FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2022**
Programme	:	Diploma In Electrical And Electronics Engineering (DEEI)
Course	:	**EEE2114: Introduction to Embedded Systems**
Date of Examination	:	04 August 2022(Thursday)
Time	:	08.00am-11.00am Reading Time : Nil
Duration	:	03 hours

Special Instructions :

This paper consists of **Four (4)** questions. Answer **ALL** questions in the answer booklet provided.

Material permitted :
Non-Programmable Scientific Calculator

Materials provided :
Nil

Examiner(s)	:	Ing Hui Hii
Chief Moderator	:	Dr. Hsiao Wei Su

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: APRIL 2022 SESSION

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

Question 1

(a) Embedded systems are widely used in industry as well as home nowadays.

(i) Briefly explain FOUR (4) types of embedded systems. (4 marks)

(ii) Referring to (a)(i), state the type of embedded system in a self-driving car. (1 mark)

(b) (i) Briefly describe THREE (3) differences between microcontroller and microprocessor. (3 marks)

(ii) Draw the block diagram for both the microcontroller and microprocessor. (2 marks)

(c) Motorola MC68HC11 and Microchip PIC16F877A microcontroller are having different CPU architecture.

(i) Name the architecture of MC68HC11 and PIC16F877A (2 marks)

(ii) State FIVE (5) differences between the architectures stated in c) (i) (5 marks)

(d) Classify Intel 8051 microcontroller whether it is based on Harvard architecture or Von Neumann architecture with the aid of appropriate diagram. (4 marks)

(e) State FOUR (4) factors to consider when selecting a microcontroller in the market for the development of an embedded system project. (4 marks)

Question 2

(a) Briefly describe the main difference between firmware and software. (2 marks)

(b) Briefly describe THREE (3) important factors to consider in embedded system design of a smart watch. (3 marks)

(c) An embedded system engineer wants to generate a delay of **50 ms** using Timer 2 in PIC16F877A as shown in block diagram in Figure 2(c)i. Timer 2 Control Register is shown in Figure 2(c)ii. Assume that the crystal oscillator frequency is **4 MHz** and the Prescaler is set to **1:16**:

(i) Compute a suitable value of **PR2** and **Postscaler** value. (5 marks)

(ii) Compute the final **actual delay timing** created by the setup in c)(i). (2 marks)

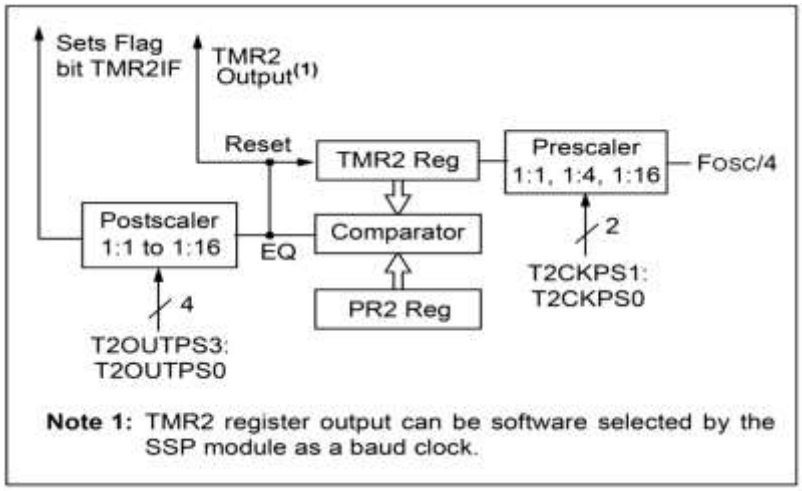

Figure 2(c)i

REGISTER 7-1: T2CON: TIMER2 CONTROL REGISTER (ADDRESS 12h)

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	TOUTPS3	TOUTPS2	TOUTPS1	TOUTPS0	TMR2ON	T2CKPS1	T2CKPS0
bit 7							bit 0

bit 7 **Unimplemented:** Read as '0'

bit 6-3 **TOUTPS3:TOUTPS0**: Timer2 Output Postscale Select bits
0000 = 1:1 postscale
0001 = 1:2 postscale
0010 = 1:3 postscale
•
•
•
1111 = 1:16 postscale

bit 2 **TMR2ON**: Timer2 On bit
1 = Timer2 is on
0 = Timer2 is off

bit 1-0 **T2CKPS1:T2CKPS0**: Timer2 Clock Prescale Select bits
00 = Prescaler is 1
01 = Prescaler is 4
1x = Prescaler is 16

Figure 2(c)ii

(d) Do the following:

(i) Construct a schematic of circuit for interfacing PIC16F877A's GPIO of **RD0** to a **high-power** LED. (3 marks)

(ii) Write a C-language code to toggle an LED (On and Off as shown by Figure 3(d) connected to the PIC16F877A's GPIO of **RD0** using timer setup of **c)** by including necessary initializations. (10 marks)

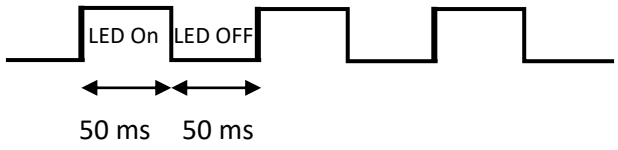

Figure 2(d)

Question 3

(a) Briefly explain THREE (3) types of memory in PIC16F877A microcontroller. (6 marks)

(b) Briefly explain why data memory of PIC16F family are divided into four banks and how bank selection is done before accessing the registers. (4 marks)

(c) The INTCON Register of a PIC16F628A microcontroller is as shown in Table 3(c) and interrupt logic is shown in Figure 3(c). A remote control is designed to sleep most of the time and wake up on PORTB interrupt to check the device status.

INTCON Register	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
	GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	RBIF

Table 3(c) INTCON Register

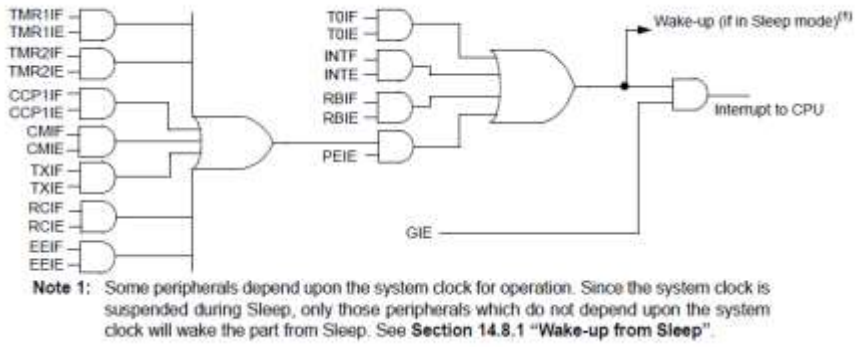

Figure 3(c)

(i) Show which are the register bits in INTCON to enable PORTB interrupt and to check the interrupt generated by PORTB interrupt. (3 marks)

(ii) Show how many pins on the remote control that is connected to PORTB that can generate interrupt on key **input state change**. (2 marks)

(iii) Sketch the schematic of interfacing the remote control's keys (tactile switches) to PIC16F628A based on answer in c)(ii). (2 marks)

(d) If an additional remote-control key (apart from the keys in Question 3(iii)) is needed to generate an interrupt on rising edge signal to wake up PIC16F628A microcontroller from sleep:

(i) Show the appropriate registers to enable the interrupt on rising edge of signal and to check the interrupt event occurrence. (3 marks)

(ii) Sketch the schematic of interfacing this key using tactile switch to PIC16F628A microcontroller to generate **rising edge** signal upon button press. (2 marks)

(e) Briefly describe why polling program to check the remote-control keys is not suitable for the application in 3(c) and why interrupts in (c) and (d) will work perfectly for this case. (3 marks)

Question 4

(f) Compare between serial and parallel communication in term of

(i) Speed of transmission (2 marks)

(ii) Distance of transmission (2 marks)

(iii) Noises (2 marks)

(iv) Example application/usage (2 marks)

b) PIC16F877A is used to communicate with Dynamixel's AX-12 digital servo, and the communication speed is set to **38400 bps**. The TXTSA Register and RCSTA Register of PIC16F877A microcontroller is as shown in Table 4(b)i and Table 4(b)ii respectively. The baud rate formula is shown in Table 4(b)iii. The PIC16F877A is running its clock from an external **8 MHz** crystal oscillator and the communication protocol used is 8N1.

R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R-1	R/W-0
CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D
bit 7							bit 0

Table 4(b)i TXTSA Register

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R-0	R-0	R-x
SPEN	RX9	SREN	CREN	ADDEN	FERR	OERR	RX9D
bit 7							bit 0

Table 4(b)ii RCSTA Register

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)

Table 4(b)iii Baud rate formula.

(i) Based on Table 4(b)iii, choose the suitable **BRGH** mode and **SPBRG** register value for the communication speed mentioned which give the minimum baud rate error. (4 marks)

(ii) Compute actual baud rate and hence the baud rate error percentage of the setting in b)(i). (2 marks)

(iii) Based on Table 4(a) and Table 4(b), show the suitable TXTSA and RCSTA values for the digital serial communication. (4 marks)

c) SPI and I^2C are very popular serial communication protocols used in embedded system.

(i) Briefly describe THREE (3) differences between SPI and I^2C communication. (3 marks)

(ii) You have two components in hand i.e. a SD memory card and a digital temperature sensor. Justify which component is using SPI interface and which is using I^2C interface based on the reasonable fact. (4 marks)

~THE END~