

## Lab 2

### Decide and Repeat: Controlling Program Flow

Applied Python Programming with AI and Raspberry Pi Interfaces

Instructor: Dr. Vikas Thammanna Gowda

Semester: ABCD 20YX

Points: 100

Assign: *TBD*

Due: *TBD*

Name: \_\_\_\_\_

#### Introduction

In this lab, you will build and program a Raspberry Pi circuit to create two projects: odd or even number detector and a temperature classifier.

The lab is split into two parts:

- **Part 1:** You will be provided with the *complete code, circuit diagram, setup, and wiring instructions*, along with a *brief in-class demonstration*. In this part, you will use an **if-else** statement in Python to indicate whether a user-input number is odd or even by lighting the corresponding LED.
- **Part 2:** A collaborative activity, where you will work in groups to read temperature data from a sensor and use an **if-elif-else** chain to classify the temperature into categories (like hot, warm, cool, etc.). Each category will be indicated by a different LED and shown on the LCD along with the actual temperature.

#### Grading Rubric:

Criteria	Points	Grade
Part 1 circuit set up	10	
Part 1 Output: correctness and documentation clarity	15	
Part 2 Classification Criterion: at least 4 categories	10	
Part 2 circuit set up	15	
Part 2 Code: use of descriptive identifiers	10	
Part 2 Code: meaningful comments	10	
Part 2 Output: correctness and documentation clarity	10	
Reflection and Analysis	20	
<b>Total</b>	<b>100</b>	

#### Comments:

## General Instructions

- Turn off power before you touch any wires or parts. Always shut down the Raspberry Pi from the menu before unplugging it.
- The Pi's pins are 3.3 V only—never put 5 V on a GPIO pin. Use a resistor with every LED (about 220-330  $\Omega$ ).
- Don't plug motors, relays, or other high-power parts straight into the Pi. Use a driver board or transistor, and give those parts their own power supply with a shared ground.
- Keep the area safe: no drinks near the electronics, handle boards by the edges, keep wires neat and short, and wear eye protection when cutting leads.
- Check before you power on: compare your circuit to the diagram, use a multimeter to spot mistakes, then do short test runs and watch for anything getting hot.
- If you smell burning, see smoke, or a part feels too hot, turn off power immediately and get the teacher. We only use low-voltage DC—never plug into wall outlets unless told and supervised.

## Learning Objectives

- Understand how to logic the various conditions.
- Use if-else statements to determine if an input number is odd or even, and light corresponding LEDs.
- Display conditional outcomes (odd/even) on the LCD.
- Apply if-elif-else statements to classify temperature into 3-5 custom categories.
- Use GPIO to light a specific LED for each temperature range.
- Combine sensor input, conditional logic, and output devices (LEDs + LCD) in a cohesive program.

## Required Components:

- Raspberry Pi (any model with 40 GPIO pins) with Raspbian/Raspberry Pi OS installed.
- Breadboard and jumper wires.
- 2 LEDs for Part 1. 3-5 for Part 2.
- 5-7 Resistors (220  $\Omega$  or 330  $\Omega$  are typical) - one for each LED to limit current.
- DHT22 temperature/humidity sensor with a 10 k $\Omega$  resistor for the required pull-up between its data pin and 3.3V
- 20x4 Character LCD.

## Part 1: Odd or Even

In this part, you will build a circuit with two LEDs: one LED will represent “EVEN” and the other “ODD” and write a Python program to turn one of them on depending whether the number is odd or even.

### Illustration

Follow these steps to assemble the LED circuit. **Make sure your Raspberry Pi is shut down or powered off while wiring the circuit to avoid any accidental short circuits or damage.**

1. **Place the LEDs on the breadboard:** Arrange the two LEDs on either side of the center gap on your breadboard. Ensure the legs of each LED are in different rows so they aren’t accidentally connected. Recall that an LED has polarity: the longer leg is the positive anode, and the shorter leg is the negative cathode. The anode will connect to a GPIO pin (through a resistor), and the cathode will connect to the Raspberry Pi’s ground. (Tip: If you forget which leg is which, note that the flat side of the LED casing corresponds to the cathode, and the cathode leg is usually shorter.)
2. **Add resistors in series with each LED:** Connect one end of a resistor to the anode of each LED. The resistor can go in the same row as the LED’s anode lead. The other end of the resistor will later go to a GPIO pin via a jumper wire. Using 220  $\Omega$  or 330  $\Omega$  resistors for standard 5mm LEDs will limit the current and protect the LED and GPIO pin. All four LEDs need their own resistor. (It doesn’t matter which end of the LED the resistor is on, as long as it’s in series - either between GPIO and anode, or between cathode and ground - the effect is the same.)

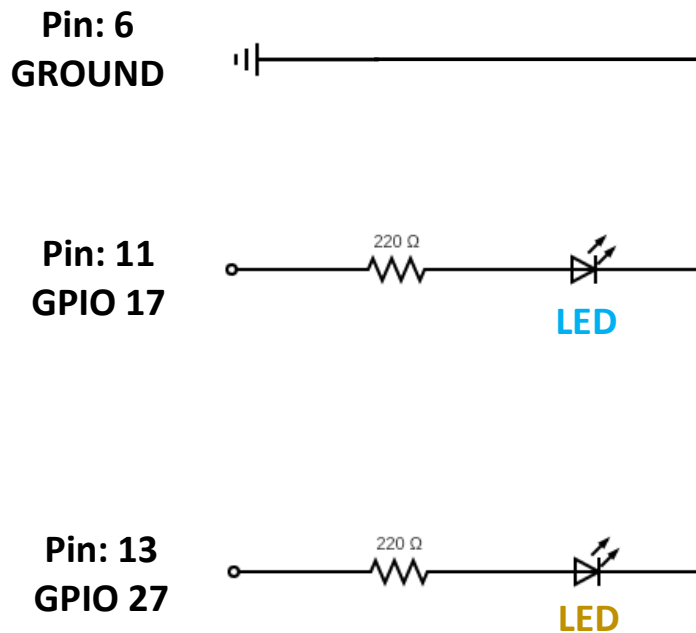


Figure 1: Circuit Diagram.

3. **Connect LED cathodes to ground:** Connect the negative leg (cathode) of each LED to the Pi’s ground. An easy way to do this is to use a ground rail on the breadboard. First, use a jumper wire from one of the Pi’s GND pins (there are several GND pins; one convenient GND is physical pin 6 on the GPIO header) to a hole in the breadboard and designate that entire row as “ground”. Then connect a short jumper from each LED’s cathode row to that ground rail. Now all LED cathodes are tied to the Pi’s ground (they can share the same ground rail since ground is common).

4. **Connect LED anodes to GPIO pins:** Now connect the free end of each resistor (the end not connected to an LED yet) to the appropriate Raspberry Pi GPIO output pin using jumper wires. We will use the Broadcom (BCM) numbering for GPIO pins (this is the default numbering system in the gpiozero library). The four GPIO pins we'll use are:

- GPIO17 - physical pin 11 on the Pi's header
- GPIO27 - physical pin 13

Each resistor end gets one jumper wire to one of these GPIO pins. For example, connect the resistor from LED1's anode to GPIO17, LED2's resistor to GPIO27, LED3's resistor to GPIO22, and LED4's resistor to GPIO23. These four GPIO pins are all on the same side of the header (they are convenient because they are adjacent pins 11, 13). Double-check your connections: each LED's path should be: GPIO pin → resistor → LED anode, then LED cathode → ground. If you wire it this way, setting a GPIO pin "HIGH" (on) will forward-bias the LED (current flows from the 3.3V output pin through the LED to ground) and the LED will light. Setting the pin "LOW" (off) will stop current flow, turning the LED off.

5. **Final check:** Ensure no two LED leads are accidentally in the same row (which would short them), and verify each LED has one side to ground and one side to a unique GPIO pin (through a resistor). Also ensure your Pi's ground pin is connected to the LED cathodes. The wiring should resemble four "spokes" from the Pi to each LED, with a common ground. Once everything looks correct, you can power on your Raspberry Pi for the next step.

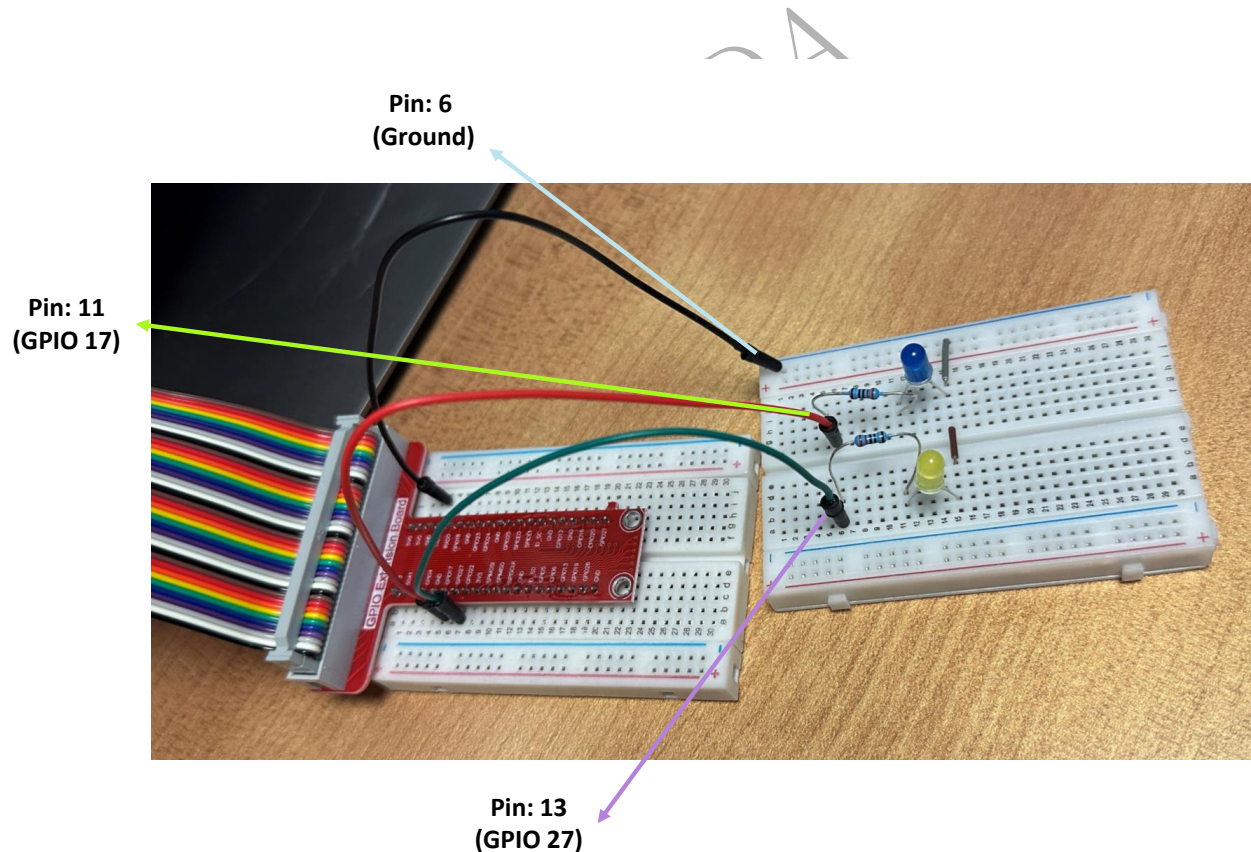


Figure 2: Wiring set-up.

**Run and Observe**

It's time to test the circuit and code. Make sure your Raspberry Pi is powered on and the circuit is connected as described. Run the provided Python script.

**Record your observations:**

Value	LED Color	Value	LED Color
123		-42	

Table 1: Observation

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## Part 2: Sensor Reading and Classification

In the second part, you will use the same Raspberry Pi and LCD, but now integrate the DHT22 temperature/humidity sensor and multiple LEDs to classify real sensor data into categories. Instead of a simple two-way choice, you'll practice using `if...elif...else` to handle multiple conditions and outputs. The program will read the ambient temperature from the DHT22, convert it to degrees Fahrenheit (if you choose to), then determine which range the temperature falls into (e.g. "hot", "warm", "cool", etc.), and finally display the category and temperature on the LCD and light up the LED corresponding to that category.

**Note:** You can make use of humidity data from the sensor if you wish.

### Classification Criterion:

No.	Temperature range	Category

Table 2: Temperature range and category

### Record your observations:

Value	LED Color	Value	LED Color
123		-42	

Table 3: Observation

## Reflection and Analysis

1. Did the odd/even logic behave as expected with all inputs? How did you debug any issues?
2. How did you decide the temperature category thresholds? Would you adjust them after testing?
3. What was your strategy to ensure that only one LED is turned on at a time?
4. How did the use of `if-elif-else` improve clarity compared to a series of if statements?
5. **Further extension:** Discuss how this project can be extended.

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