Conductors, insulators and conductivity essay sample

Conduction of electricity in electric circuits takes place due to the presence of excess electrons in materials called conductors. Electrons move in the direction in which the potential has been applied. The ability of a conductor to conduct electricity is directly proportional to the material’s area of cross section and inversely proportional to its length.

Where, G is conductance

σ is conductivity

A is area of cross section

is length of conductor

Insulators are materials which have very low conductivity as a result they are unable to conduct electricity.

The conductivity of conductors (usually metals) is very high and the conductivity of insulators is very low.

SEMICONDUCTORS

A semiconductor has electrical conductivity intermediate to that of a conductor and an insulator. Semiconductors differ from metals in their characteristic property of decreasing electrical resistivity with increasing temperature. The comprehensive theory of semiconductors relies on the principles of motion of electrons through a lattice of atoms. Current conduction in a semiconductor occurs via mobile or free electrons and holes, collectively known as charge carriers. Certain pure elements found in Group IV of the periodic table are semiconductors. The most commercially important of these elements are silicon and germanium. Semiconductor materials are useful because their behaviour can be manipulated by the addition of impurities, known as doping . Doping a semiconductor with a small amount of impurity atoms greatly increases the number of charge carriers within it. When a doped semiconductor contains excess holes it is called “ p-type”, and when it contains excess free electrons it is known as “ n-type”.

Germanium, gallium arsenide, and silicon carbide are common dopants. A pure semiconductor is often called an “ intrinsic” semiconductor. The electronic properties and the conductivity of a semiconductor can be changed in a controlled manner by adding very small quantities of other elements to the intrinsic material. This is typically achieved in crystalline silicon by adding impurities of boron or phosphorus to the melt and then allowing it to solidify into the crystal and the semiconductor is termed “ extrinsic”.

PHOTOCONDUCTIVITY

Photoconductivity is an optical and electrical phenomenon in which a material becomes more electrically conductive due to the absorption of electromagnetic radiation such as visible light, ultraviolet light, infrared light or gamma radiations. Band gap refers to the energy difference between the top of the valence band and the bottom of the conduction band; electrons are able to jump from one band to another. To cause excitation, the light that strikes the semiconductor must have enough energy to raise electrons across the band gap, or to excite the impurities within the band gap. When light is absorbed by a material such as a semiconductor, the number of free electrons and electron holes changes and raises its electrical conductivity.

LIGHT DEPENDENT RESISTOR

A photo resistor or light dependent resistor (LDR) is a resistor whose resistance decreases with increasing incident light intensity; in other words, it exhibits photoconductivity A photo resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

DIODE

A diode is a two-terminal electronic component with an asymmetric transfer characteristic, with low (ideally zero) resistance to current flow in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p-n junction connected to two electrical terminals.

The most common function of a diode is to allow an electric current to pass in one direction (called the diode’s forward direction), while blocking current in the opposite direction (the reverse direction). This unidirectional behaviour is called rectification.

FACT: Diodes were the first semiconductor electronic devices in 1874.

LIGHT EMMITING DIODES

A light-emitting diode (LED) is a semiconductor light source.

Working Mechanism:

When a light-emitting diode is forward-biased (switched on), electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the colour of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor.

Bread board

Breadboard (protoboard) is a construction base for prototyping of electronics. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. A

-VE

+ve

B

Here,

RED- Positive terminal

Black- Negative terminal

Orange- Positive terminal of components

Blue- Negative terminal of components

Green- Path of current

Connection A; represents a series connection of both components present.

Connection B; represents a parallel connection of both components present.

AIM:- The aim of this activity is to derive the relationship between current in the circuit with respect to the distance of the LDR from the source of light.

Requirements:-

1. Bread Board
2. Batteries (volts)
3. Battery Holder
4. LDR (Light dependent resitor)
5. LED (Light emitting diodes)
6. Resistors
7. Connecting wires
8. Voltmeter
9. Ammeter

Circuit Diagram

PROCEDURE

1. The following connections shown in the circuit diagram are made on the break board. 2. Different value of current and potential difference are calculated across the components in the presence and absence of light. 3. A source of light is kept at different distances from the LRD and the current in the circuit is noted. NOTE: The experiment should be conducted in a dark room so that there are no errors due to other sources of light.

OBSERVATIONS:

In Presence of light:

Potential drop (potential difference)-

Across LED = VLED = 1. 74 volts

Across resistor = Vresistor = 4 volts

Across LDR = VLDR = 3. 65 volts

Current in circuit = 0. 63 mA

Resistance = Potential DifferenceCurrent

∴, RLED = 1. 74 x 103/ 0. 63 = 2761Ω

RRESISTOR= 4 x 103/0. 63 = 6349Ω

RLDR = 3. 65 x 103/0. 63 = 5793Ω

In Absence of Light

Potential drop (potential difference)-

Across LED = VLED = 0. 05 volts

Across resistor = Vresistor = 1. 5 volts

Across LDR = VLDR = 7. 8 volts

Current in circuit = 0. 01 mA

Resistance = Potential DifferenceCurrent

∴, RLDR = 7. 8x 103/0. 1 = 7800 Ω

With Only One source of light

Distance of source from LDR| Current in circuit (in μA)| 10 cm| 0. 46|

15cm| 0. 29|

20 cm| 0. 20|

25 cm| 0. 12|

30 cm| 0. 10|

35 cm| 0. 07|

40 cm| 0. 01|

45 cm| 0. 0|

Distance from Source of light

Current (μA)

RESULT

1. As the source of light is taken away from the LRD the intensity of light of the LED keeps on depleting. 2. As source of light is taken away from the LDR the potential drop across the LDR keeps on increasing and starts decreasing across the LED and resistor. 3. As source of light is taken away from the LDR the electric current keeps on decreasing in the circuit.

USES OF LRDS

Street Lights

Automatic street lights can easily be made using a simple LED and LDR. LED LDR

At day; the resistance of LRD tends to 0. As a result the potential difference across the LED is zero , hence no current will pass through it.

At night; the resistance of the LRD increases, hence there will be less resistance in the LED branch. As a result more current passes though it, producing light.

A resistance has also been added as to reduce the potential difference between the LED hence prevent it from fusing.