UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER II
SESI 2011/2012

NAMA KURSUS	:	MIKROPENGAWAL
KOD KURSUS	:	DEK 3133 / DAE 32203
PROGRAM	:	3 DEE/DET / 3 DAE
TARIKH PEPERIKSAAN	:	MAC 2012
JANGKA MASA	:	3 JAM
ARAHAN	:	JAWAB **SEMUA** SOALAN DI BAHAGIAN A DAN **DUA (2)** SOALAN DI BAHAGIAN B

KERTAS SOALAN INI MENGANDUNGI DUA PULUH (20) MUKA SURAT

SOALAN DALAM BAHASA MALAYSIA

BAHAGIAN A

S1 (a) (i) Definisikan Mikropengawal.

(ii) Berikan empat (4) perkara yang perlu diberi perhatian untuk memilih Mikropengawal yang sesuai.

(5 markah)

(b) Rajah S1(b) adalah struktur ingatan sebuah Mikropengawal. Terdapat 8 talian data dan 12 talian alamat yang dihubungkan antara CPU dan ingatan. Dengan mengambil kira 1 Kb adalah bersamaan 1024 byte.

(i) Nyatakan saiz ruangan ingatan tersebut.

(ii) Nyatakan jenis talian bas yang akan menentukan saiz ingatan sebuah Mikropengwal.

(4 markah)

(c) Rajah S1(c) adalah contoh litar papan kekunci 1 x 2 pada sebuah Mikropengawal. Lakarkan binaan litar papan kekunci yang mempunyai saiz 3 x 3.

(5 markah)

(d) Sekiranya anda menggunakan pemasa *TMR0* bersama pengayun berkelajuan 10 MHz dan *Prescaler* 1:256,

(i) Kirakan masa yang diperlukan untuk TMR0 menghasilkan satu (1) limpahan dengan kiraan TMR0 bermula dari 100.

(ii) Tentukan nilai awal kiraan TMR0 sekiranya limpahan berlaku setiap 5ms.

(5 markah)

(e) PIC16F877A menggunakan bekalan jam berfrekuensi 20MHz.

(i) Tunjukkan pengiraan untuk mengetahui tempoh masa yang diambil oleh Mikropengawal menyelesaikan dua (2) suruhan.

(ii) Tentukan suruhan yang mampu dilaksanakan oleh Mikropengawal dalam tempoh 10.0 μs dan 100.0 μs.

(6 markah)

S2 (a) PIC16F877A mempunyai resolusi 10-Bit (0b1111111111=1023) bagi penukaran analog kepada digital. Voltan rujukan adalah +4V, tentukan nilai Saiz Langkah dan Keluaran Digital bagi *ADC* tersebut sekiranya voltan masukan analog adalah 1.23V.
(Berikan jawapan dalam nombor binari mengikut turutan *bit*)

(8 markah)

(b) Sekiranya saiz ingatan *EEPROM* sesebuah Mikropengawal adalah 256 byte. Nyatakan arahan *MikroC* yang sesuai untuk memenuhkan keseluruhan ruangan ingatan tersebut dengan nilai 0b11110000.

(4 markah)

(c) Nyatakan nilai-nilai daftar dalam PIC16F877A yang ditunjukkan dalam Rajah S2(c) selepas suruhan dibawah dilaksanakan.
(PERINGATAN:Tuliskan jawapan terakhir dalam bentuk jadual seperti di Rajah S2(c))

(i) SWAPF 11h
(ii) ANDWF 12h
(iii) COMF 09h
(iv) ADDWF 10h,w

(8 markah)

(d) Merujuk pada Rajah S2(d), sebuah motor *DC* 5V disambung kepada modul *PWM* pada modulasi frekuensi 5000 Hz. Nyatakan arahan *MikroC* supaya kelajuan putaran motor tersebut adalah 50 peratus daripada kelajuan asalnya.

(5 markah)

BAHAGIAN B

S3 Rajah S3 menunjukkan sebuah sistem kawalan untuk mengekalkan suhu sebuah bilik pada tahap 30°C hingga 40°C. Sistem ini menggunakan penderia suhu yang mengukur suhu di antara 0°C - 100°C. Keluaran litar penderia suhu adalah voltan analog (0V-5V) yang merupakan masukan kepada litar Mikropengawal. Terdapat dua komponen keluaran LED yang berfungsi untuk menunjukkan tahap suhu semasa (D2:normal dan D1:panas) dan sebuah komponen keluaran kipas yang berfungsi untuk menyejukkan suhu bilik sekiranya suhu tertentu dicapai. LED dan kipas akan berfungsi berdasarkan Jadual S3. Voltan rujukan Mikropengawal adalah 5 V.

(a) Tentukan :

(i) Saiz Langkah.
(ii) Nilai ADC apabila nilai V_{in} pada AN0 adalah 3V.
(iii) Nilai suhu dalam *Celsius* sekiranya V_{in} = 2V

(5 markah)

(b) Sekiranya PIC menggunakan Voltan rujukan +5V, tuliskan aturcara *MikroC* yang menghasilkan proses penukaran analog kepada digital dan seterusnya dapat mengawal suhu bilik.

(20 markah)

S4 Litar dalam Rajah S4 beroperasi dengan memaparkan nilai pengiraan secara menaik bermula dari nombor 0 hingga 9 dengan sela masa 1 saat. Pemasa lengahan PIC adalah daripada pemasa TMR0 dengan skala 1:8 dan nilai awalan TMR0 adalah 100. Sekiranya PIC dibekalkan pengayun, ***Fosc*** berfrekuensi 20Mhz.

(a) Tentukan:

(i) Tempoh masa bagi limpahan TMR0 bermula dari 100 hingga 255.
(ii) Bilangan limpahan TMR0 yang diperlukan untuk mendapatkan tempoh lengah satu (1) saat.

(5 markah)

(b) Dengan menggunakan pemasa TMR0 binakan kod pengaturcaraan *C* di mana paparan S*even Segment* akan memaparkan nilai pengiraan bermula dari 0 hingga 9 secara berterusan dengan sela masa 1 saat. (NOTA: Gunakan jadual S4(b) untuk nilai-nilai binari S*even Segment*)

(20 markah)

S5 Litar dalam Rajah S5 beroperasi dengan memaparkan arah putaran motor pada paparan LCD dan pada nyalaan LED apabila butang arah putaran ditekan.

(a) (i) Nyatakan fungsi pemacu ULN2003A.
(ii) Nyatakan bagaimanakah kelajuan sesebuah *STEPPER* MOTOR boleh dikawal.

(5 markah)

(b) Tuliskan kod pengaturcaraan *MikroC* di mana *stepper motor* akan berpusing mengikut arah butang yang ditekan dan seterusnya LED dan *LCD* akan memaparkan arah putaran yang dipilih.

(20 markah)

SOALAN DALAM BAHASA INGGERIS

PART A

Q1 (a) (i) Give definition of Microcontroller.

(ii) Give four (4) important aspects that require attention in choosing a suitable Microcontroller.

(5 marks)

(b) Figure Q1(b) shows the memory structure of microcontroller. There are 8 data buses and 12 address buses connected between CPU and memory. Considering 1 Kb is equal to 1024 bytes:

(i) Calculate the size of the memory for this microcontroller.

(ii) Identify which type of buses will determine the memory size of the microcontroller?

(4 marks)

(c) Figure Q1(c) shows a sample circuit of keypad 1x2 connected to a microcontroller. Draw the circuit of keypad with size 3 x 3.

(5 marks)

(d) If you use TMR0 timer with 10 MHz Oscillator and Prescaler 1:256,

(i) Calculate the time required for TMR0 to produce one (1) Overflow when TMR0 started from 100.

(ii) Find the starting value of TMR0 to start counting when overflow occurs every 5ms.

(5 marks)

(e) A PIC16F877A uses a clock frequency of 20 MHz.

(i) Show the calculation to know a time period taken by Microcontroller to complete two (2) instructions.

(ii) Determine the instructions can be executed by microcontroller within 10.0μs and 100.0μs.

(6 marks)

Q2 (a) A PIC16F877A has 10-Bit resolutions (0b1111111111=1023) for analog to digital conversion (ADC). By using the voltage reference of +4V, determine the Step Size and Digital Output of ADC when the analog input is 1.23V.
(REMINDER: Express your answer in binary format by following the bit order)

(8 marks)

(b) If the Microcontroller's EEPROM size is 256 byte, identify the suitable *MikroC* instruction to load all the memory space with value of 0b11110000.

(4 marks)

(c) Find the register values in Figure Q2(c) of PIC16F877A after execute the instruction below.
(NOTE: Write the final answer in table form like in Figure Q2(c))

(i) SWAPF 11h
(ii) ANDWF 12h
(iii) COMF 09h
(iv) ADDWF 10h,w

(8 marks)

(d) Refer to Figure S2 (d), a DC Motor (5V) is connected to the PWM module at frequency modulation of 5000 Hz. Write the instructions of MikroC to rotate the motor to 50 percent of its original speed.

(5 marks)

PART B

Q3 Figure Q3 shows a control system to maintain room temperature between 30°C to 40°C. The system used a temperature sensor to measure the temperature between 0°C to 100°C. The output of the temperature sensor is analog voltage (0V-5V) which is the input to the PIC circuit. There are two LEDs as the output components which work as an indicator for the current temperatures level (D2: normal and D1: hot) and a fan component as the output which operates to cool down the room temperature when a certain temperature is achieved. LEDs and fan will functioned based on Table Q3. Voltage reference used by PIC is 5V.

(a) Determine:
(i) Step size value.
(ii) ADC result when V_{in} to AN0 is 3V.
(iii) Temperature value in degree *Celsius* when V_{in} = 2V.

(5 marks)

(b) If the PIC uses voltage reference of +5V, write a *MikroC* program to show the conversion process from analog to digital and then control the room temperature.

(20 marks)

Q4 Circuit in Figure Q4 operates by showing the counter value by rising up the number value beginning from 0 to 9 with time interval 1 second. Delay Timer PIC is from Hardware Timer (TMR0) with prescaler 1:8 and preload value TMR0 is set to 100. If the PIC is provided with oscillator frequency, Fosc 20 MHz,

(a) Determine:

(i) The period for TMR0 to overflow starting from 100 to 255.
(ii) Number of TMR0 overflows required to get 1 second delay.

(5 marks)

(b) By using the TMR0 Timer write a *C* program where the Seven Segment display will show counting value from 0 to 9 continuously with time interval 1 second.
(NOTE: Use the Table S4 (b) for Seven Segment binary number)

(20 marks)

Q5 Circuit in Figure Q5 operates by showing the direction of stepper motor rotation into LCD display and also on LED when one of the direction buttons is pressed.

(a) (i) Explain the function of ULN2003A driver.
(ii) Determine how the speed of stepper motor can be controlled.

(5 marks)

(b) Write a MikroC code which the stepper motor will rotate in the direction of the pressed button and then the LED and the LCD will display the selected direction of rotation.

(20 marks)

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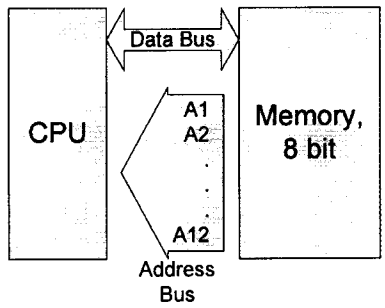
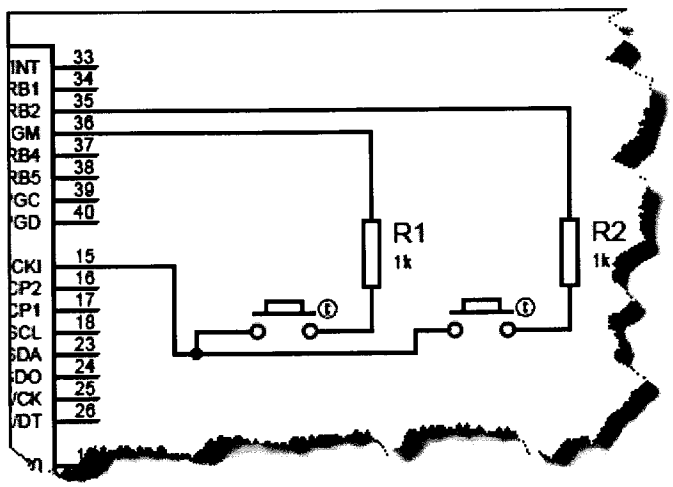


RAJAH S1(b) / FIGURE Q1(b)



RAJAH S1(c) / FIGURE Q1(c)

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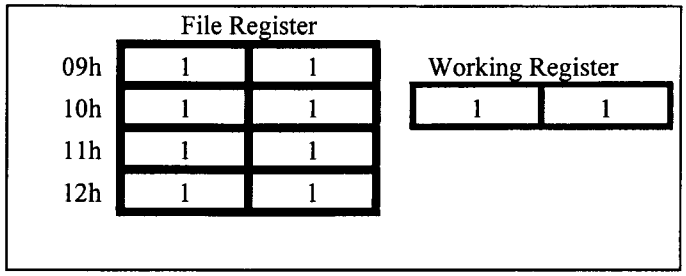
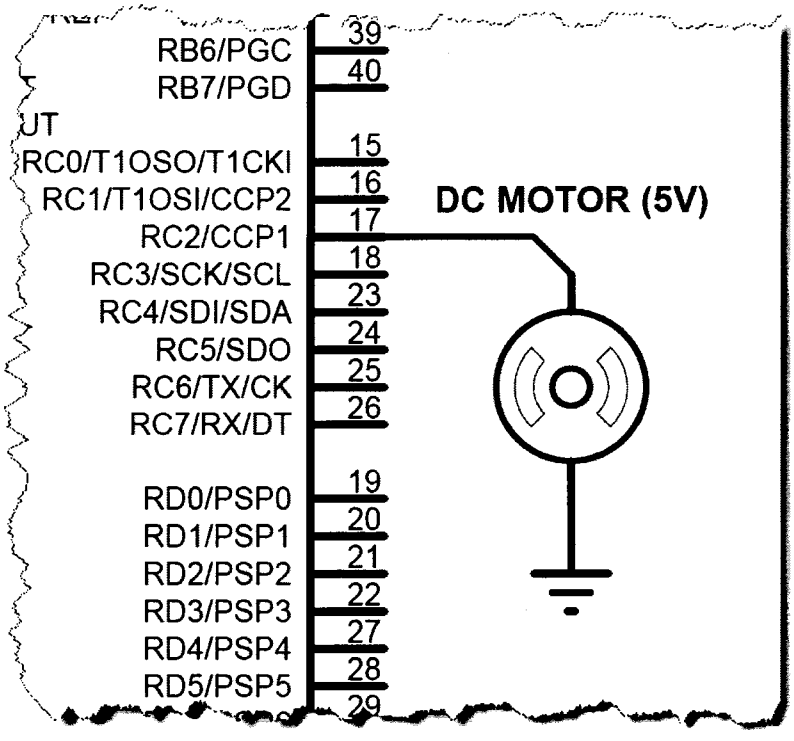


RAJAH S2(c) / FIGURE Q2(c)



RAJAH S2(d) / FIGURE Q2(d)

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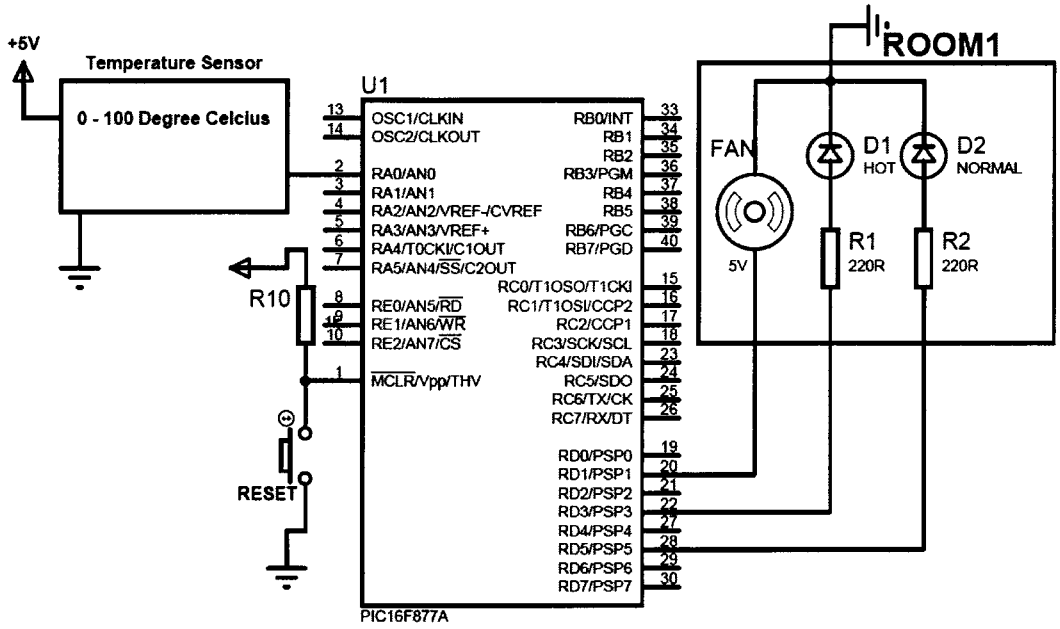

RAJAH S3 / FIGURE Q3

Temperatures	LED and Fan Status
Above 39°C	Fan = Rotate (Fan is rotate and stop when reach at 30°C)
Above 35 °C	LED D1(Hot) = ONN LED D2(Normal) = OFF
Below 35°C	LED D1(Hot) = OFF LED D2(Normal) = ON
Below 30°C	Fan = Stop

JADUAL S3 / TABLE Q3

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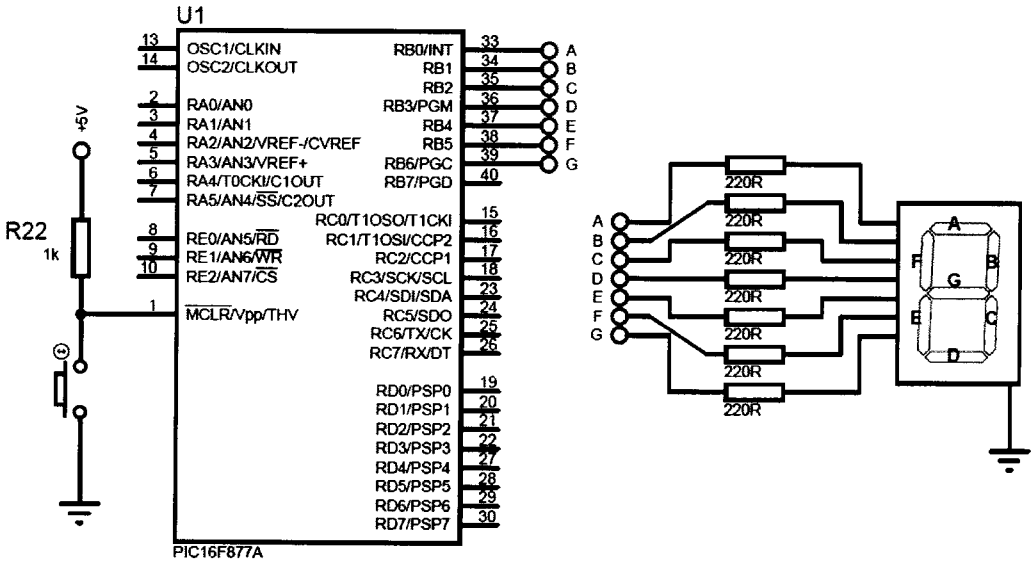

RAJAH S4 / FIGURE Q4

Seven Segment No.	Binary value
9	01101111
8	01111111
7	00000111
6	01111101
5	01101101
4	01100110
3	01001111
2	01011011
1	00000110
0	00111111

JADUAL S4 (b) / TABLE Q4 (b)

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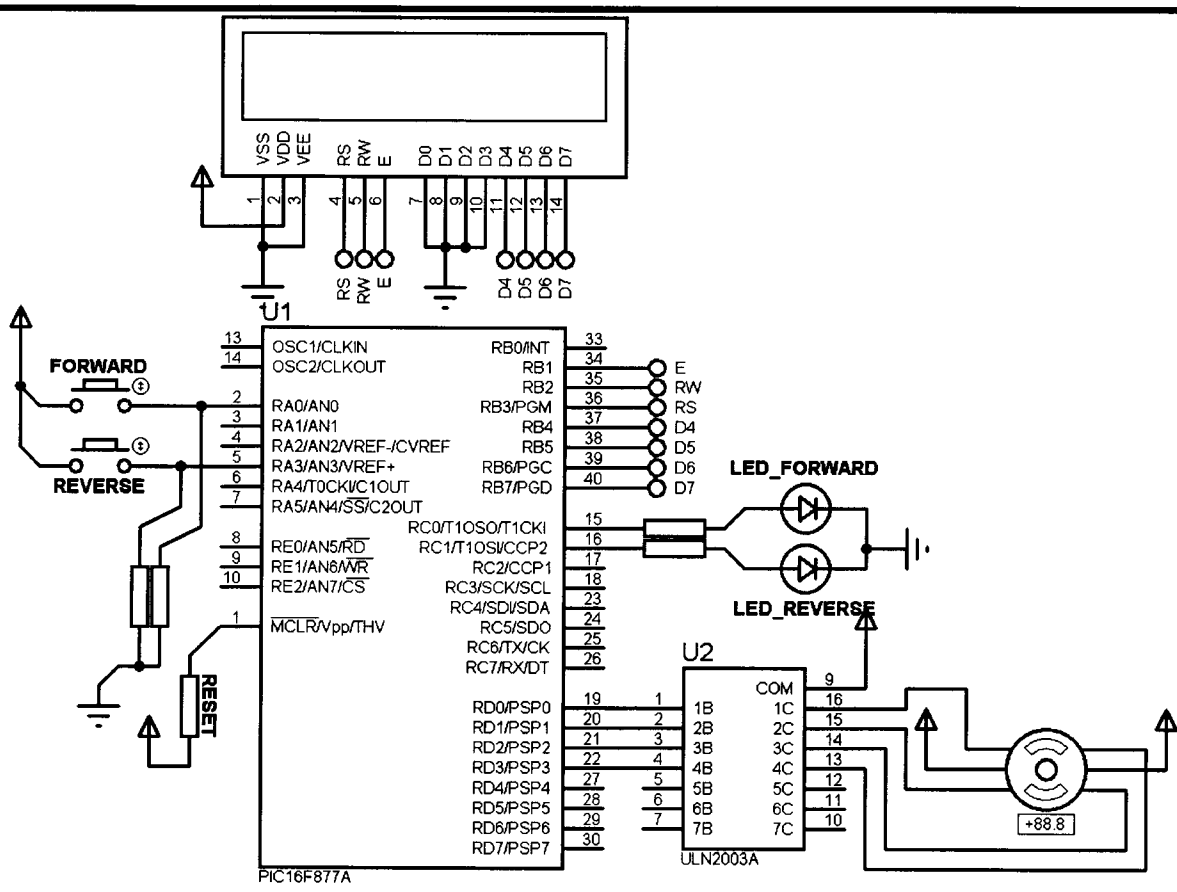

RAJAH S5 / FIGURE Q5

Forward	Step #	1B	2B	3B	4B	Reverse
	1	1	0	0	1	
	2	1	0	0	0	
	3	1	1	0	0	
	4	0	1	0	0	
	5	0	1	1	0	
	6	0	0	1	0	
	7	0	0	1	1	
	8	0	0	0	1	

JADUAL S5/ TABLE Q5

PEPERIKSAAN AKHIR

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RUJUKAN I

FIGURE 2-3: PIC16F876A/877A REGISTER FILE MAP

File Address	Bank 0	File Address	Bank 1	File Address	Bank 2	File Address	Bank 3
00h	Indirect addr.(*)	80h	Indirect addr.(*)	100h	Indirect addr.(*)	180h	Indirect addr.(*)
01h	TMR0	81h	OPTION_REG	101h	TMR0	181h	OPTION_REG
02h	PCL	82h	PCL	102h	PCL	182h	PCL
03h	STATUS	83h	STATUS	103h	STATUS	183h	STATUS
04h	FSR	84h	FSR	104h	FSR	184h	FSR
05h	PORTA	85h	TRISA	105h		185h	
06h	PORTB	86h	TRISB	106h	PORTB	186h	TRISB
07h	PORTC	87h	TRISC	107h		187h	
08h	PORTD(1)	88h	TRISD(1)	108h		188h	
09h	PORTE(1)	89h	TRISE(1)	109h		189h	
0Ah	PCLATH	8Ah	PCLATH	10Ah	PCLATH	18Ah	PCLATH
0Bh	INTCON	8Bh	INTCON	10Bh	INTCON	18Bh	INTCON
0Ch	PIR1	8Ch	PIE1	10Ch	EEDATA	18Ch	EECON1
0Dh	PIR2	8Dh	PIE2	10Dh	EEADR	18Dh	EECON2
0Eh	TMR1L	8Eh	PCON	10Eh	EEDATH	18Eh	Reserved(2)
0Fh	TMR1H	8Fh		10Fh	EEADRH	18Fh	Reserved(2)
10h	T1CON	90h		110h	General Purpose Register 16 Bytes	190h	General Purpose Register 16 Bytes
11h	TMR2	91h	SSPCON2	111h		191h	
12h	T2CON	92h	PR2	112h		192h	
13h	SSPBUF	93h	SSPADD	113h		193h	
14h	SSPCON	94h	SSPSTAT	114h		194h	
15h	CCPR1L	95h		115h		195h	
16h	CCPR1H	96h		116h		196h	
17h	CCP1CON	97h		117h		197h	
18h	RCSTA	98h	TXSTA	118h		198h	
19h	TXREG	99h	SPBRG	119h		199h	
1Ah	RCREG	9Ah		11Ah		19Ah	
1Bh	CCPR2L	9Bh		11Bh		19Bh	
1Ch	CCPR2H	9Ch	CMCON	11Ch		19Ch	
1Dh	CCP2CON	9Dh	CVRCON	11Dh		19Dh	
1Eh	ADRESH	9Eh	ADRESL	11Eh		19Eh	
1Fh	ADCON0	9Fh	ADCON1	11Fh		19Fh	
20h	General Purpose Register 96 Bytes	A0h	General Purpose Register 80 Bytes	120h	General Purpose Register 80 Bytes	1A0h	General Purpose Register 80 Bytes
7Fh		EFh		16Fh		1EFh	
		F0h	accesses 70h-7Fh	170h	accesses 70h-7Fh	1F0h	accesses 70h - 7Fh
		FFh		17Fh		1FFh	

Unimplemented data memory locations, read as '0'.
* Not a physical register.

Note 1: These registers are not implemented on the PIC16F876A.
2: These registers are reserved; maintain these registers clear.

PEPERIKSAAN AKHIR

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RUJUKAN II

PIC16F87XA

TABLE 15-2: PIC16F87XA INSTRUCTION SET

Mnemonic, Operands		Description	Cycles	14-Bit Opcode MSb			LSb	Status Affected	Notes
BYTE-ORIENTED FILE REGISTER OPERATIONS									
ADDWF	f, d	Add W and f	1	00	0111	dfff	ffff	C,DC,Z	1,2
ANDWF	f, d	AND W with f	1	00	0101	dfff	ffff	Z	1,2
CLRF	f	Clear f	1	00	0001	lfff	ffff	Z	2
CLRW	-	Clear W	1	00	0001	0xxx	xxxx	Z	
COMF	f, d	Complement f	1	00	1001	dfff	ffff	Z	1,2
DECF	f, d	Decrement f	1	00	0011	dfff	ffff	Z	1,2
DECFSZ	f, d	Decrement f, Skip if 0	1(2)	00	1011	dfff	ffff		1,2,3
INCF	f, d	Increment f	1	00	1010	dfff	ffff	Z	1,2
INCFSZ	f, d	Increment f, Skip if 0	1(2)	00	1111	dfff	ffff		1,2,3
IORWF	f, d	Inclusive OR W with f	1	00	0100	dfff	ffff	Z	1,2
MOVF	f, d	Move f	1	00	1000	dfff	ffff	Z	1,2
MOVWF	f	Move W to f	1	00	0000	lfff	ffff		
NOP	-	No Operation	1	00	0000	0xx0	0000		
RLF	f, d	Rotate Left f through Carry	1	00	1101	dfff	ffff	C	1,2
RRF	f, d	Rotate Right f through Carry	1	00	1100	dfff	ffff	C	1,2
SUBWF	f, d	Subtract W from f	1	00	0010	dfff	ffff	C,DC,Z	1,2
SWAPF	f, d	Swap nibbles in f	1	00	1110	dfff	ffff		1,2
XORWF	f, d	Exclusive OR W with f	1	00	0110	dfff	ffff	Z	1,2
BIT-ORIENTED FILE REGISTER OPERATIONS									
BCF	f, b	Bit Clear f	1	01	00bb	bfff	ffff		1,2
BSF	f, b	Bit Set f	1	01	01bb	bfff	ffff		1,2
BTFSC	f, b	Bit Test f, Skip if Clear	1 (2)	01	10bb	bfff	ffff		3
BTFSS	f, b	Bit Test f, Skip if Set	1 (2)	01	11bb	bfff	ffff		3
LITERAL AND CONTROL OPERATIONS									
ADDLW	k	Add Literal and W	1	11	111x	kkkk	kkkk	C,DC,Z	
ANDLW	k	AND Literal with W	1	11	1001	kkkk	kkkk	Z	
CALL	k	Call Subroutine	2	10	0kkk	kkkk	kkkk		
CLRWDT	-	Clear Watchdog Timer	1	00	0000	0110	0100	$\overline{TO}$,$\overline{PD}$	
GOTO	k	Go to Address	2	10	1kkk	kkkk	kkkk		
IORLW	k	Inclusive OR Literal with W	1	11	1000	kkkk	kkkk	Z	
MOVLW	k	Move Literal to W	1	11	00xx	kkkk	kkkk		
RETFIE	-	Return from Interrupt	2	00	0000	0000	1001		
RETLW	k	Return with Literal in W	2	11	01xx	kkkk	kkkk		
RETURN	-	Return from Subroutine	2	00	0000	0000	1000		
SLEEP	-	Go into Standby mode	1	00	0000	0110	0011	$\overline{TO}$,$\overline{PD}$	
SUBLW	k	Subtract W from Literal	1	11	110x	kkkk	kkkk	C,DC,Z	
XORLW	k	Exclusive OR Literal with W	1	11	1010	kkkk	kkkk	Z	

Note 1: When an I/O register is modified as a function of itself (e.g., `MOVF PORTB, 1`), the value used will be that value present on the pins themselves. For example, if the data latch is '1' for a pin configured as input and is driven low by an external device, the data will be written back with a '0'.

2: If this instruction is executed on the TMR0 register (and where applicable, d = 1), the prescaler will be cleared if assigned to the Timer0 module.

3: If Program Counter (PC) is modified, or a conditional test is true, the instruction requires two cycles. The second cycle is executed as a NOP.

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RUJUKAN III

Reference for MikroC functions:

Functions	Using C Function samples
Initialize LCD to PORTD	Lcd_Init(&PORTD);
Clear LCD	Lcd_Cmd(Lcd_CLEAR)
Read ADC conversion at AN0	Adc_Read(0)

Convert floating value to String	Unsigned float ABC; //variable ABC as float
	Char CBA[13]; //variable CBA with 13 character long
	ABC = 123.456;
	FloatToStr(ABC, CBA); //CBA = "123.456" (string format)

Show text in LCD screen	Lcd_Out(2,1, "Hello"); // Show text "Hello" at Line 2 column 1
Configure Analog inputs with Vref using Internal Vref +5V.	ADCON1 = 0x80;
Initialize PWM Freq.	Pwm_Init(unsigned long freq)
PWM Change Duty Cycle to 75%	DutyCycle = 75/100 * 255 = 191 Pwm_Change_Duty(191);
Enable PMW	Pwm_Start();
Receive Usart data	int a = Usart_Read();
Transmit Usart data	int a = 100; Usart_Write(a);
Write Data to EEPROM	Eeprom_Write(address, data)
Read from EEPROM	int a; a = eeprom_read(address);

Looping For	Unsigned int i;
	for (i=1;i<=10;i++)
	{
	??????
	}

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RUJUKAN IV

Special Function Registers

INTCON REGISTER (ADDRESS 0Bh, 8Bh, 10Bh, 18Bh)

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	PEIE	TMR0IE	INTE	RBIE	TMR0IF	INTF	RBIF
bit 7							bit 0

bit 7 **GIE:** Global Interrupt Enable bit
1 = Enables all unmasked interrupts
0 = Disables all interrupts
bit 5 **TMR0IE**: TMR0 Overflow Interrupt Enable bit
1 = Enables the TMR0 interrupt
0 = Disables the TMR0 interrupt
bit 4 **INTE**: RB0/INT External Interrupt Enable bit
1 = Enables the RB0/INT external interrupt
0 = Disables the RB0/INT external 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 **INTF**: RB0/INT External Interrupt Flag bit
1 = The RB0/INT external interrupt occurred (must be cleared in software)
0 = The RB0/INT external interrupt did not occur

PEPERIKSAAN AKHIR

SEMESTER/SESI	: II/2011/12	PROGRAM	: 3 DEE/DET / 3 DAE
KURSUS	: MIKROPENGAWAL	KOD KURSUS	: DEK3133/ DAE32203

RUJUKAN V

OPTION_REG REGISTER (ADDRESS 81h, 181h)

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
$\overline{\text{RBPU}}$	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0
bit 7							bit 0

RBPU: PORTB Pull-up Enable bit
1 = PORTB pull-ups are disabled
0 = PORTB pull-ups are enabled by individual port latch values
bit 6 **INTEDG**: Interrupt Edge Select bit
1 = Interrupt on rising edge of RB0/INT pin
0 = Interrupt on falling edge of RB0/INT pin
bit 5 **T0CS**: TMR0 Clock Source Select bit
1 = Transition on RA4/T0CKI pin
0 = Internal instruction cycle clock (CLKO)
bit 4 **T0SE**: TMR0 Source Edge Select bit
1 = Increment on high-to-low transition on RA4/T0CKI pin
0 = Increment on low-to-high transition on RA4/T0CKI pin
bit 3 **PSA**: Prescaler Assignment bit
1 = Prescaler is assigned to the WDT
0 = Prescaler is assigned to the Timer0 module
PS2:PS0: Prescaler Rate Select bits

Bit Value	TMR0 Rate	WDT Rate
000	1 : 2	1 : 1
001	1 : 4	1 : 2
010	1 : 8	1 : 4
011	1 : 16	1 : 8
100	1 : 32	1 : 16
101	1 : 64	1 : 32
110	1 : 128	1 : 64
111	1 : 256	1 : 128

PEPERIKSAAN AKHIR

SEMESTER/SESI : II/2011/12
KURSUS : MIKROPENGAWAL
PROGRAM : 3 DEE/DET / 3 DAE
KOD KURSUS : DEK3133/ DAE32203

RUJUKAN VI

REGISTER 11-2: ADCON1 REGISTER (ADDRESS 9Fh)

R/W-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	ADCS2	—	—	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

bit 7 **ADFM:** A/D Result Format Select bit
1 = Right justified. Six (6) Most Significant bits of ADRESH are read as '0'.
0 = Left justified. Six (6) Least Significant bits of ADRESL are read as '0'.

bit 6 **ADCS2:** A/D Conversion Clock Select bit (ADCON1 bits in shaded area and in bold)

ADCON1 <ADCS2>	ADCON0 <ADCS1:ADCS0>	Clock Conversion
0	00	Fosc/2
0	01	Fosc/8
0	10	Fosc/32
0	11	FRC (clock derived from the internal A/D RC oscillator)
1	00	Fosc/4
1	01	Fosc/16
1	10	Fosc/64
1	11	FRC (clock derived from the internal A/D RC oscillator)

bit 5-4 **Unimplemented:** Read as '0'

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

PCFG <3:0>	AN7	AN6	AN5	AN4	AN3	AN2	AN1	AN0	VREF+	VREF-	C/R
0000	A	A	A	A	A	A	A	A	VDD	VSS	8/0
0001	A	A	A	A	VREF+	A	A	A	AN3	VSS	7/1
0010	D	D	D	A	A	A	A	A	VDD	VSS	5/0
0011	D	D	D	A	VREF+	A	A	A	AN3	VSS	4/1
0100	D	D	D	D	A	D	A	A	VDD	VSS	3/0
0101	D	D	D	D	VREF+	D	A	A	AN3	VSS	2/1
011x	D	D	D	D	D	D	D	D	—	—	0/0
1000	A	A	A	A	VREF+	VREF-	A	A	AN3	AN2	6/2
1001	D	D	A	A	A	A	A	A	VDD	VSS	6/0
1010	D	D	A	A	VREF+	A	A	A	AN3	VSS	5/1
1011	D	D	A	A	VREF+	VREF-	A	A	AN3	AN2	4/2
1100	D	D	D	A	VREF+	VREF-	A	A	AN3	AN2	3/2
1101	D	D	D	D	VREF+	VREF-	A	A	AN3	AN2	2/2
1110	D	D	D	D	D	D	D	A	VDD	VSS	1/0
1111	D	D	D	D	VREF+	VREF-	D	A	AN3	AN2	1/2

A = Analog input D = Digital I/O
C/R = # of analog input channels/# of A/D voltage references