ADDIS ABABA SCIENCE AND TECHNOLOGY UNIVERSITY
UNIVERSITY FOR INDUSTRY

COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

(COMPUTER STREAM)

Embedded Systems (ECEg 5403)

Project – 3

- **Embedded System Design**: Temperature-Based LED Control Using PIC16F877A (20 x 4 LCD Screen Added)
- **Embedded System Design**: Motor Speed and Direction Control Using Push Buttons and PIC16F877A

Prepared by:

KALEAB TESFAYE

1. Embedded System Design: Temperature-Based LED Control Using PIC16F877A (20x4 LCD Screen added)

- This project uses a PIC16F877A microcontroller to control three LEDs (Red, Yellow, and Green) based on temperature readings from an LM35 sensor and also display the temperature readings to a 20x4 LCD Screen. When the temperature is less than or equal to 15°C, the Yellow LED lights up. If the temperature is between 15°C and 35°C, the Green LED lights up. For temperatures above 35°C, the Red LED lights up. The microcontroller processes the analog temperature data and controls the corresponding LED based on the specified thresholds.

Description of Components Used

- **PIC16F877A Microcontroller:** The central controller of the system, responsible for processing temperature readings and controlling the LEDs.

Some Key Features from the datasheet

- ✓ 8-bit RISC architecture for efficient data processing.
- ✓ Includes ADC (Analog-to-Digital Converter) to process analog signals from the LM35 sensor.
- ✓ Multiple I/O pins for interfacing with LEDs and the temperature sensor.
- ✓ Operates with a clock frequency up to 20 MHz for quick response.

- **LM35 Temperature Sensor**: Measures temperature in degrees Celsius and provides an analog voltage proportional to the temperature.

Some Key Features

- ✓ High accuracy of ±0.5°C at room temperature.
- ✓ Linear output with 10 mV per degree Celsius.
- ✓ Operates with a wide voltage range (4V to 30V).

- **LEDs (Red, Yellow, and Green)**: Indicate temperature ranges visually.

Some Key Features

- ✓ Efficient light output for minimal power consumption.
- ✓ Operate with a forward voltage of around 2.2V, compatible with the microcontroller's output pins.

- **220 Ohm Resistors (x3)**: Protect the LEDs from excessive current.

Key Feature

- ✓ Provide stable resistance to maintain consistent LED brightness.

❖ **20x4 LCD Screen**:

Some key features

- ✓ Operating Voltage: 5V
- ✓ Operating Temperature Range: -20°C to +70°C
- ✓ Power Consumption: 1.6 mA (typical)
- ✓ Duty Cycle: 1/16
- ✓ Backlight Current: 50 mA

2. Embedded System Design: Motor Speed and Direction Control Using Push Buttons and PIC16F877A

❖ This project uses a PIC16F877A microcontroller to control the speed and direction of a DC motor using three push buttons. Pressing Button 1 makes the motor run slowly forward. Pressing Button 2 makes it run fast forward. Pressing Button 3 reverses the motor's direction and runs it fast backward. The microcontroller, in conjunction with an L293D motor driver, processes the button inputs and controls the motor accordingly.

Description of Components Used

❖ **PIC16F877A Microcontroller**: The core of the project, managing button inputs and sending control signals to the motor driver.

Some Key Features from the datasheet:

- ✓ Built-in PWM (Pulse Width Modulation) channels for speed control.
- ✓ Multiple I/O pins for interfacing with buttons and the motor driver.
- ✓ Reliable 8-bit performance for real-time motor control.

❖ **L293D Motor Driver**: Interfaces the microcontroller and the DC motor, amplifying control signals to drive the motor.

Some Key Features from the datasheet

- ✓ Dual H-bridge driver, enabling forward and reverse motion.
- ✓ Handles motor voltages up to 36V and currents up to 600mA per channel.

❖ **DC Motor**: Converts electrical energy into mechanical motion.

Some Key Features

- ✓ Operates with a range of voltages and speeds.
- ✓ Reversible rotation for flexible direction control.

- **Push Buttons (x3)**: Serve as user inputs to control motor speed and direction.

Some Key Features

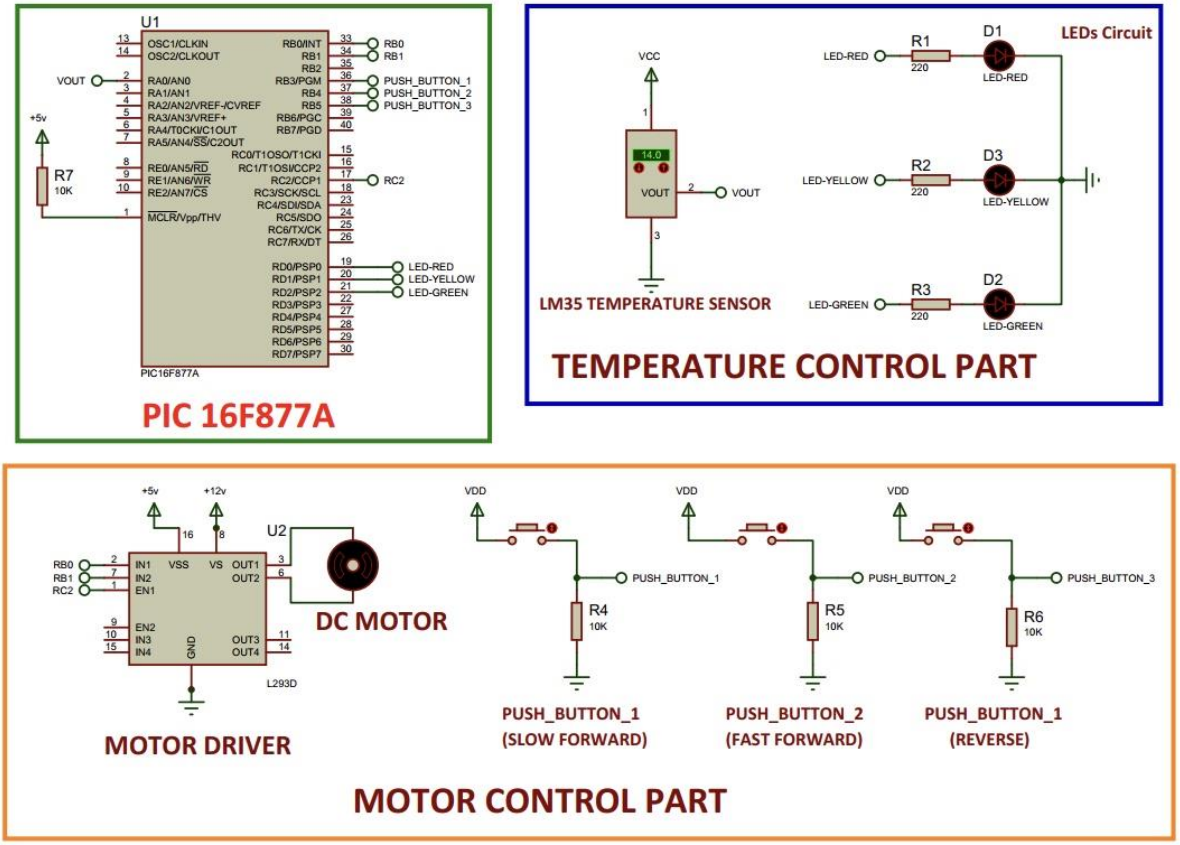
- ✓ Simple and reliable design for on/off toggling.
- ✓ Debounced using 10kΩ pull-down resistors for accurate microcontroller detection.

- **10kΩ Pull-Down Resistors (x3)**: Ensure stable button inputs by grounding the circuit when buttons are not pressed.

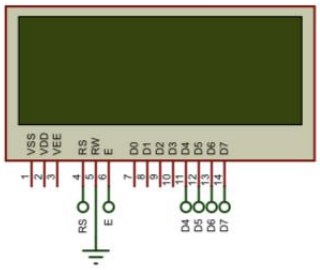
Key Feature

- ✓ Maintain logic-level accuracy in microcontroller inputs.

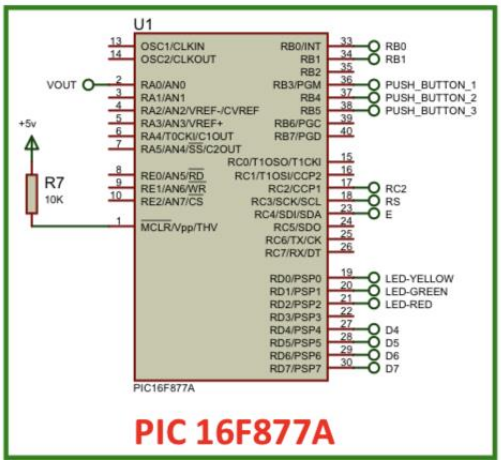
Circuit diagram using Proteus software



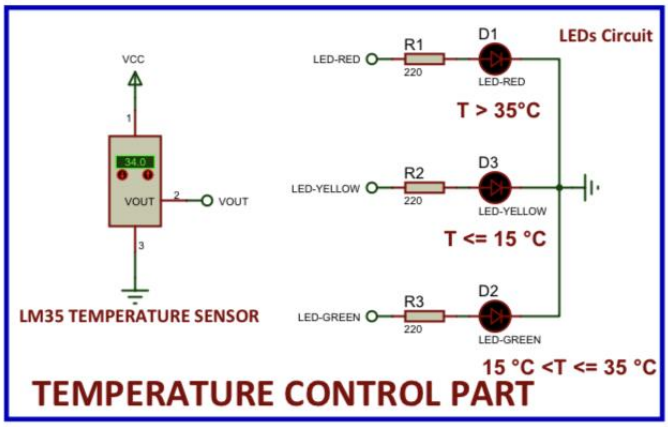
Circuit diagram using Proteus software that includes 20x4 LCD



20x4 LCD DISPLAY



PIC 16F877A



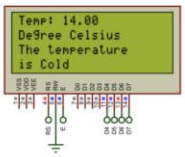
Code for the PIC16F877A using MPLAB X IDE for pic compiler

```
/*
 * File:   main.c
 * Project Name: LM35-PIC16F877A-LEDs-20x4_LCD-MOTOR-PUSH-BUTTONS
 */
```

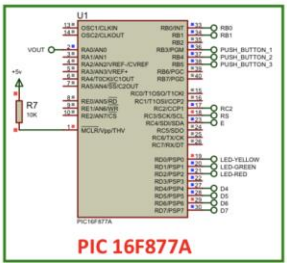
- Located in the zip folder

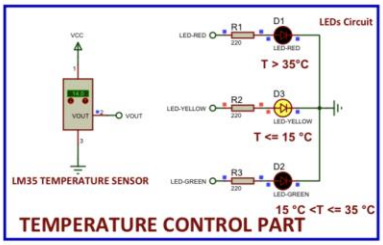
Simulation result for Temperature control part

- **When the Temperature is less than or equal to 15°C, the Yellow led lights up.**

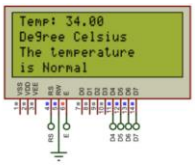


20x4 LCD DISPLAY

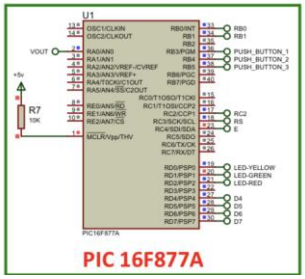


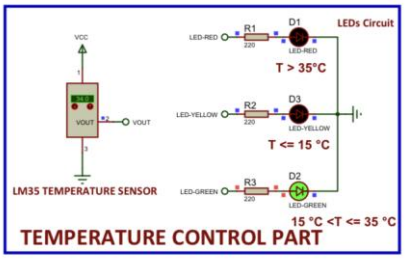


- **When the Temperature is between 15°C and 35°C, the Green led lights up.**

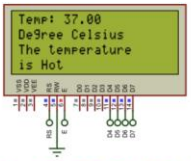


20x4 LCD DISPLAY

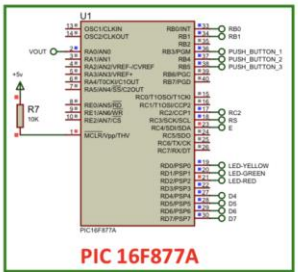


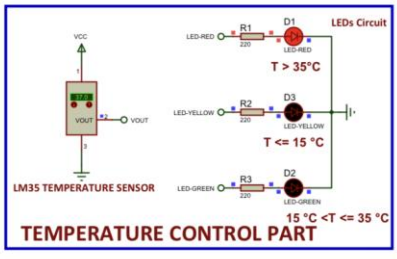


- **When the Temperature is greater than 35°C, the Red led lights up.**



20x4 LCD DISPLAY





Simulation result for Motor control part

- Result is known during simulation.