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Load Flow Analysis of IEEE-3 bus system by using Mipower Software

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***Abstract*— The load flow study or power flow analysis is very important for planning, control and operations of existing systems as well as planning its future expansion. The satisfactory operation of the system depends upon knowing the effects of interconnections, new loads, new generating stations or new transmission lines etc., before they are installed. It also helps to determine the best size and favorable locations for the power capacitors both for the improvement of the power factor and also raising the bus voltage of the electrical network. They help us to determine the best locality as well as optimal capacity of the proposed generating stations, substations or new lines.**

1) For this work the gauss-seidel method is used for numerical analysis.Nowadays Mipower software is used for load flow studies.This type of analysis is useful for solving the power flow problem in different power systems which will useful to calculate the unknown quantities.

Keywords-Power flow analysis, Power capacitors, Optimal capacity ,Guass-siedel method,Mipower software
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I. INTRODUCTION

The Load flow problem consists of calculation of voltage magnitude and its phase angle at the buses. And also the active and reactive lines flow for the specified terminal or bus conditions.

Load flow studies are used to ensure that electrical power transfer from generators to consumers through the grid system is stable, reliable and economic. Conventional techniques for solving the load flow problem are iterative, using the Newton-Raphson or the Gauss-Seidel methods. Depending upon the quantities specified for the buses, they are classified into three types namely load bus,generator bus or voltage controlled bus and slack bus or swing bus or reference bus.

II. BUS CLASSIFICATION

Buses are classified according to which two out of the four variables are specified

•Load bus: No generator is connected to the bus. At this bus the real and reactive power are specified and it is desired to find out the volatage magnitude and phase angle through load flow solutions.It is required to specify only Pd and Qd at such bus as at a load bus voltage can be allowed to vary within the permissible values.

•Generator bus or voltage controlled bus: Here the voltage magnitude corresponding to the generator voltage and real power Pg corresponds to its rating are specified. It is required to find out the reactive power generation Qg and phase angle of the bus voltage.

•Slack (swing) bus: For the Slack Bus, it is assumed that the voltage magnitude |V| and voltage phase are known, whereas real and reactive powers Pg and Qg are obtained through the load flow solution

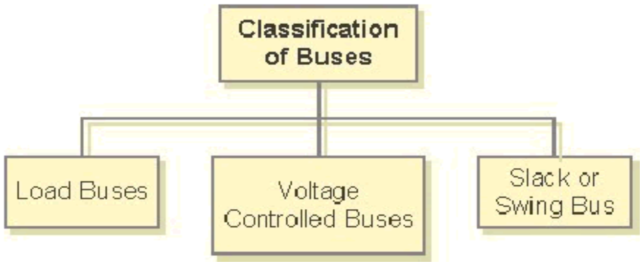
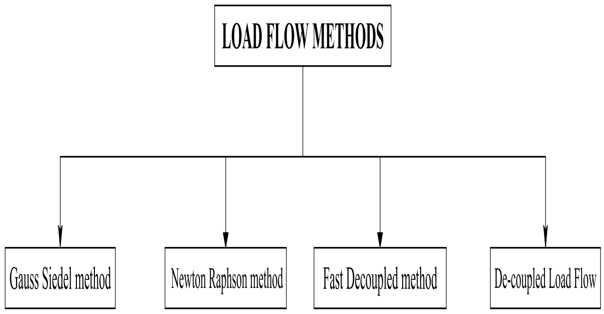


Fig.1 Bus classification

III. SOLUTION METHODS

The solution of the simultaneous nonlinear power flow equations requires the use of iterative techniques for even the simplest power systems.

There are many methods for solving nonlinear equations, as shown in Fig.2



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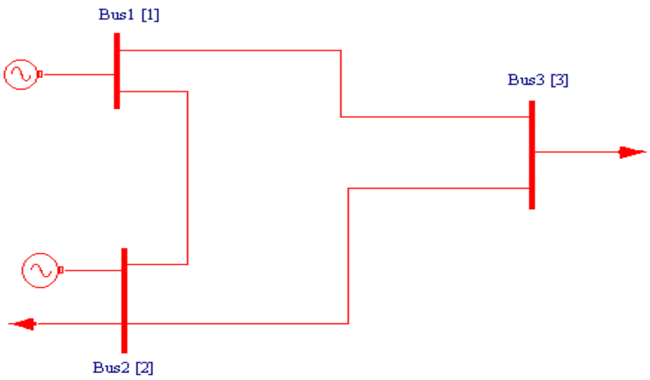
ig.2 Types of Load flow methods

IV. IEEE 3 BUS SYSTEM STABILITY

Figure shows a single line diagram of a 3 bus system with two generating units, three lines. Perunit transmission line series impedances and shunt susceptances are given on 100 MVA base in Real power generation, real and reactive power loads in MW and MVAR are give. Conduct the load flow analysis..



Assume the base voltage for the bus as 11 kV and system frequency as 50 Hz.

Impedances and line charging for the system

Table : 1.1

Bus code From - To	Admittance Ypq	Line charging Y'pq/2
1-2	1.47+j5.88	J0.015
1-3	2.94-j11.77	j0.07
2-3	2.75-j9.17	j0.04

Generation, loads and bus voltages for the system

Table : 1.2

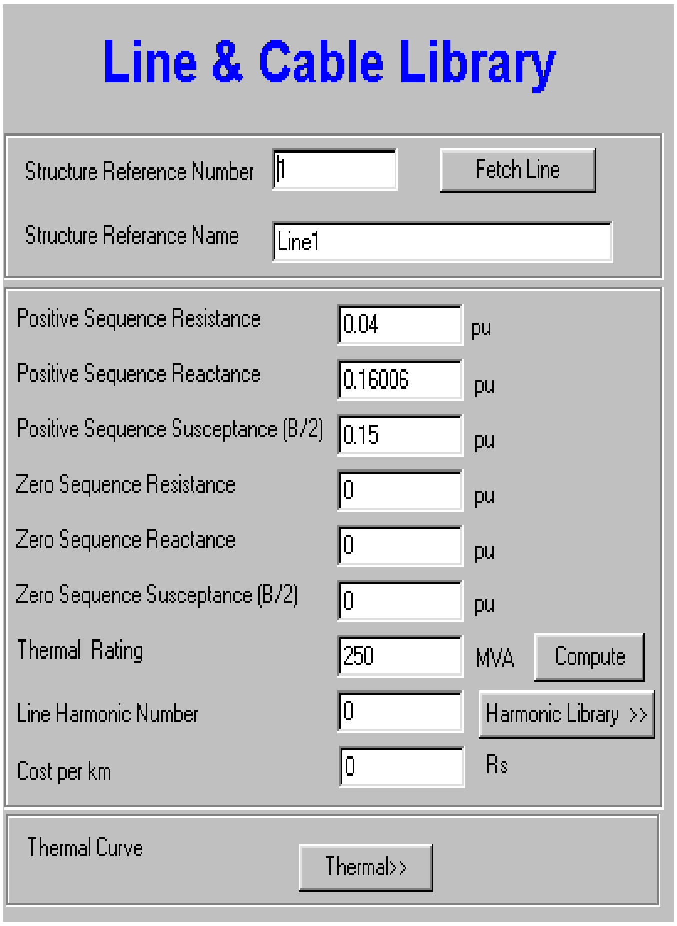
Bus No	Bus Voltage	Generation MW	Generation MVAR	Load MW	Load MVAR
1	1.04+j0.0	0	0	0	0
2	1.02+j0.0	100	--	50	20
3	1.00+j0.0	0	0	250	150

Transmission Line Element Data

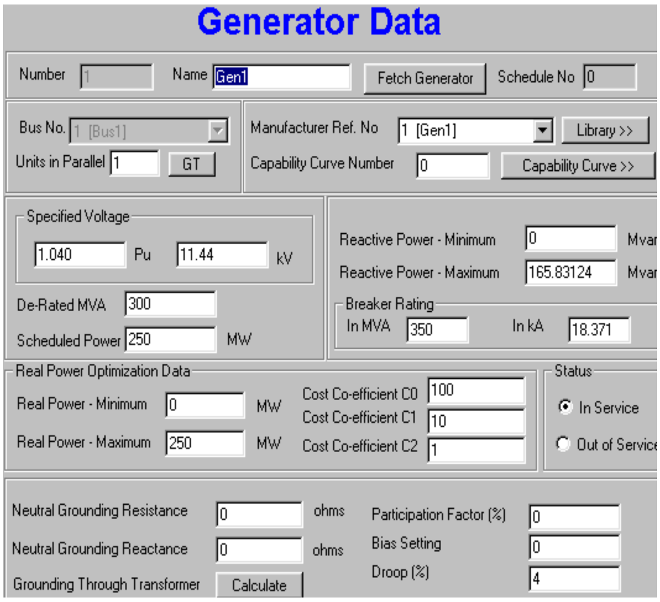
Line No	From Bus	To Bus	No. of circuits	Structure Ref. No.
2	1	3	1	2
3	2	3	1	3

Bus code No	Intertia(H)	Xd'
1	160	0.1
2	3	0.3

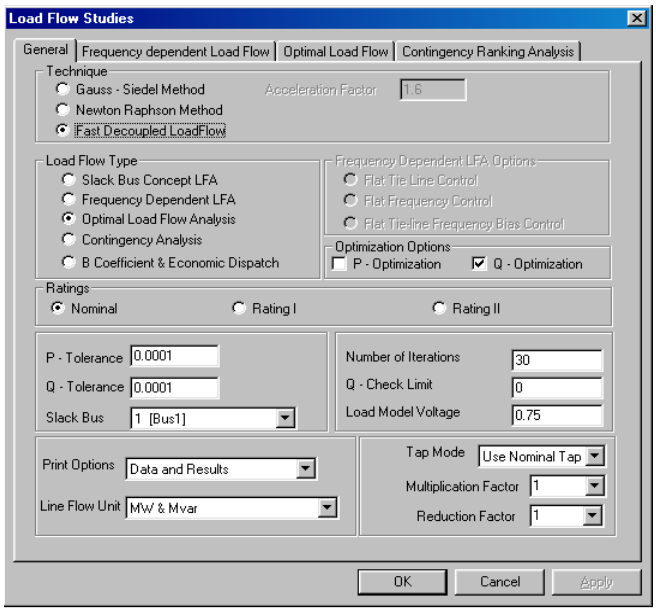
Line and cable Library



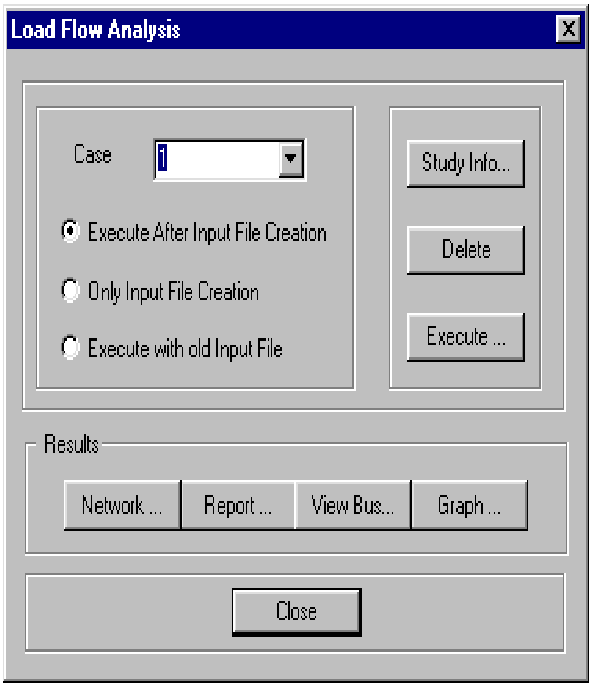
Generator Data



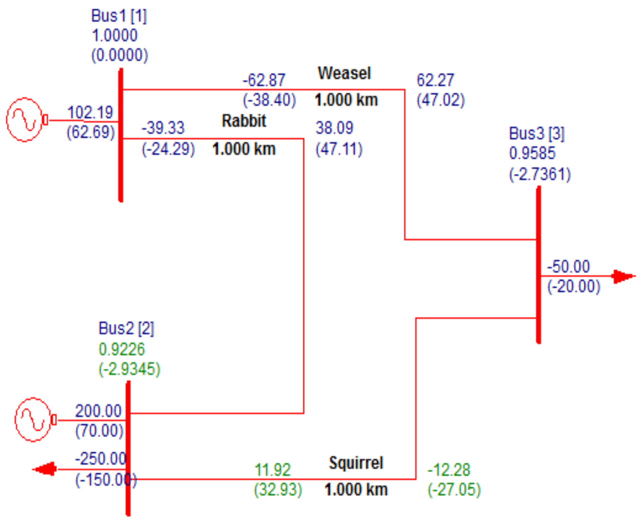
Load flow studies



Load Flow Analysis



Load flow analysis taken here for case study of IEEE-3 bus system. The network shown in Figure-3 a single line diagram is prepared using Mi-Power software.Execute load flow analysis and click on Report in load flow analysis dialog to view report.



V. SUMMARY OF RESULTS:

-
Date and Time : Fri Oct 17 12:23:30 2014

-
LOAD FLOW ANALYSIS
CASE NO : 1 CONTINGENCY : 0
SCHEDULE NO : 0
CONTINGENCY NAME : Base Case
RATING CONSIDERED : NOMINAL

-
VERSION NUMBER : 7.3
%% First Power System Network
LARGEST BUS NUMBER USED : 3
ACTUAL NUMBER OF BUSES : 3
NUMBER OF 2 WIND. TRANSFORMERS : 0 NUMBER OF 3 WIND. TRANSFORMERS : 0
NUMBER OF TRANSMISSION LINES : 3
NUMBER OF SERIES REACTORS : 0
NUMBER OF SERIES CAPACITORS : 0
NUMBER OF CIRCUIT BREAKERS : 0
NUMBER OF SHUNT REACTORS : 0
NUMBER OF SHUNT CAPACITORS : 0
NUMBER OF SHUNT IMPEDANCES : 0
NUMBER OF GENERATORS : 2
NUMBER OF LOADS : 2
NUMBER OF LOAD CHARACTERISTICS : 0 NUMBER OF UNDER FREQUENCY RELAY: 0NUMBER OF GEN CAPABILITY CURVES: 0 NUMBER OF FILTERS : 0
NUMBER OF TIE LINE SCHEDULES : 0
NUMBER OF CONVERTORS : 0
NUMBER OF DC LINKS : 0
NUMBER OF SHUNT CONNECTED FACTS: 0
POWER FORCED LINES : 0

NUMBER OF TCSC CONNECTED : 0
NUMBER OF SPS CONNECTED : 0
NUMBER OF UPFC CONNECTED : 0

LOAD FLOW - FAST DE-COUPLED TECHNIQUE : 0
NUMBER OF ZONES : 1
PRINT OPTION : 3 - BOTH DATA AND RESULTS PRINT
PLOT OPTION : 1 - PLOTTING WITH PU VOLTAGE
NO FREQUENCY DEPENDENT LOAD FLOW, CONTROL OPTION: 0
BASE MVA : 100.000000

NOMINAL SYSTEM FREQUENCY (Hzs) : 50.000000
FREQUENCY DEVIATION (Hzs) : 0.000000
FLOWS IN MW AND MVAR, OPTION : 0
SLACK BUS : 0
(MAX GENERATION BUS)
TRANSFORMER TAP CONTROL OPTION : 0
Q CHECKING LIMIT (ENABLED) : 4
REAL POWER TOLERANCE (PU) : 0.00100
REACTIVE POWER TOLERANCE (PU) : 0.00100
MAXIMUM NUMBER OF ITERATIONS : 15
BUS VOLTAGE BELOW WHICH LOAD MODEL IS CHANGED : 0.75000
CIRCUIT BREAKER RESISTANCE (PU) : 0.00000
CIRCUIT BREAKER REACTANCE (PU) : 0.00010
TRANSFORMER R/X RATIO : 0.05000

ANNUAL PERCENTAGE INTEREST CHARGES : 15.000
ANNUAL PERCENT OPERATION & MAINTENANCE CHARGES : 4.000
LIFE OF EQUIPMENT IN YEARS : 20.000
ENERGY UNIT CHARGE (KWHOUR) : 2.500 Rs
LOSS LOAD FACTOR : 0.300
COST PER MVAR IN LAKHS : 5.000 Rs

ZONE WISE MULTIPLICATION FACTORS

ZONE	P LOAD	Q LOAD	P GEN	Q GEN	SH REACT	SH CAP	C LOAD
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	1.000	1.000	1.000	1.000	1.000	1.000	1.000

BUS DATA

BUS NO.	AREA	ZONE	BUS KV	VMIN-PU	VMAX-PU	NAME
1	1	1	11.000	0.950	1.050	Bus1
2	1	1	11.000	0.950	1.050	Bus2

3 1 1 11.000 0.950 1.050 Bus3

-

TRANSMISSION LINE DATA

STA CKT FROM FROM TO TO LINE PARAMETER RATING KMS kV
NODE NAME* NODE NAME* R(P.U) X(P.U.) B/2(P.U.) MVA
--- --- ---- -------- ---- -------- --------- --------- -----
-
3 1 1 Bus1 2 Bus2 0.04000 0.16006 0.15000 250 1.0
3 1 1 Bus1 3 Bus3 0.01000 0.08000 0.07000 250 1.0
3 1 2 Bus2 3 Bus3 0.03000 0.10000 0.04000 250 1.0

-

TOTAL LINE CHARGING SUSCEPTANCE : 0.52000
TOTAL LINE CHARGING MVAR AT 1 PU VOLTAGE : 52.000

-

TOTAL CAPACITIVE SUSCEPTANCE : 0.00000 pu - 0.000 MVAR
TOTAL INDUCTIVE SUSCEPTANCE : 0.00000 pu - 0.000 MVAR

GENERATOR DATA

SL.NO* FROM FROM REAL Q-MIN Q-MAX V-SPEC CAP. MVA STAT
NODE NAME* POWER(MW) MVAR MVAR P.U. CURV RATING
------ ---- -------- --------- --------- --------- ---------
-
1 1 Bus1 250.0000 70.0000 165.8310 1.0000 0 300.00 3
2 2 Bus2 200.0000 70.0000 70.0000 1.0000 0 250.00 3

-

LOAD DATA

SLNO FROM FROM REAL REACTIVE COMP COMPENSATING MVAR VALUE CHAR F/V
* NODE NAME* MW MVAR MVAR MIN MAX STEP NO NO

STAT
---- ---- -------- -------- -------- -------- ------- -------
1 2 Bus2 250.000 150.000 0.000 0.000 100.000 1.000 0 0
3
0
2 3 Bus3 50.000 20.000 0.000 0.000 100.000 1.000 0 0
3
0

-

TOTAL SPECIFIED MW GENERATION : 450.00000
TOTAL MIN MVAR LIMIT OF GENERATOR : 140.00000
TOTAL MAX MVAR LIMIT OF GENERATOR : 235.83100
TOTAL SPECIFIED MW LOAD : 300.00000 reduced 300.00000
TOTAL SPECIFIED MVAR LOAD : 170.00000 reduced 170.00000
TOTAL SPECIFIED MVAR COMPENSATION : 0.00000 reduced 0.00000

-

TOTAL (Including out of service units)
TOTAL SPECIFIED MW GENERATION : 450.00000
TOTAL MIN MVAR LIMIT OF GENERATOR : 140.00000
TOTAL MAX MVAR LIMIT OF GENERATOR : 235.83100
TOTAL SPECIFIED MW LOAD : 300.00000 reduced 300.00000
TOTAL SPECIFIED MVAR LOAD : 170.00000 reduced 170.00000
TOTAL SPECIFIED MVAR COMPENSATION : 0.00000 reduced 0.00000

-

GENERATOR DATA FOR FREQUENCY DEPENDENT LOAD FLOW

SLNO* FROM FROM P-RATE P-MIN P-MAX %DROOP PARTICI BIAS
NODE NAME* MW MW MW FACTOR SETTING
C0 C1 C2
------ ---- -------- -------- --------- --------- --------- -
-
1 1 Bus1 250.000 0.0000 250.0000 4.0000 0.0000 0.0000
100.0000 10.0000 0.0000
2 2 Bus2 200.000 0.0000 200.0000 4.0000 0.0000 0.0000
0.0000 0.0000 0.0000

Slack bus angle (degrees) : 0.00

-

TOTAL NUMBER OF ISLANDS IN THE GIVEN SYSTEM : 1
TOTAL NUMBER OF ISLANDS HAVING ATLEAST ONE GENERATOR : 1
SLACK BUSES CONSIDERED FOR THE STUDY
ISLAND NO. SLACK BUS NAME SPECIFIED MW
---------- --------- -------- ------------
1 1 Bus1 250.000

-

ITERATION MAX P BUS MAX P MAX Q BUS MAX Q
COUNT NUMBER PER UNIT NUMBER PER UNIT

ITERATION COUNT	MAX P BUS NUMBER	MAX P PER UNIT	MAX Q BUS NUMBER	MAX Q PER UNIT
1	2	0.500	3	0.149
2	2	0.055	3	0.006
3	2	0.004	3	0.000
4	2	0.000	3	0.000
5	2	0.000	2	0.822
6	2	0.170	3	0.029
7	2	0.019	3	0.003
8	2	0.001	2	0.000
9	3	0.000	2	0.000

Number of p iterations : 6 and Number of q iterations : 7

-

BUS VOLTAGES AND POWERS

NODE FROM V-MAG ANGLE MW MVAR MW MVAR MVAR
NO. NAME P.U. DEGREE GEN GEN LOAD LOAD COMP

NODE NO.	FROM NAME	V-MAG P.U.	ANGLE DEGREE	MW GEN	MVAR GEN	MW LOAD	MVAR LOAD	MVAR COMP
1	Bus1	1.0000	0.00	102.194	62.689	0.000	0.000	0.000 <
2	Bus2	0.9226	-2.93	200.000	70.000	250.000	150.000	0.000 @
3	Bus3	0.9585	-2.74	0.000	0.000	50.000	20.000	0.000

-

NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) : 1
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) : 0
NUMBER OF GENERATORS EXCEEDING MINIMUM Q LIMIT (< mark) : 1
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark) : 0

-

LINE FLOWS AND LINE LOSSES

SLNO CS FROM FROM TO TO FORWARD LOSS %
NODE NAME NODE NAME MW MVAR MW MVAR LOADING

SLNO	CS	FROM NODE	FROM NAME	TO NODE	TO NAME	FORWARD MW	FORWARD MVAR	LOSS MW	LOSS MVAR	% LOADING
1	1	1	Bus1	2	Bus2	39.327	24.288	1.2360	-22.8217	26.3^
2	1	1	Bus1	3	Bus3	62.867	38.401	0.6014	-8.6200	32.6^
3	1	2	Bus2	3	Bus3	-11.921	-32.935	0.3574	-5.8880	15.2&

-

! NUMBER OF LINES LOADED BEYOND 125% : 0
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 0
# NUMBER OF LINES LOADED BETWEEN 75% AND 100% : 0
$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% : 0
^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% : 2
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% : 1
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% : 0

-

ISLAND FREQUENCY SLACK-BUS CONVERGED(1)
------ --------- ----------- ------------
1 50.00000 1 0

-

Summary of results
TOTAL REAL POWER GENERATION : 302.194 MW
TOTAL REAL POWER INJECT,-ve L : 0.000 MW
TOTAL REACT. POWER GENERATION : 132.689 MVAR
GENERATION pf : 0.916

TOTAL SHUNT REACTOR INJECTION : -0.000 MW
TOTAL SHUNT REACTOR INJECTION : -0.000 MVAR

TOTAL SHUNT CAPACIT.INJECTION : -0.000 MW
TOTAL SHUNT CAPACIT.INJECTION : -0.000 MVAR

TOTAL TCSC REACTIVE DRAWL : 0.000 MVAR

TOTAL SPS REACTIVE DRAWL : 0.000 MVAR

TOTAL UPFC FACTS. INJECTION : -0.0000 MVAR

TOTAL SHUNT FACTS.INJECTION : 0.000 MVAR
TOTAL SHUNT FACTS.DRAWAL : 0.000 MVAR

TOTAL REAL POWER LOAD : 300.000 MW
TOTAL REAL POWER DRAWAL -ve g : 0.000 MW
TOTAL REACTIVE POWER LOAD : 170.000 MVAR
LOAD pf : 0.870
TOTAL COMPENSATION AT LOADS : 0.000 MVAR
TOTAL HVDC REACTIVE POWER : 0.000 MVAR

TOTAL REAL POWER LOSS (AC+DC) : 2.194845 MW (2.194845+ 0.000000)
PERCENTAGE REAL LOSS (AC+DC) : 0.726
TOTAL REACTIVE POWER LOSS : -37.329685 MVAR

Zone wise distribution
Description Zone # 1
---------------- ----------
MW generation 302.1941

MVAR generation 132.6894

MW load 300.0000

MVAR load 170.0000

MVAR compensation 0.0000

MW loss 2.1948

MVAR loss -37.3297

MVAR - inductive 0.0000

MVAR - capacitive 0.0000

Zone wise export(+ve)/import(-ve)
Zone # 1 MW & MVAR
------ -------- --------
1 -----

Area wise distribution
Description Area # 1
---------------- ----------
MW generation 302.1941

MVAR generation 132.6894

MW load 300.0000

MVAR load 170.0000

MVAR compensation 0.0000

MW loss 2.1948

MVAR loss -37.3297

MVAR - inductive 0.0000

MVAR - capacitive 0.0000

Date and Time : Fri Oct 17 12:23:30 2014

VI. OUTPUT RESULT OF LOAD FLOW ANALYSIS

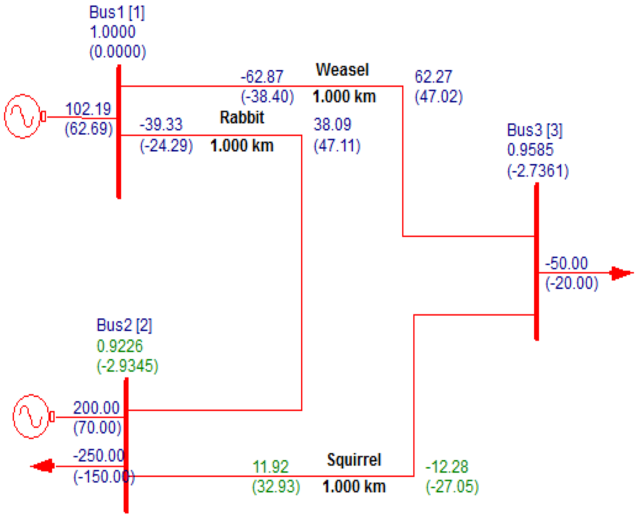


Figure-3 Output Result of Load Flow Analysis

VII. CONCLUSION

Power flow or load-flow studies are important for planning future expansion of power systems as well as in determining the best operation of existing systems. The principal information obtained from the power flow study is the magnitude and phase angle of the voltage at each bus, and the real and reactive power flowing in each line. In this paper, Gauss-Siedel method is used for analyzing the load flow of the IEEE-3 bus systems. This is verified by using the guass-seidel method and Mipower for 3 bus system. This Mipower software can be applicable for any number of buses. The standard IEEE 3 bus input data is used for IEEE 3 bus system .The future scope for this project can be extended with Newton-Raphson method and Fast Decoupled methods.

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