Arbitrary circuit analysis

This example goes through creating a **circuit** object from a **netlist**, which is contained in a text file. We start by calling the Circuit class and giving it the path to the netlist. The netlist automatically gets stored as a property called '**list**' on the circuit object.

The circuit structure in this case, has been arbitrarily chosen.

```
circuit = Circuit('circuits/passive/c8_rlc_arbitrary.txt');
circuit.list
```

```
ans =
    'Vcc 3 0 DC 1
     Vs 4 1 AC 1
     R2 3 2 1000
     R1 1 0 1000
     C1 4 0 0.000001
     C2 2 4 0.00001
     '
```

To symbolically **analyze** the circuit object, we give it to the **ELAB** class. This performs **MNV** to define the equations, which describe the circuit.

```
ELAB.analyze(circuit)
```

```
Symbolic analysis successful (0.450922 sec).
```

An **e**lectrical **c**ircuit is just a subclass of a generic system, which can be represented in any number of ways. For example, as a transfer function in the **s**ymbolic **d**omain. To see this representation, we can use the '**ec2sd**'-function.

```
sym_TF = ELAB.ec2sd(circuit, 3, 2)
```

```
Symbolic transfer function calculated successfully (4.058900e-03 sec).
sym_TF =
```

$$\frac{v_2}{v_3} = \frac{\mathrm{Vcc} + C_1\,R_1\,\mathrm{Vcc}\,s + C_2\,R_1\,\mathrm{Vcc}\,s + C_2\,R_2\,\mathrm{Vs}\,s}{\mathrm{Vcc}\,\left(C_1\,R_1\,s + C_2\,R_1\,s + C_2\,R_2\,s + C_1\,C_2\,R_1\,R_2\,s^2 + 1\right)}$$

Say the netlist contained numerical values for some, or all of its components. The evaluate function will use whatever equations were found by ELAB.analyze() to numerically **evaluate** the circuit. This numerical evaluation can now be used to create a Matlab-transfer-function object.

```
ELAB.evaluate(circuit)
```

```
Numerical evaluation successful (0.105545 sec).
```

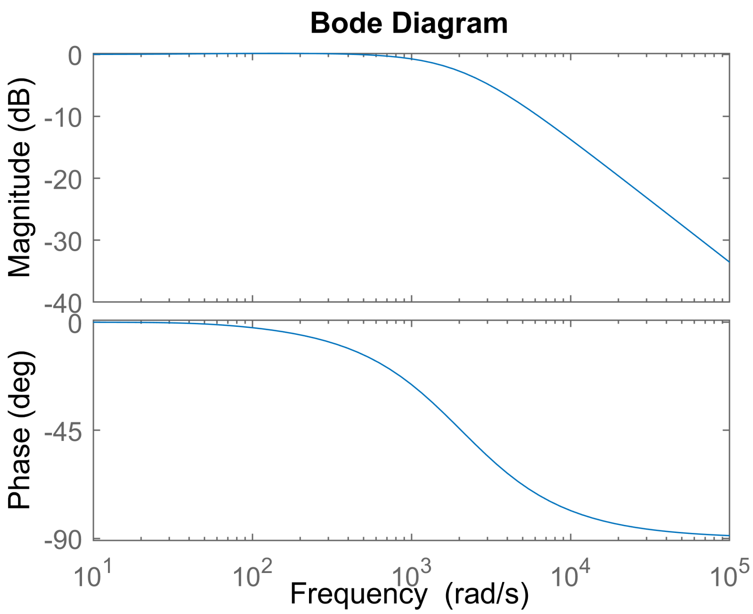
```
num_TF = ELAB.ec2tf(circuit, 3, 2)
```

```
Transfer function object created successfully (4.504490e-02 sec).

num_TF =

     2100 s + 100000
  ---------------------
  s^2 + 2100 s + 100000
```

```
Continuous-time transfer function.
```

Matlab already has extensive functionality to handle transfer function objects.

```
bode(num_TF);
```



During analysis, all node voltages and element currents were symbolically defined and stored in the circuit object.

```
circuit.symbolic_node_voltages
```

```
ans =
```

$$\begin{pmatrix} v_1 = -\dfrac{R_1\,s\,(C_1\,\mathrm{Vs} - C_2\,\mathrm{Vcc} + C_2\,\mathrm{Vs} + C_1\,C_2\,R_2\,\mathrm{Vs}\,s)}{\sigma_1} \\ v_2 = \dfrac{\mathrm{Vcc} + C_1\,R_1\,\mathrm{Vcc}\,s + C_2\,R_1\,\mathrm{Vcc}\,s + C_2\,R_2\,\mathrm{Vs}\,s}{\sigma_1} \\ v_3 = \mathrm{Vcc} \\ v_4 = \dfrac{\mathrm{Vs} + C_2\,R_1\,\mathrm{Vcc}\,s + C_2\,R_2\,\mathrm{Vs}\,s}{\sigma_1} \end{pmatrix}$$

where

$$\sigma_1 = C_1\,R_1\,s + C_2\,R_1\,s + C_2\,R_2\,s + C_1\,C_2\,R_1\,R_2\,s^2 + 1$$

```
circuit.symbolic_element_currents
```

```
ans =
```

$$\left(\begin{array}{c} i_{\mathrm{R2}} = \frac{C_2\,s\,\left(\mathrm{Vcc}-\mathrm{Vs}+C_1\,R_1\,\mathrm{Vcc}\,s\right)}{\sigma_1} \\ i_{\mathrm{R1}} = -\frac{s\,\left(C_1\,\mathrm{Vs}-C_2\,\mathrm{Vcc}+C_2\,\mathrm{Vs}+C_1\,C_2\,R_2\,\mathrm{Vs}\,s\right)}{\sigma_1} \\ i_{\mathrm{C1}} = \frac{\mathrm{Vs}+C_2\,R_1\,\mathrm{Vcc}\,s+C_2\,R_2\,\mathrm{Vs}\,s}{C_1\,\sigma_1} \\ i_{\mathrm{C2}} = \frac{\mathrm{Vcc}-\mathrm{Vs}+C_1\,R_1\,\mathrm{Vcc}\,s}{C_2\,\sigma_1} \end{array}\right)$$

where

$$\sigma_1 = C_1\,R_1\,s+C_2\,R_1\,s+C_2\,R_2\,s+C_1\,C_2\,R_1\,R_2\,s^2+1$$

And during evaluation, they were all numerically evaluated and stored. Since no numerical value was given for V_{cc}, the evaluation is partial.

```
circuit.numerical_node_voltages
```

```
ans =
```

$$\left(\begin{array}{c} v_1 = -\frac{1000\,s\,\left(\frac{s}{100000000}+\frac{1}{1000000}\right)}{\frac{s^2}{100000}+\frac{21\,s}{1000}+1} \\ v_2 = \frac{\frac{21\,s}{1000}+1}{\frac{s^2}{100000}+\frac{21\,s}{1000}+1} \\ v_3 = 1 \\ v_4 = \frac{\frac{s}{50}+1}{\frac{s^2}{100000}+\frac{21\,s}{1000}+1} \end{array}\right)$$