INTI International College Penang

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2020**
Programme	:	Diploma in Electrical & Electronic Engineering (DEEI)
Course	:	**EEE2114: Introduction to Embedded System**
Date of Examination	:	7 August 2020 (Friday)
Time	:	2.00pm – 5.00pm Reading Time : Nil
Duration	:	3 Hours

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** the questions. All questions carry equal marks.

Material permitted :

Nil

Materials provided :

Nil

Examiner(s)	:	**Mr Steven Khoo Boo Tap**
Chief Moderator	:	Dr. Su Hsiao Wei

*This paper consists of **9** printed pages, including the cover page*

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2114: INTRODUCTION TO EMBEDDED SYSTEMS
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry equal marks.

Question 1

(a) "An embedded system can be a very simple piece of electronic circuitry that performs a specific function within a larger system". Explain how a computer scanner can be an example of embedded systems applications using the diagram shown in Figure 1(a).

(5 marks)

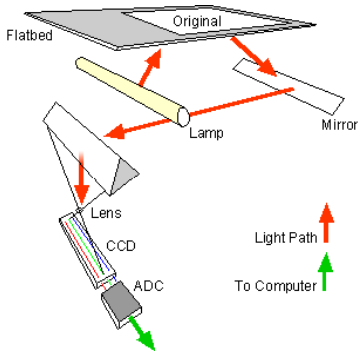

Figure 1(a) Internal structure of Computer Scanner.

(b) Illustrate with example the following types of embedded systems as shown in Figure 1(b).

(i) Real Time embedded systems.

(5 marks)

(ii) Networked embedded systems.

(5 marks)

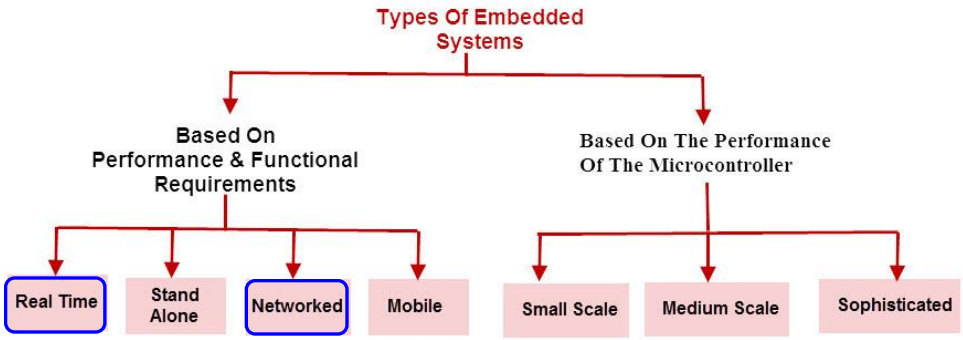

Figure 1(b) Types of Embedded System.

(c) A single microcontroller can serve several devices. There are TWO (2) methods, which can be used by microcontroller to serve the devices: Polling and Interrupt. Present the advantage and disadvantage of each method as shown in Table 1(c). Copy Table 1(c) into your answer sheet.

Table 1(c) Comparison between Polling and Interrupt.

	Advantage	Disadvantage
Polling		
Interrupt		

(5 marks)

(d) Show how to make the LED blinks for 0.5s using C language programming. 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.

(5 marks)

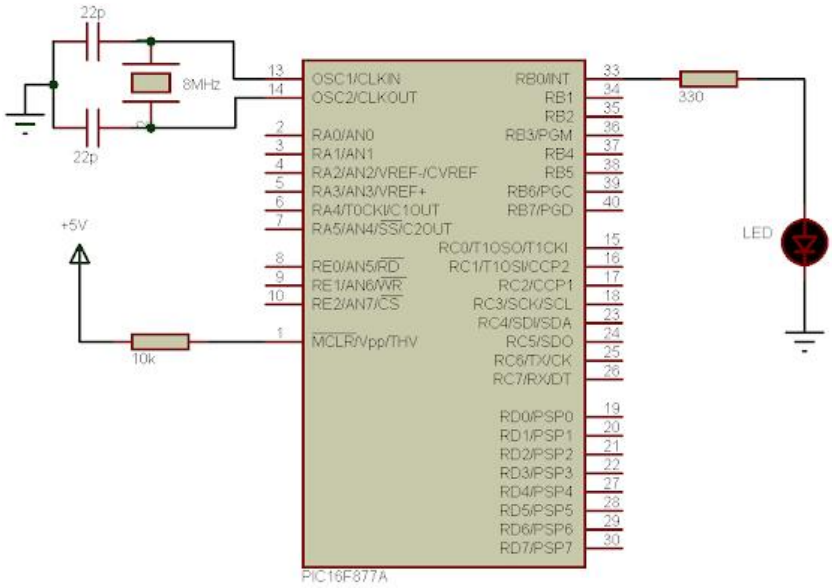

Figure 1(d) PIC16F877A microcontroller interface.

Question 2

(a) Name and explain in detail the function of the following labels shown in Figure 2(a).

(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)

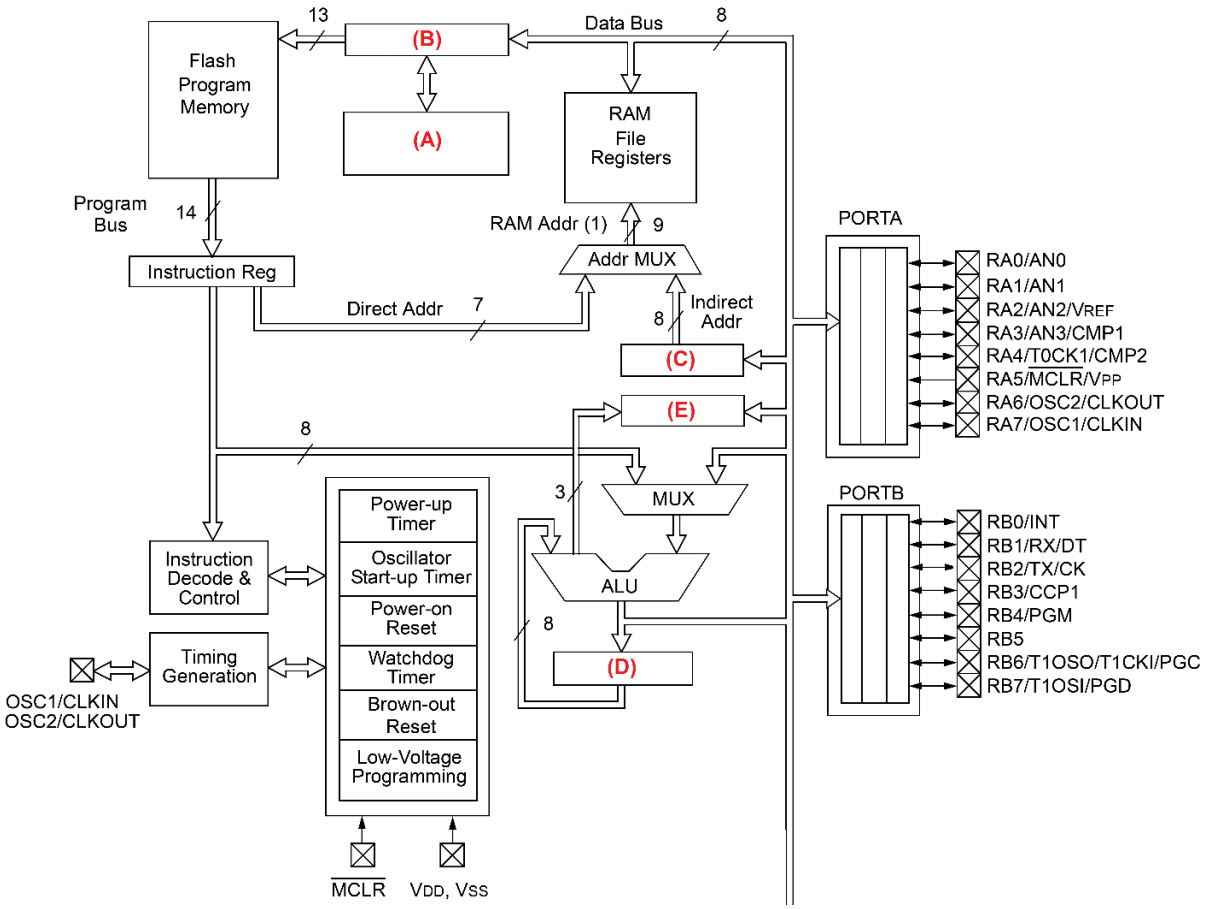

Figure 2(a) Internal architecture.

(b) Present in description THREE (3) types of memories available in the Peripheral Interface Controller (PIC) microcontroller and how each of them are being used by the programmer as shown in Figure 2(b-1) and Figure 2(b-2). The description should include the size in bytes or words and the range (Hexadecimal) of each memory. The description should be based on Figure 2(b-2).

(6 marks)

Also, compute the amount of memory usage left in Data memory and Program memory of Figure 2(b-2). State the possible type of microcontroller used for Figure 2(b-1). 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 2(b-1) Memories

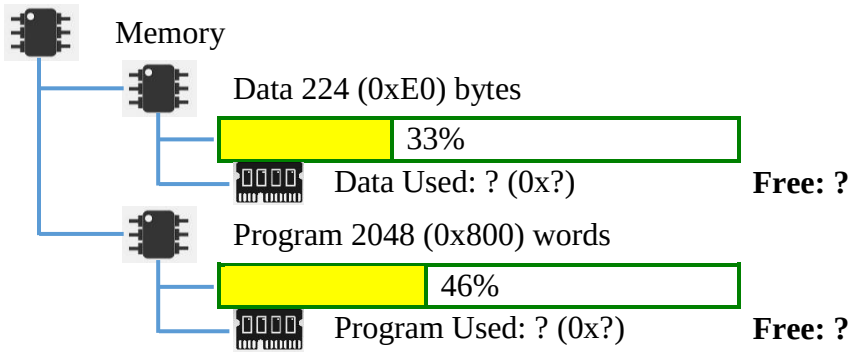

Figure 2(b-2) Memory Usage

Question 3

(a) A Timer 2 block diagram as shown in Figure 3(a) is used to generate a delay of 45μs.

(i) Compute 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 16MHz. Ignore the overhead due to instructions in the calculation.

(5 marks)

(ii) Present how the microcontroller knows the delay of 45μs has reached.

(3 marks)

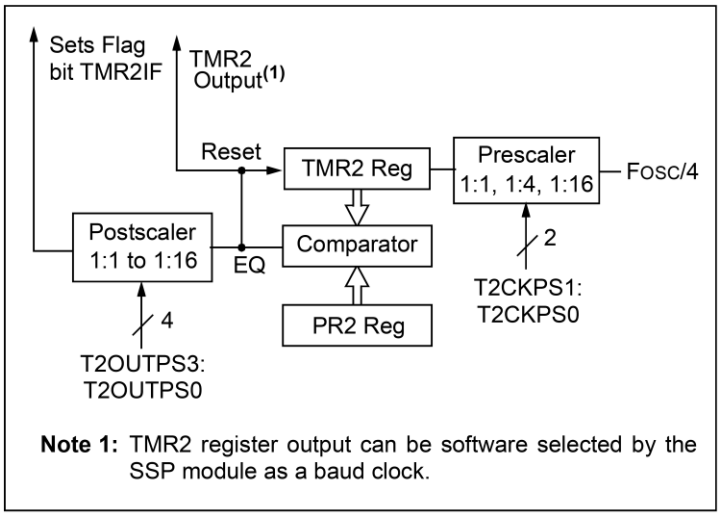

Figure 3(a) TMR2 Register

(b) The INTCON Register of a PIC16F628A microcontroller is set as shown in Table 3(b-1).

Table 3(b-1) Initial INTCON register.

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

(i) Discover which interrupts are enabled.

(ii) An interrupt occurs and the INTCON register is found to have changed to the setting shown in Table 3(b-2). Discover which interrupt source has called.

Table 3(b-2) After interrupt occurred.

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

(6 marks)

(c) A project using PIC16F877A microcontroller to toggle the LEDs connected to Port B. Port B will be connected with eight LEDs via 330Ω limiting resistors. The whole Port B is going to be toggled after 40ms delay. An external 20 MHz crystal and two 30pF capacitors are used as input clock source to PIC16F877A microcontroller. Timer 1 of PIC16F877A is used for generating this specific delay with 16-bit mode. A reset button is connected to the MCLR pin via a 10kΩ resistor.

(i) Construct the circuit diagram for this project.

(4 marks)

(ii) Show how the 40ms delay can be achieved using calculation. Show clearly the formula used. Assuming the prescaler used is 1:4. Show the required values for TMR1H and TMR1L registers using the C language shown in Table 3(c). Also, include the comment for each line of the coding.

(7 marks)

Table 3(c) TMR1H and TMR1L setting.

C Code	**Comments**
`TMR1H= ?`	`//`
`TMR1L= ?`	`//`

Question 4

(a) Figure 4(a-1) 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(a-2) shows the incoming data received at the receiver's side.

(11 marks)

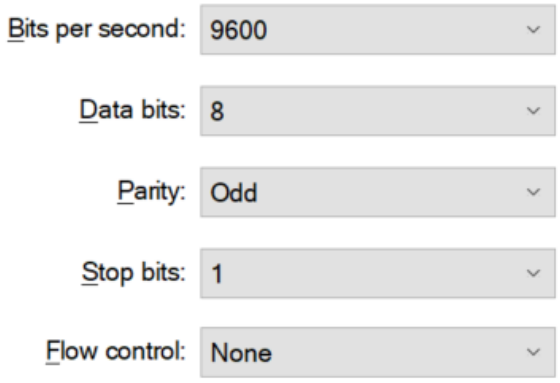

Figure 4(a-1) Serial communication setting.

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(a-2).

Incoming data:

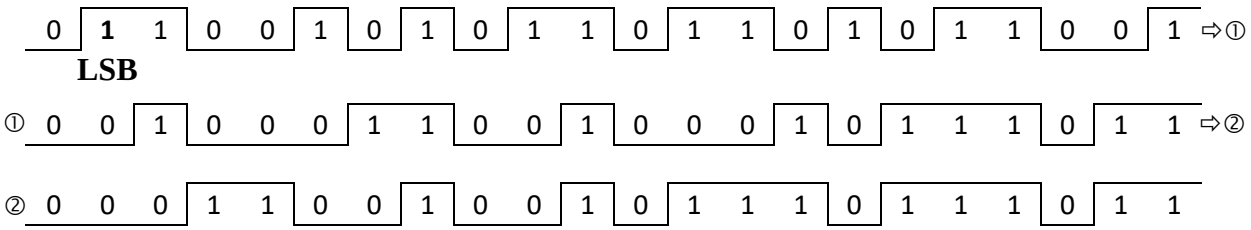

Figure 4(a-2) Data received at PIC16F877A receiver's side.

Table 4(a) ASCII Codes in Hexadecimal.

00: null	10: ►	20: spa	30: 0	40: @	50: P	60: `	70: p
01: ☺	11: ◄	21: !	31: 1	41: A	51: Q	61: a	71: q
02: ☻	12: ↕	22: "	32: 2	42: B	52: R	62: b	72: r
03: ♥	13: ‼	23: #	33: 3	43: C	53: S	63: c	73: s
04: ♦	14: ¶	24: $	34: 4	44: D	54: T	64: d	74: t
05: ♣	15: §	25: %	35: 5	45: E	55: U	65: e	75: u
06: ♠	16: ▬	26: &	36: 6	46: F	56: V	66: f	76: v
07: beep	17: ↨	27: '	37: 7	47: G	57: W	67: g	77: w

08: back	18: ↑	28: (	38: 8	48: H	58: X	68: h	78: x
09: tab	19: ↓	29:)	39: 9	49: I	59: Y	69: i	79: y
0A: newl	1A: →	2A: *	3A: :	4A: J	5A: Z	6A: j	7A: z
0B: ♂	1B: ←	2B: +	3B: ;	4B: K	5B: [	6B: k	7B: {
0C: ♀	1C: ∟	2C: ,	3C: <	4C: L	5C: \	6C: l	7C: ¦
0D: cret	1D: ↔	2D: -	3D: =	4D: M	5D:]	6D: m	7D: }
0E: ♫	1E: ▲	2E: .	3E: >	4E: N	5E: ^	6E: n	7E: ~
0F: ☼	1F: ▼	2F: /	3F: ?	4F: O	5F: _	6F: o	7F: ⌂

(b) Provide TWO (2) comparisons between SPI mode and I^{2}C mode as shown as Table 4(b). Copy Table 4(b) into your answer sheet.

(4 marks)

Table 4(b) Comparison between SPI and I^{2}C.

Description	**SPI (Serial Peripheral Interface)**	**I^{2}C (Inter-Integrated Circuit)**
Data Rate		
Number of Masters		

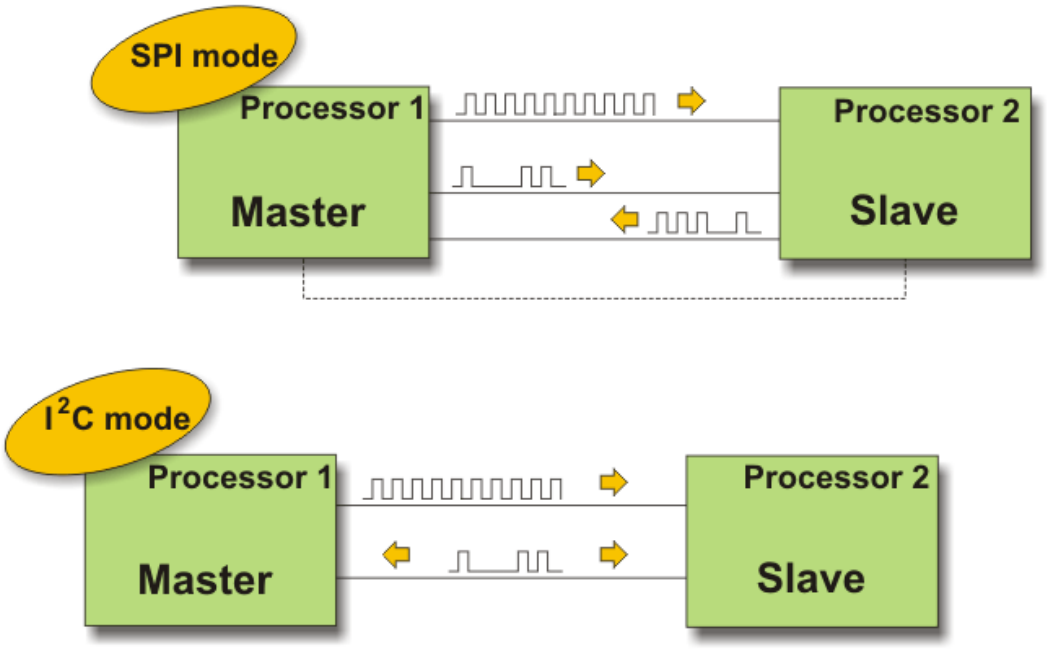

Figure 4(b) Serial communication.

(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. Assume that there is no error and awaiting for the data being to be transmitted.

Table 4(c-1) TXTSA register.

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

Table 4(c-2) RCSTA register.

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

Table 4(c-3) SPBRG register.

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

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 –

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