Lab Assignment - 3

Problem Statement -Write a program for developing an IIoT application for energy monitoring and optimization.

Component Required :

Quantity	Component
1	Arduino Uno R3
1	Temperature Sensor [TMP36]
1	LED
1	Piezo
2	220 Ω Resistor
1	Diode
1	NPN Transistor (BJT)

Steps To Perfrom :

Step 1: Power Up the Breadboard

Component Pin	Connect To	Note
Arduino 5V Pin	Breadboard Positive (+) Rail	Supplies 5 Volts to the breadboard.
Arduino GND Pin	Breadboard Negative (-) Rail	Creates a common ground connection.

Step 2: Connect the Temperature Sensor

Component Pin	Connect To	Note
Power Pin (Left)	Breadboard Positive (+) Rail	Powers the sensor.
Signal/Vout Pin (Middle)	Arduino Analog Pin A0	Sends temperature data to the Arduino.
Ground Pin (Right)	Breadboard Negative (-) Rail	Completes the sensor's circuit.

Step 3: Connect the Status LED

Component Pin	Connect To	Note
One leg of the Resistor	Arduino Digital Pin 10	The signal for the LED comes from this pin.
Resistor (Other Leg)	LED Anode (Longer Leg)	The resistor protects the LED from damage.
LED Cathode (Shorter Leg)	Breadboard Negative (-) Rail	Connects the LED to ground.

Step 4: Connect the DC Motor Control Circuit

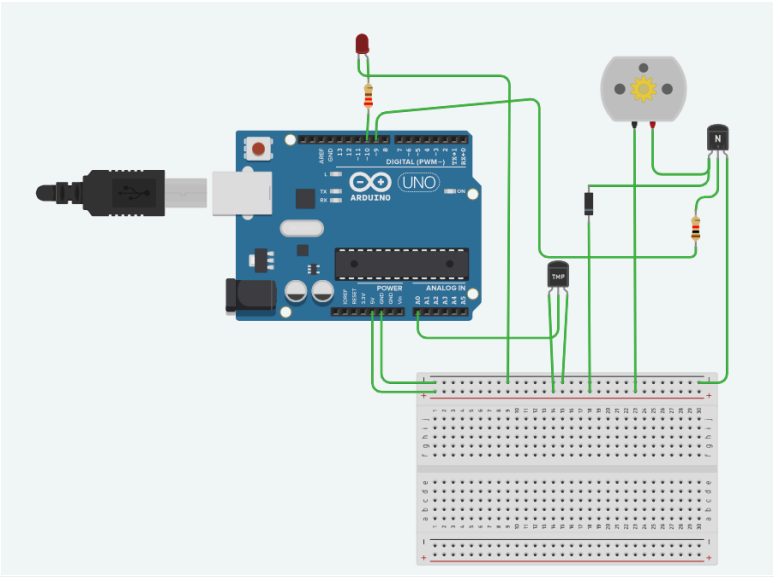
Component Pin	Connect To	Note
Motor Terminal 1	Breadboard Positive (+) Rail	Provides power to the motor.
Motor Terminal 2	Transistor Collector (Right Pin)	The transistor will control the motor's connection to ground.
Transistor Emitter (Left Pin)	Breadboard Negative (-) Rail	Connects the transistor to ground.
One leg of the Resistor	Arduino Digital Pin 9	This resistor protects the transistor.
Resistor (Other Leg)	Transistor Base (Middle Pin)	The Arduino signal on Pin 9 will switch the transistor on or off.
Diode Cathode (Stripe)	Motor Terminal 1 (at Positive Rail)	The diode protects the circuit from voltage spikes from the motor.
Diode Anode (No Stripe)	Motor Terminal 2 (at Transistor Collector)	Must be connected in parallel with the motor, but facing "backwards".

Code :

```
const int tempPin = A0;     // Temperature sensor (TMP36) connected to Analog Pin A0
const int motorPin = 9;     // Transistor base connected to PWM Pin 9 to control motor
const int ledPin = 10;      // Status LED connected to Digital Pin 10

// Safety threshold. If the motor's temperature exceeds this, it shuts down.
const float overheatThreshold = 50.0;

// The normal operating speed for the motor
const int normalMotorSpeed = 200; // A value between 0 (off) and 255 (max)

void setup() {
  // Initialize Serial communication for monitoring
  Serial.begin(9600);

  // Set the pin modes
  pinMode(motorPin, OUTPUT);
  pinMode(ledPin, OUTPUT);
}

void loop() {
  // 1. SENSE: Read the raw value from the temperature sensor
  int sensorVal = analogRead(tempPin);

  // 2. PROCESS: Convert the raw sensor reading to a temperature in Celsius
  float voltage = (sensorVal / 1023.0) * 5.0;
  float temperatureC = (voltage - 0.5) * 100;

  // 3. MONITOR: Print the data to the Serial Monitor (our simple dashboard)
  Serial.print("Motor Temperature: ");
  Serial.print(temperatureC);
  Serial.print(" C | ");

  // 4. ACTUATE based on the new PROTECTIVE logic
  if (temperatureC >= overheatThreshold) {
    // Condition: OVERHEATED! Take protective action.

    // Shut down the motor completely
    analogWrite(motorPin, 0);
```

```
    // Blink the LED to signal a critical alert
    digitalWrite(ledPin, HIGH);
    delay(250);
    digitalWrite(ledPin, LOW);
    delay(250);

    Serial.println("Status: DANGER - OVERHEATED! Motor has been shut down.");

  } else {
    // Condition: Normal. Temperature is within safe limits.

    // Run the motor at its normal speed
    analogWrite(motorPin, normalMotorSpeed);

    // Ensure the alert LED is off
    digitalWrite(ledPin, LOW);

    Serial.println("Status: Normal Operation. Motor ON.");
  }
}
```

Output :



Serial Monitor

```
perature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: -6.01 C | Status: Normal Operation. Motor ON.
Motor Temperature: 0.83 C | Status: Normal Operation. Motor ON.
Motor Temperature: 23.80 C | Status: Normal Operation. Motor ON.
Motor Temperature: 45.80 C | Status: Normal Operation. Motor ON.
Motor Temperature: 45.80 C | Status: Normal Operation. Motor ON.
Motor Temperature: 64.86 C | Status: DANGER - OVERHEATED! Motor has been shut down.
Motor Temperature: 98.09 C | Status: DANGER - OVERHEATED! Motor has been shut down.
Motor Temperature: 98.09 C | Status: DANGER - OVERHEATED! Motor has been shut down.
```