

Embedded Systems (0907333)

Homework 2

Submit Handwritten Solutions

Problem 1: Write an assembly program for the PIC 16P84A given the following specification:

- Port A is input port and Port B is output port.
- The microcontroller should continuously copy the least significant four bits from Port A to the most significant four bits of Port B, respectively.
- The least significant four bits of Port B should equal RA4.

Your program should include all needed port initialization.

Problem 2: How long does it take to execute the following subroutine on a PIC 16P84A running at an external clock of 800 kHz?

```
delay
    movlw    D'100'
    movwf   delcntrl
dell
    nop
    decfsz  delcntrl,1
    goto   dell
    return
```

Problem 3: Write an assembly program for the PIC 16P84A given the following specification:

- Port A is an output port.
- The external interrupt is enabled on RB0.
- The main routine has two modes.
- Depending on the mode, the main routine increments or decrements the contents of the working register and outputs these contents to Port A.
- The interrupt handling subroutine toggles the mode of the main routine between the increment mode and the decrement mode.

Your program should include all needed port and interrupt initialization and ISR context saving.

Problem 4: Write an assembly program for the PIC 16P84A given the following specification:

- Port B is an output port.
- The main routine increments the contents of the working register and outputs these contents to Port B.
- After updating Port B, the microcontroller should enter the sleep mode.
- Timer 0 generates an interrupt every 512 instruction cycles, causing exit of the sleep mode for one more update.

Your program should include all needed port and interrupt initialization.

Problem 5: True or false problem: Circle **T** if the statement is always true and circle **F** if the statement is false. Also you need to correct the false statements.

T F Weak pull up resistors in I/O ports are used when the I/O port is configured as output.

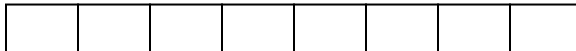
T F Decoupling capacitors are used to smooth the voltage supply of the microcontroller when the power supply is not able to do that at certain times.

T F For an 8 bit timer with its input clock of 4 MHz, the maximum time that can be measured assuming no scaling is 64 micro seconds.

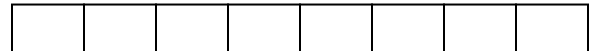
T F The WDT timeout depends on the external clock frequency.

Problem 6: Initialize the following two registers so that Timer 0 introduces a 100-second delay. Assume using an external 160-Hz crystal oscillator (show your calculations).

TMR0 Register



OPTION Register

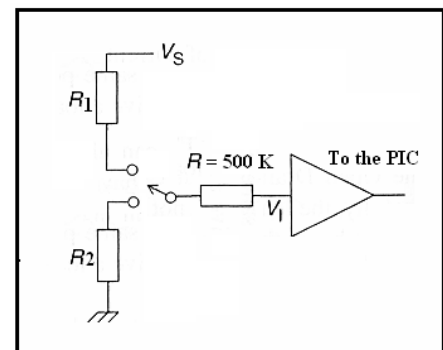


OPTION REGISTER (ADDRESS 81h)

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
RBPU	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0
bit 7				bit 0			

Problem 7: The circuit shown to the right is connected at V_I to PIC16F84A's PORTA input. What are the constraints on R_1 and R_2 resistor values?

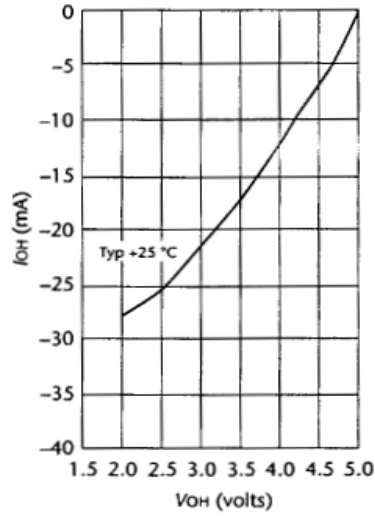
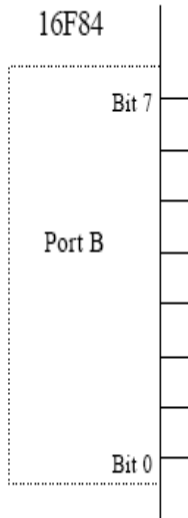
Given that $V_S = 5V$, Maximum $V_{IH} = 5.5V$, Minimum $V_{IH} = 2.4V$, Maximum $V_{IL} = 0.8V$, Minimum $V_{IL} = 0V$, and $I = 1\mu A$.



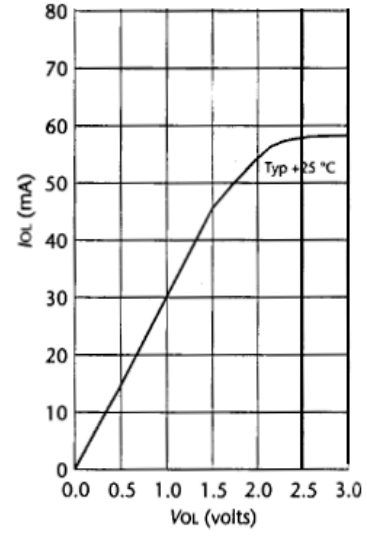
Problem 8: Four bits of Port B of a 16F84 are to be used to drive four LEDs, and the rest four bits are to be used to receive inputs from four push button switches. For the input bits, the interrupt on change option is to be used. The microcontroller power supply is 5V. Each LED requires 15mA when "ON" with forward voltage of 1.9V. Two LEDs should be "ON" when their associated port bits are at logic 1, and two should be "ON" when their associated port bits are at logic 0.

a) Show, using the diagram below to the left, how the switches and the LEDs may be connected?

- b) Use the following output characteristics to calculate the values of any resistor needed.
- c) Specify the contents of SFRs involved in this process.



(a) Output high



(b) output low