Title of Experiment:

Analog Sensor Interfacing (Temperature Sensor – LM35)

Aim:

To interface an LM35 analog temperature sensor with Arduino, read the sensor output, convert it into temperature in Celsius, and display it on the Serial Monitor or LCD.

Apparatus:

- Arduino Uno board
- LM35 temperature sensor
- USB cable
- Breadboard
- Jumper wires
- 16x2 LCD (optional)
- 10kΩ potentiometer (for LCD contrast, if LCD is used)
- Arduino IDE installed on PC

Precautions:

1. Ensure correct pin connections for the LM35 sensor (Vcc, Output, GND).
2. Do not exceed the operating voltage of the sensor (typically 5V).
3. Handle electronic components with care to avoid short circuits.
4. Disconnect USB cable before changing wiring.
5. If using an LCD, adjust contrast using the potentiometer.

Theory:

The **LM35** is a precision integrated analog temperature sensor. It provides an analog voltage output linearly proportional to the temperature in Celsius.

- It outputs **10 mV/°C** (e.g., 250 mV for 25°C).
- Arduino reads analog signals (0–5V) using its **10-bit ADC**, providing values from **0 to 1023**.
- Formula to convert analog value to Celsius:

$$\text{Temperature } (^\circ\text{C}) = \left(\frac{\text{analogRead value} \times 5.0}{1024.0} \right) \div 0.01$$

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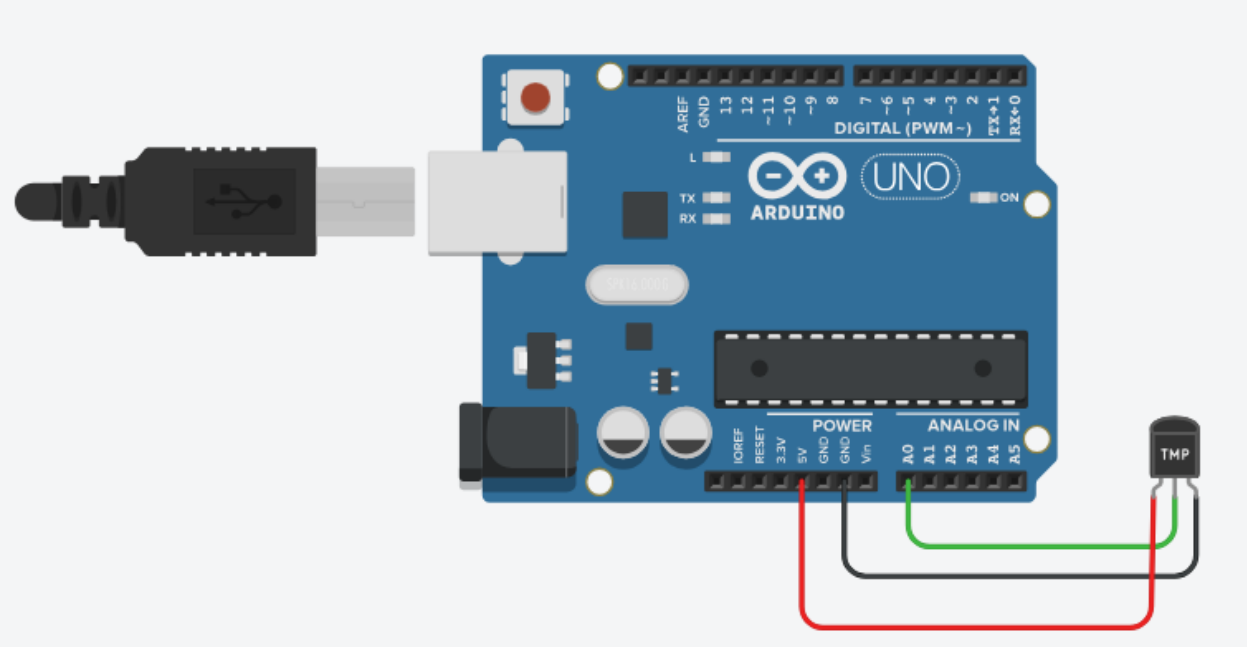
Circuit Diagram:



Procedure:

1. Connect **LM35** output pin to **A0** of Arduino, Vcc to 5V, and GND to GND.
2. If using LCD, connect it to appropriate pins with contrast potentiometer.
3. Connect Arduino to PC via USB and open Arduino IDE.
4. Write and upload the program to read analog input, convert to temperature, and display result.
5. Open **Serial Monitor** (or observe LCD if used) to view the temperature in °C.

Arduino Programming

(Using Serial Monitor Only):

```
// Define pin numbers
const int sensorPin = A0;  // LM35 connected to analog pin A0
float temperatureC = 0;    // Variable to store temperature in Celsius
void setup() {
  Serial.begin(9600);      // Start Serial Monitor at 9600 baud rate
}
void loop() {
  int sensorValue = analogRead(sensorPin);  // Read analog value (0–1023)

  // Convert analog value to voltage (0–5V)
  float voltage = sensorValue * (5.0 / 1024.0);
    // Convert voltage to temperature in Celsius
  temperatureC = voltage / 0.01;  // LM35 gives 10mV per °C
    // Print result to Serial Monitor
  Serial.print("Temperature: ");
  Serial.print(temperatureC);
  Serial.println(" °C");
  delay(1000);  // Wait for 1 second before next reading
}
```

Conclusion:

In this experiment, the LM35 analog temperature sensor was successfully interfaced with the Arduino Uno. The analog voltage output from the sensor was read using Arduino's ADC, converted into Celsius, and displayed on the Serial Monitor. This experiment helps understand analog interfacing and real-time data monitoring.

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4 Short Questions and Answers:

Q1: What is the output of the LM35 sensor per degree Celsius?
Answer: The LM35 sensor outputs **10 mV for every 1°C** temperature.

Q2: How is analog voltage from LM35 converted to temperature in Arduino?
Answer: First, the analog value is converted to voltage, then divided by 0.01 (10mV/°C) to get temperature in Celsius.

Q3: Why do we use `analogRead()` for the LM35 sensor?
Answer: `analogRead()` is used to read the analog voltage from the sensor, which represents the temperature.

Q4: What is the ADC resolution of Arduino Uno?
Answer: Arduino Uno has a **10-bit ADC**, so it provides analog readings from **0 to 1023**.