TOPICS IN SCIENTIFIC COMPUTING

COURSEWORK 1

November 23, 2018

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Queen Mary University of London

0.1 Question 1: Plotting Functions

The code for this question is stored in Coursework 1/Question 1

0.1.1 Question 1a:

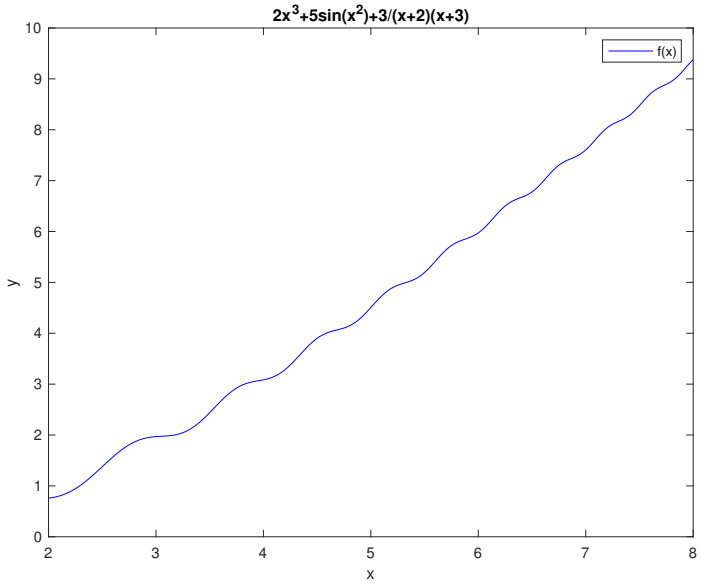


Figure 1

0.1.2 Question 1b:

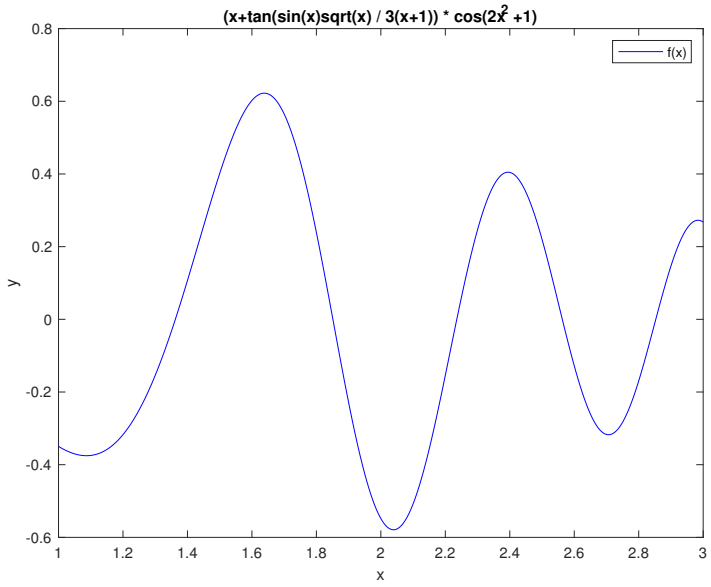


Figure 2

0.1.3 Question 1c:

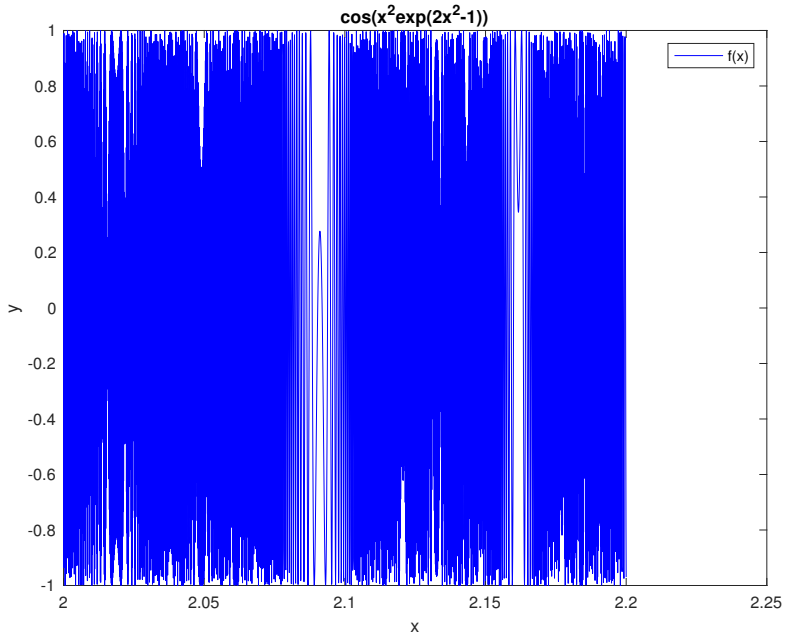


Figure 3

0.1.4 Question 1d:

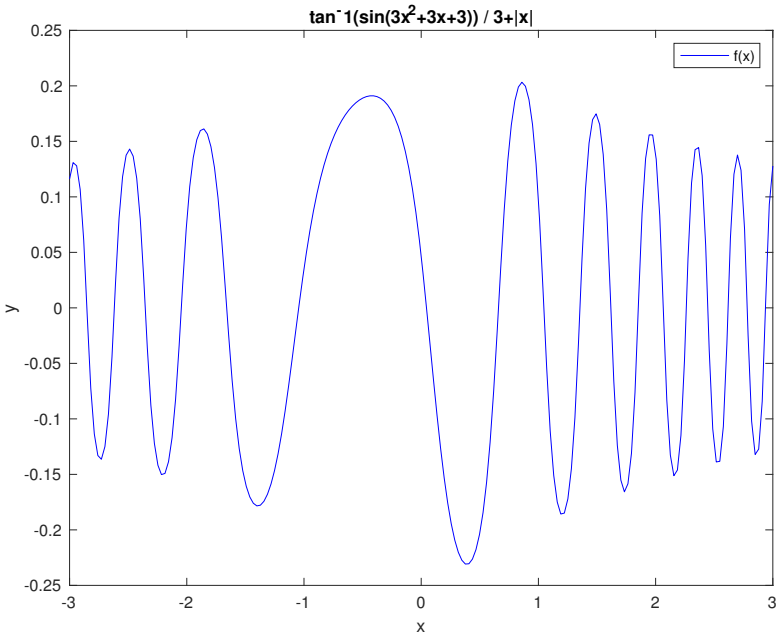


Figure 4

0.1.5 Question 1e:

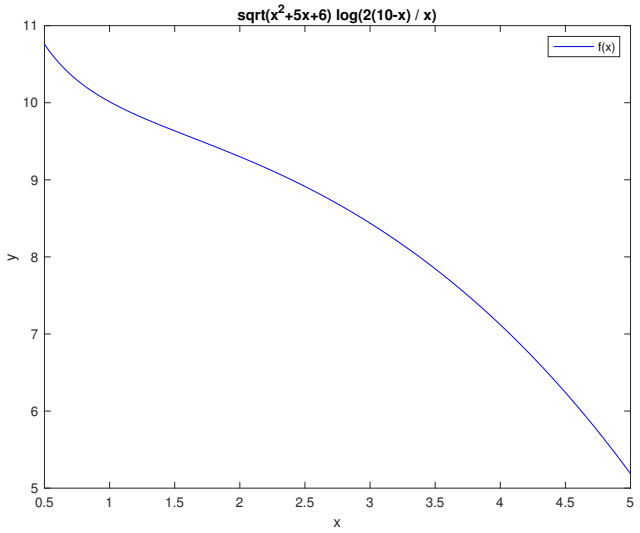


Figure 5

0.2 QUESTION 2:FUNCTIONS OF TWO VARIABLES

The code for this question is stored in Coursework 1/Question 2.
For every given $f(x,y)$ functions I have created three dimensional graphs using the surf function. The code for each of these questions are stored in folder Coursework 1/ Question 2

0.2.1 Question 2a:

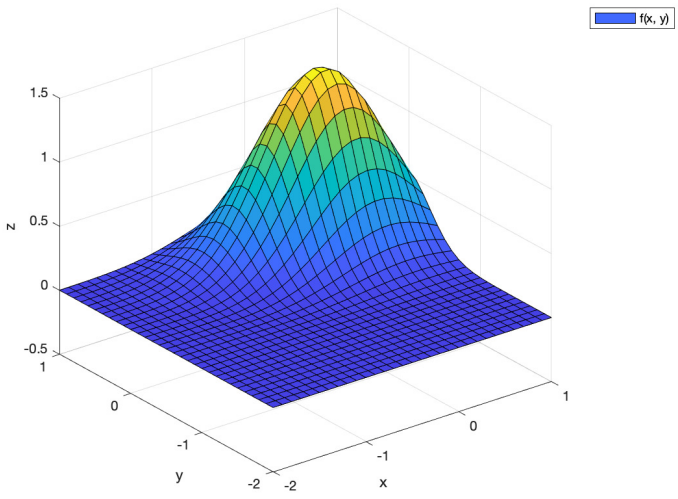


Figure 6

0.2.2 Question 2b:

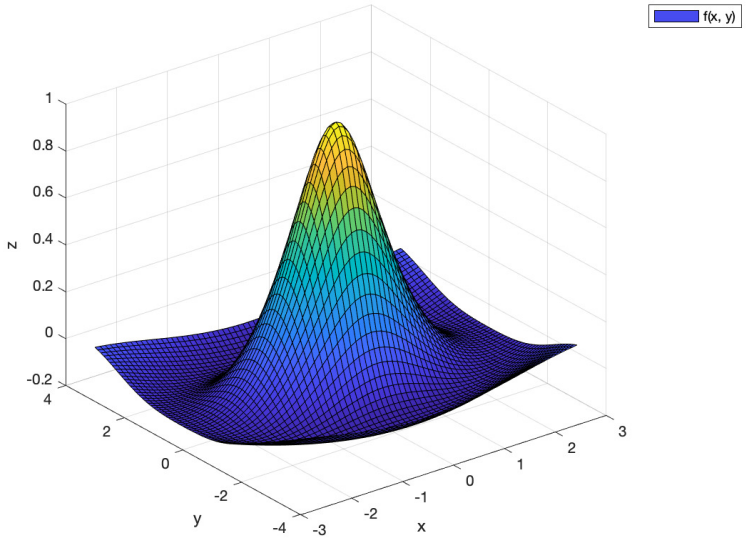


Figure 7

0.2.3 Question 2c:

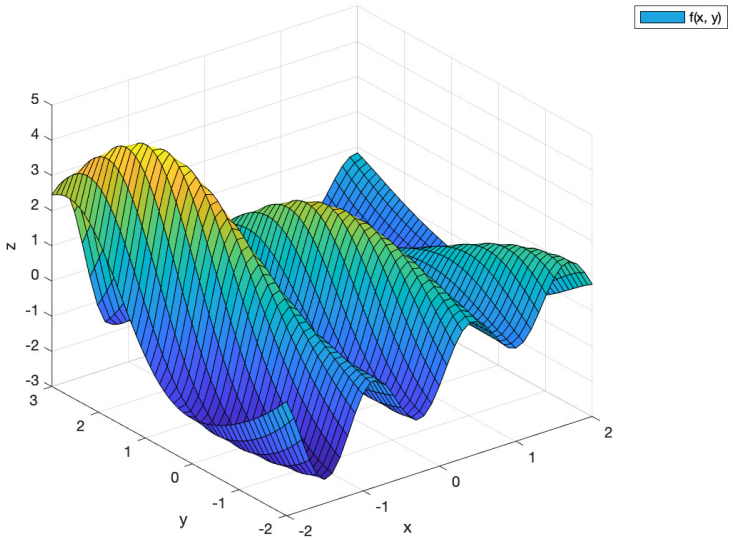


Figure 8

0.2.4 Question 2d:

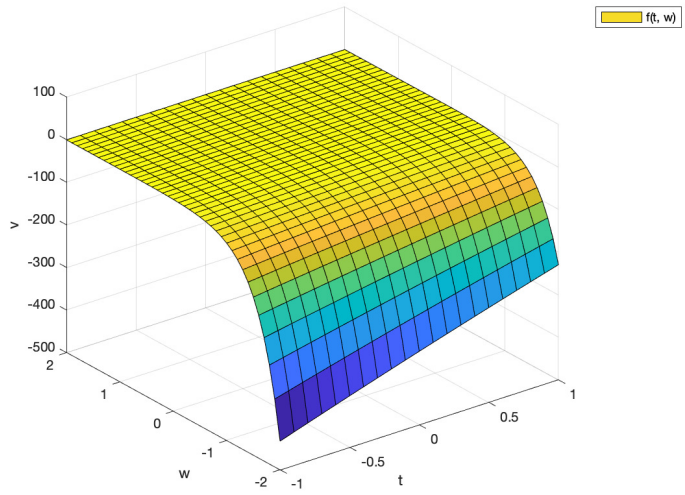


Figure 9

0.3 QUESTION 3:PARAMETRIC FUNCTIONS

The code for this question is stored in Coursework 1/Question 3

0.3.1 Question 3a:

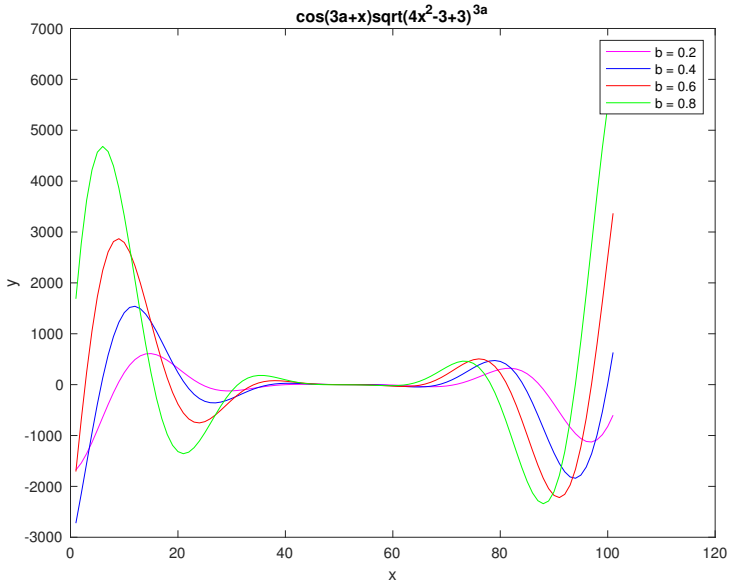


Figure 10

0.3.2 Question 3b:

Maximum and the minimum value of $f(x;a)$ for $x[-10,10]$. For this part of the question I used the mat-lab built-in functions; fMax and fMin in order to calculated the maximum and minimum value of the $f(x;a)$ function where a = 0.2, 0.4, 0.6 and 0.8.

0.3.3 Question 3c:

In this question I computed the minimum of value of a from 0 to 1, as mentioned in the question that the quantity $|maxf(x;a)$ - $minf(x;a)|$ for x from -10 to 10 is greater than 150.

0.4 QUESTION 4:FROM ORDER TO RANDOMNESS

The code for this question is stored in Coursework 1/Question 4

0.4.1 Question 4a:

For this part of the question I created a mat-lab function called $rule-90$ which takes inputs and returns output obtained by applying $rule-90$ to the input. The function begins with creating vector v with the length of N, and set the user input to be only 0's and 1's. A for-loop The code for this is saved in "Coursework-1/Question 1/rule-90.m".

0.4.2 Question 4b:

This question produces a a famous fractal figure called Sierpinski

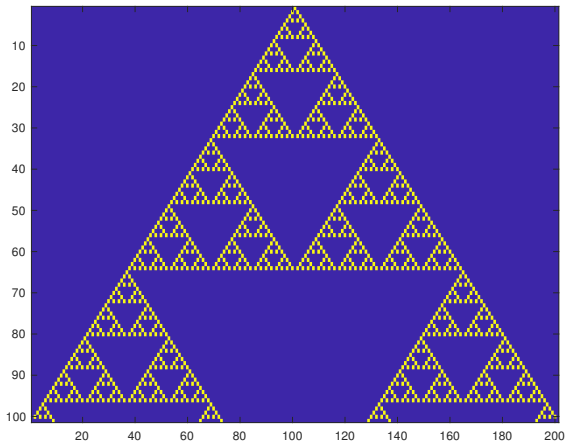


Figure 11

0.4.3 Question 4c:

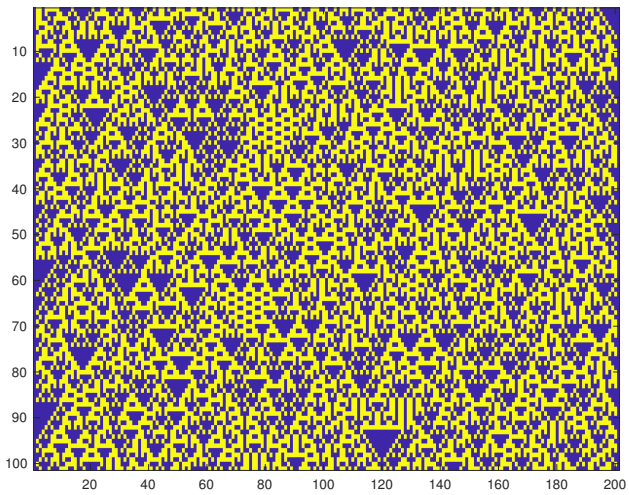


Figure 12

0.5 QUESTION 5:ABOUT PRIMES AND EVEN NUMBERS

The code for this question is stored in Coursework 1/Question 5

0.5.1 Question 5a:

For this part of the question I created an mat-lab function called $my-primes$ that takes as input a number N and outputs a vector containing all the prime numbers smaller than N. The code for this function is allocated at "Coursework-1/Question 5/my-primes.m". This code file also contains comments about how I derived the function. Figure (figure 14) below is to prove that the function is delivering the correct output.

```
>> my_primes(16)
     2     3     5     7    11    13


ans =

     2     3     5     7    11    13

>> my_primes(13)
     2     3     5     7    11    13


ans =

     2     3     5     7    11    13
```

Figure 13

0.5.2 Question 5b:

For this part I have created the functions called goldbach() and goldbach-patricians()an takes as input an even number g. and returns one Goldbach partition.

0.5.3 Question 5c:

Not Attempted

0.5.4 Question 5d:

Not Attempted

0.6 QUESTION 6: MATRIX COMPUTATIONS

The code for this question is stored in Coursework 1/Question 6. The code for 6b and c can also be found here.

0.6.1 Question 6a:

```
>> my_trace([1 1 1; 1 2 4])
error.\ input must be n by n matrix
>>
>> my_trace([1 1 1; 1 2 4; 1 3 2])

ans =

     5
```

Figure 14: result of my-trace

0.7 QUESTION 7: A SIMPLE MAP

The code for this question is stored in Coursework 1/Question 7

0.7.1 Question 7a:

In this part of the question, I created a mat-lab function called $trajectory$. This function takes 4 different inputs: which are x_0, a, b and N and returns the first N points of the trajectory of the given equation $x_{n+1} = e^{-ax_n^2} + b$. The code for this function is allocated at "Coursework-1/Question 7/trajectory.m". This code file also contains comments about how I derived the function.

0.7.2 Question 7b:

The figure below is obtained by using the function trajectory from part a. As asked in this question I set $a = 3.8$, $x_0 = -0.2$ AND $b = -0.9 to 0.9$ with space length 2 to the equation $x_{n+1} = e^{-ax_n^2} + b$. The plot contains 150 string or lines which is equal to the number of steps.

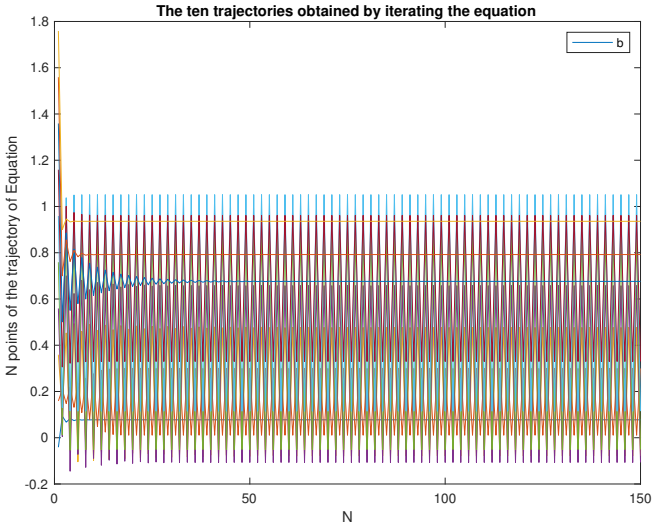


Figure 15

0.7.3 Question 7c:

The figure below uses the same number of steps and values of b as part b. The only difference is the value of $a = 9.2$ and $x_0 = -0.2$. When comparing both plots from 7b and 7c you can notice that the plot in 7c is more zoomed in and only one of the string or line goes below the negative axies.

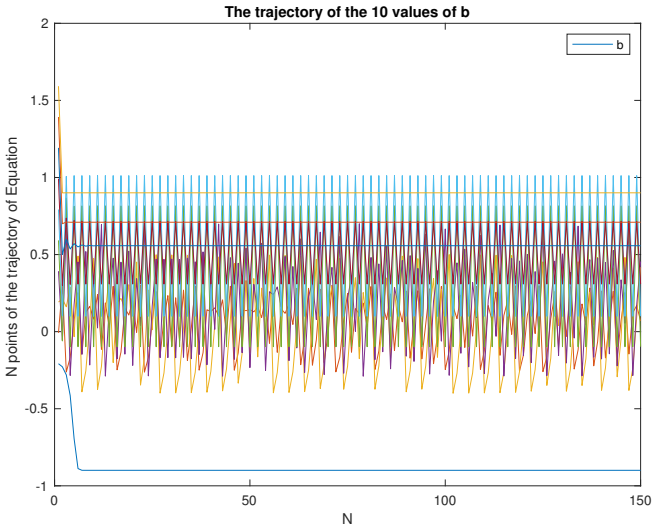


Figure 16

0.7.4 Question 7d:

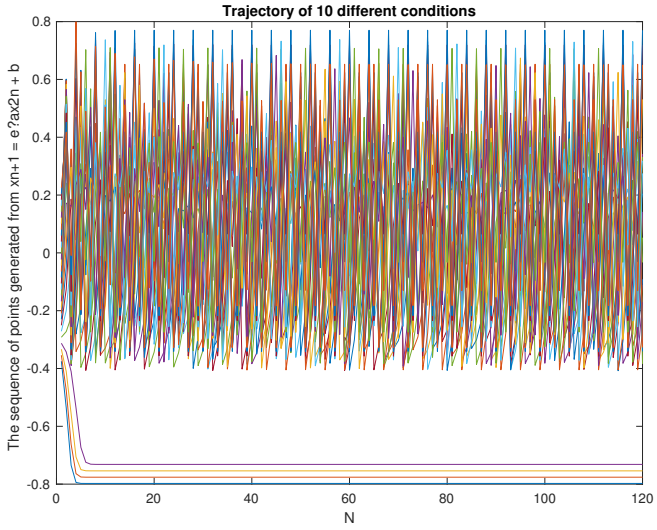


Figure 17

The table shows the expected value ad the standard deviation for 30 trajectories for the value of b with interval[-0.8,-0.2]

Figure 18

Var1	Var2	Var3
-0.8	-0.79138	0.045489
-0.77931	-0.76896	0.048124
-0.75862	-0.74567	0.052469
-0.73793	-0.72016	0.061883
-0.71724	0.035072	0.17712
-0.69655	0.017871	0.19874
-0.67586	0.019675	0.20767
-0.65517	-0.00074543	0.22684
-0.63448	-0.024277	0.24561
-0.61379	-0.015483	0.25392
-0.5931	-0.022774	0.26876
-0.57241	-0.031857	0.28486
-0.55172	-0.0075326	0.2855
-0.53103	-0.0081705	0.29752
-0.51034	0.017323	0.29608
-0.48966	-0.024918	0.34078
-0.46897	0.048782	0.30918
-0.44828	0.071005	0.30231
-0.42759	0.067622	0.32623
-0.4069	0.085418	0.3259
-0.38621	0.060611	0.38583
-0.36552	0.083964	0.40362
-0.34483	0.11439	0.40624
-0.32414	0.15189	0.33011
-0.30345	0.16772	0.31961
-0.28276	0.19657	0.33595
-0.26207	0.22101	0.30696
-0.24138	0.22763	0.35281
-0.22069	0.23806	0.38505
-0.2	0.22273	0.37706

Figure 19: table of expected value standard deviation

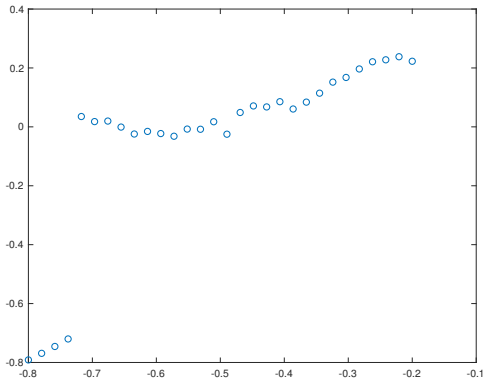


Figure 20: plot of expected value

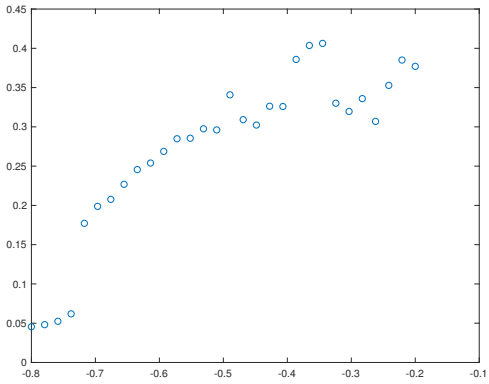


Figure 21: plot of standard deviation

0.8 QUESTION 8: SOLVING DIFFERENTIAL EQUATIONS

The code for this question is stored in Coursework 1/Question 8

0.8.1 Question 8a:

in this part I created a function called my-euler.

0.8.2 Question 8b.i:

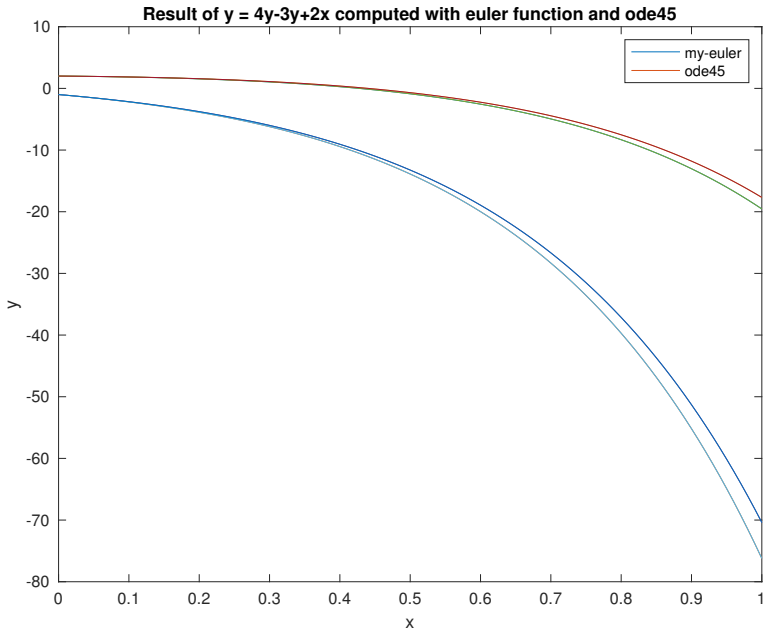


Figure 22: Graph of ode45() and my-euler()

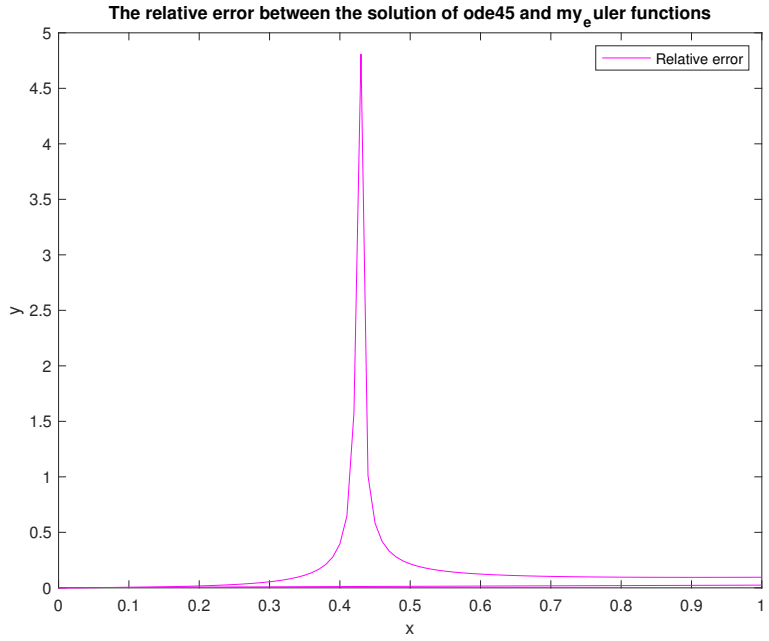


Figure 23: Graph of relative error 8i

0.8.3 Question 8b.ii:

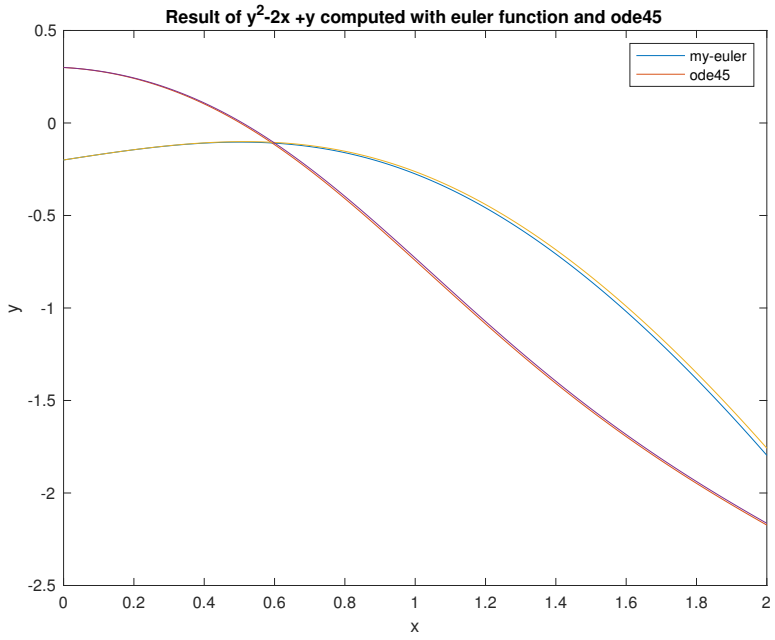


Figure 24

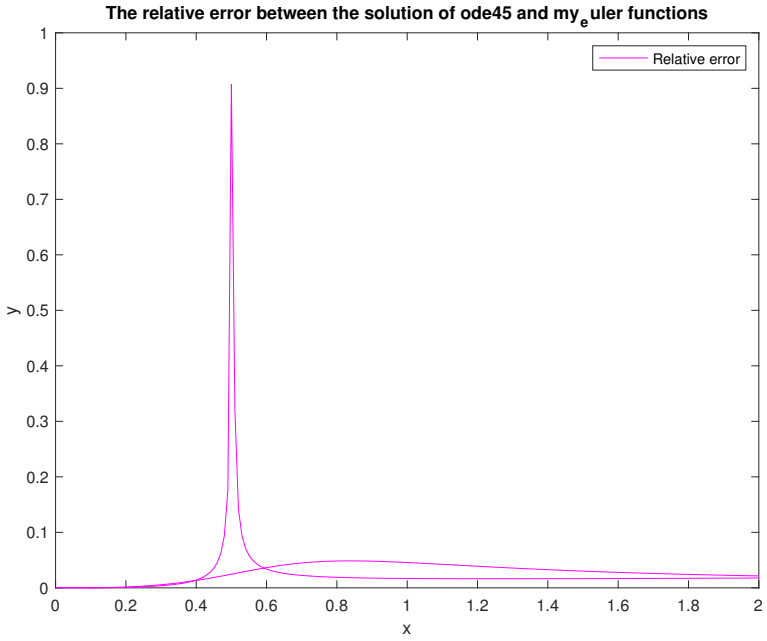


Figure 25: Graph of relative error 8ii

0.8.4 Question 8b.iii:

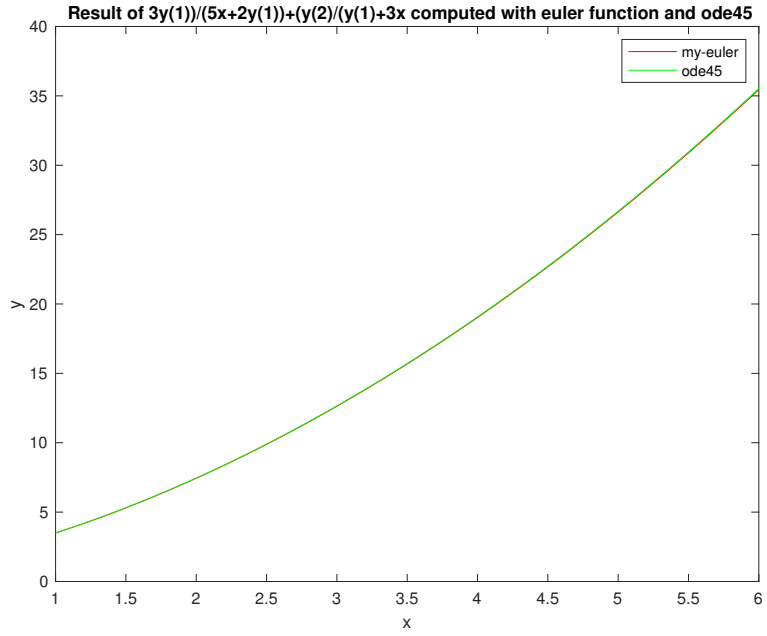


Figure 26: Graph of ode45() and my-euler()

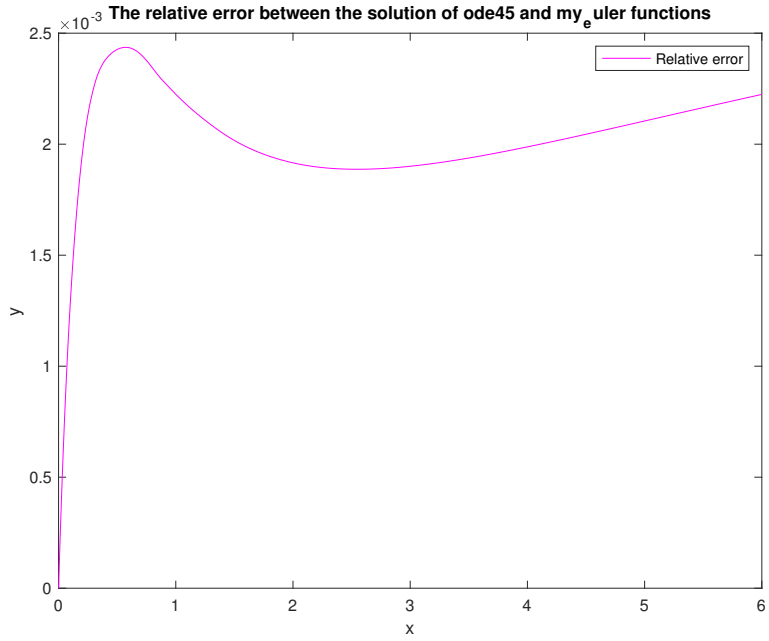


Figure 27: Graph of relative error 8iii

0.8.5 Question 8.iv:

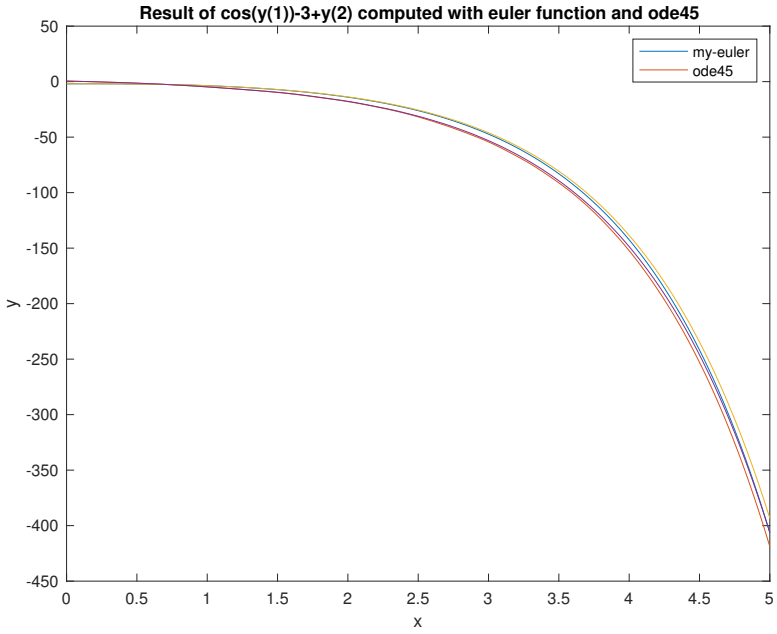


Figure 28: Graph of ode45() and my-euler()

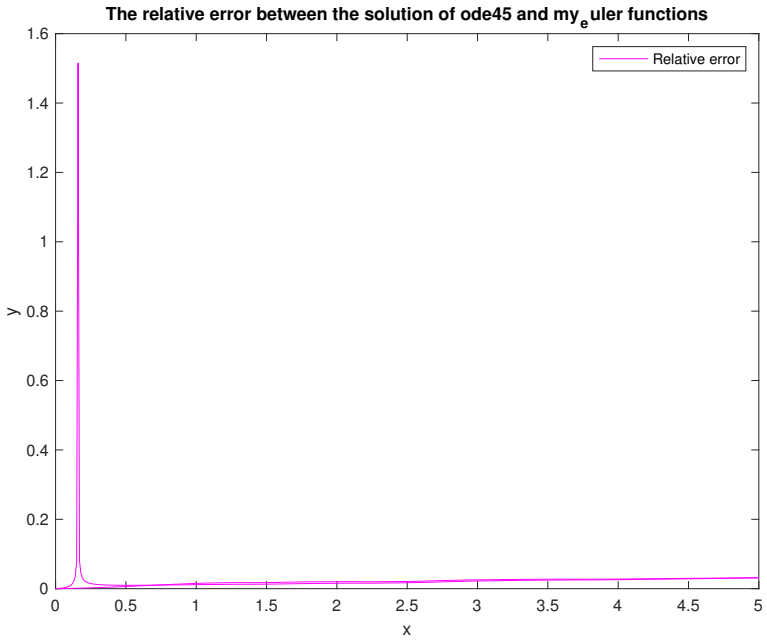


Figure 29: Graph of relative error 8iv

0.9 Question 9: A system of three ordinary differential equations

The code for this question is stored in Coursework 1/Question 9

0.9.1 Question 9a:

In this part I used the my-euler function from question 8 and I changed it to add one more differential equation. Using the same code I created another file called mod-euler.m, where I modified it to create a custom function of modified euler method.

0.9.2 Question 9b:

For this part of the question I created a function which stores the equation 2(the code for this is in the file called 'equation9') and created another mat-lab file where I plotted the 3 dimensional graph of the two trajectories.

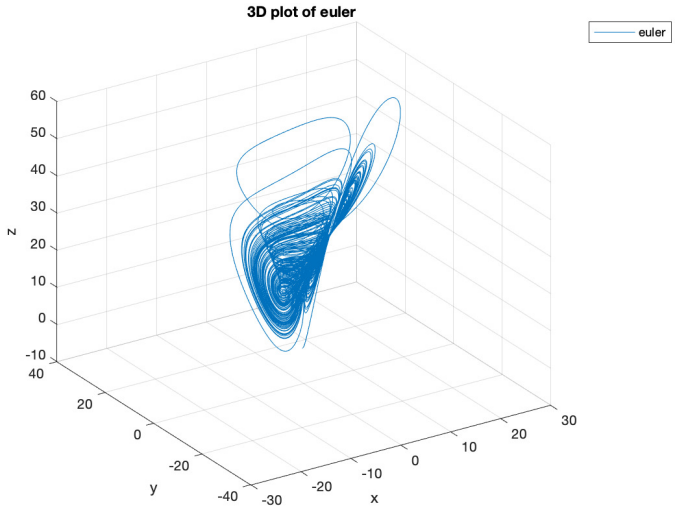
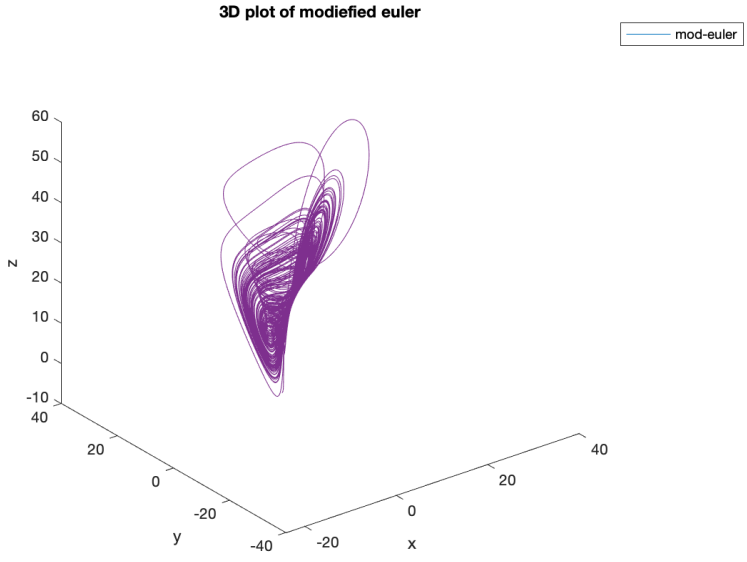


Figure 30: Graph of modified euler



0.9.3 Question 9c:

For this part of the question I compared my modified euler function with the mat-lab built in function ode45. The plot of these two functions are similar to each other, there is not a massive overlap between the two plots.This explains that the modified euler function is functioning well and it process close to accurate output.

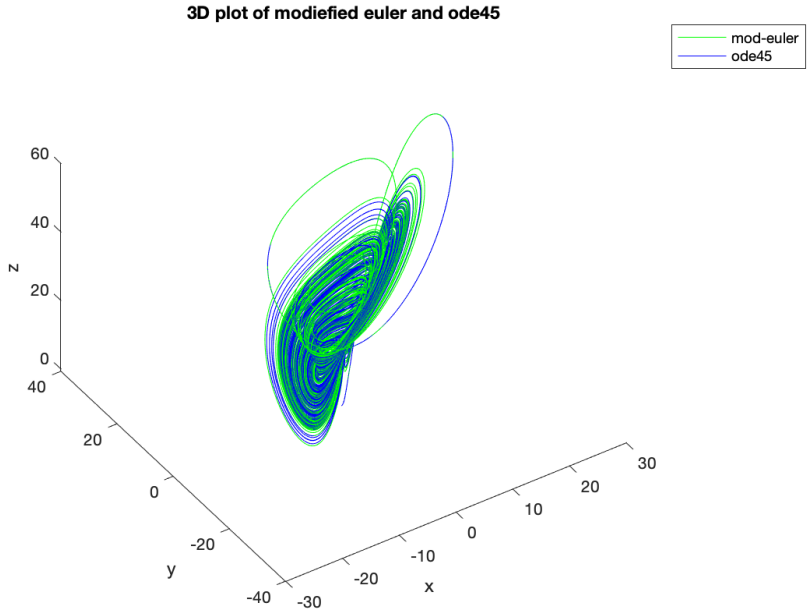


Figure 32: Graph of ode45() and my-euler()

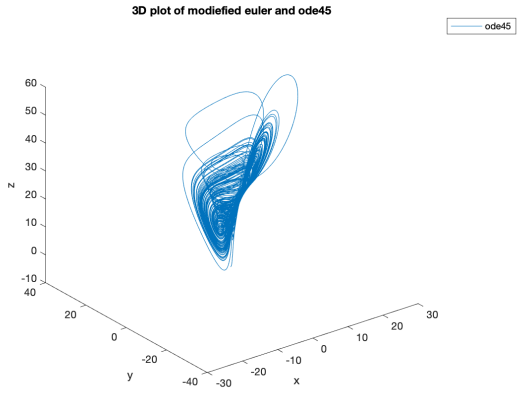


Figure 33: modified euler

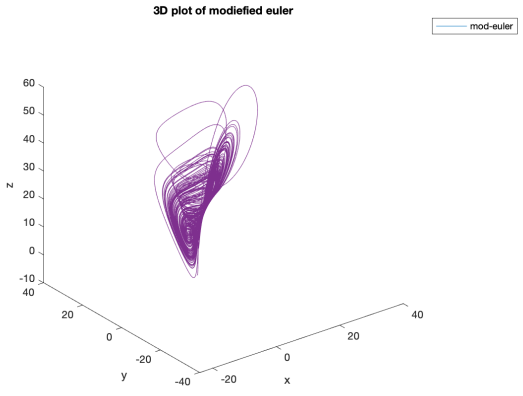


Figure 34: ode45