Assignment 3

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Topics in Electronics I: Simulation of Radio Frequency Circuits

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Part (a)

In this part consider the tuned amplifier circuit shown in Figure 1. This circuit is to excited using a periodical piecewise-linear source with period $T = 5$ns.

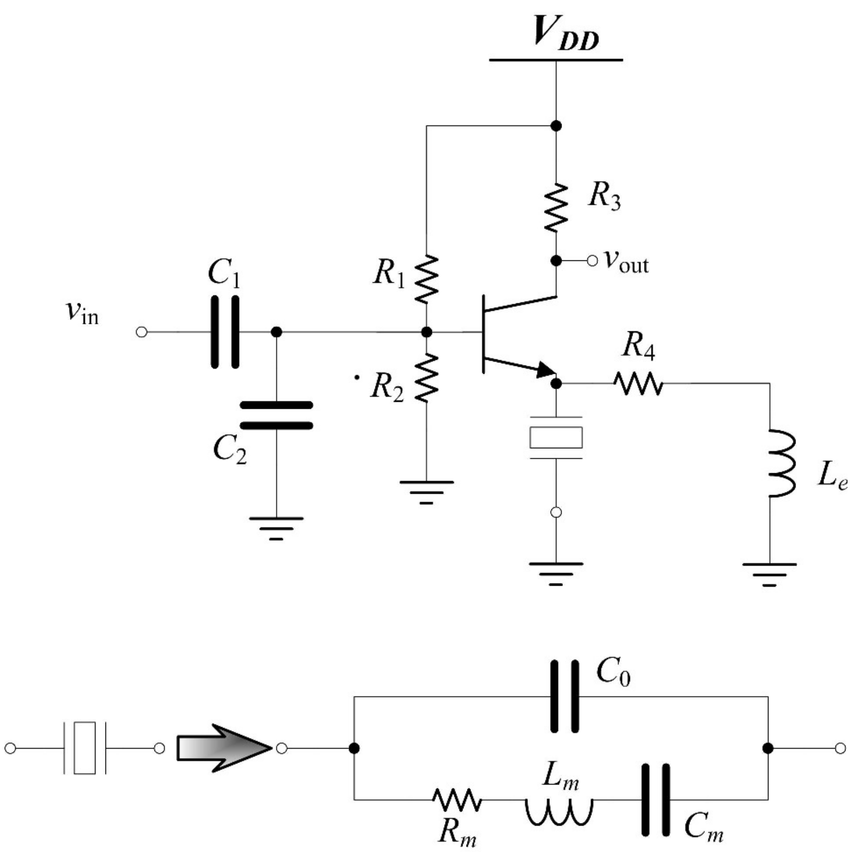

Figure 1: The circuit schematic

Using the HiSPICE-Matlab interface, develop a program in Matlab to compute the Fourier Coefficients of the source input vector $\boldsymbol{b}(t)$, i.e. $\boldsymbol{B}_0, \boldsymbol{B}_i^C$, and $\boldsymbol{B}_i^S$. [1]

The program developed must adhere to the following guidelines.

- The program must be written in the form of a Matlab function,
- The function name must be called `compute_source_coeffs`,

[1]The circuit netlist will be provided on the Blackboard Learn.

- The input to the program is a single argument defining the number of time samples at which the source must be sampled,
- The output of the program must be three arguments
  (a) The first output argument is the vector of the DC coefficient of the source vector $\boldsymbol{b}(t)$, i.e. $\boldsymbol{B}_0$
  (b) The second output argument is a matrix whose columns represent the coefficient vectors of the $\cos$ function, i.e. $\boldsymbol{B}_1^C, \boldsymbol{B}_2^C, \cdots$
  (c) The third output argument is a matrix whose columns represent the coefficient vectors of the $\sin$ function, i.e. $\boldsymbol{B}_1^S, \boldsymbol{B}_2^S, \cdots$ Thus the first line your program must be given as follows,
  `function [B0 BC BS] = compute_source_coeffs(n_Time_Points)`
  where `B0` is the same as B_0, `BC` is the same as $\left[\begin{array}{ccc} \boldsymbol{B}_1^C & \boldsymbol{B}_2^C \cdots & \end{array} \right]$ and `BS` is the same as $\left[\begin{array}{ccc} \boldsymbol{B}_1^S & \boldsymbol{B}_2^S \cdots & \end{array} \right]$
- The whole program must be contained within one `.m` file, named after the function name, i.e., `compute_source_coeffs.m`.
- The program must be able to handle an even or odd number of sampling points. For example, assume that `n_Time_Points`=5, then the program output should be as follows

$$\begin{aligned} \texttt{B0} &= \boldsymbol{B}_0 && (1)\\ \texttt{BC} &= \left[\begin{array}{cc} \boldsymbol{B}_1^C & \boldsymbol{B}_2^C \end{array} \right] && (2)\\ \texttt{BS} &= \left[\begin{array}{cc} \boldsymbol{B}_1^S & \boldsymbol{B}_2^S \end{array} \right] && (3) \end{aligned}$$

However, if `n_Time_Points`=6, then we should have

$$\begin{aligned} \texttt{B0} &= \boldsymbol{B}_0 && (4)\\ \texttt{BC} &= \left[\begin{array}{ccc} \boldsymbol{B}_1^C & \boldsymbol{B}_2^C & \boldsymbol{B}_3^C \end{array} \right] && (5)\\ \texttt{BS} &= \left[\begin{array}{cc} \boldsymbol{B}_1^S & \boldsymbol{B}_2^S \end{array} \right] && (6) \end{aligned}$$

Part (b)

Checking the correctness of your results

To check whether your program produces the correct Fourier coefficients of the source vector, you can do the following. Use the computed coefficients above to reconstruct the time-domain waveforms in the source vector. One of the reconstructed waveforms should be the piecewise-linear pulse at the input.

Part (c)

What you need to submit

You are required to submit only two files (DO NOT compress them in one zipped file):

(a) The Matlab program file `compute_source_coeffs.m`.

   (i) This file must be self-contained, in the sense that it should not need other (user-defined) programs that to run, of course with the exception of the files already supplied with the Matlab-HiSPICE interface (e.g. `mna_parse_circuit.m`): you do not need to include any of these files with your submission.

   The person marking the assignment must be able to run all of your program from the Matlab by simply typing

   ```
   [B0 BC BS] = compute_source_coeffs(n_Time_Points)
   ```

   at the command prompt and get the results.

   (ii) The second line in your Matlab file must be a Matlab comment indicating your student ID and your First and last name.

(b) A PDF file for named using your student ID # and your last name, e.g., `1234567_Gad`, showing a plot for two time-domain waveforms (super-imposed over each other) obtained as follows.

   (i) The first waveform is the one based on the direct reading of the source line on the netlist file, i.e. the line

   `Vin nVin gnd Pulse (0 1 0.1n 0.1n 0.1n 1n 5n)`

   (ii) The second waveform is the one obtained from the Fourier coefficients computed above and using `(n_Time_Points)` = 500 points.