MMME3085 solutions

Section A

```
// Solution for Q1
//
// Marking Scheme (out of 12)
//
// General
//      Comments used within code: 2 marks
//
// main() : 10 marks
//      Correct definition of variables (including sensible naming): 2
//      Value prompted for and read: 2
//      Validation of input: 2
//      Correct use of nested loops: 4


#include <stdio.h>
#include <stdlib.h>

int main()
{
    int height;
    int i,j;

    // Read in height
    printf ("Please enter the height of the triangle (in the range 1-10 )");
    scanf ("%d", &height);

    //Check height is within limit
    if ( ( height < 1 ) || ( height > 10 ))
    {
        printf ("Value for height is not in range, application will terminate");
        exit (0);
    }

    // Two nested loops to draw the shape
    for ( i = 0 ; i < height ; i++ )
    {
        for ( j = 0 ; j <= i ; j++ )
        {
            printf (" ");
        }
        printf ("##########\n");
    }
    return 0;
}
```

```
// Solution for Q2

//
// Marking Scheme (out of 20)
//
// General
//      Comments used within code: 2
//      Correct definition of structure: 1
//
// main() : 17 marks
//     Correct definition of variables (including sensible naming): 1
//     File opened with error checking 2
//     Reading until end of file: 3
//     Reading data into structure: 2
//     Test for mark within range: 2
//     Correct testing for degree class: 4
//     Displaying of results: 2
//     File closed 1


#include <stdio.h>
#include <stdlib.h>

struct Student
{
    char FirstName[20];
    char Surname[30];
    int Mark;
};

int main()
{
    FILE *fInput;

    char FileName[50];
    struct Student TestMarks;

    printf ("Please enter the name of the file to open");
    gets(FileName);

    // Check file opened successfully
    if ( ( fInput = fopen(FileName,"r")) == NULL )
    {
        printf ("ERROR: File cannot be opened, code will now terminate");
        exit (0);
    }

    // EOF must be used OR students can find file size (fseek/ftell
    while (!feof(fInput))
    {
        fscanf( fInput, "%s %s %d", TestMarks.FirstName, TestMarks.Surname, &TestMarks.Mark);
        if ( TestMarks.Mark >=0 && TestMarks.Mark <= 100 )
        {
            if ( TestMarks.Mark >= 70 )
            {
               printf( "%s %s: First Class Degree\n", TestMarks.FirstName, TestMarks.Surname);
            }
            else if ( TestMarks.Mark >= 60)
            {
                printf( "%s %s: Upper Second Class Degree\n", TestMarks.FirstName, TestMarks.Surname);
            }
            else if ( TestMarks.Mark >= 50)
            {
                printf( "%s %s: Lower Second Class Degree\n", TestMarks.FirstName, TestMarks.Surname);
            }
            else if ( TestMarks.Mark >= 40)
            {
                printf( "%s %s: Third Class Degree\n", TestMarks.FirstName, TestMarks.Surname);
            }
            else
            {
                printf( "%s %s: No degree awarded\n", TestMarks.FirstName, TestMarks.Surname);
            }
        }
        else
        {
            printf( " %s %s: Invalid mark\n", TestMarks.FirstName, TestMarks.Surname);
        }
    }

    // Must close file
    fclose(fInput);
    return 0;
}
```

```
// Solution for Q3
//
// Marking Scheme (out of 18)
//
// General
//      Comments used within code: 2 marks
//
// function() : 7 marks
//      Correct definition of variables (including sensible naming): 2
//       Test for values within range: 2
//      Calculations performed correctly: 2
//      Return method correct: 1

// main() : 9 marks
//      correct definition of variables (including sensible naming): 2
//      Values prompted for and read: 2
//      Function correctly called: 2
//       Display of correct message depending on function return value: 2
//      Display of calculated values in main to correct precision: 1


#include <stdio.h>
#include <stdlib.h>
#include <math.h>

// Vol and SurfaceArea must be (1) pointers and (2) floats, return type can be int or char
int CalcConeVolSA( float Radius, float Height, float *Vol, float *SurfaceArea )
{
    // first check for valid radius and height
    if ( Radius <= 0.0 || Height <= 0.0 )
    {
        return (-1);
    }

    float radSquared = Radius * Radius;

    *Vol = M_PI * radSquared * Height / 3.0;

    *SurfaceArea = M_PI * Radius *( Radius + sqrt(radSquared + Height*Height ) );

    // good return value
    return (0);
}

int main()
{
    float radius, height, volume, surfArea;

    // obtain parameters
    printf ("Please enter radius");
    scanf ("%f",&radius);
    printf ("Please enter height");
    scanf ("%f",&height);

    // NOTE: Validation can be done here (radius <=0 etc.)
    // however it MUST still be checked in the function
    if ( CalcConeVolSA( radius, height, &volume, &surfArea) == 0 )
    {
        printf ("The volume is %.3f m^3 and the surface area is %.3f m^2", volume, surfArea);
    }
    else
    {
        printf("Invalid inputs");
    }
    return 0;
}
```

Section B

4.

(a) The minimum linear displacement that can be measured using this setup = 100/1023 = 0.09775mm or 97.75μm.

[3 Marks]

(b) The answer is as follows:

i)

- 1 revolution of the encoder = 1/8 revolution of the ball screw.
- 1 revolution of the ball screw = 2mm of the feed drive linear movement.
- Then 1 revolution of the encoder = 1/8*2mm of the feed drive linear movement.
- 1 revolution of the encoder includes N pulses, each pulse should be corresponding to the required resolution (i.e., 10μm).
- Then

1 Pulse → 10μm

N Pulses → 1/8*2mm

- N should be at least 25.

[1 Mark each step]

ii)

- With 100 mm should be divided into M small incremental of 10μm, M=10,000
- This means that the ADC should be with n-bit where 2^n=10,000, hence n should be at least 14.

[4 Marks]

- The new resolution is 100/16383*1000 = 6.1μm.

[2 Marks]

5.

a) One possible solution of the connection is as follows:

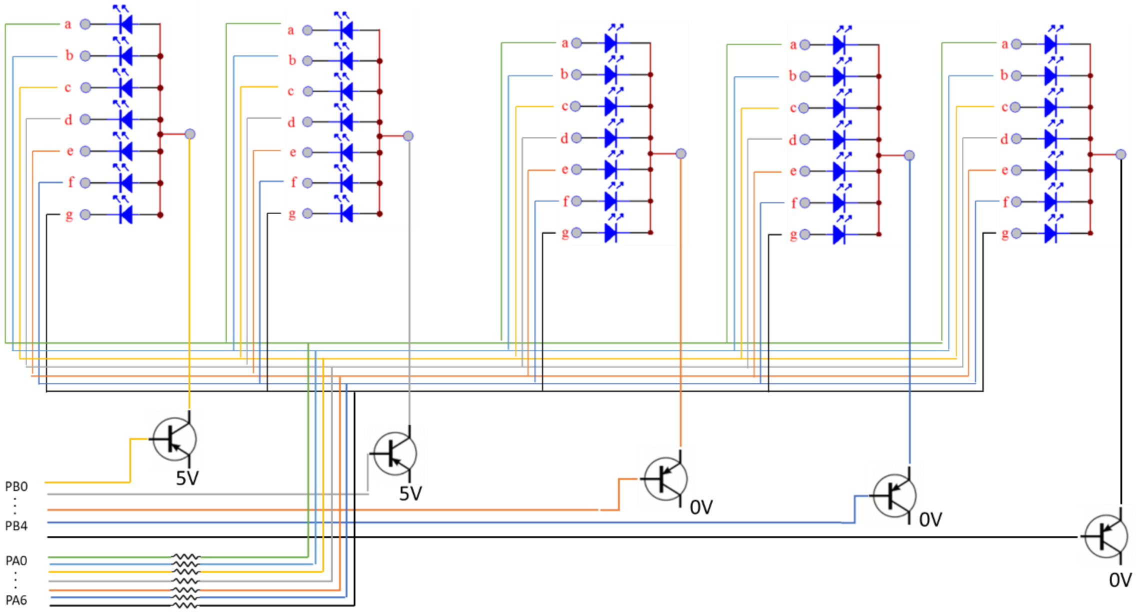

Figure A5

The marks will be given as follows:

- The concept of multiplexing

[4 Marks]

- The correct connection of the common cathodes and anodes

[3 Marks]

- The correct connection of the individual pins (a, b, c, … and g)

[3Marks]

b) The students are expected to do the following in their solution:

- Set PORT A and PORT B to be outputs (or the pins which is connected to the 7-segment display).

  [2 Marks]

- The sequence will be as follows:
  - Enable the first 7-segment display by setting PB0 to high while disabling the others by setting PB1 to low, PB2, PB3 and PB4 to high.

    [2 Marks]
  - Send the corresponding digital combination to show the first digit (i.e., for 2, Port A is 0x24 (PORTA=0x24;) and Port B 0x01(PORTB=0x01;)) to all the displays.

    [2 Marks]
  - Wait for very short time (few milliseconds)

    [2 Marks]
  - Enable the second 7-segment display by setting PB1 to high while disabling the others by setting PB0 to low, PB2, PB3 and PB4 to high.
  - Send the corresponding digital combination to show the second digit (i.e., 3) to all the displays.
  - Wait for very short time (few milliseconds)
  - …
  - Repeat the above sequence for all displays and start from beginning again and again.

    [2 Marks]

6.

- The maximum speed of the feed drive is 3 mm/s → 3/2 revolution/s on the ball screw → 3/2*8=12 revolution/s (3/2*8*60=720 RPM or 24π rad/s) on the motor shaft.

  [1 Marks]
- 12 revolution/s → 12*360/2.16=2000 step/s.

  [1 Marks]
- The maximum torque of the motor at 2000 step/s is 0.565 Nm.

  [2 Marks]
- The viscous frictional torque at 2000 step/s (720 RPM) is 0.0002*720=0.144 Nm.

  [2 Marks]
- The inertial torque is $5\text{x}10^{-3}$*acceleration.
- The acceleration = 24π/t, where t is the time to achieve the maximum speed.

  [2 Marks]
- The motor torque 0.565 Nm = The frictional torque 0.144 Nm + the inertial torque $5\text{x}10^{-3}$*24π/t, hence t = 0.8955 s.

  [3 Marks]

<u>The following figure is just to illustrate the answer and the students do not need to draw it.</u>

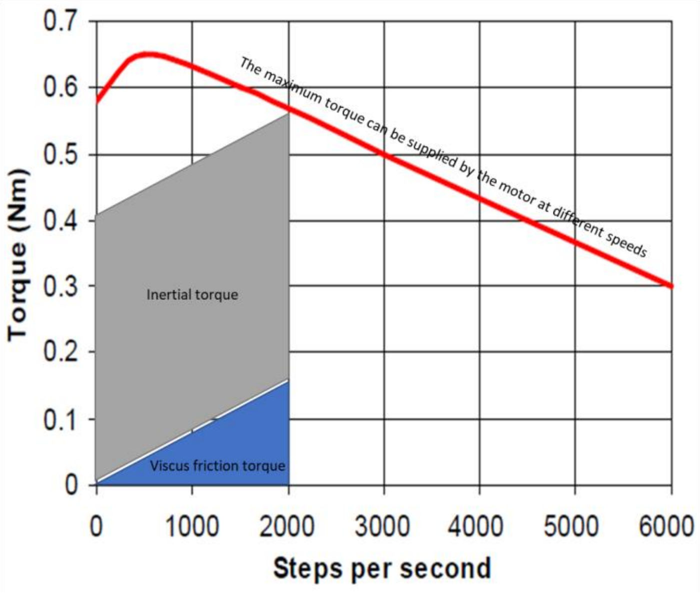

Figure A6.a

- The maximum torque of the motor at 0 step/s is 0.58 Nm which is equivalent to the maximum inertial torque. Hence 0.58 Nm = 5x10^{-3}*24π/t → t = 0.65s.

[4 Marks]

The following figure just to illustrate the answer and the students do not need to draw it.

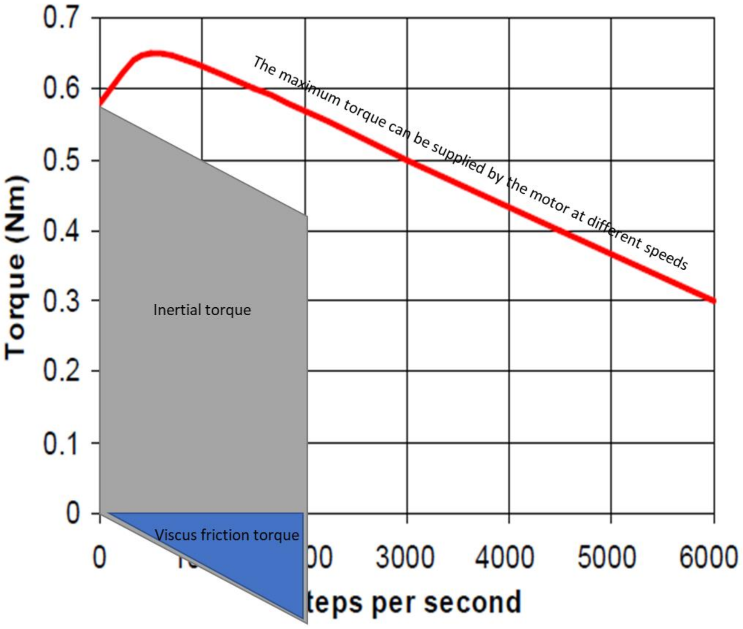

Figure A6.b