EC4050 - MINI PROJECT

DEVELOPING PCB FOR A SIMPLE ELECTRONIC CIRCUIT

SMART ROOM CONTROLLER USING LM741 IC

GROUP MEMBERS

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AIM

- To familiar with the PCB design and development.
- creating a small and effective printed circuit board layout for the Smart Room Light and Temperature Controller.
- combining light and temperature sensors to collect data in real time.
- putting in place an automated temperature and light control system using a microcontroller
- ensuring the PCB design's resilience and dependability for real-world uses.

OBJECTIVES

- Designing and simulation the circuit in Proteus software.
- Circuit construction in the breadboard.
- PCB development and testing.

APPARATUS

- NPN Transistor BC547
- Thermistor (10K)
- LDR
- Op amp (LM741)
- Resistors (1K, 100K, 4.7K)
- Variable resistor (1M)
- LED
- Buzzer and Battery (9v)
- Variable resistor
- Copper plate
- Photo paper
- FeCl3
- Thinner
- Marker
- Drilling machine
- Cutting machine
- Laser printer
- PC
- Bread board
- Soldering machine
- iron

INTRODUCTION

Introducing the Smart Room Controller PCB circuit, a cutting-edge solution designed for seamless home automation. Leveraging the precision of the operational amplifier (OP-AMP 358), this innovative system dynamically adjusts light intensity based on ambient light levels, ensuring optimal illumination.

Additionally, it intelligently regulates fan RPM in response to ambient temperature changes, enhancing comfort and energy efficiency. The integration of advanced sensing technology empowers users to create a customized and responsive environment.

This compact and efficient PCB circuit embodies the next generation of smart living, delivering a harmonious blend of comfort, sustainability, and technological sophistication.

OPAMP 358

The Operational Amplifier (OP-AMP) 358 is a versatile integrated circuit widely used in electronic applications due to its high-performance characteristics. Operating as a differential amplifier, it has two inputs, inverting (-) and non-inverting (+), and a single output.

The OP-AMP 358 is known for its low input offset voltage, making it ideal for precision applications. Its high input impedance and low output impedance facilitate signal amplification without significant loading effects. The chip typically features two OP-AMPs in a single package, maximizing functionality.

In operation, the OP-AMP amplifies the voltage difference between its inverting and non-inverting inputs. This amplified output voltage is proportional to the input voltage difference.

The 358 OP-AMP is particularly suitable for applications requiring accurate signal amplification, filtering, and signal conditioning. Its reliability, versatility, and efficiency contribute to its widespread use in electronic circuits, ranging from audio amplifiers to sensor interfaces.

WORKING CONCEPT

- In this Temperature Controlled DC Fan, we are using an Operational Amplifier as our major component which first compares reference voltage at the inverting and non-inverting input pins and controls the output voltage. Transistor BC547 is working as a switch that makes connections DC fan from the power supply. There is also connected a potentiometer in the circuit which is wired across the power supply and its variable pin to the Noninverting input of IC.

- When the temperature of the surroundings increases and attains the threshold, then the operational amplifier gives differential voltage turns ON the transistor. As a result, the connected DC fan gets ground supply and runs. If the temperature level goes below the set threshold level, then op-amp IC produces zero output, hence Q1 remains in OFF condition and so does the DC fan.

- As shown in the circuit LDR with variable resistance VR1 forms a voltage divider network. The output of this network is given to non-inverting input. The LDR is a variable resistor whose resistance change according to the intensity of light falling on it.

- Variable resistor VR1 is used to adjust the sensitivity of LDR i.e., on what intensity of light, the circuit triggers the load (LED). Another input voltage is taken from the voltage divider network using resistor R1 and R2 which forms a voltage divider network that divides Vcc into two parts thus ½ Vcc volt is available at inverting input.

- Op-amp 741 compares these two voltages and produces output. This output is fed into transistor switch Q1 and the LED glows depending on the Q1 ON and OFF conditions.

- If the voltage at pin 3 is high, the output of IC1 is also high and if the volt at pin 3 is low, the output of IC1 is low. The LDR is a variable resistor whose resistance decreases with the increase in light intensity.

- When light falling on an LDR has low intensity (dependent upon adjustment of variable resistor VR1), its resistor is large enough and the voltage across VR is less than ½ Vref thus the output of IC becomes low.

- This low output triggers the transistor Q1 and as a result LED starts to glow. However, when light falling on LDR is of large intensity, the resistance of LDR falls and the voltage drop across VR1 is large enough (more than ½ Vcc). Thus, the output of IC becomes high. This high output drives the transistor in an off state and as a result LED goes OFF.

KEY PROBLEMS FOCUSED ON

- The difficulty of maintaining an ideal room temperature is addressed by temperature regulation, which is a crucial component of the Smart Room Temperature and Light Controller. By combining an operational amplifier (LM741) with a thermosistor (10K), this is accomplished. At its input pins, the Operational Amplifier compares the reference voltage, and the Thermistor functions as a temperature-sensitive resistor.
- An Operational Amplifier generates a differential voltage that triggers a transistor switch when the ambient temperature rises above a predetermined threshold (BC547). Consequently, the DC fan is turned on or off by this switch.
- The device so actively responds to temperature changes to provide a comfortable atmosphere and encourages energy economy by only running the fan when necessary.
- Another essential component of the Smart Room Controller is Lighting Control, which improves energy efficiency and offers customised lighting settings. An operational amplifier (LM741) and an LDR (light dependent resistor) are included to help with this function. A voltage divider network is created when the LDR and a variable resistor (VR1) are combined.
- The output that regulates a transistor switch is determined by the Op-amp 741 by comparing voltages from the LDR and a reference network (Q1).
- The transistor either permits current to flow, turning on an LED, or blocks it, shutting off an LED, depending on the amount of ambient light.
- Its adaptable response to lighting circumstances guarantees the energy-efficient use of artificial lighting while also accommodating the user's choice for various lighting settings in the space, so contributing to a more adaptable and sustainable living environment.

METHODOLOGY

1. DESIGN PLAN

The Smart Room Controller PCB circuit design begins with integrating the OP-AMP 358 for precision signal processing. For ambient light control, a light-dependent resistor (LDR) will serve as the sensor, with its resistance varying based on light intensity. The LDR is connected to the non-inverting input of the OP-AMP, forming a voltage divider with a fixed resistor.

The OP-AMP amplifies the voltage difference, and the output drives a MOSFET or PWM circuit to control the light intensity. To regulate fan RPM based on ambient temperature, a temperature sensor, like a thermistor, connects to the OP-AMP's inverting input.

As temperature changes, the OP-AMP adjusts the output voltage, driving a fan speed control circuit. Both systems are powered by a stable power supply, and the overall design emphasizes efficient signal processing, minimizing interference, and ensuring a responsive and energy-efficient smart room control system.

2. DESIGNING IN PROTEUS

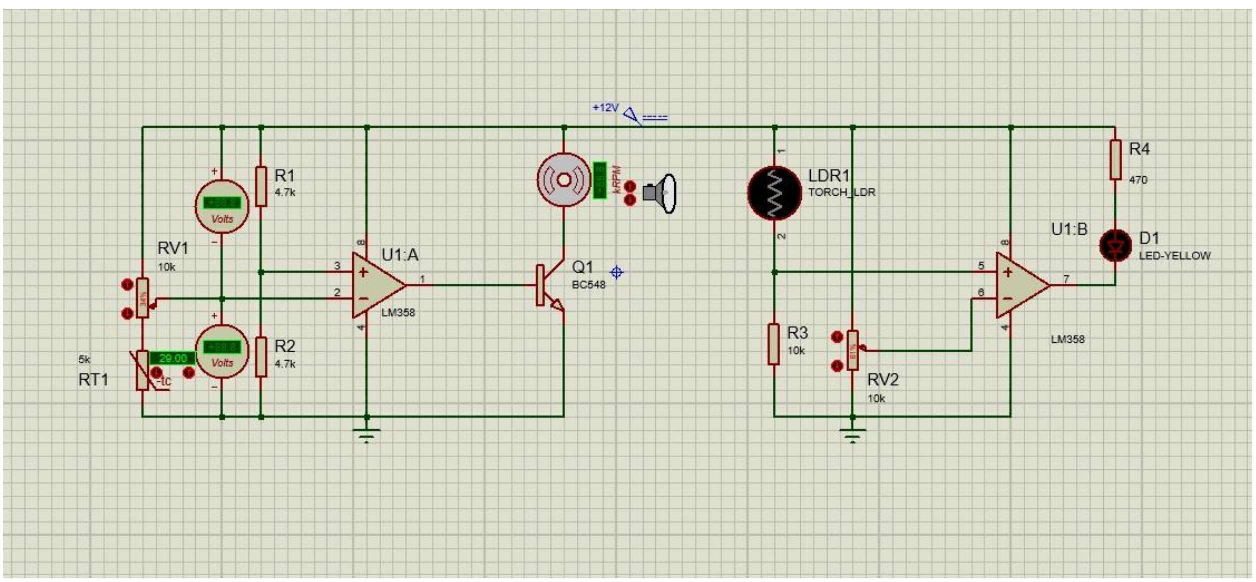

FIGURE: DESIGN THE CIRCUIT USING PROTEUS

3. SIMULATION IN PROTEUS

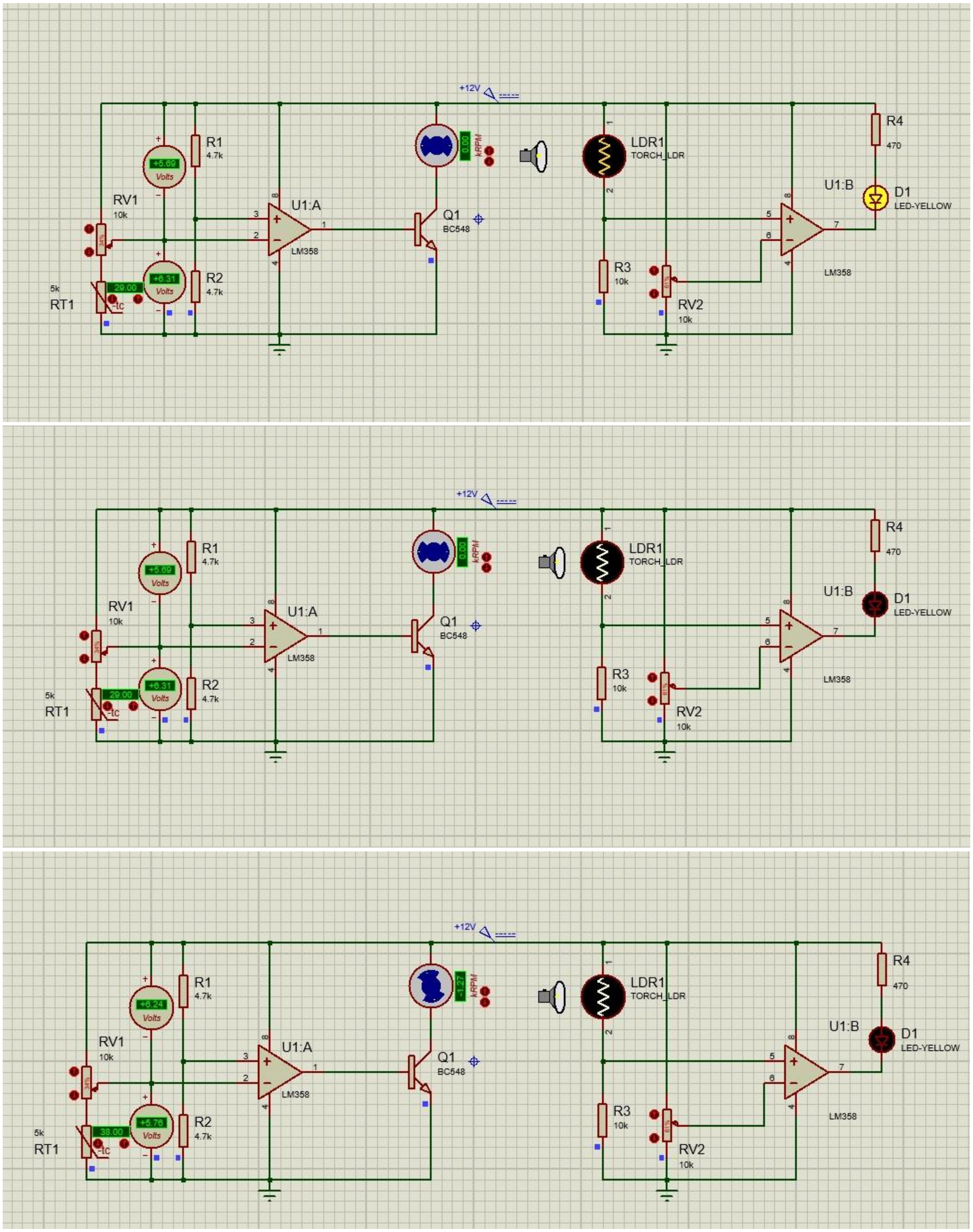

FIGURE: SIMULATION USING PROTEUS

4. CONSTRUCTION IN BREADBOARD

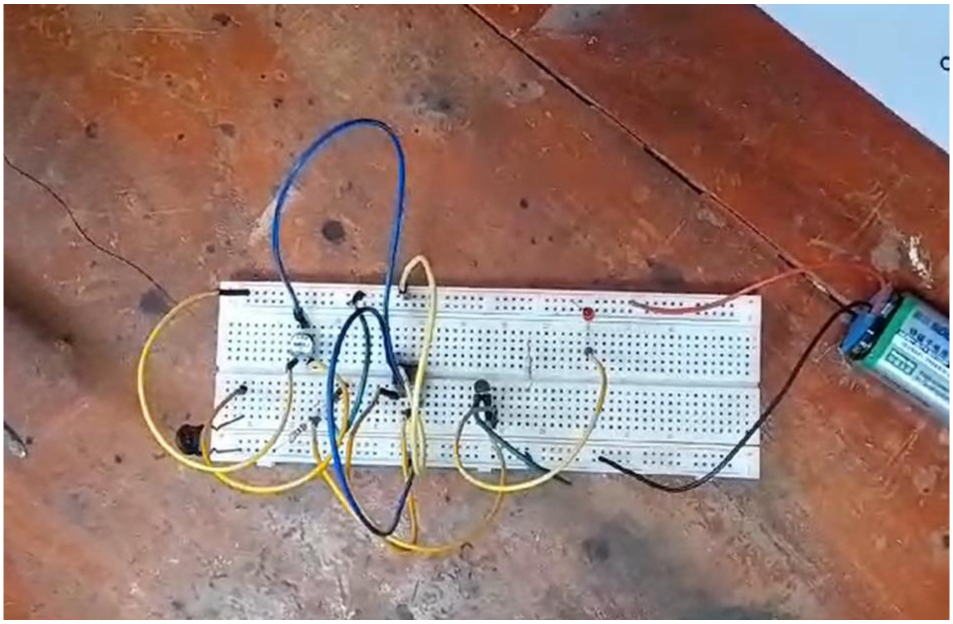

FIGURE: IMPLEMENTING LDR LIGHT, THERMISTOR CIRCUIT

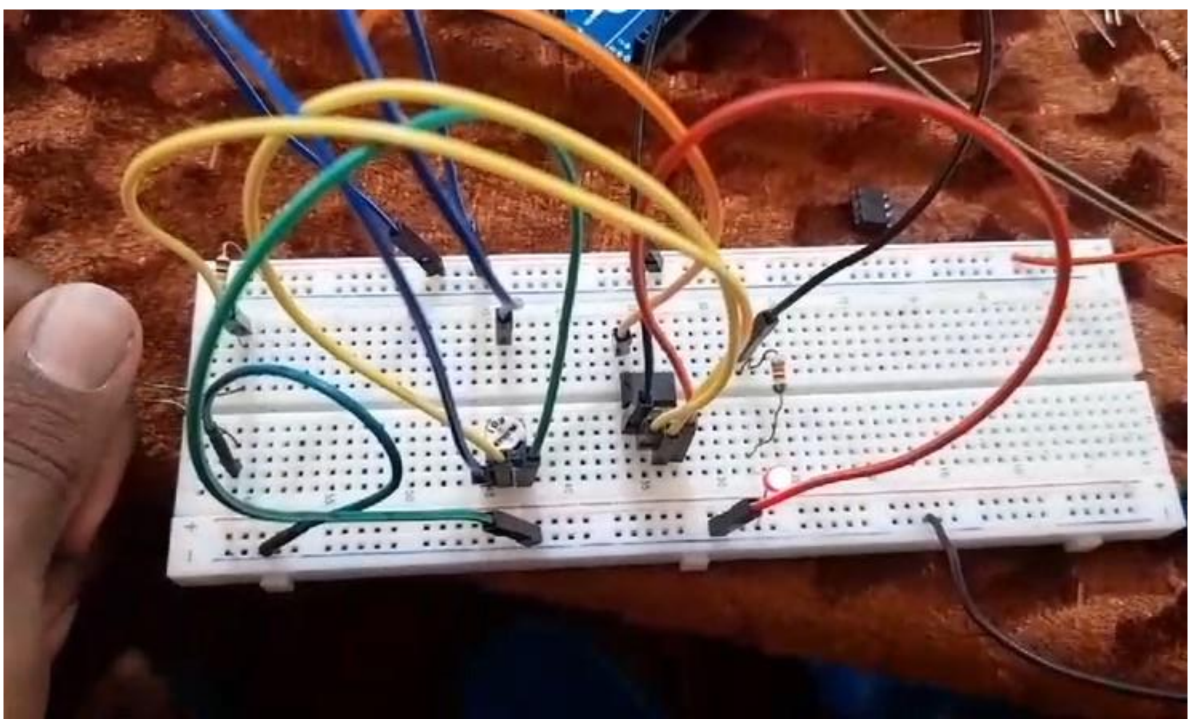

FIGURE: IMPLEMENTING FULL CIRCUIT

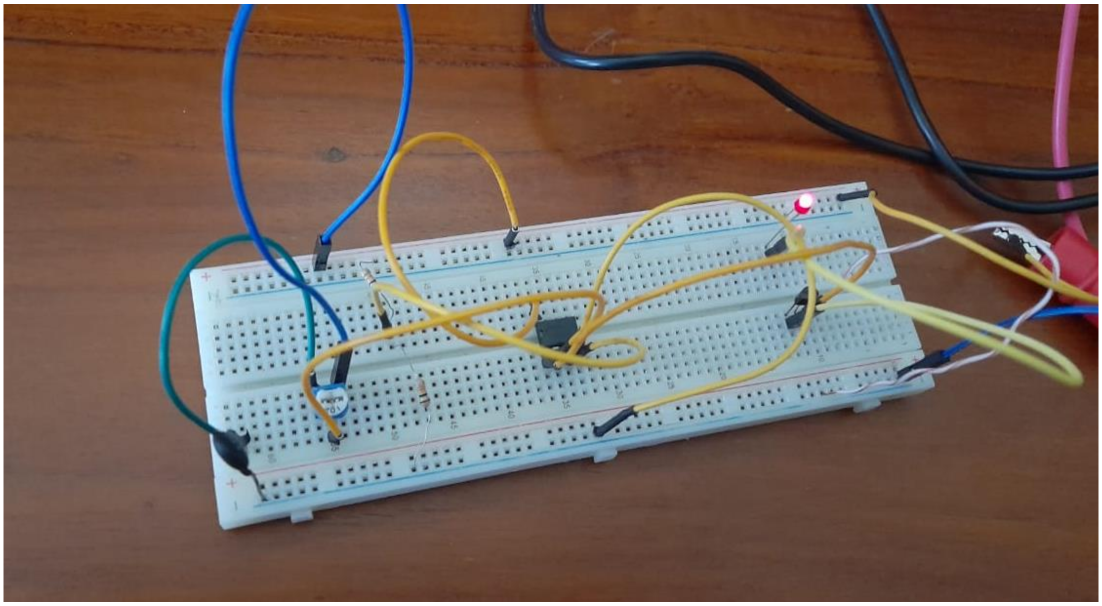

FIGURE: IMPLEMENTING LDR LIGHT CIRCUIT

5. PCB DESIGN

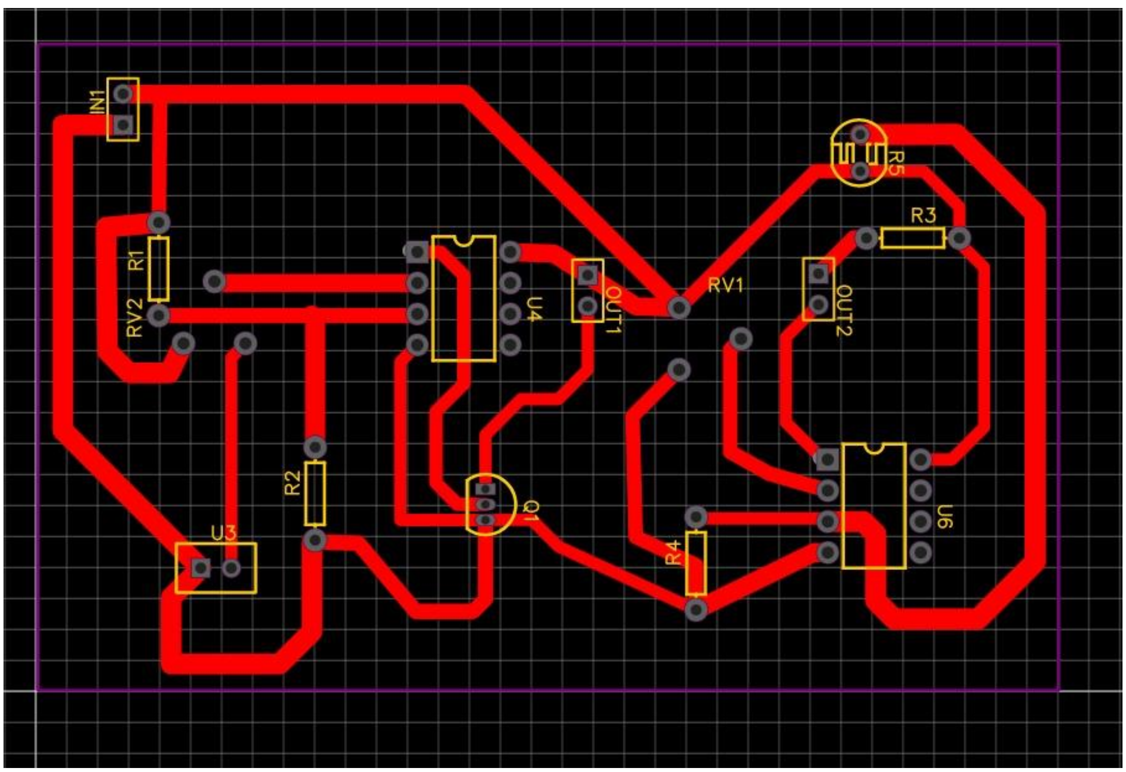

FIGURE: PCB DESIGN USING EASYEDA

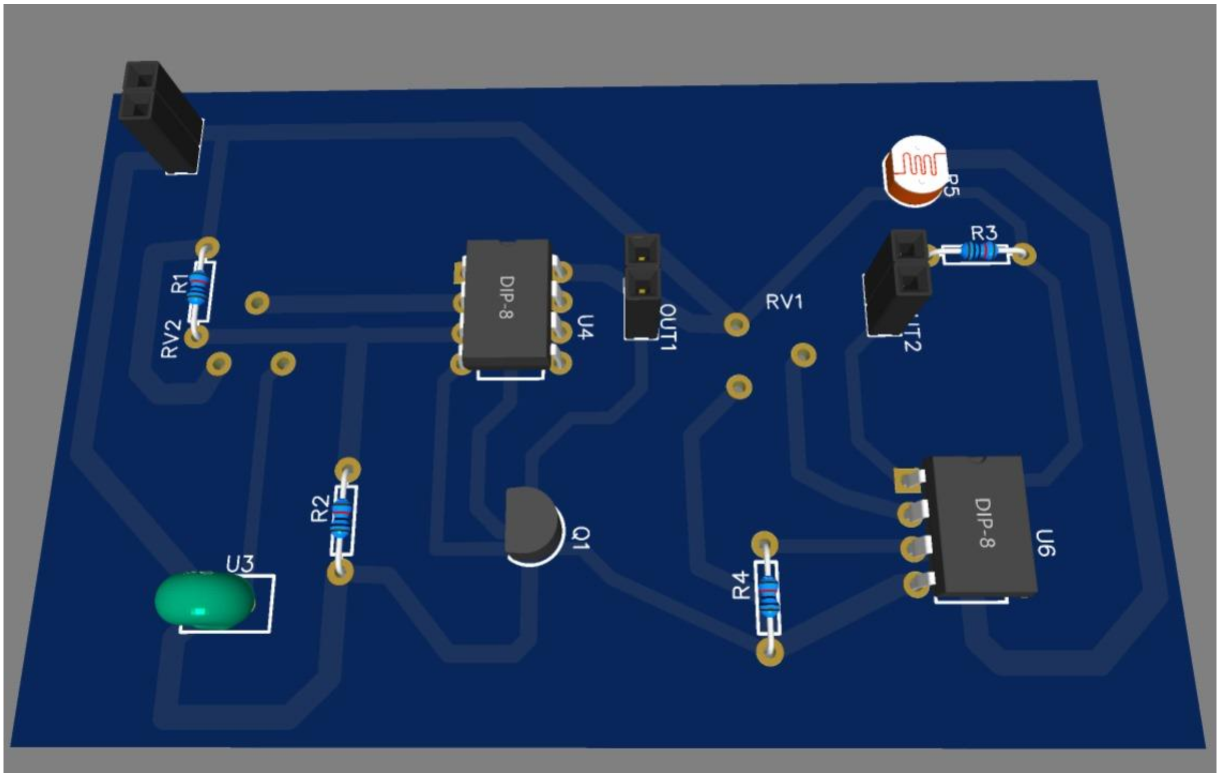

FIGURE: 3D VIEW OF PCB CIRCUIT USING EASYEDA

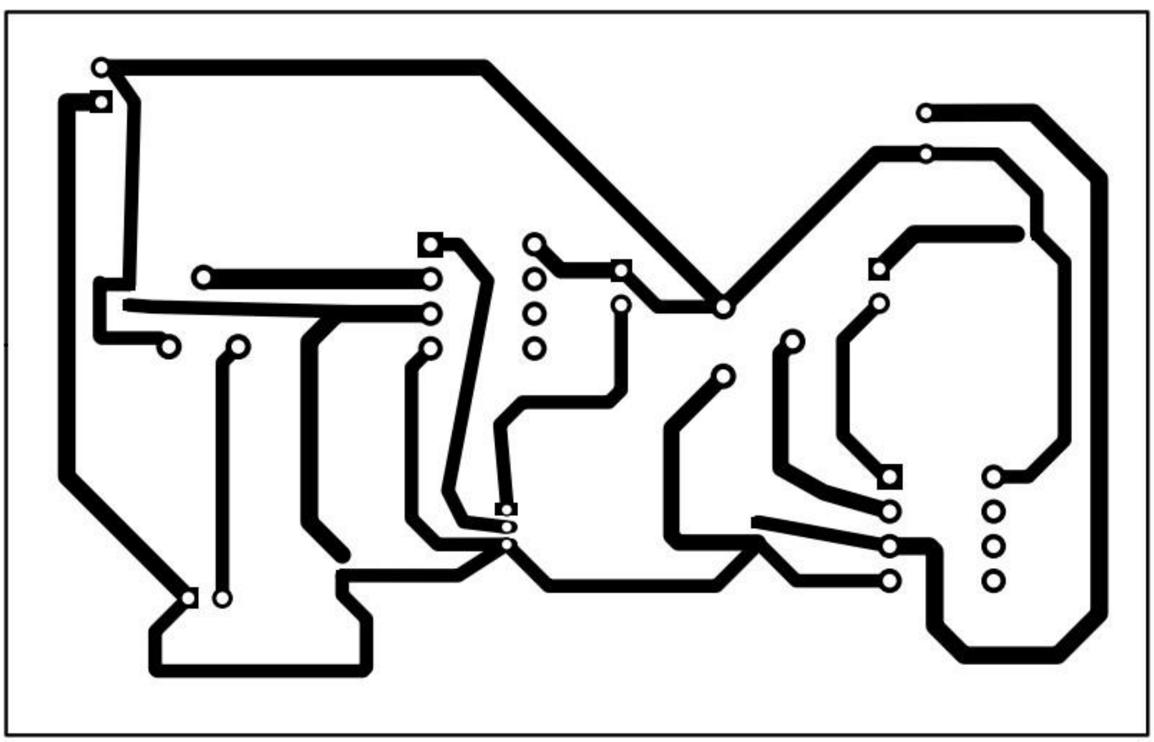

FIGURE: PCB DESIGN USING EASYEDA

6. PCB design

The toner transfer method is a popular technique for creating Printed Circuit Boards (PCBs) at home. It involves transferring a toner-based circuit design onto a copper-clad board and etching away the excess copper to create the desired circuit traces.

- Initially the PCB layout was printed into a sticker sheet.
- Copper coated sheet was acquired based on the size of the PCB layout, Then the sheet was cleaned using scotch brite and water.
- Sticker layout was carefully pasted on the copper sheet, and then the board was ironed for 5-10 minutes by applying a weight to it. (To make sure the layout was pasted on the board completely) Then the sticker was peeled off.
- After that board was drowned in FeCl3, and it was stirred for 15-20 minutes until the naked copper was removed.
- Then the board was washed with water and cleaned with scotch brite.
- Then necessary holes were using a driller.
- Finally necessary parts were soldered to the board.

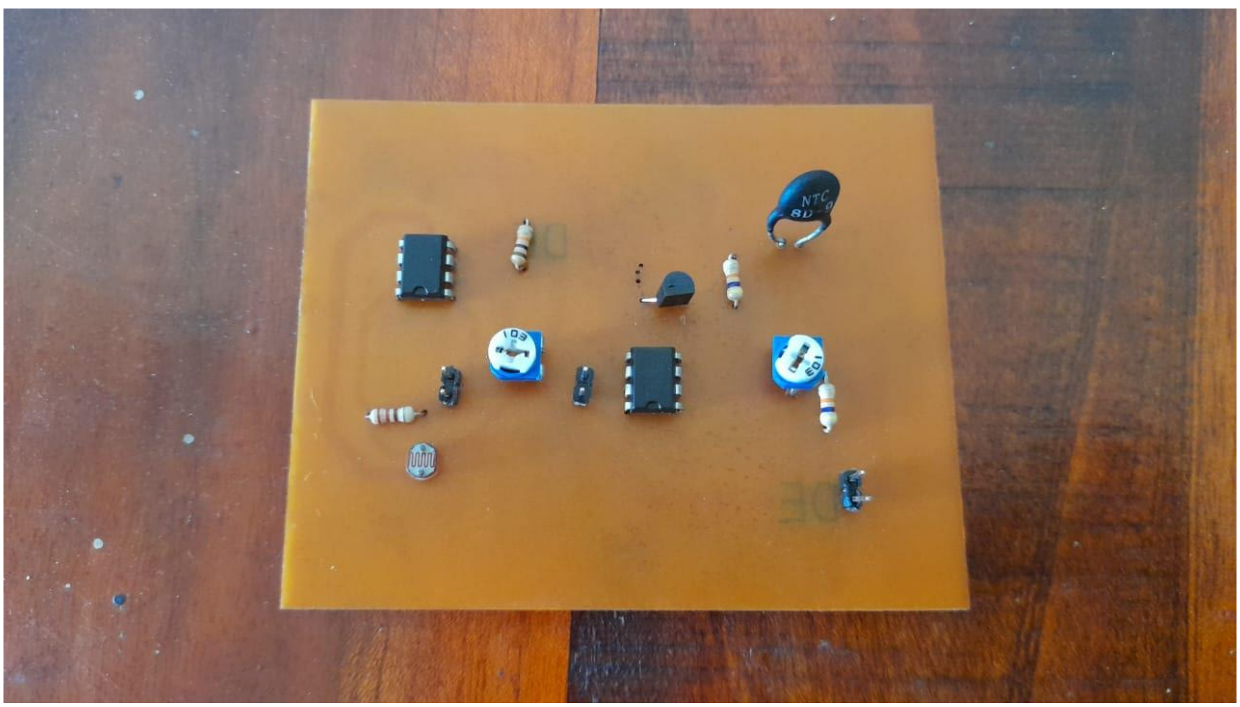

FIGURE: PLACING THE COMPONENT IN PCB BOARD

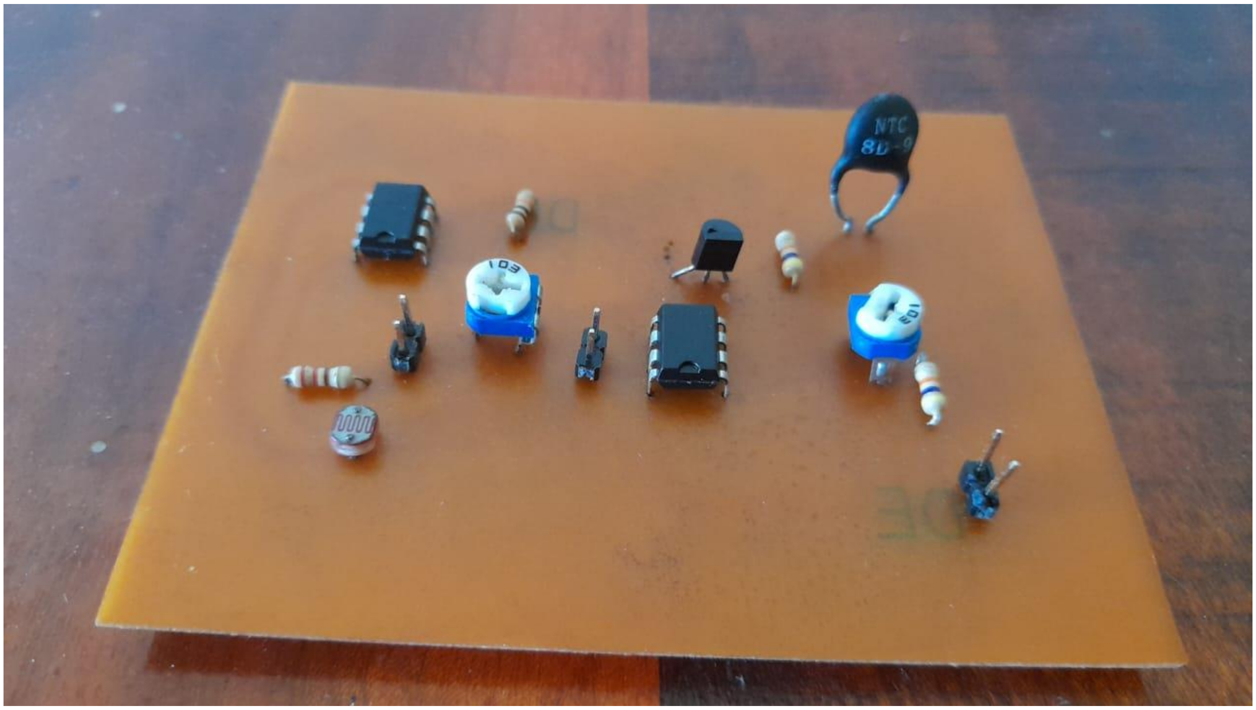

FIGURE: CIRCUIT PCB BOARD COMPONENT

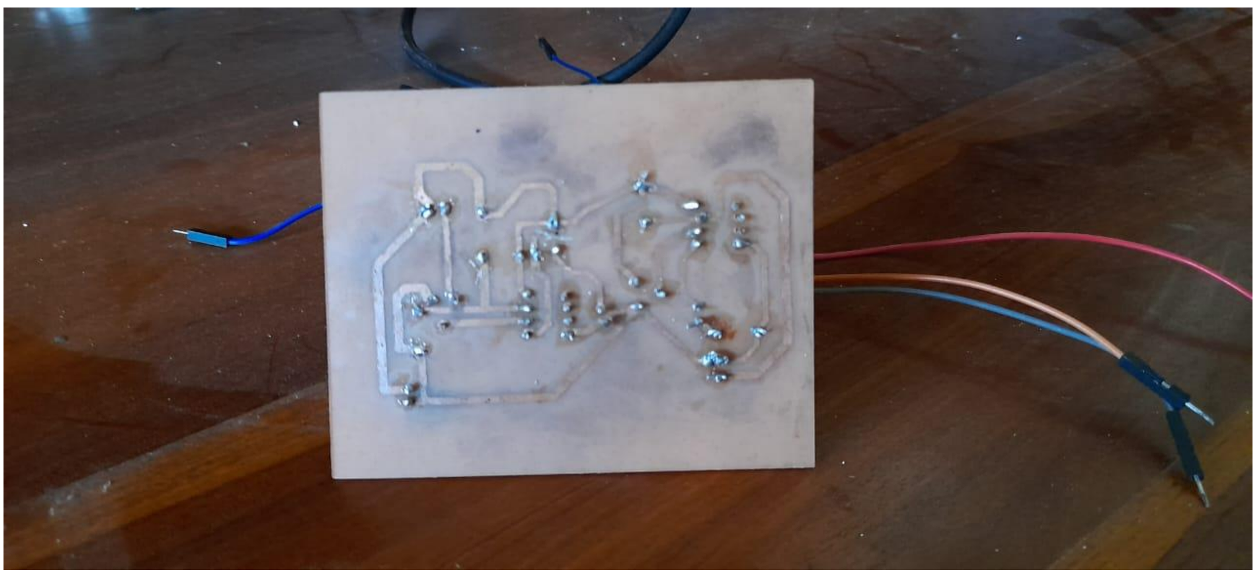

FIGURE: SOLDERING THE PCB BOARD

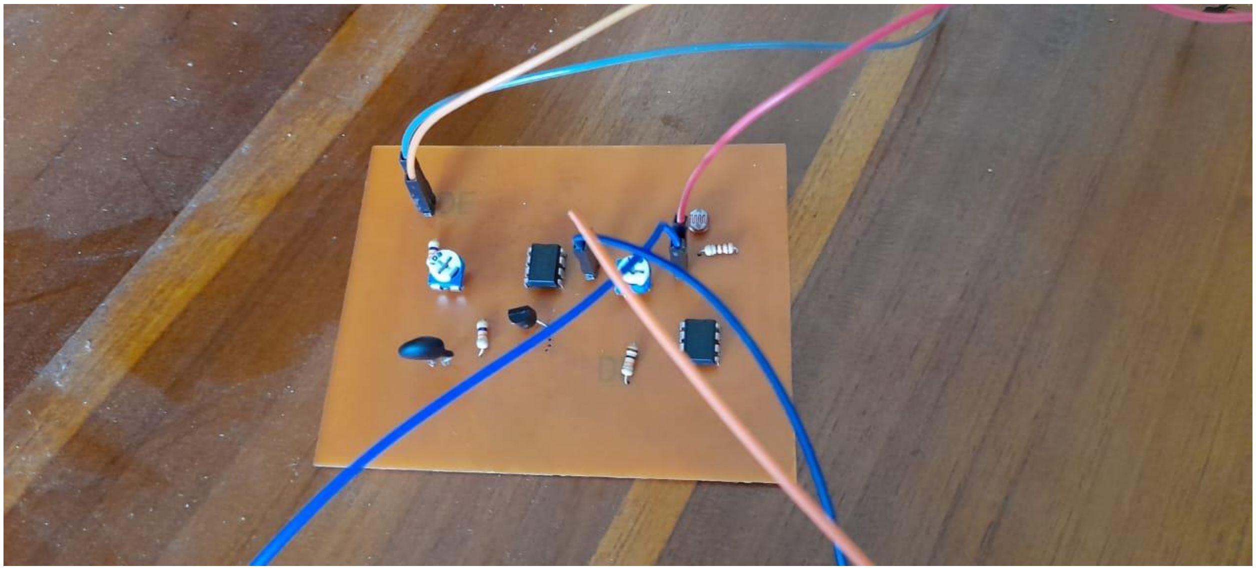

FIGURE: COMPLETED CIRCUIT PCB BOARD

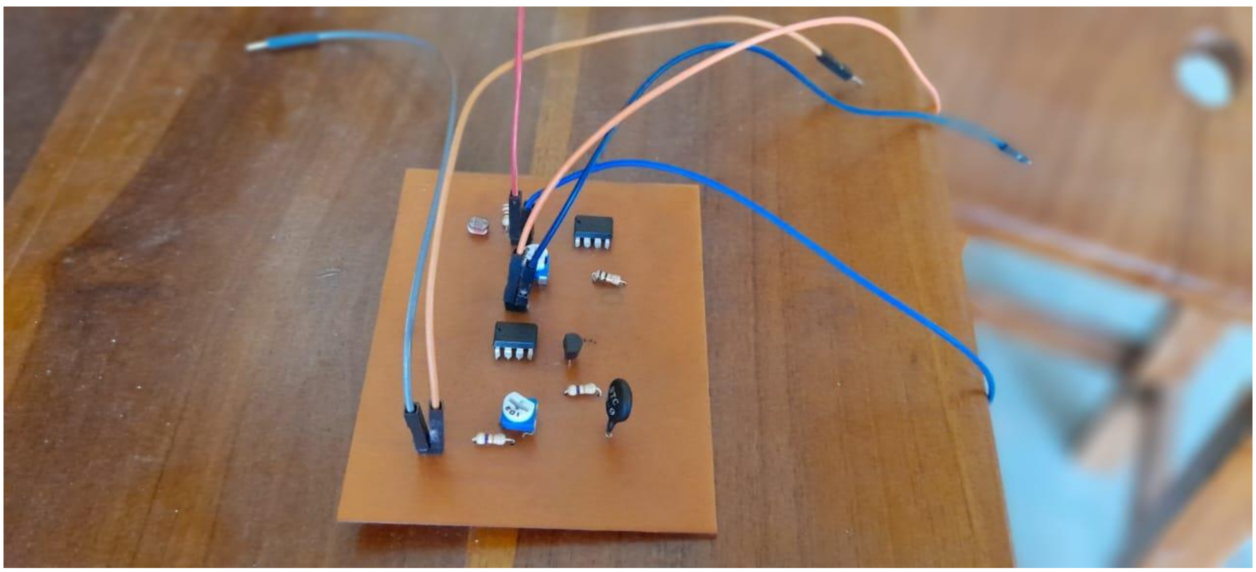

FIGURE: COMPLETED CIRCUIT PCB BOARD

CIRCUIT WORKING CONDITION

- In operation, the Smart Room Controller PCB circuit continuously monitors ambient conditions. The OP-AMP 358 processes signals from the light-dependent resistor (LDR) and temperature sensor, adjusting its output voltage accordingly.
- When ambient light changes, the OP-AMP modulates the current to the light source, dynamically altering light intensity.
- Simultaneously, temperature fluctuations trigger the OP-AMP to vary the output, regulating the fan speed through a dedicated control circuit.
- This intelligent feedback mechanism ensures optimal light levels and fan RPM in response to changing environmental factors, creating a comfortable and energy-efficient living space tailored to the room's real-time conditions.

CONCLUSION

- In conclusion, the Smart Room Controller PCB circuit featuring the OP-AMP 358 offers an advanced and responsive solution for home automation.
- By seamlessly adjusting light intensity based on ambient light levels and modulating fan RPM according to temperature changes, this system optimizes both comfort and energy efficiency. The integration of precision components ensures accurate sensor readings and reliable performance.
- This innovative design not only enhances the user experience by creating a dynamically controlled environment but also contributes to sustainability through intelligent and adaptive management of lighting and ventilation.
- The Smart Room Controller represents a significant stride toward smart living, combining technology, comfort, and energy conservation in a compact and efficient package.

REFLECTION

Making a PCB was a new experience for us, and this project taught us a lot. Additionally, it offered us a foundational understanding of the project, which will be very useful for our upcoming tasks.

It increased our understanding of work design, fabrication, testing, and troubleshooting, including simulation. Our group members were able to communicate well, and our teamwork was effective. This short project also helped us to improve our time management, source management, and issue solving abilities.