



*St. Name:*  
*St. Number:*

**Second Exam, First Semester 2011/2012**

<b>Course Title:</b> Embedded Systems Design	<b>Date:</b>	21/12/2011
<b>Course No:</b> 0630470	<b>Time Allowed:</b>	60 minutes
<b>Instructor:</b> Prof. Kasim Al-Aubidy	<b>No. of Pages:</b>	3

- Write your name and number on each page of the exam.
- Consider the **PIC 16F84** Microcontroller running from **8 MHz** crystal frequency.

**Question 1:** **[50%]**

*Objectives: Timer/Counter Applications.*

[A]. It is required to use the hardware counter/timer (TMR0) to measure the period of a square wave whose frequency is  $400 \text{ Hz} \pm 25\%$

1. Give the hardware and software initialization for this measurement case?

2. Write the HEX content for registers INTCON, OPTION, and TMR0?

	7	6	5	4	3	2	1	0
OPTION Reg								
INTCON Reg								
TMR0 Reg								

[B]. Delay can be generated by software or by hardware in a microcontroller-based system;

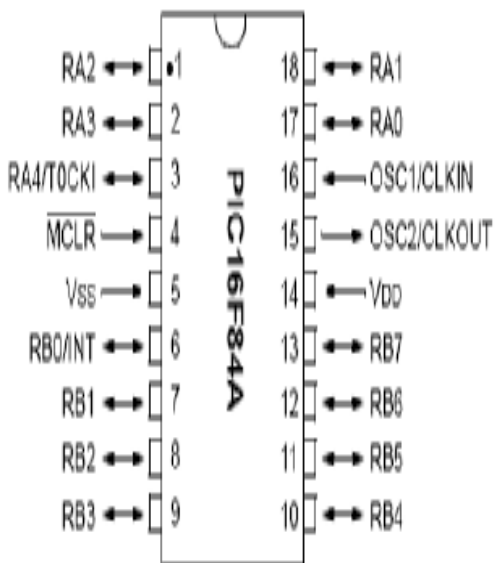
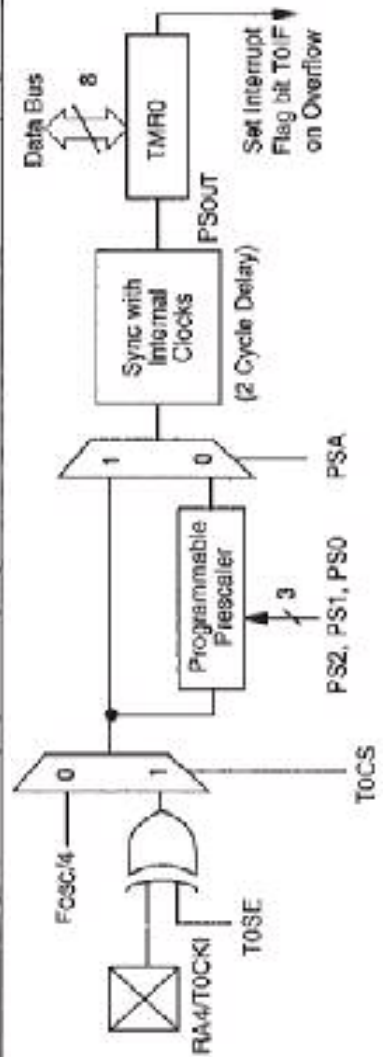
1. Write 10 msec delay subroutine using minimum number of instructions?
2. Show how such a delay can be generated using microcontroller timer/counter?

**Question 3:****[50%]***Objectives: Microcontroller Interfacing*

It is required to design an embedded system based on PIC16F84. It has two input switches (START & RESET), 3\*4 keypad, single LED and a seven-segment display to show the pressed key. (Note:  $I_o = 10 \text{ mA}$ ,  $I_L = 1 \mu\text{A}$ ,  $V_{IH} = 2.4 \text{ V}$  and  $V_D = 1.8 \text{ V}$ )

1. Give the detailed hardware design of the required system?
2. Calculate the values of each parameter in the circuit?
3. Draw a flowchart to demonstrate the keypad operation?

Mnemonic, Operands	Description	Cycles	14-Bit Opcode		Status Affected	Notes
			MSB	LSB		
<b>BYTE-ORIENTED FILE REGISTER OPERATIONS</b>						
ADDWF	f, d	Add W and f	1	00 0111 0000 0000	C,DC,Z	1,2
ANDWF	f, d	AND W with f	1	00 0101 0000 0000	Z	1,2
CLFF	f	Clear f	1	00 0001 1000 0000	Z	2
CLRW	-	Clear W	1	00 0001 0000 0000	Z	
COMF	f, d	Complement f	1	00 1001 0000 0000	Z	1,2
DECF	f, d	Decrement f	1	00 0011 0000 0000	Z	1,2
DECFSZ	f, d	Decrement f, Skip if 0	1 (2)	00 1011 0000 0000	Z	1,2,3
INCF	f, d	Increment f	1	00 1010 0000 0000	Z	1,2
INCFSZ	f, d	Increment f, Skip if 0	1 (2)	00 1111 0000 0000	Z	1,2,3
IORWF	f, d	Inclusive OR W with f	1	00 0100 0000 0000	Z	1,2
MOVF	f, d	Move f	1	00 1000 0000 0000	Z	1,2
MOVWF	f	Move W to f	1	00 0000 1000 0000		
NOP	-	No Operation	1	00 0000 0000 0000		
RLF	f, d	Rotate Left f through Carry	1	00 1101 0000 0000	C	1,2
RRF	f, d	Rotate Right f through Carry	1	00 1100 0000 0000	C	1,2
SUBWF	f, d	Subtract W from f	1	00 0010 0000 0000	C,DC,Z	1,2
SWAPF	f, d	Swap nibbles in f	1	00 1110 0000 0000	Z	1,2
XORWF	f, d	Exclusive OR W with f	1	00 0110 0000 0000	Z	1,2
<b>BIT-ORIENTED FILE REGISTER OPERATIONS</b>						
BCF	f, b	Bit Clear f	1	00 000b 0000 0000		1,2
BSF	f, b	Bit Set f	1	00 010b 0000 0000		1,2
BTFSC	f, b	Bit Test f, Skip if Clear	1 (2)	00 100b 0000 0000		3
BTFSS	f, b	Bit Test f, Skip if Set	1 (2)	00 110b 0000 0000		3
<b>LITERAL AND CONTROL OPERATIONS</b>						
ADDLW	k	Add literal and W	1	11 111k 000k 000k	C,DC,Z	
ANDLW	k	AND literal with W	1	11 1001 000k 000k	Z	
CALL	k	Call subroutine	2	10 010k 000k 000k		
CLRWDT	-	Clear Watchdog Timer	1	00 0000 0110 0100	$\overline{\text{TOPD}}$	
GOTO	k	Go to address	2	10 100k 000k 000k		
IORLW	k	Inclusive OR literal with W	1	11 1000 000k 000k	Z	
MOVLW	k	Move literal to W	1	11 000k 000k 000k		
RETRIE	-	Return from interrupt	2	00 0000 0000 1001		
RETLW	k	Return with literal in W	2	11 010k 000k 000k		
RETURN	-	Return from Subroutine	2	00 0000 0000 1000		
SLEEP	-	Go into standby mode	1	00 0000 0110 0011	$\overline{\text{TOPD}}$	
SUBLW	k	Subtract W from literal	1	11 110k 000k 000k	C,DC,Z	
XORLW	k	Exclusive OR literal with W	1	11 1010 000k 000k	Z	



GIE EEIE TOIE INTE RBIE TOIF INTF RBIF INTCON

IRP RP1 RP0 TO PD Z DC C STATUS

RBPUP INTES TOCS TOSE PSA PS2 PS1 PS0 OPTION

