

Instructions –Answer ALL questions. There are penalties for poor presentation of answers.

**Question1: (15marks)**

- Give the differences between the micro-processors and the micro-controllers. (4 marks)
- Describe briefly the architecture of the PIC16F84A micro-controller. (3 marks)
- Why is it advantageous to partition the memory of micro-controllers into program memory and data memory? (3 marks)
- The data memory portions of the PIC16F84A micro-controller are banked. What do you understand by banking with respect to micro-controller architecture? (3 marks)
- What can you deduce from the fact that the program counter register of the PIC16F84A micro-controller is 13 bit in size? (2 marks)

**Question2: (35marks)**

- Add a comment and a purpose of each line of the following program (13 marks)
- What is the behavior of PORTB and N1 after two decrements of N1? (5 marks)
- Specify the content of TRISB after the instruction "movwf TRISB"? (1 marks)
- Deduce the configuration of each bits of PORTB (2 marks)
- Draw the signal waveform obtained by connecting an oscilloscope at RB0 and at RB1; (6 marks)
- Express and calculate the period and frequency of each of them if the microcontroller is using a crystal of 4 MHz. (8 marks)

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LIST p=16F84A
#include P16F84A.inc
__CONFIG_CP_OFF & _XT_OSC & _PWRTE_OFF & _WDT_OFF
N1 EQU 0x0C
movlw 2
movwf N1
bsf STATUS,RP0
movlw 2
movwf TRISB
bcf STATUS,RP0
clrf PORTB
loop
comf PORTB,
call tempo
goto loop
tempo
decfsz N1,f
goto tempo
movlw 2
movwf N1
return
end

```

2.  
1  
0

**Question3 (20marks)**

In Port-B register, bits RB4, RB5, RB6 and RB7 can be used as the External Interrupt sources. We have mentioned that one of the important uses of this interrupt sources is to wake the processor from the SLEEP mode. This allows developing applications that can run on a small power source (such as batteries) since the program uses almost no power until some action associated with the interrupt source wakes up the PIC.

Design a program to implement an interruption on RB7; LED1 connects to RB2 should be ON when there is no interruption and the alarm system connects to RB3 should be ON in the other case.

*Mid-range PIC Instruction Set*

MNEMONIC	OPERAND	DESCRIPTION	CYCLES	BITS AFFECTED
BYTE-ORIENTED OPERATIONS:				
ADDWF	f,d	Add w and f	1	C,DC,Z
ANDWF	f,d	AND w with f	1	Z
CLRF	f	Clear f	1	Z
CLRWF	-	Clear w	1	Z
COMF	f,d	Complement f	1	Z
DECF	f,d	Decrement f	1	Z



MNEMONIC	OPERAND	DESCRIPTION	CYCLES	BITS AFFECTED
<b>BYTE-ORIENTED OPERATIONS</b>				
DECFSZ	f,d	Decrement, skip if 0	1(2)	-
INCF	f,d	Increment f	1	Z
INCFSZ	f,d	Increment, skip if 0	1(2)	-
IORWF	f,d	Inclusive OR w and f	1	Z
MOVF	f,d	Move f	1	Z
MOVWF	f	Move w to f	1	-
NOP	-	No operation	1	-
RLF	f,d	Rotate left through carry	1	C
RRF	f,d	Rotate right through carry	1	C
SUBWF	f,d	Subtract w from f	1	C,DC,Z
SWAPF	f,d	Swap nibbles in f	1	-
XORWF	f,d	XOR w and f	1	-
<b>BIT-ORIENTED OPERATIONS</b>				
BCF	f,b	Bit clear in f	1	-
BSF	f,b	Bit set in f	1	-
BTFSC	f,b	Bit test, skip if clear	1	-
BTFSS	f,b	Bit test, skip if set	1	-
<b>LITERAL AND CONTROL OPERATIONS</b>				
ADDLW	k	Add literal and w	1	C,DC,Z
ANDLW	k	AND literal and w	1	Z
CALL	k	Call procedure	2	-
CLRWDI	-	Clear watchdog timer	1	TO,PD
GOTO	k	Go to address	2	-
IORLW	k	Inclusive OR literal with w	1	Z
MOVLW	k	Move literal to w	1	-
RETFIE	-	Return from interrupt	2	-
RETLW	k	Return literal in w	2	-
RETURN	-	Return from procedure	2	-
SLEEP	-	Go into SLEEP mode	1	TO,PD
SUBLW	k	Subtract literal and w	1	C,DC,Z
XORLW	k	Exclusive OR literal with w	1	Z

Legend:

f = file register

d = destination:

0 = w register

1 = file register

b = bit position

k = 8-bit constant

#### OPTION REG REGISTER

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
RBP0	INTEDG	TOCS	TOSE	PSA	PS2	PS1	PS0
bit7							bit0

bit 7: RBP0: PORTB Pull-up Enable bit  
1 = PORTB pull-ups are disabled  
0 = PORTB pull-ups are enabled (by individual port latch values)

bit 6: INTEDG: Interrupt Edge Select bit  
1 = Interrupt on rising edge of RB0/INT pin  
0 = Interrupt on falling edge of RB0/INT pin

#### INCON REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-x
GIE	EEIE	TOIE	INTE	RBIE	TOIF	INTF	RBIF
bit7							bit0

bit 7: GIE: Global Interrupt Enable bit  
1 = Enables all un-masked interrupts  
0 = Disables all interrupts

bit 1: INTF: RB0/INT Interrupt Flag bit  
1 = The RB0/INT interrupt occurred  
0 = The RB0/INT interrupt did not occur

bit 4: INTE: RB0/INT Interrupt Enable bit  
1 = Enables the RB0/INT interrupt  
0 = Disables the RB0/INT interrupt

bit 3: RBIE: RB Port Change Interrupt Enable bit  
1 = Enables the RB port change interrupt  
0 = Disables the RB port change interrupt

bit 0: RBIF: RB Port Change Interrupt Flag bit  
1 = When at least one of the RB7:RB4 pins changed state (must be cleared in software)  
0 = None of the RB7:RB4 pins have changed state

Good luck