Revision of Lab Experiments

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:

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			50	Freq. Base (Hz)
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Command Line			20	Ending Time (s)
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PSAT	Power Flow		Time Domain	Settings
	CPF		Load System	Plot
Version 2.1.10 May 26, 2016	OPF		Save System	Close
PSAT version 2.1.10, Copyright (C				

Options and settings you will be using:

Open a data file <	File Edit Run Tools	PSAT 2.1.7 Interfaces View Optio		results	power flow s, "Static t" icon
Launch the - PSAT- Simulink model library (to set up your one-line diagram)	Perturbation File Command Line Cettroly>		100 0 20 1e-05 20 1e-05 20	Power Bass (MVA) Starling Time (s) Ending Time (s) PF Tolerance Max PF Iter. Dyn. Tolerance Max Dyn. Iter.	Program settings
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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.

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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.

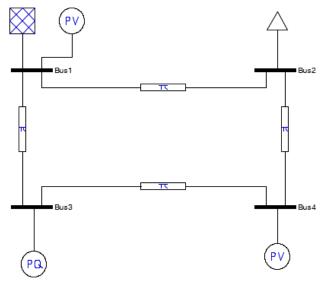
Line data:

From Bus to Bus	R	X	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.

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File name: LFA	•
Save as type: Simulink Models (*.mdl)	•
Hide Folders	Save Cancel
PSAT 2.1.10	
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	100 Power Base (MVA)
Perturbation File	0 Starting Time (s)
Command Line	20 Ending Time (s)
	1e-05 PF Tolerance
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	1e-05 Dyn. Tolerance
PSAT Power Flow	Time Domain Settings
СРГ	Load System Plot
Version 2.1.10 May 26, 2016 OPF	Save System Close
Set a data file for editing snapshots.	

Load Data File		
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PSAT Simulink (.mdl) Translate PSAT file to:		Load
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Verbose conversion Silent conversion		Cancel

Running Power Flow:

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

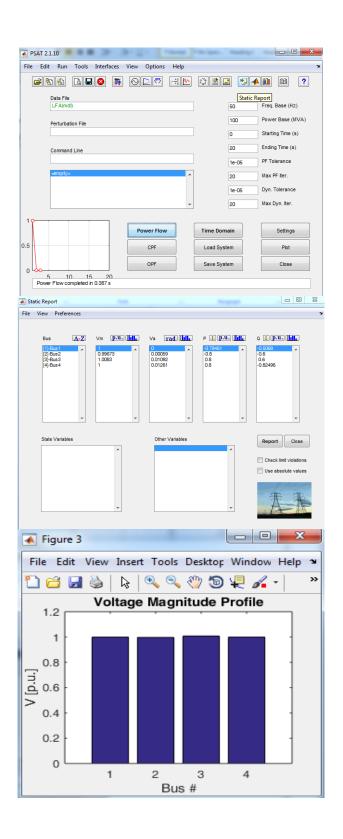
• Click on the "Power Flow" icon.

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

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					OPF		Save System	n	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.

🔺 Sta	atic Repo	ort					
File	View	Preference	es				-
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Load Flow Analysis of Single line diagram

In this lab we will first implement/design the single line diagram in ETAP and then calculate load flow analysis. In the right side of etap we have element toolbar. Click on the Power grid icon one time and drag it.



Now click on the bus and drag it in the workspace.

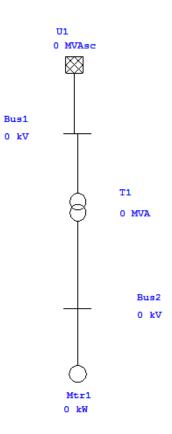
Bus1 0 kV

Now click on the two winding transformer.



And then drag another bus. Also click on the motor and drag it in the one line diagram.

Now to connect the pins we have three separate options. First you can find the connection pin at the end of one element click it once and extend it to the other element you are connecting to. The second way is to click on the element in simple way and drag it to the element you are connecting to. The final way is to double click on the element section and in the info section you have to specify the bus you are going to be connecting to. So you final single line diagram will be like this.



Now after this we enter the data for each element in this single line diagram and to run Load flow calculation. We will first start by entering the data in the transformer by double clicking the transformer icon and then click on the rating tab.

	Reliability		Remarks		Comment
Info	Rating Ir	npedance T	ap Grounding	Sizing	Protection Harmonie
0 MVA	IEC Liquid-Fill (Other 65 C			0 0 kV
-Voltage Prim Sec	. V	FLA		Bus k Vnom	Z Base MVA 0
Power F	Rating				Alert - Max
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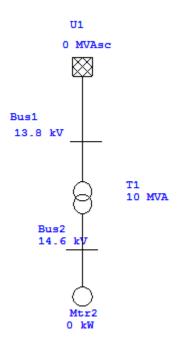
We will enter 13.8 kV in the Primary and for the secondary we will enter 14.6 KV and also enter the rated MVA as 10. When you enter the MVA rating you will notice that the etap automatically set the Max MVA to 10 and calculate the full load amps FLA primary and secondary.

Reliability Remarks				Comment		
Info Rating Impedan	ce Tap	Grounding	Sizing	Protection	Harmonic	
10 MVA IEC Liquid-Fill Other	65 C			13.8 1	4.6 kV	
Sec. 14.6	FLA 418.4 395.4 her 65	B	us kVnom 0 0		VA 0	
Power Rating				Alert - Max		
Rated 10 Other 65 Derated 10				M 1 O Derated O User-Def) MVA	
% Derating 0				Installation Altitu 10 Ambie		
MFR				3	0°C	
Туре	Sub Type		Class	Te	mp. Rise	
Liquid-Fill 🔹 🗸	ther	▼ Other		•	5 -	

ETAP also provide typical values for various parameters. For example go to impedance page and click on the typical Z & X/R button. You will notice that the etap populate the %Z impedance and X/R ratio for transformer. Next select OK.

	Reliability		Re	marks	Comment	
Info	nfo Rating Impedance		Tap Grounding		Sizing	Protection Harmonic
10 MVA	IEC Liquid	Fill Other 65 C				13.8 14.6 kV
Impedanc	e					Z Base
	%Z X/R		R/X %X		%R	
Positive	8.35	13	0.077	0.077 8.325		MVA
Zero	8.35	13	0.077	8.325	0.64	10 OOther 65
Z Variation @	-5	6 Tap 6 Tap	%Z 8.35 8.35	% Z Va)	Z Tolerance
No Load T	est Data (L sitive	lsed for Unbala % FLA 0	nced Load Flo kW 0	w only)	% G 0	% B 0
	Zero	0	0			

Now you will see that in the single line diagram both the bus 1 and bus 2 values will automatically updated.



Now enter the data in the Power Grid. Double click the power grid icon and go to its rating page. Here you will see that etap will automatically update the nominal voltage for this element.

Rating		uit H	amonic	Reliability	Energy	Price	Remarks	Comment	
13.8 kV Sw	ing								
	Rated kV	[13.8	B	alanced	O U	nbalanced		
Gen. (Cat.	%V	Vangle	MW	Mvar	%PF	Qmax	Qmin	
Design		100	0						
Normal		100	0						
Shutdown		100	0						
Emergenc	y i	100	0						
Standby		100	0						
Startup		100	0						
Accident		100	0						
Summer L		100	0						
Winter Loa		100	0						
Gen Cat 1	0	100	0						
perating		% V 0	Vang 0	le	MW 0	Mva 0	r		

Now double click on the induction machine and go to the name plate page. Here we will see that the rated voltage will automatically be selected as standard rating. Now enter the KW power for this element. The KW power we will be entering is 500. When we enter this value and click outside the box etap will automatically update the Power factor its efficiency the full load amps and the other data.

Cable/Vd Cable Amp		Amp	Protectio	n F	Reliability	Remai	rks	Comment	
nfo	Nameplate	Imp	Model	Inertia	Load	d Star	t Dev	Start Cat	
	00 kW 14.6 kV					Cabl	e Info not	available	
Ratin	esian Other		F	L		NL	0	L	
De	Uther	-	100)% 75%	75 % 50 %		10	00 %	
kW	/ 500 k\	/ 14.6	% PF 92	.2 92.2	92.2	0)	
kV	A 581 FLA	22.97	% Eff 93.	37 93.3	7 93.37	0)	
		%	FLA 10	0 75	50	0	10	00	
	Slip 0.05 RPM	1499	Poles 4	4 RPM	1500		SF 1		
Load	ling			Motor	Load	Feed	er Loss		
	Loading Category	% Loading	kW	kW	kvar	kW	kvar		
1	Design	100	500	535.5	224.9	0	0		
2	Normal	90	450	482	202.4	0	0		
3	Brake	0	0	0	0	0	0		
4	Winter Load	0	0	0	0	0	0		
5	Summer Load	0	0	0	0	0	0		
6	FL Reject Emergency	0	0	0	0	0	0		
7									

Now we have entered all the necessary data and ready for the load flow analysis. Click on the load flow icon on the left corner.



And then click on the right side corner run load flow analysis.

Î	P→ q↓
Run Loa	d Flow

When you click on it will ask you report name so enter LFA for load flow. Then click OK ETAP will show you the calculation and the result of the single line diagram.

