



TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Medical Engineering

UNIVERSITY EXAMINATION FOR:

Bachelor of Science Medical Engineering

TEE 4431 Microcontroller

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2024

TIME: 2 HOURS

DATE: Pick Date Select Month Pick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition, attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

- a) Differentiate between a laptop computer system and a microcontroller system and state the architectures for their development [4 marks]
- b) Explain the difference between an assembler directive and an assembly instruction [4 marks]
- c) Assuming that the following code has been executed.
 movlw 2f
 addlw 55
 - i) Specify the condition of the following three status flags:
C; DC; Z
 - ii) The binary content of the working register[7 marks]
- d) Write assembly instruction to make the I/O port as follows
 - i) RB4 and RB5 as input
 - ii) PORT A as output
- e) Write an assembly language program to add the literal h'64' to the contents of File h'30' and store the result in File h'40'. State the highest sum from this routine that can be accomplished. [6 marks]

- f) Suppose STATUS – 0x10, determine which bank is selected [2 marks]

Question TWO

- a) Write a PIC MCU assembly-level program to check that the byte content of File h'30' (to be named NUMBER1) and the byte content of File h'31' (to be called NUMBER2) are the same, and if they are, the contents of File h'40' (to be named EQUAL) are to be made h'FF' otherwise the contents of File h'40' are to be h'00'. [12marks]
- b) Without writing code, explain how could you extend your approach to (a) to determine if NUMBER2 is higher than or lower than NUMBER1. [4marks]
- c) State any FOUR factors to configure when choosing a microcontroller for use in an application. [4 marks]

Question THREE

- a) Explain the FOUR elements of PIC16F84 assembly language instruction. [8 marks]
- b) With the aid of a diagram show how you would set Port A pin RA0 as an output and all other Port A and Port B pins as inputs [9 marks]
- c) Determine the contents of the W and STATUS/Z after the following instruction sequence.
MOVLW 10
SUBLW 10 [3 marks]

Question FOUR

- a) A switch is connected to pin RB3. Write a program to check the status of the switch and perform the following:
i) If switch = 0, turn on LED on RA3
ii) If switch = 1, maintain LED off [12 marks]
- b) Almost any embedded system needs to transfer digital data between its CPU and the outside world. Explain the categories in which the parallel inputs/outputs are grouped. [8 marks]

Question FIVE

- a) State the role of the stack in the process used by the PIC to execute subroutines. [3 marks]
- b) The following code has an infinite loop, explain why and provide a remedy.
MOVLW 10
MOVWF PORTB
LOOP: DECFSZ PORTB, W
GOTO LOOP [6 Marks]
- c) With the aid of a flow chart, write a PIC assembly-level code to compare the two numbers NUMBER1 in File h'30' and NUMBER2 in File h'31' and if these are equal add 6 onto DATUM in File h'40', otherwise decrement it. [11 Marks]

REGISTER FILE MAP

File Address		File Address	
00h	Indirect addr. ⁽¹⁾	Indirect addr. ⁽¹⁾	80h
01h	TMR0	OPTION	81h
02h	PCL	PCL	82h
03h	STATUS	STATUS	83h
04h	FSR	FSR	84h
05h	PORTA	TRISA	85h
06h	PORTB	TRISB	86h
07h			87h
08h	EEDATA	EECON1	88h
09h	EEADR	EECON2 ⁽¹⁾	89h
0Ah	PCLATH	PCLATH	8Ah
0Bh	INTCON	INTCON	8Bh
0Ch	68 General Purpose registers (SRAM)	Mapped (accesses) in Bank 0	8Ch
4Fh			CFh
30h			D0h
7Fh			FFh
Bank 0		Bank 1	

■ Unimplemented data memory location; read as '0'.
Note 1: Not a physical register

Instruction	Mnemonic	Operation	Flags	
			Z	C
Arithmetic				
Add W and File	addwf f,d	(d) $\leftarrow$ W + (f)	✓	✓
Add Literal and W	addlw L	W $\leftarrow$ #L + W	✓	✓
Bit Clear File bit n	bcf f,n	f _n $\leftarrow$ 0	•	•
Bit Set File bit n	bsf f,n	f _n $\leftarrow$ 1	•	•
Clear File	clrf f	(f) $\leftarrow$ 00	✓	•
Increment File	incf f,d	(d) $\leftarrow$ (f) + 1	✓	•
Decrement File	decf f,d	(d) $\leftarrow$ (f) - 1	✓	•
Subtract W from File	subwf f,d	(d) $\leftarrow$ (f) - W	✓	✓
Movement				
Move File	movf f,d	(d) $\leftarrow$ (f)	✓	•
Move W to File	movwf f	W $\leftarrow$ (f)	•	•
Move Literal to W	movlw L	W $\leftarrow$ #L	•	•
Logic				
AND W and File	andwf f,d	(d) $\leftarrow$ W · (f)	✓	•
AND Literal and W	andlw L	W $\leftarrow$ #L · W	✓	•
Complement File	comf f	(f) $\leftarrow$ $\overline{(f)}$	✓	•
Inclusive OR W and File	iorwf f,d	(d) $\leftarrow$ W + (f)	✓	•
Inclusive OR Literal and W	iorlw L	W $\leftarrow$ #L + W	✓	•
Skip and Jump				
Bit Test File, Skip if Clear	btfsc f,b	b == 0 ? PC++ : PC	•	•
Bit Test File, Skip if Set	btfss f,b	b == 1 ? PC++ : PC	•	•
Call (jump to) subroutine	call aaa	(TOS) $\leftarrow$ pc, pc $\leftarrow$ aaa	•	•
Go to address	goto aaa	pc $\leftarrow$ aaa	•	•
Return from subroutine	return	pc $\leftarrow$ (TOS)	•	•

✓	: Flag operates normally	•	: Flag not affected
aaa	: Address of instruction	b	: Bit b (0-7) in file
C	: Carry or Borrow, bit 0 in F3	Z	: Zero, bit 2 in F3
d	: Destination; 0 = W, 1 = file	W	: Working register
L	: 8-bit Literal	==	: Equivalent to
++	: Increment	()	: Contents of
A?S1:S2	: IF A is True THEN DO S1 ELSE DO S2	TOS	: Top Of Stack
f	: File	d	: File or W
pc	: Program Counter		

PIC16F83/84 Special-Purpose Register file summary

File address	Name	7	6	5	4	3	2	1	0	Power-on Reset	All other Resets	
Bank 0												
00h	INDF	Uses contents of this to address Data memory (not a physical register)										
01h	TMR0	8-bit real-time clock/counter								XXXX XXXX	UUUU UUUU	
02h	PCL ¹	Lower-order 8 bits of the Program Counter								0000 0000	0000 0000	
03h	STATUS ¹	IRP	RP1	RP0	T0	PD	Z	DC	C	0001 1XXX	000? 7UUU	
04h	FSR	Indirect Data memory address pointer 0								XXXX XXXX	UUUU UUUU	
05h	PORTA	—	—	—	RA4	RA3	RA2	RA1	RA0	—X XXXX	—U UUUU	
06h	PORTB	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	XXXX XXXX	UUUU UUUU	
08h	EEDATA	Data EEPROM Data register								XXXX XXXX	UUUU UUUU	
09h	EEADR	Data EEPROM Address register								XXXX XXXX	UUUU UUUU	
0Ah	PCLATH	—	—	—	Write buffer for top 5 PC bits					—0 0000	—0 0000	
0Bh	INTCON	GIE	EEIE	TOIE	INTE	RBIE	TOIF	INTF	RBIF	0000 000X	0000 000U	
Bank 1												
80h	INDF	Uses contents of this to address Data memory (not a physical register)										
81h	OPTION	RBPV	INTEDG	TOCS	TOSE	PSA	PS2	PS1	PS0	1111 1111	1111 1111	
82h	PCL ¹	Lower-order 8 bits of the Program Counter								0000 0000	0000 0000	
83h	STATUS ¹	IRP	RP1	RP0	T0	PD	Z	DC	C	0001 1XXX	000? 7UUU	
84h	FSR	Indirect Data memory address pointer 0								XXXX XXXX	UUUU UUUU	
85h	TRISA	—	—	—	Port A Direction Register					—1 1111	—1 1111	
86h	TRISB	Port B Data Direction Register								1111 1111	1111 1111	
88h	EECON1	Data EEPROM Data register								XXXX XXXX	UUUU UUUU	
89h	EECON2	EEPROM Control register (not a physical register)										
8Ah	PCLATH	—	—	—	Write buffer for top 5 PC bits					—0 0000	—0 0000	
8Bh	INTCON	GIE	EEIE	TOIE	INTE	RBIE	TOIF	INTF	RBIF	0000 000X	0000 000U	

X Not known

U Unchanged

? Value depends on whether a Watchdog Reset and if in Sleep mode before Reset.

— Unimplemented; reads as 0.

Note 1: Next instruction address if PIC in Sleep mode.