Name of the teacher— Mrs. Monika Sharma

Department of Physics and Electronics

Name of the course— B.Sc. (H) Physics

Semester- IV

Name of the paper—Electrical circuits and Network Skills

Paper code-32223903

Lecture timings: 10:40 to 12:40 AM

Topics to be covered:

Name of the unit: Previous year question paper

- *Solution of the questions*

[This question paper contains 2 printed pages.]

Sr. No. of Question Paper : 2144 **GC-3** **Your Roll No................**

Unique Paper Code : 32223903

Name of the Paper : Electrical Circuits and Network Skills

Name of the Course : **B.Sc. (Hons.) Physics – C.B.C.S. – Skill Enhancement Course**

Semester : III

Duration : 3 Hours Maximum Marks : 50

Instructions for Candidates

1. Write your Roll No. on the top immediately on the receipt of this question paper.
2. **All** questions carry equal marks.
3. Question No. **1** is compulsory.
4. Attempt **five** questions in all.
5. Use of Scientific Calculators is allowed.

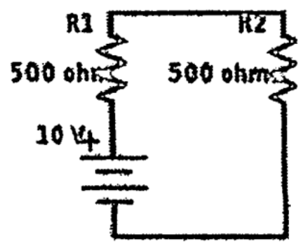
1. Attempt any **Five** :

   (i) Give one example each of electrical components which obey and disobey Ohm's Law.

   (ii) State Kirchhoff s Laws

   (iii) Define power factor. What is power factor of an ideal source ?

   (iv) Find the voltage across R1



P.T.O.

(v) Draw Electrical Symbols for a Zener Diode and a Fuse.

(vi) Define ripple factor of a Rectifier.

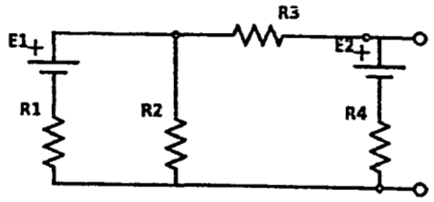
(vii) Define speed of a motor. What does the speed depends on ? (2×5)

2. (a) Explain with the help of relevant circuit diagrams, how an analog multimeter can be used as a dc voltmeter, dc ammeter and ohm meter.

(b) How can a multimeter be used to test a diode ? (8,2)

3. (a) State Thevenin's Theorem.

(b) Find the Thevenin Equivalent of the following Circuit. (2,8)



4. (a) Describe the construction and working of a dc generator. Support your answer with relevant diagrams.

(b) List the different kind of losses that occur in a dc generator. (8,2)

5. Describe the construction and working of a Bridge-Rectifier. What will be the effect of a capacitor connected in parallel with the load on the output of the bridge rectifier ? (7,3)

6. (a) Discuss the basic design and working of a single phase motor. What are the advantages of a polyphase motor ?

(b) Define the speed of an ac motor. What does it depend on ? (8,2)

7. Write a short note on any **two** of the following :

(i) Zener diode as a voltage regulator

(ii) Fuses and Surges

(iii) Relay

(iv) Conduits

(v) Ground Protection and isolated grounds (5,5)

(500)

Question 1(i)

Give one example each of electrical components which obey and disobey Ohm's Law.

Answer:

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points. Introducing the constant of proportionality, the resistance, one arrives at the usual mathematical equation that describes this relationship:

I= V/R

*Most basic **components** of **electricity** are voltage, current, and resistance. **Ohm's law** shows a simple relation between these three quantities. **Ohm's law** states that the current through a conductor between two points is directly proportional to the voltage across the two points.*

The conductors which does not obey ohm's law is called Non – Ohmic Conductors. Semi – conductors like Germanium and silicon do not obey Ohm's law. Other examples include transistor, vacuum tubes, diode and triode valve. The circuits which consists of non - ohmic conductors are known as Non – Ohmic Circuits.

Diode in forward biased condition follows Ohm's law to some extent. But on the whole diode is said to be a non ohmic device.

Question 1(ii)

(ii) State Kirchhoff s Laws

Answer:

Kirchhoff's laws are fundamental to circuit theory. They quantify how current flows through a circuit and how voltage varies around a loop in a circuit.

- ***Kirchhoff's current law (1st Law) states that current flowing into a node (or a junction) must be equal to current flowing out of it. This is a consequence of charge conservation.***

  Current flow in circuits is produced when charge carriers travel though conductors. Current is defined as the rate at which this charge is carried through the circuit. A fundamental concept in physics is that charge will always be conserved. In the context of circuits this means that, since current is the rate of flow of charge, the current flowing into a point must be the same as current flowing out of that point.

- ***Kirchhoff's voltage law (2nd Law) states that the sum of all voltages around any closed loop in a circuit must equal zero. This is a consequence of charge conservation and also conservation of energy.***

  As charge carriers flowing through a circuit pass though a component, they either gain or lose electrical energy, depending upon the component (cell or resistor for example).

*Microscopically, this is due to the fact that work is done on them by the electric forces inside the circuit components. The negative of the work done by these electric forces on a unit of charge which passes through a component is called the **potential difference**, or **voltage**, across the component. In most circuits which you'll meet, it turns out that the work done by the electric forces around any closed loop in the circuit must be zero. This means that the sum of all potential differences across the component involved in the loop must be zero. This explains why connecting both ends of a voltmeter to the same point in a circuit gives a zero reading, as expected.*

Question 1

(iii) Define power factor. What is power factor of an ideal source ?

Answer

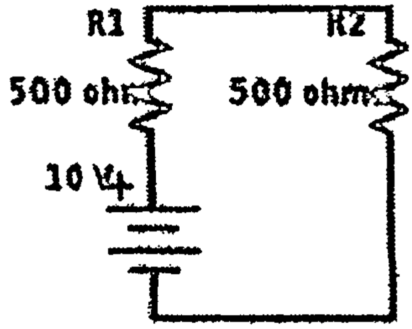
*In electrical engineering, the **power factor** (PF or cosφ) is the ratio between the **power** that can be used in electric circuit (real **power**, P) and the **power** from the result of multiplication between the current and voltage circuit (apparent **power**, S). The **power factor** is defined as: PF ranges from zero to one.*

***Power Factor** = Real **Power**/Apparent **Power**, or p.f. = W/VA. Then the cosine of the resulting angle between the current and voltage is the **power factor**. Generally **power factor** is expressed as a percentage, for example 95%, but can also be expressed as a decimal value, for example 0.95.*

*The **ideal power factor** is unity, or one. Anything less than one means that extra **power** is required to achieve the actual task at hand. All current flow causes losses both in the supply and distribution system. A load with a **power factor** of 1.0 results in the most efficient loading of the supply.*

Question 1

(iv) Find the voltage across R1



Answer:

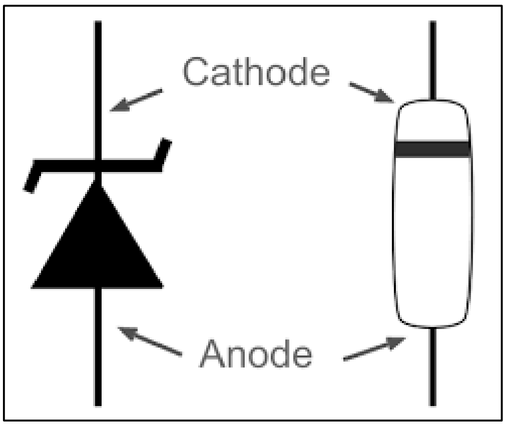
Perform yourself and verify with each other.

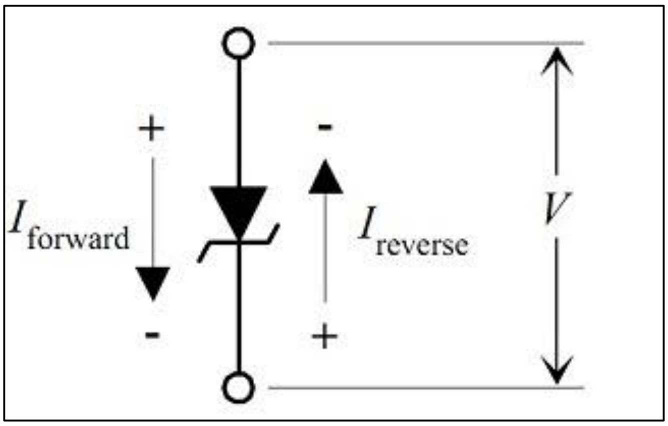
Question1

(v) Draw Electrical Symbols for a Zener Diode and a Fuse.

Answer:

*A **Zener diode** is a type of diode that allows current to flow in the conventional manner - from its anode to its cathode i.e. when the anode is positive with respect to the cathode. When the voltage across the terminals is reversed and the potential reaches the Zener voltage (or "knee"), the junction will break down and current will flow in the reverse direction - a desired characteristic. This effect is known as the Zener effect, after Clarence Zener, who first described the phenomenon. Zener diodes are manufactured with a great variety of Zener voltages (Vz) and some are even variable.*





Fuse	 Fuse Circuit Symbol	*Used in circuits where a probability of excessive current flows. The fuse will break the circuit if excessive current flows and saves the other devices from damage.*

Question 1

(vi) Define ripple factor of a Rectifier.

Ripple factor: Ripple factor is a measure of effectiveness of a rectifier circuit. It is defined as the ratio of RMS value of the AC component (ripple component) Irrms in the output waveform to the DC component VDC in the output waveform.

$$r = I_{rms}/I_{DC}$$

We can measure the value of RMS component of overall output waveform from which we can estimate the value of Irrms.

Ripple factor r =1.21 for half wave rectifier. On the other hand the effectiveness of the circuit improves in full wave rectifier. In full wave rectifier the ripple factor reduces to 0.48.

Question 1

(vii) Define speed of a motor. What does the speed depends on ?

Answer:

The speed at which an induction motor operates depends on the input power frequency and the number of electrical magnetic poles in the motor

- *the power supply frequency, and.*
- *the number of poles in the motor winding.*

The synchronous speed can be calculated as:

n = f (2 / p) 60

where

n = shaft rotation speed (rev/min, rpm)

f = frequency of electrical power supply (Hz, cycles/sec, 1/s)

p = number of poles

Question 2

(a) Explain with the help of relevant circuit diagrams, how an analog multimeter can be used as a dc voltmeter, dc ammeter and ohm meter.

Answer:

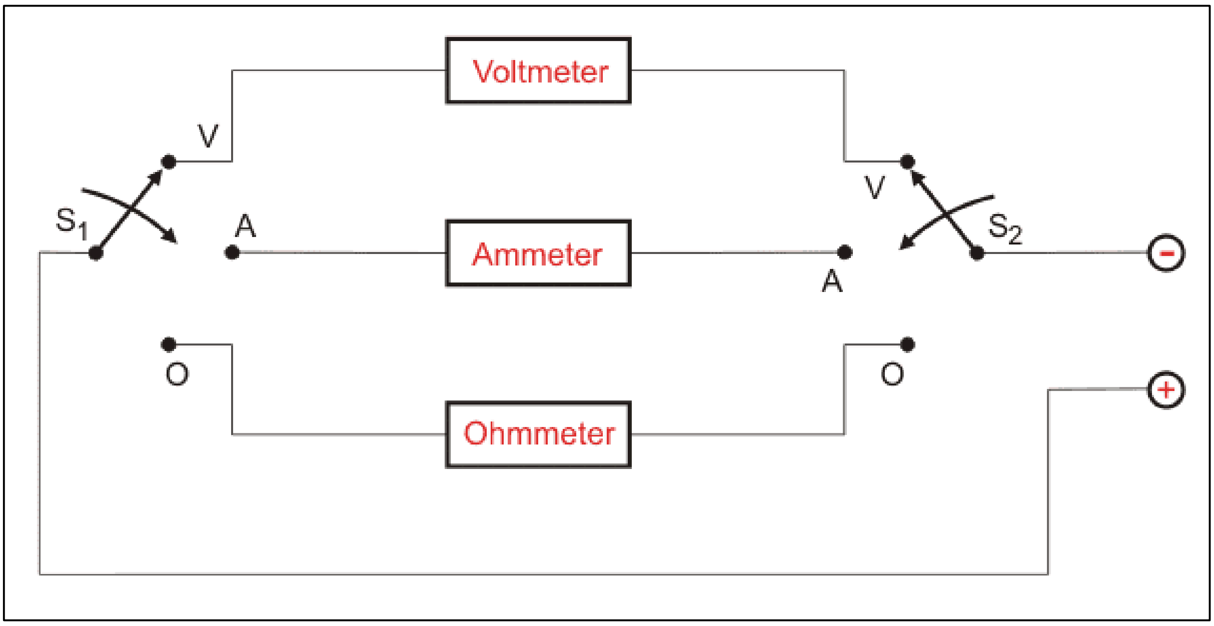
Multimeters as the name suggest the meters that we use to measure multiple quantities with the same instrument. The most basic multimeter measures voltage, current, and resistance. Since we use it for measuring current (A), voltage (V) and resistance (Ohm), we call it as AVO meter.

The meter acts as an ammeter with a low series resistance to measure direct current. For measuring high current, we connect a shunt resistor across the galvanometer so that the current through the galvanometer does not cross its maximum allowed value. Here, a significant portion of the current to be measured bypasses through the shunt. With that shunt resistance, an ***analog multimeter*** *can measure even milli-ammeter or ammeter ranges of current.*

For ***DC voltage measurement****, the primary instrument becomes a DC voltage measuring apparatus or DC voltmeter. By adding a multiplier resistance, an analog multimeter can measure the voltage from milli-volts to kilovolts, and this meter works as a millivoltmeter, a voltmeter or even as a kilo voltmeter.*

*By adding a battery and a resistance network, this instrument can work as an **ohmmeter**. We can change the range of the ohmmeter by connecting a switch to a suitable shunt resistance. By selecting different values of shunt resistance, we can obtain different scales of resistance measurement. Here below we are showing a basic block diagram of an **analog multimeter**.*

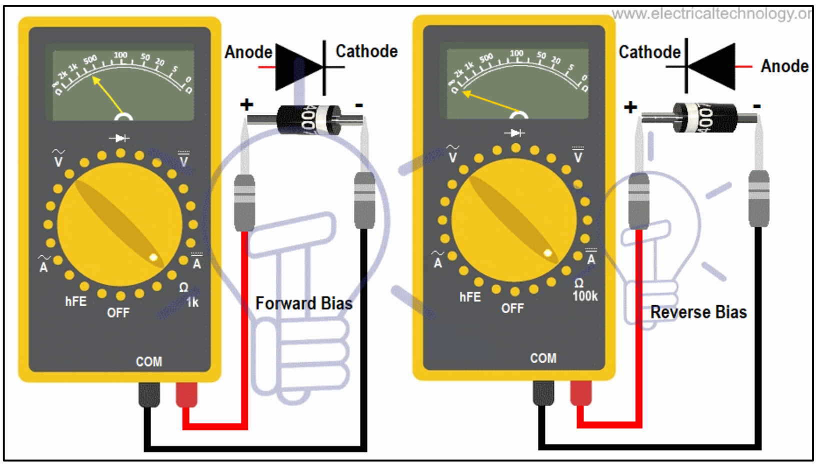
Here in the figure below, we are using two switches namely S_1 and S_2 to select the desired meter. We may use additional range-selector switches to choose particular range required in reading amperes, volts, and ohms. We use a rectifier to measure an AC voltage or current with the multimeter.



Question 2

(b) How can a multimeter be used to test a diode ?

Answer:



If "diode test is not available in case of digital multimeter or you have to test the diode with analog multimeter, Resistance mode (Ω) can be used to test the diode as alternative. To check a diode using the analog multimeter, follow these steps:

1. *Remove the diode from the circuit and make sure that power supply is disconnected from the circuit and there is no voltage across the diode which has to be tested. Also, discharge all the capacitors by shorting their leads in the circuits if any.*
2. *Set the meter on "Resistance mode (Ω)" Mode by turning the rotary switch of multimeter. For better result, set the Ω range on 1kΩ for forward bias and 100kΩ for reverse bias as shown in fig below.*
3. *Connect the RED test lead to the anode of the diode and BLACK test lead to the cathode of diode (Forward Bias) as shown in fig. Note the measurement and reading.*
4. *Now reverse the test leads i.e. RED test lead to cathode and BLACK to anode (Reverse Bias) and note the reading and measurement displayed by multimeter.*

- *If multimeter shows 1k Ω to 10 MΩ (not OL or infinite ∞), its mean the diode is in good condition (forward-biased). Mostly, the best value is below 1kΩ i.e. for good diode, the forward bias resistance should be low.*
- *If multimeter shows "OL" in reverse biased. The diode is good as well.*
- *If the multimeter displays same reading and measurement in both directions (i.e. forward biased and reverse bias), its mean diode is bad and need to be replaced accordingly.*
- *If multimeter shows the same results i.e. low resistance or high resistance (OL) in both direction (forward and reverse bias), the diode is short and open respectively. In other words, if the multimeter shows 0Ω resistance in both reverse and forward bias, the diode is short, if ohmmeter shows ∞, OL or very high resistance in both forward and reverse bias, the diode is open and need to be replaced with new one.*
- *To make sure the result is accurate, the best practice is that test and compare the result of good diodes in Resistance Mode.*