Part 2

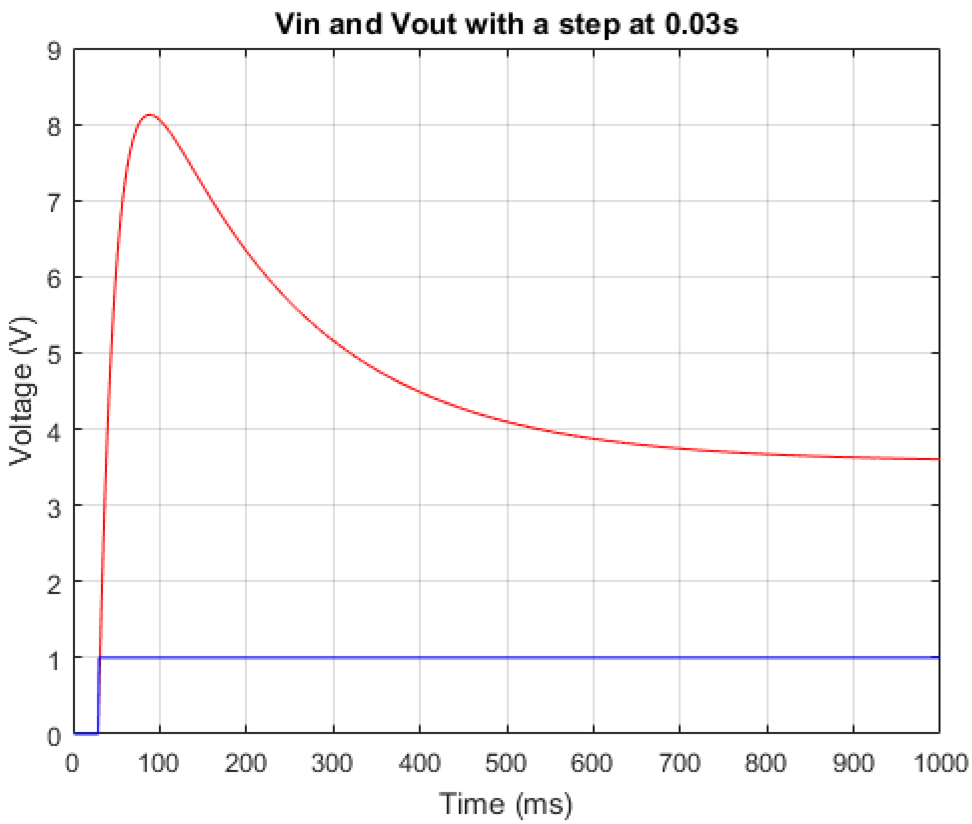
In part 2, we are given with different types of voltage input, and we have to simulation its output. The first type of input is a single step, the second one is a sine function and the last one is a guassian pulse.

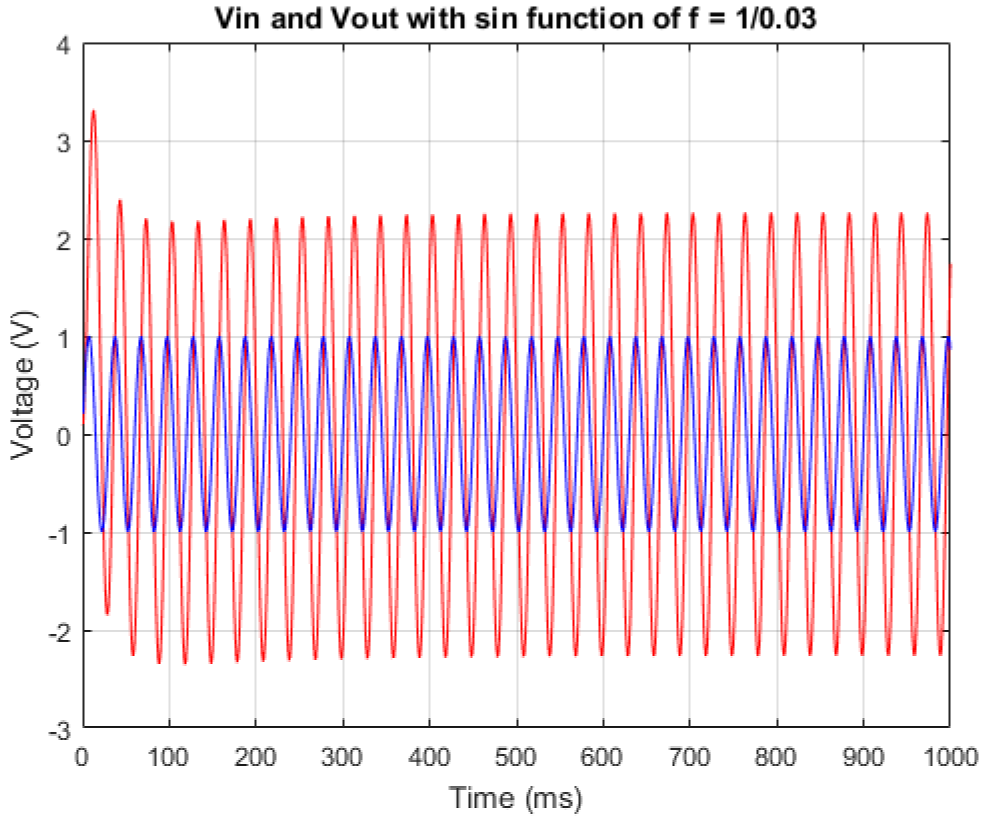
```
% Reset Everything
close all
clear

% Define Constant
R1 = 1;
G1 = 1/R1;
c = 0.25;
R2 = 2;
G2 = 1/R2;
L = 0.2;
R3 = 10;
G3 = 1/R3;
a = 100;
R4 = 0.1;
G4 = 1/R4;
Ro = 1000;
Go = 1/Ro;
Vin = 1;

% Define Matrices
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;];

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 -a 1 0;
    0 0 0 G3 -1 0 0;
    0 0 0 0 0 -G4 G4+Go];

F = [Vin;
    0;
    0;
    0;
    0;
    0;
    0;];

Foff = [Vin-Vin;        % F matrix when the circuit is off (0V)
        0;
```

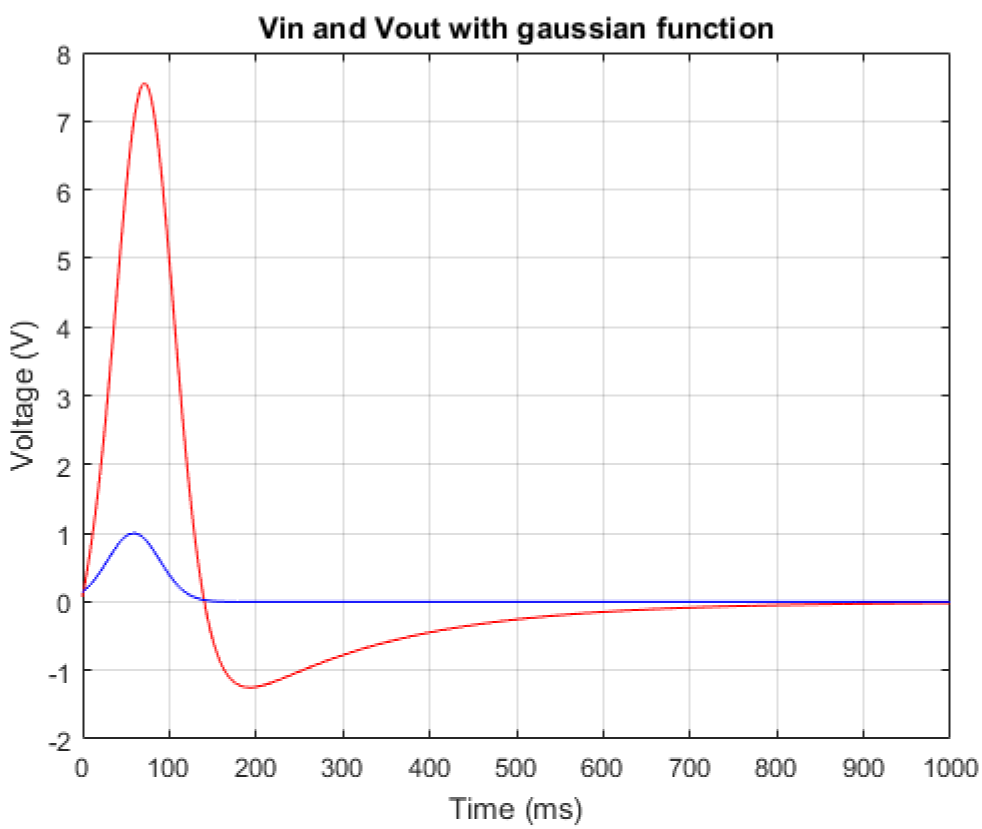
```
        0;
        0;
        0;
        0;
        0;];

% Simulation in time domain
ts = 1000;              % Time step

% Calculating and plotting the voltage output with step transistion
 input
V1 = zeros(7, ts);
Vstart = zeros(7, 1);
dt = 1e-3;
for i = 1:ts

    if i < 30
        V1(:,i) = (C./dt+G)\(Foff+C*Vstart/dt);
    elseif i == 30
        V1(:,i) = (C./dt+G)\(F+C*Vstart/dt);
    else
        V1(:,i) = (C./dt+G)\(F+C*Vpast/dt);
    end
    Vpast = V1(:, i);

end
figure(1)
plot(1:ts, V1(7,:), 'r')
hold on
plot(1:ts, V1(1,:), 'b')
title('Vin and Vout with a step at 0.03s')
xlabel('Time (ms)')
ylabel('Voltage (V)')
grid on

% Calculating and plotting the voltage output with sine function input
V2 = zeros(7, ts);
Fsin = zeros(7,1);
for j = 1:ts

    Vsin = sin(2*pi*(1/0.03)*j/ts);
    Fsin(1,1) = Vsin;
    if j == 1
        V2(:,j) = (C./dt+G)\(Fsin+C*Vstart/dt);
    else
        V2(:,j) = (C./dt+G)\(Fsin+C*Vpast/dt);
    end
    Vpast = V2(:, j);

end
figure(2)
plot(1:ts, V2(7,:), 'r')
hold on
plot(1:ts, V2(1,:), 'b')
```

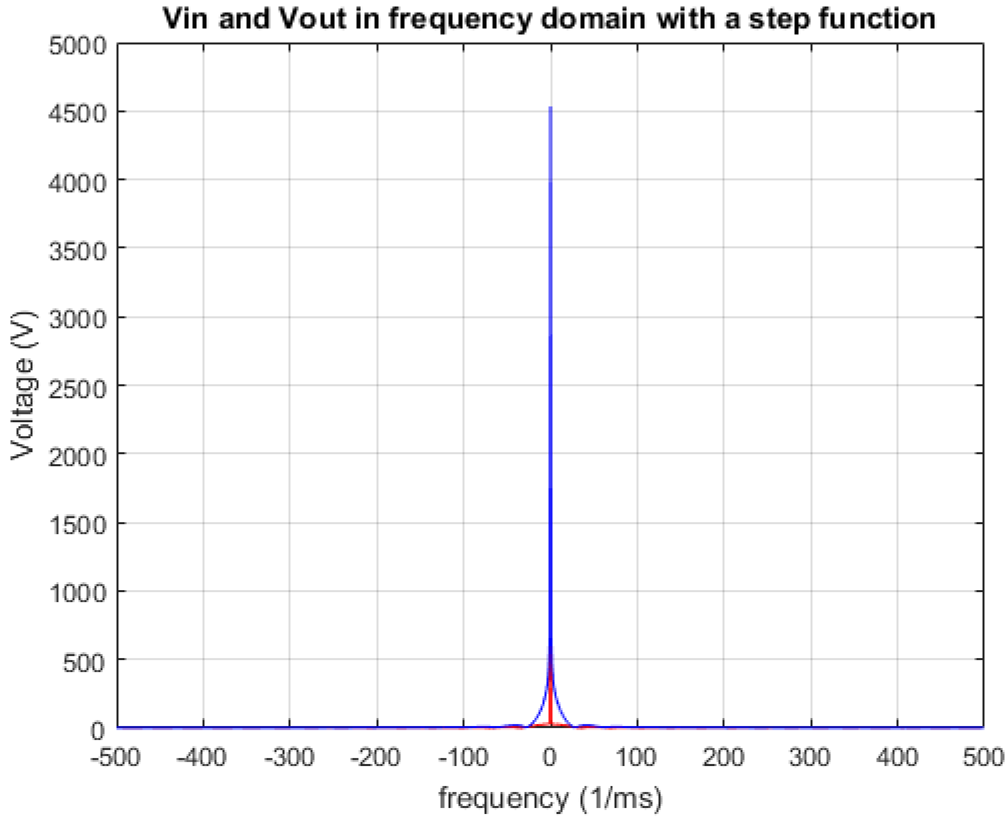
```
title('Vin and Vout with sin function of f = 1/0.03')
xlabel('Time (ms)')
ylabel('Voltage (V)')
grid on


% Calculating and plotting the voltage output with guassian function
 input
V3 = zeros(7, ts);
Fgauss = zeros(7,1);
for k = 1:ts

    Vgauss = exp(-1/2*((k/ts-0.06)/(0.03))^2);
    Fgauss(1,1) = Vgauss;
    if k == 1
        V3(:,k) = (C./dt+G)\(Fgauss+C*Vstart/dt);
    else
        V3(:,k) = (C./dt+G)\(Fgauss+C*Vpast/dt);
    end
    Vpast = V3(:, k);

end
figure(3)
plot(0:ts-1, V3(7,:), 'r')
hold on
plot(0:ts-1, V3(1,:), 'b')
title('Vin and Vout with gaussian function')
xlabel('Time (ms)')
ylabel('Voltage (V)')
grid on

% Simulation in frequency domain
f = (-ts/2:ts/2-1);                % Frequency range

% Frequency response for the step function input
fV1in = fft(V1(1, :));
fV1out = fft(V1(7, :));
fsV1in = fftshift(fV1in);
fsV1out = fftshift(fV1out);
figure(4)
plot(f, abs(fsV1in), 'r')
hold on
plot(f, abs(fsV1out), 'b')
title('Vin and Vout in frequency domain with a step function')
xlabel('frequency (1/ms)')
ylabel('Voltage (V)')
grid on

% Frequency response for the sine function input
fV2 = fft(V2.');
fsV2 = fftshift(fV2);
figure(5)
plot(f, abs(fsV2(:, 1)), 'r')
hold on
```

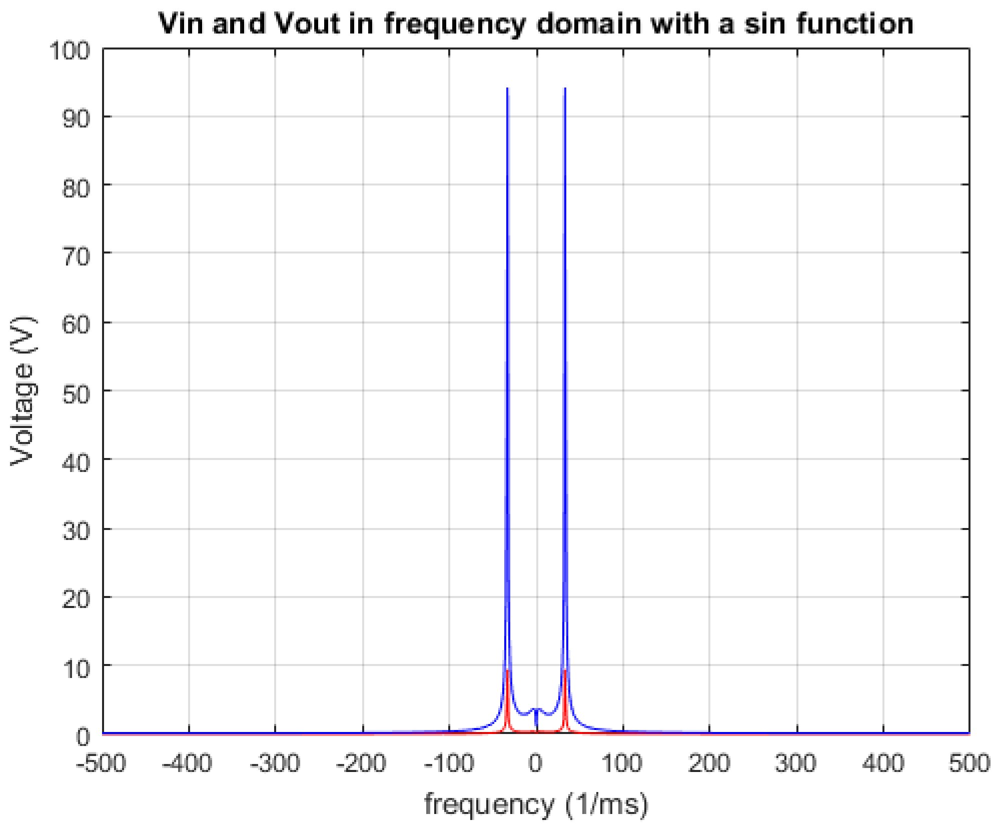
```
plot(f, abs(fsV2(:, 7)), 'b')
title('Vin and Vout in frequency domain with a sin function')
xlabel('frequency (1/ms)')
ylabel('Voltage (V)')
grid on

% Frequency response for the guassian function input
fV3 = fft(V3.');
fsV3 = fftshift(fV3);
figure(6)
plot(f, abs(fsV3(:, 1)), 'r')
hold on
plot(f, abs(fsV3(:, 7)), 'b')
title('Vin and Vout in frequency domain with a gaussian function')
xlabel('frequency (1/ms)')
ylabel('Voltage (V)')
grid on
```

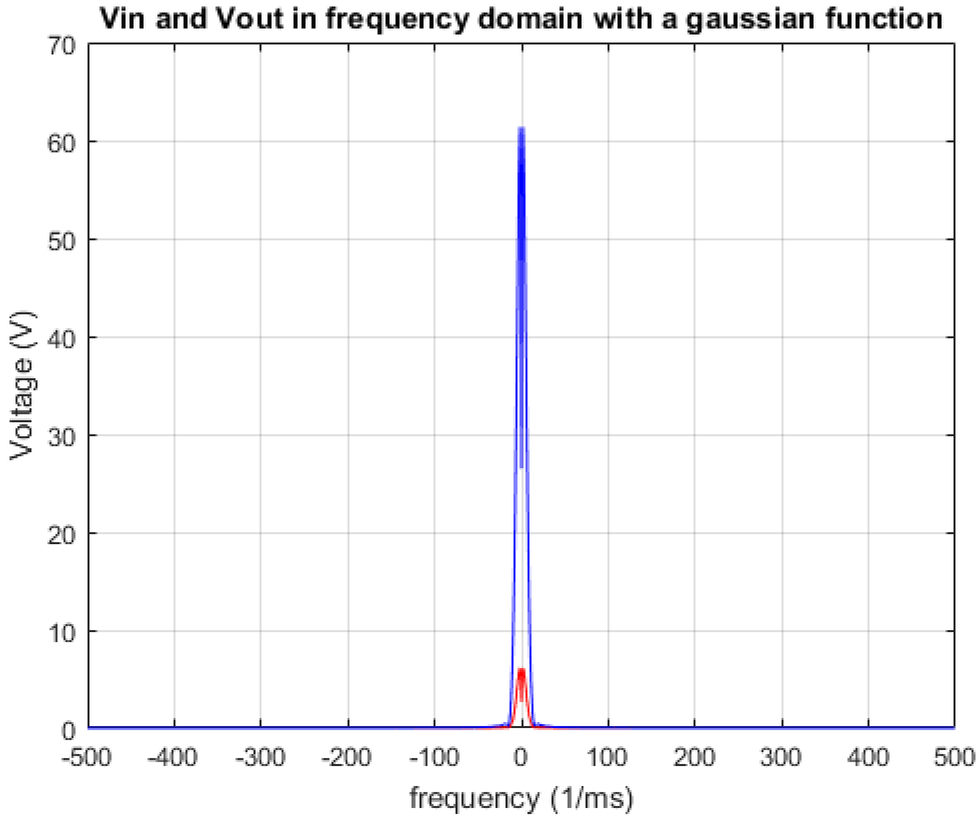



Vin and Vout with sin function of f = 1/0.03
Voltage (V)
Time (ms)
4
3
2
1
0
-1
-2
-3
0
100
200
300
400
500
600
700
800
900
1000


Vin and Vout with gaussian function
Voltage (V)
Time (ms)
8
7
6
5
4
3
2
1
0
-1
-2
0
100
200
300
400
500
600
700
800
900
1000


Vin and Vout in frequency domain with a step function
Voltage (V)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-400
-300
-200
-100
0
100
200
300
400
500
frequency (1/ms)


Vin and Vout in frequency domain with a sin function
Voltage (V)
100
90
80
70
60
50
40
30
20
10
0
-500
-400
-300
-200
-100
0
100
200
300
400
500
frequency (1/ms)



Discussion

By increasing and decreasing the time step, the simulations will get less and more defined respectively. However, the simulation will start to break when the time step is too small or unable to record properly when it is too big.

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