ELEC 4700

Assignment 4

Circuit Modeling

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Part 1: Circuit MNA Modeling

Component stamps were created as separate functions in MatLab to add values to the respective cells in the G, C and b matrices respective of where the components are located in the circuit. Solving for the voltage matrix where $V = (G + sC)\backslash b$ gives the G, C and b matrices given in Figure 2, and the gain of the circuit in the DC response is given in Figure 1.

Figure 1: DC Gain

```
G =

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

C =

    0.2500   -0.2500        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        0        0        0  -0.2000        0        0
         0        0        0        0        0        0        0        0
         0        0        0        0        0        0        0        0
```
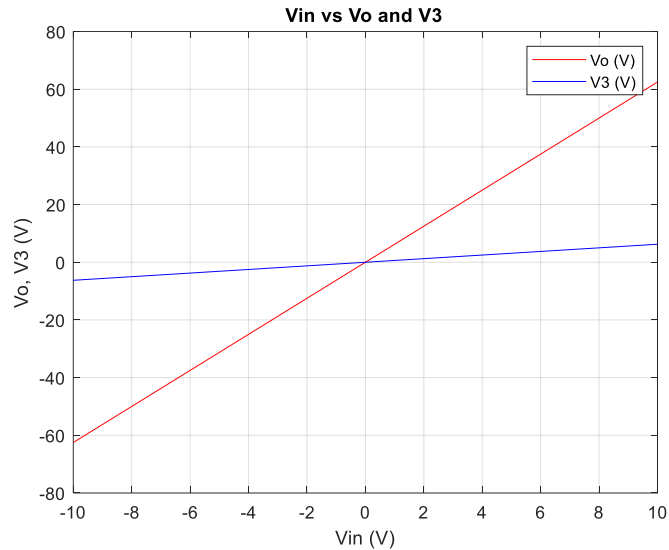
```
b  =

       0
       0
       0
       0
       0
       0
       0
      10
```

Figure 2: G, C, b matrices

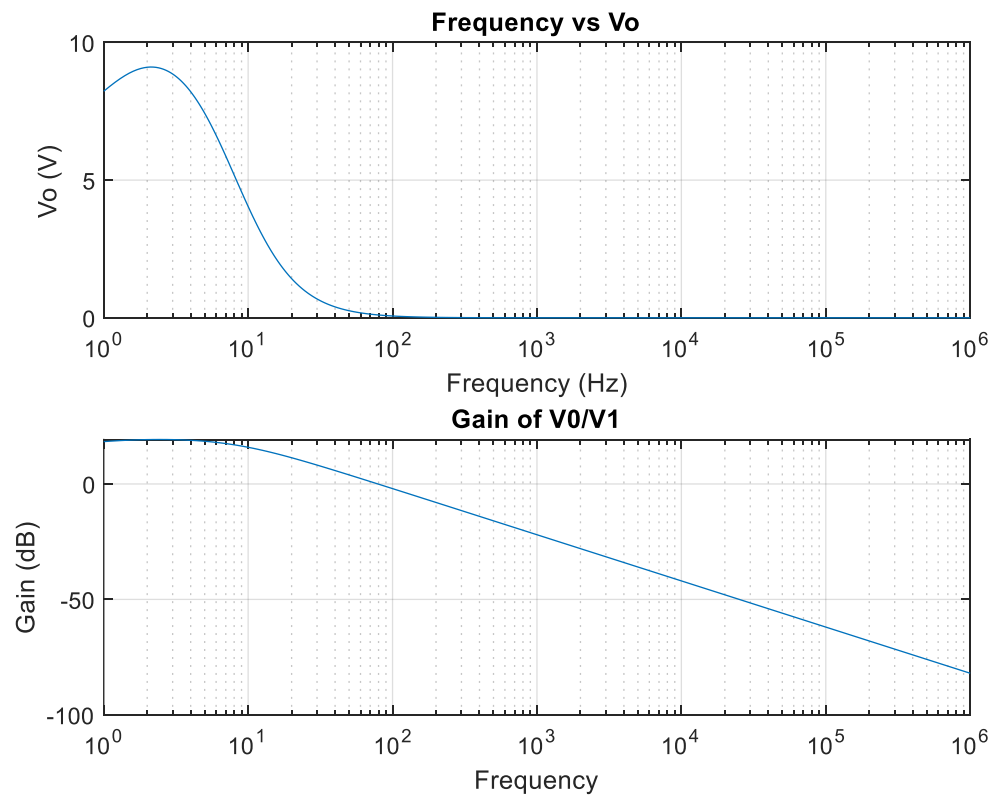Next the AC frequency response can be modelled, as shown in figure 3.

Figure 3: Frequency Response

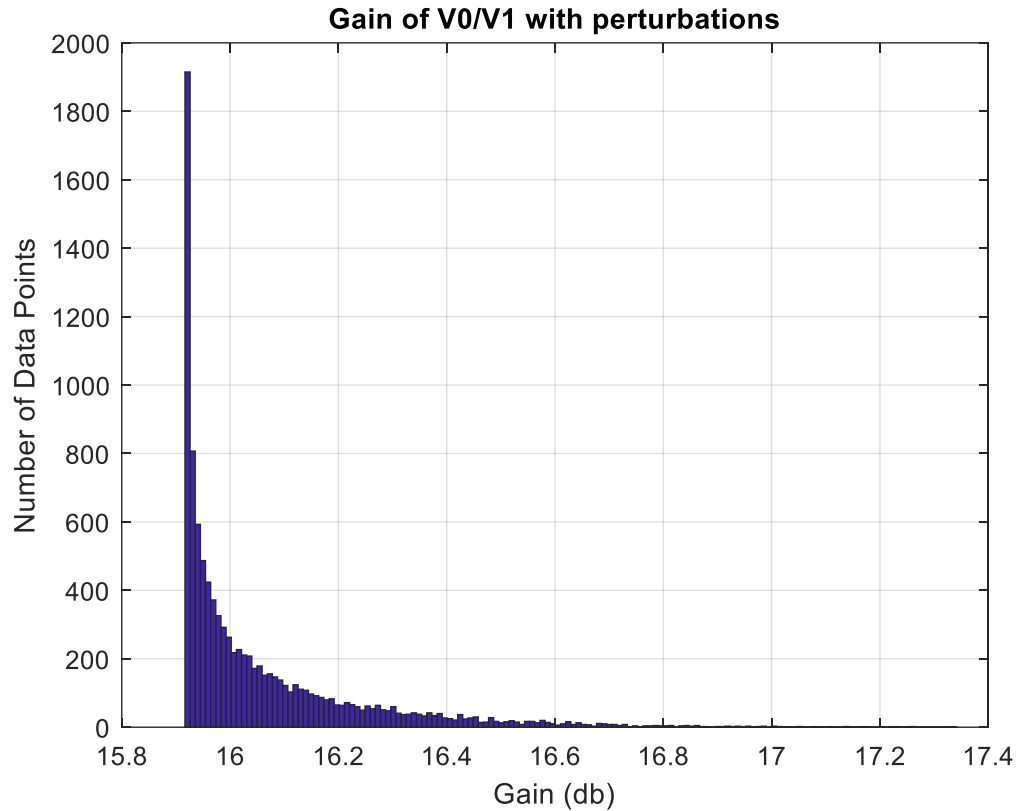Finally, random perturbations in the C matrix can be modelled, as shown in Figure 4.

Gain of V0/V1 with perturbations

Figure 4: Perturbations in C

Part 2: Transient Circuit Simulation

The circuit acts as a low pass filter with an amplifier. The low frequency responses will be amplified, while the high frequencies have no output.

A step response is shown in Figure 5, sinusoidal response in Figure 6 and Gaussian pulse in Figure 7.
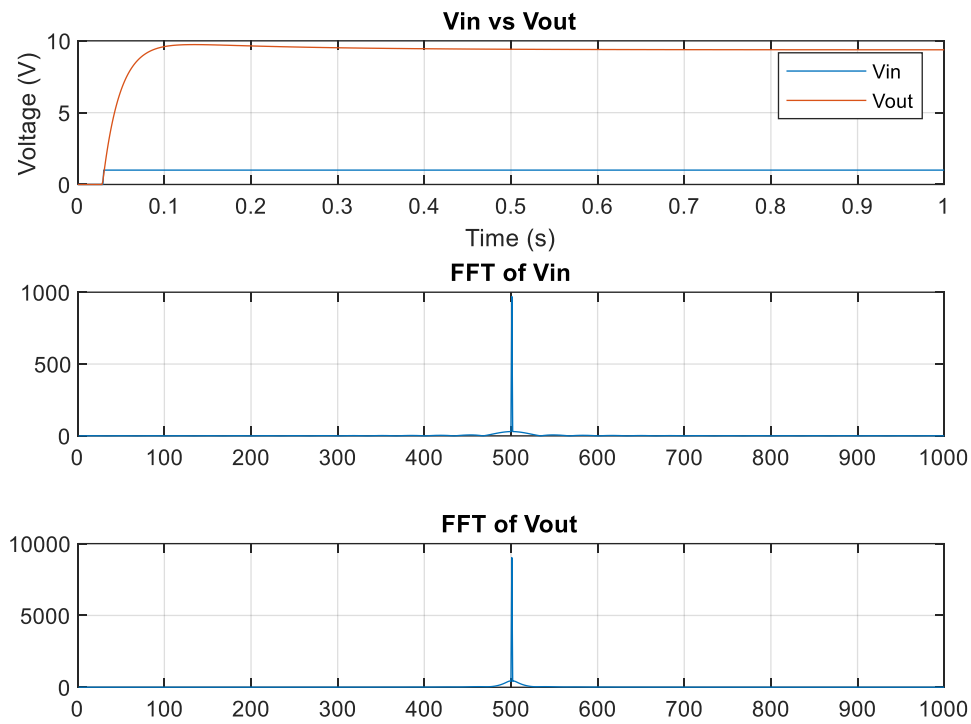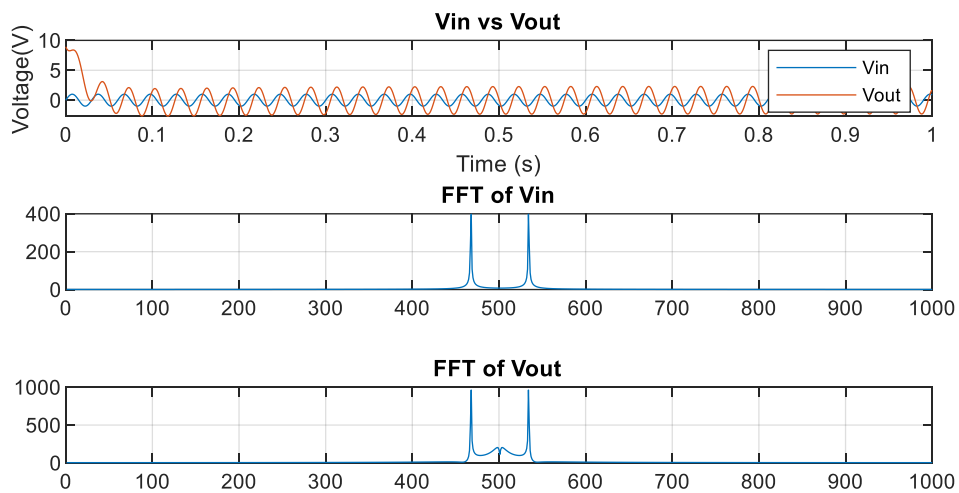
Figure 5: Step Response
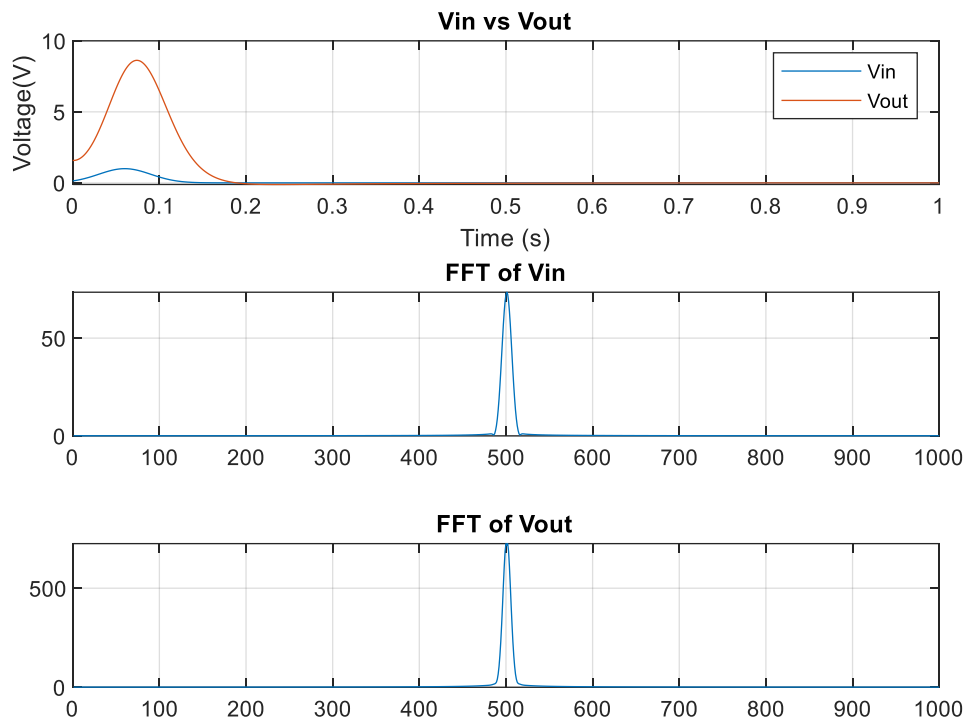

Figure 6: Sinusoidal Response

Figure 7: Gaussian Pulse Response

Part 3: Circuit with Noise

With the addition of noise in the circuit, the C matrix has been updated, as shown below:

```
   2.5000e-01  -2.5000e-01            0            0            0            0
  -2.5000e-01   2.5000e-01            0            0            0            0
            0            0   1.0000e-05            0            0            0
            0            0            0            0            0            0
            0            0            0            0            0            0
            0            0            0            0            0  -2.0000e-01
            0            0            0            0            0            0
            0            0            0            0            0            0

Columns 7 through 8

            0            0
            0            0
            0            0
            0            0
            0            0
            0            0
            0            0
            0            0
```

Figure 8: C Matrix

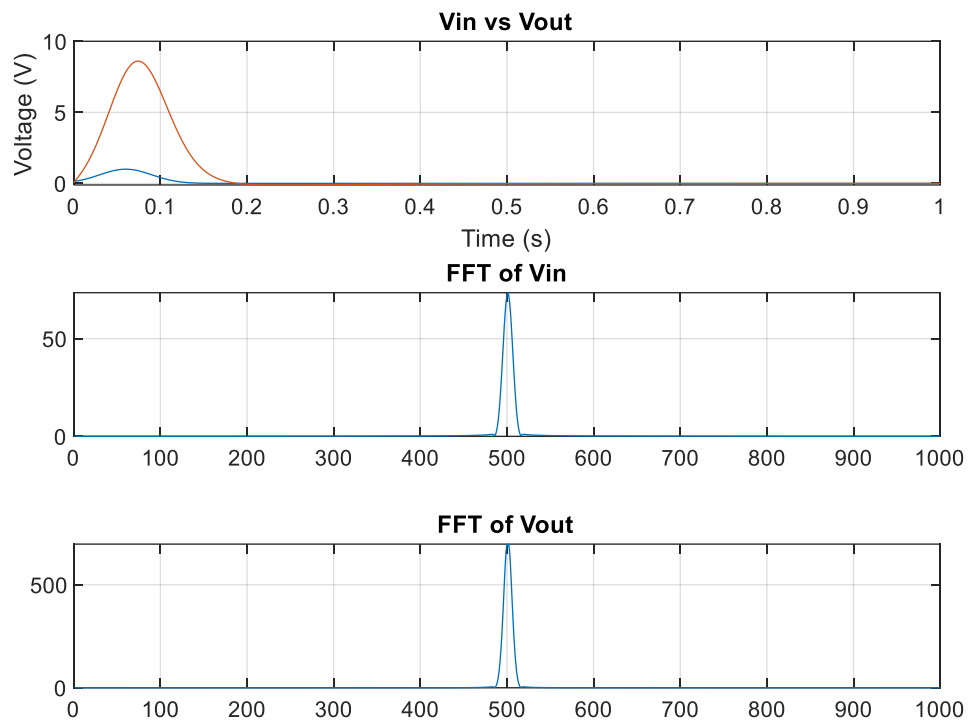There is also a new FFT response, shown below:

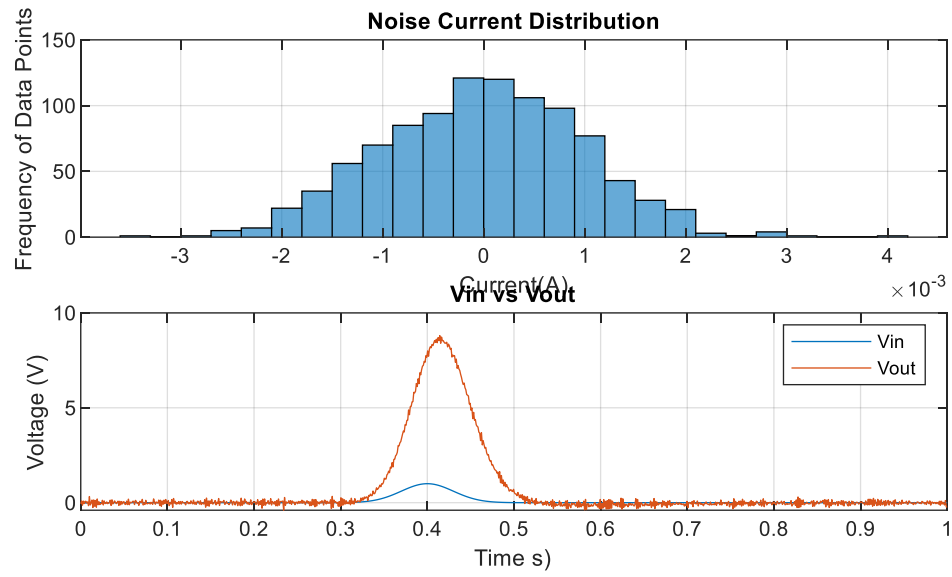Figure 9: FFT Response

There is also noise in the circuit now, so a distribution can be modelled:

Figure 10: Noise Distribution