**Shri Guru Gobind Singhji Institute of Engineering and Technology**
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Govemment Aided Autonomous Institute OTE Code: 2020
NAAC Accredited Institute GRADE B+, CGPA 2.11 (2020-2025)
Vision Statement: Education of Human Power for Technological Excellence

## Department of Electrical Engineering

A Micro Project
Report on

# AUTOMATIC CAR HEADLIGHT ON AND OFF CIRCUIT

## Submitted by

Project Group code – PGEE25

| Sr.No. | Name of Students | Registration No. |
|---|---|---|
| 01. | Pampatwar Aishwarya Balu | 2024BEL502 |
| 02. | Tayde Shubham Krushna | 2024BEL503 |
| 03. | Garole Ramkishan Harichandra | 2024BEL504 |
| 04. | Waghmare Akanksha Chandrakant | 2024BEL507 |
| 05. | Rajmane Abhijeet Mahaling | 2024BEL508 |

**Date:** 22/04/2025 **Guided by : Ms. S. B. Pachpute**

# CERTIFICATE

This is to certify that the group

| | | |
|---|---|---|
| 1. | Pampatwar Aishwarya Balu. | 2024BEL502 |
| 2. | Tayde Shubham Krushna. | 2024BEL503 |
| 3. | Garole Ramkishan Harichandra. | 2024BEL504 |
| 4. | Waghmare Akanksha Chandrakant. | 2024BEL507 |
| 5. | Rajmane Abhijeet Mahaling | 2024BEL508 |

Students of Electrical Engineering have successfully completed their group project titled:
“**Automatic Car Headlight on and Off Circuit**"
During the academic session 2024-25 in a satisfactory manner as part of the curriculum for the subject: Micro Project.

**Ms. S.B. Pachpute**
**Project Guide**

**Dr.S.M. Gudhe.**
**Head of Department**

# DECLARATION

We, the undersigned students of Second Year Electrical Engineering, Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded, hereby declare that the micro project entitled "Automatic Car Headlight ON and OFF Circuit”
has been completed by us under the guidance of Ms.S.B.Pachpute in partial fulfillment of the curriculum requirements for the academic year 2024–2025.

We affirm that the work presented in this report is the result of our own efforts, learning, and understanding. The project is based on the knowledge and skills we have acquired during our coursework and practical sessions. All the data, circuit designs, and content included in this report have been prepared sincerely and accurately to the best of our abilities.

# ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Ms.S.B.Pachpute for their valuable guidance, support, and encouragement throughout the completion of our micro project titled “Automatic Car Headlight ON and OFF Circuit”. Their constant supervision and timely suggestions played a vital role in the successful execution of this project.

We are also thankful to Dr.S.M.Gudhe Head of the Department of Electrical Engineering, for providing the necessary resources and academic environment to carry out this work.

We also extend our thanks to the faculty members and staff of the Electrical Engineering Department, SGGSIE&T Nanded, for their assistance and cooperation during the project work.

# ABSTRACT

The micro project titled “Automatic Car Headlight ON and OFF Circuit” focuses on the development of an intelligent lighting control system designed to improve driving safety and reduce energy consumption in vehicles. In today’s fast-paced world, where automation is rapidly becoming a standard in automotive technology, this project aims to eliminate the manual effort required to operate vehicle headlights by automatically controlling them based on the surrounding light conditions.

The system uses a Light Dependent Resistor (LDR) to sense ambient light intensity. When the light level falls below a specified threshold—such as during nighttime, overcast weather, fog, or when entering tunnels—the circuit automatically activates the headlights. In contrast, when there is sufficient daylight or bright surroundings, the circuit switches the headlights OFF. The design incorporates basic yet effective components such as IC 555, transistors, diodes, relays, and resistors, making the circuit simple, low-cost, and easy to implement.

This project not only addresses the issue of driver distraction due to manual switching but also contributes to energy efficiency, especially in electric vehicles where power management is critical. The automated headlight system ensures that the headlights are always used appropriately without driver intervention, thus improving visibility and reducing the risk of accidents.

Through this project, we gained hands-on experience in designing sensor-based circuits, understanding the practical applications of analog electronics, and working as a team to solve a real-world problem. The final outcome is a reliable, functional prototype that demonstrates how simple automation can enhance both convenience and safety in the automotive sector.

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# 1: Introduction

## 1.1 Background

In recent years, road safety has become a growing concern due to the increasing number of vehicles on the road. One of the critical aspects of vehicle safety, especially during low-light conditions such as fog, dusk, or nighttime, is proper illumination. However, drivers often forget to turn on headlights in such conditions, leading to accidents. This has motivated the development of automatic lighting systems that eliminate the need for manual intervention. An automatic headlight ON/OFF system uses sensors to detect ambient light levels and control the headlights accordingly, thereby enhancing driver convenience and safety.

## 1.2 Motivation

Manual control of headlights is prone to human error and delay, particularly when lighting conditions change suddenly. There have been many cases where accidents occurred because headlights were not turned on in time. This motivated us to design a circuit that automates the process of turning vehicle headlights ON or OFF depending on ambient light. Not only does this enhance road safety, but it also introduces a level of automation suitable for modern smart vehicles.

## 1.3 Objectives

- The main objectives of this project are:
- To design a circuit that automatically switches the car's headlight ON in low-light conditions and OFF in daylight.
- To utilize light-dependent resistor (LDR) sensors for detecting ambient light.
- To implement a reliable and cost-effective solution that can be integrated into existing vehicles.
- To simulate the circuit in Proteus software and analyze its performance.

## 1.4 Scope of Work

The scope of this project includes:

1. Designing the complete circuit on a breadboard and in simulation.
2. Using basic electronic components such as LDR, transistors, and relays for switching.
3. Demonstrating the working using simulation tools and presenting the current and voltage graphs during ON, OFF, and AUTO states.
4. Analyzing the circuit's response to changing light conditions.
5. Proposing how this system can be extended with microcontroller integration or sensor enhancements in the future.

## 1.5 Organization of Report

This report is organized into the following chapters:

- ✓ Chapter 1 provides an introduction to the project, including the background, motivation, objectives, scope, and structure of the report.
- ✓ Chapter 2 presents a review of existing literature and technologies related to automatic lighting systems.
- ✓ Chapter 3 details the methodology used for system design and explains the circuit operation.
- ✓ Chapter 4 discusses the implementation including components used, PCB layout (if applicable), and build photos.
- ✓ Chapter 5 presents the results from simulations and their analysis.
- ✓ Chapter 6 discusses real-world applications and future scope.
- ✓ Chapter 7 concludes with key findings and achievements.

# 2.Literature Review

The increasing emphasis on road safety and energy efficiency has led to significant advancements in automotive lighting systems. Automating headlight operation based on ambient light conditions is a pivotal development in this domain.

**Hilary Ezea and colleagues** designed an automatic headlight switching system that transitions from high to low beam upon detecting an oncoming vehicle, aiming to reduce glare-induced accidents. Their circuit utilized a Light Dependent Resistor (LDR), a potential divider network, and a relay mechanism, achieving effective switching at a sensing distance of approximately 147 meters.

In another study, **Ganesh Kanike et al**. reviewed various automatic light control mechanisms in vehicles. They discussed systems employing Arduino Uno, LDRs, and accelerometers to automate headlight intensity adjustments, highlighting the potential of integrating such technologies for enhanced driving safety.

**Aman Doraya and Alekh Jain** focused on designing a headlight circuit aimed at reducing power consumption. Their approach involved an automatic system that deactivates headlights during daylight, thereby conserving energy and improving mechanical efficiency.

Additionally, **Swaroop et al.** explored the design of light-sensing automatic headlamps and taillamps, emphasizing the role of photo-sensors in enhancing vehicle lighting systems. Their work underscores the importance of integrating sensor-based technologies for improved automotive safety.

These studies collectively underscore the significance of automating headlight operations to enhance road safety and energy efficiency. The insights and methodologies from these works have informed the development of our project, which aims to implement a cost-effective and efficient automatic headlight control system using LDRs and basic electronic components.

# 3.System Design/ Methodology

## 3.1 Block Diagram

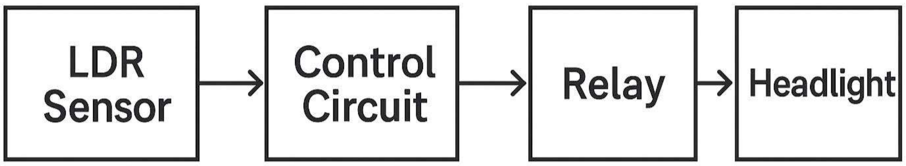



fig.3.1. Block Diagram

## 3.2. Circuit Diagram

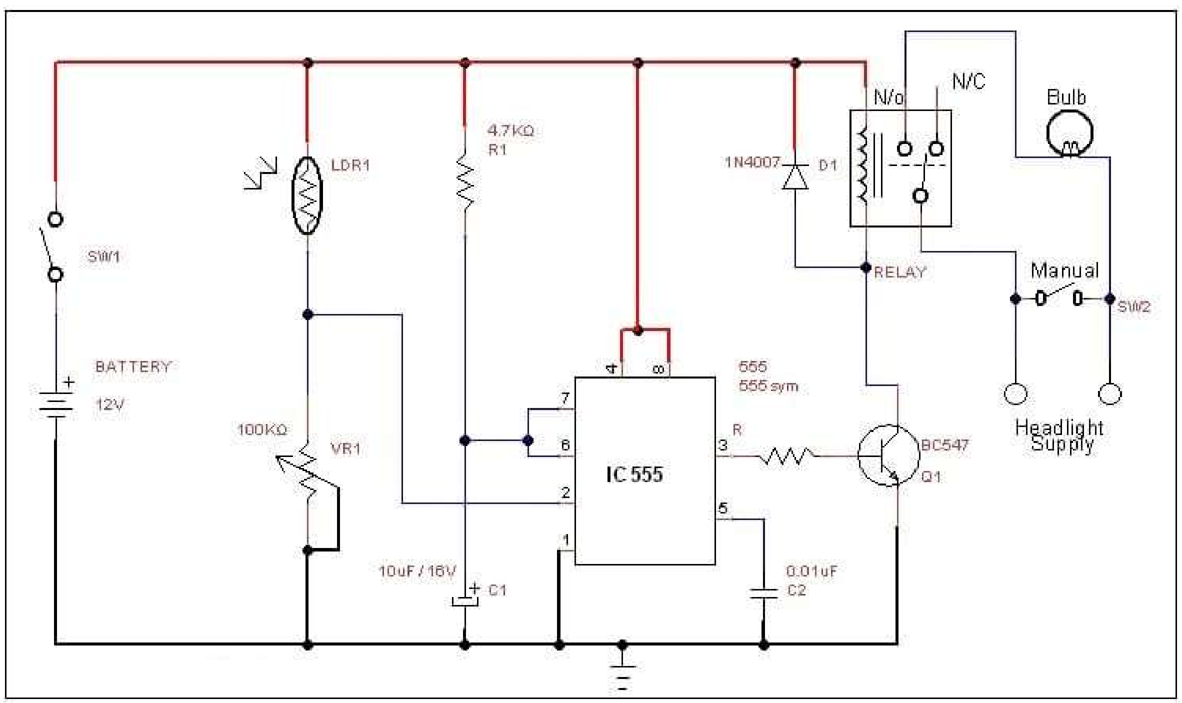



fig.3.2. Circuit Diagram

## 3.3 Description / Working

The automatic headlight system operates by detecting the ambient light level and switching the headlight ON or OFF accordingly without any manual intervention. The main sensing component in the circuit is an LDR (Light Dependent Resistor), which changes its resistance based on the surrounding light intensity. During daytime or when sufficient light is present, the resistance of the LDR remains low. This results in a higher voltage being applied to the trigger pin (pin 2) of the 555 Timer IC, keeping the timer inactive. In this state, the output of the timer (pin 3) stays LOW, which means the transistor connected to it remains in the OFF state, and the relay is de-energized. Consequently, the headlight remains turned OFF.

However, when the ambient light decreases—such as at night or in a tunnel—the resistance of the LDR increases significantly. This causes the voltage at the trigger pin of the 555 Timer to drop below one-third of the supply voltage (Vcc). This low voltage triggers the timer, causing its output to go HIGH for a certain duration determined by the external resistor and capacitor connected to the timer (RC time constant). The HIGH output signal activates the NPN transistor (BC547), allowing current to flow through the relay coil. As a result, the relay energizes, and its normally open (NO) contacts close, completing the circuit for the headlight. The headlight then switches ON automatically.

Additionally, a manual override switch (SW2) is included in the circuit to allow the user to manually control the headlight if desired. A diode (1N4007) is connected across the relay coil to protect the transistor from voltage spikes (back EMF) generated when the relay is turned OFF. This entire process allows the headlight to operate intelligently based on lighting conditions, enhancing convenience and safety in low-visibility environments.

## 3.4 Components Used

1. **LDR (Light Dependent Resistor):**

Senses the ambient light level. Its resistance decreases in bright light and increases in darkness. It forms a voltage divider with the variable resistor to control the input to the 555 timer.

2. **Variable Resistor (Potentiometer):**

Adjusts the sensitivity of the circuit to light. It allows the user to set the light level at which the headlight should automatically turn ON.

3. **555 Timer IC:**

Acts as the main control unit. It is configured in monostable mode to provide a HIGH output pulse when the ambient light drops below a set level (as detected by the LDR-voltage divider).

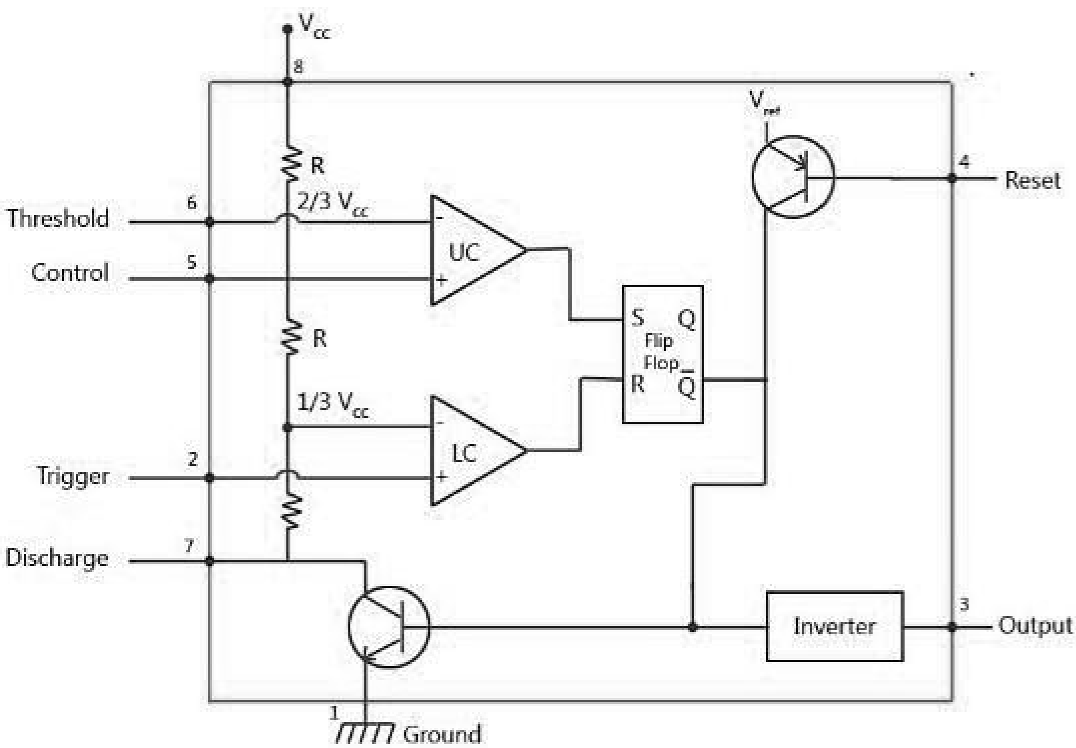



fig.3.4.1.IC555 Circuit Diagram

4. **Capacitor (connected to 555 Timer):**

Determines the duration of the output pulse from the 555 timer when triggered. Also helps in noise filtering and stabilizing the circuit.

5. **Resistors**:

Used to limit current to various parts of the circuit and to form part of the timing and voltage divider networks. They ensure proper biasing of the transistor and functioning of the timer.

6. **BC547 NPN Transistor:**

Acts as a switch. It amplifies the output from the 555 timer and drives the relay by allowing higher current to pass through the relay coil.

7. **Relay:**

An electromagnetic switch that turns the headlight ON or OFF. It isolates the low-power control circuit from the high-power headlight load.

8. **Diode (1N4007):**

Protects the transistor from the reverse voltage (back EMF) generated by the relay coil when it turns OFF.

9. **Bulb (Headlight):**

The output load of the system. It turns ON when the relay is activated in low light conditions.

10. **Switch SW1 (Power Switch):**

Used to turn the entire circuit ON or OFF manually.

11. **Switch SW2 (Manual Override):**

Allows the user to bypass the automatic system and turn ON the headlight manually when needed.

12. **Power Supply (12V)**

Powers the entire circuit, including the timer, relay, and headlight.

### 3.4.1 Component Specifications

| Sr.No. | Name of Components | Specifications |
|---|---|---|
| 01. | Relay | Coil voltage: 5V<br>Contact rating: 10A at 250V AC or 30V DC |
| 02. | LED | Forward Voltage: 1.8V to 2.2V<br>Forward Current: 10mA to 20mA |
| 03. | Potentiometer | Resistance: 100kΩ |
| 04. | Fixed Resistor R1. | Resistance: 10kΩ<br>Power Rating: 0.25W |
| 05. | LDR (Light Dependent Resistor) | Resistance in darkness: ~1MΩ<br>Resistance in light: ~1kΩ or less<br>Response time: 20ms to 100ms<br>Max voltage: ~150V |
| 06. | Power Supply | 12 V regulated dc power supply |
| 07. | Switch SW1 (Power Switch) | Current rating: ≥1A<br>Voltage rating: ≥12V |
| 08. | Switch SW2 | Current rating: ≥1A<br>Voltage rating: ≥12V |
| 09. | Diode (1N4007) | Peak repetitive reverse voltage: 1000V<br>Average forward current: 1A<br>Forward voltage drop: 0.7V |
| 10. | IC555 | Operating voltage: 4.5V – 15V DC<br>Output current: 200mA max |

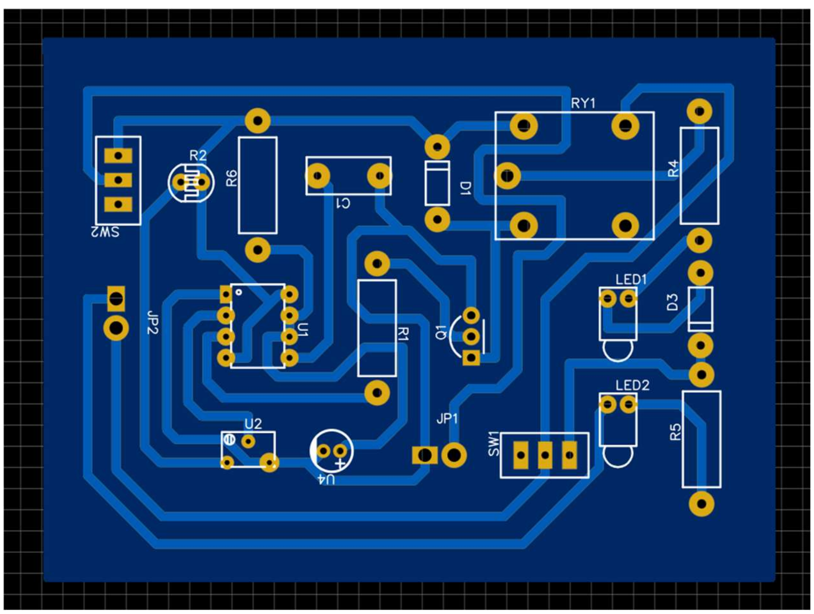
## 3.5 Hardware / Software Used

1. Breadboard – Used for initial prototyping and testing of the circuit without soldering.
2. Soldering Kit – For assembling components onto the PCB after finalizing the design.
3. PCB (Printed Circuit Board) – Final version of the circuit is implemented on a PCB for durability and professional finish

### Software Requirements:

1. EasyEDA – Used for schematic design and PCB layout creation. It helps in converting the breadboard prototype into a printed circuit board format.
2. Proteus – Used to simulate the circuit behavior before building the physical prototype. It allows for virtual testing and debugging of the design, ensuring functionality.

- ## 2D layout of circuit

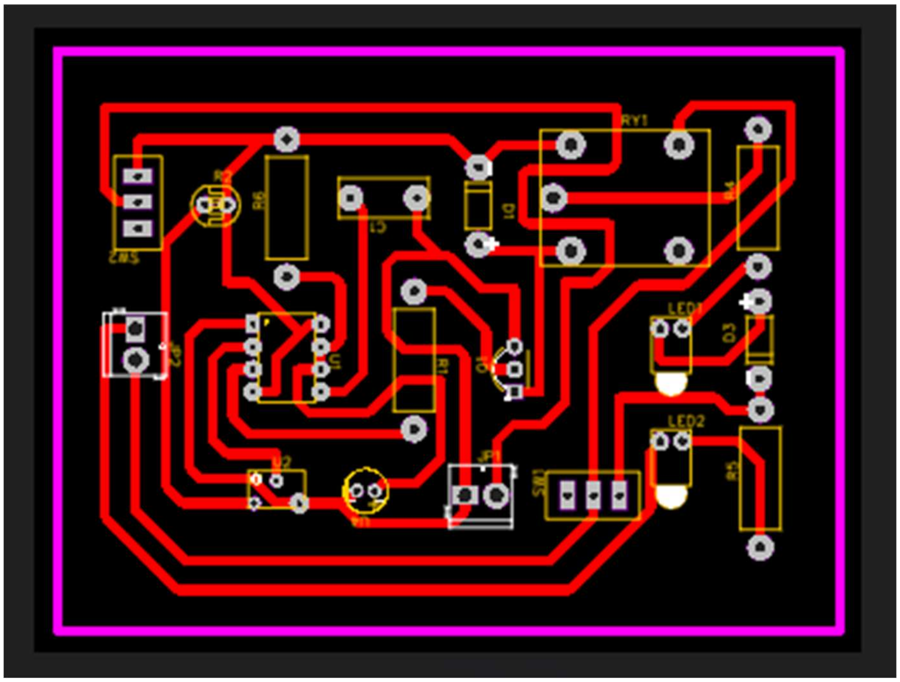


# 4.Implementation

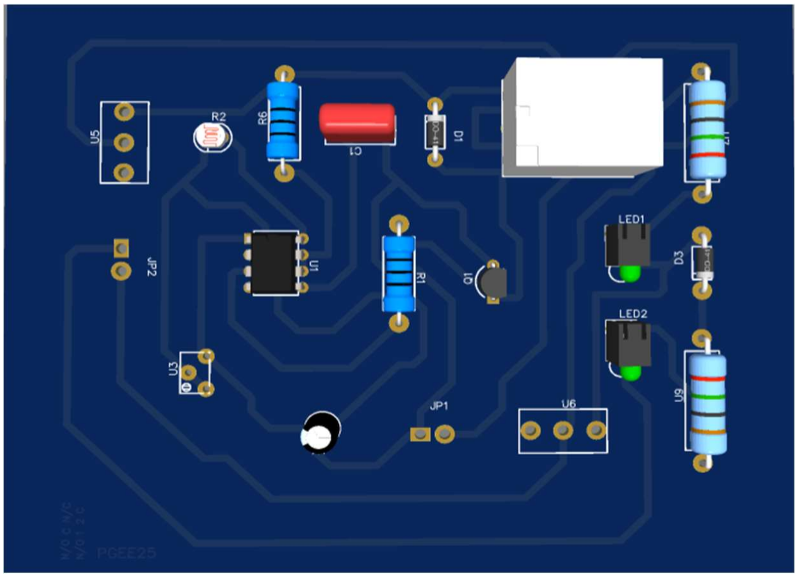
## 4.1 Tools Used

1. Breadboard – For testing the circuit before soldering.
2. Soldering Iron & Soldering Wire – Used to assemble components on the PCB.
3. Multimeter – To test voltage levels and connections.
4. PCB Board – Used to mount the final circuit.
5. Laptop with EasyEDA and Proteus Software – For simulation and PCB design.

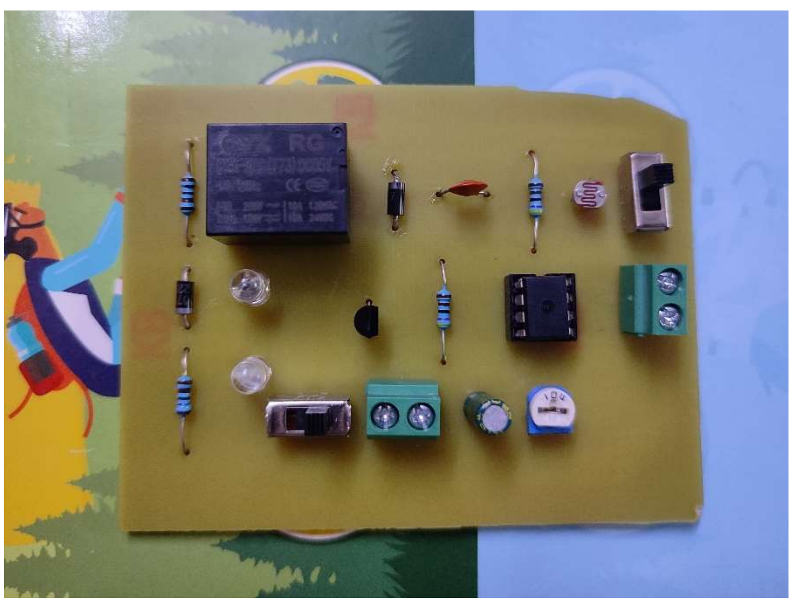
## 4.2 PCB Track Layout



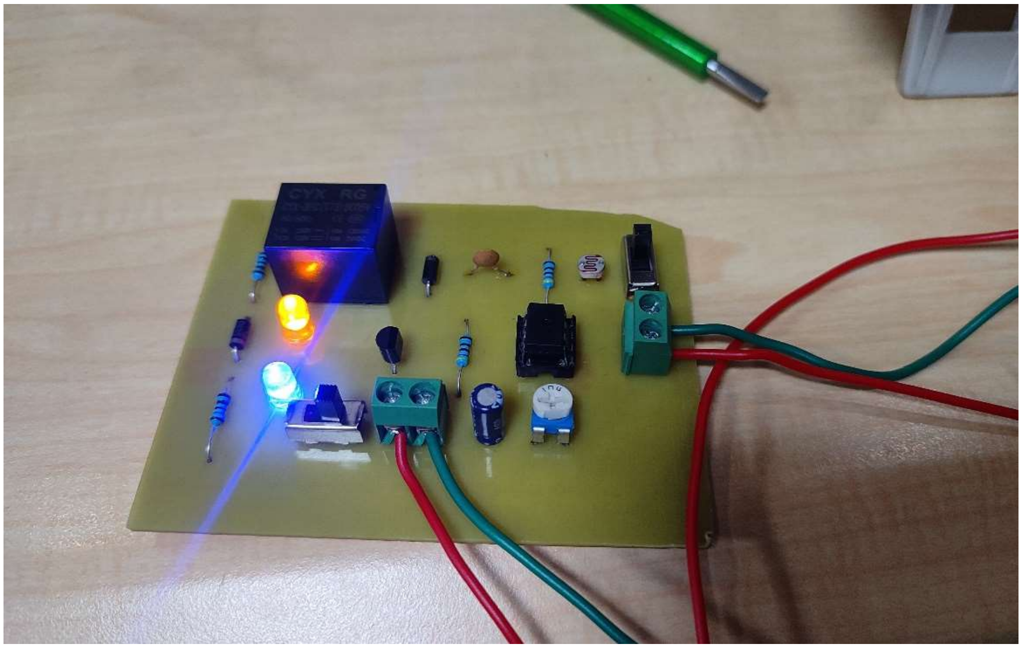
## 4.3 PCB 3D Layout / Top View



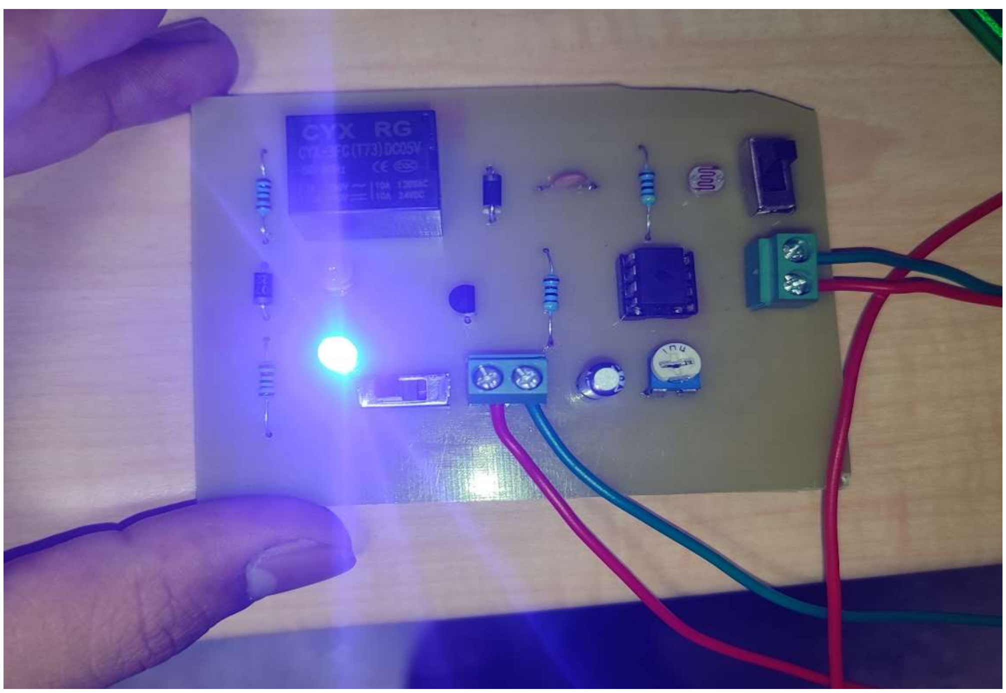

## 4.4 Fabricated PCB



## ➢ Automatic ON condition



## ➢ Manual ON condition



# 5.Results and Discussion

## 5.1. Simulation Output

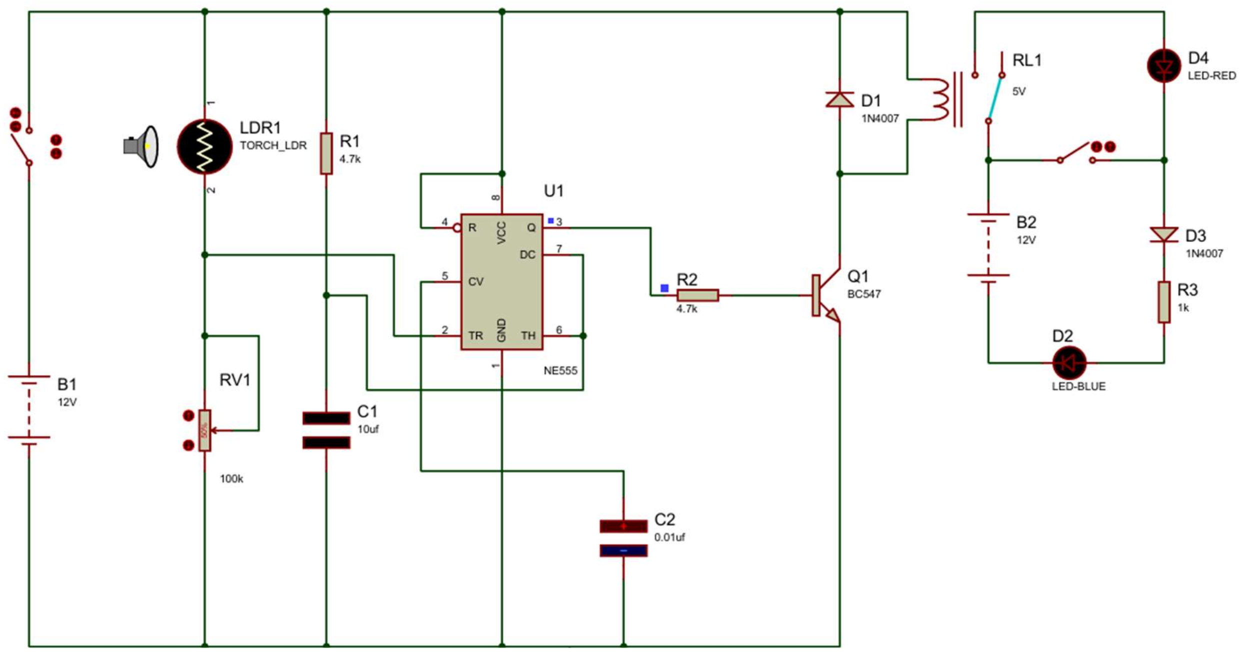



fig.5.1.1.OFF Condition 1

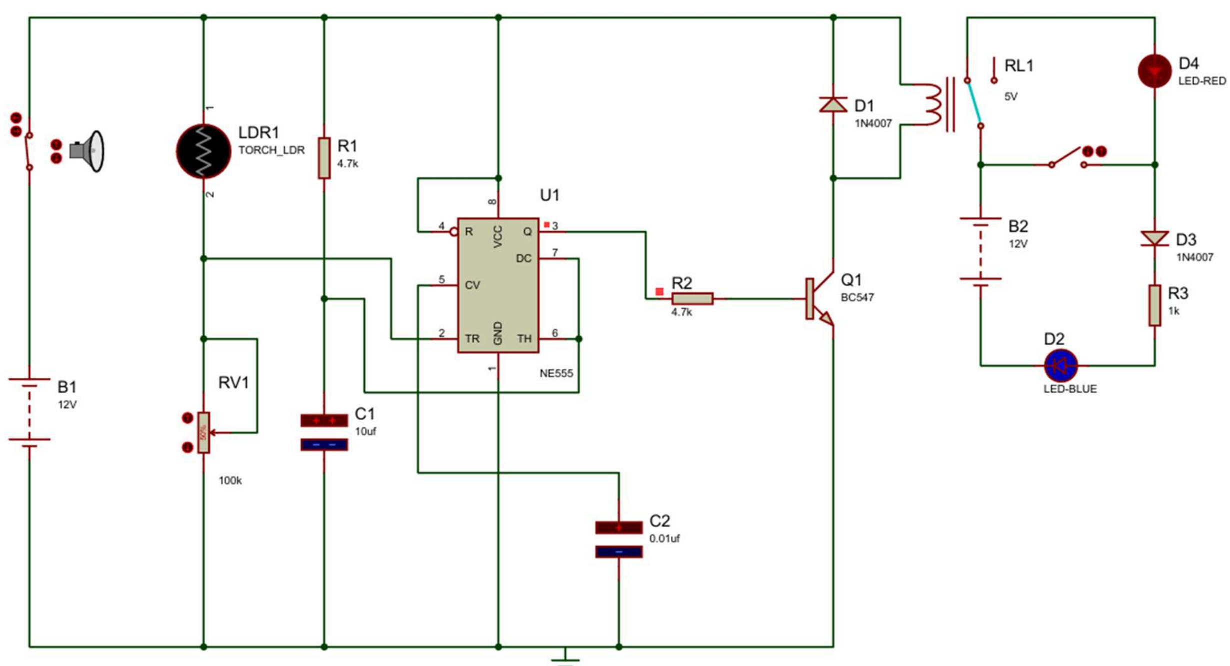



fig.5.1.2. OFF Condition 2

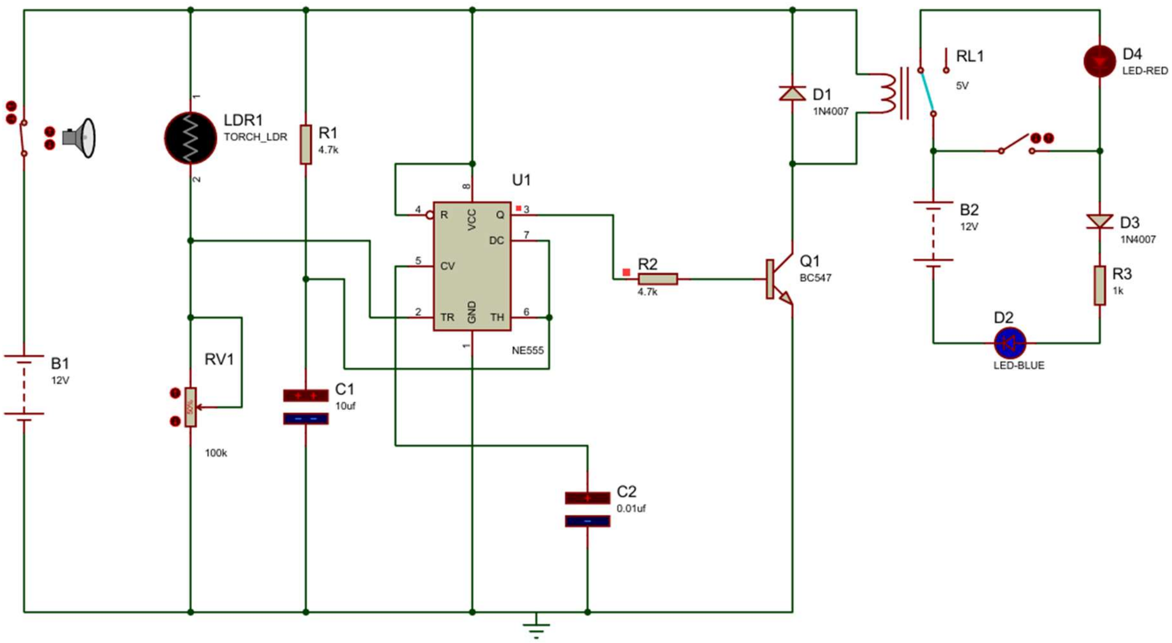



fig.5.1.3.Automatic ON Condition

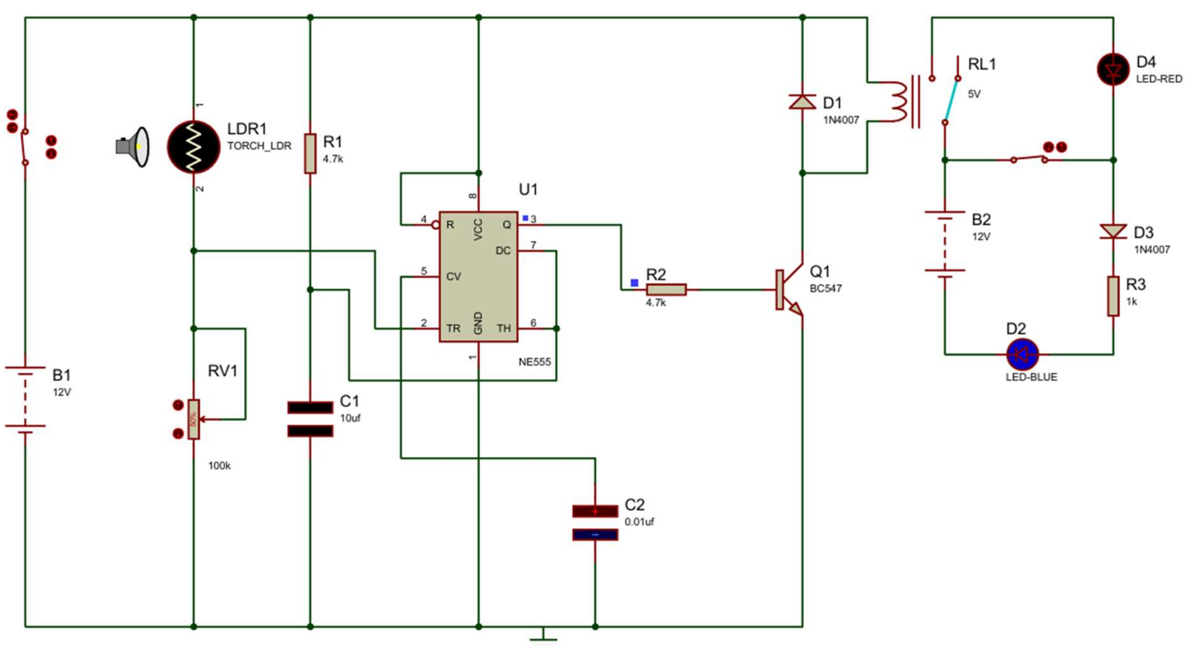
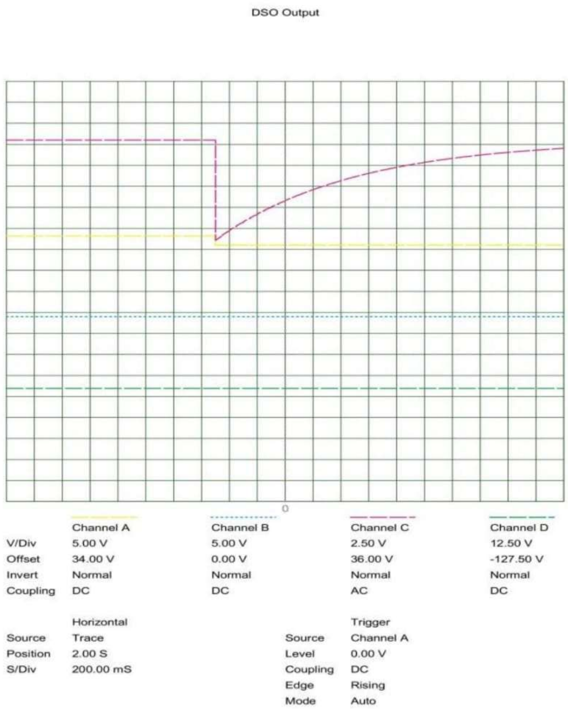


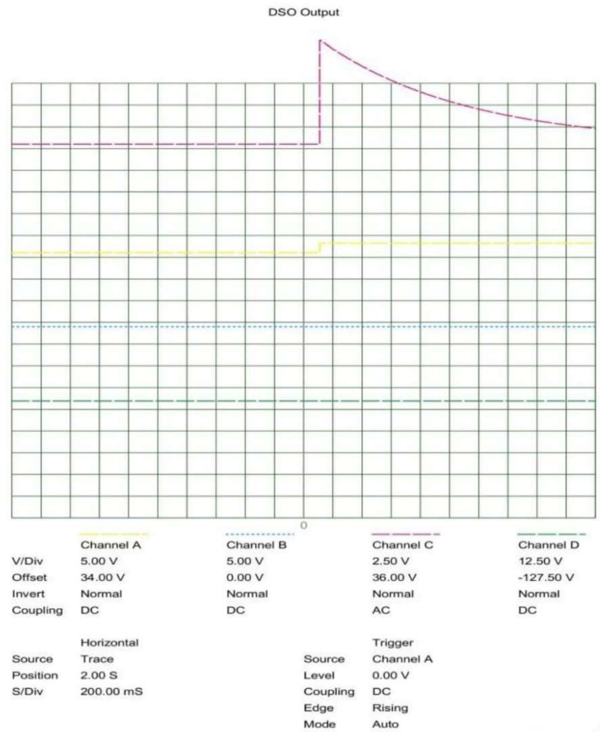

fig.5.1.4. Manual ON Condition

## ➢ graphical simulation output

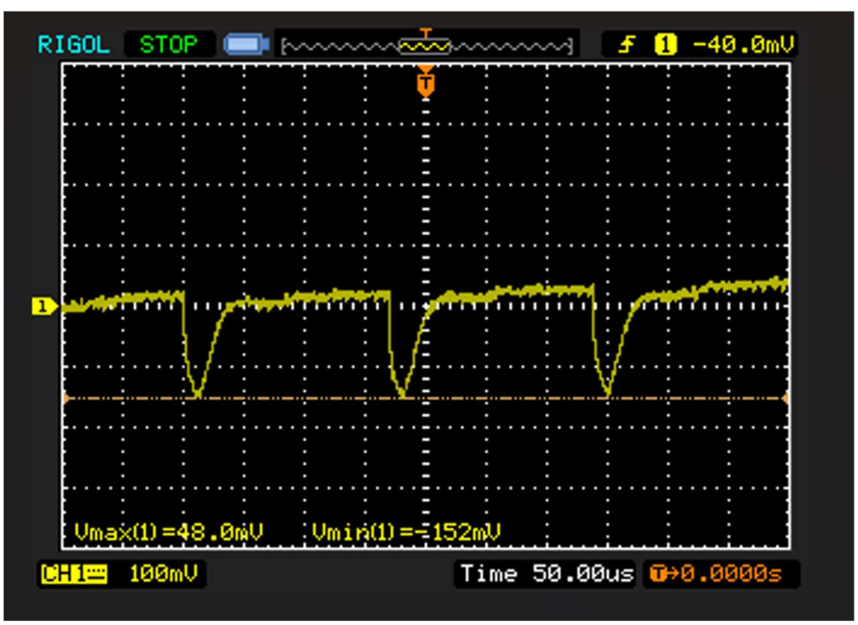
During ON to OFF condition
( light intensity goes high )




During OFF to ON condition
( light intensity goes low




## ➢ Actual graphical output



### 5.2. Result

The automatic headlight system circuit was successfully simulated and tested using Proteus simulation software. The system was evaluated under four different conditions: automatic ON, manual ON, and two OFF conditions. In the automatic ON condition, the LDR sensor detected low ambient light levels, triggering the control circuit to activate the relay and turn on the headlight automatically. In the manual ON condition, the headlight could be turned on manually regardless of light intensity, demonstrating user override functionality. The first OFF condition occurred when sufficient ambient light was detected, causing the headlight to remain off automatically. The second OFF condition involved manual deactivation, allowing the user to switch off the headlights even if the system was in automatic mode. The simulation results confirmed that the circuit operated accurately and reliably under all defined scenar

# 6. Applications and Future Scope

### 6.1 Applications

The Automatic Headlight ON/OFF circuit has various practical applications in different fields. Some of the major applications include:

1. Automotive Headlight Control:

Used in two-wheelers, cars, and other vehicles to automatically switch on headlights during low light or nighttime, enhancing driver safety.

2. Automatic Street Lighting:

Useful in street light systems to turn ON the lights automatically in the evening and OFF in the morning, thereby saving energy.

3. Home Automation:

Can be implemented in smart home systems for automatic outdoor or indoor lighting based on ambient light levels.

4. Security Lighting Systems:

Helps in activating security lights automatically during nighttime to improve visibility and surveillance.

5. Solar Lighting Projects:

Applicable in solar garden or pathway lights that only illuminate when it gets dark, making them energy efficient.

## 6.2 Future Scope

There is significant scope for enhancing this project further using modern technologies. Some possible future developments include:

1. Microcontroller Integration:
Adding a microcontroller like Arduino or ESP32 for programmable light control, adjustable thresholds, and timing functions.

2. IoT-Based Control:
Integration with IoT platforms for remote control and monitoring through mobile applications or web interfaces.

3. Smart Power Management:
Incorporating PWM (Pulse Width Modulation) techniques for dynamic brightness control based on real-time ambient light intensity.

4. Battery and Solar Power:
Designing portable, energy-efficient systems powered by rechargeable batteries and solar panels for off-grid applications.

5. Environmental Sensing:
Enhancing the system to respond to rain, fog, or dust levels in addition to darkness, for better safety and automation.

# 7.Conclusion

The automatic headlight system was successfully designed, simulated, and analyzed. The system effectively responds to varying light conditions using an LDR sensor and a control circuit to automate headlight operation. It also incorporates manual override functions for user flexibility. The Proteus simulation verified the proper functioning of all four conditions—automatic ON, manual ON, and both OFF conditions—demonstrating the reliability and practicality of the design. This system enhances driving safety by ensuring headlights operate appropriately without driver intervention, especially in low-light or tunnel environments.