CHARACTERISTICS STUDY OF LIGHT DEPENDENT RESISTORS AND ITS APPLICATIONS AS SENSORS

PROJECT REPORT

Submitted by

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B.Sc. PHYSICS

PROJECT REPORT

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This is to certify that this project work entitled 'CHARACTERISTIC STUDY OF LIGHT DEPENDENT RESISTORS AND ITS APPLICATIONS AS SENSORS' is an authentic work done by NANDANA S.

Dr.PriyaParvathiAmeena Jose

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Submitted for the external examination held at St Teresa's College(Autonomous),Ernakulam.

Date : 04/5/22

Examiner:

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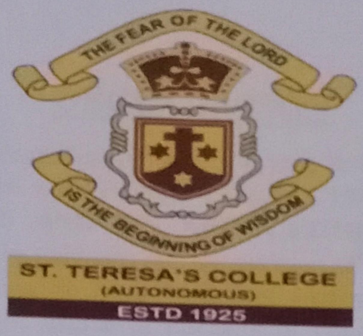


CERTIFICATE

This is to certify that the project report entitled '**CHARACTERISTIC STUDY OF LIGHT DEPENDENT RESISTORS AND ITS APPLICATION AS SENSORS**' is an authentic work done by **NANDANA S**, Register Number **AB19PHY020**, St Teresa's College, Ernakulam, under my supervision at Department of Physics, St Teresa's college for the partial requirements for the award of Degree of Bachelor of Science in Physics during the academic year 2021-2022 .The work presented in this dissertation has not been submitted for any other degree in this or any other university .

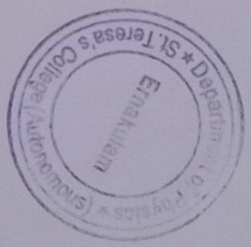
Dr.PriyaParvathiAmeena Jose

Head of Department

Supervising Guide

Date :04-05-2022

Place : ERNAKULAM



DECLARATION

I, final year B.Sc. Physics student, Department of Physics, St Teresa's college, Ernakulam, do hereby declare that the project work entitled **'CHARACTERISTIC STUDY OF LIGHT DEPENDENT RESISTORS AND ITS APPLICATION AS SENSORS'** has been originally carried out under the guidance and supervision of Dr. Priya Parvathi Ameena Jose, Head of department of Physics, St Teresa's College (Autonomous), Ernakulam in partial fulfilment for the award of the degree of Bachelor of Physics. I further declare that this project is not partially or wholly submitted for any other purpose and the data included in the project is collected from various sources and are true to the best of my knowledge.

Date : 04-05-2022

Place: ERNAKULAM

ACKNOWLEDGEMENT

I would like to thank God Almighty for enriching our minds with knowledge and leading us along the project. I express a deep sense of gratitude to my project guide, Dr. Priya Parvathi Ameena Jose, H.O.D, Department of Physics, for providing able support and guidance.

I also express my sincere thanks to Rev. Sr. Dr. Vinitha CSST, Provincial Superior & Manager, Rev. Sr. Emeline, Director and Dr. Lizzy Matthew, Principal for their support and encouragement.

I would also like to thank all the faculty members, lab assistants and non-teaching staff for their help and co-operation throughout my work. And last but not least, I would like to thank my team members for their hard work and support.

ABSTRACT

The basic characteristics of the passive component- LIGHT DEPENDENT RESISTOR (LDR) is analysed in this project. V-I characteristics and distance-resistance relation of LDR using red LED is studied graphically. Two applications using LDR such as electronic eye-controlled security system and Automatic Street light control system were designed and constructed.

INDEX

1) INTRODUCTION

1.1) PHOTOCONDUCTIVITY

The increase in the electrical conductivity of certain materials when they are exposed to light of sufficient energy is known as photoconductivity. Photoconductivity serves as a tool to understand the internal process in these materials.

Certain crystalline semiconductors, such Silicon, Germanium, Lead Sulphide and Cadmium Sulphide and the related semimetal Selenium are strongly photoconductive. Normally semiconductors are relatively poor electrical conductors because they have only a small number of electrons that are free to move under a voltage. Most of the electrons are bound to their atomic lattice in the set of energy states called the valence band. But if external energy is provided, some electrons are raised to the conduction band, where they can move and carry current. Photoconductivity ensures when the material is bombarded with photons of sufficient energy to raise electrons across the band gap, a forbidden region between the valence and conduction bands. This is shown in the figure 1.1.1. In Cadmium Sulphide energy gap is 2.42 eV, corresponding to a photon of wavelength 512 nm, which is visible green light. In Lead Sulphide, the energy gap is 0.41 eV, making this material sensitive to infrared light.

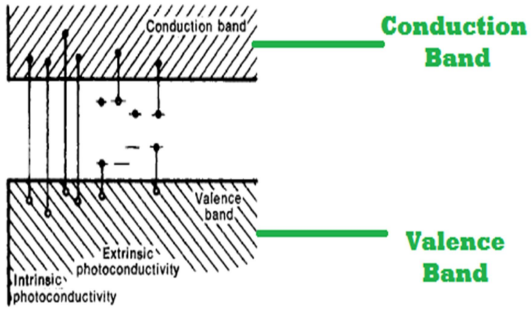


FIGURE 1.1.1) ENERGY BAND DIAGRAM

Because the current ceases when the light is removed, photoconductive materials form the basis of light controlled electrical switches. These materials are used to detect infrared radiation in military application as guiding missiles to heat producing targets.

1.2) PHOTO CELLS

A photocell is a light-sensitive module, which works on the principle of photoconductivity. It is a kind of resistor, which can be used to change its resistive value based on the light intensity. These are inexpensive, simple to obtain in numerous sizes as well as in specifications. In the dark, this photocell has a resistance of approximately 500 kΩ, and in bright light the resistance drops to approximately 10 kΩ.
Photovoltaic cell, photoresistors, charge –coupled devices, golay cells etc are examples of photocells.

Photocells are used in automatic lights to activate whenever it gets dark, and the activation/deactivation of streetlights. These are also used as timers in a running race to calculate the runner's speed, to count the vehicles on the road, in burglar alarms. They are

also used in exposure meters (which can be used with a camera for knowing the correct time of exposure to get a good photo). They acts as switches as well as sensors.

Let's concentrate more on PHOTORESISTORS.

1.3) LIGHT DEPENDENT RESISTORS(LDR)

Light Dependent Resistors, also known as photoresistors or photoconductive cells works on the principle of Photoconductivity. Photoresistors are made from semiconductor materials whose resistance changes when illuminated with light energy. Such materials (also known as photo-conductors) are Cadmium Sulphide (CdS), Cadmium Selenium (CdSe) and Lead Sulphide (PbS). The figure 1.3.1 shows a commonly used CdS cell. When these materials are exposed to light, the covalent bonds are broken. This produces charge carriers.

The amount of illumination on the surface of the material determines the number of electron-hole pairs generated in the material. This in turn determines the resistance of the Photoconductive cells. The greater the amount of light falling on the surface (called surface illumination), greater will be the number of electron-hole pairs generated and therefore lower will be the value of resistance of the material. The lower the amount of light falling on the surface, higher will be the value of resistance of the material. Thus, the resistance of the semiconductor varies inversely with the intensity of light.

When the device is kept in darkness, its resistance is called Dark Resistance. When light falls on it, its resistance decreases up to several kilo ohms or even hundreds of ohms, depending on the intensity of light falling on it.

The construction of the LDR consists of light sensitive material deposited on an insulating substrate like a ceramic. To get the desired resistance and power rating, the metal is deposited in the pattern of a zigzag. This pattern separates the metal deposited areas into two regions and on both sides of the pattern the Ohmic contact is prepared. The symbol of an LDR is given in the figure 1.3.2.

FIGURE 1.3.1) CdS LDR

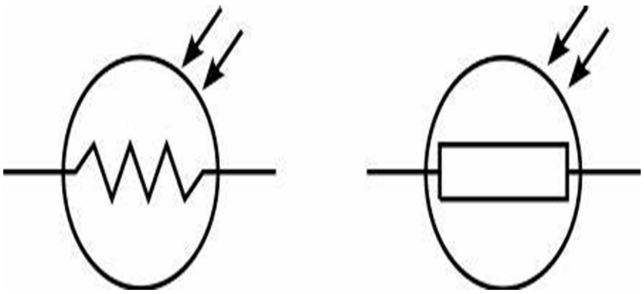


FIGURE 1.3.2) SYMBOL OF LDR

2) EXPERIMENT DETAILS

2.1 V-I CHARACTERISTICS OF LDR WITH RED LED

CIRCUIT DIAGRAM

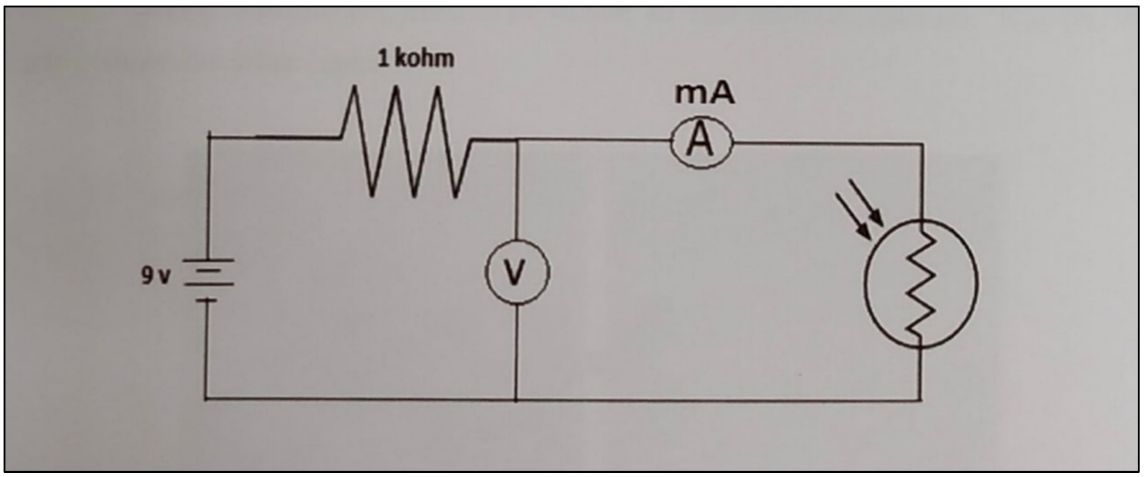


FIGURE 2.1.1

CIRCUIT COMPONENTS

- Light Dependent Resistor
- Connection Wires
- Red light
- Meter Scale
- Battery 9V
- Multimeter
- Bread Board

PROCEDURE

Connections are made as shown in the circuit diagram in figure 2.1.1. Set red LED at distances 1cm, 2 cm etc using a meter scale mount on a holder. Switch on the circuit and turn on the red light so that the light falls on the LDR. Measure corresponding current and voltage using multimeter and note down in the tabular column.

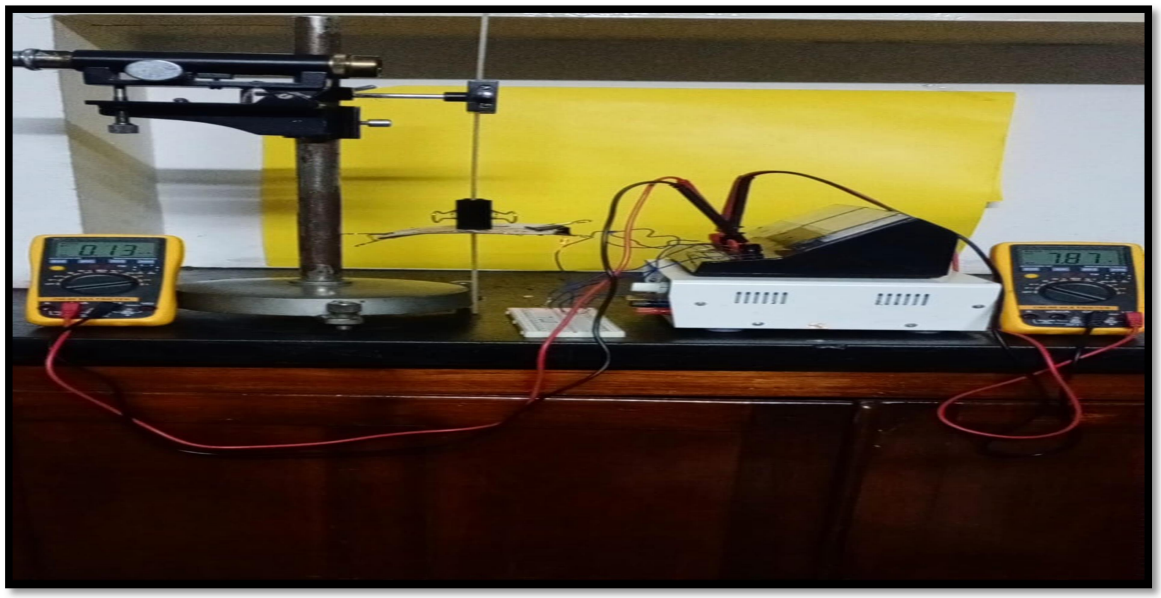


FIGURE 2.1.2) EXPERIMENTAL SETUP

OBSERVATIONS

Measurements for V-I characteristics of LDR using red LED

Distance[cm]	Voltage[volt]	Current[mA]
4	6.37	0.61
5	6.88	0.44
6	6.98	0.40
7	7.40	0.28
8	7.65	0.20
9	7.72	0.18
10	7.79	0.16
11	7.93	0.11
12	8.00	0.08
13	8.10	0.06
14	8.10	0.06
15	8.15	0.05
20	8.20	0.03
25	8.23	0.02
30	8.26	0.01

V-I CHARACTERISTICS OF LDR USING RED LIGHT

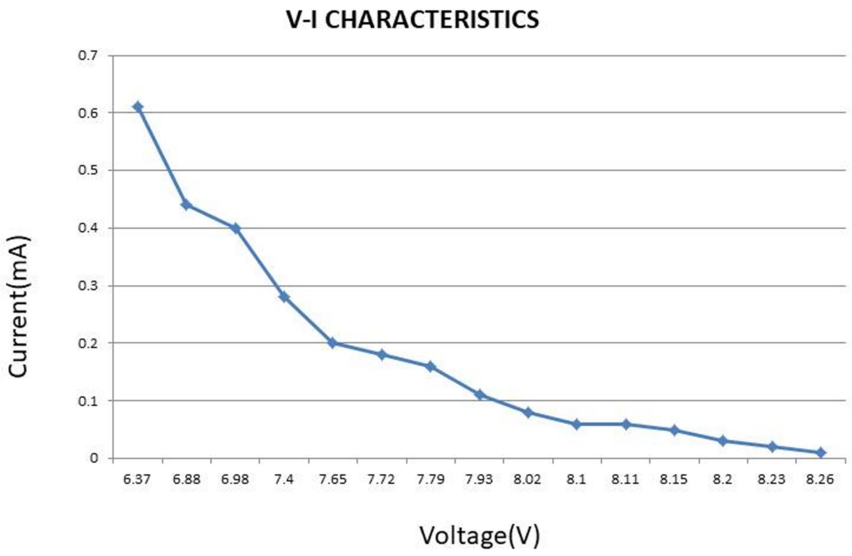


FIGURE 2.1.3

INFERENCES

From current vs voltage graph

a) Current varies across LDR for red light from various distances.

b) There is a decrease in current as distance of the light source increases.

2.2) STUDY OF RESISTANCE ACROSS THE LDR

- For red light with change in distance of the light source.

CIRCUIT COMPONENTS

- Bread Board
- Meter Scale
- Red Light
- Multimeter

PROCEDURE

Connect the LDR in bread board. Meter scale is mount on a holder. Red light is kept at distances 1 cm ,2 cm, etc. Corresponding resistances across LDR is noted using a multimeter.

OBSERVATIONS

Measurements for distances vs resistance graph of LDR using RED LIGHT.

DISTANCE (cm)	RESISTANCE (Kilo ohm)
4	10.44
5	15.63
6	17.45
7	26.42
8	38.25
9	42.88
10	48.68
11	72.09
12	100.25
13	135
14	135.16
15	163
20	273.33
25	411.5
30	826

DISTANCE Vs RESISTANCE GRAPH OF LDR USING RED LIGHT

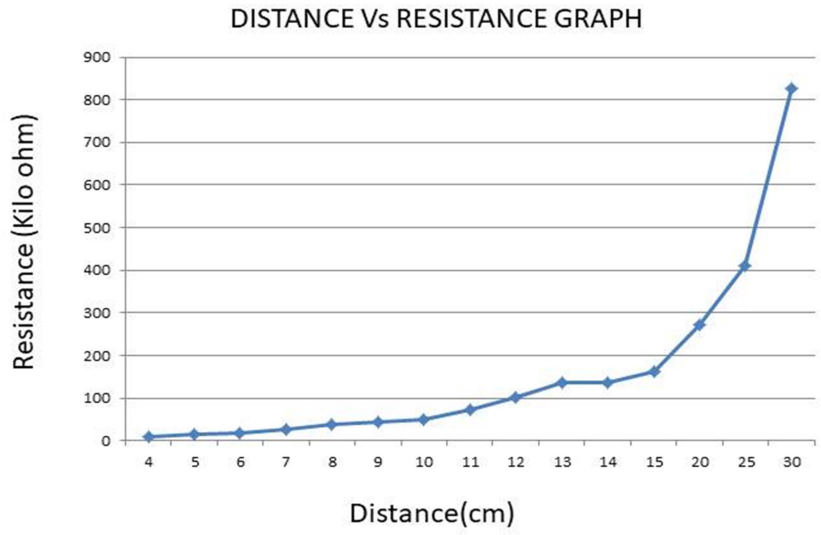


FIGURE 2.2.1

INFERENCE

- LDR resistance increases with increase in distance.
- LDR resistance increases with decrease in intensity of light.

2.3) DEMONSTRATION OF LIGHT SENSITIVITY OF LDR

The circuit is set up as shown in figure 2.3.1. The output terminals are connected to a Digital Storage Oscilloscope (DSO). The digital storage oscilloscope is defined as the oscilloscope which stores and analysis the signal digitally, i.e., in the form of 1 or 0 preferably storing them as analogue signals. The digital oscilloscope takes an input signal, store them and then display it on the screen. The digital oscilloscope has advanced features of storage, triggering and measurements. Also, it displays the signal visually as well as numerically. The LDR is exposed to red, and pulsed light and corresponding waveforms are observed.

CIRCUIT DIAGRAM

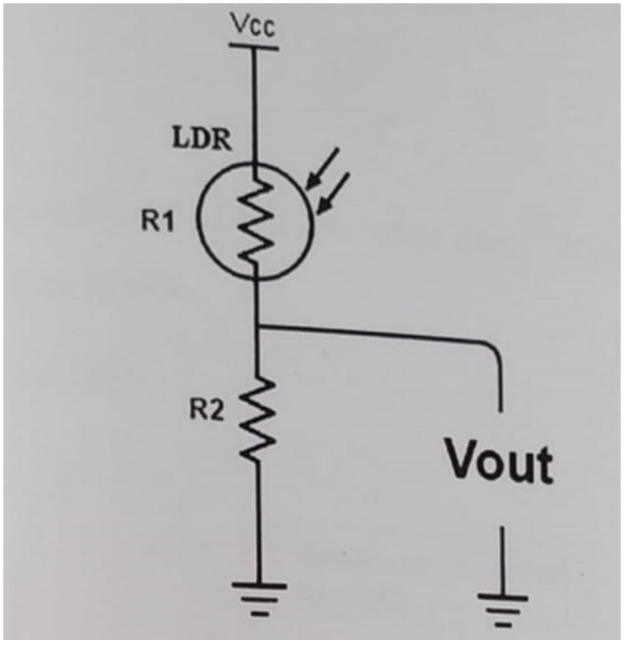


FIGURE 2.3.1

OBSERVATIONS

In the presence of RED LIGHT,

Intensity Vs Time period

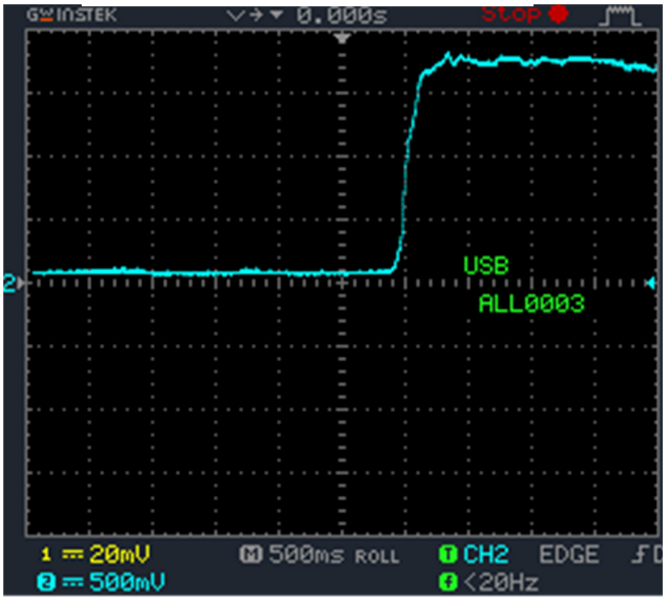


FIGURE 2.3.2

In the presence of pulsated light,

Intensity Vs Time period

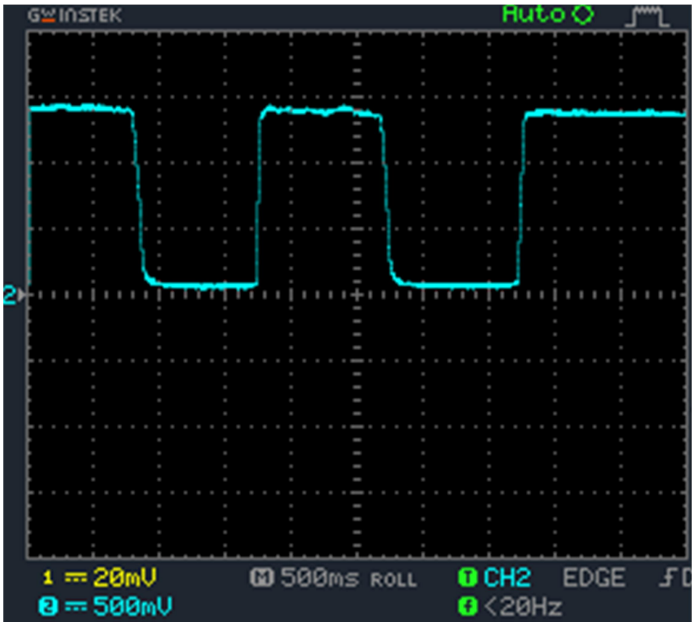


FIGURE 2.3.3

INFERENCE

- Intensity increases and stays at a peak value when LED light shines on the LDR.
- Intensity becomes zero when LED does not shine on the LDR.
- This pattern repeats for pulsated light i.e., repeatedly turning the LED on and off for varying intensities.

3) APPLICATION

There are many applications for LDR. Electronic eye-controlled security system, automatic street light control system, emergency light, control relay etc can be constructed using LDR. Here, we construct and explain the first two.

3.1) ELECTRONIC EYE CONTROLLED SECURITY SYSTEM

This is a home security application. Electronics eye controlled security system has LDR as the main sensor. It is a magic eye. As the automation is an emerging technology these days, we have a door bell that automatically rings when a person visits our home. This also provides security when any person is trying to enter the house without our permission.

PRINCIPLE

The main principle of the circuit is to ring the doorbell when there is any person at the entrance. In order to detect a person, an LDR is used as the sensor. Light on the LDR determines whether a person is present or not. When there is any object at the entrance. LDR is in dark and buzzer starts ringing and the LED starts glowing.

CIRCUIT DIAGRAM

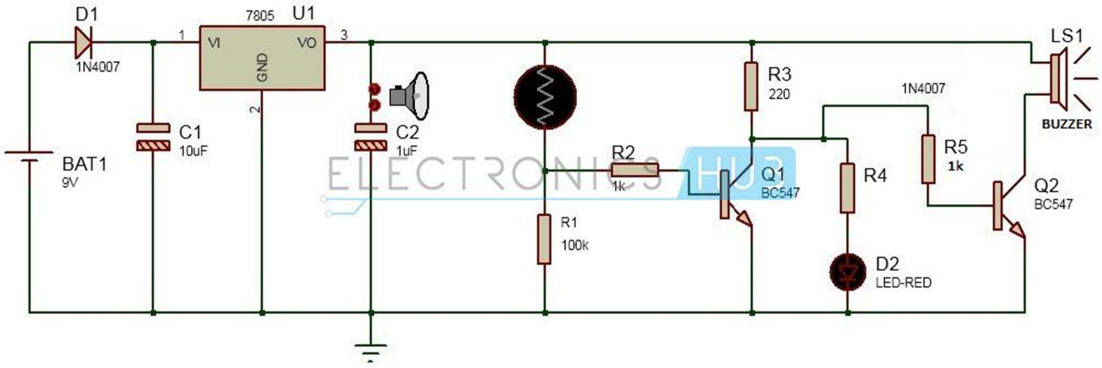


FIGURE 3.1.1

CIRCUIT COMPONENTS

- 7805 Regulator
- Resistors -220 ohm x 2, 1K ohm x 2,100K ohm
- IN4007 PN Diode
- Capacitors – 1 micro F,10 micro F
- Transistors –BC 547 x 2
- Light Dependent Resistor (LDR)
- Buzzer
- LED
- Bread Board
- Connecting Wires
- 9V Battery

DESIGN

This circuit can be divided into two parts. One is the power supply and the other is the logic circuit. In the power supply circuit, a 9 V supply from a battery is converted to the 5V. The logic circuit operates the buzzer and an LED when any shadow falls on the LDR.

DESIGN OF POWER SUPPLY

Power supply circuits consists of battery, diode, regulator and capacitors. Initially a 9V battery is connected to the diode. Diode used here is a simple PN junction diode of IN4007 series. In this circuit, IN4007 is connected in the forward bias condition.

The main purpose of the diode in this circuit is to protect the circuit from reverse polarity i.e., to protect the circuit if by any chance the battery is connected in reverse polarity. So, the PN junction diode connected in the forward bias allows the current to flow only on one direction and thus the circuit can be protected. There is some voltage drop across the diode.

A regulator is used for regulating the output voltage of the circuit. The regulator IC used here is 7805. 78 represent the series and 05 represent the output voltage. Thus, a voltage of 5V is produced at the output of the regulator. Two capacitors are used before and after the regulator. These two capacitors eliminate the ripples. Thus, a constant voltage is produced at the output of the regulator, which is applied to the logic circuit.

DESIGN LOGIC CIRCUIT

The logic circuit mainly consists of Light Dependent Resistor, Transistors, a Buzzer, an LED and a few passive components. A 100K ohm resistor is connected in series to the LDR in a voltage divider fashion.

LDR will have resistance in mega ohms when it is placed in the dark. This resistance value will decrease gradually when it is placed in the light, thus, there is a variation in the series resistances.

If the LDR is in dark it has a high resistance and produced the logic high value at the output whereas in the light the resistance value of the LDR decreases which causes a logic low voltage.

The output of the voltage divider is fed to a transistor which inverts the input from the LDR. The second transistor drives the buzzer. The diode is placed for protection.

We have used a 5V magnetic buzzer. It has two pins at the output. One pin is connected to the supply and the other to the collector of the second transistor. LED is used for indication only. When the output from first transistor is high, the buzzer rings. LED is also turned on.

WORKING

Initially, the circuit is connected as in the figure 3.1.1 on a bread board. Using a battery, a 9V power supply is given. LDR is placed in light. We can observe that no sound is produced from the buzzer. Place the LDR and the buzzer starts making sound. Also, the LED glows. As the intensity of light falling on the LDR increases sound produced by the buzzer decreases.

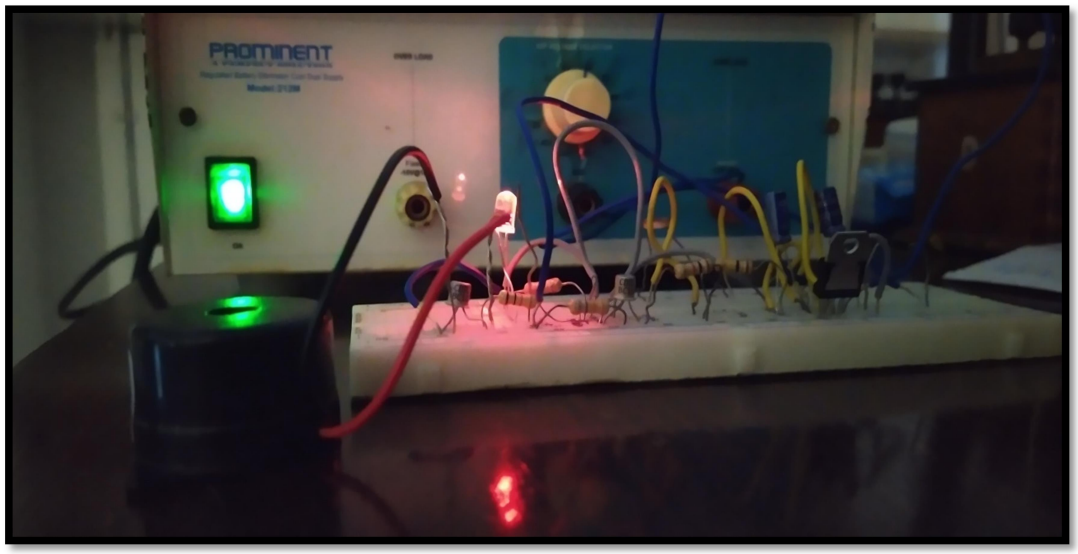


FIGURE 3.1.2) EXPERIMENTAL SETUP

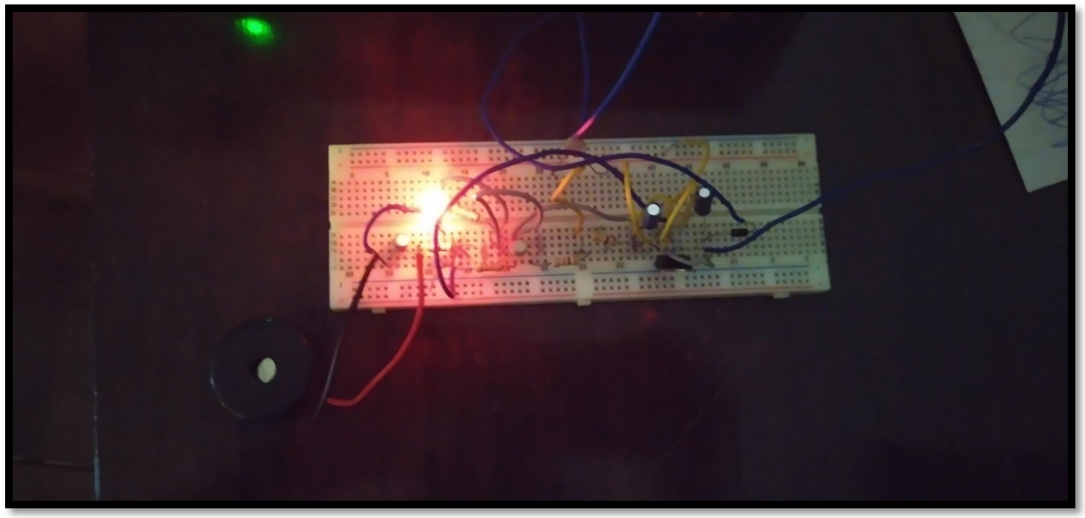


FIGURE 3.1.3) CIRCUIT WHEN LIGHT IS OFF – THE BUZZER RINGS

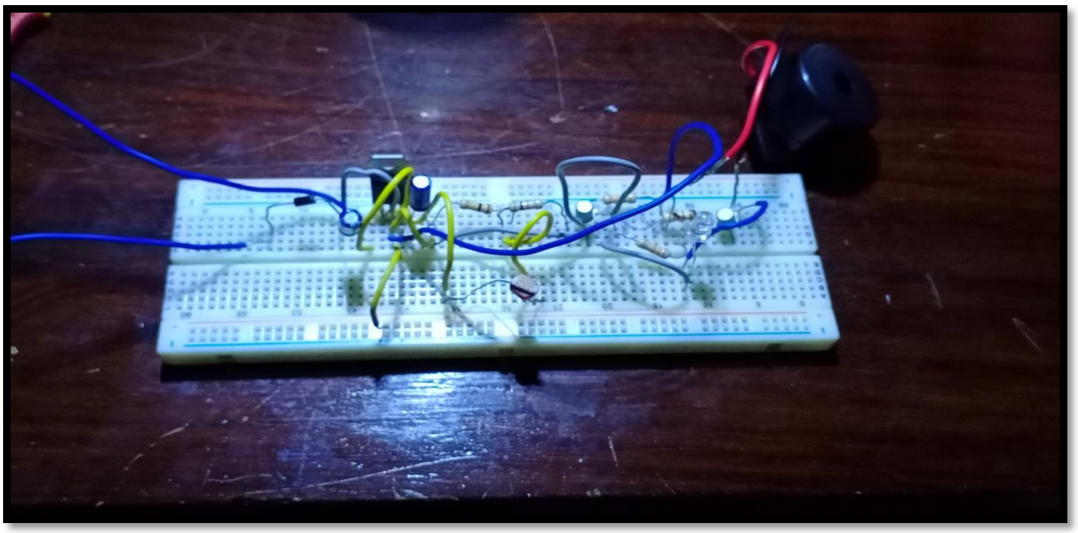


FIGURE 3.1.4) CIRCUIT WHEN LIGHT IS ON – THE BUZZER STOPS RINGING

Electronic eye can be used in security applications. It is used in doorbell applications.

3.2) AUTOMATIC STREET LIGHT CONTROL SYSTEM

We often see street lights remaining on even after sunrise. By using this Automatic system for street light controlling, we can reduce energy consumption because the manually operated streetlight are not switched off properly even after the sunlight comes and also not switched on earlier before sunset.

Also, in rainy days ON and OFF time differ noticeably which is one of the major disadvantages of using timer circuits or manual operations for switching the street light system.

This Automatic Street light control system is a simple and powerful concept which uses transistor as a switch to switch ON and OFF the street light system automatically, by using LDR as the sensor which senses the light just like our eyes.

CIRCUIT DIAGRAM

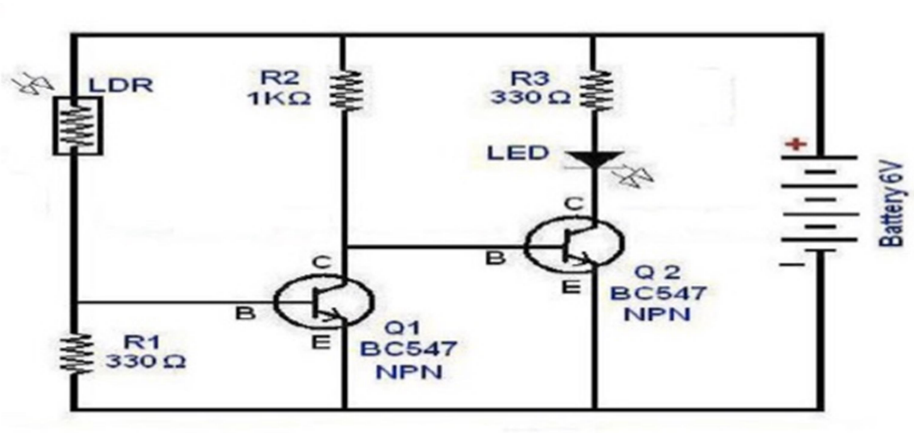


FIGURE 3.2.1

CIRCUIT COMPONENTS

- LDR
- Transistor –BC547 X 2
- Resistors -1K ohm,330 ohm,470 ohm
- Light Emitting Diode (LED)
- Connecting Wires
- 9V Battery

WORKING

The circuit is made as shown in the figure 3.2.1 Connect a 9V battery. As we block the Light Falling on LDR, the LDR glows.

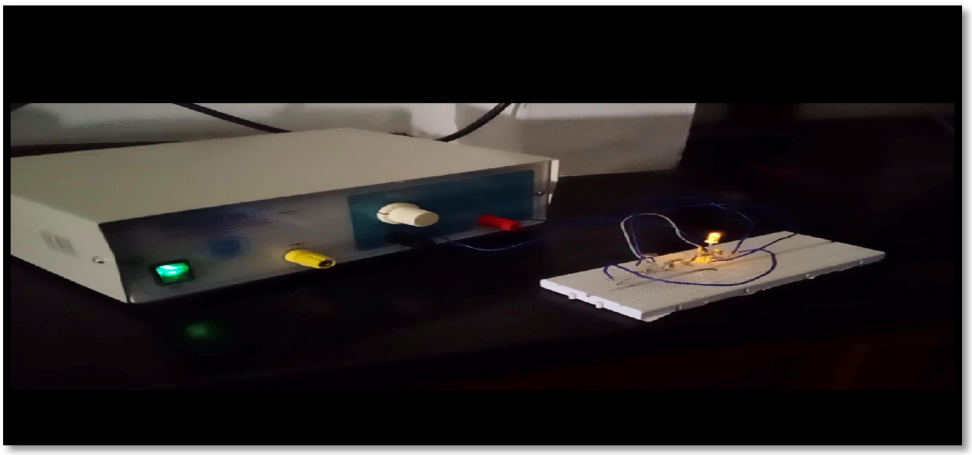


FIGURE 3.2.2) THE LED GLOWS WHEN THE LIGHT GOES OFF

Automatic street light control system automatically switches on lights when the sunlight goes below the visible region of our eyes. (i.e., In evening after sunset). It also switches OFF lights when sunlight falls on it (i.e., In the morning).

4) CONCLUSION

- Sensor is constructed using Light Dependent Resistors(LDR). The basic characteristics of this passive component were analysed. This includes

    a) V-I characteristics of LDR using RED LIGHT .
    The V-I characteristics of LDR shows that there is a decrease in current as distance of light source increases .
    b) Study of the resistance across LDR.
    It was found that LDR resistance increase with increase in distance, Also, LDR resistance increase with decrease in intensity of light .

- Light sensitivity of LDR was also demonstrated using DSO .
- The spectral response of a CdS (Cadmium Sulphide Cells) cell closely matches that of human eye. Hence it is often used in applications where human vision is a factor such as street light control. Light sensors which use LDR as the main light sensing component were constructed.
- LDR can also be used along with an LED and a resistor to construct an emergency light. When power fails, the LED glows.
- Control relays can be constructed with LDR, transistor and resistor. The relay gets turned ON in the darkness.

5) REFERENCES

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