# University of Sri Jayewardenepura

**Faculty of Technology**

**Bachelor of Engineering Technology Honors**

**Department of Materials and Mechanical Technology**

Marks

## ETM 2082 –Embedded Systems and Applications

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# Assignment-1

# (Design of an embedded system for a DC motor control application)


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Index No – EGT 19517

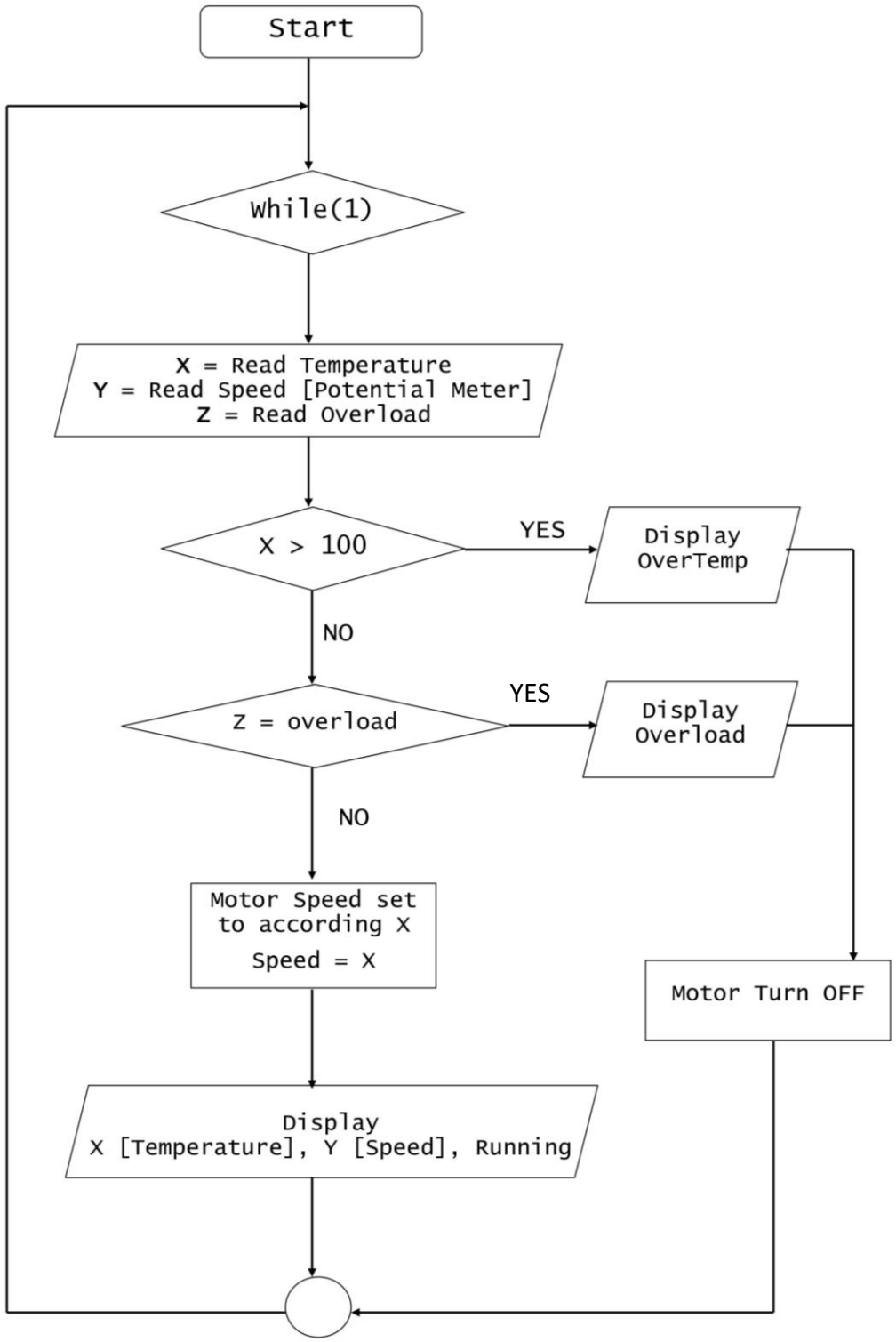
Focus Area - Mechatronics


Date of Submission – 11. 06. 2022

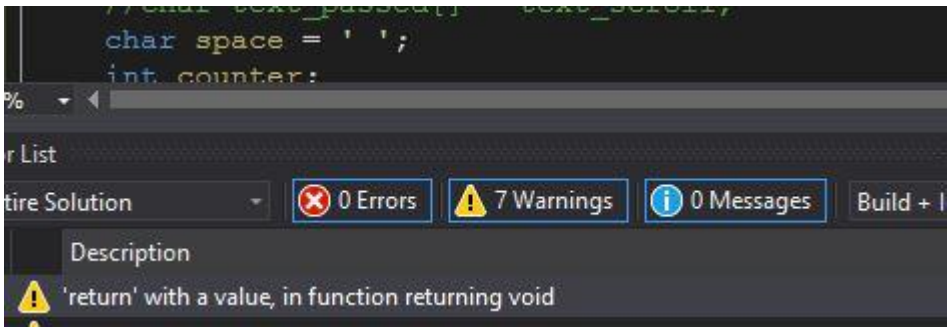
Student's (electronic) Signature

(I declare that this assignment is my own work)

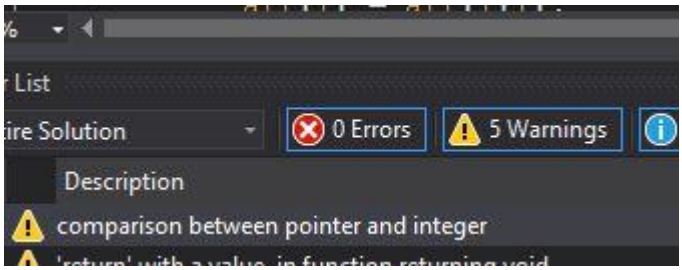
## Flow Chart for Algorithm



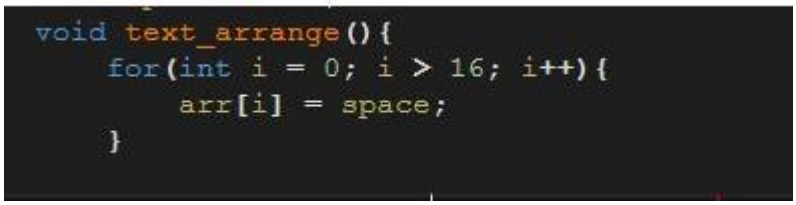
## Errors while writing the program

1. 


This error came when I try to return a value from a void function. At that I did not know we cannot return values from void function. Therefore I created int function instead of void and get rid of the warning error.

2. 

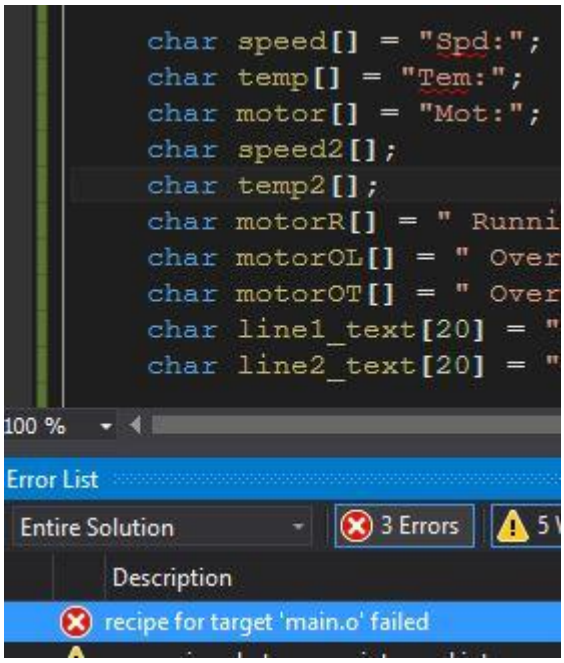

This error came when I try to check whether a variable is NULL or not. Finally I deleted that code line and used another way to check the condition.

3. 

```
void text_arrange(){
    for(int i = 0; i > 16; i++){
        arr[i] = space;
    }
```

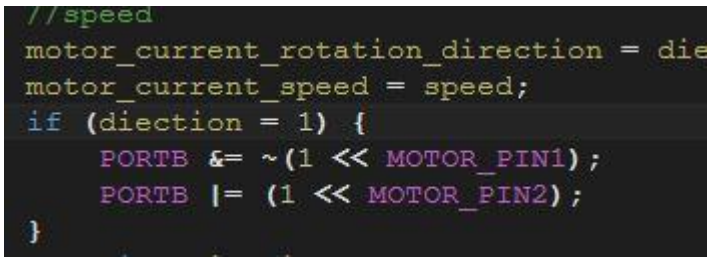
This is not a technical error. There was nothing wrong with the code technically. But when it runs, I did not get the out which I was expected. Finally I found the error. I change the middle of the for loop as i < 16 and correct the error.

4.



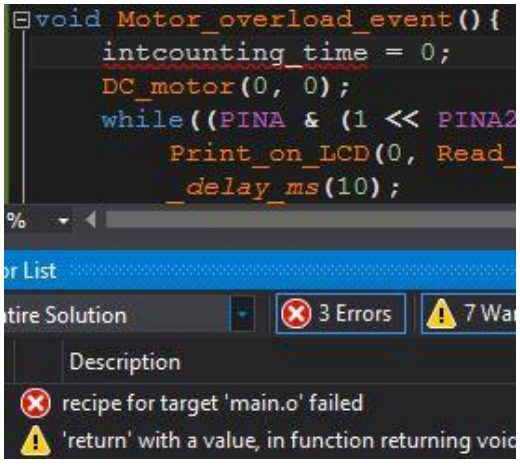

This error came when I try create a char array without the array size. I changed the above char speed2 [16]; and char temp2 [16];

5.




This error popup when I use an if condition without double equal marks. Therefore, I changed the logic as direction == 1.

6.




**Missing space between int counting_time = 0;**

7.

```
}
if(speed <= 255){
    speed = 255;
}
OCR0 = speed;
return 0;


void Motor_overload_event(){ // not yet finish
```

**This was a runtime error with wrong logic. So I changed the code line as if (speed >= 255) and correct that error.**

8.

```
    if(read_res =! check_res || read_temp =! check_temp || read_overl =! check_ove){
        LCD_Command (0x80);
        LCD_String(line1_text);
        LCD_Command(0xC0);
        LCD_String(line2_text);
        check_res = read_res; check_temp = read_temp; check_ove = read_overl;
        //this if statement for update the LCD display only if some value has changed.
    }
}
```

or List
tire Solution | 2 Errors | 7 Warnings | 0 Messages | Build + IntelliSense

Description
recipe for target 'main.o' failed

The error of this code line was, I have written the not equal sign wrong way. Therefore I change it as != and correct the error.

9.

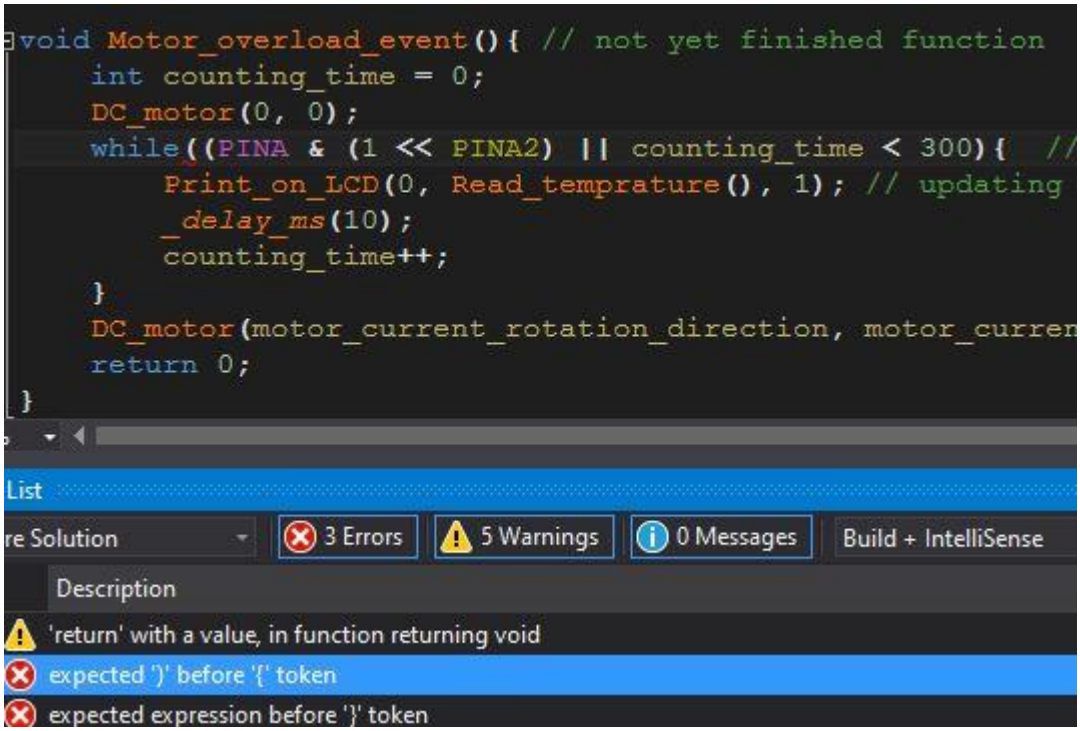
```
//temp print on lcd
sprintf(temp2,"%d", read_temp);
if(read_temp < 10) {temp2[1] = ' ' temp2[2] = ' '}
if(read_temp < 100) {temp2[2] = ' '}

for(int k = 0; k < 4; k++){
    line1_text[9+k] = temp[k];
}
for(int l = 0; l < 3; l++){
    line1_text[13+l] = temp2[l];
```

or List
ntire Solution | 3 Errors | 7 Warnings | 0 Messages | Build + IntelliSense

Description
expected ';' before 'temp2'
expected ';' before '}' token

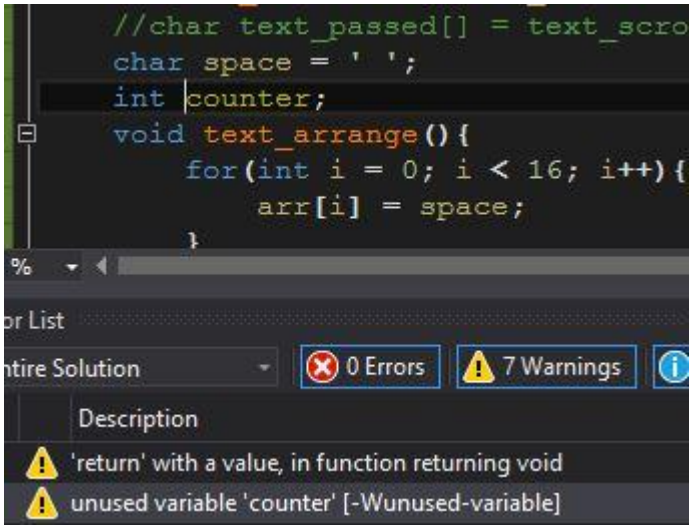
Missing semicolons.

**10.**



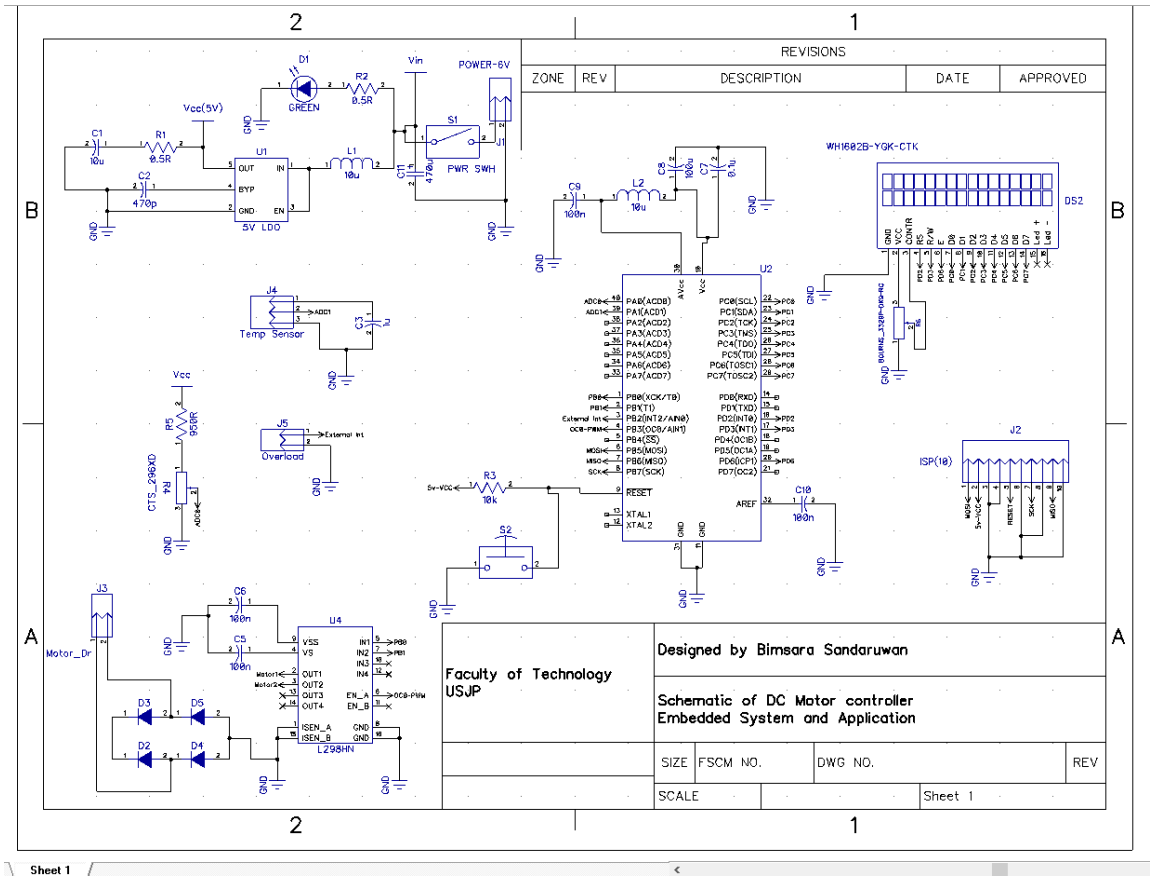

This error came out because I have used the bracket for the if condition a wrong way. Therefore I remove the bracket which is right after while keyword and get rid of the error.

**11.**

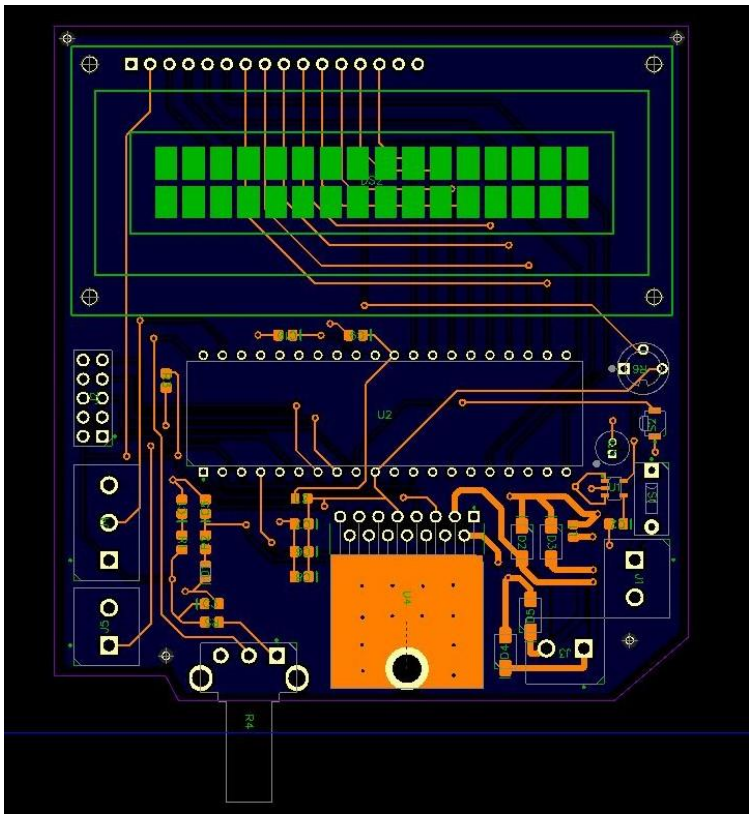



**This was not an error but a warning. Here I have misused the computer memory by creating variables without a reason. I remove that counter variable and correct the warning.**

## PCB Schematic

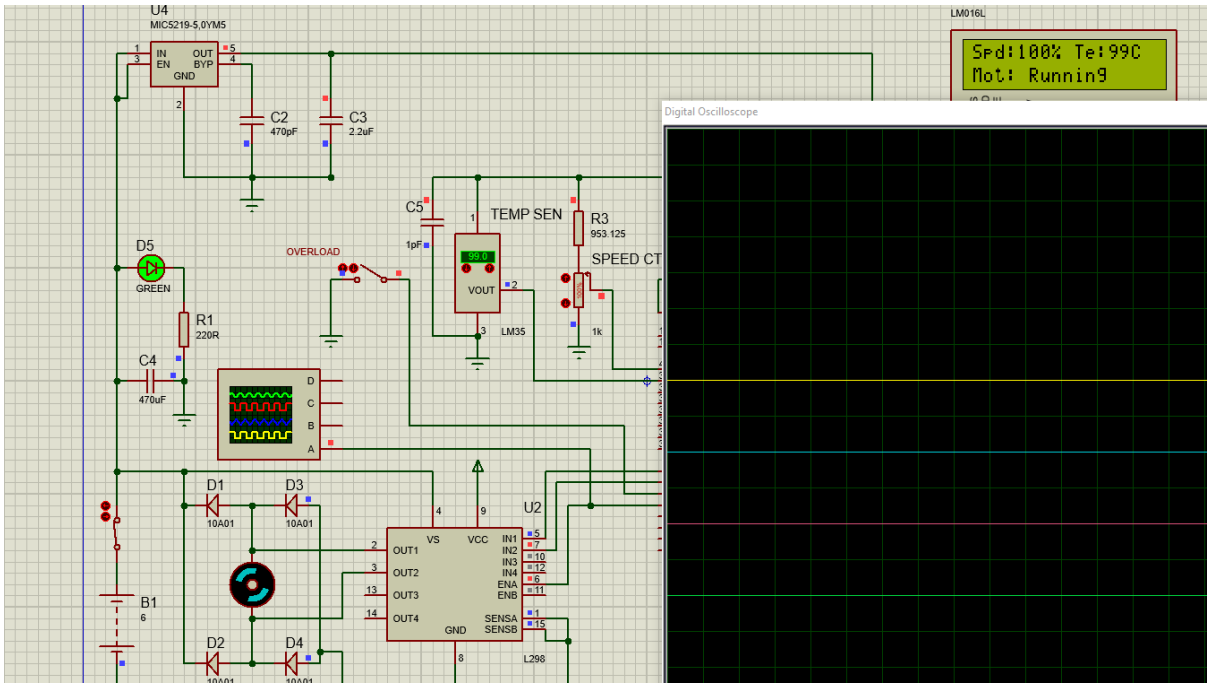



## PCB Layout

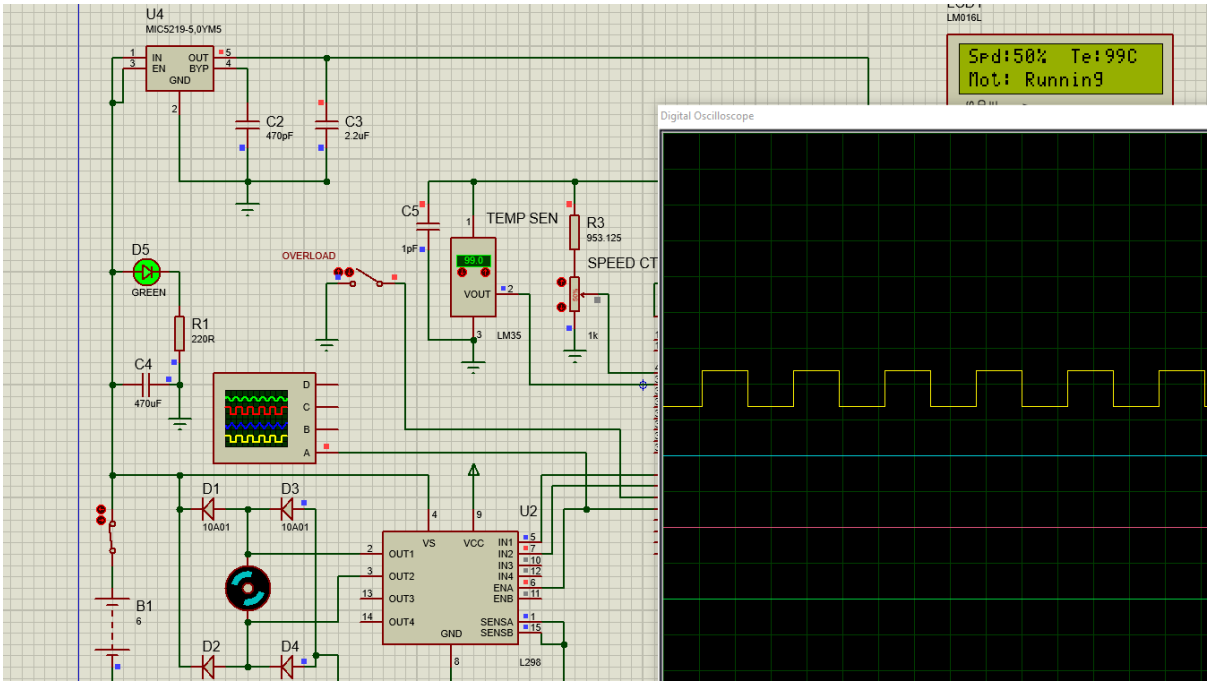


## Motor PWM

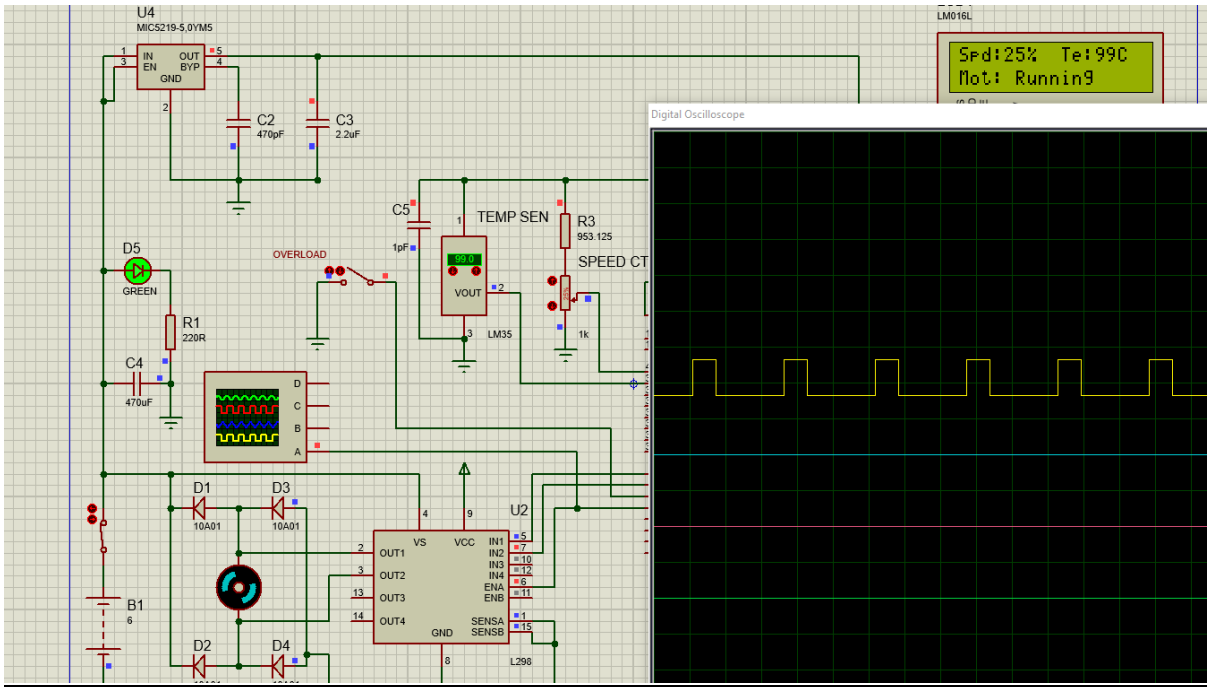
- **100 % Speed –**



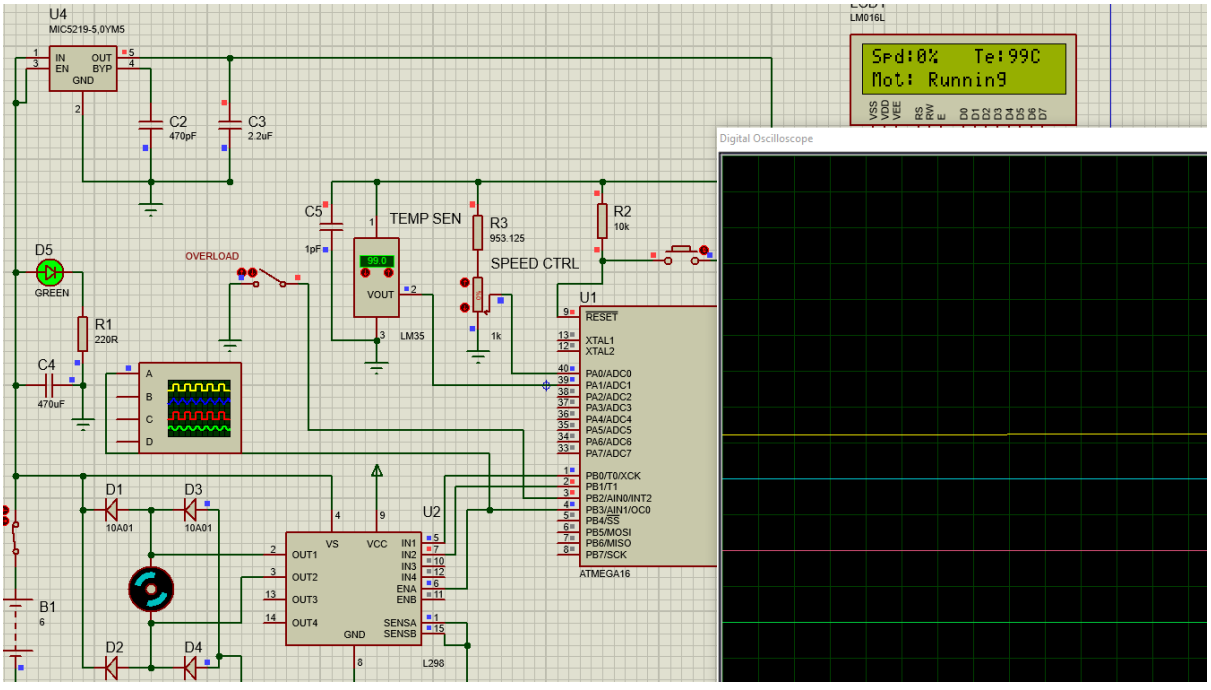

- **50 % Speed –**



- **25 % Speed –**




- **0 % Speed –**



**Pin Selection**

- ✓ PORTC = LCD Display Data Pins
- ✓ PD2, PD3, PD6 = LCD Display RS, RW, S Pins
- ✓ PB0, PB1 = Motor Direction Controlling Pins
- ✓ PB3 = Motor Driver Enable Pin for PMW
- ✓ PA0 = Speed Controlling Potential Meter
- ✓ PA1 = LM35 Temperature Sensor
- ✓ PB2 = Interrupt Overload

**Instructions**

- The assignment must be submitted as a PDF file.
- Provide simulation, schematic, and PCB files to support your answers.
- Zip all the files (include the PDF) and upload to LMS (Index number).
- Submit the files within the deadline (the marks will be deducted for late submissions).
- Must participate in a 10-minute Q&A session on the evaluation date for feedback.

| Starting date | Supportive session 1 | Supportive session 2 | Deadline | Evaluation and feedback |
|---|---|---|---|---|
| 16/05/2022 | 23/05/2022 | 30/05/2022 | 06/06/2022 | 13/06/2022 |

**Problem (Total marks- 100%)**

Assume that you are working as an engineering technologist in an embedded systems development company. A client wants a DC motor control system with protection and speed indication. Following are the client's requirements and specifications for the design:

- Number of units: 01
- DC motor: 6V/ 1A, Rated load= 50%, no-load speed=1000 rpm, $R_{coil}$= 12 Ω. $L_{coil}$= 100 mH
- Speed control: Phase correct PWM mode, open-loop, and zero to full speed (0%- 100%) adjustment using a variable resistor knob
- Speed of the motor: display using an LCD
- Protection: Over-temperature and overload shutdown

As per the client's requirements, the design engineer has decided to design the system using a microcontroller. The following hardware components have been selected to design the system.

- Microcontroller: AtMega16L- 8PU
  - Use the internal 1MHz oscillator
  - Use the internal 2.56V voltage reference
- DC motor driver: L298N Full bridge driver
- Temperature sensor: LM35
  - Over-temperature threshold: 100 $^{o}$C
- Display: LCD 16x2 (C162C-YTY-LW65 or LM016L)
  - Show the motor speed as % to its full speed
  - Show the temperature in $^{o}$C
  - Show the status of the motor: Running, Overload, Over temperature
- Power source: DC 6V battery
- Voltage regulator: 5V/500mA LDO (MIC5219-5.0YM5)
- Power ON/OFF
  - Use a button
  - Use a green LED indicator to show the ON status
- Reset: Use a button
- Overload detection
  - Use a manual switch for testing (5V at overload and 0V at normal operation)
  - Use external interrupts for detecting the voltage change of this switch
  - Turn off the motor immediately if an overload occurs
  - Keep at least 3s delay before turning on the motor after the overload event

The following software packages have been recommended for the initial design and development.

- Programming: Atmel Studio
- Simulation: Proteus
- Schematic and PCB design: Dip Trace/KiCad/Altium Designer

As the technologist, you are asked to perform the following subtasks: Make any assumptions with clear justifications when required.

1. Design a circuit in Proteus software to the specifications (20%).
   (*When designing the circuit, you should correctly interface the external devices to the appropriate pins of the microcontroller. Justify your selections)*
2. Construct an algorithm/flow chart before implementing the program (10%).
3. Write a program in C language using Atmel Studio (*here you should modularize the program according to the specifications)* and verify it by building (*note down any compilation errors that occurred, and methods used to rectify them)* (20%).
4. Simulate and verify the design according to the client specifications using the Proteus simulation platform (30%). Get the following test results:
   i. ADC readings in decimal for different settings of the variable resistor knob: Use 8bit ADC resolution (0%, 50% and 100%)
   ii. PWM signal from the microcontroller for different settings of the variable resistor knob (0%, 50% and 100%)
   iii. Motor speed in RPM for different settings of the variable resistor knob (0%, 50% and 100%)
   iv. Data on the LCD screen (motor speed, temperature, and status)
   v. System response when the motor temperature exceeds 100$^{o}$C
   vi. System response when an overload event occurs
5. Design a PCB for the proposed system (20%)
   (*Refer to the datasheet layout examples of each device*)