2) RLC circuit

Introduction:

The following script tests the 4th order classic Runge-Kutta for an RLC circuit, which is a second order ODE. To simulate the system we use the rukasecond.m function, which calculates the next iteration of the numeric ODE solution. This function is called in the auxilary N_step_rk(), which repeats and saves the output for N number of steps

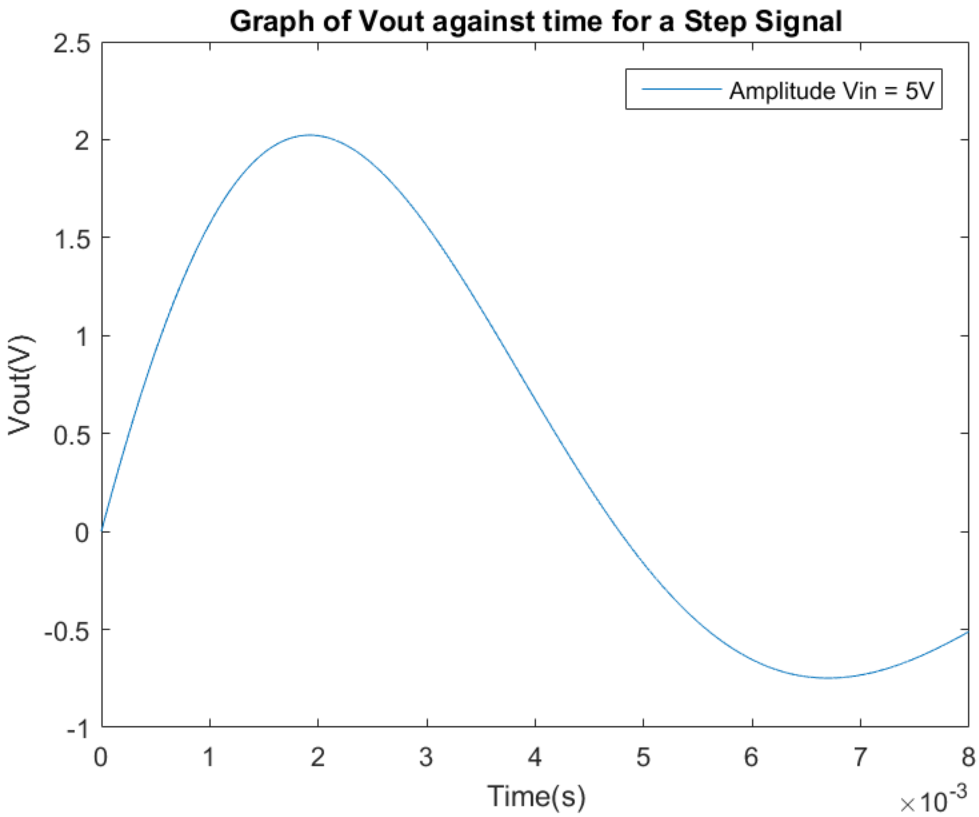
Mathematics involved The system is characterized by the following equations: VIN EQN HERE VOUT EQN HERE We first need to rewrite the first equation as two simultaneous first order equations to be solved by our Runge-Kutta algorithm. Since we are dealing with variances in charge (the derivative of q in terms of t) this can convinently be represented as the current i. EQN FOR i' here EQN q' = i

Finally we can also rewrite our voltage output in terms of the current, which leads to the more recognizable equation

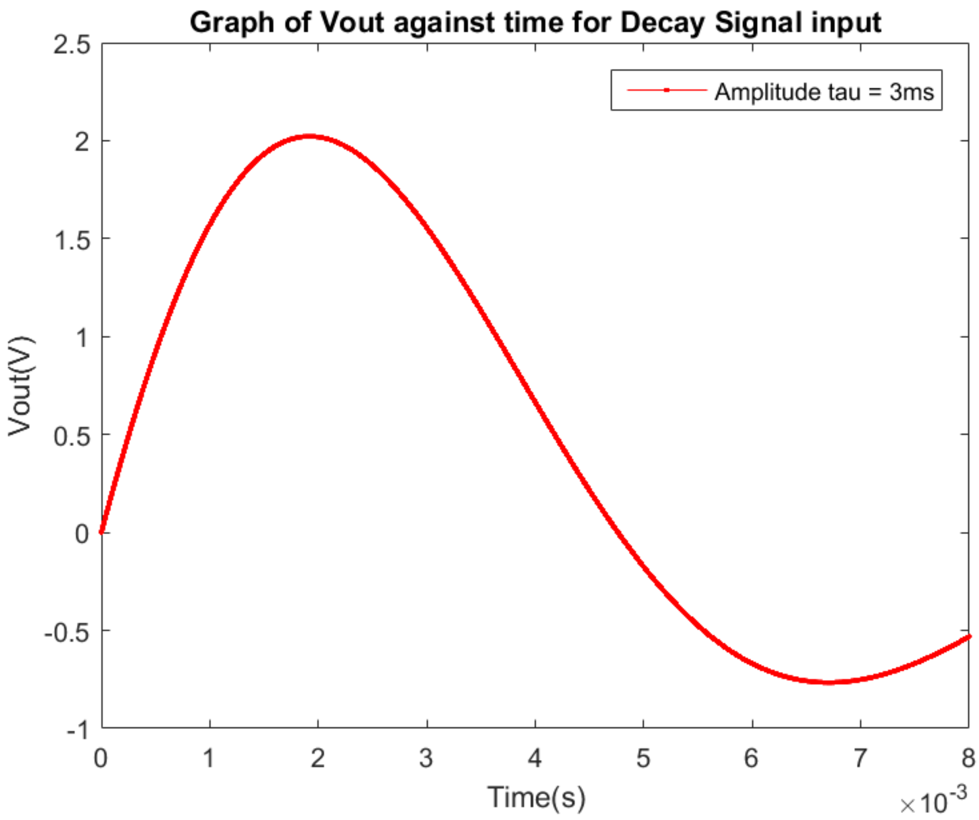
```
VOLTAGE OUT  = CURRENT * RESISTANCE
```

```
function RLC_script()

%Local function to produce Vout for the current set Vin and conditions
 for N steps.
%       _Note: since we have set the whole script to be a function we
 can
%       use local functions that hae access to the variables within
 the
%       script. This means it will be evaluated with the value Vin, R,
 C
%       etc have when the function is called
function [Tout,Vout] = N_step_rk()
q=zeros(N,1);
i=zeros(N,1);
func=@(q, i, t) (1/L)*(v_in(t)-(R*i)-(q/C));
t=(0:h:h*(N-1));
for ind = 1:N-1
   [q(ind+1), i(ind+1)]=rukasecond(q(ind), i(ind), t(ind), h, func);
end
Tout=t;
Vout=R*i;
end

%Set given conditions
R=250;
L=600e-3;
C=3.5e-6;
h=0.0000008;
N=10000;
q(1)=500e-9;
i(1)=0;

%*Step signal input*
```

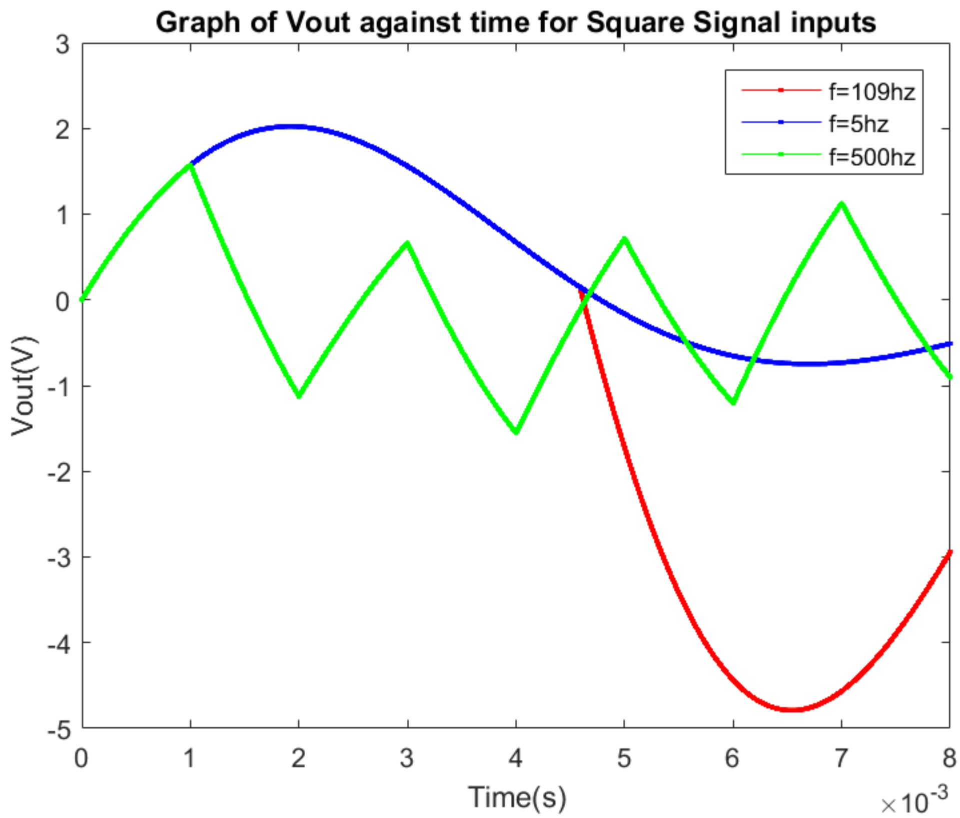
```
v_in = @(t) 5*heaviside(t);
[Tout,Vout] = N_step_rk();
figure(1);
plot(Tout,Vout);

title('Graph of Vout against time for a Step Signal');
xlabel('Time(s)');
ylabel('Vout(V)');
legend('Amplitude Vin = 5V')
```



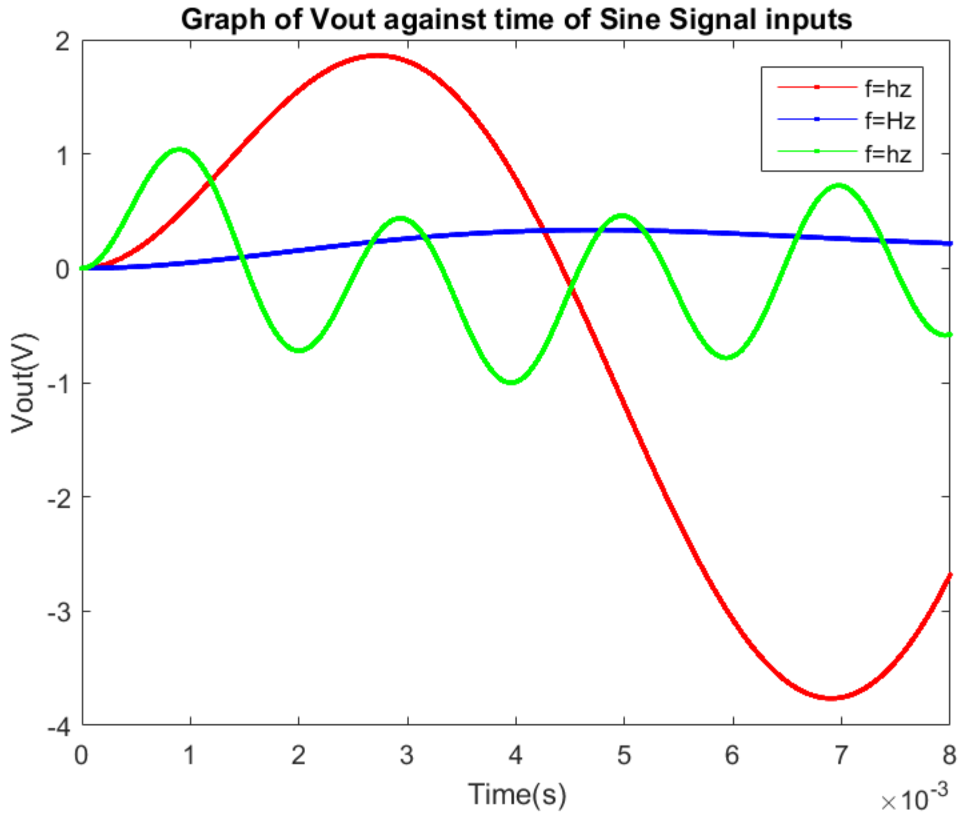

```
%*Decay signal input*
v_in = @(t) 5*heaviside(t)*exp(-t^2/(0.003));
[Tout,Vout] = N_step_rk();
figure(2)
plot(Tout,Vout,'-r.');

title('Graph of Vout against time for Decay Signal input');
xlabel('Time(s)');
ylabel('Vout(V)');
legend('Amplitude tau = 3ms');
```




```
%*Square signal inputs*
f=109;
v_in = @(t) 5*square((2*pi*f*t));
[Tout,Vout] = N_step_rk();
figure(3);
plot(Tout,Vout,'-r.');
hold on

f=5;
v_in = @(t) 5*square((2*pi*f*t));
[Tout,Vout] = N_step_rk();
plot(Tout,Vout,'-b.');
hold on

f=500;
v_in = @(t) 5*square((2*pi*f*t));
[Tout,Vout] = N_step_rk();
plot(Tout,Vout,'-g.');
hold on


title('Graph of Vout against time for Square Signal inputs');
xlabel('Time(s)');
ylabel('Vout(V)');
legend('f=109hz','f=5hz', 'f=500hz');
```




```
%SINE SIGNAL
f=109;
v_in = @(t) 5*sin((2*pi*f*t));
[Tout,Vout] = N_step_rk();
figure(4);
plot(Tout,Vout,'-r.');
hold on

f=9;
v_in = @(t) 5*sin((2*pi*f*t));
[Tout,Vout] = N_step_rk();
plot(Tout,Vout,'-b.');
hold on

f=500;
v_in = @(t) 5*sin((2*pi*f*t));
[Tout,Vout] = N_step_rk();
plot(Tout,Vout,'-g.');
hold on

title('Graph of Vout against time of Sine Signal inputs');
xlabel('Time(s)');
ylabel('Vout(V)');
legend('f=hz','f=Hz', 'f=hz');
```




```
end
```

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