

# Softwarový systém DYNAST

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VIC ČVUT

# Úvod

- **System DYNAST je sada nástrojů pro podporu modelování a simulace**
- **Jádro systému tvoří dva programy**
  - **simulátor DYNAST**
  - **Integrované uživatelské prostředí, DYN SHELL**

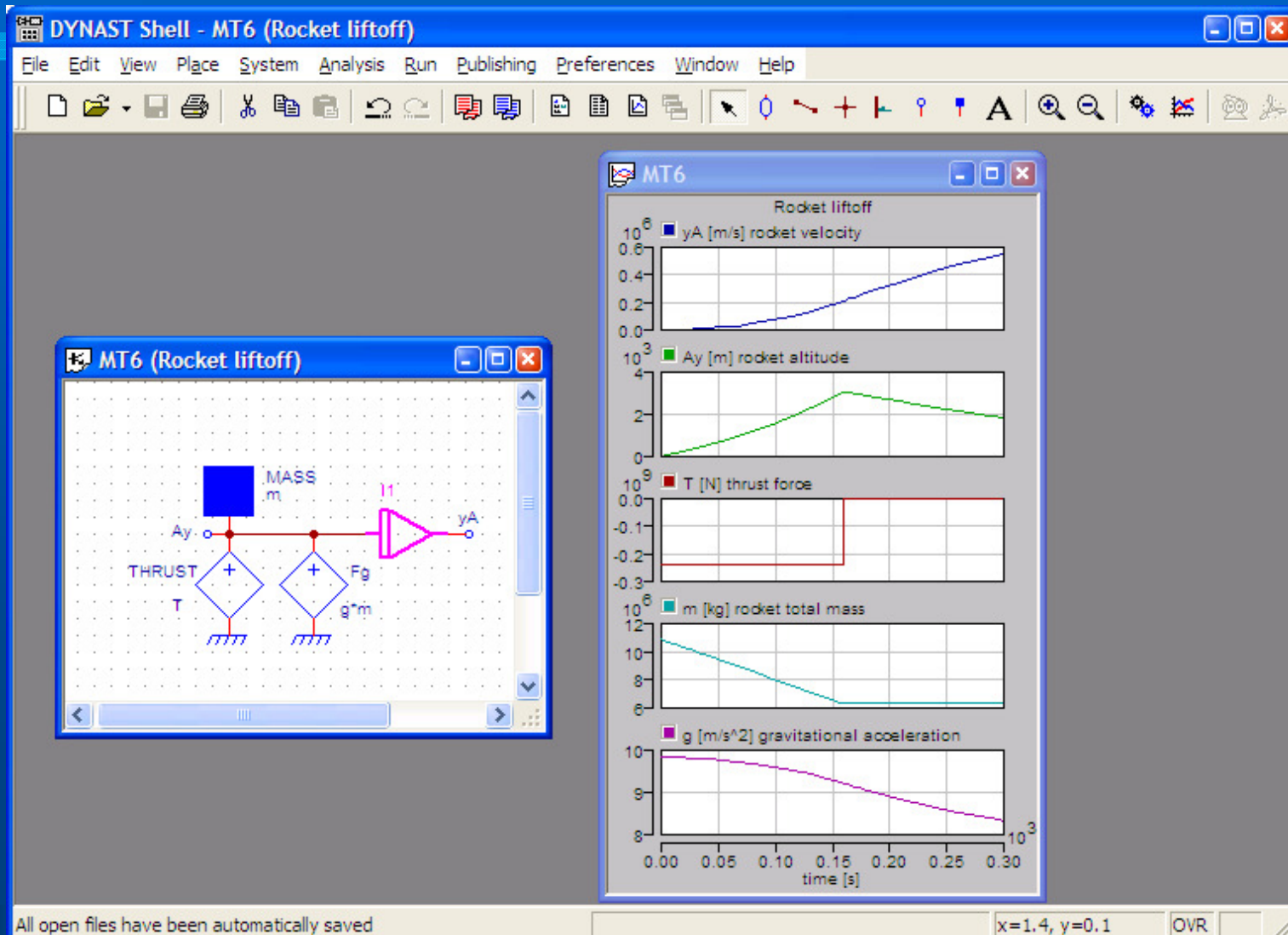
# Základní funkce DYNShellu

- Příprava simulačních modelů
- Spouštění simulátoru DYNAST
- Prezentace výsledků simulace
- Dokumentace
- nápověda

# Základy ovládání DYNSELLu

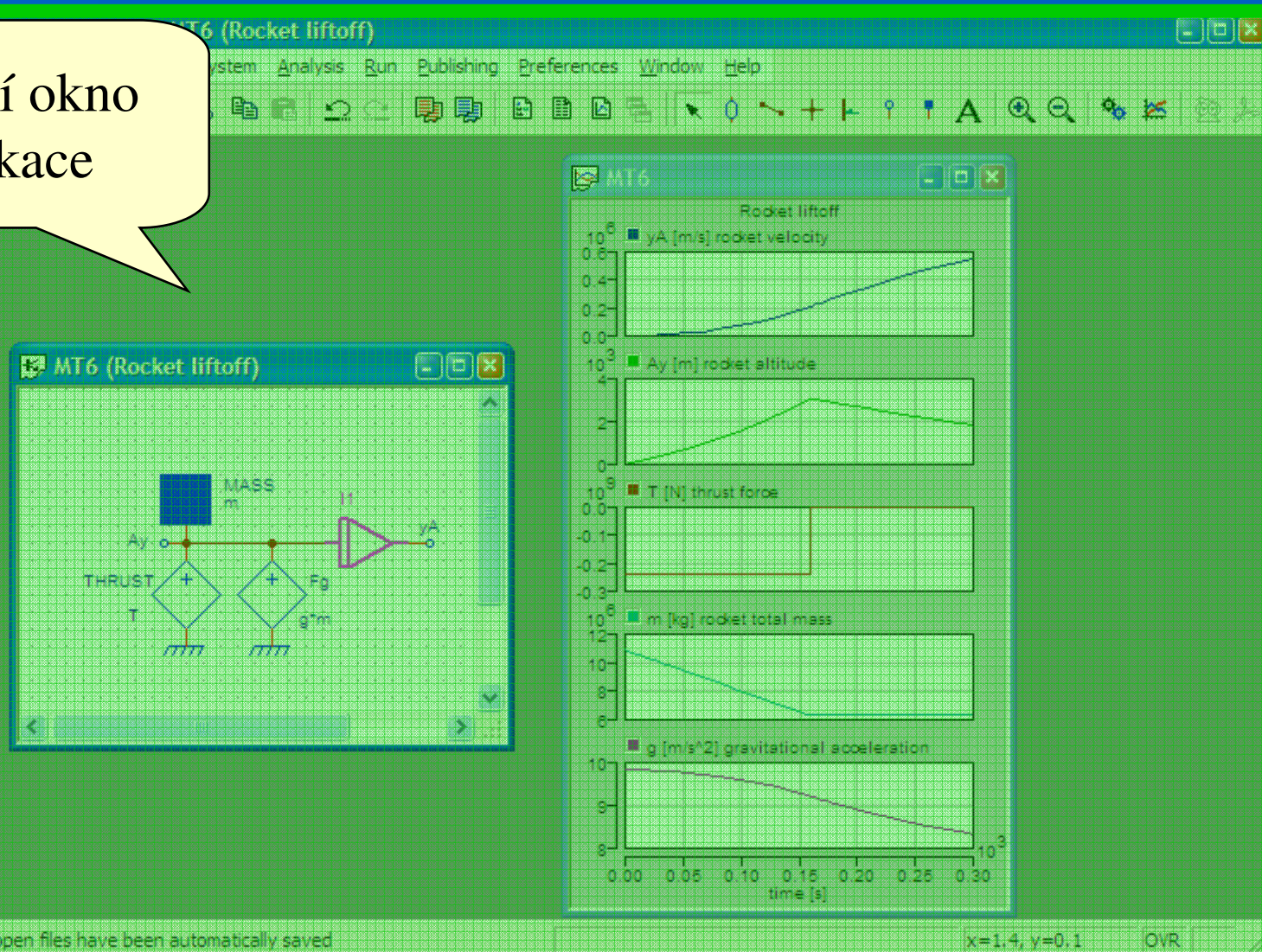
- Základní prvky uživatelského rozhraní
- Různé typy dokumentů

# Prvky uživatelského rozhraní



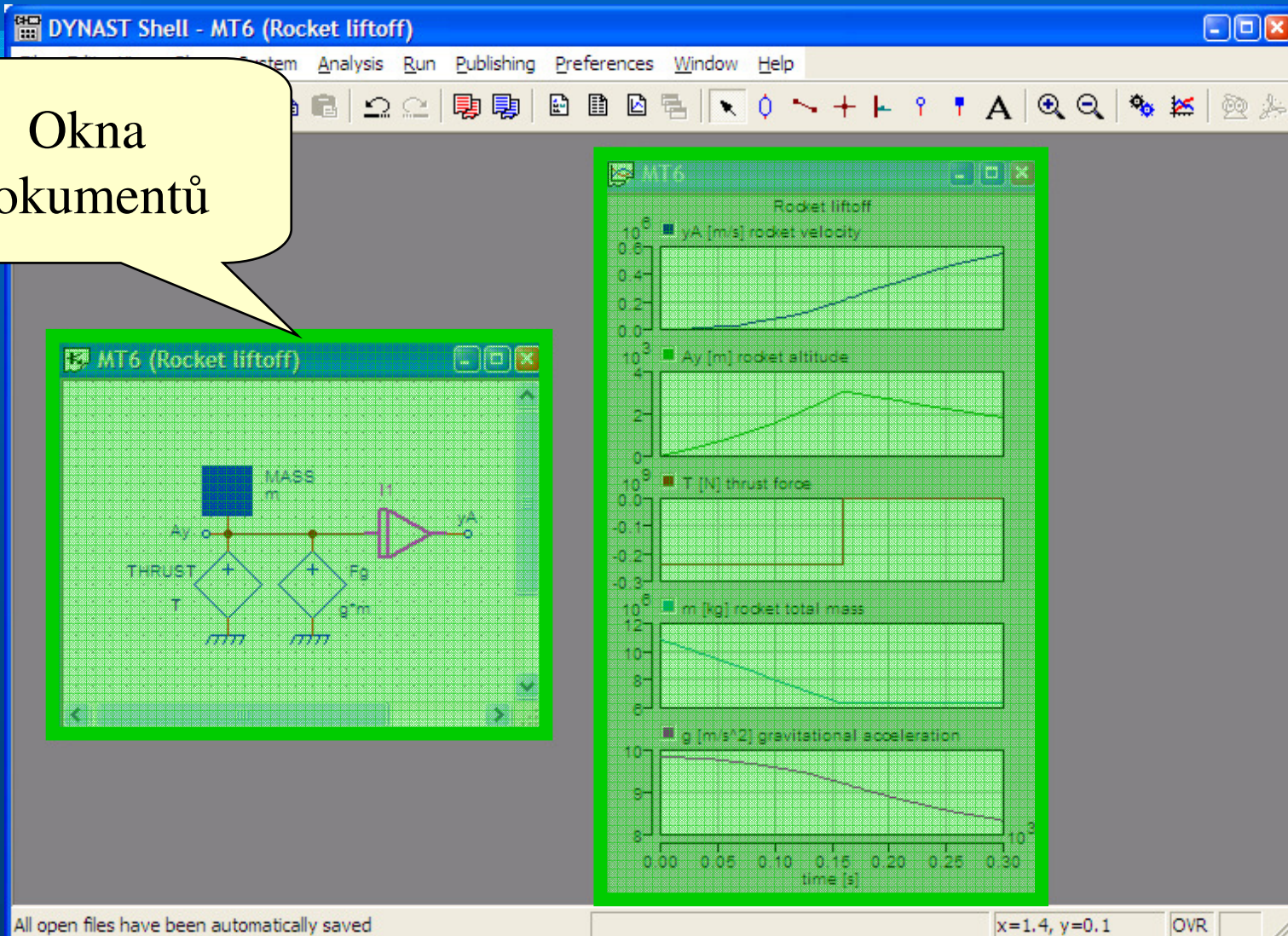
# Prvky uživatelského rozhraní

Hlavní okno aplikace



# Prvky uživatelského rozhraní

Okna dokumentů



# Prvky uživatelského rozhraní

DYNAST Shell - MT6 (Rocket liftoff)

File Edit View Place System Analysis Run Publishing Preferences Window Help

- Diagram part
- Link
- Link junction
- Multilink entry
- Node label
- Pole label
- Text note

Roletové menu

MT6 Rocket liftoff

Rocket liftoff

- yA [m/s] rocket velocity
- Ay [m] rocket altitude
- T [N] thrust force
- m [kg] rocket total mass
- g [m/s<sup>2</sup>] gravitational acceleration

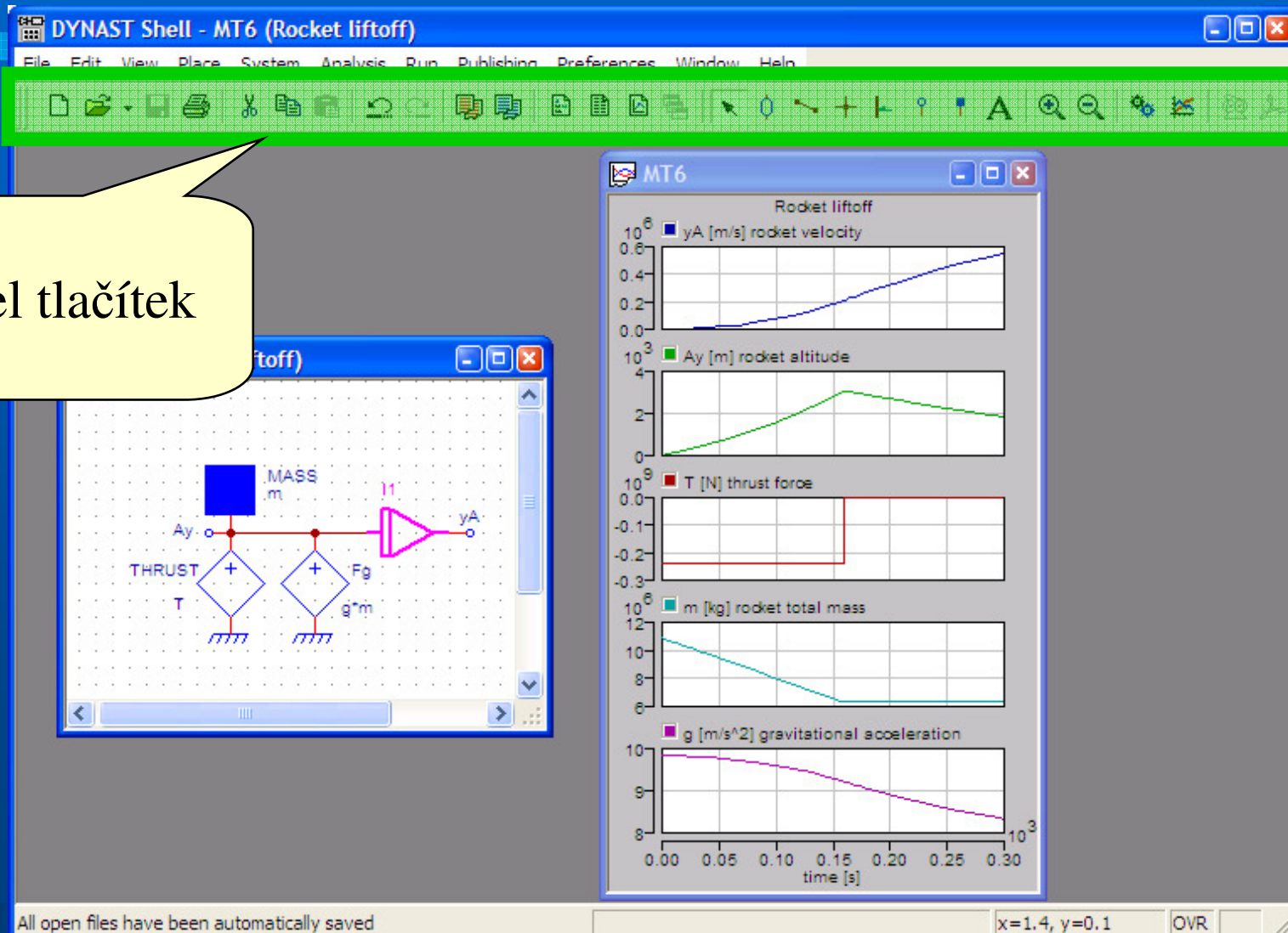
time [s]

x=2.5, y=0.0 OVR



# Prvky uživatelského rozhraní

Panel tlačítek



# Prvky uživatelského rozhraní

The screenshot displays the DYNAST Shell - MT6 (Rocket liftoff) application window. The interface includes a menu bar (File, Edit, View, Place, System, Analysis, Run, Publishing, Preferences, Window, Help) and a toolbar with various icons for file operations and analysis. The main workspace is divided into several panels:

- Block Diagram:** A schematic diagram of a rocket system. It features a central block labeled 'THRUST' with a plus sign, connected to a block labeled 'T'. Below this, there is a block labeled 'Fg' with a plus sign, connected to a block labeled 'g\*m'. A block labeled 'Ay' is also present. A yellow callout bubble points to a specific part of the diagram, labeled 'I1'.
- Plot (MT6):** A window titled 'Rocket liftoff' showing three graphs over time (0.00 to 0.30 s). The top graph shows 'yA [m/s] rocket velocity' (blue line) increasing from 0 to approximately 0.6. The middle graph shows 'Ay [m] rocket altitude' (green line) increasing to about 3.5 and then slightly decreasing. The bottom graph shows 'T [N] thrust force' (red line) decreasing from 10<sup>9</sup> to 10<sup>3</sup>.
- Context Menu:** A green callout bubble points to the 'I1' part in the diagram, displaying a menu with the following options:
  - Edit properties of part 'I1'
  - View sheet of submodel 'Int' in PostScript
  - View sheet of submodel 'Int' in HTML
  - View text of submodel 'Int'
  - Edit diagram of submodel 'Int'
  - Edit text of submodel 'Int'
  - View symbol 'I1' in symbol library 'block\_sub'

The status bar at the bottom indicates 'All open files have been automatically saved' and shows coordinates 'x=2.0, y=0.9' and a zoom level 'OVR'.

# Příprava simulačních modelů

- Specifikace modelu
- Specifikace analýzy

# Specifikace modelu

- **Graficky**
  - mnohopólovým diagramem
  - blokovým diagramem

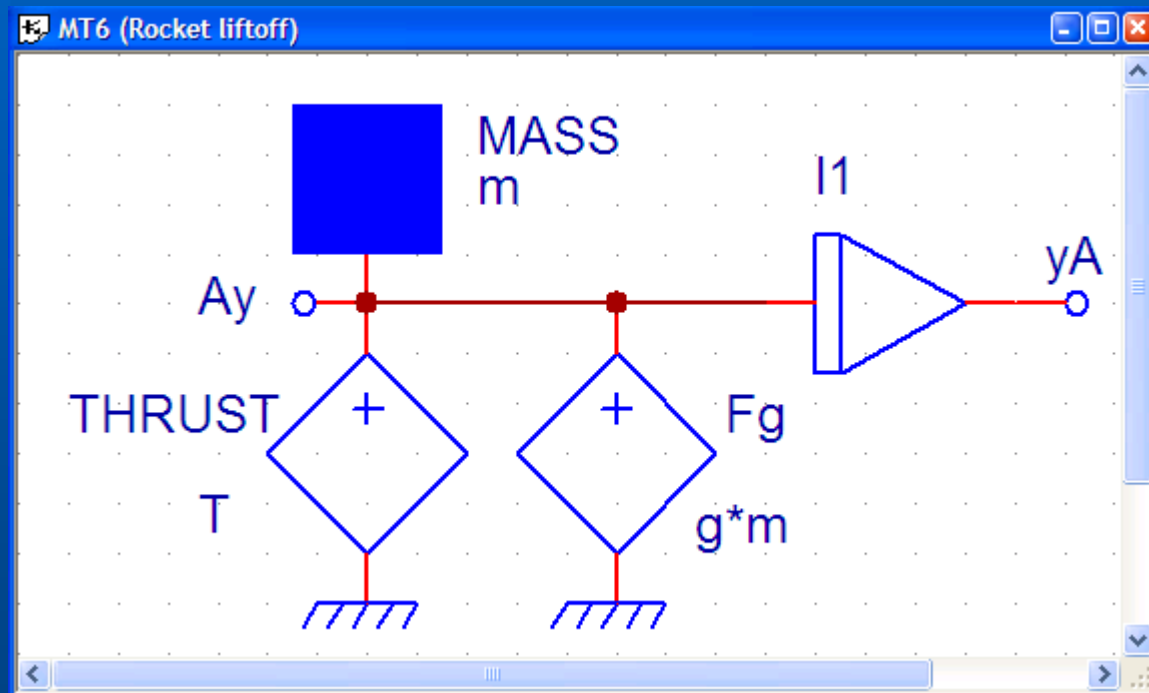
**Editor diagramů**
- **Pomocí rovnic**

**Formulářové rozhraní**

# Editor diagramů

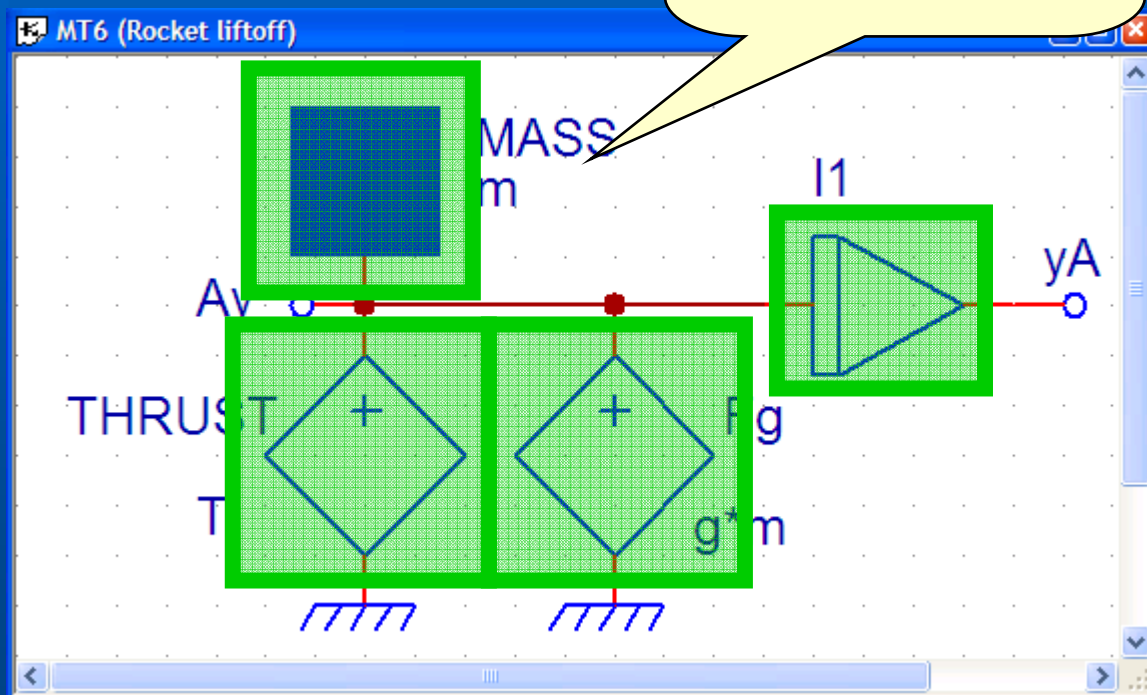
- Umožňuje zadávat simulační modely graficky
- Obsahuje knihovnu standardních submodelů
- Knihovnu lze rozšiřovat o uživatelské submodely

# Editor diagramů

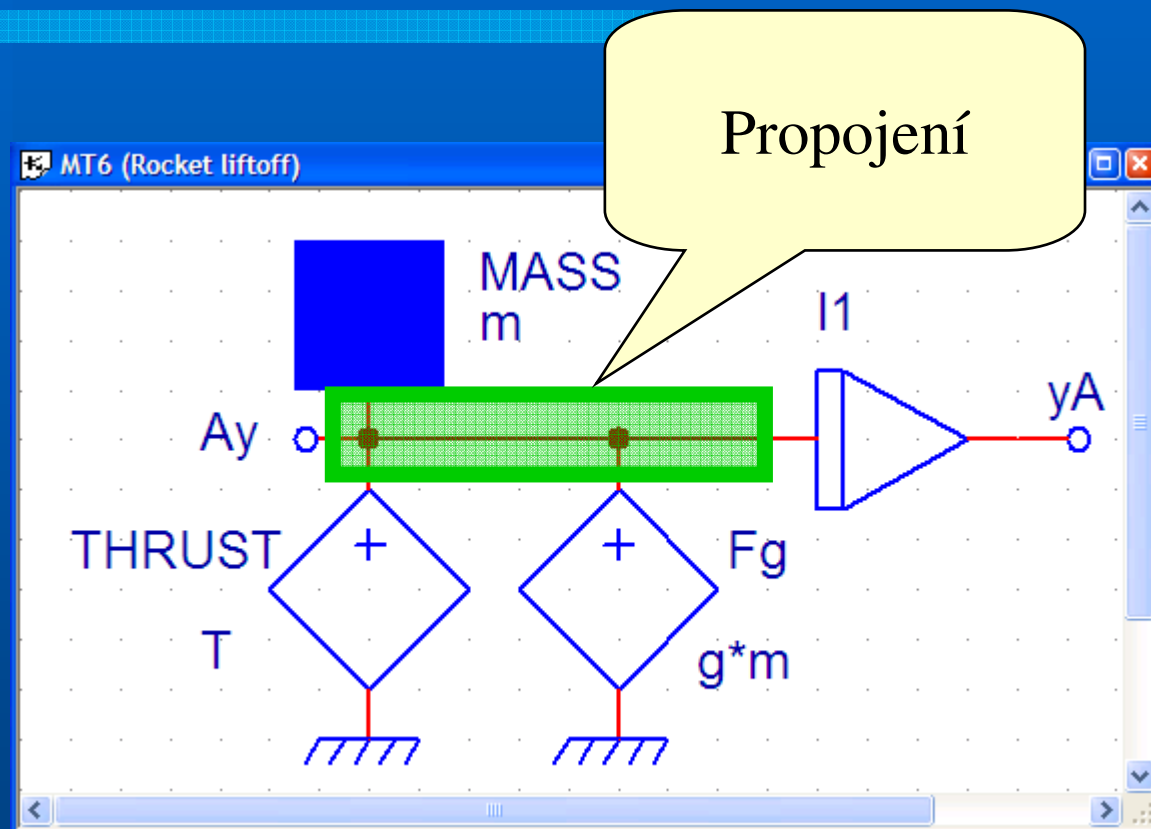


# Editor diagramů

Submodely



# Editor diagramů





# Vlastnosti submodelu

ASTABLE (Astable multivibrator)

Submodel Properties

NPN-BJT  
Gummel and Poon model

Name:  
T2

Submodel parameters:  
Parameters from a catalog:

Parameter	Value	Description
IS	1E-16	[A] transport saturation current
BF	100	[-] ideal maximum forward beta
NF	1	[-] forward current emission coeffi...
VAF	1E10	[V] forward Early voltage
VA	VAF	(equal)
IKF	1E10	[A] forward-beta high-current roll-o...
ISE	0	[A] base-emitter leakage saturation ...
C2	ISE/IS	[-] base-emitter leakage saturation ...

$10^{15}$   $10^{12}$   $10^9$   $10^6$   $10^{-3}$   $10^3$   $10^6$   $10^9$   $10^{12}$  |  $\pi$  Expression...

OK  
Cancel  
Help

# Vlastnosti submodelu

**Submodel Properties**

NPN-BJT  
Gummel and Poon model

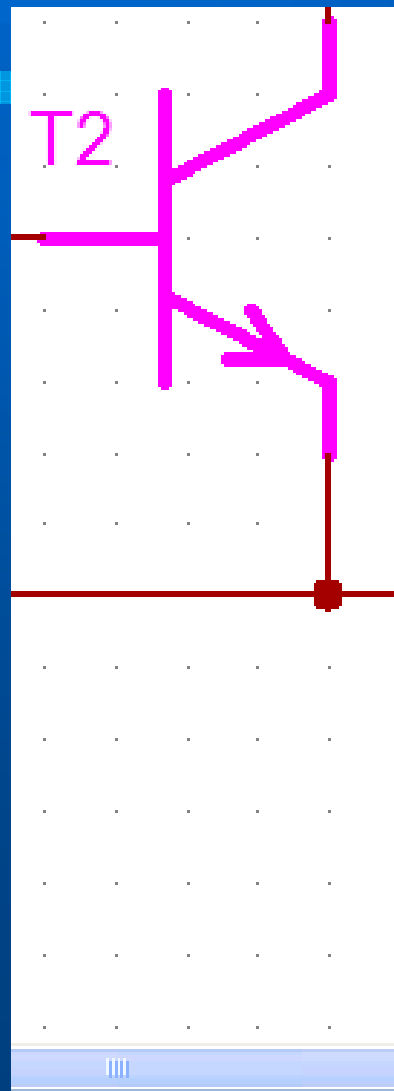
Name:  
T2

Submodel parameters:  
Parameters from a catalog:

Parameter	Value	Description
IS	1E-16	[A] transport saturation current
BF	100	[-] ideal maximum forward beta
NF	1	[-] forward current emission coeffi...
VAF	1E10	[V] forward Early voltage
VA	VAF	(equal)
IKF	1E10	[A] forward-beta high-current roll-o...
ISE	0	[A] base-emitter leakage saturation ...
C2	ISE/IS	[-] base-emitter leakage saturation ...

$10^{-15}$   $10^{-12}$   $10^{-9}$   $10^{-6}$   $10^{-3}$   $10^3$   $10^6$   $10^9$   $10^{12}$  |  $\pi$  Expression...

# Vlastnosti submodelu



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$10^{-15}$   $10^{-12}$   $10^{-9}$   $10^{-6}$   $10^{-3}$   $10^3$   $10^6$   $10^9$   $10^{12}$  |  $\pi$  Expression...

OK  
Cancel  
Help

Název submodelu

# Vlastnosti submodelu

Název součástky

Submodel Properties

NPN-BJT  
Gummel and Poon model

Name:  
T2

Submodel parameters:

Parameters from a catalog:

Parameter	Value	Description
IS	1E-16	[A] transport saturation current
BF	100	[-] ideal maximum forward beta
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VAF	1E10	[V] forward Early voltage
VA	VAF	(equal)
IKF	1E10	[A] forward-beta high-current roll-o...
ISE	0	[A] base-emitter leakage saturation ...
C2	ISE/IS	[-] base-emitter leakage saturation ...

10<sup>-15</sup> 10<sup>-12</sup> 10<sup>-9</sup> 10<sup>-6</sup> 10<sup>-3</sup> 10<sup>3</sup> 10<sup>6</sup> 10<sup>9</sup> 10<sup>12</sup> | π Expression...

# Vlastnosti submodelu

Parametry součástky

**Submodel Properties**

NPN-BJT  
Gummel and Poon model

Name:

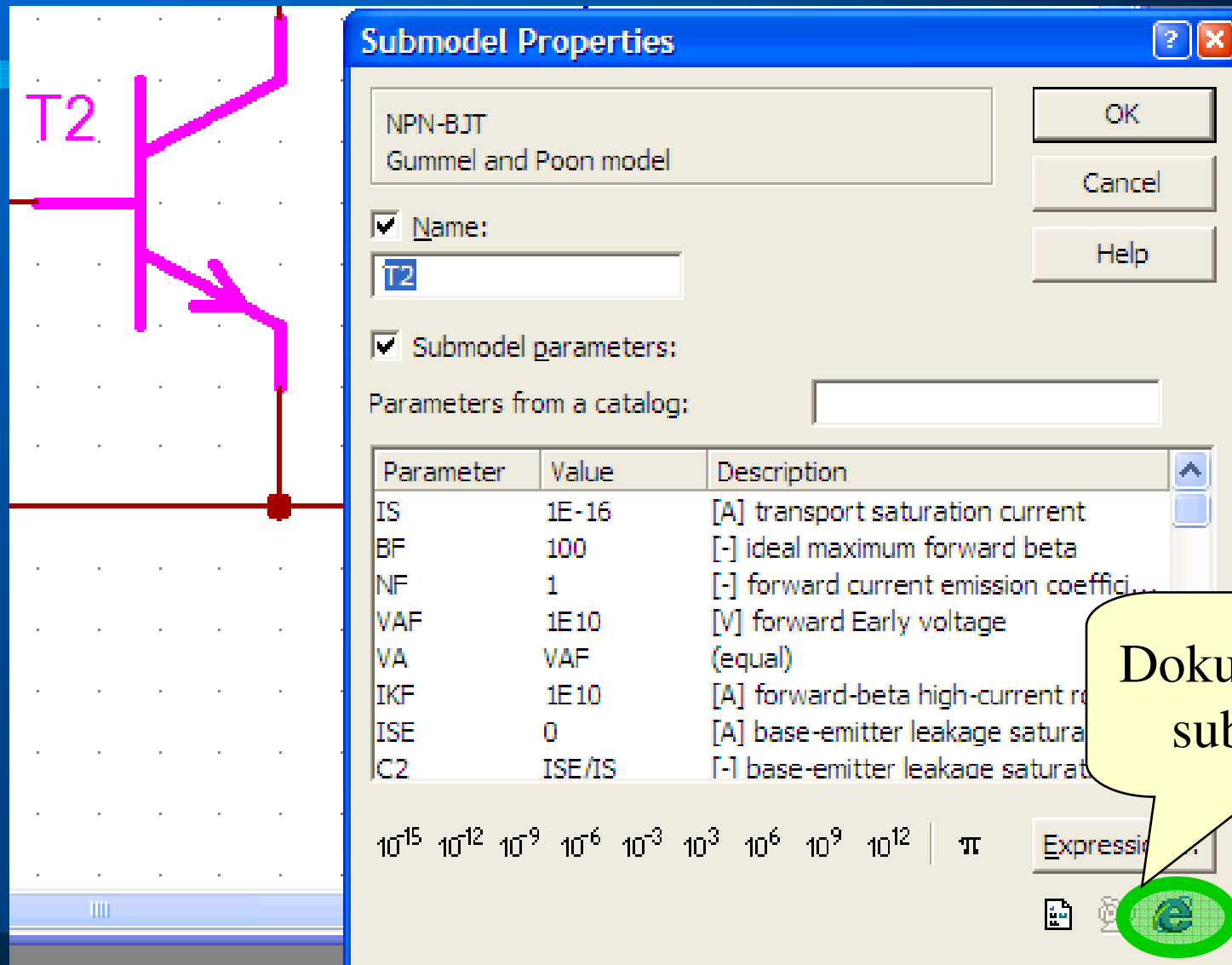
Submodel parameters:

Parameters from a catalog:

Parameter	Value	Description
IS	1E-16	[A] transport saturation current
BF	100	[-] ideal maximum forward beta
NF	1	[-] forward current emission coeffi...
VA	1E10	[V] forward Early voltage
IKF	1E10	[A] forward-beta high-current roll-o...
ISE	0	[A] base-emitter leakage saturation ...
C2	ISE/IS	[-] base-emitter leakage saturation ...

$10^{-15}$   $10^{-12}$   $10^{-9}$   $10^{-6}$   $10^{-3}$   $10^3$   $10^6$   $10^9$   $10^{12}$  |  $\pi$  Expression...

# Vlastnosti submodelu



The image shows a circuit simulation software interface. On the left, a schematic diagram features a pink NPN BJT model labeled 'T2' with a red arrow indicating current flow. The main window is the 'Submodel Properties' dialog box, which is configured for an NPN-BJT using the Gummel and Poon model. The name 'T2' is entered in the 'Name' field. The 'Submodel parameters' section is checked, and a table lists various parameters and their values. A yellow callout bubble points to a help icon (a green circle with an 'e') in the bottom right corner of the dialog box.

**Submodel Properties**

NPN-BJT  
Gummel and Poon model

Name:  
T2

Submodel parameters:  
Parameters from a catalog:

Parameter	Value	Description
IS	1E-16	[A] transport saturation current
BF	100	[-] ideal maximum forward beta
NF	1	[-] forward current emission coefficient
VA	1E10	[V] forward Early voltage
VA	VA	(equal)
IKF	1E10	[A] forward-beta high-current recombination current
ISE	0	[A] base-emitter leakage saturation current
C2	ISE/IS	[-] base-emitter leakage saturation current ratio

10<sup>-15</sup> 10<sup>-12</sup> 10<sup>-9</sup> 10<sup>-6</sup> 10<sup>-3</sup> 10<sup>3</sup> 10<sup>6</sup> 10<sup>9</sup> 10<sup>12</sup> | π Expressi...

Dokumentace k submodelu

# Dokumentace submodelu

The screenshot shows a help window titled "Help" with a toolbar containing "Hide", "Back", "Print", and "Options". The left pane shows a "Contents" list with a search bar. The "Electronic" category is expanded, listing various models, with "NPN-BJT" selected. The right pane displays the documentation for "Model: NPN2" using the "Gummel and Poon model".

Model: NPN2 Gummel and Poon model

## NPN-BJT

**Figure NPN2-1:** Model symbol of the NPN-BJT.

### Assumptions

This is a dynamic Gummel and Poon model of the bipolar transistor.

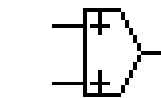
# Úvod do knihovny modelů DYNASTu

- **Bloky**
- **Fyzikální elementy**
- **Modely komponent**
  - **Elektronika**
  - **Hydraulika**
  - **Motory**
  - **Řídicí systémy**

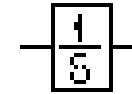


# Úvod do knihovny modelů DYNASTu

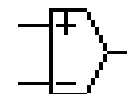
- **Bloky**
- **Fyzikální elementy**
- **Modely komponent**
  - Elektronika
  - Hydraulika
  - Motory
  - Řídicí systémy



summator



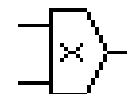
integrator



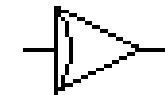
difference



2D vector integrator



multiplier



differentiator



static block



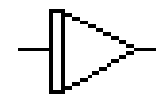
transport-delay block



scalar









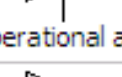

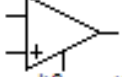








sample&amp;hold block



integrator

# Úvod do knihovny modelů DYNASTu

- Bloky
- Fyzikální elementy
- Modely komponent
  - Elektronika
  - Hydraulika
  - Motory
  - Řídicí systémy

— reference node (electrical ground)	
 source of current	
 electrical conductor	
 electrical resistor	
 electrical capacitor	
 electrical inductor	
 source of voltage	
 source of voltage	
 source of voltage	

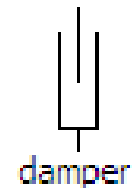
## Elektrické

# Úvod do knihovny modelů DYNASTu

- Bloky
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  - Elektronika
  - Hydraulika
  - Motory
  - Řídicí systémy

**Mechanické**

reference node (absolute frame)



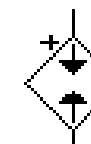
translatory inertor



translatory spring



source of velocity

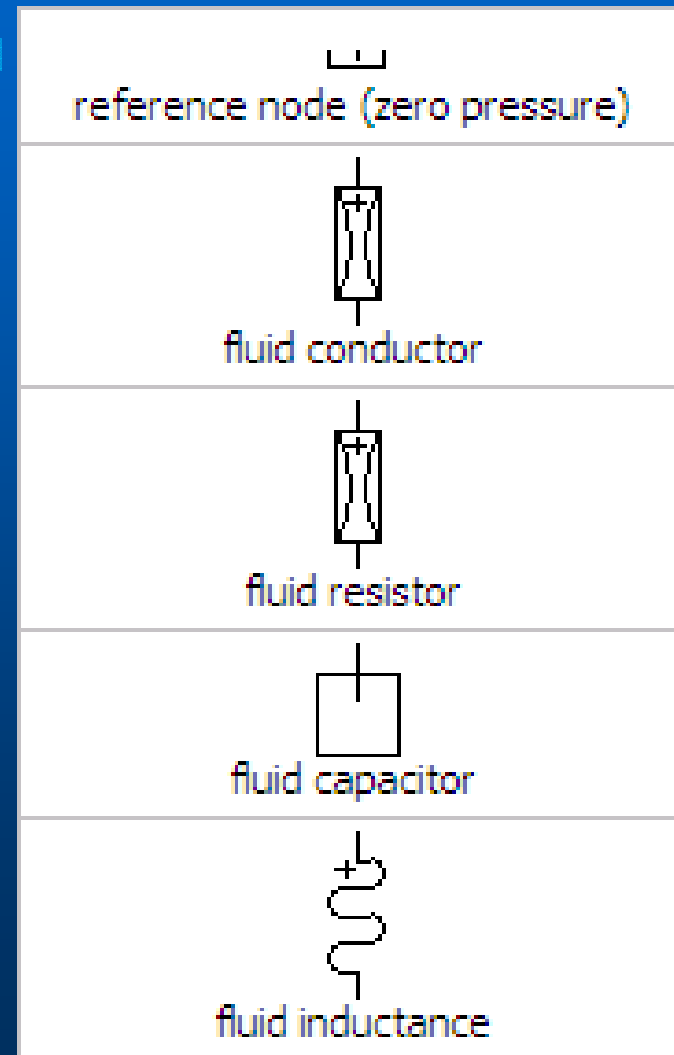


source of force

# Úvod do knihovny modelů DYNASTu

- Bloky
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  - Řídicí systémy

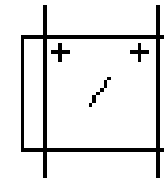
## Hydraulické



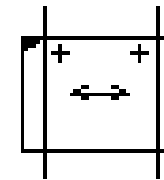
# Úvod do knihovny modelů DYNASTu

- Bloky
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  - Řídící systémy

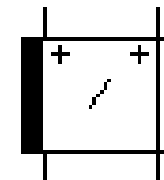
Vazby



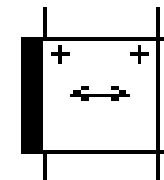
transfer transformer



transfer gyrator



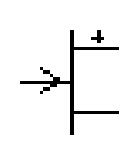
storing transformer



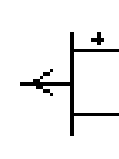
storing gyrator

# Úvod do knihovny modelů DYNASTu

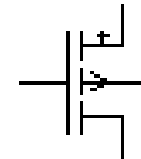
- Bloky
- Fyzikální elementy
- Modely komponent
  - Elektronika
  - Hydraulika
  - Motory
  - Řídící systémy



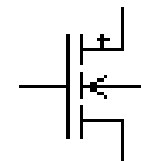
N-channel JFET



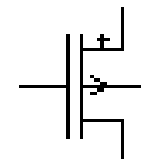
P-channel JFET



P-MOSFET enh



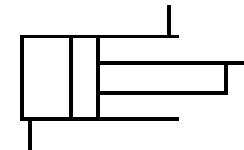
N-MOSFET enh



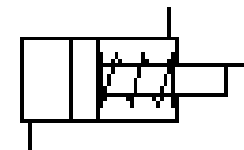
P-MOSFET dep

# Úvod do knihovny modelů DYNASTu

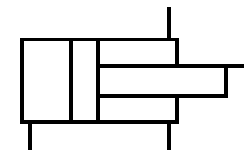
- Bloky
- Fyzikální elementy
- Modely komponent
  - Elektronika
  - **Hydraulika**
  - Motory
  - Řídicí systémy



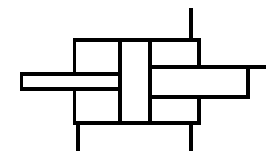
single-acting force-return



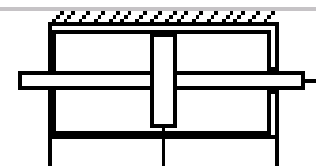
single-acting spring-return



double-acting single-rod



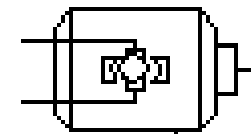
double-acting double-rod



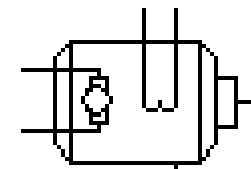
cylinder

# Úvod do knihovny modelů DYNASTu

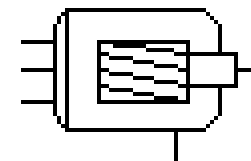
- Bloky
- Fyzikální elementy
- Modely komponent
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  - Hydraulika
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  - Řídicí systémy



permanent-magnet DC machine



excited DC machine

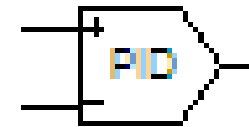


induction motor

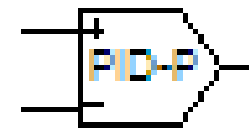


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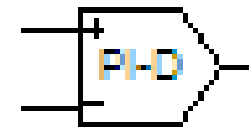
- Bloky
- Fyzikální elementy
- Modely komponent
  - Elektronika
  - Hydraulika
  - Motory
  - Řídicí systémy



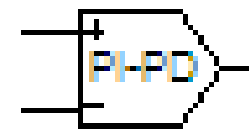
PID controller



PID\_P controller



PI\_D controller



PI\_PD controller

# Zadávání negrafických dat

- Části modelu, které nelze zadat graficky, lze zadávat pomocí formulářů
  - rovnice
  - uživatelské funkce
  - parametry submodelu atd.

# Definice nové rovnice

Insert Equation

Type:

Left-hand side:  
0

Right-hand side  
sin(Udd)

$10^{-15}$   $10^{-12}$   $10^{-9}$   $10^{-6}$   $10^{-3}$   $10^3$   $10^6$   $10^9$   $10^{12}$   $\pi$  Expression...

Statement  
0 = sin(Udd);

Insert  
Cancel  
Help

Pravá strana rovnice  
(symbolický výraz)

# Definice nové rovnice

Nabídka proměnných,  
funkcí a operátorů

**Insert Equation**

Type:

Left-hand side:

Right-hand side:

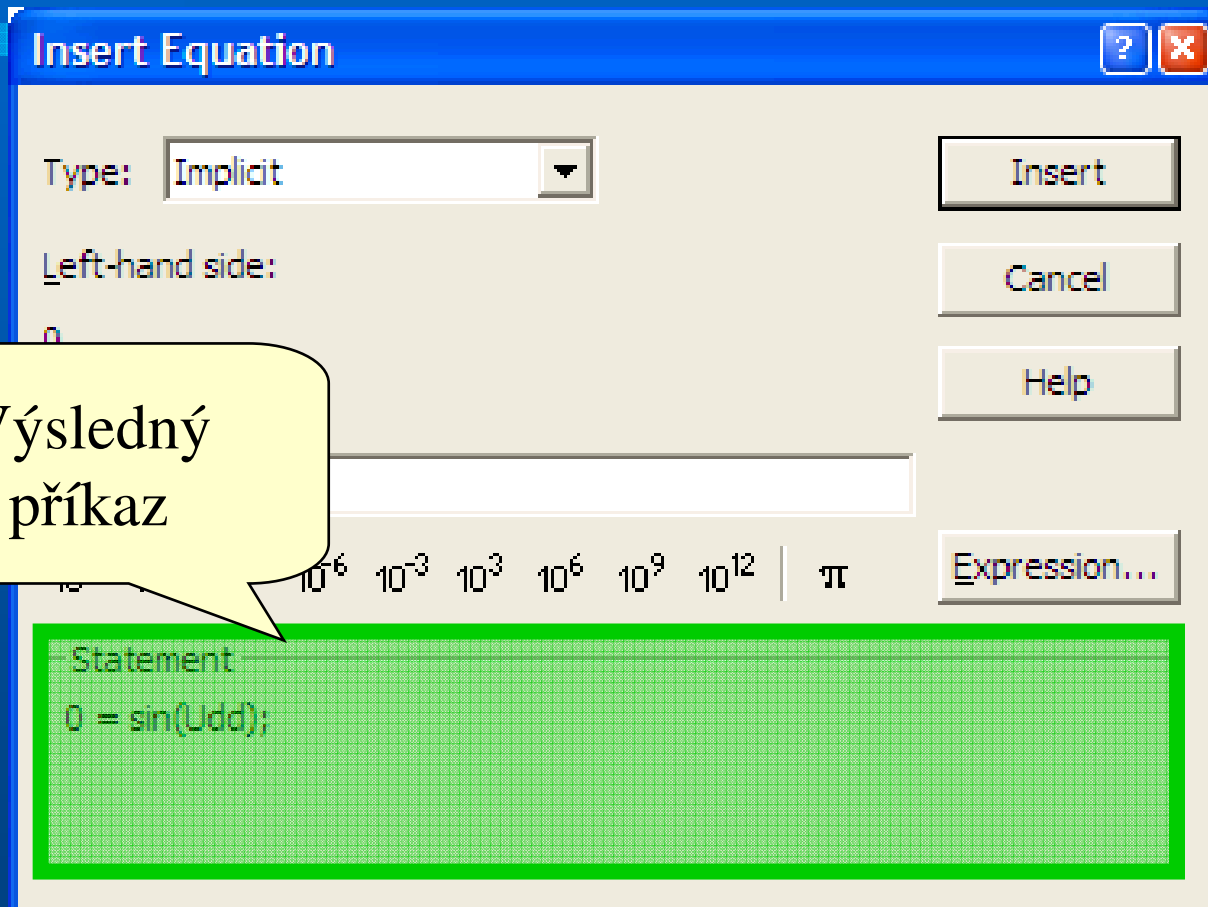
Statement:  $0 = \sin(\dots)$

**Expression**

Variables:		Functions:	Operators:
Symbol	Description	Standard functions:	
Solved variables:		( )	+ addition
Udd		ABS()	- subtraction
VB1 [V]		ACOS()	* multiplication
VC1 [V]		ACTN()	/ division
VB2		ASIN()	** power
VC2		ATAN()	= equal
Element across variables:		ATAN2()	<> not equal
V.Edd		COS()	< less than
V.R1		COSH()	<= less or equal
V.R2		COTGH()	> greater than
V.R4		CTN()	>= greater or equal
V.R3		E10()	& logical AND
V.C1		EXP()	logical OR
			% differentiation

Undo Help Close <<

# Definice nové rovnice



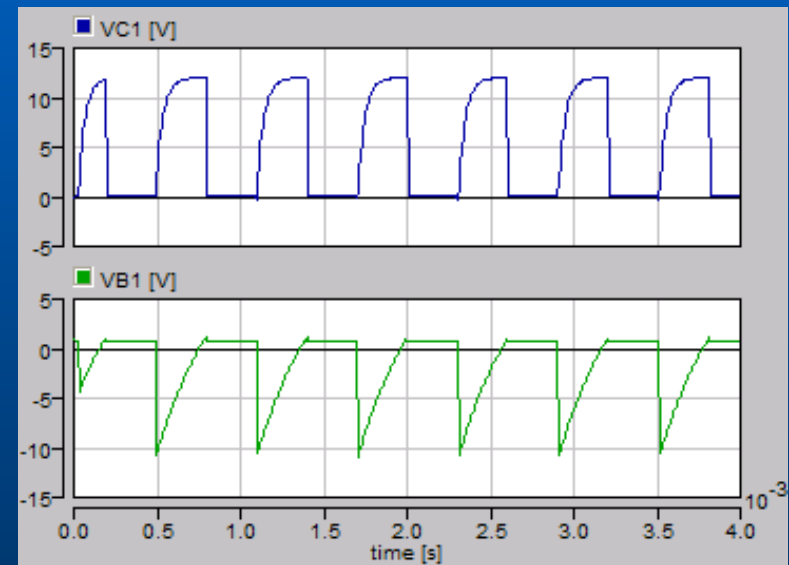
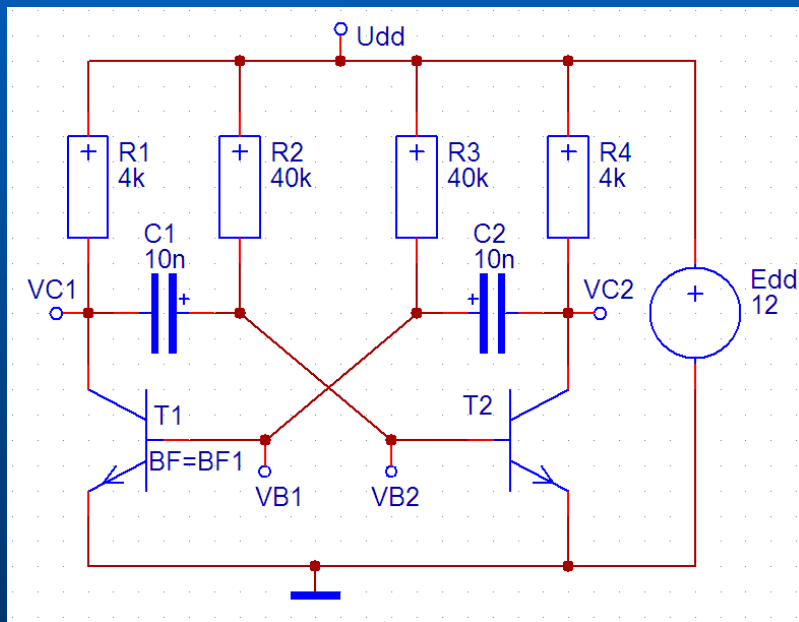
# Příprava simulačních modelů

- Specifikace modelu
- Specifikace analýzy

# Typy analýz

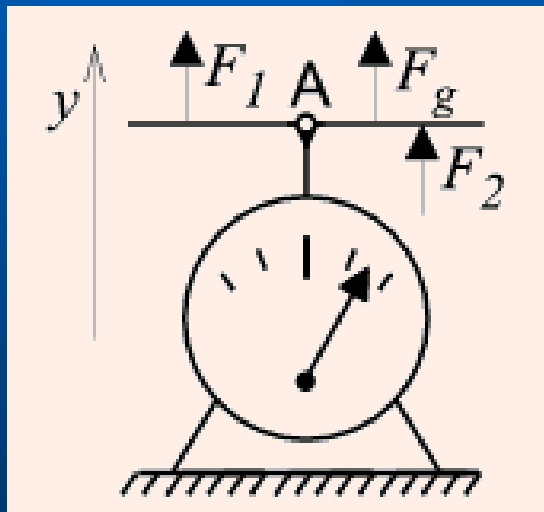
- **Numerická nelineární analýza**
  - analýza nelineární soustavy v časové oblasti
  - statická analýza (výpočet pracovního bodu)
- **Numerická frekvenční analýza**
  - analýza lineární soustavy ve frekvenční oblasti
- **Semisymbolická lineární analýza**
  - analýza lineární soustavy v časové nebo frekvenční oblasti, v symbolickém tvaru

# Numerická nelineární analýza



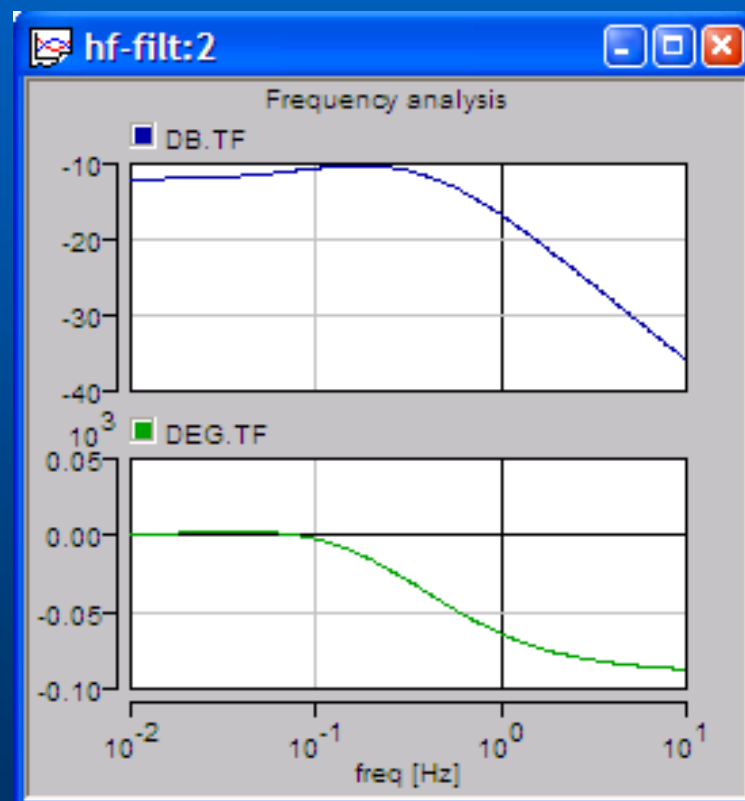
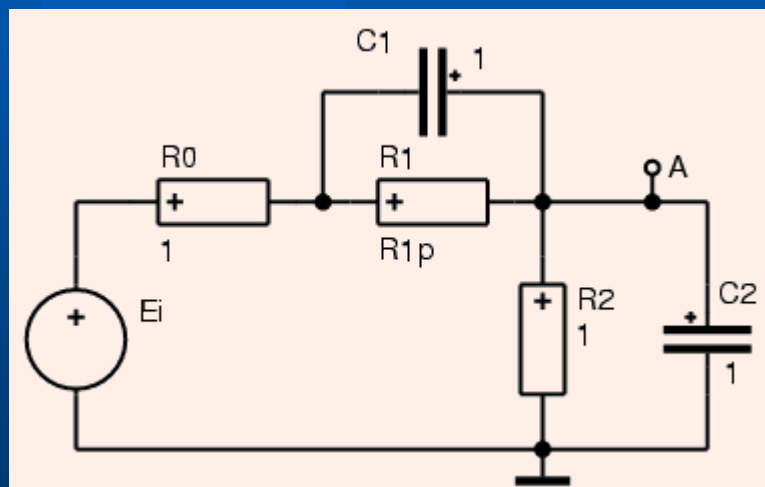


# Numerická nelineární analýza

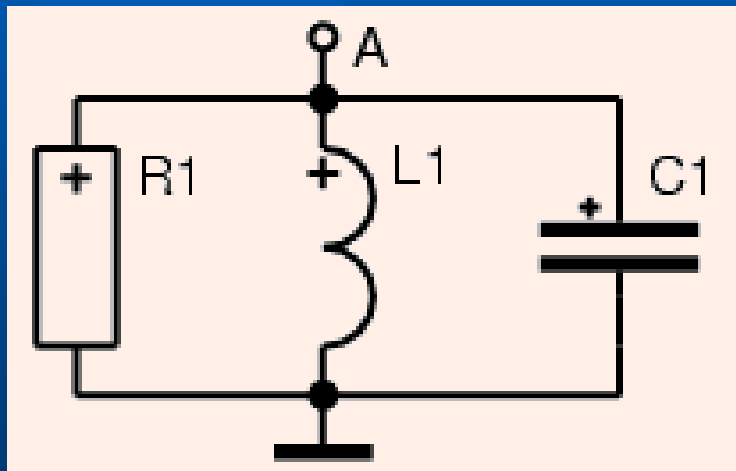


1	...	F1	3.500000e+000
2	...	F2	-4.500000e+000
3	...	I.Emeter	-1.981000e+000
4	...	Fg	-9.810000e-001
5	...	Fsum	-2.220446e-016

# Frekvenční analýza



# Semisymbolická analýza



$$v_C(s) = \frac{s - 1}{(s - 0.5 - j 0.866)(s - 0.5 + j 0.866)}$$

$$i_L(s) = \frac{s + 2}{(s - 0.5 - j 0.866)(s - 0.5 + j 0.866)}$$

$$v_C(t) = 2 \exp^{-0.5 t} \cos(0.866 t - 1.047)$$

$$i_L(t) = 2 \exp^{-0.5 t} \cos(0.866 t + 1.047)$$

# Specifikace analýzy

- Numerická nelineární analýza

The image shows a dialog box titled "Numerical Nonlinear Analysis" with a blue title bar and standard window controls (help, close). The dialog has four tabs: "Analysis", "Desired Variables", "Initial Values", and "Computation Control". The "Analysis" tab is active. It contains three radio button options for "Analysis mode": "Transient" (selected), "Static steady-state", and "Fourier". The "Transient" option has input fields for "from: 0" and "to: 1" with "[s]" units. The "Static steady-state" option has a "parametric" checkbox and a "Parameter" dropdown menu with "swept from:" and "to:" input fields. The "Fourier" option has input fields for "Period: 1" [s], "Harmonics: 10", and "Points: 128". Below these is a "Desired results" section with a checkbox for "Equidistant results" at "501" points and a checkbox for "Hold results". At the bottom are "OK", "Cancel", and "Help" buttons.

**Numerical Nonlinear Analysis** [?] [X]

Analysis | Desired Variables | Initial Values | Computation Control

Analysis mode:

**Transient** from:  to:  [s]

**Static steady-state**

parametric

Parameter:  swept from:  to:

**Fourier** Period:  [s] Harmonics:  Points:

Desired results:

Equidistant results at  points  Hold results

OK Cancel Help

# Specifikace analýzy

Typ analýzy

## Numerická nelineární analýza

**Numerical Nonlinear Analysis** [?] [X]

Analysis | Desired Variables | Initial Values | Computation Control

Analysis mode:

**Transient** from:  to:  [s]

**Static steady-state**

parametric

Parameter:  swept from:  to:

**Fourier** Period:  [s] Harmonics:  Points:

Desired results:

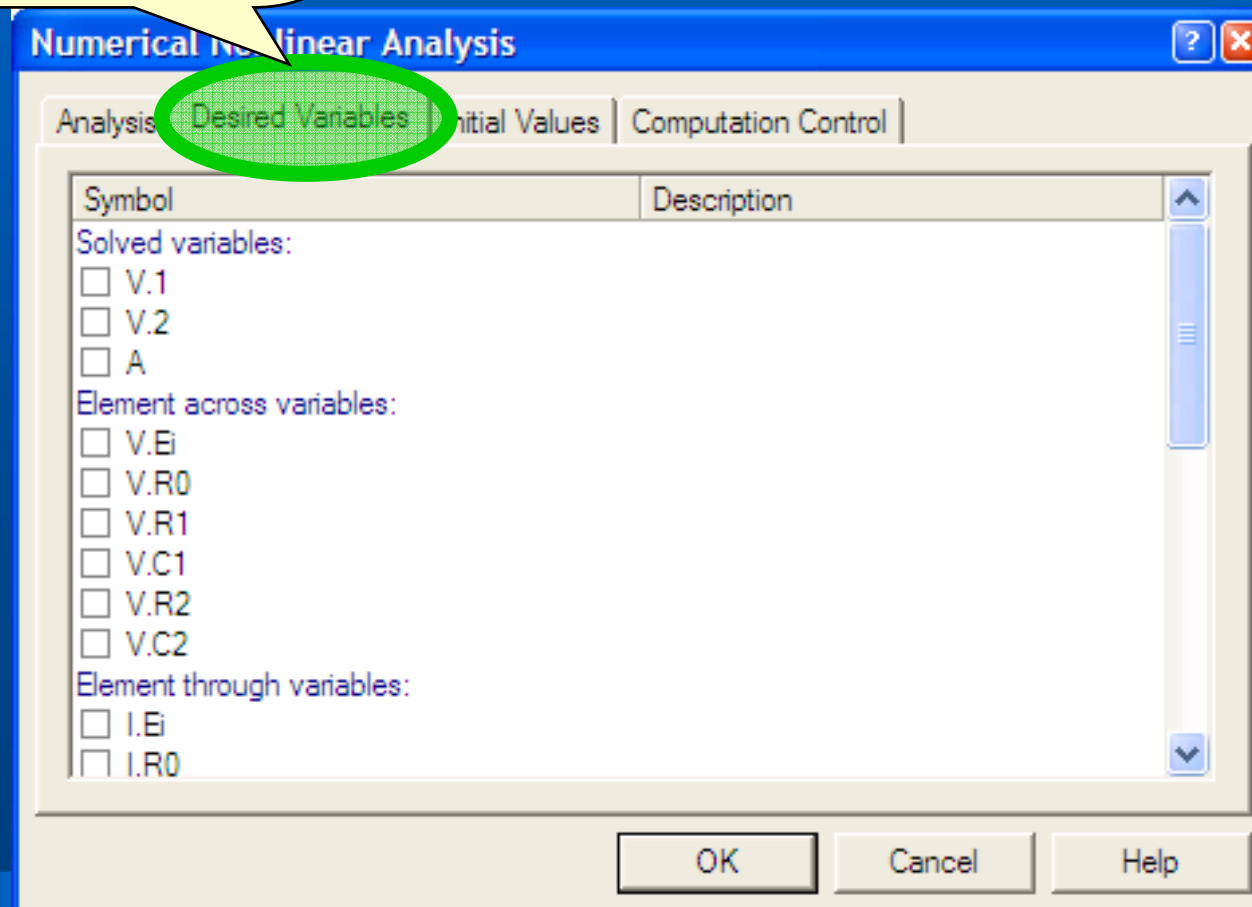
**Equidistant results** at:  points  **Hold results**

OK Cancel Help

# Specifikace analýzy

Výstupní  
proměnné

## á nelineární analýza

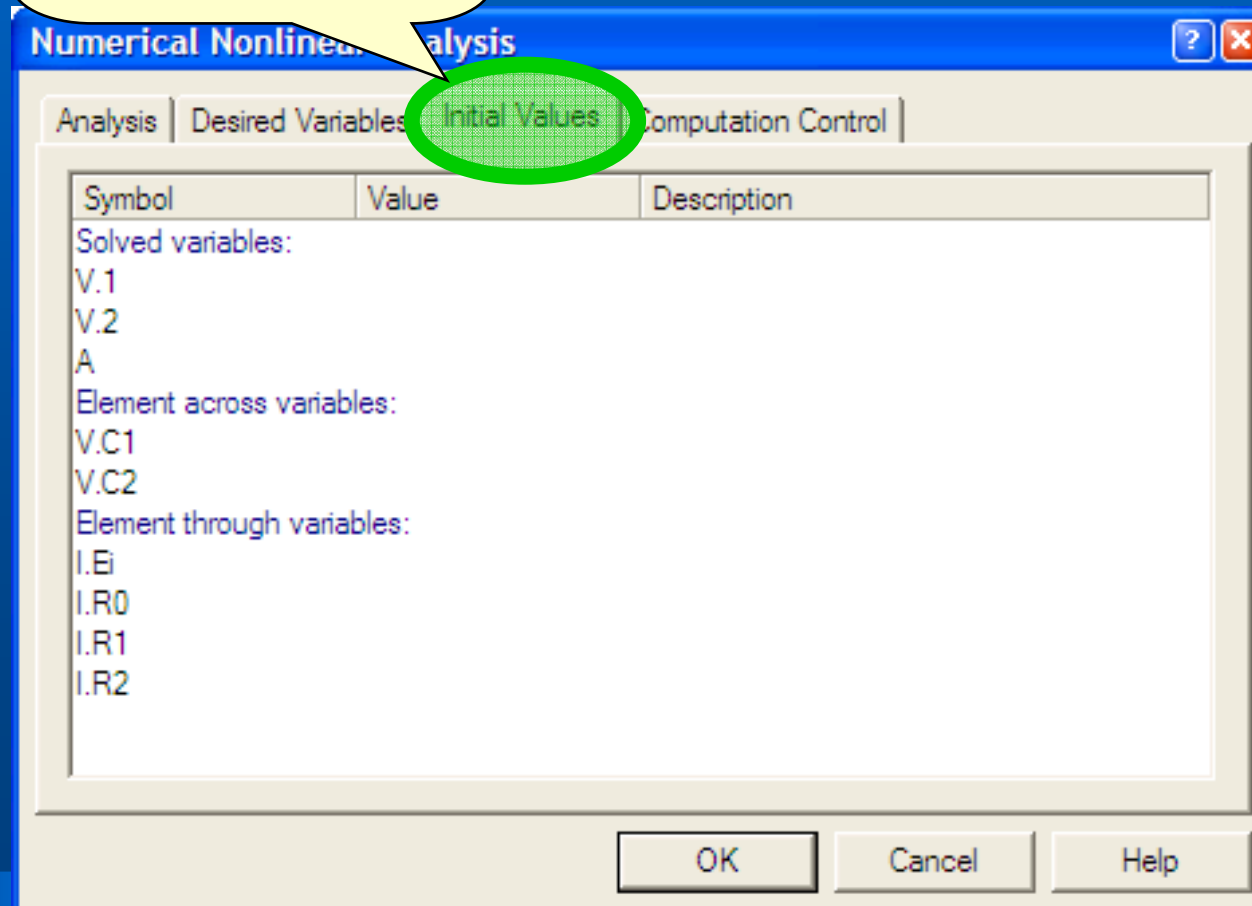


# Specifikace analýzy

- N

Počáteční  
podmínky

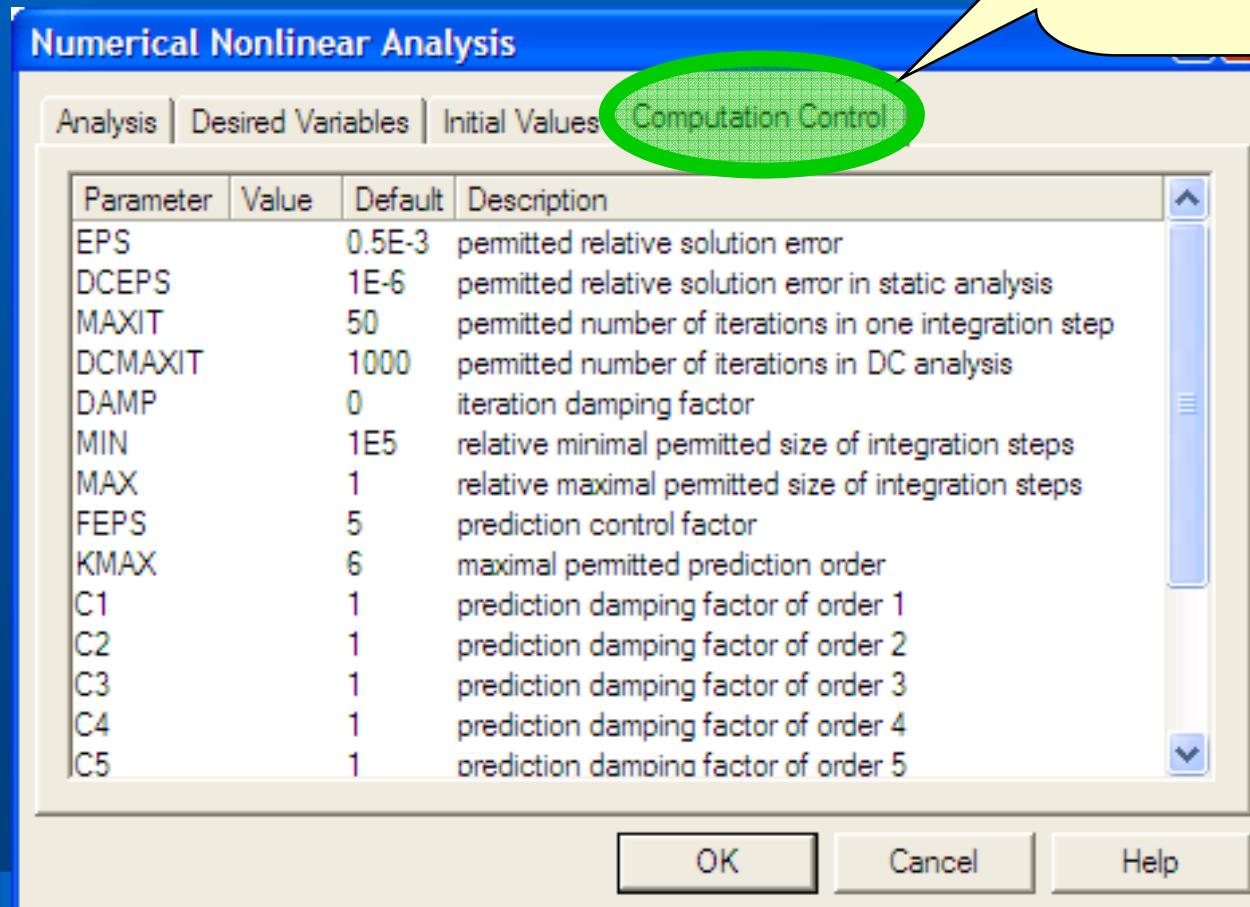
## lineární analýza



# Specifikace analýzy

- Numerická nelineární analýza

Řízení výpočtu

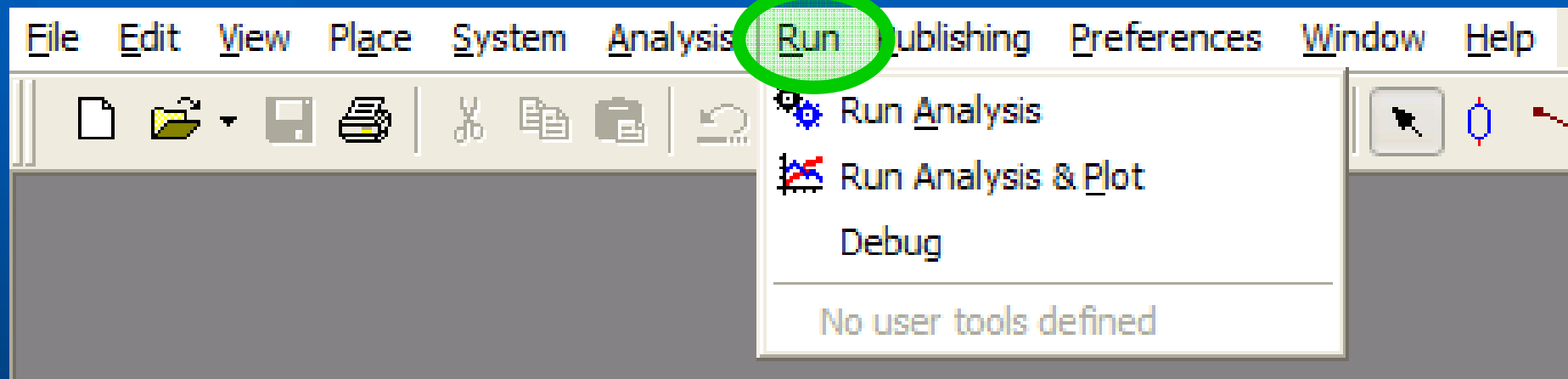




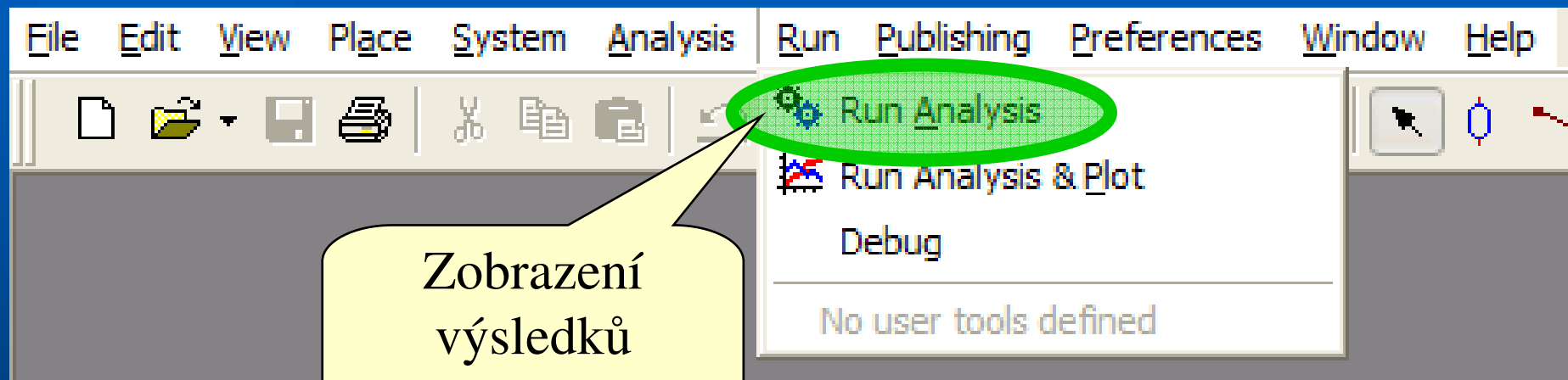
# Spouštění simulátoru

- **Jakmile jsou vstupní data připravena pro výpočet, je možné spustit simulátor DYNAST**
- **Existuje několik verzí simulátoru**
  - Free verze
  - Studentská verze
  - Profesionální verze
  - Online verze

# Spouštění simulátoru

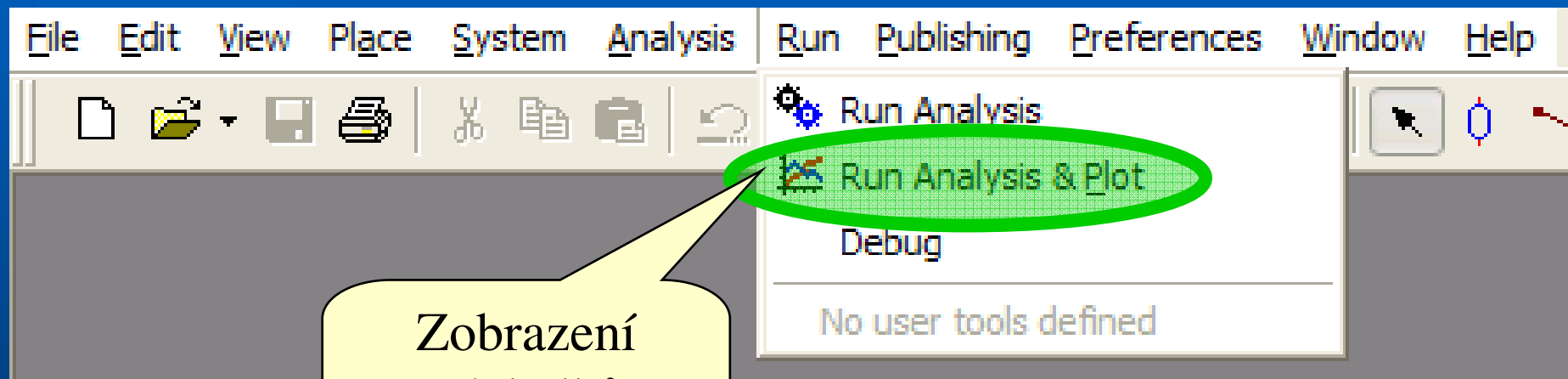


# Spouštění simulátoru



Zobrazení  
výsledků  
**textově**

# Spouštění simulátoru

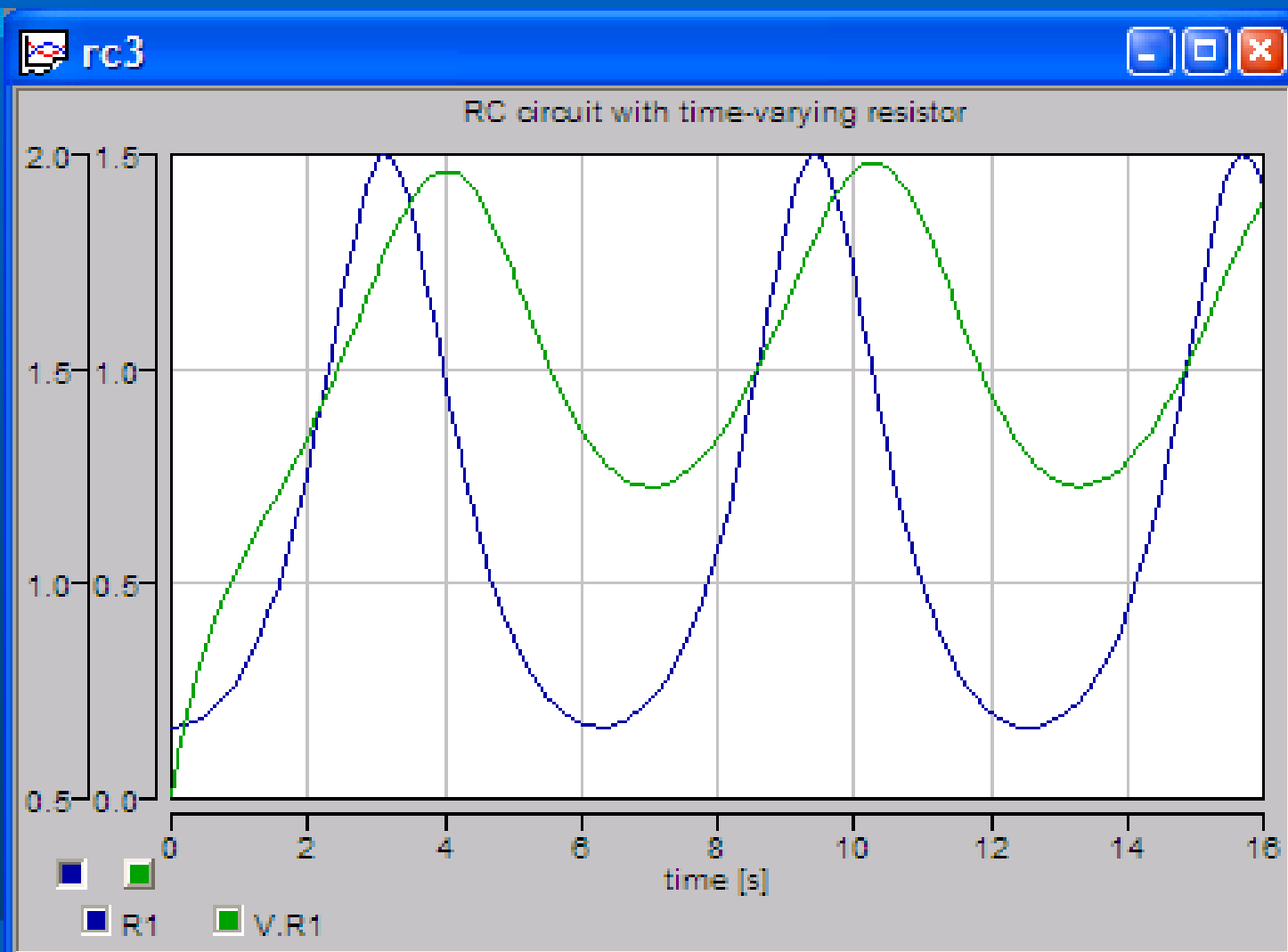


Zobrazení  
výsledků  
graficky

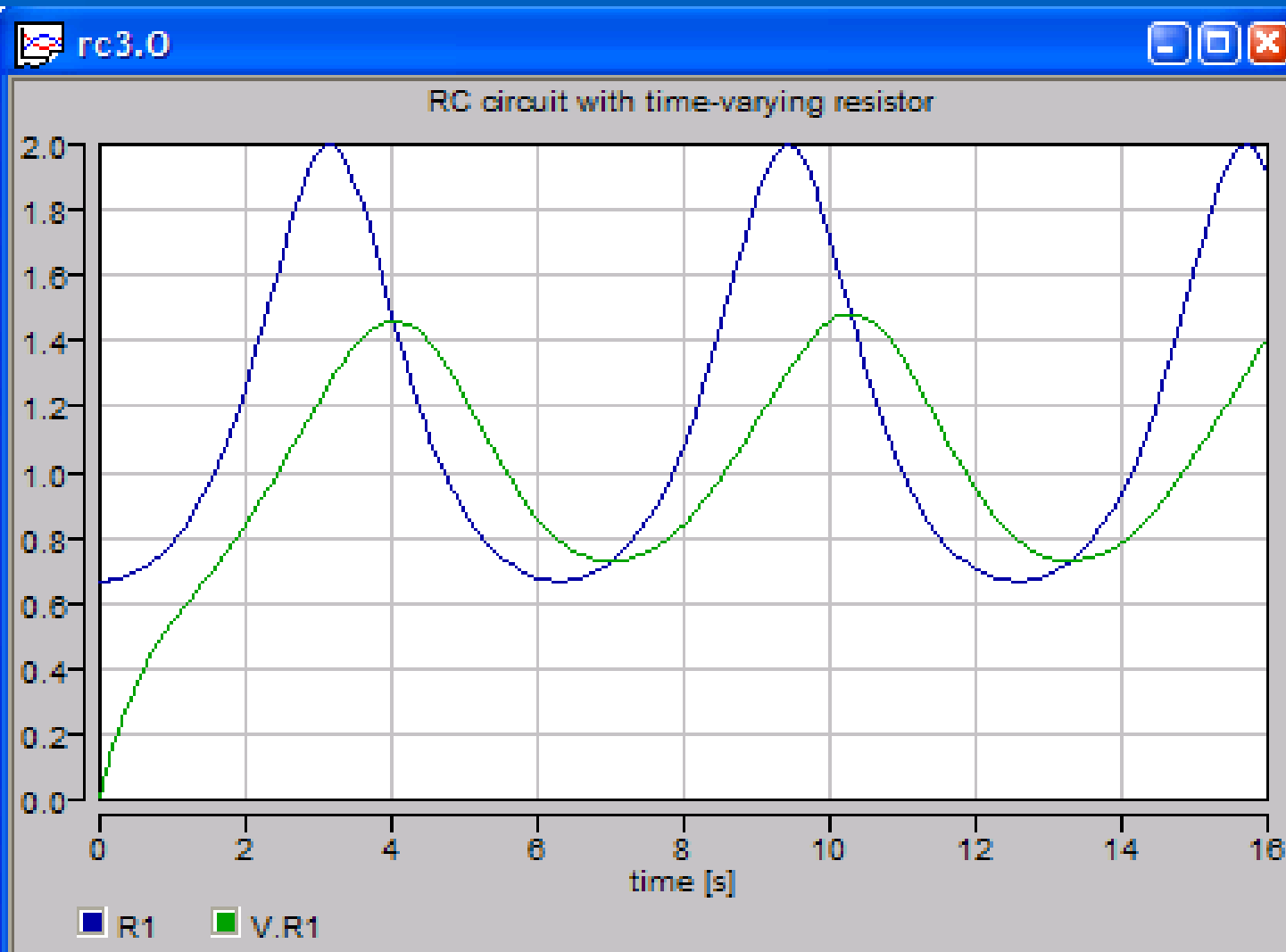
# Grafická prezentace výsledků

- **Zobrazovač grafů**
  - Zobrazování numerických dat ve formě grafů
  - Různé režimy zobrazení
  - Speciální pomůcky (odečítání souřadnic, sledování křivek, kurzor)
  - Export do jiných programů (např. MS Excel)

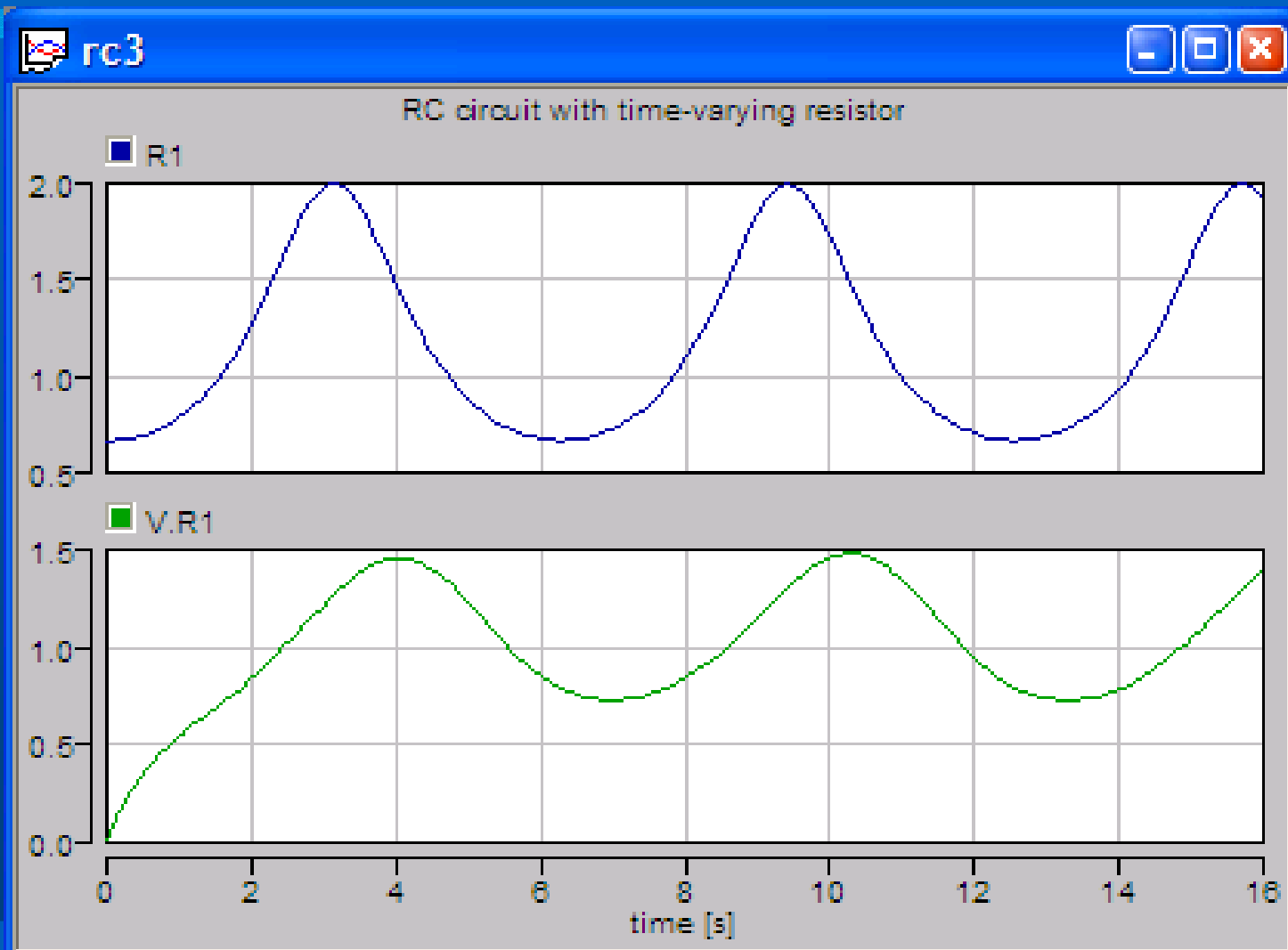
# Režimy zobrazování



# Režimy zobrazování

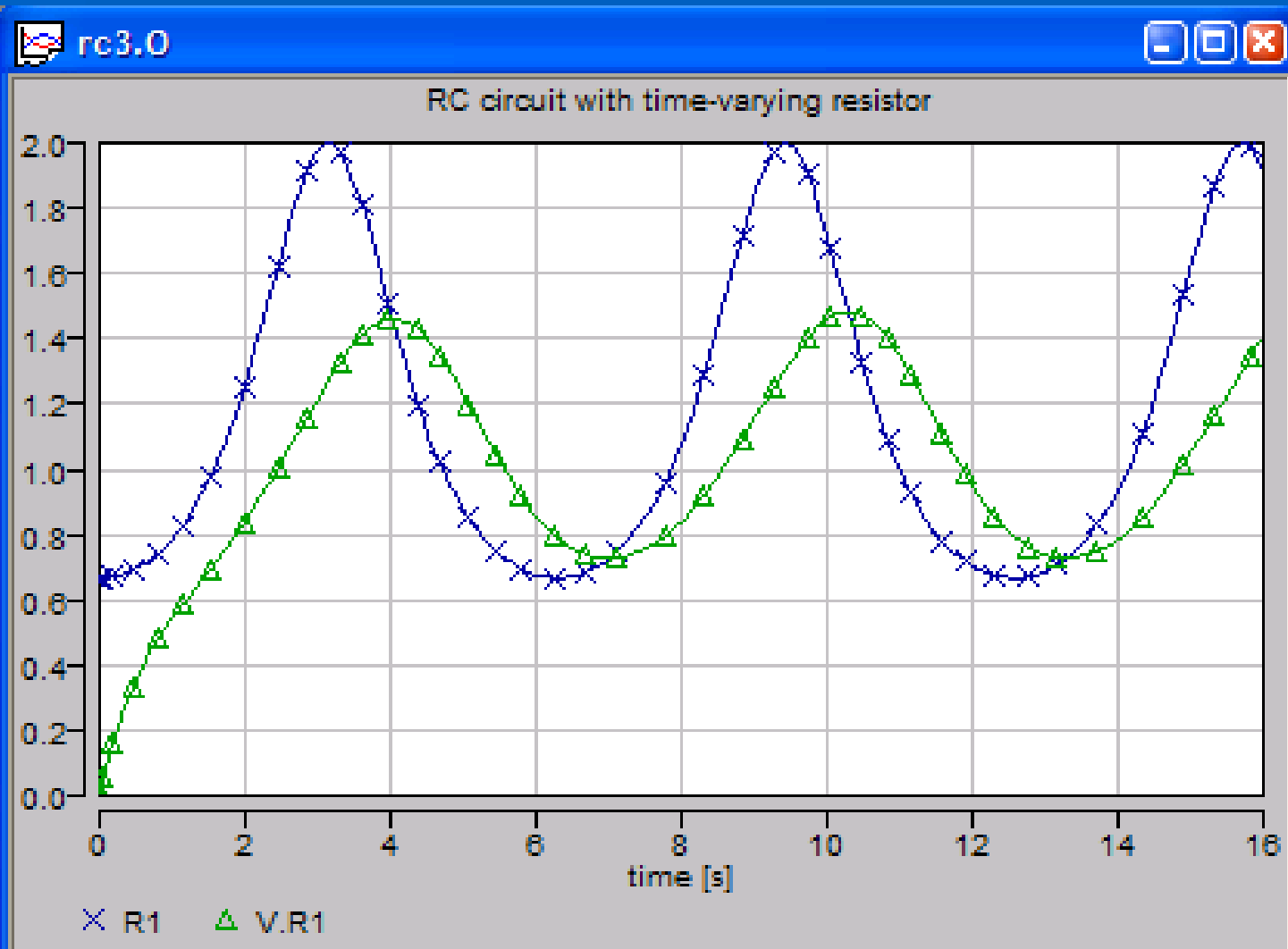


# Režimy zobrazování

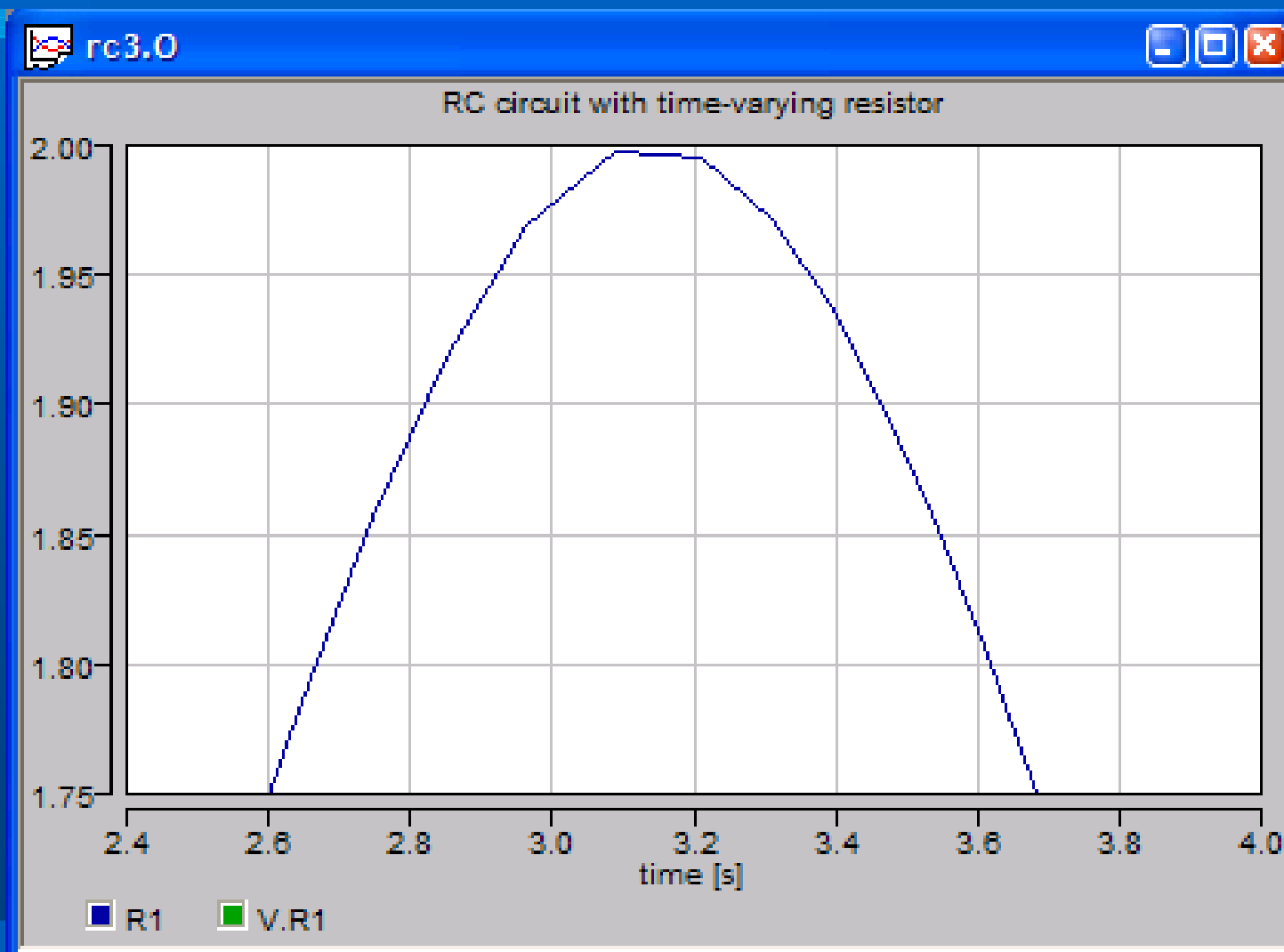




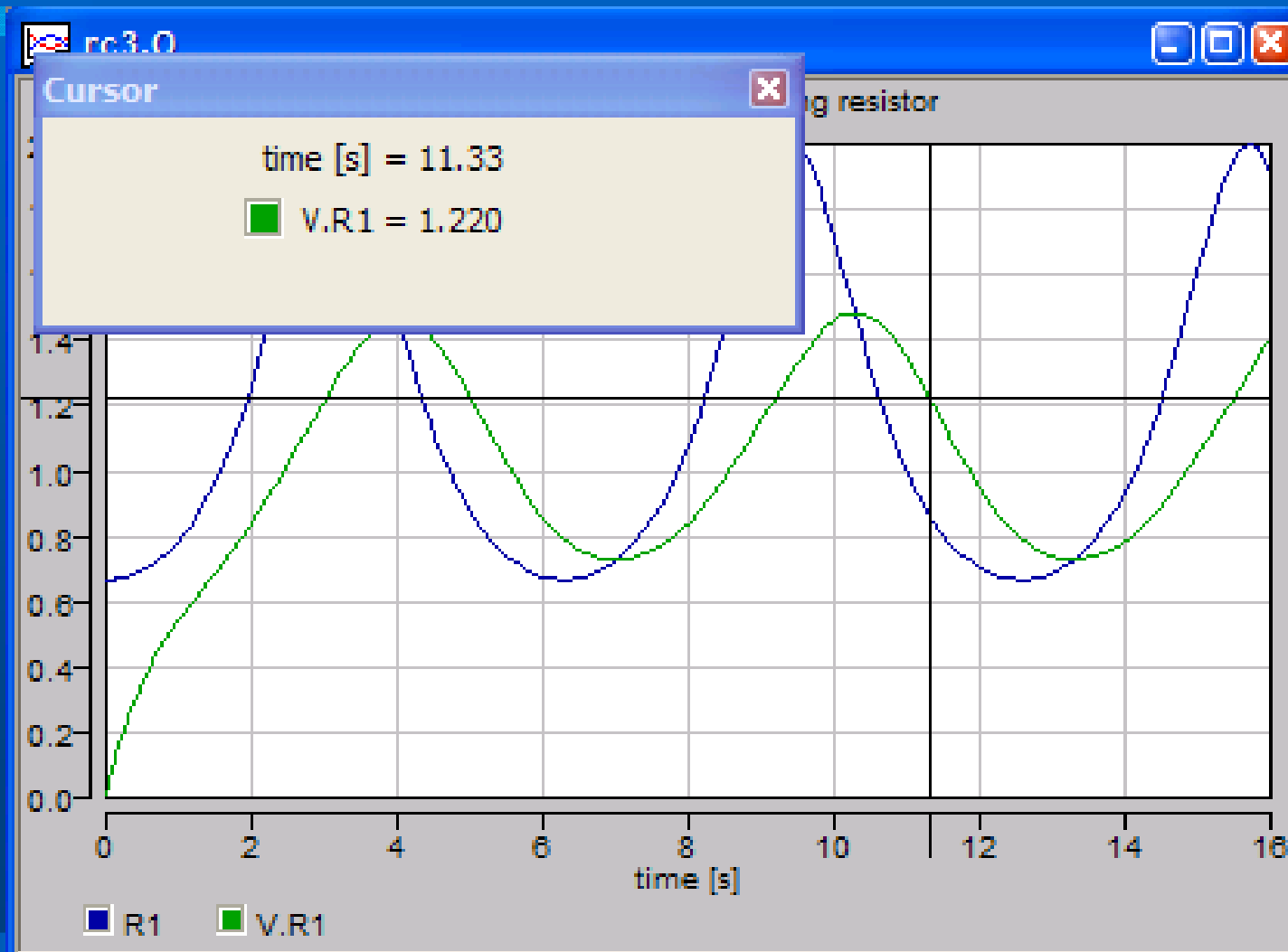
# Režimy zobrazování



# Detail (zoom)



# Sledování křivky



# Textová prezentace výsledků

```
rc3.o
Number of nodes:      1
Number of equations:  2

RC circuit with time-varying resistor

X ...    time [s]
1 ...    R1
2 ...    V.R1

      X              1              2
0.000000e+000  6.666667e-001  0.000000e+000
1.600000e-004  6.666667e-001  1.599616e-004
3.200000e-004  6.666667e-001  3.198848e-004
4.800000e-004  6.666667e-001  4.797697e-004
6.400000e-004  6.666667e-001  6.396162e-004
8.000000e-004  6.666667e-001  7.994371e-004
9.600000e-004  6.666668e-001  9.592255e-004
1.120000e-003  6.666668e-001  1.118976e-003
1.280000e-003  6.666668e-001  1.278688e-003
1.553596e-003  6.666669e-001  1.551704e-003
1.962718e-003  6.666671e-001  1.959748e-003
2.662306e-003  6.666675e-001  2.656914e-003
3.858585e-003  6.666683e-001  3.847357e-003
5.647439e-003  6.666702e-001  5.623505e-003
```

# Textová prezentace výsledků

```
ASTABLE.O
Number of implicit equations: 30

Astable multivibrator

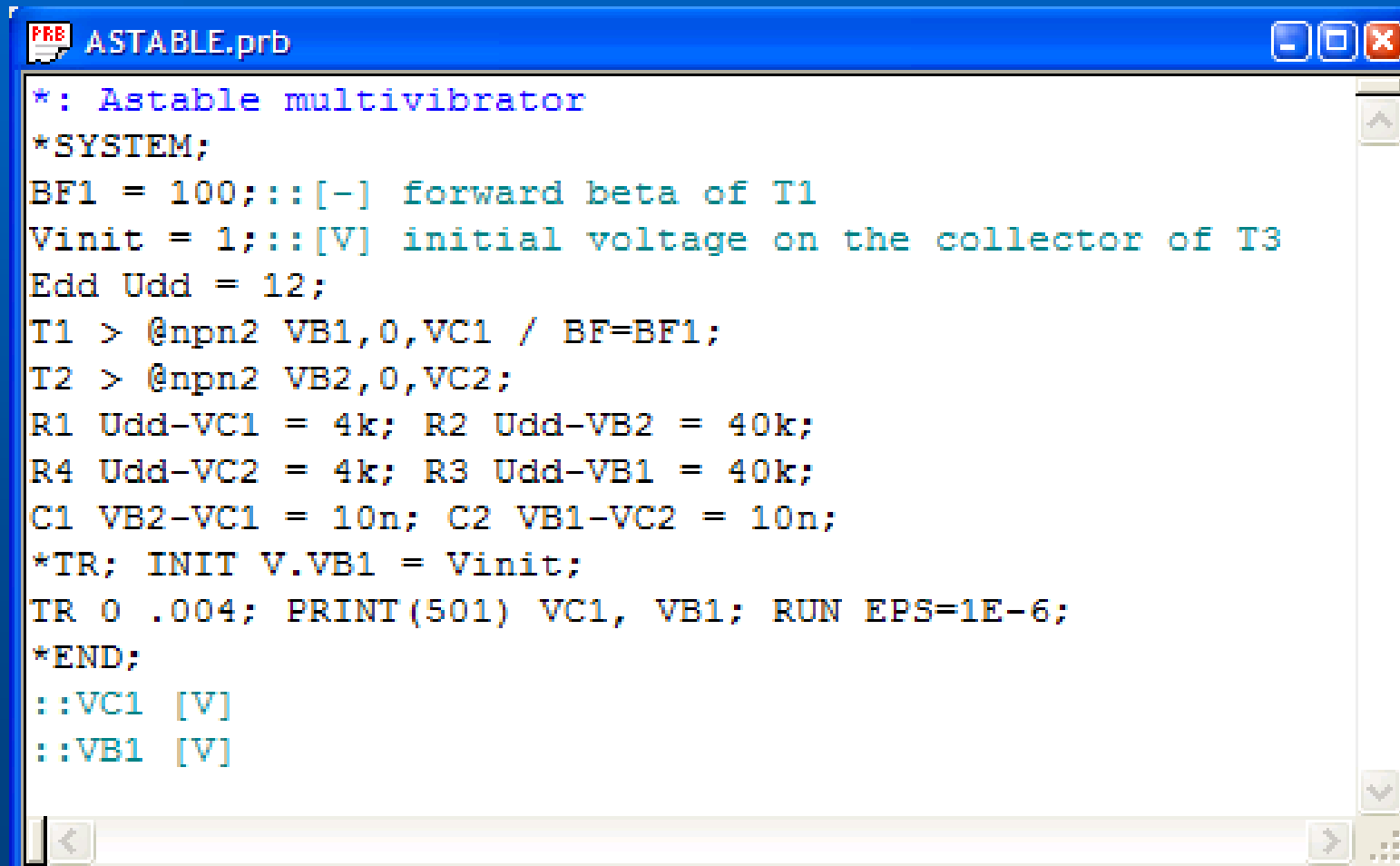
X ...      time [s]
1 ...      VC1 [V]
2 ...      VB1 [V]

          X          1          2
0.000000e+000  0.000000e+000  1.000000e+000
?Warning: No convergence
8.000000e-006  3.019246e-002  8.297441e-001
1.600000e-005  3.203121e-002  8.269257e-001
?Warning: No convergence
?Warning: No convergence
?Warning: No convergence
2.400000e-005  5.034058e-002  8.042996e-001
3.200000e-005  8.725907e-001 -4.218552e+000
4.000000e-005  2.886386e+000 -3.895645e+000
4.800000e-005  4.526764e+000 -3.579155e+000
5.600000e-005  5.879368e+000 -3.268597e+000
```

# Textová specifikace modelů

- **Data pro simulátor lze zadávat ručně v textové podobě, pomocí vstupního jazyka DYNASTu**
- **K tomu slouží specializovaný textový editor**

# Textová specifikace modelů



```
PRB ASTABLE.prb
*: Astable multivibrator
*SYSTEM;
BF1 = 100;::[-] forward beta of T1
Vinit = 1;::[V] initial voltage on the collector of T3
Edd Udd = 12;
T1 > @nnp2 VB1,0,VC1 / BF=BF1;
T2 > @nnp2 VB2,0,VC2;
R1 Udd-VC1 = 4k; R2 Udd-VB2 = 40k;
R4 Udd-VC2 = 4k; R3 Udd-VB1 = 40k;
C1 VB2-VC1 = 10n; C2 VB1-VC2 = 10n;
*TR; INIT V.VB1 = Vinit;
TR 0 .004; PRINT(501) VC1, VB1; RUN EPS=1E-6;
*END;
::VC1 [V]
::VB1 [V]
```

# Textová specifikace modelů

```
PRB ASTABLE.prb
*: Astable multivibrator
*SYSTEM;
BF1 = 100;::[-] forward beta of T1
Vinit = 1;::[V] initial voltage on the collector of T3
T1 > @npn2 VB1,0,VC1 / BF=BF1;
R1 Udd-VC1 = 4k; R2 Udd-VB2 = 40k;
R4 Udd-VC2 = 4k; R3 Udd-VB1 = 40k;
C1 VB2-VC1 = 10n; C2 VB1-VC2 = 10n;
*TR; INIT V.VB1 = Vinit;
TR 0 .004; PRINT(501) VC1, VB1; RUN EPS=1E-6;
*END;
::VC1 [V]
::VB1 [V]
```



# Textová specifikace modelů

Název  
součástky

```
T1 > @npn2 VB1, 0, VC1 / BF=BF1;
```

# Textová specifikace modelů

Název  
submodelu

```
T1 > @nbn2 VB1, 0, VC1 / BF=BF1;
```

# Textová specifikace modelů

Zapojení  
součástky do  
systému

```
T1 > @npn2 VB1,0,VC1 / BF=BF1;
```

# Textová specifikace modelů

Parametry  
součástky

```
T1 > @npn2 VB1, 0, VC1 / BF=BF1:
```

# Tvorba dokumentace

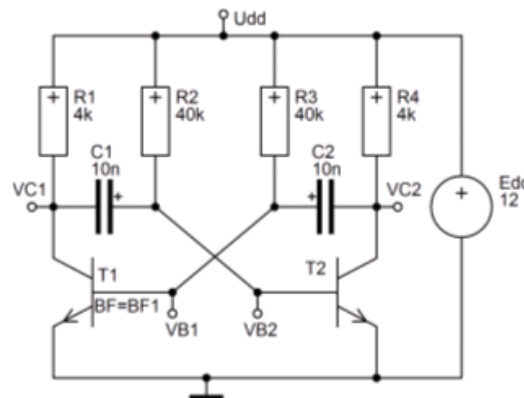
- Podpora pro tvorbu dokumentace vně DYNSELLu
- Integrovaný dokumentační systém

# Tvorba dokumentace

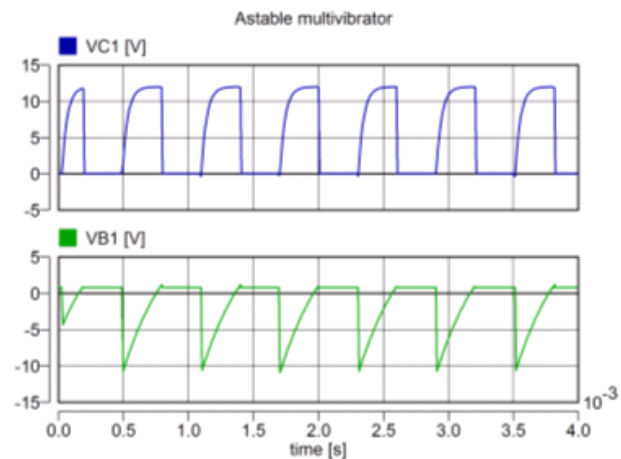
- Dokumentaci lze vytvářet nezávisle na aplikaci DYN SHELL, pomocí libovolného textového procesoru
- Do dokumentace lze kopírovat objekty z DYN SHELLu (diagramy, grafy apod.)

# Tvorba dokumentace

Příklad dokumentace vytvořené v MS Wordu



Obrázek 1: zapojení obvodu



Obrázek 2: výsledky simulace

# Integrovaný dokumentační systém

- Příkazy pro dokumentaci jsou součástí specifikace modelu
- Výstup je generován v různých formátech (HTML, PDF, Flash)
- Vhodné pro zpracování většího množství dokumentů

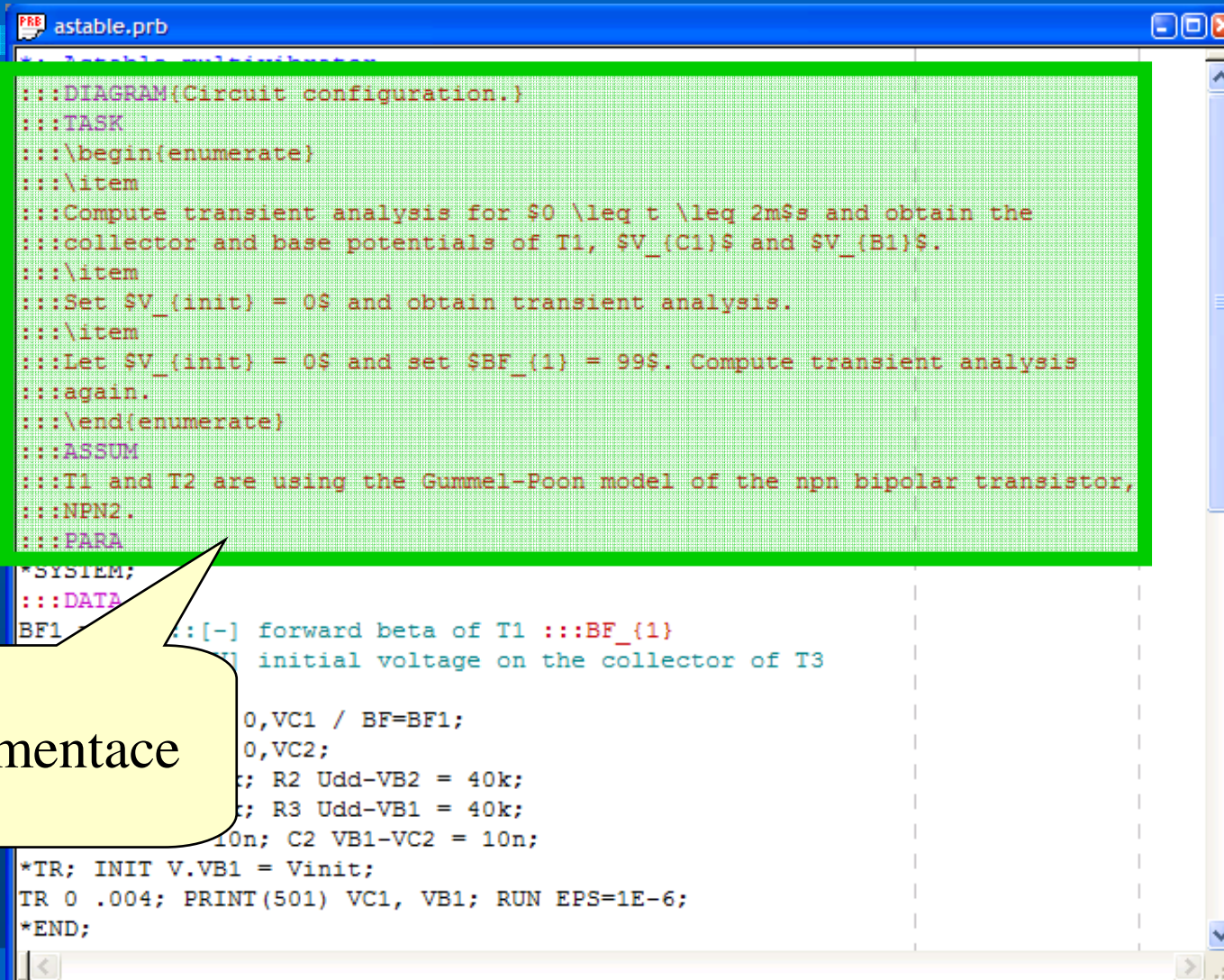


# Integrovaný dokumentační systém

```
astable.prb
*: Astable multivibrator
:::DIAGRAM{Circuit configuration.}
:::TASK
:::\begin{enumerate}
:::\item
:::Compute transient analysis for $0 \leq t \leq 2m\$s and obtain the
:::collector and base potentials of T1, $V_{C1}$ and $V_{B1}$.
:::\item
:::Set $V_{init} = 0\$ and obtain transient analysis.
:::\item
:::Let $V_{init} = 0\$ and set $BF_{1} = 99\$. Compute transient analysis
:::again.
:::\end{enumerate}
:::ASSUM
:::T1 and T2 are using the Gummel-Poon model of the npn bipolar transistor,
:::NPN2.
:::PARA
*SYSTEM;
:::DATA
BF1 = 100;:::[-] forward beta of T1 :::BF_{1}
Vinit = 1;:::[V] initial voltage on the collector of T3
Edd Udd = 12;
T1 > @nnp2 VB1,0,VC1 / BF=BF1;
T2 > @nnp2 VB2,0,VC2;
R1 Udd-VC1 = 4k; R2 Udd-VB2 = 40k;
R4 Udd-VC2 = 4k; R3 Udd-VB1 = 40k;
C1 VB2-VC1 = 10n; C2 VB1-VC2 = 10n;
*TR; INIT V.VB1 = Vinit;
TR 0 .004; PRINT(501) VC1, VB1; RUN EPS=1E-6;
*END;
```



# Integrovaný dokumentační systém



```
astable.prb
...
:::DIAGRAM{Circuit configuration.}
:::TASK
:::\begin{enumerate}
:::\item
:::Compute transient analysis for $0 \leq t \leq 2mS$ and obtain the
:::collector and base potentials of T1, $V_{(C1)}$ and $V_{(B1)}$.
:::\item
:::Set $V_{(init)} = 0$ and obtain transient analysis.
:::\item
:::Let $V_{(init)} = 0$ and set $BF_{(1)} = 99$. Compute transient analysis
:::again.
:::\end{enumerate}
:::ASSUM
:::T1 and T2 are using the Gummel-Poon model of the npn bipolar transistor,
:::NPN2.
:::PARA
*SYSTEM;
:::DATA
BF1 :[:] forward beta of T1 :::BF_{1}
Vinit :[:] initial voltage on the collector of T3

0,VC1 / BF=BF1;
0,VC2;
; R2 Udd-VB2 = 40k;
; R3 Udd-VB1 = 40k;
10n; C2 VB1-VC2 = 10n;
*TR; INIT V.VB1 = Vinit;
TR 0 .004; PRINT(501) VC1, VB1; RUN EPS=1E-6;
*END;
```

Dokumentace

# Integrovaný dokumentační systém

Example: ASTABLE

## Astable multivibrator

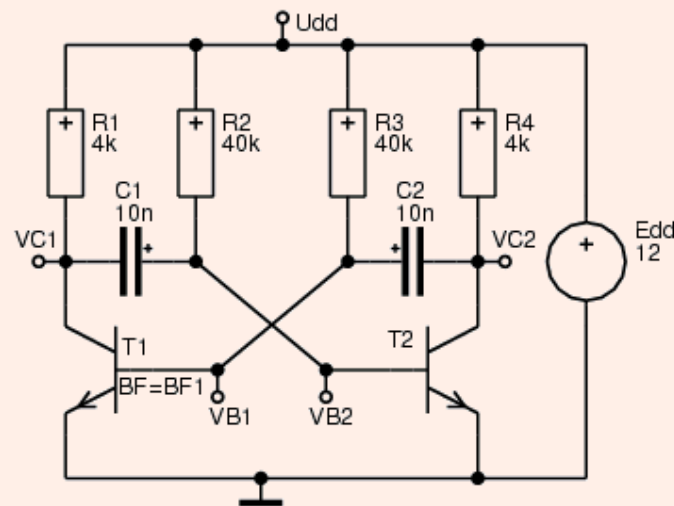


Figure 1: Circuit configuration.

### Task

1. Compute transient analysis for  $0 \leq t \leq 2ms$  and obtain the collector and base potentials of T1,  $V_{C1}$  and  $V_{B1}$ .
2. Set  $V_{init} = 0$  and obtain transient analysis.
3. Let  $V_{init} = 0$  and set  $BF_1 = 99$ . Compute transient analysis again.

### Assumptions

T1 and T2 are using the Gummel-Poon model of the npn bipolar transistor, NPN2.

# Nový dokumentační systém

- Založen na WYSIWYG editačním systému
- Lze používat jak běžné struktury (tabulky, seznamy, obrázky atd.), tak speciální DYNASTové objekty (diagramy, grafy, symboly)

# Nový dokumentační systém

DYNAST Documentation System

Editor Batch Processor

animations

- carrpend.prb
- eqs5.prb
- fallrod.prb
- flu.prb
- fluidmix.prb
- fourbar4.prb
- jojo.prb
- springp\_test.prb
- typos\_test.prb

control

electrical

electro-mechanical

electronic

ab

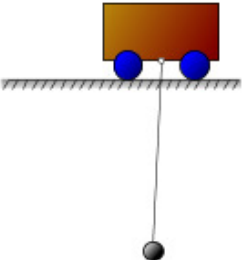
- Article Carriage with pendulum
  - System
  - Sites of Interaction
  - System Parameters
  - System excitation
  - Task
  - Assumptions
  - Solution
  - Last Update

File Insert

## Carriage with pendulum

**System**

The carriage is moving freely in the horizontal direction. The pendulum is suspended down from the carriage.



**Figure CARRPEND-1 Geometric configuration.**

**Sites of Interaction**

A	...	pendulum bob
B	...	pendulum suspension

**System Parameters**

mC	$m_C = 2$	[kg]	carriage mass
d	$d = 1$	[N.s/m]	carriage damping
m	$m = 1$	[kg]	bob mass

# Nový dokumentační systém

The screenshot displays the DYNAST software interface. On the left, a file explorer window is open, showing a directory structure with files like 'carrpend.prb', 'eqs5.prb', 'fluidmix.prb', and 'spring\_test.prb'. A green box highlights this file explorer. In the center, a diagram titled 'Carriage with pendulum' shows a carriage on wheels with a pendulum suspended from it. Below the diagram, the text reads 'Figure CARRPEND-1 Geometric configuration.' To the right of the diagram, there are sections for 'Sites of Interaction' and 'System Parameters'.

**Sites of Interaction**

A	...	pendulum bob
B	...	pendulum suspension

**System Parameters**

mC	$m_C = 2$	[kg]	carriage mass
d	$d = 1$	[N.s/m]	carriage damping
m	$m = 1$	[kg]	bob mass

Soubory  
(příklady a  
submodely)

# Nový dokumentační systém

Struktura  
vybraného  
souboru

DYNAST Documentation System

Editor Batch Processor

animations  
carrpend.prb  
5.prb  
rb  
rb  
est.prb  
t.prb  
-mechanical  
ic

File Insert

## Carriage with pendulum

**System**

The carriage is moving freely in the horizontal direction. The pendulum is suspended down from the carriage.

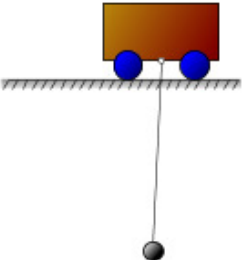


Figure CARRPEND-1 Geometric configuration.

**Sites of Interaction**

A	...	pendulum bob
B	...	pendulum suspension

**System Parameters**

mC	$m_C = 2$	[kg]	carriage mass
d	$d = 1$	[N.s/m]	carriage damping
m	$m = 1$	[kg]	bob mass

Article: Carriage with pendulum

- System
- Sites of Interaction
- System Parameters
- System excitation
- Task
- Assumptions
- Solution
- Last Update



# Nový dokumentační systém

Úprava  
vybraného  
souboru

DYNAST Documentation System

Editor Batch Processor

File Insert

animations

- carrpend.prb
- eqs5.prb
- fallrod.prb
- flu.prb
- fluidmix.prb
- fourbar4.prb
- jojo.prb
- springp\_test.prb
- typos\_test.prb

control

electrical

electro-mechanical

electronic

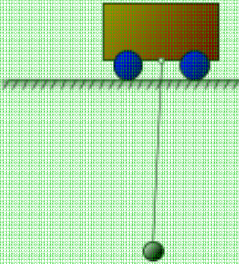
ab

- Article Carriage with pendulum
  - System
  - Sites of Interaction
  - System Parameters
  - System excitation
  - Task
  - Assumptions
  - Solution
  - Last Update

**Carriage with pendulum**

**System**

The carriage is moving freely in the horizontal direction. The pendulum is suspended down from the carriage.



**Figure CARRPEND-1 Geometric configuration.**

**Sites of Interaction**

A	...	pendulum bob
B	...	pendulum suspension

**System Parameters**

mC	$m_c = 2$	[kg]	carriage mass
d	$d = 1$	[N.s/m]	carriage damping
m	$m = 1$	[kg]	bob mass

# Nový dokumentační systém

**Problem File**  
Create Problem File Documentation

- Include Diagram
- Include System Parameters
- Include Sites of Interaction
- Include Data
- Include Plot
- Include Origin

**Preview**

**Parallel RLC circuit**

Figure RLC2-1 Diagram

**System Parameters**

R:  $R=1$  [ohm] resistance  
L:  $L=1$  [H] inductance  
C:  $C=1$  [F] capacitance

Initial-condition response

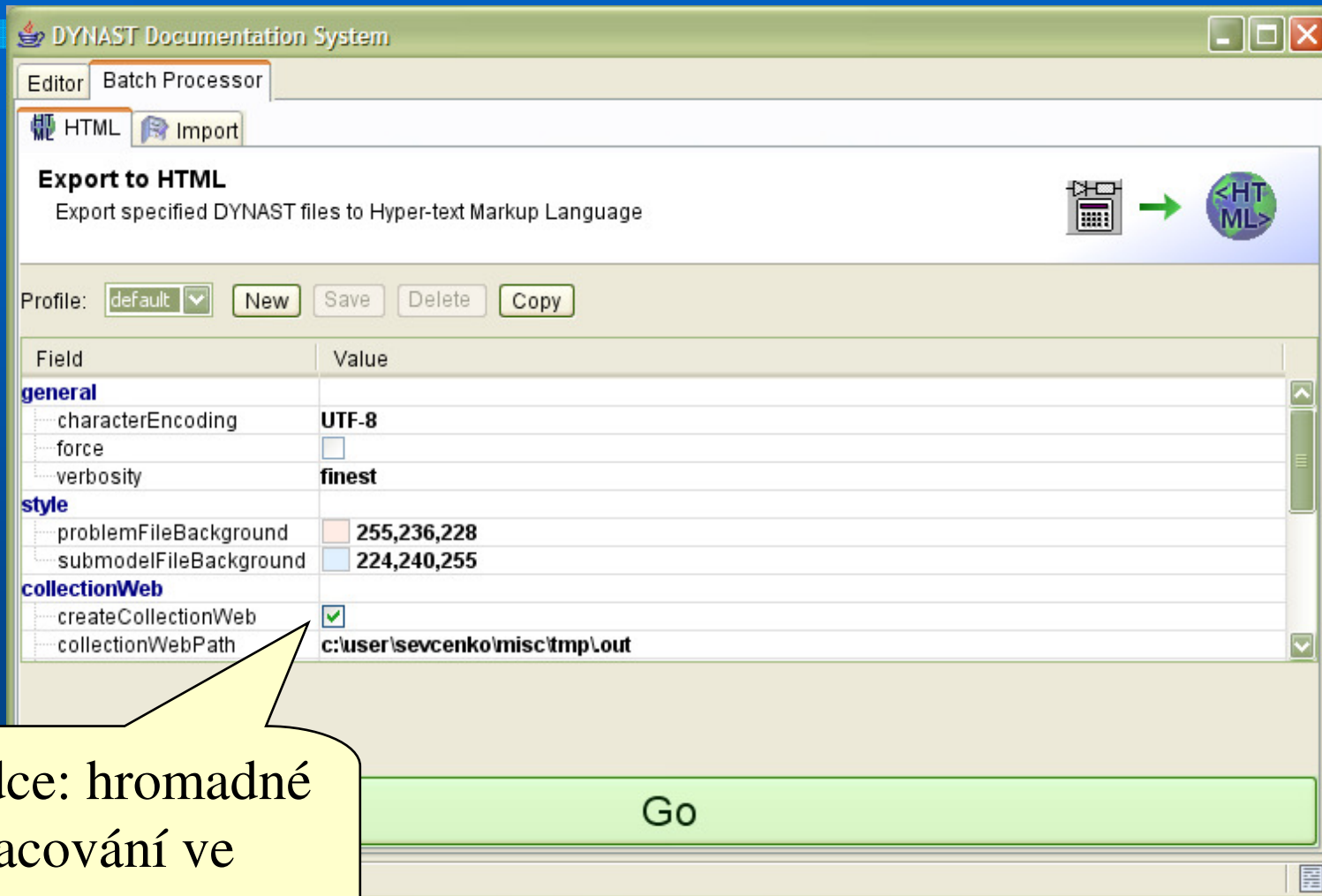
Figure RLC2-2 Plot

Last Update  
Feb 1, 2006

Close

Průvodce:  
vytvoření nové  
dokumentace

# Integrovaný dokumentační systém



Průvodce: hromadné  
zpracování ve  
formátu HTML

# Nový dokumentační systém

Example: EQS5

## Four-bar linkage kinematic analysis

System

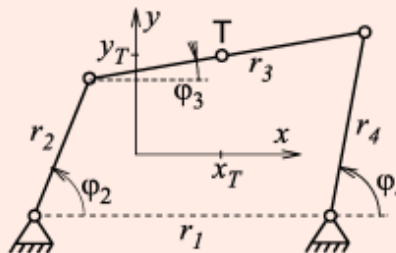
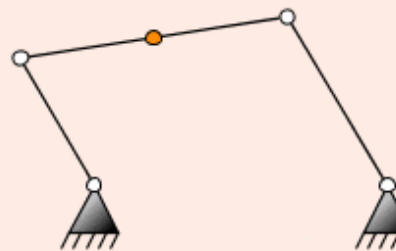


Figure EQS5-1 Four-bar mechanism.



Prezentace ve  
formátu HTML  
– výsledek

# Doplňkové nástroje systému DYNAST

- **DYNAST na webu**
- **DYNAST Server a DYNAST Monitor**
- **Propojení se systémem  
MATLAB/SIMILINK**
- **„virtuální experimenty“**

# DYNAST na Webu

- <http://virtual.cvut.cz/dyn/>
  - Sbírka interaktivních příkladů a simulačních modelů
  - Kurs modelování a simulace
  - Download uživatelského prostředí

# DYNAST na Webu

Simulation examples - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Examples

- ⊕ Equations
- ⊕ Electrical
- ⊕ Electronic
- ⊕ Power electronic
- ⊕ Electro-mechanical
- ⊖ Mechanical
  - [Viscous friction experiment](#)
  - [Body driven by given velocity](#)
  - [Vertical throw of a ball](#)
  - [Body driven by given force](#)
  - [Body driven by a frequency-variable force](#)
  - [Static equilibrium of forces](#)
  - [Composition of motions](#)
  - [Jumping ball](#)
  - [Mass-spring system with dry friction](#)
  - [Motor on vibration isolator with stop](#)
  - [Transformer mounted in a case](#)
  - [Car suspension system 1](#)
  - [Physical pendulum 1](#)
  - [Rocket liftoff](#)
  - [Surge waves of a long spring](#)
  - [Impact of a long spring](#)
  - [Prof. Nozicka's drive](#)
  - [Oblique throw](#)
  - [Central star and planet](#)
  - [Rolling cylinder](#)
  - [Truck model](#)

Example: MT6

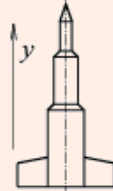
## Rocket liftoff

**Purpose**

Time-variable mass, variable gravitation

**System**

The first stage of Saturn V rocket is fired vertically up from the earth's surface at the north pole. It accelerates until the fuel, which burns at a constant rate, is exhausted.



**Figure 1:** Saturn V rocket

**System Parameters**

$m_r = 6.32m_e$	[kg]	mass of rocket without fuel
$m_f = 4.56m_e$	[kg]	launch mass of fuel
$t_1 = 160$	[s]	period of fuel burnout
$u = 8470$	[m/s]	exhaust velocity of burned gases

Done Internet

# DYNAST na Webu

Simulation examples - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Examples

- Equations
- Electrical
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- Power electronic
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- Mechanical
  - Viscous fricti
  - Body driven b
  - Vertical throw
  - Body driven b
  - Body driven b force
  - Static equilibr
  - Composition
  - Jumping ball
  - Mass-spring
  - Motor on vibra
  - Transformer
  - Car suspensi
  - Physical pend
  - Rocket liftoff
  - Surge waves
  - Impact of a lo
  - Prof. Nozicka
  - Oblique throw
  - Central star a
  - Rolling cylinder
  - Truck model

MASS m 11

DynastViewer 2.07 beta (JDK 1.1.6) - /tmp/dynast/f\_108719895530608.o

X Variable Y Variables Axis Graph

Full View

10 <sup>5</sup>	10 <sup>3</sup>	10 <sup>8</sup>
6.0	3.5	0.0
4.8	2.8	-0.5
3.6	2.1	-1.0
2.4	1.4	-1.5
1.2	0.7	-2.0
0.0	0.0	-2.5

# Rocket liftoff

gravitational law as

es mass

yA [m/s] rocket velocity

Warning: Applet Window

Submit to DYNAST Reset data

Done Internet



# DYNAST Server

- Výpočetní server umožňující vzdálené výpočty z pracovních stanic
- Vhodný např. pro výuku
- Možnost sledování provozu na serveru a archivace spočítaných úloh (DYNAST Monitor)

# DYNAST Monitor

- **Doplňková aplikace k DYNAST serveru**
- **Zobrazuje archiv úloh spočítaných na serveru**

# DYNAST Monitor

virtual.cvut.cz - 1 minute idle - Monitor

File Computers Submits Messages View Help

09:46:46 | RemoteSolver (Win32) 3.7.7 beta

- 0 | ASTABLE | RemoteSolver (Win32) 3.7.7 beta | 1 | 1 minute idle
  - 09:46:46 | RemoteSolver (Win32) 3.7.7 beta
    - ASTABLE.dia
    - ASTABLE.prb
- hyorin.kaist.ac.kr | in | empty user name | 98 | 29 minutes idle
- a10prg-182.dialup.vol.cz | input | empty user name | 1 | 1 day idle
- royal.kts.vslib.cz | input | empty user name | 1 | 2 days idle
- minasmorgul.stuwo-steinweg.de | text2-yanzhe | John Smith | 47 | 2 days idle

online

Prev Next

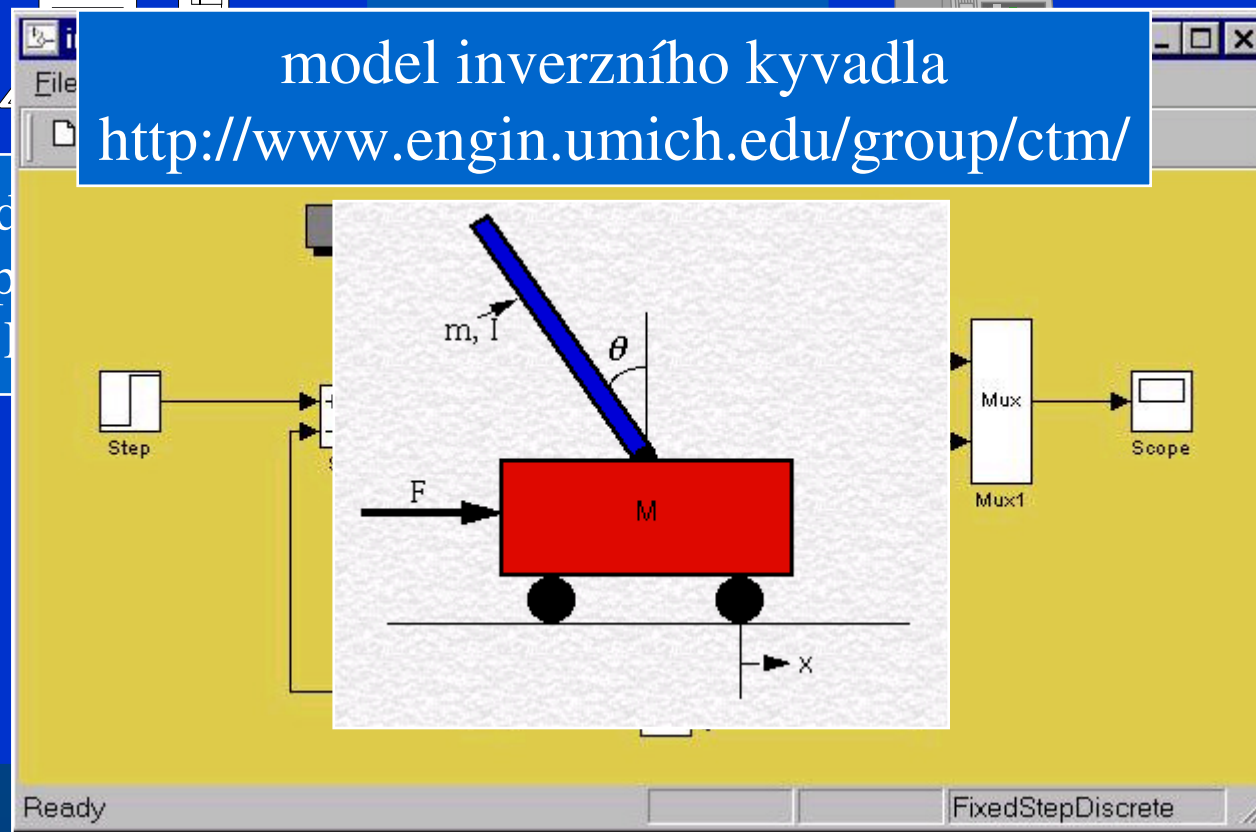
# Propojení s MATLABem

- **DYNAST lze využít jako modelovací toolbox pro systém MATLAB**
- **Vhodné pro návrh řízení**
  - DYNAST se použije pro modelování a simulaci řízené soustavy
  - MATLAB se použije pro návrh a implementaci řídicí struktury
- **System lze implementovat zčásti v DYNASTu a zčásti v MATLABU**

# Řídicí struktura implementovaná v MATLABu

model inverzního kyvadla  
<http://www.engin.umich.edu/group/ctm/>

Řídicí  
Implementace  
v MATLABu



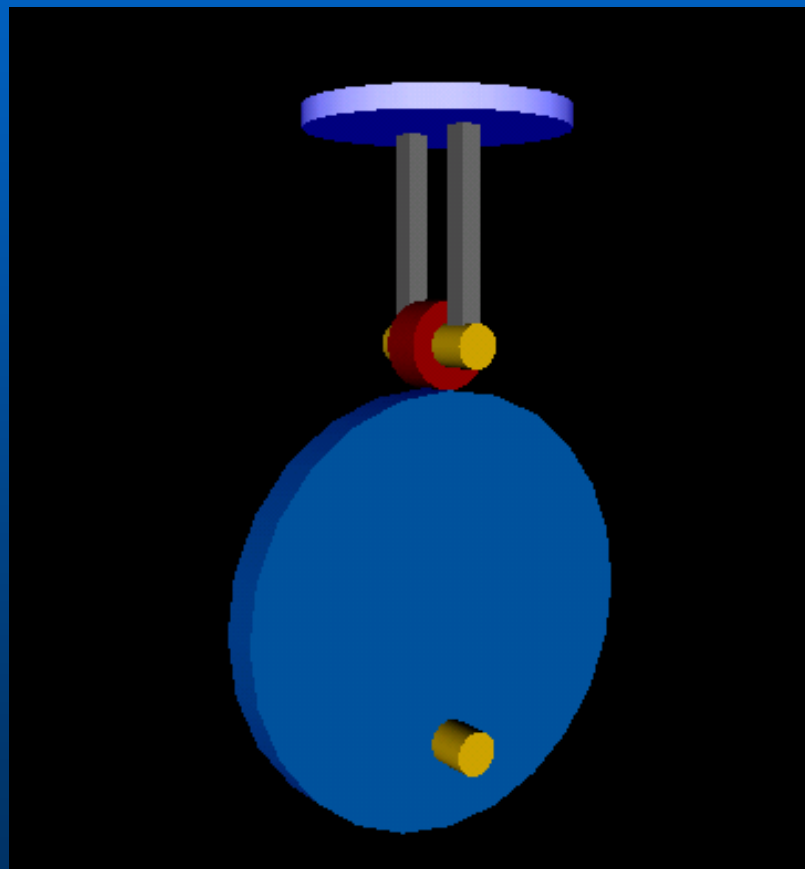
Simulátor

Model  
řízeného  
systému

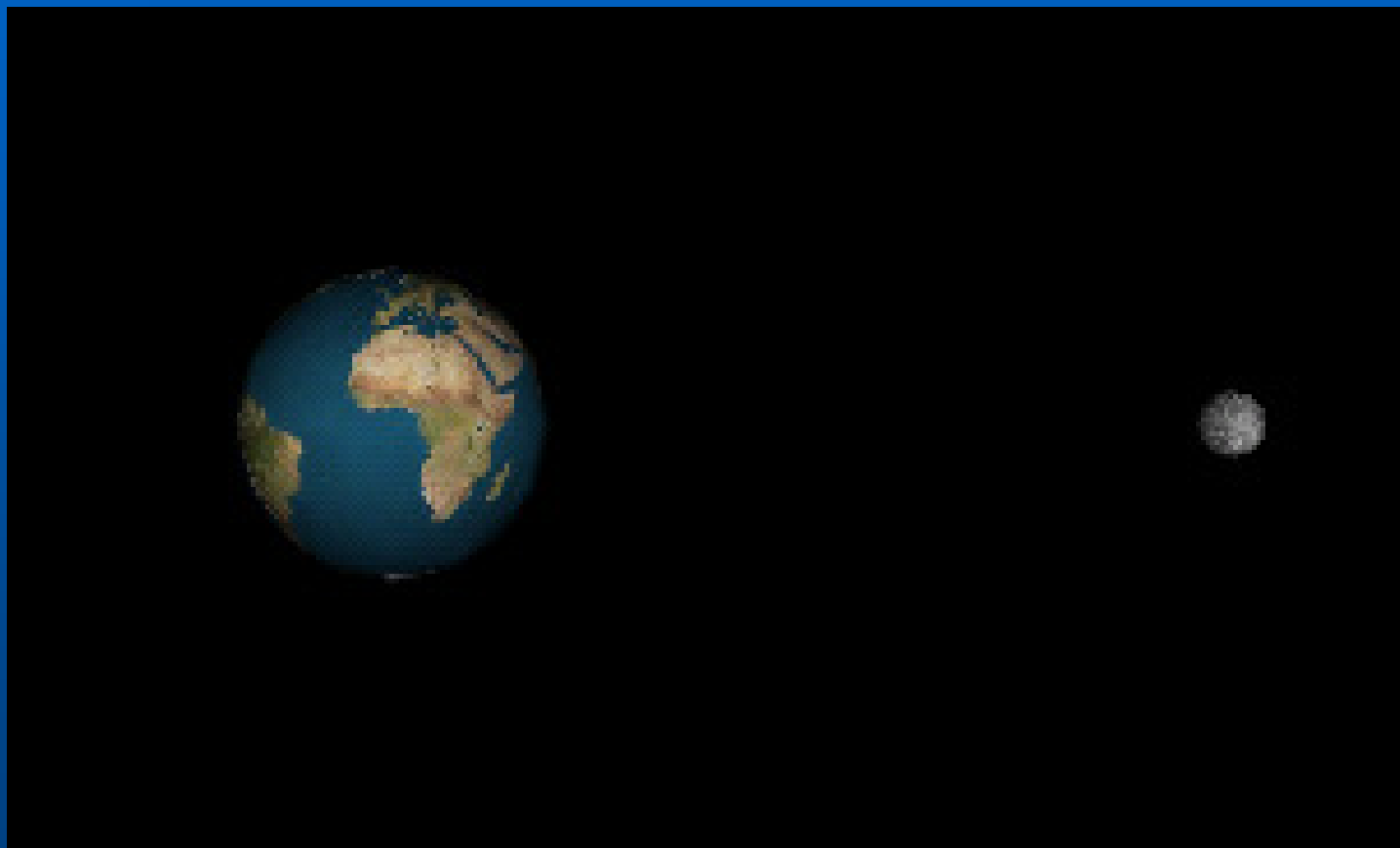
# Virtuální experimenty

- Simulace soustav v reálném čase
- Vizualizace ve 3D

# Virtuální experimenty



# Virtuální experimenty

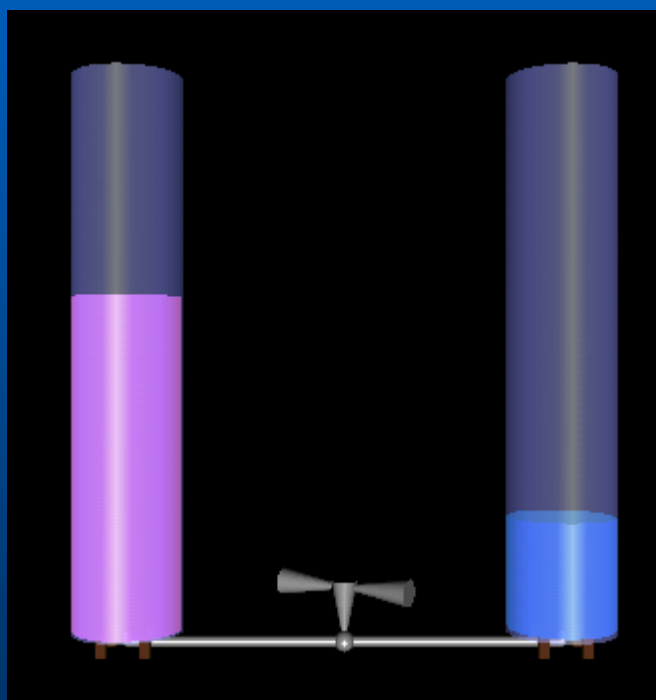


Prev

Next



# Virtuální experimenty

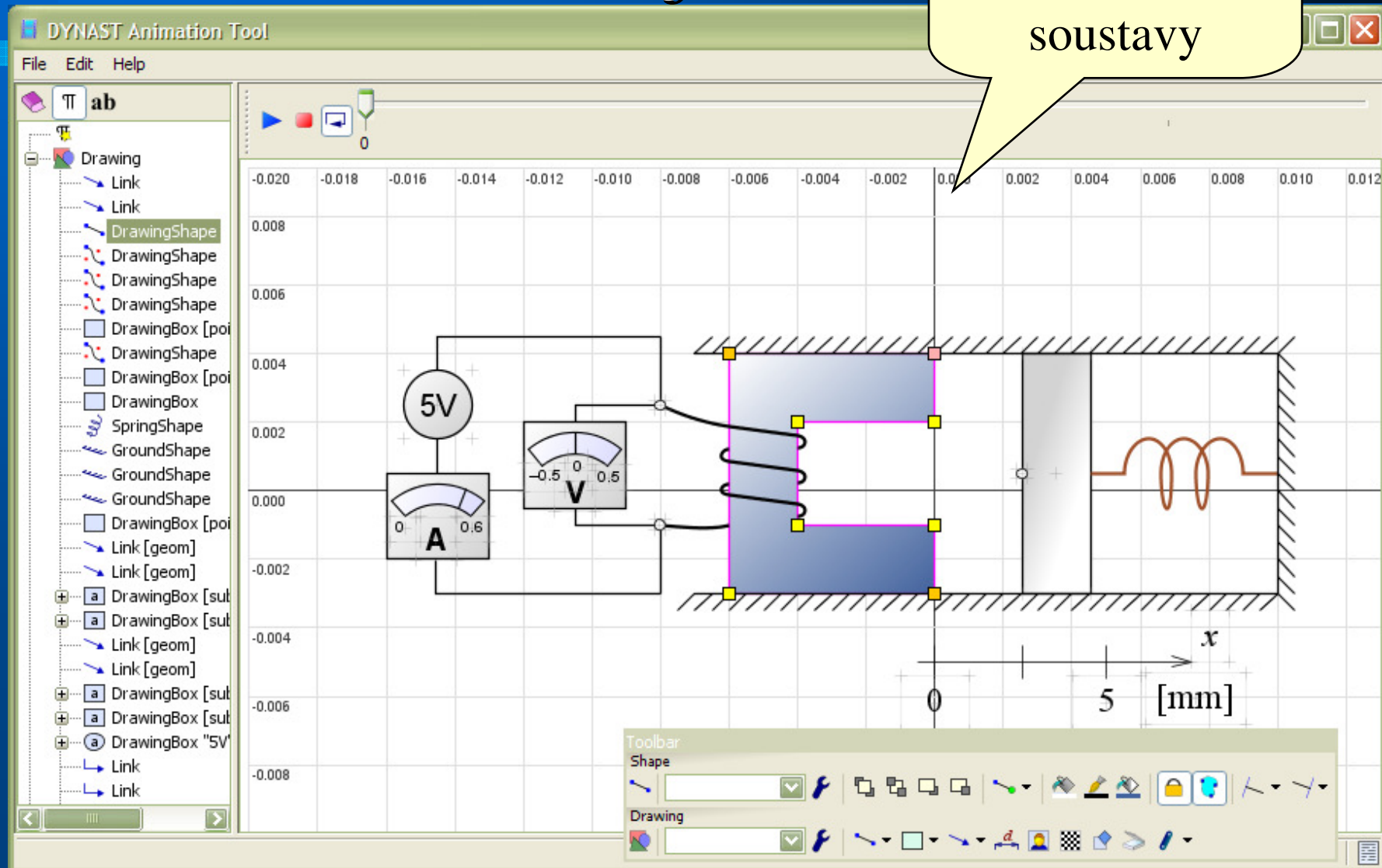


# Animační nástroj DYNASTu

- **Nástroj pro vizualizaci dynamických jevů pomocí 2D grafiky**
- **Neinteraktivní animace (“video”)**
- **Automatický export do formátu Adobe Flash, umožňující prezentaci na Internetu**

# Animační nástroj

Statický  
obrázek  
soustavy



# Animační nástroj

Animační  
pravidla

The screenshot shows the 'Animation Rules' dialog box. It is divided into several sections:

- Rules:** A list of animation rules, including:
  - D1.x=dynast.Xb[time]
  - D2.x=dynast.Xb[time]
  - L1.x1=dynast.Xb[time]
  - L1.x2=dynast.Xb[time]
  - S1.p1.x=dynast.Xb[time]+0.002
  - mV.value=dynast.V.L1[time]
  - mA.value=dynast.i[time]
  - L2.x2=-dynast.JF[time]/1500
  - t1[0].x=dynast.Xb[time]-0.003
- Visual Components:** A tree view showing components like DrawingShape, DrawingBox, and DrawingBox - D1, with sub-elements like x, y, width, and height.
- DYNAST variables:** A list of variables including V.L1, Xb, and JF.
- Preview:** A diagram of a circuit with a 5V source, an ammeter, a voltmeter, and a coil. A blue arrow indicates the direction of movement of a component, and a coordinate system with 'x' and '5 [mm]' is shown.

Buttons for 'New', 'Modify', 'Up', 'Down', 'Delete', 'Start', 'Stop', 'OK', and 'Cancel' are visible.

# Animační nástroj

Výsledek

Příklady  
animací

# Animační nástroj

