ELEC 4700 - Assignment 4
Circuit Modeling

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Introduction

The purpose of this assignment was to model an electric circuit and simulate its behaviour under varying conditions that will be discussed below.

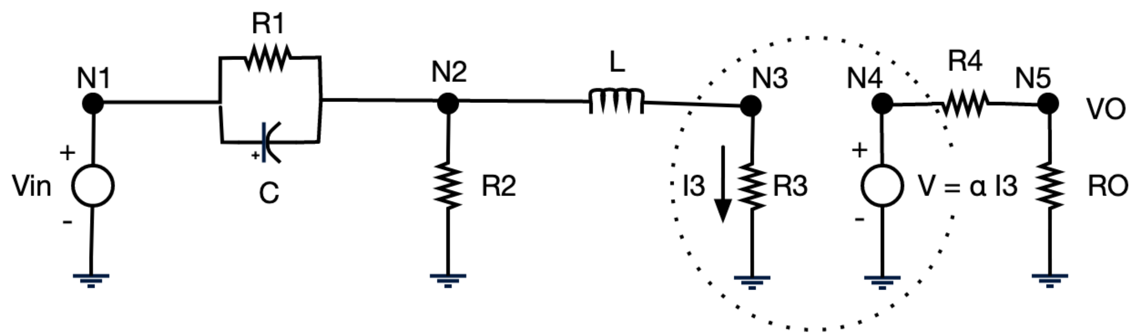

Figure 1. Circuit which was modeled

Part 1

The average current for a voltage sweep was plotted using a linear fit model, R3 was found to be 10 ohms.

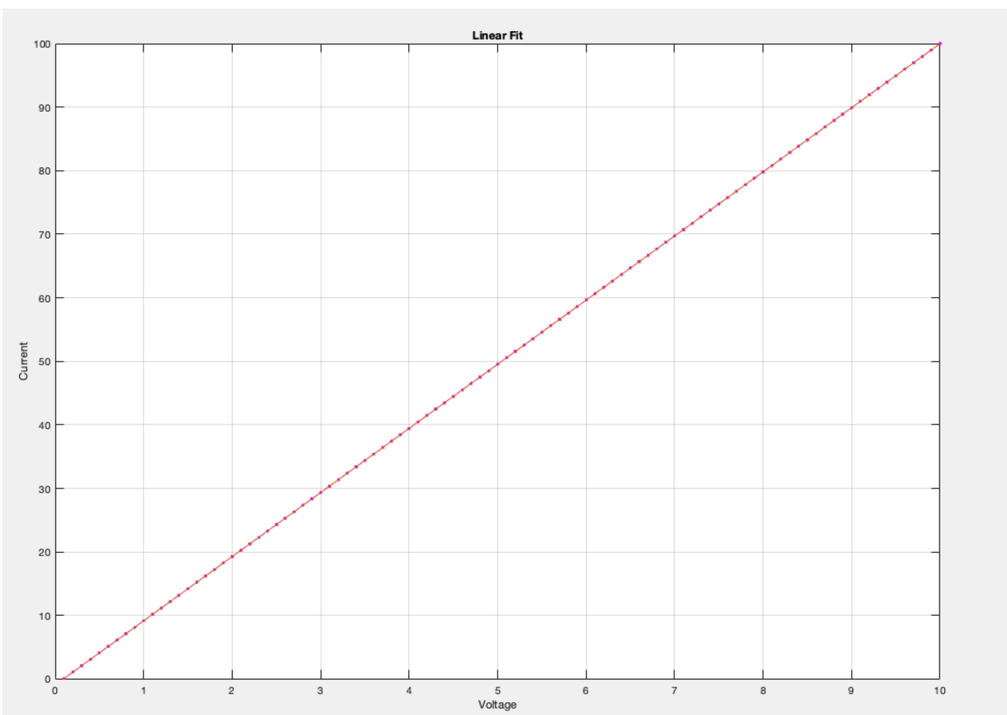

Figure 1.Linear fit for voltage sweep

R3 was found by use of the slope equation of a line, where y = mx + b. Instead of slope, m represents the resistance and here we found m to be 10.

Circuit Simulation

a) **G and C matrices**

```
G =

    1.0000         0         0         0         0         0         0
   -1.0000    1.5000         0         0         0    1.0000         0
         0         0    0.1000         0         0   -1.0000         0
         0         0    0.1000         0         0         0   -1.0000
         0         0         0  -10.0000   10.0010         0         0
         0    1.0000   -1.0000         0         0         0         0
         0         0         0    1.0000         0         0 -100.0000


C_matrix =

         0         0         0         0         0         0         0
   -0.2500    0.2500         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0         0         0
         0         0         0         0         0   -0.2000         0
         0         0         0         0         0         0         0
```

Figure 2. C & G matrices

b) **Plot of DC sweep**

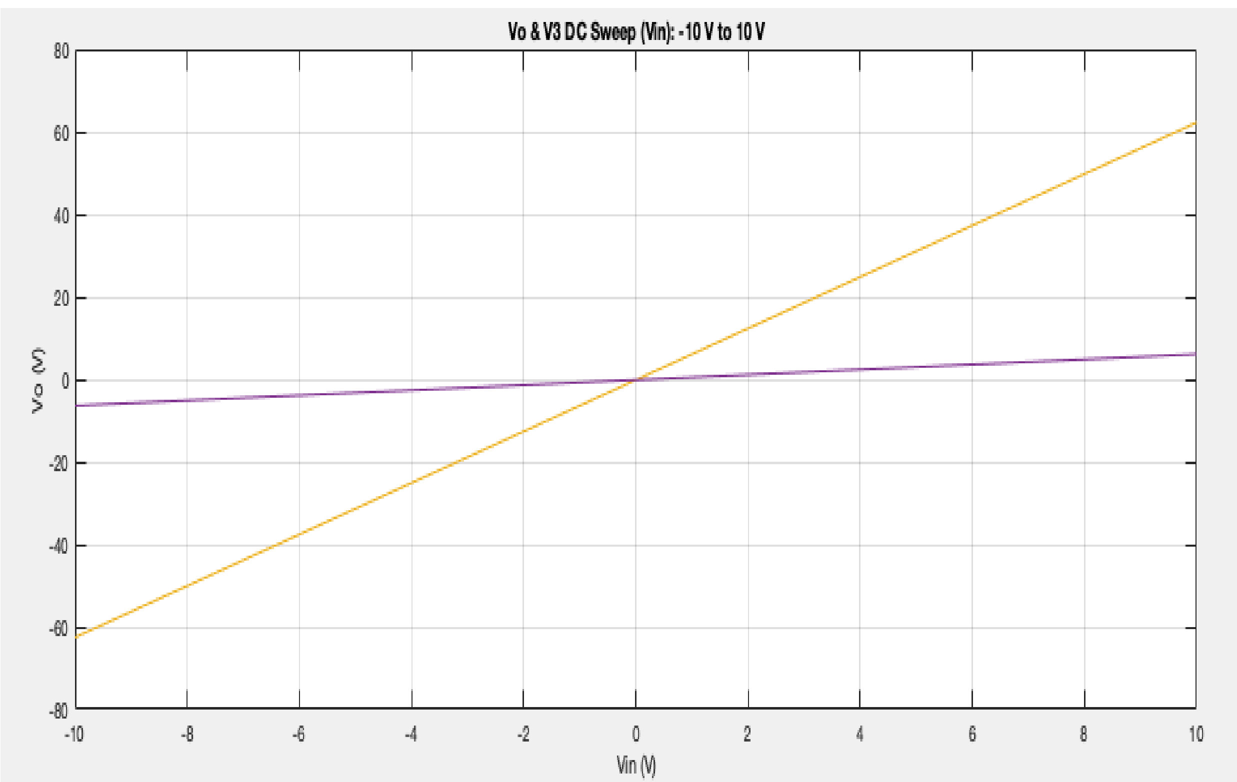

Figure 3. DC sweep

c) Plots from AC case of gain

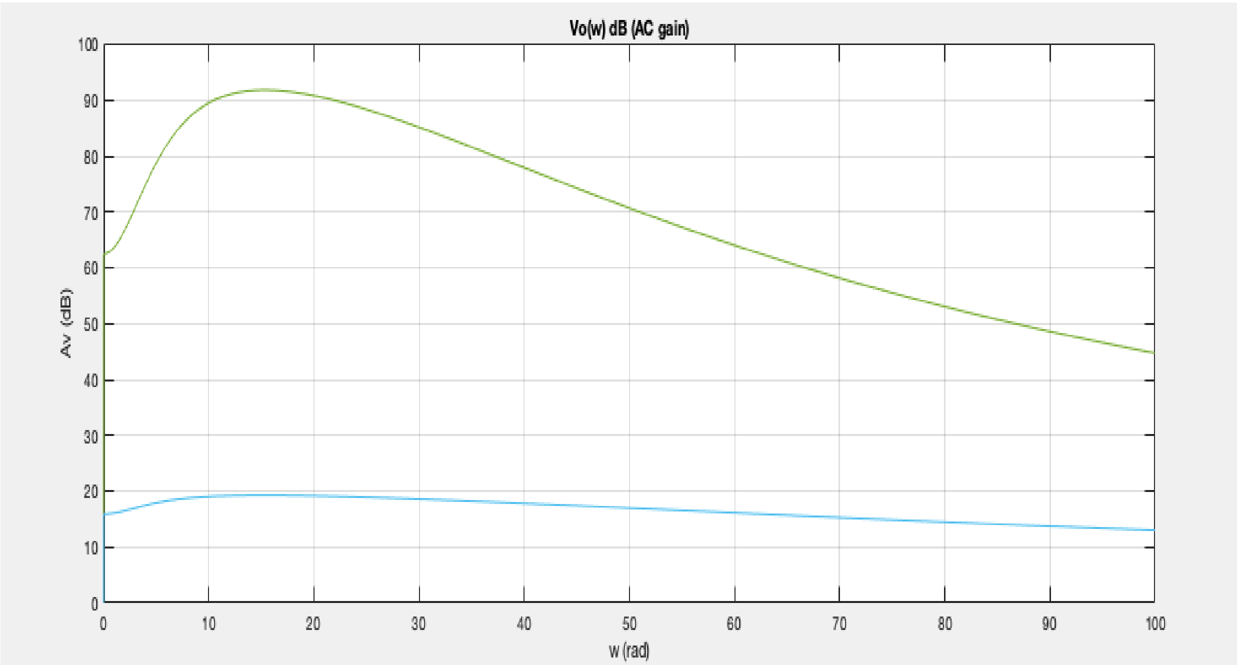

Figure 4.AC gain

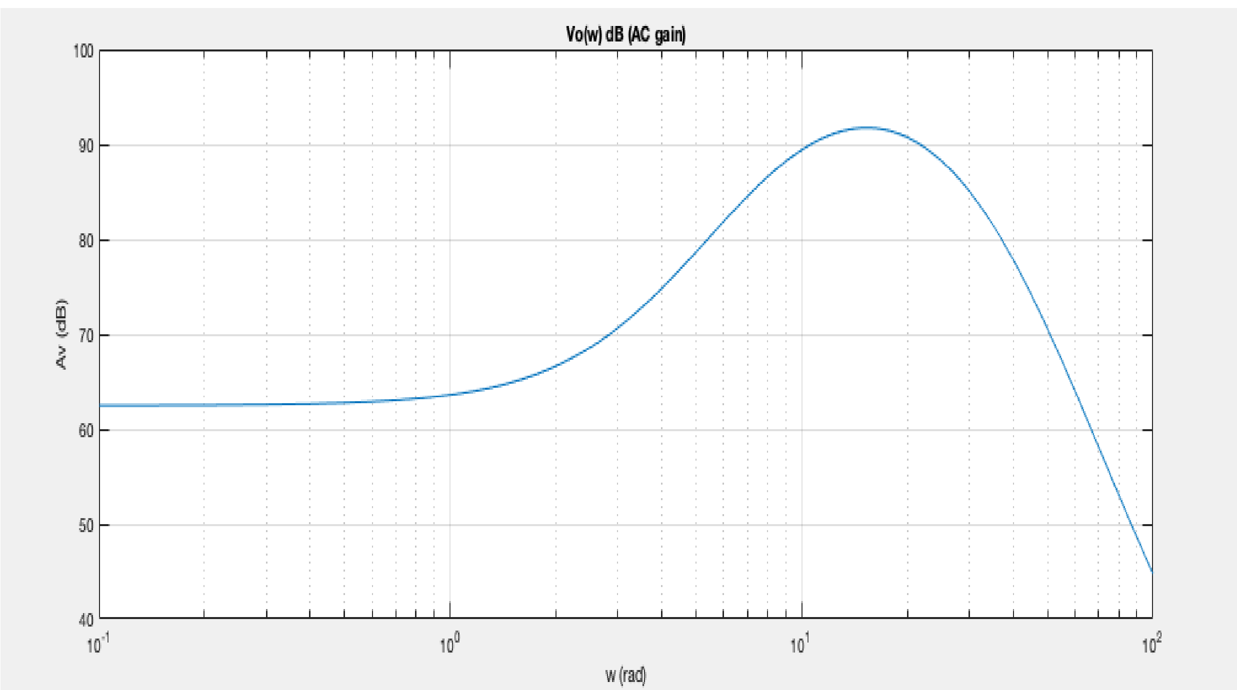

Figure 5. AC gain

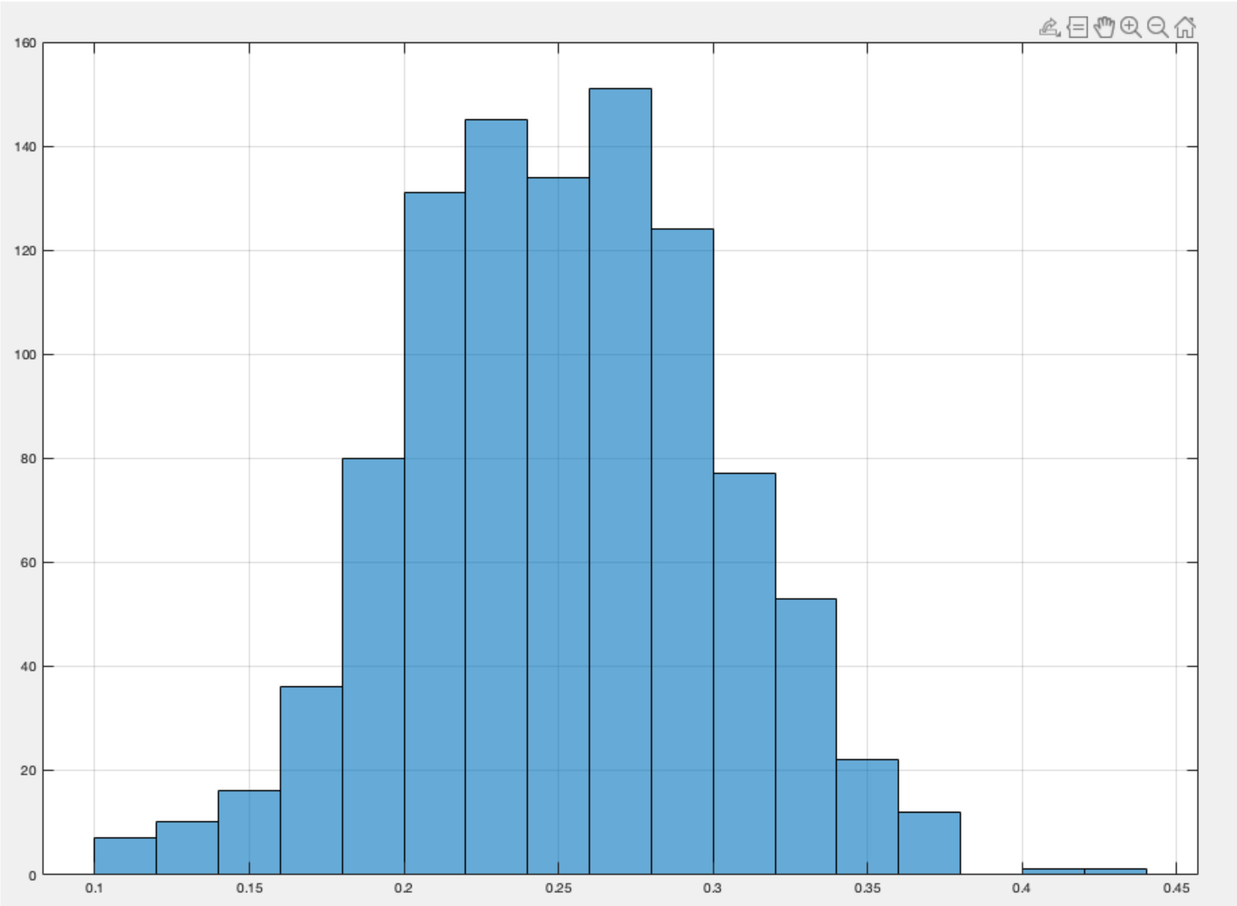

Figure 6. Histogram of gain

d) Vin vs Vout in Time Domain

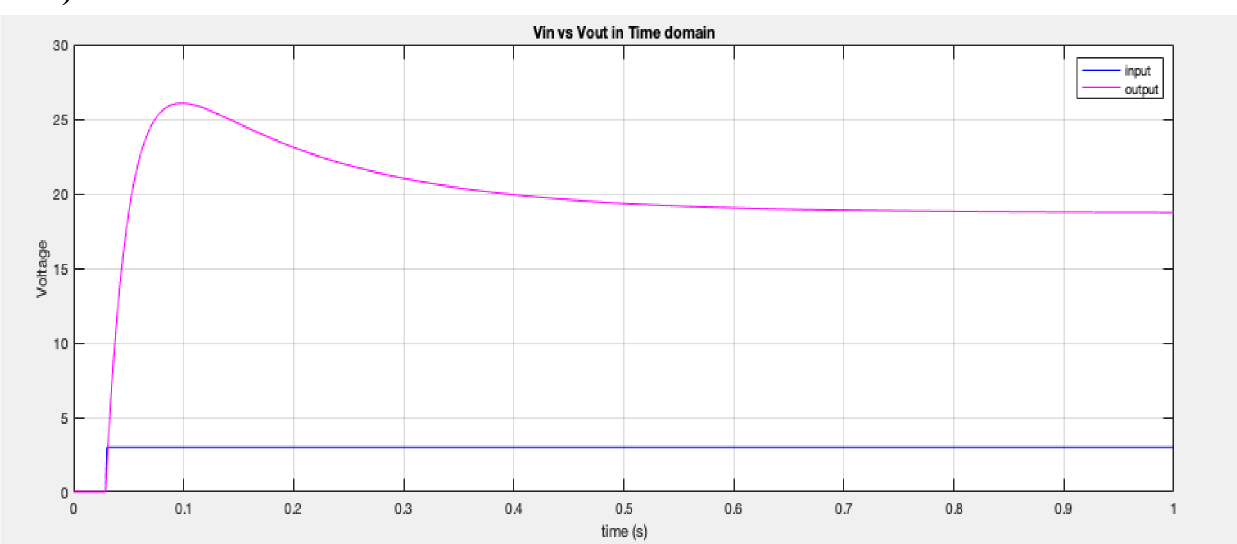

Figure 7. AC voltage with step function

4a) By inspection, this is a low pass filter.
4b) We expect the frequency response to allow low frequencies and cut off high.
4d) As time step increases, the accuracy decreases.

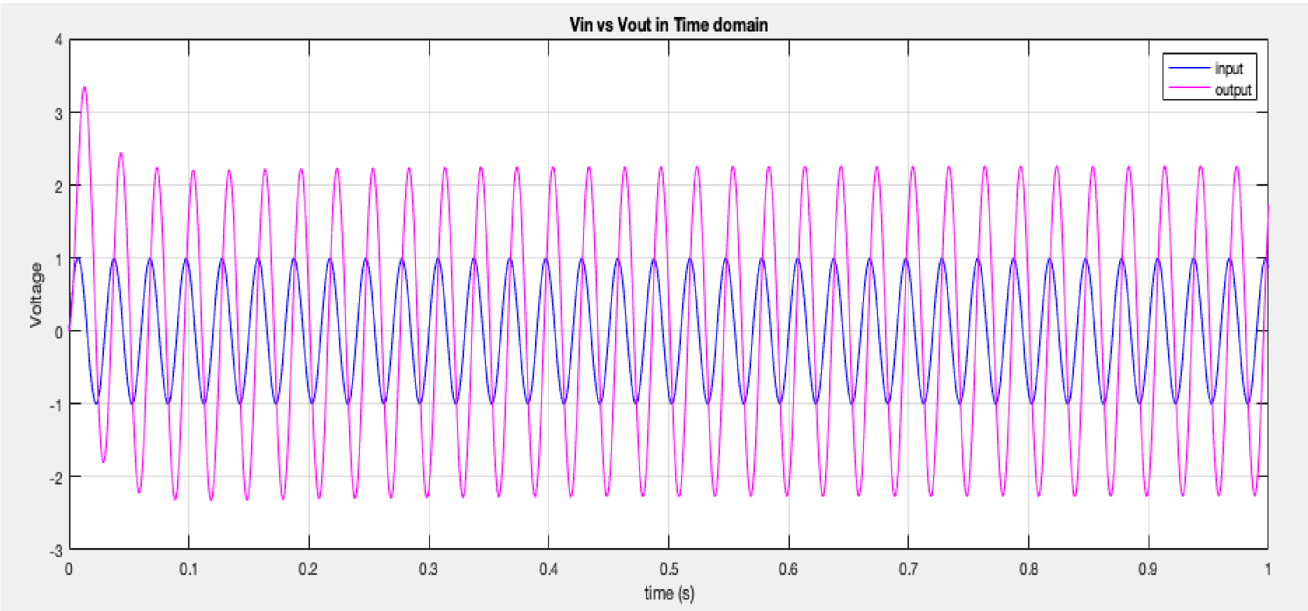

Figure 8. AC response for sine signal

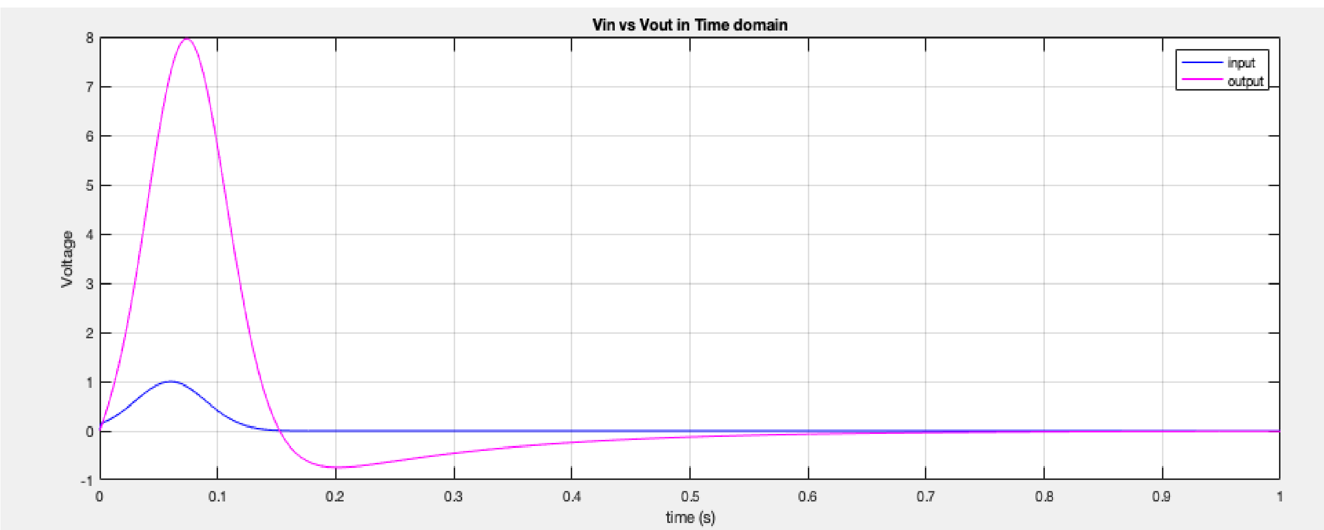

Figure 9. Vin vs Vout in Time Domain

e) Fourier transform plots of Frequency Response

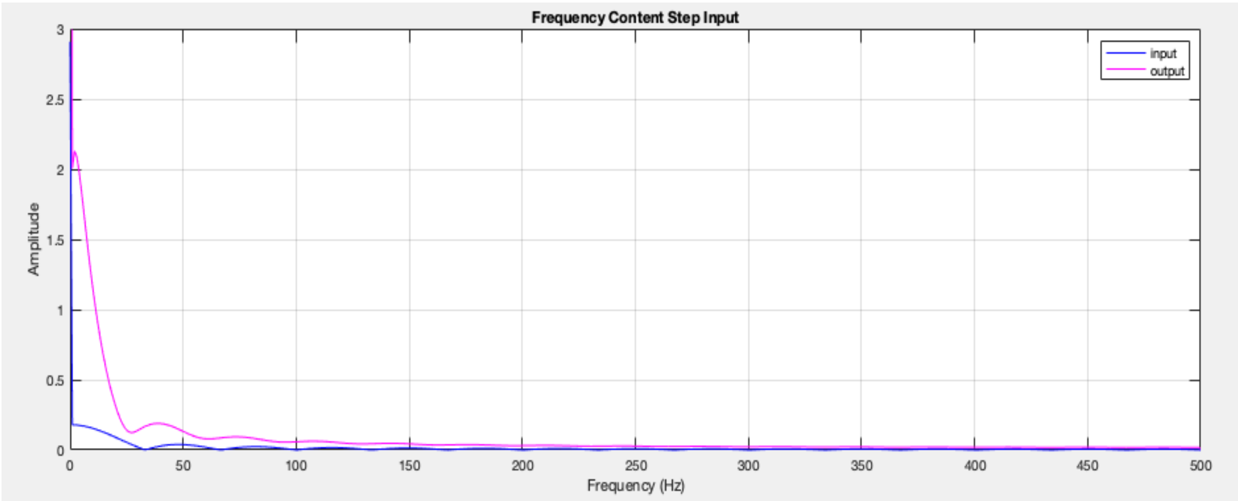

Figure 10. Frequency response with step inputs

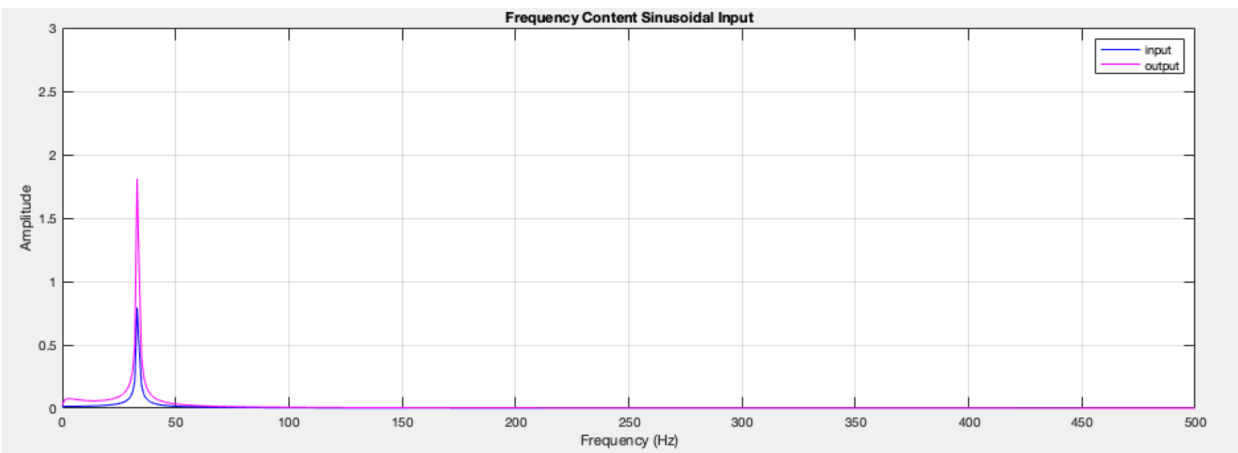

Figure 11. Frequency response with sine inputs

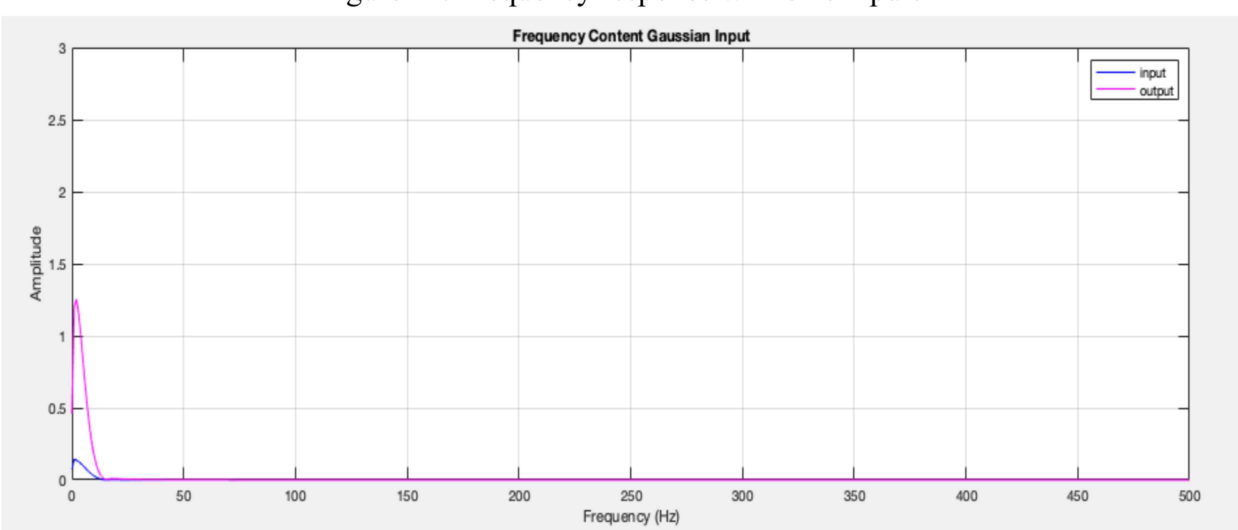

Figure 12. Frequency response with gaussian inputs

Part 2

a) cUpdated C matrix

C1 =

0.2500	-0.2500	0	0	0	0	0	0
-0.2500	0.2500	0	0	0	0	0	0
0	0	0.0000	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	-0.2000	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Figure 13. Updated C matrix

b & d)**Vout with noise source**

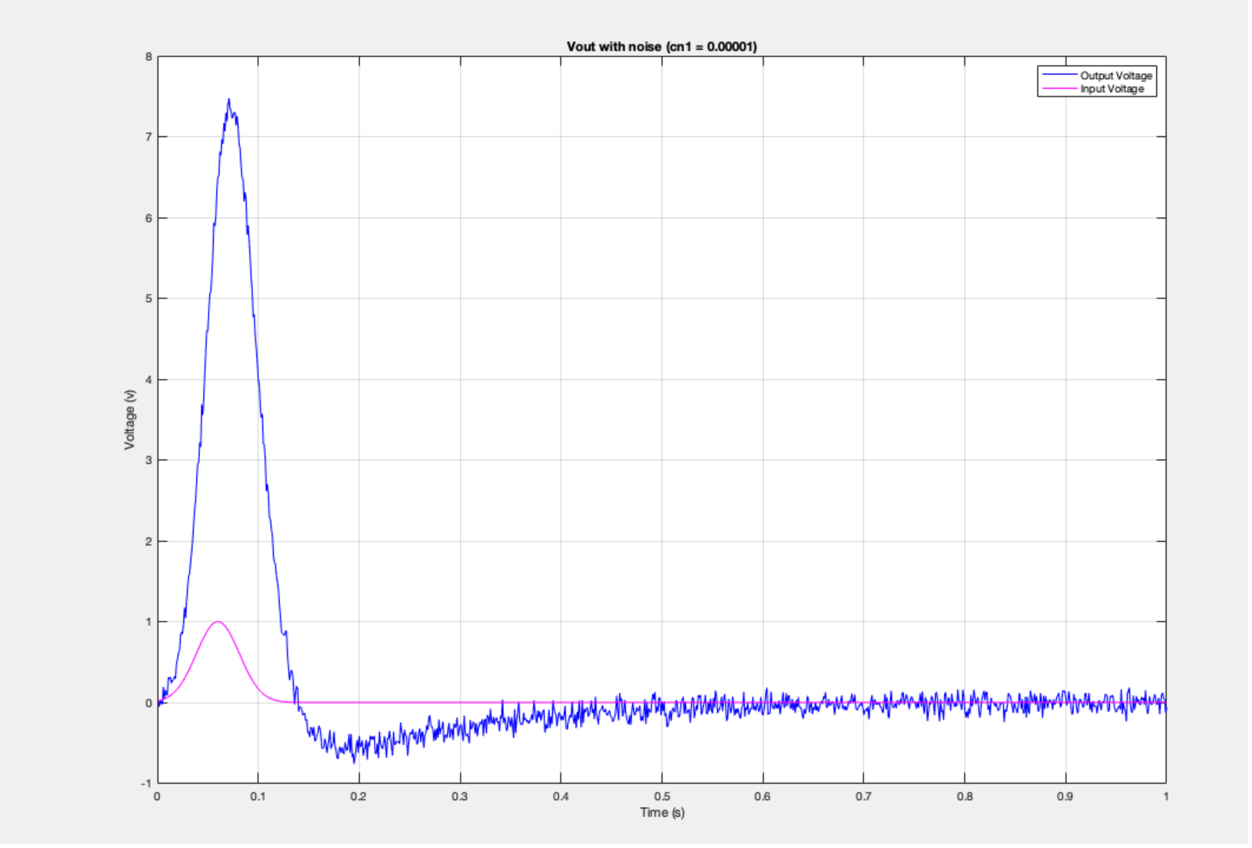

Figure 14. Vout with noise (cn1 = 0.00001)

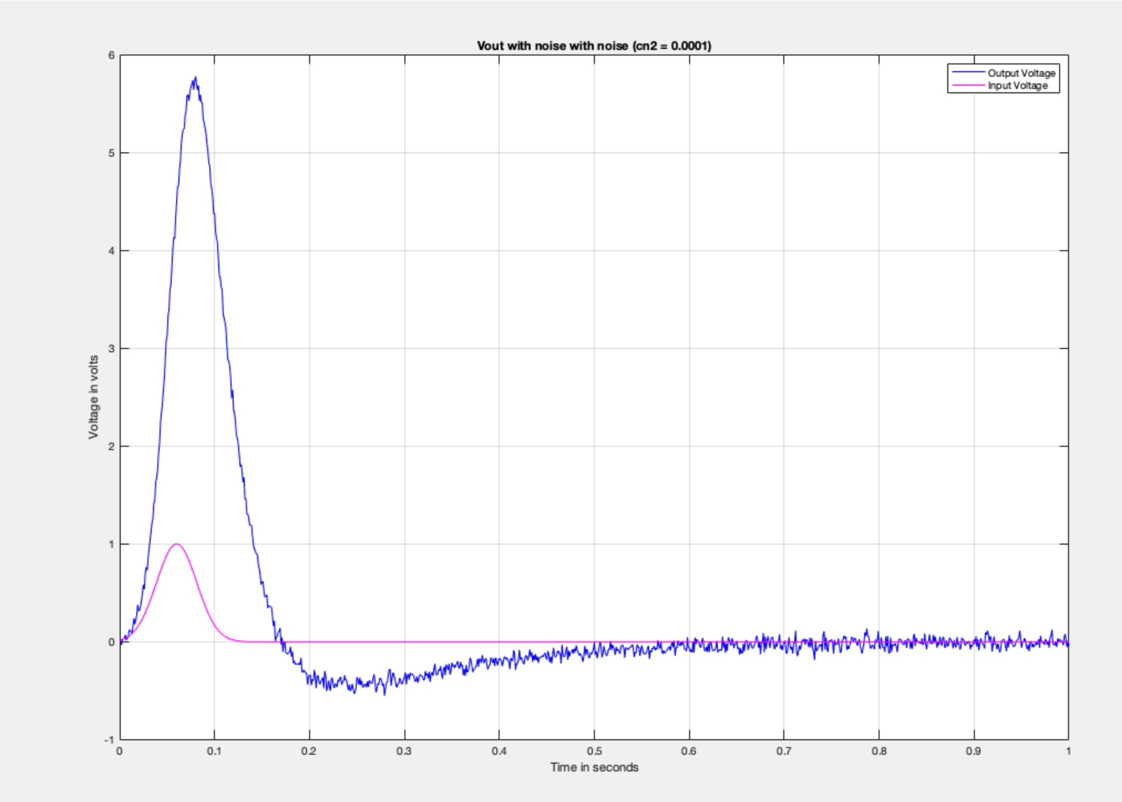

Figure 15. Vout with noise (cn2 = 0.0001)

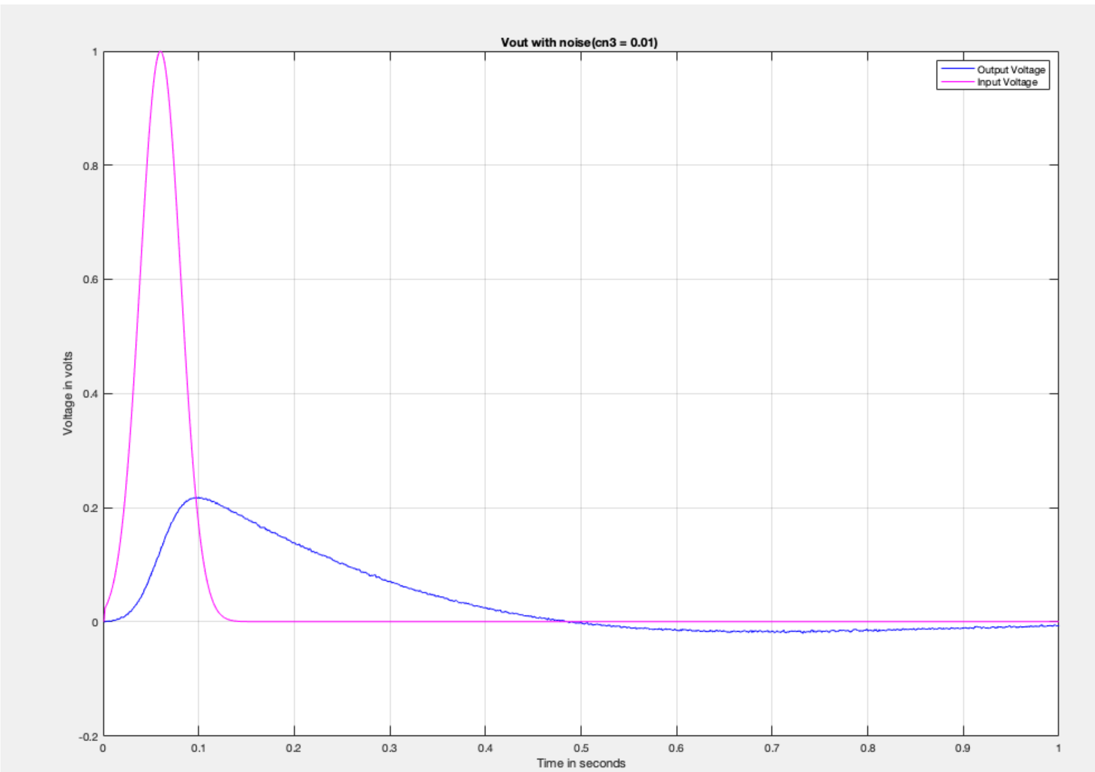

Figure 16. Vout with noise (cn3 = 0.01)

c & e)**Fourier Transforms**

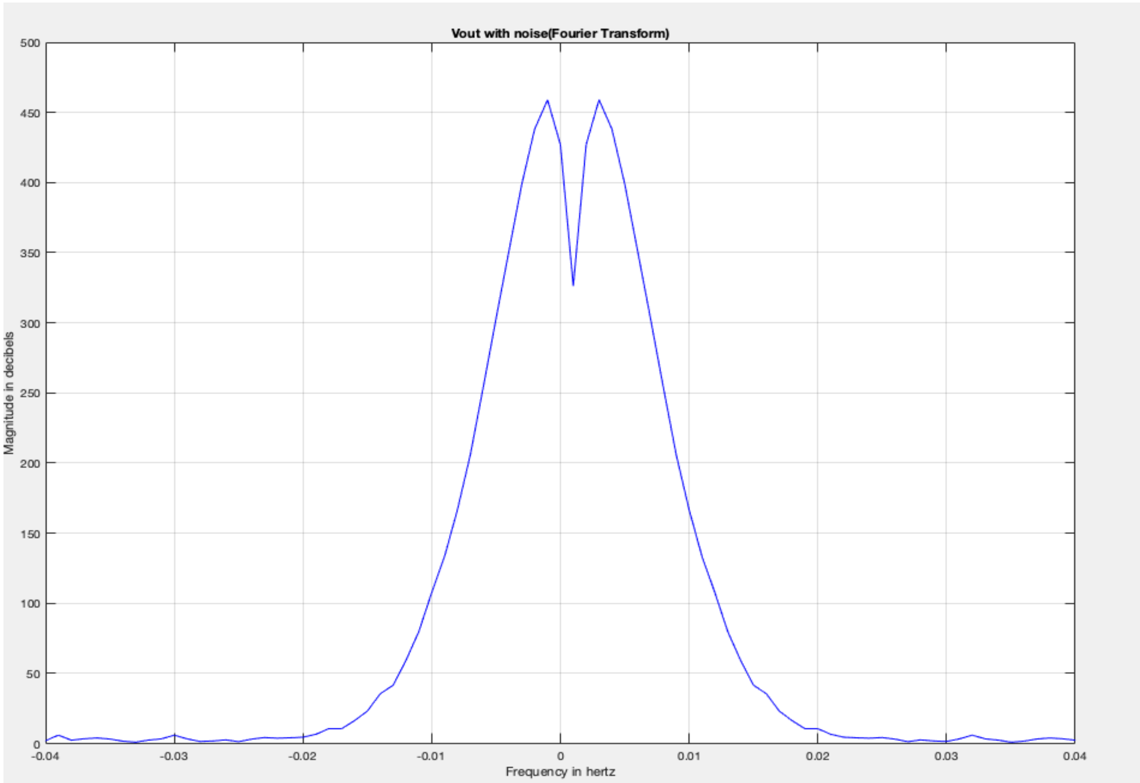

Figure 17. Vout with noise, Fourier Transform for cn1

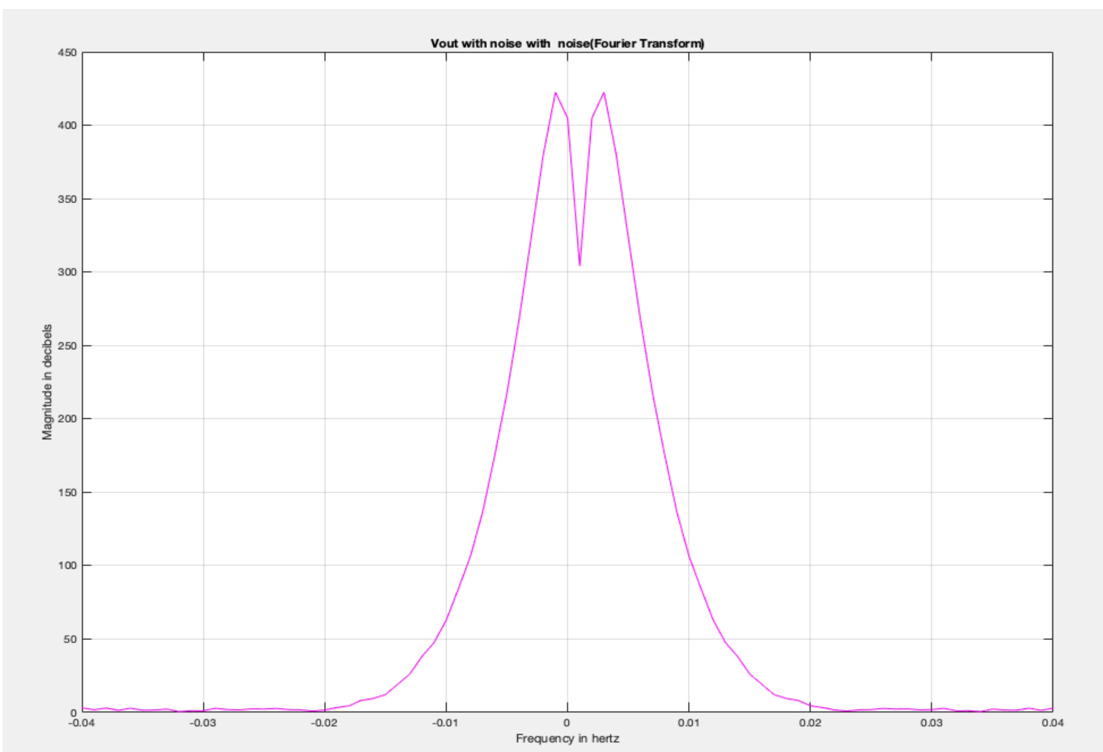

Figure 18. Vout with noise, Fourier Transform for cn2

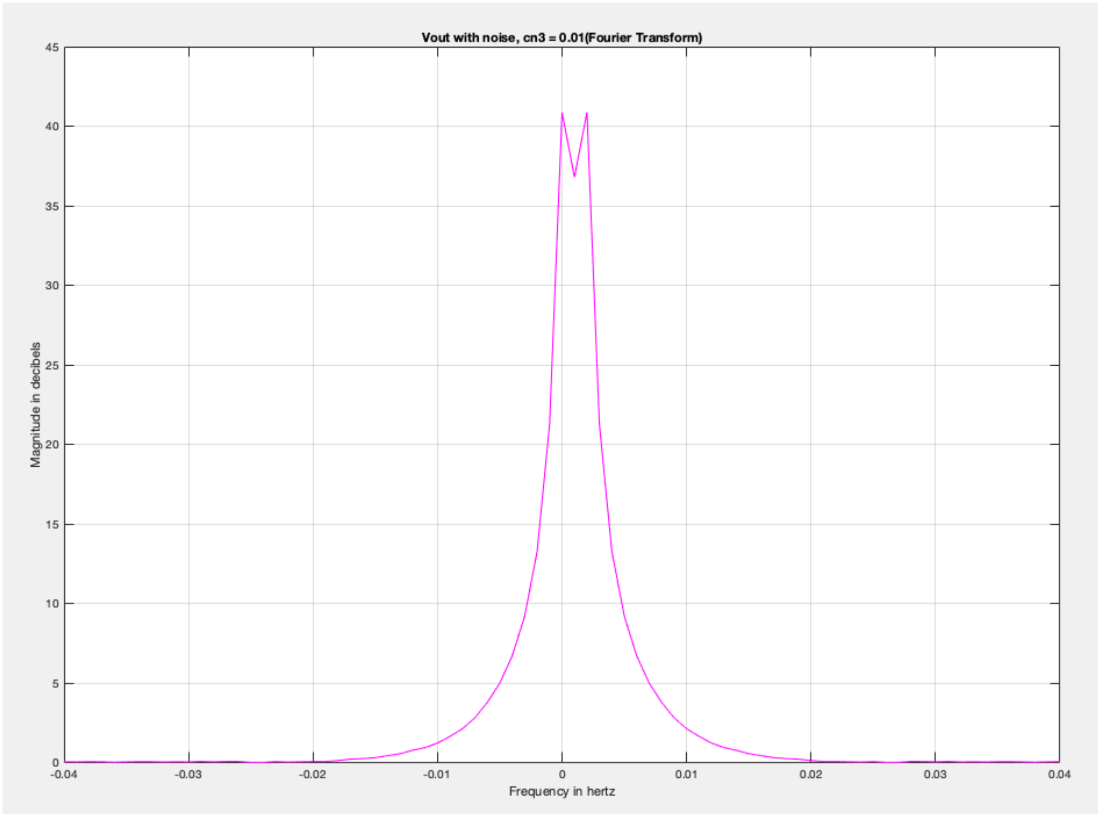

Figure 19. Vout with noise, Fourier Transform for cn3

In conclusion, it was observed that as the value of cn increases, the size of bandwidth decreases.

f) **2 plots of Vout with different time steps**

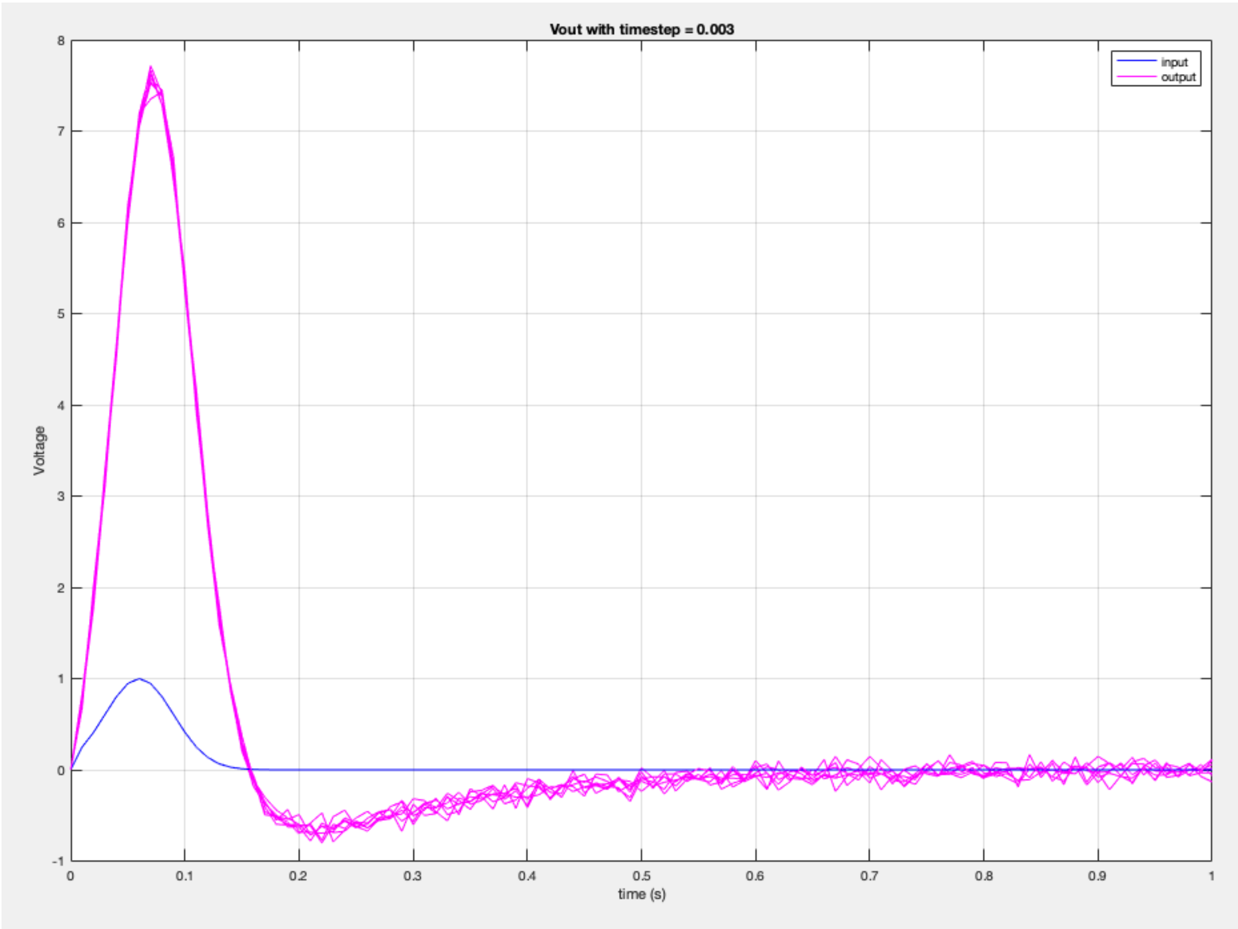

Figure 20. Vout with timestep = 0.003

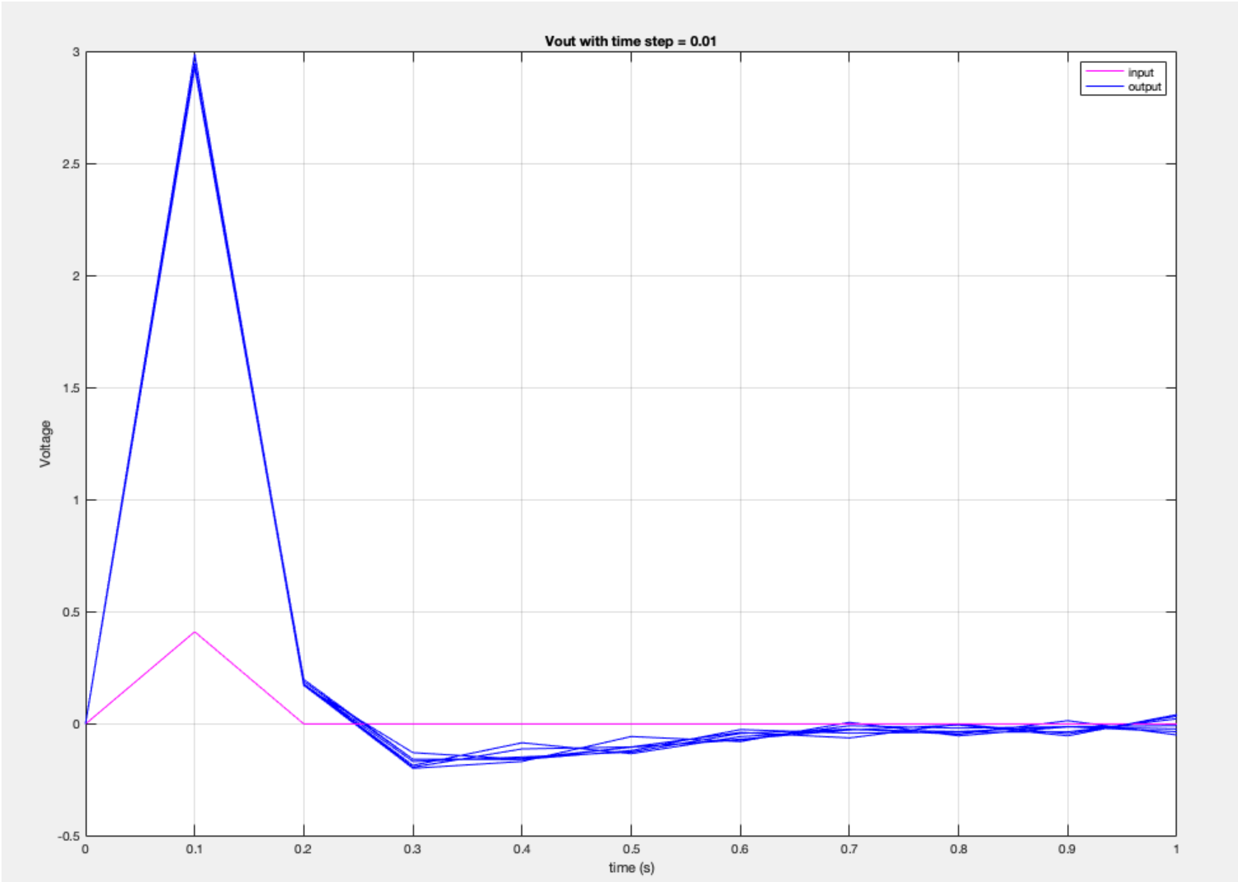

Figure 21. Vout with time step = 0.01

Note: The increased time step seems to increase accuracy.

Part 3

Non-Linearity

In order to implement this, we would have to implement an additional matrix to contain the non-linear elements of the circuit, a new column vector of B(v) would be added.After this, the system would need to be solved using the Newton Raphson method instead of Gaussian.