A STUDY OF CHARACTERISTICS OF LIGHT DEPENDENT RESISTOR AND IT'S APPLICATIONS

PROJECT REPORT

Submitted by

Pratheeksha P

Register number: AB21PHY034

Under the guidence of

Dr. Priya Parvathi Ameena Jose

Assistant Professor,

St. Teresa's College (Autonomous),

Ernakulam, Kochi-682011

Submitted to

Mahatma Gandhi University, Kottayam

In partial fulfillment of the requirements for the Award of

BACHELOR DEGREE OF SCIENCE IN PHYSICS

DEPARTMENT OF PHYSICS

ST. TERESA'S COLLEGE (AUTONOMOUS)

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ERNAKULAM

B.Sc PHYSICS

PROJECT REPORT

Name :PRATHEEKSHA P

Register Number :AB21PHY034

Year of Work :2023-2024

This is to certify that this project work entitled **'A STUDY OF CHARACTERISTICS OF LIGHT DEPENDENT RESISTOR AND IT'S APPLICATIONS'** is an authentic work done by PRATHEEKSHA P.

Department of Physics • St. Teresa's College (Autonomous) • Ernakulam

Dr.PRIYA PARVATHI AMEENA JOSE
Staff member in-charge

Dr.PRIYA PARVATHI AMEENA JOSE
Head of the Department

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

DATE: 30/04/2024

EXAMINERS:

Mary Linta L S

2

ST. TERESA’S COLLEGE (AUTONOMOUS)

ERNAKULAM

CERTIFICATE

This is to certify that the project report entitled ‘**A STUDY OF CHARACTERISTICS OF LIGHT DEPENDENT RESISTOR AND IT’S APPLICATIONS**’ is an authentic work done by **PRATHEEKSHA P**, Register Number **AB21PHY034**, 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 2023-2024. The work presented in this dissertation has not been submitted for any other degree in this or any other university.

Dr. PRIYA PARVATHI AMEENA JOSE

Assistant Professor

Supervising Guide

Dr.PRIYA PARVATHI AMEENA JOSE

Assistant Professor

Head of the Department

Place: Ernakulam

Date 30/04/2024

DECLARATION

I, **PRATHEEKSHA P**, Final year B.sc. Physics student, Department of Physics, St.Teresa's College, Ernakulam do hereby declare that the project work entitled '**A STUDY OF THE CHARACTERISTICS OF LIGHT DEPENDENT RESISTOR AND IT'S APPLICATION'** has been originally carried out under the guidance and supervision of Dr. PRIYA PARVATHI AMEENA JOSE, Assistant Professor, Department of Physics, St. Teresa's College(Autonomous), Ernakulam in partial fulfillment 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.

Place : Ernakulam

Date :30/04/2024

ACKNOWLEDGEMENT

I would like to thank God Almighty for enriching our minds with knowledge and leading all along the project. It gives me immense pleasure to express deep sense of gratitude to my project guide, Dr. Priya Parvathi Ameena Jose, Assistant Professor, Department of Physics ,for providing able support and guidance.

I also express my sincere thanks to Dr. Sr. Vineetha CSST, Manager, Dr. Alphonsa Vijaya Joseph, Principal, Dr. Priya Parvathi Ameena Jose, Head of the Department of Physics for providing all support and help throughout my project work, which has enabled me to enrich my knowledge.

I would like to thank all the faculty members and non-teaching for their co-operation throughout my work.

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 different light sources are studied graphically. Three applications using LDR such as electronic eye-controlled security system, automatic street light control system and laser security system were designed and constructed.

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1.INTRODUCTION

1.1 PHOTOCONDUCTIVITY

Photoconductivity is an optical and electrical phenomenon in which a material become more electrically conductive due to the absorption of electromagnetic radiation such as visible light, ultraviolet light, infrared light, or gamma radiations. It is the effect of increasing electrical conductivity in a solid due to light absorption.

Certain crystalline semiconductors, such as Silicon, Germanium, Lead Sulphide and Cadmium Sulphide and the related semi-metal 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. 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. To cause excitation, the light that strikes the semiconductor must have enough energy to raise electrons across the band gap. When a photoconductive material is connected as part of a circuit, it functions as a resistor whose resistance depends on the light intensity. In this context the material is called a photoresistor.

1.2 LIGHT DEPENDENT RESISTOR

Light dependent resistors, also known as photoresistors or photoconductive cells works on the principal of Photoconductivity. Photoconductivity refers to the phenomenon where the electrical conductivity of a material increases upon exposure to light. In materials exhibiting Light photoconductivity, incident photons with sufficient energy can generate electron-hole pairs, creating additional charge carriers. These carriers contribute to an increase in the material's conductivity, allowing it to conduct electricity more effectively.

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 Selenide (CdSe) and Lead Sulphide (PbS). The figure 1 below 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 photo-conductive 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 an LDR includes a light-sensitive material that is placed on an insulating substrate like ceramic. The material is placed in a zigzag shape in order to get the required power rating and resistance. The area of zigzag separates the metal-placed areas into two regions. Where the Ohmic contacts are made either on the sides of the area. The resistances of the contacts must be as less as possible to make sure that the resistance, mainly varies due to the light effect only.

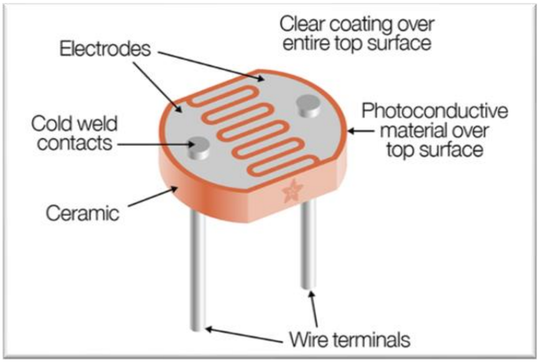


Figure 1

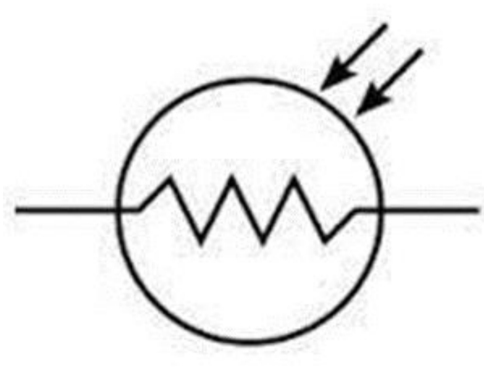


Figure 2

2.EXPERIMENTAL DETAILS

2.1 V-I CHARACTERISTICS OF LDR IN THREE LIGHT SOURCES OF DIFFERENT WAVELENGTH

1.RED LASER LIGHT

CIRCUIT DIAGRAM

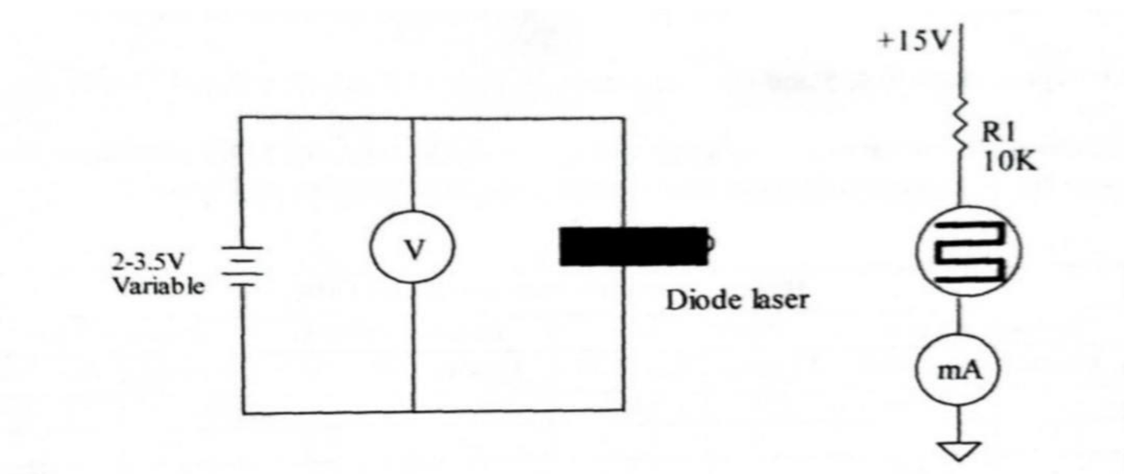


Figure 3

CIRCUIT COMPONENTS

- Light Dependent Resistor
- Red diode laser light
- Variable power supply (2-3.5V)
- Battery 15V
- Resistor 10K
- Voltmeter
- Milliammeter
- Breadboard

PROCEDURE

Connections are made as shown in the circuit diagram. Keep a distance of 15cm between the LDR and Laser source. Switch on the power supply. Adjust the torch and LDR to allow the light beam to fall on the light sensitive surface of the LDR. Now gradually increase the applied voltage and note down the corresponding current passing through the LDR.

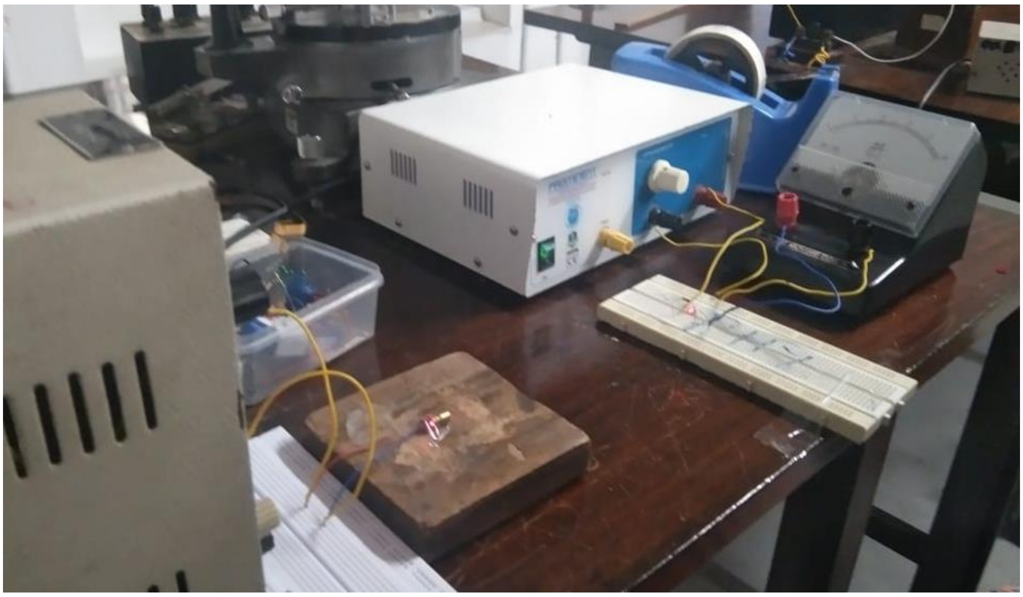
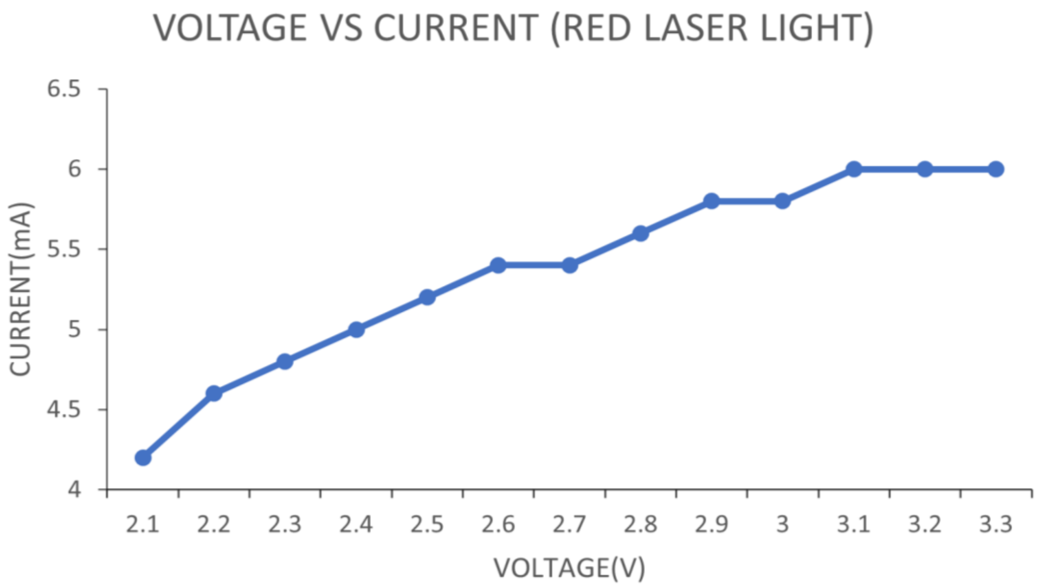


Figure 4

Figure 5

OBSERVATIONS

Voltage (V)	Current (mA)
2.1	4.2
2.2	4.6
2.3	4.8
2.4	5.0
2.5	5.2
2.6	5.4
2.7	5.4
2.8	5.6
2.9	5.8
3.0	5.8
3.1	6.0
3.2	6.0
3.3	6.0



2.RED AND BLUE LED LIGHT

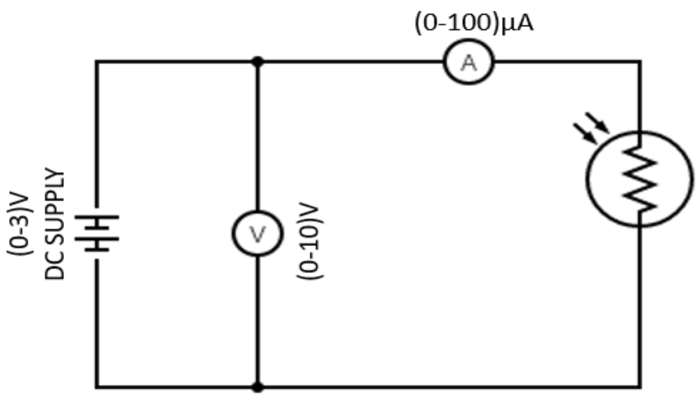


Figure 6

CIRCUIT COMPONENTS

- Light Dependent Resistor
- Variable power supply
- Voltmeter
- Ammeter
- Breadboard
- Connection wires

PROCEDURE

Connections are made as shown in the diagram. Keep a distance of 5cm between the LDR and red LED source. Switch on the power supplies. Adjust the LED and LDR to allow the light to fall on the light sensitive surface of the LDR. Now gradually increase the voltage and note the corresponding ammeter reading using digital multimeter. Repeat the same procedure for blue light.

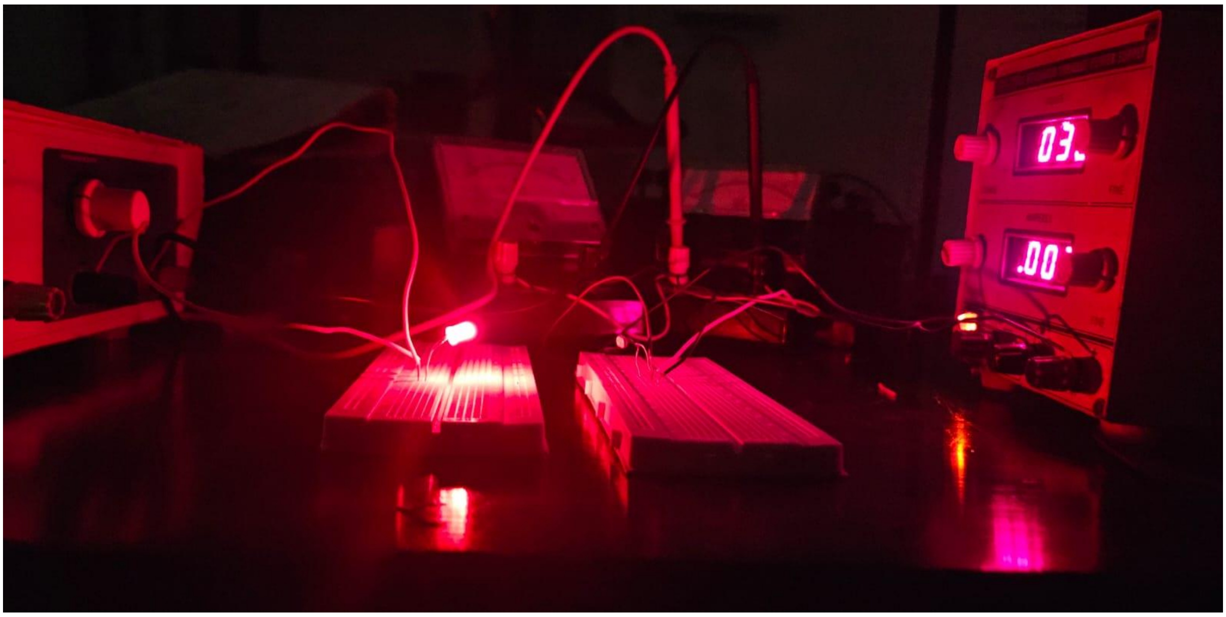


Figure 7

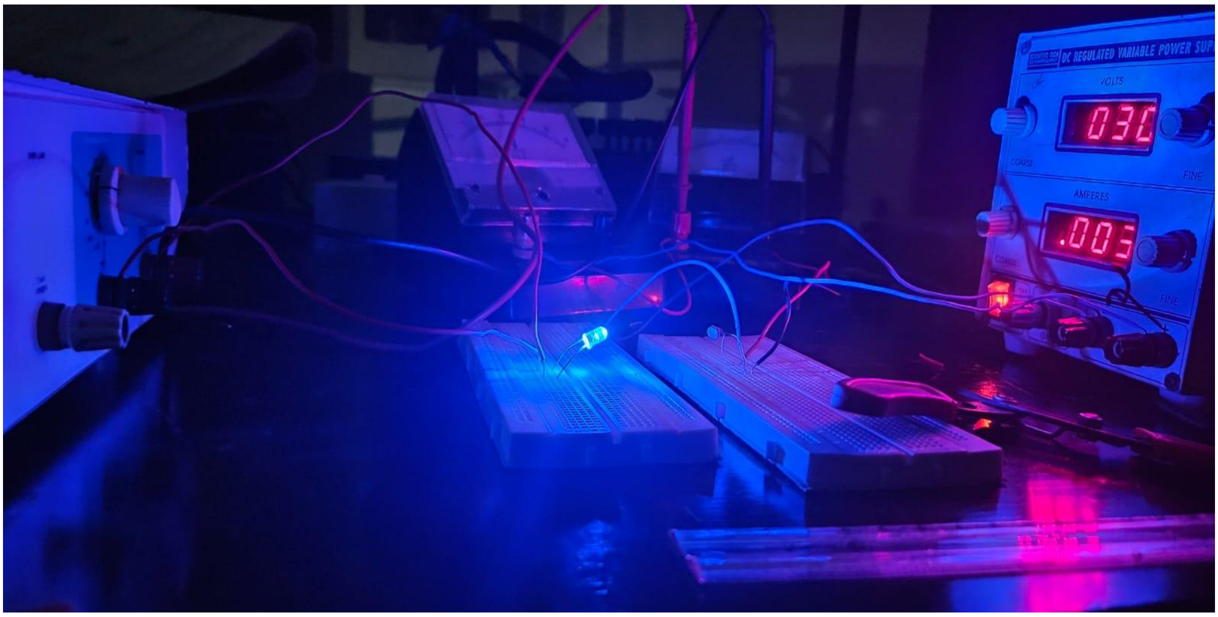
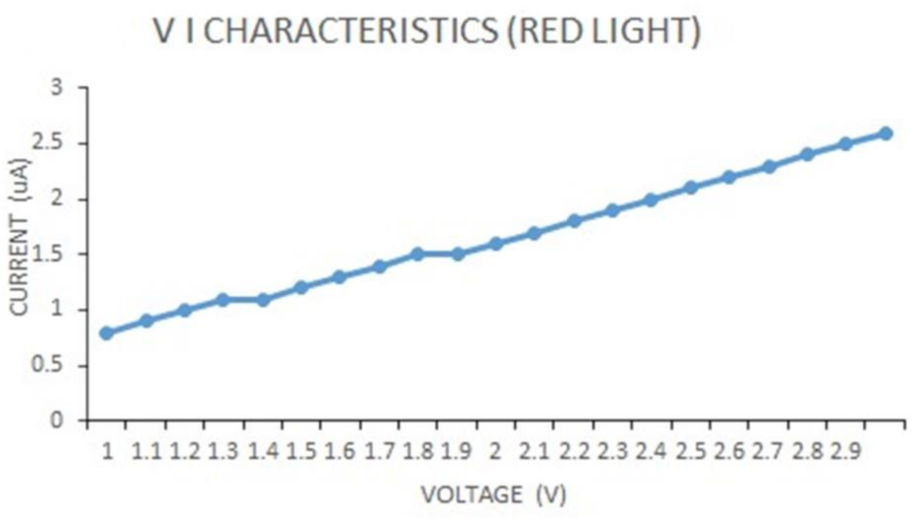


Figure 8

OBSERVATIONS

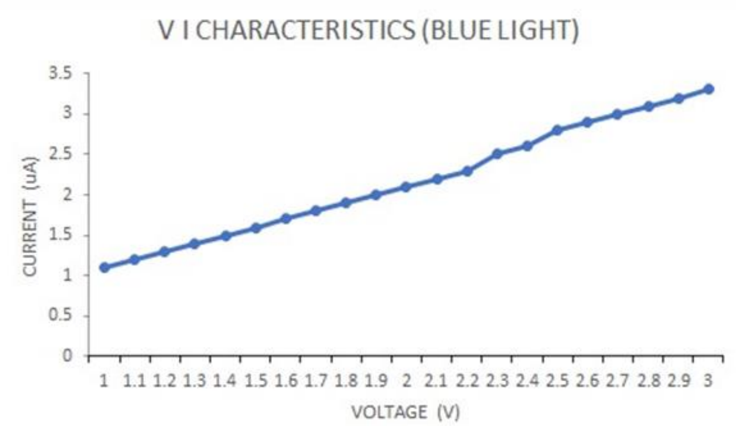
RED LIGHT

Voltage (V)	Current (μA)
1.0	0.8
1.1	0.9
1.2	1.0
1.3	1.1
1.4	1.1
1.5	1.2
1.6	1.3
1.7	1.4
1.8	1.5
1.9	1.5
2.0	1.6
2.1	1.7
2.2	1.8
2.3	1.9
2.4	2.0
2.5	2.0
2.6	2.1
2.7	2.2
2.8	2.3
2.9	2.4
3.0	2.5



BLUE LIGHT

Voltage (V)	Current(μA)
1.0	1.1
1.1	1.2
1.2	1.3
1.3	1.4
1.4	1.5
1.5	1.6
1.6	1.7
1.7	1.8
1.8	1.9
1.9	2.0
2.0	2.1
2.1	2.2
2.2	2.3
2.3	2.5
2.4	2.6
2.5	2.8
2.6	2.9
2.7	3.0
2.8	3.1
2.9	3.2
3.0	3.3



INFERENCES

From Current vs Voltage graph

a. Current varies across LDR for red laser light, red LED and blue LED.
b. There is an increase in current as voltage increases.

2.2 STUDY OF RESISTANCE ACROSS LDR

a. For red laser light

b. For red LED

c. For blue LED

with change in distance of the light source.

CIRCUIT DIAGRAM

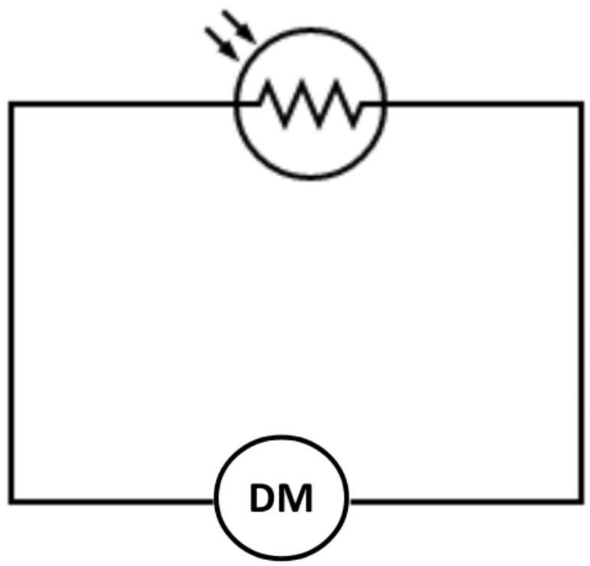


Figure 9

CIRCUIT COMPONENTS

- Light Dependent Resistor
- Light source
- Multimeter
- Meter scale

PROCEDURE

Connections are made as shown in the circuit diagram. Red laser light is made to fall on the LDR. Using a meter scale, the distance between the red laser source and LDR is varied from 1cm,2cm…The corresponding resistance is found using multimeter and is noted. The procedure is repeated for red LED and blue LED.

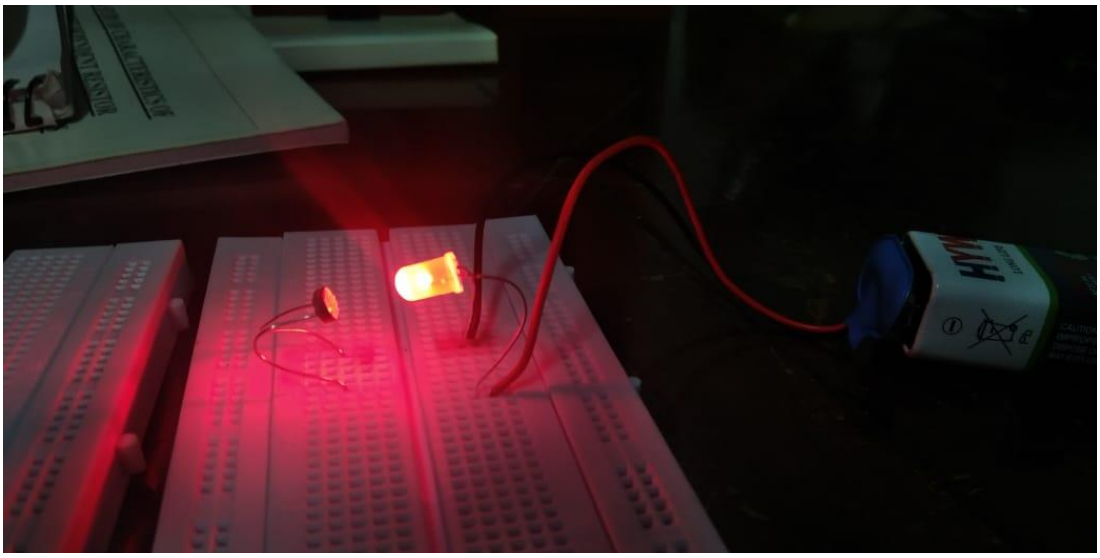


Figure 10

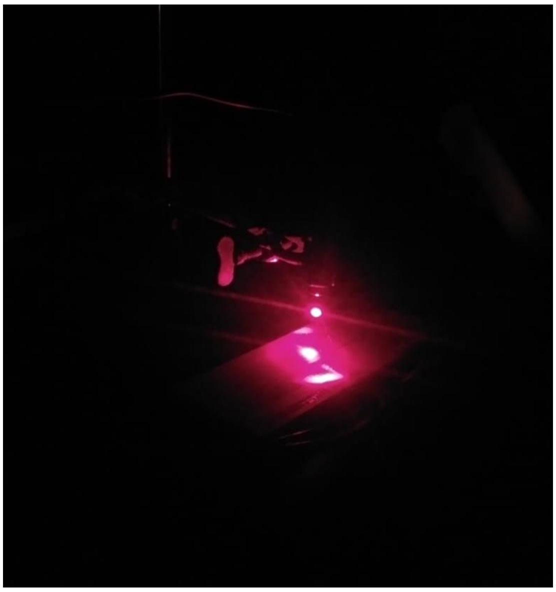
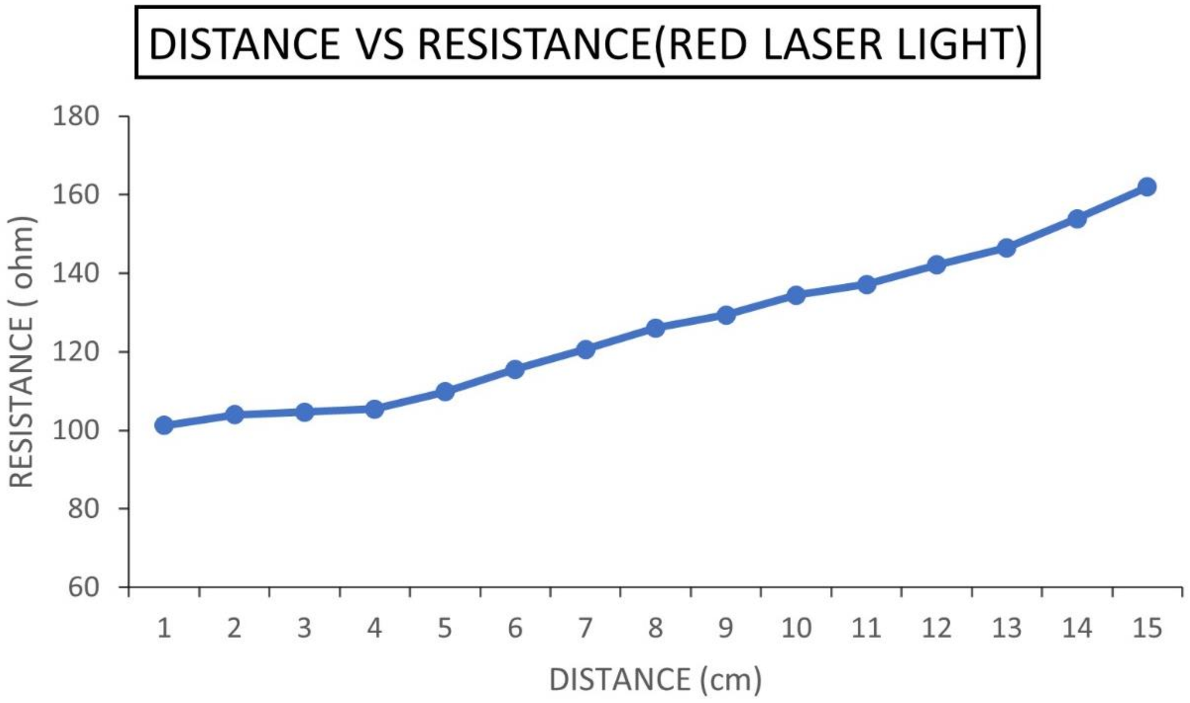


Figure 11

OBSERVATIONS

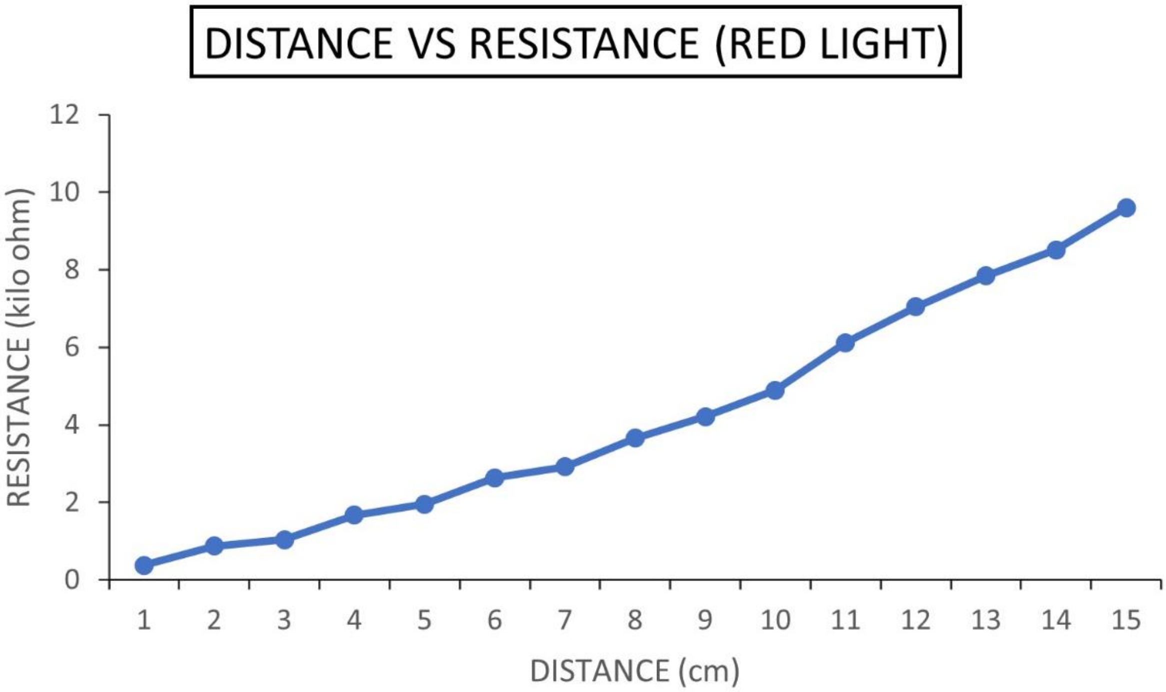
Measurements for distance vs resistance graph of LDR using Red light

Distance(cm)	Resistance(Ω)
1	101.3
2	104.0
3	104.7
4	105.4
5	109.8
6	115.6
7	120.6
8	126.1
9	129.4
10	134.4
11	137.2
12	142.1
13	146.5
14	153.9
15	162.0



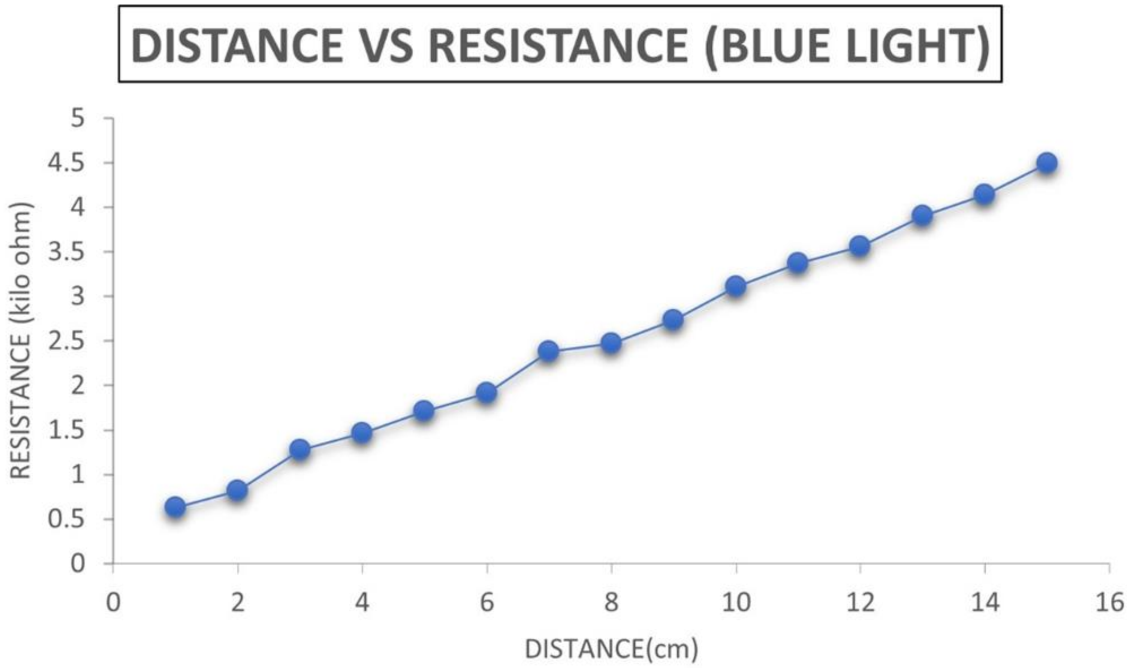
Measurements for distance vs resistance graph of LDR using red LED light

Distance(cm)	Resistance(kΩ)
1	0.384
2	0.878
3	1.040
4	1.674
5	1.960
6	2.640
7	2.920
8	3.660
9	4.210
10	4.890
11	6.120
12	7.050
13	7.840
14	8.520
15	9.610



Measurements for distance vs resistance graph of LDR using blue LED light

Distance(cm)	Resistance(kΩ)
1	0.631
2	0.816
3	1.273
4	1.465
5	1.706
6	1.910
7	2.380
8	2.470
9	2.730
10	3.110
11	3.370
12	3.560
13	3.900
14	4.140
15	4.490



INFERENCES

a.The resistance of LDR increases with the increase of distance.

b.The resistance of LDR increases with the decrease of intensity of light.

3.APPLICATIONS

3.1 ELECTRONIC EYE CONTROLLED SECURITY SYSTEM

INTRODUCTION

This home security system uses LDR as the main sensor. Also known as 'Magic eye', Electronic eye controlled security system automatically rings the doorbell as soon as someone is at the door. This also acts as a security system in the case of trespassers.

PRINCIPLE

The circuit operates on the principle of detecting a person at the entrance and triggering the doorbell accordingly. An LDR serves as the sensor, with its light sensitivity determining the presence of a person. When an object blocks the light to the LDR, indicating someone's presence, the circuit activates: the buzzer starts ringing, and the LED lights up. This setup effectively alerts occupants to the presence of someone at the entrance.

CIRCUIT DIAGRAM

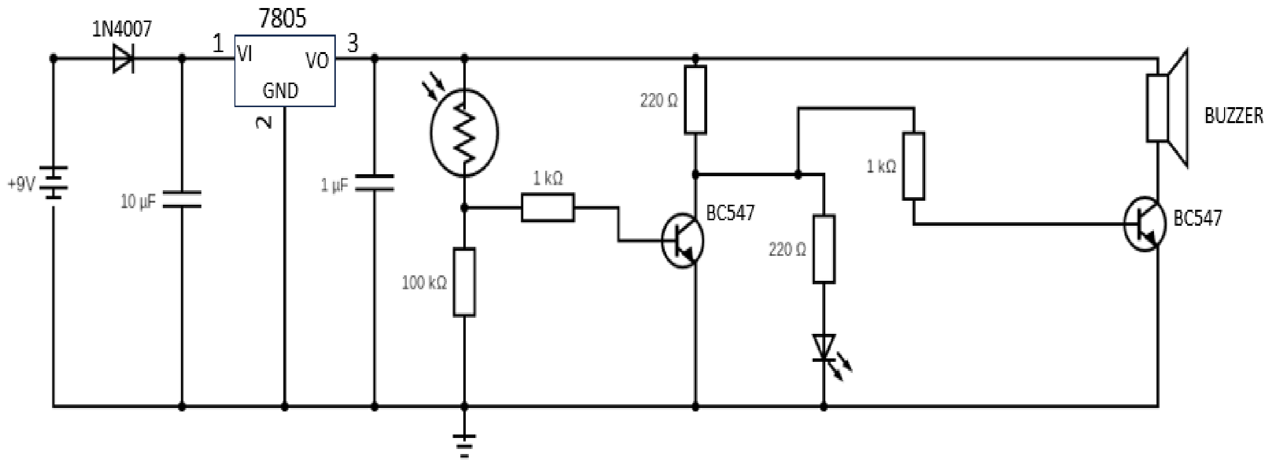


Figure 12

CIRCUIT COMPONENTS

- 7805 regulator
- Resistors-220Ω,1 kΩ,100 kΩ
- 1N4007 PN Diode
- Capacitors-1µF,10µF
- Transistors- BC 547
- Light Dependent Resistor(LDR)
- Buzzer
- LED

- Bread board
- 9V Battery

DESIGN

The circuit of the electronic eye controlled security system is divided into two parts. One is the power supply and the other is the logic circuit. In the power supply circuit, a 9V supply from a battery is converted to the 5V .The logic circuit operates the buzzer and on LED when any shadow falls on the LDR.

DESIGN OF POWER SUPPLY

The power supply circuit is designed with a battery, capacitors, P-N junction diode and regulators.Diode used here is simple PN junction diode of IN4007.In this circuit,diode is connected in forward bias condition. The main purpose of diode 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 diode is connected in the forward bias, which allows the flow of current in only one direction and thus the circuit can be protected. The voltage drop across the diode is 0.7V. A voltage regulator (IC 7805) is used to regulate the output voltage of the circuit. Here 05 denotes the output voltage and 78 denotes the series. Thus 5 volts is generated at the output of the voltage regulator. To eliminate the ripples two capacitors are connected before and after the voltage regulator. Thus a constant voltage is produced at the output of the regulator,which is applied to the logic circuit.

DESIGN OF LOGIC CIRCUIT

The logic circuit mainly consists of Light Dependent Resistor, transistors, a buzzer,an LED and a few passive components. A 100KΩ resistor is connected in series to the LDR in a voltage divider fashion.The output of the LDR is connected to a transistor NOT gate circuit.

In darkness, the LDR's resistance increases significantly. The reduced current flow through the LDR circuit triggers a logic high output from the NOT gate. In simpler terms, darkness makes the LDR act like an open switch, causing the NOT gate to flip its output to the opposite state (logic high).This turns the second transistor to ON state, which drives the buzzer and illuminates the LED. The Buzzer used here is 5V magnetic buzzer. It has two pins at the output,where one is connected to the supply and the other is connected to the collector of the second transistor.LED is used for indication only.

In the presence of light, the LDR’s resistance will decrease. Thus a logic low value is produced at the output of the transistor which turns the transistor to OFF state.

WORKING

The circuit is connected as shown in the figure. Conncet a 9V battery to the circuit. When the LDR is exposed to light, it has low resistance and the circuit remains inactive. The buzzer stays silent and the LED is off. When the LDR is in darkness, its resistance decreases. This triggers the circuit, activating the buzzer and LED.The brighter the light shining on the LDR, the weaker the buzzer sound and dimmer the LED.Conversly, the darker the environment, the louder the buzzer and brighter the LED.

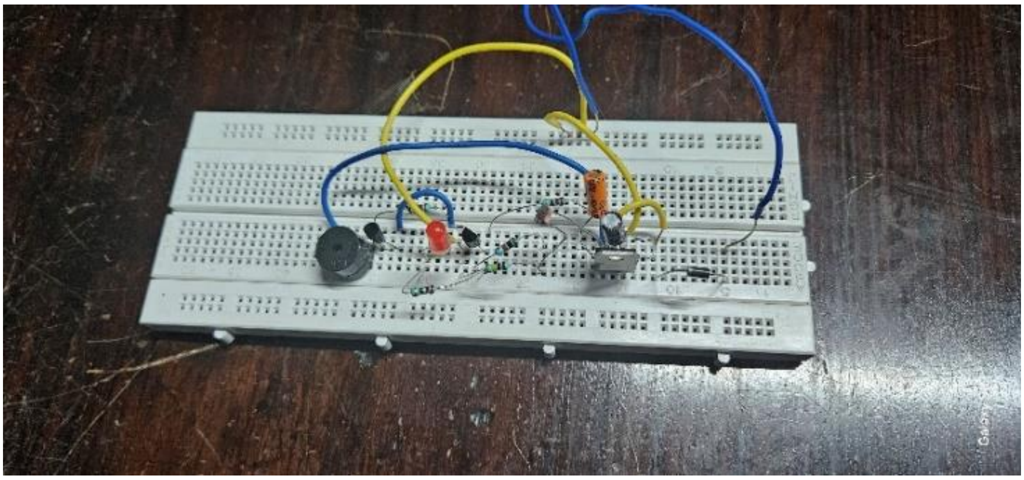


Figure 13

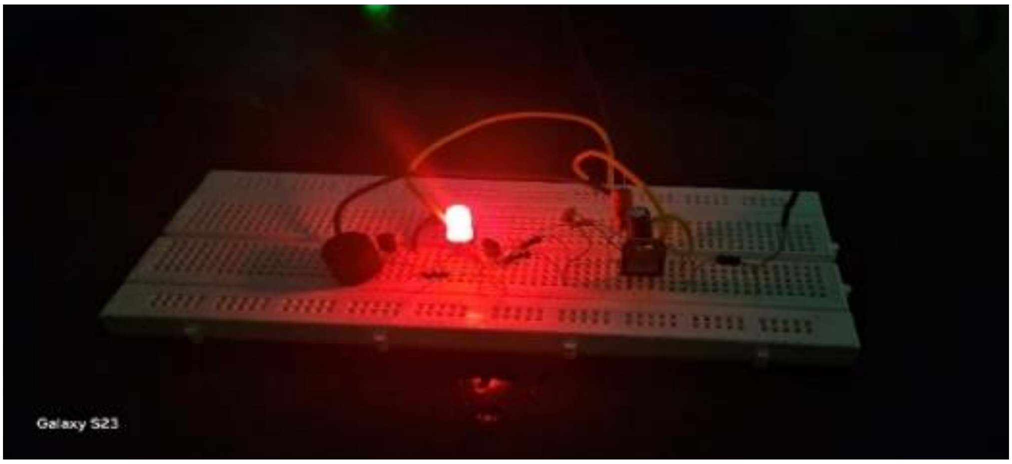


Figure 14

3.2 AUTOMATIC STREET LIGHT CONTROL SYSTEM

INTRODUCTION

Traditional street lights often waste energy due to manual operation or timers that don't adapt to changing light conditions. An automatic system uses a light sensor to turn lights on at dusk and off at dawn, significantly reducing energy consumption.

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

PRINCIPLE

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. It 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), by using LDR as the sensor which senses the light just like our eyes.

CIRCUIT DIAGRAM

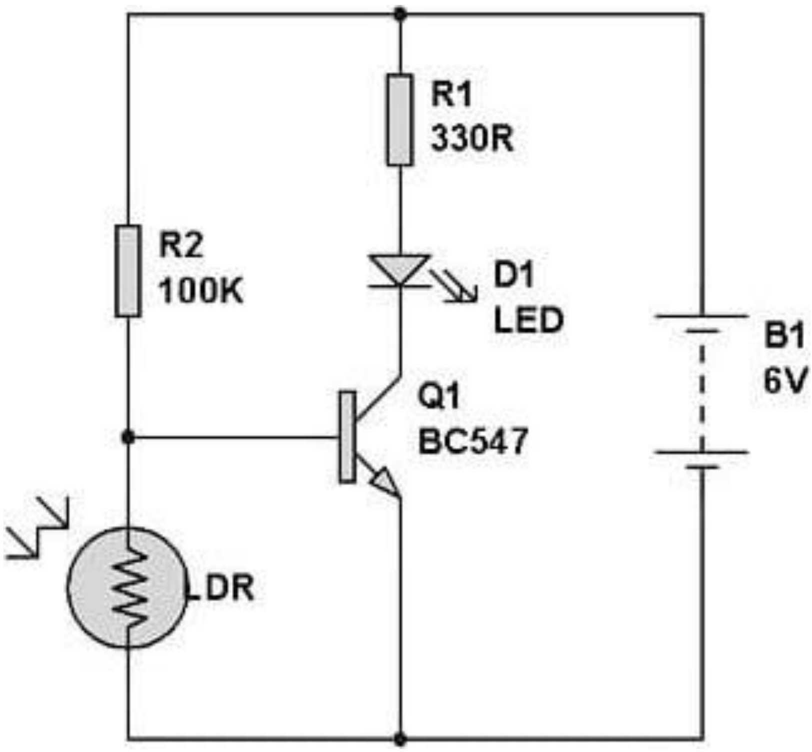


Figure 15

CIRCUIT COMPONENTS

- Light Dependent Resistor(LDR)
- Resistors-330Ω,100 kΩ
- Transistor BC547
- LED
- Bread board
- 6V Battery

DESIGN

The circuit consists of a light-dependent resistor (LDR), a transistor, and a few other components . Light-dependent resistor (LDR) acts as a light sensor. Its resistance decreases when exposed to bright light and increases in darkness.Transistor acts as a amplifier amplifying current so that sufficient current is produced to light the LED. The LDR and resistor form a voltage divider circuit that controls the voltage at the base of the transistor. Current travels through the 100KΩ resistor and then has 2 paths- it can either go through the base of the transistor or go through the photoresistor. Current always takes the path of least resistance. When exposed to bright light, the photoresistor's resistance decreases and allows more current to flow through the circuit it. In contrast, a transistor base typically operates with a much lower resistance than a photoresistor in bright light. Therefore, most of the current will go through the photoresistor and very little will go to the base of the transistor. So the base of the transistor is bypassed. Thus, the transistor does not receive enough current to turn on the LED. Hence, the LED is off when there is a lot of light in the surroundings. As darkness falls, the photoresistor's resistance increases significantly. This effectively limits the current flowing through it and diverts most of the current towards the transistor's base. Hence the transistor receive enough current to turn on the LED.

WORKING

The circuit is made as shown in the figure. Connect a 6V battery. As we block the light falling on LDR, the LED glows.

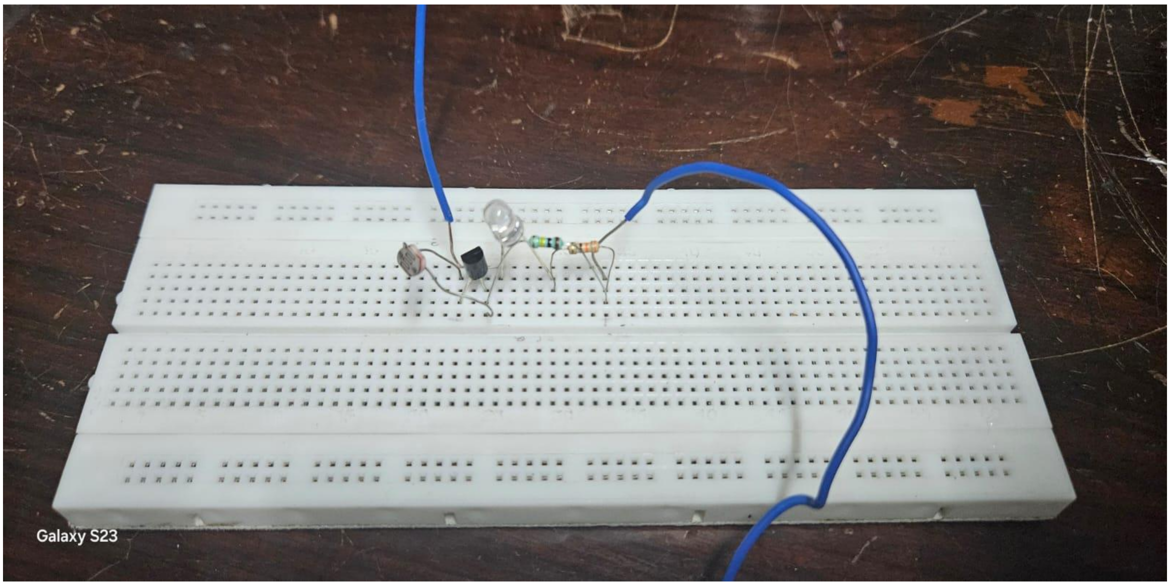


Figure 16

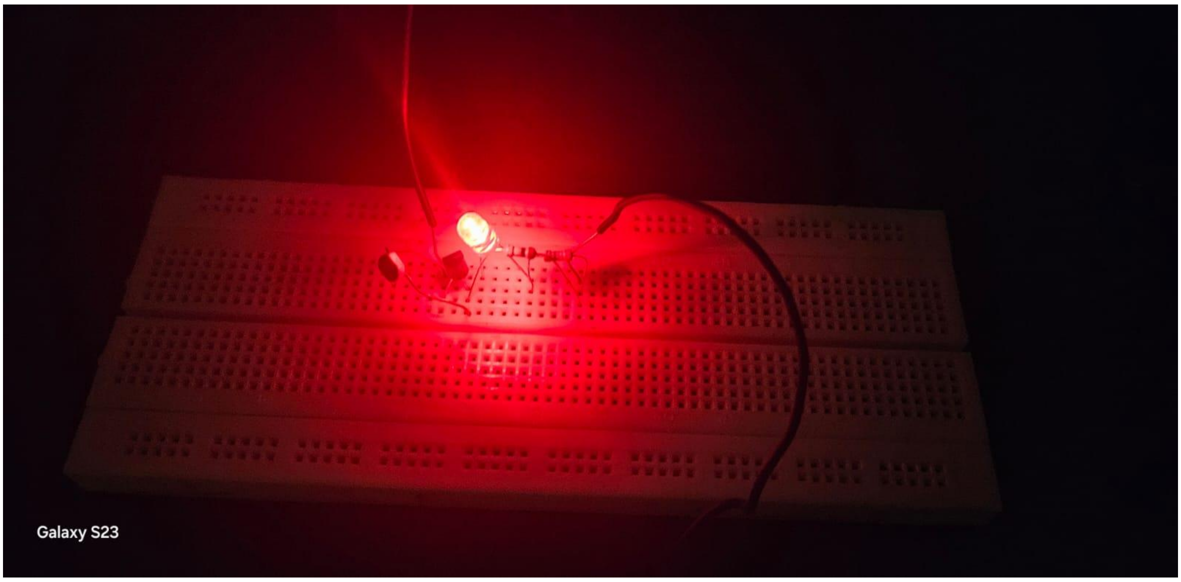


Figure 17

3.3 LASER SECURITY SYSTEM

INTRODUCTION

A laser security system can function independently, emitting sound or noise upon detecting irregular activity, or it can integrate into a larger security and home automation system. This laser-based security system operates like a tripwire, sounding an alarm when its laser beam is interrupted.

PRINCIPLE

The principle behind a laser security system involves emitting a laser beam across a protected area and detecting any interruption or disruption of that beam. When the beam is interrupted, such as by an intruder crossing its path, the system is triggered to activate an alarm or other security response. This interruption is typically detected by sensors placed strategically along the laser's path. The system can then respond by sounding an alarm, activating lights, or sending alerts to a monitoring station or the homeowner. This technology is commonly used in both residential and commercial security applications due to its reliability and effectiveness in detecting unauthorized access or intrusion.

CIRCUIT DIAGRAM

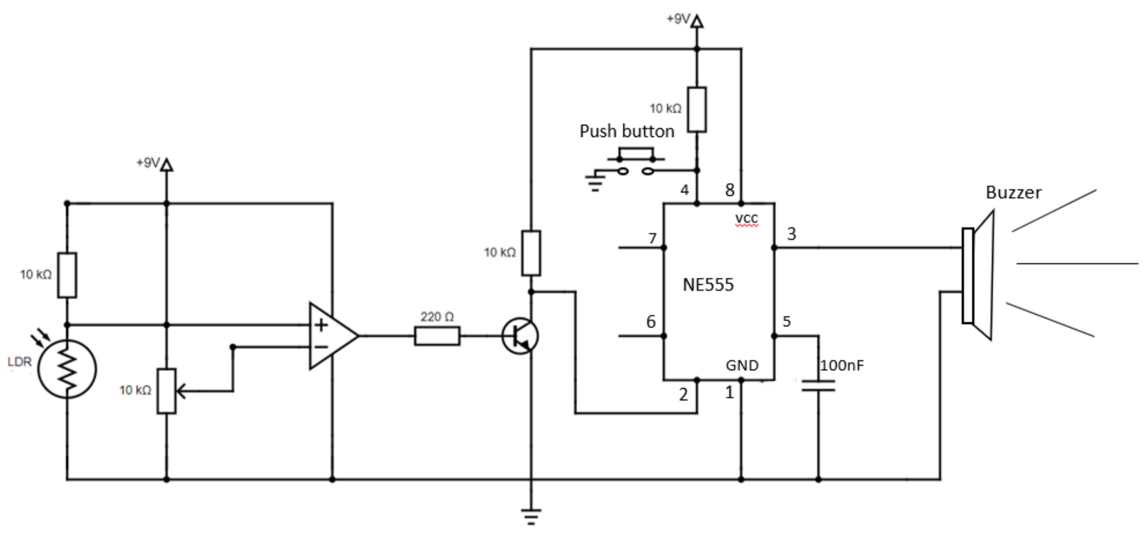


Figure 18

CIRCUIT COMPONENTS

- LM358 (Op – Amp IC)
- NE555 (Timer IC)
- LDR
- 10 KΩ Resistors
- 220 Ω Resistors
- 10 KΩ Potentiometer
- BC547 (NPN Transistor)
- Buzzer
- 100 nF Capacitor
- Push Button
- Laser Pointer
- 9V Battery
- Breadboard (Prototyping board)

DESIGN

The setup involves the connection of an LDR and a 10 KΩ resistor in a voltage divider configuration. Their output, the common point, is linked to pin 3 (non-inverting) of the Op-Amp IC LM358.

For the inverting terminal (pin 2), the wiper of a 10 KΩ potentiometer is connected (with the other two terminals of the POT linked to VCC and GND).

The Op-Amp's output (Pin 1) is then connected to the base of the transistor (BC547) via a resistor.

To initiate the 555 IC, the trigger pin (Pin 2) is pulled high using a 10 KΩ resistor.

The reset pin (pin 4) of the 555 IC is attached to VCC through a 10 KΩ resistor, and a push button is connected between Pin 4 of the 555 and GND. Additionally, a bypass capacitor of 100 nF is connected between pins 5 and GND.

Lastly, a buzzer is connected to pin 3 of the 555 IC. The remaining connections are illustrated in the accompanying circuit diagram.

WORKING

The connection is made as shown. The operational amplifier (Op-Amp) circuit functions as a comparator by comparing the voltages at its inverting and non-inverting terminals, generating an output accordingly. The voltage divider comprising the LDR and a 10 KΩ resistor is connected to the non-inverting terminal, while a potentiometer (POT) is linked to the inverting terminal. Assuming the laser pointer directly aligns with the LDR, continuously illuminating it, the LDR's resistance decreases to a few ohms. Consequently, the voltage at the non-inverting terminal becomes lower than that at the inverting terminal. As a result, the Op-Amp's output goes low, causing the transistor to turn off.

If the laser light is obstructed by an intruder, even momentarily, preventing it from reaching the LDR, the resistance of the LDR increases to a few hundred ohms. Consequently, the output of the Op-Amp goes high, causing the transistor to turn on. Since the transistor's output is linked to the Trigger Pin (Pin 2) of the 555 Timer IC, its activation results in a short low pulse being sent to the trigger pin. This action causes the output of the 555 Timer IC to go high, triggering the alarm by activating the buzzer.

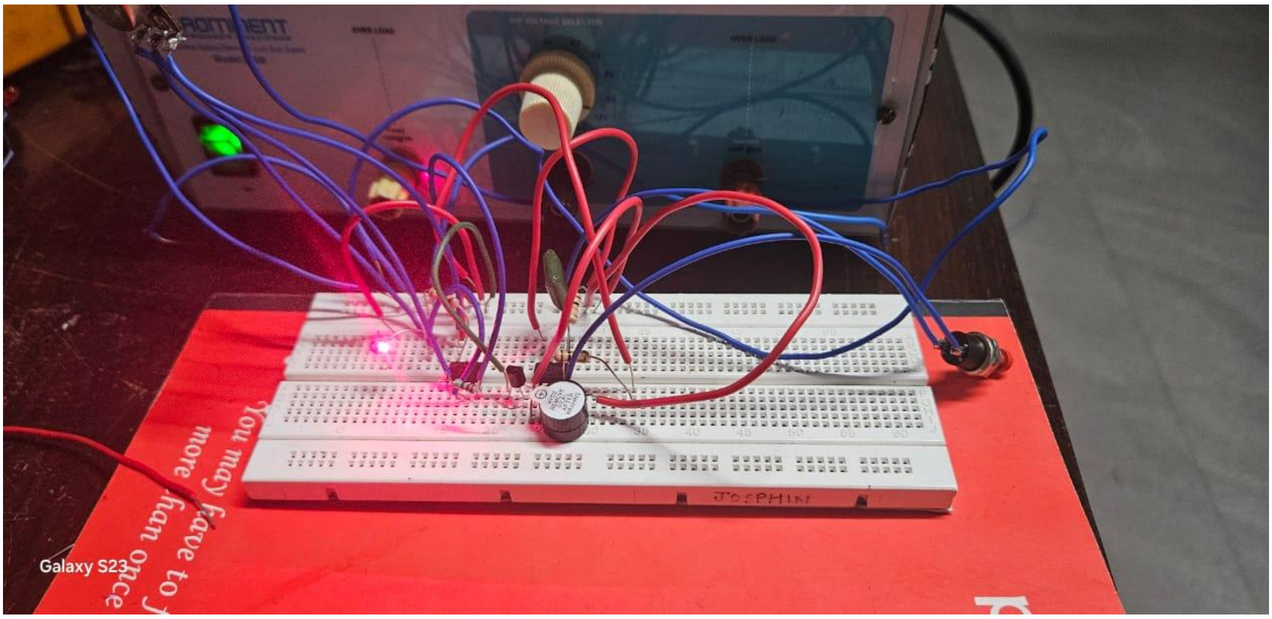


Figure 19

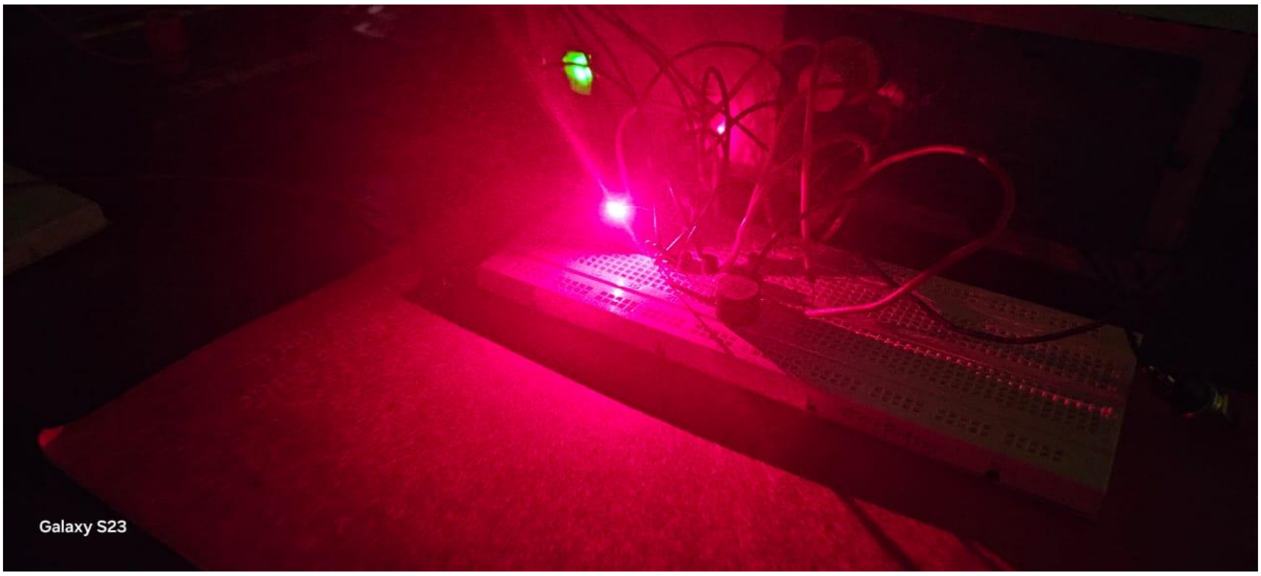


Figure 20

4. CONCLUSION

- The basic characteristics of the passive component- LIGHT DEPENDENT RESISTOR (LDR) were analyzed. This includes

i. V-I characteristics of LDR using red laser light,red and blue LED.
The V-I characteristics of LDR shows that there is an increase in current with increase in voltage for all 3 light source.

ii. Study of the resistance across LDR
It was found that LDR resistance increases with increase in distance.
Also, LDR resistance increases with decrease in intensity of light.

- The spectral response of a Cds cell closely matches that of human eye. Hence,is often used in applications where human vision is a factor such as street light control.This sensor is commonly used in automatic lighting systems to conserve energy. For instance, LDR sensors can automatically turn off street lights during the daytime, or dim lights based on the amount of natural daylight available. LDR sensors are also used in motion detectors and burglar alarm security systems.

5.REFERENCES

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