

EE 5308
FALL 2015
PROJECT

NAME: REKHA TATTAMANGALAM RAJAN

UTA ID: 1001164021

POWER WORLD SIMULATOR

Power World Simulator is an interactive power system simulation package designed to simulate high voltage power system operation on a time frame ranging from several minutes to several days.

The software contains a highly effective power flow analysis package capable of efficiently solving systems consisting of several buses. It is user friendly and a highly interactive power system analysis and visualization platform. It integrates many commonly performed power system tasks like contingency analysis, OPF, PVQV, fault analysis, SCOPF, sensitivity analysis, loss analysis, etc.

Unlike other commercially available power flow packages, however, Simulator allows the user to visualize the system through the use of full-colour animated one line diagrams with full zooming and panning capability. Transmission lines may be switched in or out of service, new transmission or generation may be added, and new transactions may be established, all with a few mouse clicks. Simulator's extensive use of graphics and animation greatly increases the user's understanding of system characteristics, problems, and constraints, as well as of how to remedy them.

Simulator also provides a convenient medium for simulating the evolution of the power system over time. Load, generation, and interchange schedule variations over time may be prescribed, and the resulting changes in power system conditions may be visualized. This functionality may be useful, for example, in illustrating the many issues associated with industry restructuring.

- A. Download the power flow data for the IEEE 30 bus system or one can also find them in the handout (the same folder of this project description). The required Information for building up the system, such as system base, bus voltage, and transmission line impedance, can all be found in the data file. Choose the proper connection types for the transformers by yourself and create the system model in Power World Simulator. Note that bus 1 is the swing bus.

PROCEDURE

A new case is created by clicking 'Open Case' under File menu. The features of the software are then introduced using this sample case.

1. INPUT OF BUSES

In the given system, there are 30 buses which are connected through various transmission lines. The new case is then put in the edit mode. The buses are then drawn by selecting the option bus from the network tool from the draw menu bar.

STEPS:

1. Go to Edit Mode.
2. Click Draw menu and select bus.
3. Place the bus on the desired position on the one line diagram.
4. A dialog box named bus options appears on the screen.
5. Enter the necessary information into the dialog box.
6. Check the system slack bus if the bus is chosen as the slack bus.
7. Click OK to finish the input of the particular bus.

Bus Options

Bus Number: 1 Find By Number Find ...

Bus Name: Glen Lyn - 1 Find By Name

Nominal Voltage: 132.0 kV

Labels ... no labels

	Number	Name
Area	1	1
Zone	1	1
Owner	1	1
Substation		

Bus Information Display Attached Devices Geography Custom

Bus Voltage: 1.0600 Voltage (p.u.)

Angle (degrees): 0.000

Bus Voltage Regulator Devices

☒ System Slack Bus

OK Save Cancel

2. INPUT OF GENERATORS

STEPS

1. Go to Edit Mode.
2. Click Draw menu and select generator.
3. Place the generator on the desired position on the one line diagram.
4. A dialog box named generator options appears on the screen.
5. Enter the necessary information into the dialog box.
6. Select the appropriate machine model, excitor model and governor model.
7. Click OK to finish the input of the particular generator.

Generator Options

Bus Number 1	Find By Number	Status <input type="radio"/> Open <input checked="" type="radio"/> Closed
Bus Name Glen Lyn - 1	Find By Name	Generator MVA Base 100.00
ID 1	Find ...	Fuel Type Unknown
Area Name 1	Unit Type UN (Unknown)	
Labels ... no labels		

Display Information | Power and Voltage Control | Costs | Fault Parameters | Owner, Area, Zone, Sub | Custom

Power Control

MW Output 260.951	<input checked="" type="checkbox"/> Available for AGC	Part. Factor 10.00
Min. MW Output 0.000	<input checked="" type="checkbox"/> Enforce MW Limits	
Max. MW Output 1000.000		

Voltage Control

Mvar Output -16.787	Regulated Bus Number 1
Min Mvars -9900.000	<input checked="" type="checkbox"/> Available for AVR
Max Mvars 9900.000	SetPoint Voltage 1.0600
<input type="checkbox"/> Use Capability Curve	Remote Reg % 100.0

Wind Control Mode

Mode None	Power Factor 1.0000
--------------	------------------------

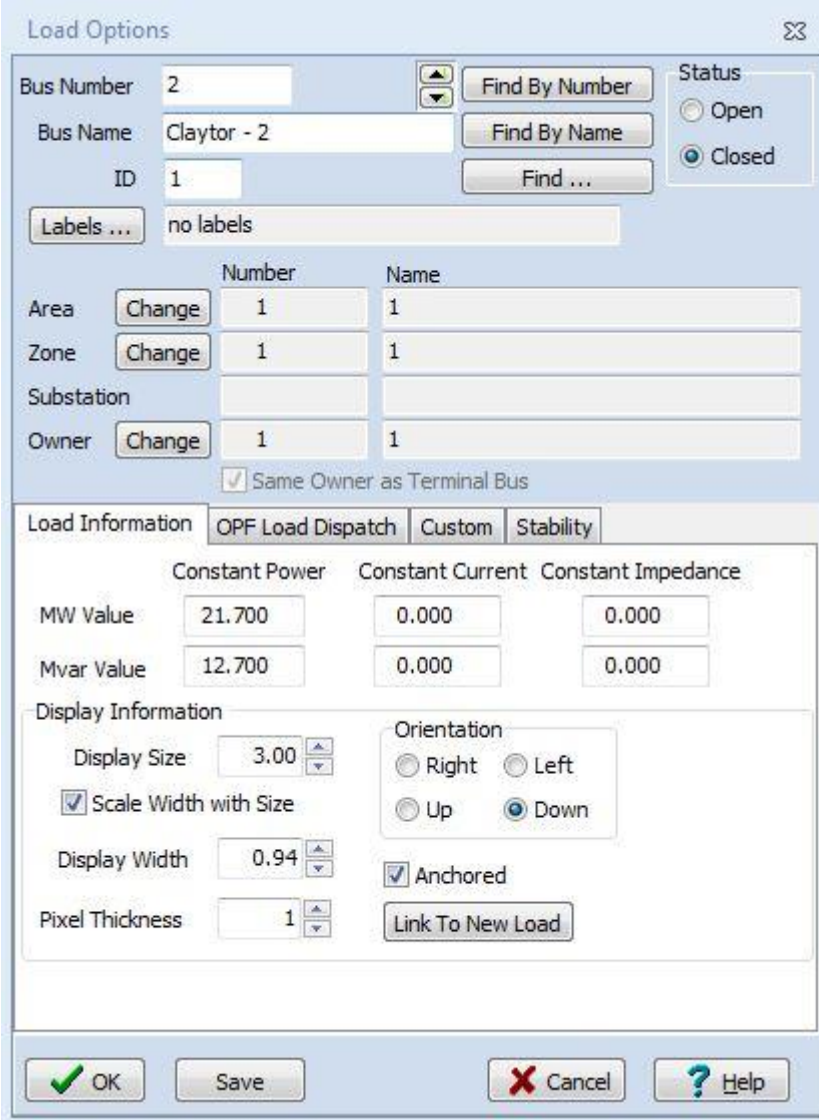
MW	Min Mvar	Max Mvar

OK Cancel Help

3. INPUT OF LOAD

STEPS

1. Go to Edit Mode.
2. Click Draw menu and select load.
3. Place the load on the desired position on the one line diagram.
4. A dialog box named load options appears on the screen.
5. Enter the necessary information into the dialog box.
6. Click OK to finish the input of the particular load.



The image shows a 'Load Options' dialog box with various input fields and tabs. The 'Load Information' tab is active, showing 'Constant Power' settings. The 'Status' is set to 'Closed'. The 'Display Information' section includes 'Display Size', 'Scale Width with Size', 'Display Width', 'Pixel Thickness', 'Orientation', and 'Anchored' options.

Load Options

Bus Number: 2
Bus Name: Claytor - 2
ID: 1
Labels: no labels

Find By Number
Find By Name
Find ...

Status:
☐ Open
☒ Closed

Area: Change
Zone: Change
Substation:
Owner: Change

Number: 1
Name: 1

☒ Same Owner as Terminal Bus

Load Information: OPF Load Dispatch | Custom | Stability

Constant Power | Constant Current | Constant Impedance

MW Value: 21.700
Mvar Value: 12.700

Display Information:
Display Size: 3.00
☒ Scale Width with Size
Display Width: 0.94
Pixel Thickness: 1

Orientation:
☐ Right ☐ Left
☐ Up ☒ Down
☒ Anchored
Link To New Load

OK Save Cancel Help

4. INPUT OF TRANSMISSION LINES

STEPS

1. Go to Edit Mode.
2. Click Draw menu and select transmission line.
3. Place the transmission line on the desired position on the one line diagram.
4. A dialog box named branch/transmission line options appears on the screen.
5. Enter the necessary information into the dialog box.
6. Click OK to finish the input of the particular transmission line.

Branch Options X

Line: From Bus: 1 To Bus: 2 Circuit: 1
Name: Glen Lyn - 1
Area Name: 1 (1)
Nominal kV: 132.0

Find By Numbers
Find By Names
Find ...
☒ From End Metered
☒ Default Owner (Same as From Bus)

Labels ... no labels

Display Parameters Fault Info Owner, Area, Zone, Sub Custom Stability

Status: ☐ Open ☒ Closed
Branch Device Type: Line
☐ Allow Consolidation
Length: 0.00
Calculate Impedances >
Convert Line to Transformer
D-FACTS Devices on the Line ☐ Has D-FACTS

Per Unit Impedance Parameters
Series Resistance (R): 0.019200
Series Reactance (X): 0.057500
Shunt Charging (B): 0.052800
Shunt Conductance (G): 0.000000
☐ Has Line Shunts Line Shunts

MVA Limits
Limit A: 0.000
Limit B: 0.000
Limit C: 0.000
Limit D: 0.000
Limit E: 0.000
Limit F: 0.000
Limit G: 0.000
Limit H: 0.000
Limit I: 0.000

OK Save Cancel Help

5. INPUT OF TRANSFORMERS

STEPS

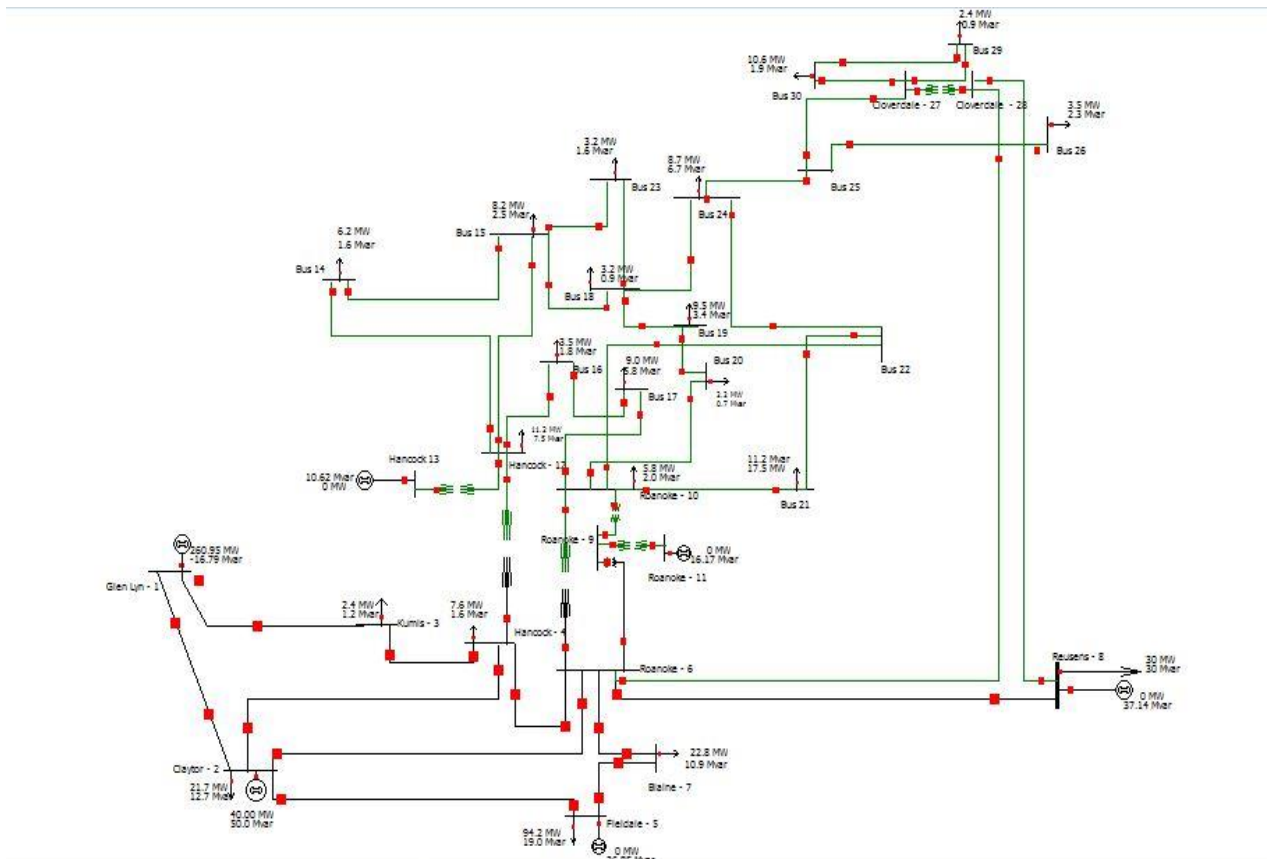
1. Go to Edit Mode.
2. Click Draw menu and select transformer.
3. Place the transformer on the desired position on the one line diagram.
4. A dialog box named branch/transformer options appears on the screen.
5. Enter the necessary information into the dialog box.
6. Click OK to finish the input of the particular transformer.

The 'Branch Options' dialog box is shown with the following details:

- Transformer Information:**
 - Transformer Number: 12
 - From Bus: 12
 - To Bus: 13
 - Circuit: 1
 - Name: Hancock - 12
 - Area Name: 1 (1)
 - Nominal kV: 33.00
 - Labels: no labels
- Search and Settings:**
 - Buttons: Find By Numbers, Find By Names, Find ...
 - Checkboxes: ☒ From End Metered, ☒ Default Owner (Same as From Bus)
- Tabs:** Display, Parameters, Transformer Control, Fault Info, Owner, Area, Zone, Sub, Custom, Stability.
- Parameters Tab Content:**
 - Status:** ☐ Open, ☒ Closed
 - Branch Device Type:** Transformer
 - Allow Consolidation:** ☐
 - Length:** 0.00
 - Buttons:** Calculate Impedances >, Convert Transformer to Line
 - Per Unit Impedance Parameters:**
 - Series Resistance (R): 0.000000
 - Series Reactance (X): 0.140000
 - Shunt Charging (B): 0.000000
 - Shunt Conductance (G): 0.000000
 - Magnetizing Conductance: 0.000000
 - Magnetizing Susceptance: 0.000000
 - ☐ Has Line Shunts
 - Line Shunts button
 - MVA Limits:** Limit A through Limit I, all set to 0.000
- Bottom Bar:** OK (with green checkmark), Save, Cancel (with red X), Help (with question mark).

Following all the above mentioned steps and inputting the values from the data sheet, the complete system is built in the Power World Simulator shown below.

The IEEE 30 bus test system shown below is a portion of American Electric Power system built using the Power World Simulator.



The system model is created in Power World based on the requirements and instructions given.

- B. Run the power flow program and obtain the bus, line, and transformer input/output data files that you prepared in part A. Compare your power flow results with the given results from the IEEE 30 bus system data (part A).

SOLVING THE CASE

STEPS

1. Put the case in the Run Mode.
2. Select Play/Solve from the simulation menu.
3. Click on Model Explorer to view the results.
4. Once the results are viewed, Terminate/Stop the play/solve button from the simulation menu.

RESULTS

First 15 Buses:

Model Explorer: Buses - Case: Rekha_EE5308_1001164021.pwb Status: Running (PF) | Simulator 18 GSO

File Case Information Draw Onlines Tools Options Add Ons Window

Edit Mode Abort Log Run Mode Script Mode Log

Single Solution - Full Newton Simulator Options... Restore... Contingency Analysis... Sensitivities Time Step Simulation... Line Loading Replicator... Limit Monitoring... Difference Flows... Scale Case... Model Explorer... Connections Other... Equivalencing... Modify Case... Renummer... Edit Mode

Explore Fields

Filter Advanced Bus Find... Remove Quick Filter...

Records Geo Set Columns Options

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar	Switched Shunts Mvar	Act G Shunt MW	Act B Shunt Mvar	Area Nu
1	1 Glen Lyn - 1	1	132.00	1.06000	139.920	0.00			260.95	-16.79		0.00	0.00	
2	2 Claytor - 2	1	132.00	1.04313	137.694	-5.35	21.70	12.70	40.00	50.00		0.00	0.00	
3	3 Kumis - 3	1	132.00	1.02074	134.738	-7.53	2.40	1.20				0.00	0.00	
4	4 Hancock - 4	1	132.00	1.01176	133.553	-9.28	7.60	1.60				0.00	0.00	
5	5 Fieldale - 5	1	132.00	1.01000	133.320	-14.17	94.20	19.00	0.00	36.85		0.00	0.00	
6	6 Roanoke - 6	1	132.00	1.01026	133.354	-11.06	0.00	0.00				0.00	0.00	
7	7 Blaine - 7	1	132.00	1.00238	132.314	-12.87	22.80	10.90				0.00	0.00	
8	8 Reusens - 8	1	132.00	1.01000	133.320	-11.81	30.00	30.00	0.00	37.14		0.00	0.00	
9	9 Roanoke - 9	1	1.00	1.05091	1.051	-14.11						0.00	0.00	
10	10 Roanoke - 10	1	33.00	1.04513	34.489	-15.70	5.80	2.00				0.00	20.75	
11	11 Roanoke - 11	1	11.00	1.08200	11.902	-14.11			0.00	16.17		0.00	0.00	
12	12 Hancock - 12	1	33.00	1.05712	34.885	-14.94	11.20	7.50				0.00	0.00	
13	13 Hancock - 13	1	11.00	1.07100	11.781	-14.94			0.00	10.62		0.00	0.00	
14	14 Bus 14	1	33.00	1.04228	34.395	-15.84	6.20	1.60				0.00	0.00	
15	15 Bus 15	1	33.00	1.03768	34.244	-15.93	8.20	2.50				0.00	0.00	
16	16 Bus 16	1	33.00	1.04439	34.465	-15.53	3.50	1.80				0.00	0.00	

Recent Network

- Branches By Type
 - Branches Input
 - Branches State
 - Buses
 - DC Transmission Lin
 - Generators
 - Impedance Correcti
 - Line D-FACTS Device
 - Line Shunts
 - Loads
 - Mismatches
 - Multi-Terminal DC
 - Switched Shunts
 - Three-Winding Tran
 - Transformer Contro
 - VSC DC Transmisio

Till Bus 30:

Model Explorer: Buses - Case: Rekha_EES308_1001164021.pwb Status: Running (PF) | Simulator 18 GSO

File Case Information Draw Onelines Tools Options Add Ons Window

Edit Mode Abort Log Run Mode Script Single Solution - Full Newton Simulator Options... Solve Restore Contingency Analysis... Sensitivities Time Step Simulation... Line Loading Replicator... Limit Monitoring... Difference Flows Scale Case... Model Explorer... Connections Other... Equivalencing... Modify Case... Renummer... Edit Mode

Explore

Fields

Recent Network

Branches By Type

Branches Input

Branches State

Buses

DC Transmission Lin

Generators

Impedance Correcti

Line D-FACTS Device

Line Shunts

Loads

Mismatches

Multi-Terminal DC

Switched Shunts

Three-Winding Tran

Transformer Contro

VSC DC Transmissio

Aggregations

Areas

Injection Groups

Interfaces

Islands

Multi-Section Lines

MW Transactions

Nomograms

Owners

Substations

Super Areas

TieLines between Ar

Bus Records

Filter Advanced Bus Find... Remove Quick Filter...

Records Geo Set Columns Options

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar	Switched Shunts Mvar	Act G Shunt MW	Act B Shunt Mvar	Area Nu
3	3	Kumis - 3	1	132.00	1.02074	134.738	-7.53	2.40	1.20				0.00	0.00	
4	4	Hancock - 4	1	132.00	1.01176	133.553	-9.28	7.60	1.60				0.00	0.00	
5	5	Fieldale - 5	1	132.00	1.01000	133.320	-14.17	94.20	19.00	0.00	36.85		0.00	0.00	
6	6	Roanoke - 6	1	132.00	1.01026	133.354	-11.06	0.00	0.00				0.00	0.00	
7	7	Blaine - 7	1	132.00	1.00238	132.314	-12.87	22.80	10.90				0.00	0.00	
8	8	Reusens - 8	1	132.00	1.01000	133.320	-11.81	30.00	30.00	0.00	37.14		0.00	0.00	
9	9	Roanoke - 9	1	1.00	1.05091	1.051	-14.11						0.00	0.00	
10	10	Roanoke - 10	1	33.00	1.04513	34.409	-15.70	5.80	2.00				0.00	20.75	
11	11	Roanoke - 11	1	11.00	1.08200	11.902	-14.11			0.00	16.17		0.00	0.00	
12	12	Hancock - 12	1	33.00	1.05712	34.885	-14.94	11.20	7.50				0.00	0.00	
13	13	Hancock 13	1	11.00	1.07100	11.781	-14.94			0.00	10.62		0.00	0.00	
14	14	Bus 14	1	33.00	1.04228	34.395	-15.84	6.20	1.60				0.00	0.00	
15	15	Bus 15	1	33.00	1.03768	34.244	-15.93	8.20	2.50				0.00	0.00	
16	16	Bus 16	1	33.00	1.04439	34.465	-15.53	3.50	1.80				0.00	0.00	
17	17	Bus 17	1	33.00	1.03990	34.317	-15.86	9.00	5.80				0.00	0.00	
18	18	Bus 18	1	33.00	1.02815	33.929	-16.54	3.20	0.90				0.00	0.00	
19	19	Bus 19	1	33.00	1.02565	33.847	-16.72	9.50	3.40				0.00	0.00	
20	20	Bus 20	1	33.00	1.02974	33.981	-16.52	2.20	0.70				0.00	0.00	
21	21	Bus 21	1	33.00	1.03273	34.080	-16.14	17.50					0.00	0.00	
22	22	Bus 22	1	33.00	1.03326	34.098	-16.13						0.00	0.00	
23	23	Bus 23	1	33.00	1.02718	33.897	-16.32	3.20	1.60				0.00	0.00	
24	24	Bus 24	1	33.00	1.02158	33.712	-16.49	8.70	6.70				0.00	4.49	
25	25	Bus 25	1	33.00	1.01734	33.572	-16.07						0.00	0.00	
26	26	Bus 26	1	33.00	0.99966	32.989	-16.49	3.50	2.30				0.00	0.00	
27	27	Cloverdale - 27	1	33.00	1.02325	33.767	-15.54						0.00	0.00	
28	28	Cloverdale - 28	1	132.00	1.00682	132.900	-11.69						0.00	0.00	
29	29	Bus 29	1	33.00	1.00341	33.113	-16.77	2.40	0.90				0.00	0.00	
30	30	Bus 30	1	33.00	0.99194	32.734	-17.66	10.60	1.90				0.00	0.00	

COMPARISON OF THE VALUES

Comparing per unit voltages and angles obtained with given results:

	Final(Given)		Result(Observed)	
	voltage	angle	voltage	angle
Glen Lyn – 1	1.060	0.0	1.06000	0.00
Claytor – 2	1.043	-5.48	1.04313	-5.35
Kumis – 3	1.021	-7.96	1.02074	-7.53
Hancock – 4	1.012	-9.62	1.01176	-9.28
Fieldale – 5	1.010	-14.37	1.01000	-14.17
Roanoke – 6	1.010	-11.34	1.01026	-11.06
Blaine – 7	1.002	-13.12	1.00238	-12.87
Reusens – 8	1.010	-12.10	1.01000	-11.81
Roanoke – 9	1.051	-14.38	1.05091	-14.11
Roanoke – 10	1.045	-15.97	1.04513	-15.70
Roanoke – 11	1.082	-14.39	1.08200	-14.11
Hancock – 12	1.057	-15.24	1.05712	-14.94
Hancock 13	1.071	-15.24	1.07100	-14.94
Bus 14	1.042	-16.13	1.04228	-15.84
Bus 15	1.038	-16.22	1.03768	-15.93
Bus 16	1.045	-15.83	1.04439	-15.53
Bus 17	1.040	-16.14	1.03990	-15.86
Bus 18	1.028	-16.82	1.02815	-16.54
Bus 19	1.026	-17.00	1.02565	-16.72
Bus 20	1.030	-16.80	1.02974	-16.52
Bus 21	1.033	-16.42	1.03273	-16.14
Bus 22	1.033	-16.41	1.03326	-16.13
Bus 23	1.027	-16.61	1.02718	-16.32
Bus 24	1.021	-16.78	1.02158	-16.49
Bus 25	1.017	-16.35	1.01734	-16.07
Bus 26	1.000	-16.77	0.99966	-16.49
Cloverdale – 27	1.023	-15.82	1.02325	-15.54
Cloverdale - 28	1.007	-11.97	1.00682	-11.69
Bus 29	1.003	-17.06	1.00341	-16.77
Bus 30	0.992	-17.94	0.99194	-17.66

Comparing Generator real and reactive power:

	Actual		Result	
	Generation MW	Generation Mvar	Generation MW	Generation Mvar
1	260.2	-16.1	260.95	-16.79
2	40	50	40	50
5	0	37	0	36.85
8	0	37.3	0	37.14
11	0	16.2	0	16.17
13	0	10.6	0	10.62

Comparing Load values:

	Actual		Result	
	Load MW	Load Mvar	Load MW	Load Mvar
2	21.70	12.70	21.70	12.70
3	2.40	1.20	2.40	1.20
4	7.60	1.60	7.60	1.60
5	94.20	19.00	94.20	19.00
7	22.80	10.90	22.80	10.90
8	30.00	30.00	30.00	30.00
10	5.80	2.00	5.80	2.00
12	11.20	7.50	11.20	7.50
14	6.20	1.60	6.20	1.60
15	8.20	2.50	8.20	2.50
16	3.50	1.80	3.50	1.80
17	9.00	5.80	9.00	5.80
18	3.20	0.90	3.20	0.90
19	9.50	3.40	9.50	3.40
20	2.20	0.70	2.20	0.70
21	17.50	11.20	17.50	11.20
23	3.20	1.60	3.20	1.60
24	8.70	6.70	8.70	6.70
26	3.50	2.30	3.50	2.30
29	2.40	0.90	2.40	0.90
30	10.60	1.90	10.60	1.90

CONCLUSION

The entire system model is created using the Power World Simulator software. The buses, transmission lines, transformers and loads are drawn as per explained. The values inserted in each of these are in accordance with the data given in the IEEE data sheet. The complete system is drawn in edit mode.

Once the complete system is created, the mode is changed from edit mode to run mode and solve option is given. Once the solve option is given, model explorer option is used to get the required results. These results are then compared with the values present in the IEEE data sheet.

The values for the per unit voltages and angles do not have much difference in them. Almost accurate results are obtained in both of these parameters.

The generator real and reactive power values also do not have much difference in them as seen from the values in the data sheet.

If there are differences in the values, it may be because of the fact that the actual process uses an algorithm using the iterative method compute the load flow for the IEEE 30 bus system and we are using Power world to compute the values.

Hence, from the results seen above, almost nearly accurate results are obtained which matches the values given in the IEEE data sheet.