001

FINAL EXAM - SOLUTIONS
(Code 001)

Grade:

Subject : **Microprocessor – Microcontroller**
Time Allowed: **90 minutes**

Materials and calculators are permitted to use.
The other electronic devices are not permitted.

Name : .....Date : .....
Student ID : .....Class : .....

	a	b	c	d		a	b	c	d		a	b	c	d		a	b	c	d
1				**X**	**6**	**X**				**11**				**X**	**16**	**X**	**X**	**X**	**X**
2				**X**	**7**			**X**		**12**		**X**			**17**				**X**
3		**X**			**8**		**X**			**13**			**X**						
4			**X**		**9**				**X**	**14**	**X**								
5	**x**				**10**				**X**	**15**	**X**								

1. Which register/s is/are mandatory to get loaded at the beginning before loading or transferring the contents to corresponding destination registers?
   a. W
   b. INDF
   c. Program Counter Low Byte (PCL) Register
   d. All of the above

2. How many bits are required for addressing 4K & 64K program memories of PIC 18F respectively?
   a. 4 & 8 bits
   b. 8 & 16 bits
   c. 11 & 12 bits
   d. 12 & 16 bits

3. Which register acts as an input-output control as well as data direction register for PORTB?
   a. INDF (80H)
   b. TRISB (85H)
   c. TRISA (85H)
   d. PCLATH (8A)

4. Choose the right answer for the following code.

```
movlw 0xF0
movwf TRISD,A
```

   a. Configure the upper four pins of port D for input
   b. Configure the upper four pins of port D for output and the lower four pins for input.
   c. Configure the upper four pins of port D for input and the lower four pins for output.
   d. None of the above

5. When does it become feasible for PORTB pins (RB4 to RB7) to support its unique feature of 'interrupt on change'?
   a. By configuring all the pins (RB4-RB7) as inputs
   b. By configuring all the pins (RB4-RB7) as outputs
   c. By configuring any one of the pins as inputs
   d. By configuring any one of the pins as outputs

6. What is the purpose of setting T0IE bit in INTCON along with GIE bit?
   a. For setting the T0IF flag in INTCON due to generation of Timer 0 overflow interrupt
   b. For setting the T0IE flag in INTCON due to generation of Timer 0 overflow interrupt
   c. For setting the RBIF flag in INTCON due to generation of PORTB change interrupt
   d. None of the above

7. Which register is suitable for the corresponding count, if the measurement of pulse width is less than 65,535 μs along with the frequency of 500 kHz?
   a. 4-bit register b. 8-bit register c. 16-bit register d. 32-bit register
8. How does the pin RC2/CCP1 get configured while initializing the CCP module in the compare mode of operation?
   a. As an input by writing it in TRISC register
   b. As an output by writing it in TRISC register
   c. As an input without the necessity of writing or specifying it in TRISC register
   d. Compare mode does not support pin RC2/CCP1 configuration CCP initialization

Using the below code to answer 4 following questions. Assume the following memory contents, W register has the value 0xE3 in it, and that initial values of C, Z are both '0'.

```
Location   Content
0x048      0xA0
0x049      0x00
0x04A      0x40
0x04B      0x1A

iorwf 0x48
bcf   0x04A,3
rlcf  0x04B,f
addwf 0x04B,f
```

9. What is the content of the working register after executing instructions *iorwf 0x48* ?
   a. W = 0x48 c. W = 0xEB
   b. W = 0xE7 d. None of the above
10. What is the content of the location *0x4A* after executing instructions *bcf 0x04A,3* ?
   a. 0x47 c. 0x4F
   b. 0x4A d. None of the above
11. What is the content of the location *0x4B* after executing instructions *rlcf 0x04B,f* ?
   a. 0x1D c. 0x3B
   b. 0x3A d. None of the above
12. What is the content of *C, Z* flags after executing instructions addwf *0x04B,f* ?
   a. C=0; Z=0 c. C=1; Z=1
   b. C=1; Z=0 d. None of the above
13. What is the content of *T2CON* register to configure *TIMER2* for prescale of 4, and postscale of 11, internal clock as the clock source, and turns the timer on?
   a. T2CON = 0x55 c. T2CON = 0x5D
   b. T2CON = 0x59 d. T2CON = 0xAD
14. You are running a PIC18F program that uses two I/O ports, Port A and Port C. If *TRISA* = 0xFE and *TRISC* = 0xAB, how many I/O pins, in total, are configured as outputs?
   a. 4 b. 7 c. 9 d. 15

Use the CCP channel 1 in capture mode to measure the period of an unknown signal. Use the number of clock cycles as the unit of period. The period of the unknown signal is shorter than 65536 clock cycles. This part is used for 3 following questions

15. What is the content of CCP1CON register to configure CCP1 in capture mode on every falling edge?
   a. CCP1CON = 0x04 c. CCP1CON = 0x06
   b. CCP1CON = 0x05 d. CCP1CON = 0x07
16. What is the content of T3CON register to Select Timer1 as the base timer for the CCP1 capture mode?

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a. T3CON = 0x81
b. T3CON = 0x83
c. T3CON = 0xB1
d. T3CON = 0xB3

17. What is the content of T1CON register to configure TIMER1 16-bit operation, use external clock from pin RC0 as clock source, prescaler set to 8?

a. T1CON = 0x81
b. T1CON = 0x83
c. T1CON = 0xB1
d. T1CON = 0xB3

18. Find the size of the delay of the code snippet below if the crystal frequency is 4 MHz

```
MYREG   EQU     0x08   ; use location 08 as counter

DELAY   MOVLW   0xFF           1 cycle
        MOVWF   MYREG          1
AGAIN   NOP                    1
        NOP                    1
        DECF    MYREG, F       1
        BNZ     AGAIN          2
        RETURN                 1
```

ANSWER:

T-intruction cycle = 4/4*10^-6 = 1 us

Number of instruction cycles: 1 + 1 + ((1 + 1 + 1 + 2) x 255) + 1 = 1278

Size of delay = T-instruction cycle * Number of instruction cycles = 1278 us

19. If we want to use timer 0 with low priority interrupt. Which bits should we set/clear?

ANSWER:

Set TMR0IE, IPEN, GIEH, GIEL,
Clear TMR0IP

20. What is the difference between the RETURN and RETFIE instructions?

ANSWER:

Return is used for normal sub-routine calls
Retfie is used for interrupt service routine calls

21. Explain why we cannot use RETURN instead of RETFIE as the last instruction of an ISR?

ANSWER:

We will not get any other interrupt service. This is because the Retfie instruction automatically enables the global interrupt flag, which is needed for the next interrupt service.

22. Assume that the crystal oscillator is running at 10 MHz, write a PROGRAM to generate a square wave (Duty Cycle 50%) of 100 Hz using Timer1 with maximum prescaler.

    Hint: Timer1 should be configured as follows:

    - 16-bit mode, internal clock, prescaler 1:8
    - Calculate the value loaded into the TMR1H and TMR1L, note that a square wave of 100 Hz is 5ms at level 0 and 5ms at level 1

Solutions:

```
        org 0x00
        goto MAIN
        org 0x08
        goto ISR_TIMER1
        org 00100
MAIN
        movlw       0x0F
        movwf       ADCON1
        bcf         TRISD, .5
        bsf         RCON, IPEN
        bsf         IPR1, TMR1IP
        bsf         INTCON, GIEH
        bsf         PIE1, TIMR1IE
        movlw       0xB3
        movwf       T1CON
        bsf         PIR1,TMR1IF
        goto $
ISR_TIMER1
        bcf         T1CON,TMR1ON
        movlw       high (-6250)
        movwf       TMR1H
        movlw       low (-6250)
        movwf       TMR1L
        btg         LATD, 5
        bcf         PIR1, TMR1IF
        bsf         T1CON, TMR1ON
        retfie
END
```

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23. Assume that the crystal oscillator is running at 10 MHz, write a PROGRAM to generate a 100 Hz signal with Duty Cycle 25% using Timer1 with maximum prescaler.

    Hint: Timer1 should be configured as follows:

    - 16-bit mode, internal clock, prescaler 1:8
    - Calculate the value loaded into the TMR1H and TMR1L, note that a 100 Hz signal with duty cycle 25% is 7.5ms at level 0 and 2.5ms at level 1

```
        org 0x00
        goto MAIN
        org 0x08
        goto ISR_TIMER1
        org 00100
        counter res     .1
MAIN
        movlw           0x00
        movwf           counter
        movlw           0x0F
        movwf           ADCON1
        bcf             TRISD, .5
        bcf             LATD, .5

        bsf             RCON, IPEN
        bsf             IPR1, TMR1IP
        bsf             INTCON, GIEH
        bsf             PIE1, TIMR1IE
        movlw           0xB3
        movwf           T1CON
        bsf             PIR1,TMR1IF
        goto $
ISR_TIMER1
        bcf             T1CON,TMR1ON
        movlw           high (-3125)
        movwf           TMR1H
        movlw           low (-3125)
        movwf           TMR1L
        movlw           .1
        cpfslt          counter
        goto            LT_4
        bsf             LATD, 5
        incf            counter
        goto            EXIT
LT_4
        movlw           4
        cpfslt          counter
        goto            CLEAR_COUNTER
        bcf             LATD, 5
        incf            counter
        goto            EXIT
CLEAR_COUNTER
        clrf            counter
```

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```
EXIT
        bcf             PIR1, TMR1IF
        bsf             T1CON, TMR1ON
        retfie
END
```

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24. Write a corresponding ASM code of the following C code that implements a switch case statement. Assuming that there nothing inside sub functions namely Intro(), Voltmeter(), Temperature(); and Clock();

```
enum {St_Intro, St_Voltmeter, St_Temperature, St_Clock,} State_Machine;
unsigned char State = St_Intro;
void FSM(){
    switch (State){
        case St_Intro:        Intro();
        break;
        case St_Voltmeter: Voltmeter();
        break;
        case St_Temperature: Temperature();
        break;
        case St_Clock: Clock();
        break;
    }
}
```

Solution

```
St_Intro            equ    .1
St_Voltmeter        equ    .2
St_Temperature      equ    .3
St_Clock            equ    .4

state   res     .1

FSM
        movwf       state,  w
        xorlw   St_Intro
        btfsz   STATUS, Z
        call    Intro
        xorlw   St_Voltmeter^St_Intro
        btfsz   STATUS, Z
        call    Voltmeter
        xorlw   St_Temperature^St_Voltmeter
        btfsz   STATUS, Z
        call    Tempterature
        xorlw   St_Clock^St_Temperature
        btfsz   STATUS, Z
        call    Clock
        return

Intro
        Return
Voltmeter
        Return
Temperature
        Return
Clock
        Return
END
```

Department **Instructor**