Fall 2018, EECE 549: Assignment 1:
Introduction to Simulink and Modeling of Basic RLC Circuits
Due on Thursday, Sep. 27 (in Class)

1) Consider a typical harmonic filter circuit depicted in Fig. 1(a) above. Develop a Simulink model of the
circuit shown in Fig. 1(a) using conventional Simulink block (sums, gains, etc.). The circuit parameters
are: \( L = 0.1364 \) H, \( r_L = 29.76 \) Ω, \( C = 8.1 \) μF, \( r_C = 40 \) kΩ, and dc source \( v_{dc} = 1000 \) V. The switch \( S \)
is closed at \( t = 0.01s \). You can implement this source using a step function. You will calculate the
transient response (solutions) on time interval \([0, 0.12]\) s.

2) Establish the system eigenvalues first analytically, and then numerically using the functions LINMOD and
EIG on Matlab command line. How many “modes” are present in this system and what are they? Is this
system stiff? Considering the system eigenvalues, estimate the fixed-time step \( h_{max} \) that would be required
by: a) explicit Euler method (solver ode1); and b) explicit RK method (solver ode5)?

3) Use any one of the fixed-step solvers of your choice. Display/plot the solution \( i_L, v_c \). Experimentally
establish the largest time step \( h_{max} \) that produces a stable and convergent solution that you can trust and it
looks sufficient for representing the transient response. Compare your result with the result of using the
ODE5 at \( h = 0.5e - 3s \), then, \( h = 1e - 3s \), and \( h = 2e - 3s \).

4) Experiment with variable-step solvers. Using a variable-time-step solver of your choice, establish a
convergent solution that you can trust. Plot the solution \( i_L, v_c \), and the time step \( h \) as functions of time.
This will be your reference solution.

5) Using variable-step solvers, set \( h_{max} = 1e - 2s \) and both error tolerances \( \varepsilon_{abs} = \varepsilon_{rel} = 1e - 3 \). Experiment
with all available variable-step solvers, and for each case find and tabulate the maximum time-step size
\( h_{max} \) chosen by each solver and the total number of steps taken. Comment on how these solutions compare
with the reference solution found in 4). Which solver in your opinion is more efficient and does the best
job for this system? Compare the step-size and the overall number of steps observed in 3), 4) and 5).

6) Modify your model to implement the filter of Fig. 1(b) considering the following parameters:
\( L_1 = 0.0064 \) H, \( r_{L1} = 4.76 \) Ω, \( L_2 = 0.13 \) H, \( r_{L2} = 25 \) Ω, \( r_{leak} = 1000 \) kΩ.

7) Repeat parts 2) through 5) for this new system. In what way this system behaves differently (or the same)
from the one depicted in Fig. 1(a)? What is the effect of a very large (almost negligible!) leakage
resistance? Which system is harder to simulate (requires more computational resources) and why?

8) Implement model of the filter of Fig. 1(b) using SimScape (SimPowerSystems) blockset and its library
components. Extract the eigenvalues numerically and verify them to step 2). Repeat steps 3) and 4) and
comment on the time step selection that gives you a good result.

Reporting
All reports should be typed. The assignment report should demonstrate the individual work and include
printouts of the model windows, simulation results, as well as answers/discussions and conclusions
wherever appropriate. The discussions and comments should not be long (avoid writing long reports!),
but they should demonstrate your individual models and understanding of the problem. Use subplot
command to group variables for more efficient/compact presentation and clearly label all variables and
axes in your figures.