Assignment 4 Part 2 - Andrew Paul 100996250

The second section of this assignment involved doing a transient analysis on the given circuit.

After inspecting the circuit it was found that this is a low pass filter and that is a linear cirucit.

The frequency response would be that low frequency signals would be passed (lower than the corner frequency) and higher frequency singals would be attenuated.

```
close all;
clear;

%Initialize variables and matricies

G = zeros(8,8);
C = zeros(8,8);

R1 =1;
R2 = 2;
R3 = 10;
R4 = 0.1;
R0 = 1000;
cap = 0.25;
L = 0.2;
alpha = 100;

G1 = 1/R1;
G2 = 1/R2;
G3 = 1/R3;
G4 = 1/R4;
G0 = 1/R0;

G(1, 1) = -G1;
G(1, 2) =  G1;
G(2, 1) =  G1;
G(1, 3) =  G1;
G(2, 3) = -G1-G2;
G(3, 4) = -G3;
G(2, 7) = -1;
G(3, 7) = 1;
G(4, 3) = 1;
G(4, 4) = -1;
G(5, 6) = G4;
G(5, 7) = -alpha*G4;
G(5, 8) = 1;
G(6, 6) = -G4-G0;
G(6, 7) = alpha*G4;
G(7, 1) = 1;
G(8, 5) = 1;
G(8, 7) = -alpha;

% Create C matrix
C(1,1)= -cap;
```

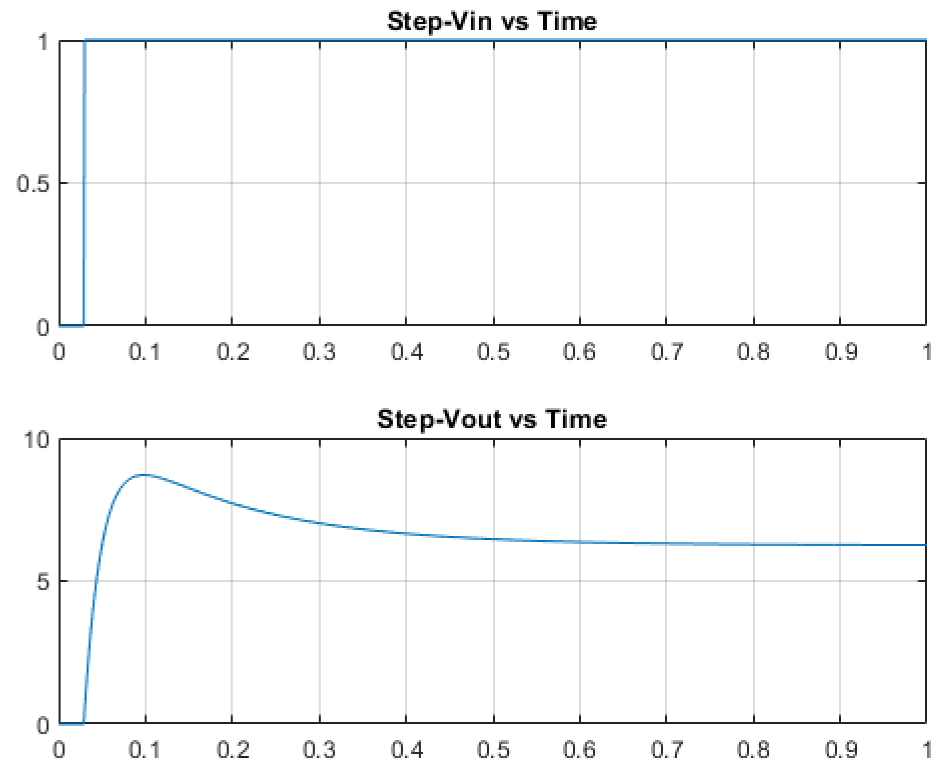
```
C(2,1)= cap;
C(1,3)= cap;
C(2,3)= -cap;
C(4,7)= -L;

time_step = 0.001;

Vout = zeros(1000,1);
Vin = zeros(1000,1);
Vsolp = zeros(8,1);

A = C/(time_step)+G;
time = zeros(1000,1);

i = 1;

F = zeros(1,8);

for t=0:time_step:1
    if(t<0.03)
        F(1,7) = 0;
    else
        F(1,7) = 1;
    end

    time(i) = t;
    Vsol = inv(A)*(C*Vsolp/time_step + F');
    Vout(i) = Vsol(6);
    Vin(i) = Vsol(1);
    Vsolp = Vsol;
    i = i+1;
end

figure(1)
subplot(2,1,2)
plot(time,Vout)
title('Step-Vout vs Time')
grid on

subplot(2,1,1)
plot(time,Vin)
title('Step-Vin vs Time')
grid on

freq = 1000;
freqOut = fft(Vout);
x = length(Vout);
y = fftshift(freqOut);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(2)
semilogy(freqShift,shift)
title('Step frequency spectrum output')
```

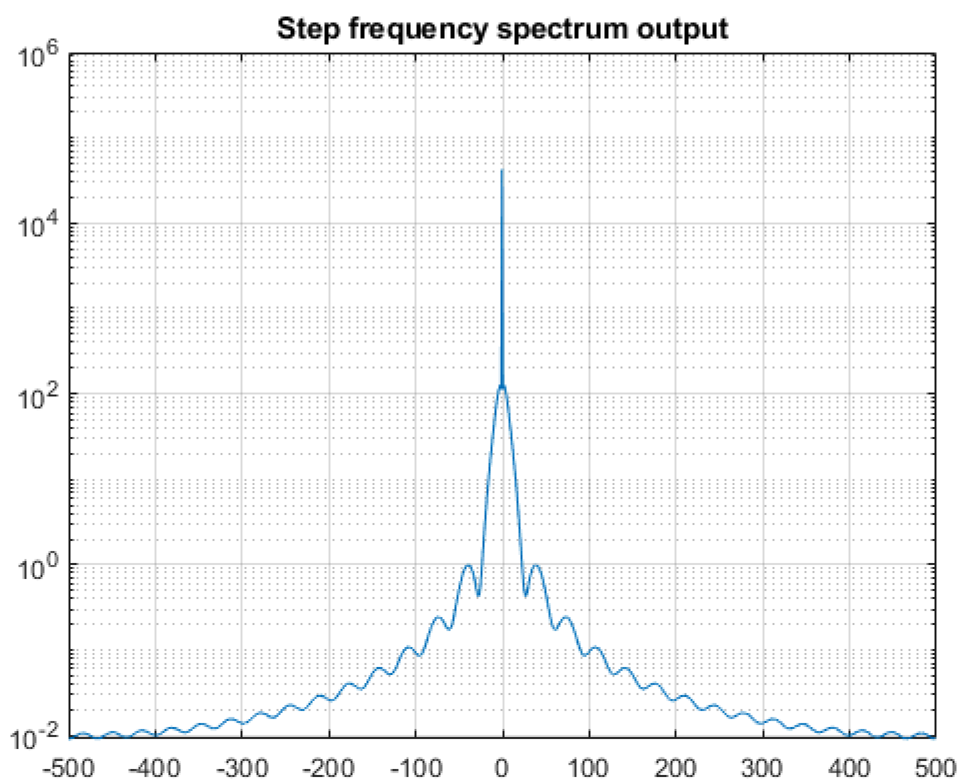
```
grid on

%Vin

freqIn = fft(Vin);
x = length(Vin);
y = fftshift(freqIn);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(3)
semilogy(freqShift,shift)
title('Step frequency spectrum input')
grid on

%Sine wave input

Vt = @(t) sin(2*pi*(1/0.03)*t);
Vout = zeros(1000,1);
Vin = zeros(1000,1);
Vsolp = zeros(8,1);

A = C/(time_step)+G;
time = zeros(1000,1);

i = 1;

F = zeros(1,8);

for t=0:time_step:1

    F(1,7) = Vt(t);

    time(i) = t;
    Vsol = inv(A)*(C*Vsolp/time_step + F');
    Vout(i) = Vsol(6);
    Vin(i) = Vsol(1);
    Vsolp = Vsol;
    i = i+1;
end

figure(4)
subplot(2,1,2)
plot(time,Vout)
title('Sine-Vout vs Time')
grid on

subplot(2,1,1)
plot(time,Vin)
title('Sine-Vin vs Time')
grid on

freq = 1000;
freqOut = fft(Vout);
```

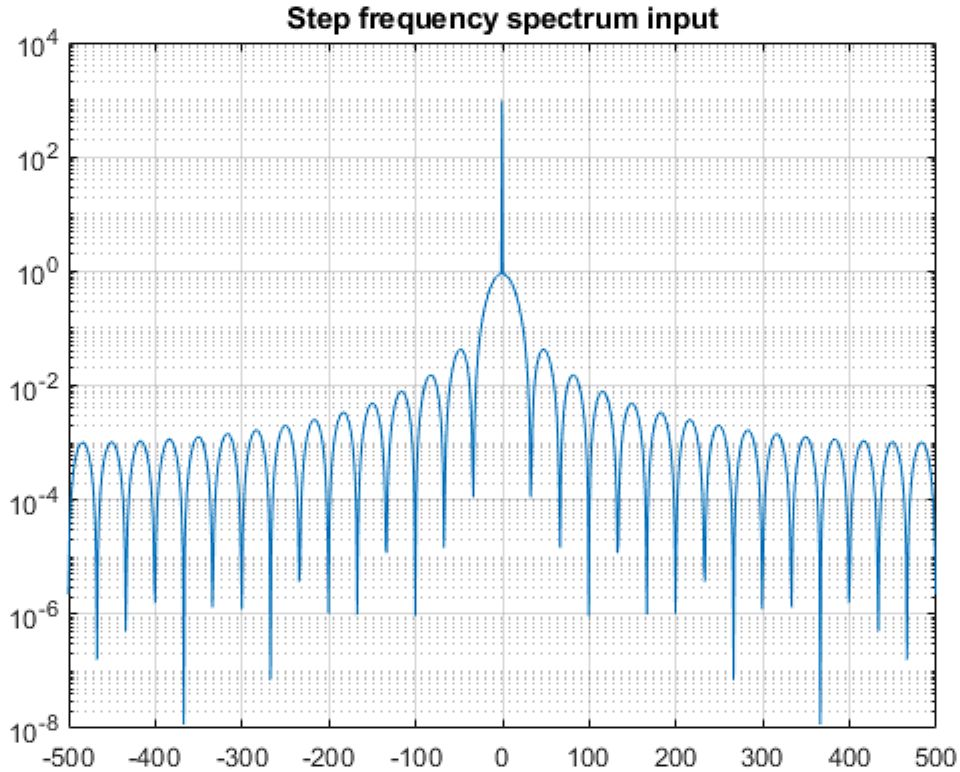
```
x = length(Vout);
y = fftshift(freqOut);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(5)
semilogy(freqShift,shift)
title('Sine frequency spectrum output')
grid on

freqIn = fft(Vin);
x = length(Vin);
y = fftshift(freqIn);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(6)
semilogy(freqShift,shift)
title('Sine frequency spectrum input')
grid on

% Gaussian input

Vt = @(t) exp(-(1/2)*((t-0.06)/(0.03))^2);
Vout = zeros(1000,1);
Vin = zeros(1000,1);
Vsolp = zeros(8,1);

A = C/(time_step)+G;
time = zeros(1000,1);

i = 1;

F = zeros(1,8);

for t=0:time_step:1

    F(1,7) = Vt(t);

    time(i) = t;
    Vsol = inv(A)*(C*Vsolp/time_step + F');
    Vout(i) = Vsol(6);
    Vin(i) = Vsol(1);
    Vsolp = Vsol;
    i = i+1;
end

figure(7)
subplot(2,1,2)
plot(time,Vout)
title('Gaussian-Vout vs Time')
grid on

subplot(2,1,1)
```

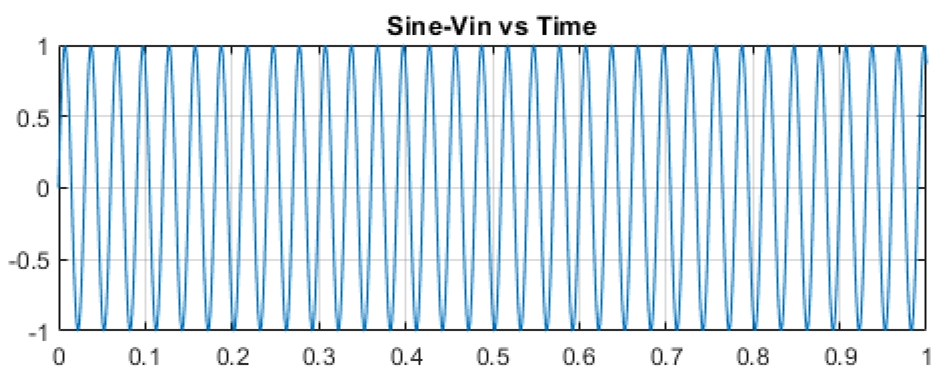
```
plot(time,Vin)
title('Gaussian-Vin vs Time')
grid on

freq = 1000;
freqOut = fft(Vout);
x = length(Vout);
y = fftshift(freqOut);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(8)
semilogy(freqShift,shift)
title('Gaussian frequency spectrum output')
grid on

freqIn = fft(Vin);
x = length(Vin);
y = fftshift(freqIn);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(9)
semilogy(freqShift,shift)
title('Gaussian frequency spectrum input')
grid on

%Larger time step for Sine wave input

time_step = 0.1;

Vt = @(t) sin(2*pi*(1/0.03)*t);
Vout = zeros(1000,1);
Vin = zeros(1000,1);
Vsolp = zeros(8,1);

A = C/(time_step)+G;
time = zeros(1000,1);

i = 1;

F = zeros(1,8);

for t=0:time_step:1

    F(1,7) = Vt(t);

    time(i) = t;
    Vsol = inv(A)*(C*Vsolp/time_step + F');
    Vout(i) = Vsol(6);
    Vin(i) = Vsol(1);
    Vsolp = Vsol;
    i = i+1;
end
```

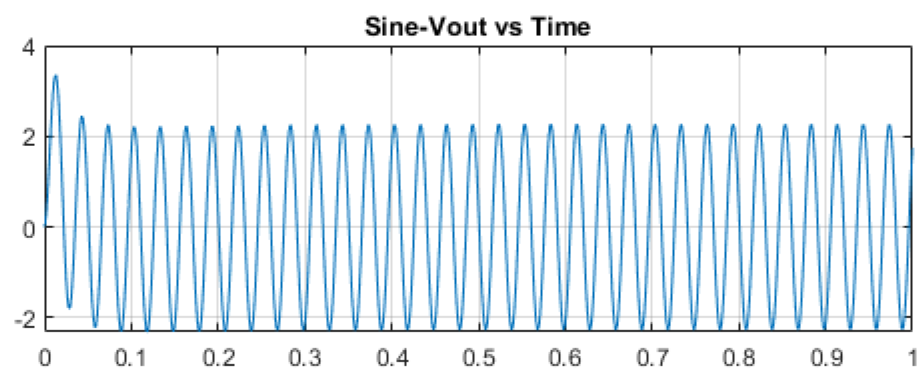
```
figure(10)
subplot(2,1,2)
plot(time,Vout)
title('Sine-Vout vs Time: Larger Time Step')
grid on

subplot(2,1,1)
plot(time,Vin)
title('Sine-Vin vs Time: Larger Time Step')
grid on

freq = 1000;
freqOut = fft(Vout);
x = length(Vout);
y = fftshift(freqOut);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(11)
semilogy(freqShift,shift)
title('Sine frequency spectrum output: Larger Time Step')
grid on

freqIn = fft(Vin);
x = length(Vin);
y = fftshift(freqIn);
freqShift = (-x/2:x/2-1)*(freq/x);
shift = abs(y).^2/x;

figure(12)
semilogy(freqShift,shift)
title('Sine frequency spectrum input: Larger Time Step')
grid on
```

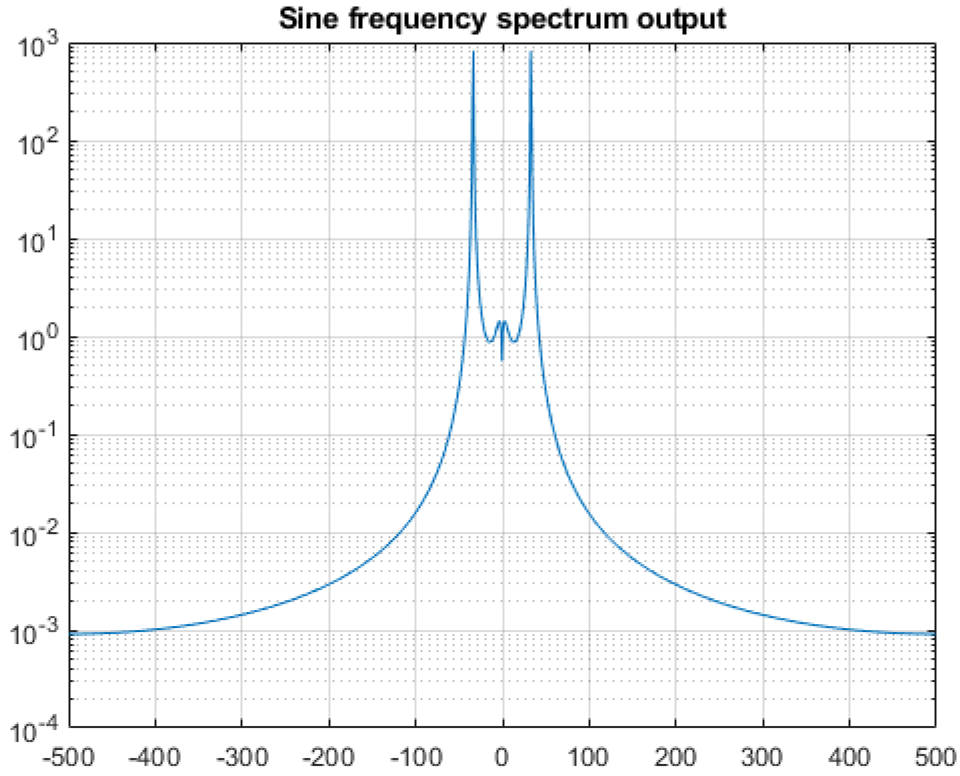

Step-Vin vs Time
1
0.5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Step-Vout vs Time
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

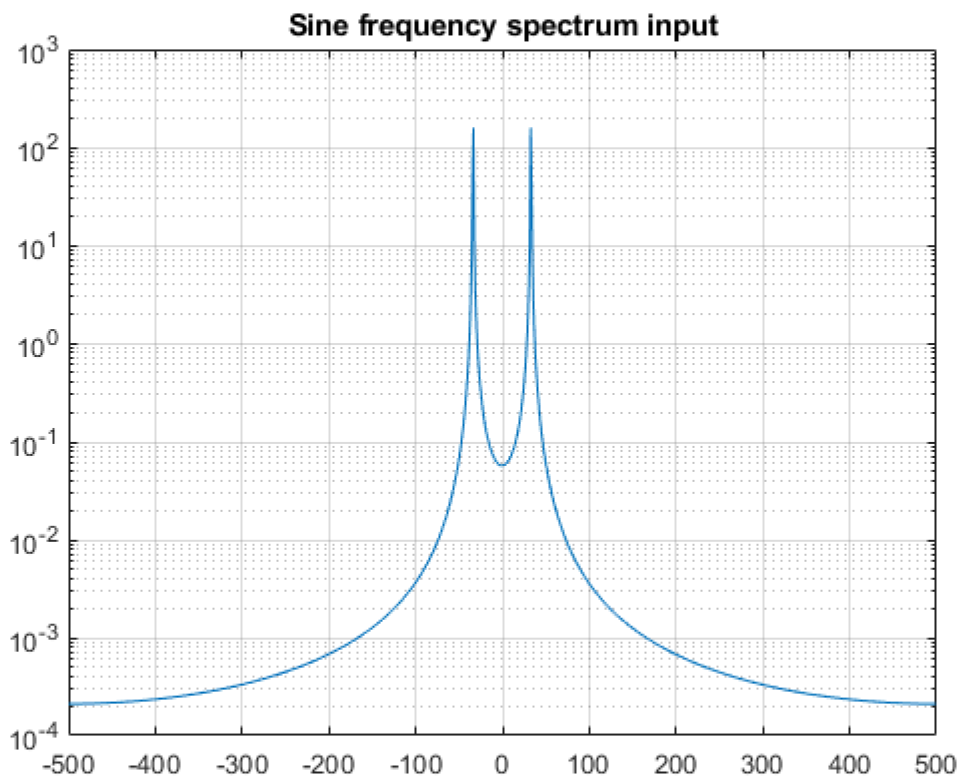

Step frequency spectrum output
10^6
10^4
10^2
10^0
10^{-2}
-500
-400
-300
-200
-100
0
100
200
300
400
500

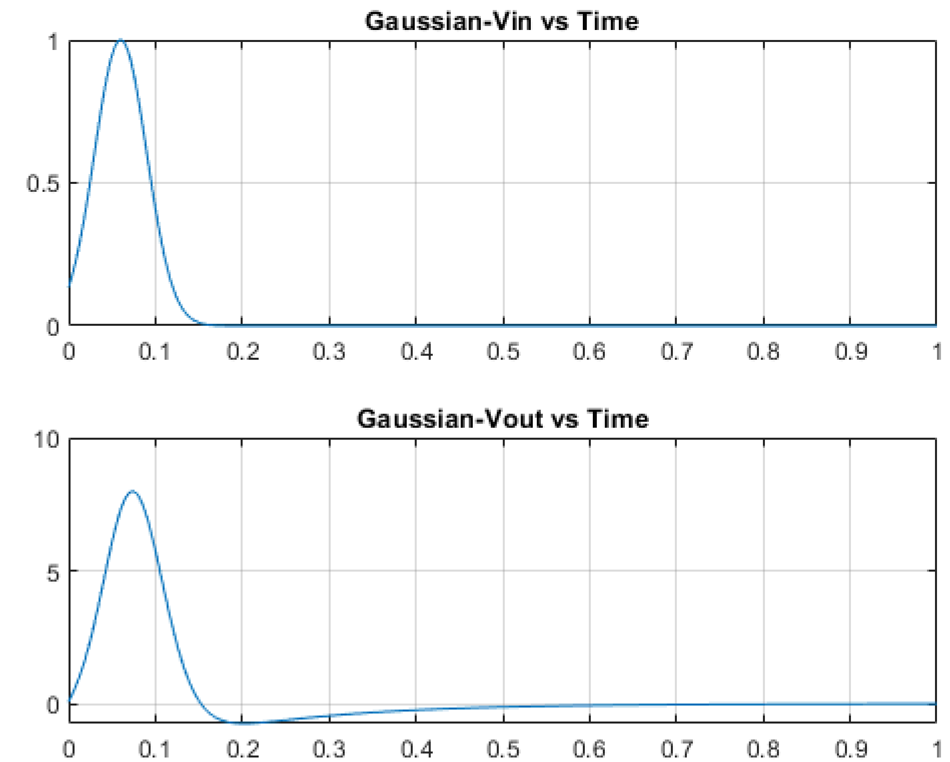

Step frequency spectrum input
10^4
10^2
10^0
10^-2
10^-4
10^-6
10^-8
-500
-400
-300
-200
-100
0
100
200
300
400
500

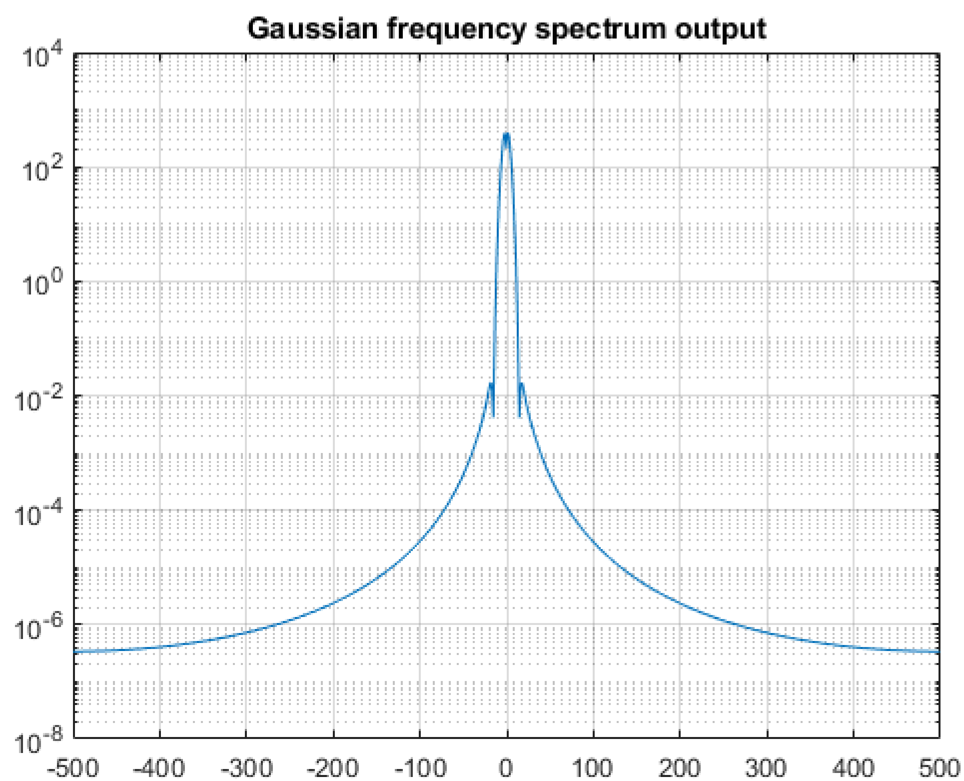

Sine-Vin vs Time
1
0.5
0
-0.5
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

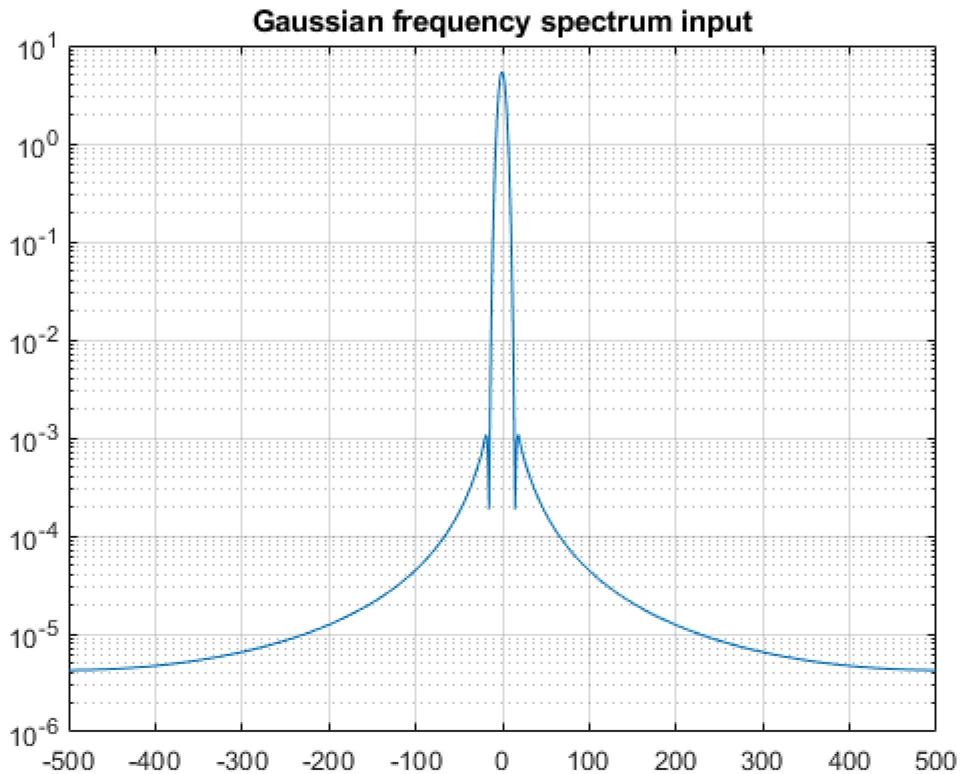

Sine-Vout vs Time
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

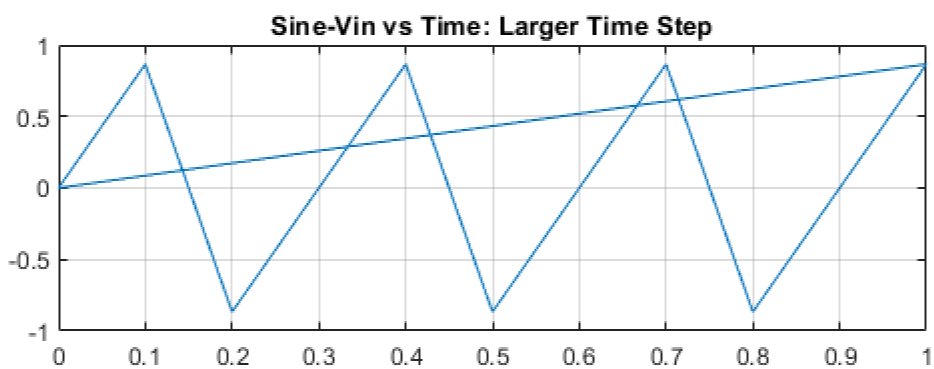

Sine frequency spectrum output
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
-500 -400 -300 -200 -100 0 100 200 300 400 500

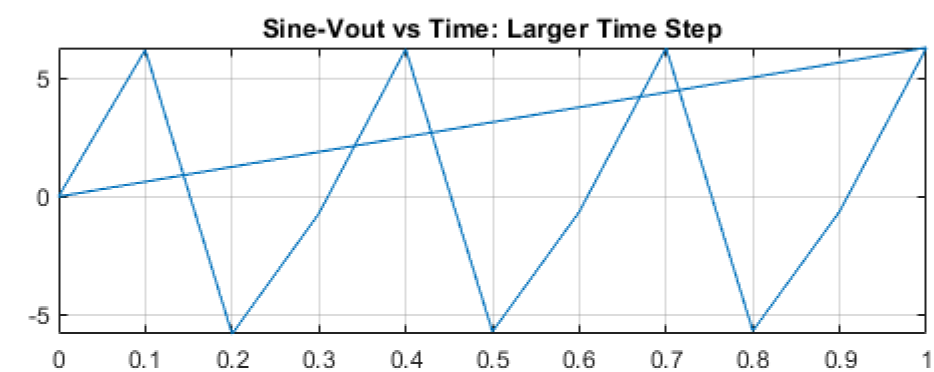

Sine frequency spectrum input
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
-500 -400 -300 -200 -100 0 100 200 300 400 500

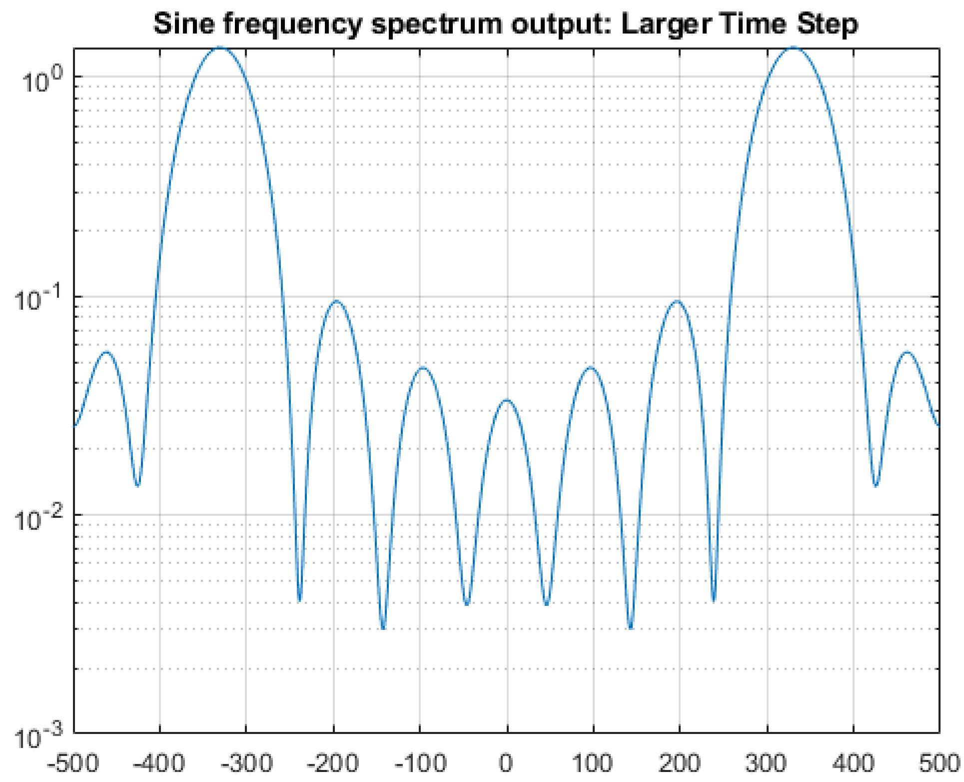

Gaussian-Vin vs Time
1
0.5
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Gaussian-Vout vs Time
10
5
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

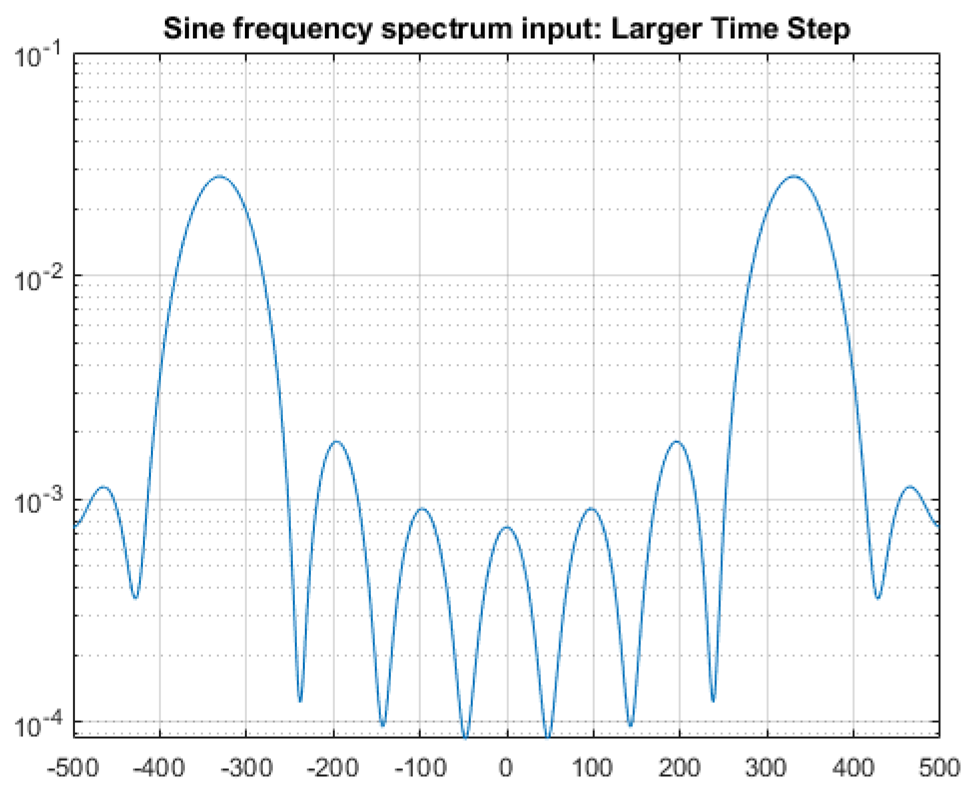

Gaussian frequency spectrum output
10^4
10^2
10^0
10^{-2}
10^{-4}
10^{-6}
10^{-8}
-500 -400 -300 -200 -100 0 100 200 300 400 500


Gaussian frequency spectrum input
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
-500 -400 -300 -200 -100 0 100 200 300 400 500


Sine-Vin vs Time: Larger Time Step
1
0.5
0
-0.5
-1
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1


Sine-Vout vs Time: Larger Time Step
5
0
-5
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1


Sine frequency spectrum output: Larger Time Step
10^0
10^-1
10^-2
10^-3
-500
-400
-300
-200
-100
0
100
200
300
400
500


Sine frequency spectrum input: Larger Time Step
10^-1
10^-2
10^-3
10^-4
-500
-400
-300
-200
-100
0
100
200
300
400
500

From the time domain analyiss of the circuit it was found that as the time step was increased the output waveform would appear to have more distorsion, thus a smaller time step would give a cleaner signal and should be used for analysis.

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