POLITECNICO DI MILANO

Modeling Techniques exercises

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Exercise 1

Switched resistive circuit

- Recall Simulink and Simscape basics
- Build small circuit
- Launch simulink with `ssc_new('exercise_1')`

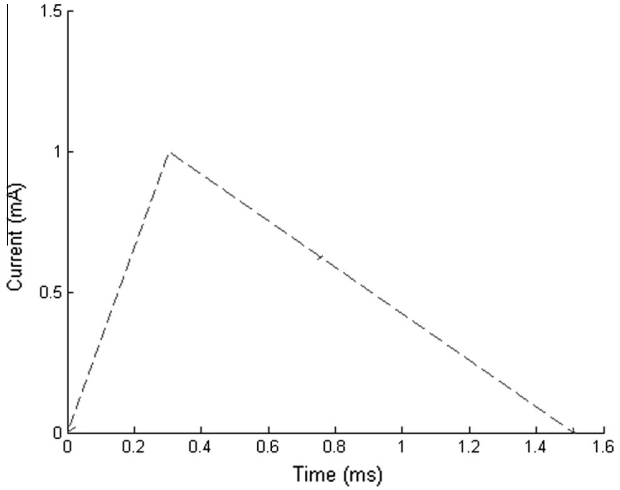
a) Use Simscape to build a simple circuit made up of:
   - One resistor with arbitrary resistance
   - One DC voltage generator

b) Add a switch to the circuit:
   - Initially opened
   - Closes at 0.5s

Exercise 2

User defined signal generator

- Build a circuit with:
  - One resistor with arbitrary resistance (es. $1000\ \Omega$)
  - One current generator with custom signal
    - Asymmetric triangle wave
    - Length 1.515 ms
    - Turning point at 1/5 of its length
  - Use `scope` to visualize the input



- HINT: use simulink `signal builder` to define two signals corresponding to the rising and decreasing part of the triangle.

Exercise 3

Switched circuit with user defined signal generator

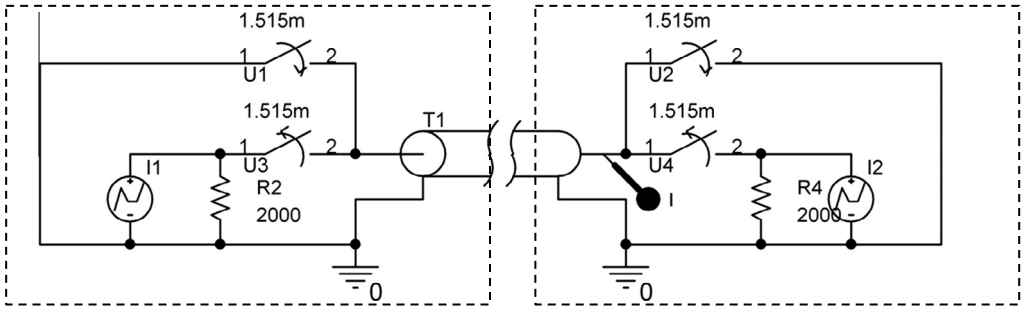
- Combine the results of exercise 1 and exercise 2 in a single circuit
  - One resistor with arbitrary resistance (es. $1000\ \Omega$)
  - One current generator with custom signal
  - Use `scope` to visualize the input
  - Use `scope` to visualize the voltage at the resistor
  - Change commuting time and comment the results

Exercise 4

Plucked string modeling

- A plucked string can be modelled as a circuit with a transmission line.

a



b

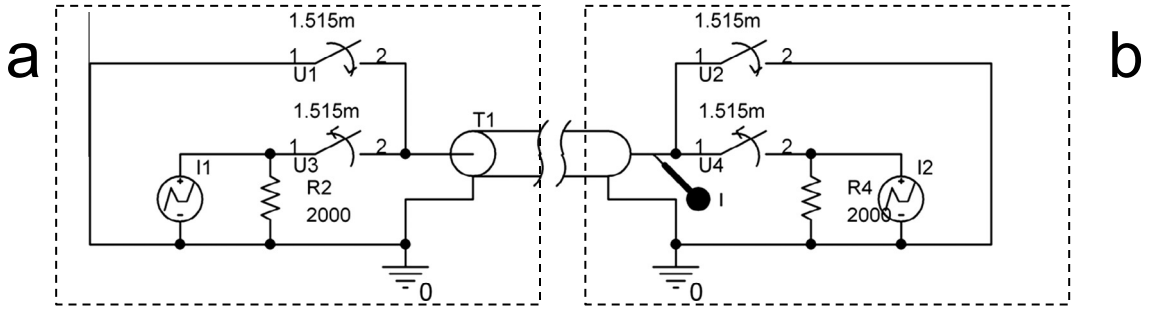
a) Model the left side of the circuit
   - Insert a resistor in place of the transmission line
   - Check the results with `Simscape viewer`

b) Model the right side in another file
   - Symmetric input signal
   - Inspect the current using `scope`

Exercise 4 (2)

Plucked string modeling

- A plucked string can be modelled as a circuit with a transmission line.



c) Combine the two parts:

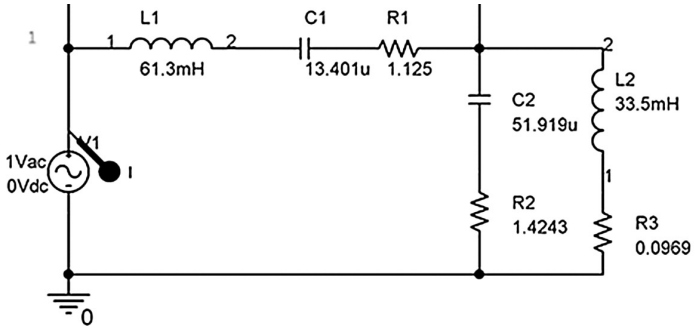
- Connect the two circuits
- Add a transmission line with:
  - Delay 1.515 ms
  - Impedance 2000Ω
- Inspect the signal using `scope`

- Comment the results

Exercise 5

Simple guitar model

- We model the guitar as a plate and air cavity



- Controlled voltage generator:
  - Input signal: damped square wave
    - $\mathrm{V_{in}} = \mathrm{sgn}(\sin(2\pi f_0 t))\, e^{-\beta t}$, with $f_0 = 300$ Hz and $\beta = 3$
  - Output signal: current at the probe position
  - Simulation time 5s
- Use `to Workspace` module to export the current I
- Call the simulation in a script
- Resample the time series object
- Plot the signal, its spectrum magnitude and phase
- Listen to the results and save it on the disk

Exercise 6

Complete guitar model

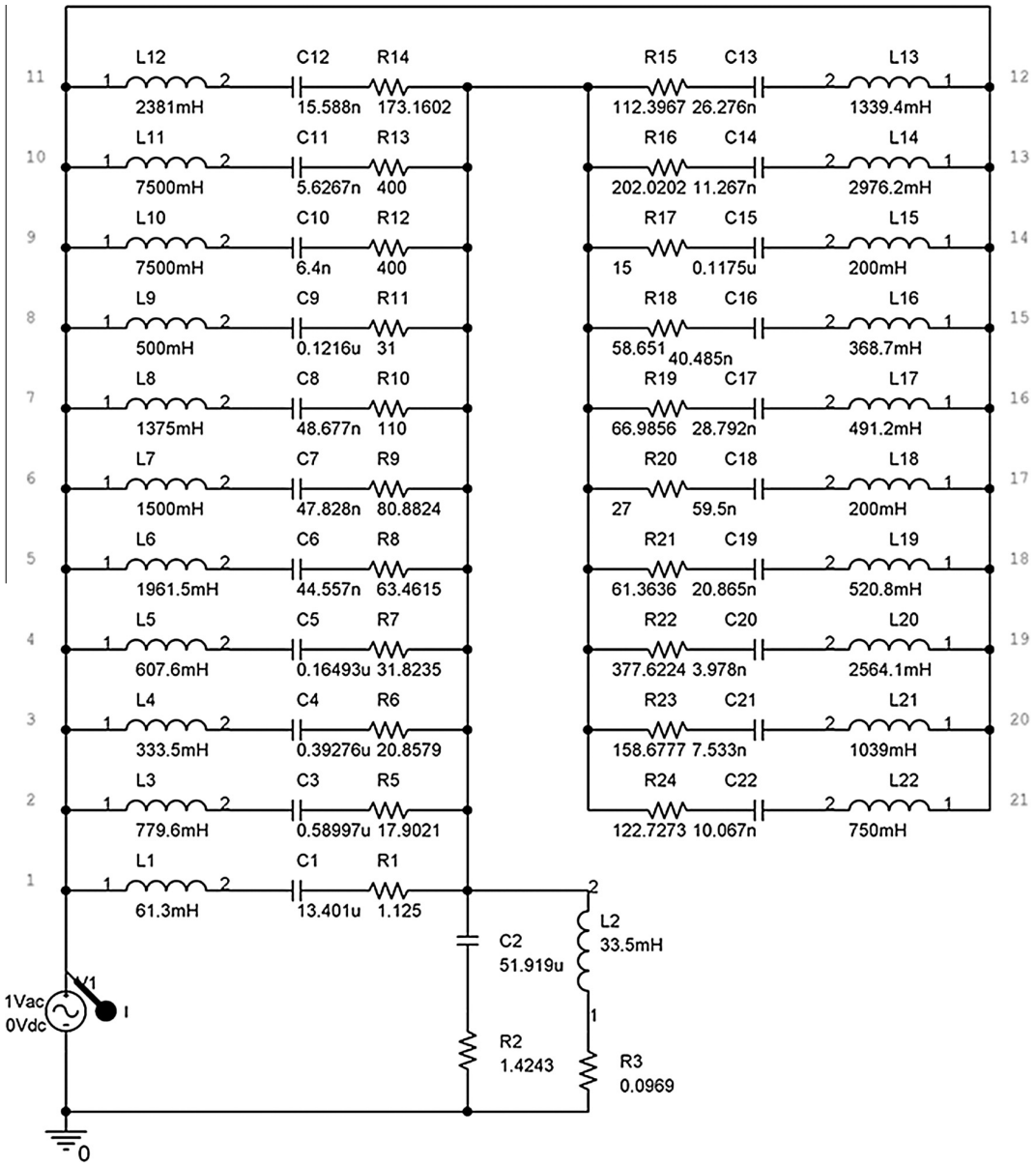
- Implement the complete guitar model presented on the slides

a) Model the 20 resonances
   - Do no to consider the string modeling
   - Substitute it with a voltage generator
     - Use the damped square of exercise_5 as input signal

b) Add the string model
   - Substitute the voltage generator with the string model

- Use the values given in the next slide scheme
- Write a matlab script that
  - Executes the model
  - Plot the signal
  - Play the signal
  - Save it on disk
- Comment the results. What's the difference with respect to the simple model?

Exercise 6


L12 C12 R14
2381mH 15.588n 173.1602
L11 C11 R13
7500mH 5.6267n 400
L10 C10 R12
7500mH 6.4n 400
L9 C9 R11
500mH 0.1216u 31
L8 C8 R10
1375mH 48.677n 110
L7 C7 R9
1500mH 47.828n 80.8824
L6 C6 R8
1961.5mH 44.557n 63.4615
L5 C5 R7
607.6mH 0.16493u 31.8235
L4 C4 R6
333.5mH 0.39276u 20.8579
L3 C3 R5
779.6mH 0.58997u 17.9021
L1 C1 R1
61.3mH 13.401u 1.125
R15 C13 L13
112.3967 26.276n 1339.4mH
R16 C14 L14
202.0202 11.267n 2976.2mH
R17 C15 L15
15 0.1175u 200mH
R18 C16 L16
58.651 40.485n 368.7mH
R19 C17 L17
66.9856 28.792n 491.2mH
R20 C18 L18
27 59.5n 200mH
R21 C19 L19
61.3636 20.865n 520.8mH
R22 C20 L20
377.6224 3.978n 2564.1mH
R23 C21 L21
158.6777 7.533n 1039mH
R24 C22 L22
122.7273 10.067n 750mH
C2
51.919u
L2
33.5mH
R2
1.4243
R3
0.0969
V1
1Vac
0Vdc
I
0