EXPERIMENTAL STUDY OF THE ELECTRICAL RESPONSE OF AN LDR UNDER VARYING ILLUMINATION

PROJECT REPORT

Submitted by

ARDRA V S (AB23PHY004)

Under the guidance of

Dr. PRIYA PARVATHI AMEENA JOSE
Associate Professor

Department of Physics & Centre for Research

St. Teresa's College (Autonomous), Ernakulam.

In partial fulfillment of the requirement of award of Bachelor Degree of science in Physics.

ST. TERESA'S COLLEGE (AUTONOMOUS)
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CERTIFICATE

This is to certify that the project report entitled **"EXPERIMENTAL STUDY OF THE ELECTRICAL RESPONSE OF AN LDR UNDER VARYING ILLUMINATION "** is an authentic work done by **ARDRA V S** ,St Teresa's College(Autonomous),Ernakulam, under my supervision at Department of Physics & Centre for Research, St. Teresa's College (Autonomous),Ernakulam, for the partial requirements for the award of Degree of Bachelor of Science in Physics during the academic year 2025-26. The work presented in this dissertation has not been submitted for any other degree in this or any other university.

Supervising Guide

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B.Sc. PHYSICS
PROJECT REPORT

NAME : ARDRA V S

REGISTER NUMBER : AB23PHY004

YEAR OF WORK : 2025-26

This is to certify that this project work entitled, "EXPERIMENTAL STUDY OF THE ELECTRICAL RESPONSE OF AN LDR UNDER VARYING ILLUMINATION" is an authentic work done by ARDRA V S.

Staff member in-charge | Head of the Department

Dr. PRIYA PARVATHI AMEENA JOSE | **Dr. MARY VINAYA**

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

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

DATE: 16/04/26

EXAMINER:

1. Athira Prakash.

2.

DECLARATION

I, ARDRA V S, final-year B.Sc. Physics student of the Department of Physics & Centre for Research, St. Teresa's College (Autonomous), Ernakulam, do hereby declare that the project work entitled **"EXPERIMENTAL STUDY OF THE ELECTRICAL RESPONSE OF AN LDR UNDER VARYING ILLUMINATION"** has been originally carried out under the guidance and supervision of **Dr. PRIYA PRAVATHI AMEENA JOSE**, Associate Professor, Department of Physics &Centre for Research, St. Teresa's College (Autonomous) , Ernakulam, in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Physics.

I further declare that this project has not been partially or wholly submitted for any other purpose, and that the data included in this project were collected from various sources and are true to the best of our knowledge.

Place: Ernakulam

Date: 01/04/2026

ACKNOWLEDGEMENT

I would like to thank God Almighty for enriching my mind 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**, Associate Professor, Department of Physics & Centre for Research, for providing support and guidance.

I also express my sincere thanks to **Rev. Sr. Dr. NILIMA CSST** Manager, **Dr. ANU JOSEPH**, Principal, and **Dr. MARY VINAYA,** Head of the Department of Physics & Centre for Research for providing all support and help throughout my project work, which has enabled us to enrich my knowledge.

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

ABSTRACT

This project presents an experimental investigation of the electrical behavior of a Light Dependent Resistor (LDR) under varying illumination conditions. The variation of current with applied voltage was examined to understand its response characteristics. The change in resistance of the LDR with respect to distance from two different light sources (red and blue LEDs) was also analyzed graphically. In addition, two practical circuits—an electronic eye-based security system and an automatic street lighting system—were designed and implemented to demonstrate real-life applications of the LDR.

CONTENTS

1.INTRODUCTION

1.1 PHOTOCONDUCTIVITY

Photoconductivity refers to the phenomenon in which the electrical conductivity of a material increases when it is exposed to electromagnetic radiation. When light energy is incident on certain materials, it supplies sufficient energy to excite electrons from the valence band to the conduction band, thereby increasing the number of charge carriers available for conduction. As a result, the material exhibits enhanced electrical conductivity.

This behavior is commonly observed in semiconducting materials such as silicon, germanium, cadmium sulphide, lead sulphide, and selenium. Under normal conditions, semiconductors possess limited free charge carriers and therefore exhibit moderate electrical conductivity. However, upon illumination with radiation of appropriate energy (greater than or equal to the band gap energy), additional electron–hole pairs are generated, leading to a measurable increase in current.

When a photoconductive material is incorporated into an electrical circuit, it behaves as a variable resistor whose resistance decreases with increasing light intensity. Such a device is commonly known as a Light Dependent Resistor (LDR) or photoresistor.

1.2 LIGHT DEPENDENT RESISTOR

A Light Dependent Resistor (LDR), also known as a photoresistor or photoconductive cell, operates on the principle of photoconductivity. Photoconductivity is the phenomenon in which the electrical conductivity of certain semiconductor materials increases when exposed to light. When photons with energy equal to or greater than the band gap energy strike the material, electrons are excited from the valence band to the conduction band, producing electron–hole pairs. The increase in charge carriers enhances the electrical conductivity of the material.

LDRs are commonly fabricated using photoconductive semiconductor materials such as cadmium sulphide (CdS), cadmium selenide (CdSe), and lead sulphide (PbS). The resistance of these materials depends strongly on the intensity of incident light. As illumination increases, more electron–hole pairs are generated, leading to a decrease in resistance. In low light or dark conditions, the number of free charge carriers is minimal, resulting in very high resistance. The resistance measured in complete darkness is referred to as dark resistance.

Structurally, an LDR consists of a thin layer of light-sensitive semiconductor material deposited on an insulating substrate, typically ceramic. The material is arranged in a zigzag or serpentine pattern to obtain higher effective resistance within a compact area. Metallic contacts are provided at both ends to form low-resistance Ohmic contacts, ensuring that the observed resistance variation is primarily due to changes in illumination rather than contact resistance.

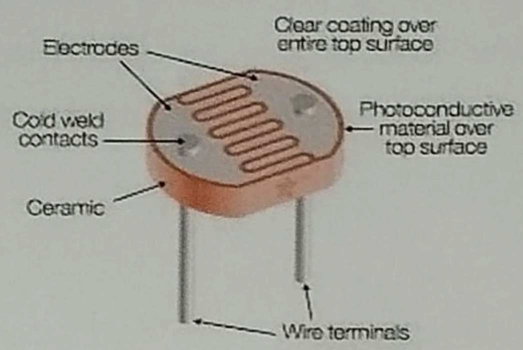


Figure 1

Photoresistor (LDR)

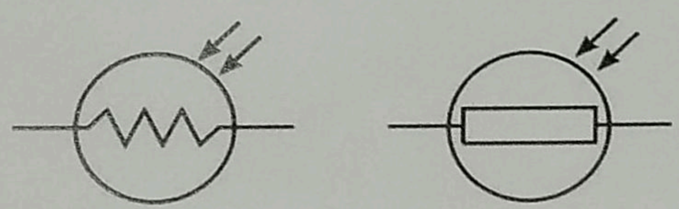


Figure 2

LDR symbol used in circuit diagram

The resistance of a Light Dependent Resistor (LDR) changes according to the intensity of the incident light. According to the inverse square law, the intensity of light is inversely proportional to the square of the distance from the source. Hence, as the distance between the light source and the LDR increases, the intensity of light falling on the LDR decreases. Therefore, the resistance of the LDR increases with increase in distance and decreases with increase in light intensity.

However, when the intensity of light falling on the LDR is kept constant, the number of photogenerated charge carriers within the semiconductor material remains constant. Under this condition, the resistance of the LDR remains constant for that particular level of illumination. When the applied voltage across the LDR is increased, the electric field across the device increases, causing the charge carriers to move more easily through the semiconductor material. Hence, as the voltage increases, the current through the LDR increases. Therefore, at constant illumination, an approximately linear relationship between voltage and current is obtained, and the LDR behaves almost like an ohmic device whose resistance depends on light intensity.

2.EXPERIMENTAL DETAILS

2.1 V_R-I_R- CHARACTERSTICS OF LDR

When a diode is reverse biased, the reverse saturation current is constituted by minority carriers. These minority carriers are produced (due to thermal energy that dislodges for release) the valence electrons from their orbits, thereby producing free electrons and holes. If the energy is provided to a p-n junction by light (of suitable wavelength), it can also produce electron - hole pairs the same way Stronger the intensity of light falling, more will be the number of charge carriers and hence larger will be the reverse current. The amount of light striking the p-n junction controls the reverse current. This current is of the order of few microampere

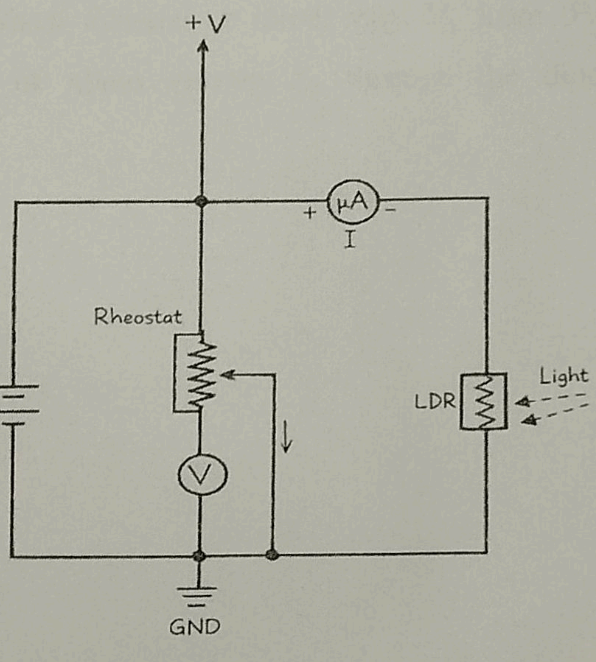


Figure 3

Circuit diagram

CIRCUIT COMPONENTS

- Light Dependent Resistor (LDR)
- Rheostat
- Voltmeter
- Micro ammeter
- DC variable source

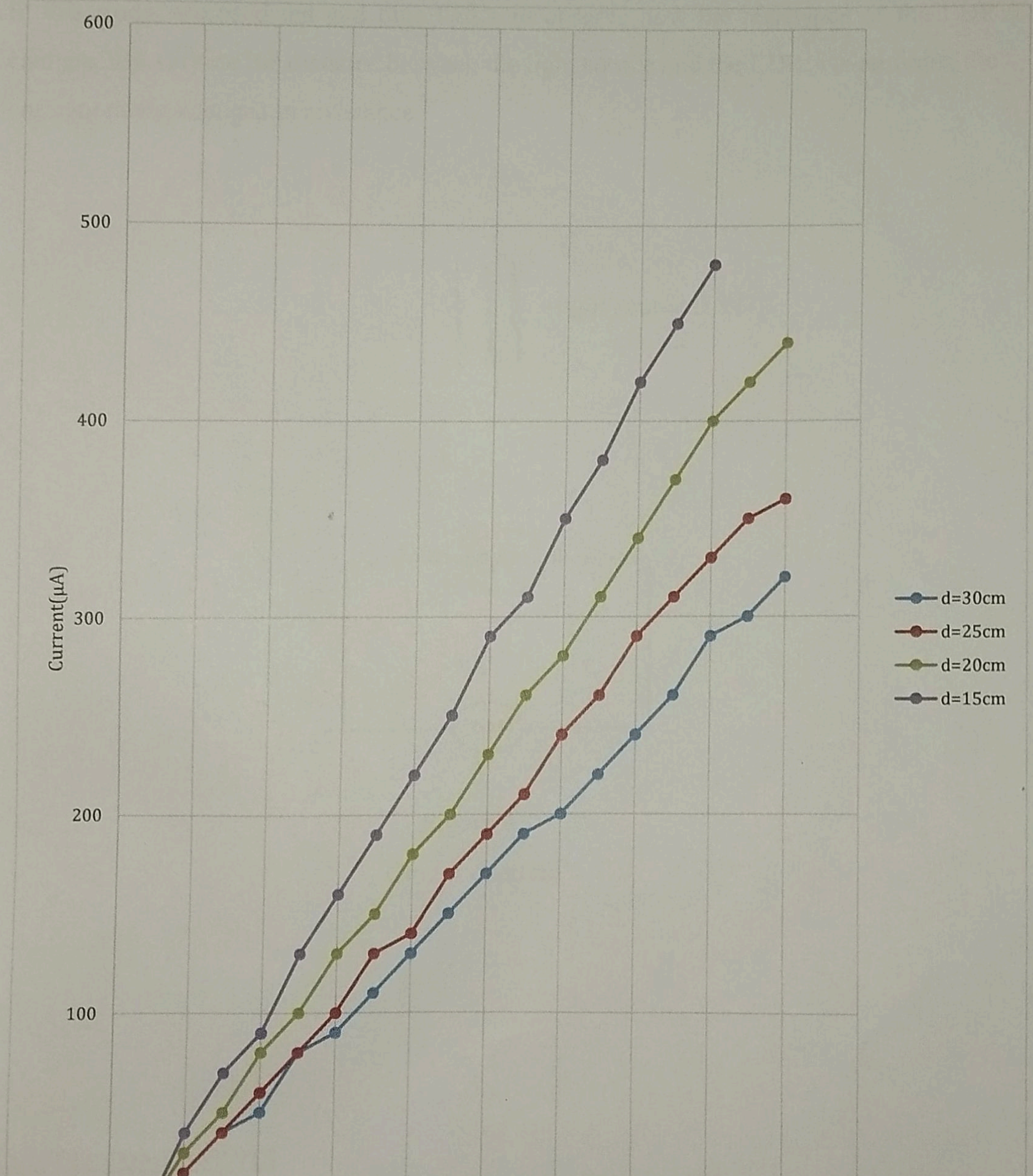
PROCEDURE

Make the connections as shown in figure 3. Place a filament lamp at a distance d (about 100 cm) from the LDR. With the lamp off, vary the reverse voltage V_R from 0 to 5V and observe the corresponding values of current (dark current if any) Dark current is the reverse saturation current reaching the junction corresponding to zero light. Now switch on the lamp. Keep distance d fixed, vary V, from 0V to 5V and note the corresponding values of photo current I_R through the diode. Finally draw the characteristic curve.

OBSERVATIONS

Trial No	d = 30 cm		d = 25 cm		d = 20 cm		d = 15 cm	
	V_R (volts)	I_R (μA)	V_R (volts)	I_R (μA)	V_R (volts)	I_R (μA)	V_R (volts)	I_R (μA)
1	0.05	0	0.05	0	0.05	0	0.05	0
2	0.1	20	0.1	20	0.1	30	0.1	40
3	0.15	40	0.15	40	0.15	50	0.15	70
4	0.20	50	0.20	60	0.20	80	0.20	90
5	0.25	80	0.25	80	0.25	100	0.25	130
6	0.3	90	0.3	100	0.3	130	0.3	160
7	0.35	110	0.35	130	0.35	150	0.35	190
8	0.40	130	0.40	140	0.40	180	0.40	220
9	0.45	150	0.45	170	0.45	200	0.45	250
10	0.5	170	0.5	190	0.5	230	0.5	290
11	0.55	190	0.55	210	0.55	260	0.55	310
12	0.60	200	0.60	240	0.60	280	0.60	350
13	0.65	220	0.65	260	0.65	310	0.65	380
14	0.70	240	0.70	290	0.70	340	0.70	420
15	0.75	260	0.75	310	0.75	370	0.75	450
16	0.80	290	0.80	330	0.80	400	0.80	480
17	0.85	300	0.85	350	0.85	420	-	-
18	0.90	320	0.90	360	0.90	440	-	-

V_R-I_R CHARACTERISTICS



2.2 STUDY OF RESISTANCE ACROSS LDR WITH CHANGE IN DISTANCE FROM LIGHT SOURCE

In this study, we used red and blue LEDs to observe how the resistance of the LDR changes. By varying the distance between the light source and the LDR, we recorded the corresponding changes in resistance.

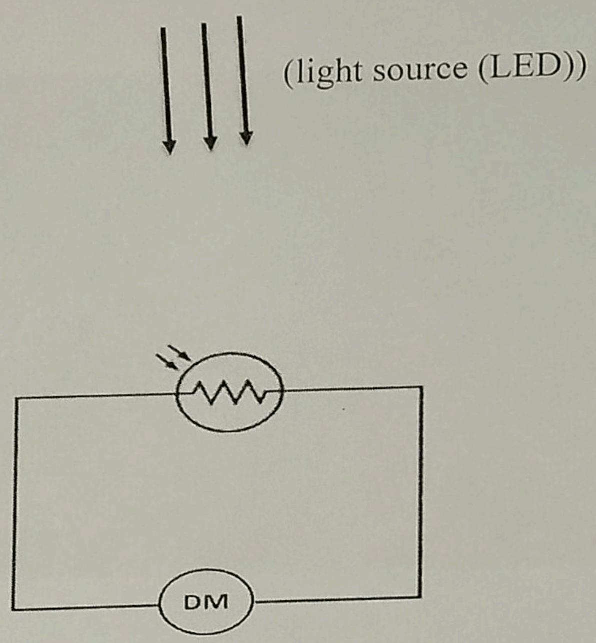


Figure 4

Circuit diagram

CIRCUIT COMPONENTS

- Light Dependent Resistor
- Light source

- Multimeter
- Meter scale

PROCEDURE

Connections are made as shown in the circuit diagram figure 4. 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 blue LED light source.

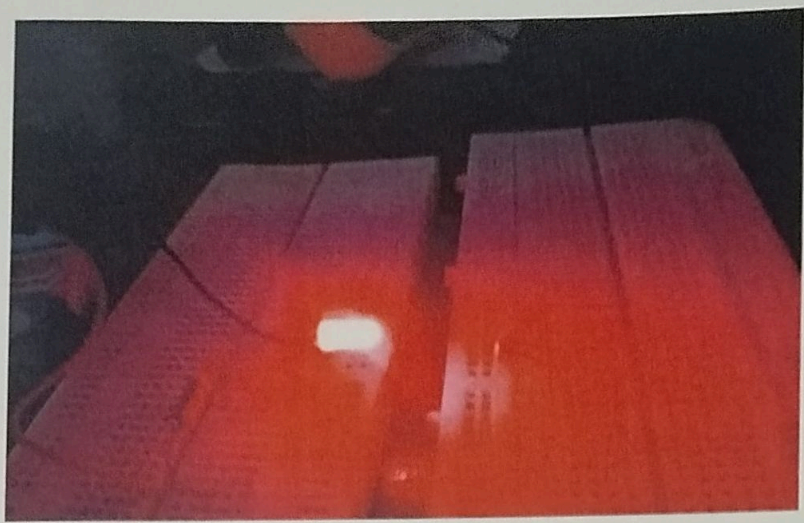
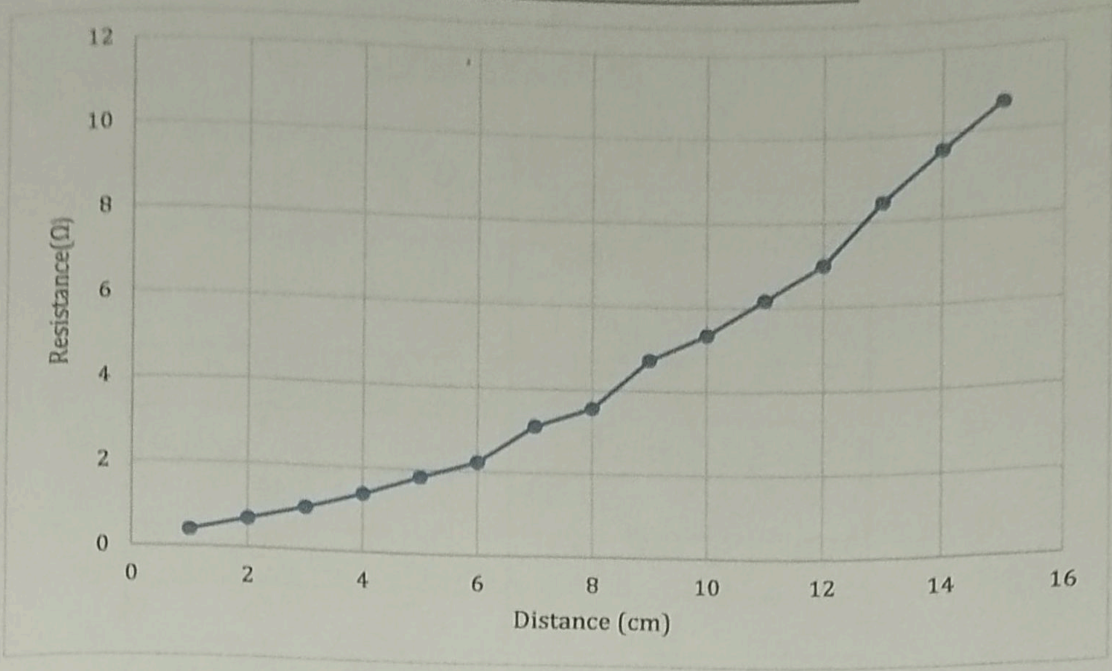


Figure 5
Experiment set up with Red LED

OBSERVATIONS

Distance(cm)	Resistance(Ω)
1	0.386
2	0.676
3	0.989
4	1.368
5	1.81
6	2.21
7	3.10
8	3.55
9	4.73
10	5.34
11	6.17
12	6.98
13	8.43
14	9.60
15	10.66

DISTANCE -RESISTANCE GRAPH



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

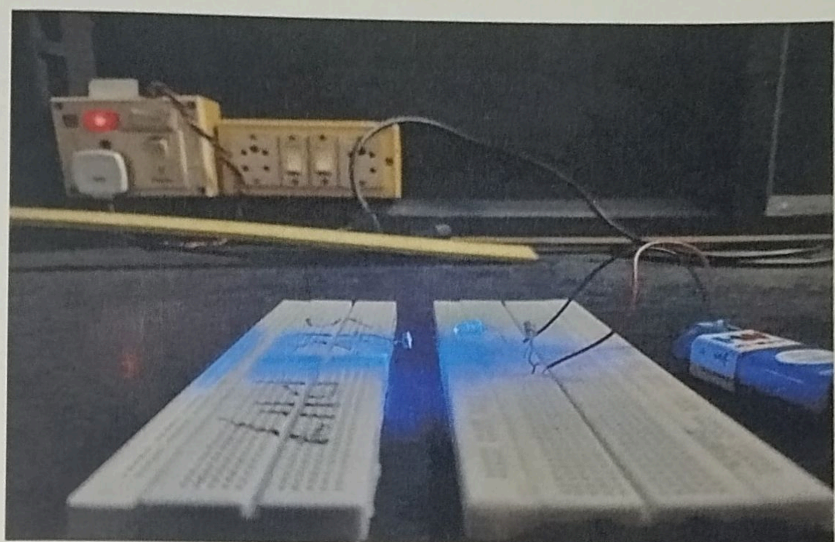


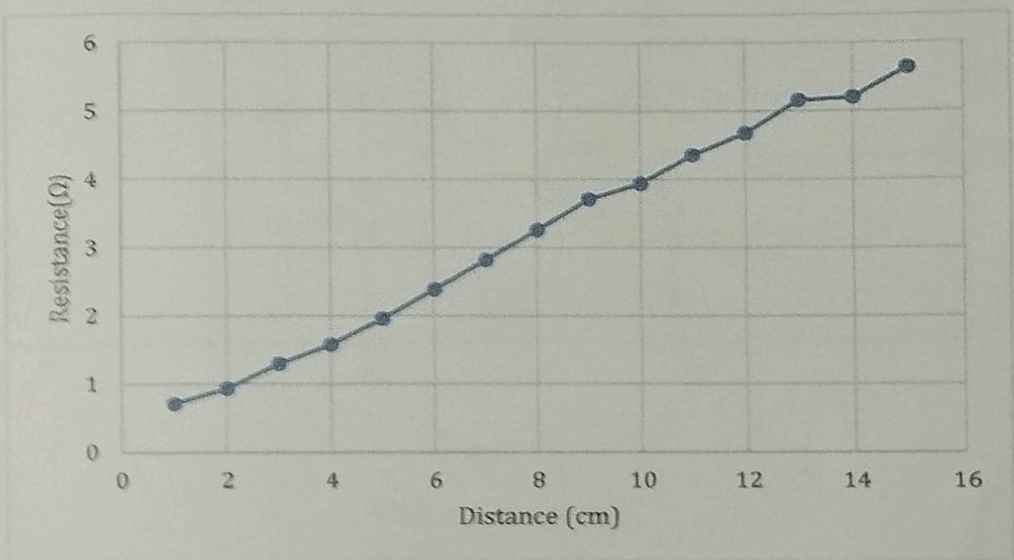
Figure 6

Experiment set up with Blue LED

OBSERVATION

Distance (cm)	Resistance(Ω)
1	0.709
2	0.929
3	1.294
4	1.571
5	1.95
6	2.38
7	2.81
8	3.25
9	3.70
10	3.93
11	4.35
12	4.67
13	5.15
14	5.19
15	5.63

DISTANCE -RESISTANCE GRAPH



3.APPLICATIONS

3.1 ELECTRONIC EYE CONTROLLED SECURITY SYSTEM

INTRODUCTION

The electronic eye-controlled security system utilizes a Light Dependent Resistor (LDR) as the primary sensing element. This system operates by detecting variations in incident light intensity. When a person or object obstructs the light falling on the LDR, its resistance changes, activating the connected circuit. Consequently, the doorbell rings when someone approaches the entrance. In addition to serving as an automatic door alert, the system functions as a basic security device capable of detecting unauthorized entry.

PRINCIPLE

The circuit operate 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 light up. This setup effectively alerts occupants to the presence of someone at the entrance.

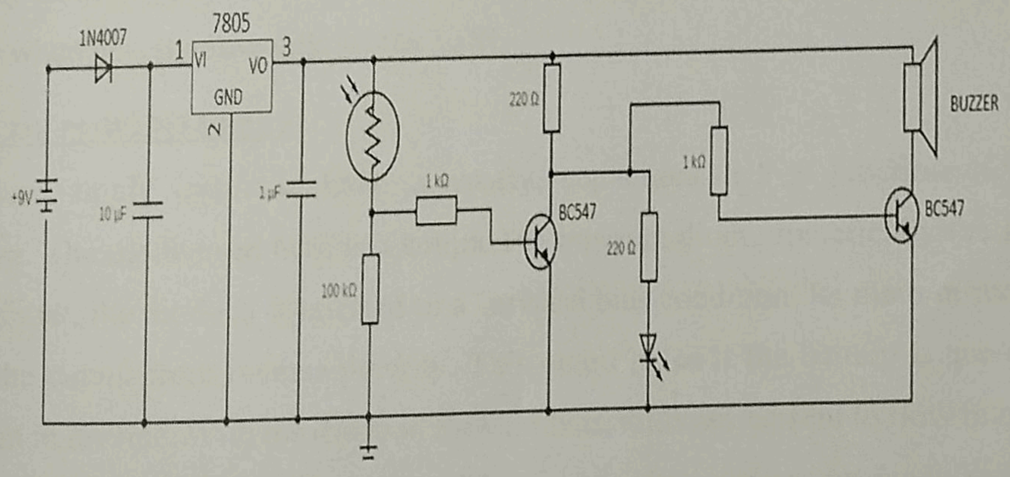


Figure 7

Circuit diagram

CIRCUIT COMPONENTS

- 7805 Regulator
- Resistor -220 0hm, 1kΩ,100k Ω
- IN4007 PN Diode
- Capacitor-1μ f,10 μ f
- Transistors –BC 547
- Light Dependent Resistor (LDR)
- Buzzer
- LED
- Bread board
- 9Vbattery

DESIGN

The circuit of the Electronic Eye Controlled Security System is dividing 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 includes a battery, capacitors, a P-N junction diode, and regulators. The diode used here is a simple PN junction diode, specifically the IN4007. In this circuit, the diode is connected in a forward bias condition. Its main purpose is to protect the circuit from reverse polarity. This guard helps if the battery is accidentally connected in reverse. With the diode in forward bias, it allows current to flow in only one direction, thus safeguarding the circuit. The voltage drop across the diode is 0.7V. A voltage regulator, IC 7805, is used to control the output voltage of the circuit. The "05" indicates the output voltage, while "78" refers to the series. This setup generates 5 volts at the output of the voltage regulator. To remove ripples, two capacitors are connected before and after the voltage regulator. This setup produces a steady voltage at the output, which is then 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 100K 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 SV 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. Connect 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 we buzzer sound and dimmer the LED Conversely, the darker the environment, the louder the and brighter the LED.

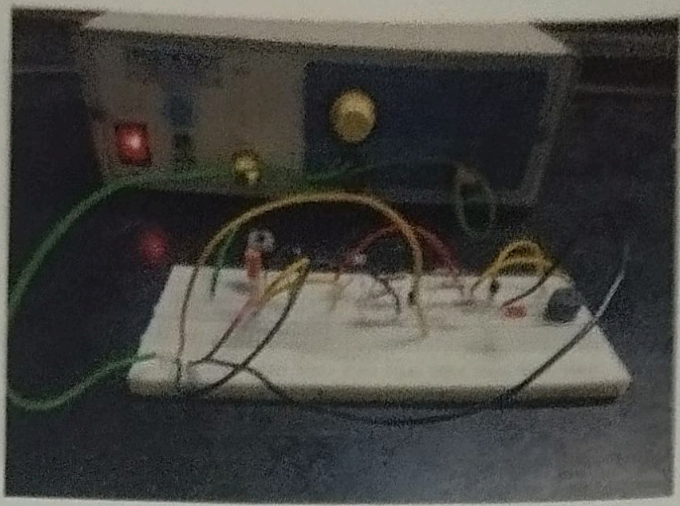


Figure 8(a)

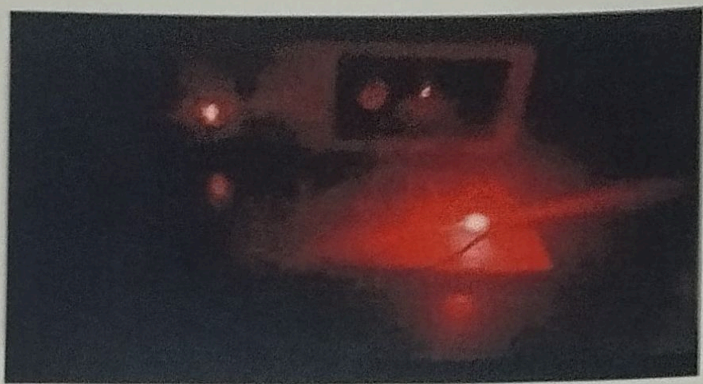


Figure 8(b)

Experiment set up with electronic Eye-Controlled Security System

3.2 AUTOMATIC STREET LIGHT CONTROL SYSTEM

INTRODUCTION

Traditional street lighting systems face the problem of wasting a considerable amount of energy due to manual operation or the use of timers that cannot be adjusted according to the changing lighting conditions. In the automatic system, a light sensor is used to switch the lights on in the evening and off in the morning. This reduces the energy consumption considerably. In rainy weather, the time for switching the lights on and off is different by a considerable margin, which is a major disadvantage of using a timer or a manual system for controlling the street lighting system.

PRINCIPLE

This automatic street light control system is a simple and powerful concept which uses transistor as a 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 switched 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.

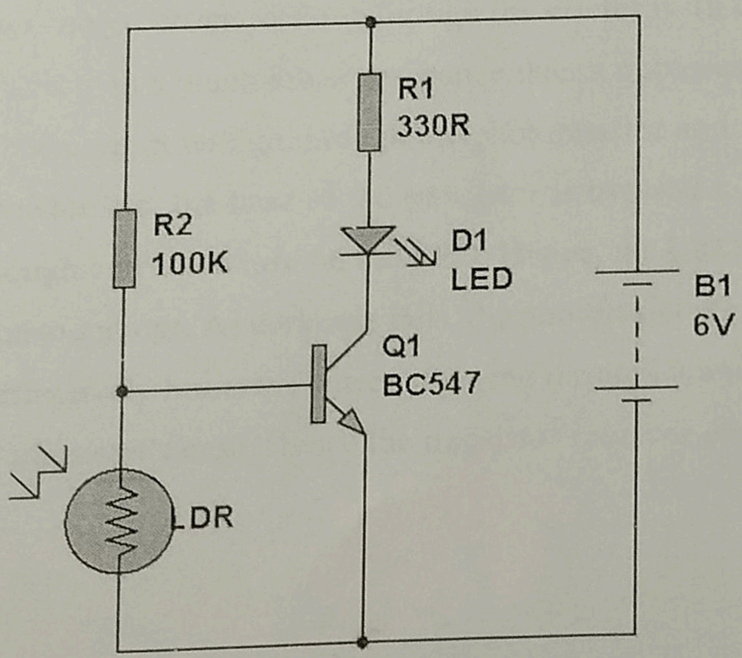


Figure 10 - circuit diagram

CIRCUIT COMPONENTS

- Light Dependent Resistor (LDR)
- Resistor-330 Ω,100 k Ω
- 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 an 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 100KO 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 receives enough current to turn on the LED.

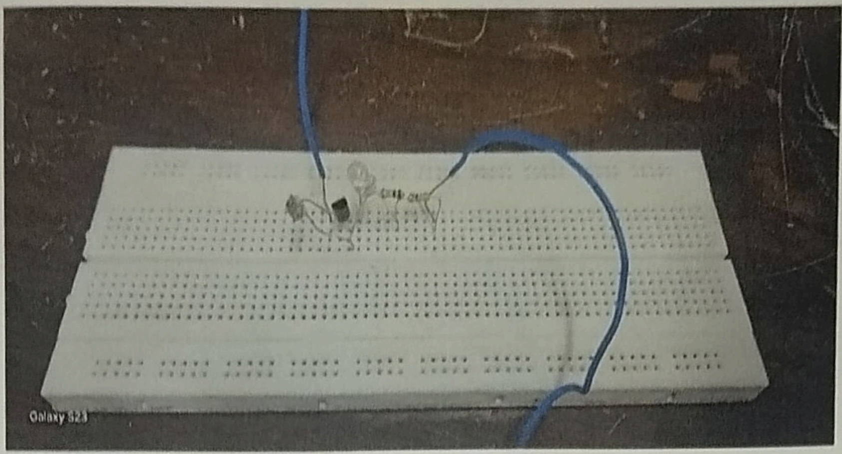


Figure 11(a)

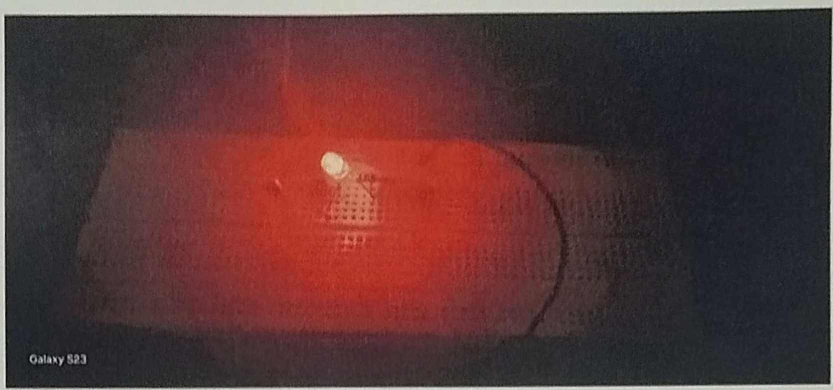


Figure 11(b)

Experiment set up with Automatic Street light control system

4.CONCLUSION

The primary characteristics of the passive component - LIGHT DEPENDENT RESISTOR (LDR) have been studied. This includes V-I Characteristics of LDR using red and blue LED light sources.

It has been observed that the V-I Characteristics of LDR show that the current increases with the voltage for these light sources.

In Study of the Resistance Across LDR, it has been observed that the resistance of the LDR increases when the distance increases. Which is due to the fact that the resistance of the LDR increases when the intensity of the light decreases.

The spectral response of a LDR fabricated using Cds is similar to the spectral response of the human eye. Hence, it is used in applications where the human eye is involved, e.g., street light control. This type of sensor is used in the automatic lighting of the street to conserve energy. For example, the street light can be turned off during the daytime by using the LDR sensors. Also, the lights can be dimmed depending on the natural light available. This type of LDR sensor is used in the motion detectors and burglar alarm security systems.

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