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NARSIMHA REDDY ENGINEERING COLLEGE

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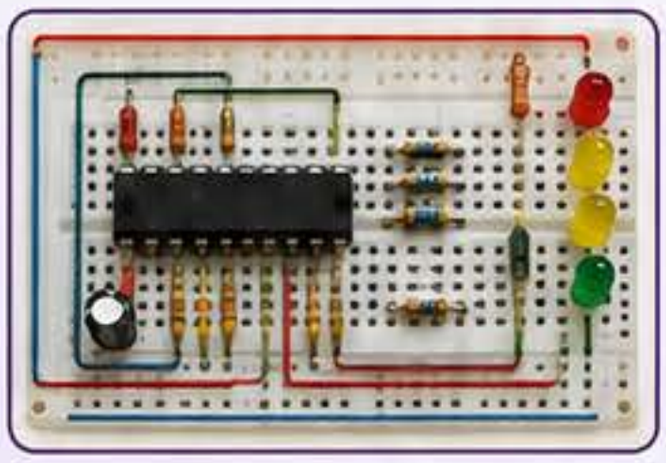
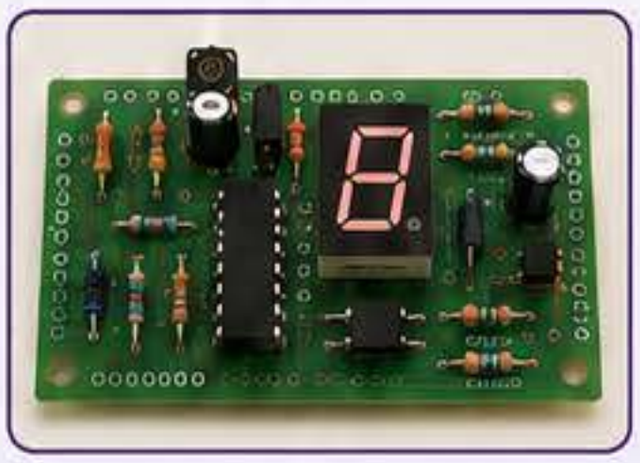
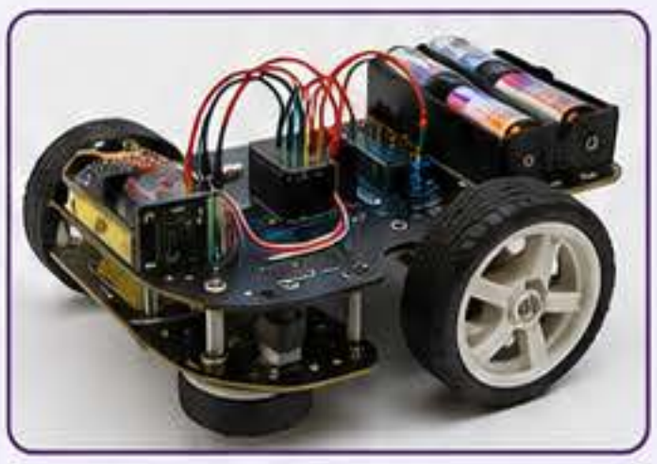
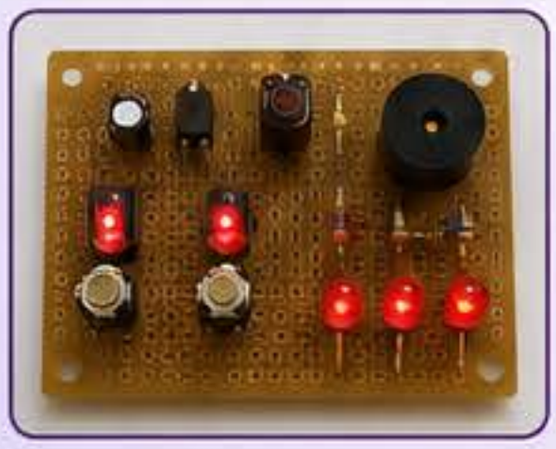
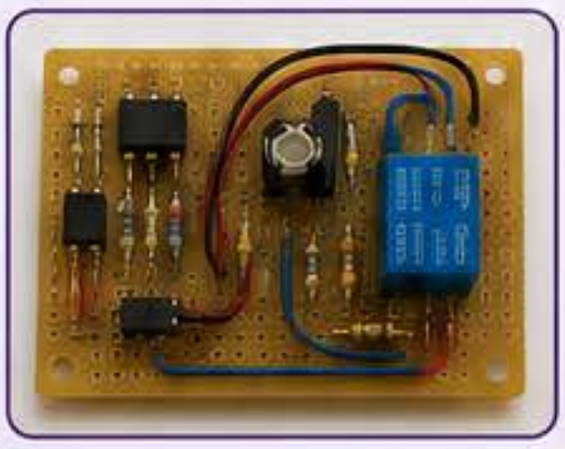
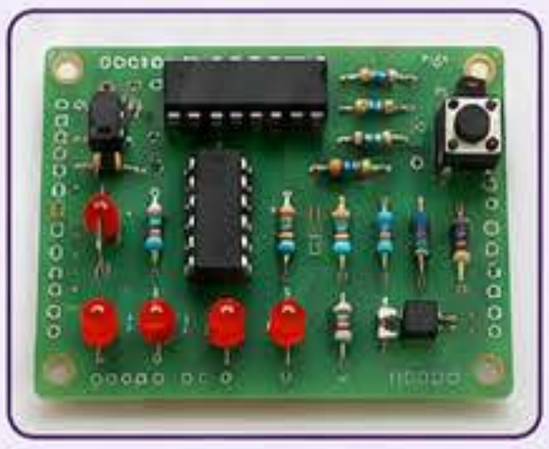
Department of
ELECTRONICS AND COMMUNICATION ENGINEERING

DESIGN AND IMPLEMENTATION OF ELECTRONIC AND DIGITAL CIRCUITS

PROJECT-BASED LEARNING

for II B.Tech I Semester Students

PREPARED BY

Dr V PURANDHAR REDDY

Head of the Department

Effective for AY 2025–26

Hands-on Learning
Innovative Projects

Skill Development
Problem Solving

Department of

ELECTRONICS AND COMMUNICATION ENGINEERING

DESIGN AND IMPLEMENTATION OF ELECTRONIC AND DIGITAL CIRCUITS

PROJECT-BASED LEARNING

for II B.Tech I Semester Students

LIST OF PROJECTS

S.No	Project Title	Components Used	Concepts Covered
1.	Automatic Street Light Controller	LDR, BC547, Relay, LED	LDR, Transistor Switching
2.	Temperature Controlled DC Fan	LM35, LM358, Relay, DC Fan	Temperature Sensing, Comparator
3.	Water Level Indicator	BC547, LEDs, Buzzer	Conductivity Sensor, Transistor
4.	Rain Alarm System	Rain Sensor, BC547, Buzzer	Rain Detection
5.	Fire Alarm Using Thermistor	NTC Thermistor, Buzzer	Temperature Detection
6.	Clap Switch	Microphone, LM358, Relay	Sound Detection
7.	IR Obstacle Detector	IR LED, IR Receiver, BC547	Infrared Sensing
8.	Door Open Alarm	Magnetic Reed Switch, Buzzer	Security Systems
9.	Automatic Bathroom Light	PIR Sensor, Relay, Lamp	Motion Detection
10.	LED Running Lights	NE555 Timer, CD4017 Decade Counter	Timer, Digital Counter
11.	Traffic Light Controller	NE555 Timer, CD4017 Decade Counter, LEDs	Sequential Logic
12.	Electronic Dice	NE555 Timer, CD4017 Decade Counter	Digital Electronics
13.	Battery Level Indicator	LM3914, LEDs	Voltage Measurement
14.	Burglar Alarm Using Laser	Laser Module, LDR, Buzzer	Light Beam Security
15.	Solar Mobile Charger	Solar Panel, Voltage Regulator, USB Module	Renewable Energy Basics

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Department of Electronics and Communication Engineering

- Hands-on Learning
- Innovative Projects
- Skill Development

Department of

ELECTRONICS AND COMMUNICATION ENGINEERING

DESIGN AND IMPLEMENTATION OF ELECTRONIC AND DIGITAL CIRCUITS

PROJECT-BASED LEARNING

for II B.Tech I Semester Students

SKILLS STUDENTS WILL LEARN

S.No.	Skill	Description
1.	**Basic circuit design**	Understand and design simple electronic circuits using components.
2.	**PCB/Breadboard implementation**	Assemble and test circuits on breadboard and PCB.
3.	**Soldering techniques**	Learn proper soldering techniques for reliable connections.
4.	**Sensor interfacing**	Interface various sensors and acquire real-world data.
5.	**Analog electronics**	Study and apply concepts of analog circuits and components.
6.	**Digital electronics**	Work with digital ICs, logic gates, counters and timers.
7.	**Power supply design**	Design and test regulated power supplies for electronic circuits.
8.	**Relay driving circuits**	Design transistor-based circuits to drive relays and loads.
9.	**Troubleshooting and testing**	Identify faults, test circuits and ensure proper working.

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Department of Electronics and Communication Engineering

- Hands-on Learning
- Innovative Projects
- Skill Development

PROJECT MANUAL

1. AUTOMATIC STREET LIGHT CONTROLLER

AIM

To design and implement an automatic street light controller which turns ON the street light at dusk (low light) and turns OFF at dawn (high light) using an LDR sensor.

COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	LDR (Light Dependent Resistor)	5mm	1
2	Resistor (R1)	10 kΩ	1
3	Resistor (R2)	1 kΩ	1
4	Transistor	BC547	1
5	Relay	12V SPDT	1
6	Diode	1N4007	1
7	LED (Indicator)	Red	1
8	Street Light (Load)	12V DC / Lamp	1
9	Power Supply	12V DC	1

APPLICATIONS

- Automatic control of street lights
- Used in gardens, parking areas, campuses
- Energy saving and efficient control

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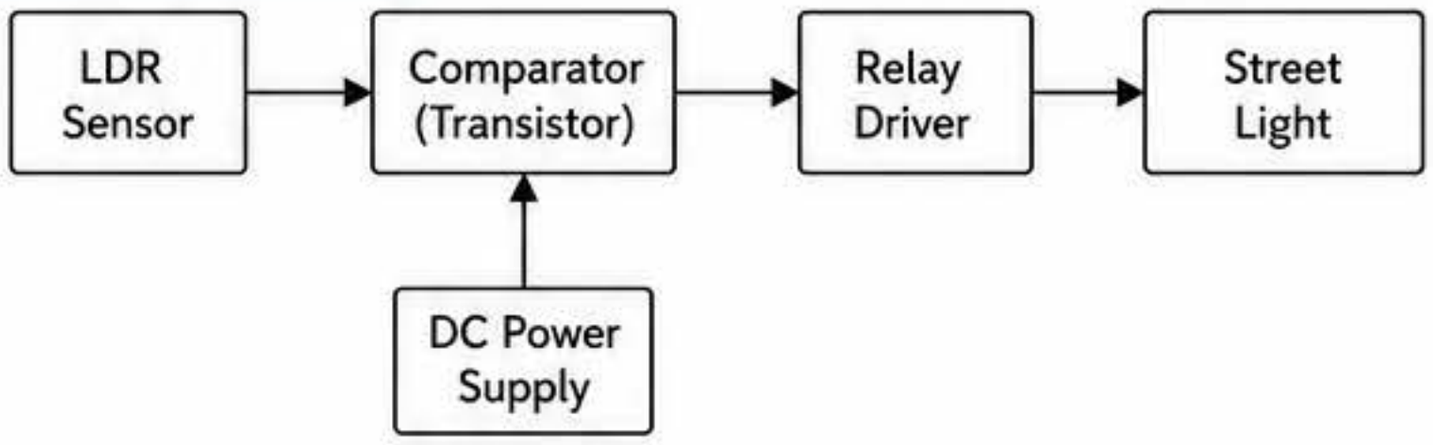
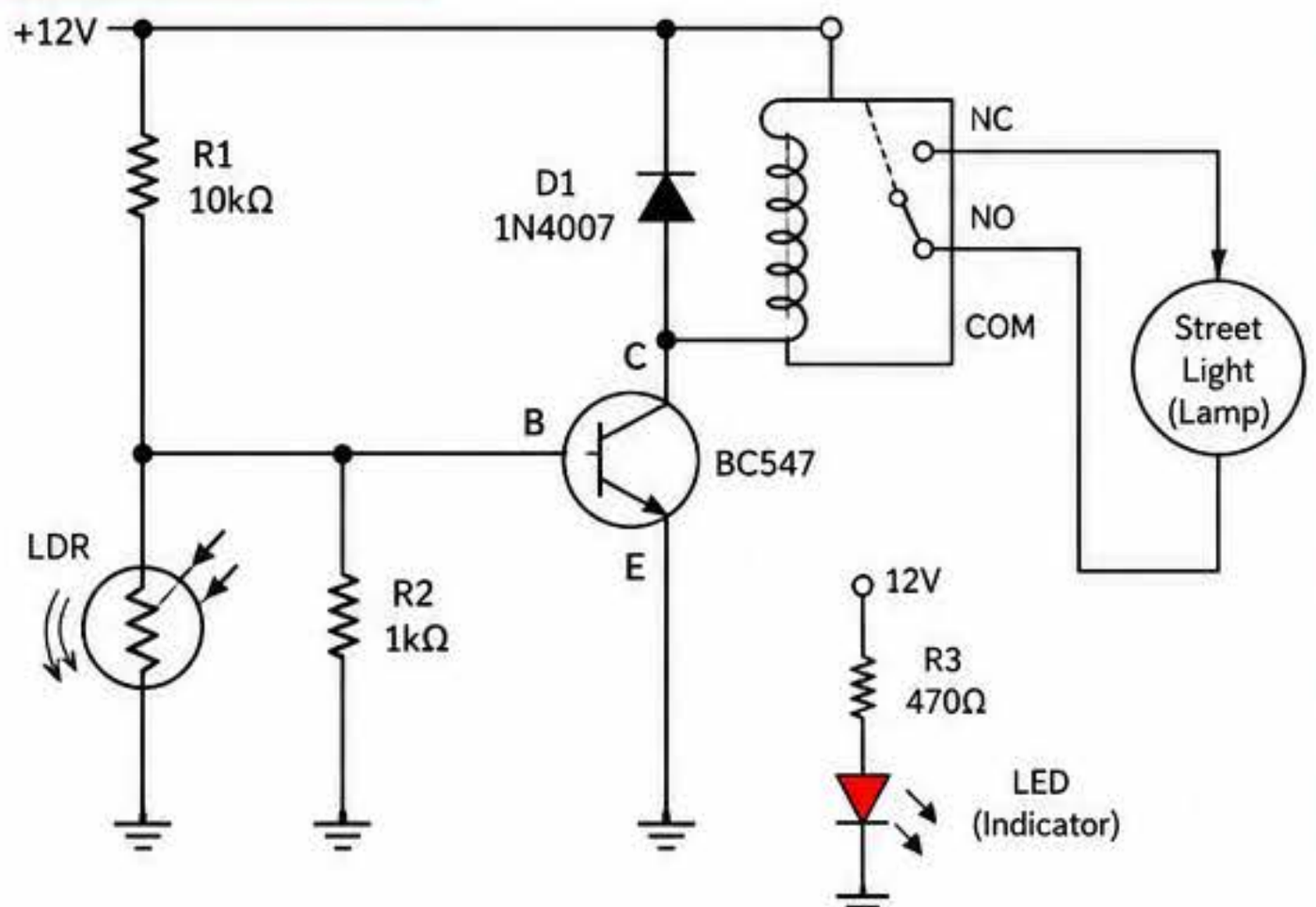


CIRCUIT DIAGRAM

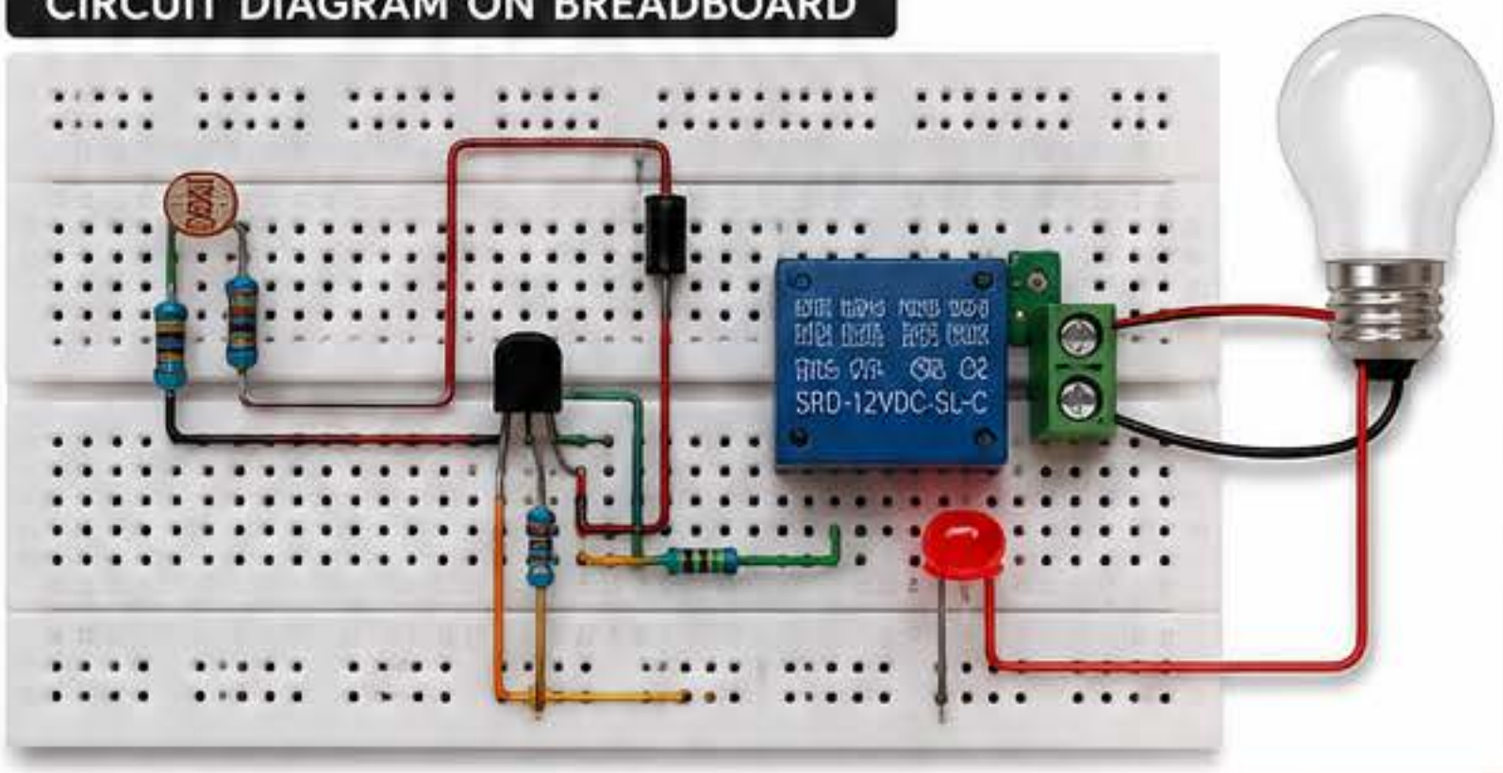


WORKING

The LDR's resistance is high in dark and low in light. At dusk (low light), LDR resistance increases. The voltage at the base of the transistor becomes high enough to turn ON the transistor. The transistor saturates and energizes the relay coil. The relay contact (NO) closes and the street light turns ON.

At dawn (high light), LDR resistance decreases. The transistor turns OFF and relay de-energizes. The street light turns OFF.

CIRCUIT DIAGRAM ON BREADBOARD

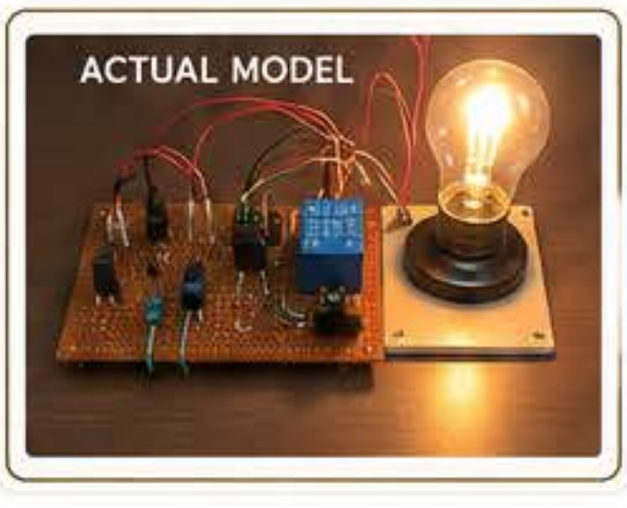


PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Provide 12V DC to the circuit.
3. Cover the LDR with your hand or place it in dark. The street light should turn ON.
4. Expose the LDR to light. The street light should turn OFF.
5. Adjust R2 slightly (if required) for proper switching point.
6. Fix the circuit in a suitable enclosure.

RESULT

The automatic street light controller was designed successfully and it turns ON the street light in dark and turns OFF in light conditions as expected.



PRECAUTIONS

- Ensure correct polarity of power supply.
- Use proper rating relay as per load.
- Keep the LDR away from artificial light during testing.
- Do not touch the circuit when power is ON.

FUTURE SCOPE

The project can be extended using a microcontroller to include dimming, timing control and fault detection.

PROJECT MANUAL

2. TEMPERATURE CONTROLLED DC FAN

AIM

To design and implement a temperature controlled DC fan using LM35 temperature sensor and comparator. The fan turns ON when temperature exceeds a set value and turns OFF when temperature falls below the set value.

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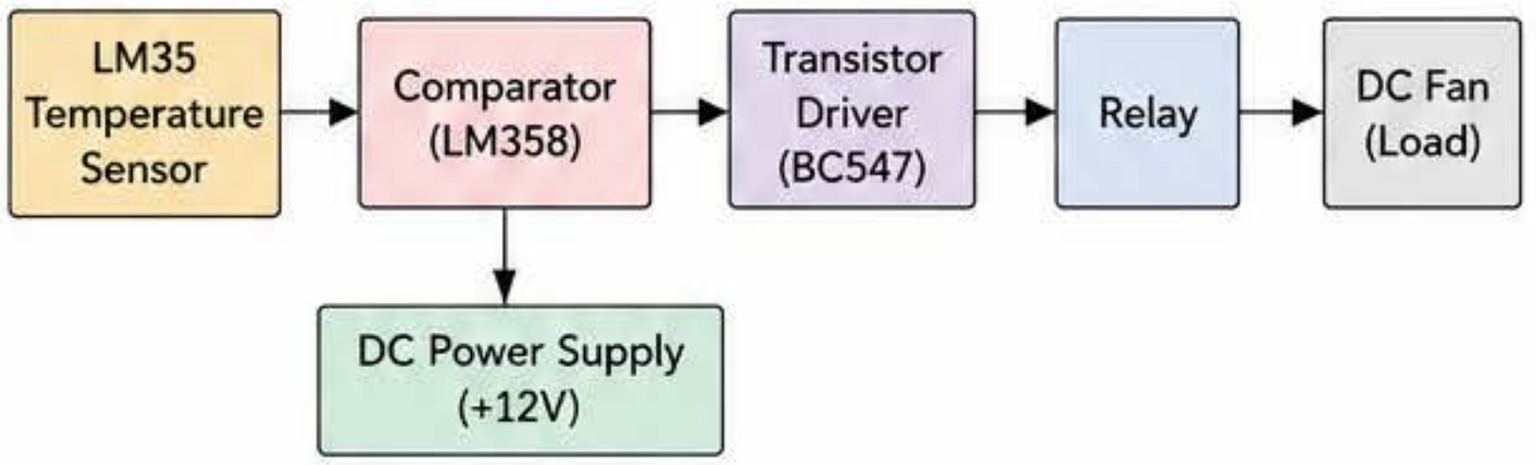
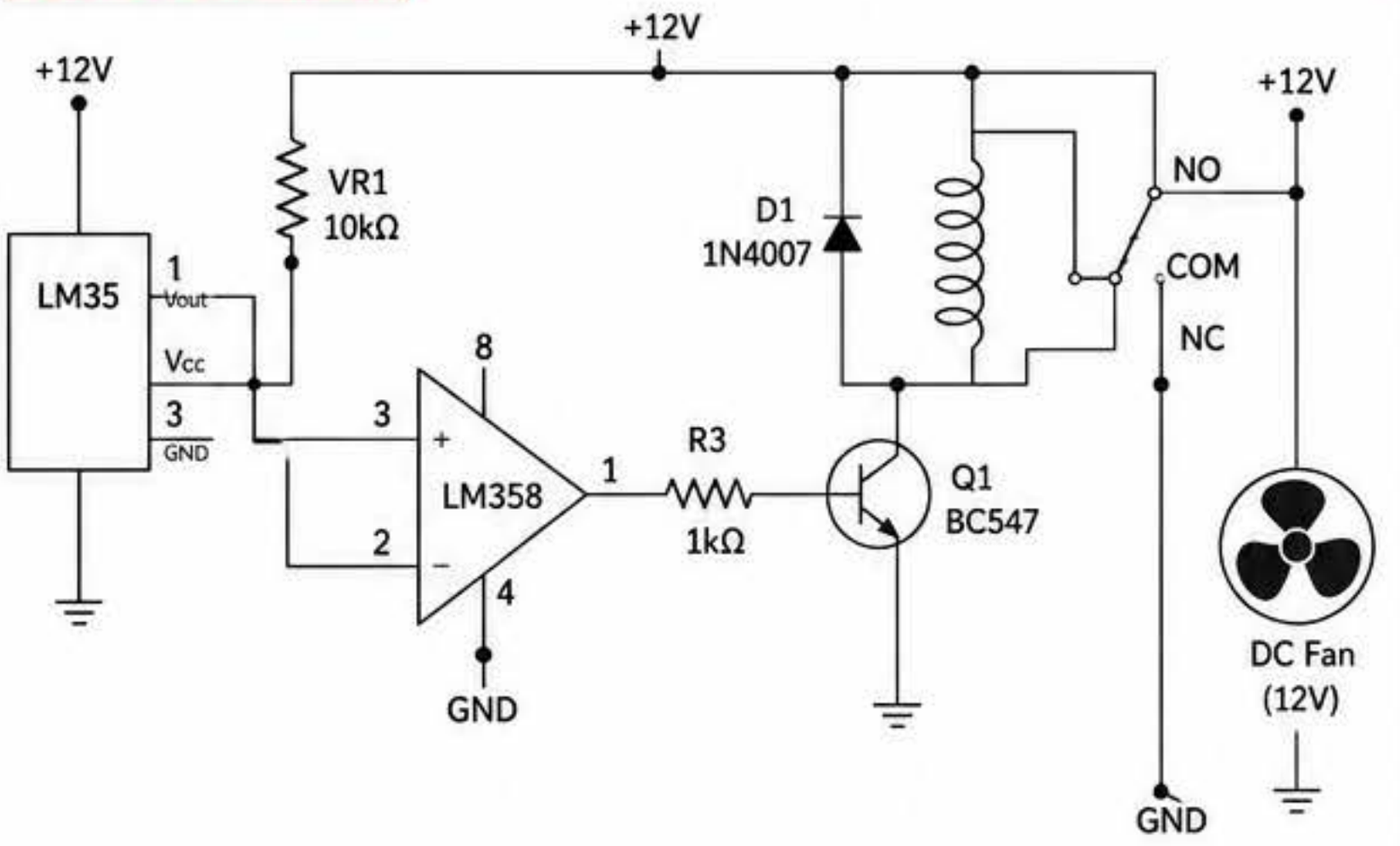


COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	LM35 Temperature Sensor	-	1
2	LM358 IC (Dual Op-Amp)	-	1
3	Resistor (R1)	10 kΩ	1
4	Resistor (R2)	10 kΩ	1
5	Preset (VR1)	10 kΩ	1
6	Resistor (R3)	1 kΩ	1
7	Transistor (Q1)	BC547	1
8	Relay	12V SPDT	1
9	Diode (D1)	1N4007	1
10	DC Fan	12V DC	1
11	Power Supply	12V DC	1

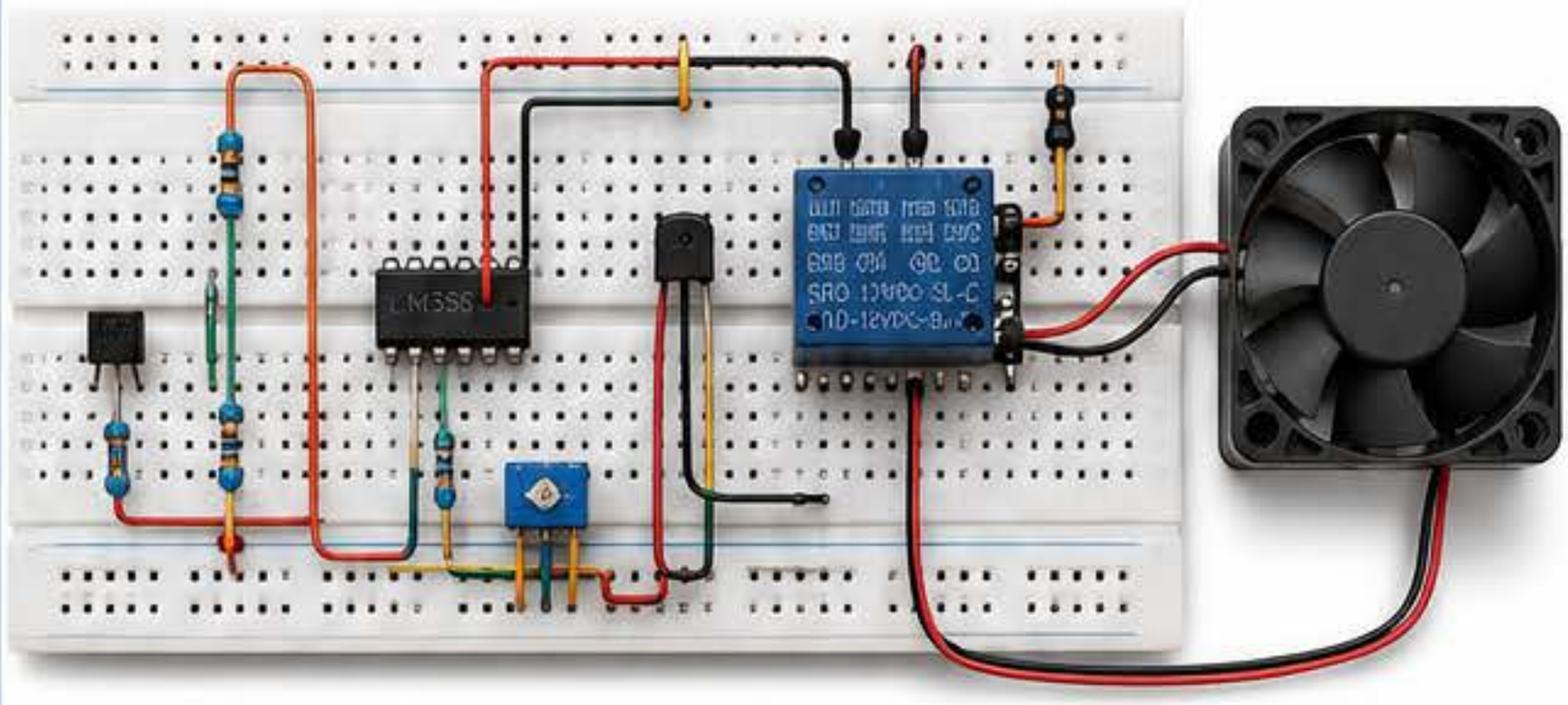
CIRCUIT DIAGRAM



APPLICATIONS

- Automatic temperature control in electronic equipment
- Used in green houses, incubators
- Computer systems & power supplies
- Home automation systems

CIRCUIT DIAGRAM ON BREADBOARD



WORKING

LM35 senses the ambient temperature and produces an analog voltage (10mV/°C). This voltage is applied to the non-inverting input of LM358 comparator. The reference voltage (set temperature) is adjusted using preset VR1 and applied to inverting input.

When temperature exceeds the set value, the output of LM358 goes HIGH, turning ON the transistor. The transistor energizes the relay coil and the relay contact (NO) closes, switching ON the DC fan.

When temperature falls below the set value, the output goes LOW, transistor and relay turn OFF, so the fan stops.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +12V DC power supply.
3. Adjust the preset (VR1) to set the desired temperature.
4. Heat the LM35 gently (by hand or heat source).
5. Observe that the fan turns ON when temperature exceeds the set value.
6. Cool the sensor and observe that the fan turns OFF.
7. Enclose the circuit in a suitable box for practical use.

RESULT

The temperature controlled DC fan works as expected. The fan automatically turns ON when temperature exceeds the set value and turns OFF when temperature falls below the set value.

PRECAUTIONS

- Ensure correct polarity of power supply.
- Do not exceed the voltage rating of relay.
- Keep LM35 sensor away from direct heat while testing.
- Use proper heatsink/ventilation if required.

FUTURE SCOPE

This project can be extended using a microcontroller to display temperature on LCD and control multiple fans with variable speed using PWM.

PROJECT MANUAL

3. WATER LEVEL INDICATOR

AIM

To design and implement a water level indicator that indicates the water level in a tank using LEDs and buzzer. It shows Low, Medium, High levels.

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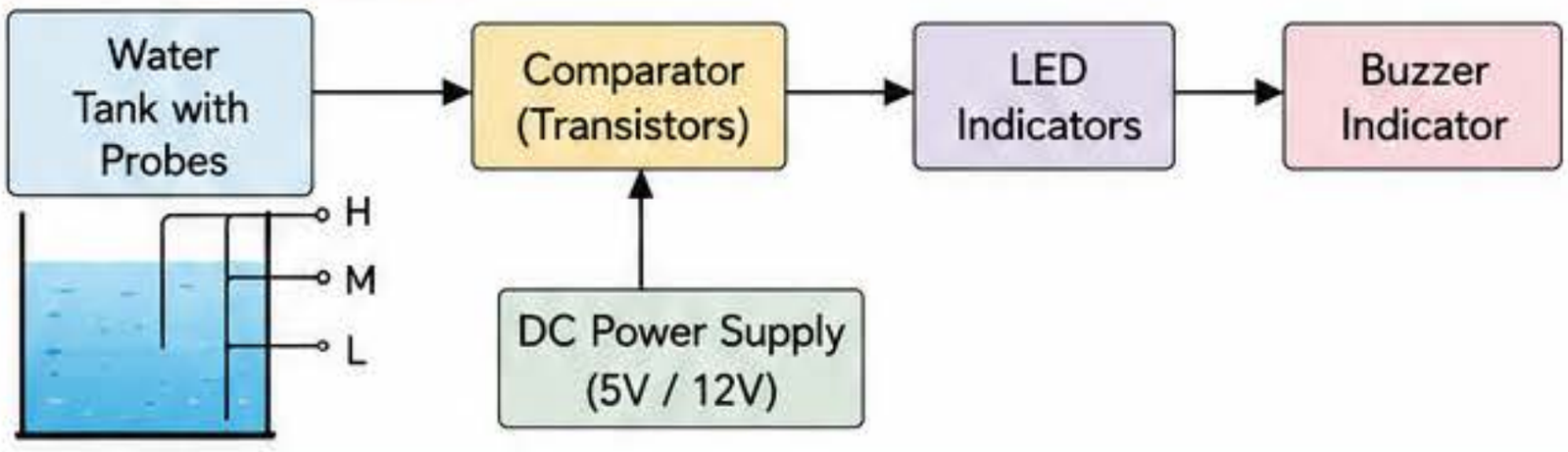
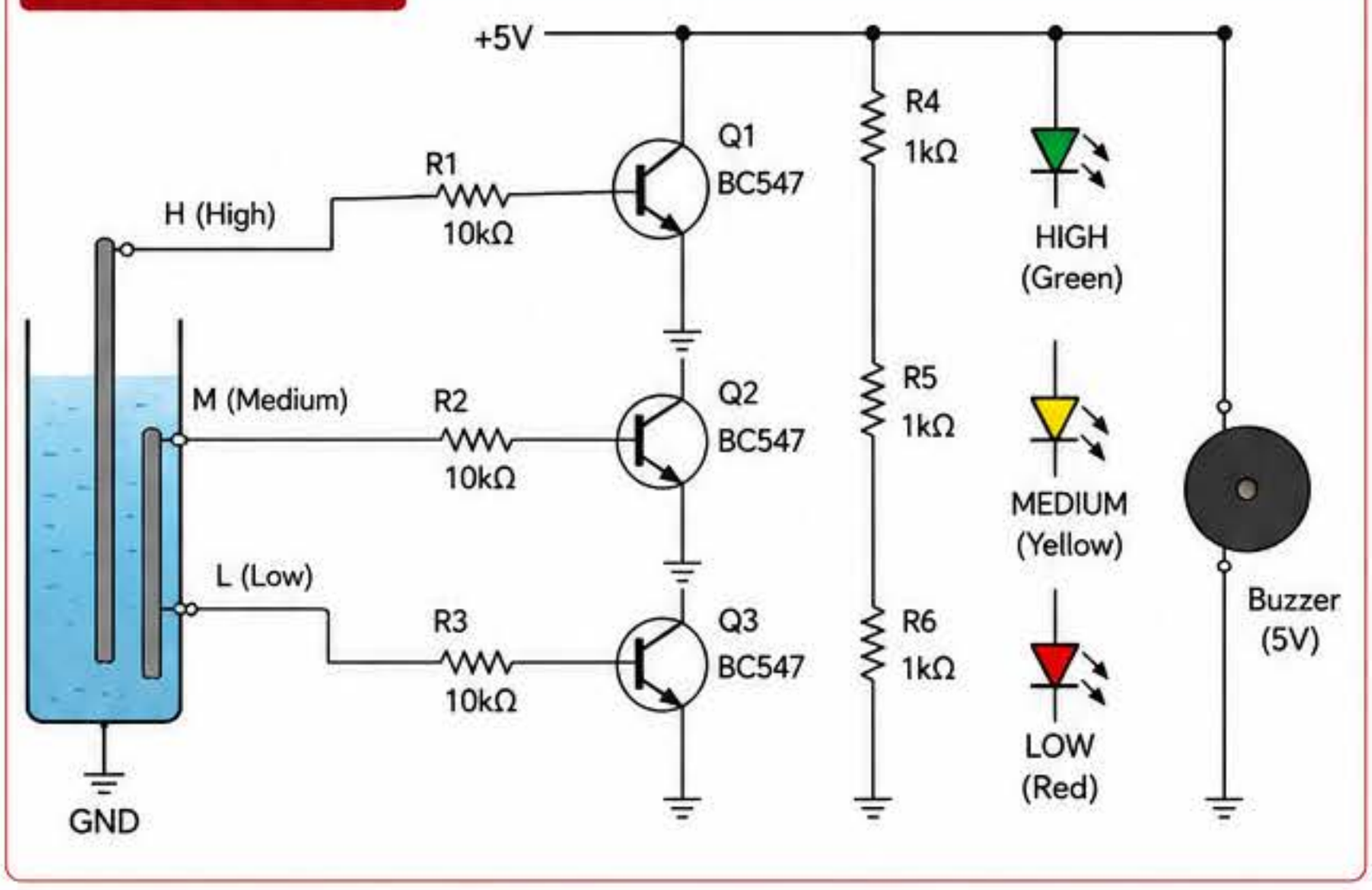


COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	NPN Transistor	BC547	3
2	Resistor (R1, R2, R3)	10 kΩ	3
3	Resistor (R4, R5, R6)	1 kΩ	3
4	LED (Green)	High Level	1
5	LED (Yellow)	Medium Level	1
6	LED (Red)	Low Level	1
7	Buzzer	5V DC	1
8	Probes	Stainless Steel	3
9	Power Supply	5V DC	1

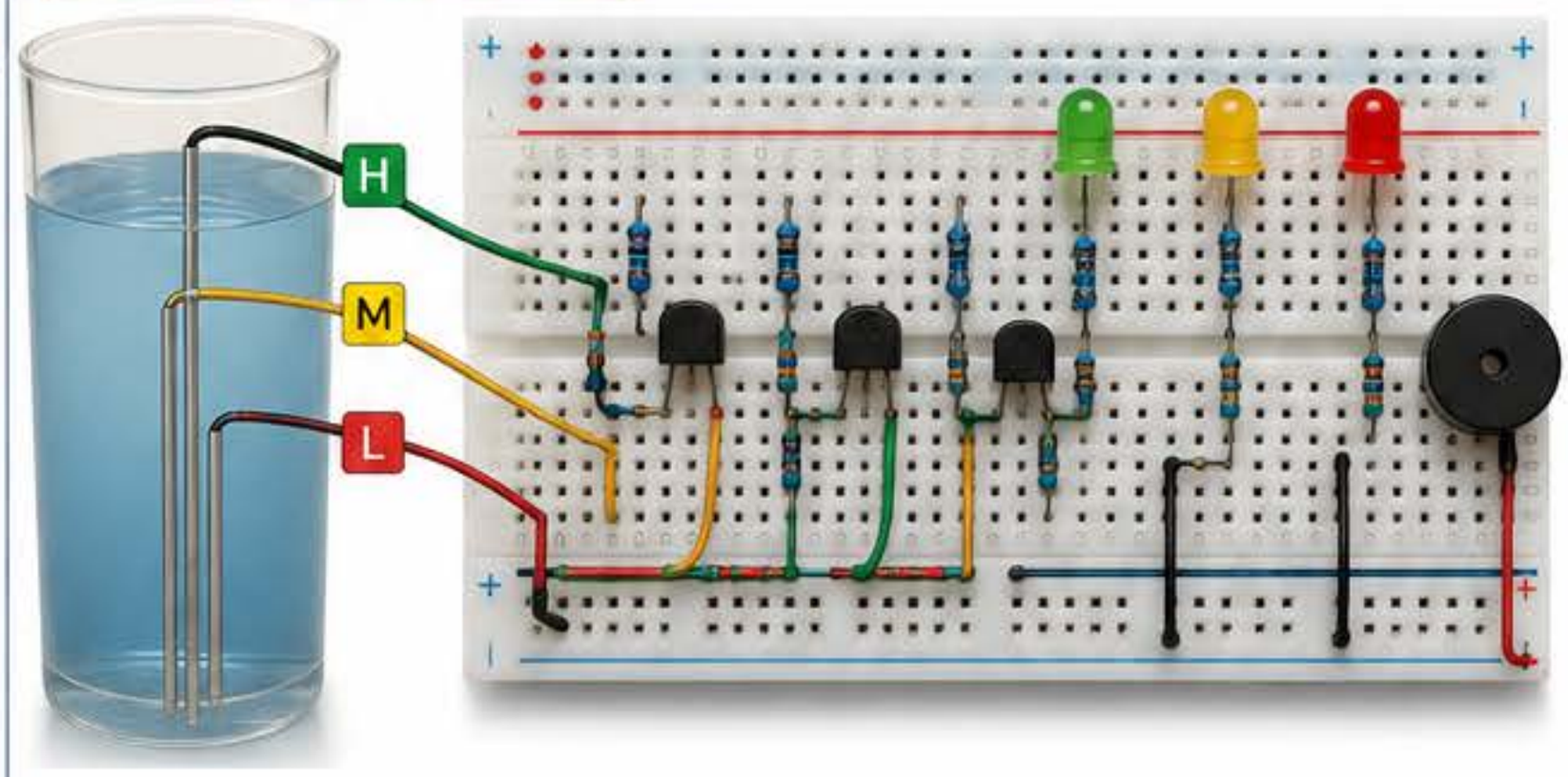
CIRCUIT DIAGRAM



APPLICATIONS

- Overhead water tanks
- Industrial water level monitoring
- Home automation
- Prevents water overflow and dry running of pumps

CIRCUIT ON BREADBOARD



WORKING

Three probes are placed at Low, Medium and High levels in the water tank. The water conducts electricity. When the water touches a probe, the base of the corresponding transistor gets biased through water and resistor (10 kΩ). The transistor saturates and turns ON the corresponding LED.

Low level probe turns ON the Red LED.

Medium level probe turns ON the Yellow LED.

High level probe turns ON the Green LED.

When water reaches the high level probe, the buzzer also turns ON indicating tank full.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Insert the three probes at Low, Medium and High levels in the tank.
3. Connect +5V DC to the circuit.
4. Slowly fill the tank with water.
5. Observe the LEDs:
   - Red LED glows at Low level
   - Yellow LED glows at Medium level
   - Green LED glows at High level
6. When water reaches High level, the buzzer also sounds.
7. Remove water and observe the indicators turning OFF in reverse order.

RESULT

The water level indicator works successfully and indicates Low, Medium and High water levels using LEDs. The buzzer alerts when the tank is full.

PRECAUTIONS

- Ensure proper connections and correct polarity of supply.
- Use clean tap water for better conductivity.
- Don't allow probes to touch each other.
- Use stainless steel or copper probes to prevent corrosion.

FUTURE SCOPE

The project can be extended using microcontroller to display water level on LCD and control the motor automatically.

PROJECT MANUAL

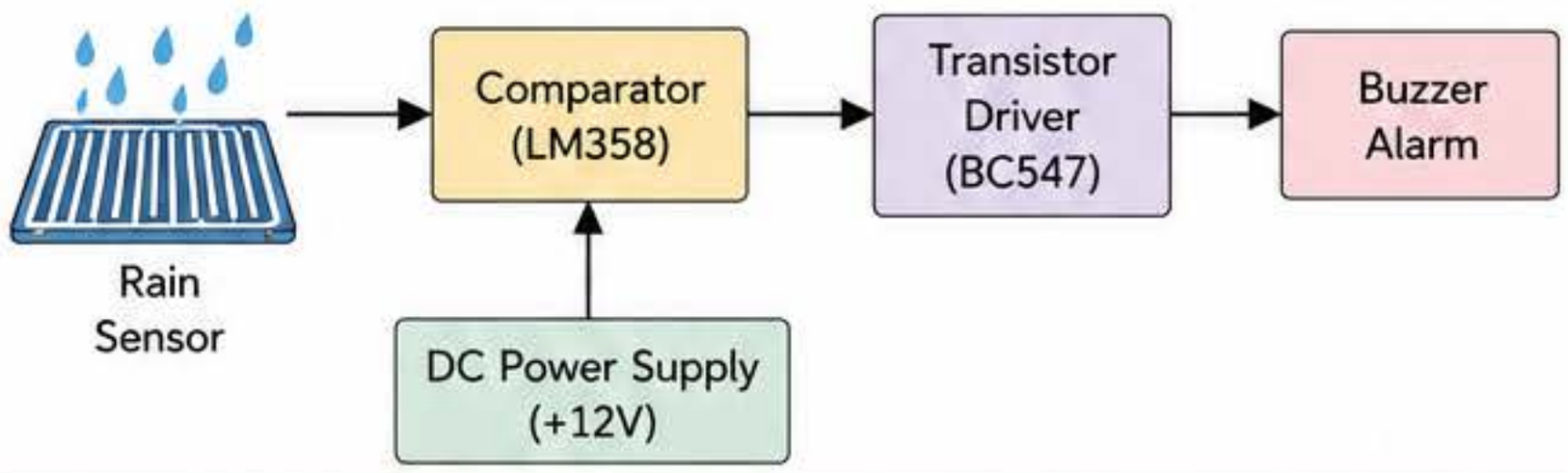
4. RAIN ALARM SYSTEM

AIM

To design and implement a rain alarm system that detects rain using a rain sensor and activates an alarm (buzzer).

The alarm turns ON when rain is detected and turns OFF when it stops raining.

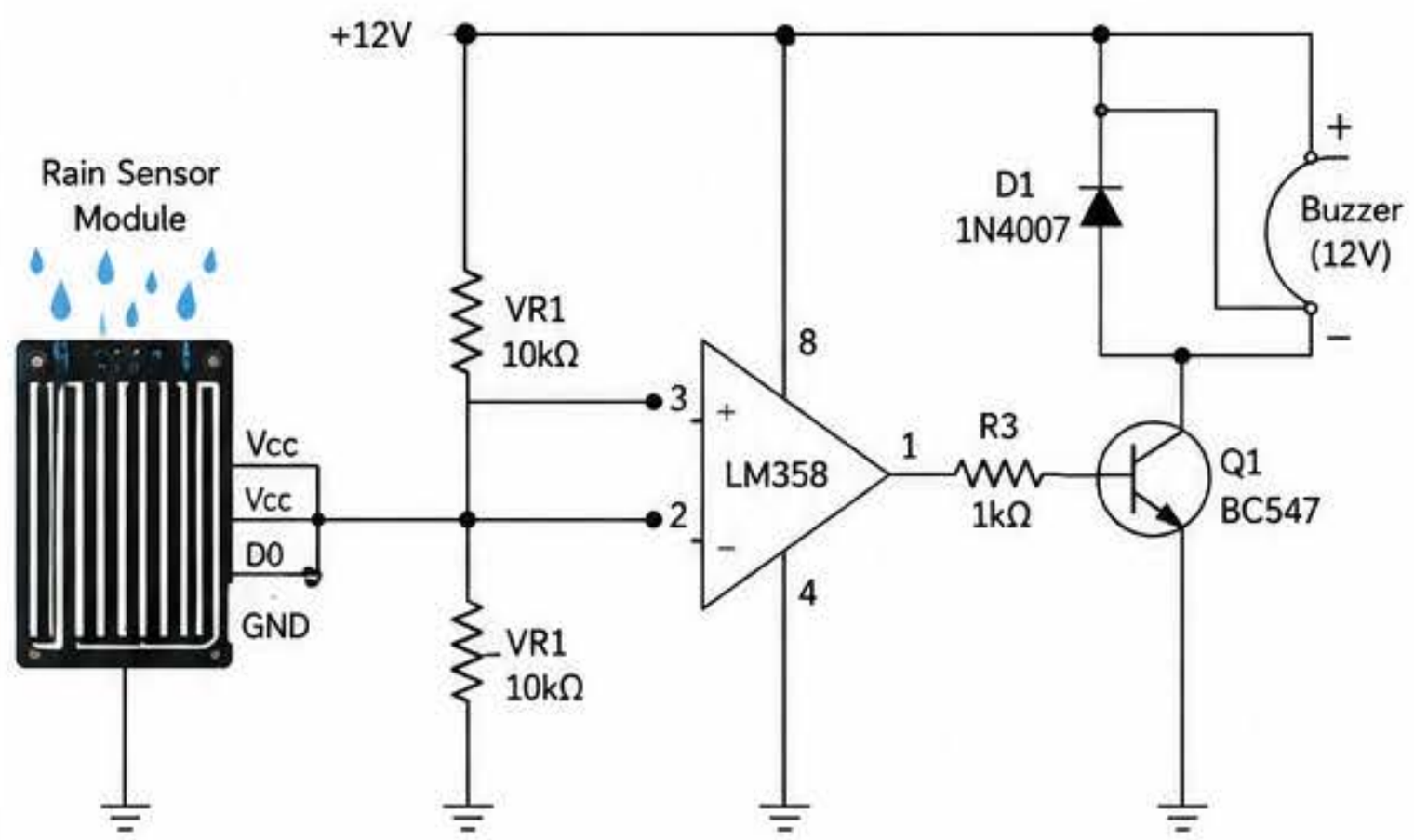
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	Rain Sensor Module	-	1
2	LM358 IC (Dual Op-Amp)	-	1
3	Resistor (R1)	10 kΩ	1
4	Resistor (R2)	10 kΩ	1
5	Preset (VR1)	10 kΩ	1
6	Resistor (R3)	1 kΩ	1
7	Transistor (Q1)	BC547	1
8	Buzzer	12V DC	1
9	Diode (D1)	1N4007	1
10	Power Supply	12V DC	1

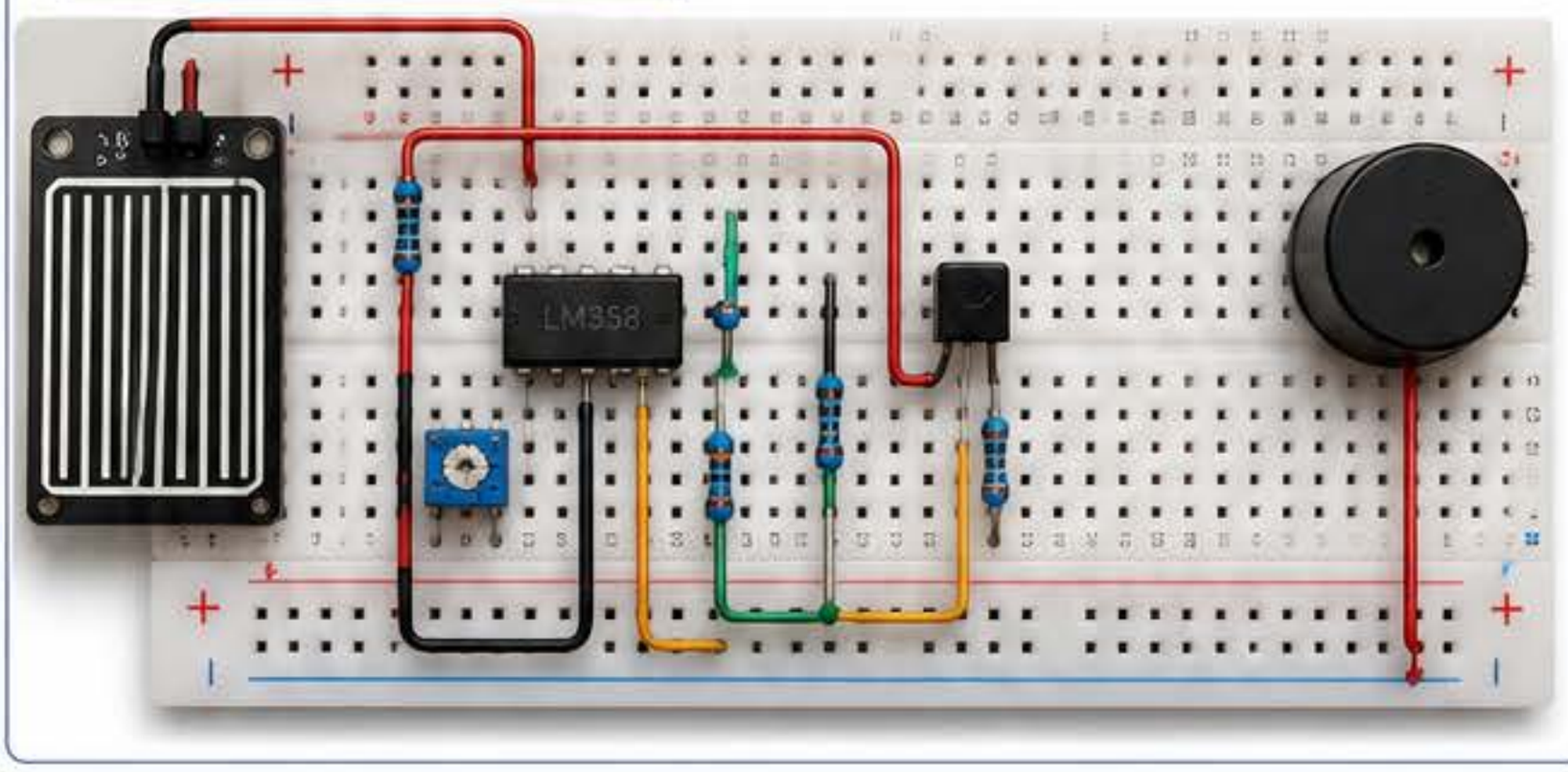
CIRCUIT DIAGRAM



APPLICATIONS

- Residential and commercial use
- Protects clothes, crops, and equipment
- Industrial automation
- Weather monitoring systems

CIRCUIT ON BREADBOARD



WORKING

The rain sensor module has a conductive plate which detects rainwater. When rain drops fall on the sensor, the resistance between the tracks decreases, and the DO output goes HIGH.

This HIGH signal is applied to the non-inverting input of LM358 comparator. When rain is detected, the output of LM358 goes HIGH, turning ON transistor Q1. The transistor energizes the buzzer and the alarm sounds.

When it stops raining, the sensor output goes LOW, the comparator output goes LOW, transistor turns OFF and buzzer stops.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +12V DC power supply.
3. Adjust the preset (VR1) to set the sensitivity.
4. Sprinkle a few water drops on the rain sensor. The buzzer should sound (alarm ON).
5. Wipe the sensor dry. The buzzer should stop (alarm OFF).
6. Enclose the circuit in a suitable box for practical use.

RESULT

The rain alarm system detects rain effectively and activates the buzzer alarm. The alarm stops automatically when the sensor becomes dry.

PRECAUTIONS

- Ensure correct polarity of power supply.
- Keep the sensor clean for accurate detection.
- Do not touch the sensor tracks with hands or metal objects.
- Use proper enclosure for outdoor protection.

FUTURE SCOPE

This system can be extended using a microcontroller to send rain alerts to mobile phones or display rainfall intensity on LCD.

PROJECT MANUAL

5. FIRE ALARM USING THERMISTOR

AIM

To design and implement a fire alarm system that detects high temperature using a thermistor and activates an alarm (buzzer). The alarm turns ON when temperature exceeds a set value and turns OFF when temperature falls below the set value.

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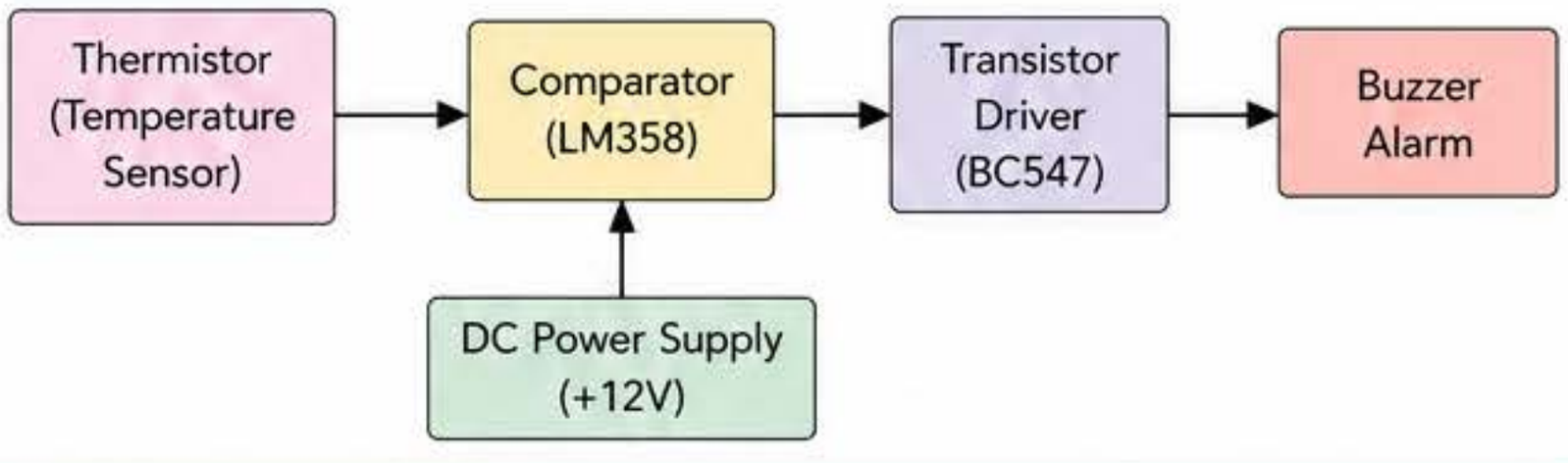
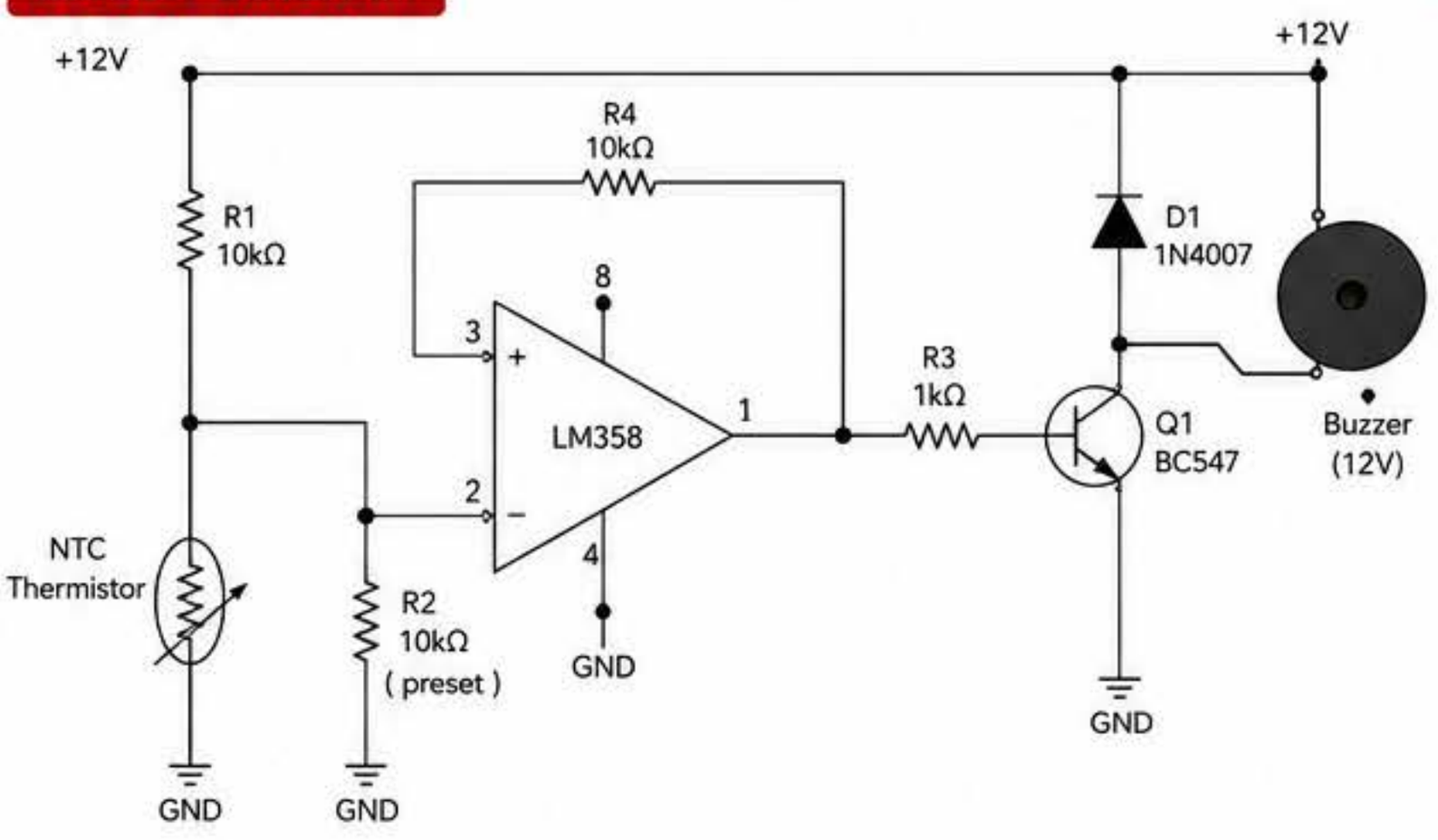


COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	Thermistor (NTC)	10kΩ @ 25°C	1
2	LM358 IC (Dual Op-Amp)	-	1
3	Resistor R1	10kΩ	1
4	Resistor R2	10kΩ (Preset)	1
5	Resistor R3	1kΩ	1
6	Resistor R4	10kΩ	1
7	Transistor (Q1)	BC547	1
8	Diode (D1)	1N4007	1
9	Buzzer	12V DC	1
10	Power Supply	12V DC	1

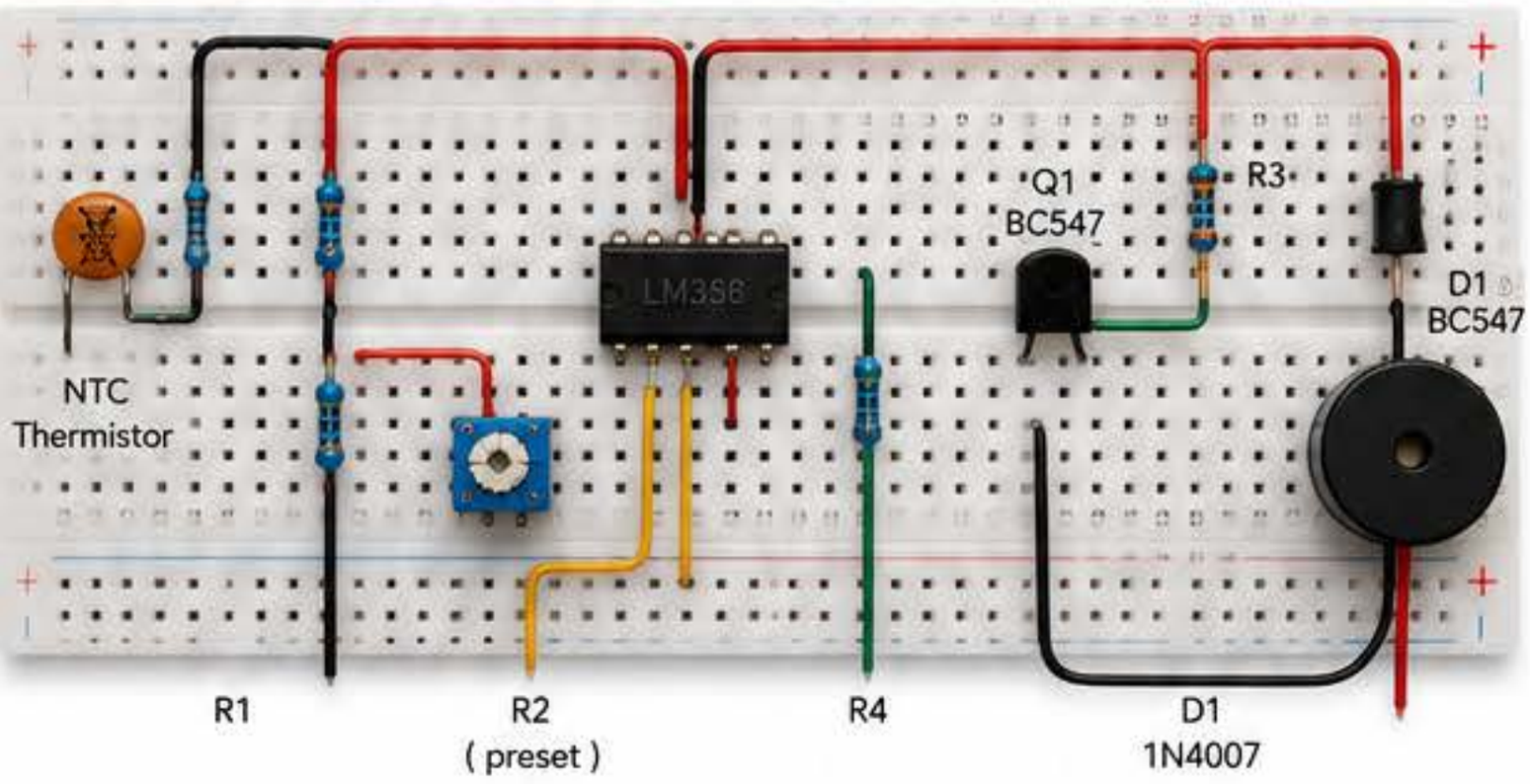
CIRCUIT DIAGRAM



APPLICATIONS

- Fire detection in homes, industries
- Temperature monitoring systems
- Safety and security systems
- Laboratory and equipment protection

CIRCUIT ON BREADBOARD



WORKING

The thermistor is sensitive to temperature. At normal temperature, its resistance is high.
As the temperature increases, the resistance of the NTC thermistor decreases.

The voltage at the non-inverting input (+) of LM358 increases with temperature.
When temperature exceeds the set value (defined by preset R2), the voltage at (+) input becomes higher than (−) input, causing the output of LM358 to go HIGH.

The HIGH output drives the transistor Q1 into saturation, allowing current to flow through the buzzer, and the alarm sounds.
When temperature falls below the set value, the output goes LOW, transistor turns OFF and buzzer stops.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +12V DC power supply to the circuit.
3. Adjust the preset (R2) to set the desired temperature level.
4. Heat the thermistor using a lighter or hot air (Do not touch directly).
5. When temperature exceeds the set value, the buzzer should sound (alarm ON).
6. Allow the thermistor to cool down.
7. When temperature falls below the set value, the buzzer should stop (alarm OFF).
8. Fix the circuit in an enclosure for practical use.

RESULT

The fire alarm system detects high temperature using a thermistor and activates the buzzer alarm. The alarm sounds when temperature exceeds the set value and stops when temperature returns to normal.

PRECAUTIONS

- Ensure correct polarity of power supply.
- Do not touch the thermistor with hands.
- Keep thermistor away from open flame after testing.
- Use proper enclosure to avoid false triggering due to dust or airflow.

FUTURE SCOPE

This project can be enhanced using a microcontroller to display temperature on LCD and send SMS or alerts when fire is detected.

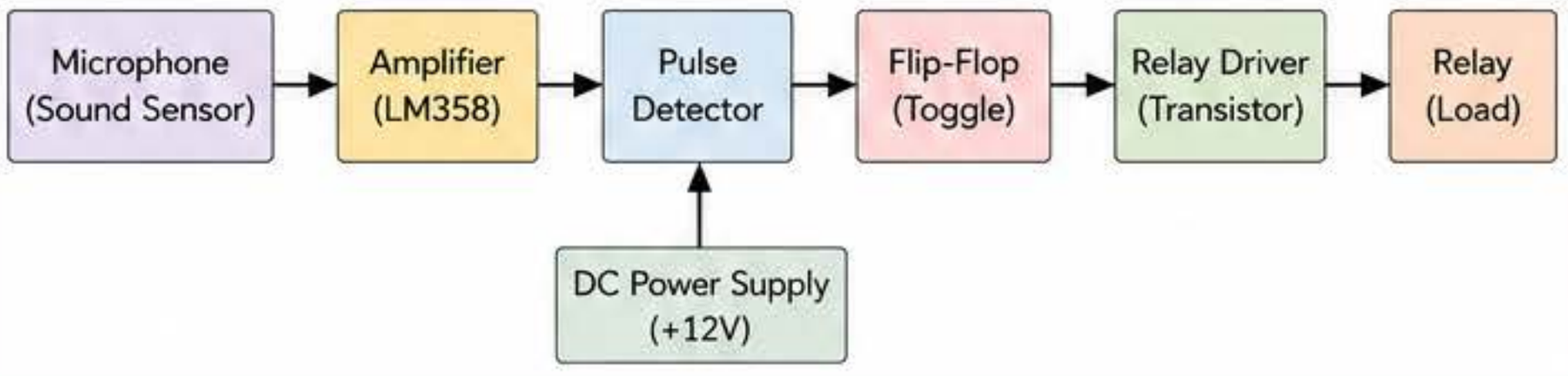
PROJECT MANUAL

6. CLAP SWITCH

AIM

To design and implement a clap switch which turns ON a load (LED/Bulb/Fan) by clapping hands and turns it OFF by clapping again. It uses a microphone to detect the sound of clap.

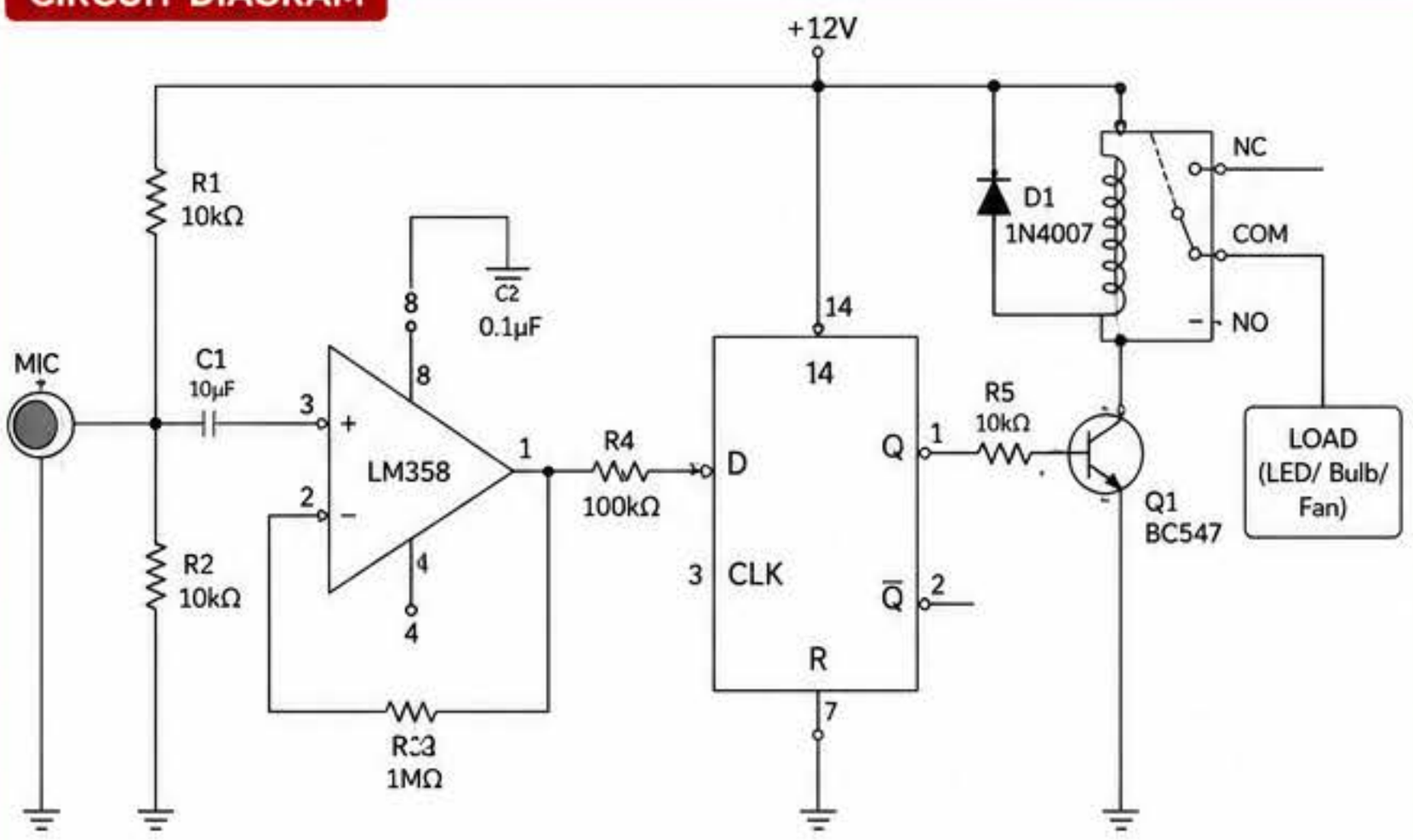
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	Electret Microphone	-	1
2	LM358 IC (Dual Op-Amp)	-	1
3	Resistor R1	10 kΩ	1
4	Resistor R2	10 kΩ	1
5	Resistor R3	1 MΩ	1
6	Resistor R4	100 kΩ	1
7	Resistor R5	10 kΩ	1
8	Capacitor C1	10 µF / 16V	1
9	Capacitor C2	0.1 µF	1
10	CD4013 IC (Dual D Flip-Flop)	-	1
11	Transistor Q1	BC547	1
12	Diode D1	1N4007	1
13	Relay	12V SPDT	1
14	LED / Bulb / Fan	12V DC	1
15	Power Supply	12V DC	1

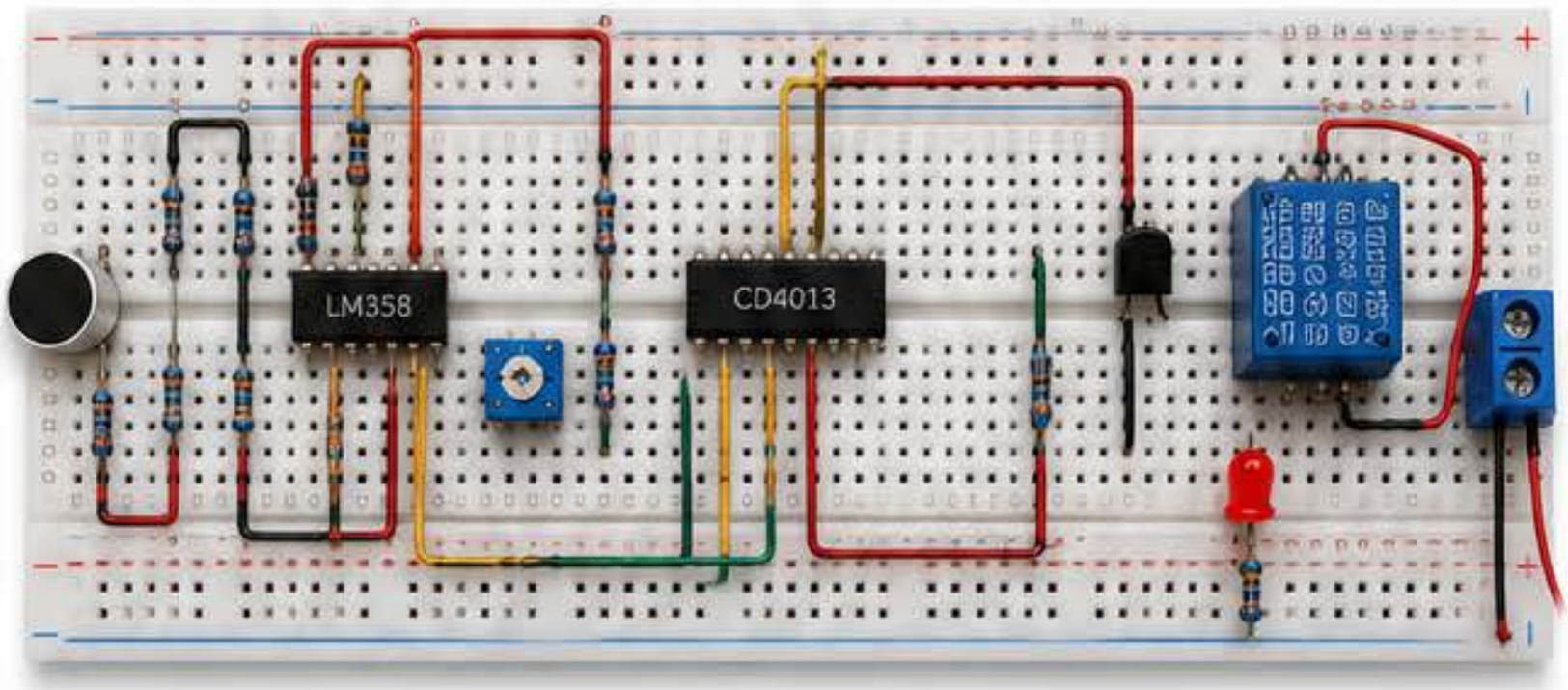
CIRCUIT DIAGRAM



APPLICATIONS

- Home automation
- Controlling lights and fans
- Useful in theaters and auditoriums
- Security systems

CIRCUIT DIAGRAM ON BREADBOARD



WORKING

The microphone senses the sound of clap and produces a small AC signal. The LM358 amplifier amplifies this signal. When a clap is detected, the amplifier output produces a short HIGH pulse. This pulse is given to the clock (CLK) input of CD4013 flip-flop.

Each clap toggles the state of the flip-flop.

- First clap: Q becomes HIGH → Transistor ON → Relay ON → Load ON
- Second clap: Q becomes LOW → Transistor OFF → Relay OFF → Load OFF

Thus, the load can be turned ON/OFF by clapping.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Provide +12V DC to the circuit.
3. Adjust R3 (1MΩ preset) if required for sensitivity of clap detection.
4. Clap your hands once near the microphone. The load (LED/Bulb/Fan) should turn ON.
5. Clap again, the load should turn OFF.
6. Enclose the circuit in a suitable box for practical use.

RESULT

The clap switch works as expected. The load turns ON with the first clap and turns OFF with the second clap.

PRECAUTIONS

- Ensure correct polarity of power supply.
- Keep the microphone away from noise sources during testing.
- Do not touch the components when power is ON.
- Use proper relay rating as per load.

FUTURE SCOPE

The project can be extended using a microcontroller to control multiple appliances and provide wireless clap control.

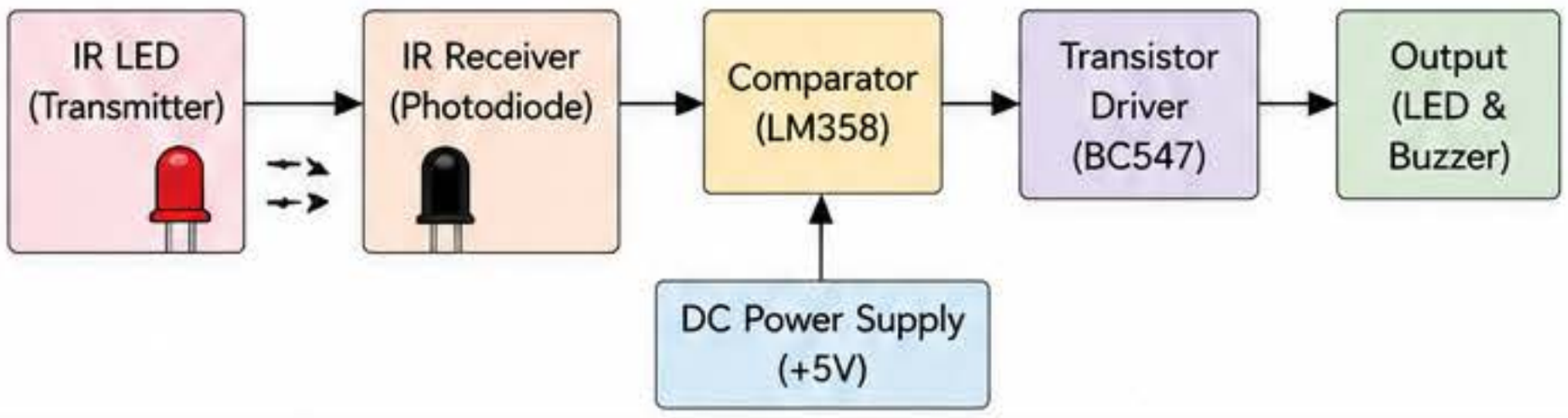
PROJECT MANUAL

7. IR OBSTACLE DETECTOR

AIM

To design and implement an IR Obstacle Detector which detects the presence of an obstacle in front of the IR sensor and gives an alert through an LED and buzzer.

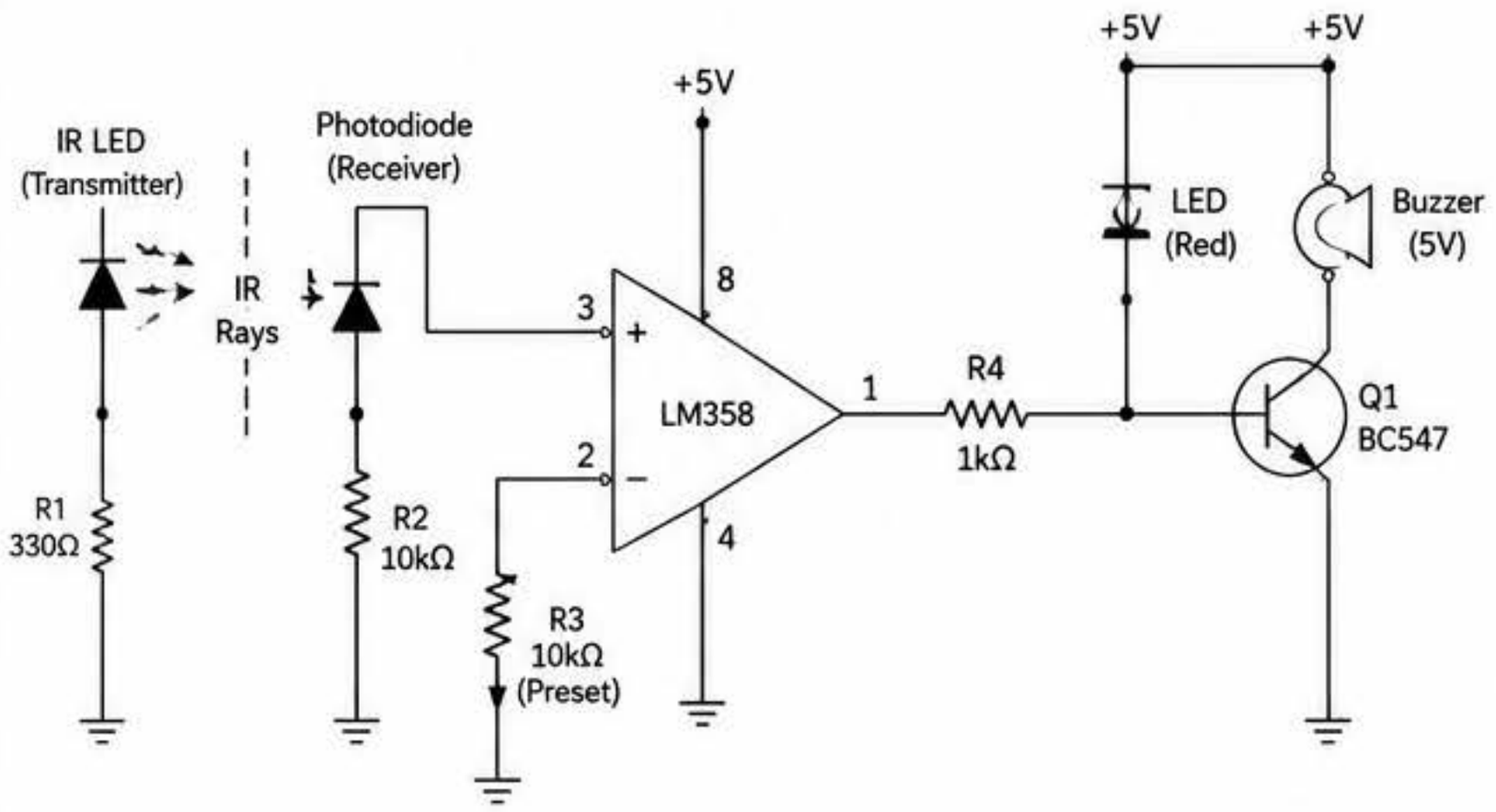
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	IR LED (Transmitter)	940 nm	1
2	Photodiode (Receiver)	-	1
3	LM358 IC (Dual Op-Amp)	-	1
4	Resistor R1	330 Ω	1
5	Resistor R2	10 kΩ	1
6	Resistor R3	10 kΩ (Preset)	1
7	Resistor R4	1 kΩ	1
8	Transistor Q1	BC547	1
9	LED (Red)	5 mm	1
10	Buzzer	5V DC	1
11	Power Supply	5V DC	1

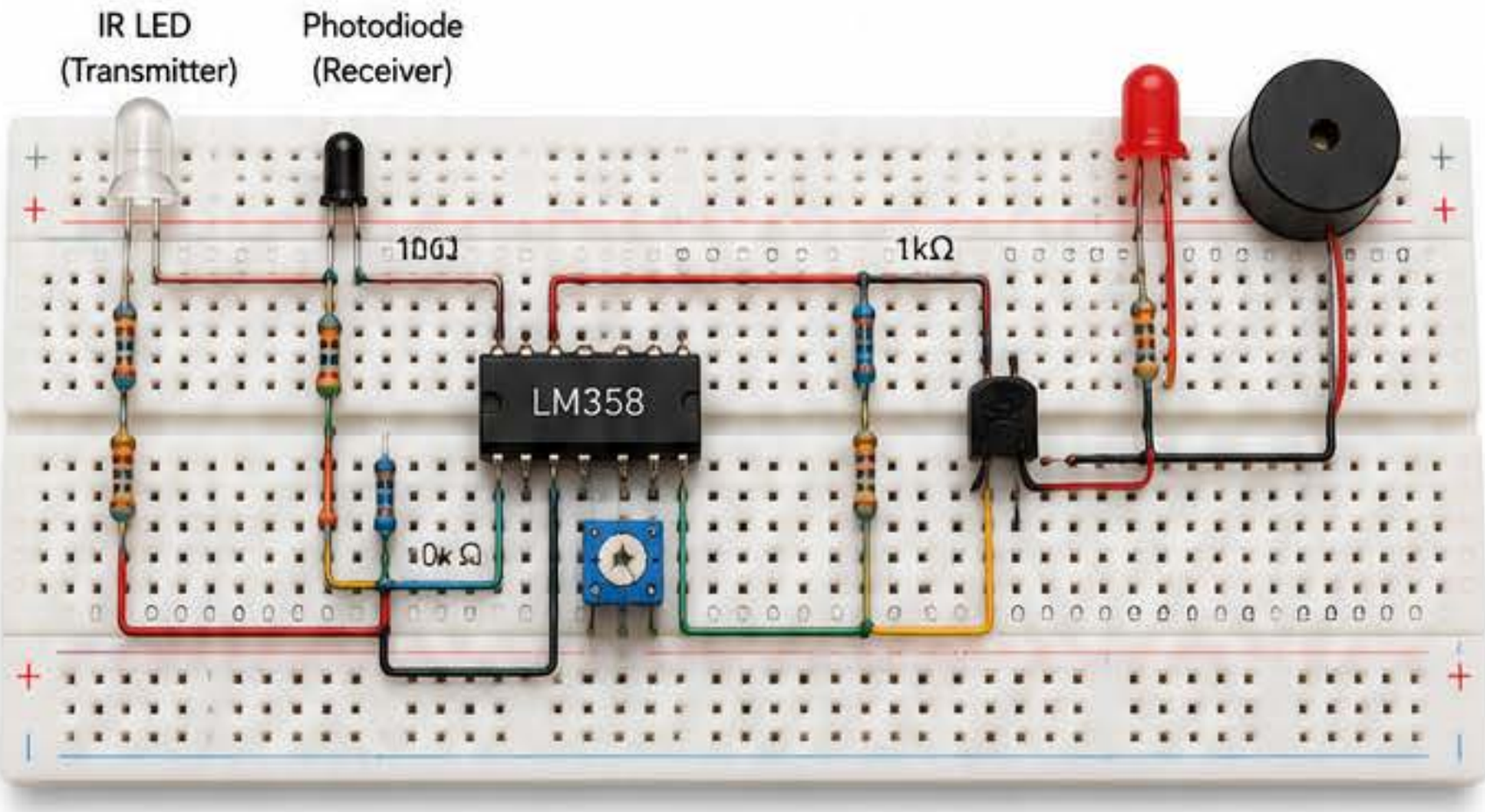
CIRCUIT DIAGRAM



APPLICATIONS

- Robot obstacle detection
- Automation projects
- Object counting systems
- Security and safety systems

CIRCUIT ON BREADBOARD



WORKING

The IR LED continuously emits infrared light. When no obstacle is in front of the sensor, the IR light falls on the photodiode and it conducts. This makes the voltage at the non-inverting input (+) of LM358 high. The output of LM358 becomes LOW, so the transistor remains OFF. Hence LED and buzzer are OFF.

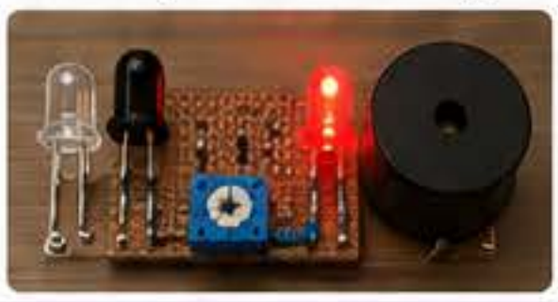
When an obstacle is detected, the IR light is reflected back insufficiently to the photodiode. The photodiode current decreases and the voltage at (+) input goes LOW. Now the output of LM358 goes HIGH, turning ON the transistor. The LED glows and the buzzer sounds.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +5V DC power supply to the circuit.
3. Adjust the preset (R3) slowly until the LED turns ON when an obstacle is placed in front of the sensor (2–10 cm range).
4. Test the circuit by placing different objects in front of the sensor.
5. Enclose the circuit in a suitable box for practical use.

RESULT

The IR obstacle detector detects the obstacle and gives an alert indication through LED and buzzer. The circuit works accurately within the set range.



PRECAUTIONS

- Ensure correct polarity of power supply.
- Do not look directly into IR LED light.
- Adjust sensitivity properly to avoid false triggering.
- Keep the sensor clean for accurate detection.

FUTURE SCOPE

This project can be enhanced using a microcontroller to measure the distance and control robots or automatic systems.

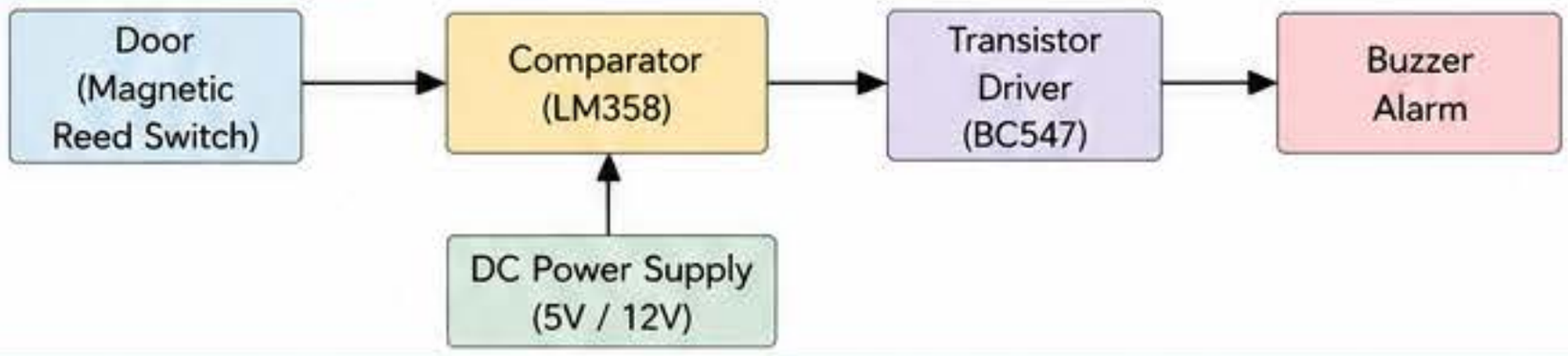
PROJECT MANUAL

8. DOOR OPEN ALARM

AIM

To design and implement a Door Open Alarm system that gives an alert when the door is opened without authorization. The alarm remains ON as long as the door is open and turns OFF when the door is closed.

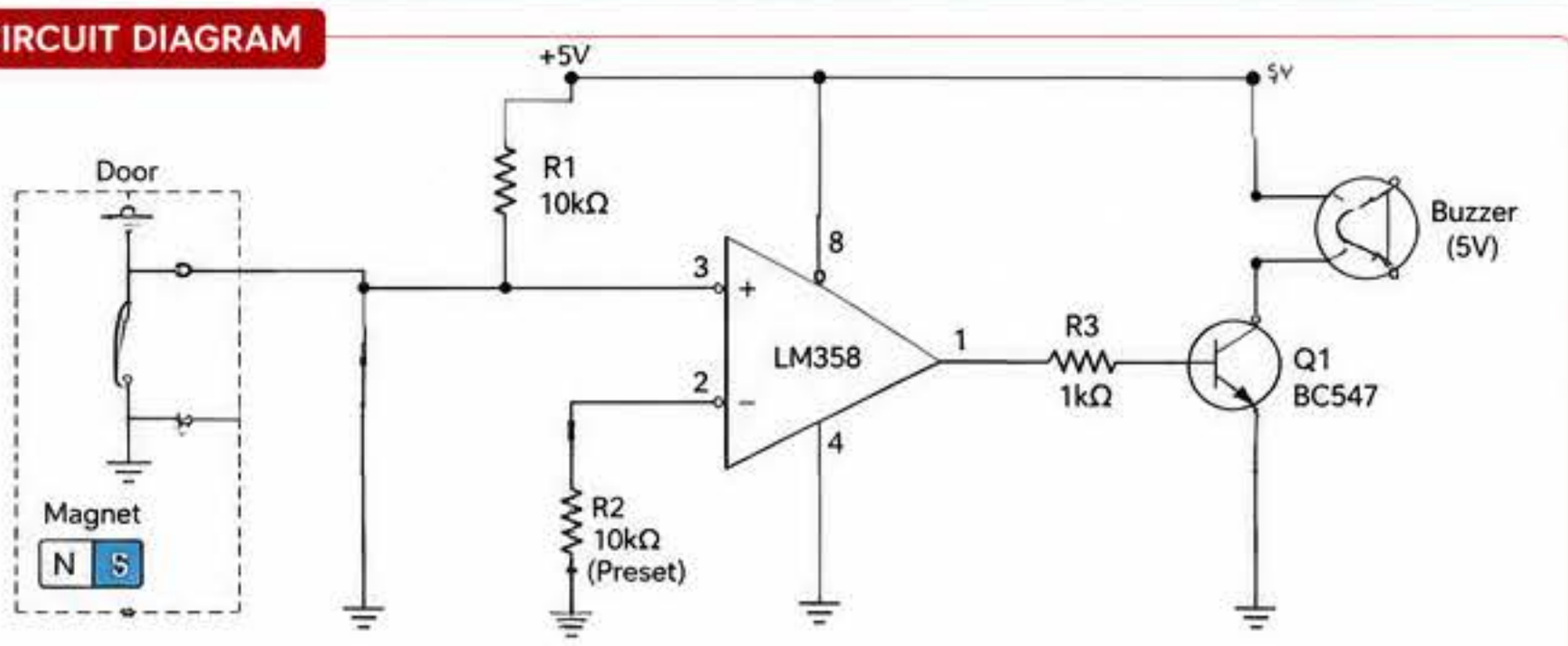
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	Reed Switch (Door Sensor)	-	1
2	Magnet	-	1
3	LM358 IC (Dual Op-Amp)	-	1
4	Resistor R1	10 kΩ	1
5	Resistor R2 (Preset)	10 kΩ	1
6	Resistor R3	1 kΩ	1
7	Transistor Q1	BC547	1
8	Buzzer	5V DC	1
9	Power Supply	5V DC	1

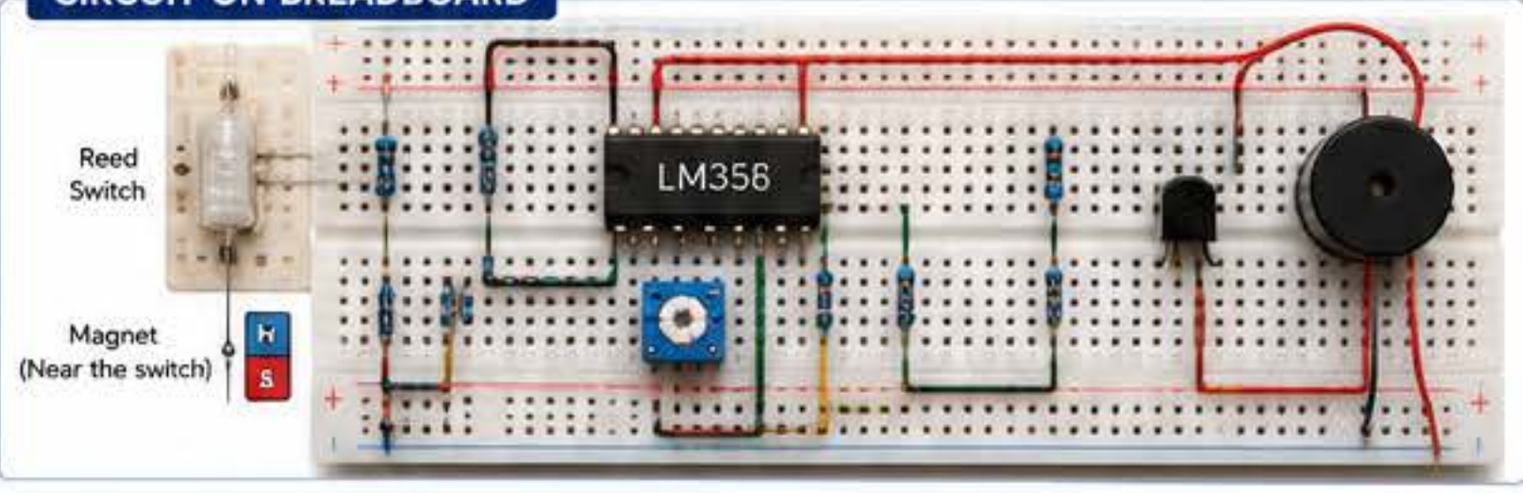
CIRCUIT DIAGRAM



APPLICATIONS

- Home and office security
- Alarms for cupboards and lockers
- Industrial safety systems
- Unauthorized entry detection

CIRCUIT ON BREADBOARD



WORKING

When the door is closed, the magnet is near the reed switch, so the switch remains closed (connected). This makes the voltage at the non-inverting input (+) of LM358 lower than the inverting input (–), so the output goes LOW. Transistor remains OFF and buzzer is silent.

When the door is opened, the magnet moves away and the reed switch opens. Now the (+) input voltage becomes higher than the (–) input. The output of LM358 goes HIGH, turning ON the transistor and the buzzer sounds as an alarm.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Place the magnet near the reed switch (door closed).
3. Power ON the circuit (5V DC).
4. Move the magnet away (door open).
5. Observe that the buzzer turns ON.
6. Bring the magnet near again (door closed).
7. Observe that the buzzer turns OFF.

RESULT

The circuit works as expected. When the door is opened, the alarm (buzzer) sounds. When the door is closed, the alarm stops.

PRECAUTIONS

- Keep the magnet aligned with the reed switch.
- Use regulated power supply.
- Do not place magnet very far, otherwise it may not activate the switch.

FUTURE SCOPE

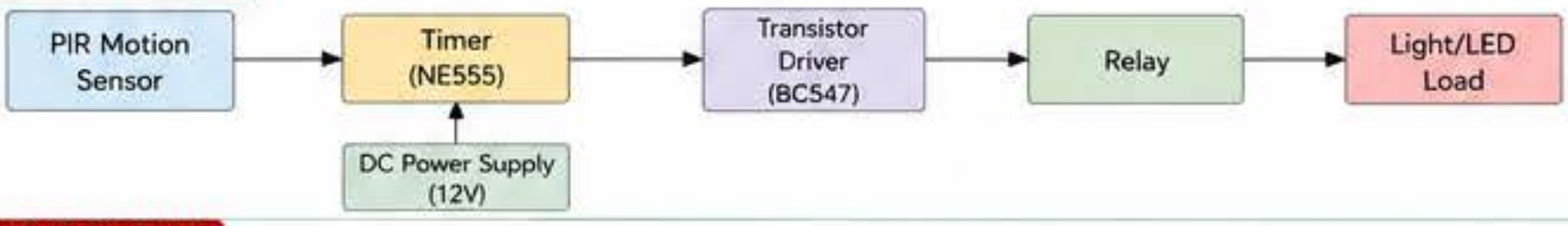
This system can be enhanced using a microcontroller to send SMS alerts, log door status or integrate with home automation systems.

9. AUTOMATIC BATHROOM LIGHT

AIM

To design an automatic bathroom light that turns ON when a person enters (motion detected) and turns OFF after a short delay when the person leaves.

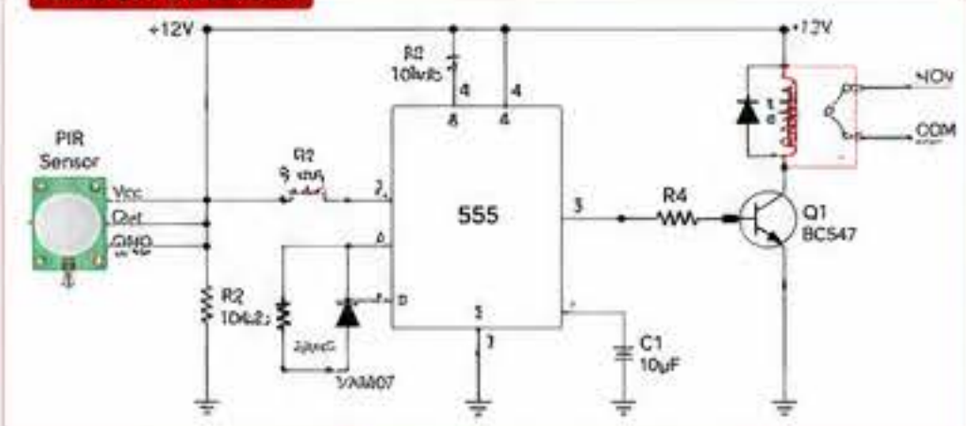
BLOCK DIAGRAM



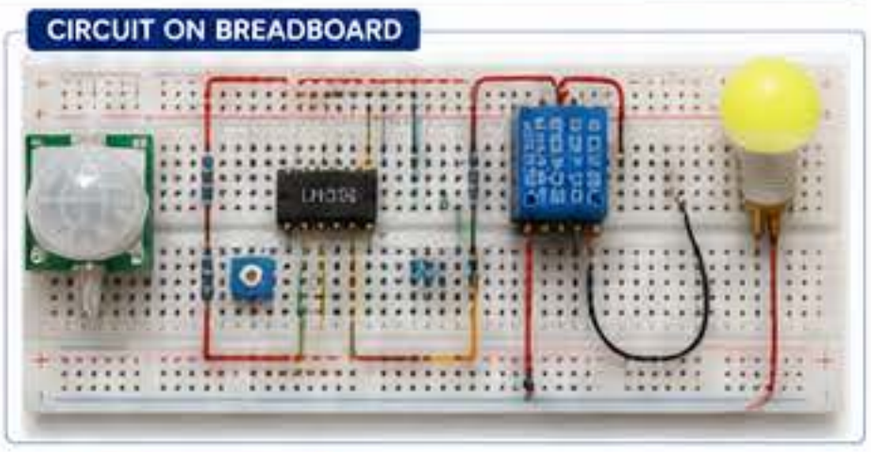
COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	PIR Motion Sensor	HC-SR501	1
2	NE555 Timer IC	-	1
3	Resistor R1	1 kΩ	1
4	Resistor R2	10 kΩ	1
5	Resistor R3	100 kΩ	1
6	Capacitor C1	10 µF / 16V	1
7	Diode D1	1N4007	1
8	Transistor Q1	BC547	1
9	Relay (12V)	SPDT	1
10	Lamp / LED	12V DC / LED	1
11	Power Supply	12V DC	1

CIRCUIT DIAGRAM



CIRCUIT ON BREADBOARD



WORKING

When a person enters the bathroom, the PIR sensor detects body heat (motion) and its output goes HIGH. This triggers the NE555 timer which generates a HIGH output at pin 3. The transistor Q1 turns ON and energizes the relay coil. The relay contacts close and the light turns ON. After the person leaves, the PIR output goes LOW. The timer keeps the relay ON for a set time (adjustable using R2 & C1). After the time delay, the output goes LOW, relay turns OFF and the light turns OFF.

RESULT

The bathroom light turns ON automatically when motion is detected and turns OFF after the preset delay when no motion is detected.

PRECAUTIONS

- Install the PIR sensor at proper height and angle.
- Avoid direct air flow from fans or AC on the sensor.
- Use proper 12V supply for relay and load.
- Do not exceed relay current rating.

FUTURE SCOPE

This system can be enhanced using a microcontroller for multi-sensor control, dimming, daylight sensing and IoT based remote monitoring.

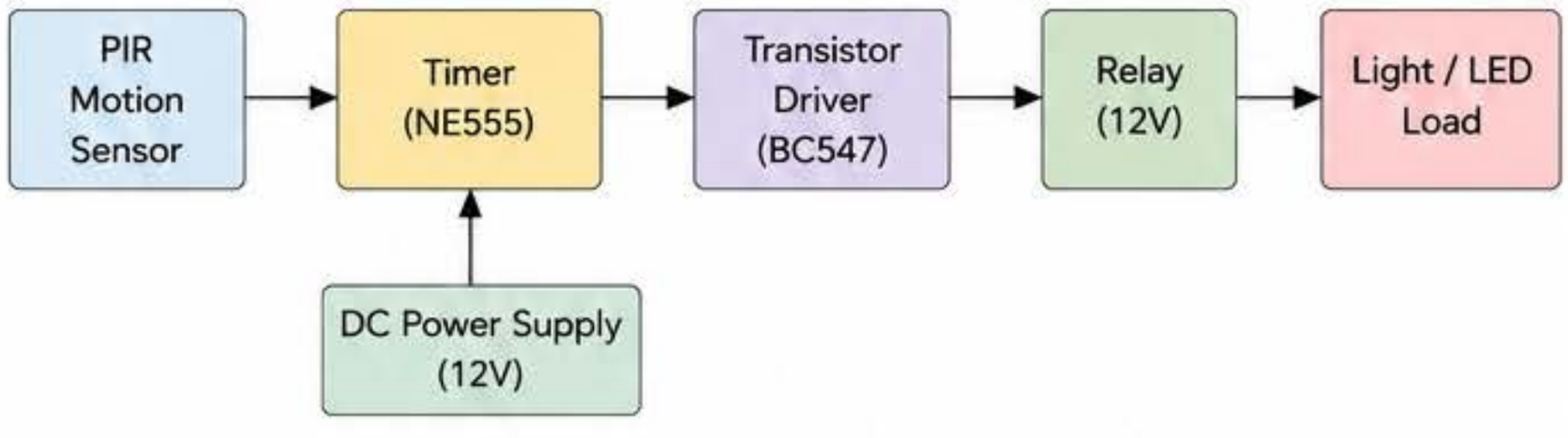
PROJECT MANUAL

9. AUTOMATIC BATHROOM LIGHT

AIM

To design and implement an Automatic Bathroom Light that turns ON when a person enters the bathroom (motion detected) and turns OFF automatically after a short delay when the person leaves. This saves energy and provides convenience.

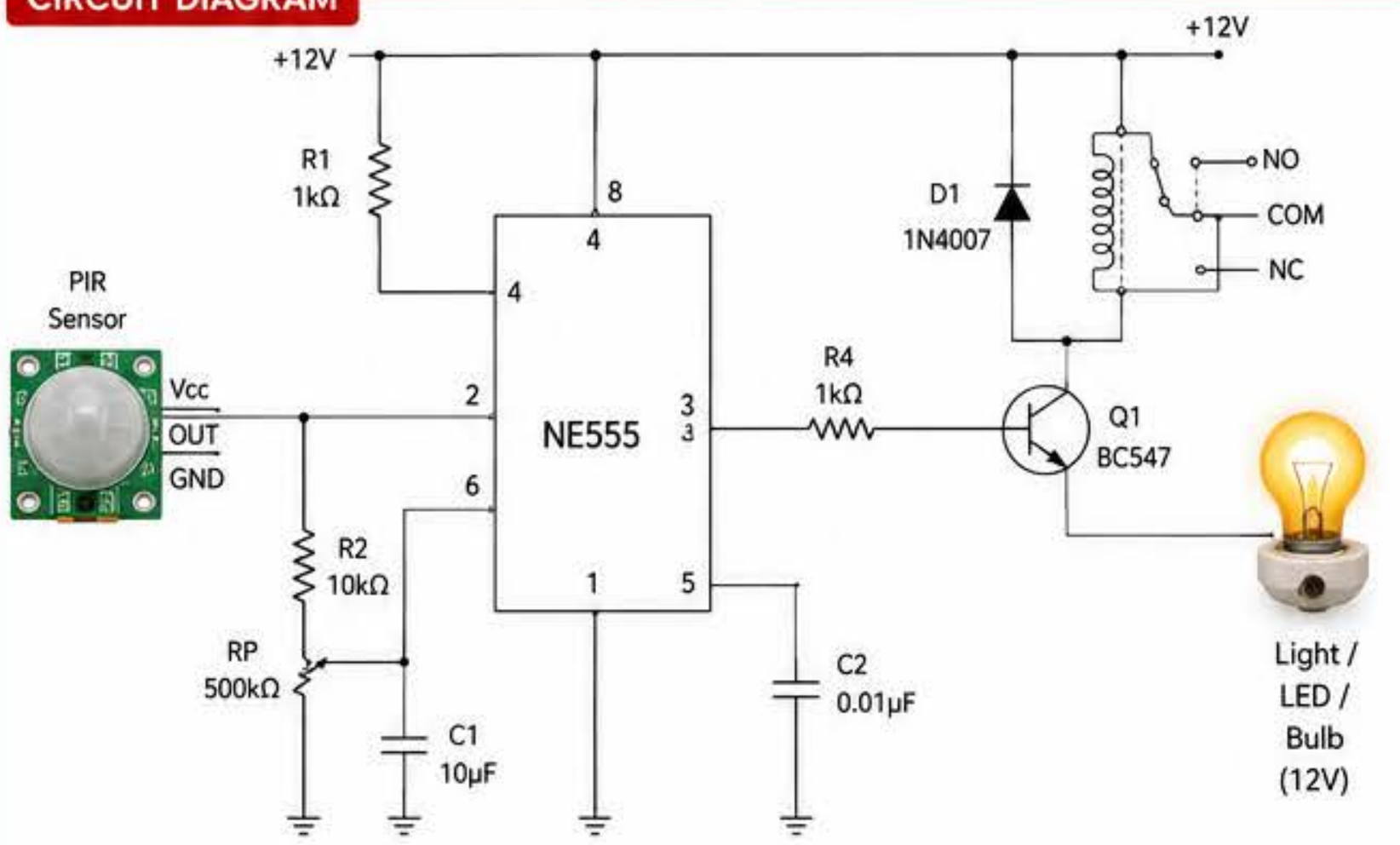
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification / Value	Quantity
1	PIR Motion Sensor	HC-SR501	1
2	NE555 Timer IC	–	1
3	Resistor R1	1 kΩ	1
4	Resistor R2	10 kΩ	1
5	Resistor R3	100 kΩ	1
6	Potentiometer	500 kΩ (Preset)	1
7	Capacitor C1	10 µF / 16V	1
8	Capacitor C2	0.01 µF	1
9	Diode D1	1N4007	1
10	Transistor Q1	BC547	1
11	Relay	12V SPDT	1
12	LED / Bulb	12V DC / AC	1
13	Power Supply	12V DC	1

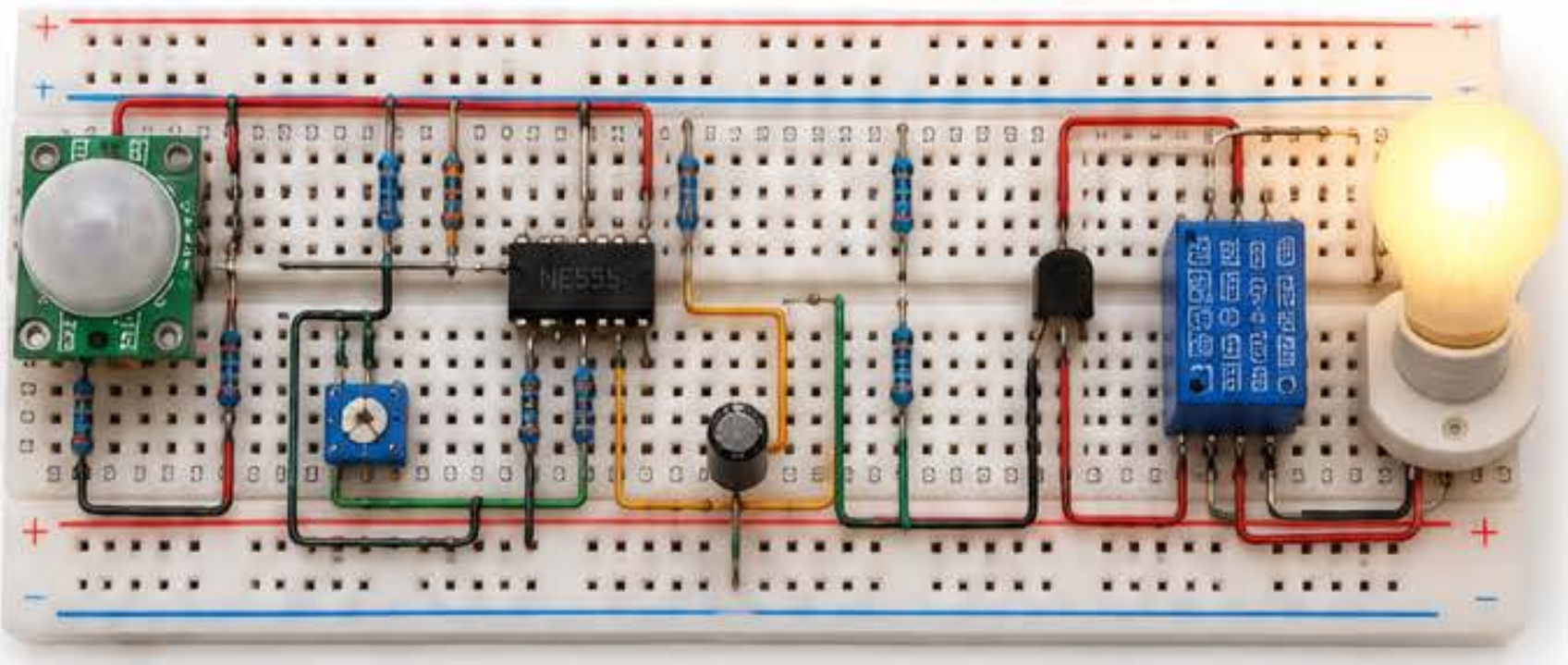
CIRCUIT DIAGRAM



APPLICATIONS

- Automatic control of bathroom lights
- Energy saving in homes, hotels
- Smart home automation
- Public toilets and washrooms
- Offices and commercial buildings

CIRCUIT ON BREADBOARD



WORKING

When a person enters the bathroom, the PIR motion sensor detects the body heat (infrared radiation) and its output goes HIGH.

This HIGH signal triggers the NE555 timer. The output at pin 3 goes HIGH, driving the transistor ON. The relay gets energized and its NO (Normally Open) contact closes, switching ON the light.

When the person leaves, the PIR output goes LOW. The timing capacitor (C1) discharges through the preset (RP). After a preset delay (adjustable), the output of NE555 becomes LOW, the relay de-energizes, and the light turns OFF automatically.

The delay can be adjusted using the potentiometer (RP).

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +12V DC power supply to the circuit.
3. Adjust the preset (RP) to set the desired delay (approx. 10 seconds to 1 minute).
4. When a person enters the range of the PIR sensor, the light should turn ON.
5. After the person leaves, wait for the preset delay. The light should turn OFF automatically.
6. Enclose the circuit in a suitable box for safe and practical use.

RESULT

The bathroom light turns ON automatically when motion is detected and turns OFF automatically after the preset delay when motion is not detected.

PRECAUTIONS

- Ensure correct polarity of the power supply.
- Install PIR sensor at proper height and angle.
- Avoid direct air flow from fans or AC on the sensor.
- Use proper relay rating as per the load.
- Do not exceed the voltage and current ratings of components.

FUTURE SCOPE

- Can be enhanced with dimming control using PWM.
- Can be integrated with IoT for remote monitoring.
- Can be extended to control exhaust fans along with light.

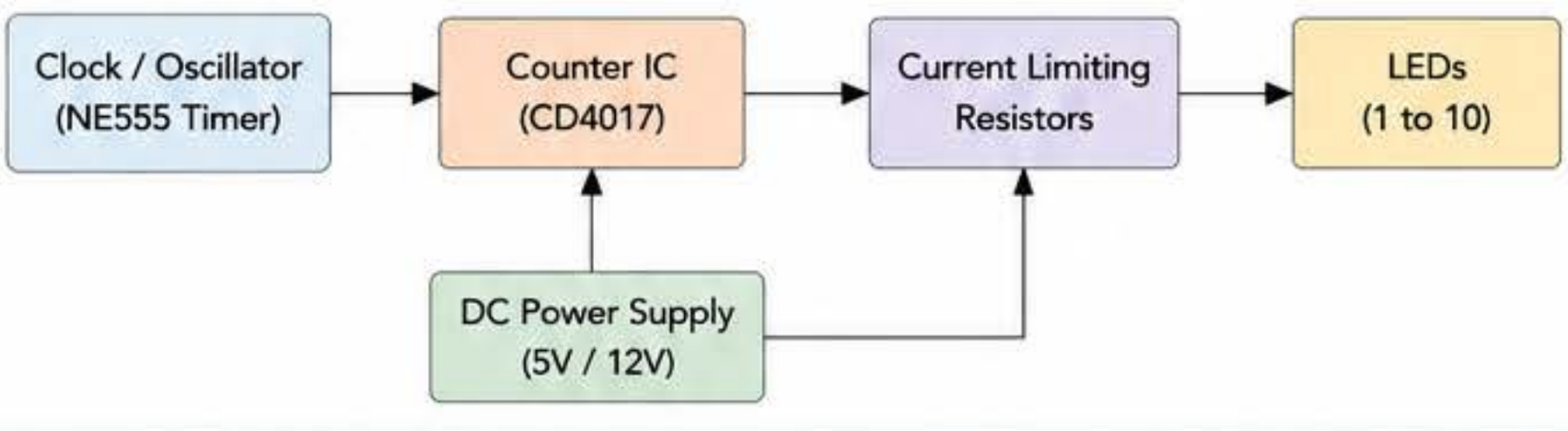
PROJECT MANUAL

10. LED RUNNING LIGHTS

AIM

To design and implement an LED Running Lights circuit in which LEDs turn ON one after another in sequence and repeat continuously in a loop, creating a running light effect. It is widely used in decorations, displays and signaling applications.

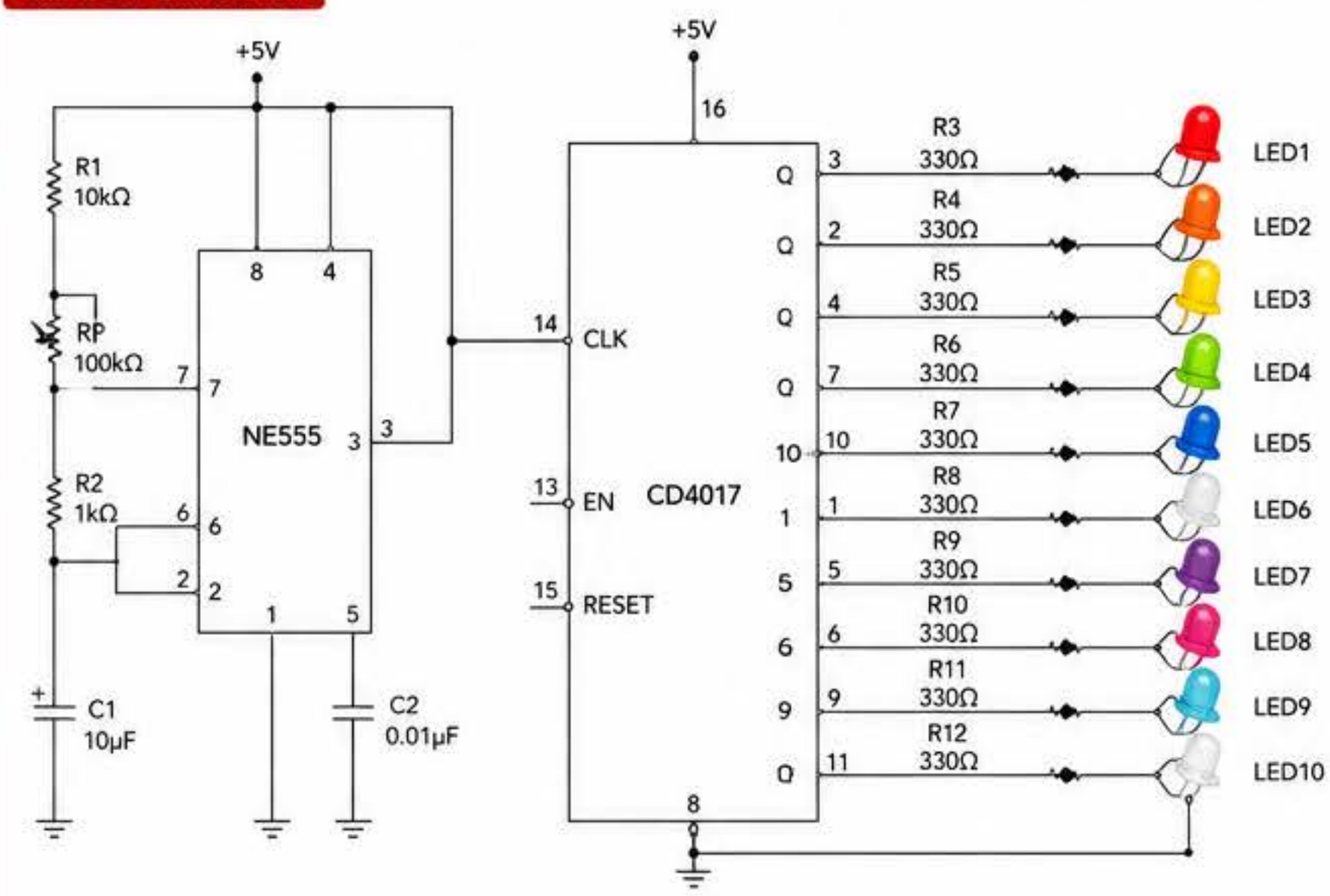
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	NE555 Timer IC	–	1
2	CD4017 Decade Counter IC	–	1
3	Resistor R1 (Timing)	10 kΩ	1
4	Potentiometer RP	100 kΩ (Preset)	1
5	Resistor R2	1 kΩ	1
6	Capacitor C1	10 µF / 16V	1
7	Capacitor C2	0.01 µF	1
8	Resistors (R3–R12)	330 Ω	10
9	LEDs (LED1–LED10)	5 mm	10
10	Power Supply	5V DC	1

CIRCUIT DIAGRAM



APPLICATIONS

- Decorative lighting
- Advertising boards and displays
- Sequential indicators
- Automotive and bike lighting
- DIY electronic projects

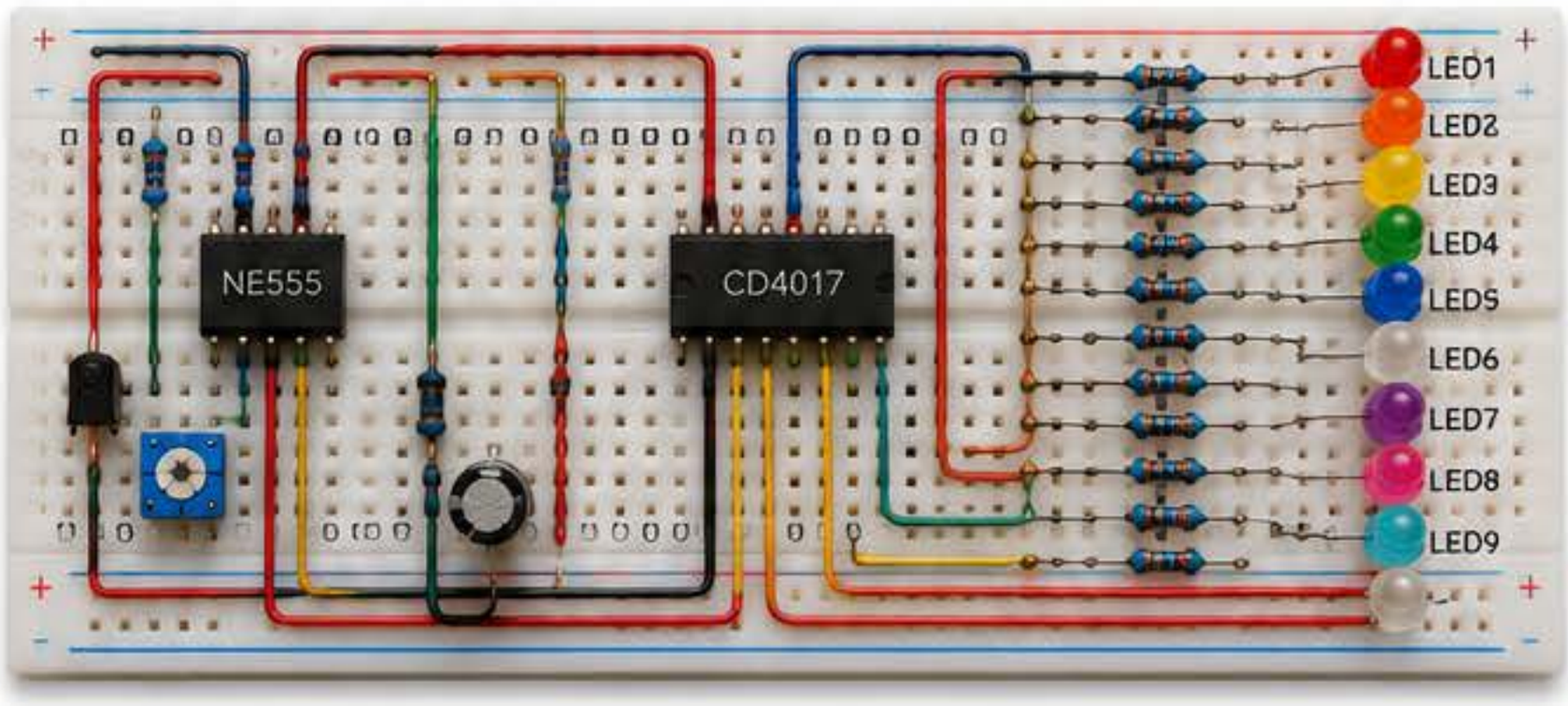
WORKING

The NE555 timer is configured in astable mode to generate continuous clock pulses. The output pulses from pin 3 of NE555 are applied to the clock input (CLK) of CD4017 (pin 14). The CD4017 is a decade counter that has ten decoded outputs (Q0–Q9).

With each clock pulse, the counter makes the next output HIGH one by one in sequence (Q0 → Q1 → Q2 … → Q9) and then returns to Q0.

The HIGH output at any pin drives the corresponding LED ON through a current limiting resistor, while all other LEDs remain OFF. This creates the "Running Lights" effect continuously.

CIRCUIT ON BREADBOARD



PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +5V DC power supply to the circuit.
3. Adjust the potentiometer RP to change the speed of running lights.
4. Observe the LEDs glowing one after another in sequence.
5. After Q9, the sequence restarts from Q0 automatically.
6. Enclose the circuit in a suitable box for practical use.

RESULT

The LEDs glow in a running sequence from LED1 to LED10 and then repeat continuously. The speed of running can be varied using the potentiometer.

PRECAUTIONS

- Ensure correct polarity of the power supply.
- Use current limiting resistors for all LEDs.
- Do not short the outputs of CD4017.
- Do not exceed the supply voltage and current ratings.

FUTURE SCOPE

- Can be extended to more LEDs using additional CD4017 ICs.
- Can be controlled using a microcontroller for advanced effects.
- Can be used in automotive and decorative lighting systems.

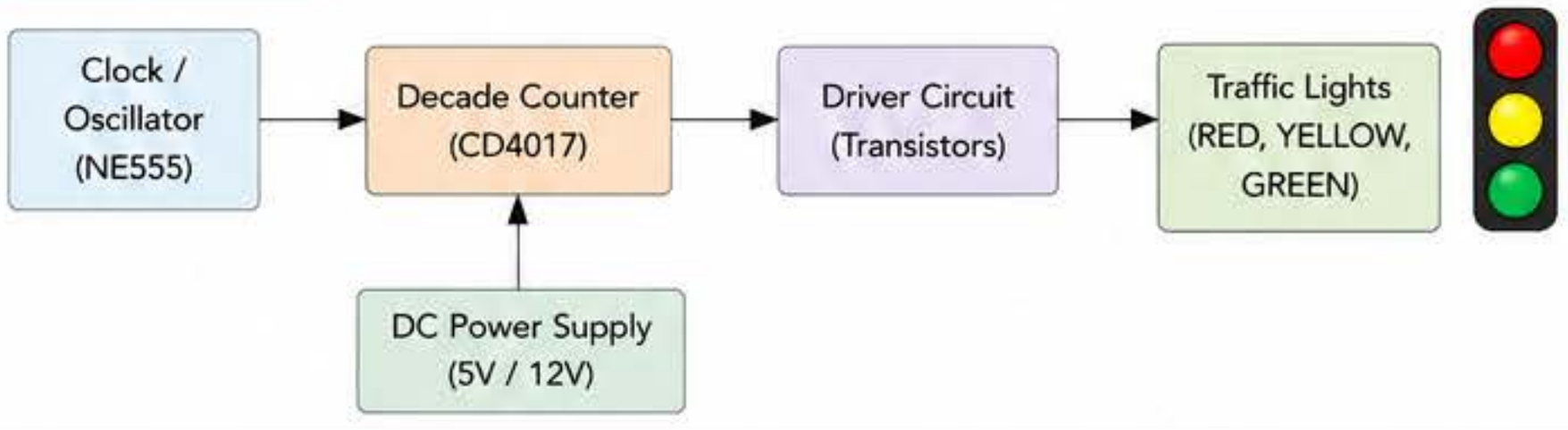
PROJECT MANUAL

11. TRAFFIC LIGHT CONTROLLER

AIM

To design and implement a Traffic Light Controller using Timer IC 555 and Counter IC CD4017 which controls the Red, Yellow and Green lights at a road junction automatically in proper sequence with preset time delays.

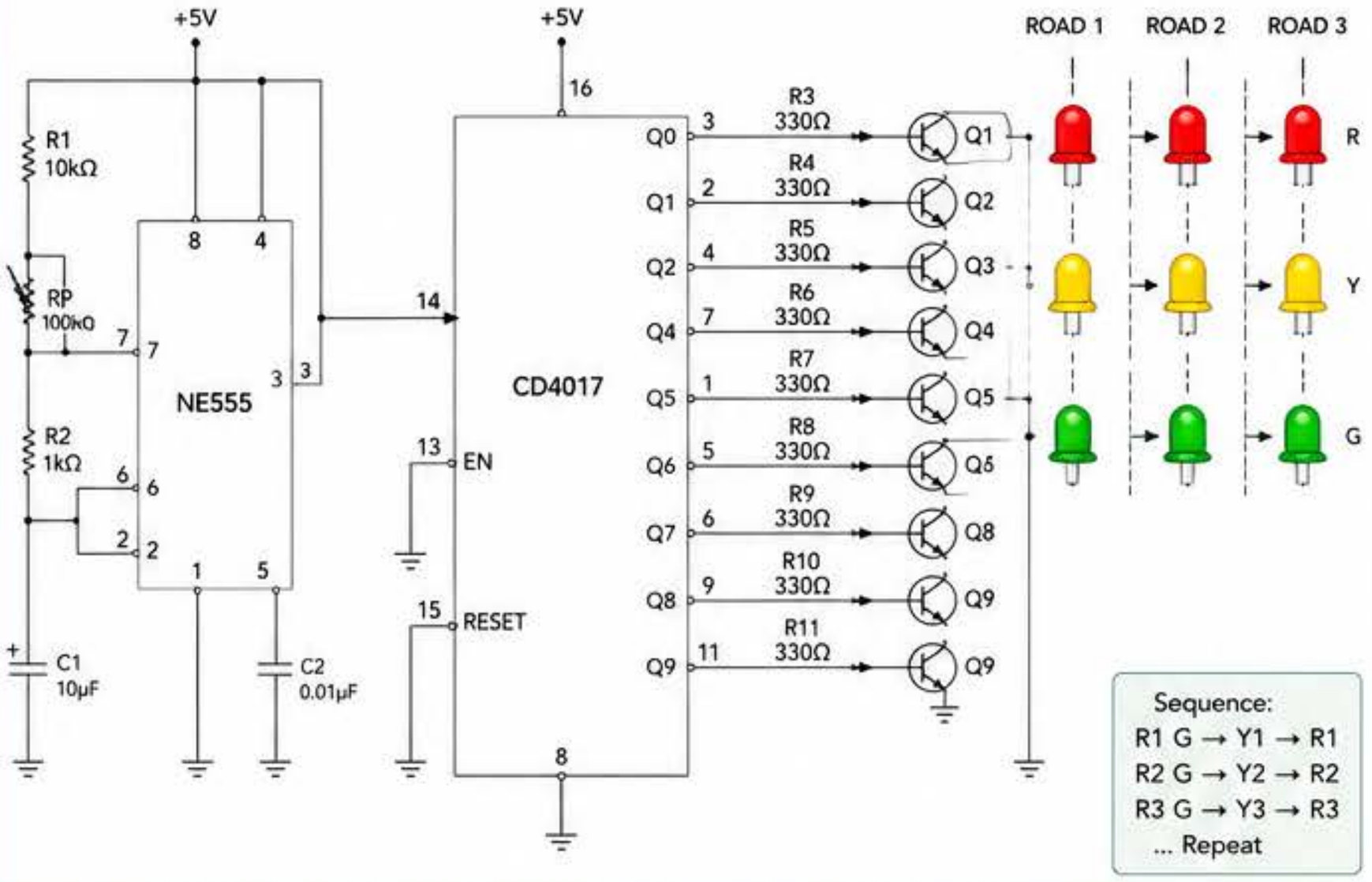
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification/	Quantity
1	NE555 Timer IC	–	1
2	CD4017 Decade Counter IC	–	1
3	Resistor R1	10 kΩ	1
4	Resistor R2	1 kΩ	1
5	Potentiometer RP	100 kΩ (Preset)	1
6	Capacitor C1	10 µF / 16V	1
7	Capacitor C2	0.01 µF	1
8	Resistors (R3–R11)	330 Ω	9
9	Transistors Q1–Q9	BC547	9
10	Red LEDs	5 mm	3
11	Yellow LEDs	5 mm	3
12	Green LEDs	5 mm	3
13	Power Supply	5V DC	1

CIRCUIT DIAGRAM



APPLICATIONS

- Traffic signal control
- Smart city automation
- Road safety systems
- Educational projects

WORKING

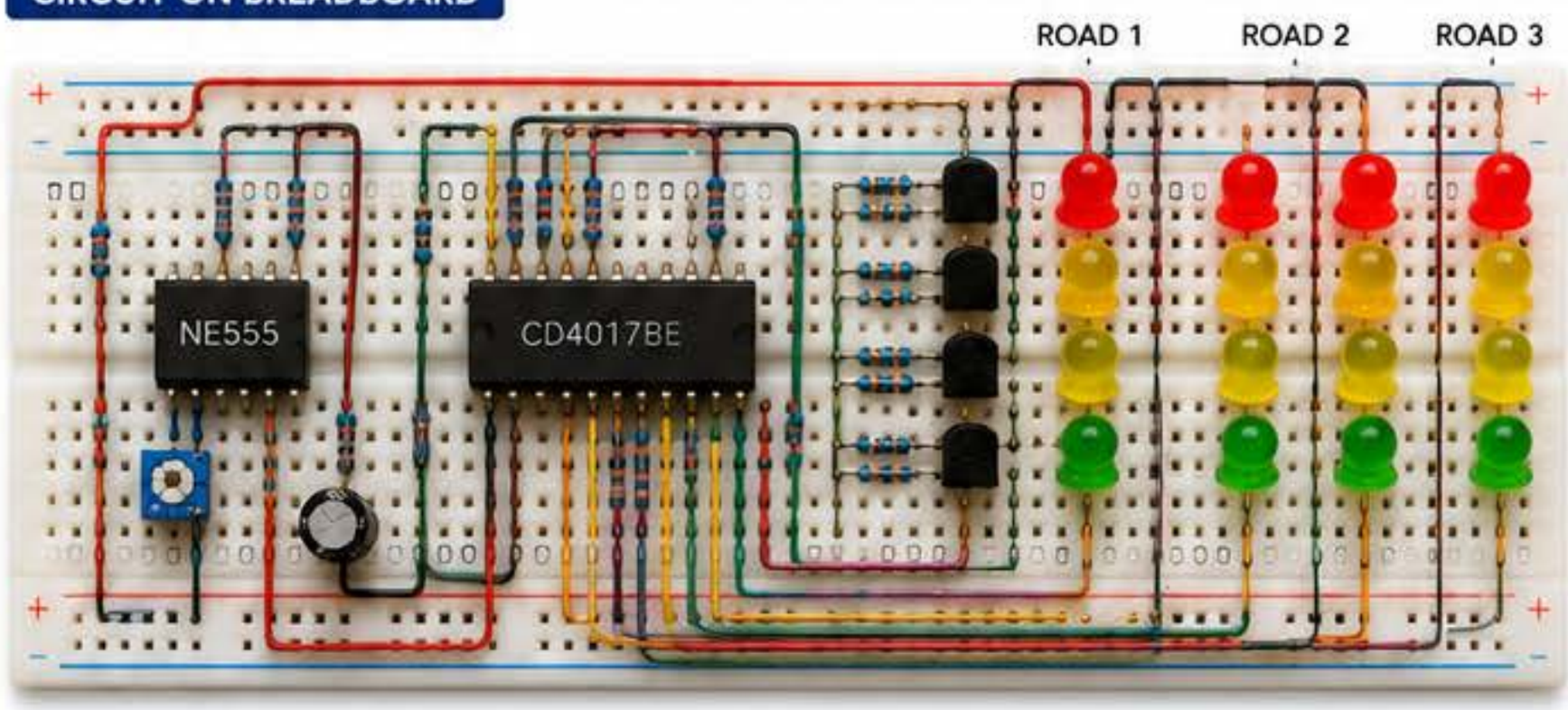
The NE555 timer is configured in astable mode to generate continuous clock pulses. These pulses are applied to the clock input (CLK) of CD4017 counter IC.

The CD4017 counts from Q0 to Q9 sequentially. Each output becomes HIGH for a fixed time based on the timer delay and then goes LOW.

Each output is connected to a transistor driver which turns ON the corresponding LED (Red, Yellow or Green) for a particular road and turns OFF others.

Thus the traffic lights glow in proper sequence for all three roads automatically.

CIRCUIT ON BREADBOARD



PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect +5V DC power supply to the circuit.
3. Adjust the potentiometer RP to set the desired time delay (e.g., 5–10 seconds per light).
4. Switch ON the power supply.
5. Observe the traffic lights – they will glow in the sequence: Green → Yellow → Red for each road.
6. Adjust RP if required to change the timing.
7. Enclose the circuit in a suitable box for practical use.

RESULT

The traffic light controller works as expected and controls the Red, Yellow and Green lights for three roads automatically in sequence with proper time delays.

PRECAUTIONS

- Ensure correct polarity of the power supply.
- Do not exceed current rating of LEDs and transistors.
- Use current limiting resistors for all LEDs.
- Do not short circuit the outputs of CD4017.

FUTURE SCOPE

- Can be extended to 4-way or multi-way junctions.
- Can be controlled using microcontroller for real-time traffic density.
- Can be integrated with pedestrian signals and countdown timers.

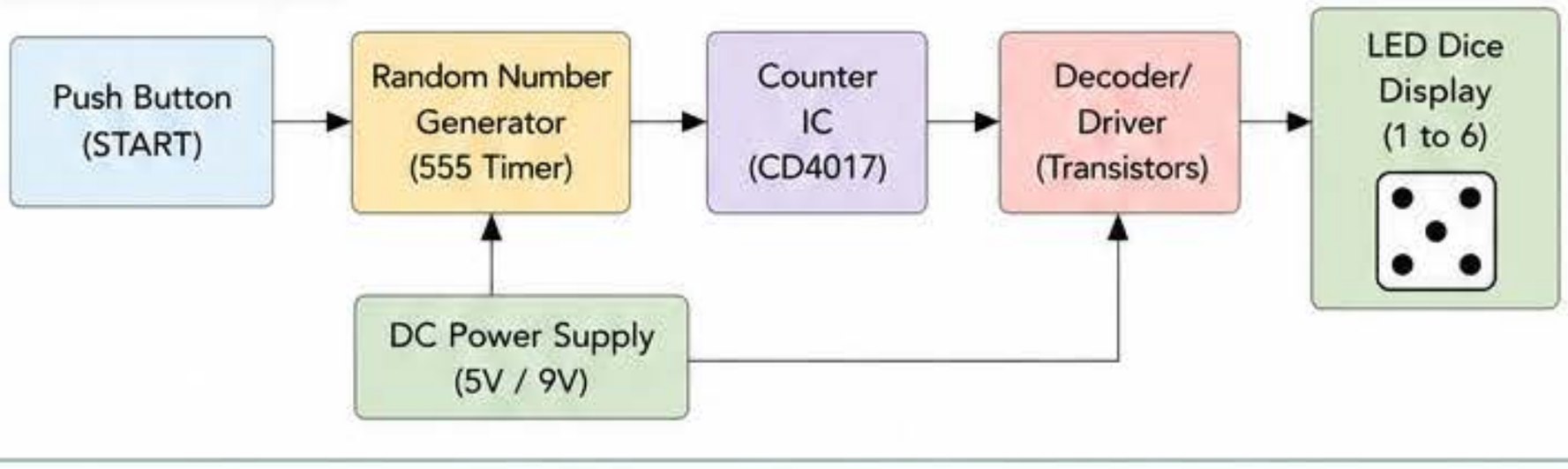
PROJECT MANUAL

12. ELECTRONIC DICE

AIM

To design and implement an Electronic Dice which generates random numbers from 1 to 6 when a push button is pressed. The number is displayed on LEDs corresponding to the dice pattern.

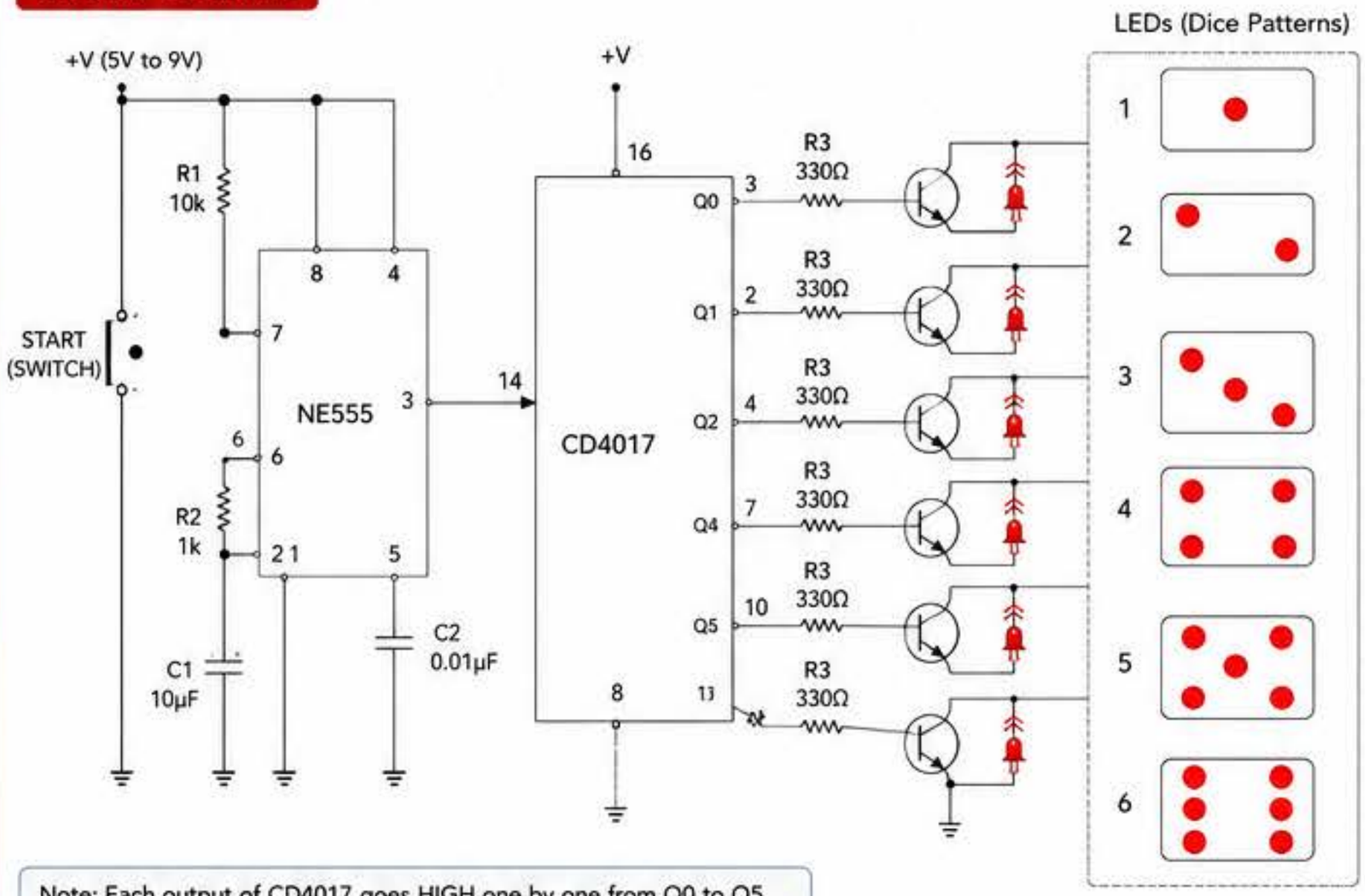
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	NE555 Timer IC	–	1
2	CD4017 Decade Counter IC	–	1
3	Push Button Switch	–	1
4	Resistor R1	10 kΩ	1
5	Resistor R2	1 kΩ	1
6	Resistor R3	330 Ω	6
7	Capacitor C1	10 µF / 16V	1
8	Capacitor C2	0.01 µF	1
9	Transistors (BC547)	–	6
10	LEDs (Red)	5 mm	21
11	9V Battery + Connector	–	1

CIRCUIT DIAGRAM

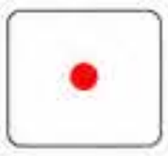
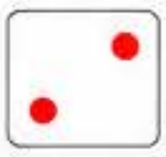
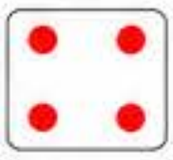


Note: Each output of CD4017 goes HIGH one by one from Q0 to Q5. The corresponding LEDs glow to display numbers from 1 to 6.

APPLICATIONS

- Board games
- Simulation and teaching aids
- DIY electronics projects
- Fun gadgets

DICE LED PATTERNS

1	2	3	4	5	6
					

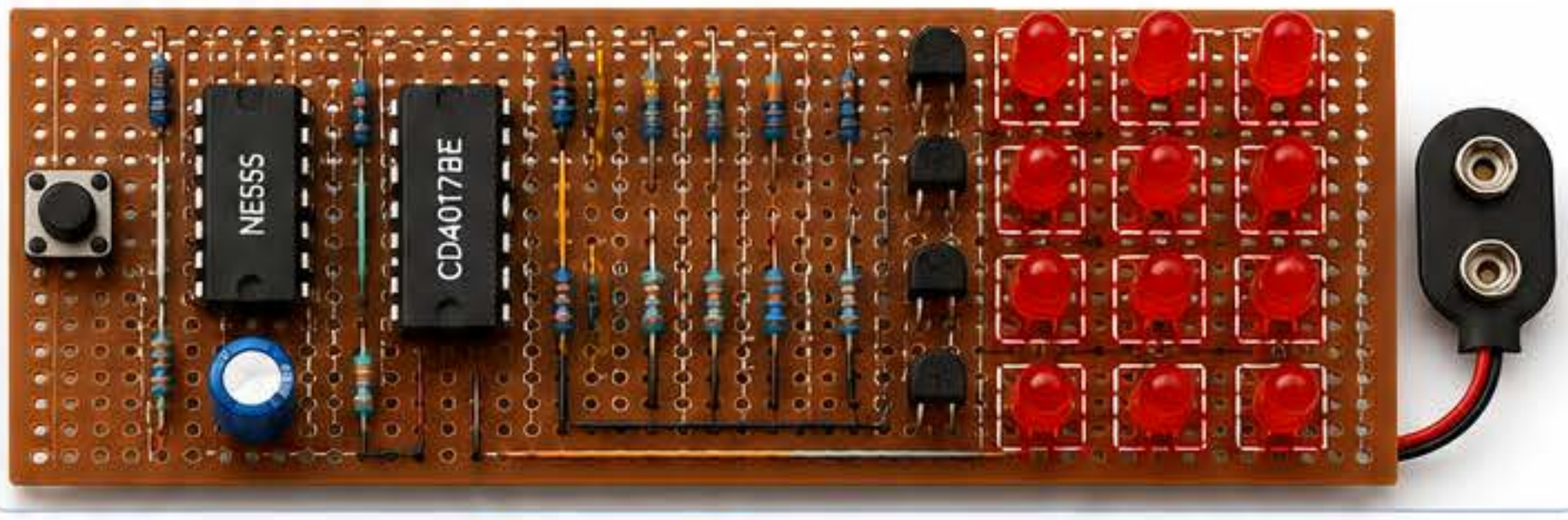
WORKING

When the START button is pressed, the 555 timer generates clock pulses in astable mode. These pulses are applied to the clock input (pin 14) of CD4017. The CD4017 is a decade counter that activates its outputs (Q0 to Q9) sequentially. Here we use Q0 to Q5 only.

When any output (Q0–Q5) goes HIGH, the corresponding transistor turns ON and the LEDs connected in that pattern glow to display the dice number (1 to 6).

Pressing the START button again generates a new random sequence and stops at any number between 1 and 6, simulating a dice.

CIRCUIT ON PERFBOARD



PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect a 5V–9V battery to the circuit.
3. Press the START button.
4. Observe the LEDs – a number from 1 to 6 will be displayed randomly.
5. Press again to get a new number.
6. Enclose the circuit in a suitable box for practical use.

RESULT

The electronic dice displays random numbers between 1 and 6 each time the push button is pressed.

PRECAUTIONS

- Ensure correct polarity of the power supply.
- Do not short circuit the IC pins.
- Use current limiting resistors with all LEDs.
- Press the button momentarily; do not hold it for long.

FUTURE SCOPE

- Can be made wireless using IR remote.
- Can be interfaced with microcontroller for advanced features.
- Can be used in digital board games and gaming systems.

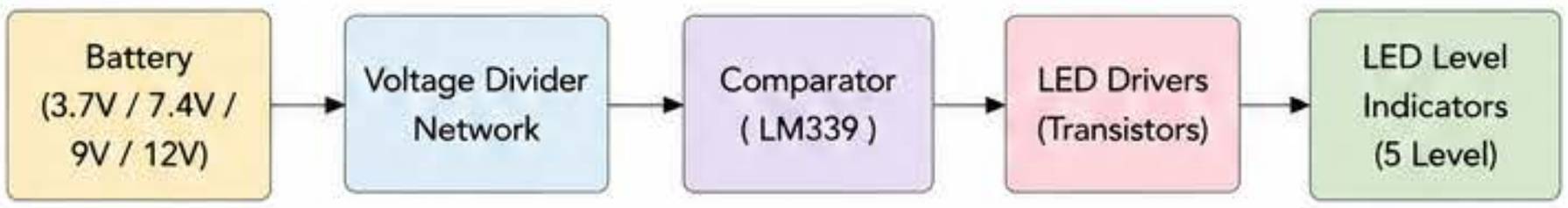
PROJECT MANUAL

13. BATTERY LEVEL INDICATOR

AIM

To design and implement a Battery Level Indicator that shows the battery status using LEDs. As the battery voltage decreases, the number of LEDs that glow reduces, indicating the charge level.

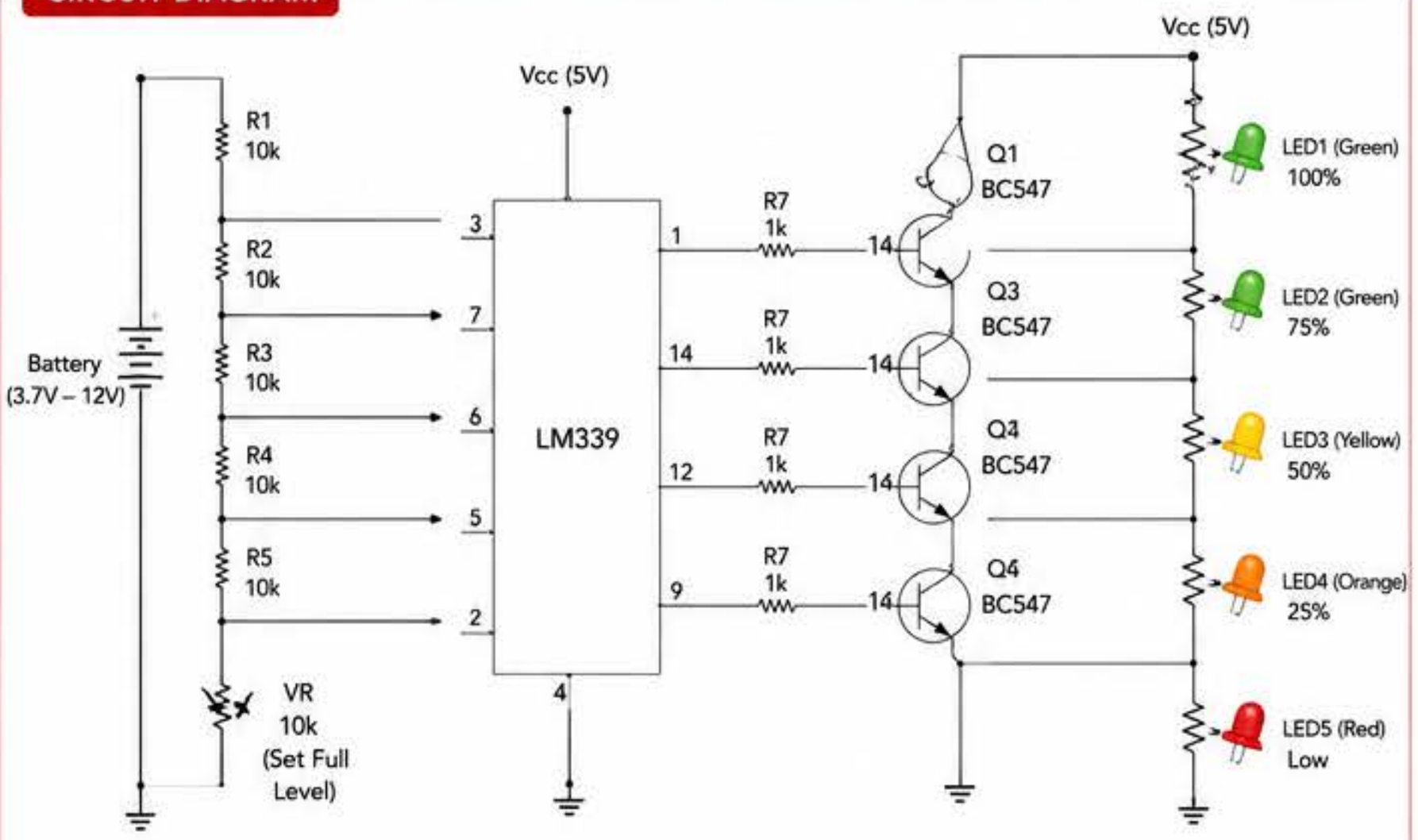
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	LM339 Comparator IC	–	1
2	Resistor R1	10 kΩ	1
3	Resistor R2	10 kΩ	1
4	Resistor R3	10 kΩ	1
5	Resistor R4	10 kΩ	1
6	Resistor R5	10 kΩ	1
7	Resistor R6	10 kΩ	1
8	Resistor R7	1 kΩ	5
9	Transistor Q1–Q5	BC547	5
10	LEDs (Green / Yellow / Red) (Level)		5
11	Potentiometer (VR)	10 kΩ	1
12	Battery Connector	–	1

CIRCUIT DIAGRAM



Note: When battery voltage is high, all LEDs glow.
As voltage decreases, LEDs turn OFF one by one from Green to Red.

APPLICATIONS

- Portable device battery monitoring
- UPS and Inverter systems
- Ebikes, Power banks
- DIY electronics projects

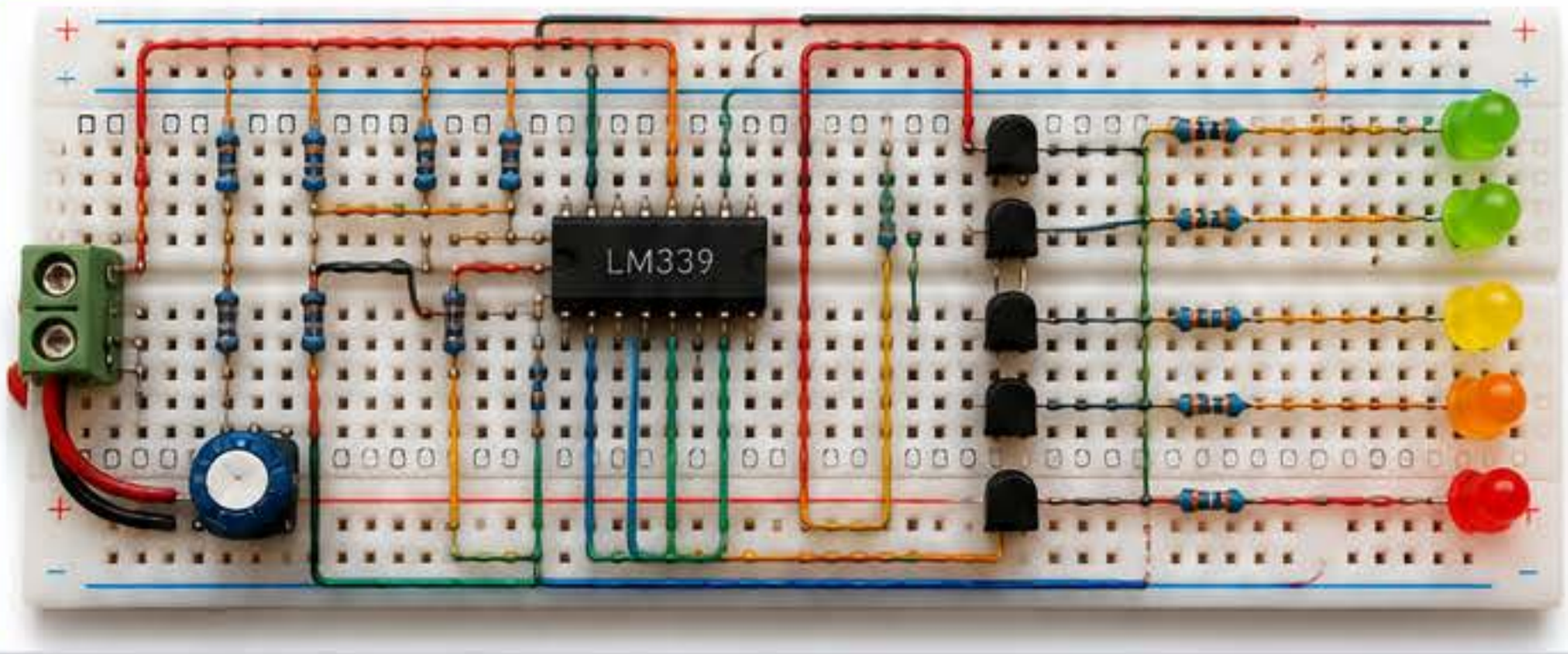
WORKING

The battery voltage is applied to a resistor divider network that creates stepped reference voltages. These reference voltages are compared with the battery voltage using the LM339 comparator IC.

When the battery voltage is higher than a reference level, the corresponding comparator output goes LOW, turning ON the transistor and the LED.

As the battery voltage drops below each reference level, the respective LED turns OFF. Thus, the number of LEDs glowing indicates the battery level.

CIRCUIT ON BREADBOARD



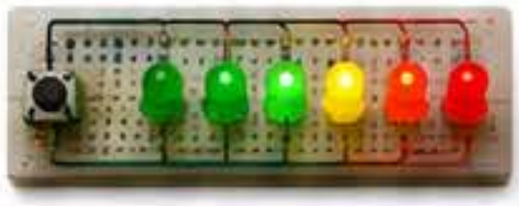
PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Connect the battery (3.7V – 12V) to the input.
3. Adjust the potentiometer (VR) so that all LEDs glow at maximum battery voltage.
4. Slowly decrease the battery voltage and observe the LEDs turning OFF one by one.
5. The LEDs indicate the battery level.

RESULT

The Battery Level Indicator works as expected. The LEDs indicate different battery levels:

5 LEDs → 100% (Full)
4 LEDs → 75%
3 LEDs → 50%
2 LEDs → 25%
1 LED → Low (Recharge)



PRECAUTIONS

- Ensure correct polarity of the battery.
- Do not exceed the maximum supply voltage (up to 12V).
- Use proper resistor values as specified.
- Do not short the battery terminals.
- Handle the IC and components carefully.

APPLICATIONS / FUTURE SCOPE

- Can be used in lithium-ion battery packs, UPS, solar systems.
- Can be interfaced with microcontroller for digital battery monitoring.
- Can be extended to 10-level or graphical display using bar graph LED / LCD.
- Useful in electric vehicles and portable devices.

This project is simple, low cost and useful for real-time battery monitoring.

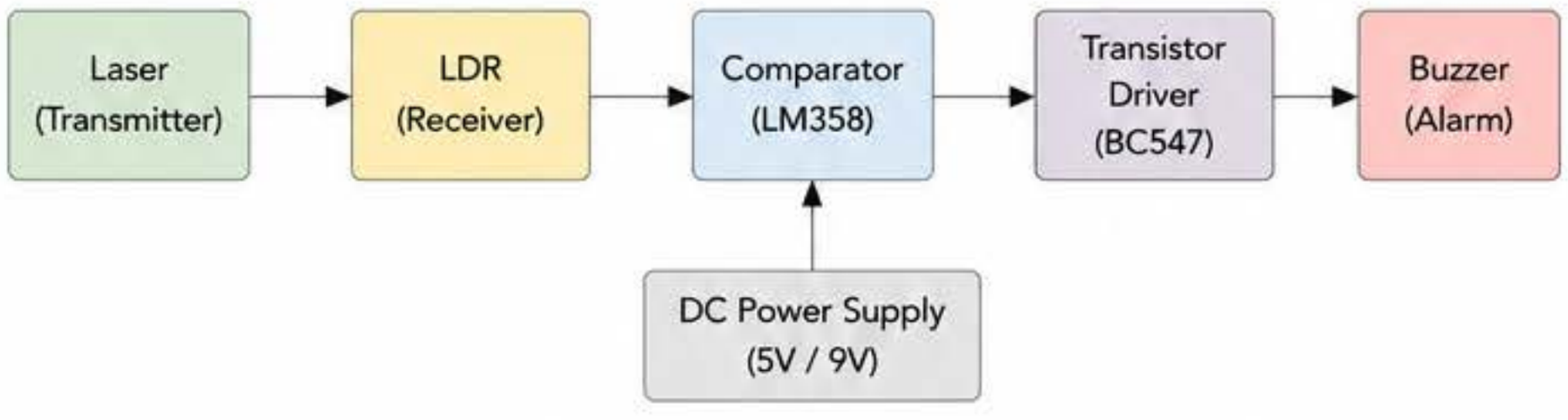
PROJECT MANUAL

14. BURGLAR ALARM USING LASER

AIM

To design and implement a Burglar Alarm system using Laser and LDR (Light Dependent Resistor). When the laser beam falling on the LDR is interrupted by any object, the alarm (buzzer) gets activated to alert about unauthorized intrusion.

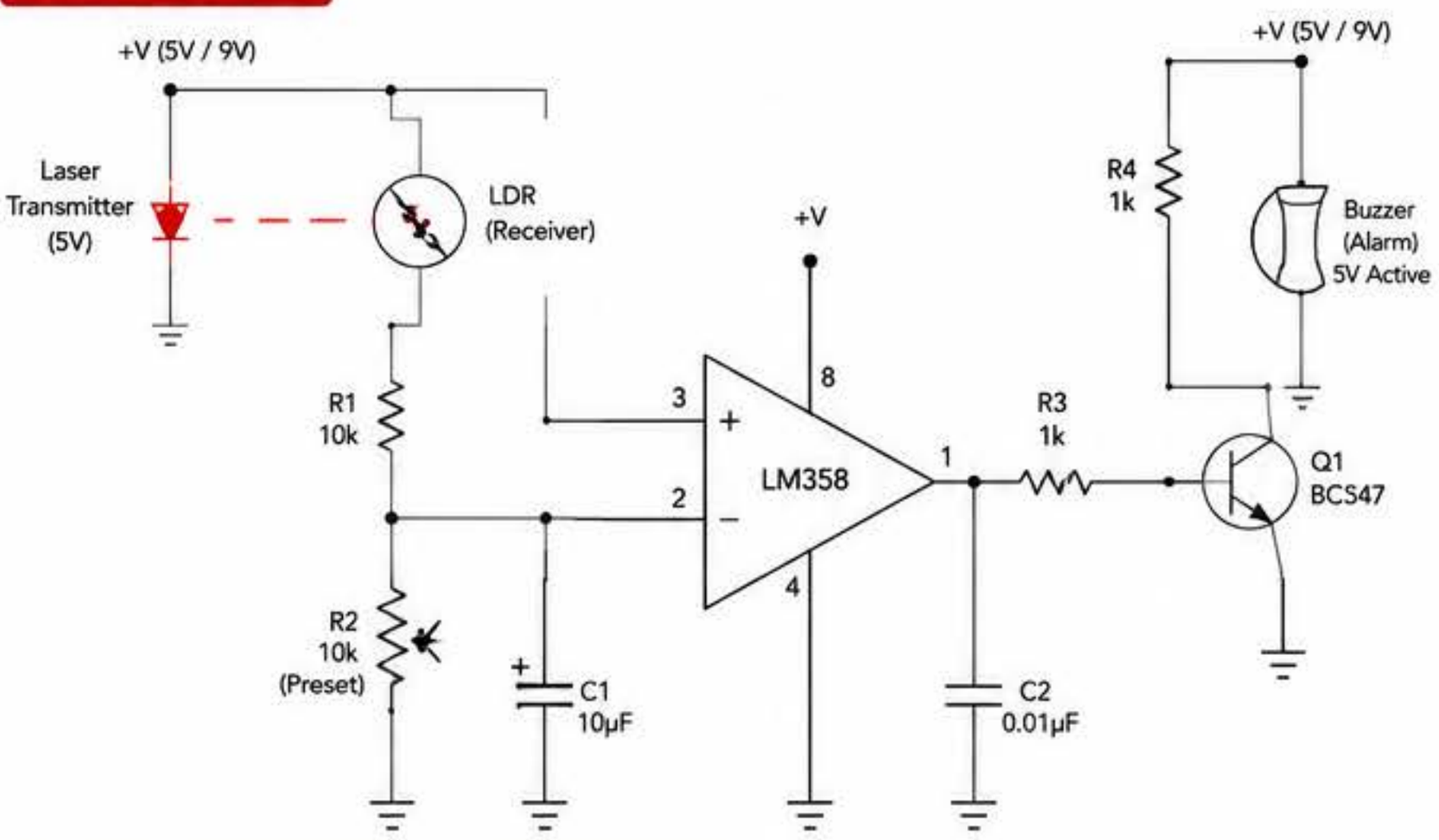
BLOCK DIAGRAM



COMPONENTS REQUIRED

S.No.	Component	Specification / Value	Quantity
1	Laser Diode	5V, Class II	1
2	LDR (Light Dependent Resistor)	GL5528	1
3	LM358 Comparator IC	–	1
4	Resistor R1	10 kΩ	1
5	Resistor R2	10 kΩ (Preset)	1
6	Resistor R3	1 kΩ	1
7	Resistor R4	1 kΩ	1
8	Transistor Q1	BC547	1
9	Buzzer	5V Active	1
10	Capacitor C1	10 µF / 16V	1
11	Capacitor C2	0.01 µF	1
12	DC Power Supply	5V / 9V DC	1
13	Laser Mount / Holder	–	1
14	Base Board / PCB	–	1

CIRCUIT DIAGRAM

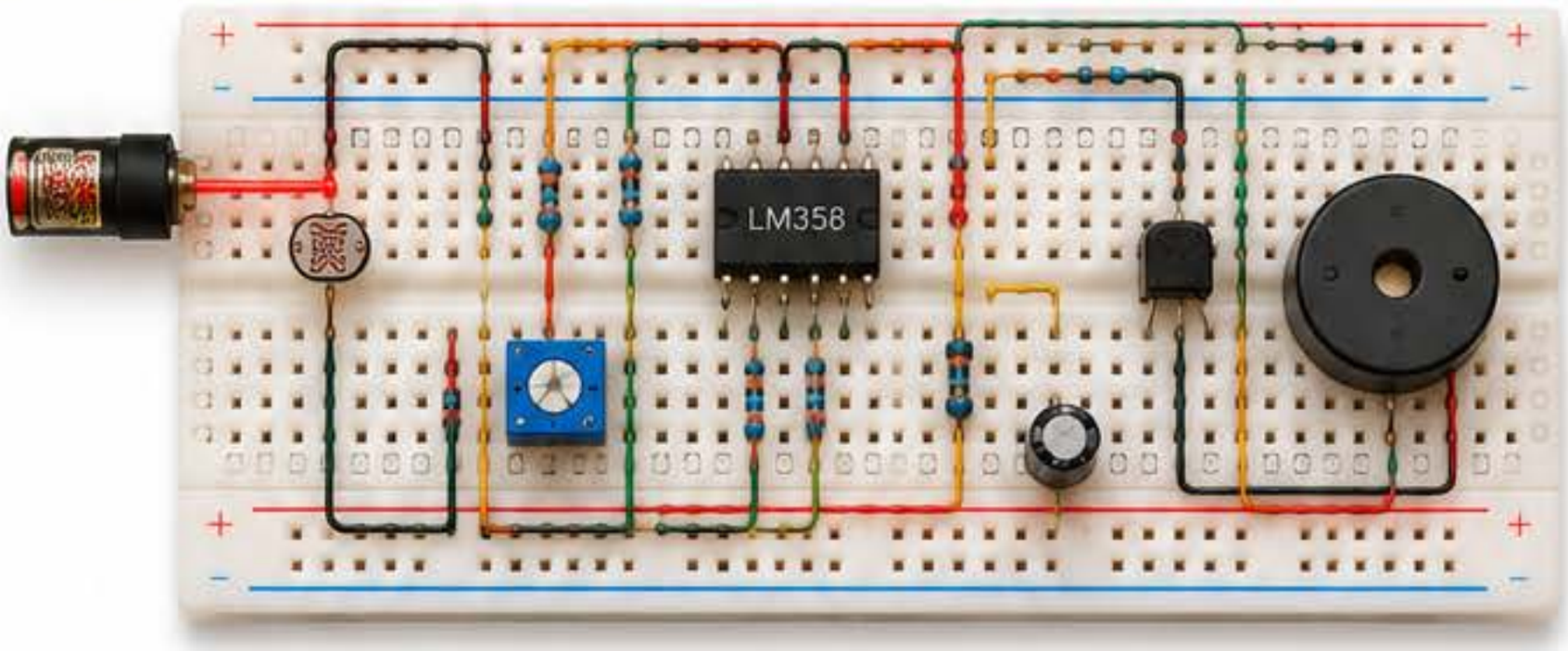


When the laser beam is interrupted, the LDR resistance increases.
This changes the voltage at the + input of LM358 and the output goes HIGH, turning ON the transistor and activating the buzzer.

APPLICATIONS

- Home and office security
- Entry point protection
- Safe lockers and cabinets
- Banks / ATMs / Museums
- DIY security systems

CIRCUIT ON BREADBOARD



WORKING

The laser diode continuously falls on the LDR. When there is no obstruction, the LDR resistance is low and the output of LM358 is LOW. Hence, the transistor remains OFF and the buzzer is silent.

When any object (human intruder) interrupts the laser beam, the light falling on the LDR reduces suddenly and its resistance increases.
This makes the voltage at the non-inverting (+) input of LM358 higher than the inverting (–) input voltage.

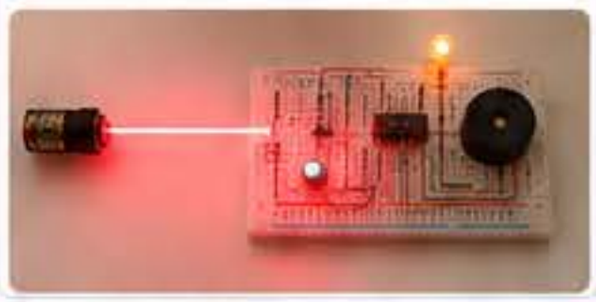
Therefore, the output of LM358 becomes HIGH, turning ON the transistor BC547. The buzzer gets activated and produces a loud sound.

PROCEDURE

1. Connect the circuit as per the circuit diagram.
2. Fix the laser diode on a stand facing the LDR at some distance.
3. Connect the 5V/9V supply and switch ON.
4. Keep the laser beam directly on the LDR. The buzzer should be OFF.
5. Now try to block the laser beam with your hand or any object.
6. The buzzer should start ringing.
7. Adjust the preset (R2) for proper sensitivity.

RESULT

The burglar alarm system using laser works successfully. When the laser beam is blocked, the buzzer gets activated immediately, providing an effective security alert.



PRECAUTIONS

- Do not look directly into the laser beam.
- Use proper laser diode (Class II) for safety.
- Ensure correct polarity of power supply.
- Adjust preset carefully for sensitivity.
- Keep the laser and LDR properly aligned.

FUTURE SCOPE

- Can be enhanced with multiple laser beams for wide area protection.
- Can be interfaced with GSM module to send SMS alerts.
- Can be integrated with siren, relay and automatic door lock systems.
- Can be replaced with IR transmitter and receiver for safer operation.

This project is simple, low cost and highly effective for security applications.

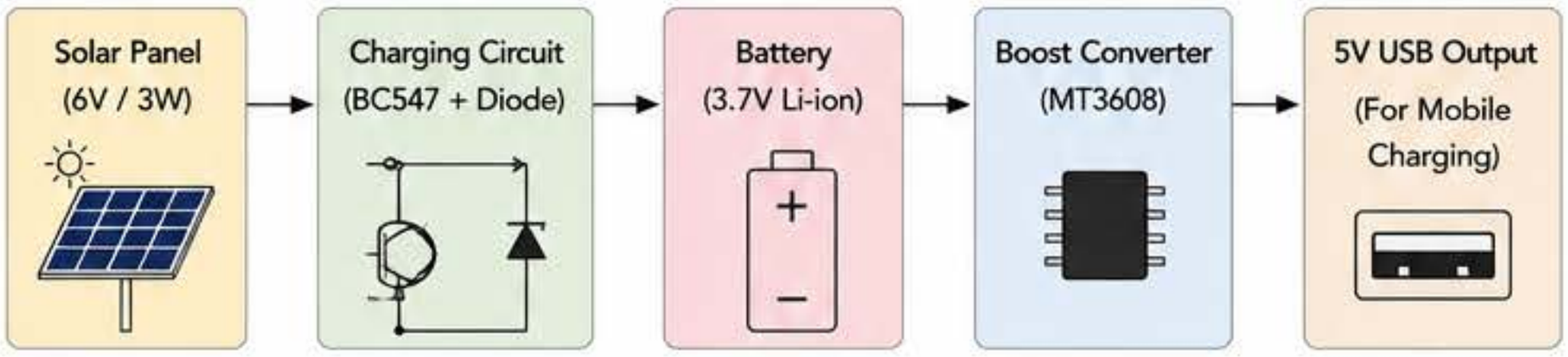
PROJECT MANUAL

15. SOLAR MOBILE CHARGER

AIM

To design and implement a Solar Mobile Charger using solar energy. The circuit converts solar power into electrical energy, charges a 3.7V rechargeeble battery and provides a regulated 5V output through USB for charging mobile phones and other devices.

BLOCK DIAGRAM



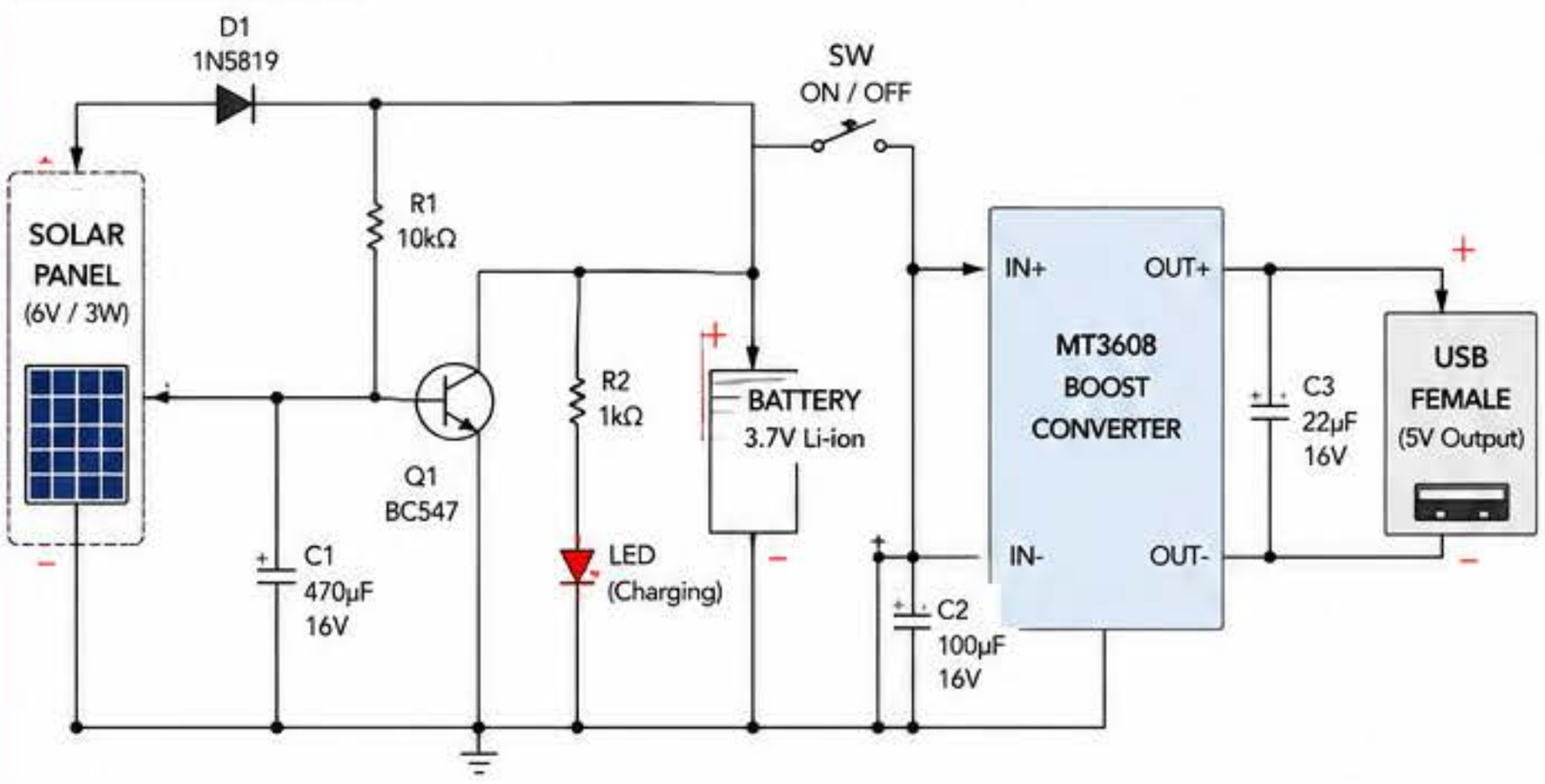
COMPONENTS REQUIRED

S.No.	Component	Specification	Quantity
1	Solar Panel	6V / 3W	1
2	Diode (D1)	1N5819	1
3	Transistor (Q1)	BC547	1
4	Resistor R1	10 kΩ	1
5	Resistor R2	1 kΩ	1
6	Resistor R3	2.2 kΩ	1
7	LED (Charging)	Red	1
8	Battery	3.7V Li-ion	1
9	Boost Converter	MT3608 Module	1
10	Capacitor C1	470 µF / 16V	1
11	Capacitor C2	100 µF / 16V	1
12	Capacitor C3	22 µF / 16V	1
13	USB Female Socket	5V Output	1
14	Switch (SPST)	ON / OFF	1
15	Connecting Wires	–	As req.

APPLICATIONS

- Mobile phone charging
- Power banks
- Emergency charging
- Outdoor and travel use
- Renewable energy projects

CIRCUIT DIAGRAM



Note: The solar panel charges the 3.7V battery through a simple charging circuit.
The MT3608 boost converter steps up the battery voltage to a stable 5V for USB output.

WORKING

The solar panel converts sunlight into electrical energy and provides DC voltage.

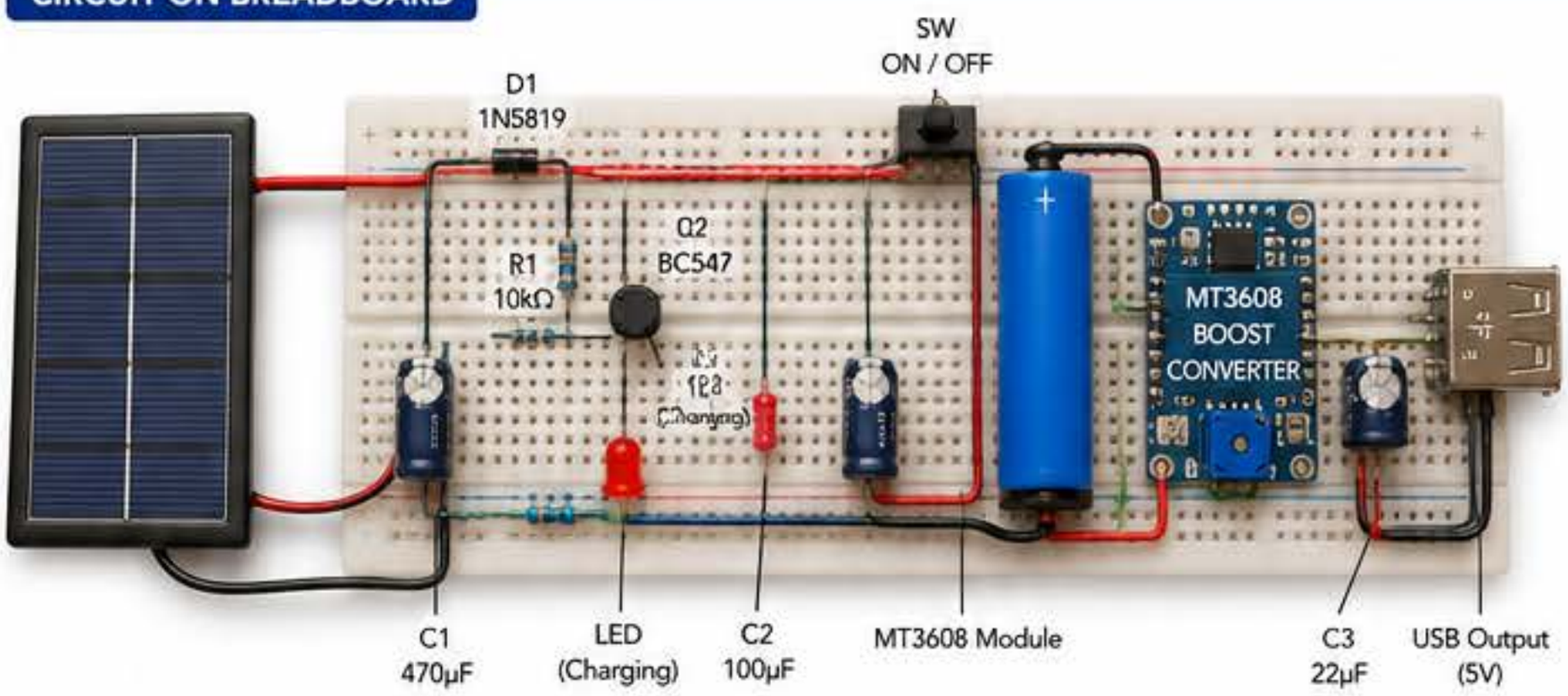
This voltage is passed through a diode (D1) which prevents reverse current flow.

The transistor (Q1) along with resistors controls the charging current to safely charge the 3.7V Li-ion battery. The LED glows indicating charging.

The stored energy in the battery is fed to the MT3608 boost converter through the switch.

The MT3608 steps up the battery voltage to a regulated 5V output which is available at the USB port to charge mobile phones and other USB-powered devices.

CIRCUIT ON BREADBOARD



PROCEDURE

1. Connect the circuit on breadboard as per the circuit diagram.
2. Connect the solar panel to the input side.
3. Expose the solar panel to sunlight.
4. Observe the LED – it should glow indicating battery charging.
5. After some time, the battery will be charged.
6. Turn ON the switch to power the boost converter.
7. Connect a mobile phone to the USB output and observe charging.

RESULT

The solar mobile charger successfully charges the 3.7V Li-ion battery using solar energy. The boost converter provides a stable 5V output to charge mobile phones and other devices.

PRECAUTIONS

- Ensure correct polarity of solar panel, battery and USB output.
- Do not reverse the battery connection.
- Use good quality solar panel for better efficiency.
- Do not overcharge or over-discharge the Li-ion battery.
- Keep the circuit in sunlight for efficient charging.

FUTURE SCOPE

- Add battery level indicator using LEDs.
- Use MPPT charge controller for better efficiency.
- Add protection circuits for overcharge, over-discharge and short circuit.
- Use higher capacity battery for faster and long backup.
- Design compact PCB version for commercial use.

This project uses renewable solar energy and is eco-friendly, low cost and highly useful.