

GNG1106 Fall 2018 - Assignment 3

Available: Sept 27

Due: Oct 7, 23:59

Instructions

This assignment is to be done INDIVIDUALLY. Use the following instructions to complete and submit this assignment.

- You will need to submit your assignment electronically to Brightspace. Prepare the following
 - An assignment file in a PDF file (this allows you to use your favorite editor to create the PDF file). For question 1, insert the programming models for parts (a) and (b) filled in as per the question instructions. You may fill in the programming model using drawing features of your editor or by hand on paper which is then scanned and inserted into your document. For Question 2, insert in your assignment file the source code (take care of its appearance), and capture the output from running the program for all test cases. Also submit your **source code** files for question 2.
 - Place all your files (PDF file and C source code files) in a directory A3_xxxxxxx where xxxxxxx and your student number.
 - Zip your PDF document and the C source files in a zip file with the name A3_xxxxxx.zip where xxxxxx is your student number.
 - Submit the zip file before the assignment deadline via Brightspace. In Brightspace, navigate to the Assignment page and click on “Click to submit Assignment 3” to reach the assignment 3 submission folder. You can also select the Assignment tab to see the Assignment folder pages. The Brightspace video “Assignments” (found in the page https://documentation.brightspace.com/EN/le/assignments/learner/submit_assignments.htm) provides details to help you submit the zip file.
 - The questions are provided in both PDF and Word files. You may use the Word file to enter your answers in the document. An rtf file is also provided so that you may edit the file with a word processor other than Word. Be sure to submit a **PDF** file.
- Do start the assignment soon and do **not** wait until the last minute. You will be more efficient with a number of smaller efforts over a few weeks before the deadline than one large effort just before the deadline.

Marking Scheme (total 30 marks)

- Question 1: 15 marks
- Question 2: 15 marks

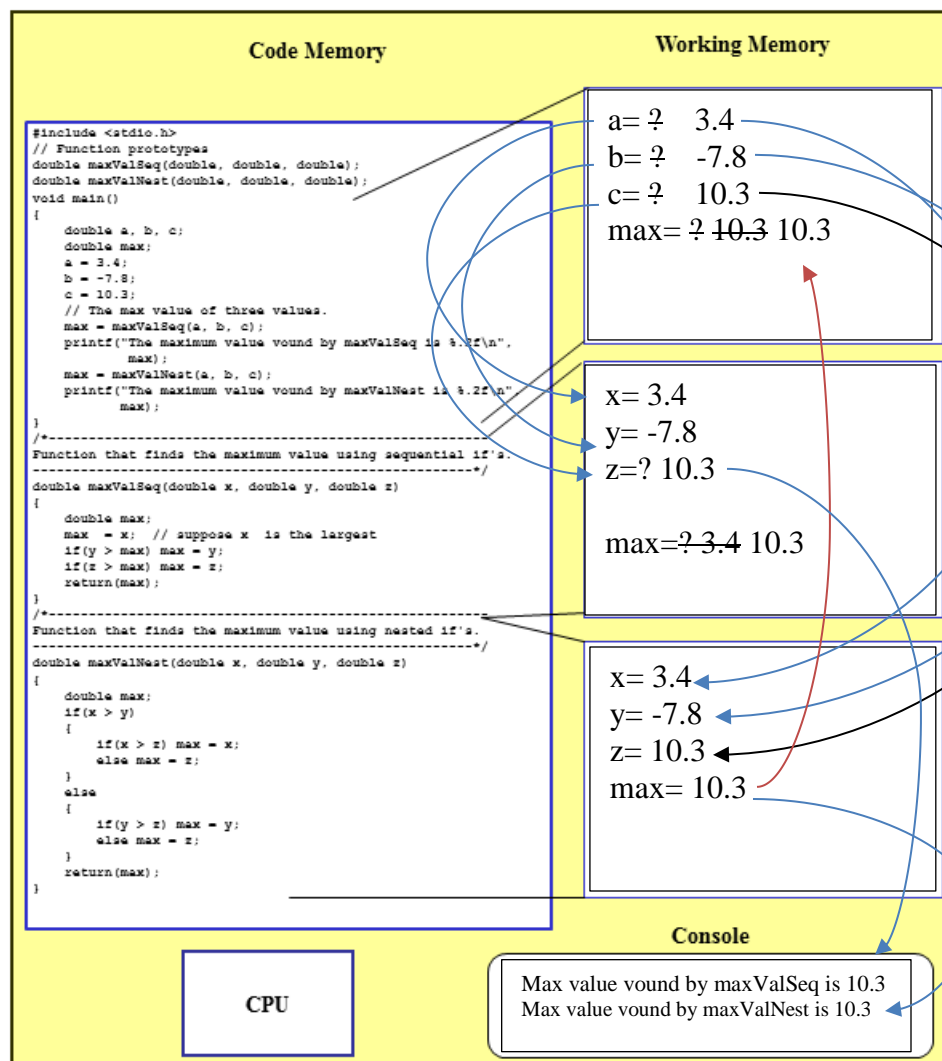
Question 1 (15 marks)

- (a) (10 points) The following programming model contains in its code memory the indicated C program composed of 3 functions: the main function and two functions that finds the maximum of 3 numbers (each which uses branching, if, instructions differently). You will be showing how the working memory is used during the execution of each function.

- Show how the variables are organized in the working memory for each function.
- Show the values are assigned to the variables. Be sure to show all values that are assigned and replaced. Record successive assignments to variables/parameters as follows (the ? indicates and unknown value):

Variable name ~~7~~, ~~2~~, ~~6~~, ~~4~~, 10

- Using arrows show how values are copied between the working memories allocated to the functions.
- In the console window show the output of the program.



(b) (5 marks) The following programming model contains in its code memory the indicated C program composed of a single function, main. You will be showing how the working memory is used during the execution of main. Show how the given C program affects the contents of the working memory:

- Show how the variables are organized in the working memory allocated to main.
- Show the values are assigned to the variables during the execution of the code (while loop and if branching instructions). Be sure to show all values that are assigned and replaced. Record successive assignments to variables/parameters as follows:

Variable name ~~2~~, ~~2~~, ~~6~~, ~~4~~, 10

Code Memory	Working Memory
<pre>#include <stdio.h> #define INC 0.3 void main() { double x, y, z; // some variables int counter; x = 2.3; y = 0.0; z = -3.4; counter = 10; while(counter >= 0) { if(counter%4 == 0) x = 4.1*y; if(counter%2 == 0) z = 0.5*y+0.25; y = y + INC; counter = counter - 2; } }</pre>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> x=2 2.3 y=2 0.0 0.3 z=2 -3.4 0.25 counter=2 10 8 </div>
<div style="border: 1px solid black; padding: 5px; display: inline-block;">UCT</div>	

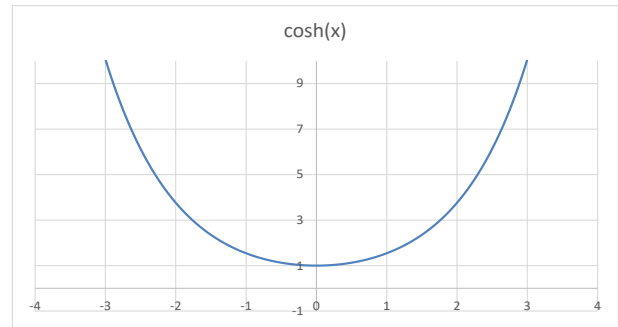
Question 2 (15 marks)

Ever wonder how the standard C math functions make their calculations. This question lets you explore how to compute hyperbolic cosine of any value of x , $\cosh(x)$. The following math infinite series gives the value of $\cosh(x)$:

$$\cosh x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \frac{x^6}{6!} + \dots = \sum_{i=0}^{\infty} \frac{x^{2i}}{(2i)!} \quad \text{Equation 1}$$

Such series serves as a basis for calculating $\cosh(x)$ in a program (i.e. in a function). To allow a computer program to calculate $\cosh(x)$, the number of terms for computing the value must be limited (it is impossible to compute an infinite number of terms). Thus the above equation is changed to:

$$\cosh x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \frac{x^6}{6!} + \dots = \sum_{i=0}^N \frac{x^{2i}}{(2i)!} \quad \text{Equation 2}$$



Develop software that meets the following requirements:

- Prompt the user for the value of x and the number of terms, n , in the series used to compute $\cosh(x)$.
 - Use a function, `getNumTerms`, to get the value for n (the function returns the value of n). The function must ensure that the user returns a value for n that is strictly positive (greater than 0). The main function shall call this function.
- Compute the value of $\cosh(x)$ using the above series and displays the results to the user.
 - Use a function, `coshyper`, to compute and return the value of $\cosh(x)$. The function receives the values of x and n . In the function use a loop to compute the values of the terms of the series and accumulate the values in a variable.
 - Given that the powers of x , x^{2i} , in the term numerator and the factorial, $(2i)!$, in the term denominator will become very large in a very few terms, calculating the values of each term separately will quickly reach the limit of the computer.
 - Use a strategy where the value of a term of equation 2 is calculated from the value of the previous term.

- The terms of the equation are numbered with i where i starts at 0: $t_0, t_1, t_2, \dots, t_N$. Thus equation 2 can be expressed as

$$\cosh x = \sum_{i=0}^N \frac{x^{2i}}{(2i)!} = \sum_{i=0}^N t_i = t_0 + t_1 + t_2 + \dots + t_N$$

$$\text{where } t_i = \frac{x^{2i}}{(2i)!}$$

- Note now that the term t_i can be computed from the previous term t_{i-1} as follows:

$$t_i = \frac{x^2}{(2i)(2i-1)} t_{i-1}$$

- The above computation does not involve the same large numbers as the numerator/denominator of the terms in Equation 2. Note that term t_0 is known to have the value 1.
 - If n is the number of terms used to calculate $\cosh(x)$, then i varies between 0 and $n-1$ (i.e. $N = n-1$ in Equation 2).
- In the function main, prompt the user to quit the program with the message “Do you wish to quit (y/n)?”, and read in a character. Repeat the above steps if the user enters ‘n’ and stop the program if the user answers ‘y’. Keep prompting the user if an invalid answer is entered (i.e. the user enters a character other than ‘y’ or ‘n’).
- Print the message “Program terminated” when the program terminates.

Respect the following guidelines:

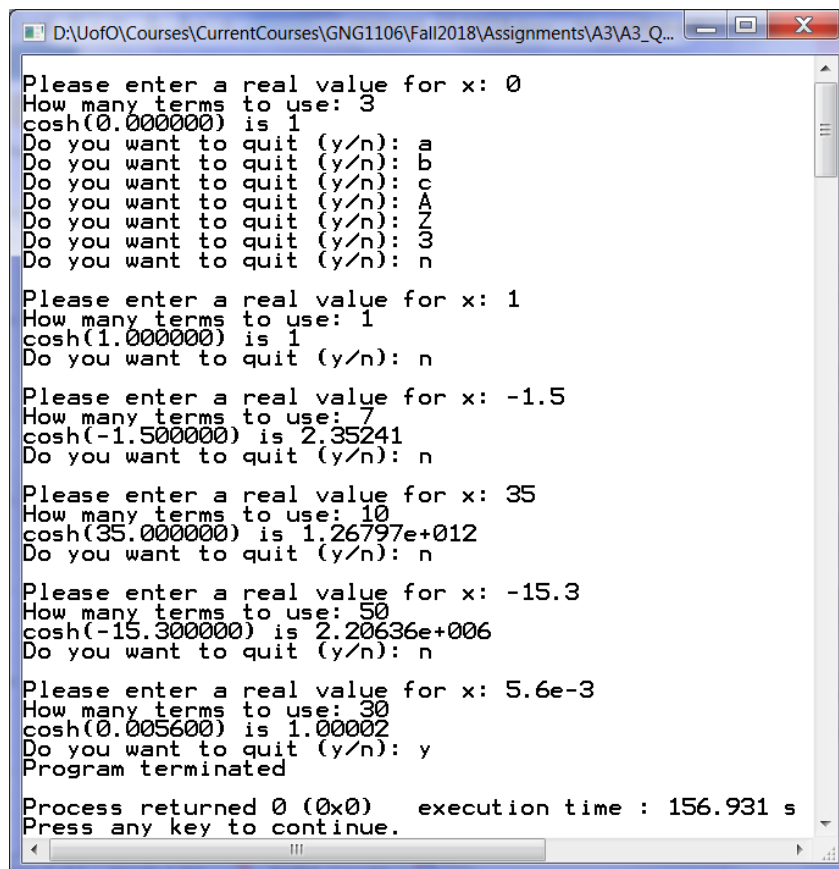
- DO NOT use arrays or structures in your answer.
- DO NOT use standard math functions in your answer.
- Recall that fflush function should be called before reading in a character input from the user.

To answer this question, please provide:

- 1) The source code to your program in a C file (DO NOT insert the source code into your assignment file, PDF file).
- 2) Insert the output for the following test cases into your assignment document. Include testing of bad values for n and the answer when prompting to quit.

x	n (number of terms)	cosh(x)
0	3	1
1	1	1.543080635
-1.5	7	2.352409615
35	10	7.93007E+14
-15.3	50	2.20636E+06
5.60E-03	30	1.00001568

Note that the values in the above table are calculated using Excel; the software may not give identical results, particularly for low value of n. The following shows a sample output that tests the above values as well as improper input.



```
D:\UofO\Courses\CurrentCourses\GNG1106\Fall2018\Assignments\A3\A3_Q...
Please enter a real value for x: 0
How many terms to use: 3
cosh(0.000000) is 1
Do you want to quit (y/n): a
Do you want to quit (y/n): b
Do you want to quit (y/n): c
Do you want to quit (y/n): A
Do you want to quit (y/n): Z
Do you want to quit (y/n): 3
Do you want to quit (y/n): n

Please enter a real value for x: 1
How many terms to use: 1
cosh(1.000000) is 1
Do you want to quit (y/n): n

Please enter a real value for x: -1.5
How many terms to use: 7
cosh(-1.500000) is 2.35241
Do you want to quit (y/n): n

Please enter a real value for x: 35
How many terms to use: 10
cosh(35.000000) is 1.26797e+012
Do you want to quit (y/n): n

Please enter a real value for x: -15.3
How many terms to use: 50
cosh(-15.300000) is 2.20636e+006
Do you want to quit (y/n): n

Please enter a real value for x: 5.6e-3
How many terms to use: 30
cosh(0.005600) is 1.00002
Do you want to quit (y/n): y
Program terminated

Process returned 0 (0x0)   execution time : 156.931 s
Press any key to continue.
```

Source code

```
#include <stdio.h>

int getNumTerms();

double coshyper(double, int);

void main()
{
    char response;

    while(response!='y')
    {
        int N = getNumTerms()-1;

        float x;

        printf ("Enter a real value for x: ");

        scanf("%f", &x);

        printf("cosh(%0.2f) is %f\n", x, coshyper(x, N)); //values of x and the function

        while (response !='y' && response !='n')
        {
            fflush(stdin);

            printf("Do you wish to quit? (y/n)"); // input of yes or no

            scanf("%c", &response);

        }
    }
}
```

```

    }

    printf("Program Terminated");

}

int getNumTerms()
{
    int n;

    do
    {
        printf("Please enter the number of terms used for calculating the hyperbolic cosine: \n");

        scanf("%d", &n);

    } while (n<=0);

    return n;
}

double coshyper (double x, int N)
{
    double t1=1;

    double t;

    double finished=t1;

    for (int i=1; i<N; i++)
    {

```

```
t=(x*x/((2*i)*(2*i-1)))*t1;
```

```
finished += t;
```

```
t1=t;
```

```
}
```

```
return finished;
```

```
}
```

Program output

```
Please enter the number of terms used for calculating the hyperbolic cosine:
3
Enter a real value for x: 0
cosh(0.00) is 1.000000
Do you wish to quit? (y/n)a
Do you wish to quit? (y/n)b
Do you wish to quit? (y/n)c
Do you wish to quit? (y/n)A
Do you wish to quit? (y/n)Z
Do you wish to quit? (y/n)3
Do you wish to quit? (y/n)n
Please enter the number of terms used for calculating the hyperbolic cosine:
1
Enter a real value for x: 1
cosh(1.00) is 1.000000
Please enter the number of terms used for calculating the hyperbolic cosine:
7
Enter a real value for x: -1.5
cosh(-1.50) is 2.352409
Please enter the number of terms used for calculating the hyperbolic cosine:
10
Enter a real value for x: 35
cosh(35.00) is 297721594059.823790
Please enter the number of terms used for calculating the hyperbolic cosine:
50
Enter a real value for x: -15.3
cosh(-15.30) is 2206356.367004
Please enter the number of terms used for calculating the hyperbolic cosine:
30
Enter a real value for x: 5.6e-3
cosh(0.01) is 1.000016
```