```
% Patrobas Adewumi
% 100963608
% ELEC 4700
% assignment4
clear all

runTime = 1; % in seconds
timecuts = 1000;
dt = runTime/timecuts;

Cn = 0.00001;
R1 = 1;
C1 = 0.25;
R2 = 2;
L1 = 0.2;
R3 = 10;
a = 100;
R4 = 0.1;
Ro = 1000;


C = [  0, 0,   0,  0, 0, 0, 0, 0; ... V1
     -C1,C1,   0,  0, 0, 0, 0, 0; ... V2
       0, 0, -L1,  0, 0, 0, 0, 0; ... I1
       0, 0,   0, Cn, 0, 0, 0, 0; ... V3
       0, 0,   0,  0, 0, 0, 0, 0; ... I3
       0, 0,   0, Cn, 0, 0, 0, 0; ... V4
       0, 0,   0,  0, 0, 0, 0, 0; ... In
       0, 0,   0,  0, 0, 0, 0, 0];   %Vo

   %     V1             V2  I1    V3  I3     V4  In             Vo
G = [     1,             0,  0,    0,  0,     0,  0,            0; ...
 V1
      -1/R1, (1/R2 + 1/R1), -1,    0,  0,     0,  0,            0; ...
 V2
          0,             1,  0,   -1,  0,     0,  0,            0; ...
 I1
          0,             0, -1, 1/R3,  0,     0, -1,            0; ...
 V3
          0,             0,  0,    0, -a,     1,  0,            0; ...
 I3
          0,             0,  0, 1/R3, -1,     0, -1,            0; ...
 V4
          0,             0,  0,    0,  0,     0,  1,            0; ...
 In
          0,             0,  0,    0,  0, -1/R4,  0, (1/R4 +1/Ro)];
  %Vo

disp('Question 3: G and C matrices:')
disp(G)
disp(C)
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Gaussian Pulse Function
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mag = 1;
dev = 0.03;
delay = 0.06;
Flist = zeros(8,1,timecuts);
for count = 1:1:timecuts
    Flist(1,1,count) = mag*exp(-((count*dt-delay)/dev)^2);
    Flist(7,1,count) = 0.001*randn;
end
Vlist = zeros(8,1,timecuts);

for count  = 2:1:timecuts
    A = C/dt +G;

    Vlist(:,:,count) = A\(C*Vlist(:,:,count-1)/dt +Flist(:,:,count));
end

V1list(1,:) = Vlist(1,1,:);
V2list(1,:) = Vlist(2,1,:);
ILlist(1,:) = Vlist(3,1,:);
I3list(1,:) = Vlist(4,1,:);
V4list(1,:) = Vlist(5,1,:);
Inlist(1,:) = Vlist(7,1,:);
Volist(1,:) = Vlist(8,1,:);

figure(7)
plot((1:timecuts).*dt,Volist(1,:))
xlabel('Time(secs)')
ylabel('Voltage')
title('Vout of Gaussian Pulse with In and Cn')
hold on
plot((1:timecuts).*dt,V1list(1,:))
hold off

figure(8)
g = abs(fftshift(fft(Volist(1,:))));
plot(((1:length(g))/timecuts)-0.5,g)
xlim([-0.005 0.005])
xlabel('Frequency')
ylabel('Magnitude')
title('Fourier Transform of Output')

% Cn 1
Cn = 0.0001;


C = [  0, 0,   0,  0, 0, 0, 0, 0; ... V1
     -C1,C1,   0,  0, 0, 0, 0, 0; ... V2
       0, 0, -L1,  0, 0, 0, 0, 0; ... I1
       0, 0,   0, Cn, 0, 0, 0, 0; ... V3
       0, 0,   0,  0, 0, 0, 0, 0; ... I3
       0, 0,   0, Cn, 0, 0, 0, 0; ... V4
```

```
       0, 0,   0,  0, 0, 0, 0, 0; ... In
       0, 0,   0,  0, 0, 0, 0, 0];   %Vo

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Gaussian Pulse Function
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mag = 1;
dev = 0.03;
delay = 0.06;
Flist = zeros(8,1,timecuts);
for count = 1:1:timecuts
    Flist(1,1,count) = mag*exp(-((count*dt-delay)/dev)^2);
    Flist(7,1,count) = 0.001*randn;
end
Vlist = zeros(8,1,timecuts);

for count  = 2:1:timecuts
    A = C/dt +G;

    Vlist(:,:,count) = A\(C*Vlist(:,:,count-1)/dt +Flist(:,:,count));
end

V1list(1,:) = Vlist(1,1,:);
V2list(1,:) = Vlist(2,1,:);
ILlist(1,:) = Vlist(3,1,:);
I3list(1,:) = Vlist(4,1,:);
V4list(1,:) = Vlist(5,1,:);
Inlist(1,:) = Vlist(7,1,:);
Volist(1,:) = Vlist(8,1,:);

figure(9)
plot((1:timecuts).*dt,Volist(1,:))
xlabel('Time(secs)')
ylabel('Voltage')
title('Vout of Gaussian Pulse with In and Cn Cn=0.0001')
hold on
plot((1:timecuts).*dt,V1list(1,:))
hold off

figure(10)
g = abs(fftshift(fft(Volist(1,:))));
plot(((1:length(g))/timecuts)-0.5,g)
xlim([-0.05 0.05])
xlabel('Frequency')
ylabel('Magnitude')
title('Fourier Transform of Output')

% Cn 2
Cn = 0.001;


C = [  0, 0,   0,  0, 0, 0, 0, 0; ... V1
     -C1,C1,   0,  0, 0, 0, 0, 0; ... V2
       0, 0, -L1,  0, 0, 0, 0, 0; ... I1
```

```
        0, 0,   0, Cn, 0, 0, 0, 0; ... V3
        0, 0,   0,  0, 0, 0, 0, 0; ... I3
        0, 0,   0, Cn, 0, 0, 0, 0; ... V4
        0, 0,   0,  0, 0, 0, 0, 0; ... In
        0, 0,   0,  0, 0, 0, 0, 0];   %Vo


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Gaussian Pulse Function
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mag = 1;
dev = 0.03;
delay = 0.06;
Flist = zeros(8,1,timecuts);
for count = 1:1:timecuts
    Flist(1,1,count) = mag*exp(-((count*dt-delay)/dev)^2);
    Flist(7,1,count) = 0.001*randn;
end
Vlist = zeros(8,1,timecuts);

for count  = 2:1:timecuts
    A = C/dt +G;

    Vlist(:,:,count) = A\(C*Vlist(:,:,count-1)/dt +Flist(:,:,count));
end

V1list(1,:) = Vlist(1,1,:);
V2list(1,:) = Vlist(2,1,:);
ILlist(1,:) = Vlist(3,1,:);
I3list(1,:) = Vlist(4,1,:);
V4list(1,:) = Vlist(5,1,:);
Inlist(1,:) = Vlist(7,1,:);
Volist(1,:) = Vlist(8,1,:);

figure(11)
plot((1:timecuts).*dt,Volist(1,:))
xlabel('Time(secs)')
ylabel('Voltage')
title('Vout of Gaussian Pulse with In and Cn Cn=0.001')
hold on
plot((1:timecuts).*dt,V1list(1,:))
hold off

figure(12)
g = abs(fftshift(fft(Volist(1,:))));
plot(((1:length(g))/timecuts)-0.5,g)
xlim([-0.05 0.05])
xlabel('Frequency')
ylabel('Magnitude')
title('Fourier Transform of Output')


% Cn 3
Cn = 0.01;
```

```
C = [  0, 0,   0,  0, 0, 0, 0, 0; ... V1
     -C1,C1,   0,  0, 0, 0, 0, 0; ... V2
       0, 0, -L1,  0, 0, 0, 0, 0; ... I1
       0, 0,   0, Cn, 0, 0, 0, 0; ... V3
       0, 0,   0,  0, 0, 0, 0, 0; ... I3
       0, 0,   0, Cn, 0, 0, 0, 0; ... V4
       0, 0,   0,  0, 0, 0, 0, 0; ... In
       0, 0,   0,  0, 0, 0, 0, 0];   %Vo
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Gaussian Pulse Function
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mag = 1;
dev = 0.03;
delay = 0.06;
Flist = zeros(8,1,timecuts);
for count = 1:1:timecuts
    Flist(1,1,count) = mag*exp(-((count*dt-delay)/dev)^2);
    Flist(7,1,count) = 0.001*randn;
end
Vlist = zeros(8,1,timecuts);

for count  = 2:1:timecuts
    A = C/dt +G;

    Vlist(:,:,count) = A\(C*Vlist(:,:,count-1)/dt +Flist(:,:,count));
end

V1list(1,:) = Vlist(1,1,:);
V2list(1,:) = Vlist(2,1,:);
ILlist(1,:) = Vlist(3,1,:);
I3list(1,:) = Vlist(4,1,:);
V4list(1,:) = Vlist(5,1,:);
Inlist(1,:) = Vlist(7,1,:);
Volist(1,:) = Vlist(8,1,:);

figure(13)
plot((1:timecuts).*dt,Volist(1,:))
xlabel('Time(secs)')
ylabel('Voltage')
title('Vout of Gaussian Pulse with In and Cn Cn=0.01')
hold on
plot((1:timecuts).*dt,V1list(1,:))
hold off

figure(14)
g = abs(fftshift(fft(Volist(1,:))));
plot(((1:length(g))/timecuts)-0.5,g)
xlim([-0.05 0.05])
xlabel('Frequency')
ylabel('Magnitude')
title('Fourier Transform of Output')
```

```
clear all
% changing timesteps
runTime = 1; % in seconds
timecuts = 100;
dt = runTime/timecuts;

Cn = 0.00001;
R1 = 1;
C1 = 0.25;
R2 = 2;
L1 = 0.2;
R3 = 10;
a = 100;
R4 = 0.1;
Ro = 1000;


C = [  0, 0,   0,  0, 0, 0, 0, 0; ... V1
     -C1,C1,   0,  0, 0, 0, 0, 0; ... V2
       0, 0, -L1,  0, 0, 0, 0, 0; ... I1
       0, 0,   0, Cn, 0, 0, 0, 0; ... V3
       0, 0,   0,  0, 0, 0, 0, 0; ... I3
       0, 0,   0, Cn, 0, 0, 0, 0; ... V4
       0, 0,   0,  0, 0, 0, 0, 0; ... In
       0, 0,   0,  0, 0, 0, 0, 0];   %Vo

   %     V1             V2  I1    V3  I3     V4  In            Vo
G = [     1,             0,  0,    0,  0,     0,  0,            0; ...
 V1
      -1/R1, (1/R2 + 1/R1), -1,    0,  0,     0,  0,            0; ...
 V2
          0,             1,  0,   -1,  0,     0,  0,            0; ...
 I1
          0,             0, -1, 1/R3,  0,     0, -1,            0; ...
 V3
          0,             0,  0,    0, -a,     1,  0,            0; ...
 I3
          0,             0,  0, 1/R3, -1,     0, -1,            0; ...
 V4
          0,             0,  0,    0,  0,     0,  1,            0; ...
 In
          0,             0,  0,    0,  0, -1/R4,  0, (1/R4 +1/Ro)];
  %Vo

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Gaussian Pulse Function
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mag = 1;
dev = 0.03;
delay = 0.06;
Flist = zeros(8,1,timecuts);
for count = 1:1:timecuts
    Flist(1,1,count) = mag*exp(-((count*dt-delay)/dev)^2);
    Flist(7,1,count) = 0.001*randn;
```

```
end
Vlist = zeros(8,1,timecuts);

for count  = 2:1:timecuts
    A = C/dt +G;
    Vlist(:,:,count) = A\(C*Vlist(:,:,count-1)/dt +Flist(:,:,count));
end

V1list(1,:) = Vlist(1,1,:);
V2list(1,:) = Vlist(2,1,:);
ILlist(1,:) = Vlist(3,1,:);
I3list(1,:) = Vlist(4,1,:);
V4list(1,:) = Vlist(5,1,:);
Inlist(1,:) = Vlist(7,1,:);
Volist(1,:) = Vlist(8,1,:);

figure(15)
plot((1:timecuts).*dt,Volist(1,:))
xlabel('Time(secs)')
ylabel('Voltage')
title('Vout of Gaussian Pulse with In and Cn timesteps=100')
hold on
plot((1:timecuts).*dt,V1list(1,:))
hold off

figure(16)
g = abs(fftshift(fft(Volist(1,:))));
plot(((1:length(g))/timecuts)-0.5,g)
xlim([-0.5 0.5])
xlabel('Frequency')
ylabel('Magnitude')
title('Fourier Transform of Output')

% Timestep
clear all
runTime = 1;
timecuts = 10000;
dt = runTime/timecuts;

R1 = 1;
C1 = 0.25;
R2 = 2;
L1 = 0.2;
R3 = 10;
a = 100;
R4 = 0.1;
Ro = 1000;
Cn = 0.00001;



C = [  0, 0,   0,  0, 0, 0, 0, 0; ... V1
     -C1,C1,   0,  0, 0, 0, 0, 0; ... V2
       0, 0, -L1,  0, 0, 0, 0, 0; ... I1
```

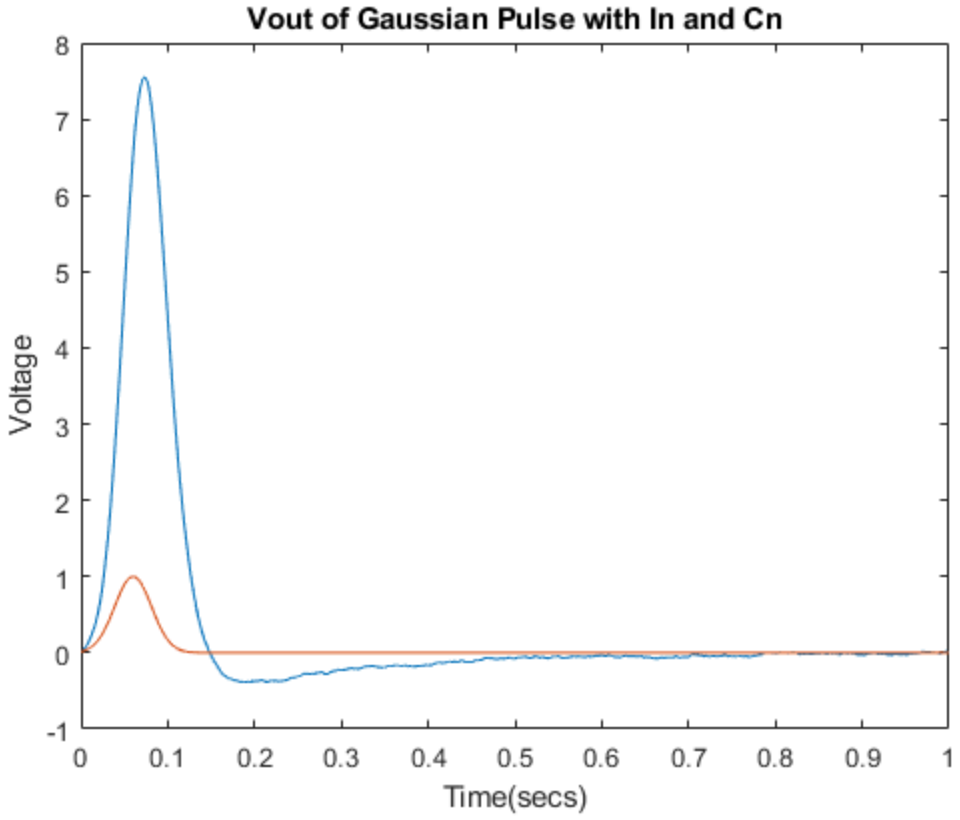
```
       0, 0,   0, Cn, 0, 0, 0, 0; ... V3
       0, 0,   0,  0, 0, 0, 0, 0; ... I3
       0, 0,   0, Cn, 0, 0, 0, 0; ... V4
       0, 0,   0,  0, 0, 0, 0, 0; ... In
       0, 0,   0,  0, 0, 0, 0, 0];   %Vo

   %     V1             V2  I1    V3  I3     V4  In             Vo
G = [     1,             0,  0,    0,  0,     0,  0,            0; ...
 V1
     -1/R1, (1/R2 + 1/R1), -1,    0,  0,     0,  0,            0; ...
 V2
          0,             1,  0,   -1,  0,     0,  0,            0; ...
 I1
          0,             0, -1, 1/R3,  0,     0, -1,            0; ...
 V3
          0,             0,  0,    0, -a,     1,  0,            0; ...
 I3
          0,             0,  0, 1/R3, -1,     0, -1,            0; ...
 V4
          0,             0,  0,    0,  0,     0,  1,            0; ...
 In
          0,             0,  0,    0,  0, -1/R4,  0, (1/R4 +1/Ro)];
  %Vo

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Gaussian Pulse Function
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
mag = 1;
dev = 0.03;
delay = 0.06;
Flist = zeros(8,1,timecuts);
for count = 1:1:timecuts
    Flist(1,1,count) = mag*exp(-((count*dt-delay)/dev)^2);%for
 gaussian pulse
    Flist(7,1,count) = 0.001*randn;
end
Vlist = zeros(8,1,timecuts);

for count  = 2:1:timecuts
    A = C/dt +G;

    Vlist(:,:,count) = A\(C*Vlist(:,:,count-1)/dt +Flist(:,:,count));
end

V1list(1,:) = Vlist(1,1,:);
V2list(1,:) = Vlist(2,1,:);
ILlist(1,:) = Vlist(3,1,:);
I3list(1,:) = Vlist(4,1,:);
V4list(1,:) = Vlist(5,1,:);
Inlist(1,:) = Vlist(7,1,:);
Volist(1,:) = Vlist(8,1,:);

figure(17)
plot((1:timecuts).*dt,Volist(1,:))
```

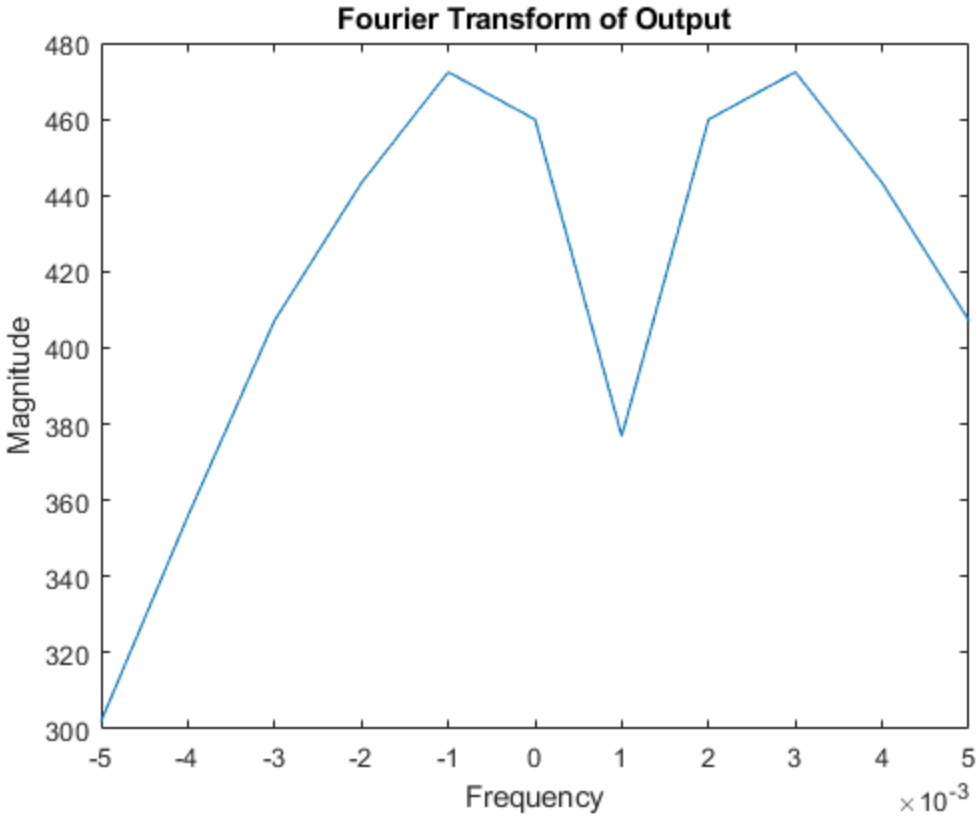
```
xlabel('Time(secs)')
ylabel('Voltage')
title('Vout of Gaussian Pulse with In and Cn timesteps=10000')
hold on
plot((1:timecuts).*dt,V1list(1,:))
hold off

figure(18)
g = abs(fftshift(fft(Volist(1,:))));
plot(((1:length(g))/timecuts)-0.5,g)
xlim([-0.005 0.005])
xlabel('Frequency')
ylabel('Magnitude')
title('Q3: Fourier Transform of Output')


disp('Q3: Increasing the value of Cn reduces the overall output of the
 circuit.')
```

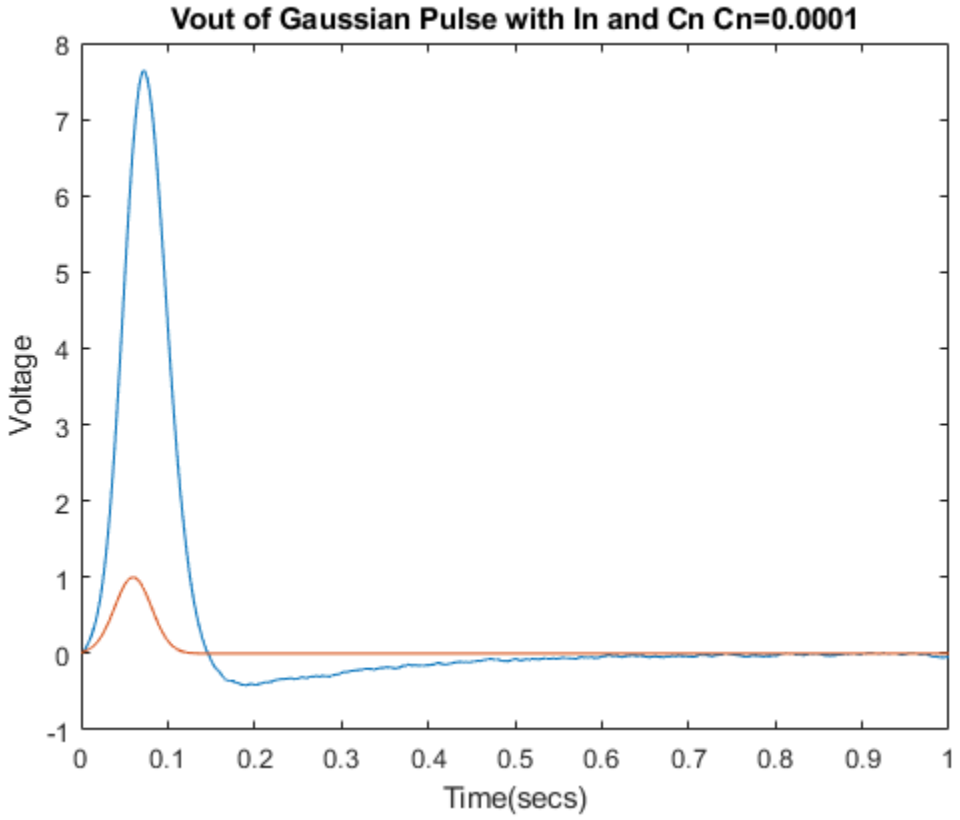
```
Question 3: G and C matrices:
  Columns 1 through 7

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

  Column 8

         0
         0
         0
         0
         0
         0
         0
   10.0010

  Columns 1 through 7

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

  Column 8
```

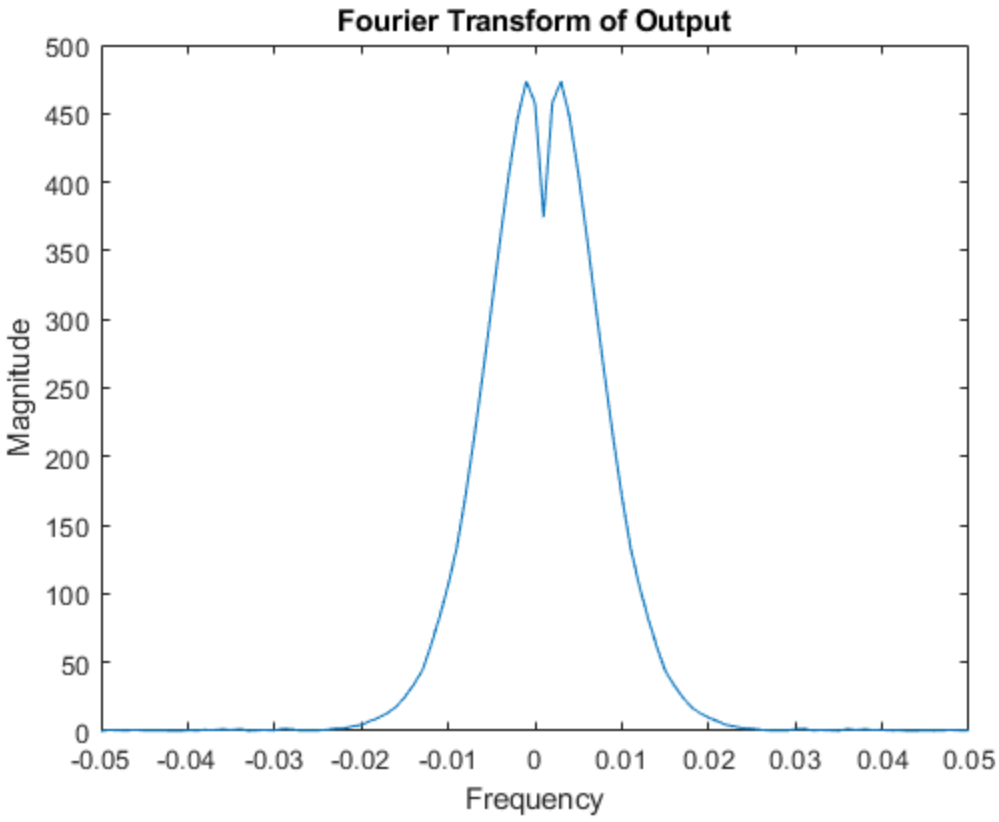
```
0
0
0
0
0
0
0
0
```

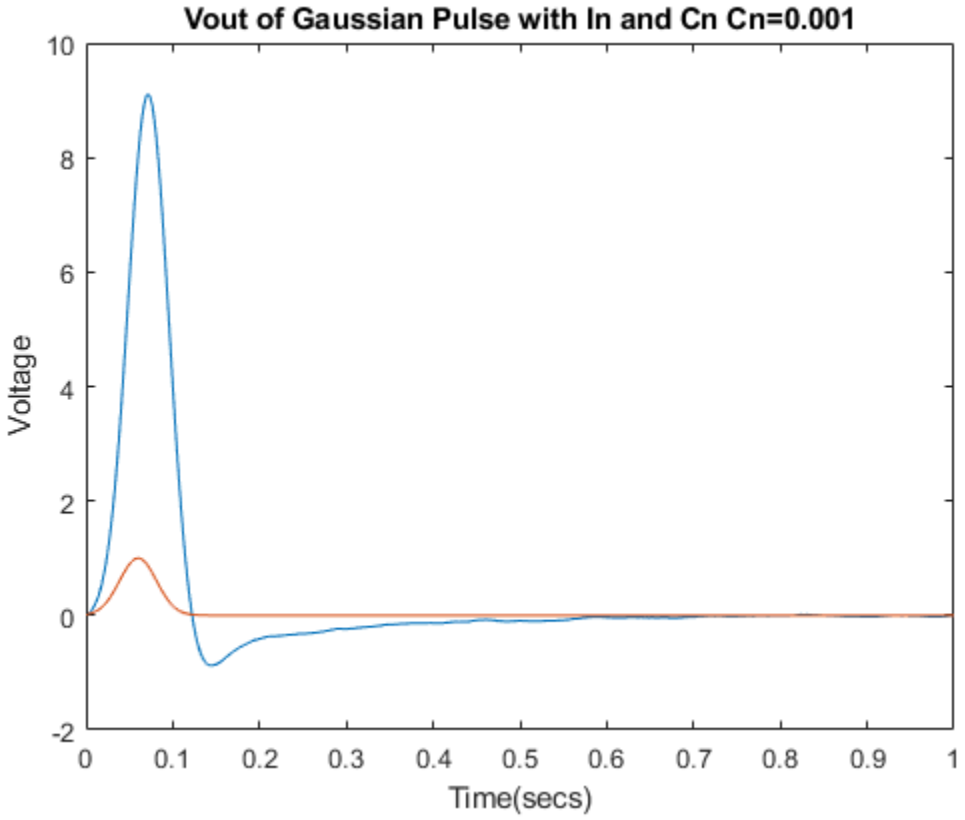
Q3: Increasing the value of Cn reduces the overall output of the circuit.

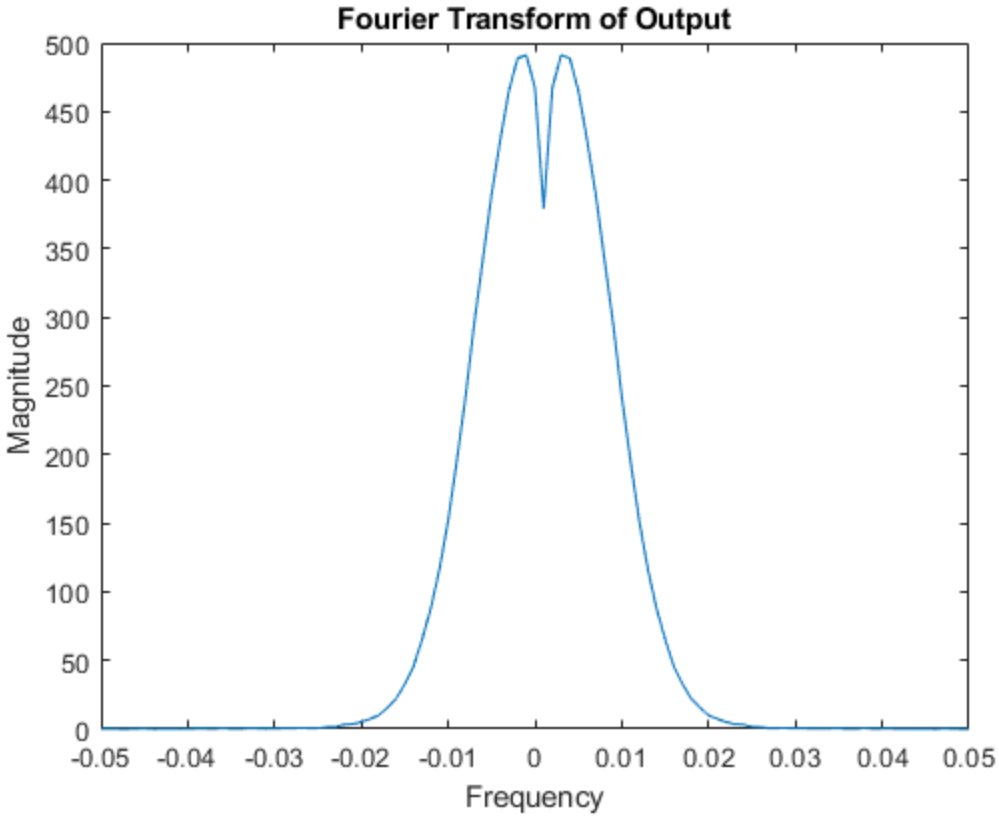


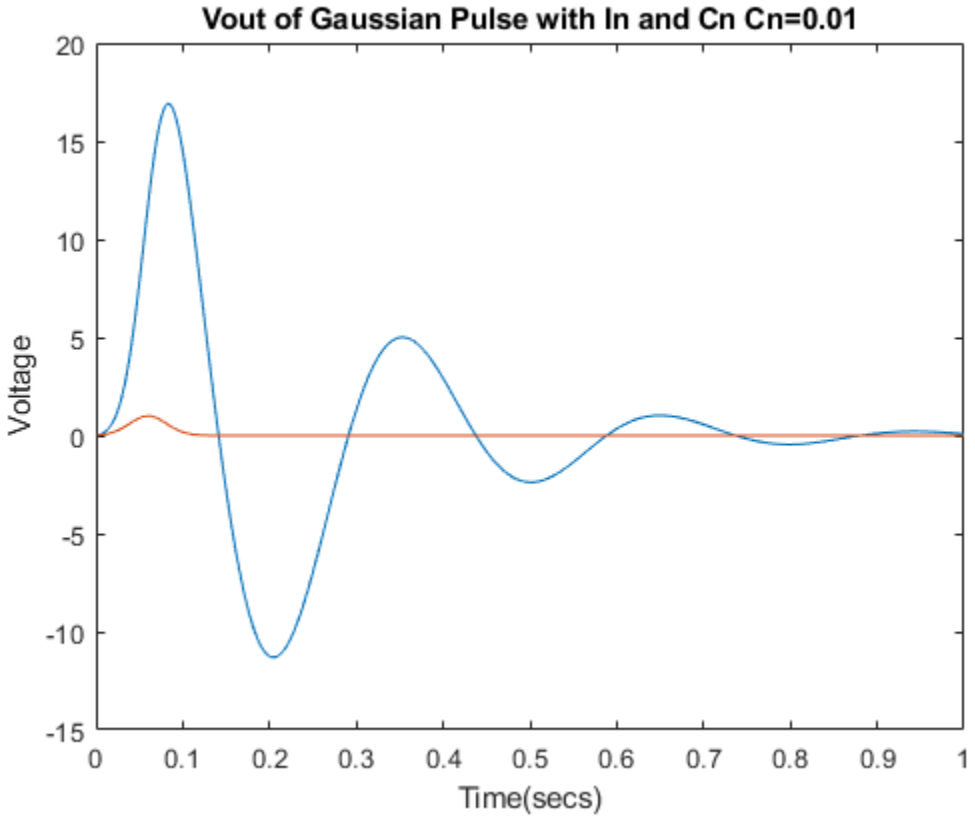

Fourier Transform of Output
Magnitude
Frequency
480
460
440
420
400
380
360
340
320
300
-5
-4
-3
-2
-1
0
1
2
3
4
5
×10-3

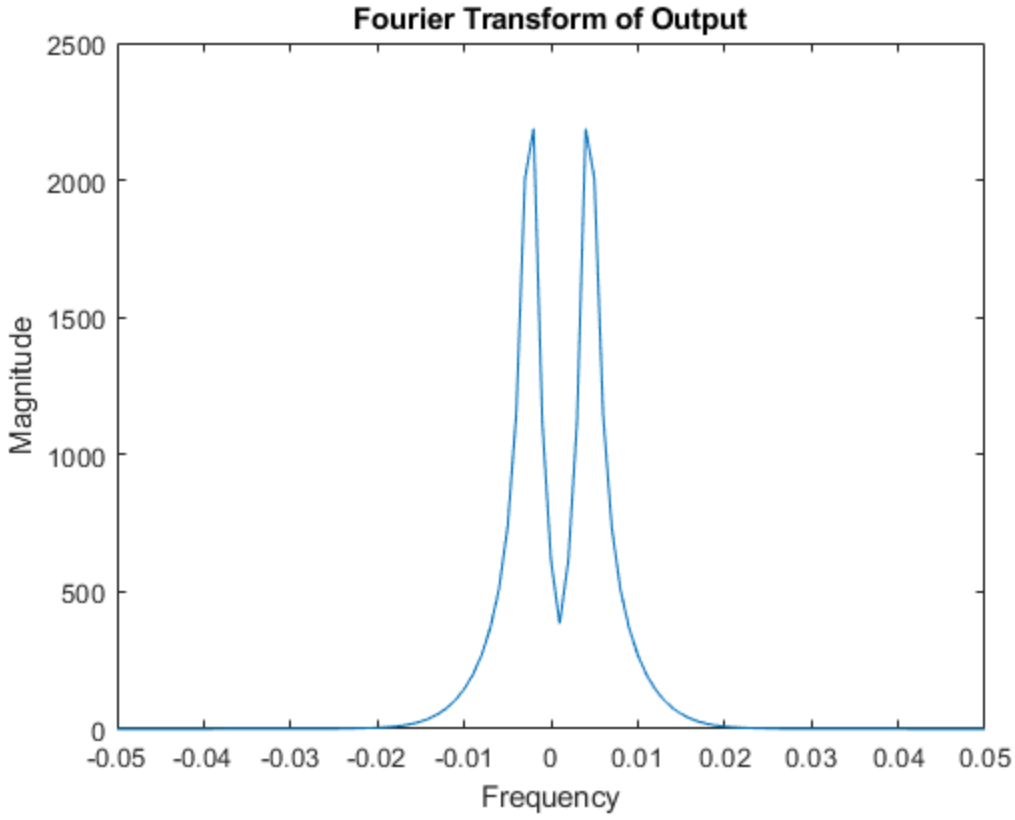

Vout of Gaussian Pulse with In and Cn Cn=0.0001
Voltage
Time(secs)
8
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

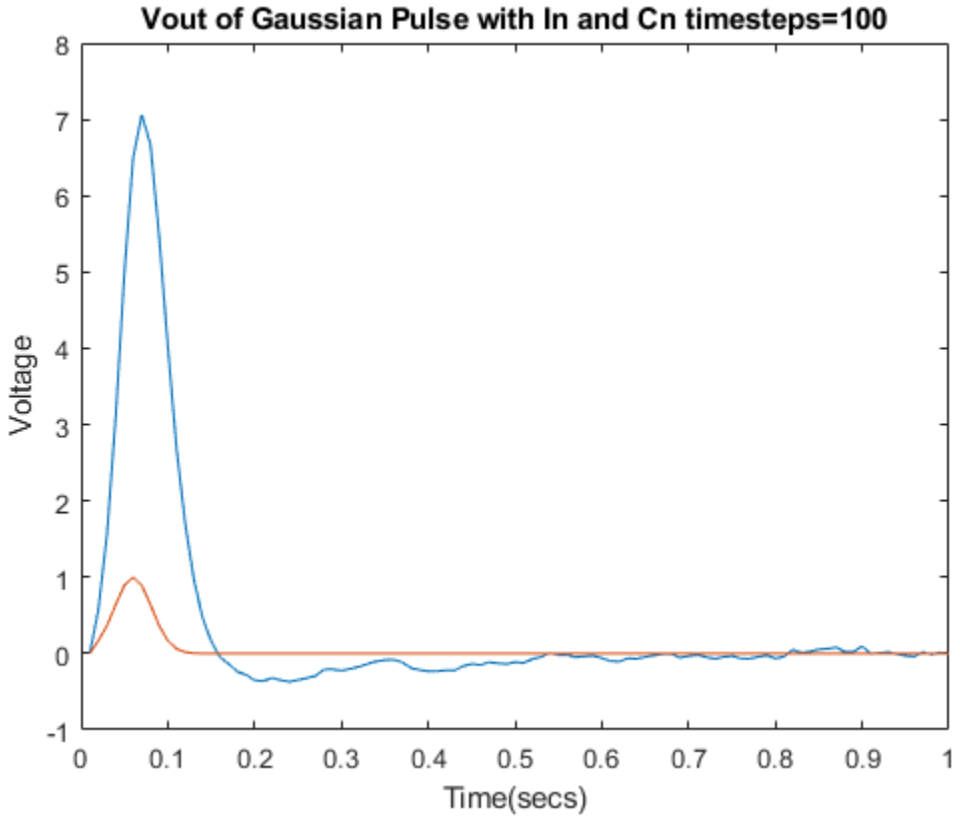

Fourier Transform of Output
Magnitude
Frequency
500
450
400
350
300
250
200
150
100
50
0
-0.05
-0.04
-0.03
-0.02
-0.01
0
0.01
0.02
0.03
0.04
0.05

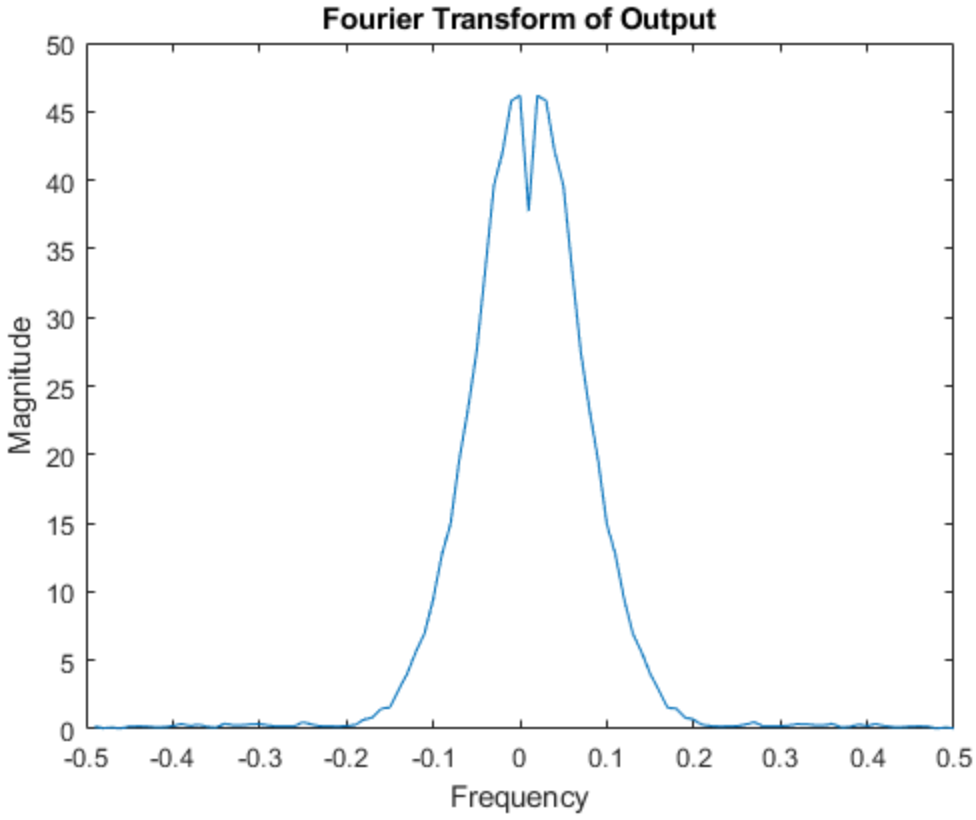

Vout of Gaussian Pulse with In and Cn Cn=0.001
Voltage
Time(secs)
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

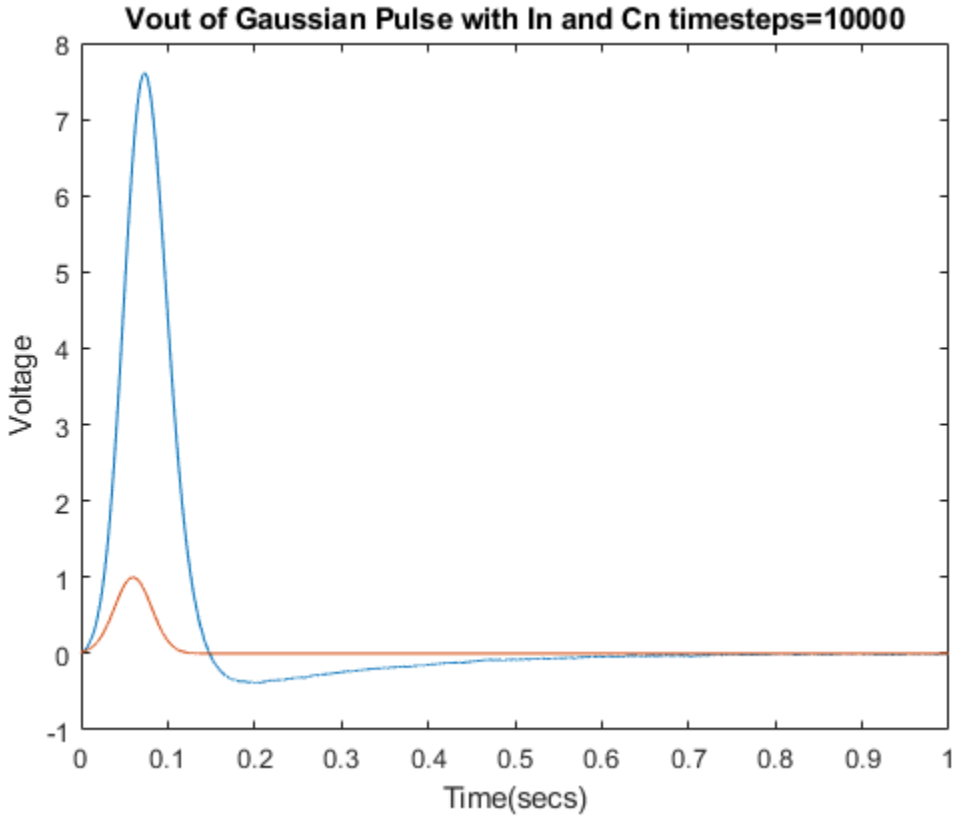

Fourier Transform of Output
Magnitude
Frequency
500
450
400
350
300
250
200
150
100
50
0
-0.05
-0.04
-0.03
-0.02
-0.01
0
0.01
0.02
0.03
0.04
0.05

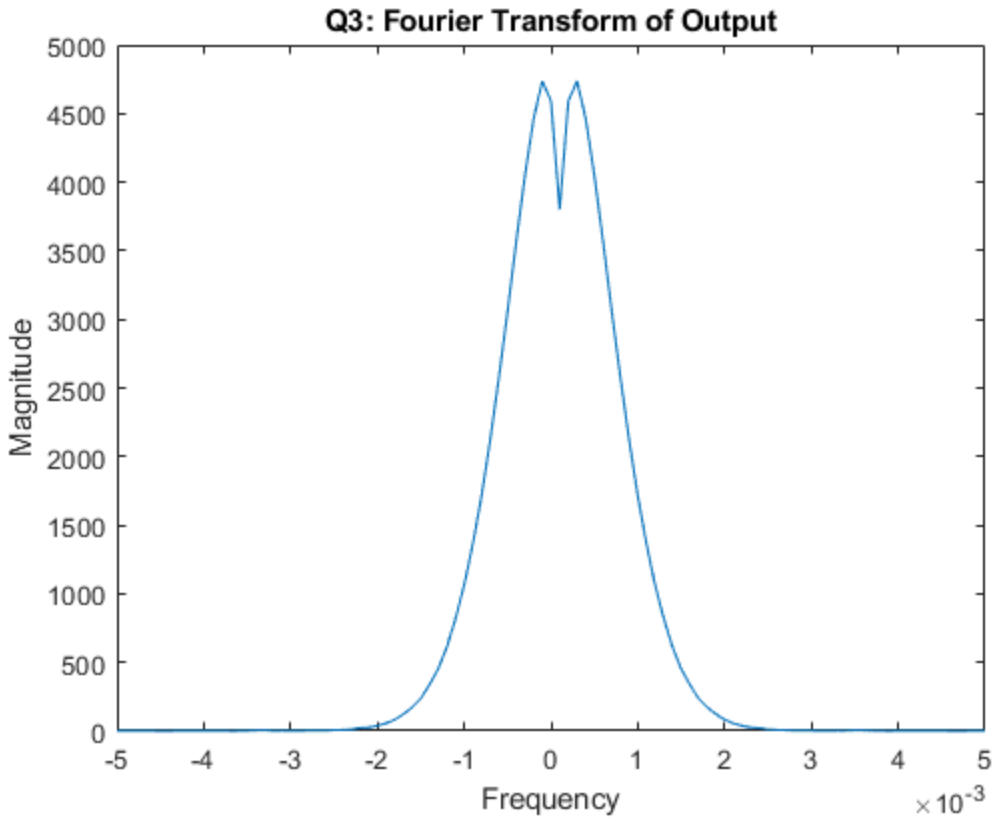

Vout of Gaussian Pulse with In and Cn Cn=0.01
Voltage
Time(secs)
20
15
10
5
0
-5
-10
-15
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Fourier Transform of Output
Magnitude
Frequency
2500
2000
1500
1000
500
0
-0.05
-0.04
-0.03
-0.02
-0.01
0
0.01
0.02
0.03
0.04
0.05


Vout of Gaussian Pulse with In and Cn timesteps=100
Voltage
Time(secs)
8
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Fourier Transform of Output
Magnitude
Frequency
50
45
40
35
30
25
20
15
10
5
0
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5


Vout of Gaussian Pulse with In and Cn timesteps=10000
Voltage
Time(secs)
8
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1



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