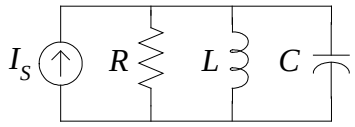
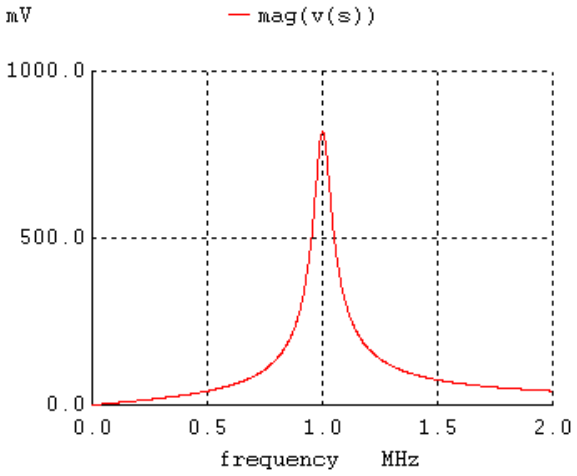
DRIVING WINSPICE FROM MATLAB – SIMPLE EXAMPLE

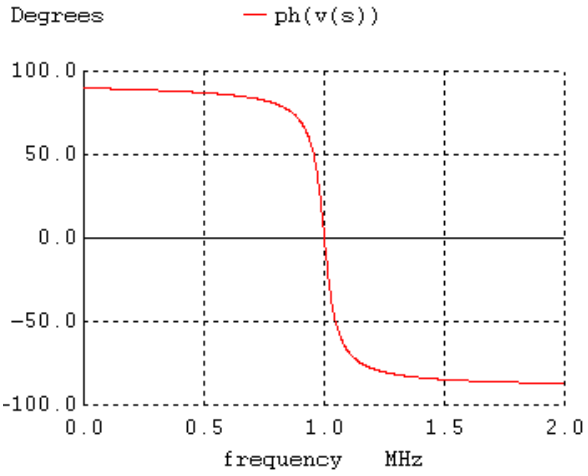
Dr. J. E. Rayas-Sánchez

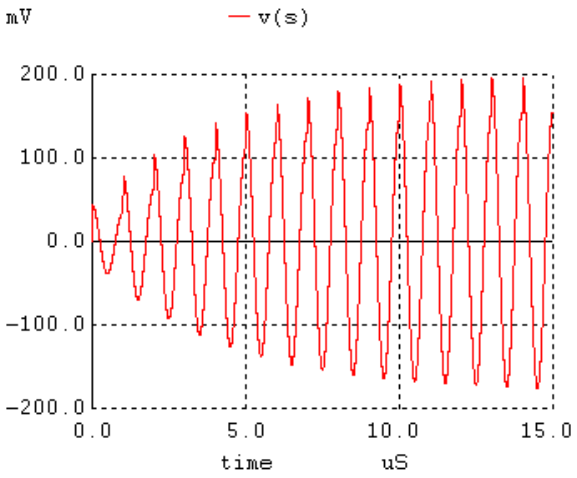
1. Write a conventional SPICE file and test its performance, making sure it works fine.

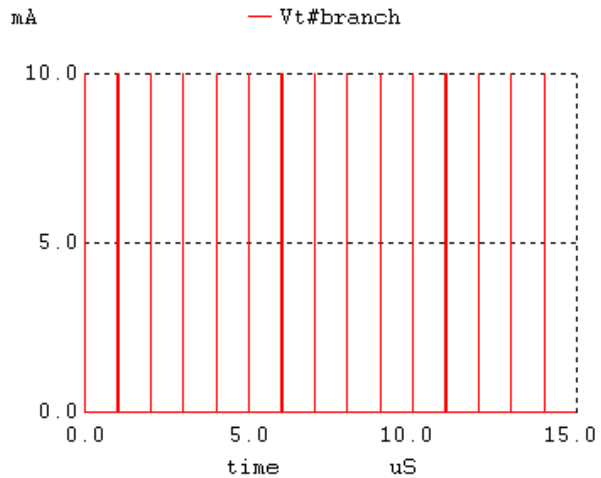



```
RLC_Tank
* --------------------------------------------------
* Dr. J. E. Rayas-Sanchez                March 30, 2016
* --------------------------------------------------
*                          RLC Tank

Is  0   st  DC 0V AC 1mA PULSE(0A 10mA 0s 1ns 1ns 10ns 1us)
Vt  st  s   DC 0V
L   s   0   10uH
R   s   0   820
C   s   0   2.53nF

.control
set units = degrees
AC LIN 300 50Hz 2MEGHz
plot vm(s)
plot vp(s)
TRAN 10ns 15us
plot v(s)
plot i(Vt)
.endc

.end
```









2. Re-direct output to csv files

```
RLC_Tank
* ------------------------------------------------------
* Dr. J. E. Rayas-Sanchez                March 30, 2016
* ------------------------------------------------------
*                       RLC Tank

Is  0   st  DC 0V AC 1mA PULSE(0A 10mA 0s 1ns 1ns 10ns 1us)
Vt  st  s   DC 0V
L   s   0   10uH
R   s   0   820
C   s   0   2.53nF

.control
set units = degrees
AC LIN 300 50Hz 2MEGHz
write RLC_Tank_AC.csv vm(s) vp(s)
TRAN 10ns 15us
write RLC_Tank_TRAN.csv v(s) i(Vt)
.endc

.end
```

3. Confirm that the corresponding csv files are correctly generated

Contents of `RLC_Tank_AC.csv`

```
frequency      mag(v(s))      ph(v(s))
5.00E+01       0.00E+00       3.14E-06       0       9.00E+01       0
6.74E+03       0.00E+00       4.23E-04       0       9.00E+01       0
1.34E+04       0.00E+00       8.44E-04       0       8.99E+01       0
.              .              .              .       .              .
.              .              .              .       .              .
.              .              .              .       .              .

1.99E+06       0.00E+00       4.24E-02       0       -8.70E+01      0
1.99E+06       0.00E+00       4.21E-02       0       -8.71E+01      0
2.00E+06       0.00E+00       4.19E-02       0       -8.71E+01      0
```

Contents of `RLC_Tank_TRAN.csv`

```
Time           v(s)           vt#branch
0.00E+00       0.00E+00       0.00E+00
1.00E-11       3.95E-07       1.00E-04
1.28E-11       5.37E-07       1.28E-04
.              .              .
.              .              .
.              .              .

1.50E-05       1.55E-01       2.12E-21
1.50E-05       1.56E-01       -1.09E-21
1.50E-05       1.56E-01       1.48E-21
```

4. Write a parameterized Matlab file to drive SPICE simulation

```
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
% Dr. José Ernesto Rayas-Sánchez                                  March 30, 2016
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
%                     Driving RLC_Tank_m.cir from Matlab
%
% Usage: [t,VoTRAN,IsTRAN,f,mVoAC,pVoAC] = RLC_Tank_SPICE(x)
%       x = [R L C], with R in ohms, L in uH, and C in nF.
%       t: Column vector of simulated time points (s).
%       VoTRAN: Column vector of transient output voltage (V).
%       IsTRAN: Column vector of transient source current (A).
%       f: Column vector of simulated frequency points (Hz).
%       mVoAC: Column vector of AC output voltage magnitude (V).
%       pVoAC: Column vector of AC output voltage phase (degrees).

function [t,VoTRAN,IsTRAN,f,mVoAC,pVoAC] = RLC_Tank_SPICE(x)

% Define SPICE Script, ss
ss{1} = 'RLC_Tank';
ss{2} = '* ------------------------------------------------------';
ss{3} = '* Dr. J.E. Rayas-Sanchez                 March 30, 2016';
ss{4} = '* ------------------------------------------------------';
ss{5} = '*                      RLC Tank';
ss{6} = 'Is  0   st DC 0A AC 1mA PULSE(0A 10mA 0s 1ns 1ns 10ns 1us)';
ss{7} = 'Vt  st  s  DC 0V';
ss{8} = ['L s 0 ' num2str(x(2)) 'uH'];
ss{9} = ['R s 0 ' num2str(x(1))];
ss{10} = ['C s 0 ' num2str(x(3)) 'nF'];
ss{11} = '.control';
ss{12} = 'set units = degrees';
ss{13} = 'AC LIN 300 50Hz 2MEGHz';
ss{14} = 'write RLC_Tank_AC.csv vm(s) vp(s)';
ss{15} = 'TRAN 10ns 15us';
ss{16} = 'write RLC_Tank_TRAN.csv v(s) i(Vt)';
ss{17} = 'quit';
ss{18} = '.endc';
ss{19} = '.end';

% Save SPICE Script as a Circuit File in Matlab Working Directory
CircuitFileName = 'RLC_Tank_m.cir';
ckt_file = char(ss); % Convert cell array "ss" to character array.
[rows,~] = size(ckt_file); % Read number of rows in "ckt_file".
fid = fopen(CircuitFileName,'w+'); % File identifier opened.
for i = 1:rows                        % Save each row of character array
   fprintf(fid, '%s', ckt_file(i,:)); % "ckt_file" in ASCII file
   fprintf(fid, '%s\r\n', '');        % "CircuitFileName".
end
fclose(fid); % File identifier closed.

% Run WinSpice Circuit File
ExecFile = 'C:\command_line_WinSpice\wspice3 ';
system([ExecFile CircuitFileName]);

% Read WinSpice Output Files
RespTRAN = csvread('RLC_Tank_TRAN.csv',1,0); % Read transient responses.
RespAC = csvread('RLC_Tank_AC.csv',1,0); % Read AC responses.
t = RespTRAN(:,1);
VoTRAN = RespTRAN(:,2);
IsTRAN = RespTRAN(:,3);
f = RespAC(:,1);
mVoAC = RespAC(:,3);
pVoAC = RespAC(:,5);

% Erase WinSpice Output Files
delete RLC_Tank_TRAN.csv;
delete RLC_Tank_AC.csv;
```

5. Write a Matlab file to test the SPICE driver, making sure it plots exactly the same responses as the original SPICE file.

```
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
%                     Plotting Responses of the RLC Tank

R = 820;  % Resistor value (ohms).
L = 10;   % Inductor value (uH).
C = 2.53; % Capacitor value (nF).
x = [R L C]; % Vector of selected parameters.

% Calculate Responses
[t,VoTRAN,IsTRAN,f,mVoAC,pVoAC] = RLC_Tank_SPICE(x);

figure
plot(t*1e6,VoTRAN*1e3)
xlabel('time (\mus)');
ylabel('output voltage (mV)');
grid on

figure
plot(t*1e6,IsTRAN*1e3)
xlabel('time (\mus)');
ylabel('source current (mA)');
grid on

figure
plot(f*1e-6,mVoAC*1e3)
xlabel('frequency (MHz)');
ylabel('magnitude of output voltage (mV)');
grid on

figure
plot(f*1e-6,pVoAC)
xlabel('frequency (MHz)');
ylabel('phase of output voltage (degrees)');
grid on
```