

**SULIT**



**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK  
KEMENTERIAN PENDIDIKAN TINGGI**

**JABATAN KEJURUTERAAN ELEKTRIK**

**PEPERIKSAAN AKHIR**

**SESI JUN 2017**

**DEC5052 : EMBEDDED SYSTEM APPLICATIONS**

**TARIKH : 02 NOVEMBER 2017**

**MASA : 2.30 PETANG - 4.30 PETANG (2 JAM)**

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Kertas ini mengandungi **TUJUH (7)** halaman bercetak.  
Bahagian A: Struktur (4 soalan)  
Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Appendix A1, Appendix A2

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**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 **FOUR (4)** structured questions. Answer **ALL** questions.

**ARAHAN:**

*Bahagian ini mengandungi EMPAT (4) soalan berstruktur. Jawab SEMUA soalan.*

**QUESTION 1****SOALAN 1**

- CLO1  
C1 (a) List **THREE (3)** embedded systems attached to a washing machine.  
*Senaraikan TIGA (3) sistem terbenam yang digunakan di dalam sebuah mesin basuh.*  
[3 marks]  
[3 markah]
- CLO1  
C3 (b) Relate **THREE (3)** examples of the applications of embedded systems in medical industry.  
*Kaitkan TIGA (3) contoh penggunaan sistem terbenam dalam industri perubatan.*  
[6 marks]  
[6 markah]
- CLO2  
C3 (a) **Build** a C18 program to toggle only the bit RB2 continuously without disturbing the rest of the bits of Port B.  
*Binakan satu aturcara dalam program C untuk togol hanya bit RB2 secara berterusan tanpa mengganggu keseluruhan bit pada Port B.*  
[6 marks]  
[6 markah]

## QUESTION 2

## SOALAN 2

CLO1  
C2

- (a) Table A2(a) shows all 8 bits of T0CON register of Timer0. Discuss the role of Bit 5 of T0CON register namely T0CS.

Jadual A2(a) menunjukkan semua alat daftar 8 bits T0CON bagi Timer0. Bincangkan peranan Bit 5 daftar T0CON bernama T0CS.

Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
T0CON	TMR0ON	T08BIT	T0CS	T0SE	PSA	T0PS2	T0PS1	T0PS0

Table A2(a) / Jadual A2(a)

[3 marks]

[3 markah]

CLO1  
C3

- (b) Referring to Figure A2(b), calculate the amount of time delay generated by Timer0 if PSA (Bit 3), T0PS2 (Bit 2), T0PS1 (Bit 1) and T0PS0 (Bit 0) of T0CON register are set to 0, 0, 0 and 1 respectively. Given, crystal oscillator frequency = 20 MHz and the content of TMR0H:TMR0L = 0BDCH.

Merujuk kepada Rajah A2(b), kira jumlah masa langkah yang dijana oleh Timer0 sekiranya PSA (Bit 3), T0PS2 (Bit 2), T0PS1 (Bit 1) and T0PS0 (Bit 0) bagi daftar T0CON diset masing-masing kepada 0, 0, 0 dan 1. Diberi frekuensi pengayun Kristal = 20 MHz dan kandungan TMR0H:TMR0L = 0BDCH.

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

Figure A2(b) / Rajah A2(b)

[6 marks]

[6 markah]

CLO2  
C3

- (c) Build a C program to generate a time delay of 2 ms. Use Timer0, 16-bit mode, no prescaler options to create the delay. Assume crystal oscillator frequency = 10 MHz. Binakan satu aturcara C bagi menjana lengah masa 2 ms. Gunakan Timer0, mod-16, tanpa pilihan prescaler bagi menjana lengah tersebut. Andaikan frekuensi pengayun Kristal = 10 MHz.

[6 marks]

[6 markah]

## QUESTION 3

## SOALAN 3

CLO1  
C1

- (a) INT0 is one external hardware interrupt sources for PIC18. State TWO (2) instructions in C language that is used to enable the interrupt. INT0 adalah salah satu sumber sampukan perkakasan luaran bagi PIC18. Nyatakan DUA (2) arahan dalam bahasa C yang digunakan untuk membolehkan sampukan.

[3 marks]

[3 markah]

CLO1  
C2

- (b) Explain the function of TMR0IF (TMR0 Overflow Interrupt Flag) bit in Timer0 for 8 bit and 16 bit operation. Terangkan fungsi bit TMR0IF (TMR0 Overflow Interrupt Flag) dalam Timer0 untuk operasi 8 bit dan 16 bit.

[5 marks]

[5 markah]

CLO1  
C3

- (c) Build a C language program for interface with external hardware interrupt pin RB0. An LED that connected to pin RD0 will toggle every time the INT0 is activated. Binakan satu aturcara dalam Bahasa C bagi pengantaramukaan perkakasan sampukan luaran pin RB0. Sebuah LED yang disambungkan dengan pin RD0 akan berubah ke keadaan togel setiap kali INT0 diaktifkan.

[7 marks]

[7 markah]

## QUESTION 4

## SOALAN 4

- CLO1  
C2 (a) Explain the Analog-to-Digital Converter (ADC) module in the PIC.  
*Terangkan modul Analog-to-Digital Converter (ADC) di dalam PIC.*
- [3 marks]  
[3 markah]
- CLO1  
C3 (b) An 8 bit ADC has reference voltage,  $V_{ref} = 5$  V. If the analog input is 4.5 V, calculate the digital value produced by the ADC in hexadecimal.  
*ADC 8 bit mempunyai voltan rujukan,  $V_{ref} = 5$  V. Jika voltan masukan adalah 4.5 V, kirakan nilai digital yang dihasilkan oleh ADC tersebut dalam heksadesimal.*
- [5 marks]  
[5 markah]
- CLO2  
C5 (c) Produce the register values of PR2, CCP1RL, DC1B2: DC1B1 and values of prescaler needed for 2 KHz Pulse Width Modulation (PWM) frequencies with 50% Duty cycle on the CCP1 pin and XTAL = 20 MHz.  
*Dapatkan nilai register PR2, CCP1RL, DC1B2: DC1B1 dan nilai prescale yang diperlukan, untuk hasilkan Pulse Width Modulation (PWM) frekuensi 2 KHz dengan 50% Duty cycle, menggunakan pin CCP1 and XTAL = 20 MHz.*
- [7 marks]  
[7 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

CLO2  
C3

A safety company has been assigned to install an automatic alarm system in a house based on PIC18 microcontroller. This system has FOUR (4) limit switches, ONE (1) Light Emitting Diodes (LED) and ONE (1) buzzer. Limit switches will be placed at different parts of the house and connected to pin RB4, RB5, RB6 and RB7 of microcontroller. These limit switches will be triggered if there are intrusions into the house. LED placed at RD1 and buzzer at RA0. During normal condition (no intrusion), LED will blink all the time. When the limit switch is triggered, the buzzer will be switched ON. Limit switches are ACTIVE LOW. Buzzer and LED are ACTIVE HIGH.

As a designer of the company, you are required to design the alarm system. List all the input and output for the system. Then, using Port B Change Interrupt to build a C program to perform the operation. Ignore any time delay functions.

Use Appendix A1 and Appendix A2 as reference.

*Sebuah syarikat keselamatan telah ditugaskan untuk memasang system penggera automatik dalam sebuah rumah berasaskan mikropengawal PIC18. Sistem ini mempunyai sebanyak EMPAT (4) suis penghad, SATU (1) Diod Pemancar Cahaya (LED) dan SATU (1) pembaz. Suis penghad akan dipasang pada tempat berbeza di dalam rumah dan disambung ke pin RB4, RB5, RB6 dan RB7 mikropengawal. Suis penghad akan dipicu jika terdapat pencerobohan masuk ke dalam rumah. LED dipasang pada RD1 dan pembaz pada RA0. Pada keadaan normal (tiada pencerobohan), LED akan berkelip sepanjang masa. Apabila suis penghad dipicu, pembaz akan dihidupkan. Suis penghad adalah AKTIF RENDAH. Pembaz dan LED adalah AKTIF TINGGI.*

*Sebagai pereka syarikat, anda diminta merekabentuk sistem penggera tersebut. Senaraikan semua masukan dan keluaran sistem tersebut. Kemudian, dengan*

menggunakan Port B Change Interrupt, bangunlah sebuah C program untuk melakukan operasi tersebut. Abaikan sebarang fungsi lengah masa. Gunakan Lampiran A1 dan Lampiran A2 sebagai rujukan.

[20 marks]

[20 markah]

## QUESTION 2

## SOALAN 2

CLO2  
C5

An embedded system is developed to control an overflow of water in a tank. The system consists of a microcontroller PIC18, one level sensor S1 attached to the highest level of the tank, one dc motor M1 placed outside of the tank and connected to a valve that will allow or block water flow to the tank, and one alarm system A1 used as water overflow indicator. When the water level is below than S1, the valve A1 normally opens and allows water to flow in the tank. When the water reaches the highest level of the tank S1, dc motor will be activated to close the valve A1 and simultaneously the alarm switch on. Level sensor S1 is connected to pin INT1, dc motor to pin RC6 and an alarm to pin RC7 of PIC18. Produce the system circuit diagram and build a C language programming for the above condition.

Satu sistem terbenam dibangunkan untuk mengawal limpahan air di sebuah tangki. Sistem tersebut mengandungi satu pengawal mikro PIC18, satu pengesan aras S1 yang diletakkan pada paras tertinggi tangki, satu motor dc M1 ditempatkan di luar tangki dan disambungkan kepada satu injap yang akan membenarkan atau menghalang aliran air ke tangki, dan satu sistem pengera A1 digunakan sebagai petunjuk limpahan air. Apabila paras air berada di bawah S1, injap A1 terbuka dan air dibenarkan mengalir masuk ke dalam tangki. Apabila air mencapai aras tertinggi tangki S1, motor dc akan diaktifkan untuk menutup injap A1 dan dalam masa sama pengera akan berbunyi. Pengesan aras S1 disambungkan kepada pin INT1, motor dc kepada pin RC1 dan pengera kepada RC7 sebuah PIC18. Hasilkan gambarajah litar dan bina aturcara di dalam bahasa C bagi keadaan di atas.

[20 marks]

[20 markah]

SOALAN TAMAT

## APPENDIX A1

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 <sup>(1)</sup>
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	<b>GIE/GIEH:</b> Global Interrupt Enable bit <u>When IPEN = 0:</u> 1 = Enables all unmasked interrupts 0 = Disables all interrupts <u>When IPEN = 1:</u> 1 = Enables all high priority interrupts 0 = Disables all high priority interrupts
bit 6	<b>PEIE/GIEL:</b> Peripheral Interrupt Enable bit <u>When IPEN = 0:</u> 1 = Enables all unmasked peripheral interrupts 0 = Disables all peripheral interrupts <u>When IPEN = 1:</u> 1 = Enables all low priority peripheral interrupts 0 = Disables all low priority peripheral interrupts
bit 5	<b>TMR0IE:</b> TMR0 Overflow Interrupt Enable bit 1 = Enables the TMR0 overflow interrupt 0 = Disables the TMR0 overflow interrupt
bit 4	<b>INT0IE:</b> INT0 External Interrupt Enable bit 1 = Enables the INT0 external interrupt 0 = Disables the INT0 external interrupt
bit 3	<b>RBIE:</b> RB Port Change Interrupt Enable bit 1 = Enables the RB port change interrupt 0 = Disables the RB port change interrupt
bit 2	<b>TMR0IF:</b> TMR0 Overflow Interrupt Flag bit 1 = TMR0 register has overflowed (must be cleared in software) 0 = TMR0 register did not overflow
bit 1	<b>INT0IF:</b> 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	<b>RBIF:</b> RB Port Change Interrupt Flag bit <sup>(1)</sup> 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 A2

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
RBPUP	INTEG0	INTEG1	INTEG2		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 **RBPUP**: 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 **INTEG0**: External Interrupt 0 Edge Select bit  
1 = Interrupt on rising edge  
0 = Interrupt on falling edge
- bit 5 **INTEG1**: External Interrupt 1 Edge Select bit  
1 = Interrupt on rising edge  
0 = Interrupt on falling edge
- bit 4 **INTEG2**: 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

REGISTER 10-13: IOCB: INTERRUPT-ON-CHANGE PORTB CONTROL REGISTER

R/W-1	R/W-1	R/W-1	R/W-1	U-0	U-0	U-0	U-0
IOCB7	IOCB6	IOCB5	IOCB4				
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 7-4 **IOCB<7:4>**: Interrupt-on-Change PORTB control bits  
1 = Interrupt-on-change enabled<sup>(1)</sup>  
0 = Interrupt-on-change disabled