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Group/3

Task 1:

a) **Describe** all the pins of PIC16f877A. After that, your colleagues would have enough information once they need to interface the PIC16f877A with other hardware.

1. RA0 - Analog Input 0 / Digital I/O (ADC Channel 0): This pin can be used as an analog input for the built-in 10-bit Analog-to-Digital Converter (ADC) or as a digital input/output pin.

2. RA1 - Analog Input 1 / Digital I/O (ADC Channel 1): Similar to RA0, this pin can be used as an analog input for the ADC or as a digital input/output pin.

3. RA2 - Analog Input 2 / Digital I/O (ADC Channel 2): Similar to RA0 and RA1, this pin can be used as an analog input for the ADC or as a digital input/output pin.

4. RA3 - Analog Input 3 / Digital I/O (ADC Channel 3): Similar to RA0, RA1, and RA2, this pin can be used as an analog input for the ADC or as a digital input/output pin.

5. RA4 - Digital I/O / T0CKI (Timer0 Clock Input): This pin can be used as a digital input/output pin or as the clock input for Timer0.

6. RA5 - Digital I/O / MCLR (Master Clear Reset): This pin serves multiple purposes. As a digital input/output pin, it can be used for general-purpose I/O. As the MCLR pin, it is used for external reset functionality.

7. RE0 - Digital I/O: This is a general-purpose digital input/output pin.

8. RE1 - Digital I/O: Another general-purpose digital input/output pin.

9. RE2 - Digital I/O: A third general-purpose digital input/output pin.

10. VSS (Ground): This pin is connected to the ground (0V) reference of the microcontroller.

11. VDD (Power): This pin is connected to the positive supply voltage (+5V) for the microcontroller.

12. RB0/INT - Digital I/O / External Interrupt: This pin can be used as a general-purpose digital input/output pin or as an external interrupt input.

13. RB1/SDI/SDA - Digital I/O / SPI Data Input / I2C Data: This pin can be used as a digital input/output pin or as the Serial Peripheral Interface (SPI) data input or I2C data pin, depending on the configuration.

14. RB2/SDO - Digital I/O / SPI Data Output: This pin can be used as a digital input/output pin or as the Serial Peripheral Interface (SPI) data output pin.

15. RB3/SCK/SCL - Digital I/O / SPI Clock / I2C Clock: This pin can be used as a digital input/output pin or as the Serial Peripheral Interface (SPI) clock or I2C clock pin.

16. RB4/T1OSI - Digital I/O / Timer1 Oscillator Input: This pin can be used as a general-purpose digital input/output pin or as the oscillator input for Timer1.

17. RB5/T1OSO - Digital I/O / Timer1 Oscillator Output: This pin can be used as a general-purpose digital input/output pin or as the oscillator output for Timer1.

18. RB6/TX/CK - Digital I/O / USART (Serial) Transmit / Clock: This pin can be used as a general-purpose digital input/output pin or as the USART transmit pin or clock input for synchronous communication.

19. RB7/RX/DT - Digital I/O / USART (Serial) Receive / Data: This pin can be used as a general-purpose digital input/output pin or as the USART receive pin or data input for synchronous communication.

20. RB8 - Digital I/O: A general-purpose digital input/output pin.

21. RB9 - Digital I/O: Another general-purpose digital input/output pin.

22. RB10 - Digital I/O: A third general-purpose digital input/output pin.

23. RB11 - Digital I/O: A fourth general-purpose digital input/output pin.

24. RB12 - Digital I/O: A fifth general-purpose digital input/output pin.

25. RB13 - Digital I/O: A sixth general-purpose digital input/output pin.

26. RB14 - Digital I/O: A seventh general-purpose digital input/output pin.

27. RB15 - Digital I/O: An eighth general-purpose digital input/output pin.

28. VSS (Ground): This pin is connected to the ground (0V) reference of the microcontroller.

29. VDD (Power): This pin is connected to the positive supply voltage (+5V) for the microcontroller.

30. OSC1/CLKIN - Crystal Oscillator Input: This pin is used for connecting an external crystal oscillator or ceramic resonator for clock generation.

31. OSC2/CLKOUT - Crystal Oscillator Output: This pin is used in conjunction with an external crystal oscillator or ceramic resonator for clock generation.

32. VCAP - External Capacitor Connection: This pin is used for connecting an external capacitor to stabilize the internal voltage reference.

33. CCP1/RC2 - Capture/Compare/PWM 1 / Digital I/O: This pin can be used as a digital input/output pin or as a Capture/Compare/PWM module output.

34. C2OUT/RC1 - Comparator 2 Output / Digital I/O: This pin can be used as a digital input/output pin or as the output of the second analog comparator.

35. C1OUT/RC0 - Comparator 1 Output / Digital I/O: This pin can be used as a digital input/output pin or as the output of the first analog comparator.

36. RC5/T1CKI - Digital I/O / Timer1 Clock Input: This pin can be used as a general-purpose digital input/output pin or as the clock input for Timer1.

37. TX/CK - USART (Serial) Transmit / Clock: This pin is the USART transmit pin or the clock input for synchronous communication.

38. RX/DT - USART (Serial) Receive / Data: This pin is the USART receive pin or the data input for synchronous communication.

39. RC6 - Digital I/O: A general-purpose digital input/output pin.

40. RC7 - Digital I/O: Another general-purpose digital input/output pin.

b) Explain the functions of the main blocks in PIC16f877A : ALU, Status and Control, Program Counter, Flash Program Memory, Instruction Register, Instruction Decoder

1. ALU (Arithmetic Logic Unit):The Arithmetic Logic Unit is a fundamental component of the microcontroller responsible for performing arithmetic and logical operations on data. It can perform addition, subtraction, bitwise AND, bitwise OR, bitwise XOR, and other arithmetic and logical operations. The ALU takes two operands from registers or memory, processes them according to the instruction provided by the CPU, and produces the result.

2. Status and Control : The Status and Control block contains special-purpose registers that store the status of various flags and control bits. These registers are used to keep track of important information such as carry and zero flags resulting from ALU operations, and to control the operation of the microcontroller. For example, it includes the Global Interrupt Enable bit (GIE) to enable or disable interrupts globally, the Carry (C) flag to indicate a carry-out from arithmetic operations, and many other flags and control bits.

3. Program Counter (PC):The Program Counter is a 13-bit register that keeps track of the memory address of the next instruction to be fetched and executed from the Flash Program Memory. As the microcontroller executes each instruction, the Program Counter increments to point to the next instruction in memory. It is responsible for the sequential execution of the program stored in the Flash Program Memory.

4. Flash Program Memory : The Flash Program Memory is the non-volatile memory of the microcontroller that stores the user's program code. It is where the program instructions are stored in a series of memory locations. The PIC16F877A has a 14-bit program memory address space, which allows it to store up to 8K (8192) instructions. The program is stored in Flash memory during the programming phase and can be read and executed during the microcontroller's operation.

5. Instruction Register:The Instruction Register is a temporary storage unit that holds the currently fetched instruction from the Flash Program Memory. When the microcontroller fetches an instruction, it stores it in the Instruction Register before being sent to the Instruction Decoder for further processing. The Instruction Register holds the opcode and any associated operands of the fetched instruction.

6. Instruction Decoder:The Instruction Decoder interprets the opcode fetched from the Instruction Register and generates control signals to execute the specific instruction. It determines the type of operation (e.g., arithmetic, logic, memory access, etc.) to be performed and activates the appropriate control signals to coordinate the operation of other blocks such as the ALU, Status and Control, and memory access units to execute the instruction.

c) Examine the reasons why a led, which is connected to RA4 for flashing prepose not working probably.

-Bin RA4 has special internal structure ,it contains only NMOS transistor which works on 0 voltage and produce 0 because it connected to the ground, doesn't contain PMOS transistor which connected to Vdd and produces 1 if it used in 1 case, so in source connection ,when the bin takes 1 ,transistor NMOS doesn't work and there is no PMOS to produce 1 so the bin output is not determined and the led doesn't work.

d) **Evaluate** the characteristics of ATMega328P versus PIC16f877A, by **comparing** the memory size, the power consumption, pin count… of those two MCUs

1. Memory Size:

- ATMega328P: The ATMega328P is an 8-bit microcontroller from the AVR family. It typically comes with 32KB of Flash memory for program storage and 2KB of SRAM for data storage. It does not have built-in EEPROM memory, but some versions may offer limited internal EEPROM emulation in the Flash memory.

- PIC16F877A: The PIC16F877A is also an 8-bit microcontroller, but from the PIC family. It features 14KB of Flash memory for program storage and 368 bytes of RAM for data storage. It also has 256 bytes of EEPROM memory for non-volatile data storage.

The ATMega328P generally has more Flash memory than the PIC16F877A, making it suitable for more complex applications and larger program codes. However, the PIC16F877A has more RAM and EEPROM, which can be advantageous for certain data-intensive tasks.

2. Power Consumption:

- ATMega328P: The ATMega328P is known for its relatively low power consumption, especially in idle and sleep modes. It offers various sleep modes that allow it to consume minimal power when not actively processing data or performing tasks.

- PIC16F877A: The power consumption of the PIC16F877A is relatively higher compared to the ATMega328P, especially when it comes to idle and low-power modes. While it has some power-saving features, it may not match the power efficiency of the ATMega328P.

The ATMega328P's low power consumption makes it a popular choice for battery-operated and energy-efficient applications.

3. Pin Count:

- ATMega328P: The ATMega328P is available in various packages with different pin counts. The most common package used is the 28-pin DIP (Dual In-line Package) variant.

- PIC16F877A: The PIC16F877A comes in a 40-pin DIP package.The PIC16F877A has more pins compared to the standard ATMega328P package. This can be advantageous for applications requiring more I/O pins or extensive peripheral connections. However, for projects with limited pin requirements, the smaller package of the ATMega328P might be more suitable.

Give 2 examples of embedded systems where ATMega328P is a better choice than PIC16f877A.

1. Low-Power Battery-Operated Devices:

If the embedded system is designed to operate on battery power for extended periods and requires low-power consumption, the ATMega328P is a better choice. The ATMega328P is known for its efficient power management features and multiple sleep modes, which enable it to operate at very low power levels during idle or sleep states. It is widely used in battery-powered applications such as wearable devices, wireless sensors, and IoT nodes, where power efficiency is critical for maximizing battery life.

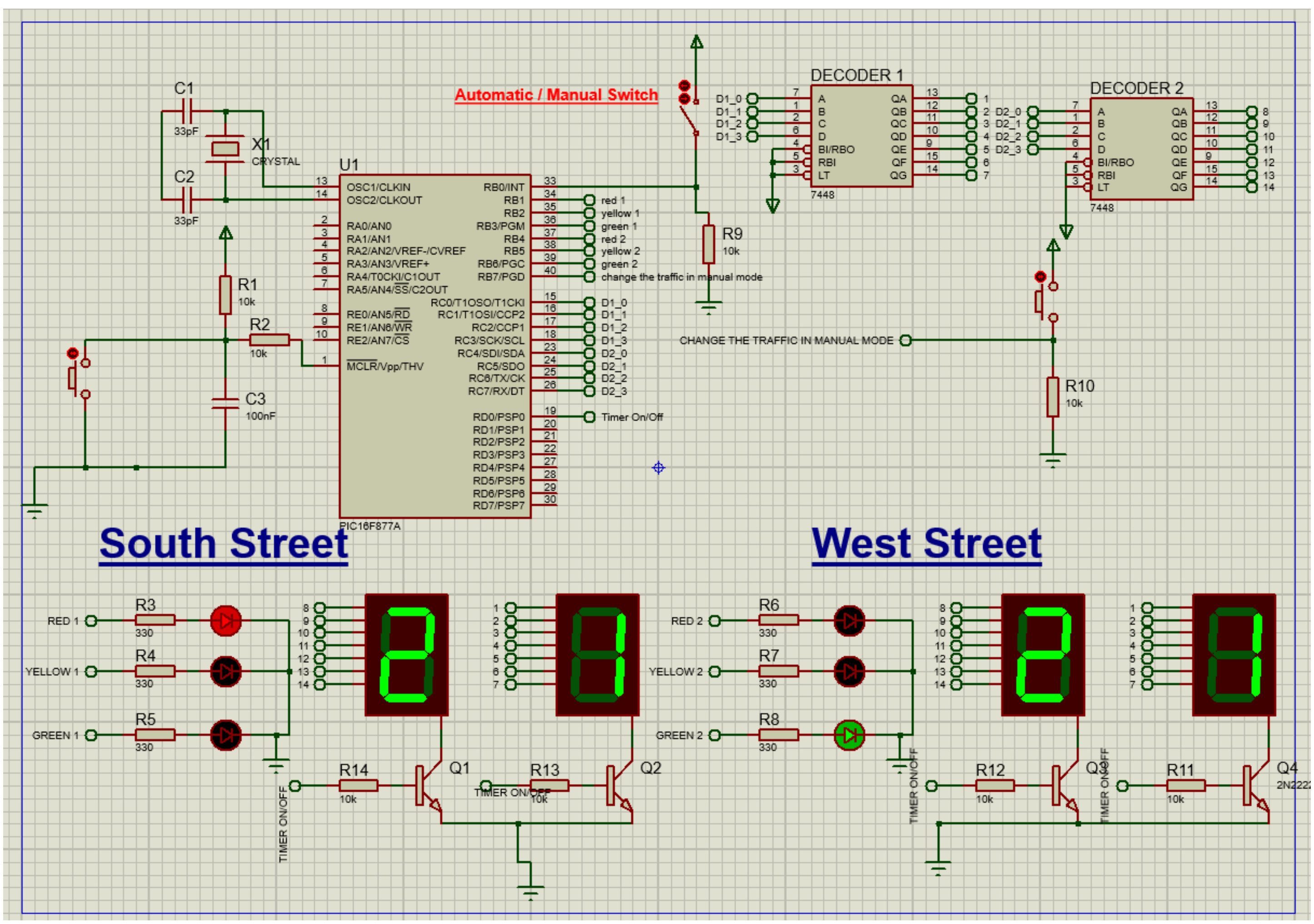
2. Compact and Space-Constrained Applications:

In projects with limited PCB real estate and tight space constraints, the ATMega328P's smaller footprint and lower pin count make it a better choice. The ATMega328P is available in compact 28-pin DIP packages, while the PIC16F877A comes in a larger 40-pin DIP package. In space-constrained applications, using the ATMega328P can help optimize the board layout and reduce the overall size of the embedded system, making it more suitable for compact and portable devices.

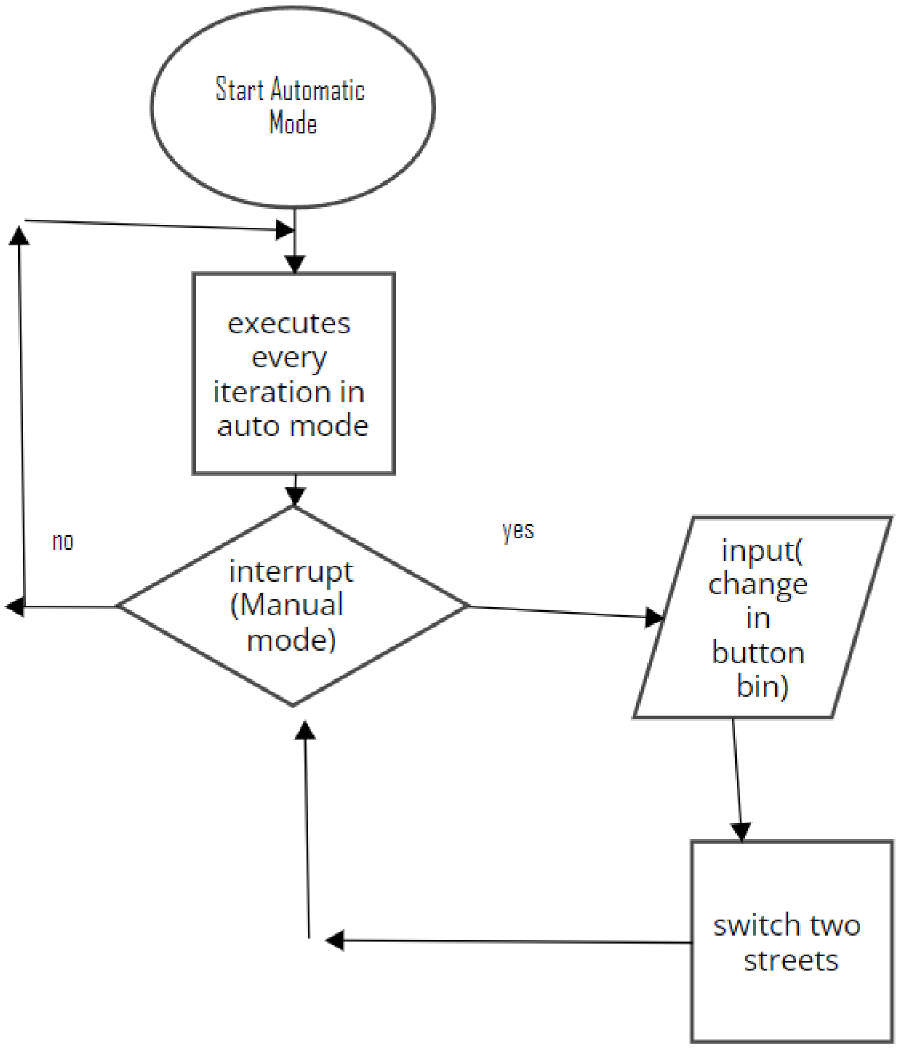
Task 2:

Traffic Light Project

1)Schematic



2)Flowchart



2)Used components

- Microcontroller PIC16F877A
- Resistors
- Common cathode 7-segment display
- Transistors npn
- Decoder 7448
- LEDs (red, yellow ,green)
- Switch
- Button

3) Automatic System

-The automatic system switches between two streets .

-First ,it counts 23seconds for first street to be red and the second one is green.

-At last 3 seconds the green switches to yellow which indicates that the traffic will be red so cars must slow

-At the end the first street traffic becomes green and the second one becomes red for 15 seconds

-Like the second one, at the last 3 seconds the first street becomes yellow to indicate that cars will stop Till the switch of Manual turned on , the automatic system will run for infinity

Procedure:

-port c is used to show counter on the seven segment .

-A tricky idea is used for making the display based on one port

-port c contains 8 bins, it divided into two groups.

-each group should represent a number from 0 ->9

- I will use binary representation for decimal number like (35) 00100011

-It consists of two groups (0010)which represent 2 in decimal and (0011) which represents 3 in decimal .

-So ,if 35 is represented in port c and each group of 4 bins taken into decoder ,then it will represent 23 in two seven segments.

-Then I decrement the value by one.

-Each two seven segments display is connected with one decoder

-As shown in Binary table (next page) the values became 32 or 16 then shifted by 6 .

-This because binary representation of 31(00011111) is not true for the sequence because second group (1111) is not a BCD number.

-The next number in this case correct for the sequence is 25 so (31) is decremented by 6.

-Binary Table for port c

Decimal	Binary	Group 1	Group 2	BCD view
35	00100011	0010→2	0011→3	23
34	00100010	0010→2	0010→2	22
33	00100001	0010→2	0001→1	21
32	00100000	0010→2	0000→0	20
25	00011001	0001→1	1001→9	19
24	00011000	0001→1	1000→8	18
23	00010111	0001→1	0111→7	17
22	00010110	0001→1	0110→6	16
21	00010101	0001→1	0101→5	15
20	00010100	0001→1	0100→4	14
19	00010011	0001→1	0011→3	13
18	00010010	0001→1	0010→2	12
17	00010001	0001→1	0001→1	11
16	00010000	0001→1	0000→0	10
9	00001001	0000→0	1001→9	09
8	00001000	0000→0	1000→8	08
7	00000111	0000→0	0111→7	07
6	00000110	0000→0	0110→6	06
5	00000101	0000→0	0101→5	05
4	00000100	0000→0	0100→4	04
3	00000011	0000→0	0011→3	03
2	00000010	0000→0	0010→2	02
1	00000001	0000→0	0001→1	01
0	00000000	0000→0	0000→0	00

4)Manual Mode

-When the user turns the switch ON the timer stops and the LEDs which were ON still being ON till the user clicks on the changing button to control two streets .

-When he clicks on the button the green LED turns into yellow for 3s and the red LED stays also for the same while then the yellow switches to red and the red switches to green .

Special Case: If the user switches into automatic mode while the LED is yellow , it continues its time (3s) and the red stays also then, yellow turns red and red turns green and the automatic mode is OFF ,Timer stops.