TASK (1)

(a) The PIC microcontroller PIC16f877a is one of the most renowned microcontrollers in the industry. This microcontroller is very convenient to use, the coding or programming of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology. It has a total number of 40 pins and there are 33 pins for input and output.

Pin1 (MCLR): This is the master clear pin, so this pin resets the PIC microcontroller. Once this MCLR pin is active low, then it must be constantly given 5V & if 0V is given then the microcontroller will reset.

Pin2 (RA0/AN0): This is the first pin of the port-A. So this pin is used as an analog pin and it is built in ADC.

Pin3 (RA1/AN1): This is the analog i/p1.

Pin4 (RA2/AN2/Vref-): This pin acts as the analog i/p2 or it acts as an analog -ve reference voltage.

Pin5 (RA3/AN3/Vref+): This pin acts as the analog i/p3 or it acts as the analog +ve reference voltage.

Pin6 (RA0/T0CKI): This pin acts as the CLK input pin to timer0, so the output type is open drain.

Pin7 (RA5/SS/AN4): This pin is the analog i/p4. This pin acts as the slave selects for the synchronous serial port within this controller.

PIN 8: RE0/RD/AN5: PORTE starts from pin 8 to pin 10 and this is also a bidirectional input output port. It can be the analog input 5 or for parallel slave port it can act as a 'read control' pin which will be active low.

PIN 9: RE1/WR/AN6: It can be the analog input 6. And for the parallel slave port it can act as the 'write control' which will be active low.

PIN 10: RE2/CS/A7: It can be the analog input 7, or for the parallel slave port it can act as the 'control select' which will also be active low just like read and write control pins.

PIN 11 and 32: VDD: These two pins are the positive supply for the input/output and logic pins. Both of them should be connected to 5V.

PIN 12 and 31: VSS: These pins are the ground reference for input/output and logic pins. They should be connected to 0 potential.

PIN 13: OSC1/CLKIN: This is the oscillator input or the external clock input pin.

PIN 14: OSC2/CLKOUT: This is the oscillator output pin. A crystal resonator is connected between pin 13 and 14 to provide external clock to the microcontroller. ¼ of the frequency of OSC1 is outputted by OSC2 in case of RC mode. This indicates the instruction cycle rate.

PIN 15: RC0/T1OCO/T1CKI: PORTC consists of 8 pins. It is also a bidirectional input output port. Of them, pin 15 is the first. It can be the clock input of timer 1 or the oscillator output of timer 2.

PIN 16: RC1/T1OSI/CCP2: It can be the oscillator input of timer 1 or the capture 2 input/compare 2 output/ PWM 2 output.

PIN 17: RC2/CCP1: It can be the capture 1 input/ compare 1 output/ PWM 1 output.

PIN 18: RC3/SCK/SCL: It can be the output for SPI or I2C modes and can be the input/output for synchronous serial clock.

PIN 23: RC4/SDI/SDA: It can be the SPI data in pin. Or in I2C mode it can be data input/output pin.

PIN 24: RC5/SDO: It can be the data out of SPI in the SPI mode.

PIN 25: RC6/TX/CK: It can be the synchronous clock or USART Asynchronous transmit pin.

PIN 26: RC7/RX/DT: It can be the synchronous data pin or the USART receive pin.

PIN 19,20,21,22,27,28,29,30: All of these pins belong to PORTD which is again a bidirectional input and output port. When the microprocessor bus is to be interfaced, it can act as the parallel slave port.

PIN 33-40: PORT B: All these pins belong to PORTB. Out of which RB0 can be used as the external interrupt pin and RB6 and RB7 can be used as in-circuit debugger pins.

(b) Arithmetic Logic Unit (ALU) operates in direct connection with all the 32 General Purpose Working registers. Within a single clock cycle, arithmetic operations between General Purpose registers or between a register and an immediate are executed. The ALU operations are divided into three main categories: arithmetic, logical, and bit-functions. Some implementations of the architecture also provide a powerful multiplier supporting both signed/unsigned multiplication and fractional format.

The Program Counter (PC) in PIC16F877A is a special register that holds the address of the next instruction to be executed in the program memory. Its functions include: Counting the number of instructions executed, Resetting the microcontroller, Branching to other parts of the program.
The function of Flash Program Memory in PIC16F877A is to store program instructions and data that are accessed by the microcontroller to perform specific tasks. The Flash Program Memory is a non-volatile memory which means it can retain data even when power is turned off.

The Instruction Register (IR) in PIC16F877A is responsible for storing the current instruction being executed by the microcontroller. It plays a critical role in the execution of instructions and the overall functioning of the microcontroller.

The Instruction Decoder in PIC16F877A is responsible for decoding the instructions fetched from memory and providing the corresponding control signals to execute the instruction.
(c) 1. Improper connection: Verify that the LED is connected correctly to the RA4 pin of the PIC16F877A and that the polarity of the LED is correct. If the polarity of the LED is reversed, it will not work correctly, or if the connection is loose or incomplete, it may interrupt current flow.

2. Output mode setting: Check that RA4 is set to output mode in the program. If RA4 is configured as an input, it will not be capable of driving the LED.

3. Insufficient power: Ensure that the PIC16F877A is receiving sufficient power to operate correctly. If the voltage supply is too low, it could affect the performance of the LED connected to RA4.

4. Wrong program instructions: Check that the program is correctly written. Errors in the program instructions can lead to the LED not receiving the correct current to operate accordingly. Program errors may include syntax errors, incorrect logic, missing functions or library references, etc.

5. Timing: Check that the timing of the program is appropriate for flashing the LED. If the timing is too fast or too slow for the LED, it may appear not to be working.

6. Damaged LED or PIC16F877A: Check that the LED is in good working condition and is not damaged. Also, ensure that the PIC16F877A is not damaged.

(d)

1. Memory size:

The ATMega328P has 32KB of Flash program memory and 2KB of SRAM whereas the PIC16F877A has only 14KB of program memory and 368 bytes of RAM. Hence, the ATMega328P has higher memory capacity than the PIC16F877A.

2. Power consumption:

The ATMega328P has lower power consumption compared to the PIC16F877A due to its advanced CMOS technology. The maximum operating current of the ATMega328P is around 20mA for a 16 MHz clock frequency, while the PIC16F877A requires around 45 mA at the same clock frequency.

3. Pin count:

The ATMega328P has a lower pin count (28 pins) compared to the PIC16F877A (40 pins).

4. Two Examples of embedded systems where ATMega328P is a better choice than PIC16F877A:
a) Low Power Applications: Despite this feature being dependent on the particular application, ATMega328P can be a better choice than the PIC16F877A in low power applications due to its lower power consumption. For instance, battery-powered devices that operate in low-power modes for an extended period of time like wearable fitness trackers, or environmental sensors can utilize the ATMega328P.

b) Projects with Limited Budget: ATMega328P is a more cost-effective microcontroller than the PIC16F877A. Projects that focus on faster prototyping or have tight budget constraints may consider using the ATMega328P. For example, small hobbyist DIY projects like home automation, Wi-Fi-enabled devices that perform non-intensive task, or IoT projects can benefit from the cost-effective ATMega328P.