ECE 521 Fall 2016

Homework #4 - Part 2 (Due Nov. 16)

In this HW you will **extend** *myspice* **to transient analysis** using uniform timesteps. The TR and BE integration methods ($\dot{x}_n = \alpha x_n + \beta$) for use in *myspice* have been provided in the function *intgr8* (the code for the BE method has been commented out). The inputs to *intgr8* are the value of *x* and $\dot{x}$ at the previous timepoint (x_{n-1} , $\dot{x}_{n-1}$), and the current timestep h_n . The values of α and β are computed and returned through pointer arguments and are to be used for computing the transient stamp of capacitors and inductors. *intgr8* should be called from the functions that load capacitors and inductors. Note that the value of β will be different for each capacitor and inductor.

a) Add the code for **readin**, **setup** and **load** of linear *capacitors*. Use a capacitance based formulation. Use the *intgr8* function that has been provided.
b) Write the loop to perform transient analysis starting from time 0 to a time Tstop (the simulation interval) using a timestep Tstep. Solve the RC circuits test[19-20].ckt using *myspice*. Assume that the initial voltage (and its time derivative) across the capacitor is zero. Solve the circuits for a simulation interval of 10 μs. Compare the results using 20 and 100 timepoints with the exact solution.
c) Add the code for **readin**, **setup** and **load** of linear *inductors*. Use the *intgr8* function that has been provided.
d) Solve the RL circuit test21.ckt using *myspice*. Assume that the initial current (and its time derivative) through the inductor is zero. Solve the circuit for a simulation interval of 10 μs using 100 timepoints.
e) Solve test22.ckt for a simulation interval of 10ns using a timestep of 0.05ns and an initial voltage of 1V for CL3 (i.e. $V(3)|_{t=0} = 1$). Plot the voltage V(3) as a function of time and determine the period of oscillation. Note this circuit is a three-stage ring oscillator.
f) Solve test23.ckt for a simulation interval of 10 μs using a timestep of 0.5ns and an initial voltage of -1.5V for C2 (i.e. $V(3)\ |_{t=0} = -1.5$). Plot the voltage V(2) as a function of time and determine the period of oscillation. Note this circuit is a MOS Colpitts oscillator.
g) Solve test24.ckt for a simulation interval of 10 μs using a timestep of 0.5ns and an initial voltage of -0.5V for C2 (i.e. $V(3)\ |_{t=0} = -0.5$). Plot the voltage V(2) as a function of time and determine the period of oscillation. Note this circuit is a BJT Colpitts oscillator.
h) Implement the following nonlinear capacitor in *myspice*. Add the code to **readin**, **setup** and **load** the nonlinear capacitor. A code template with the correct derivative and proper use of *intgr8* has been provided. *V* is the voltage across the capacitor and C_{j0} is an input parameter.

$$Q_j = 1.6 C_{j0}\left[1-\left(1-\frac{V_L}{0.8}\right)^{0.5}\right] \quad \text{where } V_L = 0.75 - 0.1\ln(1+e^{-10(V-0.75)})$$

The syntax for this element is: `Uname node node value (value of` C_{j0}`)`

i) Solve the circuit test25.ckt using *myspice* for initial voltages (*V*) of 0.7 V and -0.7 V across the capacitor.