BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENGAJIAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI I : 2022/2023

DEC40053: EMBEDDED SYSTEM APPLICATIONS

TARIKH : 29 DISEMBER 2022
MASA : 8.30 AM - 10.30 AM (2 JAM)

Kertas ini mengandungi **ENAM(6)** halaman bercetak.
Bahagian A: Subjektif (3 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Appendix

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A: 60 MARKS
BAHAGIAN A: 60 MARKAH

INSTRUCTION:
This section consists of **THREE (3)** structured questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **TIGA (3)** soalan berstruktur. Jawab semua soalan.*

QUESTION 1
SOALAN 1

CLO1
C1

a) List **FOUR (4)** sources of interruption in PIC Microcontroller
*Senaraikan **EMPAT (4)** sumber sampukan dalam pengawal mikro PIC.*

[4 marks]
[4 *markah*]

CLO1
C2

b) Explain **THREE (3)** differences between microcontroller and microprocessor.
*Terangkan **TIGA (3)** perbezaan antara pengawal mikro dan pemproses mikro.*

[6 marks]
[6 *markah*]

CLO1
C3

c) Figure A1 show the connection between input devices and output devices with PIC microcontroller. Write the C language to configure the input/output port using bit addressable and byte addressable.
Rajah A1 menunjukkan sambungan peranti masukan dan peranti keluaran dengan pengawal mikro PIC. Tuliskan aturcara Bahasa C untuk mengkonfigurasikan pim masukan/keluaran menggunakan format pengalamatan bit dan bait.

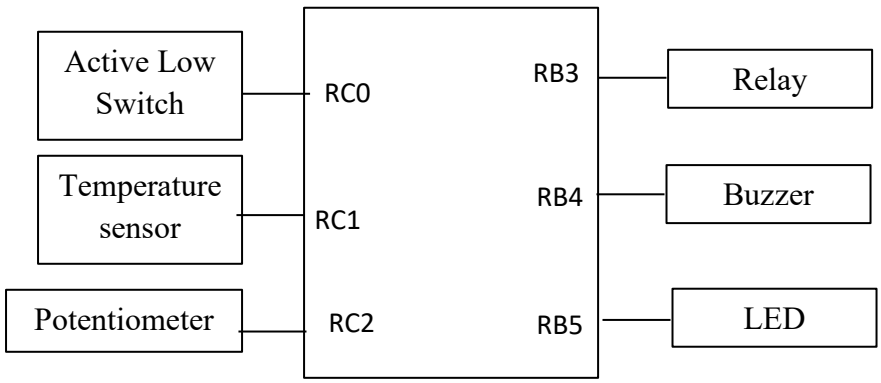

Figure A1/ *Rajah A1*

[10 marks]
[*10 markah*]

QUESTION 2
SOALAN 2

CLO1
C2

a) Explain the function of Interrupt Enable (IE) and Interrupt Flag (IF) with a suitable example

Terangkan fungsi Interrupt Enable (IE) dan Interrupt Flag (IF) beserta dengan contoh yang sesuai.

[4 marks]
[4 markah]

CLO1
C3

b) Given crystal oscillator frequency = 20MHz and the time delay generated by Timer0 is 0.5ms. Referring to Appendix 1, calculate the value that need to be loaded into TMR0H and TMR0L register if T0CON register is set to 0x08H.

Diberi frekuensi pengayun = 20MHz dan lengah masa yang dijana oleh Timer0 adalah 0.5ms. Dengan merujuk Lampiran 1, kirakan nilai yang perlu dimasukkan ke dalam pendaftar TMR0H dan TMR0L jika pendaftar T0CON disetkan kepada 0x08.

[8 marks]
[*8 markah*]

CLO1
C3

c) Write a function for void Delay( ) to generate 0.5ms delay based on Question 2(b).

Tuliskan satu fungsi untuk void Delay( ) bagi menghasilkan masa lengah selama 0.5ms berpandukan Soalan 2(b).

[8 marks]
[*8 markah*]

QUESTION 3
SOALAN 3

CLO1
C1

a) List **FOUR (4)** minimum hardware connection of PIC microcontroller.
*Senaraikan **EMPAT (4)** sambungan pekakasan minimum untuk PIC mikro pengawal.*

[4 marks]
[*4 markah*]

CLO1
C2

b) Explain the differences between an active low switch and active high switch with suitable circuit.
Terangkan perbezaan suis aktif rendah dan suis aktif tinggi dengan bantuan litar yang sesuai.

[6 marks]
[*6 markah*]

CLO1
C3

c) Calculate the value of Prescaler, PR2 register and CCPR2L value for 100%, 60% and 20% duty cycle. Given the system using PWM frequency 1.22 kHz with external crystal oscillator 20MHz and T2CON register is set 0x02.
Kirakan nilai Prescaler, pendaftar PR2 dan CCPR2L untuk 100%, 60% dan 20% kitar tugas. Diberi sistem menggunakan frekuensi PWM 1.22kHz dengan kristal osilator luaran 20MHz dan pendaftar T2CON ditetapkan kepada 0x02.

[10 marks]
[*10 markah*]

SECTION B : 40 MARKS
BAHAGIAN B : 40 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab semua soalan.*

QUESTION 1
SOALAN 1

CLO1
C3,
DP1,
DP3,
DP5,
DP7

Uthman is an engineer at a timber company in Selangor. He was assigned as an operator for wood cutting machine. Unfortunately, this machine does not have the safety features. To improve the safety features of the machine, he has been assigned to develop the safety features using one infrared sensor which operates to detect the presence of the hand. When an object (hand) was detected by the machine, it will stop immediately and a buzzer will turn on. By using PIC18 and external hardware interrupts 0 (INT0) method, sketch a block diagram for the system. Then, write a program in the C language to perform the system.

Uthman adalah seoarang jurutera syarikat balak di Selangor. Beliau ditugaskan sebagai operator mesin pemotong kayu. Walaubagimanapun, mesin ini tidak mempunyai ciri-ciri keselamatan. Untuk menambahbaik ciri keselamatan mesin tersebut, beliau telah ditugaskan untuk menambahbaik ciri keselamatan dengan menggunakan penderia infra yang berfungsi untuk mengesan kehadiran tangan. Apabila objek (tangan) dikesan, mesin akan berhenti serta merta. Dengan menggunakan PIC18 dan kaedah sampukan luaran 0 (INT0), lakarkan rajah blok untuk system tersebut. Kemudian, tuliskan satu program Bahasa C untuk melaksanakan system tersebut.

[20 marks]
[20 *markah*]

QUESTION 2
SOALAN 2

CLO2
C6,
DP1,
DP2,
DP3,
DP5,
DP7

Mr. Zakry Bin Mahmud is designing a mushroom cultivation monitoring system. He plans to equip the mushroom cultivation nursery with a temperature sensor, namely LM35 that is connected to PIC18F4550. When the temperature inside the nursery exceeds 15°C, a spraying hose release a water mist, which will assist in lowering the indoor temperature. When the temperature drops to 10°C and lower, the hose valve will be shut off to save energy and prevent excessive humidity conditions. By referring to Figure B1, design a complete schematic circuit for the system. Next, write a program in the C language to perform the operation using external oscillator 20MHz. Use VREF+ = 5V, VREF- = GND, AD result is right justified and conversion time = 12 TAD.

En. Zakry Bin Mahmud sedang merekabentuk sistem pemantauan rumah tapak semaian cendawan. Beliau bercadang untuk melengkapkan tapak semaian tersebut dengan suatu pengesan suhu iaitu LM35 yang disambungkan kepada PIC18F4550. Apabila suhu dalam rumah tapak semaian tersebut melampaui 15°C, suatu hos penyembur akan menyemburkan wap air, yang akan membantu menurunkan suhu dalaman tapak semaian tersebut. Apabila suhu turun di bawah 10°C, injap hos penyembur akan ditutup untuk menjimatkan tenaga dan mengelakkan daripada keadaan menjadi terlalu lembap. Dengan merujuk kepada Rajah B1, lakarkan gambarajah skematik bagi sistem tersebut. Seterusnya tulis program dalam Bahasa C untuk melaksanakan operasi menggunakan frekuensi pengayun kristal luaran 20MHz. Guna VREF+ = 5V, VREF- = GND, hasil AD adalah disusun ke kanan dan masa penukaran = 12 TAD.

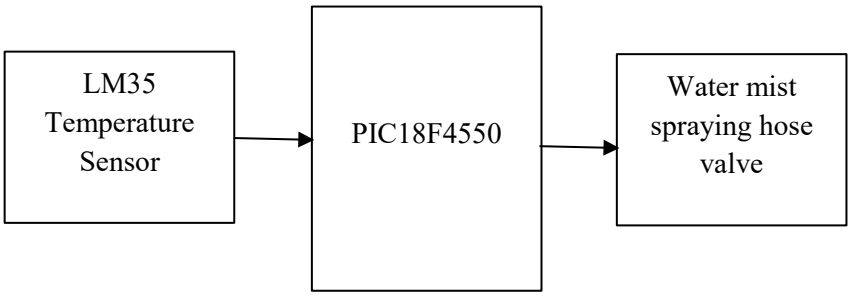

Figure B1/ Rajah B1

[20 marks]
[20 *markah*]

SOALAN TAMAT

Appendix 1

REGISTER 11-1: T0CON: TIMER0 CONTROL REGISTER

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
TMR0ON	T08BIT	T0CS	T0SE	PSA	T0PS2	T0PS1	T0PS0
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 **TMR0ON:** Timer0 On/Off Control bit
1 = Enables Timer0
0 = Stops Timer0

bit 6 **T08BIT**: Timer0 8-Bit/16-Bit Control bit
1 = Timer0 is configured as an 8-bit timer/counter
0 = Timer0 is configured as a 16-bit timer/counter

bit 5 **T0CS**: Timer0 Clock Source Select bit
1 = Transition on T0CKI pin
0 = Internal instruction cycle clock (CLKO)

bit 4 **T0SE**: Timer0 Source Edge Select bit
1 = Increment on high-to-low transition on T0CKI pin
0 = Increment on low-to-high transition on T0CKI pin

bit 3 **PSA**: Timer0 Prescaler Assignment bit
1 = TImer0 prescaler is NOT assigned. Timer0 clock input bypasses prescaler.
0 = Timer0 prescaler is assigned. Timer0 clock input comes from prescaler output.

bit 2-0 **T0PS2:T0PS0**: Timer0 Prescaler Select bits
111 = 1:256 Prescale value
110 = 1:128 Prescale value
101 = 1:64 Prescale value
100 = 1:32 Prescale value
011 = 1:16 Prescale value
010 = 1:8 Prescale value
001 = 1:4 Prescale value
000 = 1:2 Prescale value

REGISTER 13-1: T2CON: TIMER2 CONTROL REGISTER

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	T2OUTPS3	T2OUTPS2	T2OUTPS1	T2OUTPS0	TMR2ON	T2CKPS1	T2CKPS0
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 **Unimplemented:** Read as '0'

bit 6-3 **T2OUTPS3:T2OUTPS0**: Timer2 Output Postscale Select bits
0000 = 1:1 Postscale
0001 = 1:2 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

Appendix 2

REGISTER 9-1: INTCON: INTERRUPT CONTROL REGISTER

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-x
GIE/GIEH	PEIE/GIEL	TMR0IE	INT0IE	RBIE	TMR0IF	INT0IF	RBIF(1)
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 **GIE/GIEH:** Global Interrupt Enable bit
When IPEN = 0:
1 = Enables all unmasked interrupts
0 = Disables all interrupts
When IPEN = 1:
1 = Enables all high priority interrupts
0 = Disables all high priority interrupts

bit 6 **PEIE/GIEL:** Peripheral Interrupt Enable bit
When IPEN = 0:
1 = Enables all unmasked peripheral interrupts
0 = Disables all peripheral interrupts
When IPEN = 1:
1 = Enables all low priority peripheral interrupts
0 = Disables all low priority peripheral interrupts

bit 5 **TMR0IE:** TMR0 Overflow Interrupt Enable bit
1 = Enables the TMR0 overflow interrupt
0 = Disables the TMR0 overflow interrupt

bit 4 **INT0IE:** INT0 External Interrupt Enable bit
1 = Enables the INT0 external interrupt
0 = Disables the INT0 external interrupt

bit 3 **RBIE:** RB Port Change Interrupt Enable bit
1 = Enables the RB port change interrupt
0 = Disables the RB port change interrupt

bit 2 **TMR0IF:** TMR0 Overflow Interrupt Flag bit
1 = TMR0 register has overflowed (must be cleared in software)
0 = TMR0 register did not overflow

bit 1 **INT0IF:** INT0 External Interrupt Flag bit
1 = The INT0 external interrupt occurred (must be cleared in software)
0 = The INT0 external interrupt did not occur

bit 0 **RBIF:** RB Port Change Interrupt Flag bit(1)
1 = At least one of the RB7:RB4 pins changed state (must be cleared in software)
0 = None of the RB7:RB4 pins have changed state

Appendix 3

REGISTER 9-2: INTCON2: INTERRUPT CONTROL REGISTER 2

R/W-1	R/W-1	R/W-1	R/W-1	U-0	R/W-1	U-0	R/W-1
$\overline{\text{RBPU}}$	INTEDG0	INTEDG1	INTEDG2	—	TMR0IP	—	RBIP
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 **$\overline{\text{RBPU}}$:** PORTB Pull-up Enable bit
1 = All PORTB pull-ups are disabled
0 = PORTB pull-ups are enabled by individual port latch values

bit 6 **INTEDG0:** External Interrupt 0 Edge Select bit
1 = Interrupt on rising edge
0 = Interrupt on falling edge

bit 5 **INTEDG1:** External Interrupt 1 Edge Select bit
1 = Interrupt on rising edge
0 = Interrupt on falling edge

bit 4 **INTEDG2:** External Interrupt 2 Edge Select bit
1 = Interrupt on rising edge
0 = Interrupt on falling edge

bit 3 **Unimplemented:** Read as '0'

bit 2 **TMR0IP:** TMR0 Overflow Interrupt Priority bit
1 = High priority
0 = Low priority

bit 1 **Unimplemented:** Read as '0'

bit 0 **RBIP:** RB Port Change Interrupt Priority bit
1 = High priority
0 = Low priority

Appendix 4

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/$\overline{\text{DONE}}$	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)(1,2)
0110 = Channel 6 (AN6)(1,2)
0111 = Channel 7 (AN7)(1,2)
1000 = Channel 8 (AN8)
1001 = Channel 9 (AN9)
1010 = Channel 10 (AN10)
1011 = Channel 11 (AN11)
1100 = Channel 12 (AN12)
1101 = Unimplemented(2)
1110 = Unimplemented(2)
1111 = Unimplemented(2)

bit 1 **GO/$\overline{\text{DONE}}$:** 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

Appendix 5

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

U-0	U-0	R/W-0	R/W-0	R/W-0(1)	R/W(1)	R/W(1)	R/W(1)
—	—	VCFG0	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 **VCFG0:** Voltage Reference Configuration bit (V_{REF-} source)
1 = V_{REF-} (AN2)
0 = V_{SS}

bit 4 **VCFG0:** Voltage Reference Configuration bit (V_{REF+} source)
1 = V_{REF+} (AN3)
0 = V_{DD}

bit 3-0 **PCFG3:PCFG0:** A/D Port Configuration Control bits:

PCFG3: PCFG0	AN12	AN11	AN10	AN9	AN8	AN7(2)	AN6(2)	AN5(2)	AN4	AN3	AN2	AN1	AN0
0000(1)	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(1)	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

Appendix 6

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(1)

bit 2-0 **ADCS2:ADCS0:** A/D Conversion Clock Select bits
111 = FRC (clock derived from A/D RC oscillator)(1)
110 = FOSC/64
101 = FOSC/16
100 = FOSC/4
011 = FRC (clock derived from A/D RC oscillator)(1)
010 = FOSC/32
001 = FOSC/8
000 = FOSC/2