



UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF INFORMATION TECHNOLOGY

FINAL EXAMINATION
JANUARY 2016 SEMESTER

SUBJECT CODE : IBB22203
SUBJECT TITLE : MICROCONTROLLER
LEVEL : BACHELOR
TIME / DURATION : (2 ½ HOURS) 2.00 pm – 4.30 pm
DATE : 28 MAY 2016

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consists of TWO (2) sections.
4. Answer ALL questions in Section A. Answer THREE (3) questions in Section B.
5. Please write your answers on the answer booklet provided.
6. Answer all questions in English.

THERE ARE 10 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer all SIX (6) Questions
Please use the answer booklet provided.

Question 1

Harvard Architecture and Von Nuemann Architecture are two widely used computer architectures. Compare and contrast these two architectures.

(6 marks)

Question 2

For the following C program:

```
void main()
{
    int x, y;
    x = 5;
    y = (x++) + 5;
}
```

What are the values of x and y after the above C code was executed?

(6 marks)

Question 3

LED (Light Emitting Diode) and buzzer are two commonly used output components in microcontroller systems. Based on schematic diagram in Figure 1, which LED emits light, which does not? Which buzzer beeps, which does not?

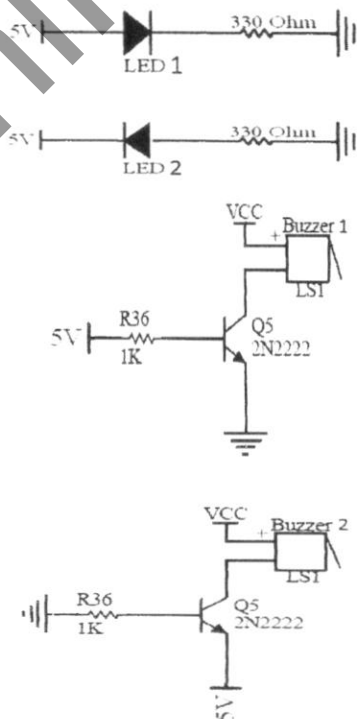


Figure 1: LEDs and Buzzer

(10 marks)

Question 4

Name the any **TWO (2)** types of memory used in microcontroller PIC16F877A. Which is used to store data, which is used to store code?

(6 marks)

Question 5

Name and briefly describe any **THREE (3)** actuators (motors) used in microcontroller systems.

(6 marks)

Question 6

In C program language, "continue" statement causes program to jump back to the beginning of a loop. Following is a C code segment, where symbol SW1 is used to store the status of a switch. The value SW1 is 1 if the switch is not pressed, otherwise, the value is 0.

```
int main(void)
{
    unsigned int step_period = 0; // to store period of stepper phase
    unsigned char direction = 0, step = 0;

    while(SW1 == 1) continue;
    step_period = 300;
    direction = 1;
    step = 5;
}
```

a. For above code segment, if SW1 has never been pressed, what are the values of variable step_period, direction, and step?

(3 marks)

b. If SW1 has been pressed, what are the values of variable step_period, direction, and step?

(3 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: There Are FOUR (4) Questions in this Section. Answer any THREE (3) Questions.

Please use the answer booklet provided.

Question 7

Stepper motor is an useful actuator in robotics application due to its feature of step to step rotation. Stepper motor has several drive methods (wave, full step, and half step). As shown in Figure 2, 5 pins (RC2, RB4, RB5, RB6 and RB7) of microcontroller PIC16F877A are used to control stepper motor. Table 1 shows the ways to drive the stepper motor in wave mode.

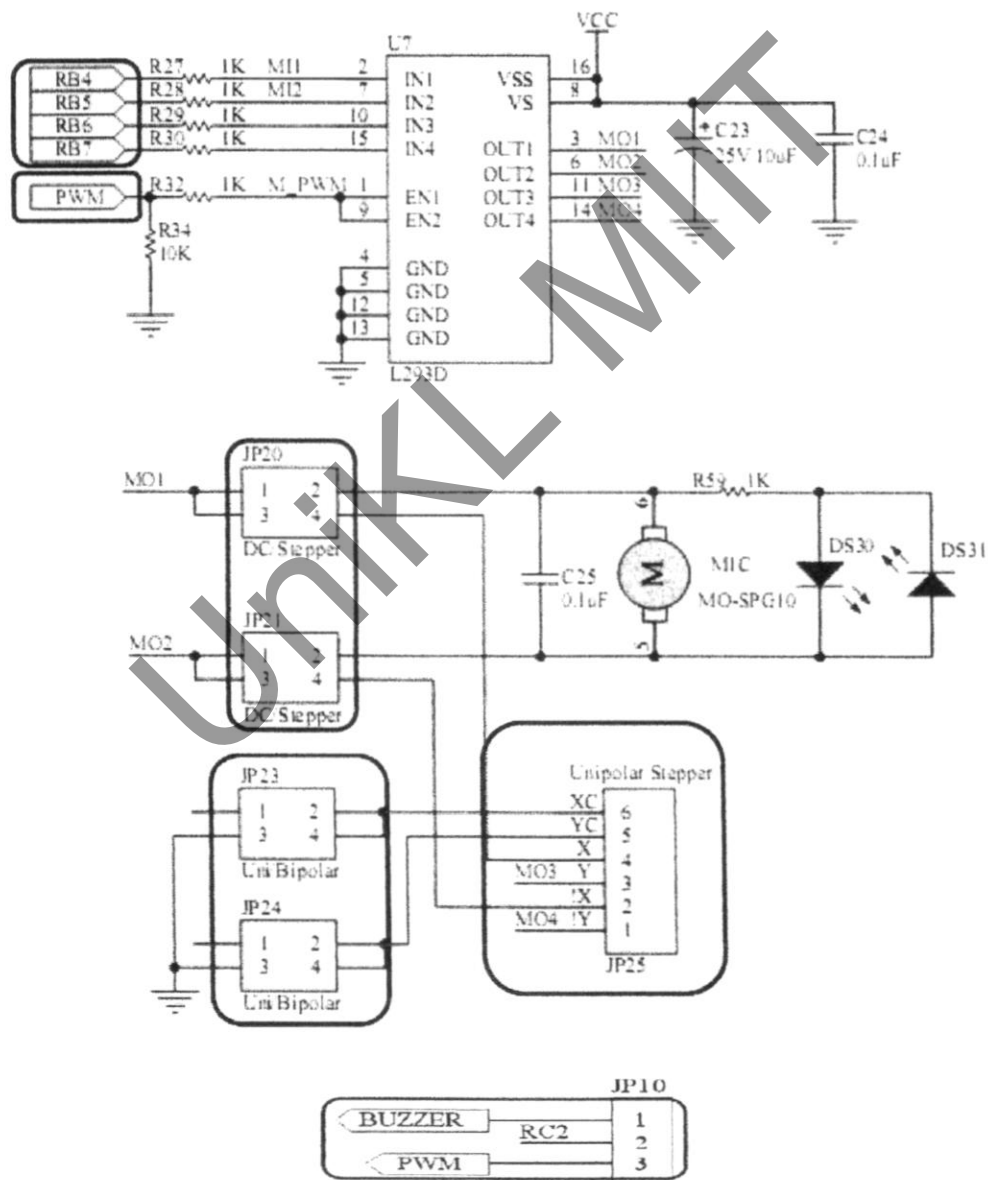


Figure 2: Stepper Motor Interface Circuit

Table 1: Stepper Motor Wave Drive

Stepper Phase	PIC Pin	Step 1	Step 2	Step 3	Step 4
X	RB4	ON	OFF	OFF	OFF
Y	RB6	OFF	ON	OFF	OFF
XN	RB5	OFF	OFF	ON	OFF
YN	RB7	OFF	OFF	OFF	ON

Partial code of lab_main.c is as following.

```

#include <htc.h>
#include "system.h"
#include "adc.h"
#include "lcd.h"
#include "pwm.h"

void delay_ms(unsigned int ui_value);
void beep(unsigned char uc_count);

char string_buffer[40] = {0};

int main(void)
{
    unsigned char speed = 0;           // to store speed value
    unsigned int step_period = 0;      // to store period of stepper phase
    unsigned char direction = 0, step = 0;
    // Code Segment 1 Start
    PORTA = 0;
    PORTB = 0;
    PORTC = 0;
    PORTD = 0;
    PORTE = 0;
    // Code Segment 1 end

    // Code Segment 2 Start
    TRISA = 0b00010001;
    TRISB = 0b00001111;
    TRISC = 0b10010011;
    TRISD = 0;
    TRISE = 0;
    //Code Segment 2 END

    // Set AN0 only as analog input.
    adc_initialize();

    // initialize LCD
    lcd_initialize();

    //Code Segment 3 Start
    beep(2);                          //beep twice to indicate program started
    LCD_BACKLIGHT = 1;                 //activate LCD Back light
    lcd_putstr("Stepper Motor \nLab");
    //Code Segment 3 End

    while(SW1 == 1)continue;           //wait for SW1 to be pressed
    L293_EN = 1;                       // Enable the L293 driver

```

```

while(1)
{
    //Code Segment 4 Start
    X = 1;           // step 1
    Y = 0;
    XN = 0;
    YN = 0;
    delay_ms(300);

    X = 0;           // step 2
    Y = 1;
    XN = 0;
    YN = 0;
    delay_ms(300);
    //Code Segment 4 End

    //Code Segment 5 Start
    X = 0;           // step 3
    Y = 0;
    XN = 1;
    YN = 0;
    delay_ms(300);

    X = 0;           // step 4
    Y = 0;
    XN = 0;
    YN = 1;
    delay_ms(300);
    //Code Segment 5 End
}
while(1) continue;
}

void delay_ms(unsigned int ui_value)
{
    while (ui_value-- > 0)
    {
        __delay_ms(1); // must not over 39ms
    }
}

void beep(unsigned char uc_count)
{
    while (uc_count-- > 0)
    {
        BUZZER = 1;
        delay_ms(50);
        BUZZER = 0;
        delay_ms(50);
    }
}

```

Based on above statement, answer the following questions.

a. In code of lab_main.c, there are **FIVE (5)** code segments marked between "Code Segment x Start" and "Code Segment x End". What are the functions of these five code segments?

(15 marks)

b. Draw the flow chart based on the code of lab_main.c

(5 marks)

[Total: 20 marks]

Question 8

RC (Radio Control) servo motors are controlled by continuous pulses of variable width. The parameters for these pulses are pulse width and period. The signal period should be 20 ms (millisecond), as shown in Figure 3. As Figure 4 shows, given the rotation constraints of the RC servo (only 180 degree), when the pulse width is 1.5 ms, the motor is at neutral position with 90 degree. When a pulse width is less than 1.5 ms the servo rotates to a position some number of degrees anti-clockwise from the neutral point. When the pulse is wider than 1.5 ms the opposite action occurs.

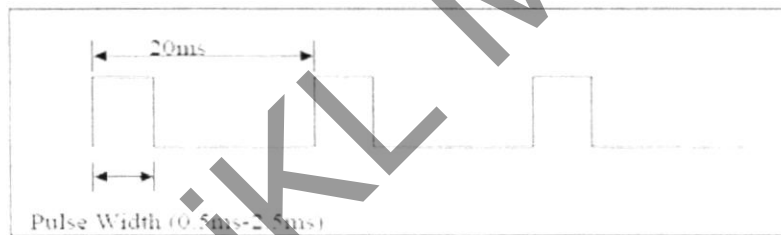


Figure 3: Continuous Pulses to RC Servo Motor

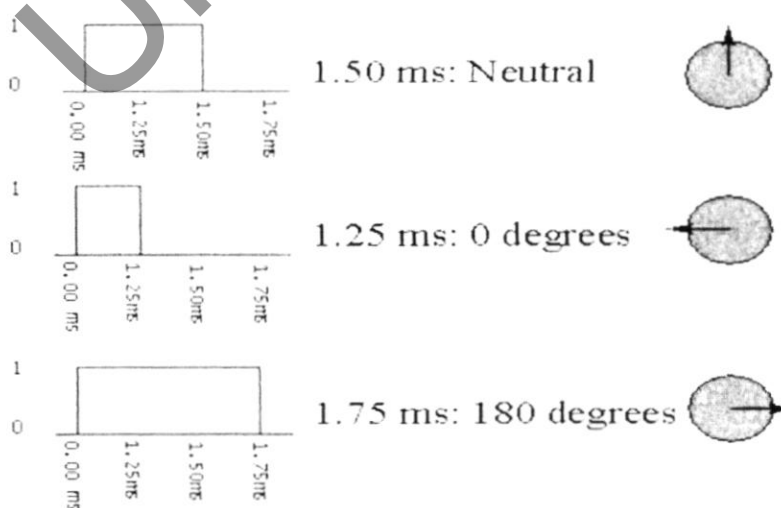


Figure 4: Positions and Pulses of Servo Motor

Followings are the partial code of header file system.h and C source file lab_main.c.

```

system.h
#define SERVO    RE2

lab_main.c

#include <htc.h>
#include "system.h"
#include "adc.h"

void delay_10us(unsigned char uc_value);
void delay_ms(unsigned int ui_value);
void beep(unsigned char uc_count);

int main(void)
{
    unsigned char angle = 0;    // declare a variable to store angle
    // ensure all the hardware port in zero initially
    PORTA = 0;
    PORTB = 0;
    PORTC = 0;
    PORTD = 0;
    PORTE = 0;

    // Initialize the I/O port direction, this must be configured according to circuit
    TRISA = 0b00010001;
    TRISB = 0b00001111;
    TRISC = 0b10010011;
    TRISD = 0;
    TRISE = 0;

    while(1)    // create an infinite loop
    {
        SERVO = 1;    // Servo pin HIGH
        delay_10us(1);    // wait for a while
        angle = ui_adc_read() >> 2;    // read adc value, from potential meter
        if ((angle > 0) && (angle <= 100))
        {
            delay_10us(angle);    // delay extra depend on adc value from
            // potential meter
        }
        SERVO = 0;    // Servo pin LOW
        delay_ms(18);    // delay for around 18ms
    }
    while(1) continue;
}

```

Based on above code, answer the following questions.

a. Which I/O pin of microcontroller is used to control the servo motor? Should this pin be initialized as input or output?

(3 marks)

b. What are the main functions of the above program?

- (5 marks)
- c. What are the largest value and smallest value of variable "angle"? (3 marks)
- d. If the value of "angle" is 100, determine the pulse width and period of the pulses outputted from the microcontroller. (3 marks)
- e. What components of the training board PTK40A are used by this program? (3 marks)
- f. What units of the PIC microcontroller are used by this program? (3 marks)

[Total: 20 marks]

Question 9

In training board PTK40A, some I/O (Input/Output) pins of microcontroller PIC16F877A are connected to LEDs and the buzzer.

- a. With the buzzer which connected to RC2 and the 3 LEDs that connected to RD5, RD6, and RD7, design **TWO (2)** different LEDs blinking patterns including buzzer. (6 marks)
- b. Figure 5 is the flow chart which shows using switch SW1 and SW2 to control LEDs and the buzzer with patterns you designed in question (a). Write C code according to this flow chart.

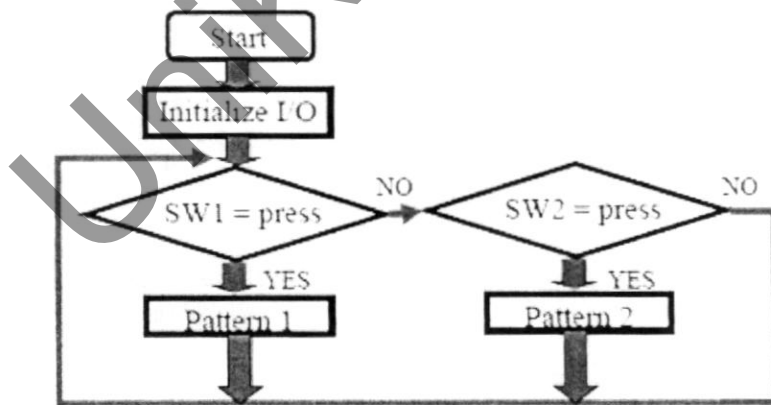


Figure 5: Pattern Control Flow Chart

You can call the following two functions.

```

void delay_ms(unsigned int ui_value)
{
    while (ui_value-- > 0)
    {
        __delay_ms(1);
    }
}
  
```

```

void beep(unsigned char uc_count)
{
    while (uc_count-- > 0)
    {
        BUZZER = 1;
        delay_ms(50);
        BUZZER = 0;
        delay_ms(50);
    }
}
    
```

(14 marks)

[Total: 20 marks]

Question 10

DC brush motor is the most common and easy-to-control actuator which is usually used in many types of machines and automation systems. In the training board, motor driver L293D, as shown in Figure 6, is employed to control the DC brush motor.

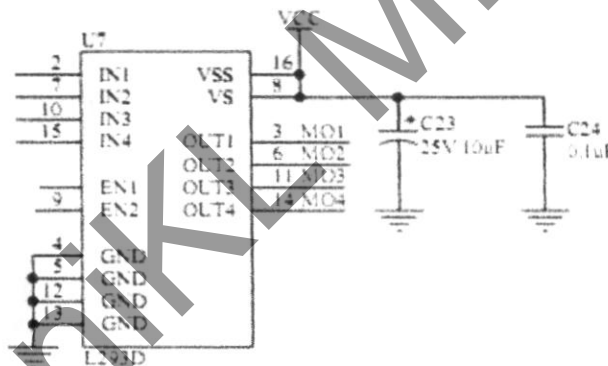


Figure 6: DC Brush Motor Driver

- Design an system with microcontroller PIC16F887A so that the microcontroller can control the motor driver L293D. You need to state how to connect I/O ports and pins of the microcontroller to pins of the motor driver. (7 marks)
- Based on your design in question (a), how to initialize corresponding ports and pins of microcontroller PIC16F877A? What are the initial values that should be assigned to data registers PORTA, PORTB, PORTC, PORTD, PORTE? What are the values of data direction registers TRISA, TRISB, TRISC, TRISD, and TRISE? (13 marks)

(13 marks)

[Total: 20 marks]

END OF EXAMINATION PAPER