FNU FIJI NATIONAL UNIVERSITY

Final Examination

College	Engineering, Science & Technollogy
School	Electrical & Electronics Engineering
Programme	Advanced Diploma in Electrical/Electronics Engineering
Semester	II
Year	2016
Unit Code	EEE612
Unit Title	Electronic Technology (Microcontroller)
Date of Examination	TBA
Time	TBA
Venue	TBA
Duration	3 Hours *(extra 10 mins allowed to read the paper)*
Maximum Marks	100

Instructions

1. There are five (5) questions worth 20 marks each. Attempt all questions in the answer booklet.
2. Write your answers legibly in the answer booklet.
3. Write your student identification number on each page used.
4. A PIC16F877 assembly instruction set is provided on the last page.

Question 1 *(20 Marks)*

(a) In your own words explain what a microprocessor (CPU) is and what it does? (2)

(b) Draw a clearly labeled generalized microprocessor block diagram showing *all* the components. (3)

(c) Calculate the number of words of memory that can be accessed by a microprocessor with 13-bit address bus. (1)

(d) What is the purpose of the following bus control lines in a microprocessor

i. BR (Bus Request) (1)

ii. BG (Bus Grant) (1)

iii. LOCK (1)

(e) Explain the purpose of the following registers in any microprocessor:

i. Status register (2)

ii. Stack pointer (2)

iii. Accumulator (1)

(f) Explain the significance of address bus and data bus in the external interface of a microprocessor and how it contributes to the performance of the microprocessor? (4)

(g) Explain what a non-maskeable interrupt is? (2)

Question 2 *(20 Marks)*

(a) Define the following:

i. PIC (1)

ii. RISC (1)

(b) What is the main difference between Microchip's mid-range and baseline category of microcontrollers? Which category does the PIC16F877 micrcontroller belong to? (2)

(c) What is the maximum sink/source current on any pin in PIC16F877? (1)

(d) What is the size of data memory in PIC16F877? (1)

(e) Give two peripheral features of PIC16F877? (2)

(f) With the aid of a diagram outline the difference between Harvard architecture and von-Neumann memory architecture? (3)

(g) Describe the instruction pipeline of the PIC16F877 microcontroller. (2)

(h) Which bits of the status register are bank select bits for direct addressing? (1)

(i) What should be the values of bank select bits to select bank 2? (1)

(j) The following questions are related to your projects completed as part of EEE612 course work

i. What is the title of your project? (½)

ii. Name the most important component/part of your project? (½)

iii. With the aid of a block diagram, discuss the overall functionality your project? (4)

Question 3 (*20 Marks*)

(a) Some EEE612 students were required to interface an LED to pin C0 of the PIC16F877 microcontroller. Assume that the LED forward voltage V_F is 2 V and forward current (continuous) I_F is 20 mA.

i. Draw a schematic diagram showing the LED connection to PIC16F877 using sinking (or active low) method. (2)

ii. Draw a schematic diagram showing the LED connection to PIC16F877 using sourcing (or active high) method. (2)

iii. Determine the size of the LED protection resistor. (2)

(b) Some EEE612 students were required to interface a push button switch to pin E0 of PIC16F877 such that when pressed, pin E0 becomes logic 'low' otherwise it stays logic 'high'.

i. Initially it was suggested to interface the push button switch as shown in Fig. 1. Explain why this is not the correct way to interface the switch. (2)

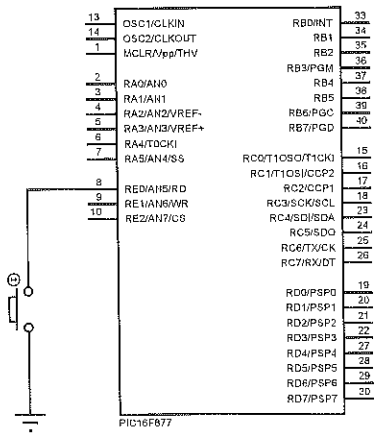

Figure 1: Push button switch connection

ii. Another solution was suggested to interface the push button switch as shown in Fig. 2. Explain why this is not the correct way to interface the switch either. (2)

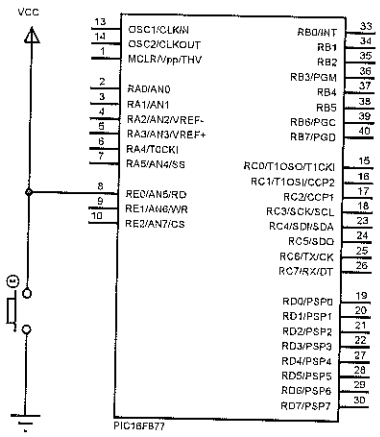

Figure 2: Push button switch connection

iii. With the aid of a schematic diagram, explain the correct way of interfacing the push button switch. (3)

iv. A common problem when interfacing switches to the microcontroller is the switch contact bounce problem. Explain in your own words how this problem occurs? (2)

(c) Some EEE612 students connected two common cathode 7-Segment displays to PIC16F877 microcontroller as shown in Fig. 3. The 7-segment data lines are connected to port B and the two control lines are connected to pin D5 and pin D7.

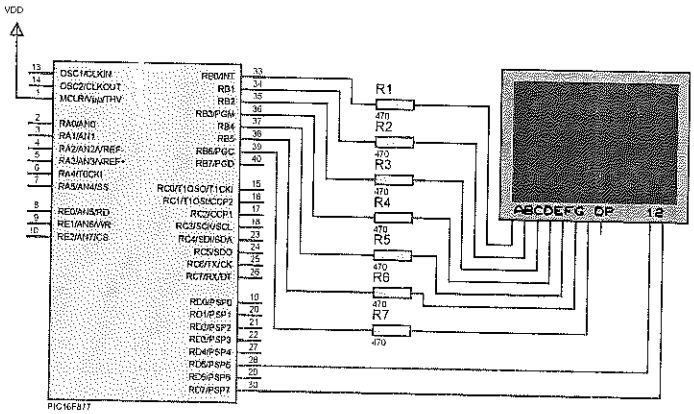

Figure 3: Schematic showing 7-segment display connection

i. While writing a program in C language to display numbers on the two 7-segment displays, the students created a driver to display numbers from 0 to 9 on each segment. Write down the code for this driver which is a constant array of type 'byte'. (Note that the driver is for common cathode 7-segments) (3)

ii. Since both the displays are connected to the same data port (port B), explain how the 7-Segment program will display two different numbers on each of the displays at the same time? (2)

Question 4 *(20 Marks)*

(a) Outline with the aid of diagrams the instruction format of the three categories of instructions in the PIC16F877 instruction set. (8)

(b) Explain what Q-cycle activity is? (2)

(c) Calculate the period of Q-cycle (T_{osc}) and the period of the instruction cycle (T_{cy}) if the device oscillator frequency (F_{osc}) of PIC16F877 is 20MHz. (2)

(d) Which bits of the status register are affected by the following instructions?

i. addwf (1)

ii. rlf (1)

(e) Write a two instruction assembly code that will copy the data 0x3B to the register PORTB in bank 0. (2)

(f) Write a simple 4-instruction assembly code that will make port B an input port. (4)

Question 5 *(20 Marks)*

(a) The schematic diagram in Fig. 4 shows a variable resistor connected to pin A0 of PIC16F877 microcontroller. It also shows a 16 × 2 character LCD display connected to the digital pins of the microcontroller. Using a program the ADC of the microcontroller is configured to be 8-bits and range of analog voltage is set between 0V-5V. This program reads the analog value on pin A0 of the microcontroller and converts it into a digital value (int) and displays this value on the LCD.

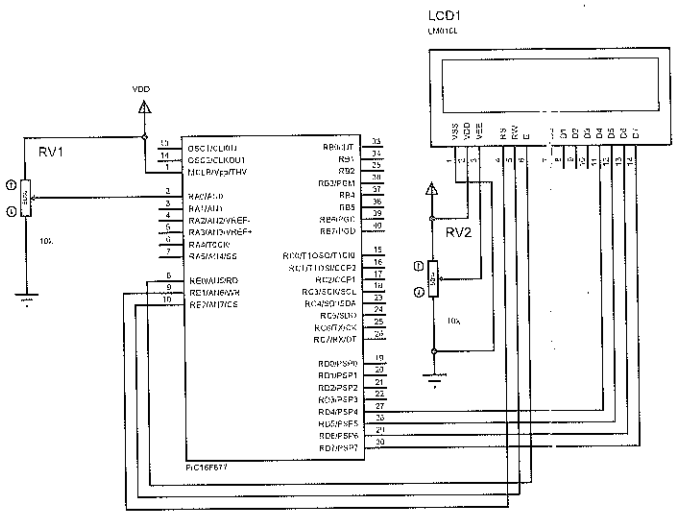

Figure 4: Schematic showing lcd and pot connection

i. Derive an equation for conversion from digital value (in decimal) to analog voltage value. (3)

ii. Using the derived equation, calculate the value of the analog voltage on pin A0 if the LCD display displays a digital value of 44. (3)

iii. Name another pin apart from pin A0 of the PIC16F877 microcontroller that can be used to read analog voltages? (1)

(b) Using C programming some students configured the PIC16F877 timer 1 as follows (2)

```
setup_timer_1(T1_INTERNAL | T1_DIV_BY_1);
set_timer_1(0);
```

Assuming that the device oscillator of PIC16F877 is 20MHz ($F_{osc} = 20MHz$), what time will it take timer 1 to overflow? (Note: Timer 1 is 16 Bits)

(c) How would the time change in the previous question if T1_DIV_BY_2 was used instead? (2)

(d) Name three sources of interrupts on PIC16F877. (3)

(e) Which pins of PIC16F877 can be used to generate PWM signal? (2)

(f) When creating a program to generate PWM output, some students use the following line in their code to set up timer 2. (4)

```
setup_timer_2(T2_DIV_BY_16,106,1)
```

Calculate the frequency of the PWM signal generated if $F_{osc} = 20MHz$.

The End
Happy Holidays!

TABLE 13-2: PIC16F87X 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	TO,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	TO,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`.

Note: Additional information on the mid-range instruction set is available in the PICmicro™ Mid-Range MCU Family Reference Manual (DS33023).