RC Circuit

Simulation: Circuit and Transfer function

Schedule

- Theory background
- Circuit simulation – Pspice
- Transfer function simulation – Octave (or Matlab)

Theory background

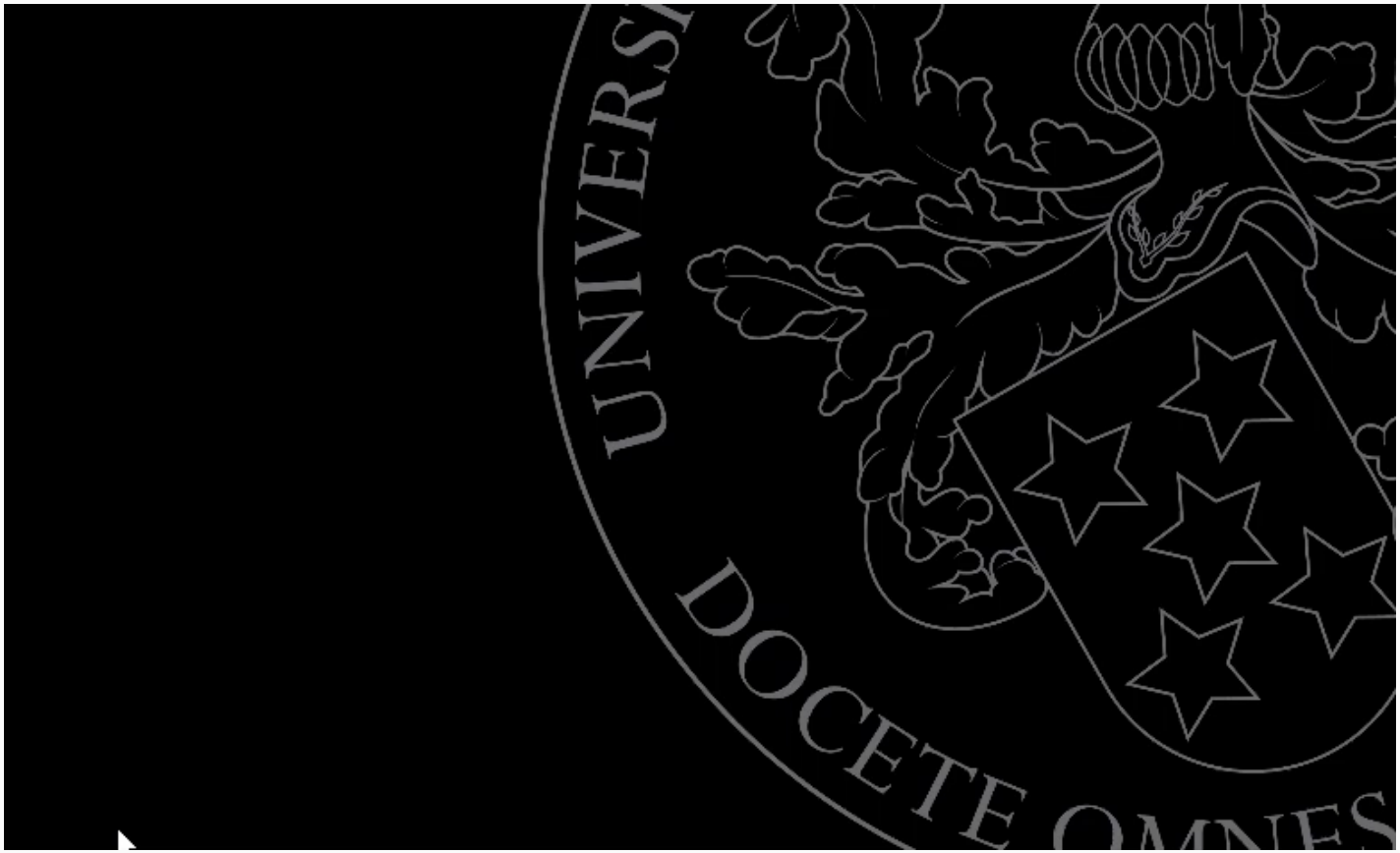
Book Electrical Circuits of Nilsson and Riedel (2008)

- First order RC circuits, Chapter 7
- Step response to a RC circuit; Section 7.4
- Circuit analysis in the frequency domain; Section 13.2
- Transfer function of a RLC circuit; Section 13.4

Circuit simulation

Circuit simulation

Pspice 9.1 student version – Opening the software

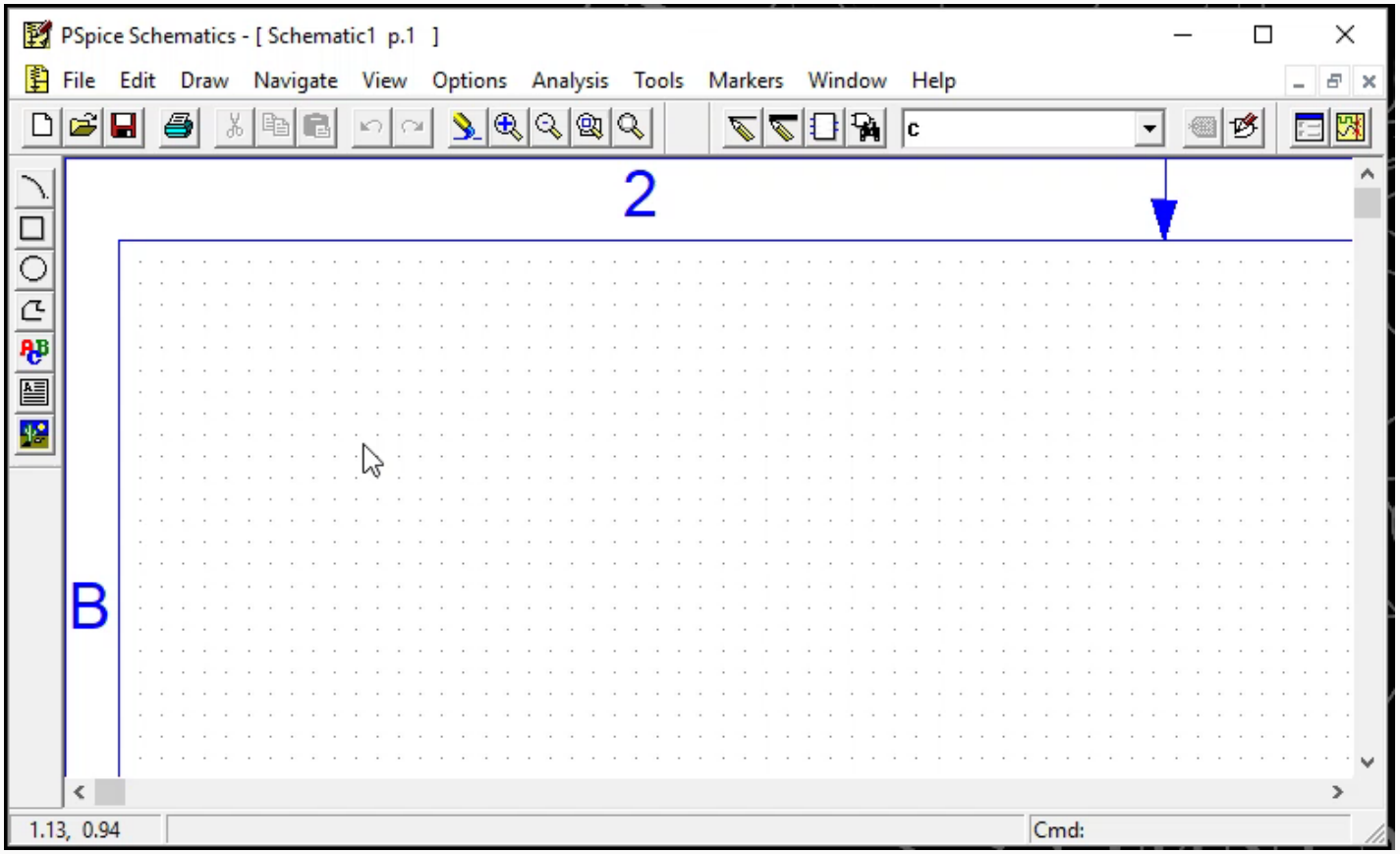


Another folder can be selected for saving the SCH file

Link

Circuit simulation

Pspice 9.1 student version – Placing new parts

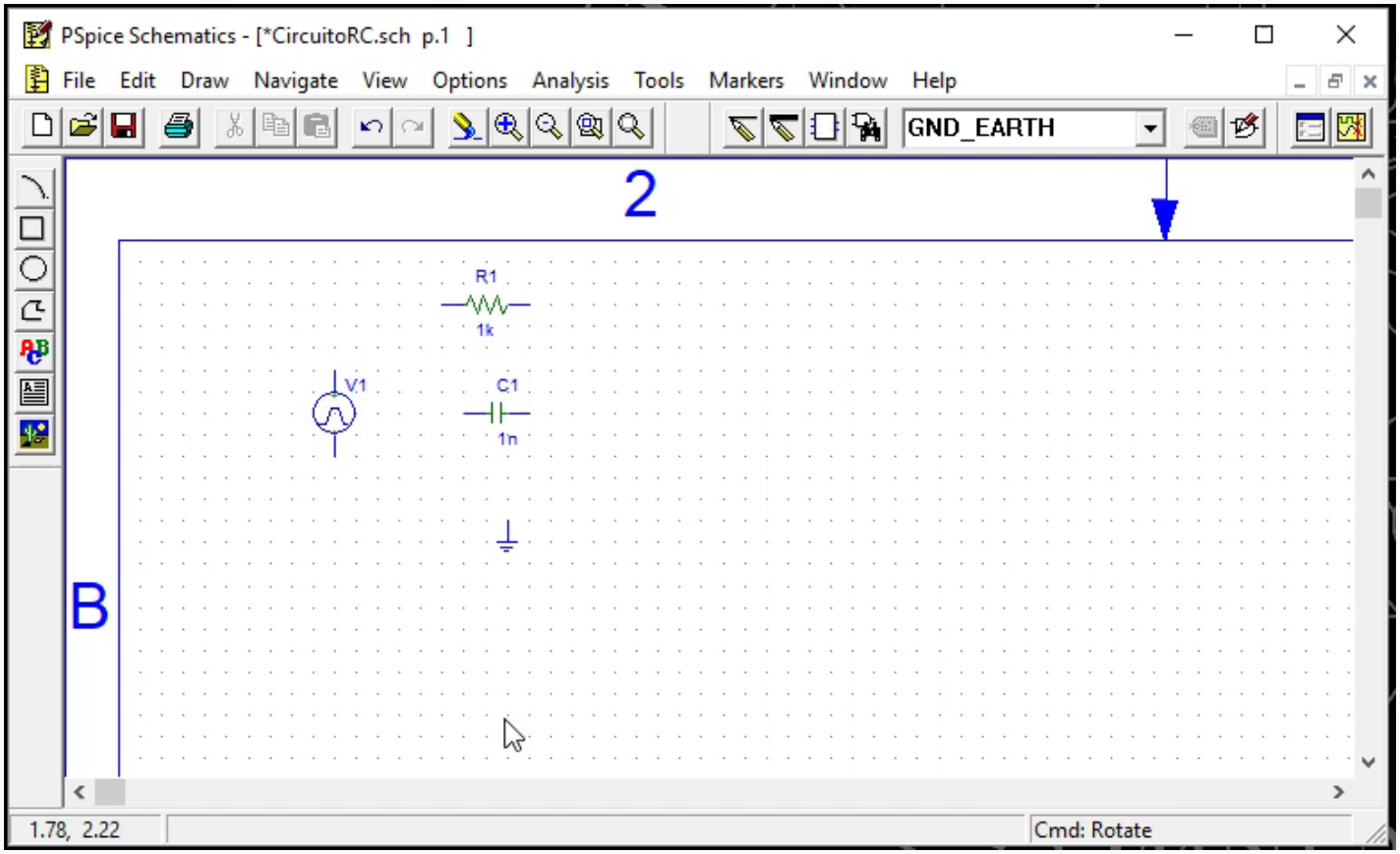


Use *Click* for selecting
Use *Esc* before select other component

Link

Circuit simulation

Pspice 9.1 student version – Wiring components

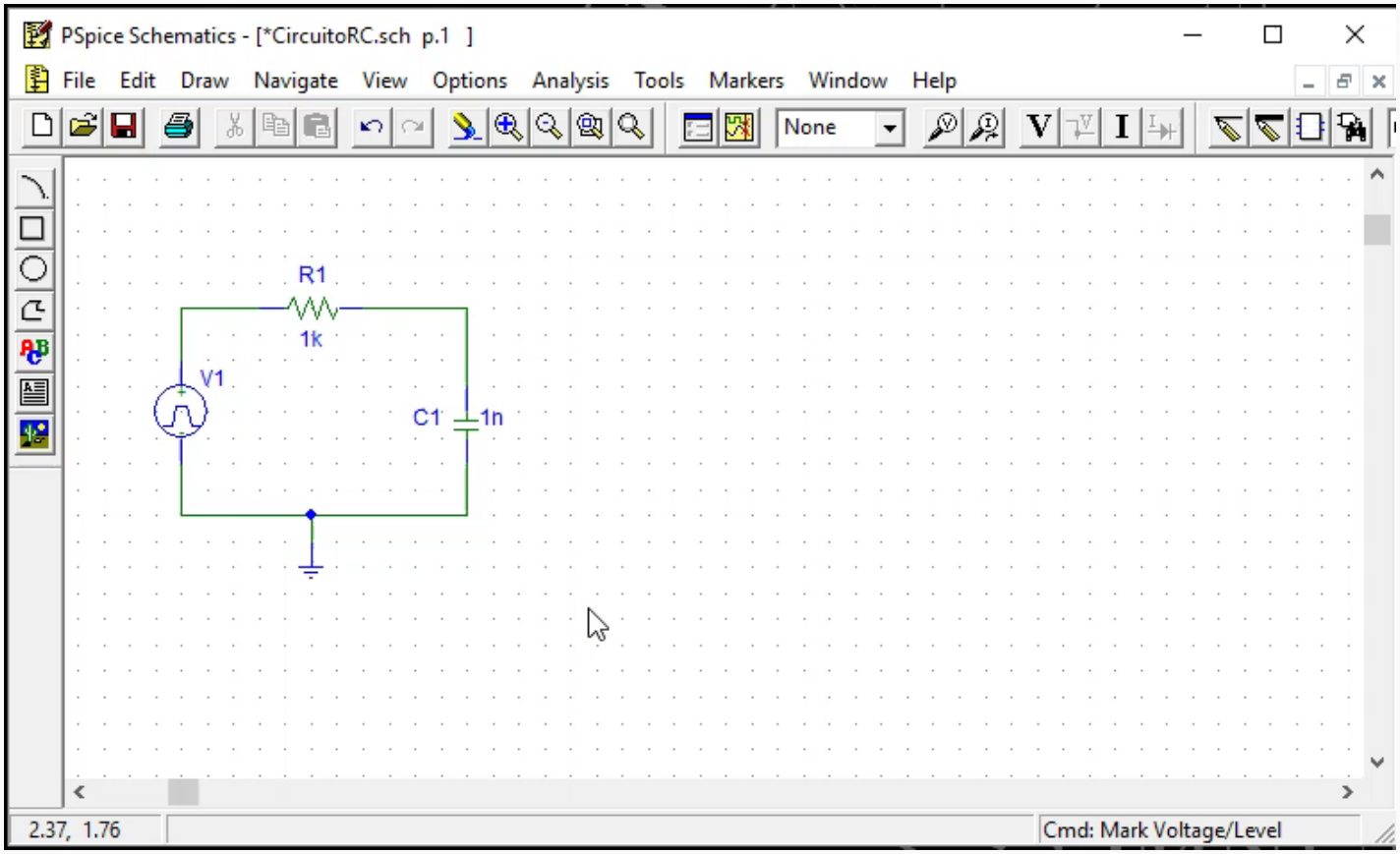


Use *Click* for selecting
Use *Ctrl + W* for wiring
Use *Ctrl + R* for rotating

Link

Circuit simulation

Pspice 9.1 student version – Setting component values



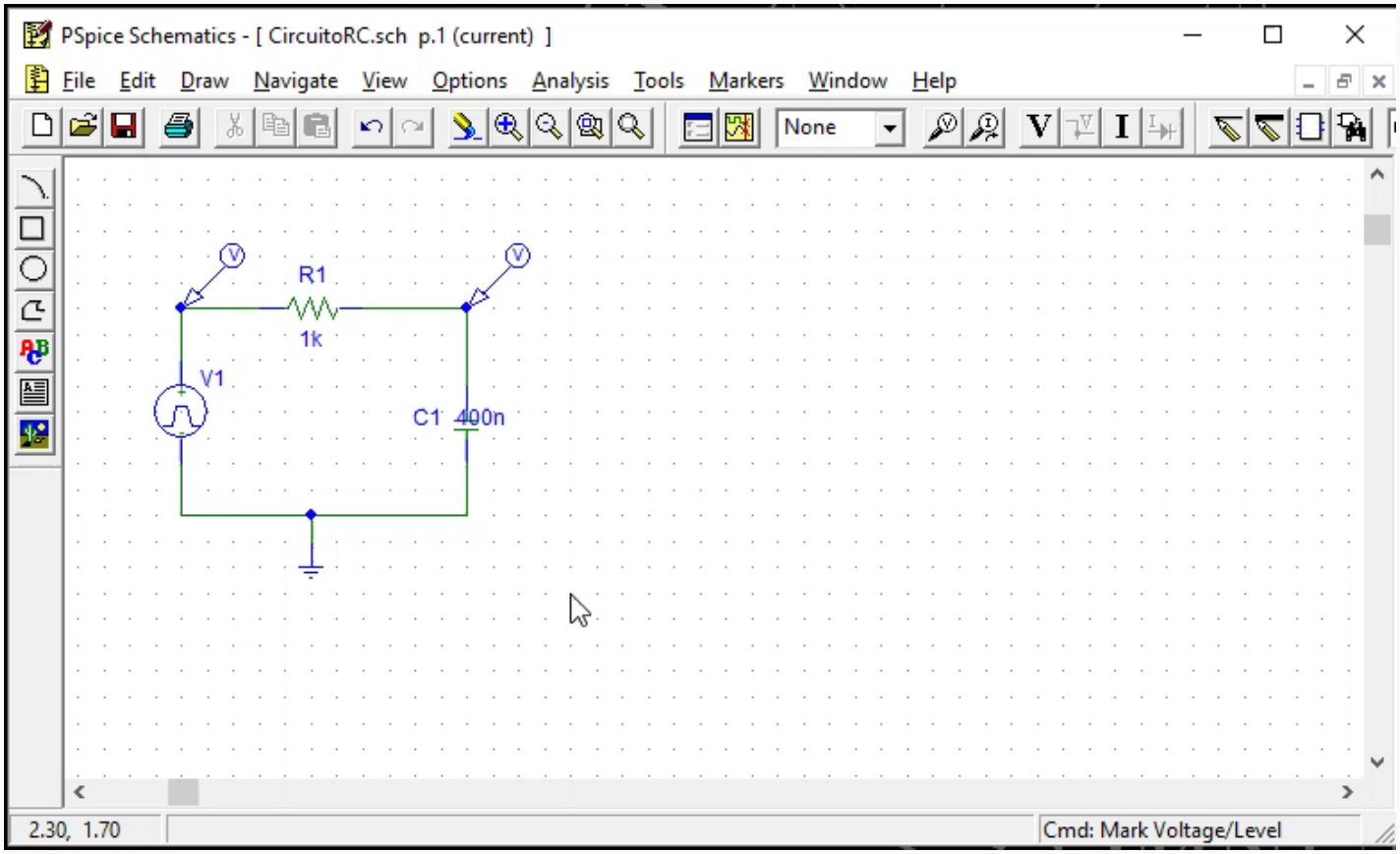
The values of VPULSE are; V1 = 0; V2 = 1; TD = 1m; TR = 1n; TF = 1n; PW = 5ms; PER = 10ms

Marks voltages are placer for measure input/output voltages

Link

Circuit simulation

Pspice 9.1 student version – Circuit simulation

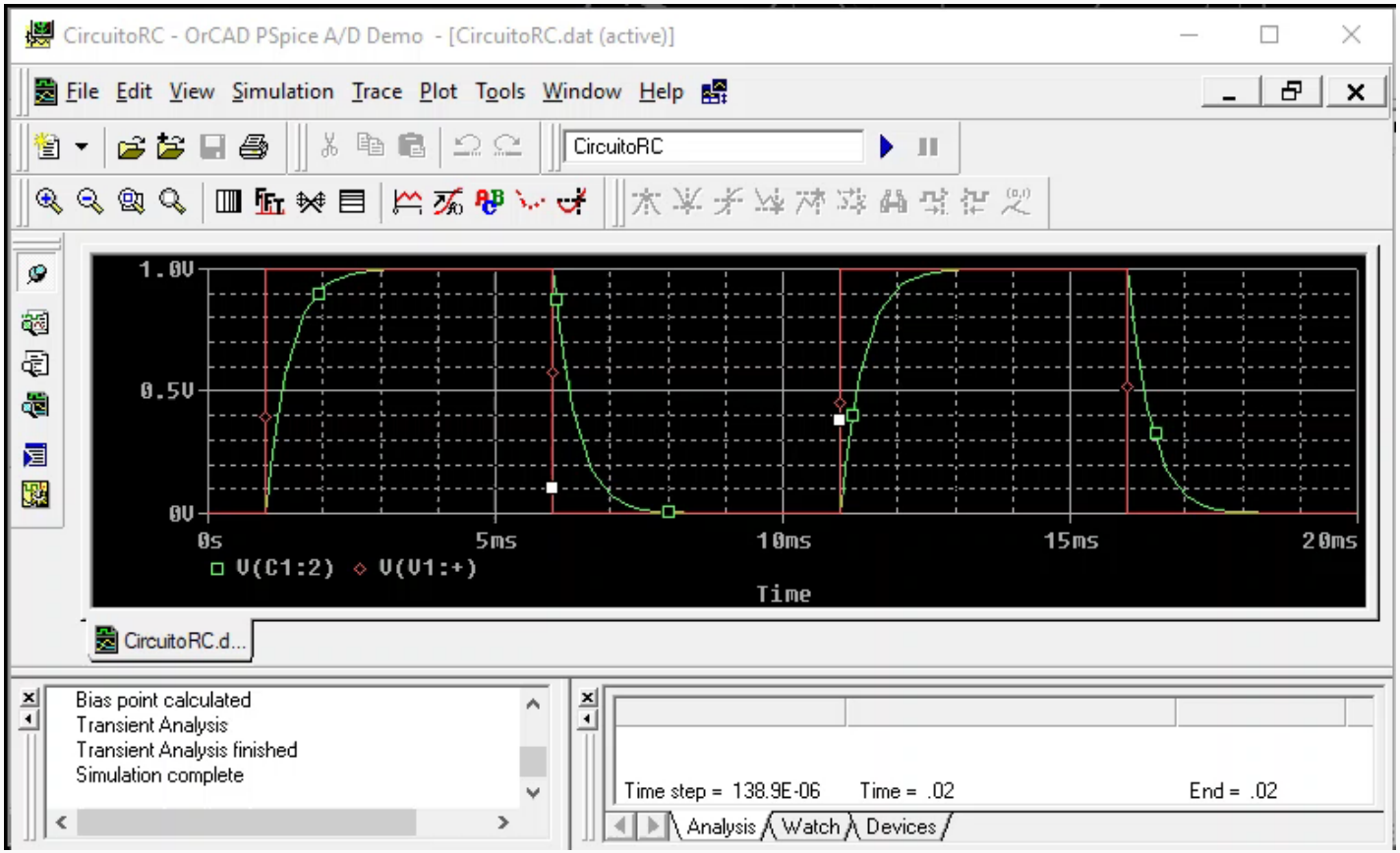


As a result, a window with response curves is loaded

Link

Circuit simulation

Pspice 9.1 student version – Enhancing response curves

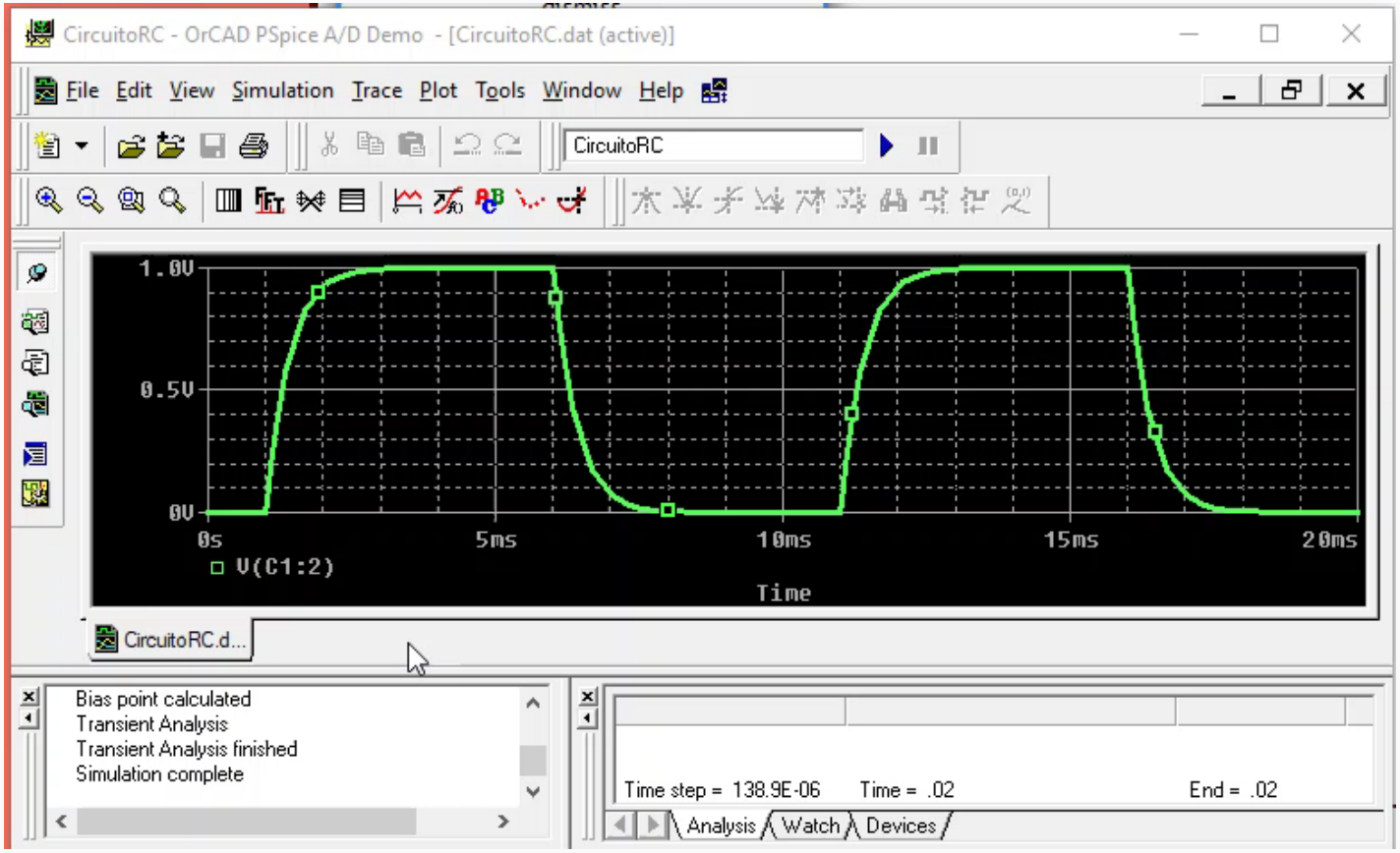


Before measuring capacitor voltage, source voltage curve (red) will be deleted

Link

Circuit simulation

Pspice 9.1 student version – Measuring voltage at $\tau = RC$



Use *Right click* and *Left click, separately,* to control the cursors

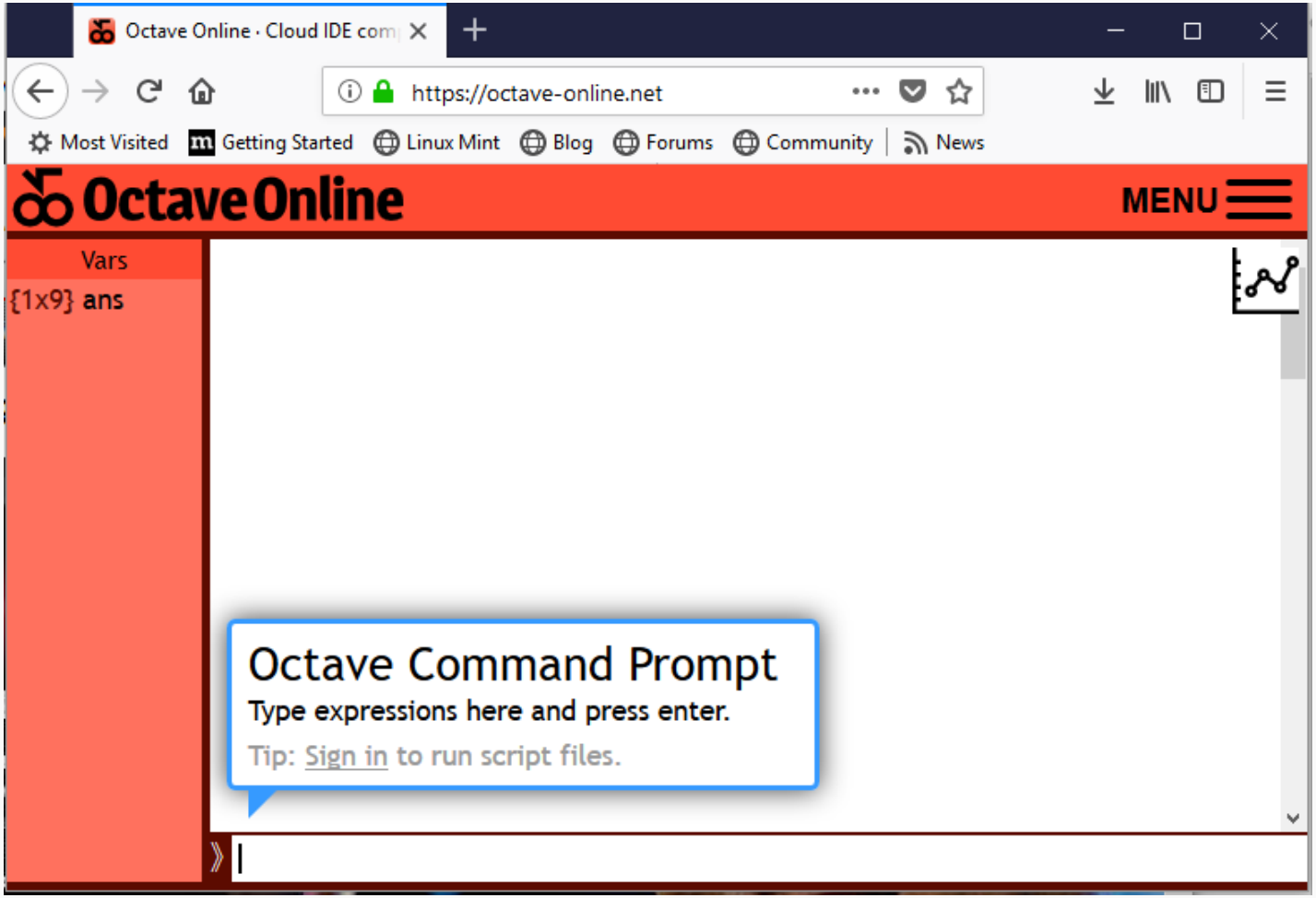
R=1k and C=400nF, then, RC=400us

Measured values:
Time: 403.727 us
Voltage: 594.257 mV

Link

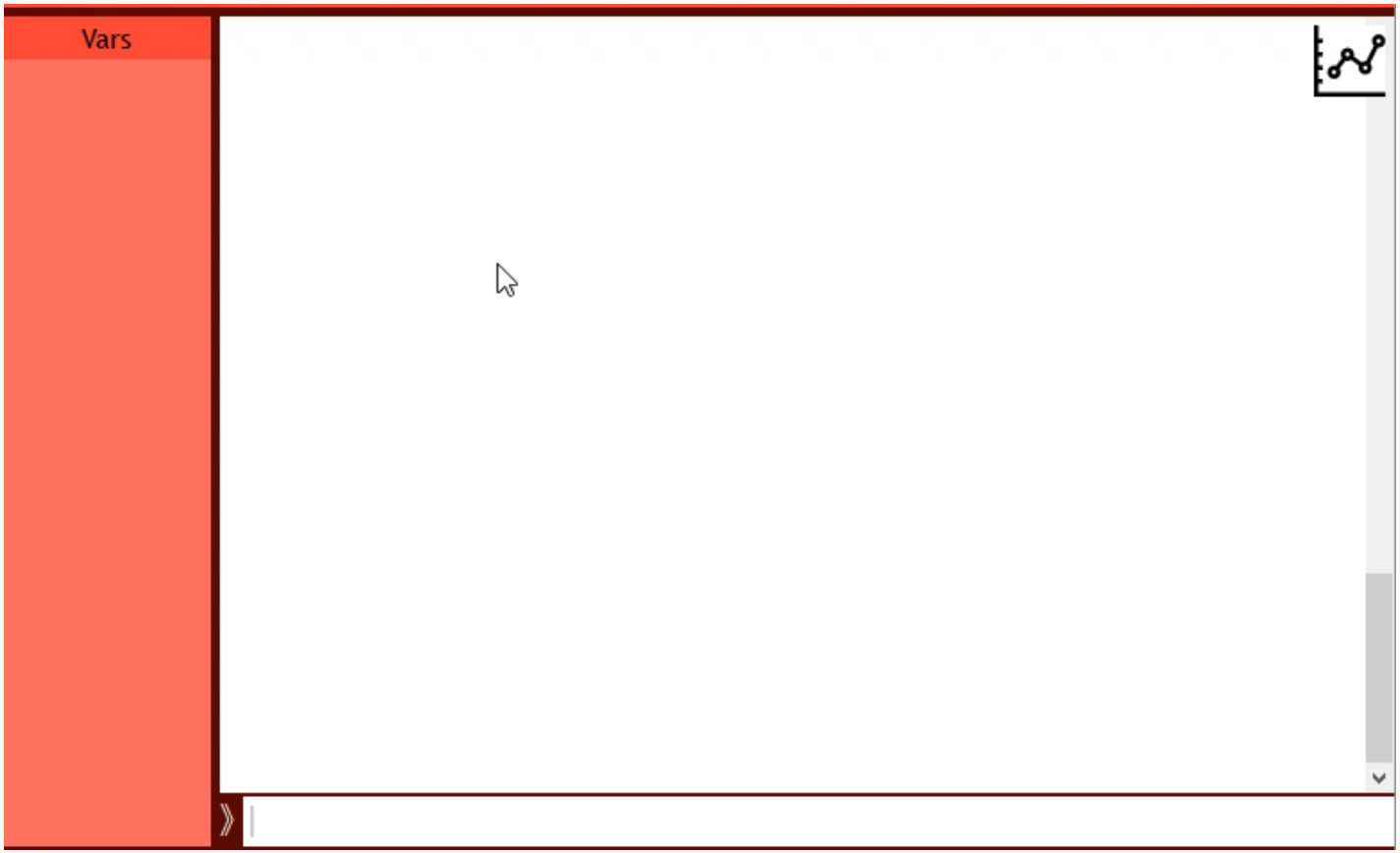
Transfer function

Transfer function



Transfer function

Octave online – Setting the transfer function



Transfer function:

$$\frac{V_o}{V_i} = \frac{1}{RCs + 1}$$

Link

Transfer function

Octave online – Plotting response to Step function

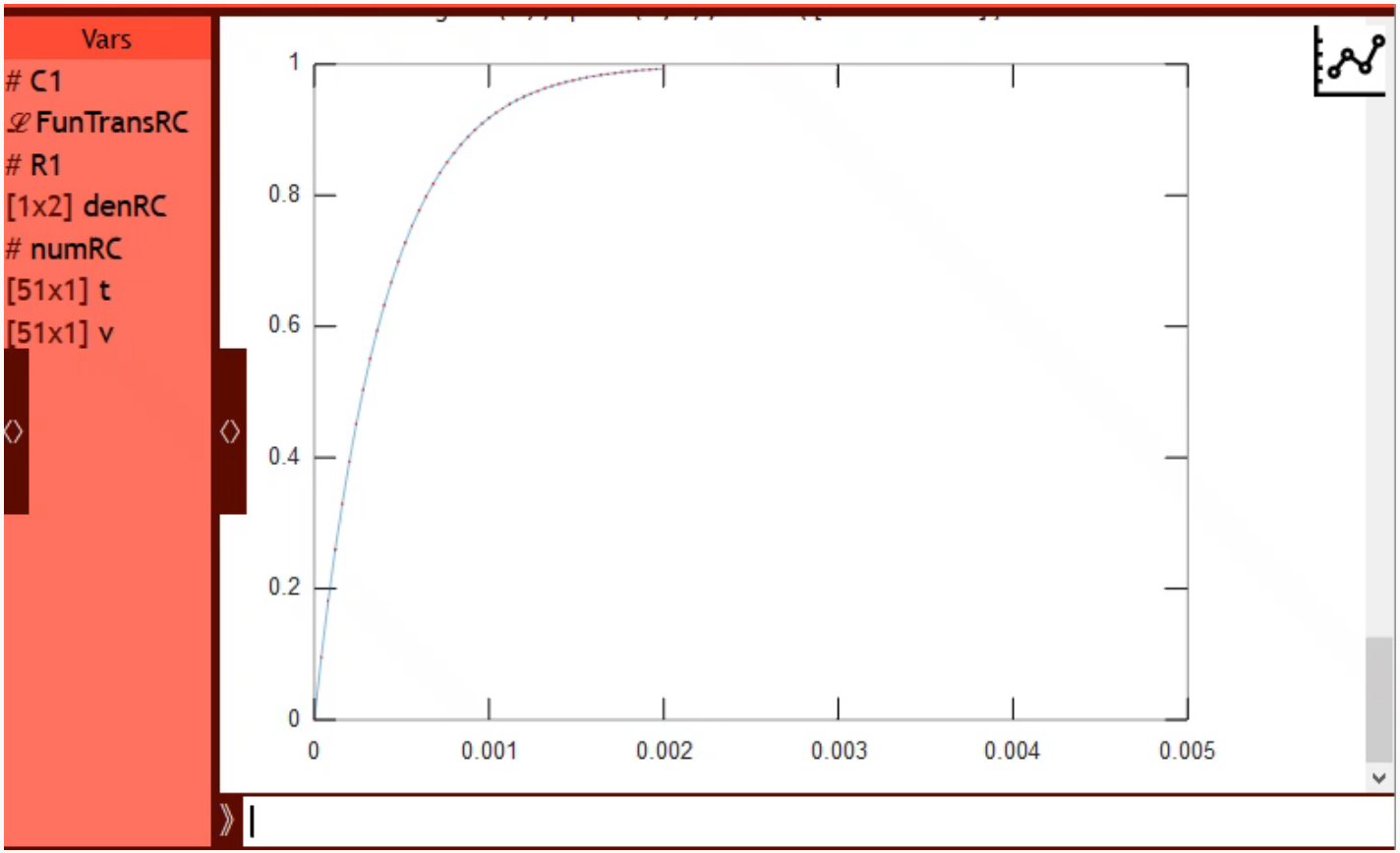
Step function:

$$u(t) = \begin{cases} 0, & t < 0 \\ 1, & t > 0 \end{cases}$$

Link

Transfer function

Octave online – Looking for the amplitude at $t = \tau$

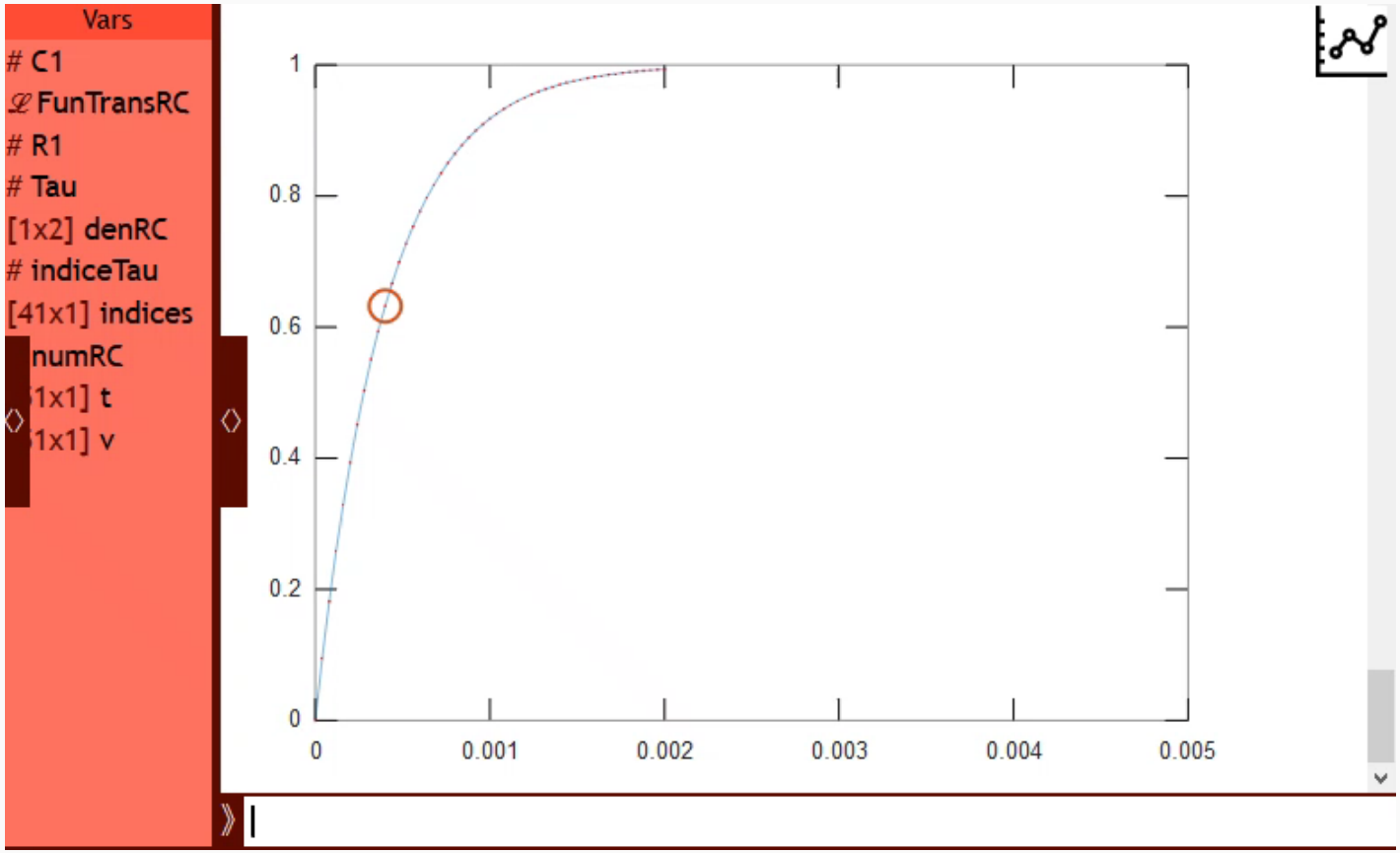


Time constant:
$\tau = RC$

Link

Transfer function

Octave online – Showing the values at τ e $v(\tau)$



The command DISP shows the value of a variable

Link

Transfer function

Octave online – Script

```
% Setting component values
R1 = 1e3;
C1=400e-9;

% Building the Transfer function
numRC = [1];
denRC=[R1*C1 1];
FunTransRC = tf(numRC, denRC);

% Plotting the step response
[v,t] = step(FunTransRC);
figure(1), plot(t,v), axis([0 5e-3 0 1])

% Looking for the voltage at Tau=R
Tau = R1*C1;
indices = find(t>=Tau);
indiceTau = indices(1);
figure(1), hold on
figure(1), plot(t(indiceTau), v(indiceTau), 'o')

% Showing Tau and Amplitude at Tau values
disp(['Tau:' num2str(t(indiceTau))]);
disp(['Voltage at Tau:' num2str(v(indiceTau))]);
```

You can copy (Ctrl + C) the script text and paste it (Ctrl + V) into command line of Octave online. It can be ran by using Enter.

Links

- Pspice: download and tutorials (link)
- Matlab for engineering in Portuguese (link)