series with an auxiliary winding its resistance may be increased by choosing a high resistance fine copper wire for winding purpose the resistance to reactance ratio of the auxiliary winding circuit being higher than the main winding currents through them are nearly in quadrature (fig c). The resulting fluxes due to these currents are therefore displaced in space through 90^0 and have considerable time phase difference. A rotating magnetic field is therefore produce (as in a two – phase motor). The motor thus develops a starting torque. Once the motor is started, the auxiliary winding is disconnected with help of centrifugal switch (S) at about 75 to 80 % of the synchronous speed.	3
Applications : These motors are commonly used in small electric tools, fans, blowers, centrifugal pumps, domestic refrigerator units, oil burners, washing machine etc.	2
c) Draw the constructional diagram of D.C. motor and write the function of four parts.	**8**
Answer: (Sketch – 4 Marks & Function – 1 Mark Each) **Constructional Sketch of D.C. motor:**	8

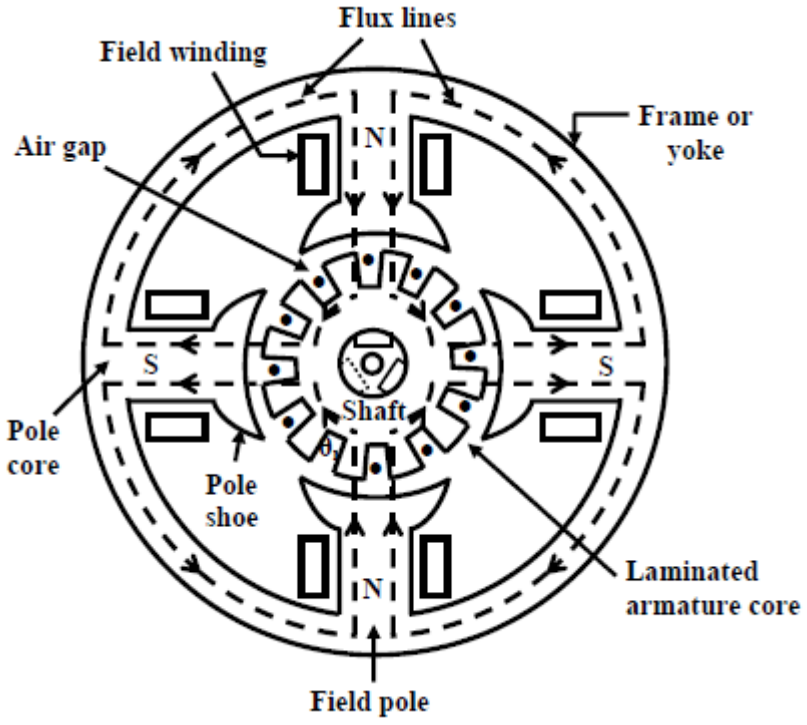


Fig DC motor

Functions of D. C. Motor Parts: (any Four- 1 Mark each)

1. **Yoke:**
   i. It provides the mechanical supports for poles
   ii. It carries magnetic flux produced by poles.
2. **Pole Core:**
   i. It spread out the flux in the air gap

ii. To support the exciting coils or field coils.

3. Armature:
i. To house the aramature conductors or coils
ii. To provide the path of very low reluctance to the flux through the aramature from N to S pole.

4. Commutator:
i. To facilate collection of current from the armature conductors

5. Brushes:
i. To collect current from commutator.

3. Attempt any TWO of the following :. **16**

a) (i) State Faraday's law **8**
(ii) Define self and mutual inductance

Answer:

(i) Faraday's Law:

There are two Faraday's law of electromagnetic induction

1. **Faraday's First Law:** This law states that whenever the number of lines of force linking with a circuit changes, an e.m.f. is always induced in it; or whenever a conductor cuts or is cut by the magnetic flux, an e.m.f. is always generated in it. 2
2. **Faraday's Second Law:** It states that the magnitude of the induced e.m.f. in any circuit is proportional to the rate of change of its flux linkages; or the magnitude of the generated e.m.f. in any conductor is proportional to the rate at which it cuts or is cut by the magnetic flux. 2

(ii) Define self and mutual inductance:

1. **Self inductance:** The self inductance is defined as that property by virtue of which coil opposes any change in current flowing through it. 2
2. **Mutual inductance**: Mutual inductance is be defined as the property due to which one coil with the change in its own current produces an e.m.f. in a nearby coil by induction. 2

b) Describe the function of wiring harness and cable connector with diagram. **8**

Answer: (Functions 2 Marks each & Sketch – 2Marks each)

Functions of Wiring Harness:

With the adoption of wiring harness method it has become quite simple the various electrical components. it has also resulted in space saving and safeguarding of the individual cables from metal objects. 2

The harness consists of bunches of cables leading to the various components to be connected. Each bunch is bound together with a PVC tape, leaving sufficient lengths of individual cables protruding at each end for making the necessary electrical connection easily as shown in fig.

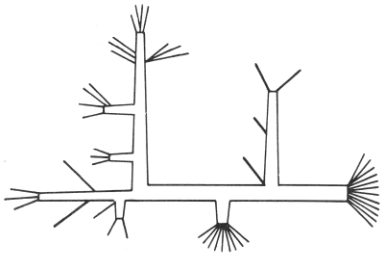
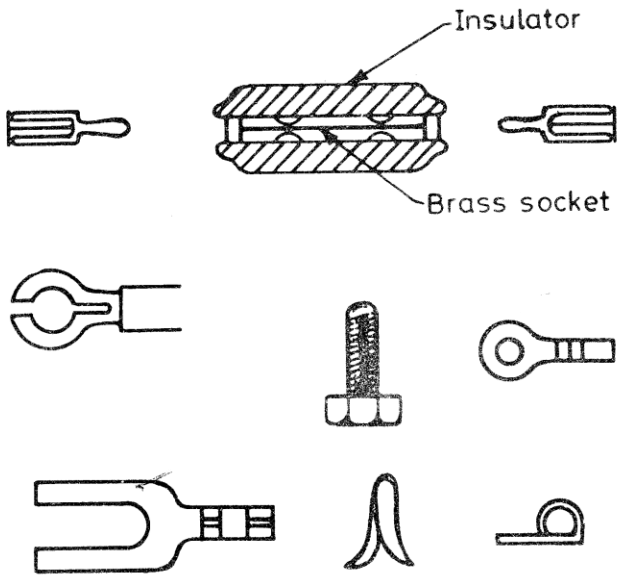
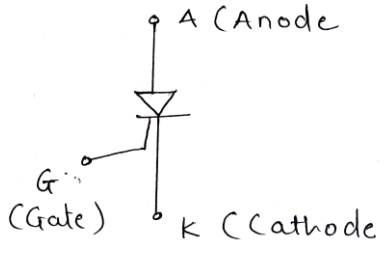
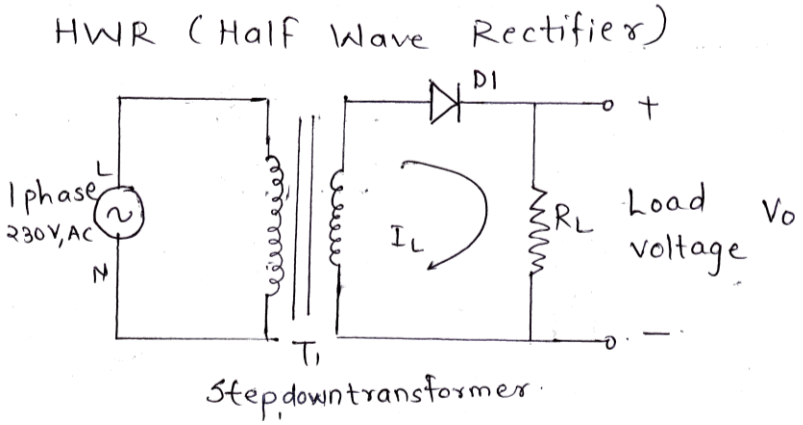
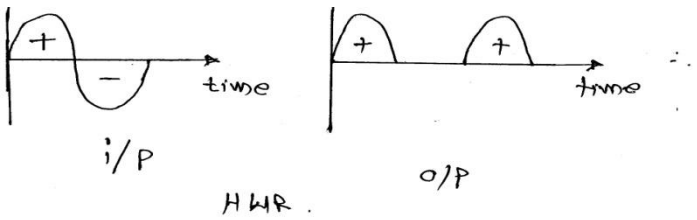
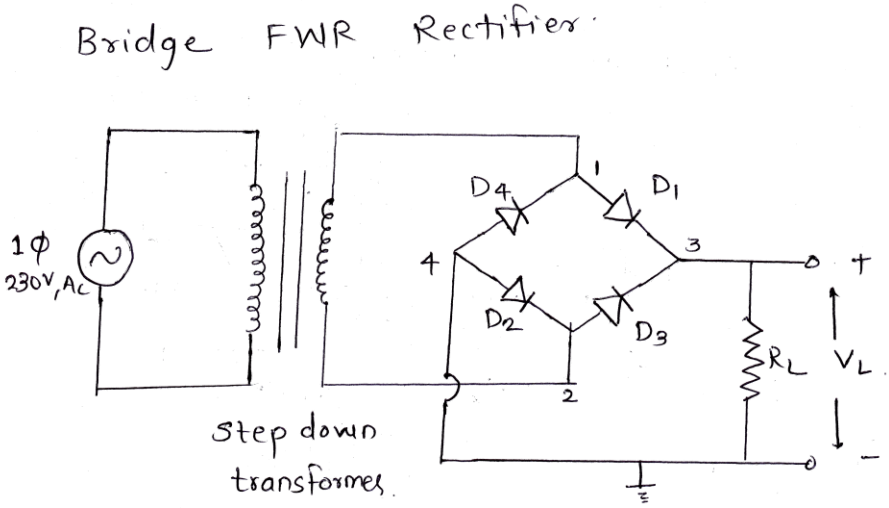


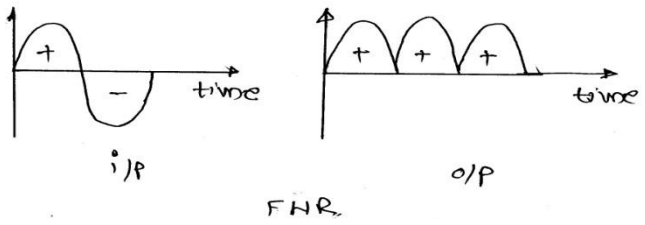
Fig Wire harness 2

Functions of Cable connector: i. It is used for connecting electrical components in the present day automobiles. ii. Cable Connectors are time saving and reliable. iii. Cable Connector improves the connections at various load positions.  Fig cable connector	2 2
c) Draw symbolic representation of SCR. State the meaning of the following terms related to SCR. **(i) holding current** **(ii) breakdown voltage** **(iii) forward current rating**	**8**
Answer: (symbolic representation – 2marks & meaning of terms – 2 marks each) **symbolic representation of SCR:**  Symbolic representation of SCR **Holding current**: It is maximum anode current gate being open at which SCR is turned off from ON conditions. **Breakdown voltage :** It is the minimum forward voltage gate being open at which SCR starts conducting heavily i.e. turned on **Forward current rating :** It is maximum anode current that an SCR is capable is capable of passing without destruction.	2 2 2 2

4. Attempt any TWO of the following.	**16**
a) Draw the circuit diagram and working principle or HWR and bridge FWR rectifier.	**8**
Answer: (Circuit diagram – 2 Marks Each & Working principle – 2 Marks each) **Circuit diagram of Half wave rectifier (HWR):**  **Fig**: **Half wave rectifier** **Working Principle of Half wave rectifier (HWR):** In half wave rectification the rectifier conducts current only during the positive half cycle of input a.c. supply. The negative half cycles of a.c. supply are suppressed i.e. during negative half cycles no current is conducted and hence no voltage papers across the load. Therefore current always flow in one direction (i.e. d.c.) through load through after every half cycle.  **Circuit diagram of Full wave Bridge rectifier (FWR):**  Fig :**Full wave bridge rectifier**	8

Working Principle of Full wave bridge rectifier (FWR) :

The need for a centre tapped power transformer is eliminated in the bridge rectifier. It contains four diodes D_1, D_2, D_3 and D_4 connected to form bridge as shown in figure. The a.c. supply to be rectified is applied to the diagonally opposite ends of the bride through the transformer. Between other two ends of the bridge the load resistance R_L is connected.



FWR

b) Draw a labelled diagram of LVDT and describe its function for displacement measurement. **8**

Answer: (Sketch of LVDT – 2 Marks & function – 6 Marks) 8

LVDT (Linear Variable Differential Transducer):

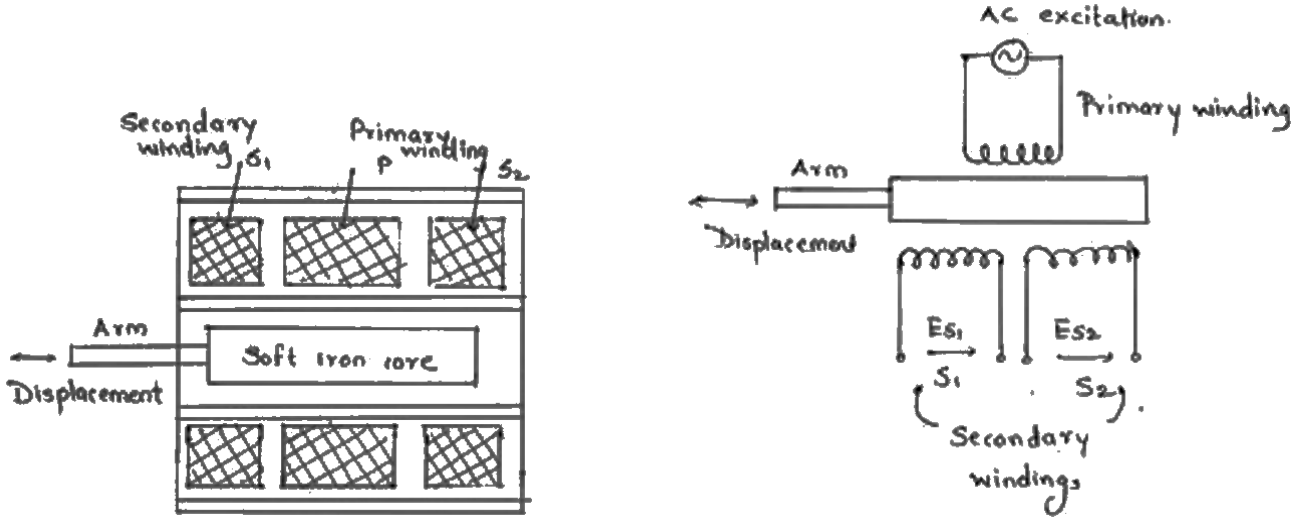


Fig : LVDT

LVDT is electromechanical transducer that can convert the rectilinear motion of an object to which it is coupled mechanically into a corresponding electrical signal. In LVDT motion of magnetic core changes the mutual inductance of two secondary coils relative to primary coil. It is based on a variable inductance principle for displacement measurements. It provides an ac voltage output proportional to the displacement of a core passing through its windings as shown in fig.

Function of LVDT for displacement measurement:

The operation of LVDT is based on position of core. The different cases of LVDT operation are:

Case1: core is at null position

The primary winding is connected to the ac source. Assume that the core is exactly at the centre of the coil. Due to equal flux linkage the secondary induced voltage are equal but they have opposite polarities. The

output voltage e0 is therefore zero corresponding to the central position of the core. This position is called null position.

Case 2: Core is at left side

If the core is displaced from its null position towards secondary 1 i.e e01 then flux linked to secondary 1 e01 is increase and flux linked to secondary 2 e02 is decrease.

e0=e01- e02

Therefore the induced voltage e01 is greater than e02 and the output voltage of LVDT i.e e0 will be positive as shown in fig.

Case 3: core is at right side

Similarly if the core is displaced from its null position towards secondary 2 i.e e02 then flux linked to secondary 2 e02 is increase and flux linked to secondary 1 e01 is decrease. Then e02 will be greater than e01 and the output voltage e0 will be negative as shown in fig.

e0= e02-e01

c) Describe the following terms accuracy and precision, sensitivity, reliability, linearity, resolution, repeatability and reproducibility related to static characteristic in measurement.. **8**

Answer: (1marks each) 8

1. **Accuracy:** Accuracy is the closeness with which an instrument reading approaches the true value of the quantity being measured. Accuracy of a measurement means conformity with truth.

2. **Precision:** Precision is a measure of a degree of agreement within a group of measurements.
   OR
   Precision is defined as the repeatability of measuring process.

3. **Sensitivity:** Sensitivity of an instrument is defined as the ratio of change in output to change in input.

4. **Reliability:** Reliability of an instrument is defined as the possibility that it will perform its assigned functions for a specific period of time under given conditions.

5. **Linearity:** Linearity is defined as the ability to reproduce the input characteristics symmetrically and linearly.

6. **Resolution:** Resolution is defined as the smallest change of input for which there will be a change of output.

7. **Repeatability:** Repeatability is the property of instrument to give the same output value each time the measurement of a given quantity is repeated under the same conditions.

8. **Reproducibility:** Reproducibility of measurement is the quantitative measure of the closeness of the agreement between the results of measurements of the same measurand , carried out by changing the method of measurement, observer, measuring instrument ,location ,condition of use ,time etc.

5. Attempt any TWO of the following :	**16**
a) (i) State the principle on which pirani vacuum gauge works. Draw a labelled block diagram of pirani gauge. **(ii) State the difference between thermister and RTD for four points**	**8**

Answer:

(i) Principle of Pirani Vacuum gauge:- (2 Marks)

Pirani vacuum gauge works on the principle of thermal conductivity which states that there is a direct relationship between pressure and conductivity. It is used to measure the low pressure. Hence it is also called as thermal conductivity gauges. 4

Sketch of Pirani Vacuum gauge:- (2 Marks)

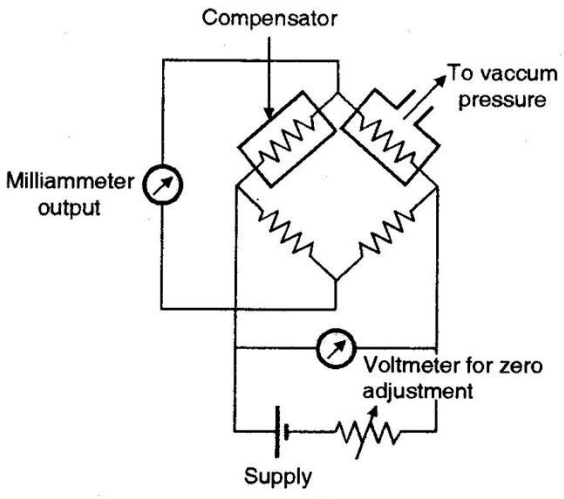


Fig Pirani vacuum gauge

(ii) Difference between thermister and RTD 4

(Note: any four points – 1 marks each. Credit should be given to suitable answer)

Sr. No.	Thermister	RTD
1	They are made of metallic oxide of Cu, Ni, Fe.	They are made of metals like Cu, Pt, Ni.
2	They are available in both types that is positive and negative temperature coefficient.	They are available in positive temperature coefficient of resistance.
3	Operating temperature range is -50^0 C to 300^0 C	Operating temperature range is -100^0 C to 650^0 C
4	Small size as well as less expensive.	Relatively big size and have more cost.
5	Used for different applications like level, velocity , temperature etc.	Used for application like temperature measurement only.

b) (i) Draw a logical symbol of four to one multiplexer. **(ii) Describe the working of ultrasonic flow meter using neat diagram**	**8**

Answer:

(i) logical symbol of four to one multiplexer: (4 marks – credit may be given to truth table) 4

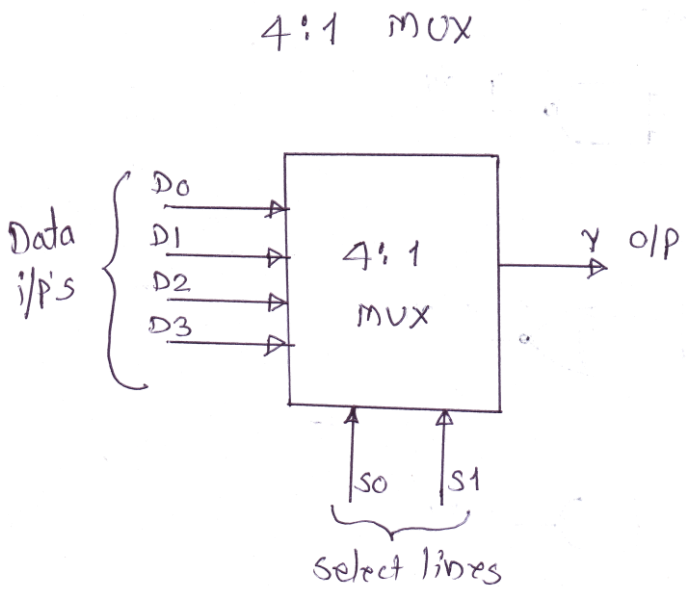


Fig 4:1 MUX

Select inputs		*Output Y*
S_1	S_0	
0	*0*	D_0
0	*1*	D_1
1	*0*	D_2
1	*1*	D_3

Fig Truth Table of 4:1 MUX

(ii) Working of ultrasonic flow meter: (2 marks –Sketch & 2 marks explanation.) 4
(Note: Credit should be given to equivalent answer)

Ultrasonic flow meter based on Doppler effect is explained here.

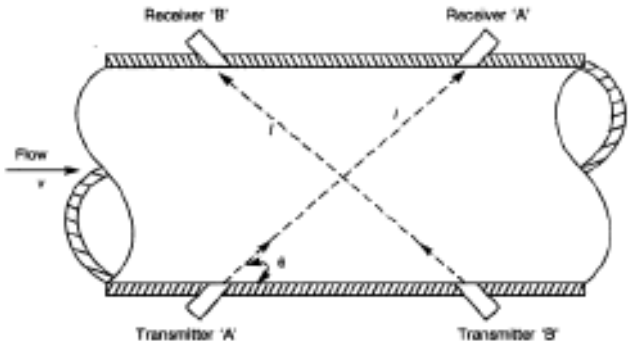


Fig Ultrasonic flow meter

A and B are Piezo -electric devices transmitting the short duration ultrasonic signals through the fluid that is flowing through the pipe at a velocity V. Similar type of crystals are used as receivers to respond to pressure fluctuations.

Due to the fluid velocity v aiding the transmission the velocity of ultrasonic signal from the transmitter A to receiver A is increased to a value c+ vCosθ, where c is the velocity of sound through the fluid in the pipe and θ is the angle between the path of sound and the pipe vale. The repetition frequency of the received pulse f_A will be

$$f_A = \frac{c + v\cos\phi}{l}$$

Where l = the distance between the transmitter and receiver. On the other hand the velocity of the ultrasonic signal transmitted by B and received by receiver B will be reduced by the fluid velocity causing a retardation of v cos θ and its pulse repetition frequency f_B will be

$$f_B = \frac{c - v\cos\phi}{l}$$

The difference between frequencies is given by

$$\Delta f = f_A - f_B = \frac{2v\cos\phi}{l}$$

By measuring the difference in the repetition frequency Δf and knowing the values of θ and l the velocity of the fluid can be computed alternatively, the flow velocity can be computed by measuring the transit time difference between the two pulse trains in either direction.

c) (i) Draw ckt. of RSF using NAND gate and write its truth table. **08**
(ii) Write the truth table for :
1)NAND gate
2) NOR gate

Answer:

i) RSFF using NAND gate: (Circuit diagram – 2 marks & truth table – 2 marks) 4

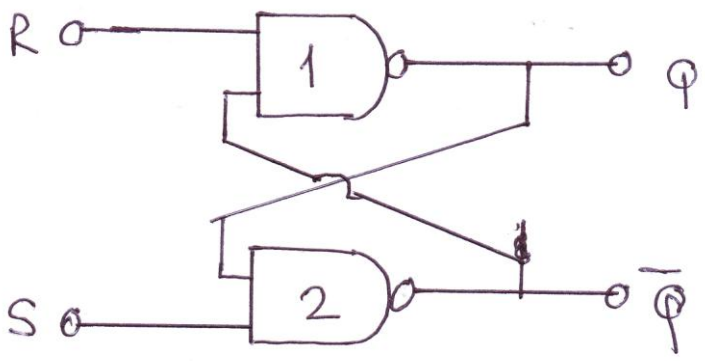
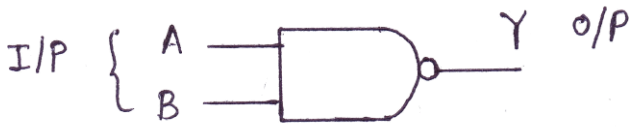


Fig : RSFF

S	R	Q_{n+1}	$\overline{Q}_{n+1}$
0	0	RACE	RACE
0	1	0	1
1	0	1	0
1	1	Q_n	$\overline{Q_n}$

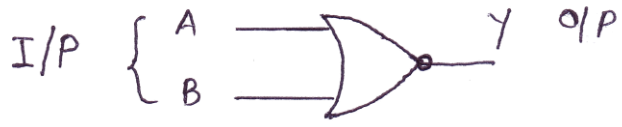
ii) Truth table for : (Truth table – 2 Marks each) 4

1)NAND gate



inputs		Output Y= $\overline{A.B}$
A	B	
0	0	1
0	1	1
1	0	1
1	1	0

2) NOR gate



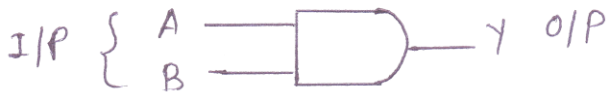
inputs		Output Y= $\overline{A+B}$
A	B	
0	0	1
0	1	0
1	0	0
1	1	0

6. Attempt any TWO of the following :	**16**
a) (i) Draw symbols of AND, OR , NOT gate. Write their truth table. **(ii) Describe the working of seven segment LED display**	**8**

Answer: (Symbols – 2 Marks & Truth table -2 marks) 4

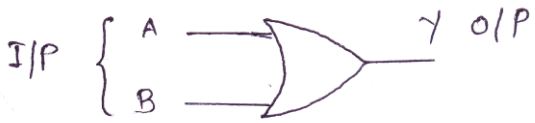
i) Symbols of AND, OR , NOT gate:

1. AND gate



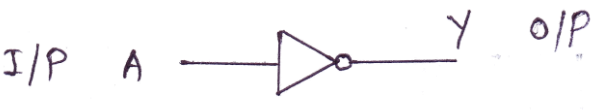
inputs		Output Y= $A.B$
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

2. OR gate



inputs		Output Y= $A+B$
A	B	
0	0	0
0	1	1
1	0	1
1	1	1

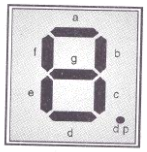
3. NOT gate



Inputs A	Output Y= $\overline{A}$
0	1
1	0

ii) Working of Seven segment LED display: — 4

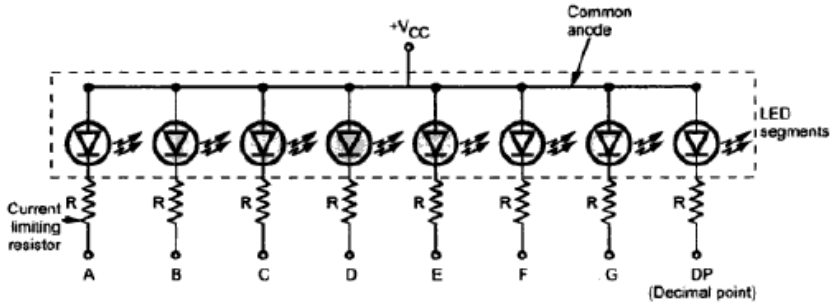
Seven segment displays consists of Eight LEDs. Depending on the various digits and letters to be displayed the combination of LEDs are forward biased.



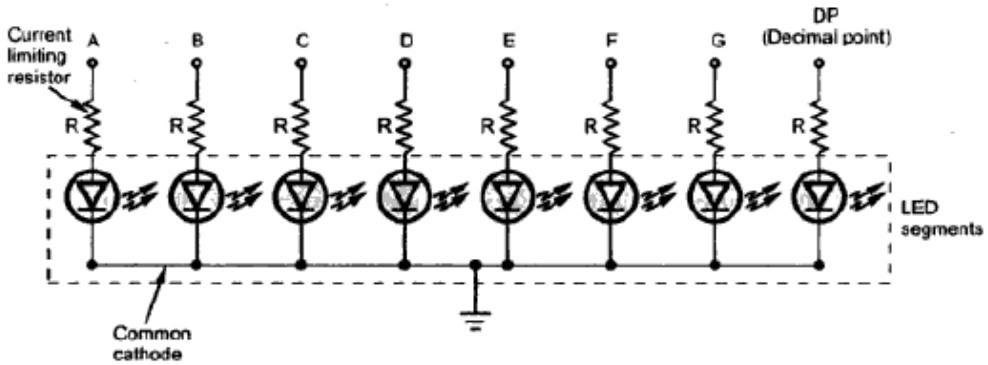
e.g. suppose we want to display the digit 3 then LED a,b,c,d should only be forward biased the two type of seven segment display are available.

1. Common anode type
2. Common cathode type

In common anode type all anodes of LEDs are connected together and common point is connected to +Vcc
In Common cathode type all cathodes of LEDs are connected together and the common point is connected to the ground.



OR



b) What are positive and negative return systems, give their comparison. — **8**

Answer: **(Explanation – 2 marks each & comparison– 1 marks for each point)**

Negative return systems:- Earthing the negative terminal of a battery whereas positive current was supplied to the electrical units. It is called negative return system. In the beginning negative earthing system was mostly used. — 4

Positive return systems: In this system positive terminal of battery is earthed. This system possesses certain advantages over negative earthing system. Which concern with temperature of spark plug, corrosion of certain parts, and voltage requirement of spark plug.

Comparison of Positive return & Negative Return system: (Any four Points):

Sr. No.	Positive return	Negative return
1.	It requires low spark plug voltage.	It requires high spark plug voltage.
2.	It reduces battery terminal corrosion.	Battery terminal corrosion is comparatively more.
3.	It has less wear at plug point	It has more wear at plug point
4.	The temp of spark plug electrode is less	The temp of spark plug electrode is more
5.	Mostly used in ignition system	Rarely used in ignition system
6.	More economical	Less economical

4

c) (i) Define following terms **8**

1. **Intrinsic semiconductor**
2. **Extrinsic semiconductor**

(ii) Describe the working of transistor as an amplifier.

Answer**:**

(i) Intrinsic semiconductor:-The semiconductors which are in their purest possible form is known as intrinsic semiconductors. 2

Extrinsic semiconductor: - These are the semiconductors which are in impure form, and can be obtained by adding impurities in pure semiconductor. 2

(ii) Transistor as an amplifier

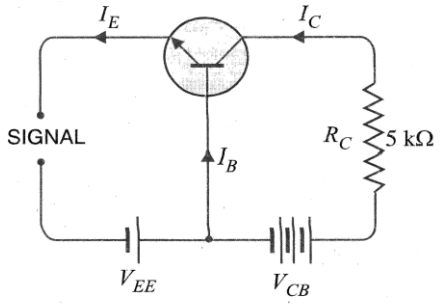


Fig Transistor as an amplifier 2

A transistor raises the strength of a weak signal and thus acts as an amplifier figure shows the basic circuit of a transistor amplifier. The weak single is applied between emitter –base junction and output is taken across the load R_C connected in the collector circuit. V_{EE} is applied in the input circuit in addition to the signal as shown. 2

As the input circuit has low resistance, therefore a small change in signal voltage causes an appreciable change in emitter current. This causes almost the same change in collector current due voltage across it. Thus a weak signal applied in the input circuit appears in the amplified form in the collector circuit. It is this way that a transistor acts as an amplifier