UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	MICROCONTROLLER
COURSE CODE	:	DAE 32203
PROGRAMME	:	3 DAE
EXAMINATION DATE	:	OCTOBER 2012
DURATION	:	2 ½ HOURS
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS ONLY.

THIS QUESTION PAPER CONSISTS OF EIGHT (8) PAGES

Q1 (a) What is the main difference between the microcontroller and microprocessor ?

(3 marks)

(b) Name the three components of a Central Processor Unit (CPU).

(3 marks)

(c) Convert the following hexadecimal number, F4CAD into a signed integer, giving the answer in decimal.

(4 marks)

(d) Draw a flowchart to explain the PIC microcontroller program development process using MPLAB software.

(6 marks)

(e) In a microcontroller there are 12 data buses and 12 address buses and 4 control busses connected between CPU and memory.

(i) What type of bus will determine the data size of the microcontroller.
(ii) Calculate the memory size for this microcontroller, giving the answer in decimal.
(iii) Draw the memory map for the microcontroller giving the answer in hexadecimal.

(9 marks)

Q2 For the given assembly language instructions, with reference to Table Q2, complete the table below. (Copy the 'No.' and 'After' column to your answer booklet)

No.	Before	INSTRUCTIONS	After
1	W = 0D 0E = FF	MOVLW 0DH	W= 0E=
2	W = 0D 0E = 3C	MOVF 0EH, 0	W= 0E=
3	OD = CC OE = 3C	BCF OD, 03	0D = 0E=
4	0C = 64 W= C3	ADDWF 0C, 1	0C= W =
5	0C = 64 W= 27	ADDLW 27H	0C= W =
6	0C = 44 W = 1C	SUBLW 33H	0C= W =
7	0C = 44 W = 44	SUBWF OC, 1	0C= W =
8	0C = 14 W = 34	IORWF 0C, 0	0C= W =

9	0C = 12 W = 64	XORWF 0C, 1	0C=	W =	
10	0D = 7B W = 34	RRF OD, 0 C = '0'	0D =	W=	C =
11	0D = BB W = 34	RLF OD, 1 C = '1'	0D =	W=	C =
12	0C = 13 W = 1C	COMF 0C, 0	0C=	W =	

(25marks)

Q3 For the given assembly language program, single-step the program and fill the table below to show the step-by-step execution of the program below.

(25 marks)

```
PORTA   EQU  10H
PORTB   EQU  20H
COUNT   EQU  30H

        MOVLW   d '6'
        MOVWF   COUNT
        MOVLW   11H
LOOP    ADDLW   15H
        MOVWF   PORTA
        DECFSZ  COUNT, 1
        GOTO    LOOP
        MOVWF   PORTB
```

INSTRUCTION	WREG	30H (COUNT)	10H(PORTA)	20H (PORTB)

(Draw and fill up the the table above in your answer booklet)

Q4 An assembly language program is shown below such that PORTA (RA0) becomes an input and PORTB (RB0) an output port respectively. Next a SWITCH (Switch 5) is connected to RA0 and a LED (Led1) to RB0. The LED flickers (on/off) each time the switch is pressed.

(a) Draw a flow chart to define the assembly language program.

(15 marks)

(b) For the delay subroutine, as shown in the assembly language program, calculate the delay if a crystal of 8 MHz is used and one instruction cycle is equal to four clock cycles. Show your calculations.

(10 marks)

```
;-------------------------------------------------------------------------------
;(HEADER)   /Assembler Directives/  Assembly Language Program /
           LIST        P=16F84
           RADIX       HEX
;-------------------------------------------------------------------------------
; (EQUATES)
PORTA   EQU  05H
PORTB   EQU  06H
COUNT1  EQU  0CH
COUNT2  EQU  0DH
;-------------------------------------------------------------------------------
                ORG         00H
;-------------------------------------------------------------------------------
; (MAIN PROGRAM)
                MOVLW       01H
                TRIS        PORTA
                MOVLW       FEH
                TRIS        PORTB
START           CLRF        PORTA
                CLRF        PORTB
BEGIN           BTFSS       PORTA,0
                GOTO        BEGIN
                BSF         PORTB, 0
                CALL        DELAY
                BCF         PORTB, 0
                CALL        DELAY
                GOTO        START
;-------------------------------------------------------------------
;( DELAY SUBROUTINE PROGRAM)
DELAY           MOVLW       FFH
                MOVWF       COUNT1
LOADC2          MOVLW       FFH
                MOVWF       COUNT2
DECC2           DECFSZ      COUNT2, 1
                GOTO        DECC2
                DECFSZ      COUNT1, 1
                GOTO        LOADC2
                RETURN
;-------------------------------------------------------------------
                END
;-------------------------------------------------------------------
```

Q5 (a) With reference to the data sheet in FigureQ5(a), describe the operation of the Hardware Counter/Timer in the PIC16F84A in Timer Mode.

(5 marks)

(b) Calculate the pre-load value required in TMR0 to obtain a delay of 10ms between the load operation and the T0IF going high, if the clock rate is 4 Mhz and the pre-scale ratio selected is 64:1.

(10 marks)

(c) In a serial communication system using RS232 standard, the charater 'A' is to be sent on the transmit data (TD) line using 7-bit data, 1 start bit, 1 stop bit and ODD parity.
(start bit = 0, stop bit = 1. ASCII code for A = 41H and RS232 specifies that LSB (Least Significant Bit) is transmitted first and uses negative logic.)

(i) Write out the logic values for the 10-bit data stream
(ii) Write out the logic values using the RS232 standard.
(iii) Draw the waveform for the voltage levels in RS232 data transmission.

(10 marks)

Q6 (a) Briefly describe the following characteristics of the analog-to-digital converter (ADC):-

(i) resolution
(ii) conversion time
(iii) V_{ref}
(iv) digital data output

(9 marks)

(b) For an 8-bit ADC, V_{ref} = 2.56 V. Calculate the resolution and the digital data output (D0 – D7) if the analog input is 2.1 V.

(8 marks)

(c) With reference to to Table Q6(c), verify the PIC output for a temperature of 30 degrees Fahrenheit. Find the valuess in the PIC18 A/D registers of ADRESL and ADRESH.

(8 marks)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2012/2013
PROGRAMME : 3 DAE
COURSE : MICROCONTROLLER
COURSE CODE : DAE32203

TABLE Q2

Mnemonic, Operands		Description	Cycles	14-Bit Opcode MSb			LSb	Status Affected	Notes
BYTE-ORIENTED FILE REGISTER OPERATIONS									
ADDWF	f, d	Add W and f	1	00	0111	dfff	ffff	C,DC,Z	1,2
ANDWF	f, d	AND W with f	1	00	0101	dfff	ffff	Z	1,2
CLRF	f	Clear f	1	00	0001	1fff	ffff	Z	2
CLRW	-	Clear W	1	00	0001	0xxx	xxxx	Z	
COMF	f, d	Complement f	1	00	1001	dfff	ffff	Z	1,2
DECF	f, d	Decrement f	1	00	0011	dfff	ffff	Z	1,2
DECFSZ	f, d	Decrement f, Skip if 0	1 (2)	00	1011	dfff	ffff		1,2,3
INCF	f, d	Increment f	1	00	1010	dfff	ffff	Z	1,2
INCFSZ	f, d	Increment f, Skip if 0	1 (2)	00	1111	dfff	ffff		1,2,3
IORWF	f, d	Inclusive OR W with f	1	00	0100	dfff	ffff	Z	1,2
MOVF	f, d	Move f	1	00	1000	dfff	ffff	Z	1,2
MOVWF	f	Move W to f	1	00	0000	1fff	ffff		
NOP	-	No Operation	1	00	0000	0xx0	0000		
RLF	f, d	Rotate Left f through Carry	1	00	1101	dfff	ffff	C	1,2
RRF	f, d	Rotate Right f through Carry	1	00	1100	dfff	ffff	C	1,2
SUBWF	f, d	Subtract W from f	1	00	0010	dfff	ffff	C,DC,Z	1,2
SWAPF	f, d	Swap nibbles in f	1	00	1110	dfff	ffff		1,2
XORWF	f, d	Exclusive OR W with f	1	00	0110	dfff	ffff	Z	1,2
BIT-ORIENTED FILE REGISTER OPERATIONS									
BCF	f, b	Bit Clear f	1	01	00bb	bfff	ffff		1,2
BSF	f, b	Bit Set f	1	01	01bb	bfff	ffff		1,2
BTFSC	f, b	Bit Test f, Skip if Clear	1 (2)	01	10bb	bfff	ffff		3
BTFSS	f, b	Bit Test f, Skip if Set	1 (2)	01	11bb	bfff	ffff		3
LITERAL AND CONTROL OPERATIONS									
ADDLW	k	Add literal and W	1	11	111x	kkkk	kkkk	C,DC,Z	
ANDLW	k	AND literal with W	1	11	1001	kkkk	kkkk	Z	
CALL	k	Call subroutine	2	10	0kkk	kkkk	kkkk		
CLRWDT	-	Clear Watchdog Timer	1	00	0000	0110	0100	$\overline{TO}$,$\overline{PD}$	
GOTO	k	Go to address	2	10	1kkk	kkkk	kkkk		
IORLW	k	Inclusive OR literal with W	1	11	1000	kkkk	kkkk	Z	
MOVLW	k	Move literal to W	1	11	00xx	kkkk	kkkk		
RETFIE	-	Return from interrupt	2	00	0000	0000	1001		
RETLW	k	Return with literal in W	2	11	01xx	kkkk	kkkk		
RETURN	-	Return from Subroutine	2	00	0000	0000	1000		
SLEEP	-	Go into standby mode	1	00	0000	0110	0011	$\overline{TO}$,$\overline{PD}$	
SUBLW	k	Subtract W from literal	1	11	110x	kkkk	kkkk	C,DC,Z	
XORLW	k	Exclusive OR literal with W	1	11	1010	kkkk	kkkk	Z	

Note 1: When an I/O register is modified as a function of itself (e.g., `MOVF PORTB, 1`), the value used will be that value present on the pins themselves. For example, if the data latch is '1' for a pin configured as input and is driven low by an external device, the data will be written back with a '0'.

2: If this instruction is executed on the TMR0 register (and, where applicable, d = 1), the prescaler will be cleared if assigned to the Timer0 Module.

3: If Program Counter (PC) is modified or a conditional test is true, the instruction requires two cycles. The second cycle is executed as a NOP.

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2012/2013 PROGRAMME : 3 DAE
COURSE : MICROCONTROLLER COURSE CODE : DAE32203

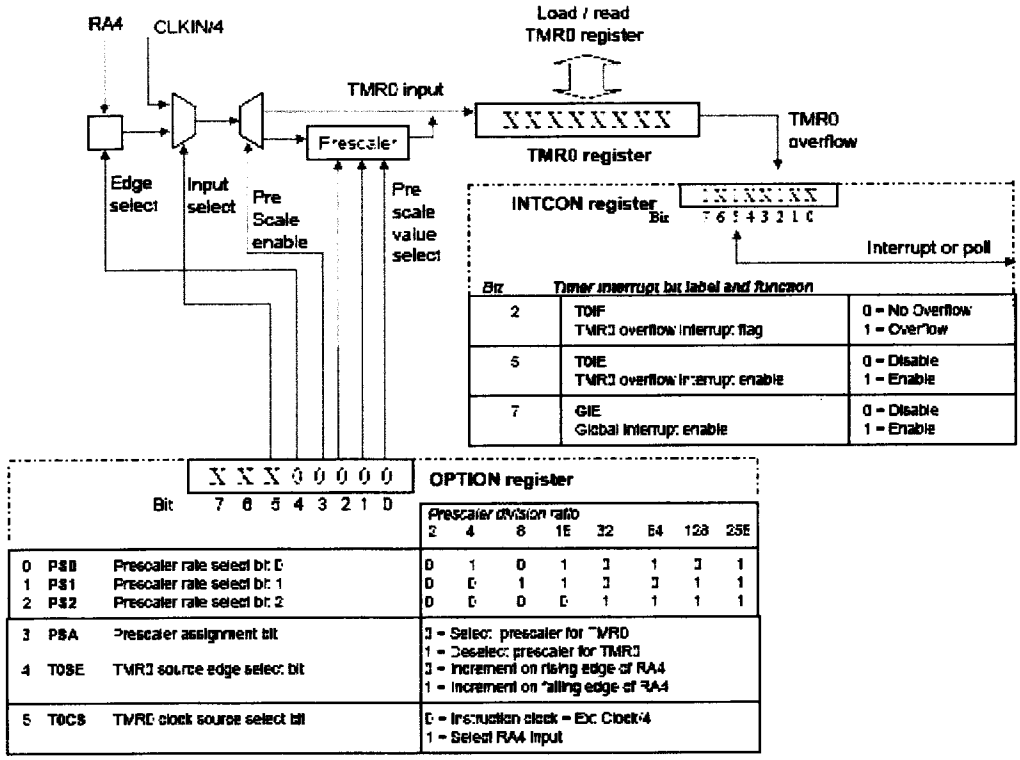

FIGURE Q5(a)

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2012/2013 PROGRAMME : 3 DAE
COURSE : MICROCONTROLLER COURSE CODE : DAE32203

TABLE Q6(c)

Table 13-9: Temperature vs. V_{out} for PIC18 with Vref = 2.56 V (SS = 2.5 mV)

Temp. (F)	V_{in} (mV)	#of steps	Binary V_{out} (b9–b0)	Temp. in Binary
0	0	0	00 00000000	00000000
1	10	4	00 00000100	00000100
2	20	8	00 00001000	00000010
3	30	12	00 00001100	00000011
10	100	20	00 00101000	00001010
20	200	80	00 01010000	00010100
30	300	120	00 01111000	00011110
40	400	160	00 10100000	00101000
50	500	200	00 11001000	00110010
60	600	240	00 11110000	00111100
70	700	300	01 00101100	01001011
80	800	320	01 01000000	01010000
90	900	360	01 01101000	01011010
100	1000	400	01 10010000	01100100