



# UTHM

Universiti Tun Hussein Onn Malaysia

## UNIVERSITI TUN HUSSEIN ONN MALAYSIA

### FINAL EXAMINATION SEMESTER II SESSION 2022/2023

COURSE NAME : MICROCONTROLLER  
APPLICATION

COURSE CODE : BND 35503

PROGRAMME CODE : BND

EXAMINATION DATE : JULY/ AUGUST 2023

DURATION : 3 HOURS

#### INSTRUCTIONS

1. ANSWER ALL QUESTIONS
2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.  
(Note : Please select)
3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF NINE (9) PAGES

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- Q1** A passive infrared (PIR) sensor as in **Figure Q1** is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They're most frequently utilized in PIR-based motion detectors. As a student who has studied the subject of Microcontroller, you are required to develop a system that can detect human presence in an area using PIC18F4550 as the system controller with some other electronic equipment such as a LED and an electronic buzzer. Using your creativity, answer the following questions:
- (a) Explain how the project works and give **TWO (2)** examples of other applications on the market that use the same system. (5 marks)
  - (b) Produce the system Flow Chart. (5 marks)
  - (c) By using handwriting, sketch a complete schematic diagram. Make sure the name of each pin terminal to be used on the equipment connection is written. (5 marks)
  - (d) Produce a suitable program using the C Programming Language. Make sure you use the MPLABX method. (10 marks)

**Q2** Answer the following questions:

- (a) Using your creativity produce a simple program and explain the difference between:
  - (i) TRIS and PORT (2 marks)
  - (ii) BTFSS and BTFSC (4 marks)
- (b) Complete the following instructions in **Figure Q2(b)** and get the final value for Working Register and TOTAL Register in hexadecimal form (3 marks)
- (c) Based on the diagram in **Figure Q2(c)**, clearly explain all the parts in the diagram (6 marks)
- (d) **Figure Q2(d)** shows a simple circuit diagram using PIC18F4550 with two digital inputs (push button) at PORTB via RB1 and RB2 pins. There are eight LED (LED1 to LED8) connected to PORTD via RD0 to RD7 pins respectively. The PIC is clocked at 8MHz. To toggle all the bits of PORTD continuously with 3ms delay, using Timer0, 16-bit mode and no use Prescaler, you are required to get some answers to the following questions.
  - (i) Calculate the instruction cycle time (TCY) (2 marks)

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- (ii) The total of tick (2 marks)
- (iii) The Value for TMR0 (TMR0H: TMR0L) (2 marks)
- (e) Give the difference between interrupt and polling. (4 marks)

**Q3** ADC stands for analog to digital converter and it is an electronic device used for converting an analog signal into a digital signal. Interrupts, on the other hand are the events that temporarily suspend the main program, pass control to external sources and execute their tasks. Based on this, answer the questions below:

- (a) Provide and describe the steps required for Analog to digital conversion using the PIC18F4550 Microcontroller. (5 marks)
- (b) Suggest an example of a real-world process involving the use of an ADC and describe how this process is clearly implemented. (4 marks)
- (c) Produce a program suitable for a variable resistor controlling 10 LEDs. The channel required is AN0, justification on Right Justify, and the program acquisition time is 20 TAD, with the A/D clock source on FOSC/16. (10 marks)
- (d) An electrical appliance has a maximum temperature value of 100 degrees Celsius and a reference voltage  $V_{ref} = 5V$ . If the temperature is 43 degrees Celsius and 72 degrees Celsius.
- (i) Calculate the voltage. (3 marks)
- (ii) Calculate the values by using the Left Justify setting. (A/D registers ADRESH and ADRESL in binary). (3 marks)

**Q4** Questions in this section require answers in the form of sketches and explanations.

- (a) Explain the meaning of PWM and its function. (2 marks)
- (b) If the reference voltage is 5 Volts, state the amount of Duty Cycle resulting for 4.2 Volts and sketch the shape of the signal resulting from the Duty Cycle. (3 marks)
- (c) Sketch and explain the diagram that shows the difference between Serial and Parallel Communication Protocols. (8 marks)

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- (d) Communication protocol allows two or more entities to talk to each other in a communication system. With the help of diagram(s), compare how I2C and SPI protocols manage the data exchange between one master device and 3 slave devices.

(12 marks)

- END OF QUESTIONS -

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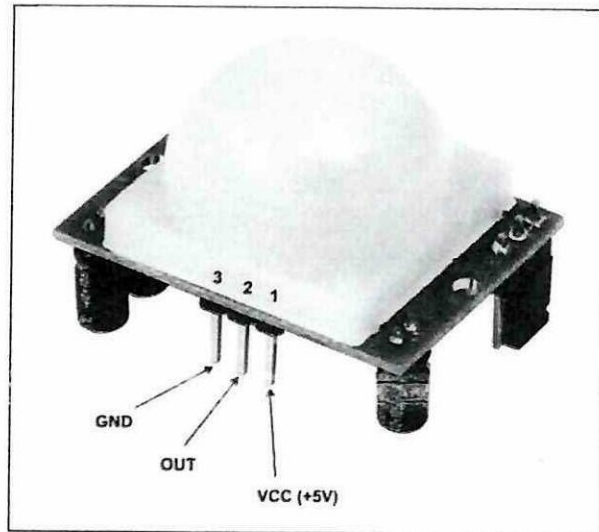


Figure Q1

```
TOTAL EQU 23H
ORG 0H
MOVLW D'37'
ADDLW B'00110100'
ADDLW 0x11
ADDLW 12H
ADDLW D'28'
ADDLW 0x06
MOVWF TOTAL

HERE GOTO HERE
END
```

Figure Q2(b)

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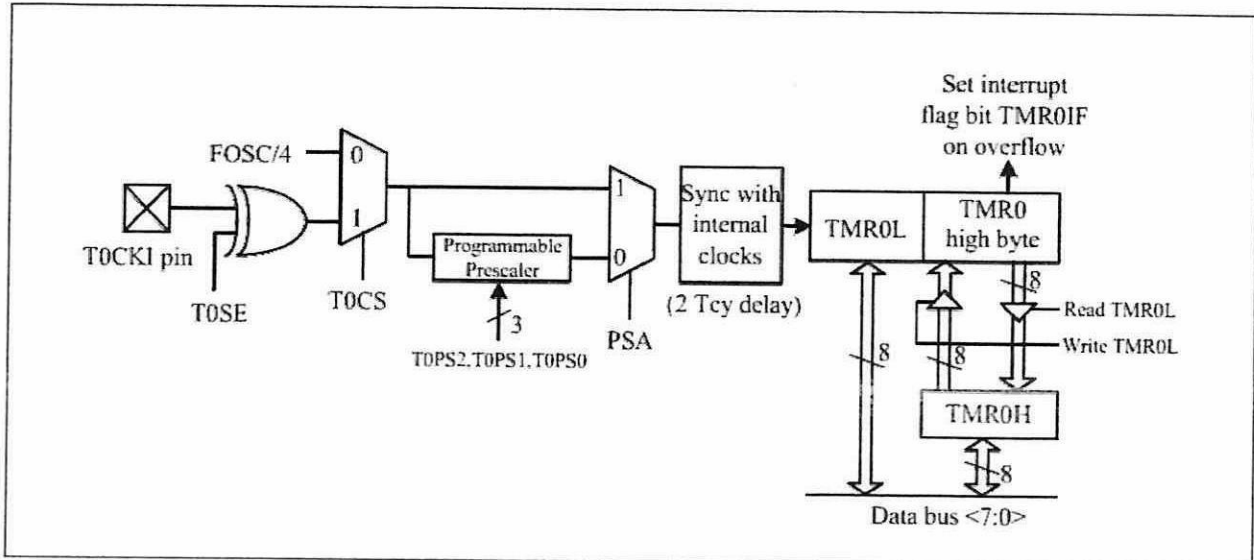


Figure Q2(c)

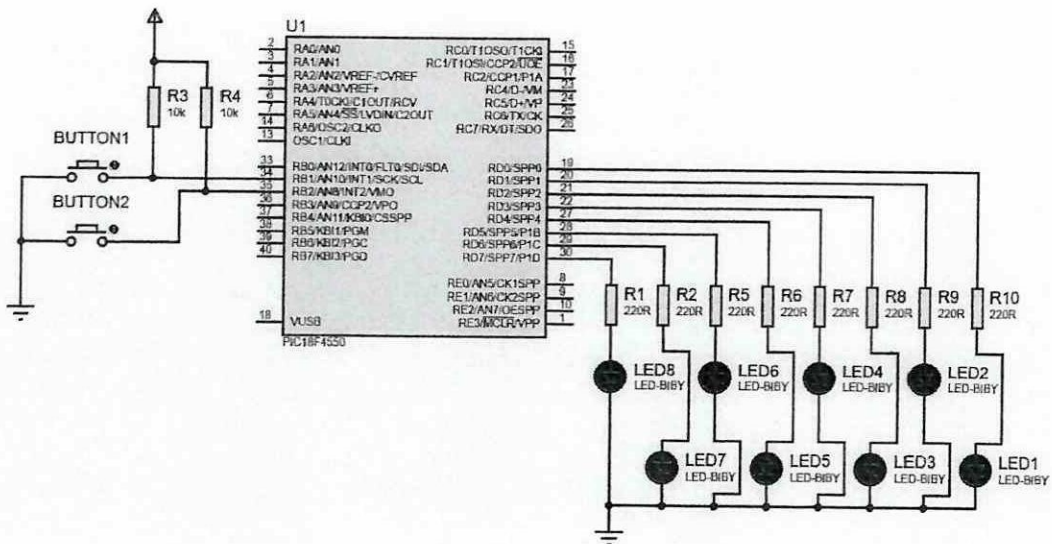


Figure Q2(d)

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**PIC18F2455/2550/4455/4550**

**21.0 10-BIT ANALOG-TO-DIGITAL CONVERTER (A/D) MODULE**

The Analog-to-Digital (A/D) converter module has 10 inputs for the 28-pin devices and 13 for the 40/44-pin devices. This module allows conversion of an analog input signal to a corresponding 10-bit digital number.

The module has five registers:

- A/D Result High Register (ADRESH)
- A/D Result Low Register (ADRESL)
- A/D Control Register 0 (ADCON0)
- A/D Control Register 1 (ADCON1)
- A/D Control Register 2 (ADCON2)

The ADCON0 register, shown in Register 21-1, controls the operation of the A/D module. The ADCON1 register, shown in Register 21-2, configures the functions of the port pins. The ADCON2 register, shown in Register 21-3, configures the A/D clock source, programmed acquisition time and justification.

REGISTER 21-1: ADCON0: A/D CONTROL REGISTER 0

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	CHS3	CHS2	CHS1	CHS0	GO/DONE	ADON
bit 7							bit 0

Legend:

R = Readable bit                      W = Writable bit                      U = Unimplemented bit, read as '0'  
 -n = Value at POR                      '1' = Bit is set                      '0' = Bit is cleared                      x = Bit is unknown

- bit 7-6                      Unimplemented: Read as '0'
- bit 5-2                      CHS3:CHS0: Analog Channel Select bits
  - 0000 = Channel 0 (AN0)
  - 0001 = Channel 1 (AN1)
  - 0010 = Channel 2 (AN2)
  - 0011 = Channel 3 (AN3)
  - 0100 = Channel 4 (AN4)
  - 0101 = Channel 5 (AN5)<sup>(1,2)</sup>
  - 0110 = Channel 6 (AN6)<sup>(1,2)</sup>
  - 0111 = Channel 7 (AN7)<sup>(1,2)</sup>
  - 1000 = Channel 8 (AN8)
  - 1001 = Channel 9 (AN9)
  - 1010 = Channel 10 (AN10)
  - 1011 = Channel 11 (AN11)
  - 1100 = Channel 12 (AN12)
  - 1101 = Unimplemented<sup>(2)</sup>
  - 1110 = Unimplemented<sup>(2)</sup>
  - 1111 = Unimplemented<sup>(2)</sup>
- bit 1                      GO/DONE: A/D Conversion Status bit
  - When ADON = 1:
  - 1 = A/D conversion in progress
  - 0 = A/D Idle
- bit 0                      ADON: A/D On bit
  - 1 = A/D converter module is enabled
  - 0 = A/D converter module is disabled

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**REGISTER 21-2: ADCON1: A/D CONTROL REGISTER 1**

U-0	U-0	R/W-0	R/W-0	R/W-0 <sup>(1)</sup>	R/W <sup>(1)</sup>	R/W <sup>(1)</sup>	R/W <sup>(1)</sup>
—	—	VCFG1	VCFG0	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

**Legend:**

R = Readable bit                      W = Writable bit                      U = Unimplemented bit, read as '0'  
 -n = Value at POR                      '1' = Bit is set                      '0' = Bit is cleared                      x = Bit is unknown

- bit 7-6                      **Unimplemented:** Read as '0'
- bit 5                      **VCFG1:** Voltage Reference Configuration bit (VREF- source)  
 1 = VREF- (AN2)  
 0 = Vss
- bit 4                      **VCFG0:** Voltage Reference Configuration bit (VREF+ source)  
 1 = VREF+ (AN3)  
 0 = VDD
- bit 3-0                      **PCFG3:PCFG0:** A/D Port Configuration Control bits:

PCFG3: PCFG0	AN12	AN11	AN10	AN9	AN8	AN7 <sup>(2)</sup>	AN6 <sup>(2)</sup>	AN5 <sup>(2)</sup>	AN4	AN3	AN2	AN1	AN0
0000 <sup>(1)</sup>	A	A	A	A	A	A	A	A	A	A	A	A	A
0001	A	A	A	A	A	A	A	A	A	A	A	A	A
0010	A	A	A	A	A	A	A	A	A	A	A	A	A
0011	D	A	A	A	A	A	A	A	A	A	A	A	A
0100	D	D	A	A	A	A	A	A	A	A	A	A	A
0101	D	D	D	A	A	A	A	A	A	A	A	A	A
0110	D	D	D	D	A	A	A	A	A	A	A	A	A
0111 <sup>(1)</sup>	D	D	D	D	D	A	A	A	A	A	A	A	A
1000	D	D	D	D	D	D	A	A	A	A	A	A	A
1001	D	D	D	D	D	D	D	A	A	A	A	A	A
1010	D	D	D	D	D	D	D	D	A	A	A	A	A
1011	D	D	D	D	D	D	D	D	D	A	A	A	A
1100	D	D	D	D	D	D	D	D	D	D	A	A	A
1101	D	D	D	D	D	D	D	D	D	D	D	A	A
1110	D	D	D	D	D	D	D	D	D	D	D	D	A
1111	D	D	D	D	D	D	D	D	D	D	D	D	D

A = Analog input                      D = Digital I/O

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**PIC18F2455/2550/4455/4550**

**REGISTER 21-3: ADCON2: A/D CONTROL REGISTER 2**

R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	—	ACQT2	ACQT1	ACQT0	ADCS2	ADCS1	ADCS0
bit 7							bit 0

**Legend:**

R = Readable bit                      W = Writable bit                      U = Unimplemented bit, read as '0'  
 -n = Value at POR                      '1' = Bit is set                      '0' = Bit is cleared                      x = Bit is unknown

- bit 7                      ADFM: A/D Result Format Select bit  
 1 = Right justified  
 0 = Left justified
- bit 6                      Unimplemented: Read as '0'
- bit 5-3                      ACQT2:ACQT0: A/D Acquisition Time Select bits  
 111 = 20 TAD  
 110 = 16 TAD  
 101 = 12 TAD  
 100 = 8 TAD  
 011 = 6 TAD  
 010 = 4 TAD  
 001 = 2 TAD  
 000 = 0 TAD<sup>(1)</sup>
- bit 2-0                      ADCS2:ADCS0: A/D Conversion Clock Select bits  
 111 = FRC (clock derived from A/D RC oscillator)<sup>(1)</sup>  
 110 = FOSC/64  
 101 = FOSC/16  
 100 = FOSC/4  
 011 = FRC (clock derived from A/D RC oscillator)<sup>(1)</sup>  
 010 = FOSC/32  
 001 = FOSC/8  
 000 = FOSC/2