Microprocessor and Microcontroller Based Systems

Solve the Following **four Questions**:

<table>
<thead>
<tr>
<th>Q1(30pt)</th>
<th>Q2(25pt)</th>
<th>Q3(15pt)</th>
<th>Q4(30pt)</th>
<th>Total(100pt)</th>
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</table>

**[Q1] Fill in spaces**

1) PIC is the abbreviation for **programmable**-interface-**controller**.
2) The PIC16F84A instruction set contains **35** instructions.
3) The PIC16F84A can be operated in four different oscillator modes:
   a) **X**
   b) **RC**
   c) **HS**
   d) **LP**
4) In PIC16F84A, there are four sources of interrupt:
   a) **Termination of writing data to EEPROM**.
   b) **TIMO interrupt caused by timer overflow**.
   c) **Interrupt during alteration on RB4/RE5/RE6/RE7 pins of portB**.
   d) **External interrupt from RST/int pin of microcontroller**.
5) Microcontroller with **Harvard** architecture called RISC microcontroller, which is the abbreviation for **Reduced**-instruction-set-computer.
6) Microcontroller with von-nuemann's architecture called **CISC** microcontroller, which is the abbreviation for **Complex**-instruction-set-computer.
7) Fill in spaces for the following graph
8) Fill in spaces for the following graph

9) For the following DELAY subroutine

```
DELAY MOVW 08H
MOVWF COUNTER1
LOOP NOP
NOP
DECFSZ COUNTER1
GOTO LOOP
NOP
RETURN
```

a) How many machine cycles exist in the above delay?

\[
441 \text{ cycle}
\]

b) Calculate the exact time for this delay when we use a 4 MHz Crystal.

\[
T_{\text{cycle}} = 4T_{\text{osc}} = 4 \times \frac{1}{4 \text{MHz}} = \frac{1}{\mu \text{s}} \Rightarrow 441 \mu \text{s}
\]

10) The INTCON Register of a PIC 16F84A is set as shown in graph a) below.

```
1 0 1 0 1 1 0 0
```

```
1 0 1 0 1 0 0 1
```

a) Determine which interrupts are enabled.

b) An interrupt occurs, and the INTCON register is found to have changed to b). Which interrupt source has called?

c) Which bit must the user change before the end of the ISR?
[Q2] Answer the following:

[1] An inexperienced programmer writes the following code for a PIC16F84A to respond to an external interrupt for increment the values of counter1 in GPR.

a) How should the INTCON register be set?
   \[ 10010000 \]

b) What are the errors in the interrupt routine?
   1. \texttt{org \ 0x04} instead of \texttt{org \ 0x14}  

   2. \texttt{Retfie} instead of \texttt{Return} 

   3. \texttt{MOVLW 0FH} 

   4. \texttt{BCF INTCON, INTF} 

<table>
<thead>
<tr>
<th>Start</th>
<th>Memo</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORG 0000 GOTO start</td>
<td></td>
</tr>
<tr>
<td>ORG 0014 GOTO my_interrupt</td>
<td></td>
</tr>
<tr>
<td>; This is the interrupt routine</td>
<td></td>
</tr>
<tr>
<td>my_interrupt MOVFW 0F</td>
<td></td>
</tr>
<tr>
<td>ADDWF counter1,1</td>
<td></td>
</tr>
<tr>
<td>RETURN</td>
<td></td>
</tr>
<tr>
<td>; Program starts here</td>
<td></td>
</tr>
<tr>
<td>start BSF STATUS,5</td>
<td></td>
</tr>
<tr>
<td>; Other program instructions</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
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</table>

[2] Refer to the following Simulator:

(a) Specify the input and output pins of both port A and port B.

   \[ \text{RA2, RB0, RB2, RB5 --- input} \]

   \[ \text{RA0, RA1, RB3, RA4, RB0, RB1, RB2, RB4, RB6, RB7 --- output} \]

(b) What is the value of work register? \( \text{20h} \)

(b) What is the content of the general-purpose register whose address is \( \text{18h} \)? \( \text{9Bh} \)

(c) What is the address of the next instruction to be executed? \( \text{18h} \)

(d) What is the value of the zero flag? \( \text{1} \)

(e) What will happen when you execute the next instruction?

\text{The address 018h will contain 9Ah}
[Q3] Answer the following:
a) Find the checksum value for the following hex record
:0400100023000798

b) For the following code:

```
ORG 0x00
  goto Main
Main
  bsf STATUS,RP0
  movlw 0EF
  movwf TRISA
  movlw 00F
  movwf TRISB
  bcf STATUS,RP0
begin
  movf portA,0
  movwf PORTB
GOTO BEGIN
```

Find the contents of the following:

Address of the begin label: ........0x07........
Trisa contents: ..........0F........
Trisb contents: .........0F0........
Oscillator type: ..........XT........
Watchdog status: ..........disabled (off)........
Code protect status: ..........disabled (off)........