INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**August 2020**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2114: Introduction to Embedded Systems**
Date of Examination	:	18 December 2020 (Friday)
Time	:	8.00am – 11.00am Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

Material permitted :
Non-Programmable Scientific Calculator

Materials provided :
Nil

Examiner(s)	:	**Johnny Wong Kee Hui**
Chief Moderator	:	Dr. Su Hsiao Wei

*This paper consists of **8** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL & ELECTRONICS ENGINEERING PROGRAMME (DEEI)
EEE2114: INTRODUCTION TO EMBEDDED SYSTEMS
FINAL ALTERNATIVE ASSESSMENT: AUGUST 2020 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

Question 1

a) List down and explain three general differences between a microcontroller and a microprocessor.

(6 marks)

b) With today's complex embedded systems product, careful planning and thought before starting are essential to any successful product development. If one takes the central elements from each of the life cycle models, one finds that a good system designers generally proceed using a minimum of five steps process. List down the five general system design process.

(3 marks)

c) What is the difference between Von Neumann architecture and Harvard CPU architecture? Illustrate and provide an example of commercially available microcontroller based on each type of CPU.

(8 marks)

d) Using XC8 C Compiler language, write a programme to show how to make the LED blinks ON and OFF alternatively for 1s. The LED Blinking sequence will only start after receiving an input from tact switch. Include the header file(s), crystal setting and comments in your code. Assuming config.h header file is available to be used for setting the configuration bits.

(8 marks)

Question 2

a) Figure 2(a) shows an internal architecture of PIC16F877A. Name and explain each of the labelling as shown in the block diagram below.

i. Label [A]

(3 marks)

ii. Label [B]

(3 marks)

iii. Label [C]

(3 marks)

iv. Label [D]

(3 marks)

v. Label [E]

(3 marks)

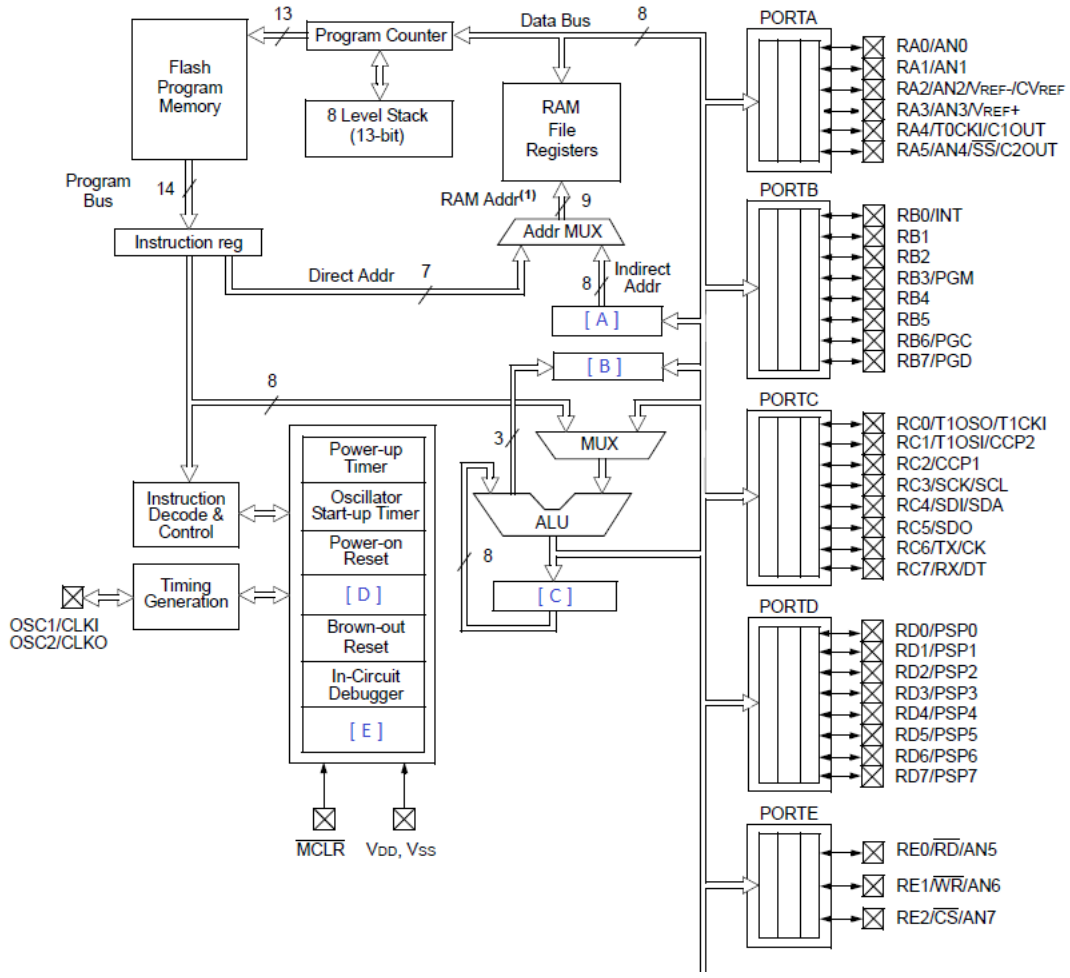

Figure 2(a): PIC16F877A Block Diagram

b) There are three types of memories available in Peripheral Interface Controller (PIC). Explain how each of them are being used by the programmer for the case as shown in Figure 2b(i) and Figure 2b(ii). The description should include the size in bytes or words and the range (hexadecimal) of each memory. The description should be based on Figure 2b(ii).

(6 marks)

Also, compute the amount of free memory left in the Data Memory and Program Memory of Figure 2b(ii). State the possible type of microcontroller used for Figure 2b(i). Appropriate diagram can be used to aid your explanation.

(4 marks)

Flash Program Memory (14-bit words)
Data Memory (bytes)
EEPROM Data Memory (bytes)

Figure 2b(i): PIC Memory

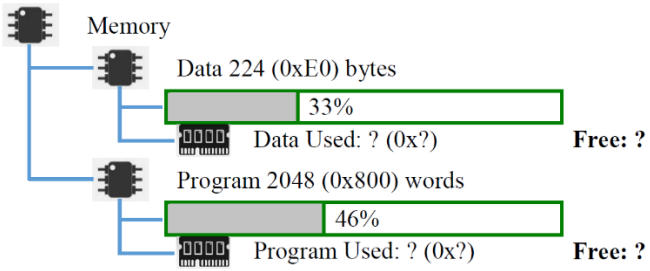

Figure 2b(ii): Memory Usage Status

Question 3

a) A Timer 2 block diagram is shown in Figure 3(a). Timer 2 is used to generate a delay of 30 µs.

i. Determine the value of the PR2 if the TMR2 is 0, the prescaler and postscaler of 1:1 are selected. Assume that the crystal clock is running at the frequency of 8MHz. Ignore the overhead due to instructions in the calculation.

(5 marks)

ii. Explain how the microcontroller knows the delay of 30µs has reached.

(3 marks)

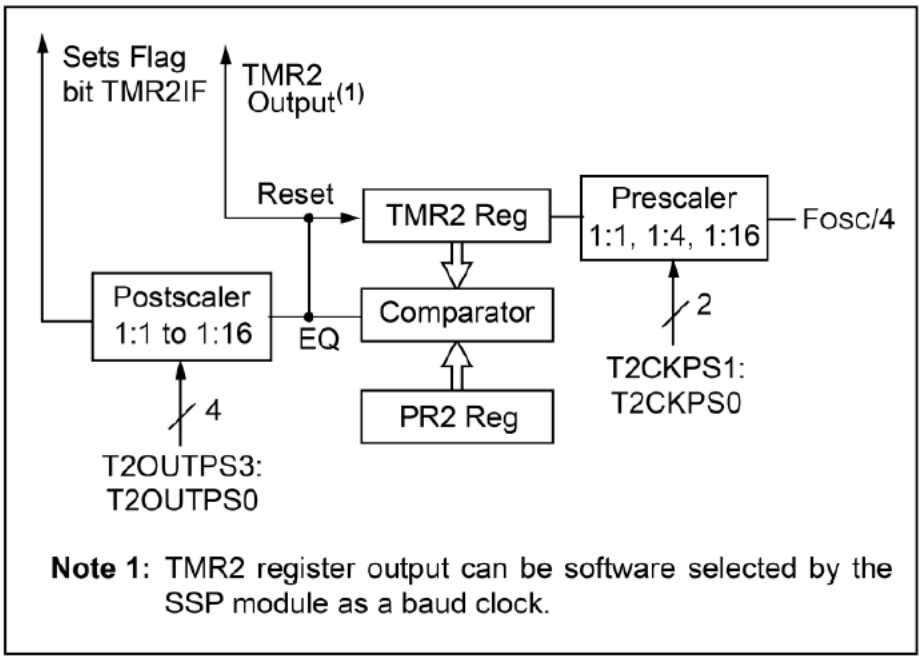

Figure 3(a): Timer 2 block diagram

b) As a design engineer, you are now required to create a delay of 1 second, as a first step to design a digital clock. Using XC8 C Compiler language, write a code that creates a delay of 1 second using TIMER 2. Please show the necessary calculation to obtain different parameters for relevant bits. You are provided with a 4MHz crystal oscillator. Include the header file(s) and comments in your code. Assuming config.h header file is available to be used for setting the configuration bits.

(10 marks)

c) Explain both the term Polling and Interrupt function available in microcontroller programming. Using a table format, list down three differences between both Polling and Interrupt mechanism.

(7 marks)

Question 4

a) Figure 4(a1) shows the serial communication settings between the transmitter and receiver. Both of the PIC16F877A transmitter and receiver's settings are identical. The transmission uses asynchronous serial data communication (UART) with LSB being transmitted first to transmit a passkey to the receiver. Figure 4(a2) shows the incoming data received at the receiver's side.

(11 marks)

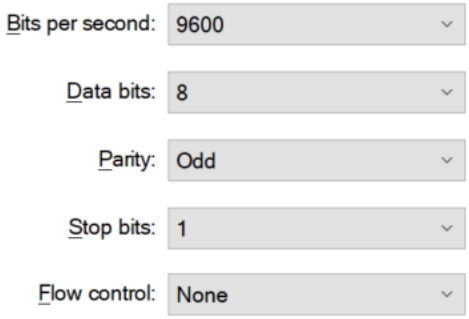

Figure 4(a1): Serial Communication setting

Referring to ASCII codes in Table 4(a), deduce the following serial data received in continuous ASCII characters message. The bit streaming flow direction is from left to right as shown in Figure 4(a2).

Incoming data:

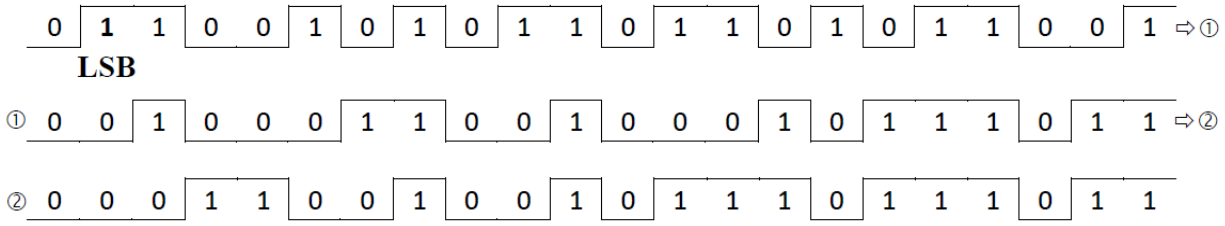

Figure 4(a2): Data received at PIC16F877A receiver's side

Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	[NULL]	32	20	[SPACE]	64	40	@	96	60	`
1	1	[START OF HEADING]	33	21	!	65	41	A	97	61	a
2	2	[START OF TEXT]	34	22	"	66	42	B	98	62	b
3	3	[END OF TEXT]	35	23	#	67	43	C	99	63	c
4	4	[END OF TRANSMISSION]	36	24	$	68	44	D	100	64	d
5	5	[ENQUIRY]	37	25	%	69	45	E	101	65	e
6	6	[ACKNOWLEDGE]	38	26	&	70	46	F	102	66	f
7	7	[BELL]	39	27	'	71	47	G	103	67	g
8	8	[BACKSPACE]	40	28	(	72	48	H	104	68	h
9	9	[HORIZONTAL TAB]	41	29	)	73	49	I	105	69	i
10	A	[LINE FEED]	42	2A	*	74	4A	J	106	6A	j
11	B	[VERTICAL TAB]	43	2B	+	75	4B	K	107	6B	k
12	C	[FORM FEED]	44	2C	,	76	4C	L	108	6C	l
13	D	[CARRIAGE RETURN]	45	2D	-	77	4D	M	109	6D	m
14	E	[SHIFT OUT]	46	2E	.	78	4E	N	110	6E	n
15	F	[SHIFT IN]	47	2F	/	79	4F	O	111	6F	o
16	10	[DATA LINK ESCAPE]	48	30	0	80	50	P	112	70	p
17	11	[DEVICE CONTROL 1]	49	31	1	81	51	Q	113	71	q
18	12	[DEVICE CONTROL 2]	50	32	2	82	52	R	114	72	r
19	13	[DEVICE CONTROL 3]	51	33	3	83	53	S	115	73	s
20	14	[DEVICE CONTROL 4]	52	34	4	84	54	T	116	74	t
21	15	[NEGATIVE ACKNOWLEDGE]	53	35	5	85	55	U	117	75	u
22	16	[SYNCHRONOUS IDLE]	54	36	6	86	56	V	118	76	v
23	17	[ENG OF TRANS. BLOCK]	55	37	7	87	57	W	119	77	w
24	18	[CANCEL]	56	38	8	88	58	X	120	78	x
25	19	[END OF MEDIUM]	57	39	9	89	59	Y	121	79	y
26	1A	[SUBSTITUTE]	58	3A	:	90	5A	Z	122	7A	z
27	1B	[ESCAPE]	59	3B	;	91	5B	[	123	7B	{
28	1C	[FILE SEPARATOR]	60	3C	<	92	5C	\	124	7C	|
29	1D	[GROUP SEPARATOR]	61	3D	=	93	5D	]	125	7D	}
30	1E	[RECORD SEPARATOR]	62	3E	>	94	5E	^	126	7E	~
31	1F	[UNIT SEPARATOR]	63	3F	?	95	5F	_	127	7F	[DEL]

Table 4(a): ASCII Codes

b) Provide two comparisons between SPI mode and I2C mode as shown in table 4(b). Copy table 4(b) into your answer sheet.

(4 marks)

Description	**SPI**	**I2C**
Data Rate		
Number of Masters		

Table 4(b): table of comparison

c) The TXTSA Register and RCSTA Register of a PIC16F877A microcontroller is set as shown in Table 4(c-1) and Table 4(c-2) respectively. Table 4(c-3) indicates the setting requires for configuring the 1200 baud rate 4 MHz oscillator at low speed operating in asynchronous mode using 8-bit data. Table 4(c-4) shows the baud rate formula. Assume that there is no error and awaiting for the data being to be transmitted.

Table 4(c-1) TXTSA register.

TXTSA	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Register	0	0	1	0	0	0	0	0

Table 4(c-2) RCSTA register.

RCSTA	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Register	1	0	0	0	0	0	0	0

Table 4(c-3) SPBRG register.

SPBRG	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
Register	?	?	?	?	?	?	?	?

Table 4(c-4) Baud rate formula.

SYNC	**BRGH = 0 (Low Speed)**	**BRGH = 1 (High Speed)**
0	(Asynchronous) Baud Rate = $F_{osc}/(64(X + 1))$	Baud Rate = $F_{osc}/(16(X + 1))$
1	(Synchronous) Baud Rate = $F_{osc}/(4(X + 1))$	N/A

Legend: X = value in SPBRG (0 to 255)

i) Describe in detail the setting used for TXSTA register.

(3 marks)

ii) Describe in detail the setting used for RCSTA register.

(3 marks)

iii) Determine the setting used for SPBRG register. Show the calculation working clearly.

(4 marks)

~THE END~