

System of differential equations

RLC_dif_eq.m

```
function dcurrent=RLC_dif_eq(t,current)
% Prepared by Ing. L.Šroubová
% differential equations of the 2nd order with constant coefficient
% to solve serial RLC circuit with the constant voltage power supply

% Resistor is 200 Ohm, inductivity 0.5H and capacitance is 5 mikroF
% At time t=0 we connect voltage power supply with voltage U0=100V.
% Voltage on capacitor at time t=0 is uC(0)=0.

% the circuit has been solved calling function RLC_reseni.m

R=200; % R = 200 Ohm
L=0.5; % L = 0,5 H
C=5e-6; % C = 5 mikroF
U0=100; % U0 = 100V
% 1st way:
% applying 2nd Kirchhoff's law:
%  $u_R + u_L + u_C = U_0$ 
%  $R \cdot i + L \cdot di/dt + u_C = U_0$ 
% is valid:  $i = C \cdot du_C/dt$ 
% after substitution:
%  $R \cdot C \cdot du_C/dt + L \cdot C \cdot d(du_C/dt)/dt + u_C = U_0$ , i.e. diff. eq. of the 2nd order

% 2nd way:
% again using 2nd Kirchhoff's law:
%  $u_R + u_L + u_C = U_0$ 
%  $R \cdot i + L \cdot di/dt + 1/C \cdot (\text{integral from 0 to t from } i(t)dt) + u_C(0) = U_0$ ,
% after derivation:
%  $R \cdot di/dt + L \cdot d(di/dt)/dt + 1/C \cdot i = 0$ , i.e. diff. eq. of the 2nd order

% we solve diff. eq. of the 2nd order with constant coefficient:
%  $L \cdot d(di/dt)/dt + R \cdot di/dt + 1/C \cdot i = 0$ 

% wanted current i we assign current(1)
% derivation di/dt we assign dcurrent(1)
% substitution: di/dt = current(2), i.e. in our assigning: dcurrent(1) =
current(2)
% 2nd derivation d(di/dt)/dt, i.e. d(dcurrent(1)/dt)/dt = d(current(2))/dt, we
assign dcurrent(2)

% now substitute: dcurrent(1) = current(2)
%  $L \cdot dcurrent(2) + R \cdot current(2) + 1/C \cdot current(1) = 0 \Rightarrow dcurrent(2) = (-$ 
 $1/C \cdot current(1) - R \cdot current(2))/L$ 
dcurrent(1,1)=current(2);
dcurrent(2,1)=(-1/C*current(1)-R*current(2))/L;
```

Solving m-file

RLC_solving.m

```
function RLC_solving
% Prepared by Ing. L.Šroubová
% Solving of serial RLC circuit with the constant voltage power supply
% Resistor is 200 Ohm, inductivity 0.5H and capacitance is 5 mikroF
% At time t=0 we connect voltage power supply with voltage U0=100V.
% Voltage on capacitor at time t=0 is uC(0)=0.

R=200; % R=200 Ohm
L=0.5; % L=0,5 H
C=5e-6; % C=5 mikroF
U0=100; % U0=100V
[t,current]=ode45(@RLC_dif_eq,[0,0.1],[0,(100/0.5)]);
% solve system of ordinary differential equations defined in m-file
RLC_dif_eq.m
% in time interval from 0 to 0.1 s. počatecnimi podmínkami i(0)=0,
di/dt(0)=U0/L=100/0.5;
% initial conditions are i(0)=0, uC(0)=0
% from 2nd Kirchhoff's law: uR + uL + uC = U0 => uL = U0-uC-uR,
% i.e. L*di/dt = U0-uC-uR => di/dt = (U0-uC-uR)/L
% for t = 0 is valid: di/dt = (U0-uC(0))/L - uR/L = (U0-uC(0))/L - R*i(0)/L
% after substitution initial conditions to the equation: di/dt = U0/L

% t is column vector
% current is matrix with 2 columns
% in the 1st colmne is evaluated current, in the 2nd column is his derivation

subplot(2,2,1) % separation of figure window into 4 parts (next plot will be in
the 1st part)
plot(t,current(:,1)) % plotting of 2D plot
title('Current in circuit');
xlabel('t [s]') % label of axe x
ylabel('i [A]') % label of axe y
legend('i [A]') % label of curve (legend)

% voltage response on inductor
uL=L*current(:,2); % by: uL = L*di/dt, di/dt stored in 2nd column of matrix
"current"
% voltage response on resistor
uR=R*current(:,1); % by: uR = R*i
% voltage response on capacitor
uC=U0-uR-uL; % based on 2nd Kirchhoff's law: uR + uL + uC = U0

subplot(2,2,2) % separation of figure window into 4 parts (next plot will be in
the 2nd part)
plot(t,uC,'r') % plotting of 2D plot, 'r' means red color for curve
title('Voltage response on capacitor');
```

```
xlabel('t [s]') % label of axe x
ylabel('u_C [V]') % label of axe y, label _ means lower index
legend('u_C [V]') % label of curve (legend), label _ means lower index

subplot(2,2,3) % separation of figure window into 4 parts (next plot will be in
the 3rd part)
plot(t,uR,'g') % plotting of 2D plot, 'g' means green color for curve
title('Voltage response on resistor');
xlabel('t [s]') % label of axe x
ylabel('u_R [V]') % label of axe y, label _ means lower index
legend('u_R [V]') % label of curve (legend), label _ means lower index

subplot(2,2,4) % separation of figure window into 4 parts (next plot will be in
the 4th part)
plot(t,uL,'m') % plotting of 2D plot, 'm' means magenta color for curve
title('Voltage response on inductor');
xlabel('t [s]') % label of axe x
ylabel('u_L [V]') % label of axe y, label _ means lower index
legend('u_L [V]') % label of curve (legend), label _ means lower index
```