Lab # 09 Power System Analysis Toolbox (PSAT)

Aim:

In this lab we will learn about how to use PSAT. In this lab we will give a simple introduction to get you "up and running" with the program.

PSAT:

PSAT is an open source power system analysis toolbox for Matlab developed by Dr. Federico Milano. It can be used for power system analysis and control, learning, education and research.

Executing the PSAT in GUI (Graphical user interface) Mode:

Once PSAT has been installed type in the Matlab Command Window: >> psat

After a splash window, the "Main GUI" will appear in your screen:

Edit Run Tools Interface	es View Options H	elp	
* \$4 L0	• <u>0</u> -		2411 12 ?
Data File			
		50	Freq. Base (Hz)
Perturbation File		100	Power Base (MVA)
		0	Starting Time (s)
Command Line		20	Ending Time (s)
		1e-05	PF Tolerance
<empty></empty>		^ 20	Max PF Iter.
		1e-06	Dyn. Tolerance
		+ 20	Max Dyn. Iter.
PSAT	Power Flow	Time Domain	Settings
	CPF	Load System	Plot
Version 2.1.10 May 26, 2016	OPF	Save System	Close

Options and settings you will be using:

Open a	File Edit Run Tools In	PSAT 2.1.7 nterfaces View Optio	ns Help	View power flow results, "Static Report" icon
data me	Later ine		50	Freq. Base (Hz)
Launch the	Perturbation File		105	Charlies Time (c)
PSAT-			0	Statung time (s)
Simulink	Command Line		20	
model library			1e-05	PF Tolerance Settings
(to set up your	<empty></empty>		20	Max PF Iter.
one-line			10-05	Dyn. Tolerance
diagram)			20	Max Dyn. Her.
				X
	PSAT	Power Flow	Time Domain	Settings
Run power		CPF	Load System	Plot
flow	Version 2.1.7 July 30, 2012	OPF	Save System	Close

Case Study and Data Preparation:

You should prepare your system data in tables for easy input into PSAT:

System Data:

Bus	V	P _g (KW)	Q _g (KVAR)	P _d (KW)	Q _d (KVAR)	Туре
1	1.00	-	-	50	30.99	Slack
2	-	0	0	170	105.35	PQ
3	-	0	0	200	123.94	PQ
4	1.02	318	-	80	49.58	PV

Line Data:

From Bus	To Bus	R(PU)	X(PU)	B(PU)
1	2	0.01008	0.0504	0.1025
1	3	0.00744	0.0342	0.0775
2	4	0.00744	0.0342	0.0775
3	4	0.01272	0.0636	0.1275

After you finish drawing your one-line diagram, you must save the file and load it to PSAT via the "Data File" field in the PSAT Main GUI. This will translate your Simulink diagram to a PSAT readable data file.

Using the Power Flow Components:

Click on the Simulink icon of the PSAT Main GUI. The Simulink model library will appear. You only need to use two of the sub libraries.

📣 PSAT 2	.1.10								-		
File Edi	t Run	Tools	Interfaces	View	Options	Help					
1	1	Q.	0	\bigcirc	<u></u>			2	2		?
	Data File	•	Оре	n PSAT	Simulink Li	brary		50	D	Freq. Base (I	Hz)
	Perturba	tion File					_	10	00	Power Base	(MVA)
								0		Starting Time	(s)
		Pa Lit	brary: fm_lib -	Simulink	-						
		File	Edit View	Displa	y Diagram	Analysi	5 Help				
		23				≣ ▼ 🥝) -			_	
		fm_l	b Man lib. ⊾								
		_								1	
		€	RI	R	FIE		b				
		23	N N	M	<u>BIE</u>						
			G					6	_		
			30	L		 بر))		
			C		Geo Contraction of the second	ſ	0-0-	~~~			
		650	Ę	Ę		> 6		AM	ም		
			6	رح ر	30	Ľ		Ľ	Ч		
		>>>	8								
		Read	y		10	00%					
		<u></u>	,,		-				1.1		

🍡 Lil	brary: fm	lib/Conn	ections	- Simul	ink					• ×
File	Edit	View Di	splay	Diagra	m Ana	lysis	Help			
▶,	• 8	<₽ ⇒			-	\oslash	•			
Con	nections									
۲	🐴 fm_lib	► Pa Co	nnection	\$						•
Q				Bu	ses & Co	nnect	ons			
K X										
A		~~ ~	Bus1	:	ĥ	>	[A]	[
04			Å	Link	6	G	oto Bus 1	Fro	n Bus2	
		°0	Ă.				_		_	
		°	- A	C-	-C°,		Plot	t variable	list	
		Bus2	Bus3		Link2			Varname		
P.										
»	â									
Read	y				100%	6				
-	L'honn a f	. Ch /Dave	en Flann	Cincil	in to					X
	Library: I	Minu (Diselect	Diam			Hala	(
		view t			ann Ana	ilysis	Help			
1	• • 🖂		v v		•	Ø	•			
P	ower Flow									
	- <u>m</u>		ower Hon	v						•
œ	£		Static	Compo	onents & l	Device	s			ń
0	3		_		_			~		
	8	×~	(PV)o	(PL)o	d	>	(ve))o	
	s	lack Bus	PV		PQ	Gor	stant	Fixed	v	
]	\sim	Genere	tor (Senerator	PG	icac	theta		
	0	12	> .	Transr	nission		Î	Å		
		Fransformer		Li	ne	-	Ţ	Ţ		
	0	(Øz)<	> <		O	0	Static	Shu	nt	-
		Tap Ratio Transformer		Ca.			_1			
		a S	\sim	0		ю	٥Ø	<u>2</u>)a-	>	
		Three-Win	ding	Pr T	ransformer	1	Tap Ra Phase	stip and Shifter		
		Transform	ner		Ch		Trans	tomer		
		۰O	00		Statis		Extra	K		
(iii	8	Autotranst	former	Co	mpensator		Transmis	sion Line		
đ		Area 1		R	egion 1					
×		Area		F	tegion					-
10.00					1009	6				

Drag and drop the components you need to use in a blank Simulink file. Drag and drop the transmission model to a blank Simulink File. Double click on the component and introduce all the data.

Line data:

From Bus to Bus	R	Х	S
1-2	0.01008	0.05040	2*0.05125

Block Parameters: Line	×
Line (mask)	
This block defines a pi model for a tree phase line.	
Parameters	
Power, Voltage and Frequency Ratings [MVA, kV, Hz]	
[100 220 50]	
Length of line [km] (0 for p.u. parameters)	
0	
Resistance [p.u. (Ohms/km)]	
0.01008	
Reactance [p.u. (H/km)]	
0.05040	
Susceptance [p.u. (F/km)]	
2*0.05125	
Imax, Pmax and Smax [p.u., p.u., p.u.]	
[0.0 0.0 0.0]	
Connected	
OK Cancel Help	Apply

Final One-Diagram:

Keep adding each of the remaining elements of the one-line diagram. If you have doubts on what to enter for each field of any element, you should first refer to the manual. If you don't have data for any specific field, use standard values. The final result looks similar to the one shown below.



Remarks on Per Unit Values in PSAT:

The default power base is 100 MVA. This value can be changed in the main PSAT window.

• Buses define the voltage base in kV.

• Per unit values of each device are defined based on the power and voltage nominal rates of the device.

• Before running the power flow analysis the per unit value of each devices are converted to the system power base and to the voltage base of the bus at which the device is connected.

Very Important Remarks:

Power bases always refer to three phase apparent powers and are expressed in MVA.

- Voltage bases always refer to line-to line values and are expressed in kV.Impedance and admittance values are always per phase.

Load the model to PSAT:

Save the Simulink model, after saving the model load it to PSAT via the "Data File" field of the MATLAB.

-			
🕒 🗢 🔳 Desktop 🔸		▼ ⁴ y Sea	rch Desktop 👂
Organize 🔻 New folder	r		₩= ▼ ()
Favorites	Libraries System Folder		E
B Recent Places ■	Homegroup System Folder		
Cibraries	Muhammad Aamir Am System Folder	an	
Videos	Computer System Folder		
🍕 Homegroup 👻 👻	Network		-
File name: LFA			•
Save as type: Simuli	nk Models (*.mdl)		•
 Hide Folders PSAT 2.1.10 			Save Cancel
File Edit Run Tools	Interfaces View Options Hel	p	لا د
	8 🗰 💿 🗁 🕂	<u> </u>) 📣 🛍 📍
Open Data File	2 1 027 -	F C C C C C C C C C C C C C C C C C C C	Freq. Base (Hz)
Open Data File	8 th 017 -1	50 100	Freq. Base (Hz) Power Base (MVA)
Open Data File	o to contraction of the second	50 100 0	Freq. Base (Hz) Power Base (MVA) Starting Time (s)
Open Data File Perturbation File Command Line	o \$ 017 -	50 100 0 20	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s)
Open Data File Perturbation File Command Line	o t ol t	50 100 0 20 1e-05	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance
Copen Data File		50 100 0 20 1e-05 20	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF ter.
Command Line		50 100 0 20 1e-05 20 1e-05	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance
Copen Data File Perturbation File Command Line	o # 017 -	50 100 0 20 1e-05 20 1e-05 20	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance Max Dyn. Iter.
Copen Data File Perturbation File Command Line command Line PSAT	S S S S S S S S S S S S S S S S S S S	Image: Second state 50 100 0 20 100 100 0 20 100 100 0 200 100 100 0 200 100 100 100 100 0 200 100 100 <t< td=""><td>Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance Max Dyn. Iter. Settings</td></t<>	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance Max Dyn. Iter. Settings
Copen Data File Perturbation File Command Line Command Line PSAT		Image: Second state 50 100 0 0 20 1e-05 20 Image: Second state 100 Image: Second state Image: Second state	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance Max Dyn. Iter. Settings Piot
Command Line	Power Flow CPF OPF	Image: Solution of the	Freq. Base (Hz) Power Base (MVA) Starting Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance Max Dyn. Iter. Settings Plot Close

Load Data File	a a	
ile Edit View		
Current path: C:Users\Am	r'Desklop'LFA	
rolders in current path.	riles in current path.	Preview
a. a.1 c.1 d.1 d.1 ['DATA*] ['PERT*] ['LOCAL*] Filters:	UFAmdi	
PSAT Simulink (.mdl) Translate PSAT file to:		Load
IEEE CDF	*	View File
Verbose conversion Silent conversion		Cancel

Running Power Flow:

Remember to adjust the settings to what you desire (Frequency is 50 Hz in the Pakistan)

• Click on the "Power Flow" icon.

• A small window in the Main GUI will show you the iteration process; you will know when the program has converged to a solution.

le Edit	Run	Tools	Interfaces	View	Options	Help			
*	1	Q.	8	\odot	<u></u>	-÷ 🏊	🔅 🔮 🔜	2	1
	Data File LFA(md	Ŋ					50)	Freq. Base (Hz)
	Perturba	tion File					10	00	Power Base (MVA)
							0		Starting Time (s)
	Comman	d Line					20	ו	Ending Time (s)
							16	e- 0 5	PF Tolerance
	⊲empty⇒					^	20	ו	Max PF Iter.
							16	e- 0 5	Dyn. Tolerance
						-	21	J	Max Dyn. Iter.
1				Р	ower Flow		Time Domain	•	Settings
5			-		CPF		Load System		Plot
					OPF		Save System		Close

Viewing the Power Flow Results:

Click on the "Static Report" icon. • The "Static Report GUI" will appear in your screen.



Generating a power flow Report:

To generate a power flow report, click on the "Report" icon on the "Static Report" GUI.

- A text file will appear in your screen with the solution details.
 You can also set your preferences, such as Text Viewer in the "Preferences Menu".
 You can also check limit violations and include shunts through the options below the "Report" button.

🔺 Stat	tic Repo	ort						
File	View	Prefe	erences					
			Switch vo	ltage units	Ctrl+K			
			Switch rad	diant/degree	Ctrl+D			
	Bus		Switch rea	al power units	Ctrl+W	rad (р [р.ц. <u> .</u>	
	[1]-E		Switch rea	ctive power units	Ctrl+U	9	-0.79461	-0.5069
	[3]-E		Switch rea	l power type	Ctrl+E	2	0.8	0.6
	1414		Switch rea	active power type	Ctrl+F		0.0	0.02400
			Use absol	ute values in report files	Ctrl+B			
			Include lir	mit violation checks	Ctrl+L			
			Embed lin	e flows in bus report	Ctrl+1			
			Select Tex	t Viewer	Ctrl+T	j		
			*	~		*	*	v
	State	e Variat	bles		Othe	er Variables		Report Close
				*			*	
								Check limit violations
								Use absolute values
								We to the star
								- ten m
								东来
				*			-	
	T	Mr.						
	lext	vie	ewer			_		
		· · · ·		han DOM/NOA			Output Farm	-
		Con	nputer	type: PCVVIN04			Output Form	at
								TMI
		Unb	x Text	Viewers				
		cat	t			-		
			-					Excel
		Line		+ 1 /income				
		Lint	JX Tex	t viewers				ASCII
						_		
		cat				*		
							- A 🍊	Testers
							Σ	Latex
		Win	dows	Text Viewers				
		there	~			-	(JK
		typ	e			T	(ж
		typ	e			T		ЛК

Lab Task:

a) What is PSAT used for?

b) Explain the important features of PSAT.

c) Explain system data and line data.

d) Explain some components of PSAT Simulink library.

e) Discuss the important remarks explained in the lab.

Marks Obtained:

Remarks: