

# **ENG1027: Instrumentação Eletrônica**



## 3.2) Projeto e Simulação de Circuitos

- ⌘ A imensa maioria dos tipos de software de simulação de circuitos é baseada no **SPICE** original
  - ☒ Desenvolvido em **1975** em Berkeley
  - ☒ Inicialmente codificado em **FORTRAN**, e posteriormente em **C** (em 1983)
  - ☒ Acrônimo de **Simulated Program with Integrated Circuits Emphasis** (Programa de Simulação com Ênfase em Circuitos Integrados)
  - ☒ Poderosa ferramenta usada para **testar e antever o** comportamento de circuitos contendo circuitos integrados, resistores, transistores, capacitores, diodos e outros componentes elétricos e eletrônicos
  - ☒ **Dezenas de versões comerciais**

## 3.2) Projeto e Simulação de Circuitos

### ⌘ Exemplos de SPICEs comerciais:

☒ PSpice/OrCAD

☒ SPICE OPUS

☒ HSpice

☒ HSiM

☒ MicroCad

☒ Dr. Spice

☒ T-Spice

☒ Intusoft

☒ Spice-It!

☒ SIMetrix

☒ TopSPICE

☒ NG-spice

☒ MultiSIM

☒ SmartSpice

☒ TINA

☒ Spectre

☒ Eldo

☒ UltraSim

☒ MacSpice

☒ NanoSim

☒ NSPICE

☒ B2SPICE

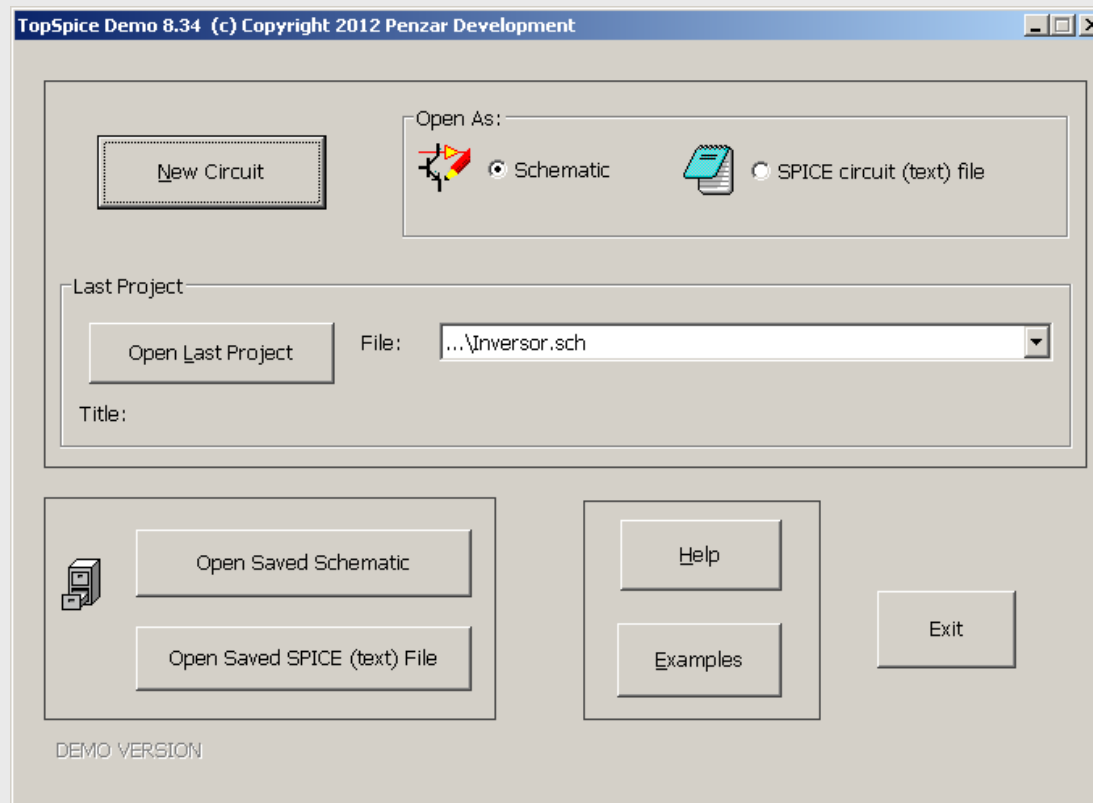
☒ ICAP/4

☒ TINA-TI

☒ Proteus ISIS

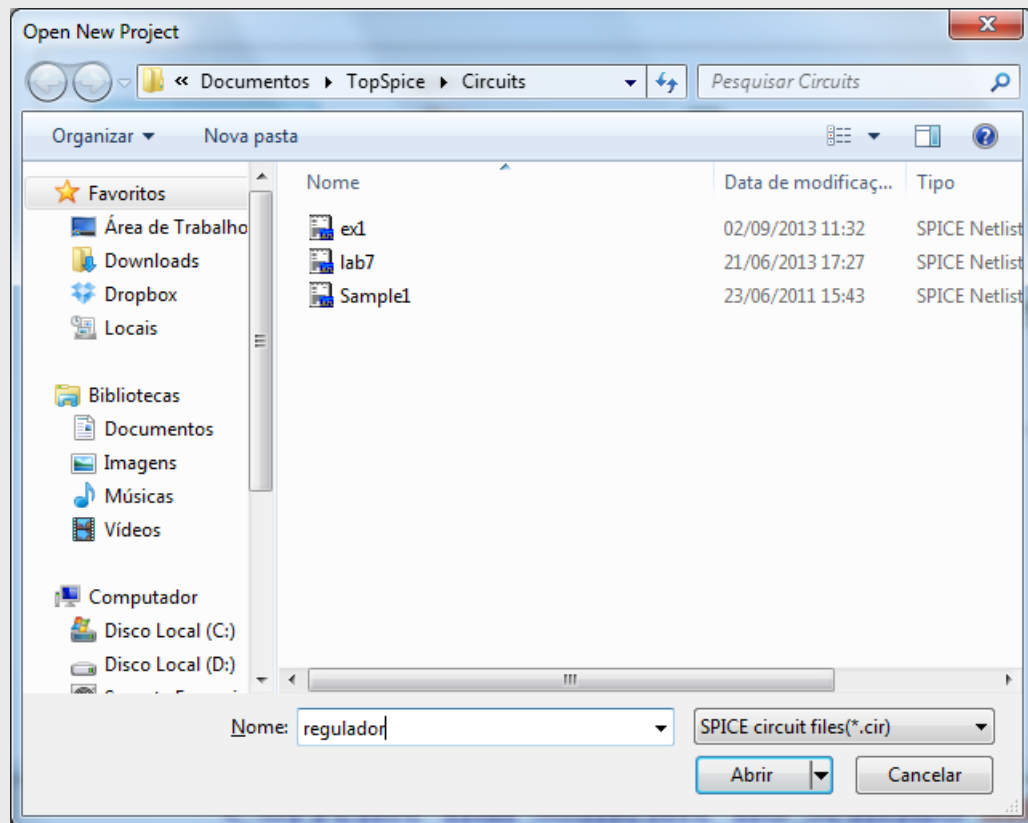
# 3.2) Projeto e Simulação de Circuitos

⌘ Nesta disciplina: TopSPICE 8 (Demo)



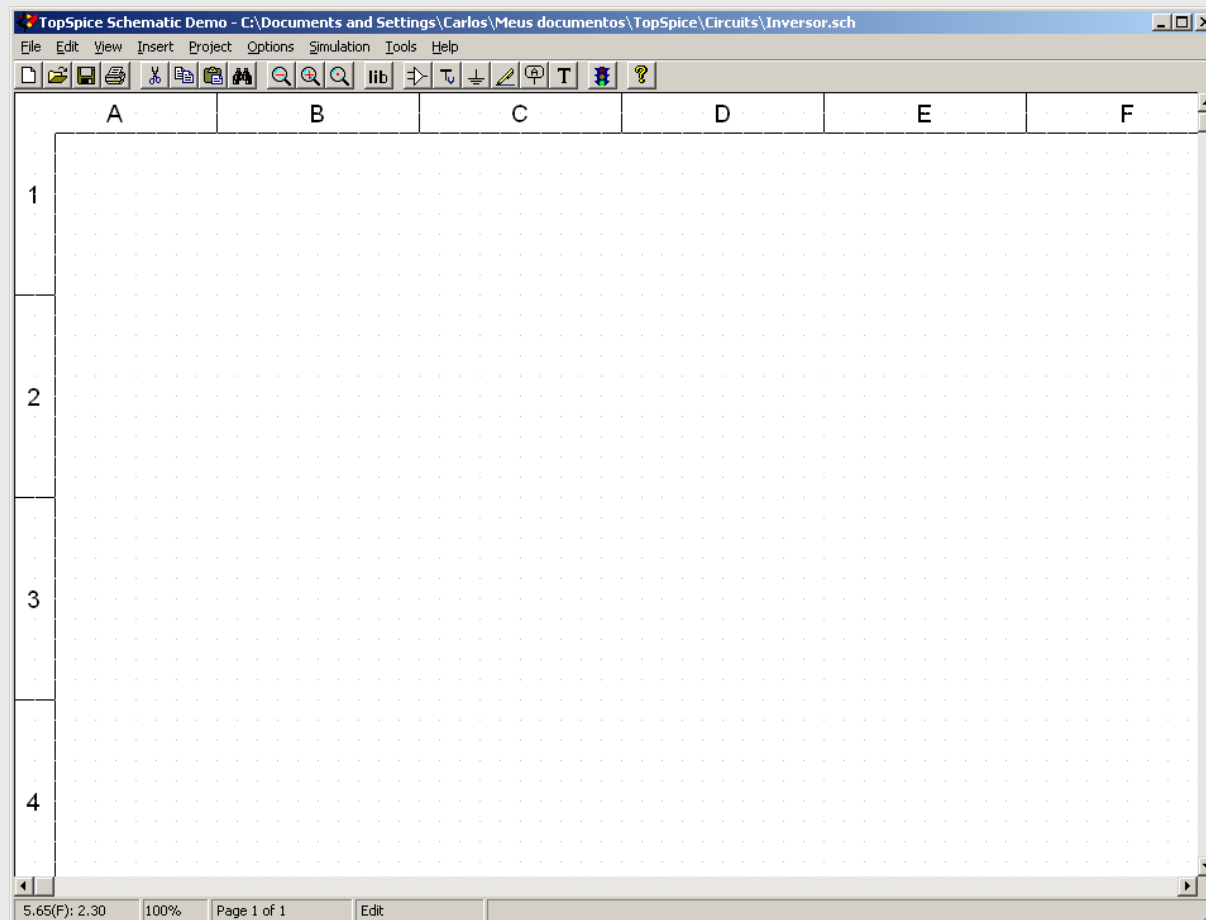
## 3.2) TopSPICE

### ⌘ Criando novo projeto



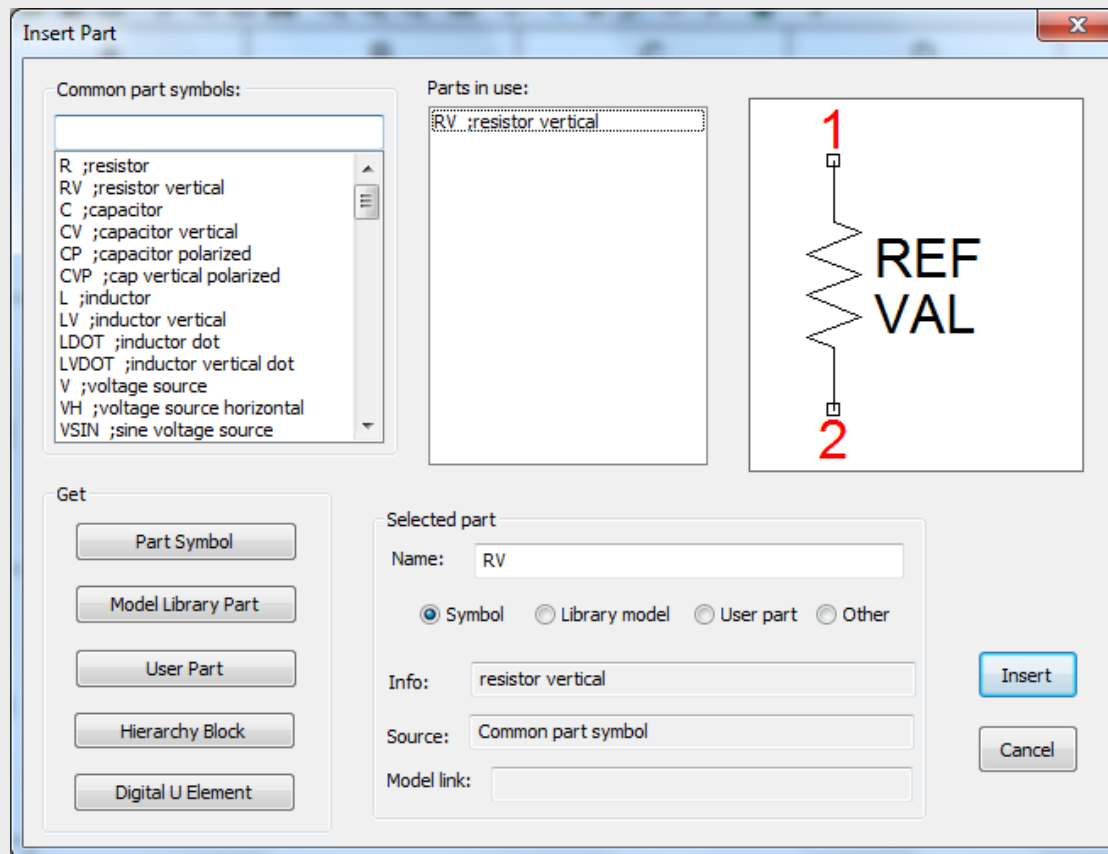
# 3.2) TopSPICE

## ⌘ Editor de Esquemático



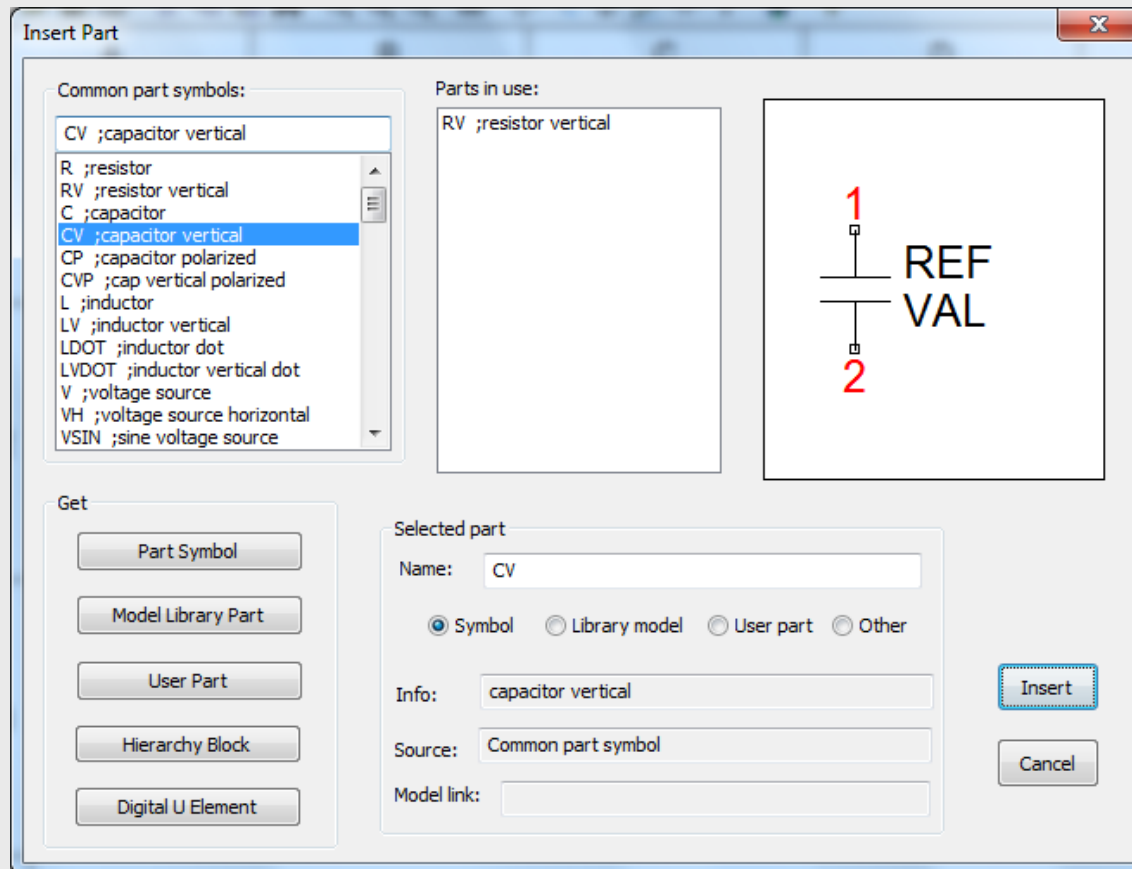
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): Resistor vertical



## 3.2) TopSPICE

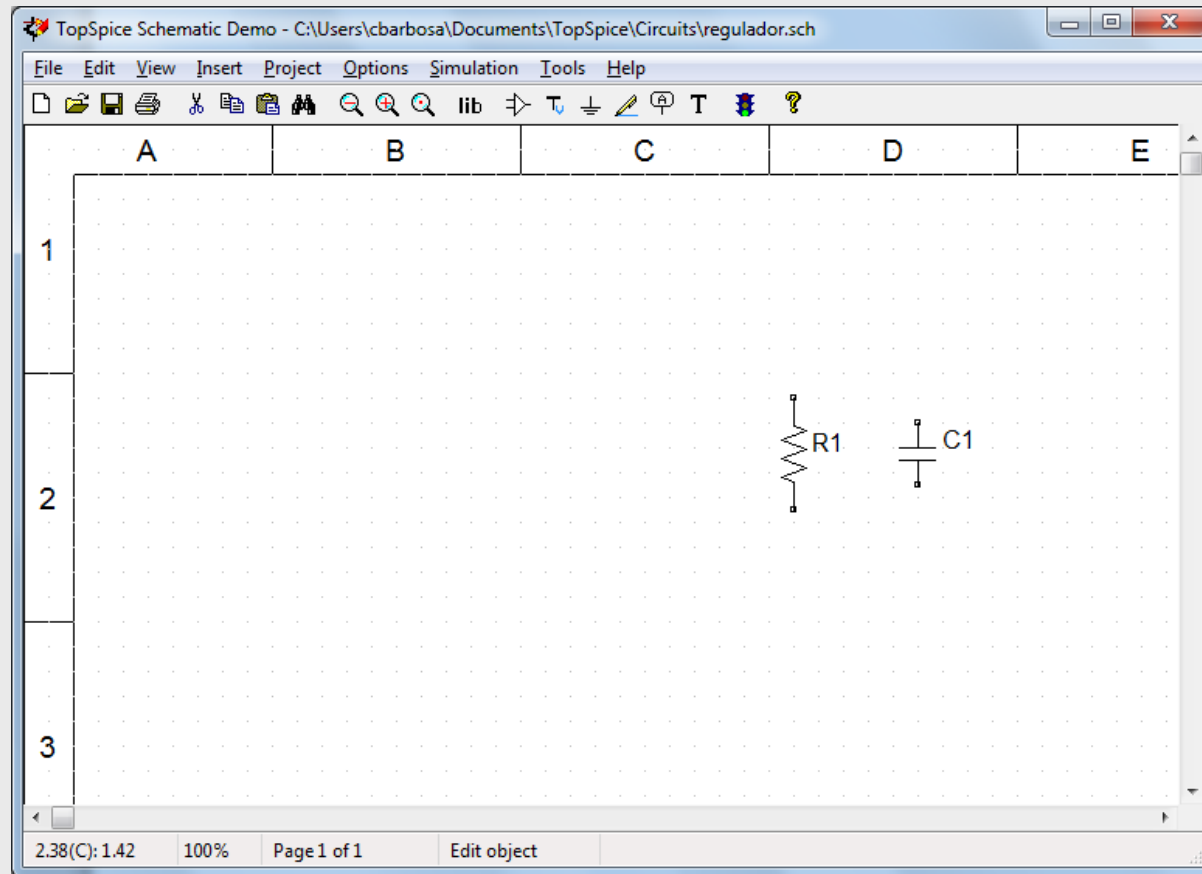
⌘ Inserir componente (Insert -> Part): Capacitor vertical





# 3.2) TopSPICE

## ⌘ Circuito Parcial:



# 3.2) TopSPICE

## ⌘ Parâmetros dos componentes:

Part Attributes - [RV]

Reference: R1 Value/name: 10k

Parameters Show

Line 1:

Line 2:

Line 3:

Netlist Options

SPICE

Device: R Template:

Layout

Template:

Model/Hierarchy File Link

Open

.LIB  .INC  MDB  Hierarchy (.HSC)

OK Cancel

Part Attributes - [CV]

Reference: C1 Value/name: 2200u

Parameters Show

Line 1:

Line 2:

Line 3:

Netlist Options

SPICE

Device: C Template:

Layout

Template:

Model/Hierarchy File Link

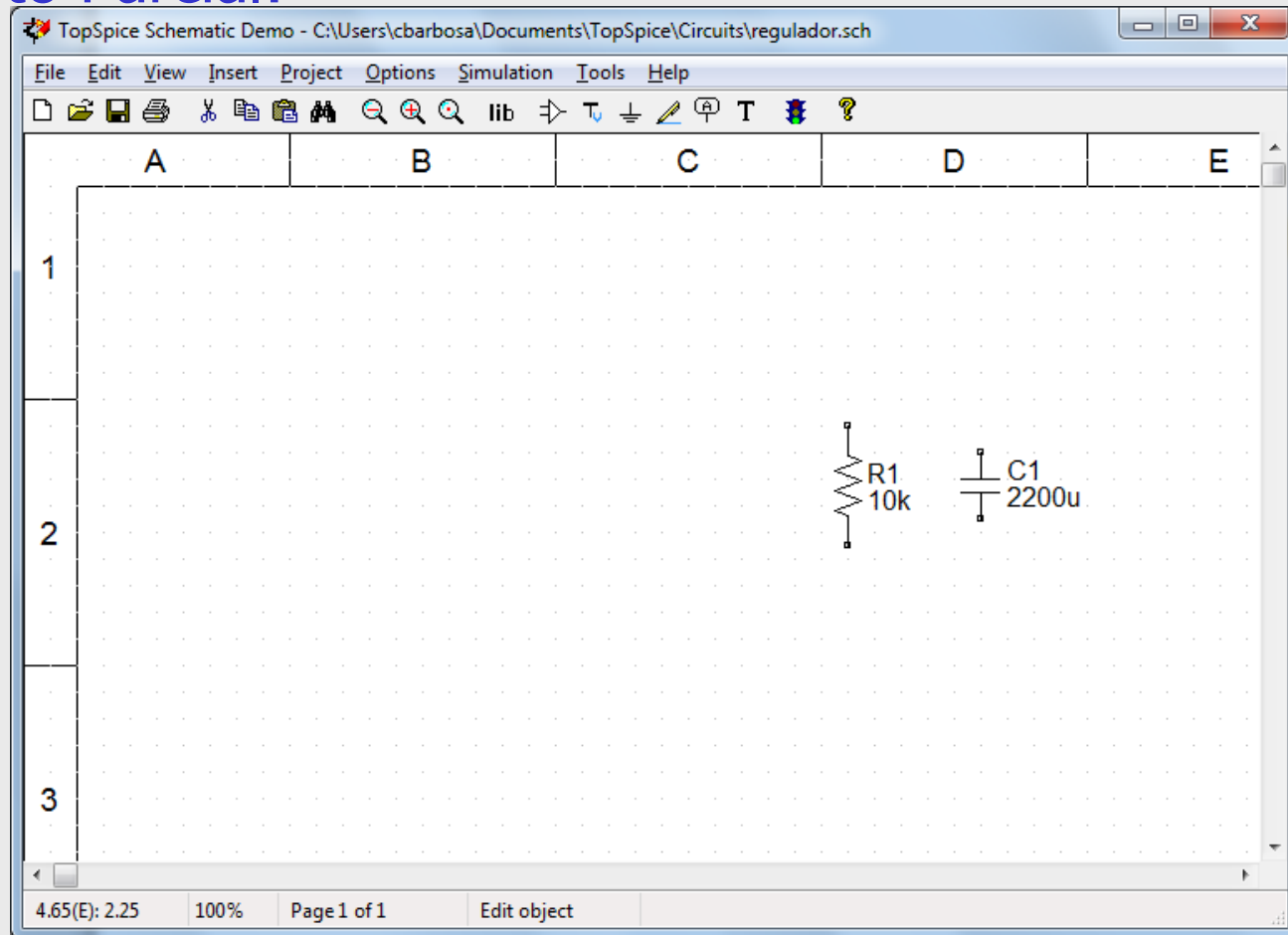
Open

.LIB  .INC  MDB  Hierarchy (.HSC)

OK Cancel

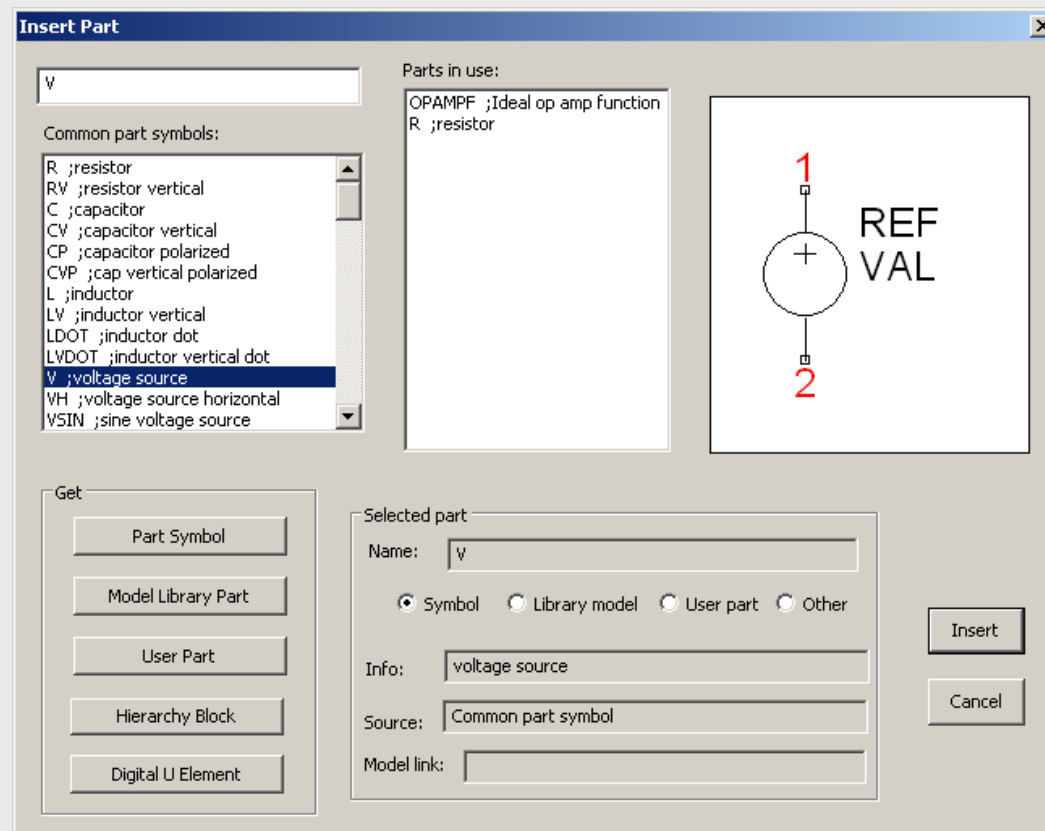
# 3.2) TopSPICE

## ⌘ Circuito Parcial:



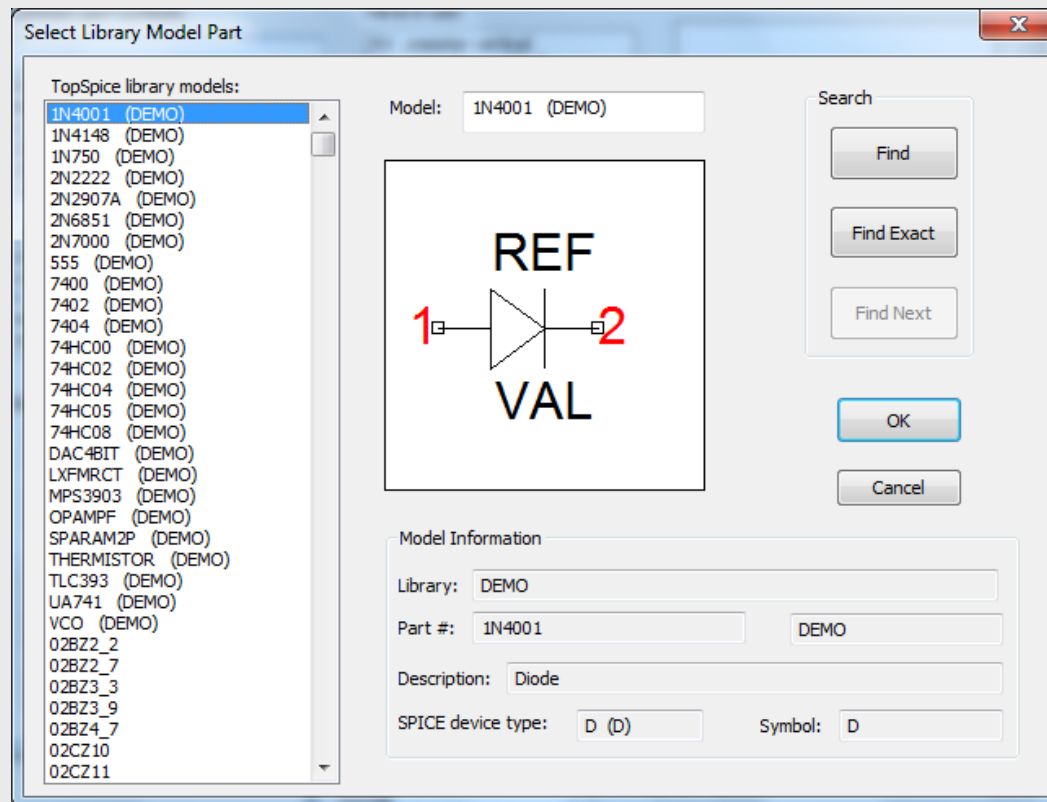
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): **Fonte de Tensão**



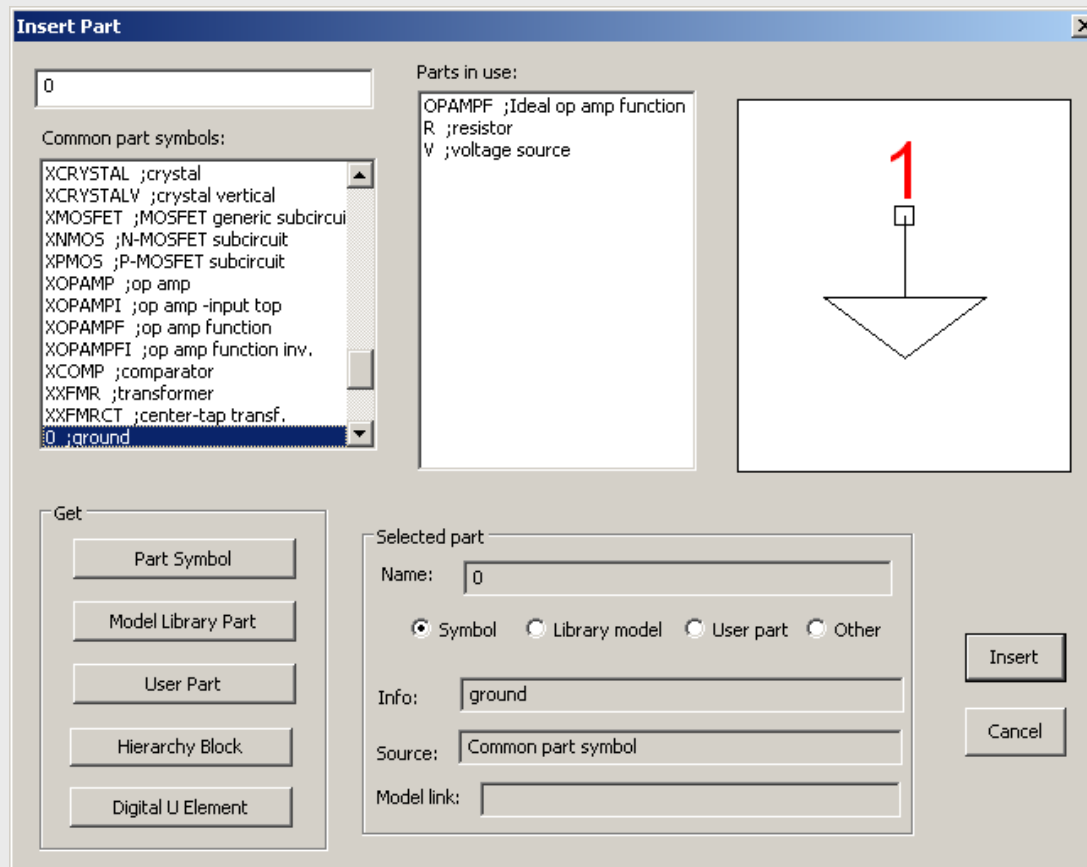
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): **Diodo**



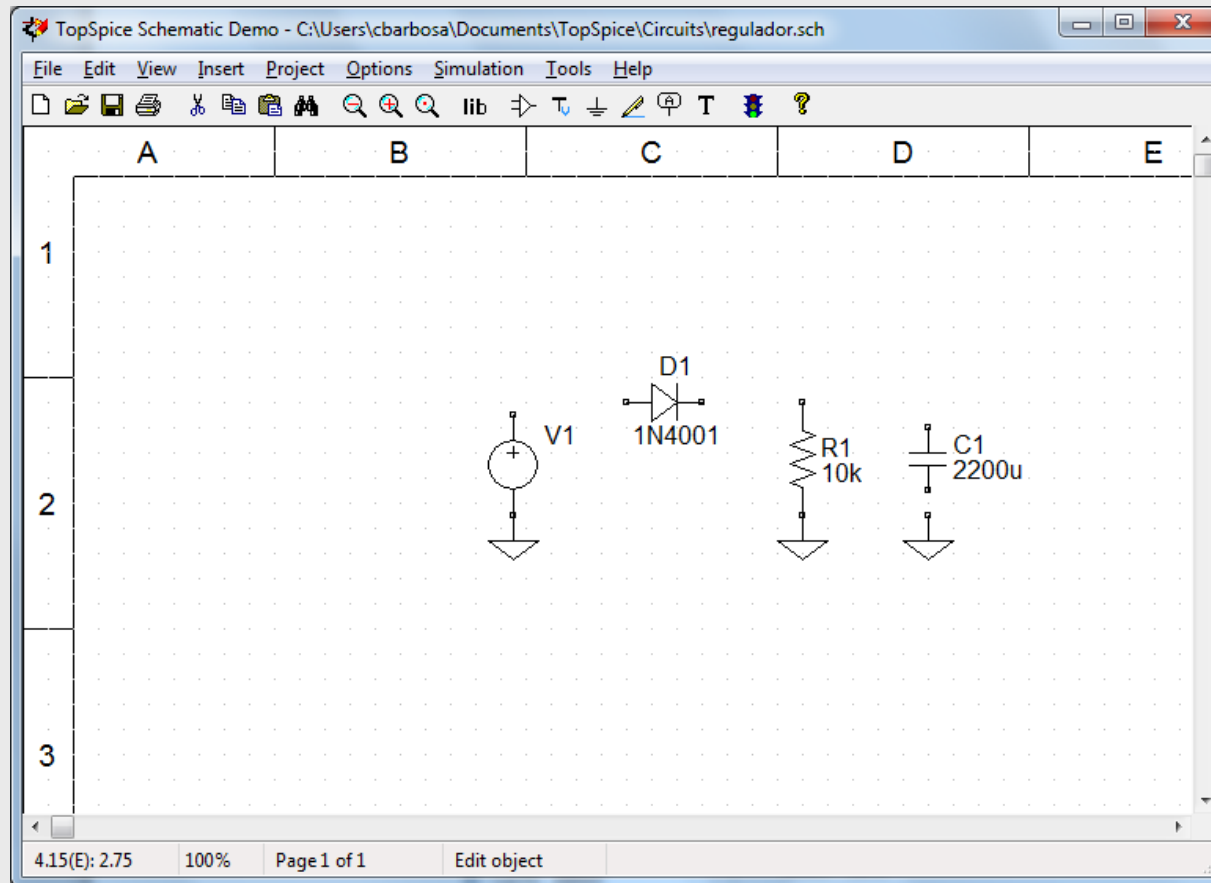
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): **Terras**



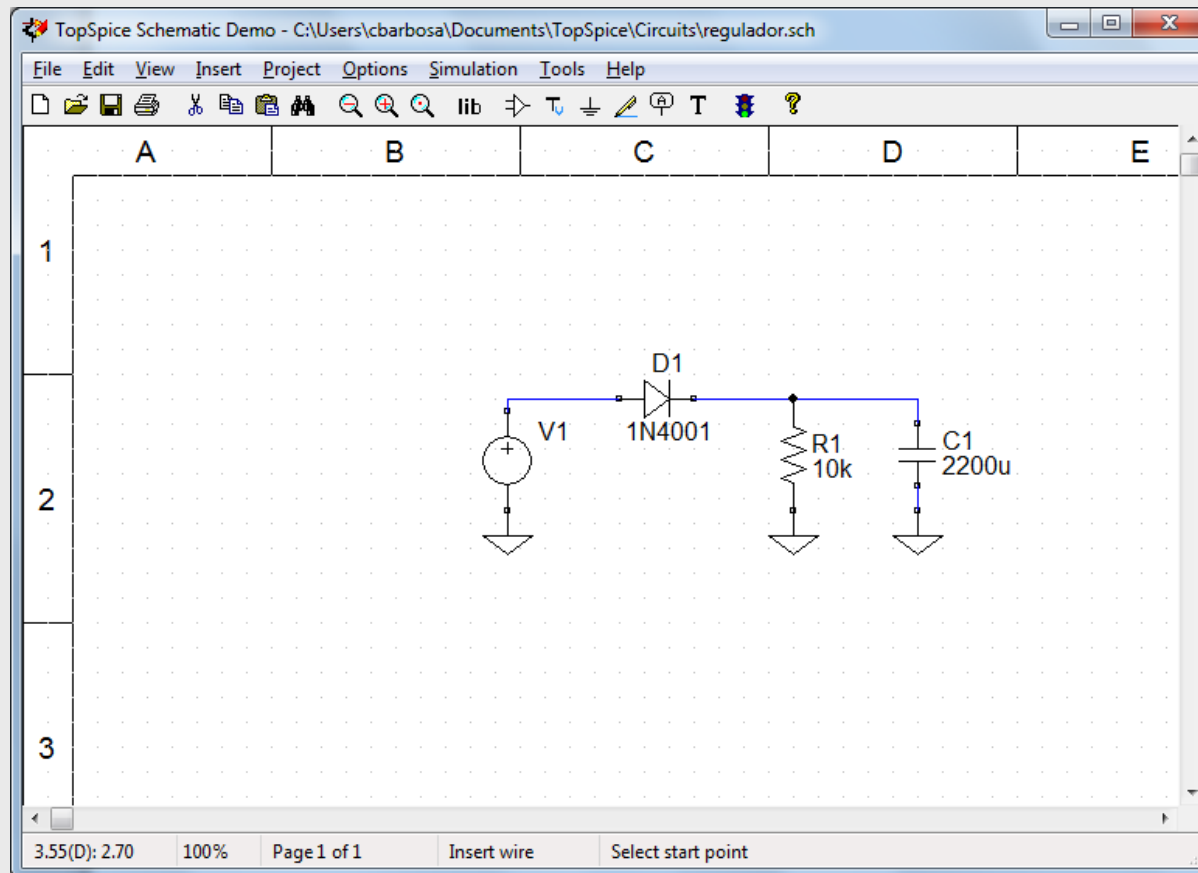
# 3.2) TopSPICE

## ⌘ Circuito Parcial:



## 3.2) TopSPICE

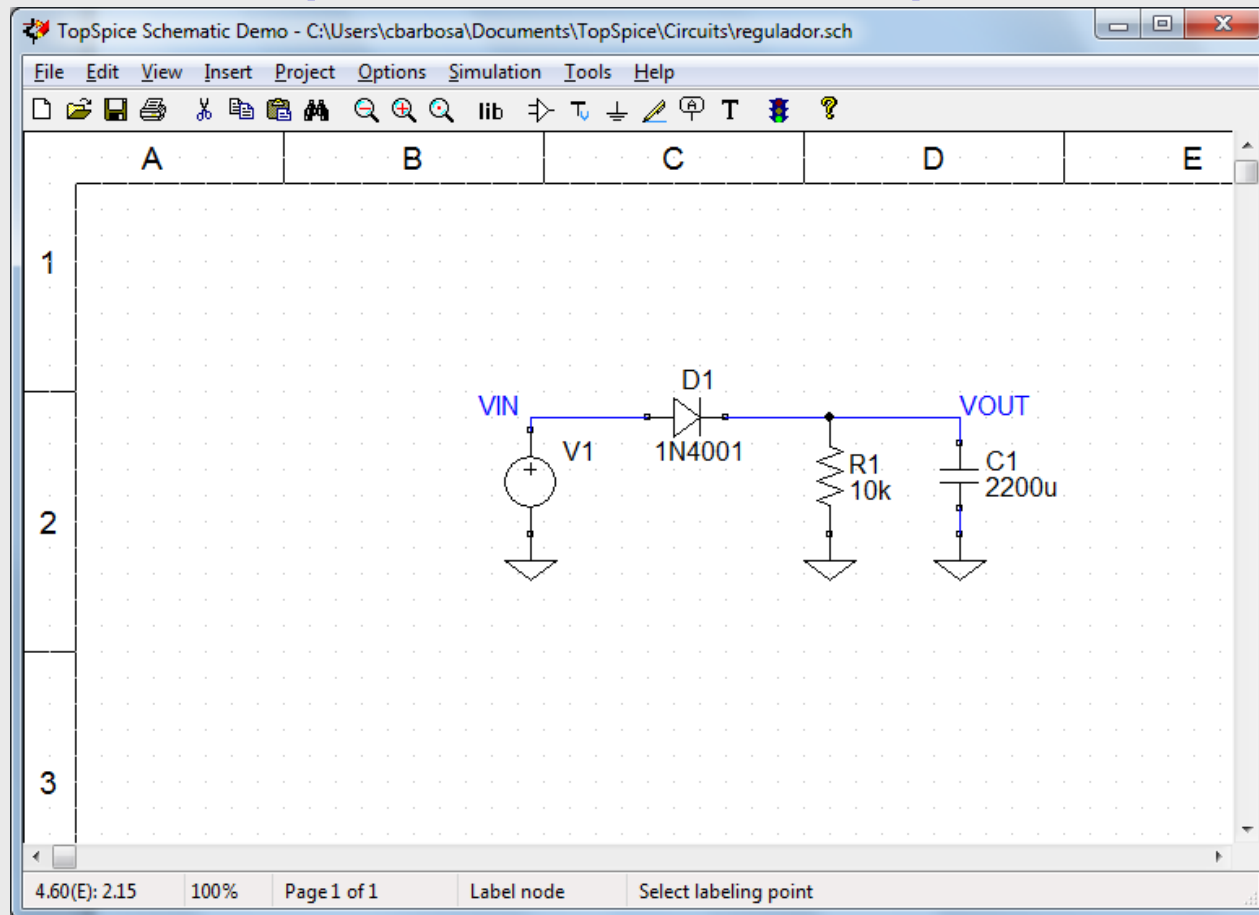
⌘ Inserir fiação (Insert -> Wire):





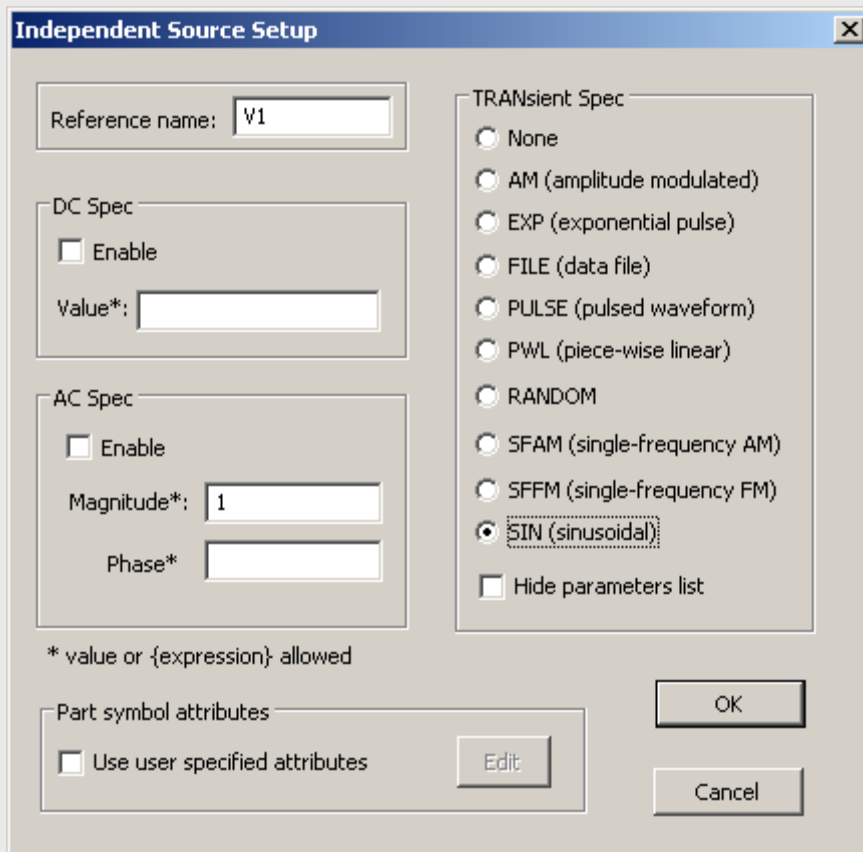
# 3.2) TopSPICE

⌘ Definir Rótulos (Insert -> Label Node):



# 3.2) TopSPICE

## ⌘ Definir Fonte de Tensão



**Independent Source Setup**

Reference name:

DC Spec  
 Enable  
Value\*:

AC Spec  
 Enable  
Magnitude\*:   
Phase\*:

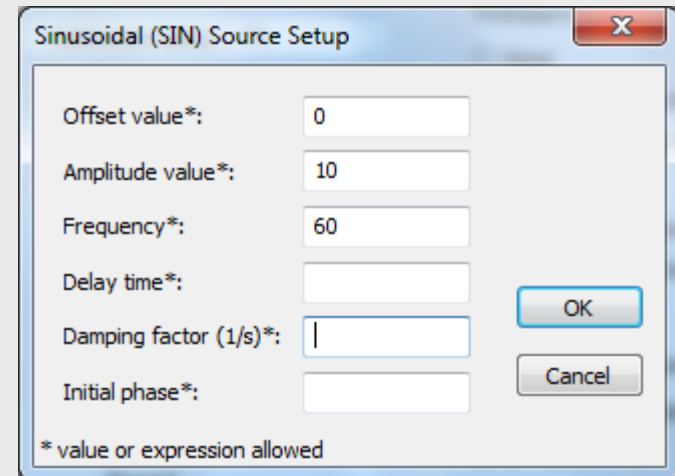
TRANSient Spec

- None
- AM (amplitude modulated)
- EXP (exponential pulse)
- FILE (data file)
- PULSE (pulsed waveform)
- PWL (piece-wise linear)
- RANDOM
- SFAM (single-frequency AM)
- SFFM (single-frequency FM)
- SIN (sinusoidal)

Hide parameters list

\* value or {expression} allowed

Part symbol attributes  
 Use user specified attributes



**Sinusoidal (SIN) Source Setup**

Offset value\*:

Amplitude value\*:

Frequency\*:

Delay time\*:

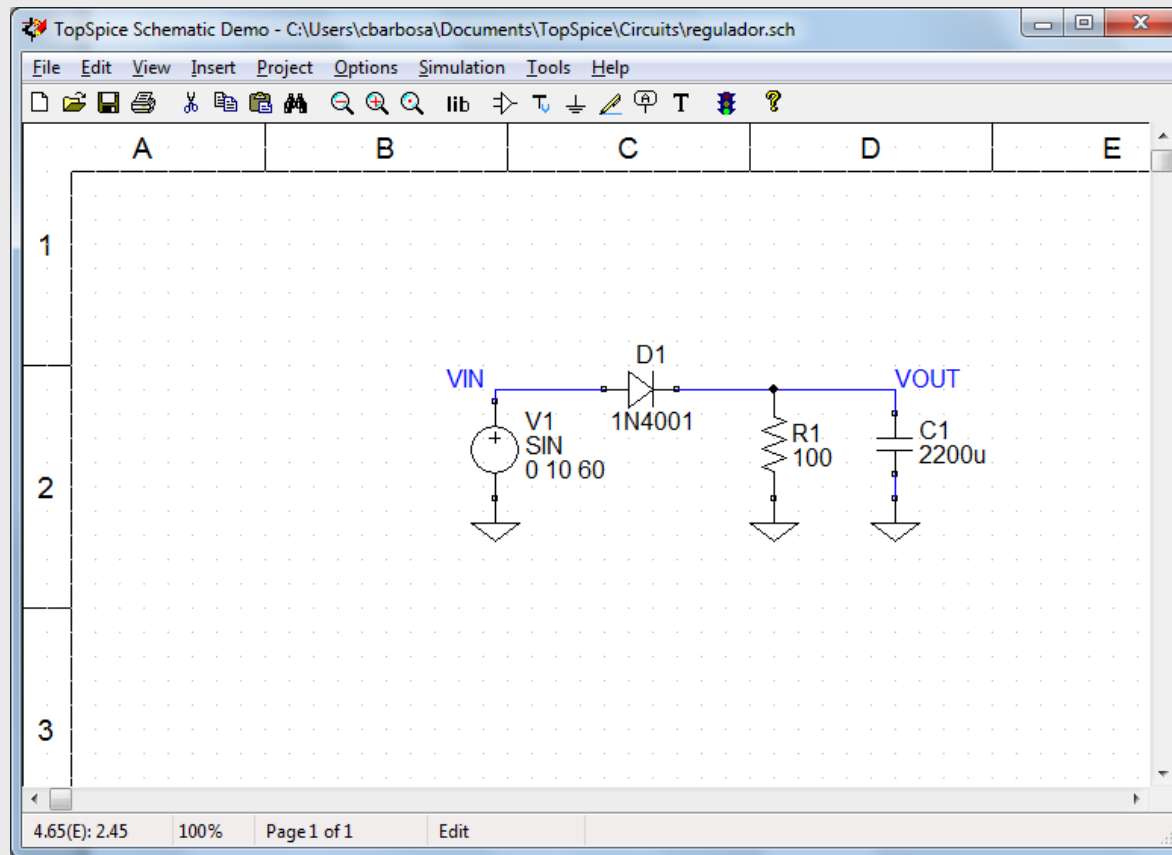
Damping factor (1/s)\*:

Initial phase\*:

\* value or expression allowed

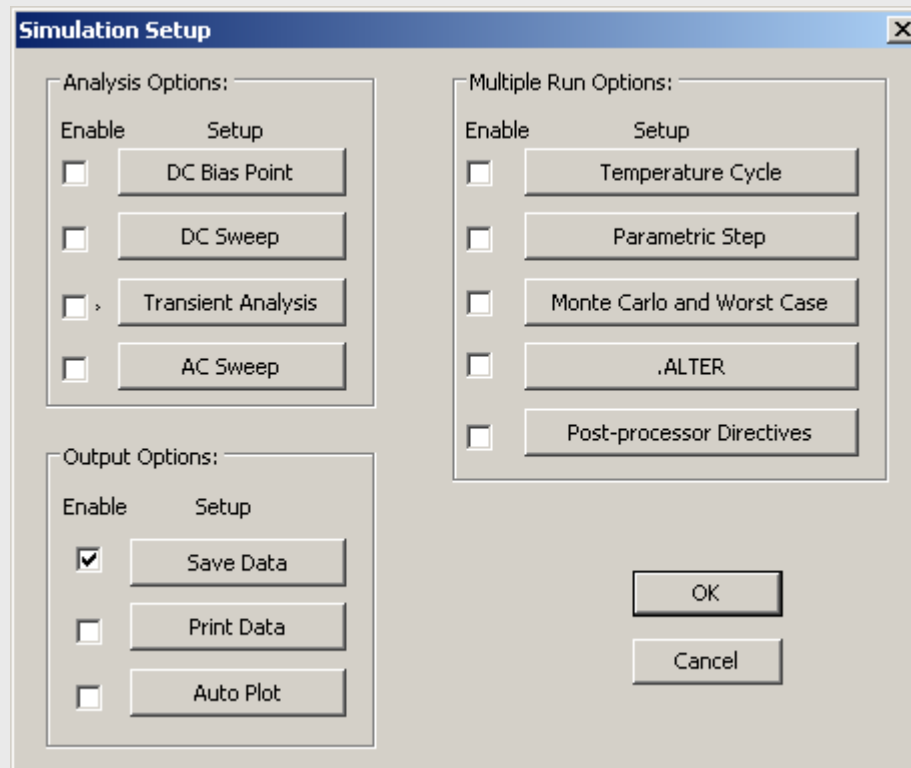
# 3.2) TopSPICE

## ⌘ Circuito Parcial:



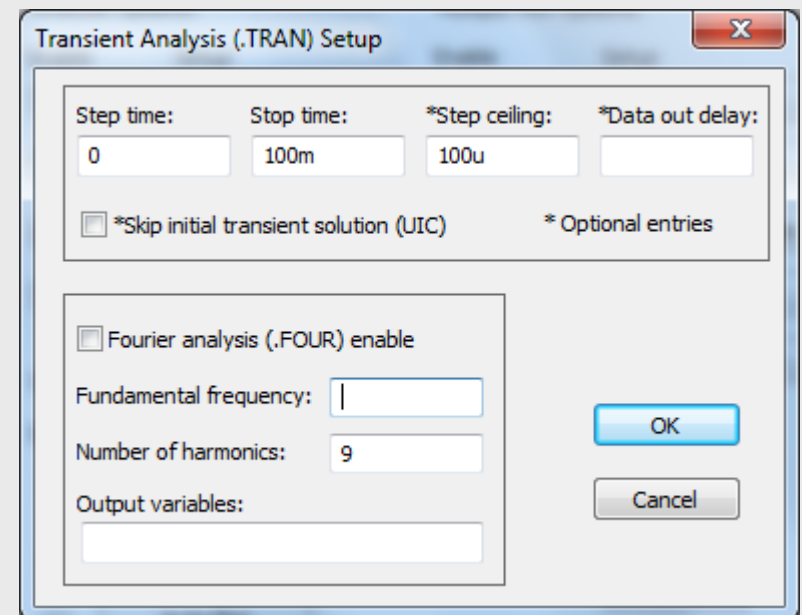
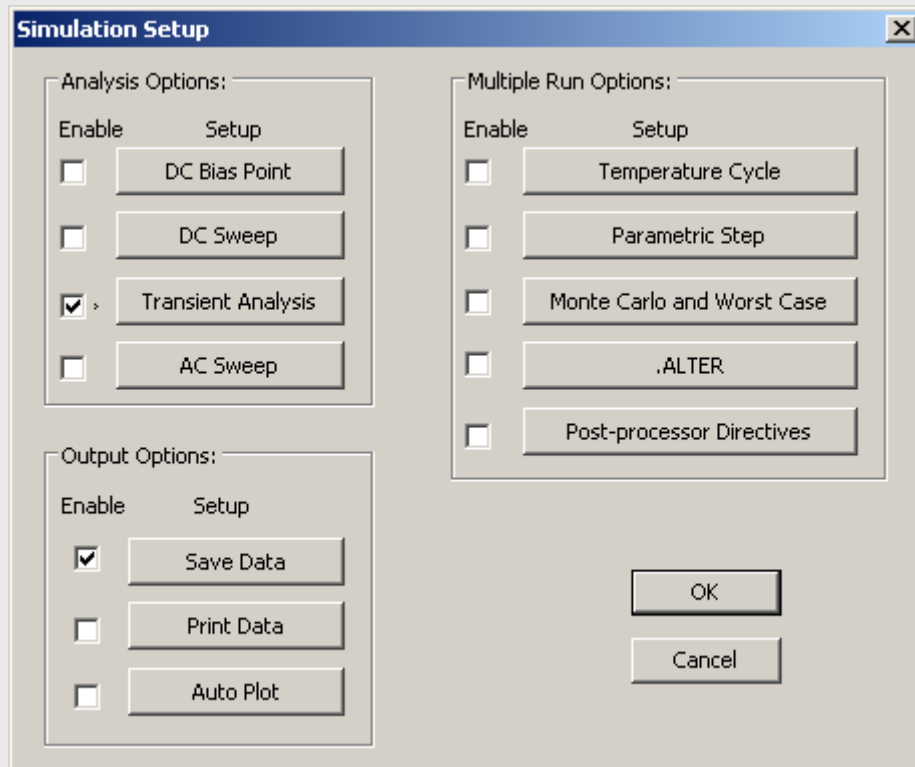
## 3.2) TopSPICE

⌘ Configurar **Simulação** (Simulation -> Setup):



# 3.2) TopSPICE

## ⌘ Analyse de Transiente:



# 3.2) TopSPICE

## ⌘ Opções de Saída:

**Simulation Setup**

Analysis Options:

Enable	Setup
<input type="checkbox"/>	DC Bias Point
<input type="checkbox"/>	DC Sweep
<input checked="" type="checkbox"/>	Transient Analysis
<input type="checkbox"/>	AC Sweep

Output Options:

Enable	Setup
<input checked="" type="checkbox"/>	Save Data
<input type="checkbox"/>	Print Data
<input checked="" type="checkbox"/>	Auto Plot

Multiple Run Options:

Enable	Setup
<input type="checkbox"/>	Temperature Cy
<input type="checkbox"/>	Parametric Ste
<input type="checkbox"/>	Monte Carlo and Wo
<input type="checkbox"/>	.ALTER
<input type="checkbox"/>	Post-processor Dire

OK Cancel

**Autoplot Graph Setup**

Enable autoplot graph setup #1

Options:

Type

- Auto
- FFT
- Histogram
- Smith chart

Analysis: Any

Axis scale: Auto

X variable:

Plots:

Add Plot Edit Delete

X axis (optional)

Scaling

Auto Min: Max: Tick:

Label:

New Previous Next Delete

OK Cancel

# 3.2) TopSPICE

## ⌘ Definição do Gráfico:

**Plot Traces and Options Setup** [X]

Enable plot    Description (optional):

Plot traces

Enter variables/expressions (one or more per line):

V(VIN) V(VOUT)

Options:

Plot number:  ▼

Y axis

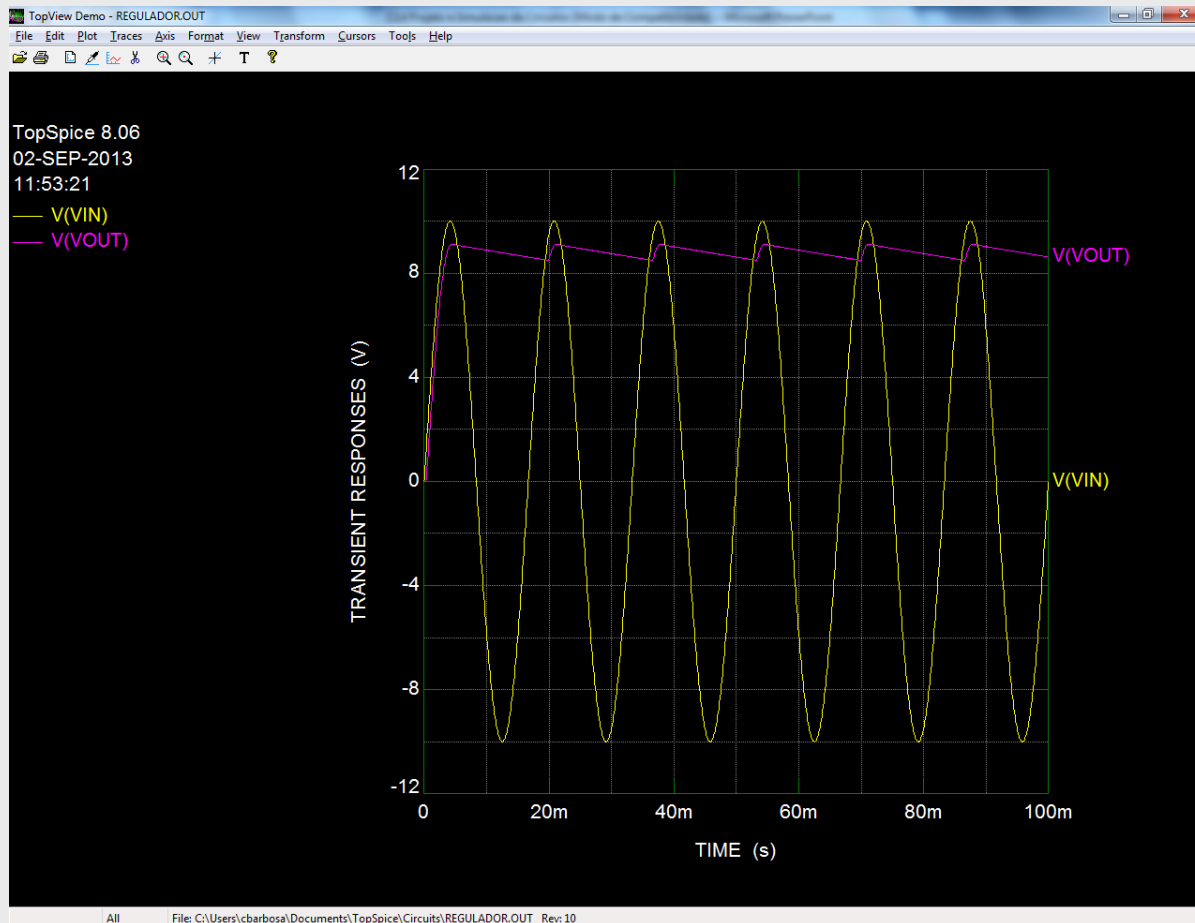
Log     Auto    Min:     Max:     Tick:

Label:

OK    Cancel

# 3.2) TopSPICE

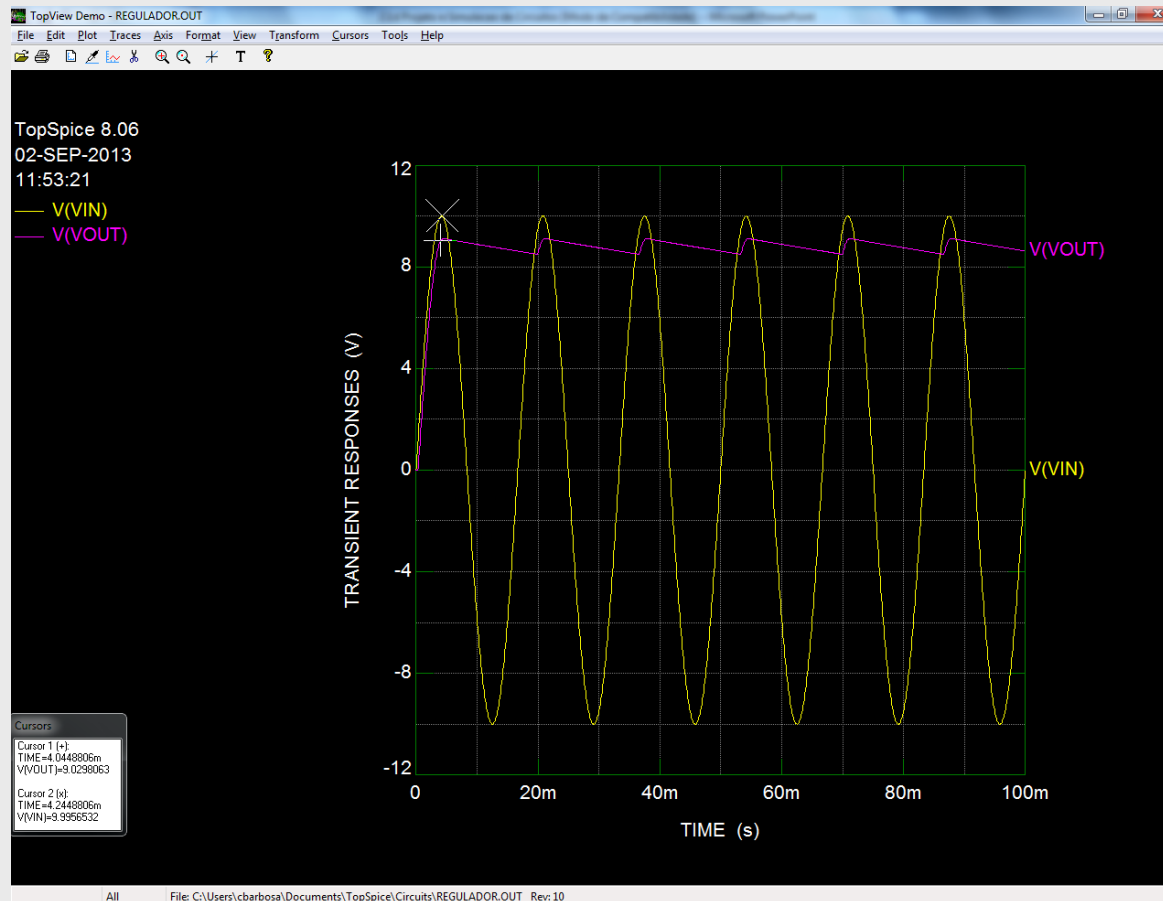
## ⌘ Executar Simulação (F9)





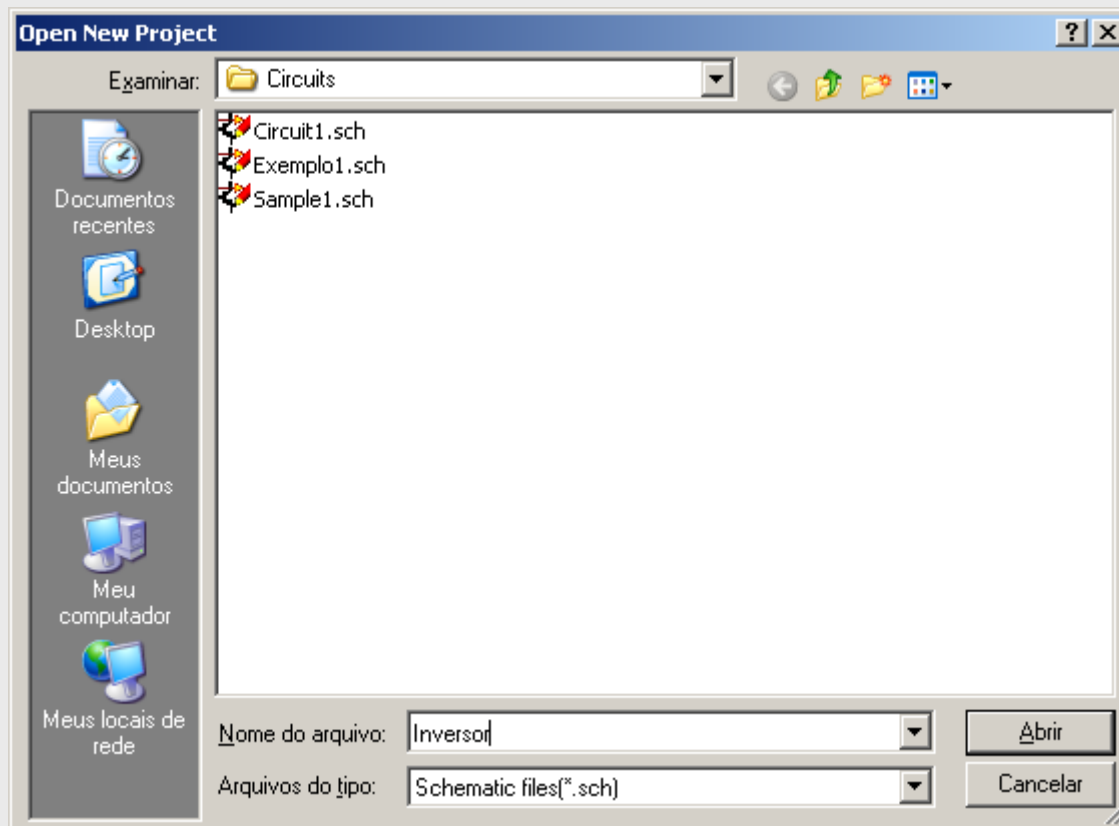
# 3.2) TopSPICE

## Utilizando Cursores



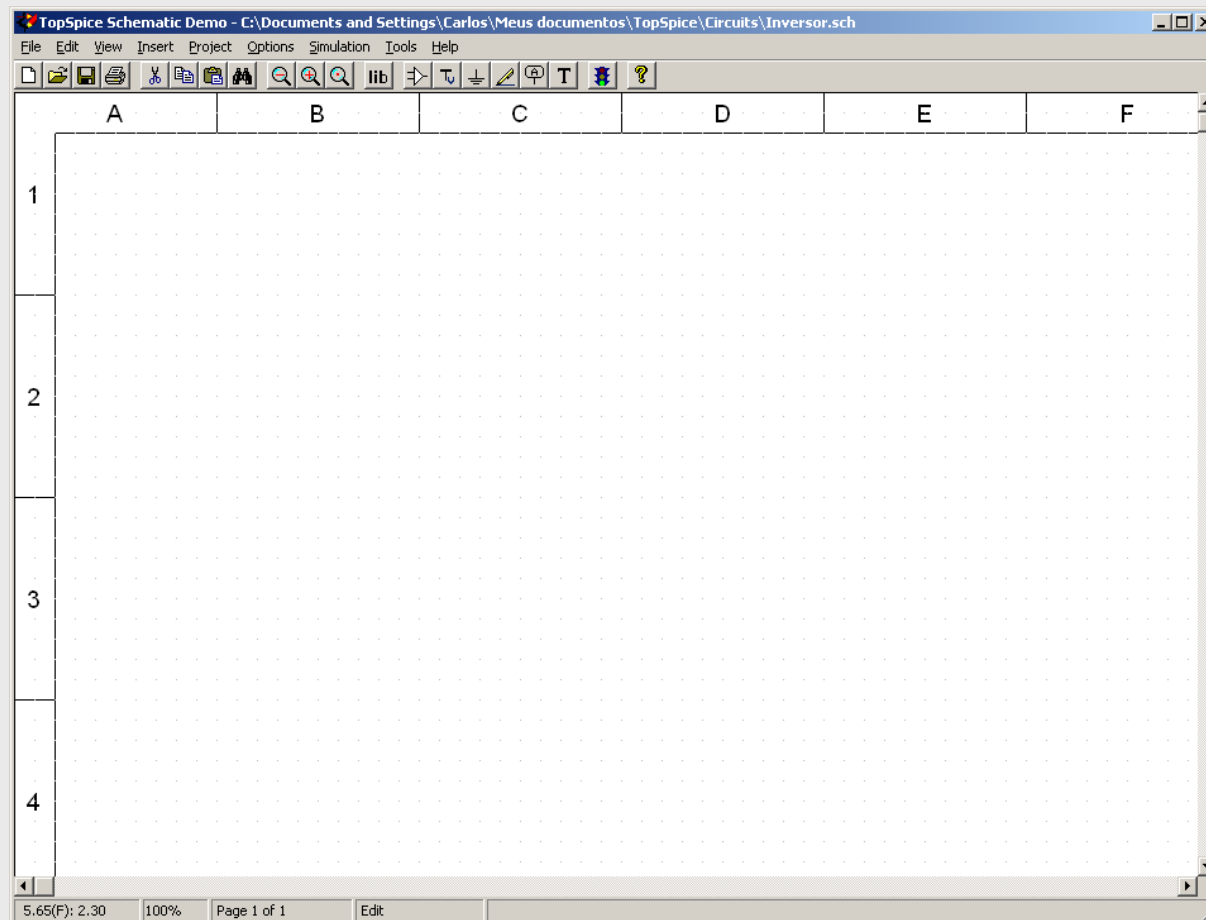
## 3.2) TopSPICE

### ⌘ Criando novo projeto



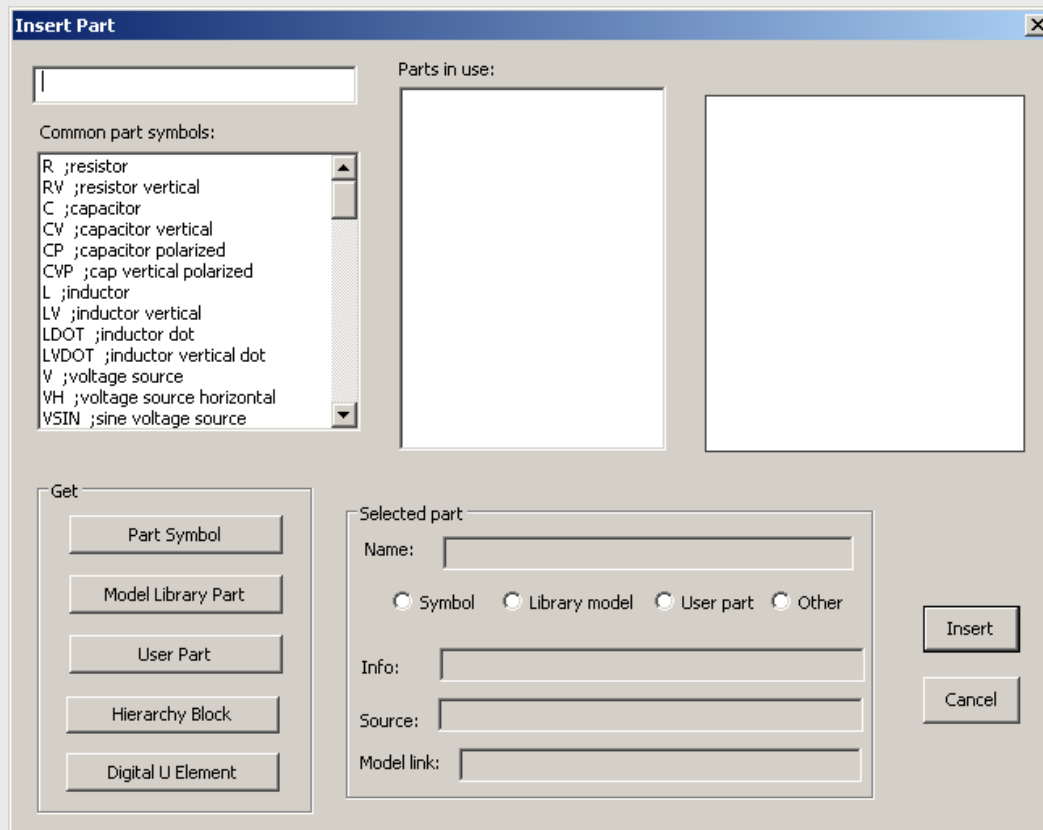
# 3.2) TopSPICE

## ⌘ Editor de Esquemático



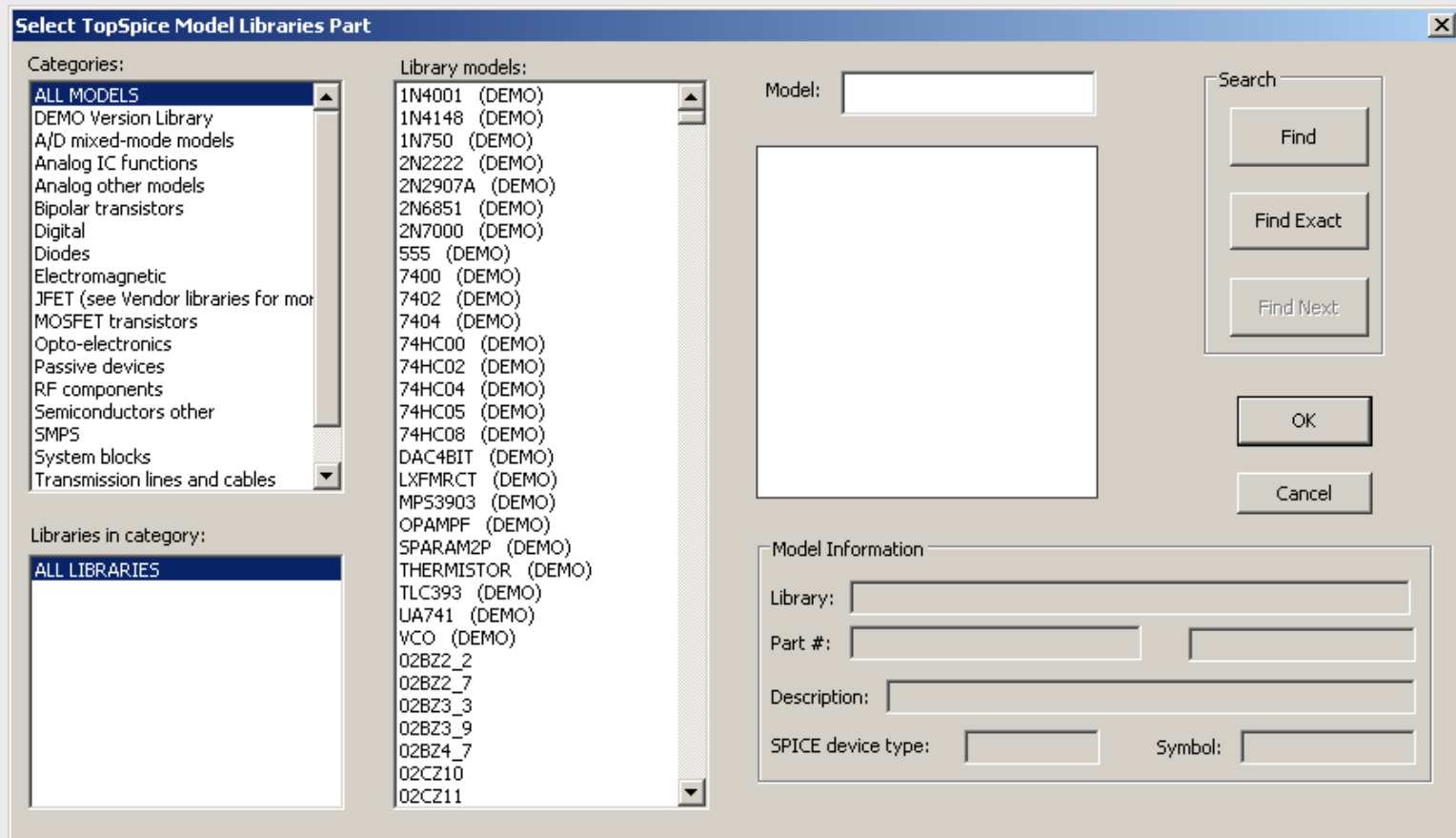
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): **Diodo Zener**



# 3.2) TopSPICE

## ⌘ Biblioteca de componentes (Model Library Part)



# 3.2) TopSPICE

## ⌘ Diodo Zener

Select TopSpice Model Libraries Part

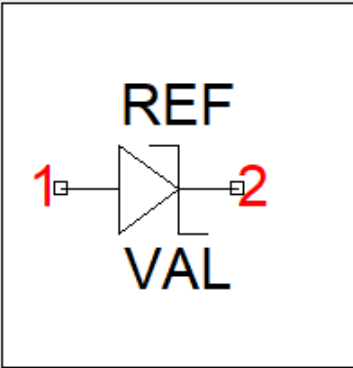
Categories:

- ALL MODELS
- DEMO Version Library
- A/D mixed-mode models
- Analog IC functions
- Analog other models
- Bipolar transistors (see Vendor lib
- Digital
- Diodes (see Vendor libraries for m
- Electromagnetic
- JFET (see Vendor libraries for mo
- MOSFET transistors (see Vendor l
- Opto-electronics (see Vendor libr
- Passive devices
- RF components
- Semiconductors other
- SMPS
- System blocks
- Transmission lines and cables

Library models:

- 1N4001 (DEMO)
- 1N4148 (DEMO)
- 1N5829 (DEMO)
- 1N750 (DEMO)
- 2N2222 (DEMO)
- 2N2907A (DEMO)
- 2N6851 (DEMO)
- 2N7000 (DEMO)
- 555 (DEMO)
- 7400 (DEMO)
- 7402 (DEMO)
- 7404 (DEMO)
- 74HC00 (DEMO)
- 74HC02 (DEMO)
- 74HC04 (DEMO)
- 74HC05 (DEMO)
- 74HC08 (DEMO)
- COMP (DEMO)
- DAC4BIT (DEMO)
- DBRIDGE (DEMO)
- LXFMRCT (DEMO)
- MPS3903 (DEMO)
- OPAMP (DEMO)
- OPAMPF (DEMO)
- OPAMPI (DEMO)
- OPENLOOPGAIN (DEMO)
- PWMCM2 (DEMO)
- SPARAM2P (DEMO)
- STG (DEMO)
- STIG (DEMO)
- THERMISTOR (DEMO)
- TLC393 (DEMO)

Model: 1N750 (DEMO)



Search

Find

Find Exact

Find Next

OK

Cancel

Model Information

Library: DEMO

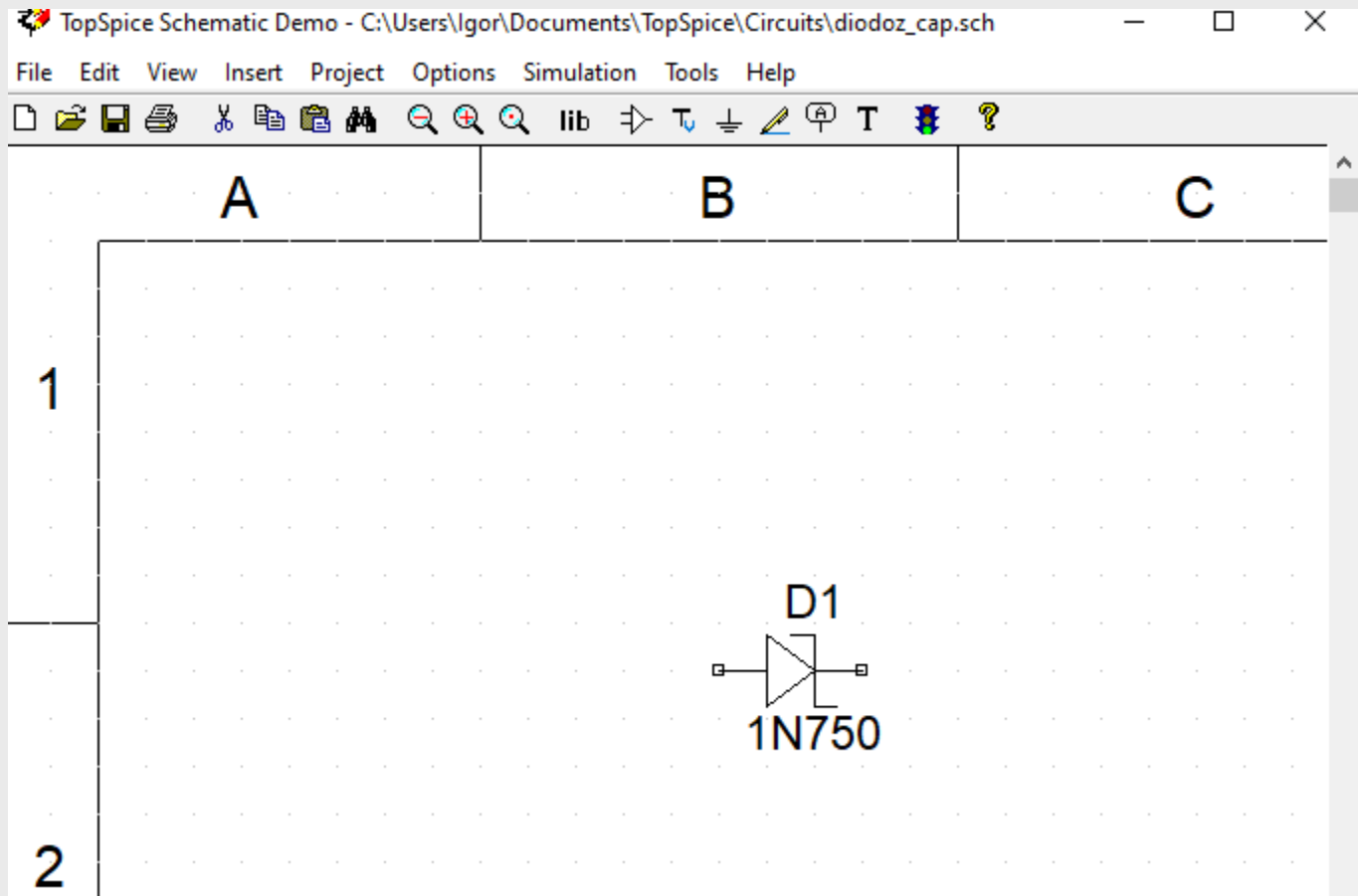
Part #: 1N750 DEMO

Description: Zener diode

SPICE device type: D (D) Symbol: DZ

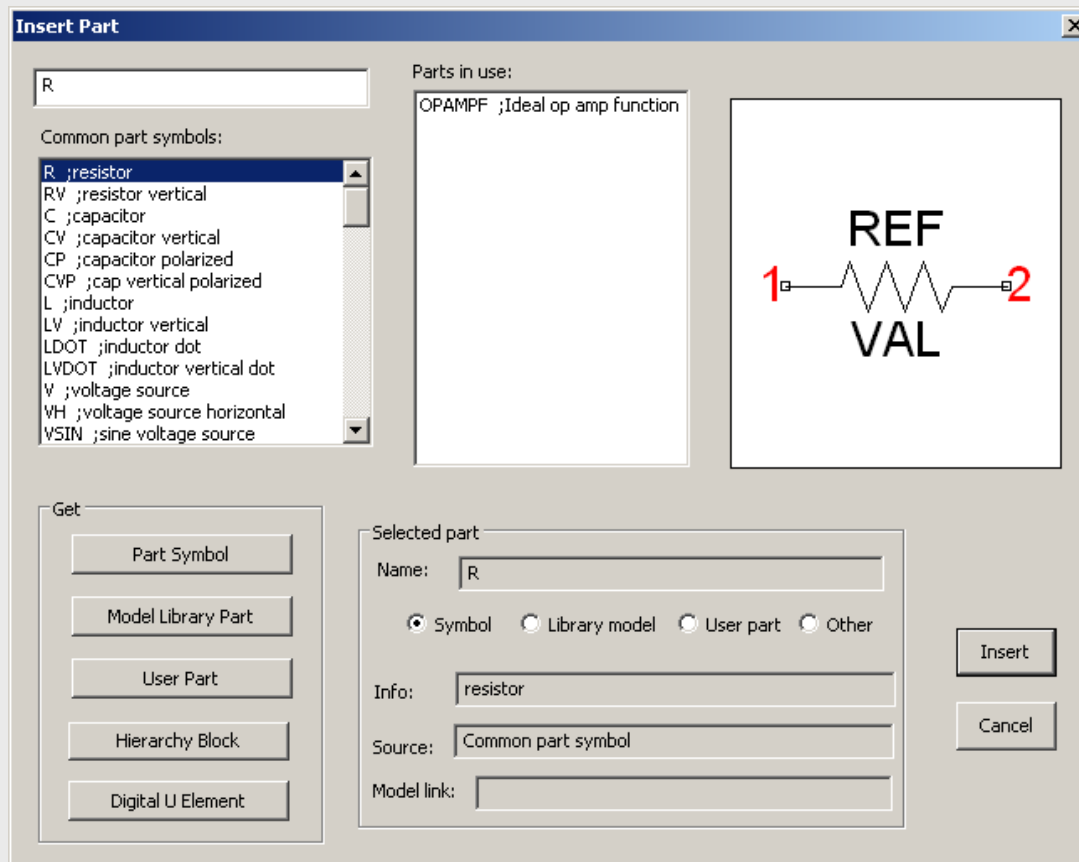
# 3.2) TopSPICE

## ⌘ Circuito Parcial:



## 3.2) TopSPICE

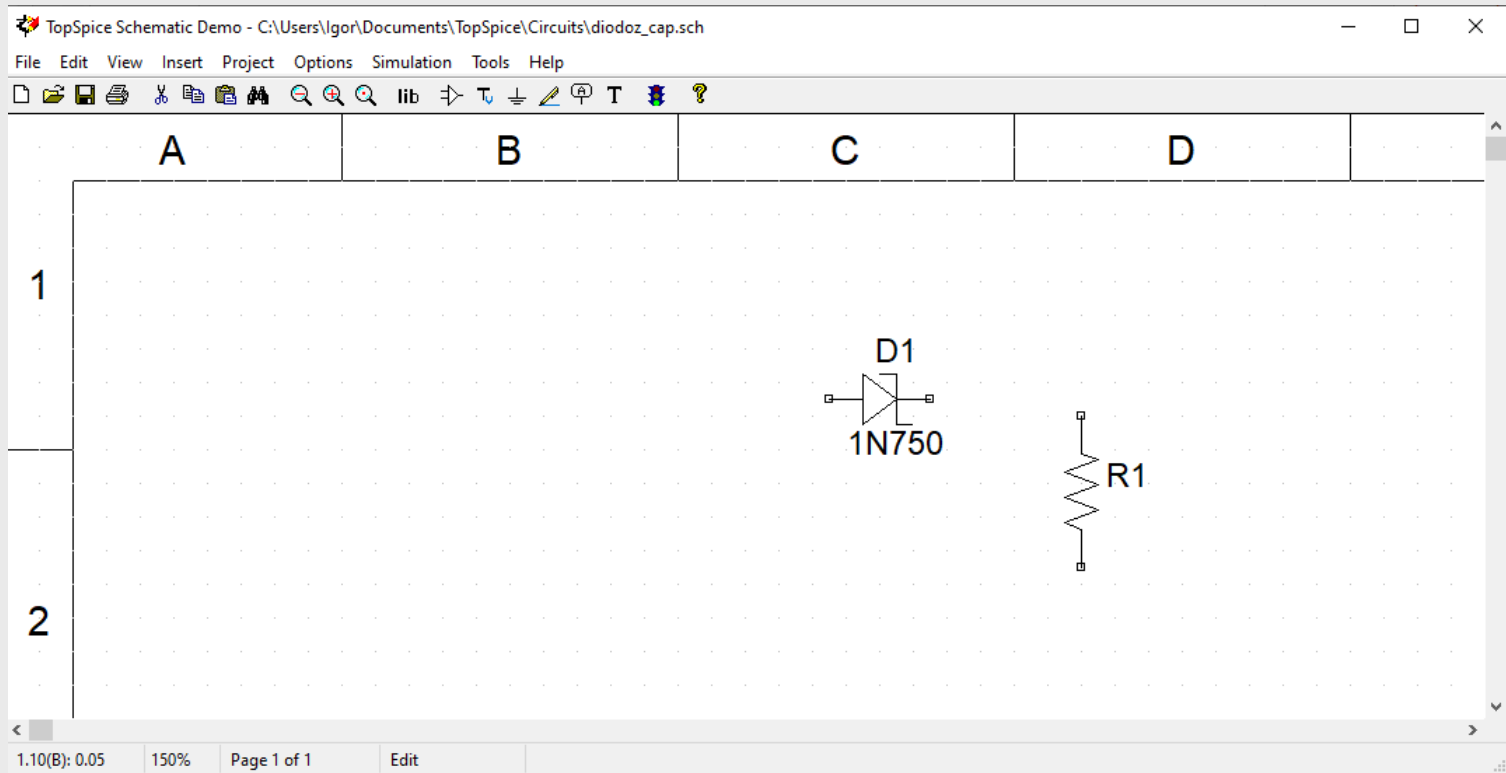
⌘ Inserir componente (Insert -> Part): **Resistores e fonte**





# 3.2) TopSPICE

## ⌘ Circuito Parcial:



## 3.2) TopSPICE

### ⌘ Parâmetros dos componentes:

**Part Attributes - [R]**

Reference:  Value/name:

Parameters

Line 1:   Show

Line 2:

Line 3:

Netlist Options

SPICE

Device:  Template:

Layout

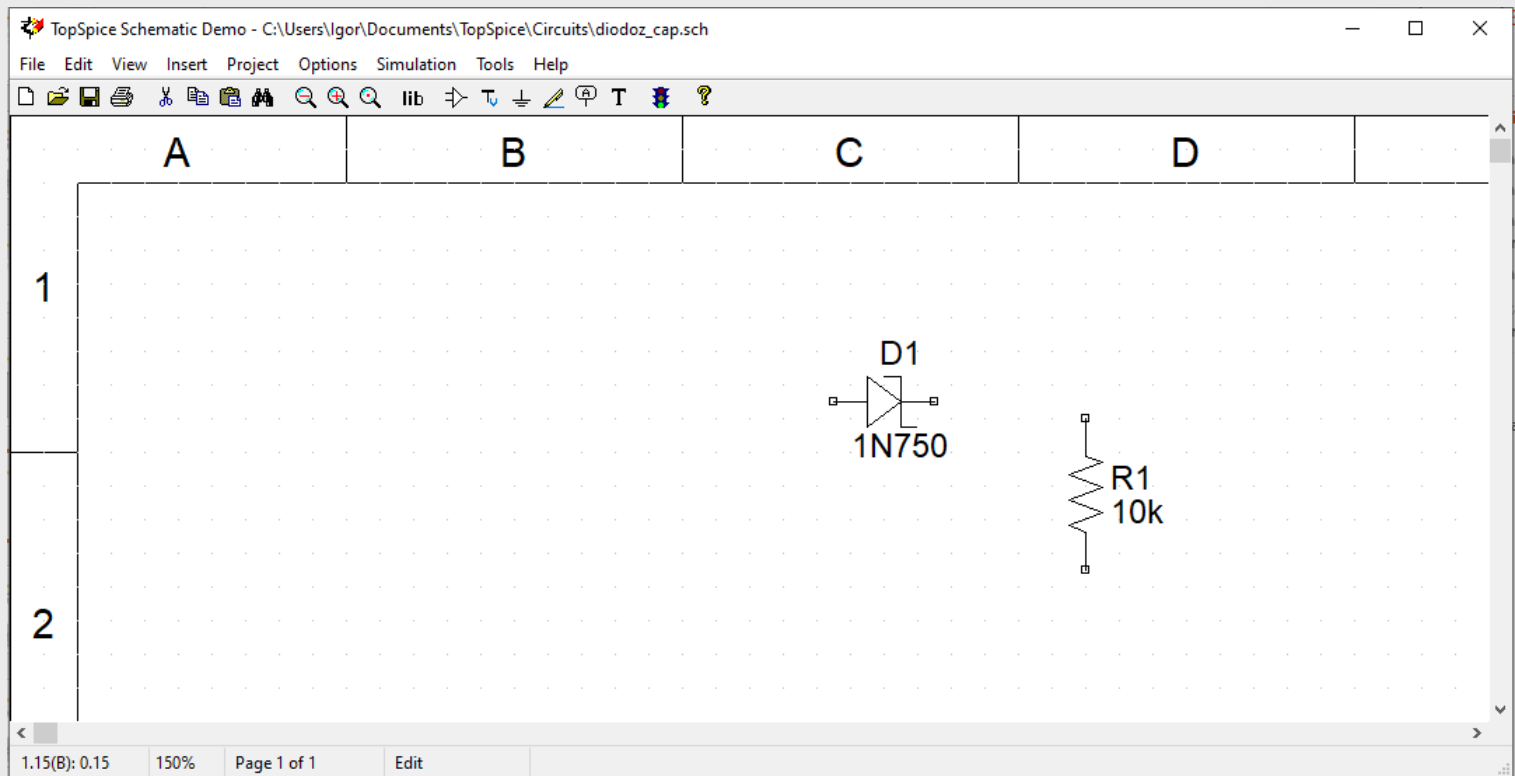
Template:

Model/Hierarchy File Link

.LIB  .INC  MDB  Hierarchy (.HSC)

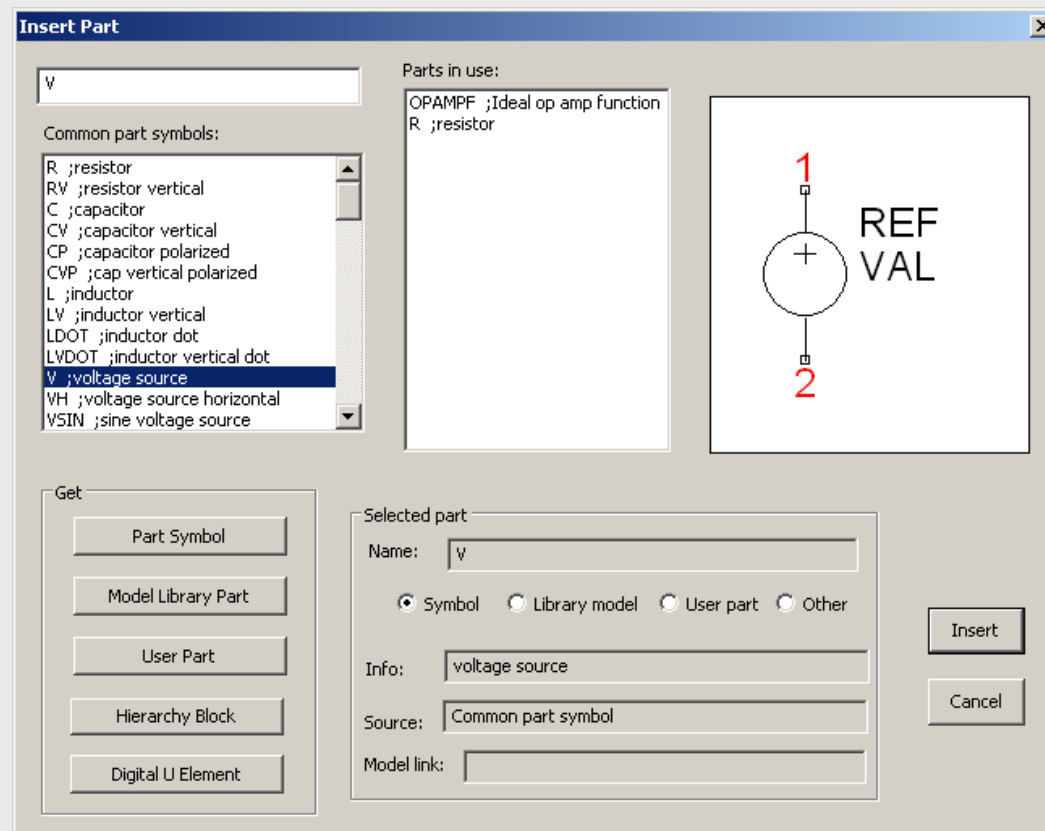
# 3.2) TopSPICE

## ⌘ Circuito Parcial:



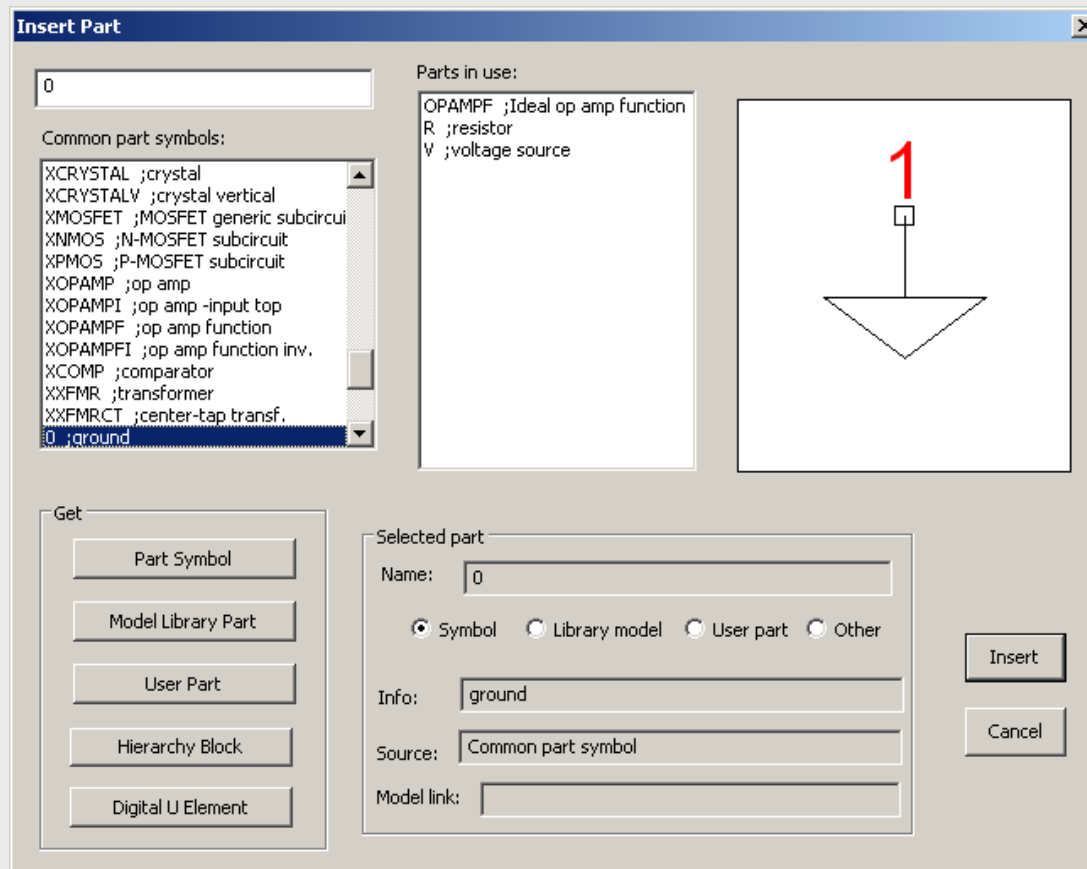
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): **Fonte de Tensão**



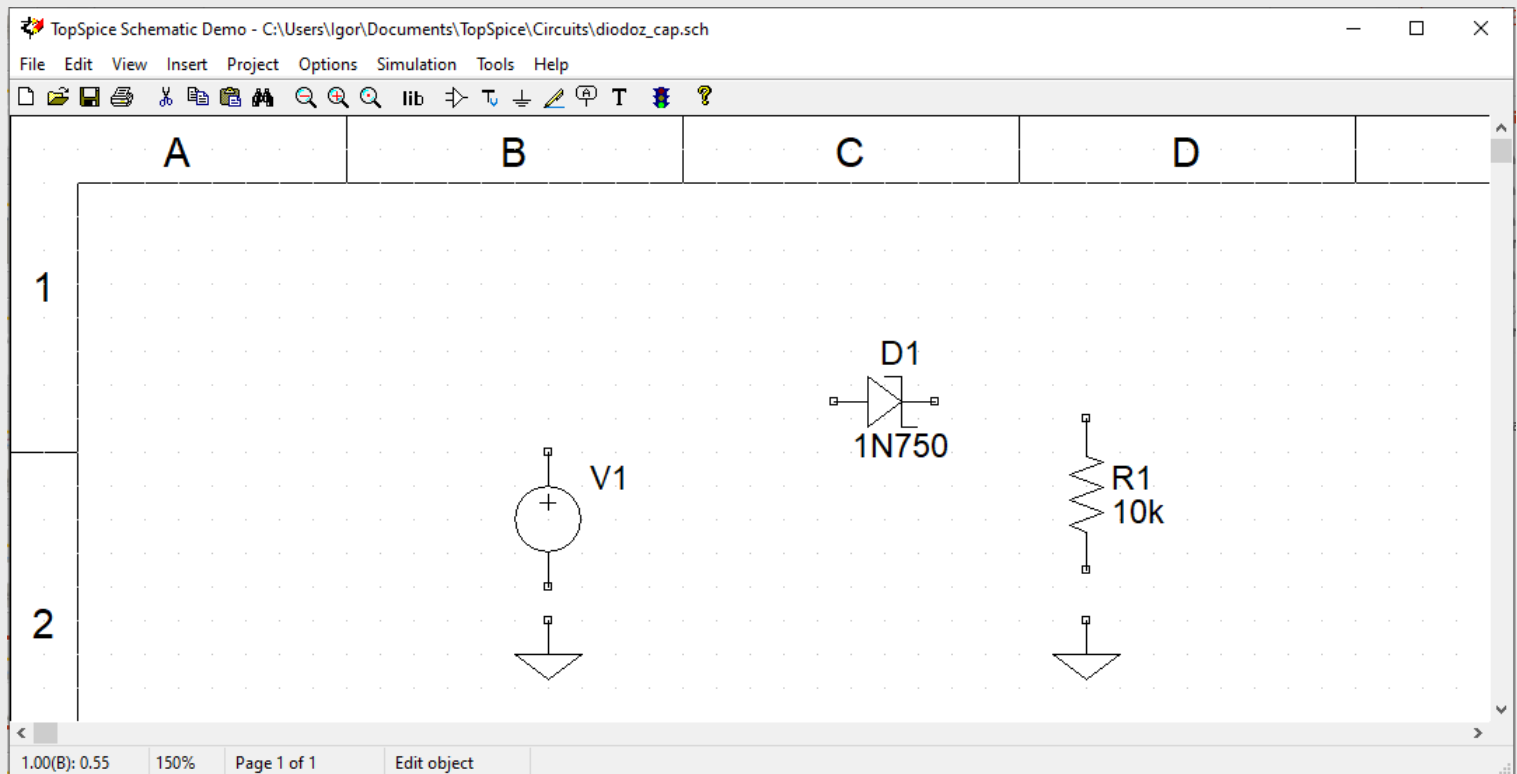
## 3.2) TopSPICE

⌘ Inserir componente (Insert -> Part): **Terras**



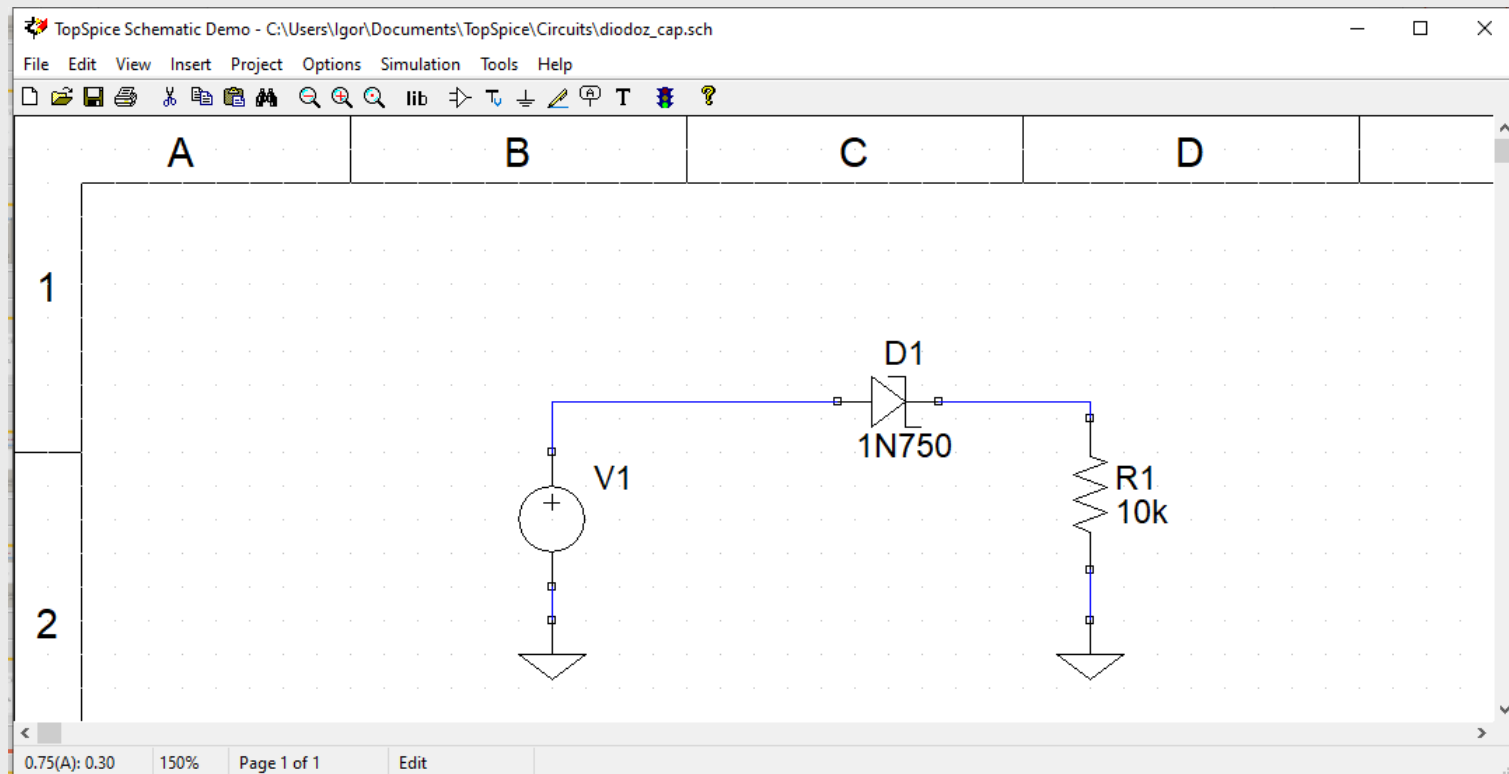
# 3.2) TopSPICE

## ⌘ Circuito Parcial:



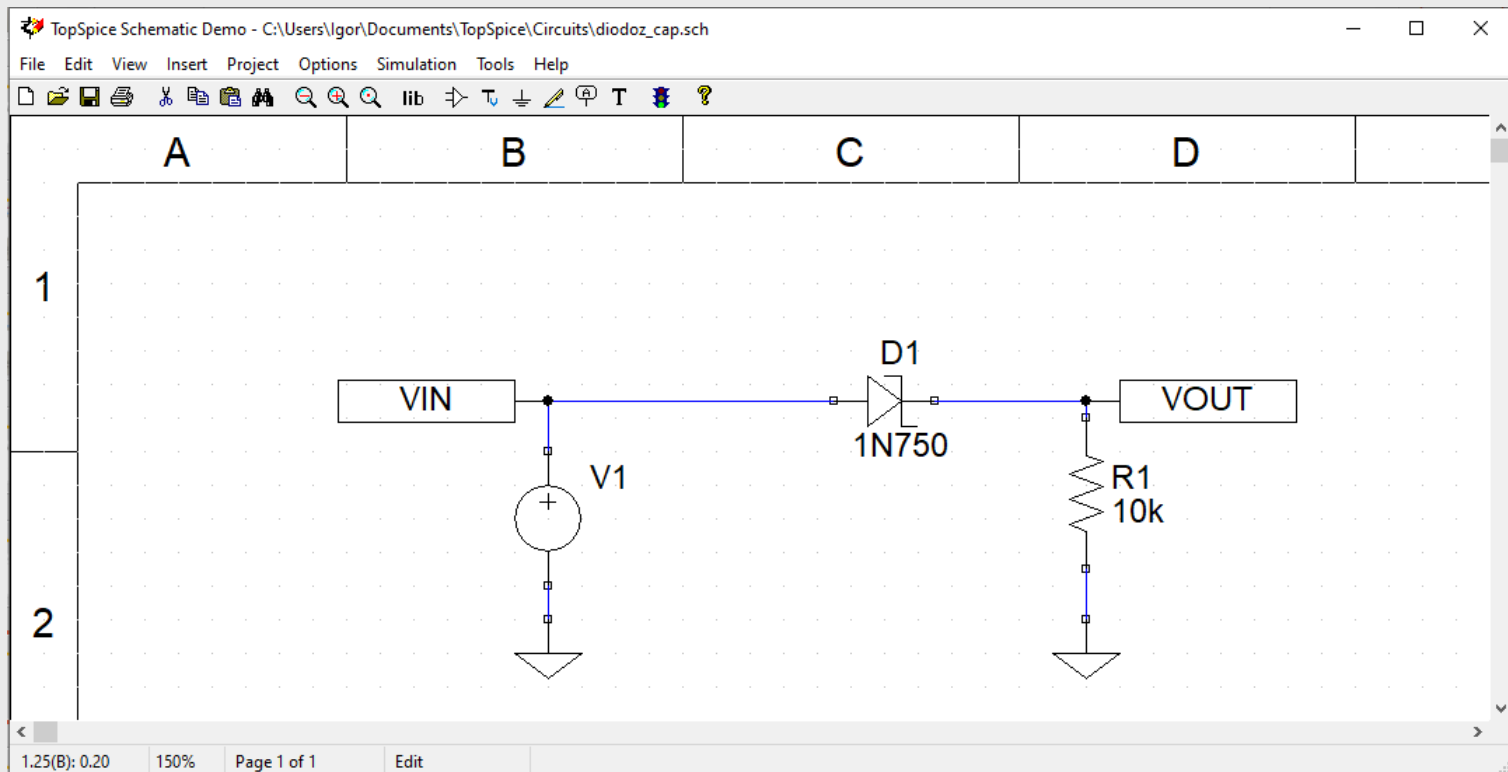
## 3.2) TopSPICE

⌘ Inserir fiação (Insert -> Wire):



## 3.2) TopSPICE

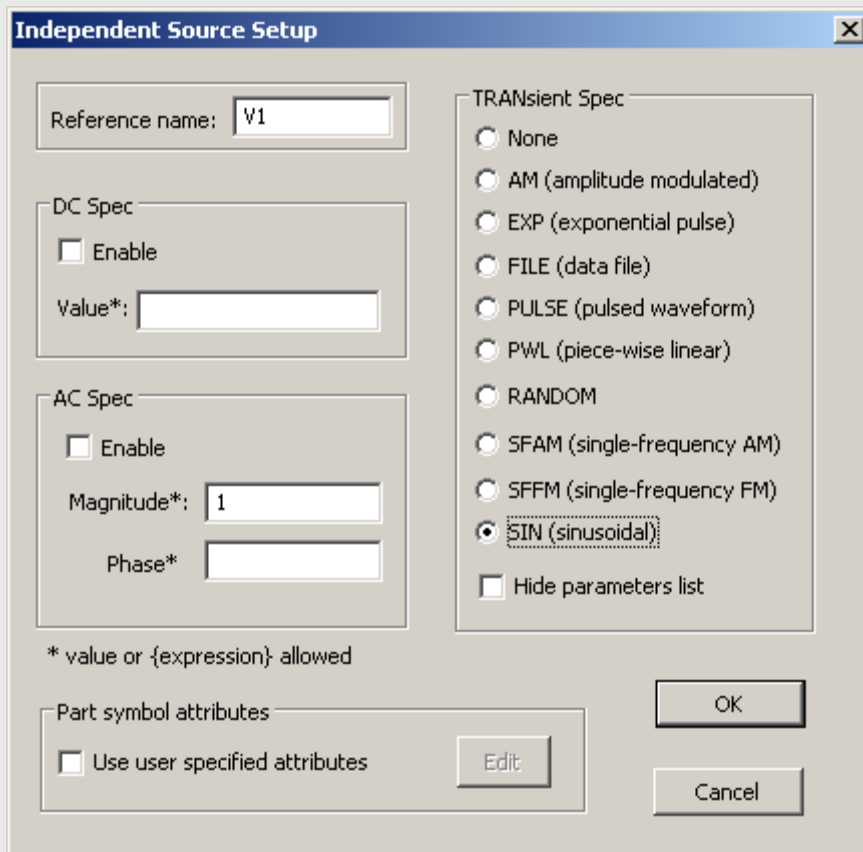
⌘ Definir Rótulos (Insert -> Label Node):





# 3.2) TopSPICE

## ⌘ Definir Fonte de Tensão



**Independent Source Setup**

Reference name:

DC Spec

Enable

Value\*:

AC Spec

Enable

Magnitude\*:

Phase\*:

TRANSient Spec

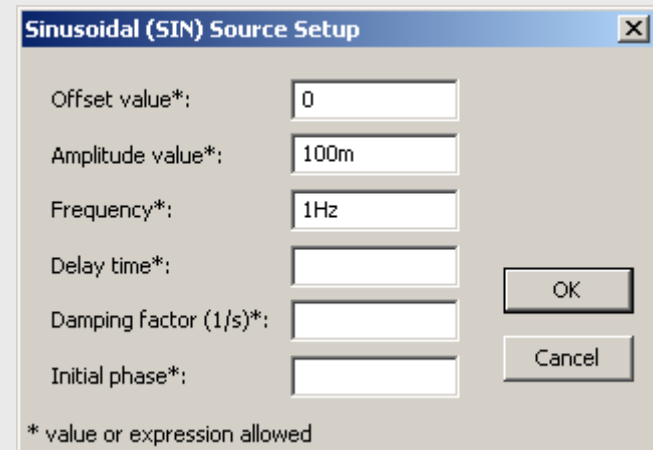
- None
- AM (amplitude modulated)
- EXP (exponential pulse)
- FILE (data file)
- PULSE (pulsed waveform)
- PWL (piece-wise linear)
- RANDOM
- SFAM (single-frequency AM)
- SFFM (single-frequency FM)
- SIN (sinusoidal)

Hide parameters list

\* value or {expression} allowed

Part symbol attributes

Use user specified attributes



**Sinusoidal (SIN) Source Setup**

Offset value\*:

Amplitude value\*:

Frequency\*:

Delay time\*:

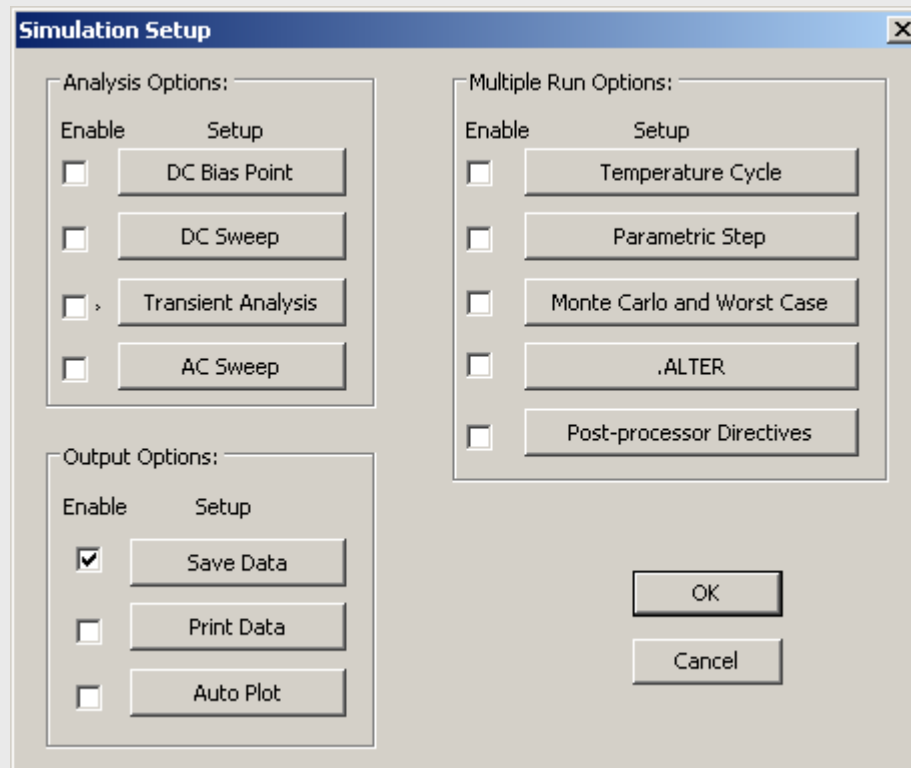
Damping factor (1/s)\*:

Initial phase\*:

\* value or expression allowed

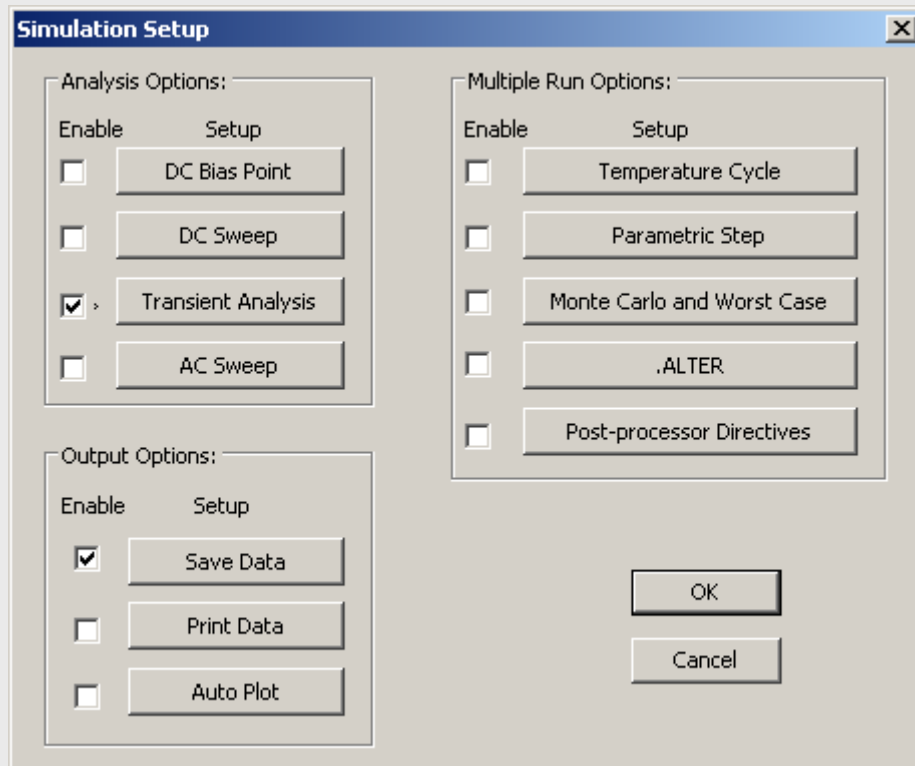
## 3.2) TopSPICE

⌘ Configurar **Simulação** (Simulation -> Setup):



# 3.2) TopSPICE

## ⌘ Análise de Transiente:



**Simulation Setup**

Analysis Options:

Enable	Setup
<input type="checkbox"/>	DC Bias Point
<input type="checkbox"/>	DC Sweep
<input checked="" type="checkbox"/>	Transient Analysis
<input type="checkbox"/>	AC Sweep

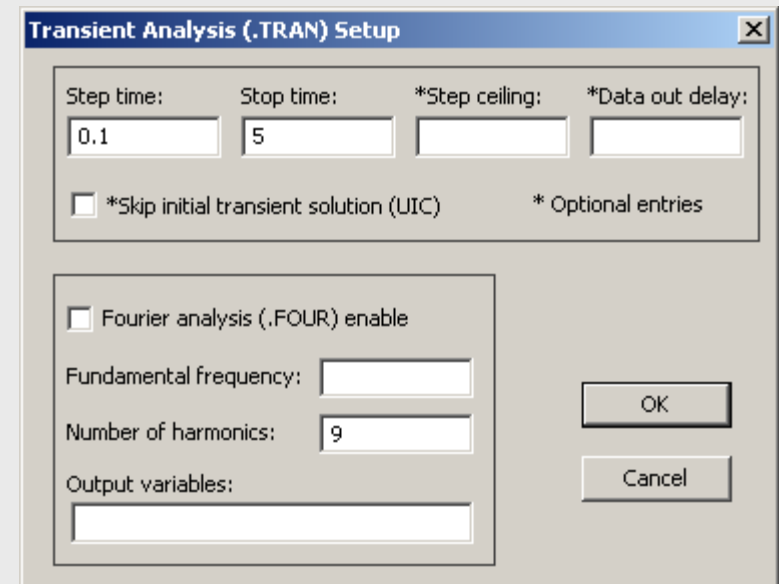
Output Options:

Enable	Setup
<input checked="" type="checkbox"/>	Save Data
<input type="checkbox"/>	Print Data
<input type="checkbox"/>	Auto Plot

Multiple Run Options:

Enable	Setup
<input type="checkbox"/>	Temperature Cycle
<input type="checkbox"/>	Parametric Step
<input type="checkbox"/>	Monte Carlo and Worst Case
<input type="checkbox"/>	.ALTER
<input type="checkbox"/>	Post-processor Directives

OK Cancel



**Transient Analysis (.TRAN) Setup**

Step time: 0.1 Stop time: 5 \*Step ceiling: \*Data out delay:

\*Skip initial transient solution (UIC) \* Optional entries

Fourier analysis (.FOUR) enable

Fundamental frequency: Number of harmonics: 9

Output variables:

OK Cancel

# 3.2) TopSPICE

## ⌘ Opções de Saída:

**Simulation Setup**

Analysis Options:

Enable	Setup
<input type="checkbox"/>	DC Bias Point
<input type="checkbox"/>	DC Sweep
<input checked="" type="checkbox"/>	Transient Analysis
<input type="checkbox"/>	AC Sweep

Output Options:

Enable	Setup
<input checked="" type="checkbox"/>	Save Data
<input type="checkbox"/>	Print Data
<input checked="" type="checkbox"/>	Auto Plot

Multiple Run Options:

Enable	Setup
<input type="checkbox"/>	Temperature Cy
<input type="checkbox"/>	Parametric Ste
<input type="checkbox"/>	Monte Carlo and Wo
<input type="checkbox"/>	.ALTER
<input type="checkbox"/>	Post-processor Dire

OK Cancel

**Autoplot Graph Setup**

Enable autoplot graph setup #1

Options:

Type

- Auto
- FFT
- Histogram
- Smith chart

Analysis: Any

Axis scale: Auto

X variable:

Plots:

Add Plot Edit Delete

X axis (optional)

Scaling

Auto Min: Max: Tick:

Label:

New Previous Next Delete

OK Cancel

# 3.2) TopSPICE

## ⌘ Definição do Gráfico:

**Plot Traces and Options Setup** [X]

Enable plot    Description (optional):

Plot traces

Enter variables/expressions (one or more per line):

V(VIN) V(VOUT)

Options:

Plot number:  ▼

Y axis

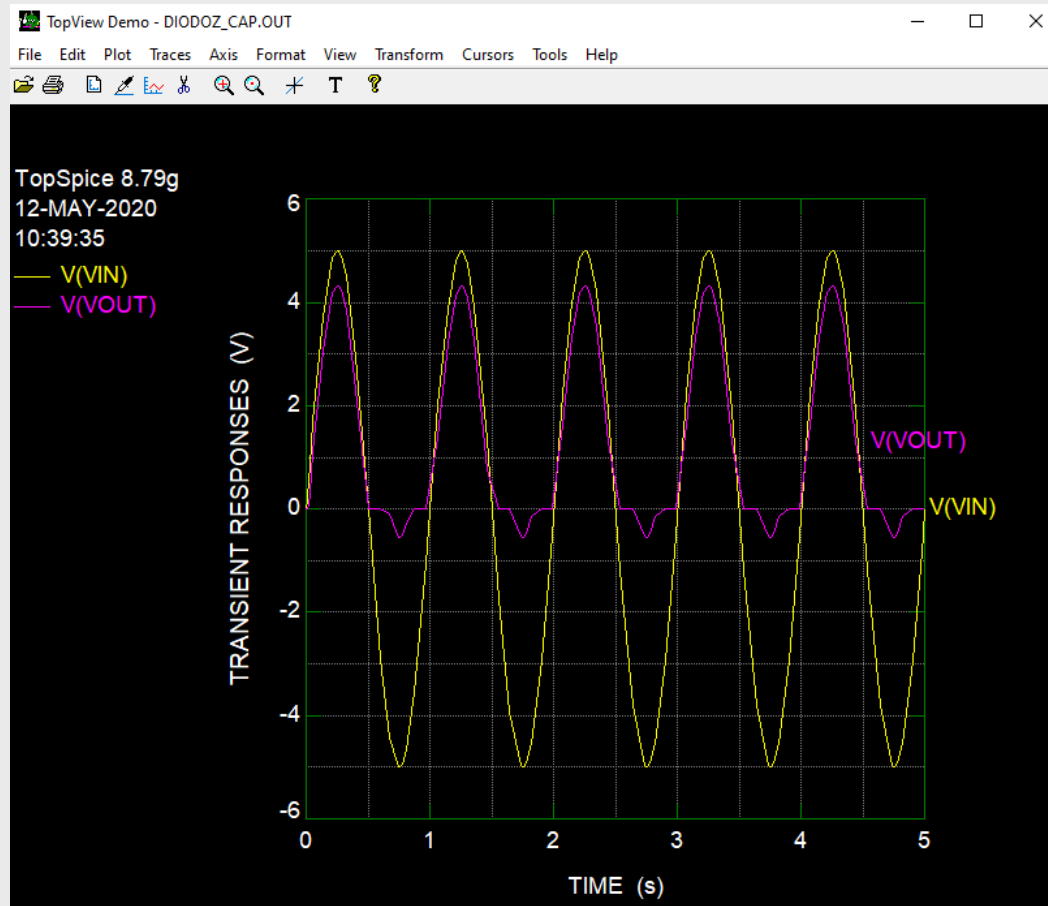
Log     Auto    Min:     Max:     Tick:

Label:

OK    Cancel

# 3.2) TopSPICE

## ⌘ Executar Simulação (F9)



# 3.2) TopSPICE

## Utilizando Cursores

