Contents

2a)

C and G matrices are shown below

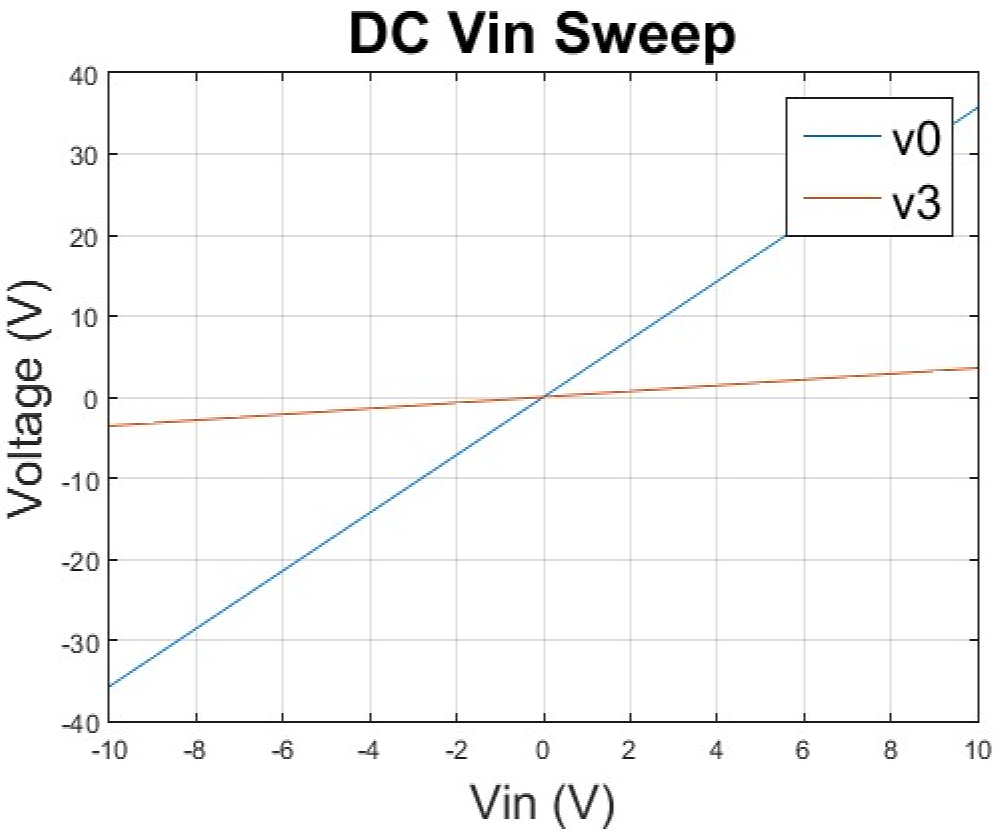
```
G1=1/1;
C=0.25;
G2=1/2;
L=0.2;
G3=1/10;
alpha=100;
G4=1/0.1;
G0=1/1000;

G = [1 0 0 0 0 0 0;
    -G2 G1+G2 -1 0 0 0 0;
    0 1 0 -1 0 0 0;
    0 0 -1 G3 0 0 0;
    0 0 0 0 -alpha 1 0;
    0 0 0 G3 -1 0 0;
    0 0 0 0 0 -G4 G4+G0];

C = [0 0 0 0 0 0 0;
    -C C 0 0 0 0 0;
    0 0 -L 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];

% V = [V1
%       V2
%       IL
%       V3
%       I3
%       V4
```

```
%       V0]

F = [0; 0; 0; 0; 0; 0; 0];
```

2b)

DC SWEEP

```
vinvec = zeros(1,21); % vin vector
v0vec = zeros(1,21); % v0 vector
v3vec = zeros(1,21); % v3 vector

for i=1:21 % sweeping vin from -10 to 10
    F = [i-11; 0; 0; 0; 0; 0; 0];
    V = G\F; % DC solution

    vinvec(i) = i-11;
    v0vec(i) =  V(7);
    v3vec(i) = V(4);
end

figure (1)
plot(vinvec,v0vec)
hold on
grid on
plot(vinvec,v3vec)
title('\fontsize{22}DC Vin Sweep')
xlabel('\fontsize{18}Vin (V)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}v0','\fontsize{18}v3')
```

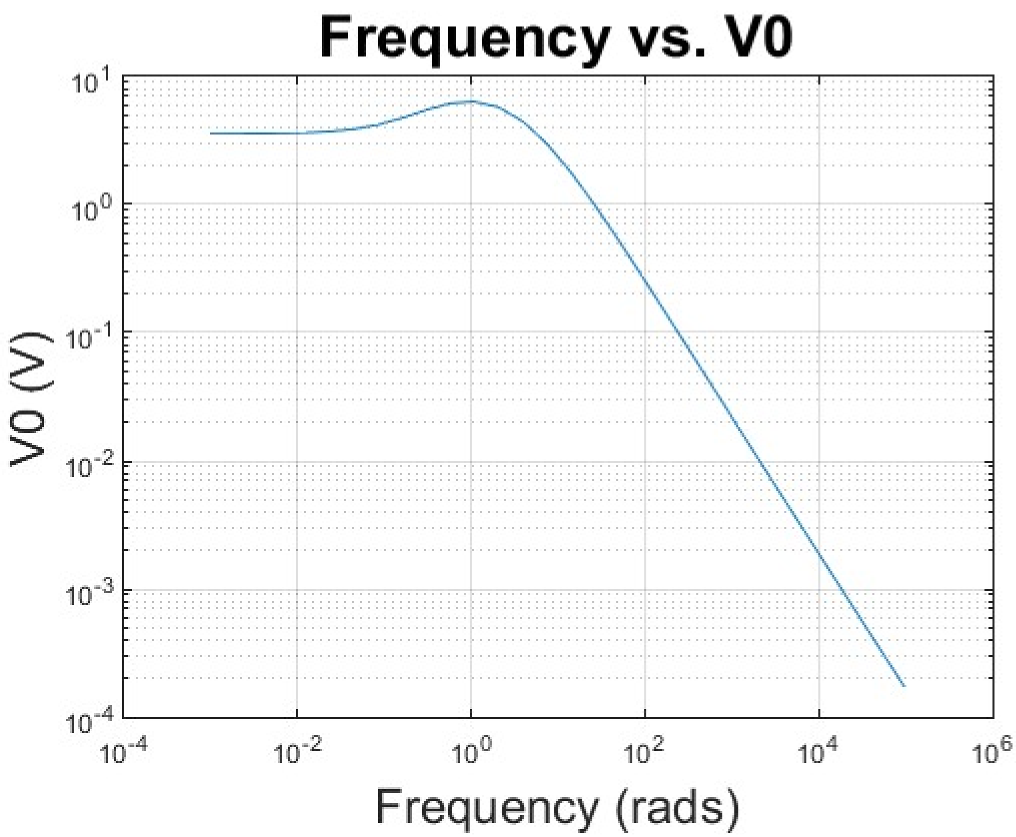


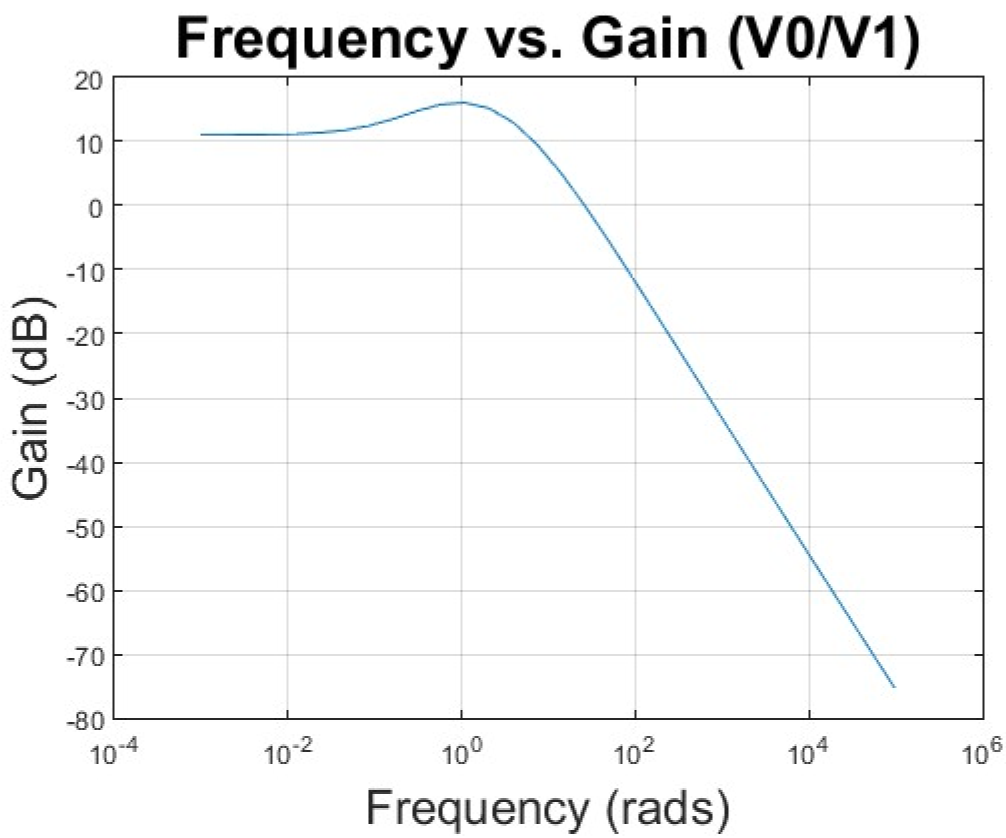
2c)

AC SWEEPS

```
omegavec = logspace(-3,5,30); % 30 log spaced values from 10^-3 to 10^5
v0vec = zeros(1,30);

F = [1; 0; 0; 0; 0; 0; 0];

for i=1:30

    V = (G+i*omegavec(i)*C)\F; % AC solution

    v0vec(i) =  V(7);
end

figure (2)
loglog(omegavec,v0vec)
hold on
grid on
title('\fontsize{22}Frequency vs. V0')
xlabel('\fontsize{18}Frequency (rads)')
ylabel('\fontsize{18}V0 (V)')

figure (3)
semilogx(omegavec,20*log10(v0vec))
hold on
grid on
title('\fontsize{22}Frequency vs. Gain (V0/V1)')
```

```
xlabel('\fontsize{18}Frequency (rads)')
ylabel('\fontsize{18}Gain (dB)')
```





2d and e)

Numerical solution in time domain, with Fourier Transforms

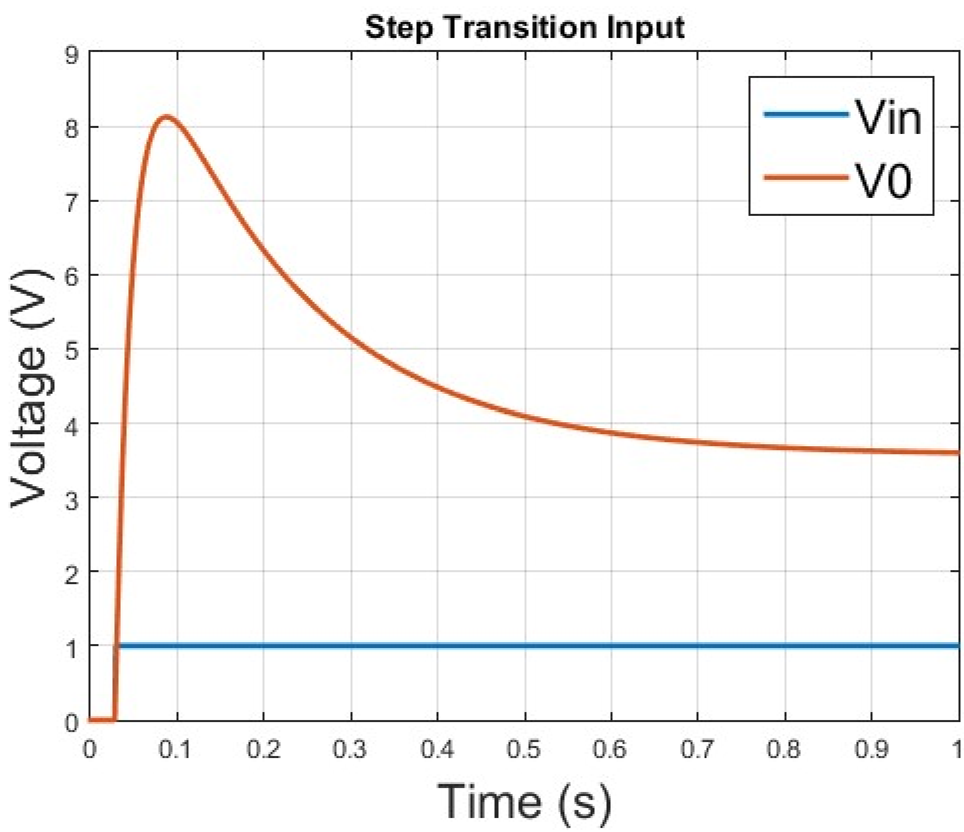
```
dt = 1e-3;
T = 1;
fs = T/dt;
time = 0:(1/fs):(1-1/fs);
n=fs;
f = (0:n-1);

V = zeros(7,T/dt);
F = zeros(7,T/dt);
Ap = inv(C/dt + G);

% Vin defined as 0 until 0.03 when source turns on
F(1,0.03/dt:T/dt) = ones([1,T/dt - 0.03/dt+1]);

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
end

figure (4)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Step Transition Input')
xlabel('\fontsize{18}Time (s)')
```

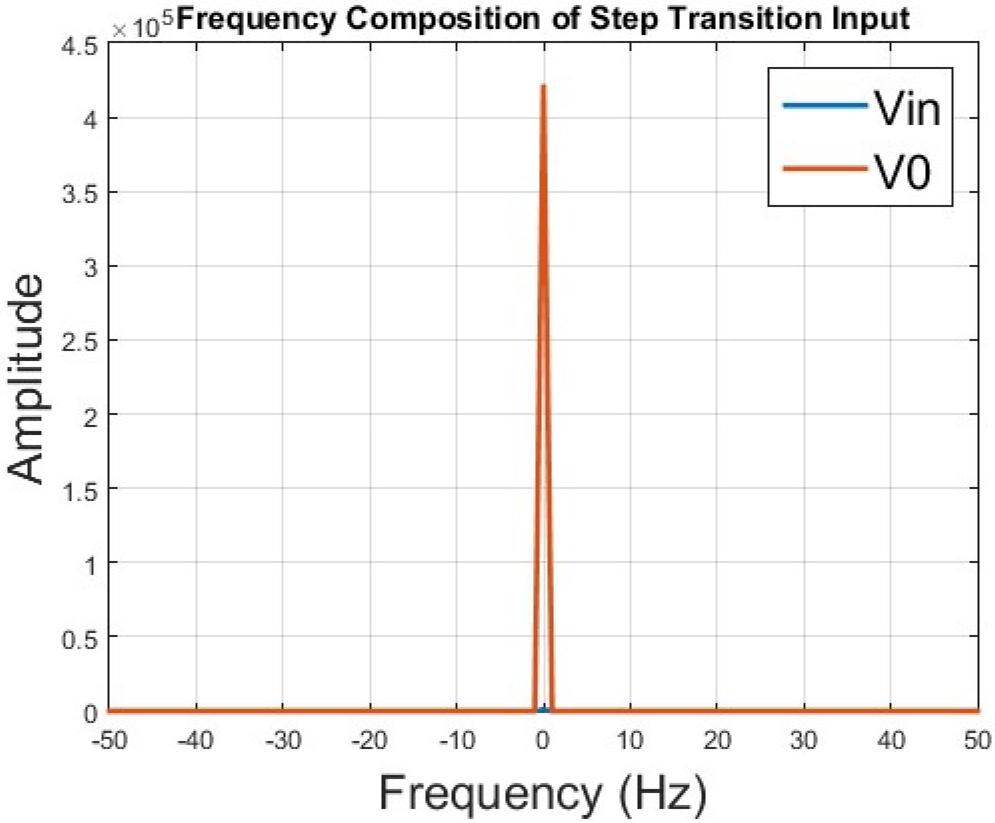
```
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (5)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Step Transition Input')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-50 50])

% Vin defined as a sinusoid
f = 1/0.03;
F1 = zeros(7,T/dt);
F2 = zeros(7,T/dt);
V = zeros(7,T/dt);
V1 = zeros(7,T/dt);
V2 = zeros(7,T/dt);

for i=dt/dt:T/dt
    F(1,i) = sin(2*pi*f*dt*i);
    F1(1,i) = sin(2*pi*(f*10)*dt*i); % 10 times the frequency
    F2(1,i) = sin(2*pi*(f*0.1)*dt*i); % 1/10 of the frequency
end

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
    V1(:,i) = Ap*(C*V1(:,i-1)/dt + F1(:,i));
    V2(:,i) = Ap*(C*V2(:,i-1)/dt + F2(:,i));
end

figure (6)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Sinusoid Input, f=1/0.03')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
```

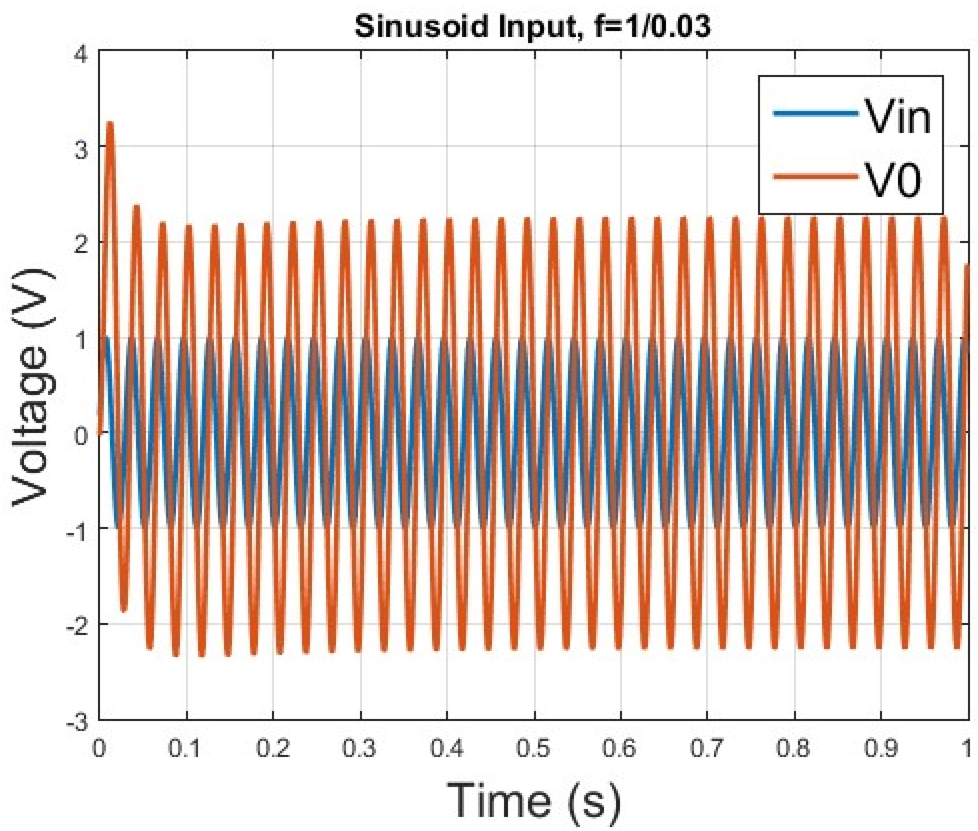
```
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (7)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Sinusoid Input, f=1/0.03')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-50 50])

figure (8)
plot(time,F1(1,:)','LineWidth',2)
hold on
grid on
plot(time,V1(7,:)','LineWidth',2)
title('\fontsize{12}Sinusoid Input, f=1/0.003')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')
axis([0 0.2 -1 1]);

XF1 = (fft(F1(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V1(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (9)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Sinusoid Input, f=1/0.003')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-500 500])

figure (10)
plot(time,F2(1,:)','LineWidth',2)
hold on
grid on
plot(time,V2(7,:)','LineWidth',2)
```

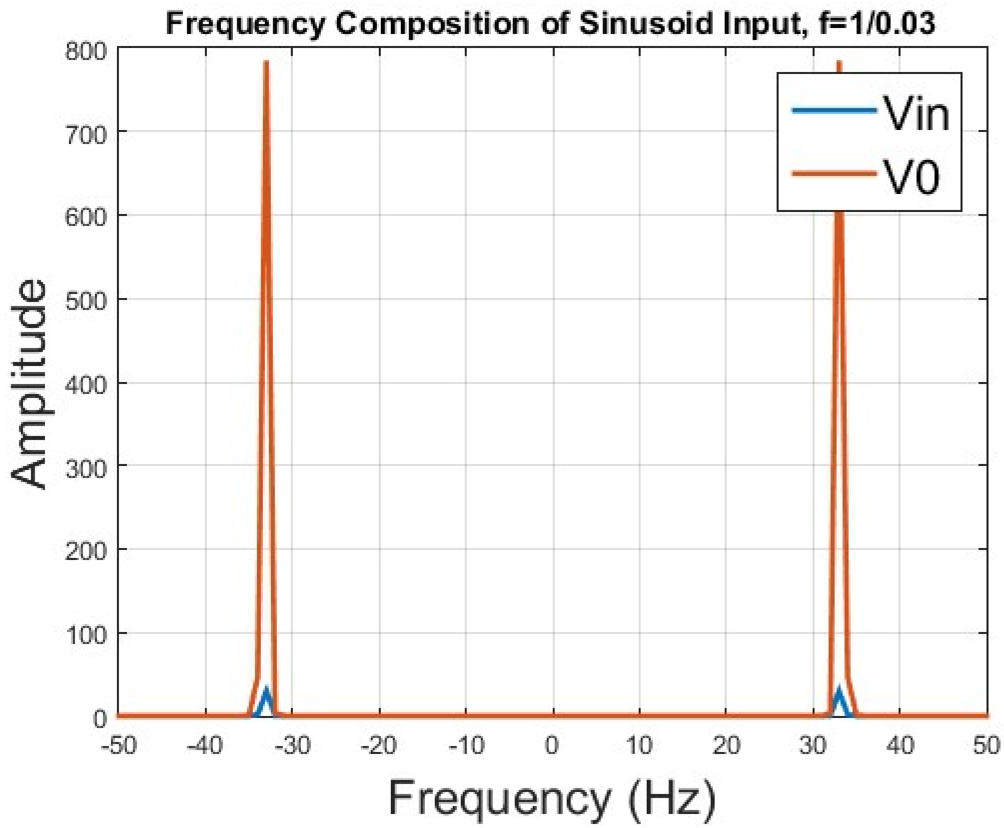
```
title('\fontsize{12}Sinusoid Input, f=1/0.3')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F2(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V2(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (11)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Sinusoid Input, f=1/0.3')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-50 50])

% Vin defined as a gaussian
V = zeros(7,T/dt);
F = zeros(7,T/dt);
F(1,:) = normpdf(time,0.06,0.03)*max(normpdf(time,0.06,0.03))^(-1);

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
end

figure (12)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Gaussian Pulse')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (13)
```

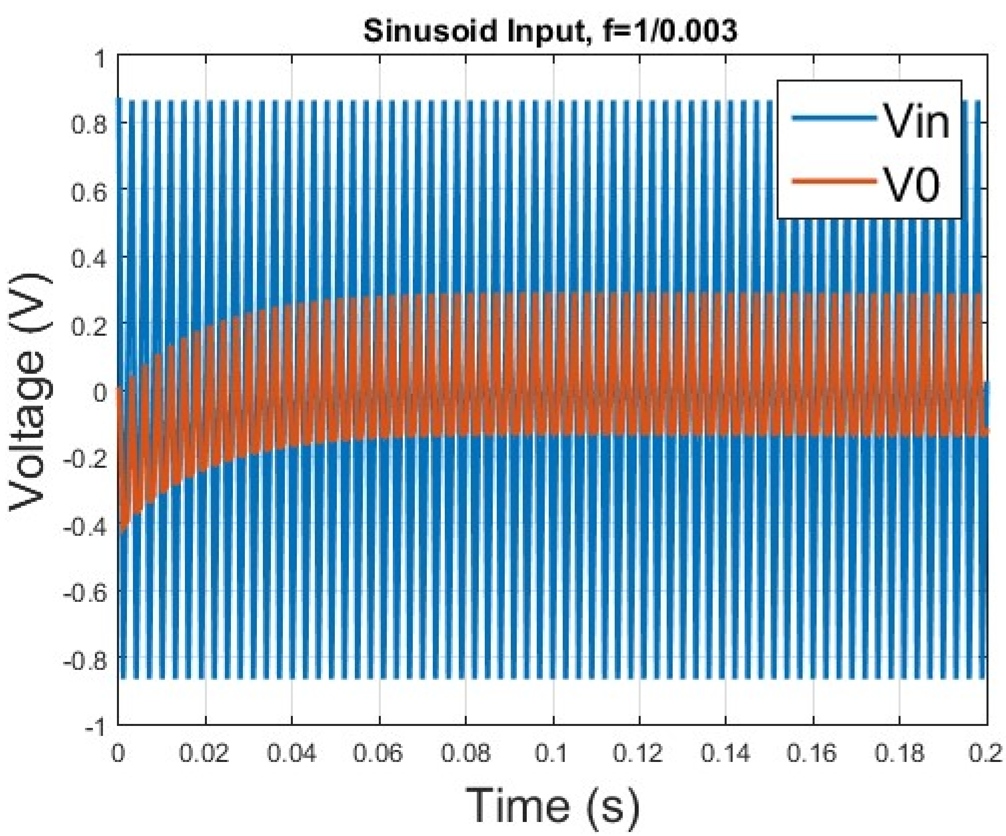
```
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Gaussian Pulse')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-50 50])
```

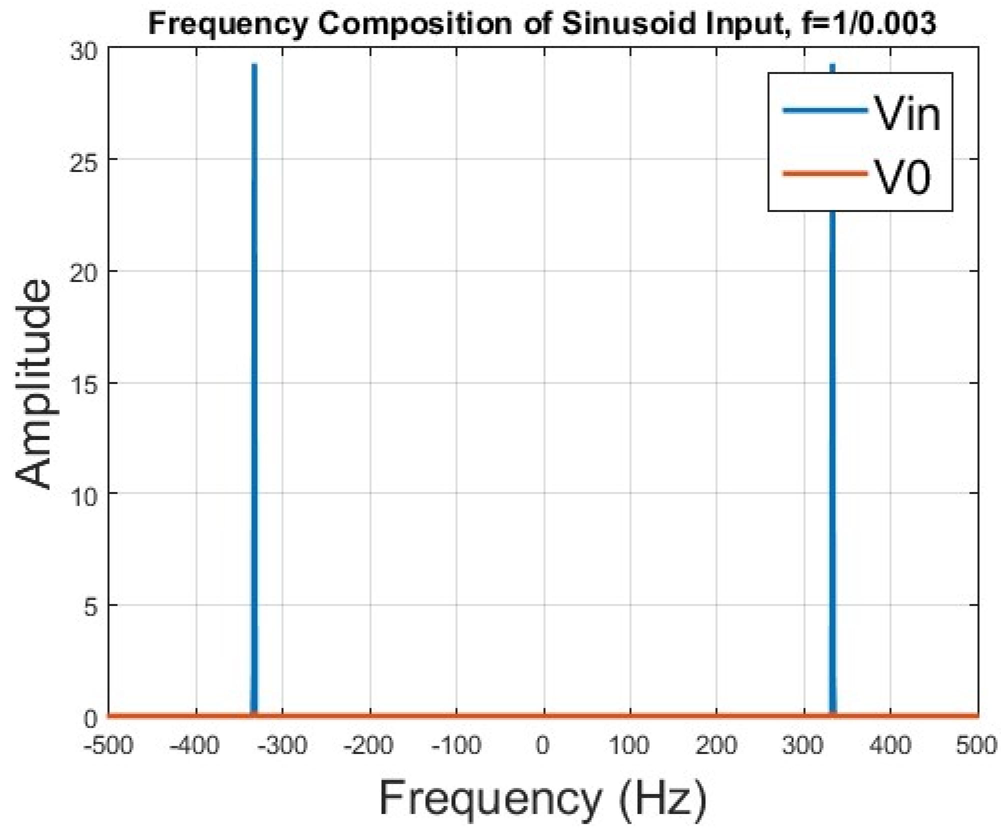


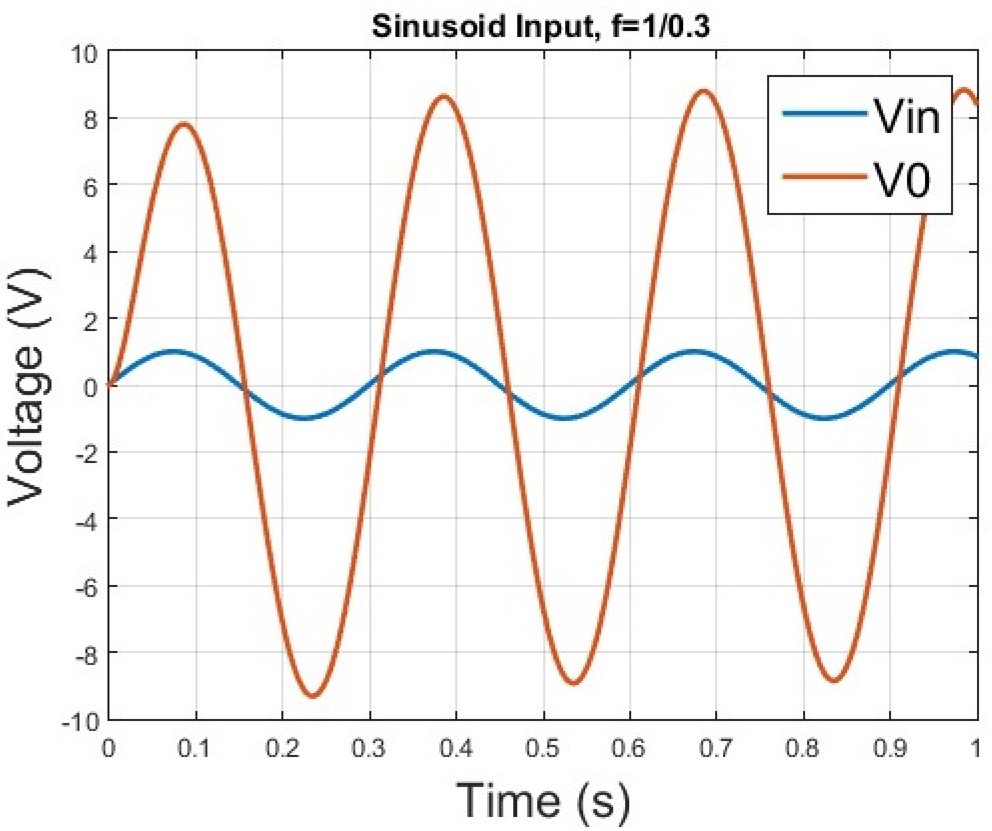

Frequency Composition of Step Transition Input
×10^5
Amplitude
Frequency (Hz)
Vin
V0

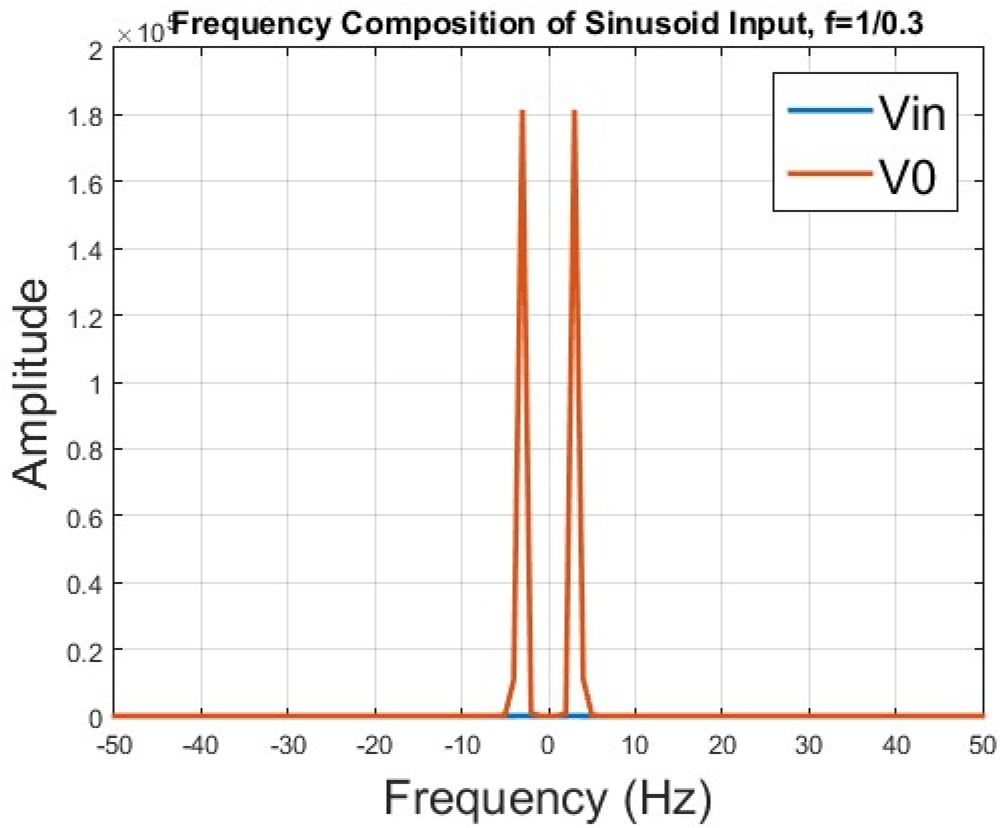

Sinusoid Input, f=1/0.03
Voltage (V)
Time (s)
Vin
V0

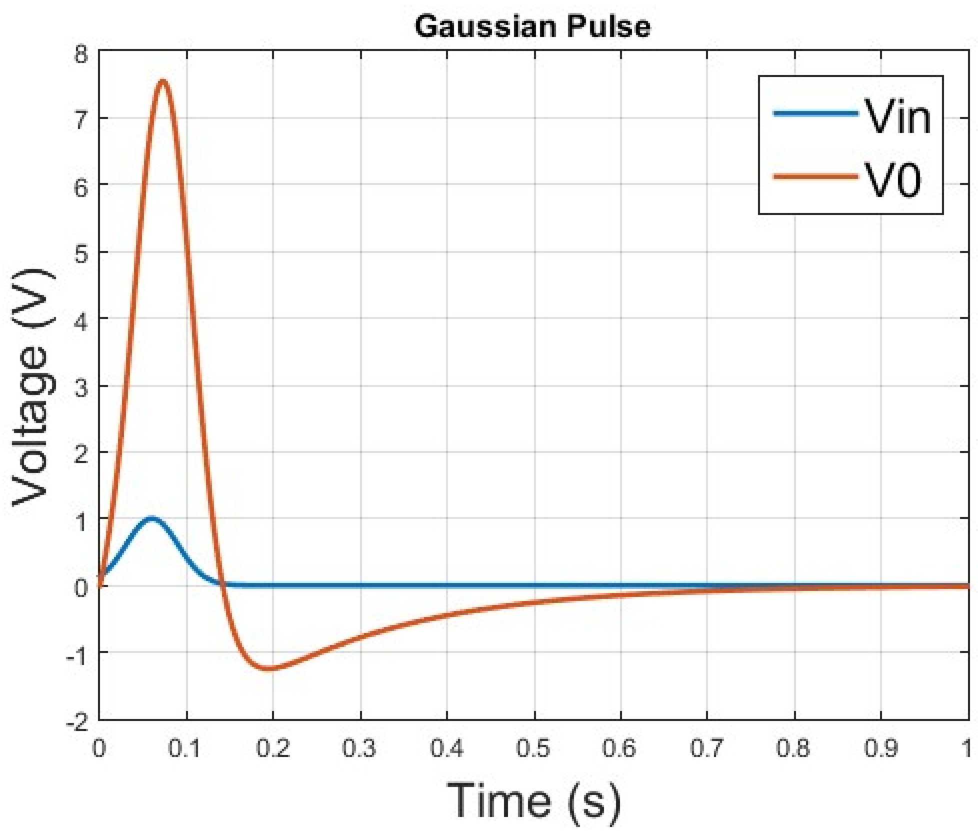

Frequency Composition of Sinusoid Input, f=1/0.03
Vin
V0
Amplitude
Frequency (Hz)
800
700
600
500
400
300
200
100
0
-50
-40
-30
-20
-10
0
10
20
30
40
50

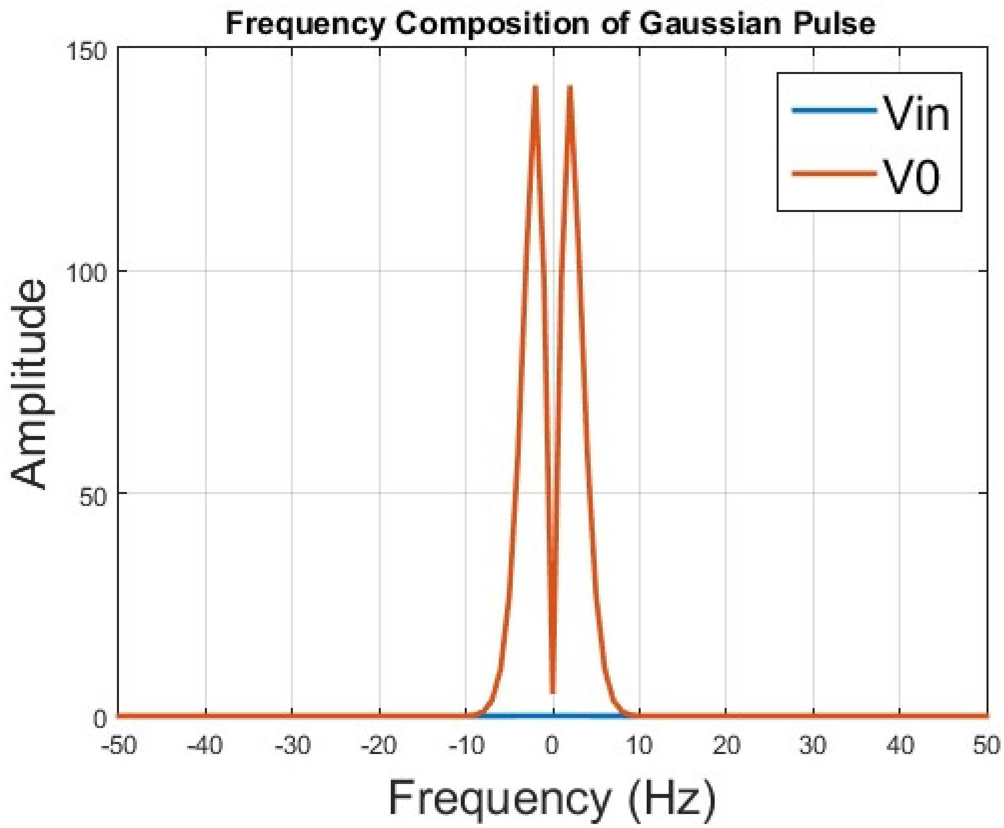

Sinusoid Input, f=1/0.003
Vin
V0
Voltage (V)
Time (s)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2


Frequency Composition of Sinusoid Input, f=1/0.003
Amplitude
30
25
20
15
10
5
0
-500
-400
-300
-200
-100
0
100
200
300
400
500
Frequency (Hz)
Vin
V0


Sinusoid Input, f=1/0.3
Voltage (V)
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Time (s)
Vin
V0


Frequency Composition of Sinusoid Input, f=1/0.3
×10^5
Vin
V0
Amplitude
Frequency (Hz)


Gaussian Pulse
Vin
V0
Voltage (V)
Time (s)



2) Comments

Increasing the time step by small amounts does not drastically reduce the accuracy of the simulation, but at around dt=30e-3 the simulation loses consistency with previous results. There is no significant improvement in accuracy when reducing dt past 1e-3

3a)

Updated C matrix

```
G1=1/1;
C=0.25;
G2=1/2;
L=0.2;
G3=1/10;
alpha=100;
G4=1/0.1;
G0=1/1000;

Cn = 0.00001;

% V = [V1
%       V2
%       IL
%       V3
%       I3
%       V4
%       V0]
```

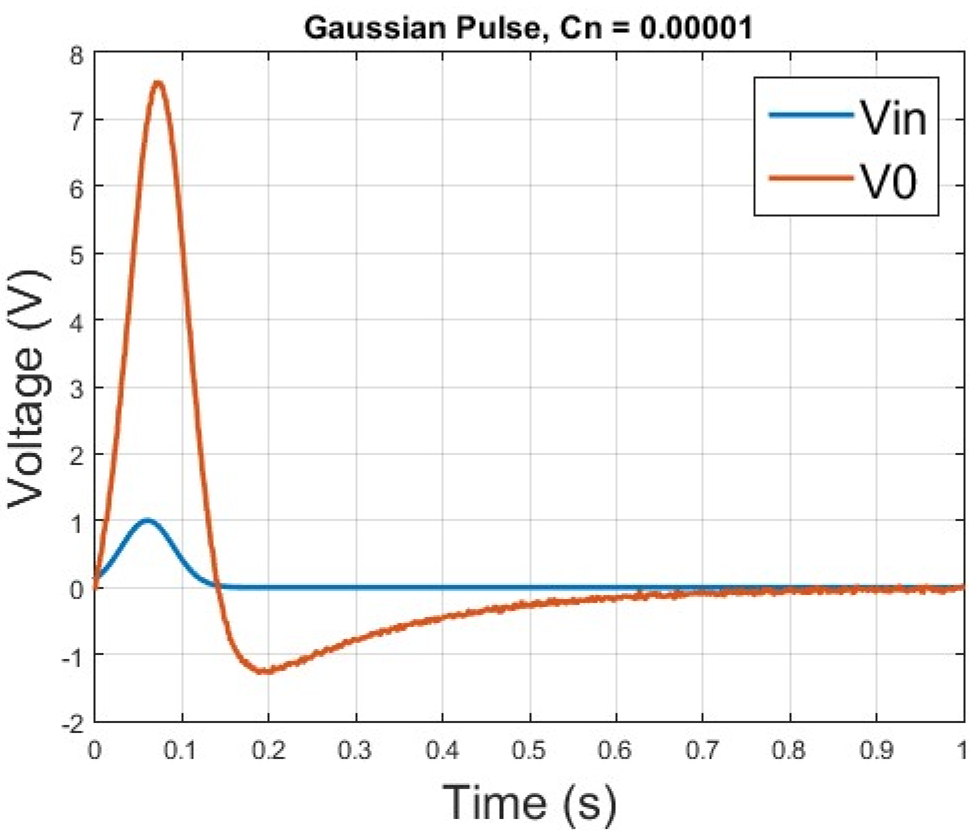
```
% F = [Vin
%       0
%       0
%       In
%       0
%       0
%       0]

G = [1 0 0 0 0 0 0;
    -G2 G1+G2 -1 0 0 0 0;
    0 1 0 -1 0 0 0;
    0 0 -1 G3 0 0 0;
    0 0 0 0 -alpha 1 0;
    0 0 0 G3 -1 0 0;
    0 0 0 0 0 -G4 G4+G0];

C = [0 0 0 0 0 0 0;
    -C C 0 0 0 0 0;
    0 0 -L 0 0 0 0;
    0 0 0 Cn 0 0 0; % Cn added to C matrix
    0 0 0 0 0 0 0;
    0 0 0 0 0 0 0;
    0 0 0 0 0 0 0];
```

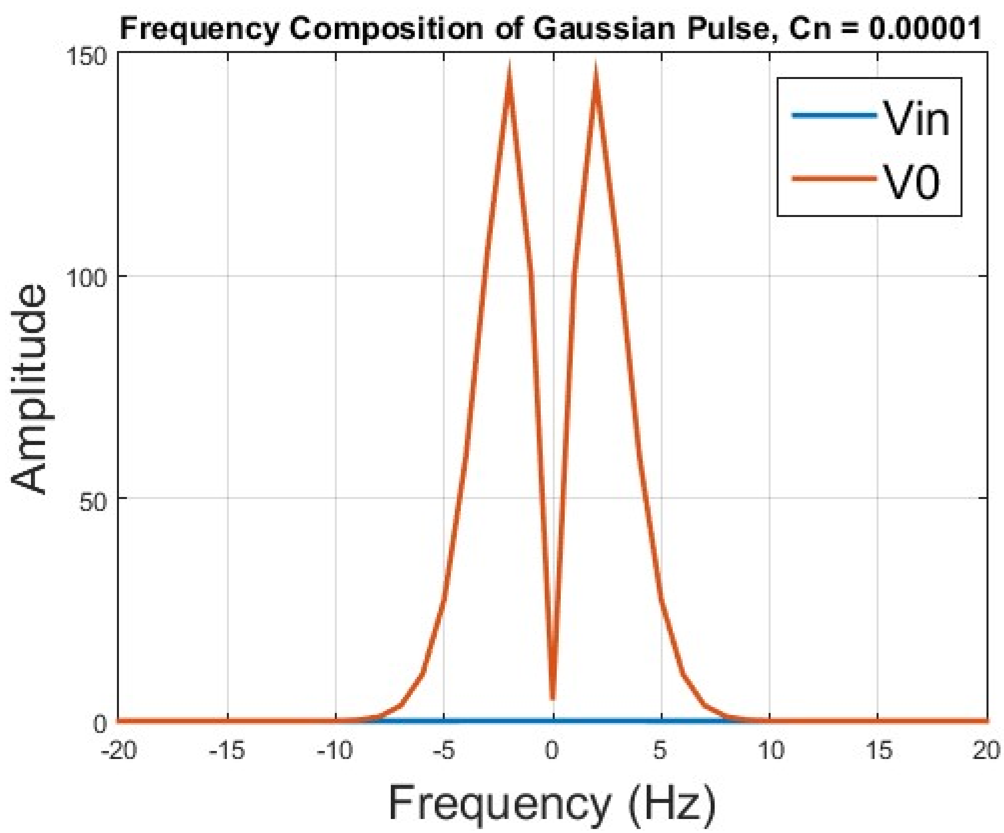
3b and c)

Plots of Vout with noise, and the Fourier transform

```
dt = 1e-3;
T = 1;
fs = T/dt;
time = 0:(1/fs):(1-1/fs);
n=fs;
f = (0:n-1);

%%%%%%%%% Cn = 0.00001 %%%%%%%%%%
V = zeros(7,T/dt);
F = zeros(7,T/dt);
Ap = inv(C/dt + G);

% Vin defined as a gaussian
F(1,:) = normpdf(time,0.06,0.03)*max(normpdf(time,0.06,0.03))^(-1);
F(4,:) = normrnd(0.001, 0.0003,1,T/dt); % In randomly picked from normal dist

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
end

figure (14)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Gaussian Pulse, Cn = 0.00001')
xlabel('\fontsize{18}Time (s)')
```

```
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;      % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;      % zero-centered power

figure (15)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Gaussian Pulse, Cn = 0.00001')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-20 20])
```





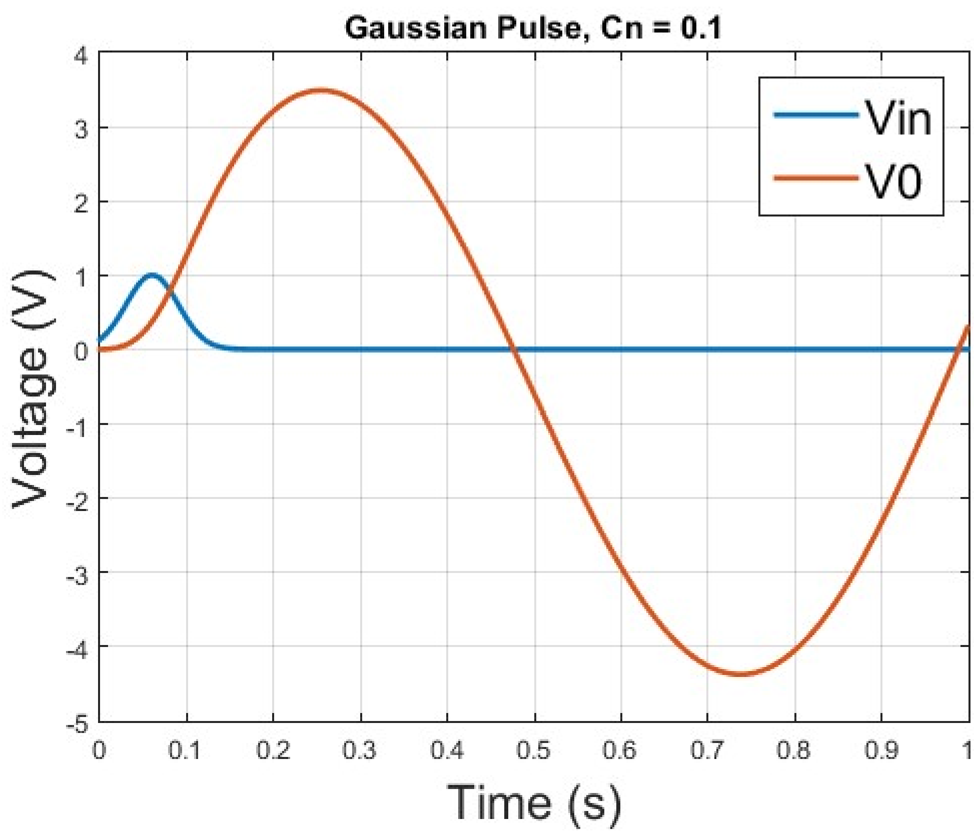
3e)

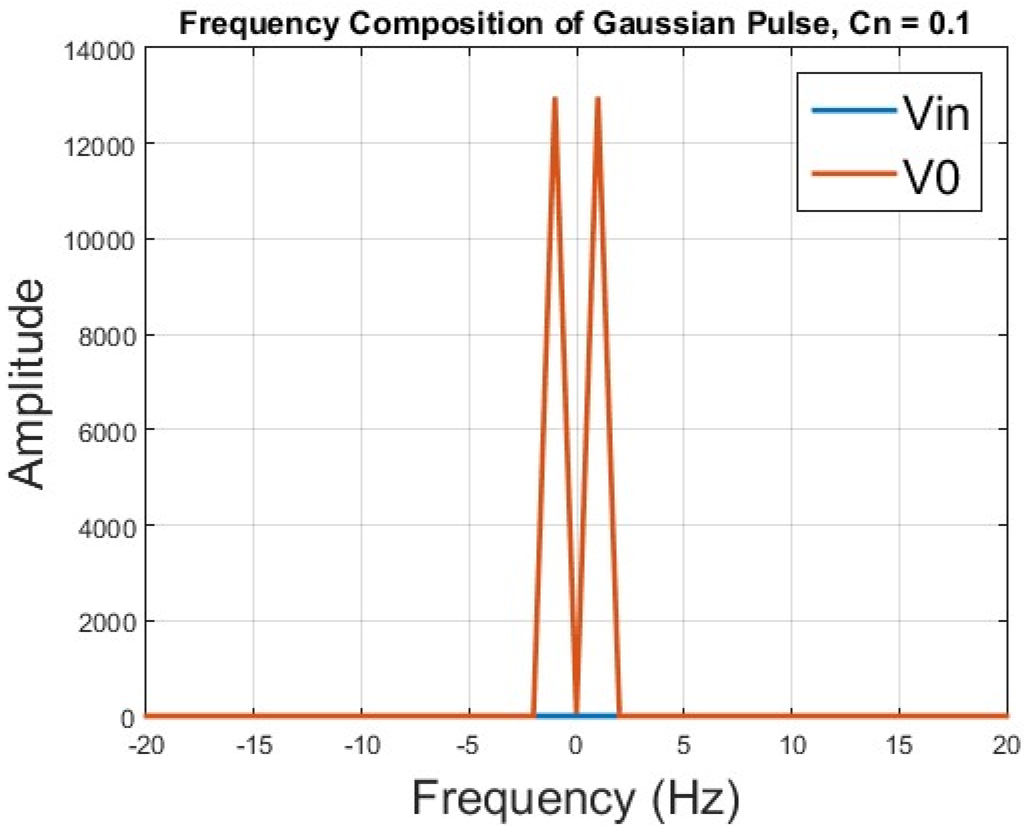
Plots as above, but with different Cn values (2 in this section, plus 1 in previous, 3 total)

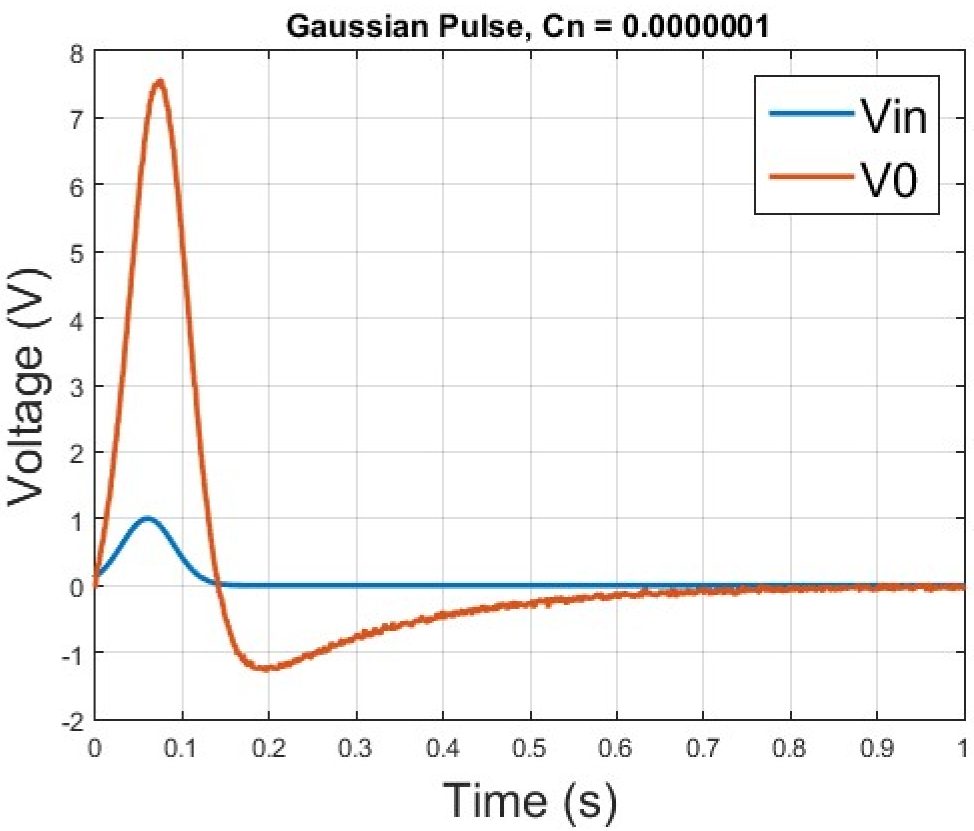
```
% Cn = 0.1
Cn = 0.1;
C(4,4) = Cn; % updating matrix

V = zeros(7,T/dt);
F = zeros(7,T/dt);
Ap = inv(C/dt + G);

% Vin defined as a gaussian
F(1,:) = normpdf(time,0.06,0.03)*max(normpdf(time,0.06,0.03))^(-1);
F(4,:) = normrnd(0.001, 0.0003,1,T/dt); % In randomly picked from normal dist

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
end

figure (16)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Gaussian Pulse, Cn = 0.1')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')
```

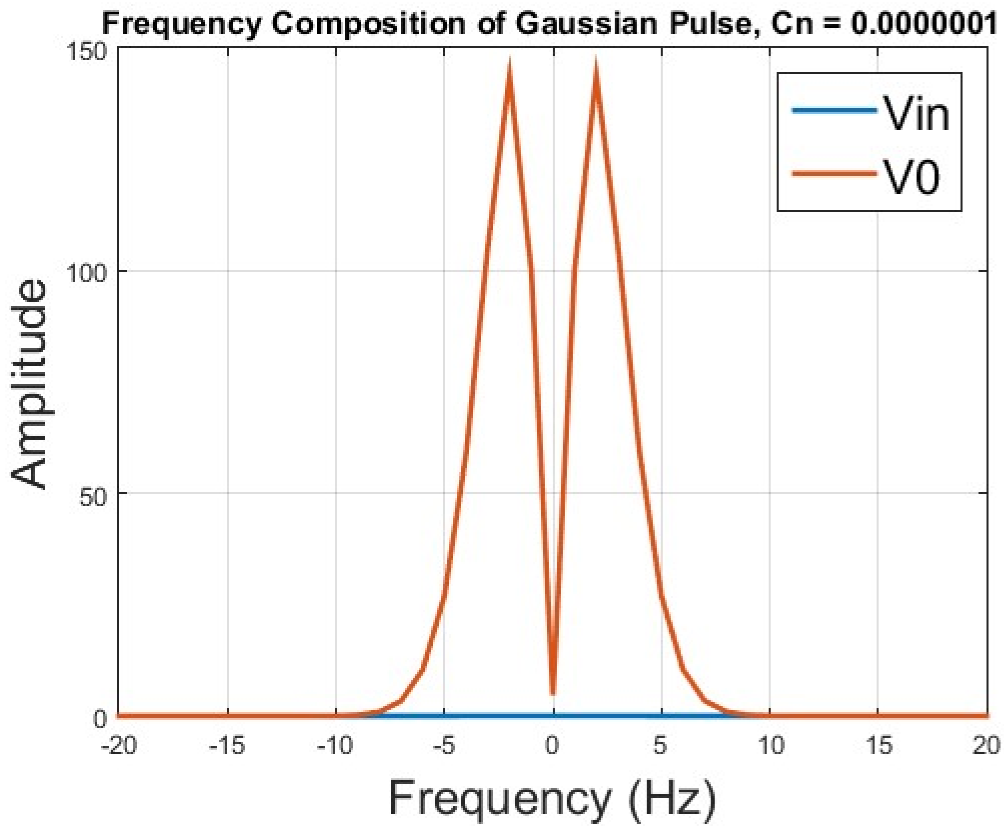
```
XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (17)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Gaussian Pulse, Cn = 0.1')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-20 20])

% Cn = 0.0000001
Cn = 0.0000001;
C(4,4) = Cn; % updating matrix

V = zeros(7,T/dt);
F = zeros(7,T/dt);
Ap = inv(C/dt + G);

% Vin defined as a gaussian
F(1,:) = normpdf(time,0.06,0.03)*max(normpdf(time,0.06,0.03))^(-1);
F(4,:) = normrnd(0.001, 0.0003,1,T/dt); % In randomly picked from normal dist

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
end

figure (18)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Gaussian Pulse, Cn = 0.0000001')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
```

```
powershiftV7 = abs(YV7).^2/n;      % zero-centered power

figure (19)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Gaussian Pulse, Cn = 0.0000001')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-20 20])
```




Frequency Composition of Gaussian Pulse, Cn = 0.1
Vin
V0
Amplitude
Frequency (Hz)
14000
12000
10000
8000
6000
4000
2000
0
-20
-15
-10
-5
0
5
10
15
20


Gaussian Pulse, Cn = 0.0000001
Vin
V0
Voltage (V)
Time (s)
8
7
6
5
4
3
2
1
0
-1
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

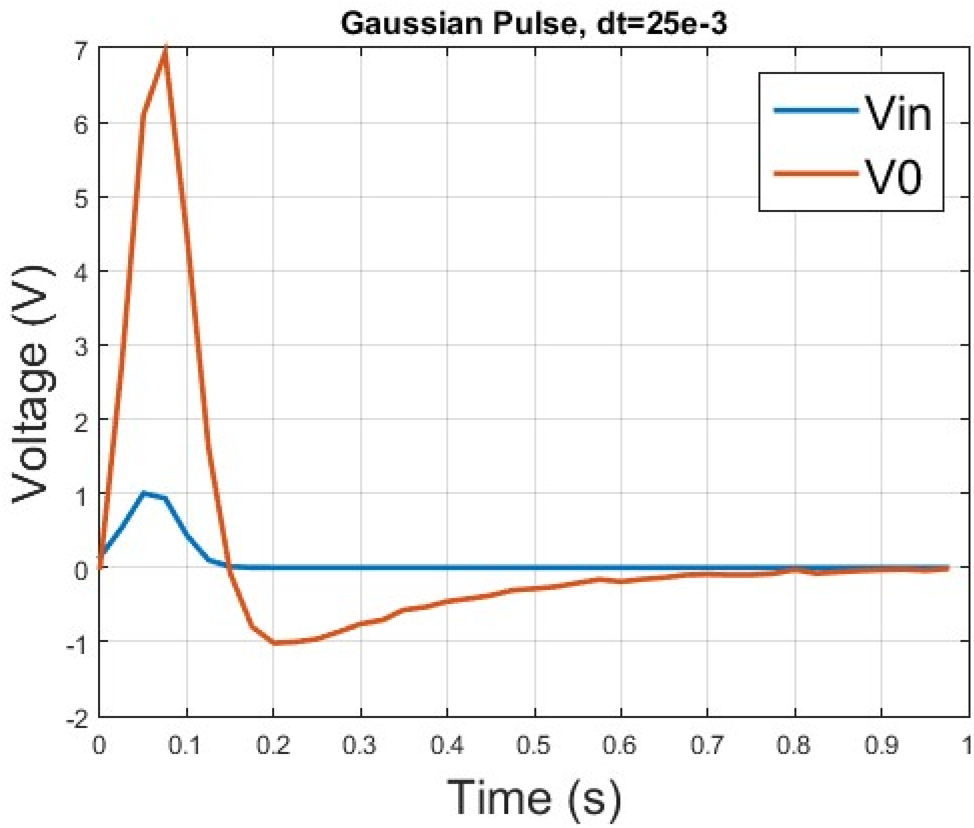


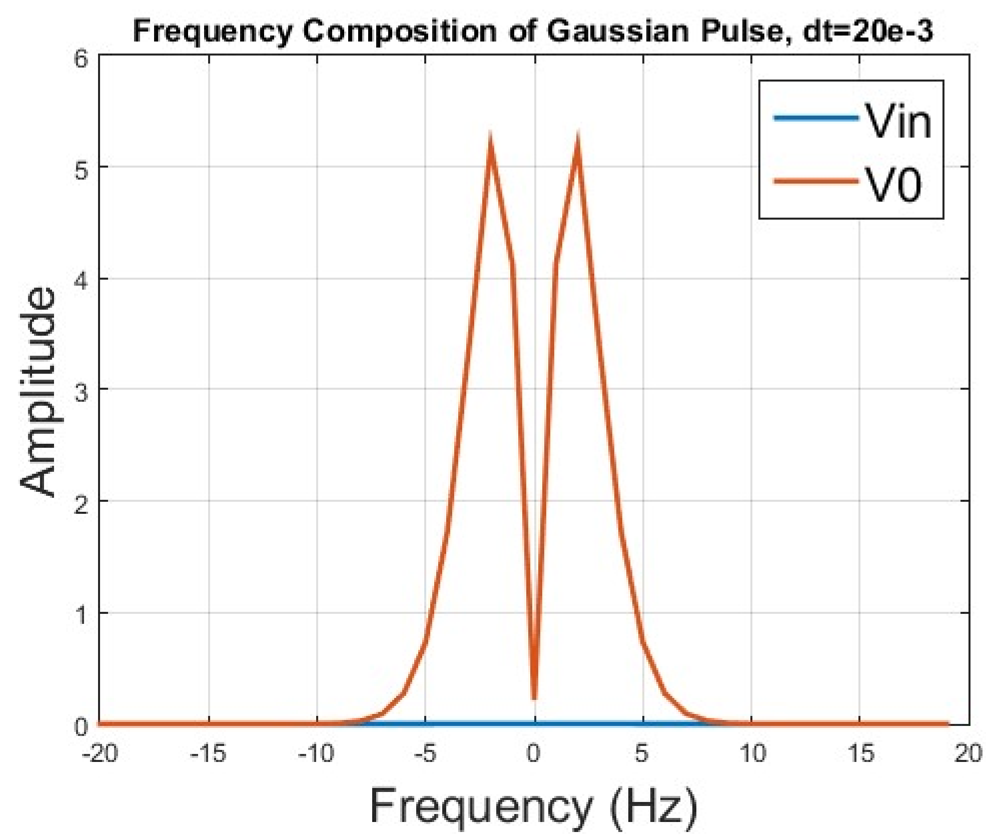
3f)

Plots of Vout with dt = 25e-3 (1 plot in this section, plus one in previous, total of 2)

```
% dt = 25e-3
Cn = 0.0001;
C(4,4) = Cn; % updating matrix

dt = 25e-3;
T = 1;
fs = T/dt;
time = 0:(1/fs):(1-1/fs);
n=fs;
f = (0:n-1);

V = zeros(7,T/dt);
F = zeros(7,T/dt);
Ap = inv(C/dt + G);

% Vin defined as a gaussian
F(1,:) = normpdf(time,0.06,0.03)*max(normpdf(time,0.06,0.03))^(-1);
F(4,:) = normrnd(0.001, 0.0003,1,T/dt); % In randomly picked from normal dist

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i));
end

figure (20)
plot(time,F(1,:)','LineWidth',2)
```

```
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Gaussian Pulse, dt=25e-3')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (21)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Gaussian Pulse, dt=20e-3')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-20 20])
```





3) Comments

The changes to the time stepping are consistent with the results discussed in part 2. Increasing Cn to around 0.1 causes the voltage output to swing much larger than with the starting Cn value of 0.00001, and also causes the bandwidth to decrease significantly. Decreasing the capacitor value past 0.00001 does not have a visible impact on the bandwidth of the signal.

4a)

The equation used to iterate through time was V(:,i)=inv(C/dt + G)*(C*V(:,i-1)/dt + F(:,i)). With the addition of a non-linear component, the equation would need to change to V(:,i)=inv(C/dt + G)*(C*V(:,i-1)/dt + F(:,i)-B(V(5,i-1))), where B is the non-linear vector that is a function of the current I3, which is V(5,i-1). The vector B would be:

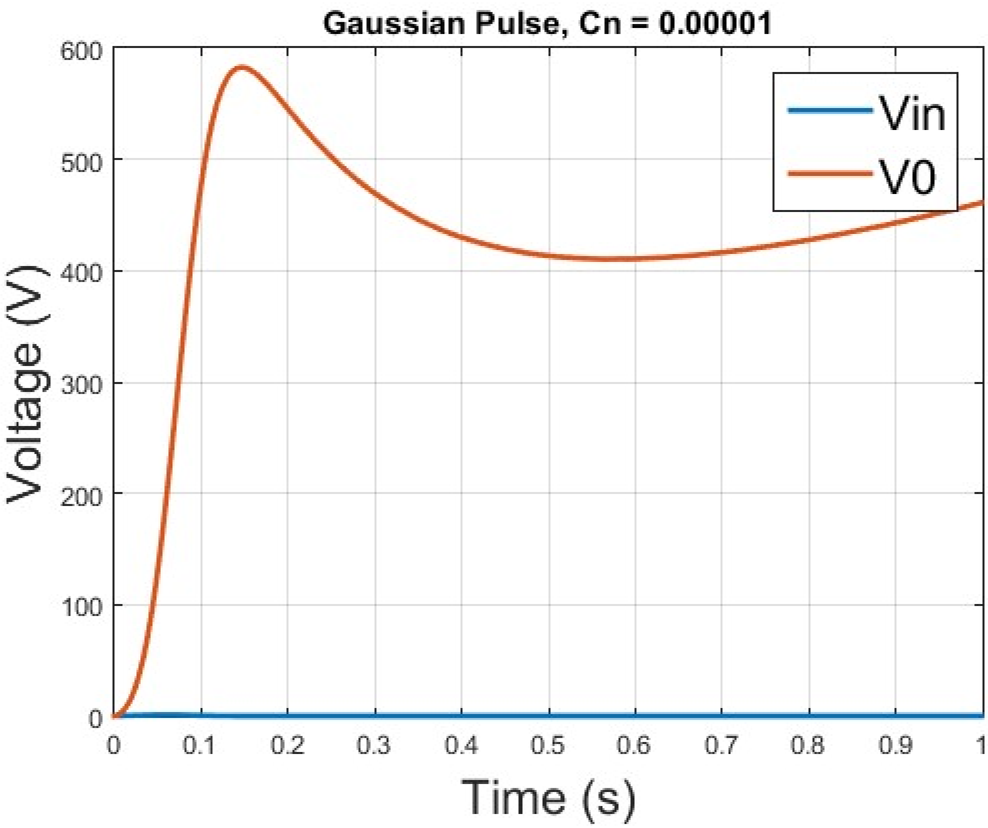
B = [0 0 0 0 0 alpha*I3 + beta*I3^2 + gamma*I3^3 0]

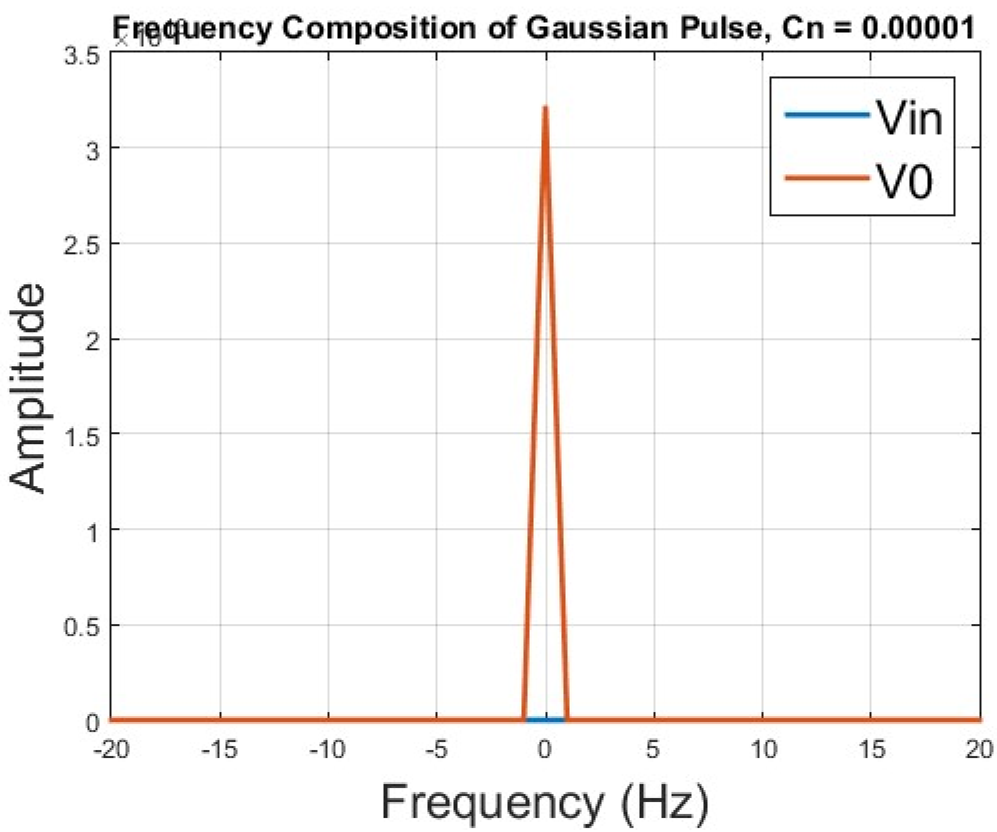
4b)

Non-linear implimentation

```
G1=1/1;
C=0.25;
G2=1/2;
L=0.2;
G3=1/10;
alpha=100;
G4=1/0.1;
G0=1/1000;

%Cn = 0.00001;
Cn = 0.00001;

% V = [V1
%       V2
%       IL
%       V3
%       I3
%       V4
%       V0]

% F = [Vin
%       0
%       0
%       In
%       0
%       0
%       0]

G = [1 0 0 0 0 0 0;
    -G2 G1+G2 -1 0 0 0 0;
    0 1 0 -1 0 0 0;
    0 0 -1 G3 0 0 0;
    0 0 0 0 -alpha 1 0;
    0 0 0 G3 -1 0 0;
    0 0 0 0 0 -G4 G4+G0];

C = [0 0 0 0 0 0 0;
    -C C 0 0 0 0 0;
    0 0 -L 0 0 0 0;
    0 0 0 Cn 0 0 0; % Cn added to C matrix
    0 0 0 0 0 0 0;
    0 0 0 0 0 0 0;
    0 0 0 0 0 0 0];
```

```
dt = 1e-3;
T = 1;
fs = T/dt;
time = 0:(1/fs):(1-1/fs);
n=fs;
f = (0:n-1);

V = zeros(7,T/dt);
F = zeros(7,T/dt);
Ap = inv(C/dt + G);
B = zeros(7,1);
alpha = 1;
beta = 0.0001;
gamma = 0.000001;

% Vin defined as a gaussian
F(1,:) = normpdf(time,0.06,0.03)*max(normpdf(time,0.06,0.03))^(-1);
F(4,:) = normrnd(0.001, 0.0003,1,T/dt); % In randomly picked from normal dist

for i=2:T/dt
    V(:,i) = Ap*(C*V(:,i-1)/dt + F(:,i)-B);
    B(6) = alpha*V(5,i) + beta*V(5,i)^2 + gamma*V(5,i)^3;
end

figure (22)
plot(time,F(1,:)','LineWidth',2)
hold on
grid on
plot(time,V(7,:)','LineWidth',2)
title('\fontsize{12}Gaussian Pulse, Cn = 0.00001')
xlabel('\fontsize{18}Time (s)')
ylabel('\fontsize{18}Voltage (V)')
legend('\fontsize{18}Vin','\fontsize{18}V0')

XF1 = (fft(F(1,:))).^2/n;
YF1 = fftshift(XF1);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftF1 = abs(YF1).^2/n;     % zero-centered power

XV7 = (fft(V(7,:))).^2/n;
YV7 = fftshift(XV7);
fshift = (-n/2:n/2-1)*(fs/n); % zero-centered frequency range
powershiftV7 = abs(YV7).^2/n;     % zero-centered power

figure (23)
plot(fshift,powershiftF1,'LineWidth',2)
hold on
grid on
plot(fshift,powershiftV7,'LineWidth',2)
title('\fontsize{12}Frequency Composition of Gaussian Pulse, Cn = 0.00001')
xlabel('\fontsize{18}Frequency (Hz)')
ylabel('\fontsize{18}Amplitude')
legend('\fontsize{18}Vin','\fontsize{18}V0')
xlim([-20 20])
```





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