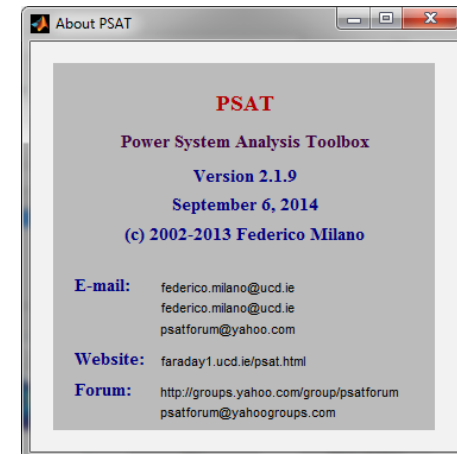
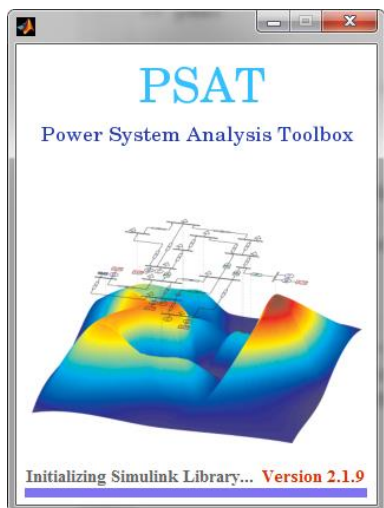


Software pro řešení chodu ES

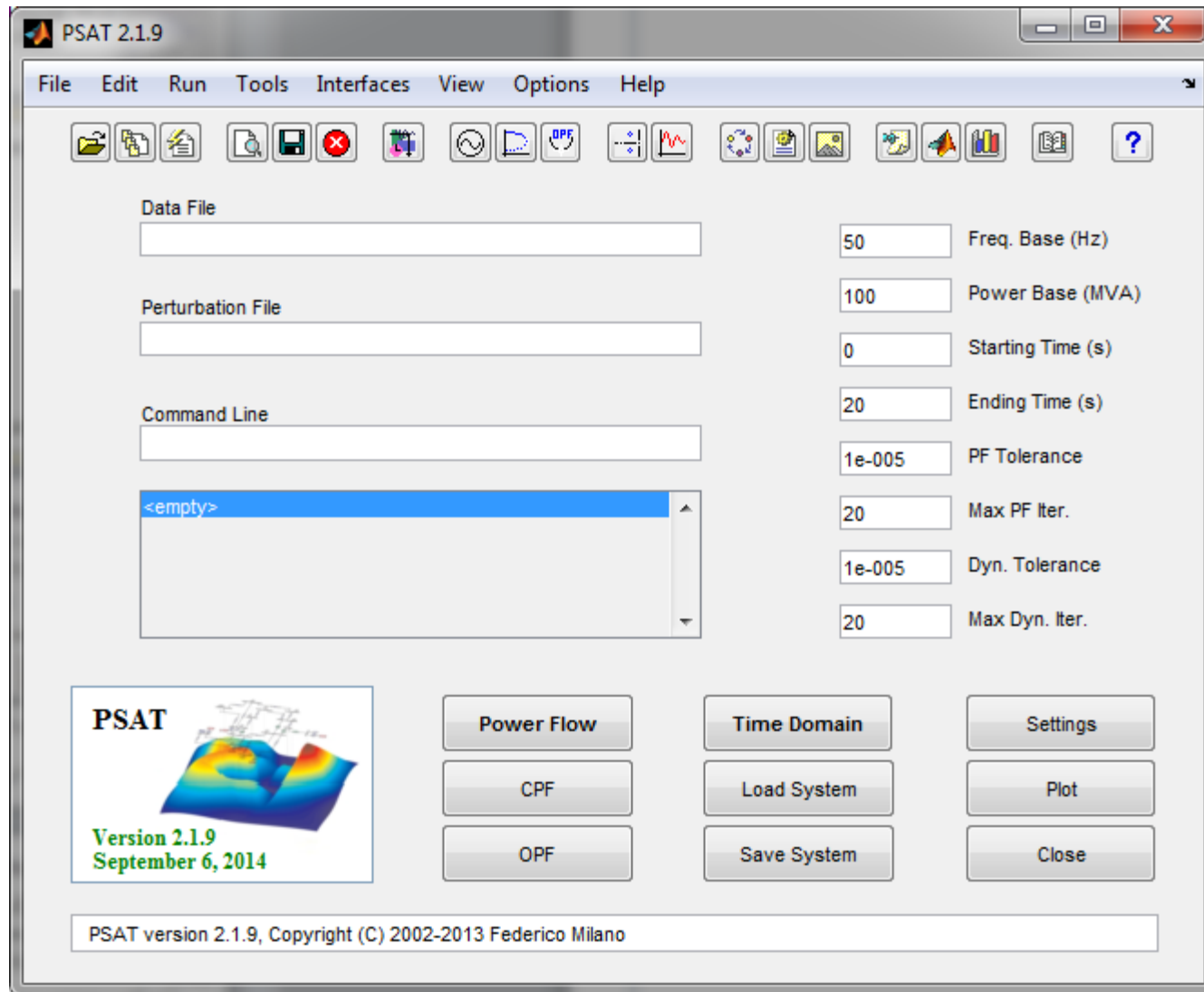
PSAT

Power System Analysis Toolbox

doc. Ing. Karel Noháč, Ph.D.
Plzeň 2017



Co je PSAT (Power System Analysis Toolbox):



<http://faraday1.ucd.ie/psat.html>

Co je PSAT (Power System Analysis Toolbox):

- PSAT je aplikace a prostředí nad systémem MATLAB (Matlab Toolbox) pro analýzu a simulace v ES.
- Verze pro příkazovou řádku je také kompatibilní s GNU Octave.
- Všechny základní operace jsou přístupné z grafického uživatelského prostředí (GUIs).
- Integrovaná knihovna pro systém Simulink slouží pro grafické zadávání topologie sítě (nikoli pro výpočty).

Co je PSAT (Power System Analysis Toolbox):

- Celý koncept je otevřený, přenosný a Open Source s General Public License (GPL).
- Lze spustit na většině operačních systémů.
- Optimalizován pro řídké matice.

Co je PSAT (Power System Analysis Toolbox):

Jsou dostupné tyto analýzy:

- **Power Flow (PF)**
 - Ustálený chod ES
- **Continuation Power Flow (CPF)**
 - Analýza napěťové stability
- **Optimal Power Flow (OPF)**
 - Optimalizace dodávaných výkonů
- **Small Signal Stability Analysis (SSSA)**
 - Stabilita malých kyvů
- **Time Domain Simulation (TDS)**
 - Přechodné elektro-mechanické děje

Další charakteristické vlastnosti:

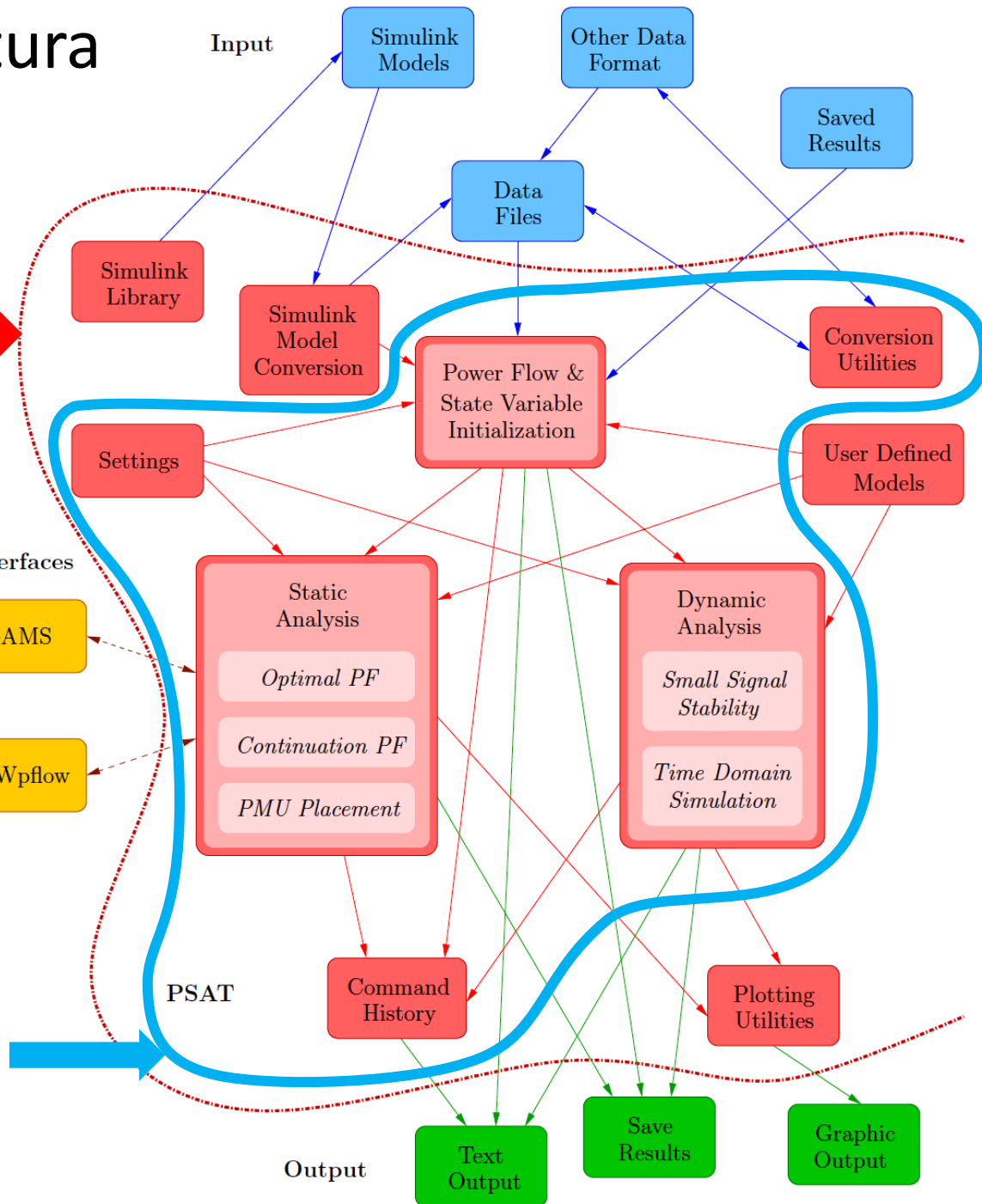
- Bohatá knihovna síťových prvků včetně např. FACTS, větrných elektráren, ..., přičemž další lze uživatelsky definovat.
- Konverze vstupních dat z mnoha jiných formátů.
- Konverze výstupů do EPS obrázků, MATLAB grafů, textových souborů, EXCEL tabulek, LaTeX dokumentů, ...
- Systém je otevřený rozšiřujícím externím analytickým modulům. Mezi stávající volná doporučená patří například rozšíření pro software GAMS a UWPFLOW.

Funkční struktura aplikace:

MATLAB



GNU Octave



Porovnání s jinými aplikacemi:

Komerční softwarové aplikace:

- **SIEMENS** PSS[®]E
- **EUROSTAG**
- **ABB** SIMPOW
- CYME Power Engineering Software
- **DigSilent PowerFactory**
- **PowerWorld** Simulator
- **NEPLAN** ...
- V ČR populární E-VLIVY, MODES, ...
 - Omezeně a obtížně uživatelsky rozšířitelné
 - Náročné (HW, instalace, obsluha)
 - Implementace komponent není otevřená a modely netransparentní
 - Licenční politika omezuje šíření výsledů analýz a budování nadstavbových projektů



Porovnání s jinými aplikacemi:

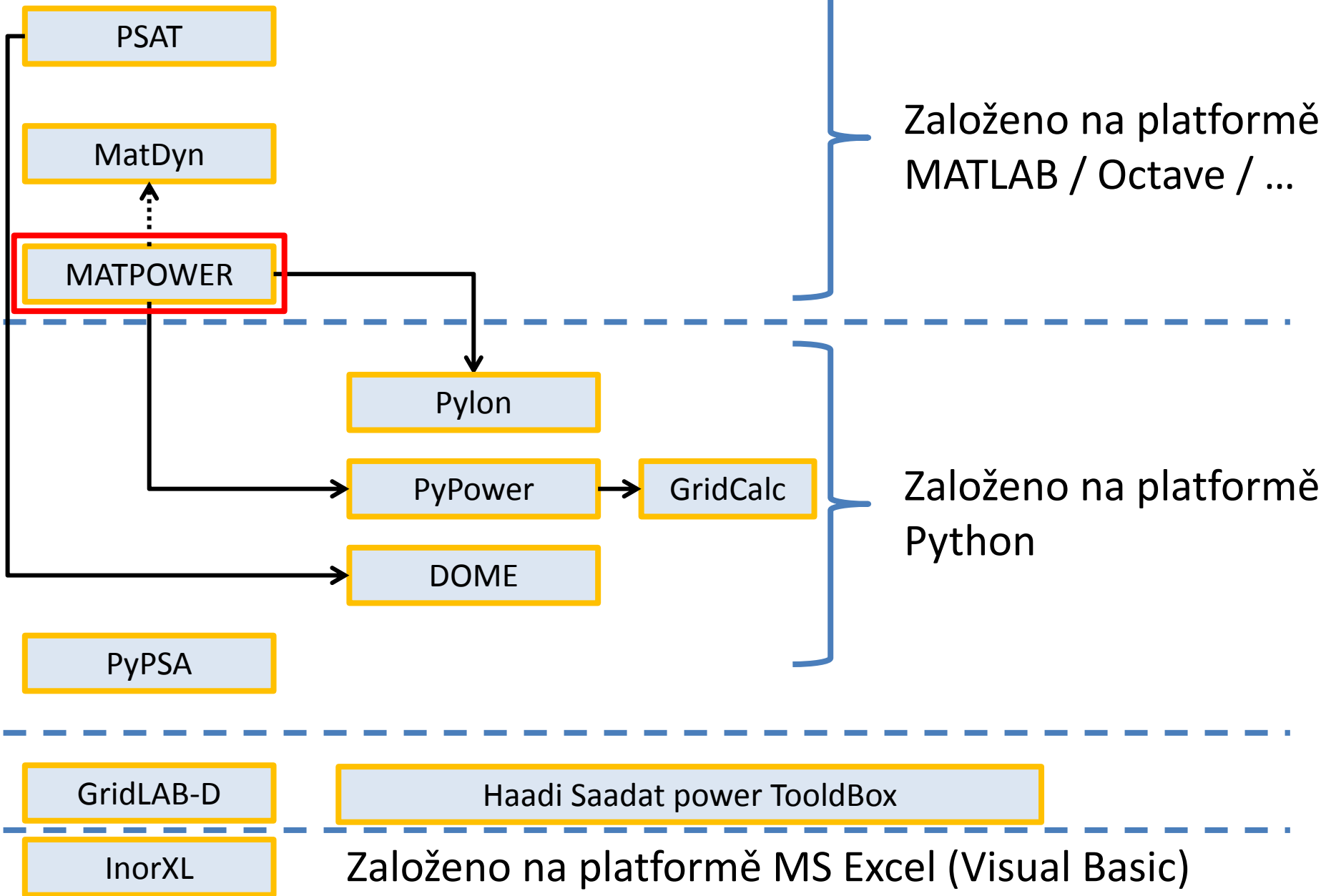
Open-Source aplikace:

- Otevřené jak stávající komponenty, tak možnosti rozšíření
- Flexibilní (snadné vytváření rozšíření - využívají spíše interpretační než kompilované jazyky) – MATLAB, Python, Mathematica, Modelica,

Populární nástroje:

- UWPFLOW
- TEFTS
- MatPower
- InterPSS
- AMES
- DCOPFJ
- OpenDSS
- MatDyn
- Modelica PowerSystems
- THYME
- Dome
- 4DIAC
- MatACDC
- GridLAB-D
- OpenETran
- OpenPMU
- ...

Vývoj otevřených aplikací pro analýzu chodu ES:



Porovnání s jinými aplikacemi:

Package	Language	PF	CPF	OPF	EA	TDS	EMT	GUI	CAD
AMES	Java	✓		✓					
EST	Matlab	✓			✓	✓			✓
InterPSS	Java	✓				✓		✓	✓
MatDyn	Matlab	✓				✓			
MatEMTP	Matlab					✓	✓	✓	✓
Matpower	Matlab	✓		✓					
ObjectStab	Modelica	✓			✓	✓		✓	✓
OpenDSS	Delphi	✓				✓		✓	✓
PAT	Matlab	✓			✓	✓			✓
PSAT	Matlab, Octave	✓	✓	✓	✓	✓		✓	✓
PST	Matlab	✓	✓		✓	✓			
Pylon	Python	✓		✓				✓	✓
UWPFLOW	C	✓	✓						
VST	Matlab	✓	✓		✓	✓		✓	

Porovnání s jinými aplikacemi:

Package	PF	CPF	OPF	SSSA	TDS	EMT	GUI	CAD
EST	✓			✓	✓			✓
MatEMTP					✓	✓	✓	✓
Matpower	✓		✓					
PAT	✓			✓	✓			✓
PSAT	✓	✓	✓	✓	✓		✓	✓
PST	✓	✓		✓	✓			
SPS	✓			✓	✓	✓	✓	✓
VST	✓	✓		✓	✓		✓	

Porovnání s jinými aplikacemi:

Nástroje založené na MATLABu / SIMULINKu:

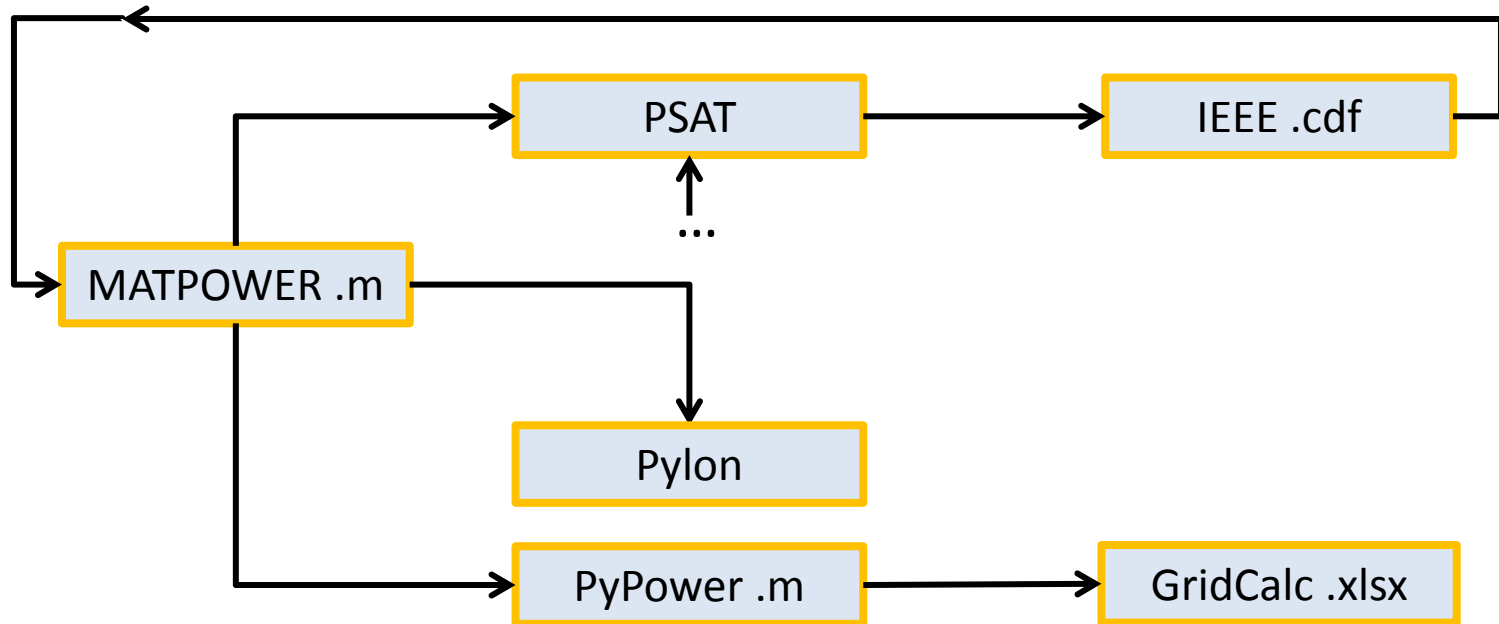
- Power System Analysis Toolbox (PSAT)
- SimPowerSystems (SPS) (komerční)
- MatPower
- Educational Simulation Tool (EST)
- MatDyn
- MatEMTP
- Power Analysis Toolbox (PAT)
- Power System Toolbox (PST)
- Voltage Stability Toolbox (VST)

Porovnání s jinými aplikacemi:

Open-Source aplikace pro MATLAB dosud nemají pro uživatele přístupně implementováno:

- Pokročilou analýzu komplikovaných poruchových stavů
- Harmonickou analýzu
- Analýzu funkce ochran a jejich koordinaci
- ...

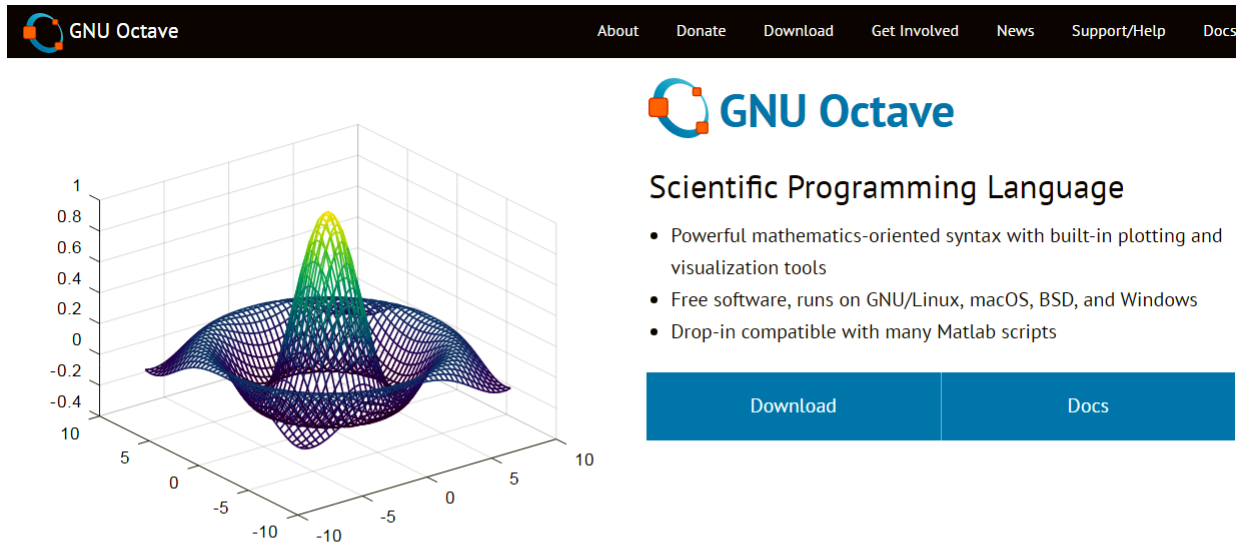
Formáty souborů otevřených aplikací pro analýzu chodu ES:



Porovnání s jinými aplikacemi:

Některé Open-Source aplikace pro MATLAB jsou kompatibilní s Open-Source prostředím GNU-Octave:

<https://www.gnu.org/software/octave/>



GNU Octave

About Donate Download Get Involved News Support/Help Docs

GNU Octave

Scientific Programming Language

- Powerful mathematics-oriented syntax with built-in plotting and visualization tools
- Free software, runs on GNU/Linux, macOS, BSD, and Windows
- Drop-in compatible with many Matlab scripts

Download Docs

Syntax Examples

The Octave syntax is largely compatible with Matlab. The Octave interpreter can be run in GUI mode, as a console, or invoked as part of a shell script. More Octave examples can be found in [the wiki](#).

Solve systems of equations with linear algebra operations on **vectors** and **matrices**.

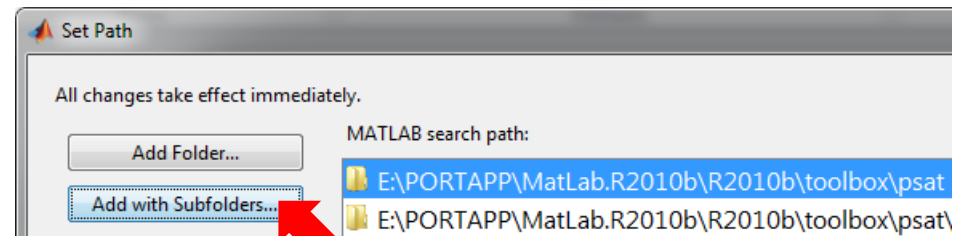
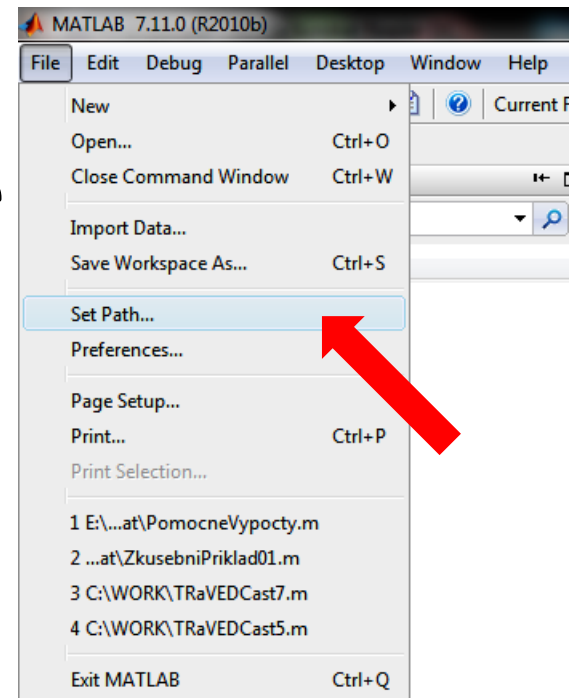
```
b = [4; 9; 2] # Column vector
A = [ 3 4 5;
      1 3 1;
      3 5 9 ]
x = A \ b     # Solve the system Ax = b
```


Instalace aplikace PSAT:

- Pro plnohodnotné vyžití včetně grafického prostředí nutný MATLAB verze 7.
- Pro uživatelské modely je navíc potřebný Symbolic Toolbox.
- Stažený soubor je vhodné umístit mezi ostatní toolboxy např. do adresáře:

... \MatLab\toolbox\psat

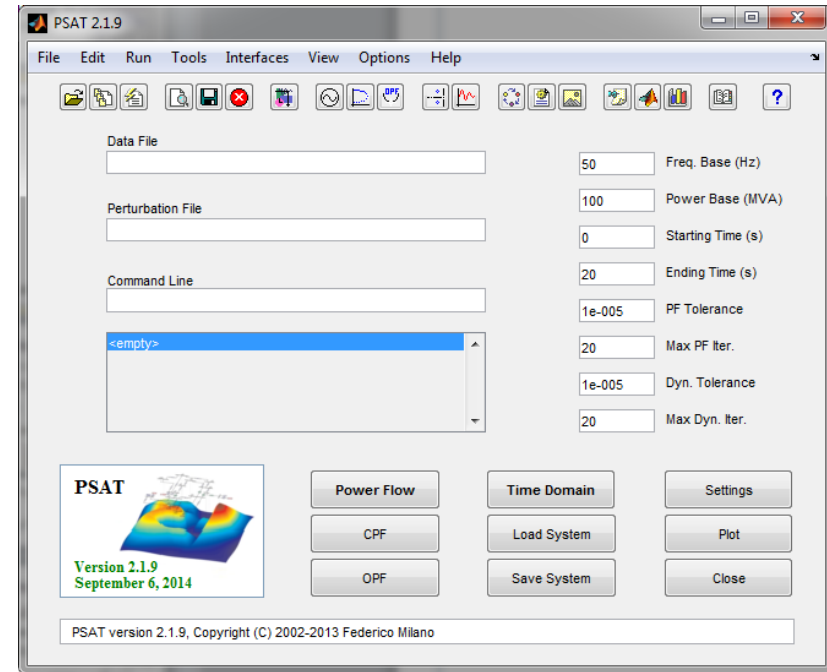
- Přidat tento adresář včetně podadresářů do cesty systému MATLAB



Spuštění aplikace PSAT:

Spuštění grafického prostředí:

>>psat



Spuštění v příkazové řádce například:

>>initpsat

>>runpsat('Priklad_md1.m','data')

>>runpsat('pf')

>>runpsat('pfpref')

>>runpsat('pfpref');



```
Command Window
GNU Octave, version 4.2.0
Copyright (C) 2016 John W. Eaton and others.
This is free software; see the source code for copying conditions.
There is ABSOLUTELY NO WARRANTY; not even for MERCHANTABILITY or
FITNESS FOR A PARTICULAR PURPOSE. For details, type 'warranty'.

Octave was configured for "i686-w64-mingw32".

Additional information about Octave is available at http://www.octave.org.

Please contribute if you find this software useful.
For more information, visit http://www.octave.org/get-involved.html

Read http://www.octave.org/bugs.html to learn how to submit bug reports.
For information about changes from previous versions, type 'news'.

>> cd d:\APP\Octave\psat
>> initpsat

      < P S A T >
      Copyright (C) 2002-2016 Federico Milano
      Version 2.1.10
      May 26, 2016

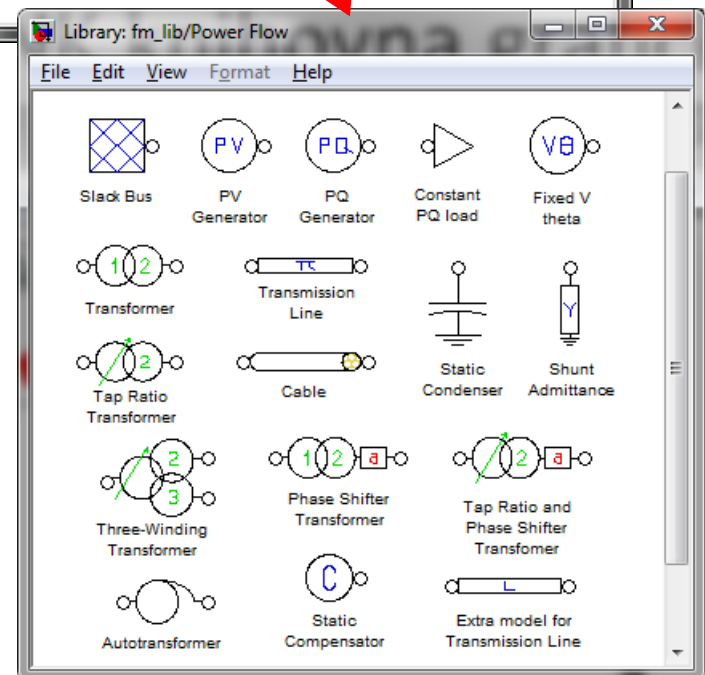
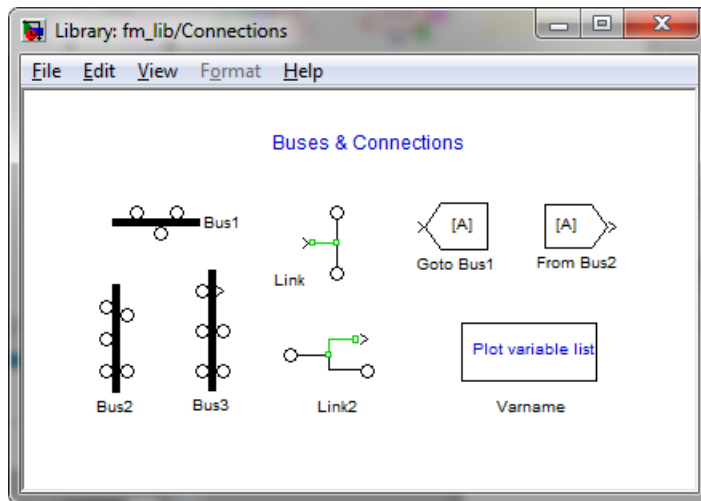
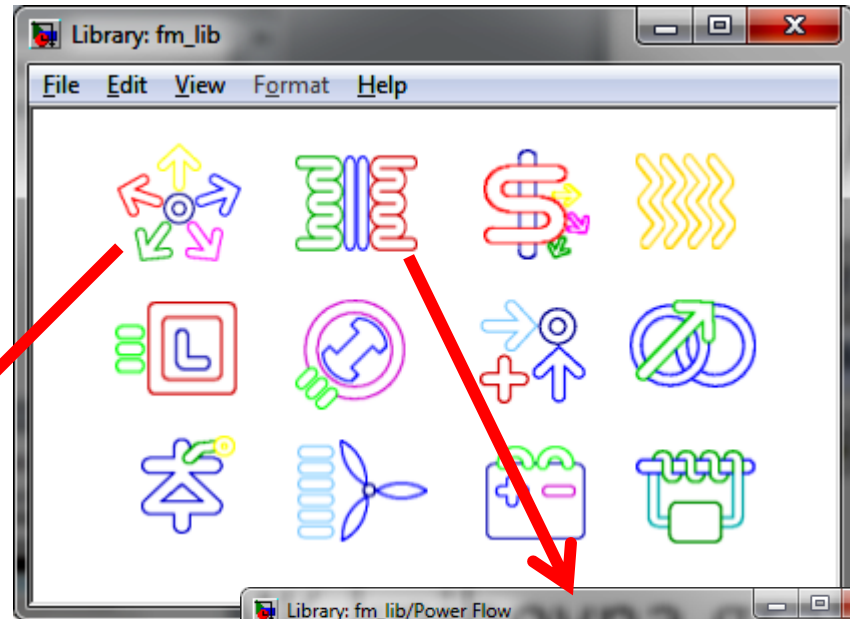
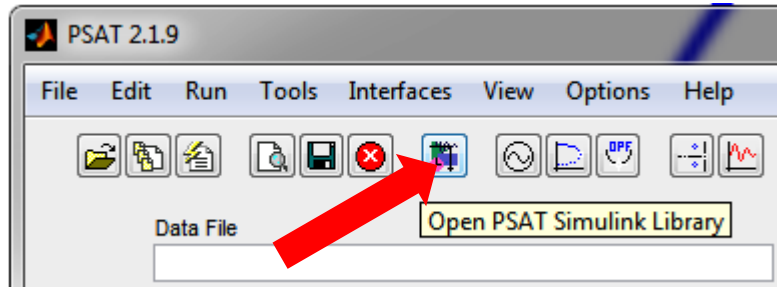
PSAT comes with ABSOLUTELY NO WARRANTY; type 'gnuwarranty'
for details. This is free software, and you are welcome to
redistribute it under certain conditions; type 'gnulicense'
for details.

Host:      Octave 4.2.0
Session:   09-Dec-2016 21:58:23
Usage:     Command Line
Path:      d:\APP\Octave\psat

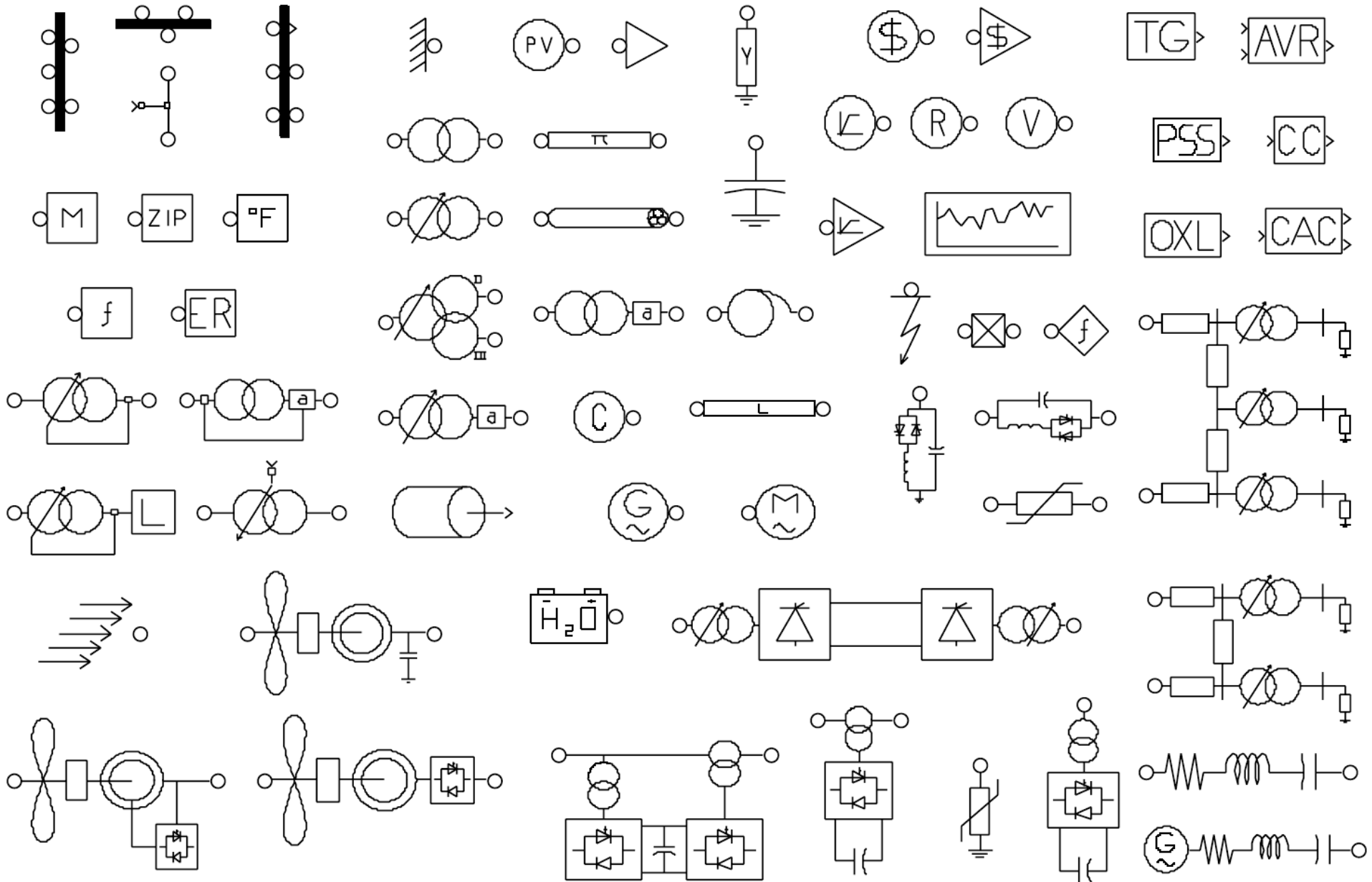
>> runpsat('Priklad01_md1.m','data')
>> runpsat('pf')
Load data from file...

Newton-Raphson Method for Power Flow Computation
Data file "d:\APP\Octave\psat\Priklad01_md1"
Writing file "fm_call" ...
PF solver: Newton-Raphson method
Single slack bus model
Iteration = 1      Maximum Convergency Error = 0.16529
Iteration = 2      Maximum Convergency Error = 0.016177
Iteration = 3      Maximum Convergency Error = 0.00033214
Iteration = 4      Maximum Convergency Error = 1.4723e-007
Power Flow completed in 0.035995 s
```

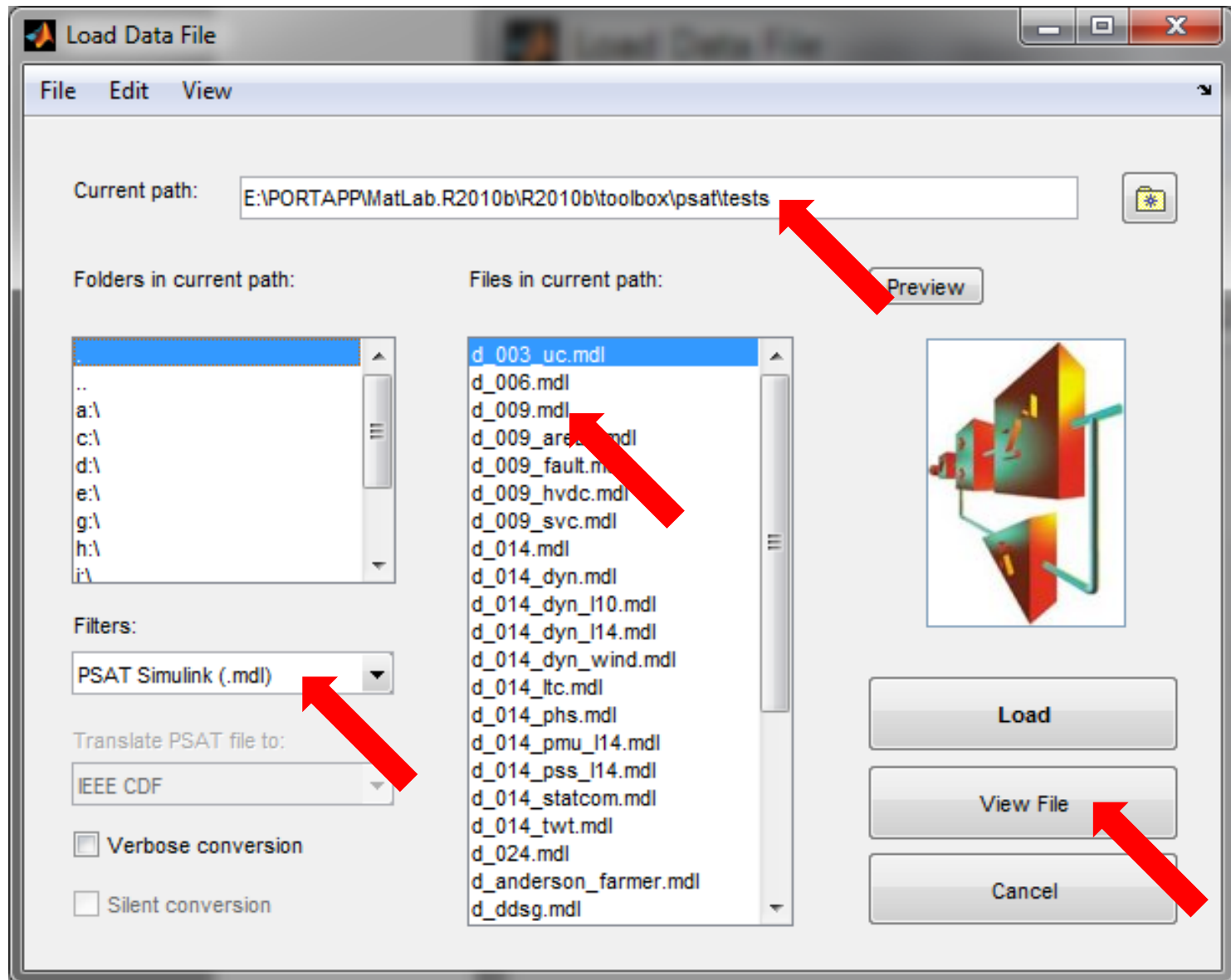
SIMULINK knihovna grafických prvků topologie:



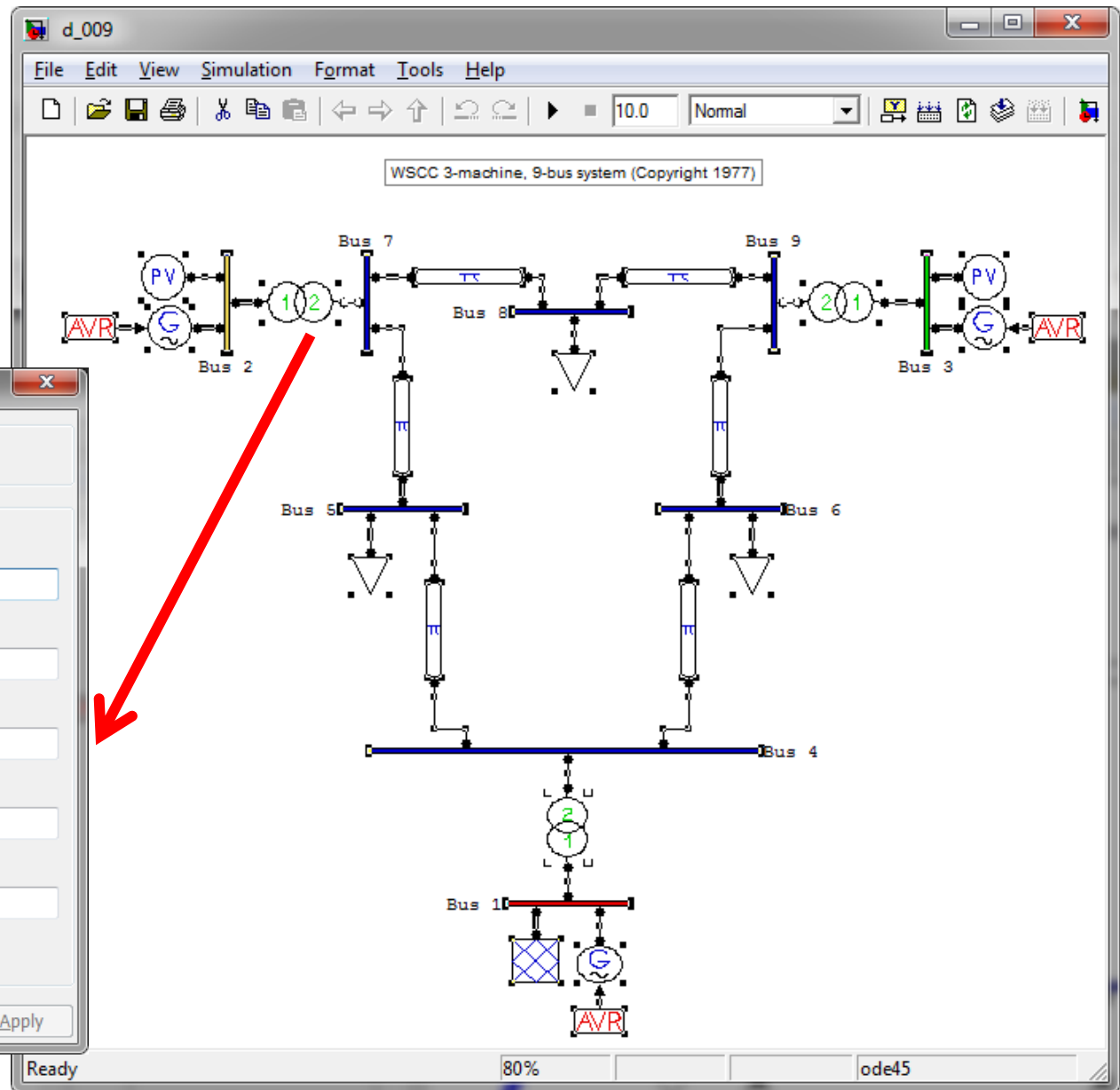
SIMULINK knihovna grafických prvků topologie:



SIMULINK knihovna grafických prvků topologie:

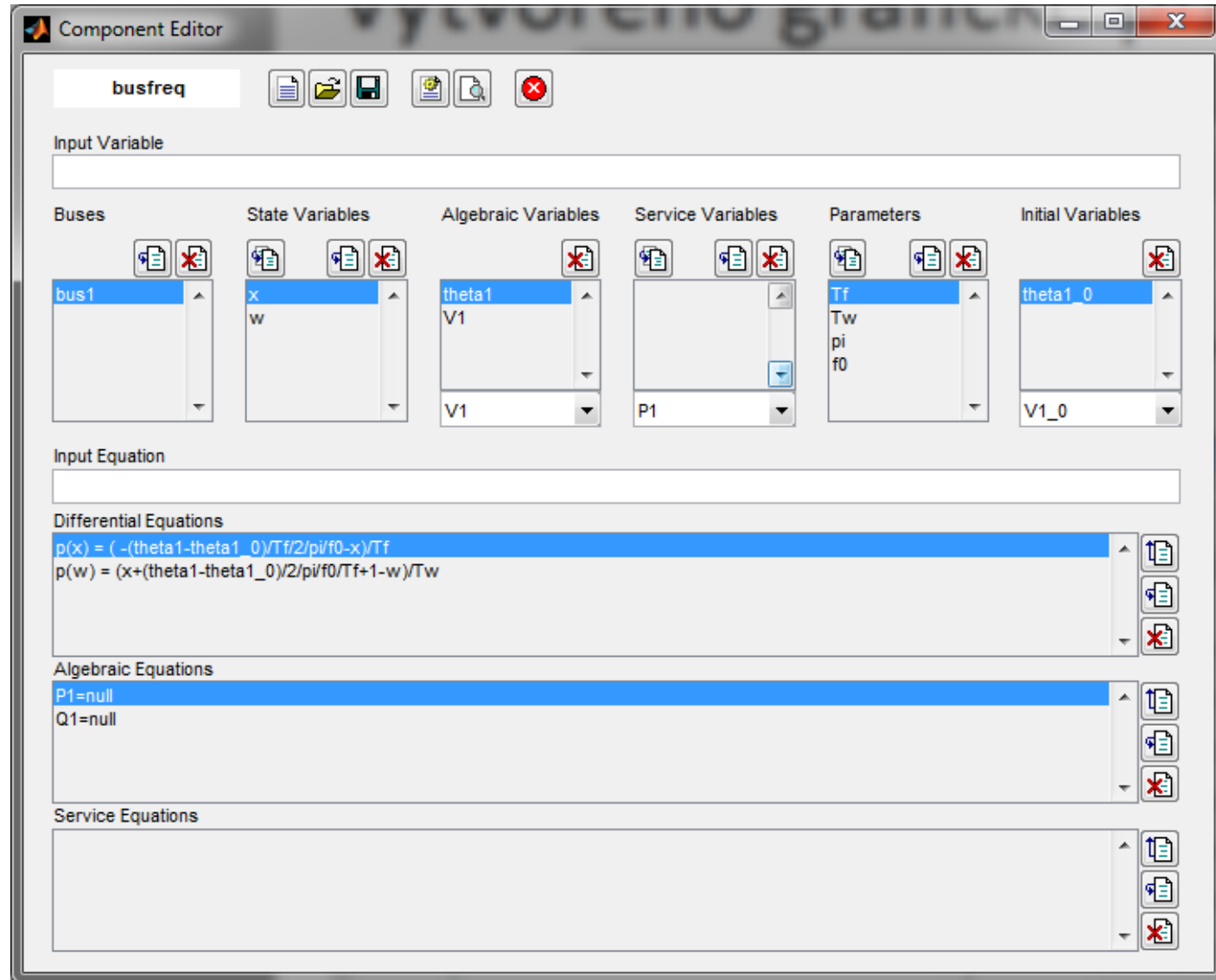


SIMULINK knihovna grafických prvků topologie:



SIMULINK knihovna grafických prvků topologie:

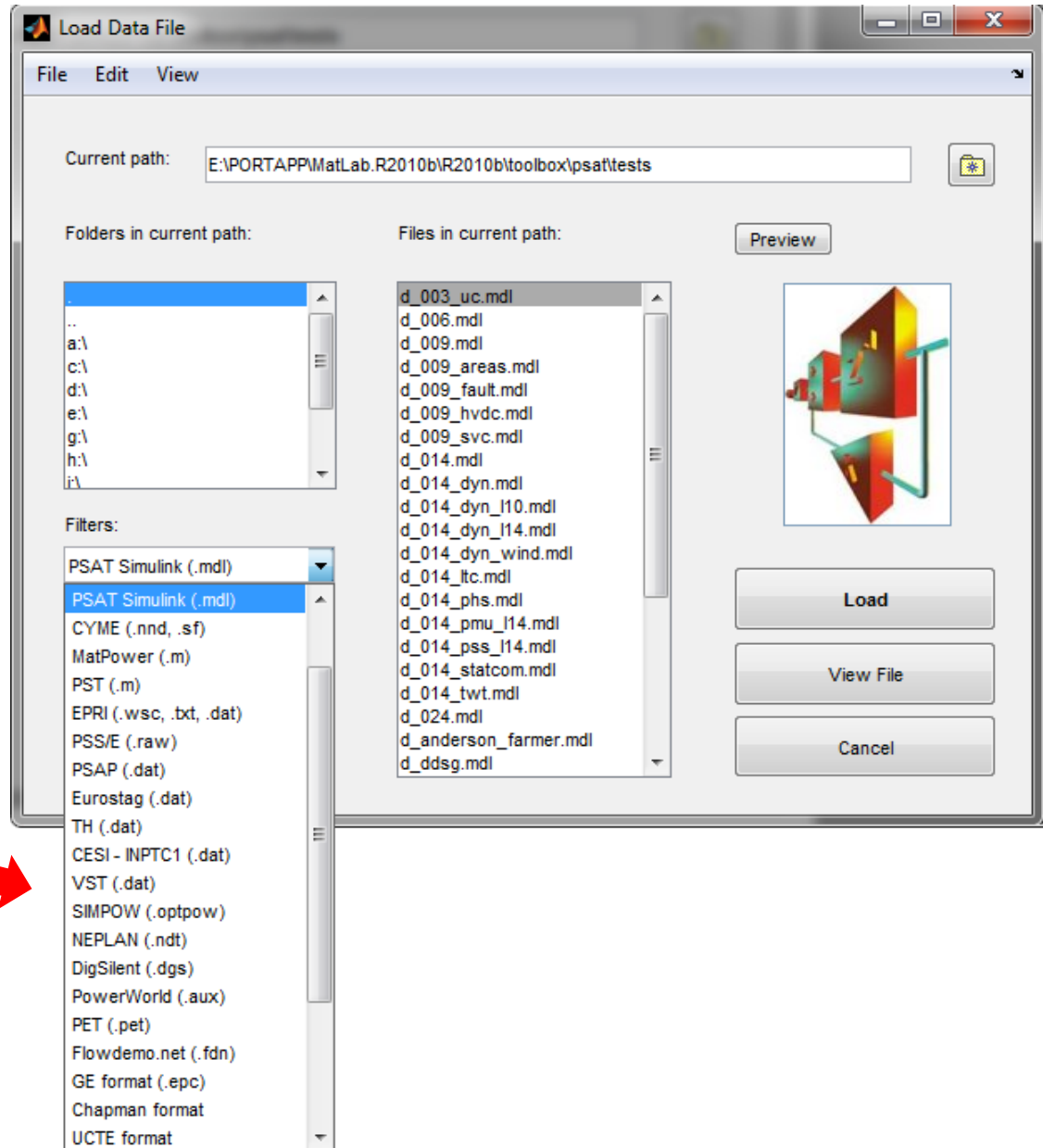
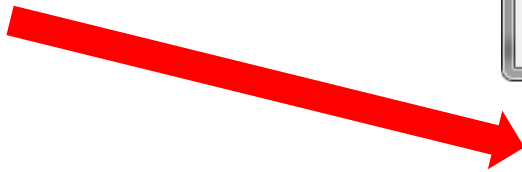
Pro definování
uživatelských
komponent je
vytvořeno
interaktivní
prostředí:



SIMULINK knihovna grafických prvků topologie:

Načtení vstupních dat:

Existují standardní data PSAT i možnost importu z mnoha formátů.



Řešení chodu sítě – Power Flow - PF:

The screenshot displays the PSAT 2.1.9 software interface. The window title is "PSAT 2.1.9". The menu bar includes "File", "Edit", "Run", "Tools", "Interfaces", "View", "Options", and "Help". The toolbar contains various icons, with a red arrow pointing to the "Power Flow" icon.

The main interface is divided into several sections:

- Data File:**
- Perturbation File:**
- Command Line:**
- Results:** A list box showing "<empty>".
- Parameters:** A series of input fields for simulation parameters:
 - Freq. Base (Hz):
 - Power Base (MVA):
 - Starting Time (s):
 - Ending Time (s):
 - PF Tolerance:
 - Max PF Iter.:
 - Dyn. Tolerance:
 - Max Dyn. Iter.:
- Buttons:** A grid of buttons for simulation modes: "Power Flow" (highlighted with a red arrow), "Time Domain", "Settings", "CPF", "Load System", "Plot", "OPF", "Save System", and "Close".
- Plot:** A graph showing the power flow result. The y-axis ranges from 0 to 1, and the x-axis ranges from 0 to 20. The plot shows a red line starting at (0, 1) and dropping to 0 by approximately 2 seconds.
- Status Bar:** A text box at the bottom indicating "Power Flow completed in 0.108 s".

Řešení chodu sítě – Power Flow - PF:

Static Report

File View Preferences

Bus	Vm (p.u.)	Va (rad)	P (p.u.)	Q (p.u.)
[1]-Bus 1	1.04	0	0.71641	0.27046
[2]-Bus 2	1.025	0.16197	1.63	0.06654
[3]-Bus 3	1.025	0.08142	0.85	-0.1086
[4]-Bus 4	1.0258	-0.03869	0	0
[5]-Bus 5	0.99563	-0.06962	-1.25	-0.5
[6]-Bus 6	1.0127	-0.06436	-0.9	-0.3
[7]-Bus 7	1.0258	0.06492	0	0
[8]-Bus 8	1.0159	0.0127	-1	-0.35
[9]-Bus 9	1.0324	0.03433	0	0

State Variables

delta_Syn_1	0.06258
omega_Syn_1	1
e1q_Syn_1	1.0564
e1d_Syn_1	0
delta_Syn_2	1.0664
omega_Syn_2	1
e1q_Syn_2	0.78817
e1d_Syn_2	0.6222
delta_Syn_3	0.94486
omega_Syn_3	1
e1q_Syn_3	0.76786


Other Variables

vf_Syn_1 =	1.0821
pm_Syn_1 =	0.71641
p_Syn_1 =	0.71641
q_Syn_1 =	0.27046
vf_Syn_2 =	1.7893
pm_Syn_2 =	1.63
p_Syn_2 =	1.63
q_Syn_2 =	-0.066537
vf_Syn_3 =	1.403
pm_Syn_3 =	0.85
p_Syn_3 =	0.85

Report Close

Check limit violations

Use absolute values

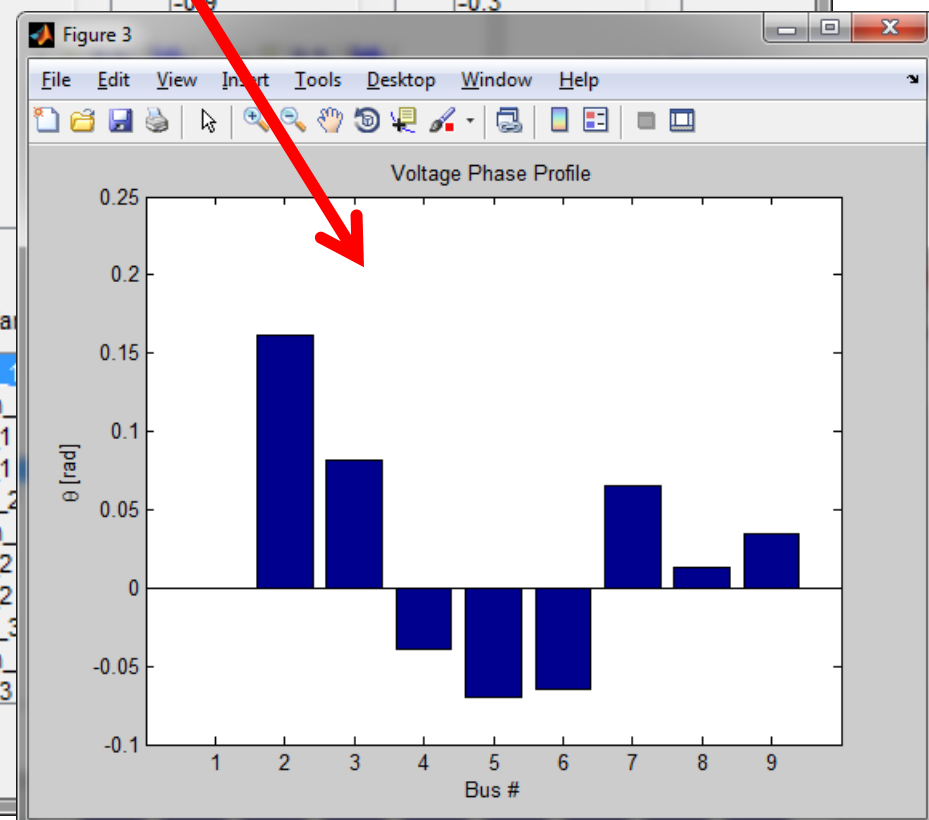
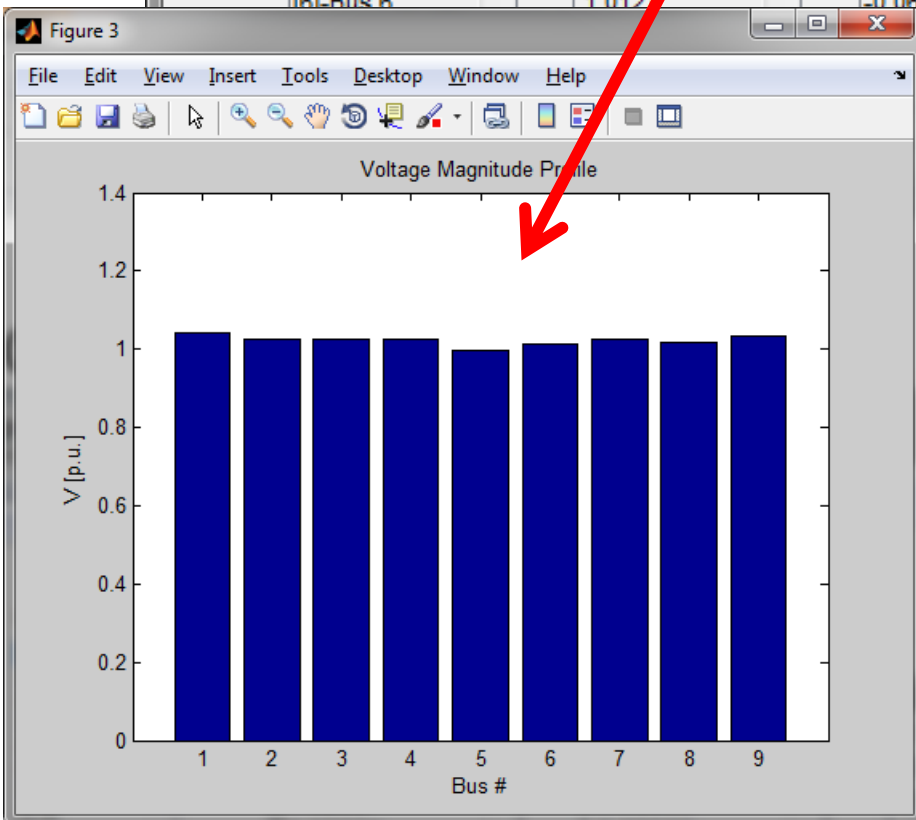


Řešení chodu sítě – Power Flow - PF:

Static Report

File View Preferences

Bus	Vm (p.u.)	Va (rad)	P (p.u.)	Q (p.u.)
[1]-Bus 1	1.04	0	0.71641	0.27046
[2]-Bus 2	1.025	0.16197	1.63	0.06654
[3]-Bus 3	1.025	0.08142	0.85	-0.1086
[4]-Bus 4	1.0258	-0.03869	0	0
[5]-Bus 5	0.99563	-0.06962	1.25	-0.5
[6]-Bus 6	1.0127	-0.06436	-0.9	-0.3



Řešení chodu sítě – Power Flow - PF:

Lister - [e:\PORTAPP\MatLab.R2010b\R2010b\toolbox\psat\tests\d_009_01.txt] 30 %

File Edit Options Encoding Help

NETWORK STATISTICS

Buses: 9
Lines: 6
Transformers: 3
Generators: 3
Loads: 3

SOLUTION STATISTICS

Number of Iterations: 4
Maximum P mismatch [p.u.]: 0
Maximum Q mismatch [p.u.]: 0
Power rate [MVA]: 100

POWER FLOW RESULTS

Bus	V [p.u.]	phase [rad]	P gen [p.u.]	Q gen [p.u.]
Bus 1	1.04	0	0.71641	0.27046
Bus 2	1.025	0.16197	1.63	0.06654
Bus 3	1.025	0.08142	0.85	-0.1086
Bus 4	1.0258	-0.03869	0	0
Bus 5	0.99563	-0.06962	0	0
Bus 6	1.0127	-0.06436	0	0
Bus 7	1.0258	0.06492	0	0
Bus 8	1.0159	0.0127	0	0
Bus 9	1.0324	0.03433	0	0

Q I (p.u.)


0.71641
1.63
0.85
0
0.99563
1.0127
1.0258
1.0159
1.0324

I (p.u.)

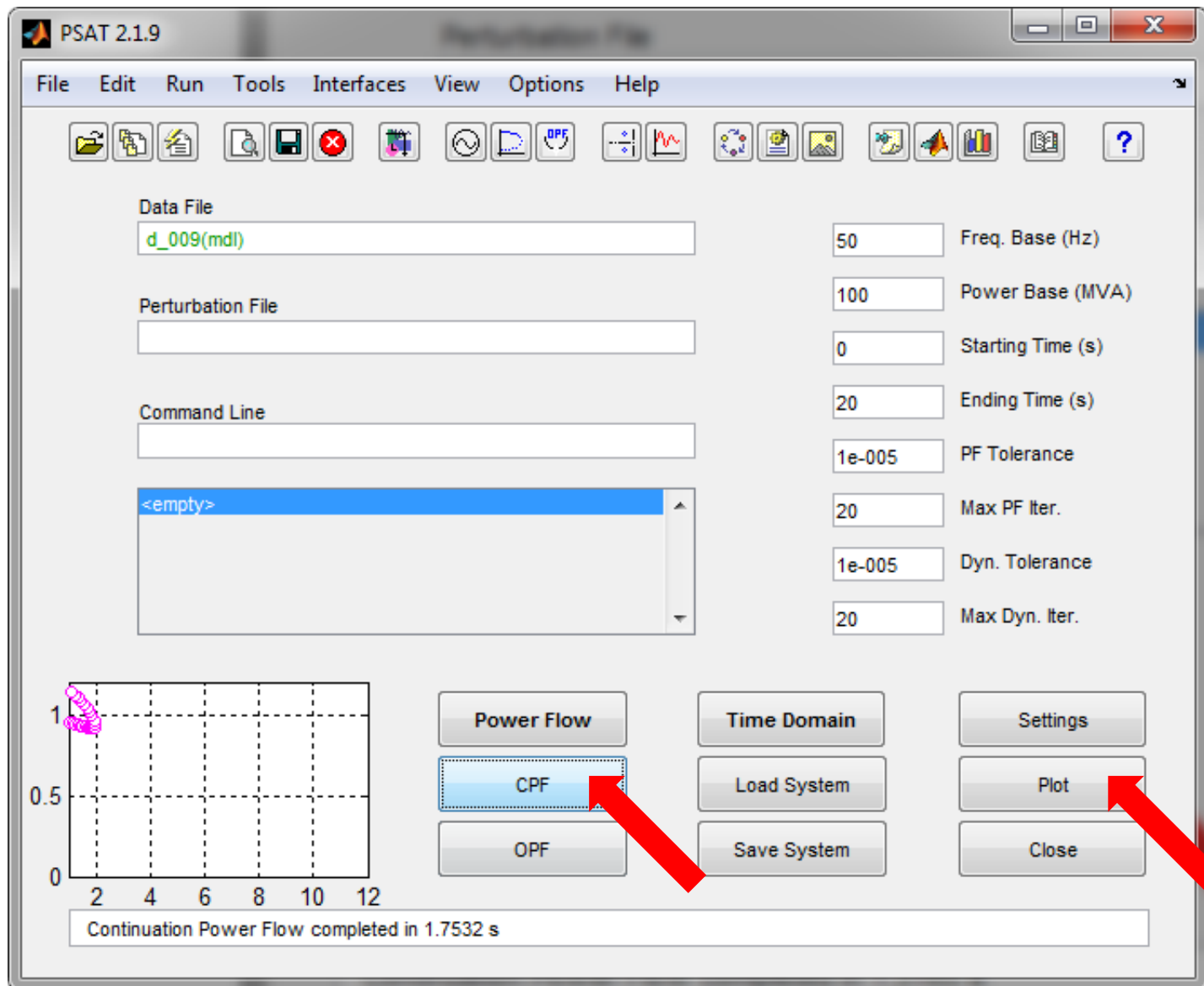
0.27046
0.06654
-0.1086
0
-0.5
-0.3
0
-0.35
0

Report Close

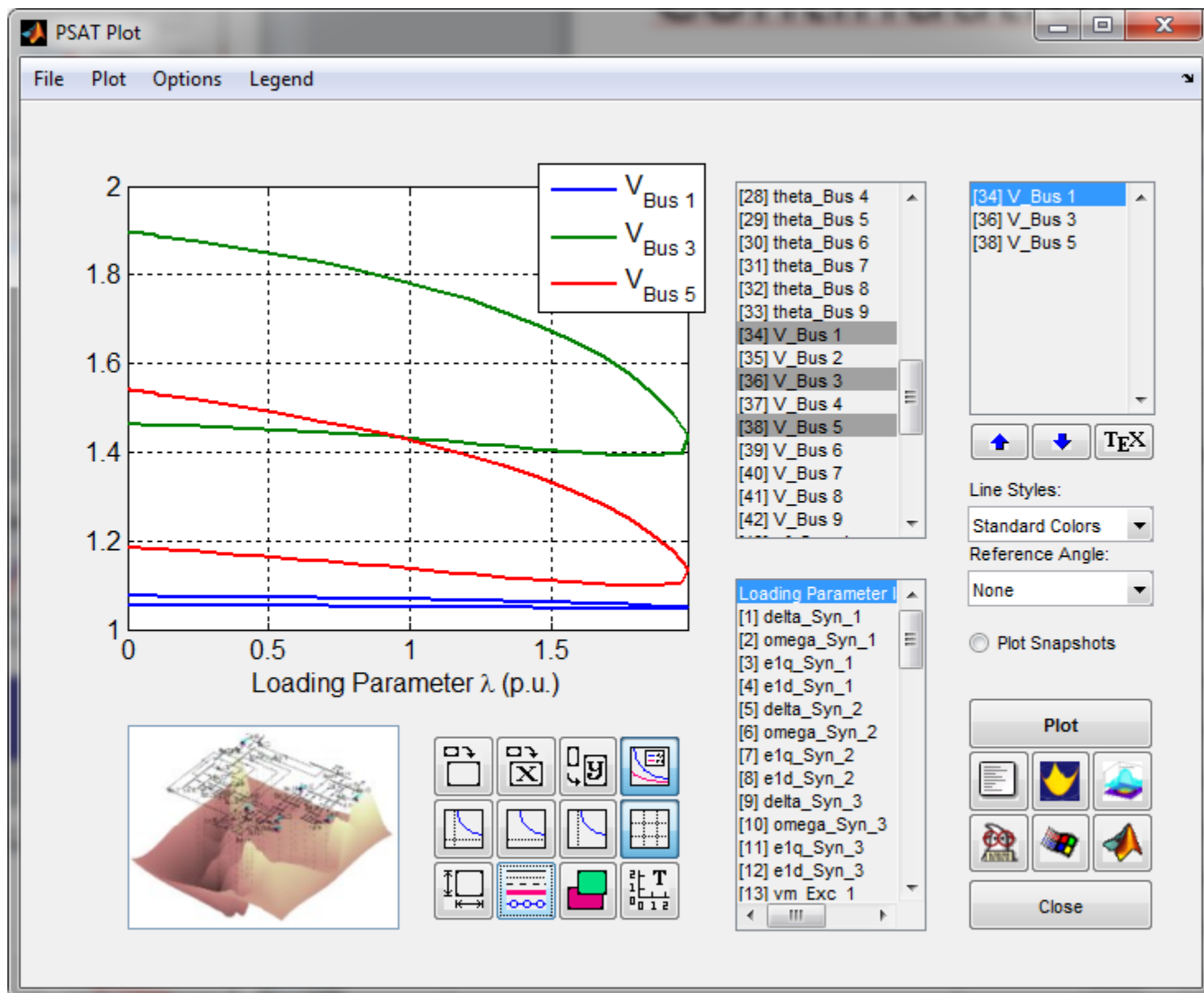
Check limit violations
 Use absolute values



Řešení napěťové stability sítě – Continuation Power Flow Analysis - CPF:



Řešení napěťové stability sítě – Continuation Power Flow Analysis - CPF:



Řešení napěťové stability sítě – Continuation Power Flow Analysis - CPF:

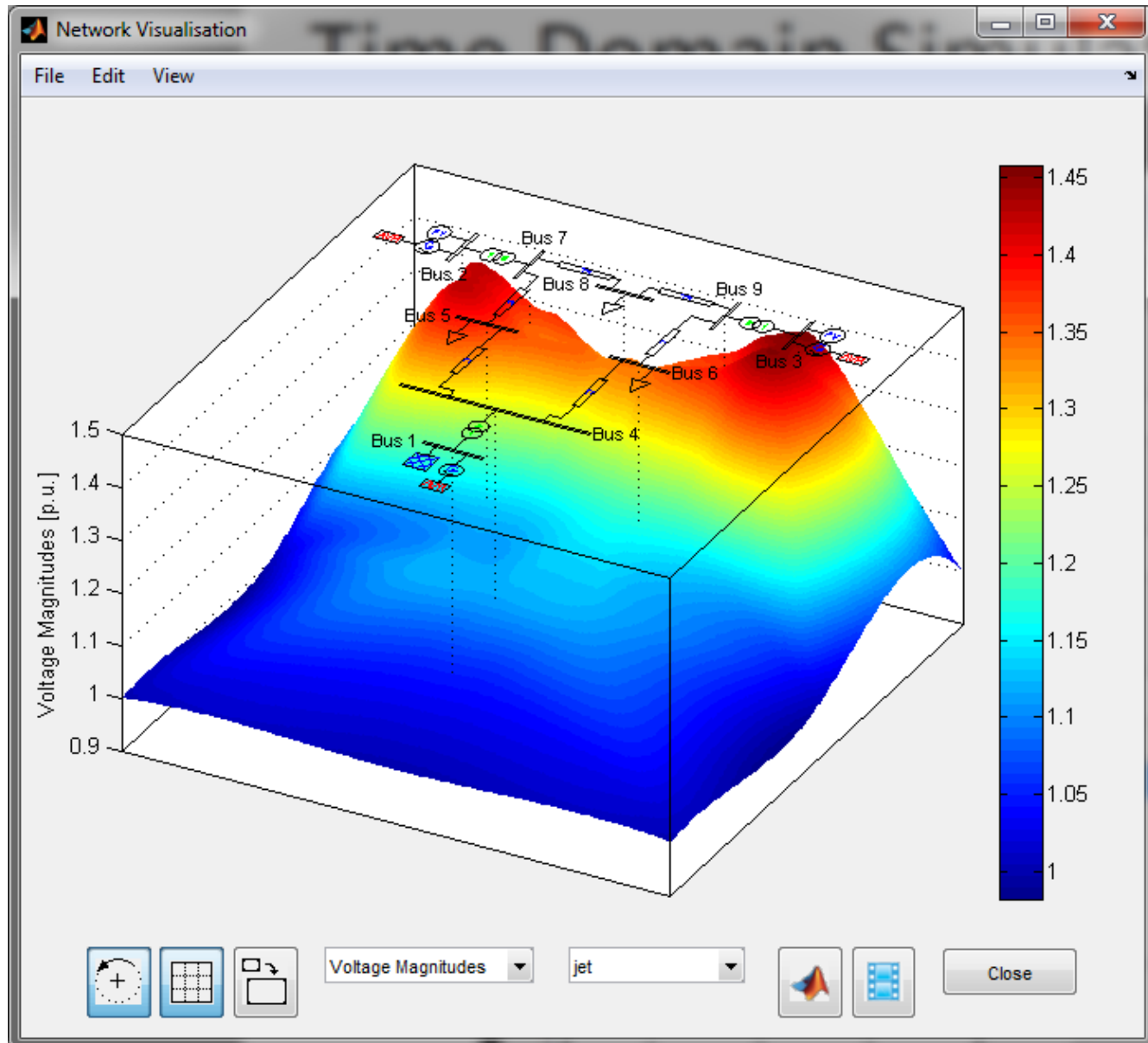
The screenshot displays the PSAT 2.1.9 software interface. The window title is "PSAT 2.1.9". The menu bar includes "File", "Edit", "Run", "Tools", "Interfaces", "View", "Options", and "Help". The toolbar contains various icons, with a red arrow pointing to the CPF icon. The main area is divided into several sections:

- Data File:**
- Perturbation File:**
- Command Line:**
- Parameters:**
 - Frequency (Hz):
 - Power Base (MVA):
 - Starting Time (s):
 - Ending Time (s):
 - PF Tolerance:
 - Max PF Iter.:
 - Dyn. Tolerance:
 - Max Dyn. Iter.:

At the bottom left, there is a plot area with a grid. The y-axis ranges from 0 to 1, and the x-axis ranges from 0 to 12. A pink scribble is present in the top-left corner of the plot area. To the right of the plot are several buttons: "Power Flow", "CPF" (highlighted with a blue border), "OPF", "Time Domain", "Load System", "Save System", "Settings", "Plot", and "Close".

At the bottom of the window, a status bar displays the text: "Continuation Power Flow completed in 1.7532 s".

Řešení napěťové stability sítě – Continuation Power Flow Analysis - CPF:



Řešení přechodného děje – Time Domain Simulation - TD:

The screenshot displays the PSAT 2.1.9 software interface. The window title is "PSAT 2.1.9". The menu bar includes "File", "Edit", "Run", "Tools", "Interfaces", "View", "Options", and "Help". The toolbar contains various icons for file operations, simulation, and plotting.

The main area is divided into several sections:

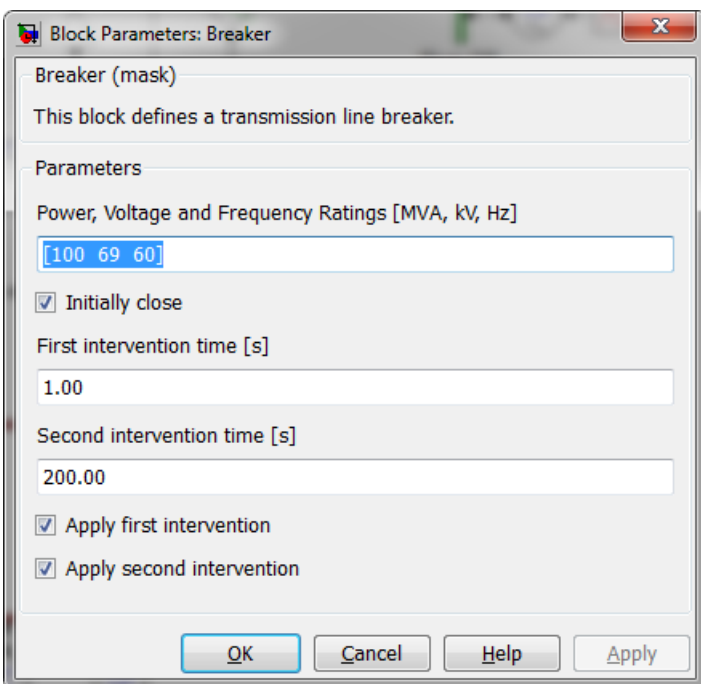
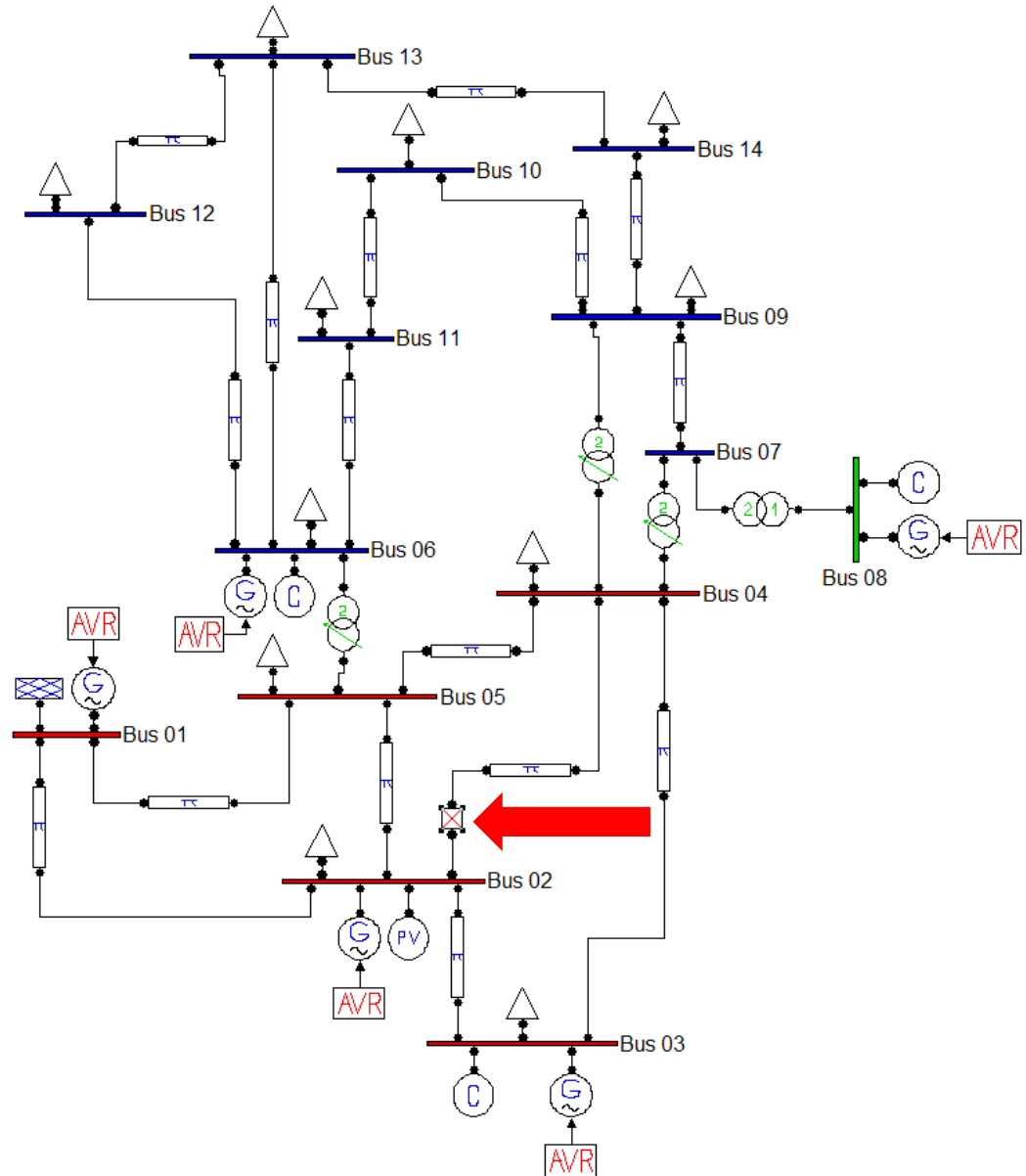
- Data File:** A text box containing "d_014_dyn.mdl". A red arrow points to this field.
- Perturbation File:** An empty text box.
- Command Line:** A text box containing "<empty>".
- Parameters:** A list of numerical values in text boxes:
 - Freq. Base (Hz): 50
 - Power Base (MVA): 100
 - Starting Time (s): 0
 - Ending Time (s): 2.3777
 - PF Tolerance: 1e-005
 - Max PF Iter.: 20
 - Dyn. Tolerance: 1e-003
 - Max Dyn. Iter.: 20

At the bottom, there is a plot area with a grid. The y-axis ranges from 0 to 1, and the x-axis ranges from 0 to 20. Two small red circles are visible on the x-axis near the origin. To the right of the plot are several buttons: "Power Flow", "CPF", "OPF", "Time Domain" (highlighted with a blue border and a red arrow), "Load System", "Save System", "Settings", "Plot" (with a red arrow), and "Close".

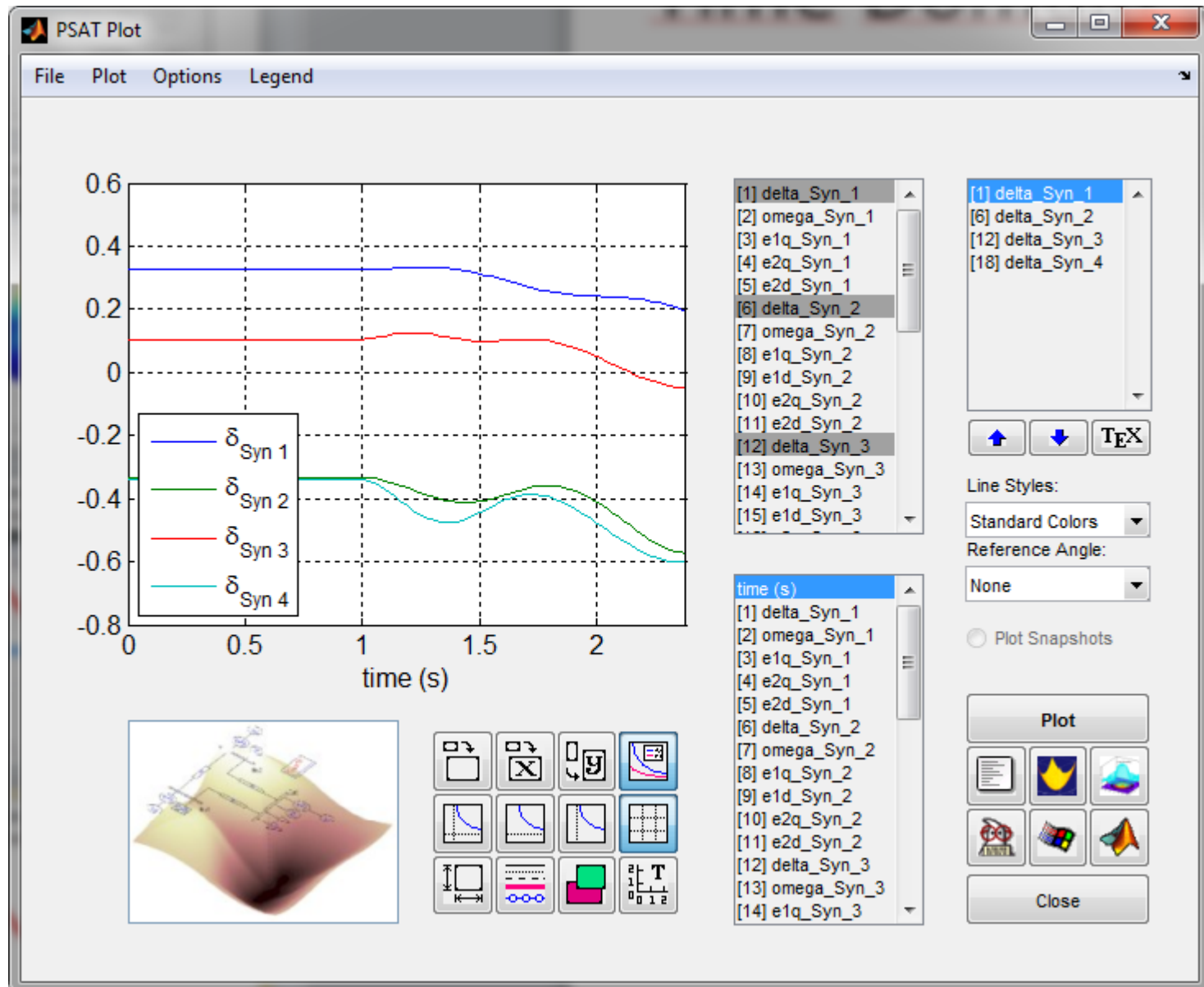
A status bar at the bottom of the window displays the text: "Dynamic Simulation completed in 1.4348 s".

Řešení přechodného děje – Time Domain Simulation - TD:

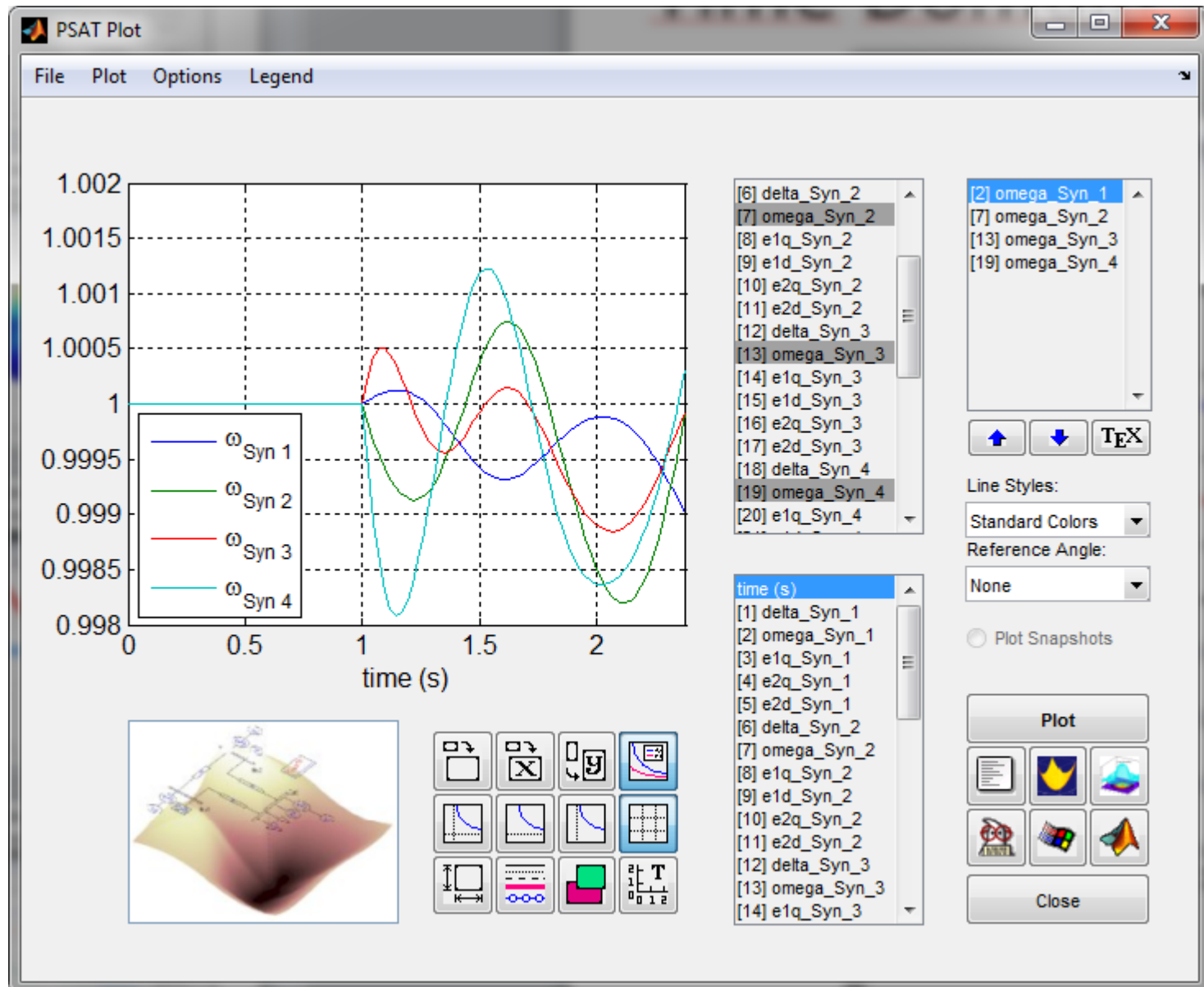
Definice časově
proměnného
inicializačního prvku:



Řešení přechodného děje – Time Domain Simulation - TD:

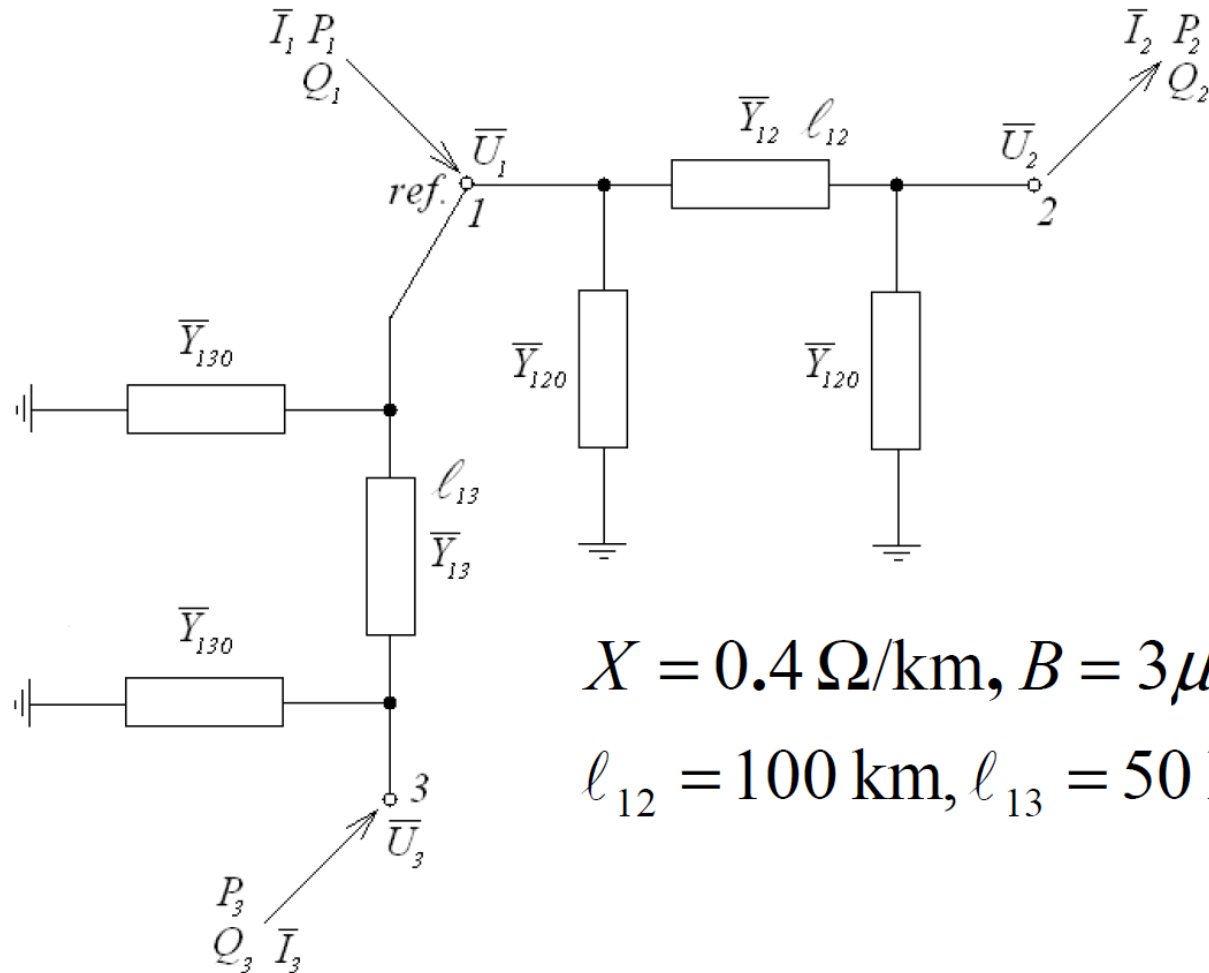


Řešení přechodného děje – Time Domain Simulation - TD:



Řešený příklad z předmětu TPR:

Řešte chod 3-uzlové soustavy



$$\bar{U}_1 = 110000 \cdot e^{j0^\circ} \text{ V}$$

$$P_2 = 50 \text{ MW}$$

$$Q_2 = 10 \text{ MVar}$$

$$P_3 = 100 \text{ MW}$$

$$Q_3 = 10 \text{ MVar}$$

$$X = 0.4 \text{ } \Omega/\text{km}, B = 3 \mu\text{S}/\text{km}$$

$$l_{12} = 100 \text{ km}, l_{13} = 50 \text{ km}$$

$$U_2, \theta_2, U_3, \theta_3 = ?$$

Řešený příklad z předmětu TPR:

Iterační algoritmus:

$$\bar{U}_2^{(p)} = \frac{1}{A_{22}} \left[\frac{P_2 - jQ_2}{\bar{U}_2^{*(p-1)}} - \bar{A}_{21}\bar{U}_1 - \sum_3 \bar{A}_{ik}\bar{U}_k^{(p-1)} \right] = \frac{1}{A_{22}} \left[\frac{P_2 - jQ_2}{\bar{U}_2^{*(p-1)}} - \bar{A}_{21}\bar{U}_1 - \bar{A}_{23}\bar{U}_3^{(p-1)} \right]$$

$$\bar{U}_3^{(p)} = \frac{1}{A_{33}} \left[\frac{P_3 - jQ_3}{\bar{U}_3^{*(p-1)}} - \bar{A}_{31}\bar{U}_1 - \sum_{k=2}^2 \bar{A}_{ik}\bar{U}_k^{(p)} \right] = \frac{1}{A_{33}} \left[\frac{P_3 - jQ_3}{\bar{U}_3^{*(p-1)}} - \bar{A}_{31}\bar{U}_1 - \bar{A}_{32}\bar{U}_2^{(p)} \right]$$

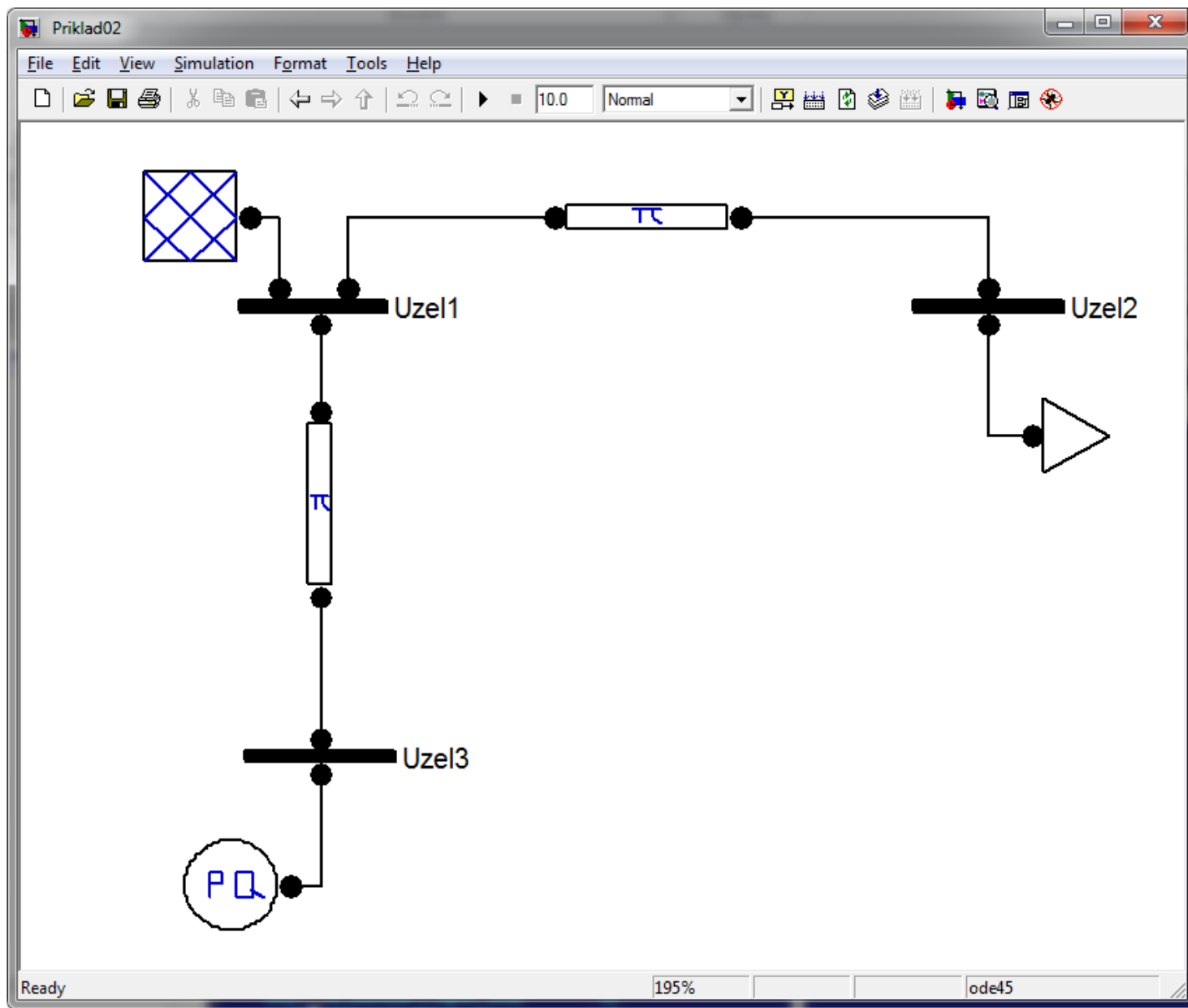
- Počáteční hodnoty:

Admitanční matice:

$$\bar{A} = j \begin{bmatrix} -0.074775 & 0.025 & 0.05 \\ 0.025 & -0.02485 & 0 \\ 0.05 & 0 & -0.049925 \end{bmatrix}$$

$$\bar{x}_0 = \begin{bmatrix} 110000 e^{j0} \\ 110000 e^{j0} \\ 110000 e^{j0} \end{bmatrix} [\text{V}]$$

Řešený příklad z předmětu TPR:



Řešený příklad z předmětu TPR:

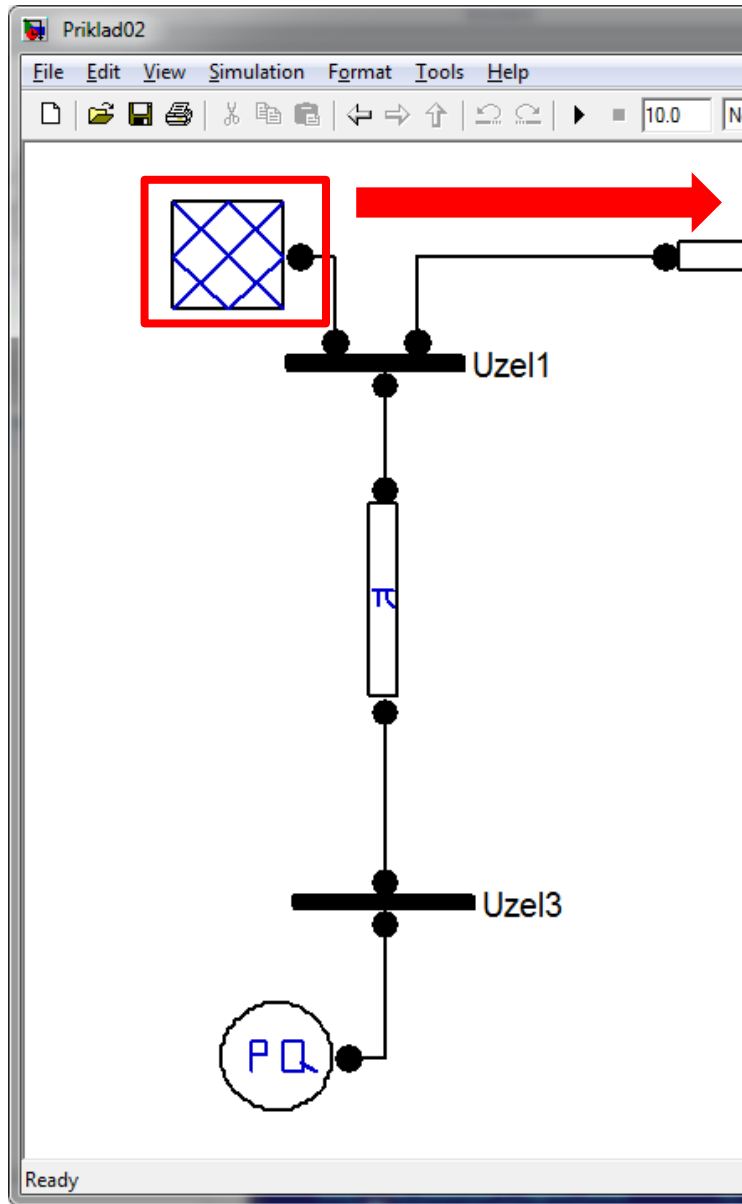
The image displays a software interface for a power system simulation. The main window, titled "Příklad02", shows a circuit diagram with three buses: "Uzel1" (highlighted with a red box), "Uzel2", and "Uzel3". A transformer labeled "T" connects Uzel1 and Uzel2. A load labeled "PQ" is connected to Uzel3. A red arrow points from the "Uzel1" box to a "Block Parameters: Uzel1" dialog box.

The "Block Parameters: Uzel1" dialog box contains the following settings:

- Bus (mask): Bus block.
- Parameters:
 - Number of inputs: 2
 - Number of outputs: 1
 - Voltage Rating [kV]: 110
 - Voltage initial guess [p.u. rad]: [1.00 0.00]
 - Area number: 1
 - Region number: 1

Buttons at the bottom of the dialog include "OK", "Cancel", "Help", and "Apply".

Řešený příklad z předmětu



Block Parameters: Slack

SW (mask)

This block defines a V-theta bus:

$$V = V_des$$
$$\theta = \theta_des$$

Parameters

Power and Voltage Ratings [MVA, kV]

[100 110]

Voltage Magnitude [p.u.]

1.00

Reference Phase Angle [rad]

0.00

Qmax and Qmin [p.u. p.u.]

[1.5 -1.5]

Vmax and Vmin [p.u. p.u.]

[1.1 0.9]

Active Power Guess [p.u.]

0.80

Loss Participation Factor

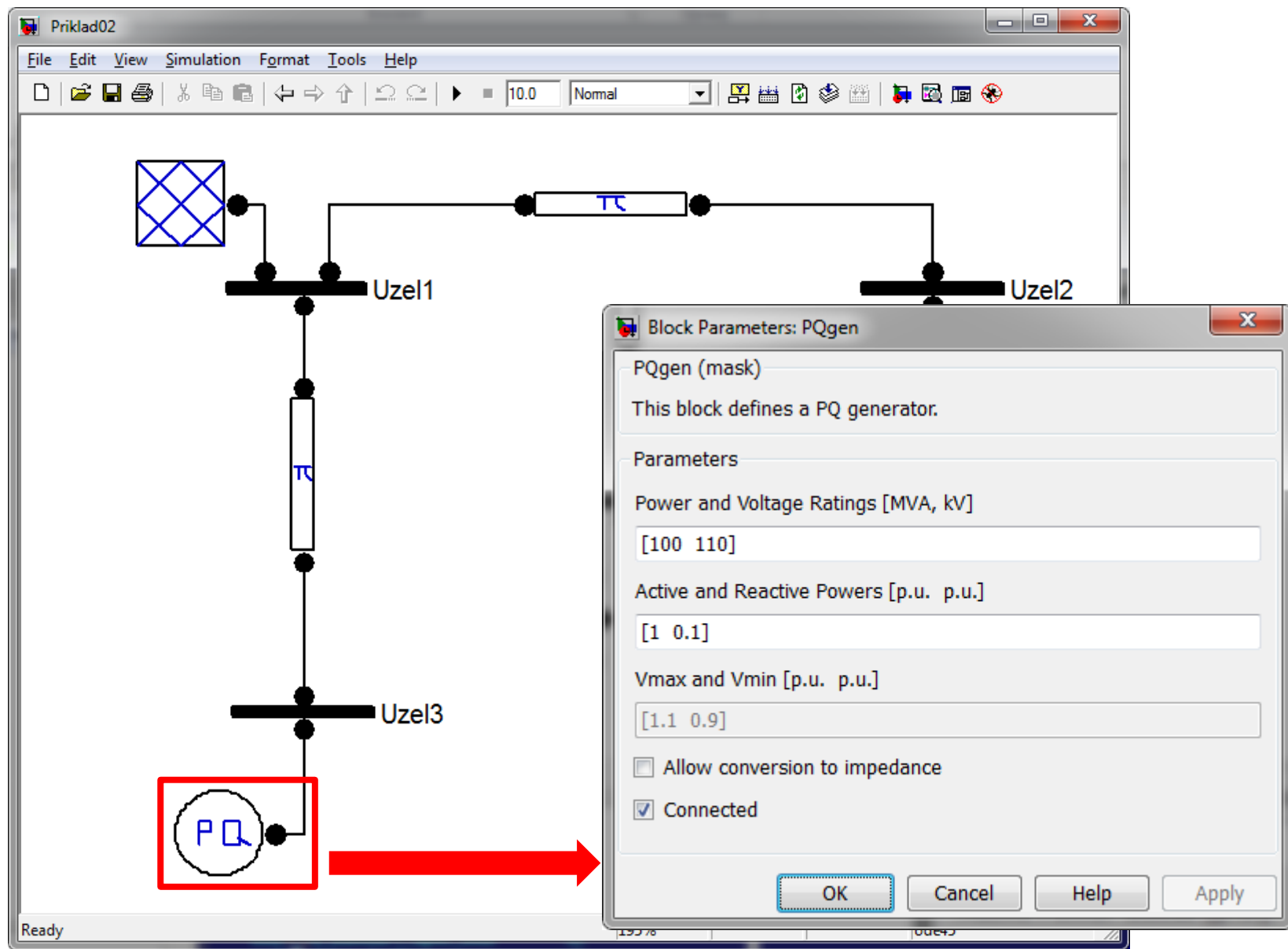
1

Reference bus

Connected

OK Cancel Help Apply

Řešený příklad z předmětu TPR:



Řešený příklad z předmětu TPR:

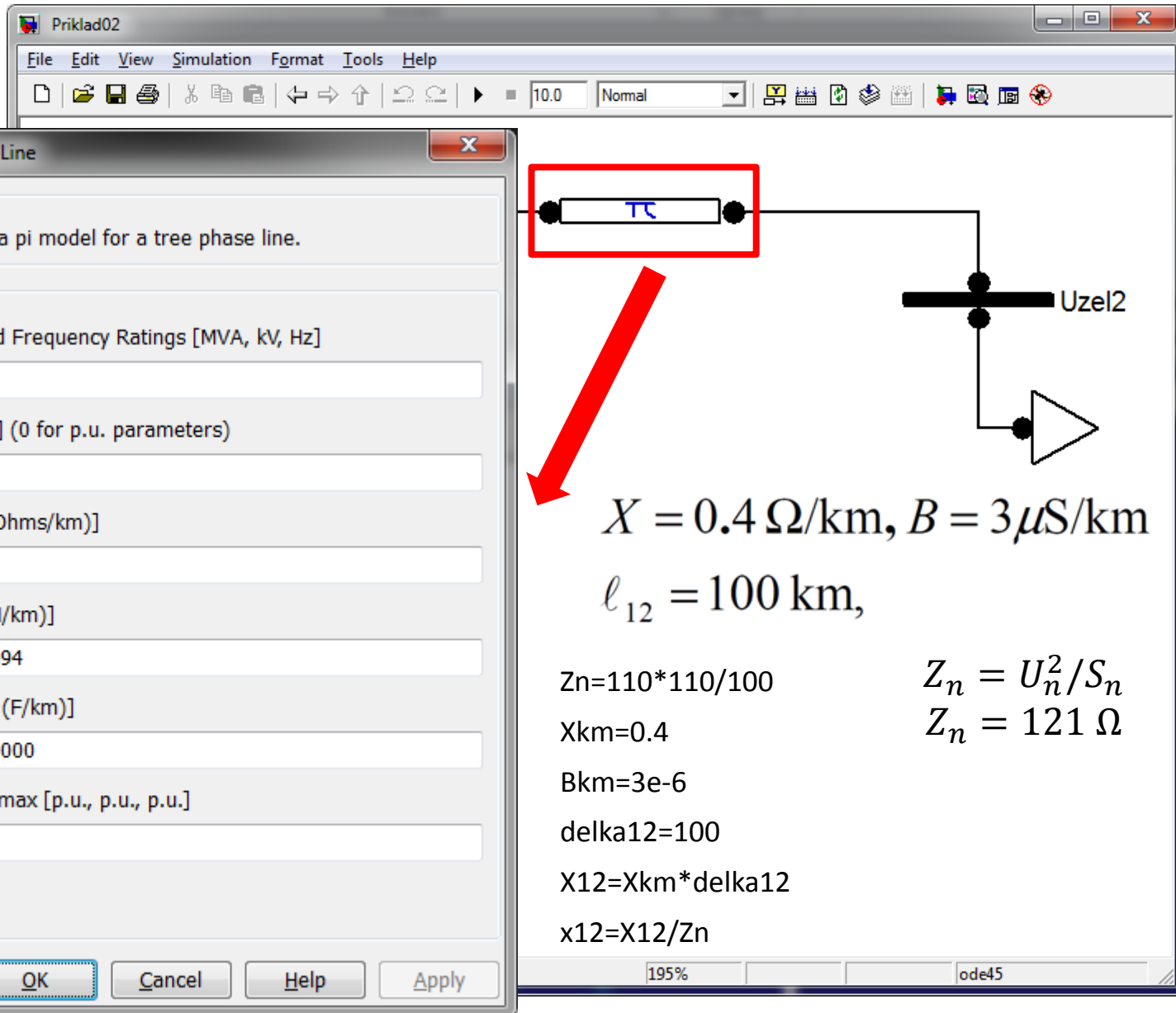
The image displays a software interface for a power system simulation. The main window, titled "Příklad02", shows a circuit diagram with a transformer, a transmission line labeled "TC", and a bus labeled "Uzel2". A red box highlights a component connected to the bus, with a red arrow pointing to the "Block Parameters: PQ" dialog box.

The "Block Parameters: PQ" dialog box contains the following information:

- PQ (mask)
- This block defines a constant power load:
- $P = P_{cost}$.
- $Q = Q_{cost}$.
- Parameters
- Power and Voltage Ratings [MVA, kV]: [100 110]
- Active and Reactive Powers [p.u. p.u.]: [0.5 0.1]
- Maximum and Minimum Allowable Voltage [p.u. p.u.]: [1.2 0.8]
- Allow conversion to impedance for min or max voltage
- Connected
- Buttons: OK, Cancel, Help, Apply

The status bar at the bottom shows "Ready", "195%", and "ode45".

Řešený příklad z předmětu TPR:



The image shows a software window titled "Příklad02" with a menu bar (File, Edit, View, Simulation, Format, Tools, Help) and a toolbar. A "Block Parameters: Line" dialog box is open, displaying the following parameters:

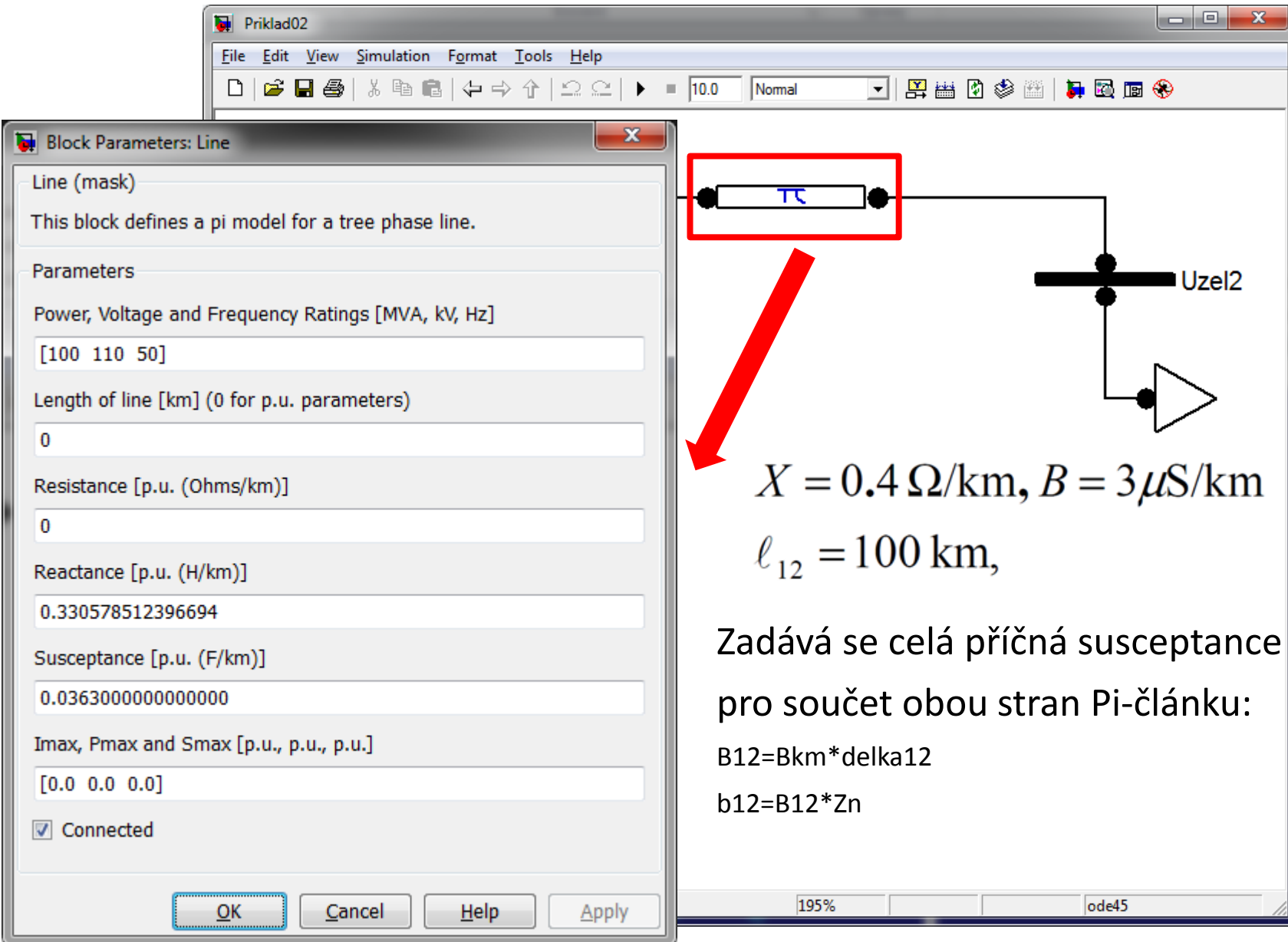
- Line (mask): This block defines a pi model for a three phase line.
- Parameters: Power, Voltage and Frequency Ratings [MVA, kV, Hz]: [100 110 50]
- Length of line [km] (0 for p.u. parameters): 0
- Resistance [p.u. (Ohms/km)]: 0
- Reactance [p.u. (H/km)]: 0.330578512396694
- Susceptance [p.u. (F/km)]: 0.0363000000000000
- Imax, Pmax and Smax [p.u., p.u., p.u.]: [0.0 0.0 0.0]
- Connected

The main window displays a circuit diagram with a transmission line block labeled "TL" highlighted by a red box. A red arrow points from this box to the following equations:

$$X = 0.4 \Omega/\text{km}, B = 3 \mu\text{S}/\text{km}$$
$$\ell_{12} = 100 \text{ km},$$
$$Z_n = 110 \cdot 110 / 100 \quad Z_n = U_n^2 / S_n$$
$$X_{\text{km}} = 0.4 \quad Z_n = 121 \Omega$$
$$B_{\text{km}} = 3 \cdot 10^{-6}$$
$$\text{delka}_{12} = 100$$
$$X_{12} = X_{\text{km}} \cdot \text{delka}_{12}$$
$$x_{12} = X_{12} / Z_n$$

The diagram also shows a bus labeled "Uzel2" connected to a load represented by a triangle symbol.

Řešený příklad z předmětu TPR:



The image shows a software interface with a circuit diagram and a parameter dialog box. The circuit diagram features a rectangular block labeled π (representing a pi-model line) connected to a bus labeled "Uzel2". A red arrow points from the π block to the text below. The dialog box, titled "Block Parameters: Line", contains the following parameters:

- Line (mask): This block defines a pi model for a three phase line.
- Parameters
- Power, Voltage and Frequency Ratings [MVA, kV, Hz]: [100 110 50]
- Length of line [km] (0 for p.u. parameters): 0
- Resistance [p.u. (Ohms/km)]: 0
- Reactance [p.u. (H/km)]: 0.330578512396694
- Susceptance [p.u. (F/km)]: 0.0363000000000000
- Imax, Pmax and Smax [p.u., p.u., p.u.]: [0.0 0.0 0.0]
- Connected

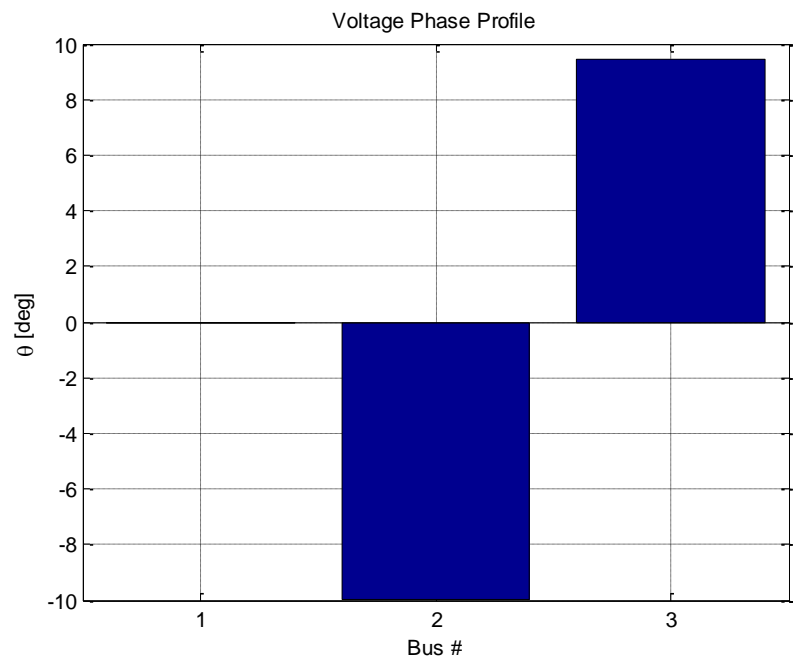
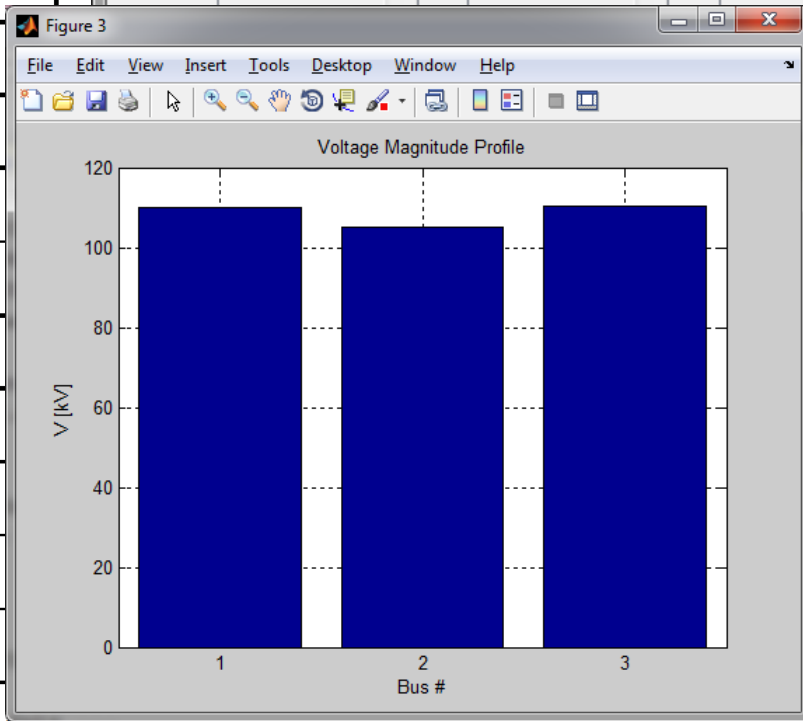
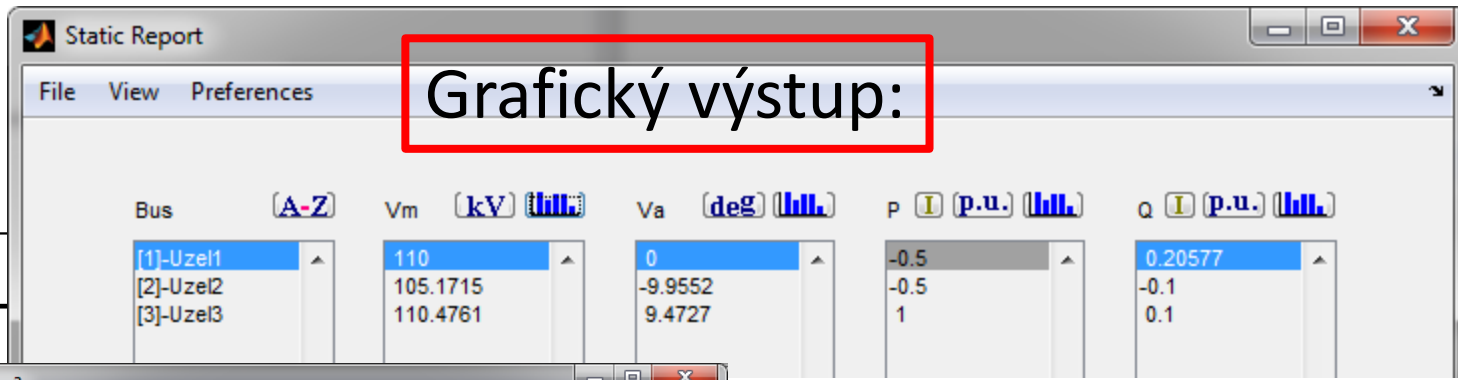
Below the diagram, the following parameters are listed:

$$X = 0.4 \Omega/\text{km}, B = 3 \mu\text{S}/\text{km}$$
$$\ell_{12} = 100 \text{ km},$$

Zadává se celá příčná susceptance pro součet obou stran Pi-článku:

$$B_{12} = B_{\text{km}} * \text{delka}_{12}$$
$$b_{12} = B_{12} * Z_n$$

Řešený příklad z předmětu TPR:



θ_3
0
1''
51''
71''
92''
93''
90''
55''
54''
56''
B'21,56''

p
0
1
2
3
4
5
6
7
8
9
10

11	105171,47643	110476,12824	11	-9°57'18,67''	9°28'21,56''
12	105171,47629	110476,12820	12	-9°57'18,67''	9°28'21,56''

Textový výstup:

POWER FLOW REPORT

P S A T 2.1.9

Author: Federico Milano, (c) 2002-2013
e-mail: federico.milano@ucd.ie
website: faraday1.ucd.ie/psat.html

File: E:\PORTAPP\MatLab.R2010b\R2010b\toolbox\psat\Priklad01.mdl
Date: 27-Nov-2016 16:13:27

NETWORK STATISTICS

Buses: 3
Lines: 2
Generators: 1
Loads: 2

SOLUTION STATISTICS

Number of Iterations: 4
Maximum P mismatch [p.u.] 0
Maximum Q mismatch [p.u.] 0
Power rate [MVA] 100

POWER FLOW RESULTS

Bus	V [p.u.]	phase [rad]	P gen [p.u.]	Q gen [p.u.]	P load [p.u.]	Q load [p.u.]
Uzel1	1	0	-0.5	0.20577	0	0
Uzel2	0.9561	-0.17375	0	0	0.5	0.1
Uzel3	1.0043	0.16533	1	0.1	0	0

,01''
3,51''
7,71''
7,02''
0,93''
0,90''
,55''
,54''
,56''
,56''
,56''

12	105171,47629	110476,12820	12	-9°57'18,67''	9°28'21,56''
----	--------------	--------------	----	---------------	--------------

Textový výstup:

LINE FLOWS

From Bus	To Bus	Line	P Flow [p.u.]	Q Flow [p.u.]	P Loss [p.u.]	Q Loss [p.u.]
Uzel1	Uzel2	1	0.5	0.15818	0	0.05818
Uzel3	Uzel1	2	1	0.1	0	0.14759

LINE FLOWS

From Bus	To Bus	Line	P Flow [p.u.]	Q Flow [p.u.]	P Loss [p.u.]	Q Loss [p.u.]
Uzel2	Uzel1	1	-0.5	-0.1	0	0.05818
Uzel1	Uzel3	2	-1	0.04759	0	0.14759

GLOBAL SUMMARY REPORT

TOTAL GENERATION

REAL POWER [p.u.] 0.5
 REACTIVE POWER [p.u.] 0.30577

TOTAL LOAD

REAL POWER [p.u.] 0.5
 REACTIVE POWER [p.u.] 0.1

0,01''
8,51''
7,71''
7,02''
0,93''
0,90''
1,55''
1,54''
1,56''
1,56''
1,56''

Řešený příklad z předmětu

Výstup HTML (pro www):

p	U_2	U_3
0	110000,00000	110000,00000
1	108557,79539	113456,92025
2	105374,88998	110502,59407
3	105284,10663	110555,03645
4	105178,50904	110476,87553
5	105175,34781	110478,27315
6	105171,71834	110476,14855
7	105171,60950	110476,18655
8	105171,48461	110476,12876
9	105171,48086	110476,12979
10	105171,47656	110476,12822
11	105171,47643	110476,12824
12	105171,47629	110476,12820

template.html

file:///C:/WORK/W1/Prikklad01_0...

NETWORK STATISTICS

Buses:	3.00000
Lines:	2.00000
Generators:	1.00000
Loads:	2.00000

SOLUTION STATISTICS

Number of Iterations:	4.00000
Maximum P mismatch [p.u.]	0.00000
Maximum Q mismatch [p.u.]	0.00000
Power rate [MVA]	100.00000

POWER FLOW RESULTS

Bus	V	phase	P gen	Q gen	P load	Q load
	[p.u.]	[rad]	[p.u.]	[p.u.]	[p.u.]	[p.u.]
Uze11	1.00000	0.00000	-0.50000	0.20577	0.00000	0.00000
Uze12	0.95610	-0.17375	0.00000	0.00000	0.50000	0.10000
Uze13	1.00433	0.16533	1.00000	0.10000	0.00000	0.00000

LINE FLOWS

From Bus	To Bus	Line	P Flow	Q Flow	P Loss	Q Loss
			[p.u.]	[p.u.]	[p.u.]	[p.u.]
Uze11	Uze12	1.00000	0.50000	0.15818	-0.00000	0.05818
Uze13	Uze11	2.00000	1.00000	0.10000	0.00000	0.14759

Řešený příklad z předmětu

Výstup MS-EXCEL (xlsx):

p	U_2	U_3
0	110000,00000	110000,00000
1	108557,79539	113456,9202
2	105374,88998	110502,5940
3	105284,10663	110555,0364
4	105178,50904	110476,8755
5	105175,34781	110478,2731
6	105171,71834	110476,1485
7	105171,60950	110476,1865
8	105171,48461	110476,1287
9	105171,48086	110476,1297
10	105171,47656	110476,1282
11	105171,47643	110476,1282
12	105171,47629	110476,1282

Příklad01_01.xls - Microsoft Excel

Soubor Domů Vložení Rozložení stránky Vzorce Data Revize Zobrazení

Calibri 11

Vložit

Schránka Písmo Zarovnění Číslo Styly Buňky Úpravy

A1 POWER FLOW REPORT

A	B	C	D	E	F	G	H	
1	POWER FLOW REPORT							
2								
3	P S A T 2.1.9							
4								
5	Author: Federico Milano, (c) 2002-2013							
6	e-mail: federico.milano@ucd.ie							
7	website: faraday1.ucd.ie/psat.html							
8								
9	File: E:\PORTAPP\MatLab.R2010b\R2010b\toolbox\psat\Příklad01.mdl							
10	Date: 27-Nov-2016 17:44:22							
11								
12	NETWORK STATISTICS							
13	Buses:			3				
14	Lines:			2				
15	Generators:			1				
16	Loads:			2				
17								
18	SOLUTION STATISTICS							
19	Number of Iterations:			4				
20	Maximum P mismatch [p.u.]		4.74E-14					
21	Maximum Q mismatch [p.u.]		7.22E-14					
22	Power rate [MVA]		100					
23								
24	POWER FLOW RESULTS							
25	Bus	V	phase	P gen	Q gen	P load	Q load	
26		[p.u.]	[rad]	[p.u.]	[p.u.]	[p.u.]	[p.u.]	
27	Uzel1		1	0	-0.5	0.205773	0	0
28	Uzel2	0.956104	-0.17375	4.74E-14	7.22E-14	0.5	0.1	
29	Uzel3	1.004328	0.165329	1	0.1	0	0	
30								

Prípraven

Řešený pří

p	U_2
0	110000,
1	108557,
2	105374,
3	105284,
4	105178,
5	105175,
6	105171,
7	105171,
8	105171,
9	105171,
10	105171,
11	105171,
12	105171,

Příklad01_01-OverleafVerse.pdf - Adobe Acrobat Reader DC

Soubor Úpravy Zobrazení Okna Nápověda

Domovská stránka Nástroje Příklad01_01-Overl... x Přihlásit se

1 / 2 150%

Table 1: Network statistics

Buses:	3.00000
Lines:	2.00000
Generators:	1.00000
Loads:	2.00000

Výstup LaTeX/pdf:

Table 2: Solution statistics

Number of iterations:	4.00000
Maximum p mismatch [p.u.]	0.00000
Maximum q mismatch [p.u.]	0.00000
Power rate [mva]	100.00000

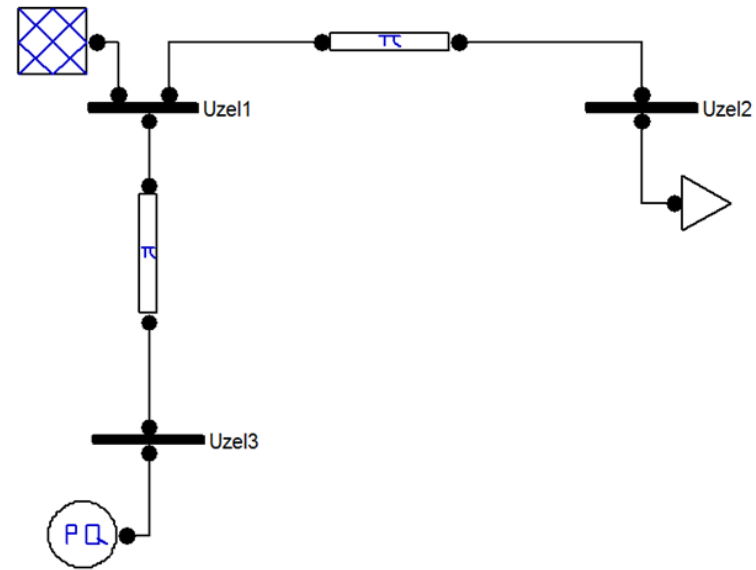
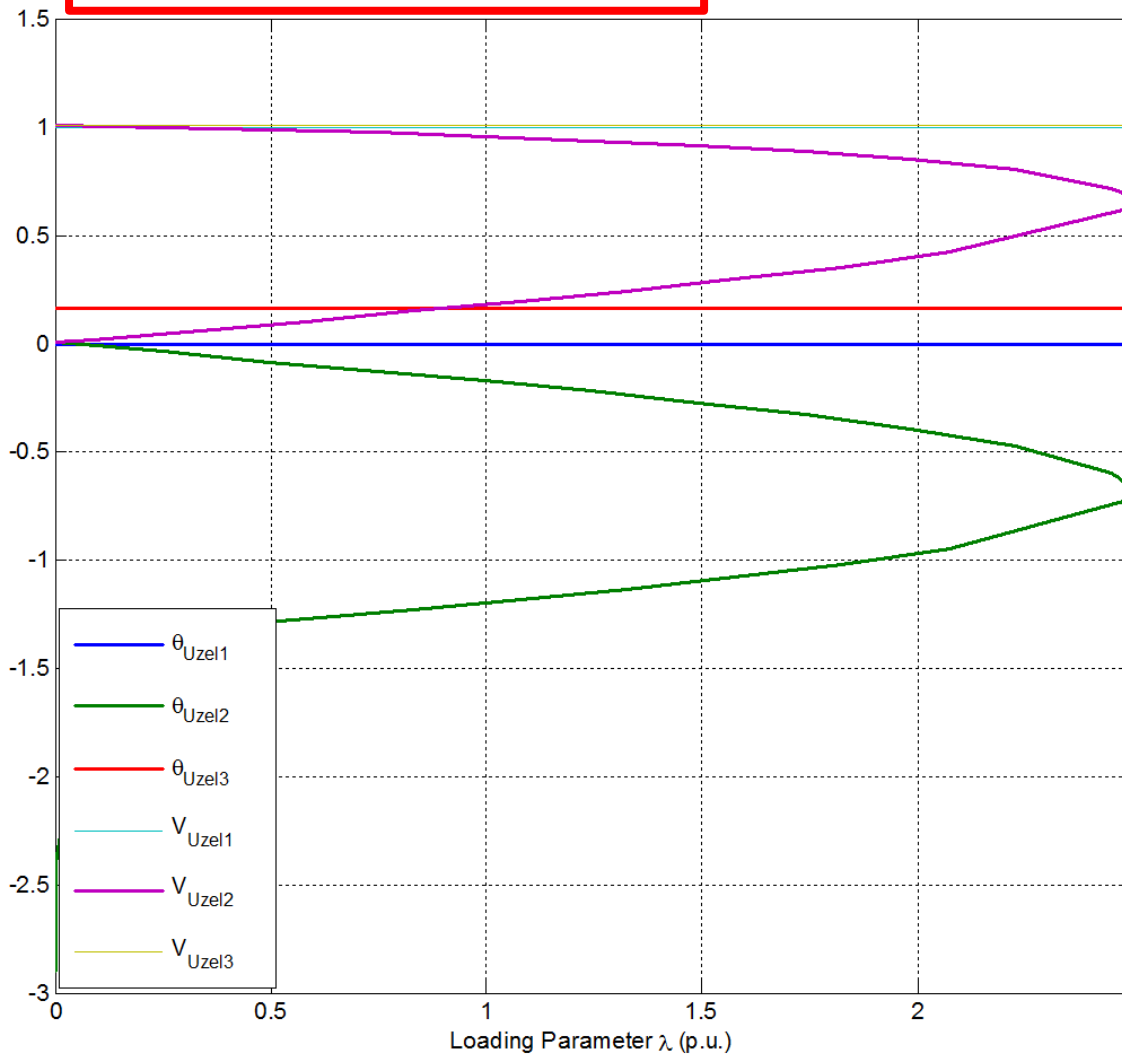
Table 3: Power flow results

Bus	V [p.u.]	Phase [rad]	P gen [p.u.]	Q gen [p.u.]	P load [p.u.]	Q load [p.u.]
Uzel1	1.00000	0.00000	-0.50000	0.20577	0.00000	0.00000
Uzel2	0.95610	-0.17375	0.00000	0.00000	0.50000	0.10000
Uzel3	1.00433	0.16533	1.00000	0.10000	0.00000	0.00000

8.27 x 11.69 "

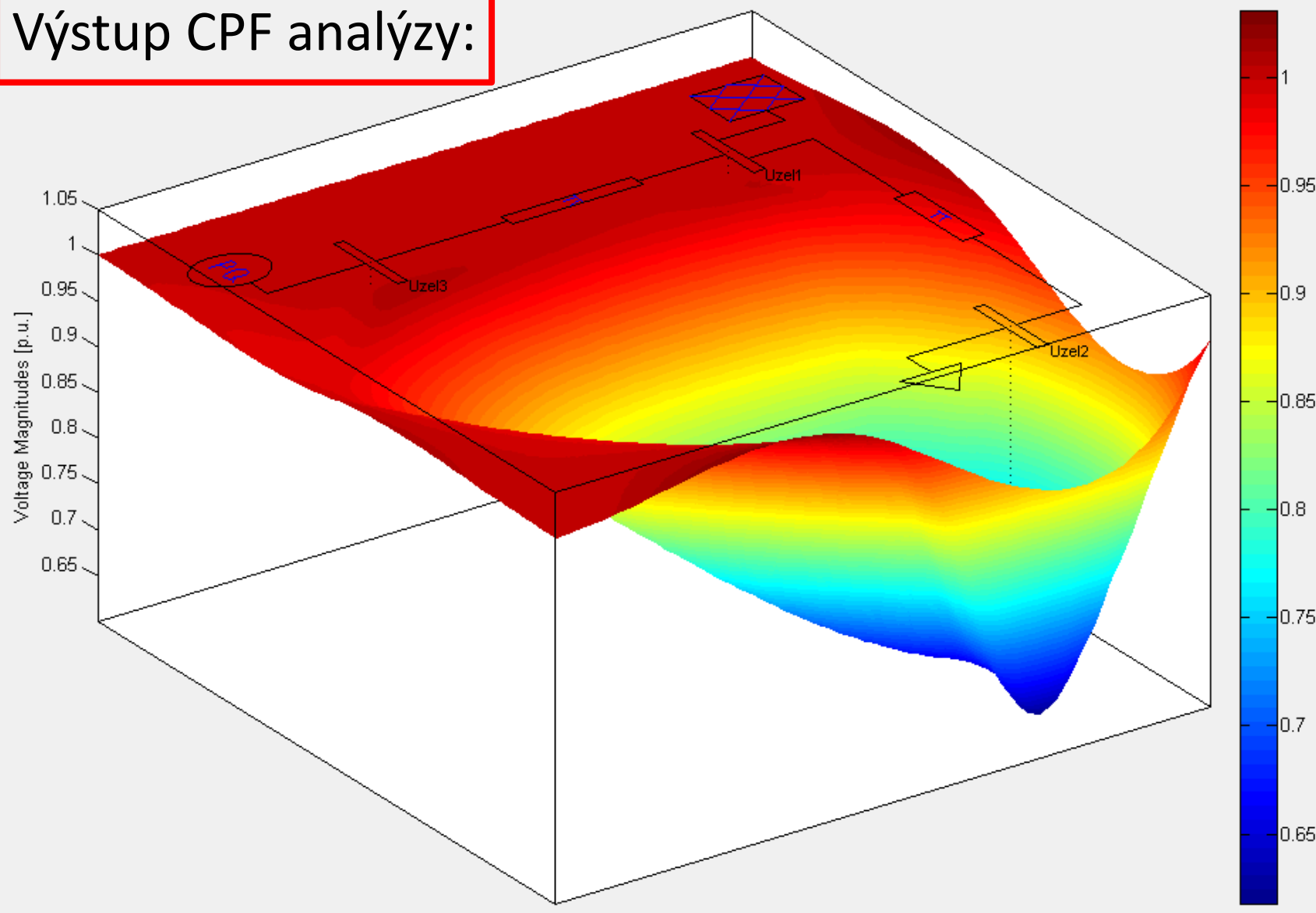
Řešený příklad z předmětu TPR:

Výstup CPF analýzy:



Řešený příklad z předmětu TPR:

Výstup CPF analýzy:



Co je PSAT Závěr:

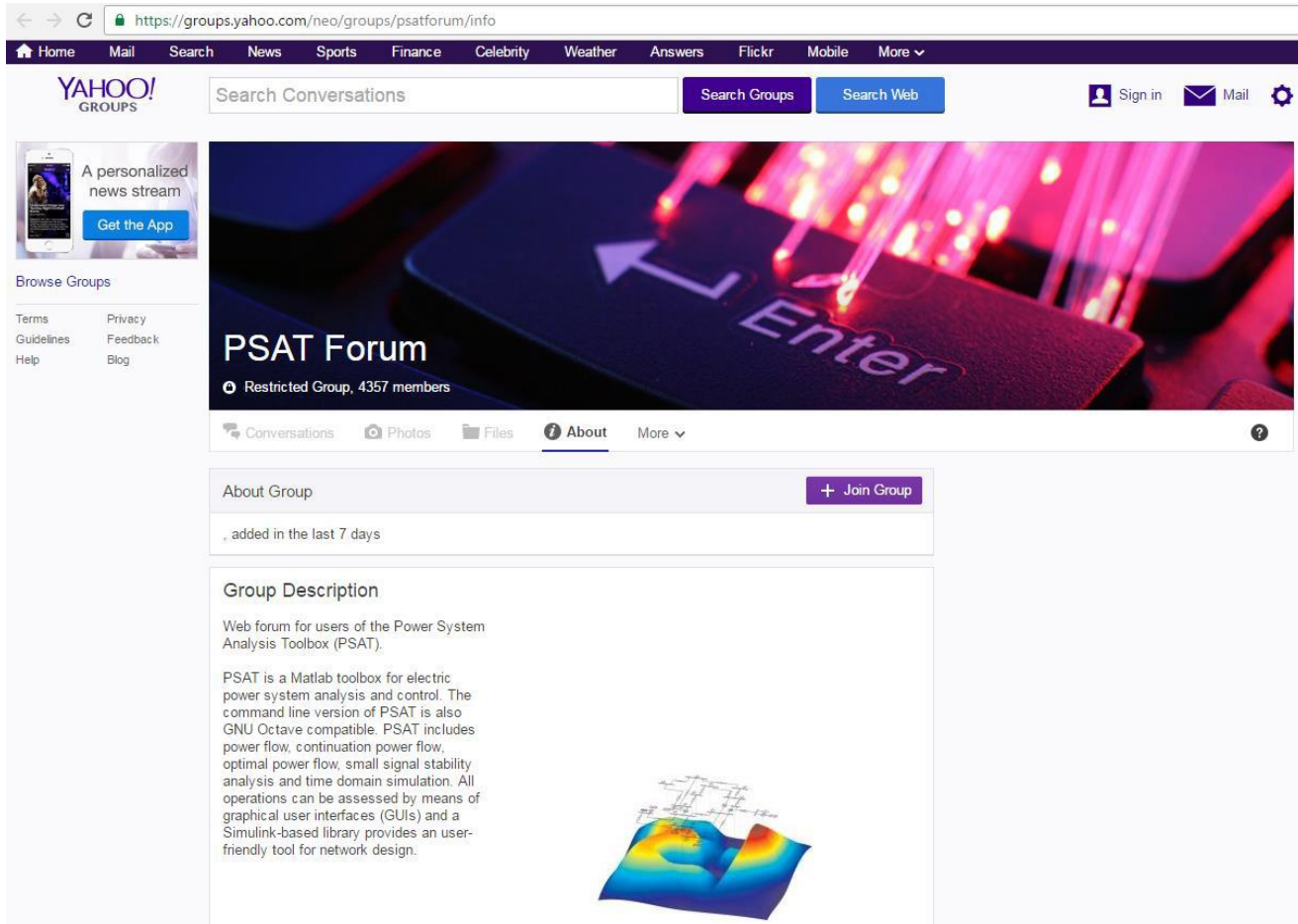
- Vhodný nástroj pro řešení ustálených stavů i přechodných elektro-mechanických dějů v elektrické síti pro výukové i vědecké účely.
- Vytváří rozhraní mezi různými software a vstupními daty, přičemž pohodlně vizualizuje získané výsledky.

PSAT (Power System Analysis Toolbox)

Další informace:

<http://faraday1.ucd.ie/psat.html>

<https://groups.yahoo.com/neo/groups/psatforum/info>



The screenshot shows the Yahoo! Groups page for the PSAT Forum. The browser address bar displays the URL <https://groups.yahoo.com/neo/groups/psatforum/info>. The page header includes navigation links for Home, Mail, Search, News, Sports, Finance, Celebrity, Weather, Answers, Flickr, Mobile, and More. The Yahoo! Groups logo is on the left, and search bars for 'Search Conversations', 'Search Groups', and 'Search Web' are in the center. On the right, there are links for 'Sign in', 'Mail', and a settings gear. A banner image shows a close-up of a keyboard with an 'Enter' key and glowing fiber optic cables. Below the banner, the group name 'PSAT Forum' is displayed, along with the status 'Restricted Group, 4357 members'. Navigation tabs for 'Conversations', 'Photos', 'Files', 'About', and 'More' are visible. The 'About Group' section includes a '+ Join Group' button and a note that members were 'added in the last 7 days'. The 'Group Description' section contains the following text: 'Web forum for users of the Power System Analysis Toolbox (PSAT). PSAT is a Matlab toolbox for electric power system analysis and control. The command line version of PSAT is also GNU Octave compatible. PSAT includes power flow, continuation power flow, optimal power flow, small signal stability analysis and time domain simulation. All operations can be assessed by means of graphical user interfaces (GUIs) and a Simulink-based library provides an user-friendly tool for network design.' To the right of the text is a 3D surface plot showing a network topology with color-coded nodes and edges.