

HOW TO SOLVE

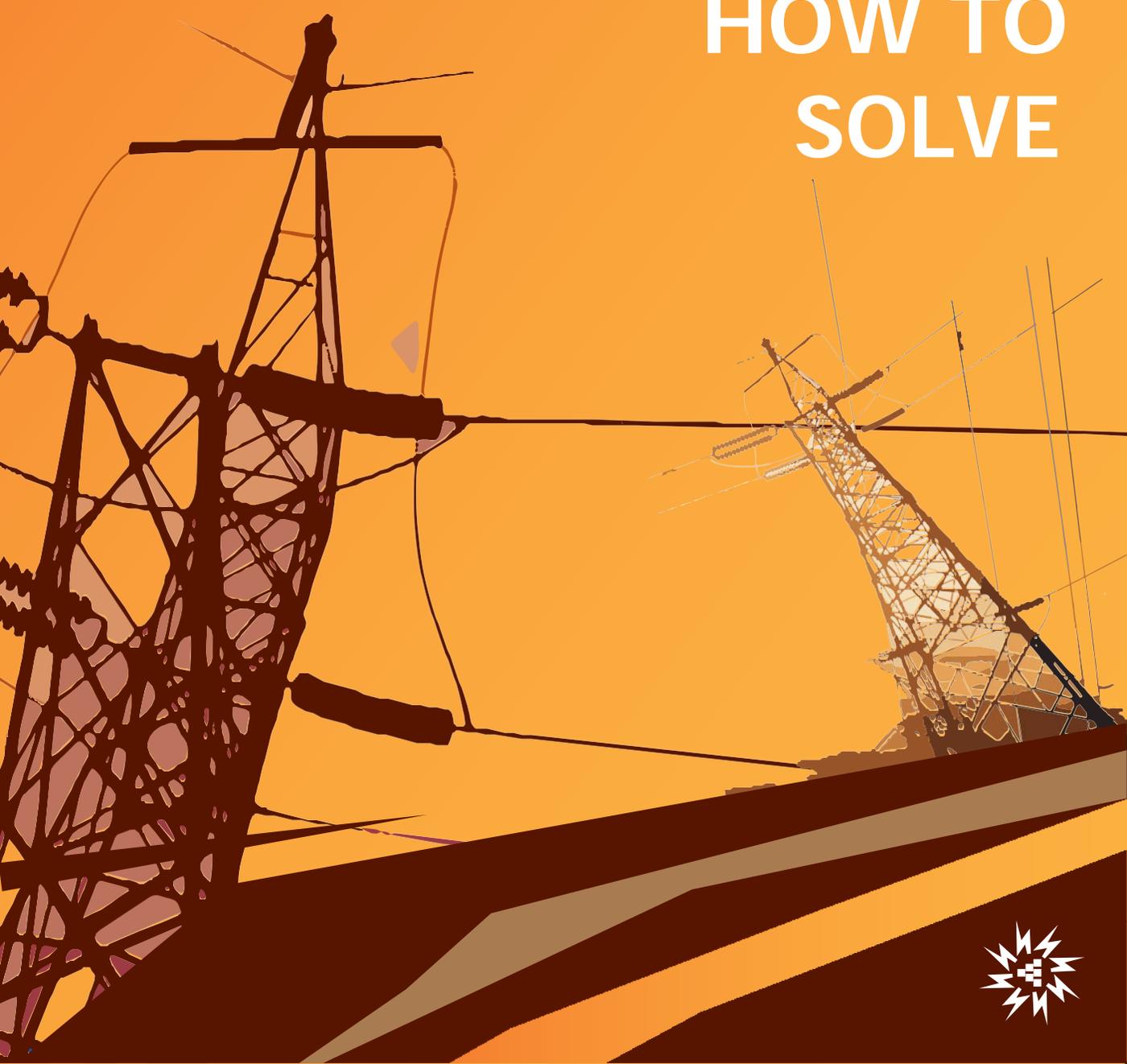


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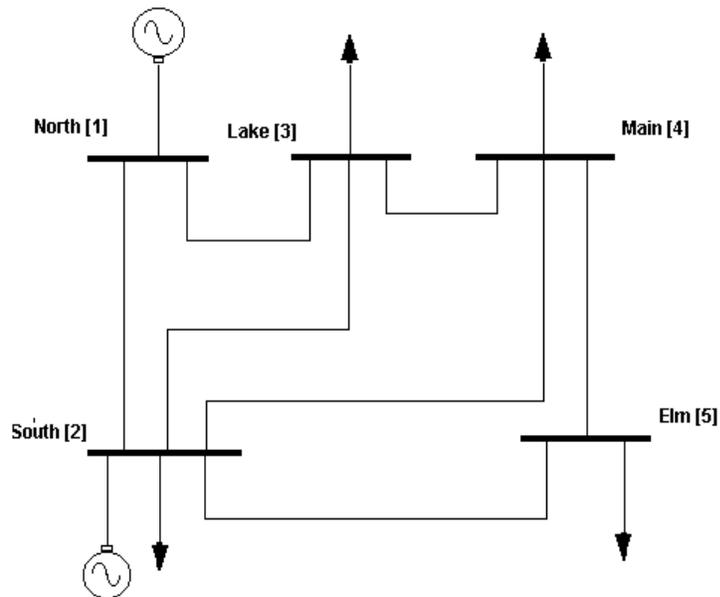
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1. How to solve Load Flow

Figure shows a single line diagram of a 5 bus system with two generating units, seven lines. Per-unit transmission line series impedances and shunt susceptances are given on 100 MVA base in table 1.1. Real power generation, real and reactive power loads in MW and MVAR are given in table 1.2.

With **bus 1** as **slack**, use the following methods to obtain a load flow solution:

- Gauss-Siedel using Y-bus, with acceleration factors of 1.4 and tolerances of 0.0001 and 0.0001 per unit for the real and imaginary components of voltage.
- Newton-Raphson using Ybus, with tolerance of 0.01 per unit for the real and reactive bus powers.



Assume the base voltage for the bus as 220 kV and system frequency as 60 Hz.

Impedances and line charging for the sample system.

Bus code From - To	Impedance R+jX in pu	Line charging B/2 in pu
1-2	0.02+j0.06	0.0+j0.030
1-3	0.08+j0.24	0.0+j0.025
2-3	0.06+j0.18	0.0+j0.02
2-4	0.06+j0.18	0.0+j0.02
2-5	0.04+j0.12	0.0+j0.015
3-4	0.01+j0.03	0.0+j0.010
4-5	0.08+j0.24	0.0+j0.025

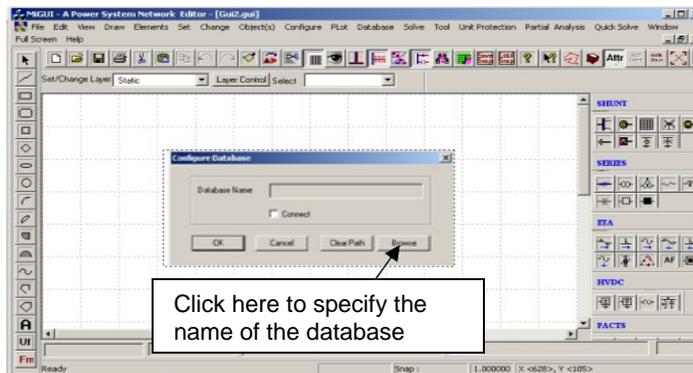
Generation, loads and bus voltages for sample system

Bus No	Bus Voltage	Generation MW	Generation MVAR	Load MW	Load MVAR
1	1.06+j0.0	0	0	0	0
2	1.00+j0.0	40	30	20	10
3	1.00+j0.0	0	0	45	15
4	1.00+j0.0	0	0	40	5
5	1.00+j0.0	0	0	60	10

Procedure to enter the data for performing studies using MiP-PSCT.

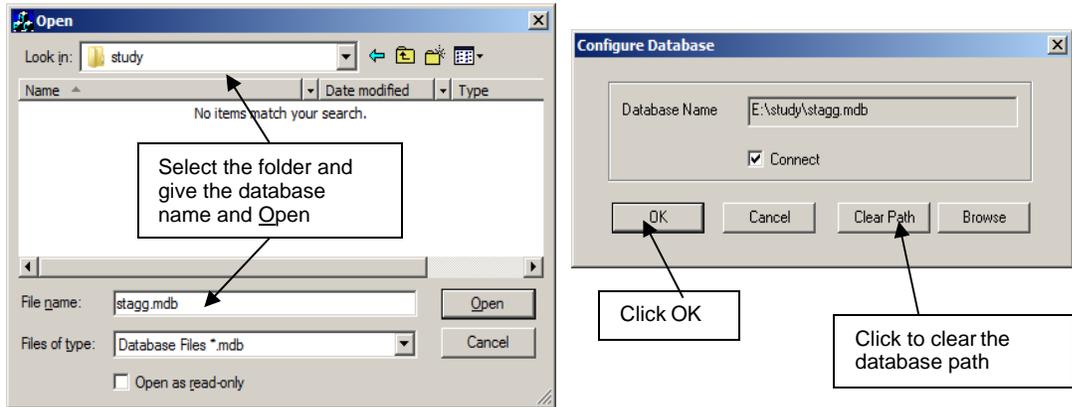
MiP-PSCT - Database Configuration

Open Power System Network Editor. Select menu option Database → **Configure**.



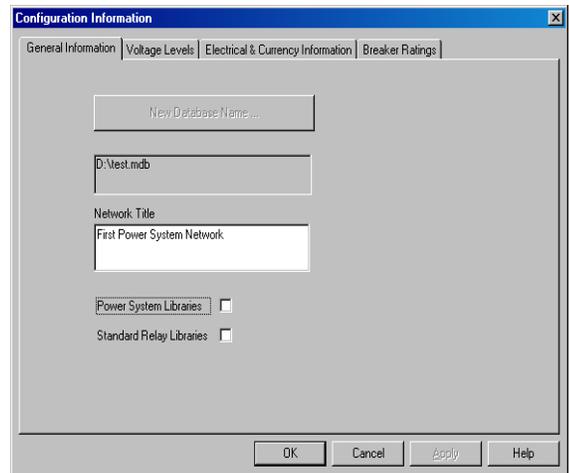
Configure Database **dialog** is popped up as shown below. Click **Browse** button. **Open dialog** box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line

diagram. Click Open button after entering the desired database name. **Configure Database** dialog will appear with path chosen.

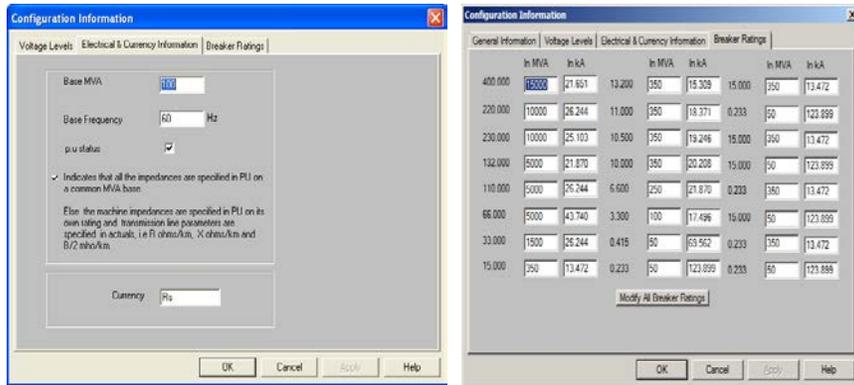


Note: Do not work in the MiP-PSCT directory.

Click OK button on the **Configure Database** dialog. The dialog as shown appears. Uncheck the *Power System Libraries* and *Standard Relay Libraries*. For this example these standard libraries are not needed, because all the data is given on Pu for power system libraries (like transformer, line\cable, generator), and relay libraries are required only for relay co-ordination studies. If Libraries are selected, standard libraries will be loaded along with the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base, check the pu status.

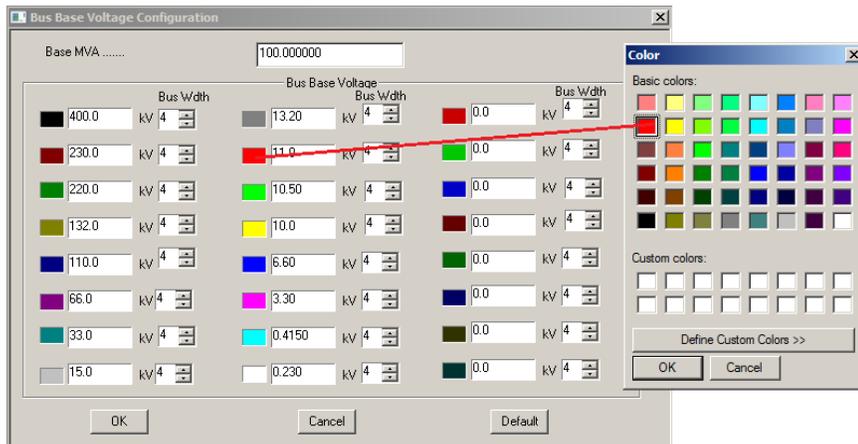


Enter the Base MVA and Base frequency as shown below. Click on Breaker Ratings button to give breaker ratings. Click OK button to create the database to return to Network Editor.



Bus Base Voltage Configuration

In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure**→**Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click **OK**.

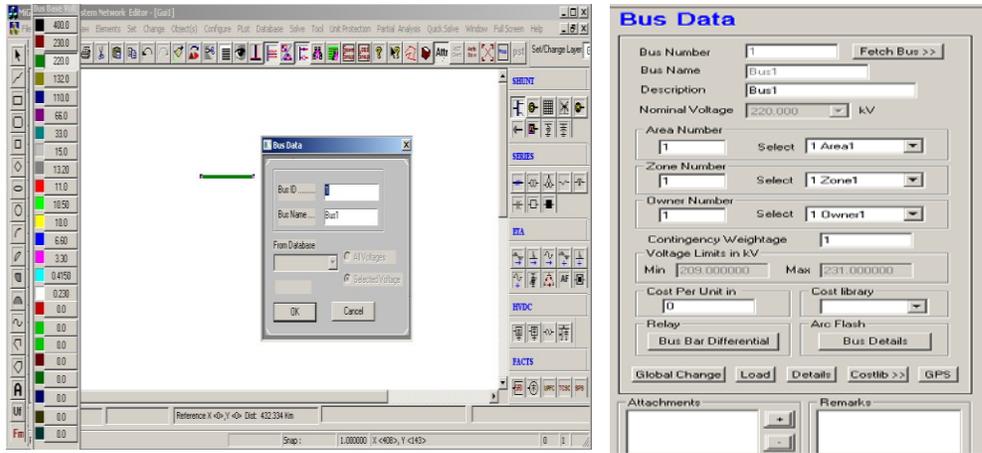


1.1 Procedure to Draw First Element - Bus

Click on **Bus** icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click OK. Database manager with corresponding **Bus Data** form will appear. Modify the Area number, Zone number and

Contingency Weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are other than this, modify these fields. Otherwise keep the default values.

Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is **Northeast**, then bus name can be given as NE and the bus description field can be North **East**.



After entering data click **save**  this invokes Network Editor. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Bus Number	Bus Name	Nominal Voltage(kV)
2	South	220
3	Lake	220
4	Main	220
5	Elm	220

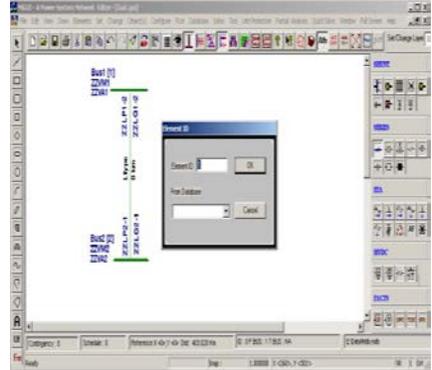
Note: Since the voltages are mentioned in pu, any kV can be assumed. So the base voltage is chosen as 220 kV.

1.2 Procedure to Draw Transmission Line

Click on Transmission **Line** icon provided on power system toolbar. To draw the line click in between two buses and to connect to

the from bus double clicking LMB (Left Mouse Button) on the

From Bus and join it to another bus by double clicking the mouse button on the **T o Bus. Element ID** dialog will appear. Enter **Element ID** number and click **OK**. Database manager with corresponding **Line\Cable Data** form will be open. Enter the details of that line as shown below. Enter **Structure Ref No.as 3001** and click on **Transmission Line Library >>** button.



Line/Cable Data

Number: 1 Fetch Line >> Name: L1 Maintenance

De-Rated MVA: 0 Structure Ref. No.:

Rating I: 0 MVA

Rating II: 0 MVA

From Bus Number: 1 [Bus1] (220.000) To Bus Number: 2 [Bus2] (220.000)

Number of Circuits: 1

Line Length: 1 km

Contingency Weightage: 1

From Breaker: Not Exists Exists MVA: 10000 kA: 26.244

To Breaker: Not Exists Exists MVA: 10000 kA: 26.244

Feed Data Type: Current Power

Amperes: 0 pf: 0.8

Show Breaker - SLD: Yes

SLD Notation: Line Cable Breaker Isolator

NOP: No From Side To Side

Status: In Service From End Open To End Open Out of Service

Commission Status: Existing Proposed Year: 0

Line & Cable Library form will appear. Enter Transmission line library data in the form as shown below for Line1-2.

Line and Cable Library

Structure Reference Number: 3001 Name: Line1-2

Positive Sequence Resistance: 0.02 pu

Positive Sequence Reactance: 0.06 pu

Positive Sequence Susceptance (B/2): 0.03 pu

Zero Sequence Resistance: 0 pu

Zero Sequence Reactance: 0 pu

Zero Sequence Susceptance (B/2): 0 pu

Thermal Rating: 100 MVA

Line Harmonic Number: 0

Cost per km: 0

Surge Impedance

Z: 1.000000 Ohms

V: 6285.714286 kms/sec

After entering data **Save**  and **Close**. **Line\Cable Data** form will appear. Click **Save** , which invokes Network Editor to update next element. Data for remaining elements given in the following table.

Transmission Line Element Data

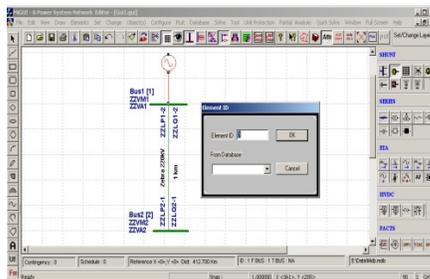
Line No	From Bus	To Bus	No. Of circuits	Structure Ref. No.
2	1	3	1	2
3	2	3	1	3
4	2	4	1	3
5	2	5	1	4
6	3	4	1	5
7	4	5	1	2

Transmission Line Library Data

Structure Ref No	Structure Ref Name	Resistance In pu	Reactance pu	Line charging B/2 in pu	Thermal Rating in MVA
1	Line 1-2	0.02	0.06	0.03	100
2	Line1-3 & 4-5	0.08	0.24	0.025	100
3	Line2-3 & 2-4	0.06	0.18	0.02	100
4	Line2-5	0.04	0.12	0.015	100
5	Line3-4	0.01	0.03	0.01	100

1.3 Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Connect it to bus 1 by clicking the LMB on **Bus 1**. The **Element ID** dialog will appear. Enter ID number and click OK. Database with corresponding **Generator Data** form will appear. Enter details as shown below.



Since the specified voltage is given as 1.06 pu, enter the value. Voltage will be calculated and appear in the specified voltage field in kV

Since generator at bus 1 is mention as slack bus, only specified voltage will have importance.

Note: At slack bus, only voltage and angle are mentioned. Scheduled power, real power minimum and maximum constraints do not have much importance.

If the bus is a PV bus (like bus 2), then scheduled power, specified voltage, minimum and maximum real and reactive power data is must.

Enter Manufacturer Ref. No.as 1 and click on **Generator Library** button. Generator library form will appear.

After entering data **Save**  and close. In **Generator Data** form click **Save** . **Network Editor** Screen will be invoked. Similarly connect generator 2 at bus 2. Enter its details as given in the following table.

Generator 2 Element Data	
Manufacturer Ref.No	2
No. of Units parallel	1
Specified voltage	220
Derated MVA	50
Scheduled Power	40
Real Power Min.	0
Real Power Max.	40

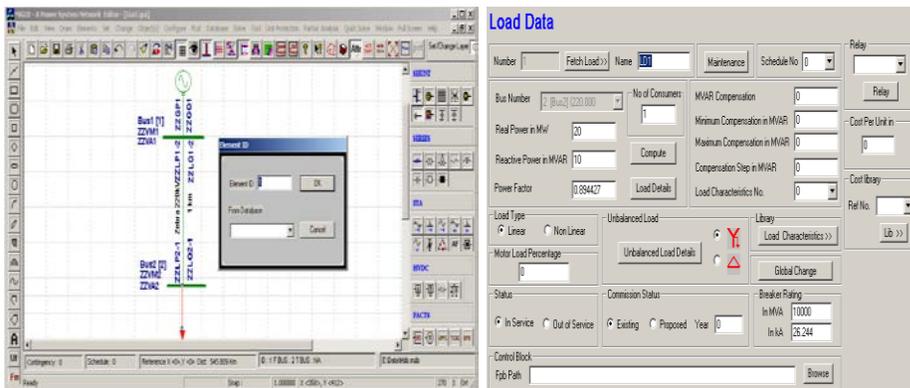
Reactive Power Min	30
Reactive Power Max	30

Note: Since in the data at bus 2, it is mentioned the Q generation as 30 MVAR. It means that generator has to generate 30 MVAR compulsorily. So mention Q min and Q max data as same (30) for this particular case. Thus bus has become PQ bus.

Generator 2 Library Data	
MVA Rating	50
MW rating	40
kV rating	220
Manufacturer Name	Gen2

1.4 Procedure to Enter Load Data

Click on **Load** icon provided on power system tool bar. Connect load 1 at BUS2 by clicking the LMB on Bus 2. **Element ID** dialog will appear. Give ID No as 1 and say OK. **Load Data** form will appear. Enter load details as shown below. Then click **save** button, which invokes Network Editor.

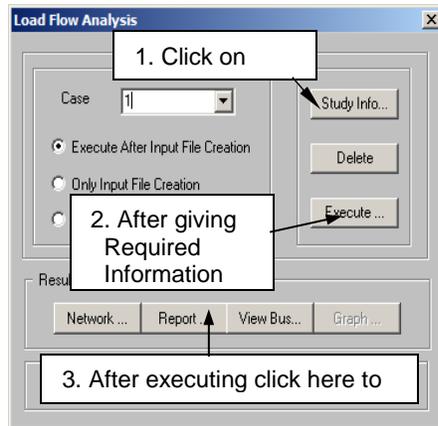


Connect other loads to buses 3, 4 and 5. Enter other load details as given in the following table.

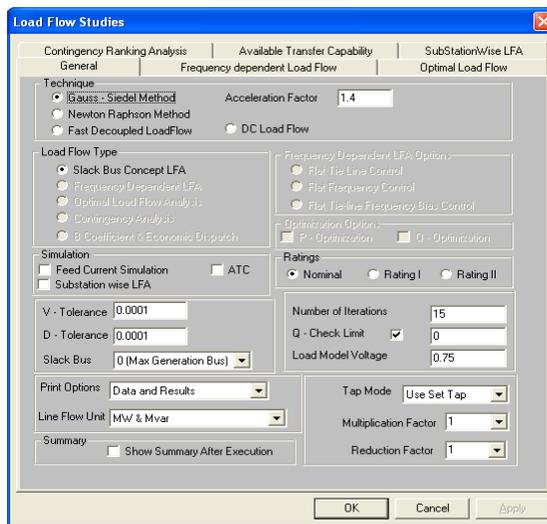
Load Details			
Load No	Bus No	MW	MVAR
2	5	60	10
3	3	45	15
4	4	40	5

1.5 Solve Load Flow Analysis

Select Menu option **Solve**→**Load Flow Analysis**. Following dialog will appear.



When **Study Info** button is clicked, following dialog will open. Select Gauss-Siedel Method and enter acceleration factor as 1.4 and P-Tolerance and Q-Tolerance as 0.0001. Click OK.



Execute load flow analysis and click on **Report** in load flow analysis dialog to view report. Repeat the procedure with P and Q tolerances as 0.01 for Newton Raphson Method.

Report

 LOAD FLOW BY GAUSS-SIEDEL METHOD
 CASE NO : 1 CONTINGENCY : 0 SCHEDULE NO : 0
 CONTINGENCY NAME : Base Case RATING CONSIDERED : NOMINAL

VERSION NUMBER : 8.2
 %%
 Largest Bus Number Used 5
 Actual Number of Buses 5
 Number of 2 Wind. Transformers : 0 Number of 3 Wind. Transformers : 0
 Number of Transmission Lines : 7 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 : 4 Number of Load Characteristics : 0
 Number of Under Frequency Relay: 0 Number 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 Number of Wind Generators : 0
 Number of wtg Curves : 0 Number of wtg Detailed Curves : 0
 Number of solar plants 0

 Load Flow With Gauss Seidel Method : 5
 Number of Zones : 1
 Print Option : 3 - Both Data and Results Print
 Plot Option : 1 - Plotting with p.u. Voltage
 No Frequency Dependent Load Flow, Control Option: 0
 Base MVA : 100.0
 Nominal System Frequency (Hz) : 60.0
 Frequency Deviation (Hz) : 0.0
 Flows in MW and MVA, Option : 0
 Slack Bus : 0 (Max. Generation Bus)
 Transformer Tap Control Option : 0
 Q Checking Limit (Enabled) : 0
 Real Power Tolerance (p.u.) : 0.00010
 Reactive Power Tolerance (p.u.) : 0.00010
 Maximum Number of Iterations : 15
 Bus Voltage Below Which Load Model is Changed : 0.75000
 Circuit Breaker Resistance (p.u.) : 0.00000
 Circuit Breaker Reactance (p.u.) : 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 (KWH) : 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(p.u.)	VMAX(p.u.)	NAME
1	1	1	220.000	0.980	1.080	North
2	1	1	220.000	0.980	1.080	South
3	1	1	220.000	0.980	1.080	Lake
4	1	1	220.000	0.980	1.080	Main
5	1	1	220.000	0.980	1.080	Elm

TRANSMISSION LINE DATA

STA	CKT	FROM NODE	FROM NAME*	TO NODE	TO NAME*	LINE R(p.u.)	PARAMETER X(p.u.)	B/2(p.u.)	RATING MVA	KMS
3	1	1	North	2	South	0.02000	0.06000	0.03000	100	1.00
3	1	1	North	3	Lake	0.08000	0.24000	0.02500	100	1.00
3	1	2	South	3	Lake	0.06000	0.18000	0.02000	100	1.00
3	1	2	South	4	Main	0.06000	0.18000	0.02000	100	1.00
3	1	2	South	5	Elm	0.04000	0.12000	0.01500	100	1.00
3	1	3	Lake	4	Main	0.01000	0.03000	0.01000	100	1.00
3	1	4	Main	5	Elm	0.08000	0.24000	0.02500	100	1.00

 Total Line Charging Susceptance (in p.u.) : 0.29000
 Total Line Charging MVar at 1 p.u. Voltage : 29.000
 Number of Lines Opened on Both the Ends : 0
 Total Line Charging susceptance of Existing Lines (in p.u.) : 0.29000
 Total Line Charging MVar at 1 p.u. Voltage of Existing Lines : 29.000

Total Capacitive Susceptance : 0.00000 p.u. - 0.000 MVar
 Total Inductive Susceptance : 0.00000 p.u. - 0.000 MVar

GENERATOR DATA

Sl.No*	FROM NODE	FROM NAME*	REAL POWER (MW)	Q-MIN MVar	Q-MAX MVar	V-SPEC p.u.	CAP. CURV	MVA RATING	STAT
1	1	North	80.0000	0.0000	60.0000	1.0600	0	100.00	3
2	2	South	40.0000	30.0000	30.0000	1.0000	0	50.00	3

LOAD DATA

Sl.no.	FROM NODE	FROM NAME	REAL *MW	REACTIVE MVAr	COMP MVAr	COMPENSATING MVAr	MIN	MVAR VALUE MAX	CHAR F/V STEP	NO.	NO.
1	2	South	20.000	10.000	0.000	0.000	0.000	0 0			
					3	0					
2	3	Lake	45.000	15.000	0.000	0.000	0.000	0 0			
					3	0					
3	4	Main	40.000	5.000	0.000	0.000	0.000	0 0			
					3	0					
4	5	Elm	60.000	10.000	0.000	0.000	0.000	0 0			
					3	0					

Total Specified MW Generation : 120.00000
Total Minimum MVAr Limit of Generator : 30.00000
TOTAL Maximum MVAr Limit of Generator : 90.00000
Total Specified MW Load : 165.00000 Changed to 165.00000
Total Specified MVAr Load : 40.00000 Changed to 40.00000
Total Specified MVAr Compensation : 0.00000 Changed to 0.00000

TOTAL (Including Out of Service Units)
Total Specified MW Generation : 120.00000
TOTAL Minimum MVAr Limit of Generator : 30.00000
Total Maximum MVAr Limit of Generator : 90.00000
Total Specified MW Load : 165.00000 Changed to 165.00000
Total Specified MVAr Load : 40.00000 Changed to 40.00000
Total Specified MVAr Compensation : 0.00000 Changed to 0.00000

GENERATOR DATA FOR FREQUENCY DEPENDENT LOAD FLOW

SLNO*	FROM NODE	FROM NAME*	P-RATE MW	P-MIN MW	P-MAX MW	%DROOP FACTOR	PARTICI SETTING	BIAS
			C0	C1	C2			

1	1	North	80.000	0.0000	80.0000	4.0000	0.0000	0.0000
				1.0000	0.1000	0.0100		
2	2	South	80.000	0.0000	40.0000	4.0000	0.0000	0.0000
				1.0000	0.1000	0.0100		

Acceleration factor : 1.40

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	North	80.000
---	---	-------	--------

Iteration count = 1 Error = 0.052538 Bus = 2

Iteration count = 2 Error = 0.015724 Bus = 5
 Iteration count = 3 Error = 0.007669 Bus = 5
 Iteration count = 4 Error = 0.002768 Bus = 2
 Iteration count = 5 Error = 0.002594 Bus = 5
 Iteration count = 6 Error = 0.001050 Bus = 4
 Iteration count = 7 Error = 0.000867 Bus = 3
 Iteration count = 8 Error = 0.000394 Bus = 2
 Iteration count = 9 Error = 0.000217 Bus = 3
 Iteration count = 10 Error = 0.000117 Bus = 3
 Iteration count = 11 Error = 0.000044 Bus = 2

 BUS VOLTAGES AND POWERS

NO.	NAME	V-MAG	ANGLE	MW	MVAr	MW	MVAr	MVAr
NO.	NAME	p.u.	DEGREE	GEN	GEN	LOAD	LOAD	COMP
1	North	1.0600	0.00	129.535	-7.468	0.000	0.000	0.000<
2	South	1.0475	-2.81	40.000	30.000	20.000	10.000	0.000
3	Lake	1.0242	-5.00	0.000	0.000	45.000	15.000	0.000
4	Main	1.0236	-5.33	0.000	0.000	40.000	5.000	0.000
5	Elm	1.0180	-6.15	0.000	0.000	60.000	10.000	0.000

-----NUMBER OF BUSES EXCEEDING

MINIMUM VOLTAGE LIMIT (@ mark) : 0

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	%		
SLNO	CS	FROM	FROM	TO	TO	MW	MVAr	MW	MVAr	LOADING
1	1	1	North	2	South	88.825	-8.610	1.4093	-2.4345	84.2#
2	1	1	North	3	Lake	40.710	1.141	1.1911	-1.8583	38.4^
3	1	2	South	3	Lake	24.690	3.535	0.3513	-3.2385	24.7&
4	1	2	South	4	Main	27.936	2.957	0.4413	-2.9660	27.5^
5	1	2	South	5	Elm	54.824	7.346	1.1253	0.1756	52.8\$
6	1	3	Lake	4	Main	18.900	-5.167	0.0357	-1.9898	19.1&
7	1	4	Main	5	Elm	6.334	-2.280	0.0307	-5.1178	6.8&

! NUMBER OF LINES LOADED BEYOND 125% : 0

@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 0

NUMBER OF LINES LOADED BETWEEN 75% AND 100% : 1

\$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% : 1

^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% : 2
 & NUMBER OF LINES LOADED BETWEEN 1% AND 25% : 3
 * NUMBER OF LINES LOADED BETWEEN 0% AND 1% : 0

 BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30 degrees ARE: ZERO

 ISLAND FREQUENCY SLACK-BUS CONVERGED(1)

 1 60.00000 1 1

Summary of results

TOTAL REAL POWER GENERATION (CONVENTIONAL) : 169.535 MW
 TOTAL REAL POWER INJECTION (-ve LOAD) : 0.000 MW
 TOTAL REACT. POWER GENERATION (CONVENTIONAL) : 22.532 MVA
 GENERATION p.f. : 0.991

TOTAL REAL POWER GENERATION (WIND) : 0.000 MW
 TOTAL REACT. POWER GENERATION (WIND) : 0.000 MVA
 TOTAL REAL POWER GENERATION (SOLAR) : 0.000 MW
 TOTAL REACT. POWER GENERATION (SOLAR) : 0.000 MVA
 TOTAL SHUNT REACTOR INJECTION : 0.000 MW TOTAL
 SHUNT REACTOR INJECTION : 0.000 MVA

TOTAL SHUNT CAPACIT.INJECTION : 0.000 MW
 TOTAL SHUNT CAPACIT.INJECTION : 0.000 MVA

TOTAL TCSC REACTIVE DRAWL : 0.000 MVA

TOTAL SPS REACTIVE DRAWL : 0.000 MVA

TOTAL UPFC INJECTION : 0.000 MVA

TOTAL SHUNT FACTS INJECTION : 0.000 MVA
 TOTAL SHUNT FACTS DRAWAL : 0.000 MVA

TOTAL REAL POWER LOAD : 165.000 MW
 TOTAL REAL POWER DRAWAL (-ve gen.) : 0.000 MW
 TOTAL REACTIVE POWER LOAD : 40.000 MVA
 LOAD p.f. : 0.972
 TOTAL COMPENSATION AT LOADS : 0.000 MVA
 TOTAL HVDC REACTIVE POWER : 0.000 MVA

TOTAL REAL POWER LOSS (AC+DC) : 4.584616 MW (4.584616+ 0.000000)
 PERCENTAGE REAL LOSS (AC+DC) : 2.704
 TOTAL REACTIVE POWER LOSS : -17.429226 MVA

-----Zone wise distribution

Description Zone # 1

 MW generation 169.5349

MVA generation 22.5315

MW wind gen.	0.0000
MVAr wind gen.	0.0000
MW solar gen.	0.0000
MVAr solar gen.	0.0000
MW load	165.0000
MVAr load	40.0000
MVAr compensation	0.0000
MW loss	4.5846
MVAr loss	-17.4292
MVAr - inductive	0.0000
MVAr - capacitive	0.0000

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

1 -----

Area wise export(+ve)/import(-ve)
Area # 1 MW & MVAr

1 -----

Area wise distribution
Description Area # 1

MW generation 169.5349
MVAr generation 22.5315
MW wind gen. 0.0000
MVAr wind gen. 0.0000
MW solar gen. 0.0000
MVAr solar gen. 0.0000
MW load 165.0000
MVAr load 40.0000
MVAr compensation 0.0000

MW loss 4.5846

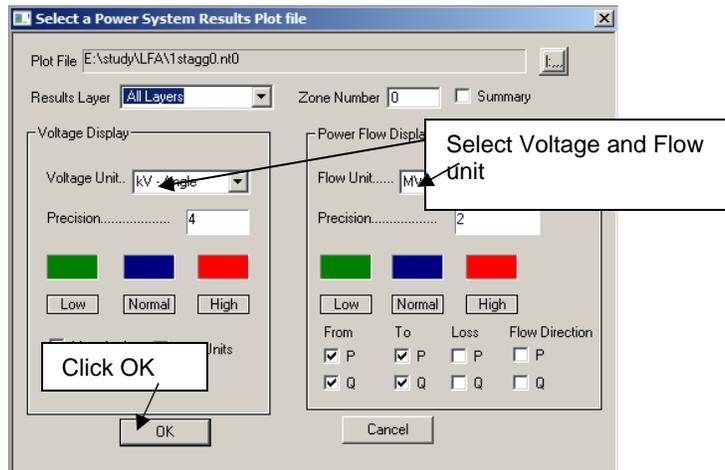
MVAr loss -17.4292

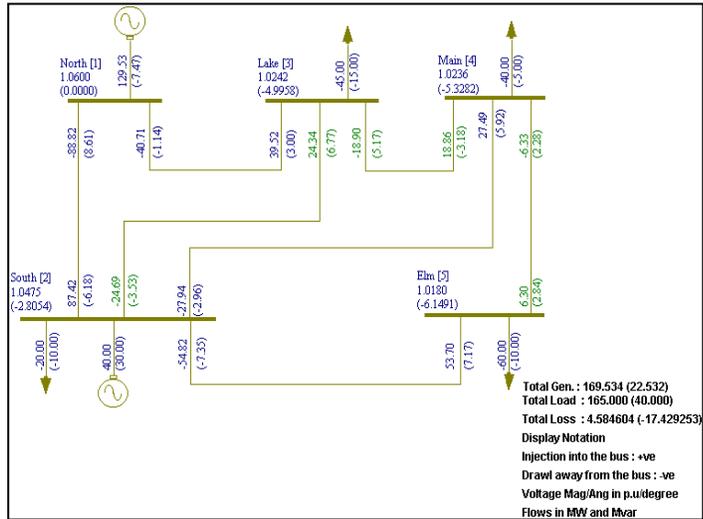
MVAr - inductive 0.0000

MVAr - capacitive 0.0000

1.6 Procedure to plot the results on the Single Line Diagram

Select Menu option **Plot**→**Load Flow Analysis**. Following dialog will appear.



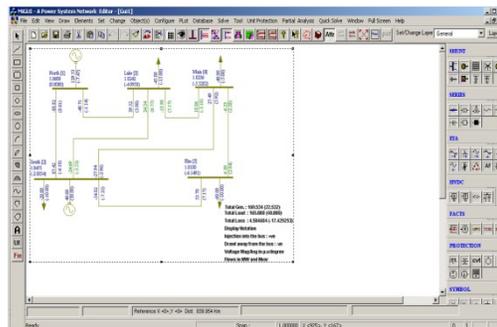


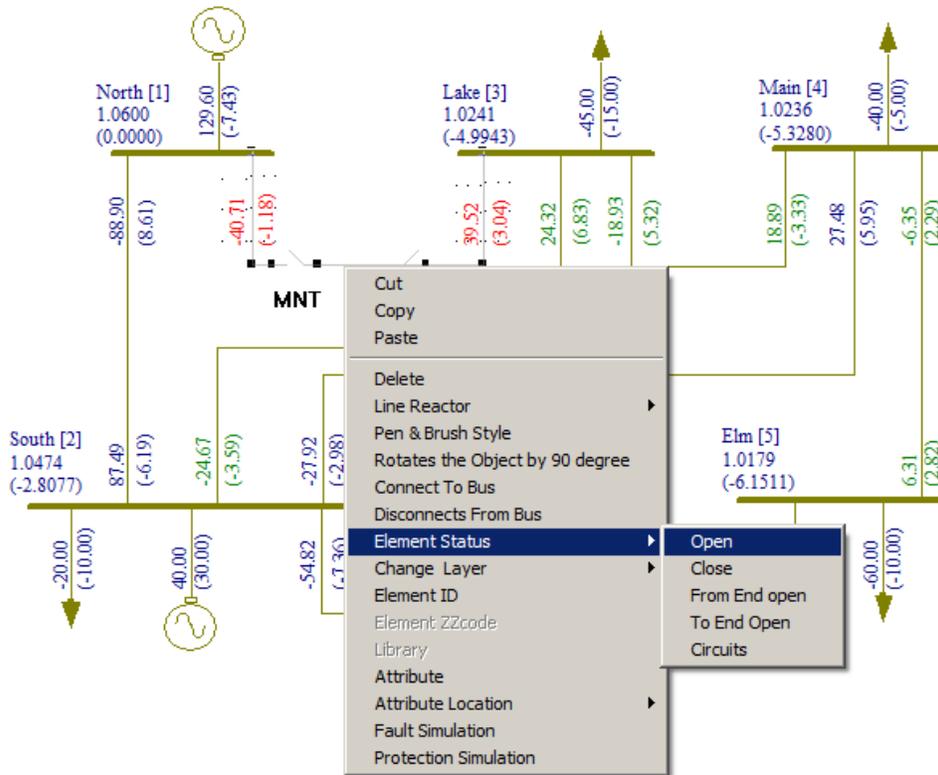
1.7 Quick Solve ->Load Flow (Shortcut method to perform Load flow analysis)

Select menu option **Quick Solve → Load Flow**. Load flow analysis is executed and automatically results are plotted on GUI.

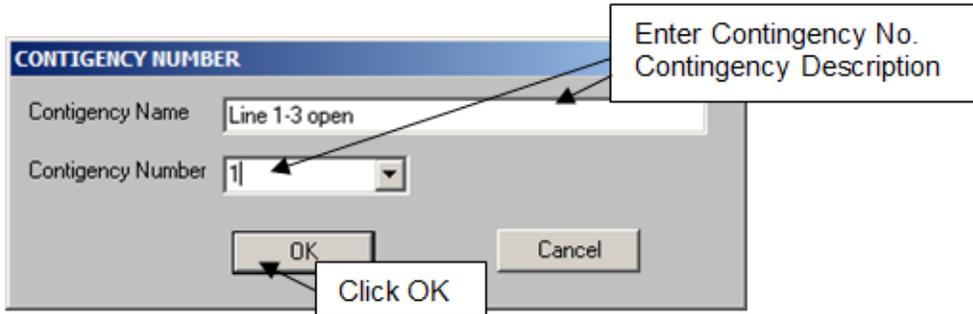
Contingency Analysis

1. Click RMB on the element to be opened (Out of service) and Select Menu option **Element Status→Open**





2. Select Menu option **Configure**→**Save Contingency** for saving contingency in database. Following dialog will appear



3. Execute Load Flow Analysis

Load Flow Result: -

BUS VOLTAGES AND POWERS

NODE	FROM	V-MAG	ANGLE	GEN MW	GEN MVAR	OAD MW	LOAD MVAR	COMP
------	------	-------	-------	--------	----------	--------	-----------	------

1	North	1.0600	0.00	131.639	5.385	0.000	0.000	
2	South	1.0328	-4.05	40.000	30.000	20.000	10.000	
3	Lake	0.9939	-8.09	0.000	0.000	45.000	15.000	
4	Main	0.9960	-8.07	0.000	0.000	40.000	5.000	
5	Elm	0.9980	-7.97	0.000	0.000	60.000	10.000	

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

LINE FLOWS AND LINE LOSSES

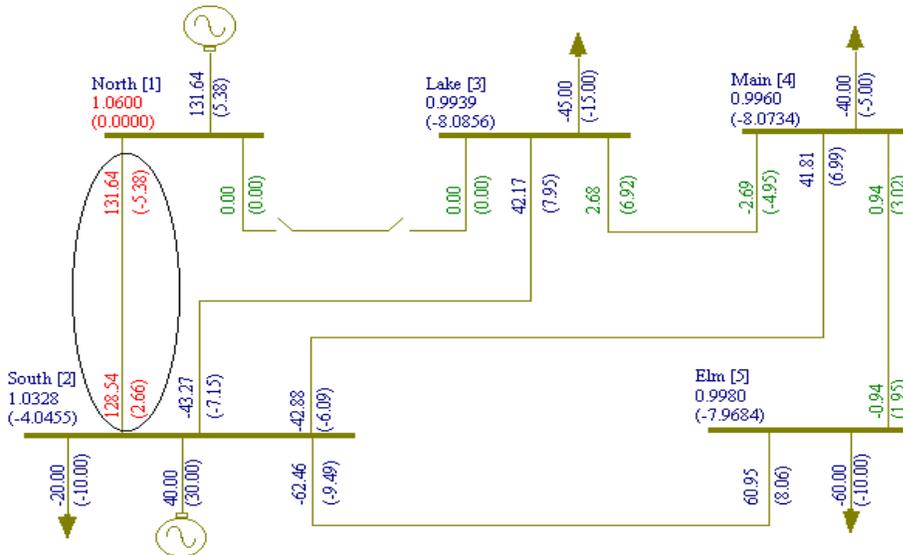
SLNO	CS	FROM	FROM	TO	TO	FORWARD	LOSS	%
		NODE	NAME	NODE	NAME	MW	MVAR	MW

1	1	1	North	2	South	131.639	5.385	3.0982
2	1	1	North	3	Lake	LINE IS OPEN		

MiP-PSCT				How to solve LFA					
3	1	2	South	3	Lake	43.274	7.150	1.1019	-0.8034
42.5^									
4	1	2	South	4	Main	42.883	6.093	1.0725	-0.8997
41.9^									
5	1	2	South	5	Elm	62.463	9.495	1.5093	1.4339
61.2\$									
6	1	3	Lake	4	Main	-2.682	-6.922	0.0043	-1.9670
7.5&									
7	1	4	Main	5	Elm	-0.938	-3.015	0.0009	-4.9674
3.2&									

Procedure to add Different Generation Schedules:

1.



Select menu option Configure -> Schedule OR Double Click LMB on the Generator to invoke database manager. Following database form will appear

The 'Generator Data' form includes the following sections:

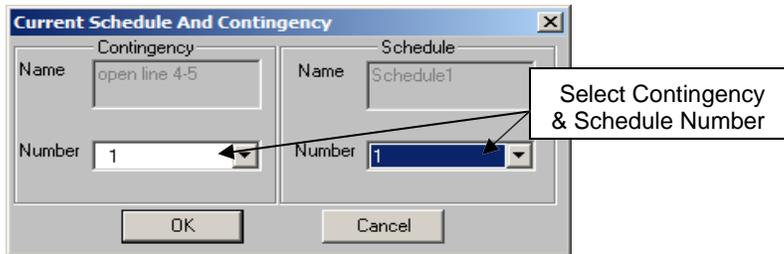
- General:** Number, Name, Maintenance, Schedule No.
- Bus Information:** Bus No., Units in Parallel, Manufacturer Ref. No., Capability Curve No.
- Specifications:** Specified Voltage (kV), De-Rated MVA, Scheduled Power, Breaker Rating (In MVA, In kA), Reactive Power limits.
- Optimization Data:** Real Power - Minimum/Maximum, Cost Coefficients (C0, C1, C2).
- Status:** In Service/Out of Service, Commission Status (Existing/Proposed), Year.
- Grounding:** Neutral Grounding Resistance/Reactance, Grounding Through Transformer.
- Model Type:** Infinite Bus Modelling, Transient Modelling, Sub Transient Modelling.
- AVR/Turbine:** AVR Ref. No., AVR FPB Name, Turbine Gov Ref. No.

Buttons at the bottom: Configure, Contingency, Select, To Network, **Schedule**, DB Desc.

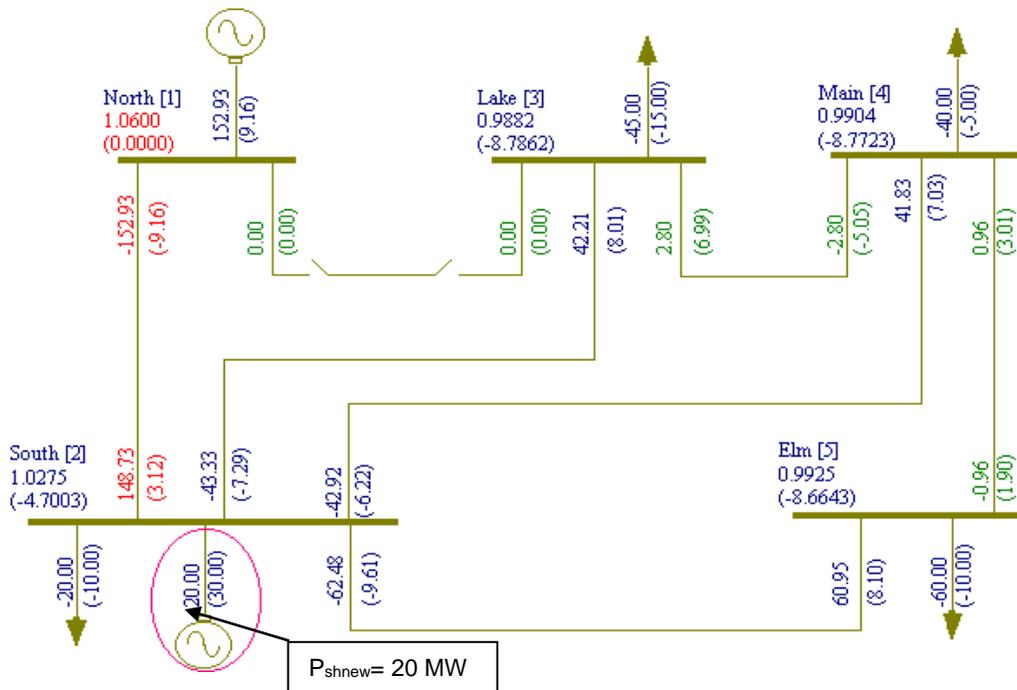
The 'Schedule' dialog box contains:

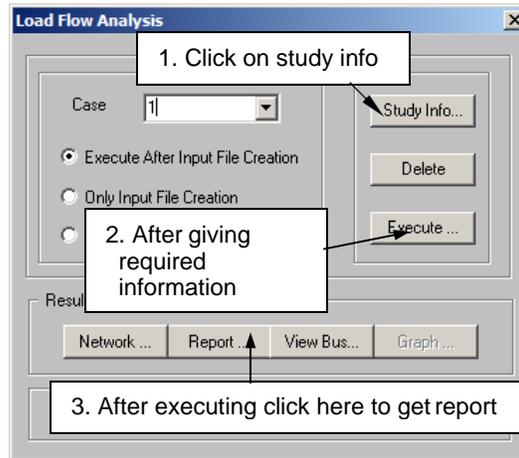
- Add:** Number (1), Copy From (0 Schedule0), Name (Schedule1).
- Modify Name:** A text field for the schedule name.
- Delete:** A text field for the schedule name to be deleted.
- Buttons:** Add, Modify, Delete, Close.

2. Close and Reopen Generator database to update the changes. Click on **Select** Button in Contingency & Schedule toolbar to switch between different Contingencies and Schedules. Following dialog box will appear.



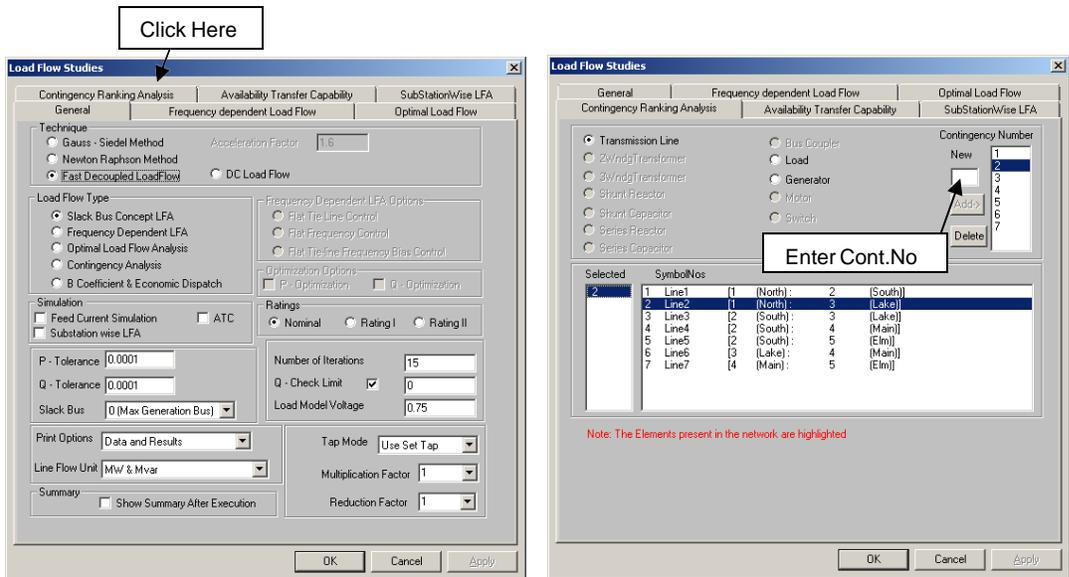
3. Enter the schedule details in Generator Data form and **save**
4. Execute Load Flow Analysis and plot the results on the Single line Diagram





Procedure for Contingency Ranking Analysis:

1. Select Menu option **Solve**→**Load Flow Analysis**. Following dialog will appear.



2. When **Study Info** button is clicked, following dialog will open. Select Fast Decoupled Method -> Contingency Analysis and click on **Contingency Ranking Analysis** tab

3. Enter the contingency number in **New** field and select elements from the **Symbol Nos.** table

4. Execute Load Flow analysis.

Report: -

CONTINGENCY RANKING

PIV: VOLTAGE PERFORMANCE INDEX

PIF: OVER LOAD PERFORMANCE INDEX

HIGH VALUE INDICATES LOAD FLOW UNABLE TO CONVERGE

```

-----
----
SLNO  FROM  NAME  TO  NAME  PIV      RANK  VOLT  PIF  RANK
LOAD
                                LESS
MORE
-----
-----
1      1      1      North  2      South  2.482e+001  1      4      2.918e+000  1
1      2      1      North  3      Lake  1.891e+000  7      0      2.287e+000  2
1      3      2      South  3      Lake  2.505e+000  5      0      1.305e+000  7
0      4      2      South  4      Main  2.434e+000  6      0      1.464e+000  4
0      5      2      South  5      Elm  6.250e+000  2      1      2.068e+000  3
0      6      3      Lake  4      Main  2.690e+000  3      0      1.462e+000  5
0      7      4      Main  5      Elm  2.649e+000  4      0      1.361e+000  6
0
-----
----

```

1.8 Frequency Dependent Load Flow:

Frequency dependent load flow is done to find the variation of frequency due to load and generation mismatch.

The types of frequency dependent load flow are

- (a) Flat Tie-Line control
- (b) Flat Frequency control

In Flat tie line control the power generation is kept constant and a slight variation in frequency is allowed. If the load is more compared to generation there will be reduction of frequency and vice versa.

In Flat frequency control the frequency is kept constant and variation in power is allowed. Each generator is given a participation factor, which decides the power it shares when there is mismatch between load and generation due to frequency being kept constant.

Flat Tie-Line control:

1. Execute LFA with FDLF->slack bus option in Load Flow Analysis study info

```
-----
--
BUS VOLTAGES AND POWERS
```

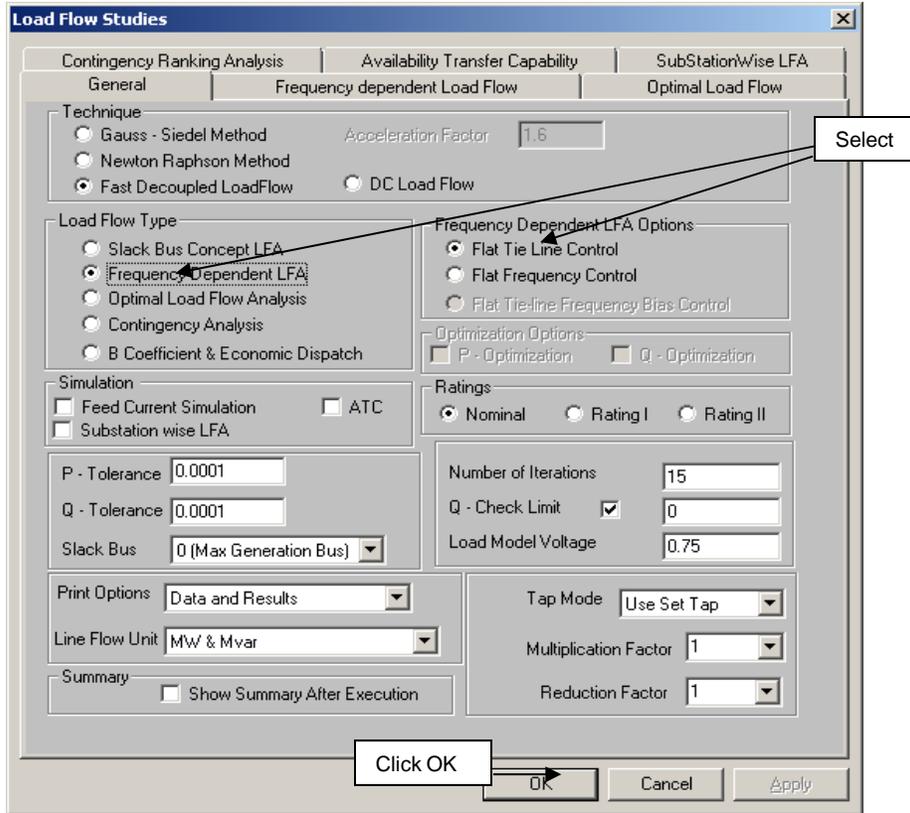
NODE NO.	FROM NAME	V-MAG P.U.	ANGLE DEGREE	MW GEN	MVAR GEN	MW LOAD	MVAR LOAD	MVAR COMP
1	North	1.0600	0.00	129.584	-7.444	0.000	0.000	
2	South	1.0475	-2.81	40.000	30.000	20.000	10.000	
3	Lake	1.0242	-5.00	0.000	0.000	45.000	15.000	
4	Main	1.0236	-5.33	0.000	0.000	40.000	5.000	
5	Elm	1.0179	-6.15	0.000	0.000	60.000	10.000	

```
-----
--
```

2. Change the generator Schedule and P_{max} to that obtained in initial load flow also enter droop in percentage in generator data form.

3. Select. **Frequency dependent Load Flow**→**Flat Tie-Line control**

4. Execute Load Flow Analysis



Report:-

BUS VOLTAGES AND POWERS

NODE	FROM	V-MAG	ANGLE	MW	MVAr	MW	MVAr
NO.	NAME	p.u.	DEGREE	GEN	GEN	LOAD	LOAD
1	North	1.0600	0.00	129.595	-7.416	0.000	0.000
2	South	1.0474	-2.81	40.000	30.000	20.000	10.000
3	Lake	1.0242	-5.00	0.000	0.000	45.000	15.000
4	Main	1.0236	-5.33	0.000	0.000	40.000	5.000
5	Elm	1.0179	-6.15	0.000	0.000	60.000	10.000

```

-----
NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) :    0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) :    1
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 NODE	FROM NAME	TO NODE	TO NAME	FORWARD		LOSS		%
						MW	MVAr	MW	MVAr	
LOADING										
1	1	1	North	2	South	88.869	-8.575	1.4106	-2.4304	
84.2#										
2	1	1	North	3	Lake	40.724	1.159	1.1920	-1.8553	
38.4^										
3	1	2	South	3	Lake	24.693	3.546	0.3515	-3.2376	
24.7&										
4	1	2	South	4	Main	27.935	2.962	0.4413	-2.9657	
27.5^	5	1	2	South	5	Elm	54.822	7.343	1.1252	0.1757
52.8\$	6	1	3	Lake	4	Main	18.874	-5.202	0.0356	-1.9898
19.1&										
7	1	4	Main	5	Elm	6.333	-2.285	0.0307	-5.1175	
6.8&										

```

---
! NUMBER OF LINES LOADED BEYOND 125% : 0
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 0
# NUMBER OF LINES LOADED BETWEEN 75% AND 100% : 1
$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% : 1
^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% : 2
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% : 3
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% : 0
-----

```

```

---
BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30 degrees ARE: ZERO
-----

```

```

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

```

```

1 59.99985 1 1
-----

```

```

---
Summary of results

```

TOTAL REAL POWER GENERATION (CONVENTIONAL)	:	169.595 MW
TOTAL REAL POWER INJECTION (-ve LOAD)	:	0.000 MW
TOTAL REACT. POWER GENERATION (CONVENTIONAL)	:	22.584 MVAr
GENERATION p.f.	:	0.991
TOTAL REAL POWER GENERATION (WIND)	:	0.000 MW

TOTAL REACT. POWER GENERATION (WIND)	:	0.000	MVAr
TOTAL REAL POWER GENERATION (SOLAR)	:	0.000	MW
TOTAL REACT. POWER GENERATION (SOLAR)	:	0.000	MVAr
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 INJECTION	:	0.000	MVAr
TOTAL SHUNT FACTS INJECTION	:	0.000	MVAr
TOTAL SHUNT FACTS DRAWAL	:	0.000	MVAr
TOTAL REAL POWER LOAD	:	165.000	MW
TOTAL REAL POWER DRAWAL (-ve gen.)	:	0.000	MW
TOTAL REACTIVE POWER LOAD	:	40.000	MVAr
LOAD P.F.	:	0.992	
TOTAL COMPENSATION AT LOADS	:	0.000	MVAr
TOTAL HVDC REACTIVE POWER	:	0.000	MVAr
TOTAL REAL POWER LOSS (AC+DC)	:	4.586907	MW (4.586907+
		0.000000)	
PERCENTAGE REAL LOSS (AC+DC)	:	2.705	
TOTAL REACTIVE POWER LOSS	:	-17.420643	MVAr

5. Change (Increase / Decrease) Load Data.

Load	Bus. No	Initial MW	New MW
Load1	2	20	25

6. Execute Frequency dependent Load Flow Analysis

Report:-

BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG p.u.	ANGLE DEGREE	MW GEN	MVAr GEN	MW LOAD	MVAr LOAD	MVAr COMP

1	North	1.0600	0.00	134.739	-4.269	0.000	0.000	0.000
#<								
2	South	1.0453	-2.91	40.000	30.000	25.000	12.500	0.000
3	Lake	1.0225	-5.08	0.000	0.000	45.000	15.000	0.000
4	Main	1.0218	-5.41	0.000	0.000	40.000	5.000	0.000
5	Elm	1.0159	-6.25	0.000	0.000	60.000	10.000	0.000

```

-----
NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) :    0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) :    1
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
LOADING							
1	1	1	North	2	South	93.180	-5.980
88.1#							1.5427
2	1	1	North	3	Lake	41.560	1.711
39.2^	3	1	2	South	3	Lake	24.330
24.3&							3.385
4	1	2	South	4	Main	27.642	2.839
27.2^							0.4323
5	1	2	South	5	Elm	54.673	7.301
52.8\$							1.1206
6	1	3	Lake	4	Main	19.308	-4.977
19.5&							0.0370
7	1	4	Main	5	Elm	6.480	-2.198
7.0&							0.0322
							-5.0805

```

-----
! NUMBER OF LINES LOADED BEYOND 125% :    0
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% :    0
# NUMBER OF LINES LOADED BETWEEN 75% AND 100% :    1
$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% :    1
^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% :    2
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% :    3
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% :    0
-----

```

```

-----
BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30 degrees ARE: ZERO
-----

```

```

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

```

```

1 59.84554 1 1
-----

```

Summary of results

```

TOTAL REAL POWER GENERATION (CONVENTIONAL) :    174.739 MW
TOTAL REAL POWER INJECTION (-ve LOAD) :    0.000 MW
TOTAL REACT. POWER GENERATION (CONVENTIONAL) :    25.731 MVAr

```

GENERATION p.f.	:	0.989
TOTAL REAL POWER GENERATION (WIND)	:	0.000 MW
TOTAL REACT. POWER GENERATION (WIND)	:	0.000 MVA _r
TOTAL REAL POWER GENERATION (SOLAR)	:	0.000 MW
TOTAL REACT. POWER GENERATION (SOLAR)	:	0.000 MVA _r
TOTAL SHUNT REACTOR INJECTION	:	0.000 MW
TOTAL SHUNT REACTOR INJECTION	:	0.000 MVA _r
TOTAL SHUNT CAPACIT. INJECTION	:	0.000 MW
TOTAL SHUNT CAPACIT. INJECTION	:	0.000 MVA _r
TOTAL TCSC REACTIVE DRAWL	:	0.000 MVA _r
TOTAL SPS REACTIVE DRAWL	:	0.000 MVA _r
TOTAL UPFC INJECTION	:	0.000 MVA _r
TOTAL SHUNT FACTS INJECTION	:	0.000 MVA _r
TOTAL SHUNT FACTS DRAWAL	:	0.000 MVA _r
TOTAL REAL POWER LOAD	:	170.000 MW
TOTAL REAL POWER DRAWAL (-ve gen.)	:	0.000 MW
TOTAL REACTIVE POWER LOAD	:	42.500 MVA _r
LOAD p.f.	:	0.970
TOTAL COMPENSATION AT LOADS	:	0.000 MVA _r
TOTAL HVDC REACTIVE POWER	:	0.000 MVA _r
TOTAL REAL POWER LOSS (AC+DC)	:	4.747187 MW (4.747187+
0.000000)		
PERCENTAGE REAL LOSS (AC+DC)	:	2.717
TOTAL REACTIVE POWER LOSS	:	-16.767246 MVA _r

Observation:

To meet increased load demand of 5 MW at **BUS 2** without increase in Generation MW, frequency drops to **59.84 Hz** from its nominal frequency **60 Hz**.

Flat Frequency control:

1. Execute LFA with FDLF->slack bus option in Load Flow Analysis study info

 --
 BUS VOLTAGES AND POWERS

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

 --

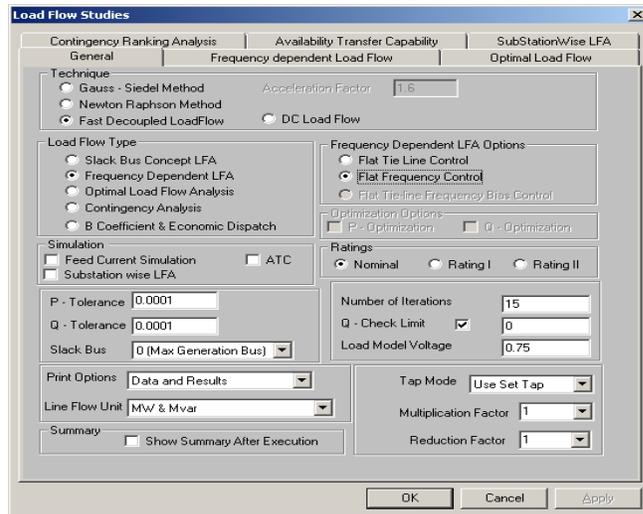
1	North	1.0600	0.00	129.584	-7.444	0.000	0.000	0.000
#<								
2	South	1.0475	-2.81	40.000	30.000	20.000	10.000	0.000
3	Lake	1.0242	-5.00	0.000	0.000	45.000	15.000	0.000
4	Main	1.0236	-5.33	0.000	0.000	40.000	5.000	0.000
5	Elm	1.0179	-6.15	0.000	0.000	60.000	10.000	0.000

--								

2. Change the generator Schedule and P_{max} to that obtained in initial load flow, also enter participation factor in generator data form. Participation factor for Gen1 = 25% and for Gen2 = 75%. Total participation factor for all generators is 100%.

Note: Real power maximum for Gen1, $P_{max} = 150\text{MW}$ and for Gen2, $P_{max} = 60\text{MW}$.

3. Select. **Frequency dependent Load Flow**→**Flat Frequency control**



4. Execute Load Flow Analysis

Report:------

BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG p.u.	ANGLE DEGREE	MW GEN	MVAr GEN	MW LOAD	MVAr LOAD	MVAr COMP
1	North	1.0600	0.00	129.590	-7.421	0.000	0.000	0.000
2	South	1.0474	-2.81	40.000	30.000	20.000	10.000	0.000
3	Lake	1.0242	-5.00	0.000	0.000	45.000	15.000	0.000
4	Main	1.0236	-5.33	0.000	0.000	40.000	5.000	0.000
5	Elm	1.0179	-6.15	0.000	0.000	60.000	10.000	0.000

NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) : 0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) : 1
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 NODE	FROM NAME	TO NODE	TO NAME	FORWARD		LOSS		%
						MW	MVAr	MW	MVAr	
1	1	1	North	2	South	88.860	-8.580	1.4103	-2.4312	
2	1	1	North	3	Lake	40.723	1.158	1.1919	-1.8555	
3	1	2	South	3	Lake	24.695	3.546	0.3515	-3.2375	
4	1	2	South	4	Main	27.937	2.962	0.4414	-2.9655	
5	1	2	South	5	Elm	54.824	7.343	1.1253	0.1759	
6	1	3	Lake	4	Main	18.874	-5.202	0.0356	-1.9898	
7	1	4	Main	5	Elm	6.333	-2.285	0.0307	-5.1176	

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

& NUMBER OF LINES LOADED BETWEEN	1% AND 25%	:	3
* NUMBER OF LINES LOADED BETWEEN	0% AND 1%	:	0

BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30 degrees ARE: ZERO

TOTAL AREA INTERCHANGE ERROR FOR ISLAND 1 : -0.000432 MW

Summary of results

TOTAL REAL POWER GENERATION (CONVENTIONAL)	:	169.590 MW
TOTAL REAL POWER INJECTION (-ve LOAD)	:	0.000 MW
TOTAL REACT. POWER GENERATION (CONVENTIONAL)	:	22.579 MVA _r
GENERATION p.f.	:	0.991
TOTAL REAL POWER GENERATION (WIND)	:	0.000 MW
TOTAL REACT. POWER GENERATION (WIND)	:	0.000 MVA _r
TOTAL REAL POWER GENERATION (SOLAR)	:	0.000 MW
TOTAL REACT. POWER GENERATION (SOLAR)	:	0.000 MVA _r
TOTAL SHUNT REACTOR INJECTION	:	0.000 MW
TOTAL SHUNT REACTOR INJECTION	:	0.000 MVA _r
TOTAL SHUNT CAPACIT. INJECTION	:	0.000 MW
TOTAL SHUNT CAPACIT. INJECTION	:	0.000 MVA _r
TOTAL TCSC REACTIVE DRAWL	:	0.000 MVA _r
TOTAL SPS REACTIVE DRAWL	:	0.000 MVA _r
TOTAL UPFC INJECTION	:	0.000 MVA _r
TOTAL SHUNT FACTS INJECTION	:	0.000 MVA _r
TOTAL SHUNT FACTS DRAWAL	:	0.000 MVA _r
TOTAL REAL POWER LOAD	:	165.000 MW
TOTAL REAL POWER DRAWAL (-ve gen.)	:	0.000 MW
TOTAL REACTIVE POWER LOAD	:	40.000 MVA _r
LOAD p.f.	:	0.972
TOTAL COMPENSATION AT LOADS	:	0.000 MVA _r
TOTAL HVDC REACTIVE POWER	:	0.000 MVA _r
TOTAL REAL POWER LOSS (AC+DC)	:	4.586773 MW (4.586773+
0.000000)		
PERCENTAGE REAL LOSS (AC+DC)	:	2.705
TOTAL REACTIVE POWER LOSS	:	-17.421289 MVA _r

---5. Change (Increase / Decrease) Load Data.

Load	Bus. No	Initial MW	New MW
Load1	2	20	30

6. Execute Frequency dependent Load Flow Analysis with Flat Frequency Control

Report:-

BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG p.u.	ANGLE DEGREE	MW GEN	MVAr GEN	MW LOAD	MVAr LOAD	MVAr COMP
1	North	1.0600	0.00	132.112	-2.027	0.000	0.000	0.000
2	South	1.0445	-2.83	47.566	30.000	30.000	15.000	0.000
3	Lake	1.0219	-5.03	0.000	0.000	45.000	15.000	0.000
4	Main	1.0211	-5.36	0.000	0.000	40.000	5.000	0.000
5	Elm	1.0151	-6.19	0.000	0.000	60.000	10.000	0.000

NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) : 0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) : 1
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 NODE	FROM NAME	TO NODE	TO NAME	FORWARD		LOSS		%
						MW	MVAr	MW	MVAr	
1	1	1	North	2	South	90.941	-4.067	1.4722	-2.2272	
85.9#										
2	1	1	North	3	Lake	41.164	2.040	1.2232	-1.7500	
38.9^										
3	1	2	South	3	Lake	24.509	3.213	0.3464	-3.2314	
24.5&										
4	1	2	South	4	Main	27.786	2.704	0.4377	-2.9543	
27.3^										
5	1	2	South	5	Elm	54.746	7.244	1.1278	0.2012	
52.9\$										
6	1	3	Lake	4	Main	19.104	-4.767	0.0363	-1.9781	
19.3&										
7	1	4	Main	5	Elm	6.415	-2.131	0.0317	-5.0875	
6.9&										

! NUMBER OF LINES LOADED BEYOND 125% : 0
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 0
NUMBER OF LINES LOADED BETWEEN 75% AND 100% : 1
\$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% : 1

```

^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% : 2
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% : 3
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% : 0
-----
---
BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30 degrees ARE: ZERO
-----
---
TOTAL AREA INTERCHANGE ERROR FOR ISLAND 1 : 10.087900 MW
-----
---
Summary of results
TOTAL REAL POWER GENERATION (CONVENTIONAL) : 179.678 MW
TOTAL REAL POWER INJECTION (-ve LOAD) : 0.000 MW
TOTAL REACT. POWER GENERATION (CONVENTIONAL) : 27.973 MVAr
GENERATION p.f. : 0.988

TOTAL REAL POWER GENERATION (WIND) : 0.000 MW
TOTAL REACT. POWER GENERATION (WIND) : 0.000 MVAr
TOTAL REAL POWER GENERATION (SOLAR) : 0.000 MW

TOTAL REACT. POWER GENERATION (SOLAR) : 0.000 MVAr
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 INJECTION : 0.000 MVAr

TOTAL SHUNT FACTS INJECTION : 0.000 MVAr
TOTAL SHUNT FACTS DRAWAL : 0.000 MVAr

TOTAL REAL POWER LOAD : 175.000 MW
TOTAL REAL POWER DRAWAL (-ve gen.) : 0.000 MW
TOTAL REACTIVE POWER LOAD : 45.000 MVAr
LOAD p.f. : 0.968
TOTAL COMPENSATION AT LOADS : 0.000 MVAr
TOTAL HVDC REACTIVE POWER : 0.000 MVAr

TOTAL REAL POWER LOSS (AC+DC) : 4.675261 MW ( 4.675261+
0.000000)
PERCENTAGE REAL LOSS (AC+DC) : 2.602
TOTAL REACTIVE POWER LOSS : -17.027382 MVAr

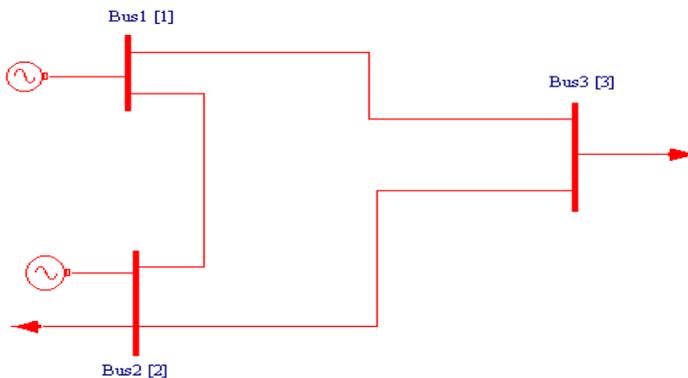
```

Observation:

To meet increased load demand of 10 MW at **BUS 2** with constant system frequency generation MW increases depending on the participation factors of generators.

1.9 Optimal Load Flow Analysis:

Figure shows a single line diagram of a 3 bus system with two generating units, three lines. Per-unit transmission line series impedances and shunt susceptances are given on 100 MVA base. Real power generation, real and reactive power loads in MW and MVAR are given in table Conduct the optimal 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 sample system

Buscode	Admittance Y_{pq}	Line charging $Y'_{pq}/2$
1-2	$1.47-j5.88$	$j0.15$
1-3	$2.94-j11.77$	$j0.07$
2-3	$2.75-j9.17$	$j0.04$

Generation, loads and bus voltages for sample system

Table: 1.2

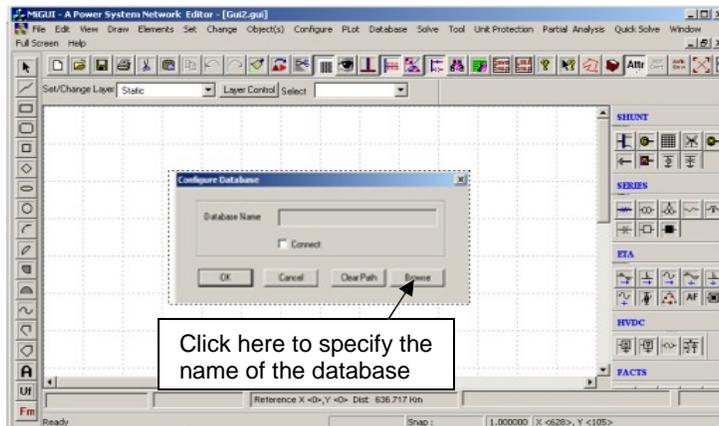
Bus No	Bus Voltage	Generation MW	Generation MVAR	Load MW	Load MVAR
1	1.04+j0.0	0	0	0	0
2	1.02+j0.0	100	--	50	20
3	1.00+j0.0	0	0	250	150

Buscode	Inertia (H)	Xd'
1	160	0.1
2	3	0.3

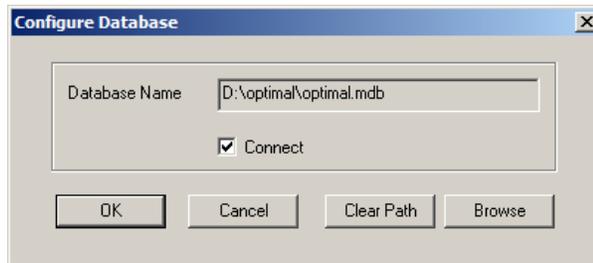
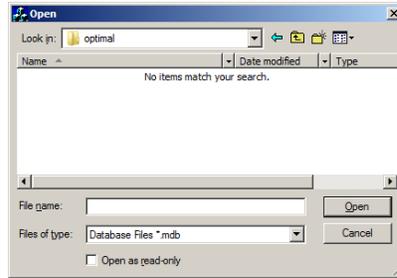
Procedure to enter the data for performing studies using MiP-PSCT.

MiP-PSCT - Database Configuration

Open Power System Network Editor. Select menu option **Database → Configure**. Configure Database **dialog** is popped up as shown below. Click **Browse** button.



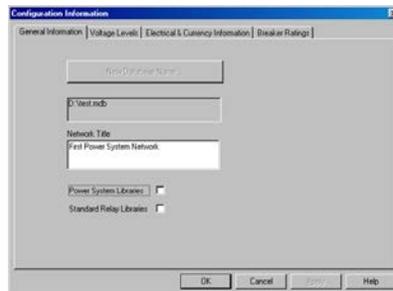
Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click Open button after entering the desired database name. **Configure Database** dialog will appear with path chosen.

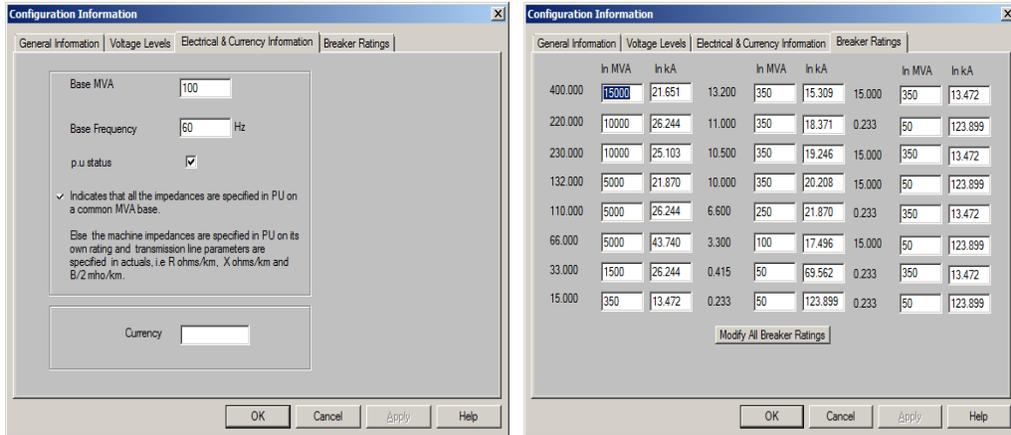


Note : Do not work in the MiP-PSCT directory

Click OK button on the **Configure database** dialog. The dialog shown below appears.

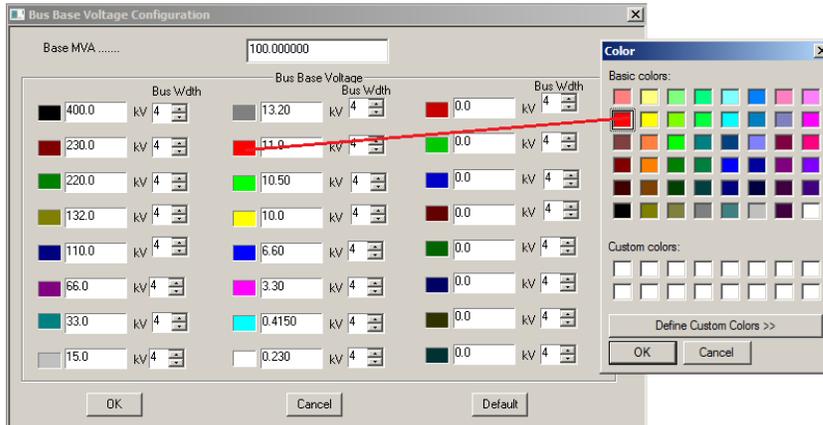
Uncheck the *Power System Libraries* and *Standard Relay Libraries* . For this example these standard libraries are not needed, because all the data is given on pu for power system libraries (like transformer, line/cable, generator), and relay libraries are required only for relay co-ordination studies. If Libraries are selected, standard libraries will be loaded along with the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base, check the pu status. Enter the Base MVA and Base frequency as shown below. Click on Breaker Ratings button to give breaker ratings. Click **OK button** to create the database to return to Network Editor.





Bus Base Voltage Configuration

In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure**→**Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click **OK**.



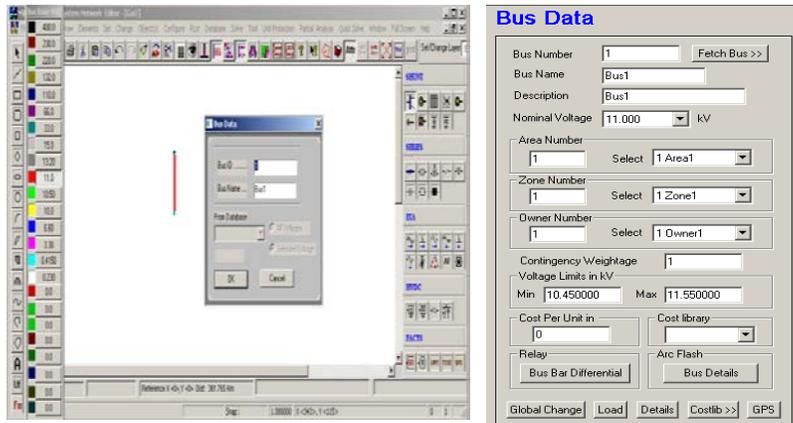
Procedure to Draw First Element - Bus

Click on **Bus** icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click OK. Database manager with corresponding **Bus Data** form will appear. Modify the Area number, Zone number and Contingency Weightage data if it is other than the default values. If this data is not

furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are other than this, modify these fields. Otherwise keep the default values.

Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus

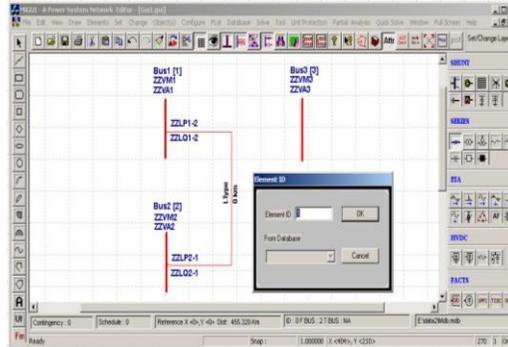
description field can be used to abbreviate the bus name. For example let us say the bus name is **Northeast**, then bus name can be given as NE and the bus description field can be **North East**.



After entering data click **Save**  which invokes **Network Editor**. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Bus Number	Bus Name	Nominal Voltage (kV)
2	Bus2	11
3	Bus3	11

Note: Since the voltages are mentioned in pu, any kV can be assumed. So the base voltage is chosen as 11kV.



Procedure to Draw Transmission Line

Click on **Transmission Line** icon provided on power system tool bar. To draw the line click in between two buses and to connect to the from bus double clicking LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear.

Enter **Element ID** number and click **OK**. Database manager with corresponding **Line/Cable Data** form will be open. Enter the details of that line as shown below.

The 'Line/Cable Data' form contains the following fields and options:

- Number: [] Fetch Line >>
- Name: [L1] Maintenance
- Feed Data Type: Current Power
- Amperes: [0] pf: [0.8]
- Show Breaker - SLD: Yes
- SLD Notation: Line Cable Breaker Isolator
- NDP: No From Side To Side
- Status: In Service From End Open To End Open Out of Service
- Commission Status: Existing Proposed Year: []
- De-Rated MVA: [100]
- Rating I: [100] MVA
- Rating II: [100] MVA
- From Bus Number: [1] [Bus1] [11.000]
- To Bus Number: [2] [Bus2] [11.000]
- Number of Circuits: [1]
- Line Length: [1] km
- Contingency Weightage: [1]
- Structure Ref. No.: [1]
- Transmission Line Library >> Line Details >>
- From Breaker: Not Exists Exists Rating: MVA [350] kA [18.37]
- To Breaker: Not Exists Exists Rating: MVA [350] kA [18.37]

Enter **Structure Ref No.** as 1 and click on **Transmission Line Library >>** button.

Line & Cable Library form will appear. Enter Transmission line library data in the form as shown below for Line1-2

Line and Cable Library

Structure Reference
 Number Name

Positive Sequence Resistance pu
 Positive Sequence Reactance pu
 Positive Sequence Susceptance (B/2) pu
 Zero Sequence Resistance pu
 Zero Sequence Reactance pu
 Zero Sequence Susceptance (B/2) pu
 Thermal Rating MVA
 Line Harmonic Number
 Cost per km Cost Per Unit in

Surge Impedance
 Z Ohms
 V kms/sec

After entering data **Save**  and **Close**. **Line\Cable Data** form will appear. Click **Save** , which invokes Network Editor to update next element. Data for remaining elements given in the following table.

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

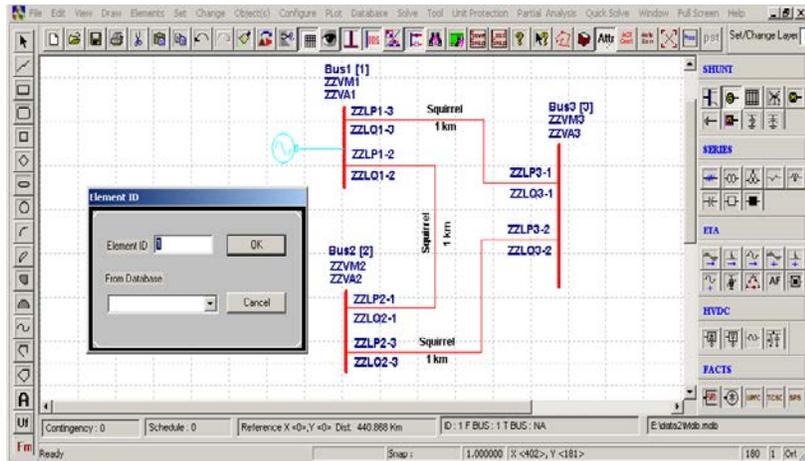
Transmission Line Library Data

Buscode	Admittance Y_{pq}	Line charging $Y'_{pq}/2$
1-2	1.47-j5.88	j0.15
1-3	2.94-j11.77	j0.07
2-3	2.75-j9.17	j0.04

* Thermal Rating 250MVA

Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Connect it to bus 1 by clicking the LMB on **Bus 1**. The **Element ID** dialog will appear. Enter ID number and click OK. Database with corresponding **Generator Data** form will appear. Enter details as shown below.



Generator Data

Number: 1	Fetch Generator >>	Name: Gen1	Maintenance:	Schedule No: 0
Bus No: 1 [Bus1] [11.000]	Manufacturer Ref. No: 1 [Gen]	Library >>	Protection: Over Current	Relay: []
Units in Parallel: 1	Capability Curve No: 0 [CAPCUR]	Capability Curve >>	Unit Protection: []	Cost Per Unit in: 0
Specified Voltage: 1.04 pu, 11.440 kV	Breaker Rating: In MVA: 350, In kA: 18.371	Reactive Power - Minimum: 0 MVar	Reactive Power - Maximum: 165.83 MVar	Select: <input type="radio"/> Utility Grid, <input checked="" type="radio"/> Generator
De-Rated MVA: 300	Scheduled Power: 250 MW	Real Power Optimization Data: Real Power - Minimum: 1 MW, Real Power - Maximum: 250 MW	Cost Coefficient C0: 100, Cost Coefficient C1: 10, Cost Coefficient C2: 0	Status: <input checked="" type="radio"/> In Service, <input type="radio"/> Out of Service
Commission Status: <input checked="" type="radio"/> Existing, <input type="radio"/> Proposed	Year: 0	Neutral Grounding Resistance: 0 ohms, Neutral Grounding Reactance: 0 ohms, Grounding Through Transformer: Calculate	Participation Factor (%): 0, Bias Setting: 0, Droop (%): 4	Model Type: <input checked="" type="radio"/> Infinite Bus Modelling (X'd & X'q), <input type="radio"/> Transient Modelling (X'd & X'q), <input type="radio"/> Sub Transient Modelling (X'd & X'q)
Global Change	AVR Ref. No: 0 [AVR] Type 0, AVR Library >>	AVR FPB Name	Turbine Gov Ref No: 0 Type 0, TG Library >>	Tur Governor Name
				Edit Files: AVR File Open, GOV File Open

Since generator at bus 1 is mention as slack bus, only specified voltage will have importance.

Note: At slack bus, only voltage and angle are mentioned. Scheduled power, real power minimum and maximum constraints do not have much importance.

If the bus is a PV bus (like bus 2), then scheduled power, specified voltage, minimum and maximum real and reactive power data is must.

Enter Manufacturer Ref. No. as 1 and click on **Generator Library** button. Generator library form will appear.

After entering data **Save**  and close. In **Generator Data** form click **Save** . **Network Editor** Screen will be invoked. Similarly connect generator 2 at bus 2. Enter its details as given in the following table.

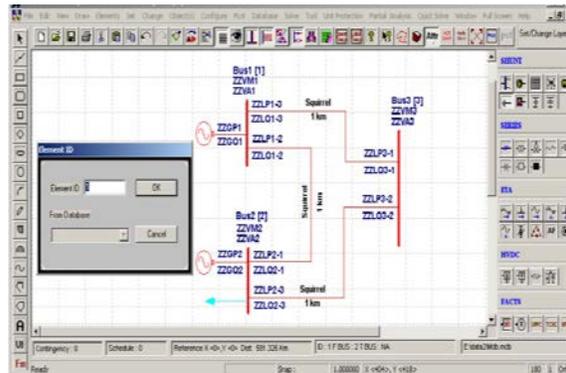
Generator 2 Element Data	
Manufacturer Ref.No	2
No. of Units parallel	1
Specified voltage	11
Derated MVA	250
Scheduled Power	100
Real Power Min.	0
Real Power Max.	200
Reactive Power Min	70
Reactive Power Max	70

Note: Since in the data at bus 2, it is mentioned the Q generation as 30 MVAR. It means that generator has to generate 30 MVAR compulsorily. So mention Q min and Q max data as same (70) for this particular case. Thus bus has become PQ bus.

Generator 2 Library Data	
MVA Rating	250
MW rating	200
kV rating	11
Manufacturer Name	Gen2

Procedure to Enter Load Data

Click on **Load** icon provided on power system tool bar. Connect load 1 at BUS2 by clicking the LMB on Bus 2. **Element ID** dialog will appear. Give ID No as 1 and say OK. **Load Data** form will appear. Enter load details as shown below. Then click **save** button, which invokes Network Editor.



Load Data

Number Name Schedule No

Bus Number No of Consumers: MVAR Compensation

Real Power in MW Minimum Compensation in MVAR

Reactive Power in MVAR Maximum Compensation in MVAR

Power Factor Load Characteristics No.

Load Type: Linear Non Linear

Motor Load Percentage:

Unbalanced Load:

Library:

Status: In Service Out of Service

Commission Status: Existing Proposed Year

Breaker Rating: In MVA In kA

Control Block: Fpb Path

Ref No.

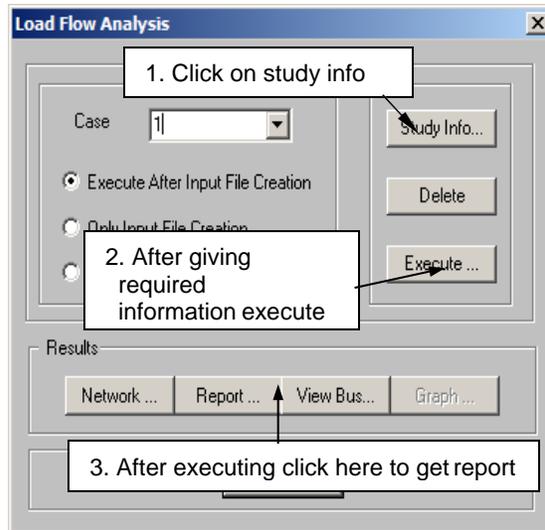
Give the compensation details

Connect other load to buses 3. Enter other load details as given in the following table.

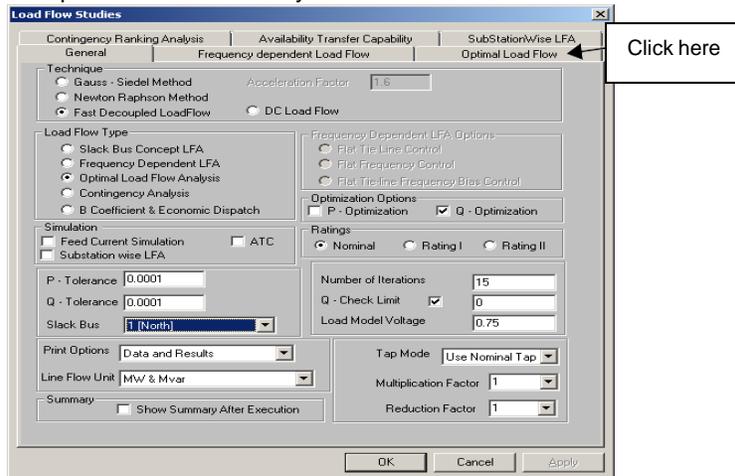
Load Details			
Load No	Bus No	MW	MVAR
2	3	50	20

Solve Load Flow Analysis

Select Menu option **Solve**→**Load Flow Analysis**. Following dialog will appear.



When **Study Info** button is clicked, following dialog will open. Select **Fast Decoupled Load Flow** and enable **Optimal Load Flow Analysis**



Enter all the details and click ok. Then execute.

Report

```

-----
---
#NO  BUS-NO  BUS-NAME  ORG-COMP  ORG-VOLT  FINAL-COMP  FINAL-VOLT
              MVar      p.u.      MVar      p.u.
-----
   1     3     Bus3     0.000     0.927     30.000     0.949
   2     2     Bus2     0.000     1.020     0.000     1.034
-----

```

```

---
ADDITIONAL COMPENSATION PROVIDED IN THE SYSTEM :      30.000 MVar
ORIGINAL LOSS IN THE SYSTEM                      :      12.190 MW
CURRENT LOSS IN THE SYSTEM                      :      10.657 MW
REDUCTION IN LOSS IN THE SYSTEM                 :           1.533 MW
ANNUAL INCOME DUE TO REDUCTION IN LOSS         :     10072539 Rs
ANNUAL EXPENSE TOWARDS O&M                    :           600000 Rs
ANNUAL SAVING DUE TO COMPENSATION              :           9472539 Rs
PRESENT WORTH OF SAVING                        :     59291763 Rs
TOTAL INVESTMENT ON ADDITIONAL CAPACITOR       :     15000000 Rs
NET PRESENT WORTH (SAVING)                     :     44291763 Rs
-----

```

BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG p.u.	ANGLE DEGREE	MW GEN	MVar GEN	MW LOAD	MVar LOAD	MVar COMP
----------	-----------	------------	--------------	--------	----------	---------	-----------	-----------

```

-----
---
  1      Bus1  1.0400   0.00  210.657   56.462    0.000    0.000
0.000
  2      Bus2  1.0338  -3.21  100.000   70.000   50.000   20.000
0.000
  3      Bus3  0.9490  -7.12    0.000    0.000  250.000  150.000
30.000 @
-----

```

```

-----
---
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) :    0
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
-----
---
  1  1    1   Bus1  2   Bus2  36.629 -20.323  0.5024 -30.2462
40.3^
  2  1    3   Bus3  1   Bus1 -167.112 -62.996  6.9160  13.7890
73.2$
  3  1    3   Bus3  2   Bus2 -82.888 -57.004  3.2388  2.9185
40.6^
-----

```

```

-----
---
! 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% :    1
^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% :    2
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% :    0
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% :    0
-----

```

```

-----
---
BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30 degrees ARE: ZERO
-----

```

```

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

```

```

  1  60.00000    1    1
-----

```

```

-----
---
Summary of results

```

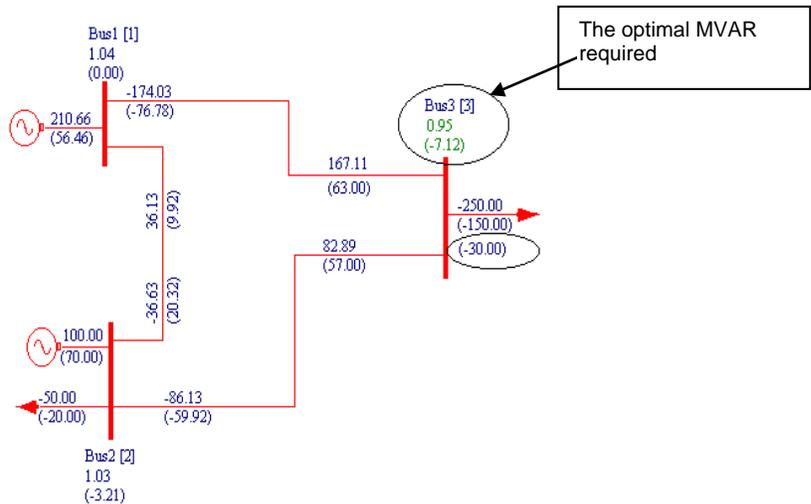
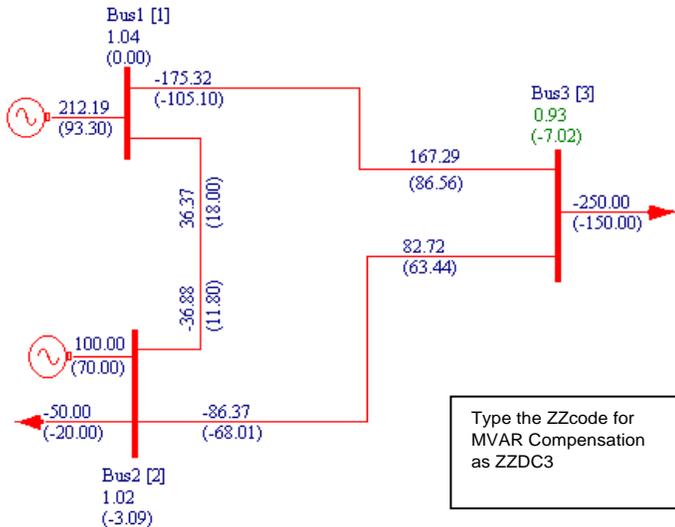
```

TOTAL REAL POWER GENERATION (CONVENTIONAL) :    310.657 MW
TOTAL REAL POWER INJECTION (-ve LOAD) :    0.000 MW
TOTAL REACT. POWER GENERATION (CONVENTIONAL) :    126.462 MVAr
-----

```

GENERATION p.f.	:	0.926
TOTAL REAL POWER GENERATION (WIND)	:	0.000 MW
TOTAL REACT. POWER GENERATION (WIND)	:	0.000 MVA _r
TOTAL REAL POWER GENERATION (SOLAR)	:	0.000 MW
TOTAL REACT. POWER GENERATION (SOLAR)	:	0.000 MVA _r
TOTAL SHUNT REACTOR INJECTION	:	0.000 MW
TOTAL SHUNT REACTOR INJECTION	:	0.000 MVA _r
TOTAL SHUNT CAPACIT. INJECTION	:	0.000 MW
TOTAL SHUNT CAPACIT. INJECTION	:	0.000 MVA _r
TOTAL TCSC REACTIVE DRAWL	:	0.000 MVA _r
TOTAL SPS REACTIVE DRAWL	:	0.000 MVA _r
TOTAL UPFC INJECTION	:	0.000 MVA _r
TOTAL SHUNT FACTS INJECTION	:	0.000 MVA _r
TOTAL SHUNT FACTS DRAWAL	:	0.000 MVA _r
TOTAL REAL POWER LOAD	:	300.000 MW
TOTAL REAL POWER DRAWAL (-ve gen.)	:	0.000 MW
TOTAL REACTIVE POWER LOAD	:	170.000 MVA _r
LOAD p.f.	:	0.870
TOTAL COMPENSATION AT LOADS	:	30.000 MVA_r
TOTAL HVDC REACTIVE POWER	:	0.000 MVA _r
TOTAL REAL POWER LOSS (AC+DC)	:	10.657196 MW (10.657196+
0.000000)		
PERCENTAGE REAL LOSS (AC+DC)	:	3.431
TOTAL REACTIVE POWER LOSS	:	-13.538651 MVA _r

The load flow results plotted before and after the Q-compensation (MVAR) is shown below.

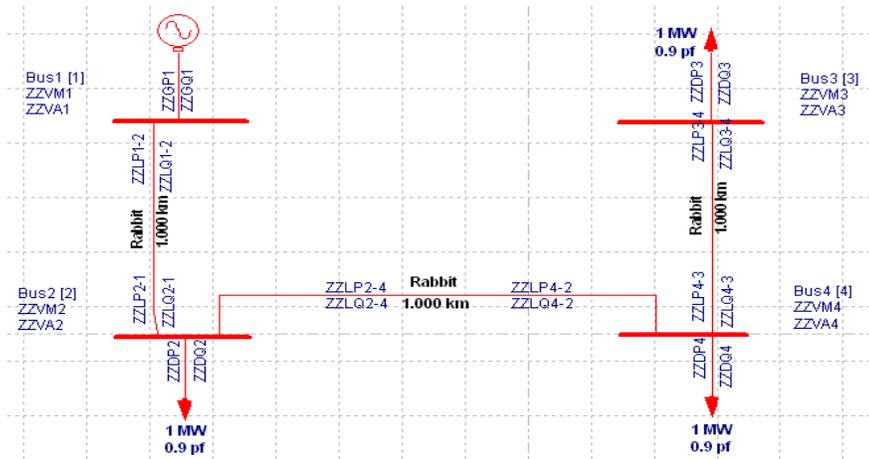


1.10 Feed Current Simulation

This simulation is for distribution network

Procedure for executing feed current simulation is given below for a sample network

1. Prepare GUI and database for the following 11 kV network



2. Execute normal load flow and plot the results on GUI as shown
3. Enter feed current data for the feeder 1-2 which is as shown below.

Feed Data : Current = 100 A and Power factor = 0.8

Line/Cable Data

Number: 4 Fetch Line >> Name: Line4 Maintenance: Feed Data Type: Current Power

11.000 kV Line

De-Rated MVA: 3.486618 Structure Ref. No.: 1 [Rabbit] Amperes: 100

Rating I: 3.486618 MVA Transmission Line Library >> Line Details >> pf: 0.8

Rating II: 3.486618 MVA

From Bus Number: 1 [Bus1] (11.000) From Breaker: Not Exists Rating: MVA: 350 kA: 18.371

To Bus Number: 2 [Bus2] (11.000) To Breaker: Not Exists Rating: MVA: 350 kA: 18.371

Number of Circuits: 1 From Breaker: To Breaker:

Line Length: 1 km To Breaker: From Breaker:

Contingency Weightage: 1

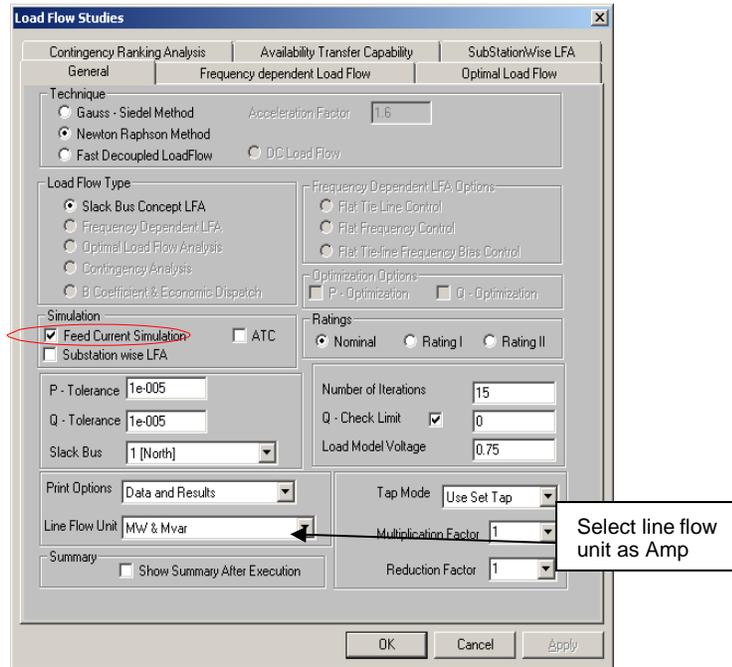
Status: In Service From End Open To End Open Out of Service Commission Status: Existing Proposed Year: 0

Show Breaker - SLD: Yes

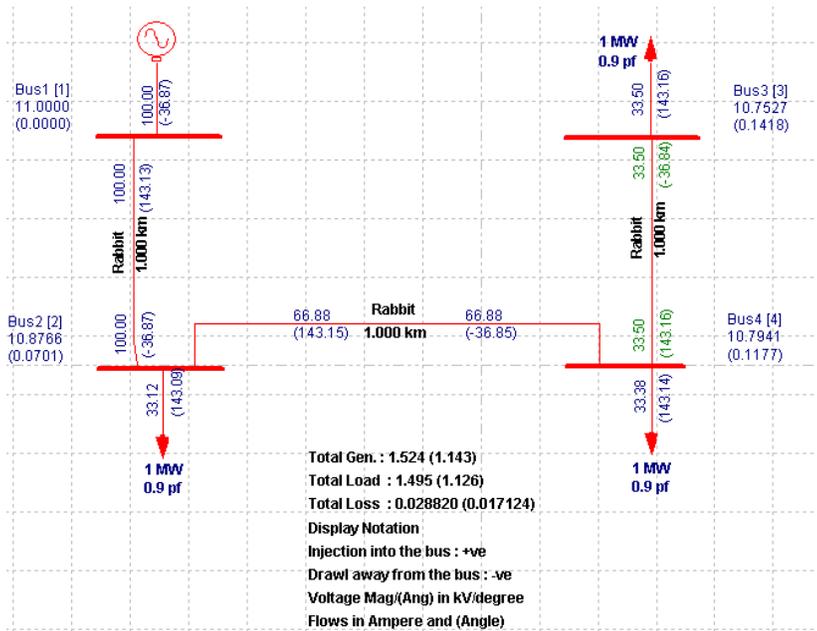
SLD Notation: Line Cable Breaker Isolator

NCP: No From Side To Side

- In Study info of Load flow analysis dialog select Feed current simulation option



- Execute load flow analysis and plot the results on GUI. In plot LFA window select the power flow display option as Amp-Angle. Following diagram shows feed current simulation results plotted on SLD.



Report:

```

-----
number 3  pspec 1.524205  qspece 1.143154  psum 3.000000  qsum 1.452966
i 1  pmult force 0.508068  qmult force 0.786772
k 2  after pload qload 0.050807  0.038105
k 3  after pload qload 0.050807  0.038105
k 4  after pload qload 0.050807  0.038105
Iteration count 0  maxp 0.050807  maxq 0.038105
-----

```

```

--
Iteration count 1  maxp 0.001077  maxq 0.000963
-----

```

```

--
Iteration count 2  maxp 0.000000  maxq 0.000001
-----

```

```

--
Iteration count 3  maxp 0.000000  maxq 0.000000
-----

```

```

number 3  pspec 1.524205  qspece 1.143154  psum 1.554081  qsum 1.160905
i 1  pmult force 0.980776  qmult force 0.984709
k 2  after pload qload 0.049830  0.037522
k 3  after pload qload 0.049830  0.037522
k 4  after pload qload 0.049830  0.037522
Iteration count 0  maxp 0.000977  maxq 0.000583
-----

```

```

--
Iteration count 1  maxp 0.000000  maxq 0.000000
-----

```

```

--
Iteration count 2  maxp 0.000000  maxq 0.000000
number 3  pspec 1.524205  qspece 1.143154  psum 1.523704  qsum 1.142786
i 1  pmult force 1.000329  qmult force 1.000321
k 2  after pload qload 0.049846  0.037535
k 3  after pload qload 0.049846  0.037535
k 4  after pload qload 0.049846  0.037535
Iteration count 0  maxp 0.000016  maxq 0.000012
-----

```

```

--
Iteration count 1  maxp 0.000000  maxq 0.000000
-----

```

```

--
Iteration count 2  maxp 0.000000  maxq 0.000000
-----

```

```

-----
Line-number  From-Bus   Name      To-Bus   Name      MW      MVAR
-----
--
      3           1      Bus1         2      Bus2      1.524    1.143
-----

```

 BUS VOLTAGES AND POWERS

NODE AMPS NO. COMP	FROM NAME	V-MAG P.U.	ANGLE DEGREE	AMPS GEN	ANG-DEG GEN	AMPS LOAD	ANG-DEG LOAD
1	Bus1	1.0000	0.00	100.001	-36.870	0.000	-90.000
2	Bus2	0.9888	0.07	0.000	-90.000	33.122	-36.910
3	Bus3	0.9775	0.14	0.000	-90.000	33.503	-36.838
4	Bus4	0.9813	0.12	0.000	-90.000	33.375	-36.862

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

 --
 LINE FLOWS AND LINE LOSSES

SLNO	CS	FROM NODE	FROM NAME	TO NODE	TO NAME	FORWARD AMPS	ANG-DEG	LOSS MW	% MVAR
1	2	1	Bus2	4	Bus4	66.879	-36.850	0.0083	0.0049
2	3	1	Bus3	4	Bus4	33.503	143.162	0.0021	0.0012
3	1	1	Bus1	2	Bus2	100.001	-36.870	0.0185	0.0110

! 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% :	1
^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% :	1
& 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	:	1.524	MW
TOTAL REAL POWER INJECT, -ve L	:	0.000	MW
TOTAL REACT. POWER GENERATION	:	1.143	MVAR
GENERATION pf	:	0.800	
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	:	1.495	MW
TOTAL REAL POWER DRAWAL -ve g	:	0.000	MW
TOTAL REACTIVE POWER LOAD	:	1.126	MVAR
LOAD pf	:	0.799	
TOTAL COMPENSATION AT LOADS	:	0.000	MVAR
TOTAL HVDC REACTIVE POWER	:	0.000	MVAR
TOTAL REAL POWER LOSS (AC+DC)	:	0.028820	MW (0.028820+ 0.000000)
PERCENTAGE REAL LOSS (AC+DC)	:	1.891	
TOTAL REACTIVE POWER LOSS	:	0.017124	MVAR

Feed current simulation will work with all type of load flow. For the above sample it gives better results with NR method. For feed current only one feeder will be considered and below that feeder there may be a ring circuit.

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2. How to solve Short Circuit

Sample 6 bus system

Figure shows a single line diagram of a 6-bus system with two identical generating units, five lines and two transformers. Per-unit transmission line series impedances and shunt susceptances are given on 100 MVA base, generator's transient reactance and transformer leakage reactances are given in the accompanying

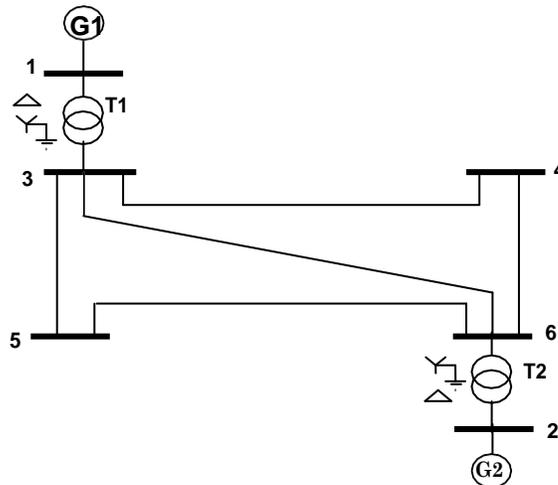


table.

If a 3 - phase to ground fault occurs at bus 5 - find the fault MVA. The data is given below.

Bus - code	Impedance Z_{pq}	Line charging
p-q	Z_{pq}	$Y'_{pq}/2$
3 - 4	$0.00 + j0.15$	0
3 - 5	$0.00 + j0.10$	0
3 - 6	$0.00 + j0.20$	0
5 - 6	$0.00 + j0.15$	0
4 - 6	$0.00 + j0.10$	0

Generator details

$G1 = G2 = 100$ MVA, 11 kV with $X'_d = 10\%$

Transformer details

$T1 = T2 = 11/110$ kV, 100 MVA, leakage reactance = $x = 5\%$

** All impedances are on 100 MVA base

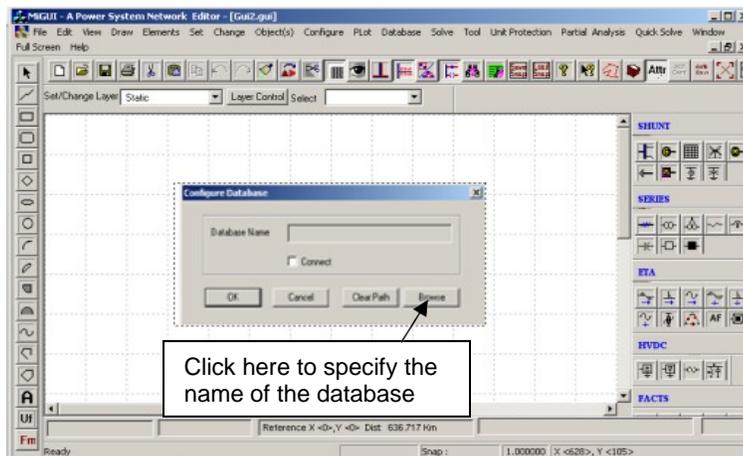
MiP-PSCT Data Interpretation:**SOLUTION:**

In transmission line data, elements 3 – 4 & 5 – 6 have common parameters. Elements 3 - 5 & 4 – 6 have common parameters. Therefore 3 libraries are required for transmission line.

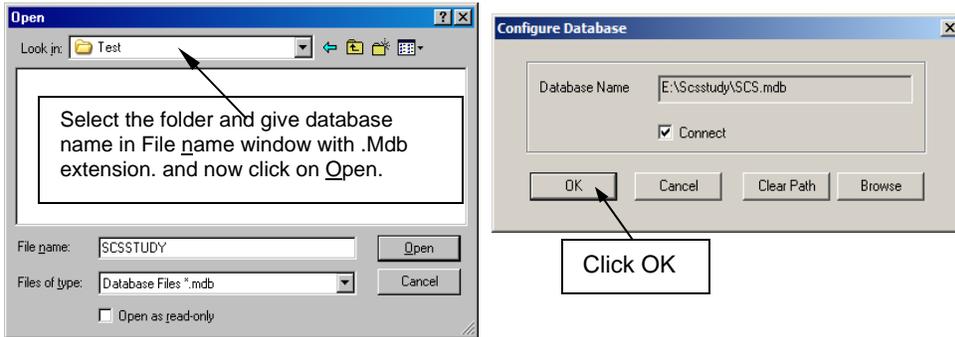
As generators G1 and G2 have same parameters, only one generator library is required. The same applies for transformers also.

Procedure to enter the data for performing studies using MiP-PSCT**MiP-PSCT - Database Configuration**

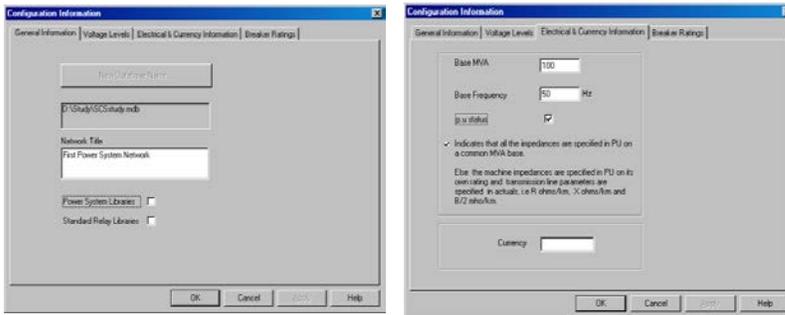
Open Power System Network Editor. Select menu option Database → Configure. Configure Database dialog is popped up. Click Browse button.



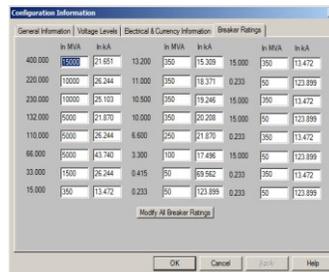
Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click Open button after entering the desired database name. Configure Database dialog will appear with path chosen.



Click on **OK** button in the **Configure database** dialog, the following dialog appears.



Uncheck the Power System Libraries and Standard Relay Libraries. For this example these standard libraries are not needed, because all the data is given on pu for power system libraries (like transformer, line/cable, generator), and relay libraries are required only for relay co-ordination studies.

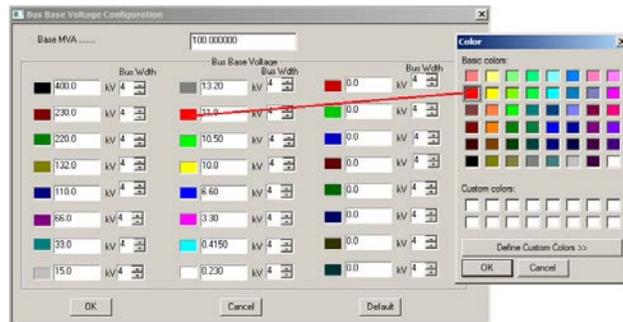


If Libraries are selected, standard libraries will be loaded along with the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base, check the pu status. Enter the Base MVA and Base frequency as shown below. Click **Breaker Ratings** tab. If the data is furnished, modify the breaker ratings for required voltage levels. Otherwise accept the default values. Click **OK** button to create the database to return to Network Editor.

Bus Base Voltage Configuration

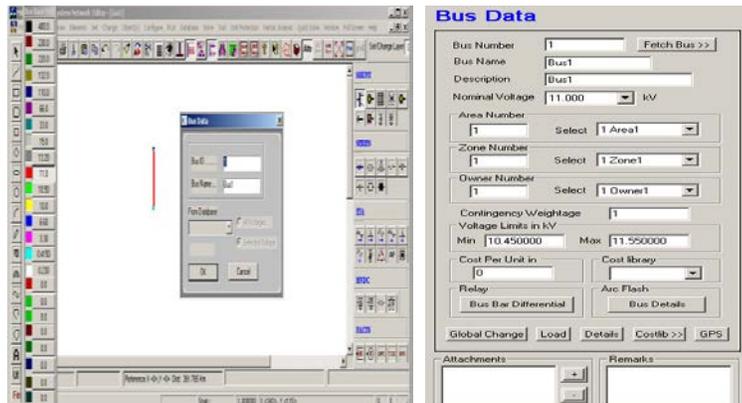
In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure→Base voltage**. Dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click **OK**.

2.1 Procedure to Draw First Element – Bus



Click on Bus icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click OK. Database manager with corresponding **Bus Data** form will appear. Modify the Area number, Zone number and Contingency Weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are other than this, modify these fields. Otherwise keep the default values.

Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is **Northeast**, then bus name can be given as **NE** and the bus description field can be **North East**.

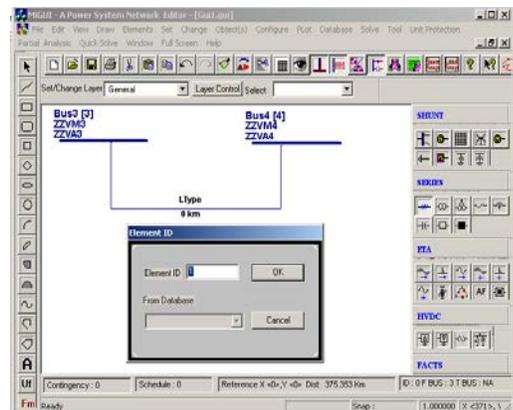


After entering data click **Save** , which invokes **Network Editor**. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Bus data						
Bus Number	1	2	3	4	5	6
Bus Name	Bus1	Bus2	Bus3	Bus4	Bus5	Bus6
Nominal voltage	11	11	110	110	110	110
Area number	1	1	1	1	1	1
Zone number	1	1	1	1	1	1
Contingency Weightage	1	1	1	1	1	1

2.2 Procedure to Draw Transmission Line

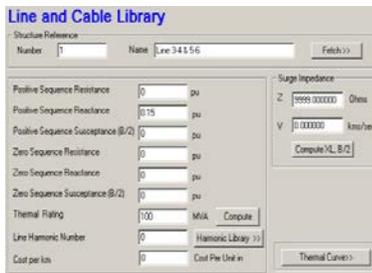
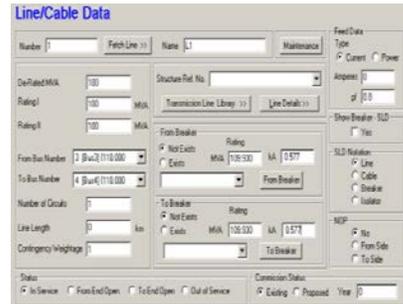
Click on **Transmission Line** icon provided on power system tool bar. To draw the line click in between two buses and to connect to the from bus, double click LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear.



Enter **Element ID** number and click OK. Database manager with corresponding **Line\Cable Data** form will be open. Enter the details of that line as shown below.

Enter **Structure Ref No. as 1** and click on **Transmission Line Library >>** button. **Line & Cable Library** form will appear. Enter transmission line library data in the form as shown for Line3-4.

After entering data, **Save**  and Close. **Line\Cable Data** form will appear. Click **Save** , which invokes network editor. Data for remaining elements given in the following table. Follow the same procedure for rest of the elements.

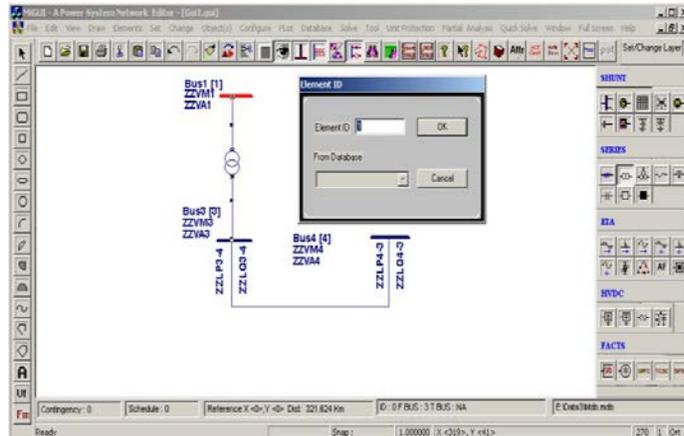


Transmission Line Element Data					
Line Number	1	2	3	4	5
Line Name	Line3-4	Line3-5	Line3-6	Line4-6	Line5-6
De-Rated MVA	100	100	100	100	100
No. of Circuits	1	1	1	1	1
From Bus No.	3	3	3	4	5
To Bus No.	4	5	6	6	6
Line Length in km	1	1	1	1	1
From Breaker Rating in kA	5000	5000	5000	5000	5000
To Breaker Rating in kA	5000	5000	5000	5000	5000
Structure Ref No.	1	2	3	2	1

Transmission Line Library Data			
Structure Ref. No.	1	2	3
Structure Ref. Name	Line3-4 & 5-6	Line3-5 & 4-6	Line3-6
Positive Sequence Resistance in pu	0	0	0
Positive Sequence Reactance in pu	0.15	0.1	0.2
Positive Sequence Susceptance in pu	0	0	0
Thermal Rating in MVA	100	100	100

2.3 Procedure to Draw Transformer

Click on **Two Winding Transformer** icon provided on power system tool bar. To draw the transformer click in between two buses and to connect to the from bus, double click LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear. Click **OK**.



Transformer Element Data form will be open. Enter the **Manufacturer Ref. Number** as **30**. Enter transformer data in the form as shown below. Click on **Transformer Library** >> button.

Two Winding Transformer Data

Transformer Number: 1	Fetch Transformer >>	Name: ZT1	Maintenance:	Global Change:	<input type="checkbox"/> Zig Zag Transformer
Secondary Voltage: 11,000 kV	De-Rated MVA: 100	Manufacturer Ref Number:	Transformer Library >>	Unit Protection Relays	
Rating I: 100 Mva	Rating II: 100 Mva	From Breaker: <input type="radio"/> Not Exists <input checked="" type="radio"/> Exists	Rating: 5000 kA	Differential Relay:	Restricted Earth Fault:
From Bus Number: 3 (Bus3) (110,000)	To Bus Number: 1 (Bus1) (11,000)	To Breaker: <input type="radio"/> Not Exists <input checked="" type="radio"/> Exists	Rating: 5000 kA	Drive Current Relay:	SLD - Show Breaker: <input type="checkbox"/> Yes
Control Bus Number: 1 (Bus1) (11,000)	No. of Units in Parallel: 1	Set Tap Position: Compute 5	Phase Shift Angle: 0 deg	Cost Per Unit in:	Contingency: 0
Contingency Weightage: 1	Status: <input checked="" type="radio"/> In Service <input type="radio"/> Out of Service	Commission Status: <input checked="" type="radio"/> Existing <input type="radio"/> Proposed	Year: 0	Cost: 0	Schedule: 0
Phi Grounding Resistance: 0 ohms	Sec Grounding Resistance: 0 ohms	Phi Grounding Resistance: 0 ohms	Sec Grounding Resistance: 0 ohms	Grounding Transformer: Primary Compute, Secondary Compute	
Transformer Details: Details >>	Control Block: Load Tap Changer		Browse		

Transformer library form will be open. Enter the data as shown below. **Save**  and **close** library screen.

Two Winding Transformer Library

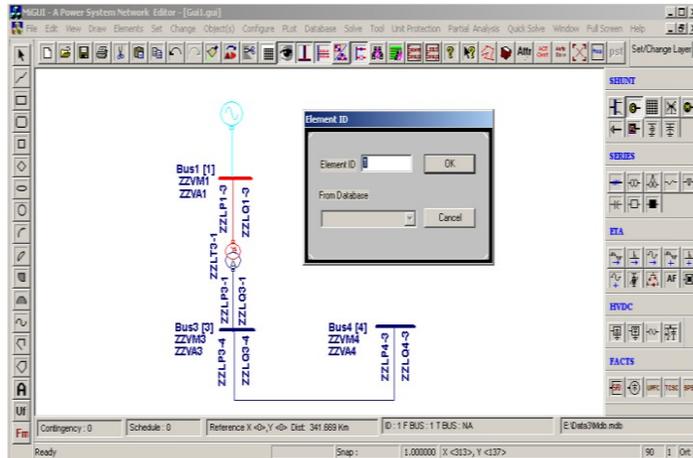
Manufacturer Ref. Number: <input type="text" value="30"/> <input type="button" value="Fetch >>"/>		Manufacturer Name: <input type="text" value="2T30"/> <input type="button" value="Transf. Parameter"/>	
MVA Rating: <input type="text" value="100"/>	Primary Voltage: <input type="text" value="110"/> kV	Secondary Voltage: <input type="text" value="11"/> kV	
Minimum Tap Number: <input type="text" value="1"/> 	TapStep: <input checked="" type="radio"/> Off-Load Tap Change <input type="radio"/> On-Load Tap Change	Maximum Tap Number: <input type="text" value="9"/> 	
Minimum Tap Voltage: <input type="text" value="104.5"/> kV <input type="button" value="Compute"/>		Maximum Tap Voltage: <input type="text" value="115.5"/> kV <input type="button" value="Compute"/>	
<p style="text-align: center;">pu on Common MVA Base</p> Pos. Seq. Impedance: <input type="text" value="0.05"/> pu Pos. Seq. X to R Ratio: <input type="text" value="9999"/> Zero Seq. Impedance: <input type="text" value="0.05"/> pu Zero Seq. X to R Ratio: <input type="text" value="9999"/>		<p style="text-align: center;">Transformer losses</p> No-load loss: <input type="text" value="0"/> W Copper loss: <input type="text" value="0"/> W <input type="button" value="Update X/R ratio"/>	
<p style="text-align: center;">Winding Configuration</p> <div style="display: flex; justify-content: space-around;">    </div> Primary ... <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> Secondary ... <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> Phase displacement: <input type="text" value="0"/> [0]			

Transformer element data form will appear. Click **Save**  button, which invokes network editor. In the similar way enter other transformer details.

2nd Transformer details	
Transformer Number	2
Transformer Name	2T2
From Bus Number	6
To Bus Number	2
Control Bus Number	2
Number of Units in Parallel	1
Manufacturer ref. Number	30
De Rated MVA	100
From Breaker Rating in kA	5000
To Breaker Rating in kA	350
Nominal Tap Position	5

2.4 Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Draw the generator by clicking LMB (Left Mouse Button) on the **Bus1**. **Element ID** dialog will appear. Click **OK**.



Generator Data form will be opened. Enter the **Manufacturer Ref. Number** as **20**. Enter Generator data in the form as shown below.

Generator Data								
Number	1	Fetch Generator >>	Name	Gen1	Maintenance	Schedule No		
Bus No.	1 [B1] (11.000)	Manufacturer Ref. No	20	Library >>>	Protection	Over Current		
Units in Parallel	1	CAPCUR	0	Capability Curve >>	Relay	Unit Protection		
Specified Voltage		Breaker Rating		Reactive Power - Minimum		Cost Per Unit in Rs		
1.0000	pu	11	kV	In MVA	350	In kA	18.371	
De-Rated MVA	100	Reactive Power - Minimum	0	MVA	Reactive Power - Maximum	60	MVA	
Scheduled Power	80	MW	Real Power Optimization Data		Cost Co-efficient C0		0	
Real Power - Minimum	0	MW	Cost Co-efficient C1	0	Select		<input type="radio"/> Utility Grid	
Real Power - Maximum	80	MW	Cost Co-efficient C2	0	<input checked="" type="radio"/> Generator			
Status	<input checked="" type="radio"/> In Service <input type="radio"/> Out of Service		Commission Status		<input checked="" type="radio"/> Existing <input type="radio"/> Proposed		Year	0

Click on **Generator Library >>** button. Enter generator library details as shown below.

Generator Library

Ref. Number Manufacturer Name

MVA Rating MW Rating kV Rating

pu on Common MVA Base

Armature Resistance (Ra) <input type="text" value="0"/> pu	Potier Reactance (Xp) <input type="text" value="0"/> pu	
Direct Axis Reactance (Xd) <input type="text" value="0"/> pu	Direct Axis Transient Reactance (X'd) <input type="text" value="0.1"/> pu	
Quadrature Axis Reactance (Xq) <input type="text" value="0"/> pu	Quadrature Axis Transient Reactance (X'q) <input type="text" value="0"/> pu	
Negative Seq. Reactance (Xn) <input type="text" value="0"/> pu	Direct Axis Sub-Transient Reactance (X''d) <input type="text" value="0"/> pu	
Zero Seq. Reactance (Xo) <input type="text" value="0"/> pu	Quadrature Axis Sub-Transient Reactance (X''q) <input type="text" value="0"/> pu	

Direct Axis Open Circuit Transient Time Constant (T'do) <input type="text" value="7.15"/>	Direct Axis Open Circuit Sub-Transient Time Constant (T''do) <input type="text" value="0.039"/>	Inertia in MJ/MVA <input type="text" value="3.31"/>
Quadrature Axis Open Circuit Transient Time Constant (T'qo) <input type="text" value="2.5"/>	Quadrature Axis Open Circuit Sub-Transient Time Constant (T''qo) <input type="text" value="0.15"/>	Damping Factor <input type="text" value="0"/>

Winding Connections

Mass Details

Mass Number <input type="text" value="0"/>	<input type="button" value="Next >>"/>
Damping Factor <input type="text" value="0"/>	MJ/MVA Counter <input type="text" value="1"/>
Stiffness Co-efficient <input type="text" value="0"/>	pu torque/Elec. Rad <input type="text" value="0"/>

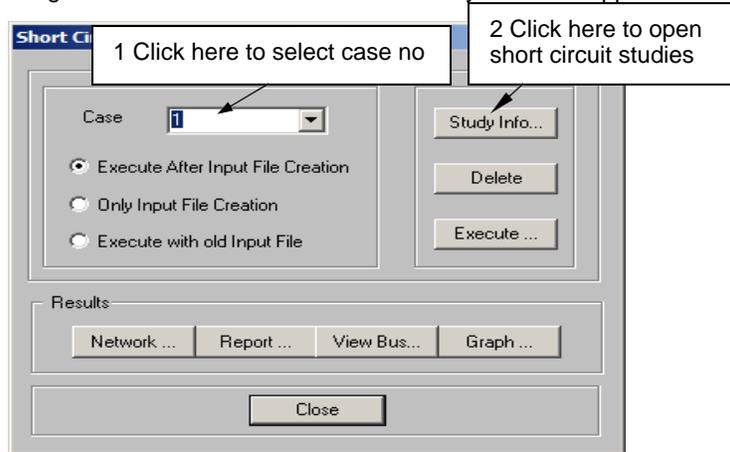
Cost Per Unit in Rs

Save and **Close** the library screen. Generator data screen will be reopened. Click **Save** button, which invokes Network Editor. Connect another generator to Bus 2. Enter its details as given in the following table.

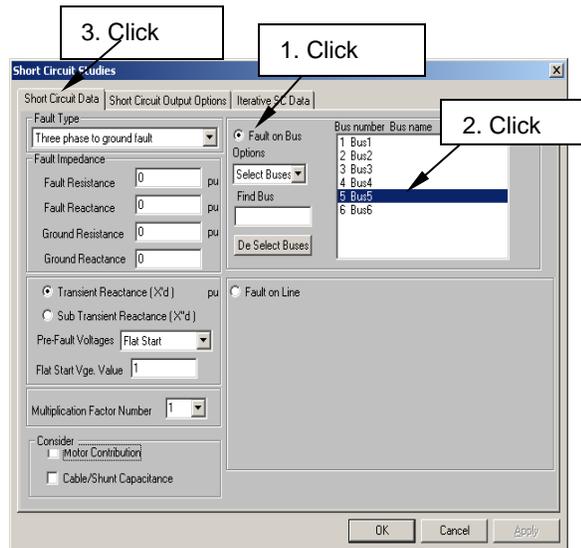
Name	GEN-2
Bus Number	2
Manufacturer Ref. Number	20
Number of Generators in Parallel	1
Capability Curve Number	0
De-Rated MVA	100
Specified Voltage in kV	11
Scheduled Power in MW	80
Reactive Power Minimum in MVAR	0
Reactive Power Maximum in MVAR	60
Breaker Rating in kA	350
Type of Modeling	Infinite

2.5 Solve Short Circuit Studies

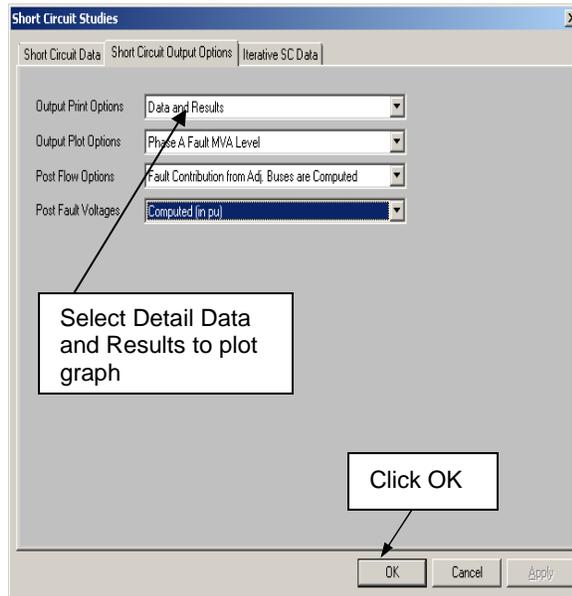
Choose menu option **Solve** → **Short Circuit Analysis** or click on **SCS** button on the toolbar on the right side of the screen. Short circuit analysis screen appears.



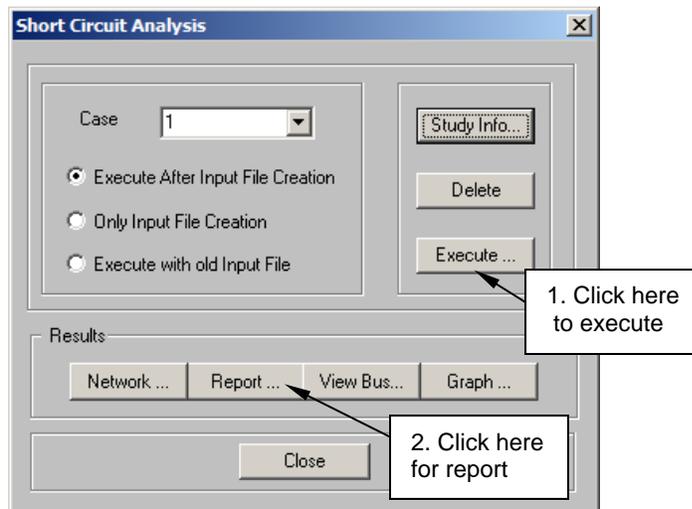
Study Information.



In Short Circuit Output Options **select the following.**



Afterwards click **Execute**. Short circuit study will be executed. Click on **Report** to view the report file.



2.6 Part of the Report is shown below

```

-----
FAULT AT BUS NUMBER 5 : NAME Bus5
CURRENT (AMPS/DEGREE)          FAULT MVA
SEQUENCE* (1,2,0) PHASE (A,B,C) SEQUENCE (1,2,0) PHASE (A,B,C)
MAGNITUDE ANGLE MAGNITUDE ANGLE MAGNITUDE MAGNITUDE
-----
    3871 -89.47    3871 -89.47    738    738
    0 -90.00    3871 150.53    0    738
    0 -90.00    3871 30.53    0    738
R/X RATIO OF THE SHORT CIRCUIT PATH : 0.0092
PEAK ASYMMETRICAL SHORT-CIRCUIT CURRENT : 10840 AMPS
PASCC = k x sqrt(2) x If , k = 1.9801

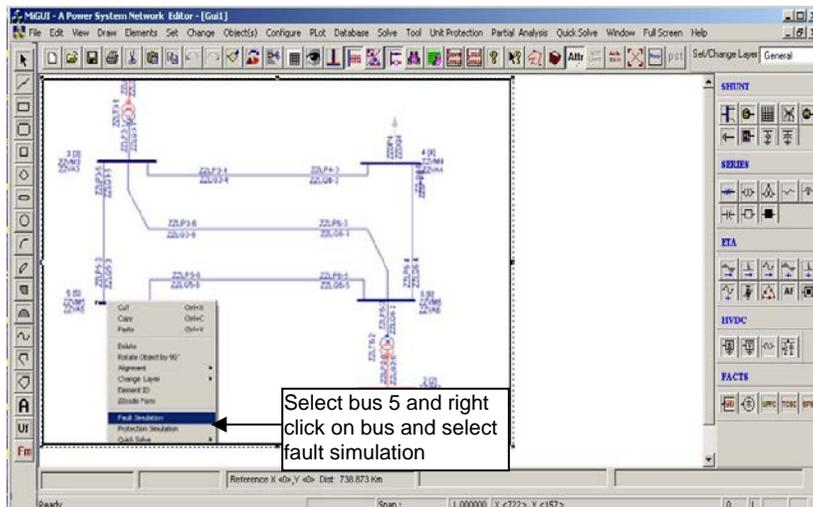
```

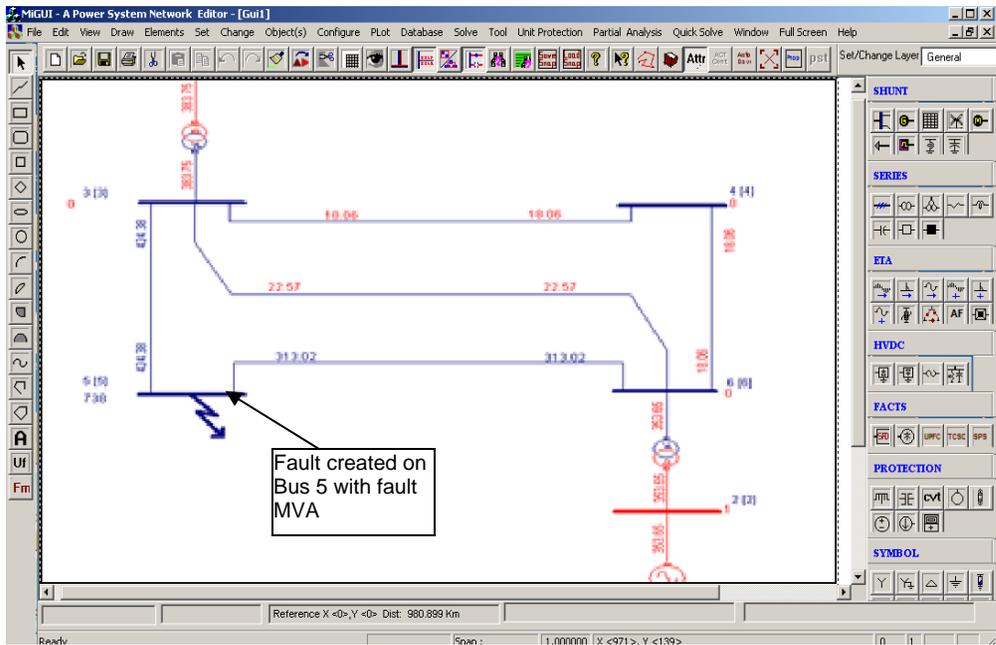
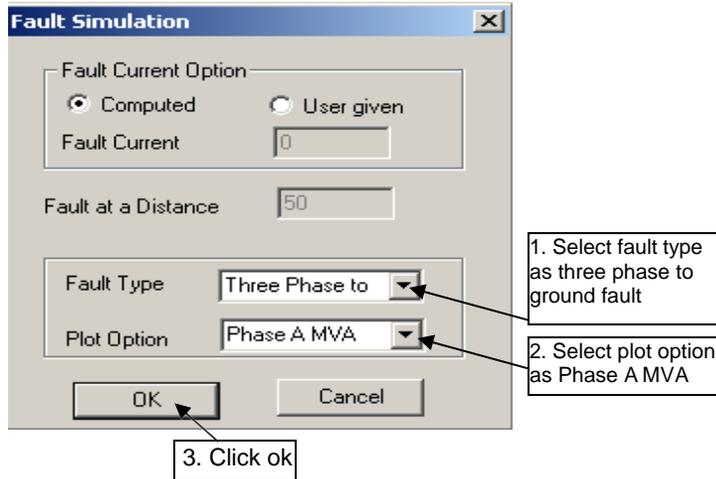
Sequence* (1,2,0) : Represents Positive , negative and zero sequence currents

k=1.9801: explain

2.7 Procedure to execute fault simulation:

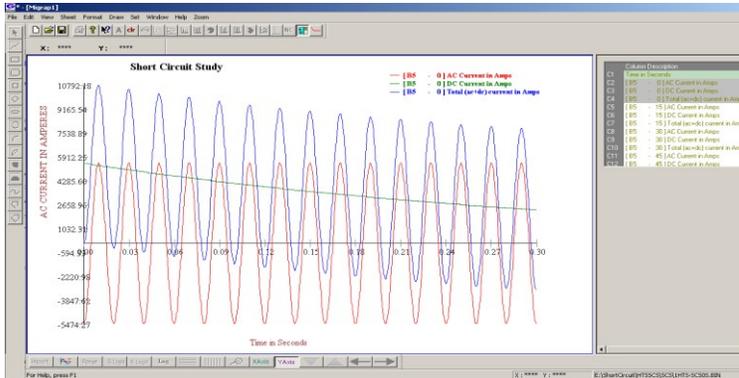
1. Select bus 5 and right click on bus as shown below
2. Select fault simulation and select fault type as three phase to ground fault
3. Select plot option as Phase A MVA and click ok
4. Fault symbol is created on GUI and result is also plotted automatically





Procedure to Plot Short Circuit Current Envelope:

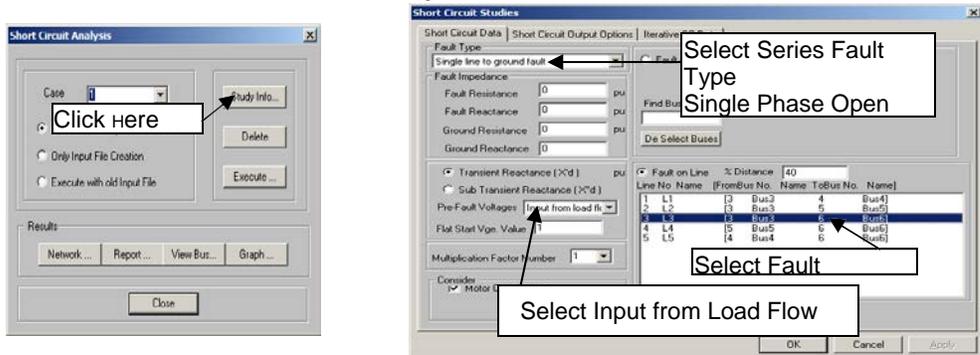
1. Click on Graph Button of Short Circuit Analysis Dialog Box



2.8 Procedure to Simulate open conductor faults:-

To perform open-conductor fault –

- Run a load flow study.
- In short circuit analysis info, select one phase open fault or two phase open fault.
- Select the line for open conductor fault.
- Select pre-fault voltages option as **input from load flow** and then execute short circuit studies.
- Select Solve → **Short Circuit Analysis**



Report: -

FAULT AT BUS NUMBER 3 : NAME B3				FAULT MVA	
CURRENT (AMPS/DEGREE)				SEQUENCE (1,2,0)	
SEQUENCE (1, 2,0)		PHASE (A,B,C)		PHASE	
(A,B,C)					
MAGNITUDE	ANGLE	MAGNITUDE	ANGLE	MAGNITUDE	MAGNITUDE
95	-174.28	0	7.13	18.19	0.00
72	5.78	149	82.09	13.72	28.41
23	5.53	149	-70.62	4.47	28.46

2.9 Quick Solve->Short circuit Analysis (Shortcut method to perform Short circuit analysis)

Go to **Quick Solve** menu →select **Short Circuit Study**. Short circuit analysis is executed and automatically results are plotted on GUI.

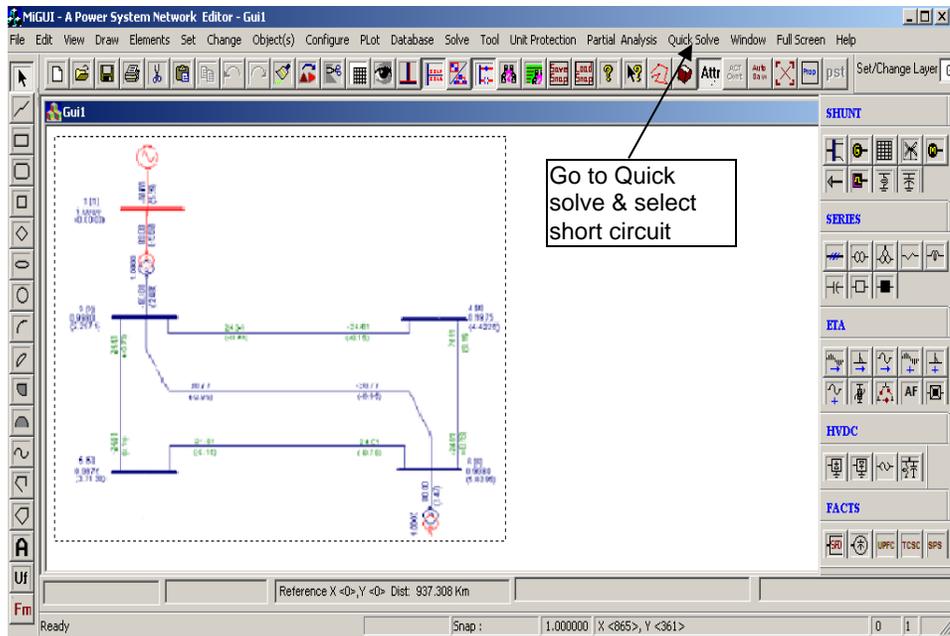
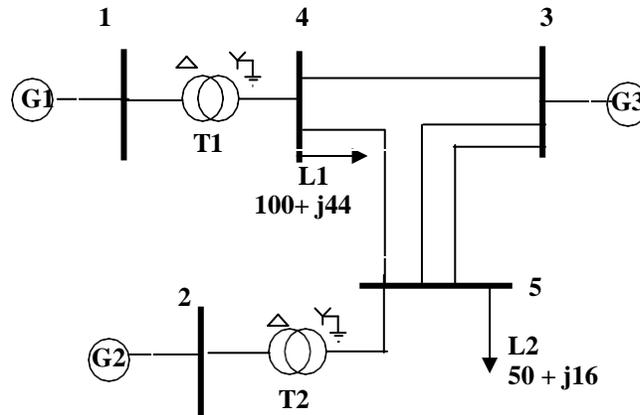


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3. How to solve Transient Stability

Figure shows a single line diagram of a 5-bus system with three generating units, four lines and two transformers and two loads. Per-unit transmission line series impedances and shunt susceptances are given on 100 MVA base, generator's transient reactance and transformer leakage reactances are given in the accompanying table.



Values given are on 100 MVA Base. Frequency = 60 Hz

If a 3 - phase fault occurs on line 4 - 5 near bus 4 and the fault is cleared by simultaneously opening the circuit breaker at the ends of the line 4-5 at 0.225 seconds (fault clearing time), plot the swing curve and comment on stability of machine 1 and machine 2

Transmission Line Details		
Bus - code	Impedance	Line charging
p-q	Zpq in pu	Y'pq/2 in pu
3 - 4	0.007 + j0.04	j0.041
3 -5(1)	0.008 + j0.047	j0.049
3 -5 (2)	0.008 + j0.047	j0.049
4 - 5	0.018 + j0.110	j0.113

Transformer Details:

T1 = 20/230 kV 400 MVA with Leakage reactance = 0.022 pu

T2 = 18/230 kV 250 MVA with Leakage reactance = 0.040 pu

Generator Details:

G1 = 400 MVA, 20 kV, X'd = 0.067 pu, H = 11.2 MJ / MVA

G2 = 250 MVA, 18 kV, X'd = 0.10 pu, H = 8.0 MJ / MVA

G3 = 1000 MVA, 230 kV, X'd = 0.00001 pu, H = 1000 MJ / MVA (Infinite Bus Modelling)

G3 is grid or slack bus and is represented as generator.

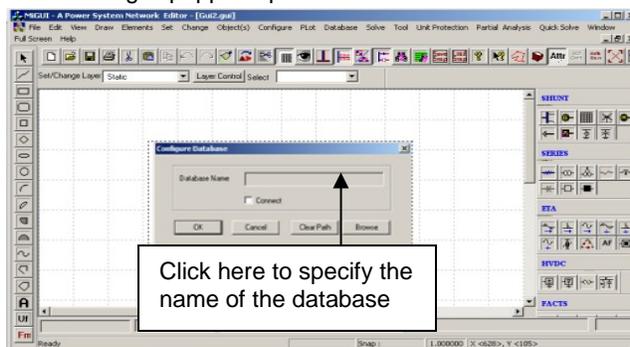
Generation and Load Details					
Bus Code 'p'	Generation		Load		Specified Voltage in pu
	MW	Mvar	MW	Mvar	
1	350	71.2	0	0	1.03
2	185	29.8	0	0	1.02
3	800	0	0	0	1.0
4	0	0	100	44	Unknown
5	0	0	50	16	Unknown

Interpretation according to MiP-PSCT:

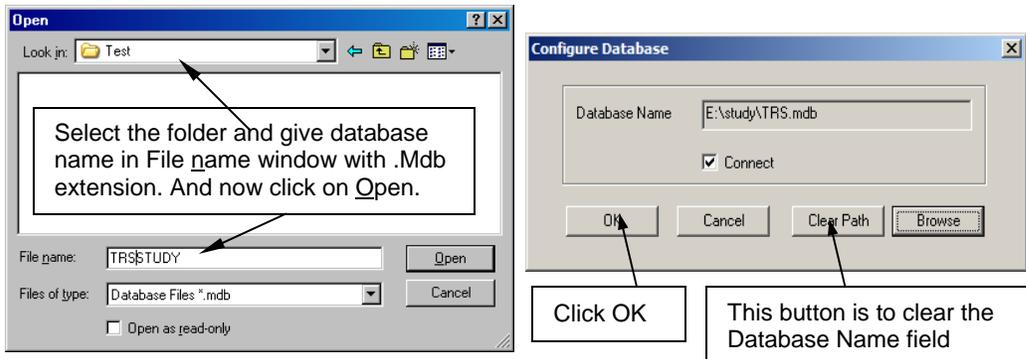
- Observe transmission line details. You will find lines connected to nodes 3 and 5 have common parameters.
- No of transmission line libraries = 3
- No of generator libraries = 3 (Three different generators)
- No. of transformer libraries = 2 (two different transformers)

Procedure to enter the data for performing studies using MiP-PSCT. MiP-**PSCT - Database Configuration**

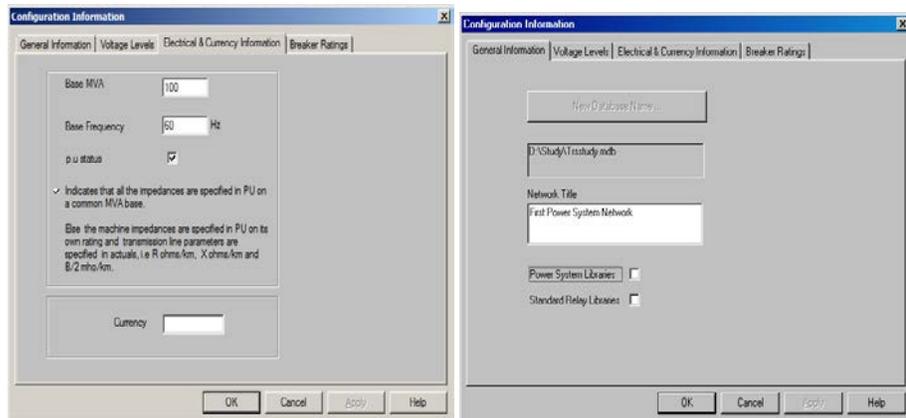
Open power system network editor. Select menu option **Database** → **Configure**. Configure Database dialog is popped up as shown below. Click **Browse** button.



Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click **Open** button after entering the desired database name. **Configure Database** dialog will appear with path chosen.



Click **OK** button on the **Configure Database** dialog. The dialog shown below appears.

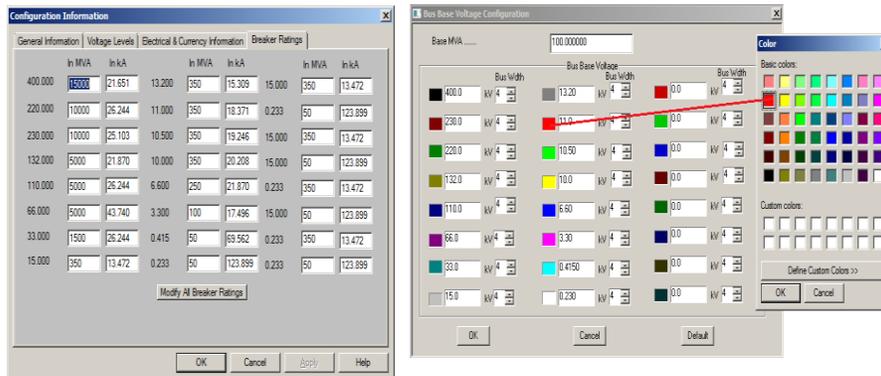


Uncheck the Power System Libraries and Standard Relay Libraries. For this example these standard libraries are not needed, because all the data is given on pu for power system libraries (like transformer, line/cable, generator), and relay libraries are required only for relay co-ordination studies. If Libraries are selected, standard libraries will be

loaded into the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base check the pu status as shown below. Enter the Base MVA and Base frequency as shown above. Click on Breaker Ratings button to give breaker ratings. Click **OK** button to create the database to return to Network Editor.

Bus Base Voltage Configuration

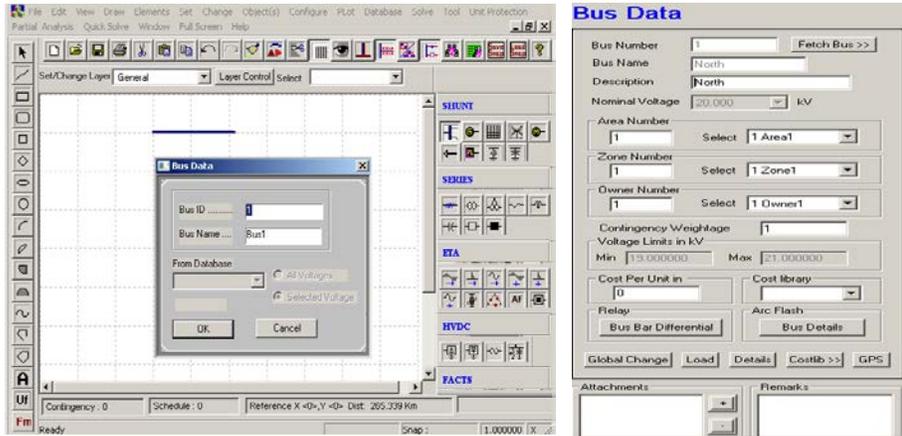
In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure→Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click **OK**.



3.1 Procedure to Draw First Element – Bus

Click on Bus icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click **OK**. Database manager with corresponding **Bus Data** form will appear. Modify the Area number, Zone number and Contingency Weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are different, modify these fields. Otherwise keep the default values.

Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is Northeast, then bus name can be given as NE and the bus description field can be **North East**

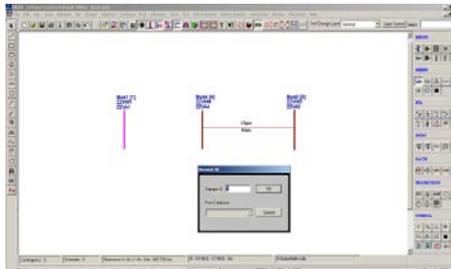


After entering data click **Save**  which invokes **Network Editor**. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Bus Data					
Bus Number	1	2	3	4	5
Bus Name	Bus-1	Bus-2	Bus-3	Bus-4	Bus-5
Nominal voltage in kV	20	18	230	230	230
Area number	1	1	1	1	1
Zone number	1	1	1	1	1
Contingency weightage	1	1	1	1	1

3.2 Procedure to Draw Transmission Line

Click on **Transmission Line** icon provided on power system tool bar. To draw the line click in between two buses and to connect to the from bus double clicking LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear.



Enter **Element ID** number and click **OK**. Database manager with corresponding **Line\Cable Data** form will be open. Enter the details of that line as shown below.

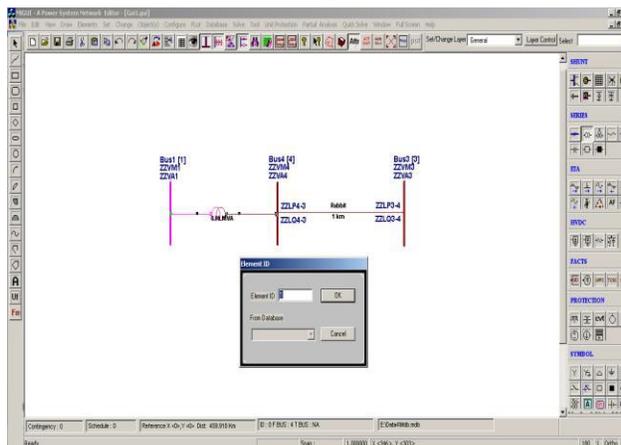
Enter **Structure Ref No.** as **1** and click on **Transmission Line Library >>** button. **Line & Cable Library** form will appear. Enter transmission line library data in the form as shown below for Line3-4. Enter other line libraries and element data details as per the following tables:

Transmission Line Libraries			
Structure Ref. No.	1	2	3
Structure Ref. Name	Line-3-4	Line-3-5	Line-4-5
Positive Sequence Resistance in pu	0.007	0.008	0.018
Positive Sequence Reactance in pu	0.040	0.047	0.110
Positive Sequence Susceptance in pu	0.041	0.049	0.113
Thermal Rating in MVA	100	100	100

Transmission Line Element Data Details				
Line Number	1	2	3	4
Line Name	Line3-4	Line3-5	Line4-5	Line3-5
De-Rated MVA	100	100	100	10
No. Of Circuits	1	1	1	1
From Bus No.	4	3	4	3
To Bus No.	3	5	5	5
Line Length in km	1	1	1	1
From Breaker Rating in MVA	5000	5000	5000	5000
To Breaker Rating in MVA	5000	5000	5000	5000
Structure Reference No.	1	2	3	2

3.3 Procedure to Draw Transformer

Click on **Two Winding Transformer** icon provided on power system tool bar. To draw the transformer click in between two buses and to connect to the from bus double clicking LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. The **Element ID** dialog will appear. Click **OK**.



Two Winding Transformer Data form will be open. Enter the **Manufacturer Ref. Number** as **30**. Enter transformer data in the form as shown below. Click on **Transformer Library >>** button.

Two Winding Transformer Data

Transformer Number: 1 Fetch Transformers >> Name: 2T1 Maintenance Global Change Zig Zag Transformer

Secondary Voltage: 20,000 kV

De-Rated MVA: 400 Manufacturer Ref Number: 30 (2T30) Unit Protection Relays

Rating I: 400 MVA Rating II: 400 MVA From Breaker: Not Exists Events To Breaker: Not Exists Exists Set Tap Position: Compute 0 Nominal Tap Position: 0 Phase Shift Angle: 0 deg

From Bus Number: 4 (Bus4) (230,000) To Bus Number: 1 (Bus1) (20,000) Control Bus Number: 0 (Bus0)

No. of Units in Parallel: 1 Contingency Weightage: 1

Unit Protection Relays: Differential Relay: Restricted Earth Fault: OverCurrent Relay: SLD - Show Breaker: Yes

Cost Per Unit in: Cost 0 Contingency: 0 Schedule: 0

Status: In Service Out of Service Commission Status: Existing Proposed Year: 0

Phi Grounding Resistance: 0 ohms Phi Grounding Reactance: 0 ohms Grounding Transformer: Primary Compute Secondary Compute

Sec Grounding Resistance: 0 ohms Sec Grounding Reactance: 0 ohms

Transformer Details: Control Block: Load Tap Changer: Browse

Enter transformer library details as shown below. Click **Save** button and close the screen. Transformer element data form will appear. Click **Save** button, which invokes Network Editor. In the similar way enter other transformer details.

Two Winding Transformer Library

Manufacturer Ref. Number: 30 Fetch >> Manufacturer Name: 2T30 Transf. Parameter

MVA Rating: 400 Primary Voltage: 230,000 kV Secondary Voltage: 20,000 kV

Minimum Tap Number: 1 Tap Step: Off-Load Tap Change On-Load Tap Change Maximum Tap Number: 9

Minimum Tap Voltage: 218,500 kV Compute Maximum Tap Voltage: 241,500 kV Compute

pu on its Own Rating: Pos. Seq. Impedance: 0.022 pu Pos. Seq. X to R Ratio: 9999 Zero Seq. Impedance: 0.022 pu Zero Seq. X to R Ratio: 9999

Transformer losses: Noload loss: 0 W Copper loss: 0 W Update X/R ratio

Winding Configuration: Primary ... Secondary ... Phase displacement: 0 [0]

Magnetization Curve Data in pu on its Own Rating: Magnetization Curve Primary Winding Secondary Winding

Residual Flux: Phase A: 0 Phase B: 0 Phase C: 0

I-V Characteristics: I in % V in pu Add Delete

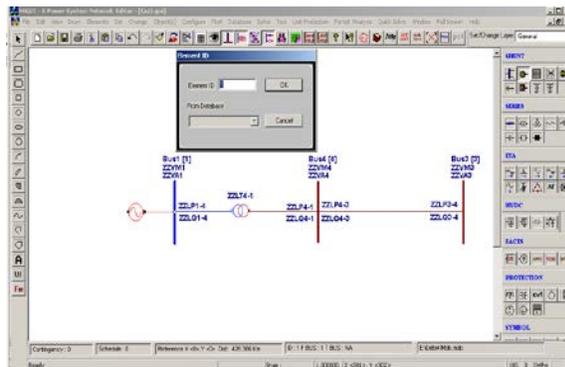
Thermal Curve: Thermal >> Cost Per Unit in: 0

Transformer Library Details		
Manufacturer ref. No.	1	2
Manufacturer Name	2T30	2T31
MVA Rating	400	250
Primary Voltage in kV	230	230
Secondary Voltage in kV	20	18
Minimum Tap	1	1
Maximum Tap	9	9
Minimum Tap Voltage in kV	218.5 (230 * 0.95)	218.5 (230 * 0.95)
Maximum Tap Voltage in kV	241.5 (230 * 1.05)	241.5 (230 * 1.05)
Positive Sequence Impedance in pu	0.022	0.040
X/R* Ratio	9999 (R is Negligible)	9999 (R is Negligible)

Transformer Element Detail		
Transformer Number	1	2
Transformer Name	2T1	2T2
From Bus Number	4	5
To Bus Number	1	2
Control Bus Number	1	2
Number of Units in Parallel	1	1
Manufacturer ref. Number	2T30	2T31
De Rated MVA	400	250
From Breaker Rating in MVA	5000	5000
To Breaker Rating in MVA	350	350
Nominal Tap Position	5	5

3.4 Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Draw the generator by clicking LMB (Left Mouse Button) on the **Bus1**. The **Element ID** dialog will appear. Click **OK**.



Generator Data form will be opened. Enter the **Manufacturer Reference No** as **30**. Enter generator data in the form as shown below.

Generator Data

Number: 1 Name: Gen1 Schedule No: 0

Bin No: 1 (Bin1) (20,000) Manufacturer Ref. No: 30

Units in Parallel: 1 .BT Capability Curve No: 0 (CAPCUR)

Specified Voltage: 1.0000 pu 20,000 kV Breaker Rating: In MVA: 50,0000 In kA: 1,443

De-Rated MVA: 400 Reactive Power - Minimum: 71.2 MVA/ Reactive Power - Maximum: 71.2 MVA/

Scheduled Power: 350 MW

Real Power Optimization Data: Real Power - Minimum: 0 MW Cost Co-efficient C0: 0 Cost Co-efficient C1: 0.1 Cost Co-efficient C2: 0.01 Real Power - Maximum: 350 MW

Status: In Service Out of Service Commission Status: Existing Proposed Year: 0

Neutral Grounding Resistance: 0 ohms Participation Factor (%): 0 Neutral Grounding Reactance: 0 ohms Bias Setting: 0 Grounding Through Transformer: Calculate Droop (%): 4

Model Type: Infinite Bus Modelling (X'd) Transient Modelling (X'd & X'q) Sub Transient Modelling (X''d & X''q)

AVR Ref No: 0 (AVR) Type 0 AVR FPB Name: Turbine Gov Ref No: 0 Type 0 Tur Governor Name:

Click on **Generator Library >>** button. Enter generator library details as shown below.

Generator Library

Ref. Number: 30 Manufacturer Name: Gen14

MVA Rating: 400 MVA Rating: 350 kV Rating: 20

pu on its Own Rating

Armature Resistance (Ra): 0 pu Potier Reactance (Xp): 0 pu Direct Axis Reactance (Xd): 0 pu Direct Axis Transient Reactance (X'd): 0.067 pu Quadrature Axis Reactance (Xq): 0 pu Quadrature Axis Transient Reactance (X'q): 0 pu Negative Seq. Reactance (Xn): 0 pu Direct Axis Sub-Transient Reactance (X''d): 0 pu Zero Seq. Reactance (Xo): 0 pu Quadrature Axis Sub-Transient Reactance (X''q): 0 pu

Direct Axis Open Circuit Transient Time Constant (T'do): 7.15 Direct Axis Open Circuit Sub-Transient Time Constant (T''do): 0.039 Inertia in MJ/MVA: 11.2

Quadrature Axis Open Circuit Transient Time Constant (T'qo): 2.5 Quadrature Axis Open Circuit Sub-Transient Time Constant (T''qo): 0.15 Damping Factor: 0

Winding Connections: Y Y A

Mass Details: Mass Number: 0 Inertia: 0 MJ/MVA Counter: 0 Damping Factor: 0 Stiffness Co-efficient: 0 pu torque/Elec. Rad

Cost Per Unit in: 0

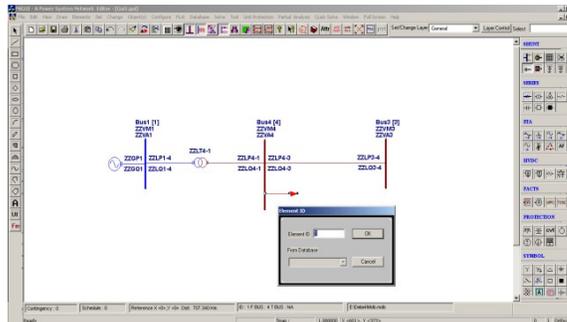
Enter other generator libraries and element details as per the following table.

Generator Library Details			
Reference Number	30	31	32
Manufacturer Name	BHEL-1	BHEL-2	BHEL-3
MVA Rating	400	250	1000
MW Rating	350	185	800
kV Rating	20	18	230
Ra	0	0	0
Xd	0	0	0
Xq	0	0	0
Xn	0	0	0
Xo	0	0	0
Xp	0	0	0
X'd	0.067	0.10	0.00001
X'q	0	0	0
X d	0	0	0
X q	0	0	0
Inertia MJ/MVA	11.2	8.0	1000

Generator Element Details			
Name	GEN-1	GEN-2	GEN-3
Bus Number	1	2	3
Manufacturer Ref. Number	30	31	32
Number of Generators in Parallel	1	1	1
Capability Curve Number	0	0	0
De-Rated MVA	400	250	1000
Specified Voltage in kV	20.6	18.36	230
Scheduled Power in MW	350	185	800
Reactive Power Minimum in MVAR	71.2	29.8	0
Reactive Power Maximum in MVAR	71.2	29.8	600
Breaker Rating in MVA	350	350	10000
Type of Modeling	Infinite	Infinite	Infinite

3.5 Procedure to Draw Load

Click on **Load** icon provided on power system tool bar. Draw the load by clicking LMB (Left Mouse Button) on the **Bus4**. The **Element ID** dialog will appear. Click **OK**.



Load Data form will be opened. Enter the load details as shown below.

The screenshot shows the 'Load Data' form in the software. The form contains the following fields and values:

- Number: 1
- Fetch Load >>
- Name: LD1
- Maintenance: []
- Schedule No: 0
- Relay: []
- Bus Number: 4 (Bus4) (230.000)
- No. of Consumers: 1
- MVAR Compensation: 0
- Real Power in MW: 100
- Minimum Compensation in MVAR: 0
- Maximum Compensation in MVAR: 0
- Reactive Power in MVAR: 44.000010
- Compensation Step in MVAR: 0
- Load Characteristics No: 0
- Power Factor: 0.915315
- Load Details: []
- Library: []
- Cost Per Unit in: []
- Cost Library: []
- Ref No.: []
- Lib >>
- Load Type: Linear Non Linear
- Unbalanced Load: Unbalanced Load Library
- Motor Load Percentage: 0
- Global Change: []
- Status: In Service Out of Service
- Commission Status: Existing Proposed
- Year: 0
- Breaker Rating: In MVA: 10000.00000, In kA: 25.103
- Control Block: []
- File Path: []
- Browser: []

Connect other load (50 + j16) to bus 5.

To solve load flow studies choose menu option Solve → **Load Flow Analysis** or click **LFA** button on the toolbar, which is on the right side of the screen. Load flow analysis screen appears.

3.6 Load flow results

INTERMEDIATE VOLTAGE AND POWER ERROR AT THE END OF EACH ITERATION:

NODE NAME	VOLT-MAG	VOLT-ANG	P-ERROR-MW	Q-ERROR-MVAR
1 Bus1	1.0300	0.155	0.0099	0.0014
2 Bus2	1.0200	0.112	-0.0003	-0.0001
3 Bus3	1.0000	0.000	1180.5015	-0.0272
4 Bus4	1.0175	0.082	-0.0032	-0.0002
5 Bus5	1.0109	0.040	-0.0016	0.0001

Number of p iterations : 3 and Number of q iterations : 5

BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG P.U.	ANGLE DEGREE	MW GEN	MVAR GEN	MW LOAD	MVAR LOAD
1	Bus1	1.0300	8.90	350.000	71.200	0.000	0.000
2	Bus2	1.0200	6.39	185.000	29.800	0.000	0.000
3	Bus3	1.0000	0.00	-380.502	-26.497	0.000	0.000
4	Bus4	1.0175	4.68	0.000	0.000	100.000	44.000
5	Bus5	1.0109	2.27	0.000	0.000	50.000	16.000

NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) : 0
 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

TRANSFORMER FLOWS AND TRANSFORMER LOSSES

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

```

1 1 4 Bus4 1 Bus1 -349.987 -44.745 0.0026 26.4537
86.7# 2 1 5 Bus5 2 Bus2 -184.999 -16.300 0.0014 13.4998
73.5$

```

```

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

```

LINE FLOWS AND LINE LOSSES

SLNO	CS	FROM NODE	FROM NAME	TO NODE	TO NAME	FORWARD		LOSS		%
						MW	MVAR	MW	MVAR	
LOADING										
3	1	4	Bus4	3	Bus3	210.573	11.960	3.0157	8.8875	
207.3!	4	1	3	Bus3	5	Bus5	-86.472	-11.712	0.6019	-
6.3713		87.3#								
5	1	3	Bus3	5	Bus5	-86.472	-11.712	0.6019	-6.3713	
87.3#										
6	1	4	Bus4	5	Bus5	39.418	-11.215	0.2702	-21.5963	
40.3^										

```

-----
! NUMBER OF LINES LOADED BEYOND 125% : 1
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 0

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

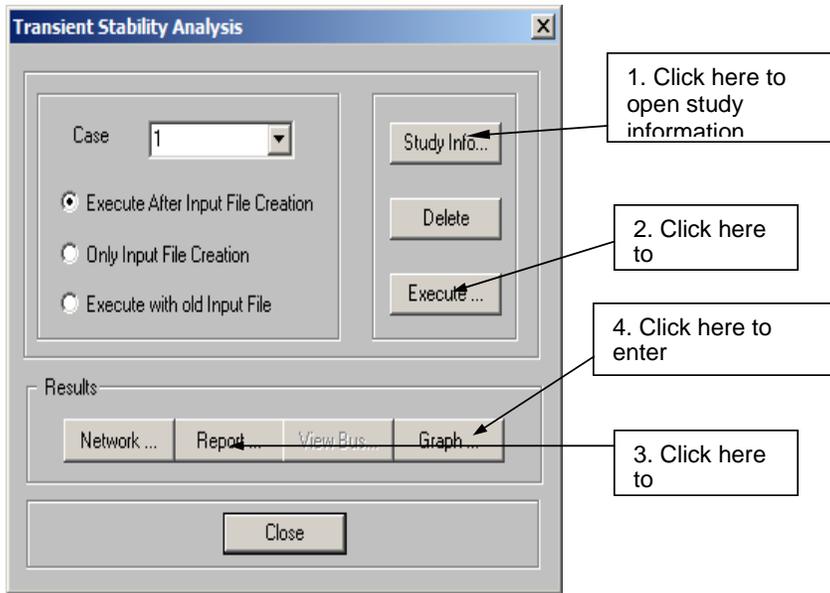
```

This will become the initial condition for transient stability analysis

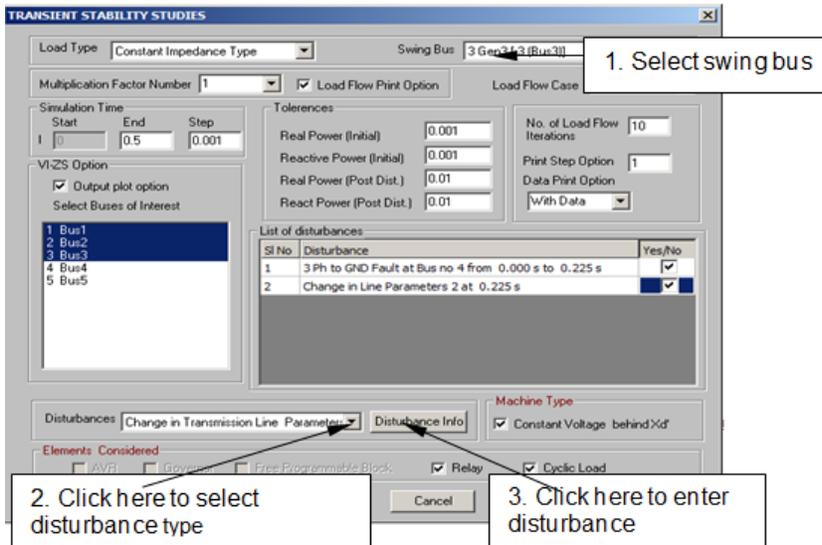
Note: You have to get the same results to conduct transient stability study.

3.7 Executing transient stability study

Click on **Solve** → **Transient stability analysis**.



On **Transient Stability Studies** screen click on **Study Info...** button.



Enter all the details as shown:

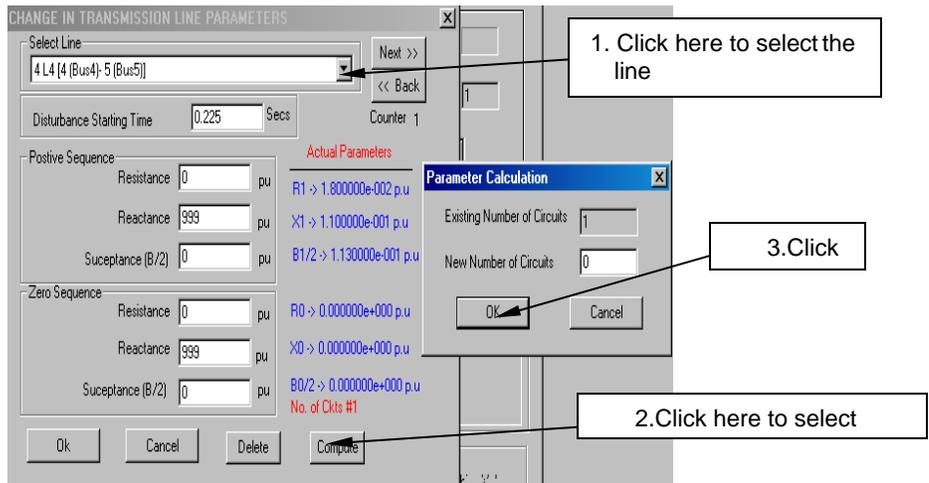
To simulate 3 phase to ground fault, select the **Disturbances** as *Three Phase To Ground Fault* from the disturbance list and click on **Disturbance Info** button to enter the fault data.

Fault is on bus 4 so select bus 4 from the Bus number list box.

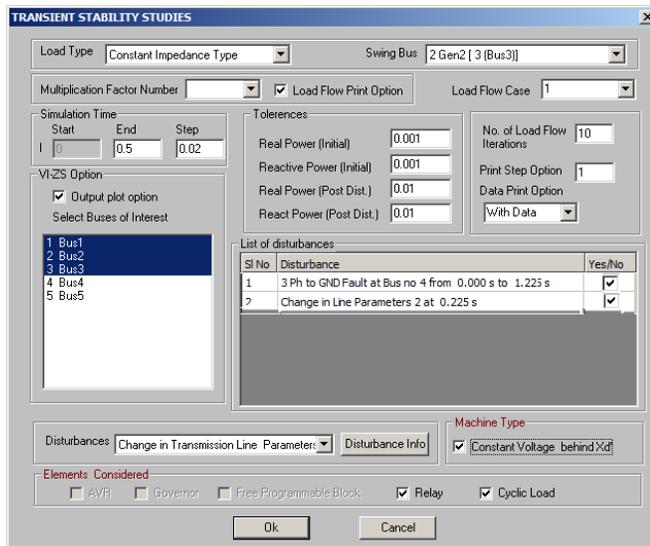
Click **OK** to return to previous form.

To account the effect of opening of breaker, in the disturbance list select *Change in transmission Line Parameters* and click on **Disturbance Info** button.

In this, select line between bus 4 and bus 5. Give disturbance starting time as 0.225 secs and make positive sequence resistance as zero and reactance very high accounting for opening of the line (let us say 9999).

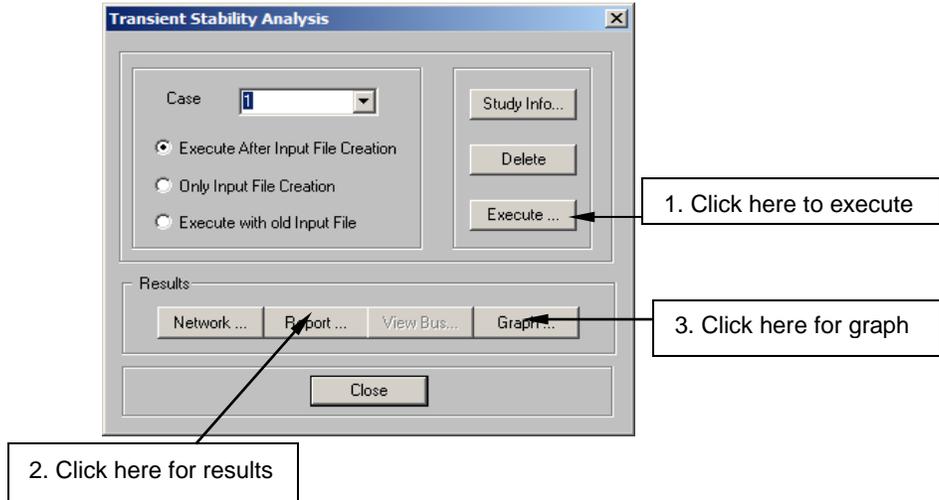


Finally you will return to the previous dialog. Here list of disturbances applied on the network are listed as shown below. Click **OK** button to return to **Solve** dialog. On the **Solve** dialog box, click **Execute** button to execute transient stability study.



Results Observation:

The results can be observed by clicking **Report** button. The results can be best analysed using graph. For this click on **Graph** button.

**Part of Report is Shown below :**

```

---
Time = 0.00000 Seconds
Intermediate results for Machines
GNo Name Voltage Angle Delta Freq Pgen Qgen Pmech
Efd/Slip pu Degree Degree Hzs. MW MVAR MW pu/PU
---
1 Bus1 1.03 8.9 20.8 60 350 71.2 350
1.1
2 Bus2 1.02 6.39 16.2 60 185 29.8 185
1.06
3 Bus3 1 0 -0.00218 60 -381 -26.5 -381
1

```


 Maximum rotor angle difference : 20.84325 b/w buses : 1 and 3

3 phase fault 0.00000 4 Bus4
 kp 1 kq 0 Iterations 10 dpxmax 0.064557 dqmax 0.003461

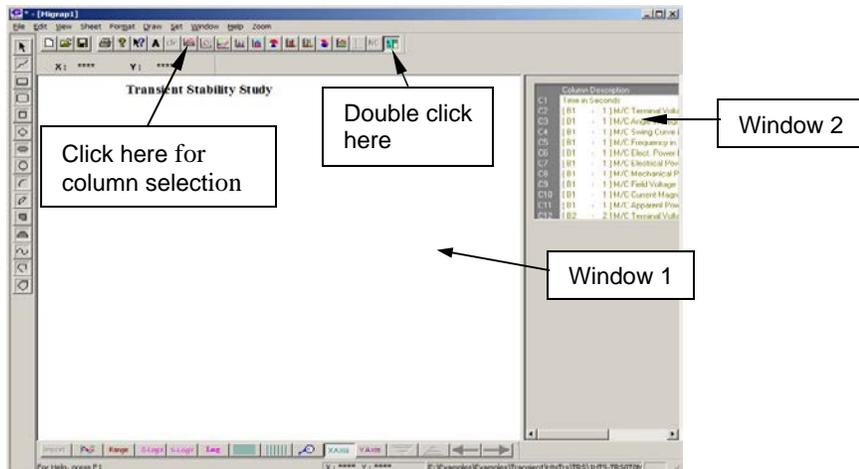
Time = 0.00100 Seconds

Intermediate results for Machines

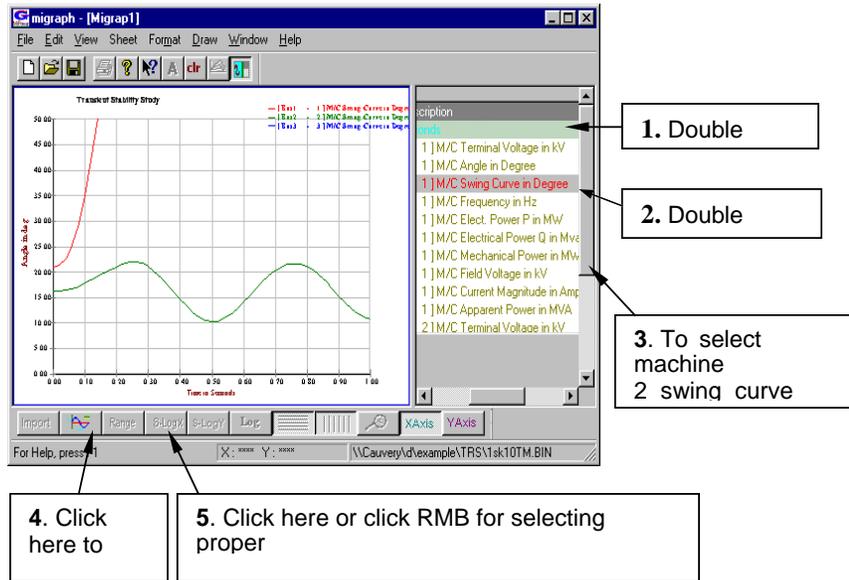
GNo	Name	Voltage	Angle	Delta	Freq	Pgen	Qgen	Pmech
Efd/Slip	pu	Degree	Degree	Hzs.	MW	MVAR	MW	
1	Bus1	0.275	20.1	20.8	60	5.93	339	350
2	Bus2	0.908	6.55	16.2	60	162	129	185
3	Bus3	1	-0.00455	-0.0022	60	414	3.02e+003	-381

 Maximum rotor angle difference : 20.84410 b/w buses : 1 and 3
 Island 1 Common system frequency60.000

Click Graph button on **Solve** dialog box, Graph Utility screen will be open, which is shown below.



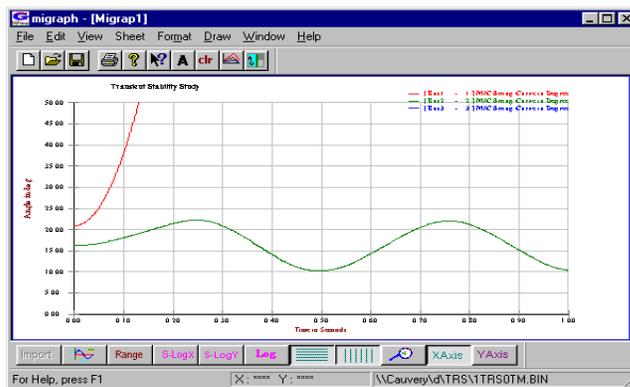
Graph editor will open the corresponding plot file of the study. Window 1 is used for displaying the graphs and window 2 holds the plot variables like time in seconds, swing curve of machines, machine internal angle, machine voltage, machine current etc. User has to choose plot variables in the 2nd window.



Final output is shown below

Comment: As seen from the graph

- ❖ Machine 1 turns out to be unstable and machine 2 is stable.

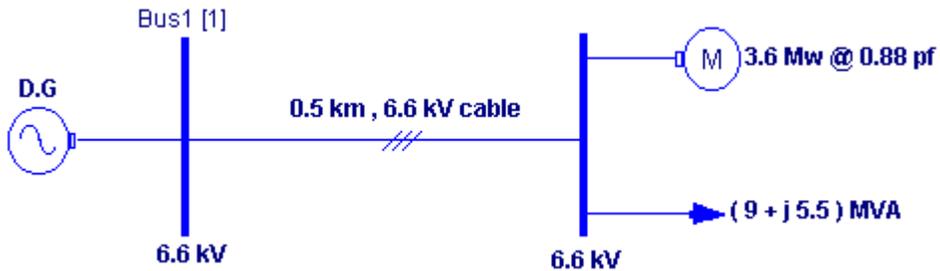


Exercise: For different clearing times conduct studies and observe the swing curves

Hint: Take clearing time = 0.05sec and execute transient stability.

3.8 Procedure to connect AVR, Governor designed using FPB module

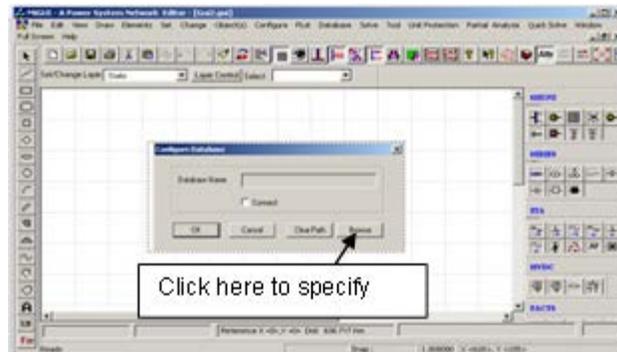
1. Draw Single Line Diagram and enter the element details in database manager



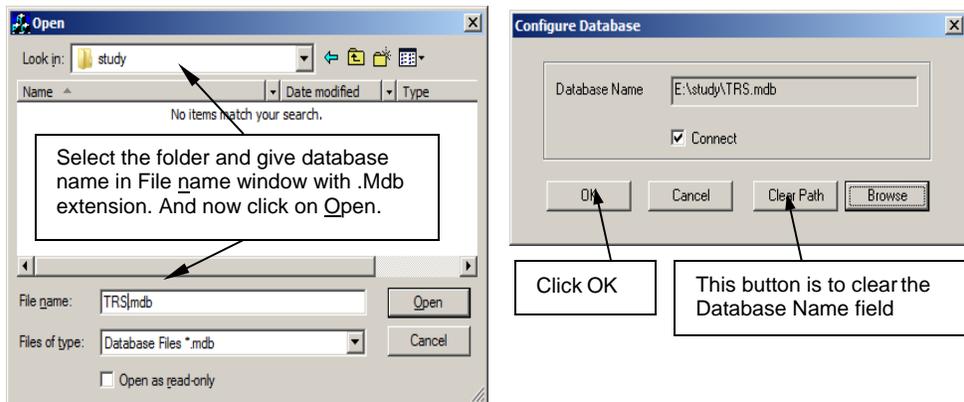
Procedure to enter the data for performing studies using MiP-PSCT. MiP-

PSCT - Database Configuration

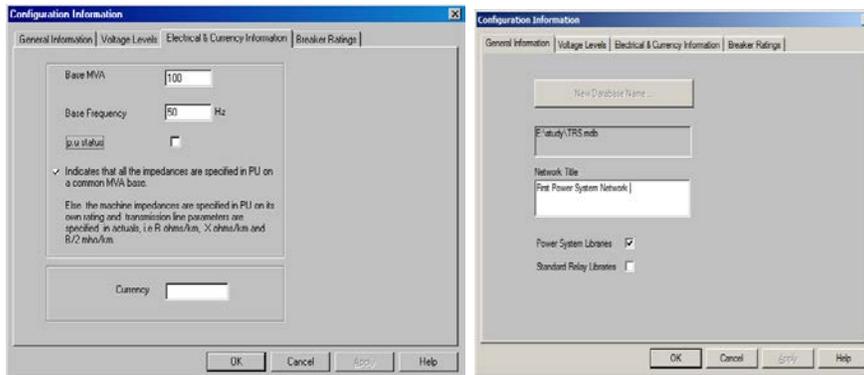
Open power system network editor. Select menu option **Database → Configure**. Configure Database dialog is popped up as shown below. Click **Browse** button.



Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click **Open** button after entering the desired database name. **Configure Database** dialog will appear with path chosen.



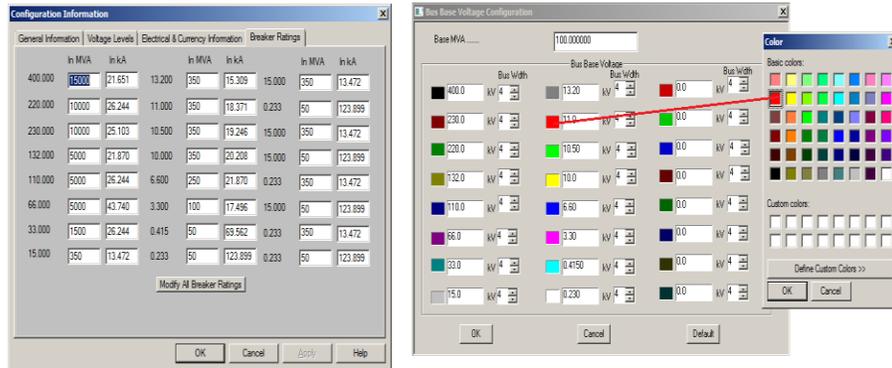
Click **OK** button on the **Configure Database** dialog. The dialog shown below appears.



Check the Power System Libraries and uncheck Standard Relay Libraries . For this example these standard relay libraries are not needed, because relay libraries are required only for relay co-ordination studies. Power system Libraries are selected, standard libraries will be loaded into the database. Click **Electrical Information** tab. Since the impedances are given on its own base uncheck the pu status as shown above. Enter the Base MVA and Base frequency as shown above. Click on Breaker Ratings button to give breaker ratings. Click **OK** button to create the database to return to Network Editor.

Bus Base Voltage Configuration

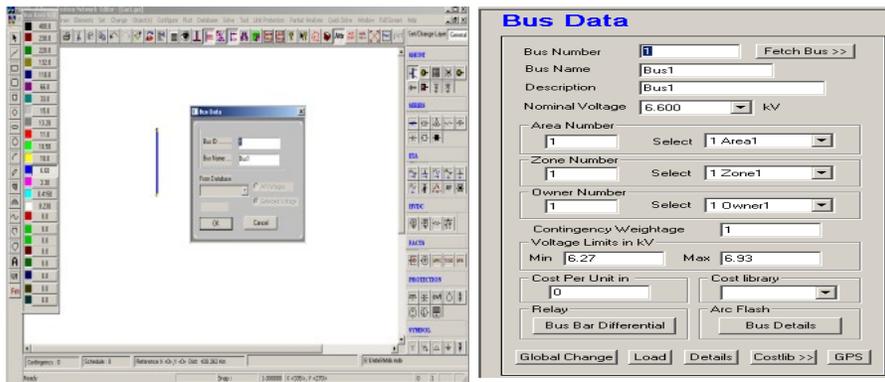
In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure**→**Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages**, **color**, **Bus width** and click **OK**.



Procedure to Draw First Element - Bus

Click on **Bus** icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click OK. Database manager with corresponding **Bus Data** form will appear. Modify the Area number, Zone number and Contingency Weight age data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are different, modify these fields. Otherwise keep the default values.

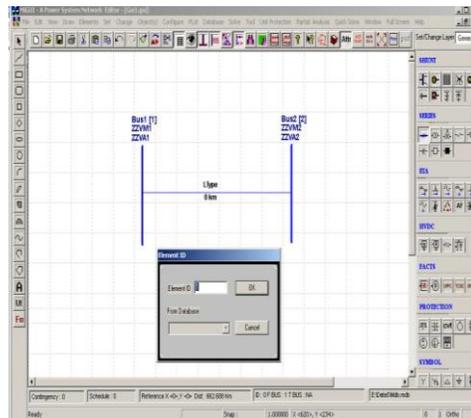
Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is Northeast, then bus name can be given as NE and the bus description field can be north **East**.



After entering data click **Save**  which invokes **Network Editor**. Follow the same procedure for remaining buses.

Procedure to Draw Transmission Line

Click on **Transmission Line** icon provided on power system tool bar. To draw the line click in between two buses and to connect to the from bus double clicking LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear.



Enter **Element ID** number and click **OK**. Database manager with corresponding **Line/Cable Data** form will be open. Enter the details of that line as shown below.

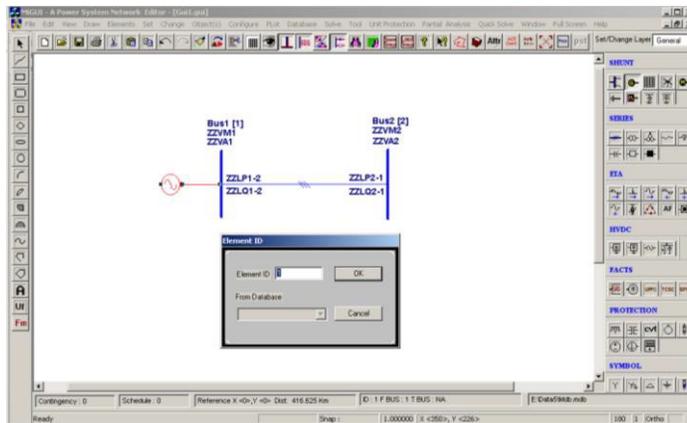
Select **Structure Ref No.** As **1141** and click on **Save** 

Line/Cable Data

Number	<input type="text" value="1"/>	Fetch Line >>	Name	<input type="text" value="L1"/>	Maintenance
De-Rated MVA	<input type="text" value="4.2344"/>	Structure Ref. No.	<input type="text" value="1141 [3Cx300sqmm(6.35/11kV)]"/>		
Rating I	<input type="text" value="4.2344"/> MVA	Transmission Line Library >>		Line Details >>	
Rating II	<input type="text" value="4.2344"/> MVA	From Breaker			
From Bus Number	<input type="text" value="1 [Bus1] {6.600}"/>	Rating		MVA <input type="text" value="250.0000"/> kA <input type="text" value="21.870"/>	
To Bus Number	<input type="text" value="2 [Bus2] {6.600}"/>	<input type="text"/>		From Breaker	
Number of Circuits	<input type="text" value="3"/>	To Breaker			
Line Length	<input type="text" value="0.5"/> km	Rating		MVA <input type="text" value="250.0000"/> kA <input type="text" value="21.870"/>	
Contingency Weightage	<input type="text" value="1"/>	<input type="text"/>		To Breaker	
Status	<input checked="" type="radio"/> In Service <input type="radio"/> From End Open <input type="radio"/> To End Open <input type="radio"/> Out of Service				Commission Status
					<input checked="" type="radio"/> Existing <input type="radio"/> Proposed Year <input type="text" value="0"/>
Feed Data Type: <input checked="" type="radio"/> Current <input type="radio"/> Power Amperes: <input type="text" value="0"/> pf: <input type="text" value="0.8"/> Show Breaker - SLD: <input type="checkbox"/> Yes SLD Notation: <input checked="" type="radio"/> Line <input type="radio"/> Cable <input type="radio"/> Breaker <input type="radio"/> Isolator NOP: <input checked="" type="radio"/> No <input type="radio"/> From Side <input type="radio"/> To Side					

Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Draw the generator by clicking LMB (Left Mouse Button) on the **Bus1**. The **Element ID** dialog will appear. Click OK.



Generator Data form will be opened. Select the Manufacturer Reference No as 1[Thermal120MW]. Click on Save 

Generator Data

Number: 1 | Fetch Generator >> | Name: Gen1 | Maintenance: | Schedule No: 0

Bus No: 1 [Bus1] [6.600] | Manufacturer Ref. No: 1 [Thermal120MW] | Library >> | Protection: Over Current

Units in Parallel: 1 | GT | Capacity Curve No: 0 [CAPCUR] | Capacity Curve >> | Relay: | Unit Protection: | Cost Per Unit in: 0

Specified Voltage: 1.0000 pu | 6.600 kV | Breaker Rating: In MVA: 250 | In kA: 21.870

De-Rated MVA: 31.25 | Reactive Power - Minimum: 0 MVar | Reactive Power - Maximum: 3 MVar

Scheduled Power: 25 MW

Real Power Optimization Data: Real Power - Minimum: 0 MW | Cost Co-efficient C0: 0 | Real Power - Maximum: 25 MW | Cost Co-efficient C1: 0 | Cost Co-efficient C2: 0

Status: In Service | Out of Service | Commission Status: Existing | Proposed | Year: 0

Neutral Grounding Resistance: 0 ohms | Participation Factor (%): 0 | Neutral Grounding Reactance: 0 ohms | Bias Setting: 0 | Grounding Through Transformer: Calculate | Droop (%): 4

Model Type: Infinite Bus Modelling (X'd) | Transient Modelling (X'd & X'q) | Sub-Transient Modelling (X'd & X'q) | Global Change

AVR Ref No: 0 [AVR] Type 0 | AVR Library >> | AVR File Open: | Governor Ref No: 0 Type 0 | TG Library >> | GOV File Open: | Edit Files: |

Click here to browse AVR and Governor data files

Generator Library Details:

Generator Library

Ref. Number: 1 | Fetch Generator | Manufacturer Name: Thermal120MW

MVA Rating: 31.25 | MW Rating: 25 | kV Rating: 6.6 | Compute X'd, X'q, X''d, X''q

Armature Resistance (Ra): 0 pu | Potier Reactance (Xp): 0.2 pu

Direct Axis Reactance (Xd): 2 pu | Direct Axis Transient Reactance (X'd): 0.25 pu

Quadrature Axis Reactance (Xq): 2 pu | Quadrature Axis Transient Reactance (X'q): 0.25 pu

Negative Seq. Reactance (X'n): 0.2 pu | Direct Axis Sub-Transient Reactance (X''d): 0.2 pu

Zero Seq. Reactance (X'o): 0.2 pu | Quadrature Axis Sub-Transient Reactance (X''q): 0.2 pu

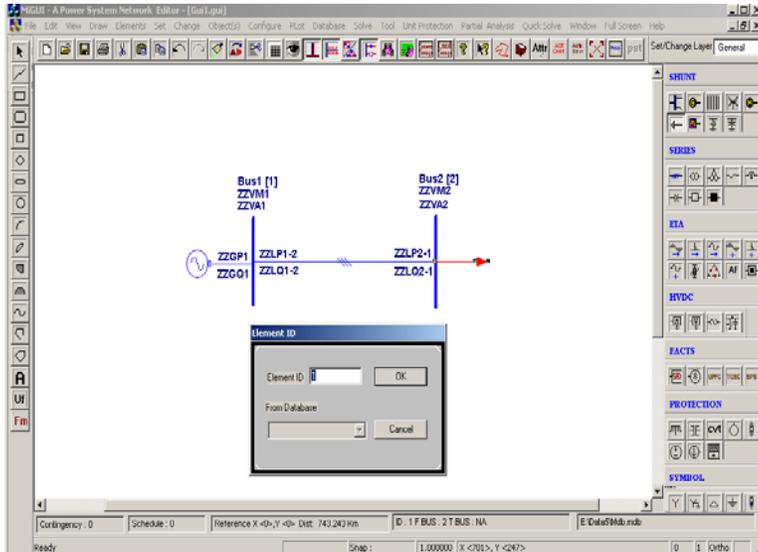
Direct Axis Open Circuit Transient Time Constant (T'do): 7 | Direct Axis Open Circuit Sub-Transient Time Constant (T'd'o): 0.04 | Inertia in MJ/MVA: 5

Quadrature Axis Open Circuit Transient Time Constant (T'qo): 2.5 | Quadrature Axis Open Circuit Sub-Transient Time Constant (T'q'o): 0.2 | Damping Factor: 0

Winding Connections: | Mass Details: Mass Number: 0 | Next >> | Inertia: 0 MJ/MVA | Counter: | Damping Factor: 0 | << Back: | Thermal Curves: | SMIness Co-efficient: 0 | pu torque/Elec. Rad: | Delete: | Thermal Curves: Thermal >> | Cost Per Unit in: 0

Procedure To Draw Load

Click on **Load** icon provided on power system tool bar. Draw the load by clicking LMB (Left Mouse Button) on the **Bus2**. The **Element ID** dialog will appear. Click **OK**.



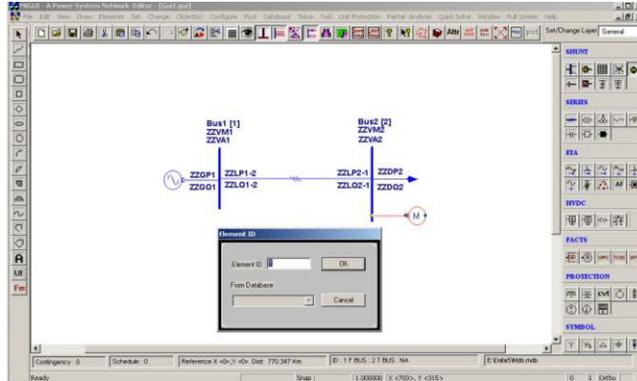
Load Data form will be opened. Enter the load details as shown below. Click on **Save**



Load Data									
Number	1	Fetch Load >>	Name	_LD1	Maintenance	Schedule No	0	Relay	
Bus Number	2 (Bus2) 6600	No of Consumers	1	MVAR Compensation	0	Minimum Compensation in MVAR	0	Cost Per Unit in	0
Real Power in MW	0	Reactive Power in MVAR	5.5	Compensation Step in MVAR	0	Load Characteristics No.	0	Cost library	
Power Factor	0.853262	Load Details		Library	Load Characteristics >>	Global Change		Rel No.	
Load Type	<input checked="" type="radio"/> Linear <input type="radio"/> Non Linear	Unbalanced Load	<input checked="" type="checkbox"/> Y <input type="checkbox"/> Δ	Commission Status	<input checked="" type="checkbox"/> Existing <input type="checkbox"/> Proposed	Year	0	Breaker Rating	In MVA 250.000 In kA 21.870
Motor Load Percentage	0	Status	<input checked="" type="checkbox"/> In Service <input type="checkbox"/> Out of Service	Control Block	Fpb Path	Browse			

3.9 Procedure to Draw Motor

Click on **Motor** icon provided on power system tool bar. Draw the motor by clicking LMB (Left Mouse Button) on the **Bus2**. The **Element ID** dialog will appear. Click **OK**



Motor Data form will be opened. Enter the Motor details as shown below.

Motor Data

Motor Number: Fetch Motor >> Name: Maintenance

De-Rated MVA: Manufacturer Ref. No.: Motor Library >>

Bus Number: Breaker Rating: In MVA In kA Cost Per Unit in:

Units in Parallel:

Winding Type: Y Y_n Δ

Neutral Resistance: ohms Neutral Reactance: ohms

Slip: P in MW: MW Q in MVAR: Mvar

Motor Torque: Formula Characteristics

Torque Constant (Tc): Motor Load Library:

Constant Torque Component (C1): Load Library >>

Torque Component Proportional to Speed (C2): Load Library >>

Torque Component Proportional to Square of Speed (C3): Load Library >>

Speed Vs Torque Characteristics

Status: In Service Out of Service Motor details:

Starting Mode: Auto Transformer Resistance Star-Delta Direct Online (DOL)

Slip: Time: Auto Tap Value:

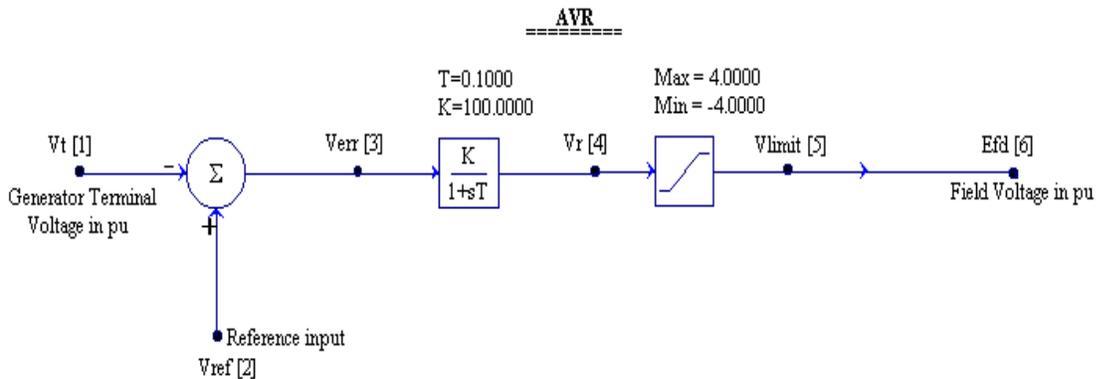
R Start: R End:

Click on **Motor Library** >> button. Enter motor library details as shown below.

Motor Library			
Manufacturer Ref. Number	<input type="text" value="1"/>	<input type="button" value="Fetch >>"/>	Motor Name <input type="text" value="Mot1"/>
MVA Rating	<input type="text" value="4.261"/>	Rated Speed	<input type="text" value="1483"/> rpm
kV Rating	<input type="text" value="6.5999999046"/>	% Efficiency at Full Load	<input type="text" value="95.999997854"/>
MW Rating	<input type="text" value="3.6"/>	<input type="button" value="Compute"/>	Locked Rotor Current <input type="text" value="1677.5"/> Amps
		Inertia Constant	<input type="text" value="1.3713"/>
Model			Cost Per Unit in
<input checked="" type="radio"/> Parameter <input type="radio"/> P - Q (Characteristic)		<input type="button" value="Add/Edit Characteristics"/>	<input type="text" value="0"/>
pu on its Own Rating			
Stator Resistance	<input type="text" value="0.005156"/> pu	Stator Reactance	<input type="text" value="0.10667"/> pu
Rotor Resistance at Slip = 1	<input type="text" value="0.0186"/> pu	Rotor Reactance at Slip = 1	<input type="text" value="0.10667"/> pu
Rotor Resistance at Slip = 0	<input type="text" value="0.0186"/> pu	Rotor Reactance at Slip = 0	<input type="text" value="0.10667"/> pu
Parameters	<input type="button" value="Compute >>"/>	Magnetizing Reactance	<input type="text" value="3.4713"/> pu
Thermal Curve	<input type="button" value="Cold & Hot >>"/>	<input type="button" value="Start Motor"/>	<input type="button" value="Report"/> <input type="button" value="Graph"/>

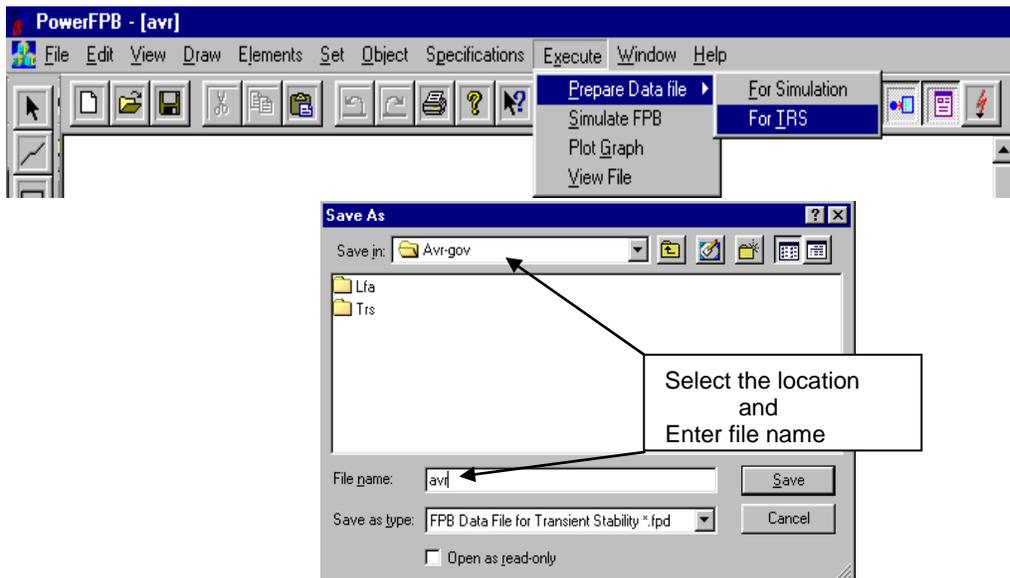
Click on **Save** . Also **Save**  the motor data.

Design AVR using Free Programmable Blocks module of MiP-PSCT

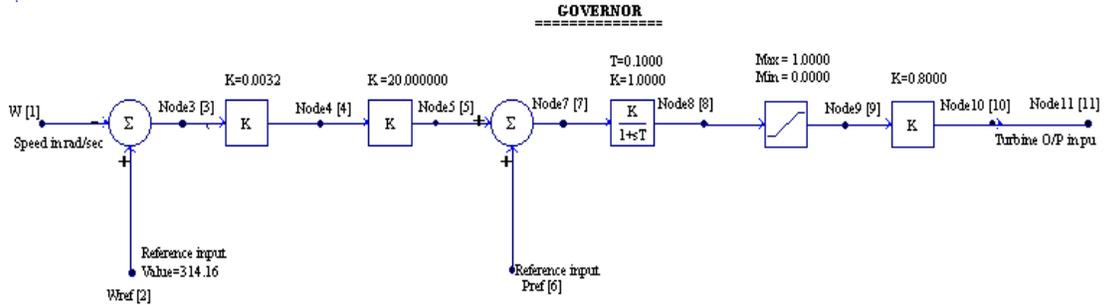


3.10 Procedure to generate AVR data file for Transient Stability Analysis

Select menu option **Execute** → **Prepare Data file** → **For TRS**



Similarly Design and generate Governor data file for Transient Stability Analysis



Browse these file name paths in **Generator Data**

Execute **Load Flow Analysis** to establish the initial condition

3.11 Load flow results

```

-----
---
ITERATION      MAX P BUS      MAX P      MAX Q

BUS            MAX Q COUNT   NUMBER    PER UNIT      NUMBER    PER UNIT
-----
      1          2      0.090        2      0.097
      2          2      0.080        2      0.036
      3          2      0.001        2      0.001
      4          2      0.001        2      0.001
Number of p iterations : 3 and Number of q iterations : 2
-----
---
BUS VOLTAGES AND POWERS

NODE FROM      V-MAG  ANGLE      MW      MVAR      MW      MVAR
MVAR
NO.  NAME      P. U.  DEGREE      GEN      GEN      LOAD    LOAD
COMP
-----
---
      1      Bus1  1.0000   0.00      9.140    5.607      0.000    0.000
0.000
      2      Bus2  0.9936  -0.02      0.000    0.000      9.000    5.500
0.000
-----
---
NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) : 0

```

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

1	3	1	Bus1	2	Bus2	9.140	5.607	0.0572	0.0286
84.4#									

---! NUMBER OF LINES LOADED BEYOND 125% : 0
 @ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 0
 # NUMBER OF LINES LOADED BETWEEN 75% AND 100% : 1
 \$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% : 0
 ^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% : 0
 & NUMBER OF LINES LOADED BETWEEN 1% AND 25% : 0
 * 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 : 9.140 MW
 TOTAL REAL POWER INJECT,-ve L : 0.000 MW
 TOTAL REACT. POWER GENERATION : 5.607 MVAR
 GENERATION pf : 0.852

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

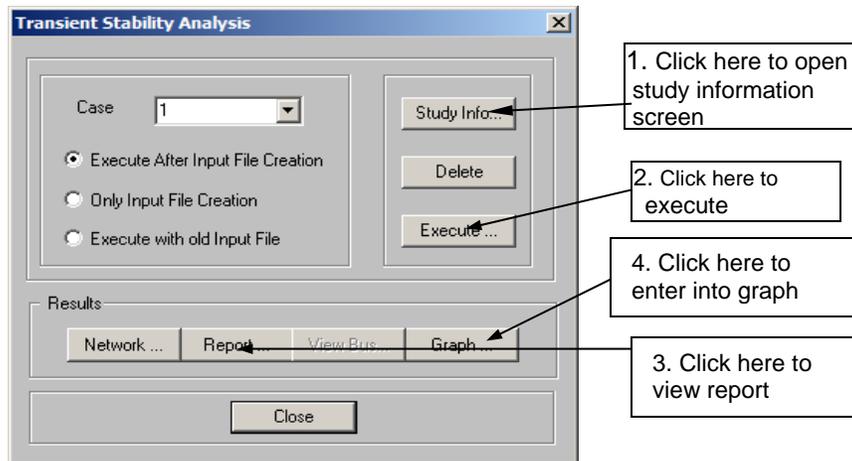
TOTAL UPFC FACTS. INJECTION : 0.0000 MVAR

TOTAL SHUNT FACTS.INJECTION : 0.000 MVAR

TOTAL SHUNT FACTS.DRAWAL	:	0.000	MVAR
TOTAL REAL POWER LOAD	:	9.000	MW
TOTAL REAL POWER DRAWAL -ve g	:	0.000	MW
TOTAL REACTIVE POWER LOAD	:	5.500	MVAR
LOAD pf	:	0.853	
TOTAL COMPENSATION AT LOADS	:	0.000	MVAR
TOTAL HVDC REACTIVE POWER	:	0.000	MVAR
<hr/>			
TOTAL REAL POWER LOSS (AC+DC)	:	0.057220	MW (0.057220+ 0.000000)
PERCENTAGE REAL LOSS (AC+DC)	:	0.626	
TOTAL REACTIVE POWER LOSS	:	0.028631	MVAR

3.12 Executing transient stability study with AVR And Governor

Click on **Solve** → **Transient stability analysis**.



The screenshot shows the 'TRANSIENT STABILITY STUDIES' dialog box. Annotations are as follows:

- 1. Select Motor:** Points to the 'Disturbance' dropdown menu in the 'List of disturbances' table.
- 2. Uncheck the:** Points to the 'Constant Voltage behind Xd'' checkbox under the 'Machine Type' section.
- 3. Click:** Points to the 'Disturbance Info' button.
- 4. Uncheck:** Points to the 'AVR' checkbox in the 'Elements Considered' section.

List of disturbances table:

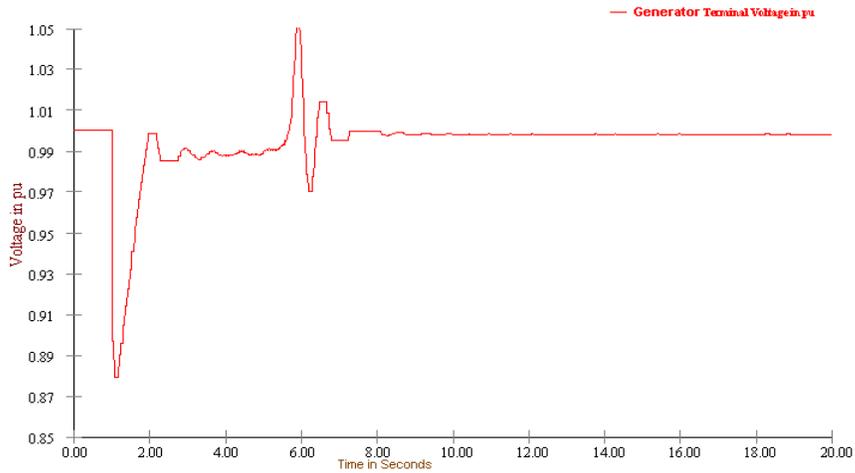
Sl No	Disturbance	Yes/No
1	Motor Start/Stop Event 1 at 1.000 s	<input checked="" type="checkbox"/>

The screenshot shows the 'Motor Start/ Stop' dialog box. Annotations are as follows:

- Select the motor and enter the Disturbance Time:** Points to the 'Motor Number' dropdown menu (showing '1 Mot1 [2 (Bus2)]') and the 'Disturbance Starting Time' input field (containing '1').

Click **OK** and **Execute** Transient Analysis

Effect of AVR on Generator terminal voltage



Effect of Governor on Generator frequency

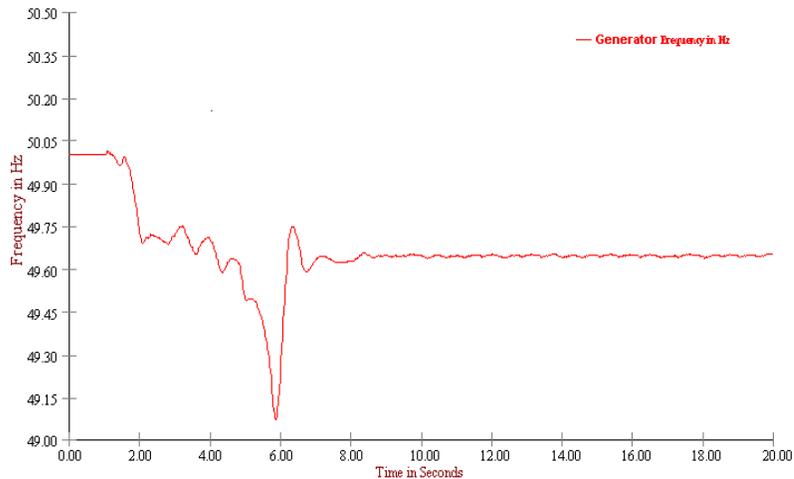


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4. How to solve Network Reduction

For a typical 24 Bus System with maximum generation as slack bus. Element parameters are specified in the element tables.

Generate a Single line diagram using MiP-PSCT Power system Network Editor simultaneously

Compute the Electrical parameters in p.u. on 100MVA base.

Do Load Flow Analysis in Fast decoupled method, tolerance of 0.001. Do

Ybus Network Reduction using following methods

Case1: Retaining all generator buses

Network reduced with retaining all the buses to which the generators are connected, such as 1,2,3 and 4.

Case2: Retaining all Generator buses and Zone 1 buses

Network reduced with retaining all the buses to which the generators are connected, and buses belonging to Zone1, such as 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17.

Case3: Retaining all Zone 1 buses

Network reduced with retaining all the Zone1 buses, such as 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17.

Case4: Network Reduction for Dynamic Stability study.

Network reduced with retaining all the buses to which the generators are connected taking the option Dynamic Stability

Bus data table

Sl. No	Bus Name	Area No	Zone No	kV rating
1	Bus1	3	1	11.000
2	Bus2	1	2	11.000
3	Bus3	1	2	11.000
4	Bus4	1	1	11.000
5	Bus5	1	1	220.000
6	Bus6	1	1	220.000
7	Bus7	1	1	220.000
8	Bus8	1	1	220.000
9	Bus9	1	1	220.000
10	Bus10	1	1	220.000
11	Bus11	1	1	220.000
12	Bus12	1	1	220.000

13	Bus13	1	1	220.000
14	Bus14	1	1	400.000
15	Bus15	1	1	400.000
16	Bus16	1	1	220.000
17	Bus17	1	1	220.000

18	Bus18	1	2	220.000
19	Bus19	1	2	220.000
20	Bus20	1	2	220.000
21	Bus21	1	2	220.000
22	Bus22	1	2	220.000
23	Bus23	1	2	220.000
24	Bus24	1	2	220.000

Transmission Line data Table

Sl. No.	From Bus	To Bus	Positive Sequence		
			Resistance R(P.U.)	Reactance X(P.U.)	Susceptance B/2(P.U.)
1	15	14	0.00430	0.04770	0.63700
2	7	11	0.02444	0.12226	0.10272
3	12	13	0.01321	0.06608	0.05552
4	13	11	0.00314	0.01570	0.05275
5	13	16	0.00578	0.02891	0.02429
6	16	11	0.00495	0.02478	0.02082
7	16	17	0.00248	0.01239	0.01041
8	5	6	0.00450	0.02251	0.30260
9	6	7	0.03716	0.18586	0.15616
10	6	13	0.05169	0.25856	0.21723
11	6	16	0.01530	0.07655	0.57882
12	6	8	0.01239	0.06195	0.20822
13	8	9	0.00363	0.01817	0.06107
14	8	10	0.00330	0.01652	0.05552
15	18	19	0.00537	0.02685	0.09022
16	19	5	0.01263	0.06319	0.21237
17	19	20	0.01131	0.05658	0.19016
18	20	24	0.01982	0.09913	0.08328
19	24	5	0.02494	0.12473	0.10480
20	22	23	0.03633	0.18173	0.15269
21	22	20	0.01734	0.08674	0.29149
22	22	21	0.00330	0.01652	0.01388

Transformer data table

From Bus	To Bus	Resistance R	Reactance X	MVA Rating
Bus4	Bus15	0.001402	0.02804	475.00
Bus14	Bus11	0.00063	0.01250	475.00
Bus5	Bus1	0.000694	0.013872	704.63
Bus2	Bus18	0.003484	0.06968	156.25
Bus3	Bus22	0.002804	0.05609	237.50

Generator data table

Generator	Gen1	Gen2	Gen3	Gen4
P-sch MW	563.7	125.0	190.0	380.0
P-rate MW	712	135	300	420
P-min MW	400	50	120	240
P-max MW	760	140	330	440
V-pu	1.02	1.02	1.02	1.02
Positive sequence				
R	0.00126	0.00073	0.00051	0.00026
X'd	0.03409	0.07473	0.05247	0.02623
Negative sequence				
R	0.00126	0.00073	0.00051	0.00026
X'd	0.03409	0.07479	0.05251	0.02626
Zero sequence				
R	0.00126	0.00073	0.00051	0.00026
X'd	0.03413	0.07497	0.05264	0.02632
Inertia(H)	6.917	6.917	6.917	6.917

Generator Capability Curve

Point No.	P(pu)	Q-min (pu)	Q-max (pu)
1	0.0	-0.3	0.707
2	0.6	-0.2	0.6
3	0.9	-0.2	0.5
4	1.0	0.0	0.0

Load Data

Bus no.	P-load Mvar	Q-load Mvar	Q-comp Mvar
6	70	30	30
7	150	40	30
9	30	10	0
10	90	50	0
11	35	15	0
12	30	10	0
13	150	60	0
16	230	60	0
17	60	25	0
19	130	100	0
20	50	35	0
21	73	48	0
23	50	30	0
24	95	50	0

4.1 Procedure to enter Bus Data

Similarly enter other bus, as per details given in the bus data table.

The screenshot shows the 'Bus Data' configuration window. The fields are filled with the following values:

- Bus Number: 1
- Bus Name: Bus1
- Description: Bus1
- Nominal Voltage: 11.000 kV
- Area Number: 1 (Selected: 1 Area1)
- Zone Number: 1 (Selected: 1 Zone1)
- Owner Number: 1 (Selected: 1 Owner1)
- Contingency Weightage: 1
- Voltage Limits in kV: Min: 10.450000, Max: 11.550000
- Cost Per Unit in: 0
- Cost \$/kvar: (Empty)
- Relay: Bus Bar Differential
- Arc Flash: Bus Details

Buttons at the bottom include: Global Change, Load, Details, CostMb >>, and GPS. There are also sections for Attachments and Remarks.

4.2 Procedure to enter Transmission line details:

Select main menu “**Libraries → Series Elements → Transmission Line**”

Line and Cable Library

Structure Reference
 Number Name

Positive Sequence Resistance pu
 Positive Sequence Reactance pu
 Positive Sequence Susceptance (B/2) pu
 Zero Sequence Resistance pu
 Zero Sequence Reactance pu
 Zero Sequence Susceptance (B/2) pu
 Thermal Rating MVA
 Line Harmonic Number
 Cost per km Cost Per Unit in Rs

Surge Impedance
 Z Ohms
 V kms/sec

Enter other **Transmission** data similarly, as per the data given in **Transmission line data table**.

Procedure to enter Element detail:

Select main menu **Elements → Series Elements → Transmission Line →**

Line/Cable Data

Number Name

De-Rated MVA
 Rating I MVA
 Rating II MVA

From Bus Number
 To Bus Number
 Number of Circuits
 Line Length km
 Contingency Weightage

Structure Ref. No.

From Breaker Rating
 Not Exists
 Exists MVA kA

To Breaker Rating
 Not Exists
 Exists MVA kA

Feed Data Type
 Current Power
 Amperes
 pf

Show Breaker - SLD
 Yes

SLD Notation
 Line
 Cable
 Breaker
 Isolator

NDP
 No
 From Side
 To Side

Status
 In Service From End Open To End Open Out of Service

Commission Status
 Existing Proposed Year

From Side Open
 TNOP Maintenance Fault Others

To Side Open
 TNOP Maintenance Fault Others

Enter remaining **Transmission line data** similarly according to the following table.

Line No.	From Bus	To Bus	No. of circuits	Line Length in km	Structure reference no.
2	7	11	1	1	2
3	12	13	1	1	3
4	13	11	1	1	4
5	13	16	1	1	5
6	16	11	1	1	6
7	16	17	1	1	7
8	5	6	1	1	8
9	6	7	1	1	9
10	6	13	1	1	10
11	6	16	1	1	11
12	6	8	1	1	12
13	8	9	1	1	13
14	8	10	1	1	14
15	18	19	1	1	15
16	19	5	1	1	16
17	19	20	1	1	17
18	20	24	1	1	18
19	24	5	1	1	19
20	22	23	1	1	20
21	22	20	1	1	21
22	22	21	1	1	22

4.3 Procedure to enter Transformer details

Select menu option **Libraries** → **Series Element** → **Two winding Transformer**

Two Winding Transformer Library

Manufacturer Ref. Number: Fetch >> Manufacturer Name: Transf. Parameter

MVA Rating: Primary Voltage: kV Secondary Voltage: kV

Minimum Tap Number: Tap Step → 0.016667 p.u. Maximum Tap Number:
 Off-Load Tap Change On-Load Tap Change

Minimum Tap Voltage: kV Compute Maximum Tap Voltage: kV Compute

pu on Common MVA Base

Pos. Seq. Impedance: pu
 Pos. Seq. X to R Ratio:
 Zero Seq. Impedance: pu
 Zero Seq. X to R Ratio: Update X/R ratio

Transformer losses

No-load loss: W
 Copper loss: W

Winding Configuration

Primary ...
 Secondary ...

Phase displacement: [300]

R and X data given in Transformer details table.

$$\text{Impedance } Z = \sqrt{R^2 + X^2}$$

Enter remaining **Transformer** details similarly according to the following table.

Manufacturer no.	2	3	4	5
Manufacturer name	14-11	5-1	2-18	3-22
MVA rating	475.00	704.63	156.25	237.50
Impedance	0.01252	0.11112	0.06977	0.05616
X/R Ratio	19.8413	19.988	20	20.0036
Primary kV	400	220	11	11
Secondary kV	220	11	220	220
Min Tap No	1	1	1	1
Max Tap No	7	13	7	7
Min Tap in kV	360	198	10.45	10.45
Max Tap in kV	420	231	12.1	12.1

Transformer Element details

Select menu option **Element** → **Series Element** → **Two winding Transformer**

Two Winding Transformer Data

Transformers Number: Fetch Transformers >> Name: Maintenance

Global Change 7q7ag Transformer

Secondary Voltage: 400.000 kV

De-Rated MVA:

Rating I: Mva

Rating II: Mva

From Bus Number:

To Bus Number:

Control Bus Number:

No. of Units in Parallel:

Contingency Weightage:

Status: In Service Out of Service

Commission Status: Existing Proposed Year:

Phi Grounding Resistance: ohms

Sec Grounding Resistance: ohms

Transformer Details:

Manufacturer Ref Number:

Unit Protection Relays:

Differential Relay:

Restricted Earth Fault:

OverCurrent Relay:

SLD - Show Breaker: Yes

Cost Per Unit in:

Contingency: U

Schedule: 0

Grounding Transformer:

Primary:

Secondary:

Control Block:

Load Tap Changer:

Firm Breaker: Not Exists Exists Rating: MVA kA

Tn Breaker: Not Exists Exists Rating: MVA kA

Set Tap Position:

Nominal Tap Position:

Phase Shift Angle: deg

Enter other **Transformer** details similarly. Details as shown in the following table.

Transformer no.	2	3	4	5
Transformer name	2T2	2T3	2T4	2T5
From Bus number	14	5	2	3
To Bus number	11	1	18	22
Control Bus number	14	5	18	22
Manufacturer ref number	2	3	4	5
De-Rated MVA	475.00	704.63	156.25	237.50
Nominal Tap	5	9	3	3

4.4 Generator Capability Curve

Select menu option **Libraries** → **Capability Curve**

The screenshot displays the 'Capability Curve Library' dialog box. It includes a 'Curve Number' field set to 1, a 'Curve Name' field set to 'GenCapCurve 1', and buttons for 'Fetch Curve ...' and 'Preview'. Below these are input fields for 'Voltage' (1.00), 'Real Power in p.u.' (0), 'Minimum Reactive Power' (-0.2), and 'Maximum Reactive Power' (0.707). A graph shows a bell-shaped curve with 'P' on the vertical axis and 'Qmin' and 'Qmax' on the horizontal axis. A 'Record Add' dialog box is overlaid on the right, asking 'Add New Record?' with 'Yes' and 'No' buttons.

Click next the following dialog appears say yes to enter next counter follow same procedure until 4th counter, at 4th counter say no so that it will save that counter and close

Generator Capability curve detail

Point No.	P(pu)	Q-min (pu)	Q-max (pu)
2	0.6	-0.2	0.6
3	0.9	-0.2	0.5
4	1.0	0.0	0.0

4.5 Generator Details

Select menu option **Libraries™ Shunt Elements™ Generator**

Generator Library

Ref. Number Fetch Generator Manufacturer Name

MVA Rating MW Rating kV Rating Compute X[d,"d,n,0]

pu on Common MVA Base

Armature Resistance (Ra) <input type="text" value="0.01"/>	pu	Potier Reactance (Xp) <input type="text" value="0.1515"/>	pu
Direct Axis Reactance (Xd) <input type="text" value="0.98"/>	pu	Direct Axis Transient Reactance (X'd) <input type="text" value="0.2727"/>	pu
Quadrature Axis Reactance (Xq) <input type="text" value="0.5657"/>	pu	Quadrature Axis Transient Reactance (X'q) <input type="text" value="0.2525"/>	pu
Negative Seq. Reactance (Xn) <input type="text" value="0.2727"/>	pu	Direct Axis Sub-Transient Reactance (X''d) <input type="text" value="0.2121"/>	pu
Zero Seq. Reactance (Xo) <input type="text" value="0.2727"/>	pu	Quadrature Axis Sub-Transient Reactance (X''q) <input type="text" value="0.2121"/>	pu

Direct Axis Open Circuit Transient Time Constant (T'do) <input type="text" value="9"/>	Direct Axis Open Circuit Sub-Transient Time Constant (T''do) <input type="text" value="0.045"/>	Inertia in MJ/MVA <input type="text" value="4.3164"/>
Quadrature Axis Open Circuit Transient Time Constant (T'qo) <input type="text" value="4"/>	Quadrature Axis Open Circuit Sub-Transient Time Constant (T''qo) <input type="text" value="0.045"/>	Damping Factor <input type="text" value="0"/>

Winding Connections 	Mass Details	Cost Per Unit in <input type="text" value="0"/>
	Mass Number <input type="text" value="2"/> Next >> Inertia <input type="text" value="0.88"/> MJ/MVA Counter Damping Factor <input type="text" value="1"/> << Back Stiffness Co-efficient <input type="text" value="50"/> pu torque/Elec. Rad Delete	Thermal Curves <input type="button" value="Thermal>"/>

Enter other Generator details similarly. Data given in following table.

Generator	Gen1	Gen2	Gen3	Gen4
P-sch MW	563.7	125.0	190.0	380.0
P-rate MW	712	135	300	420
P-min MW	400	50	120	240
P-max MW	760	140	330	440
V-pu	1.02	1.02	1.02	1.02
Positive sequence				
R	0.00126	0.00073	0.00051	0.00026
X'd	0.03409	0.07473	0.05247	0.02623
Negative sequence				
R	0.00126	0.00073	0.00051	0.00026
X'd	0.03409	0.07479	0.05251	0.02626
Zero sequence				
R	0.00126	0.00073	0.00051	0.00026
X'd	0.03413	0.07497	0.05264	0.02632
Inertia(H)	6.917	6.917	6.917	6.917

Generator Element details

Select menu **option Elements** → **Shunt Elements** → **Generator**

Generator Data

Number <input type="text" value="2"/> <input type="button" value="Fetch Generator >>"/>		Name <input type="text" value="get2AT1"/> <input type="button" value="Maintenance"/>		Schedule No <input type="text" value="0"/>
Bus No. <input type="text" value="1 [Bus1] (11.000)"/>	Manufacturer Ref. No. <input type="text" value="1 [GNT]"/>	<input type="button" value="Library >>"/>		
Units in Parallel <input type="text" value="8"/> <input type="button" value="GT"/>	Capability Curve No. <input type="text" value="2"/>	<input type="button" value="Capability Curve >>"/>		
Specified Voltage <input type="text" value="1.0200"/> Pu <input type="text" value="11.22"/> kV		Breaker Rating In MVA <input type="text" value="50"/> In kA <input type="text" value="2.624"/>		Protection Over Current <input type="text" value=""/> <input type="button" value="Relay"/> <input type="button" value="Unit Protection"/>
De-Rated MVA <input type="text" value="99"/>	Scheduled Power <input type="text" value="70.4625"/> MW	Reactive Power - Minimum <input type="text" value="-71.25"/> Mvar	Reactive Power - Maximum <input type="text" value="71.25"/> Mvar	Cost Per Unit in <input type="text" value="0"/>
Real Power Optimization Data		Select		
Real Power - Minimum <input type="text" value="50"/> MW	Real Power - Maximum <input type="text" value="95"/> MW	Cost Co-efficient C0 <input type="text" value="6390"/>	Cost Co-efficient C1 <input type="text" value="35007"/>	<input type="radio"/> Utility Grid
		Cost Co-efficient C2 <input type="text" value="1617"/>		<input checked="" type="radio"/> Generator
Status <input checked="" type="radio"/> In Service <input type="radio"/> Out of Service		Commission Status <input checked="" type="radio"/> Existing <input type="radio"/> Proposed Year <input type="text"/>		
Neutral Grounding Resistance <input type="text" value="0"/> ohms	Neutral Grounding Reactance <input type="text" value="0"/> ohms	Participation Factor (%) <input type="text" value="0"/>	Bias Setting <input type="text" value="0"/>	
Grounding Through Transformer <input type="button" value="Calculate"/>		Droop (%) <input type="text" value="5"/>		
Model Type <input type="radio"/> Infinite Bus Modelling (X'd)		AVR Ref No. <input type="text" value="1 [AVR1] Type 1"/>	<input type="button" value="AVR Library >>"/>	
<input type="radio"/> Transient Modelling (X'd & X'q)		AVR FPB Name <input type="text"/>		
<input checked="" type="radio"/> Sub Transient Modelling (X'd & X'q)		Turbine Gov Ref No. <input type="text" value="2 Type 2"/>	<input type="button" value="TG Library >>"/>	
		<input type="button" value="AVR File Open"/> <input type="button" value="GOV File Open"/>		

Enter remaining **Generators** similarly. Detail given in following table

Name	GEN-2	GEN-3	GEN-4
Bus Number	2	3	4
Manufacturer Reference Number	2	3	4
Number of Generators in Parallel	1	1	1
Capability Curve Number	1	1	1
De-Rated MVA	225	225	225
Specified Voltage	11.22	11.22	11.22
Scheduled Power	125	190	380
Reactive Power Minimum	-105	-330	-330
Reactive Power Maximum	95	330	330
Breaker Rating	350	350	350

4.6 Load details

Select menu option **Elements** → **Shunt Elements** → **Load**

Load Data

Number 1 Fetch Load >> Name LD1 Maintenance Schedule No 0 Relay

Bus Number 11 [Bus11] (220.000) No of Consumers 1 MVAR Compensation 0 Relay

Real Power in MW 35 Minimum Compensation in MVAR 0 Cost Per Unit in

Reactive Power in MVAR 15.000003 Compute Maximum Compensation in MVAR 0 0

Power Factor 0.919145 Load Details Compensation Step in MVAR 0 Cost library

Load Type Load Characteristics No. 2 Ref No. Lib >>

Linear Non Linear Unbalanced Load Library

Motor Load Percentage 0 Unbalanced Load Details Y Δ Load Characteristics >>

Status Commission Status Breaker Rating

In Service Out of Service Existing Proposed Year 0 In MVA 50

Control Block In kA 0.131

Fpb Path Browse

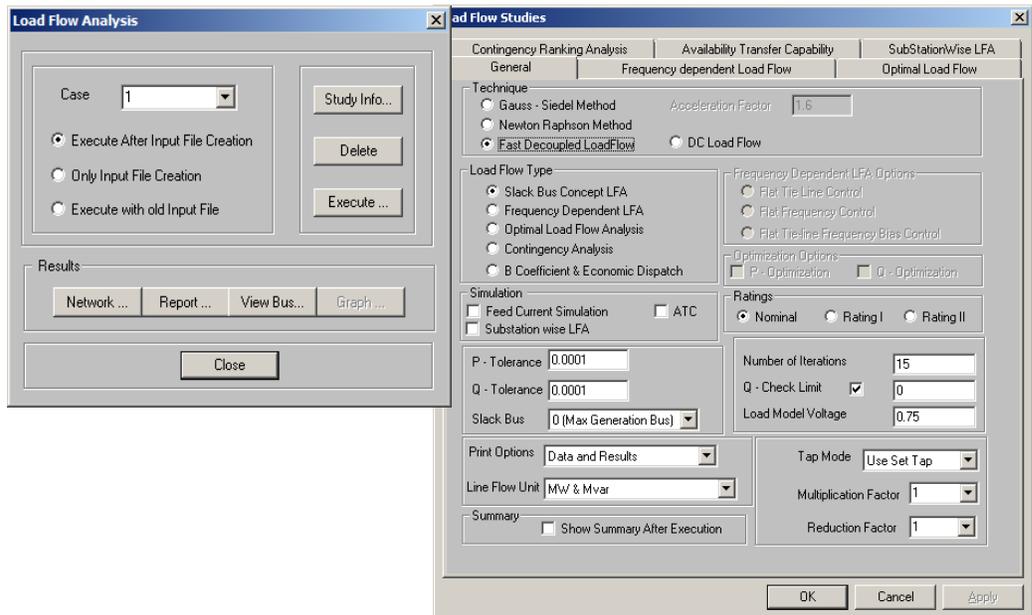
Global Change

Enter remaining **loads** similarly. Details given in the following table

Bus no.	P-load MW	Q-load Mvar	Q-comp Mvar
6	70	30	30
7	150	40	30
9	30	10	0
10	90	50	0
11	35	15	0
12	30	10	0
13	150	60	0
16	230	60	0
17	60	25	0
19	130	100	0
20	50	35	0
21	73	48	0
23	50	30	0
24	95	50	0

4.7 Solving Load Flow

Select menu option “Solve -> Load Flow”.



Report

Load flow results are given below.

BUS VOLTAGES AND POWERS

NODE NO.	FROM NAME	V-MAG P.U.	ANGLE DEGREE	MW GEN	MVAR GEN	MW LOAD	MVAR LOAD	MVAR COMP
1	BUS1	1.0200	0.00	563.711	19.574	0.000	0.000	0.000
2	BUS2	1.0200	1.61	125.000	22.496	0.000	0.000	0.000
3	BUS3	1.0200	3.52	190.000	39.568	0.000	0.000	0.000
4	BUS4	1.0200	3.91	380.000	35.241	0.000	0.000	0.000
5	BUS5	1.0164	-4.32	0.000	0.000	0.000	0.000	0.000
6	BUS6	1.0050	-10.41	0.000	0.000	70.244	30.104	30.000
7	BUS7	0.9677	-19.85	0.000	0.000	146.636	39.103	30.000
8	BUS8	0.9756	-14.54	0.000	0.000	0.000	0.000	0.000
9	BUS9	0.9737	-14.85	0.000	0.000	29.453	9.818	0.000
10	BUS10	0.9650	-15.33	0.000	0.000	87.820	48.789	0.000
11	BUS11	0.9733	-15.09	0.000	0.000	34.351	14.722	0.000
12	BUS12	0.9568	-17.67	0.000	0.000	29.103	9.701	0.000
13	BUS13	0.9642	-16.52	0.000	0.000	146.276	58.510	0.000
14	BUS14	0.9814	-12.32	0.000	0.000	0.000	0.000	0.000
15	BUS15	1.0105	-2.00	0.000	0.000	0.000	0.000	0.000
16	BUS16	0.9638	-16.86	0.000	0.000	224.238	58.497	0.000
17	BUS17	0.9593	-17.27	0.000	0.000	58.310	24.296	0.000
18	BUS18	1.0039	-3.23	0.000	0.000	0.000	0.000	0.000
19	BUS19	0.9922	-5.08	0.000	0.000	129.295	99.458	0.000
20	BUS20	0.9910	-5.83	0.000	0.000	49.687	34.781	0.000
21	BUS21	0.9882	-3.03	0.000	0.000	72.398	47.604	0.000
22	BUS22	0.9984	-2.42	0.000	0.000	0.000	0.000	0.000
23	BUS23	0.9469	-7.40	0.000	0.000	48.171	28.903	0.000 @
24	BUS24	0.9726	-7.97	0.000	0.000	93.194	49.050	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) : 0

NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark) : 0

TRANSFORMER FLOWS AND TRANSFORMER LOSSES

SLNO	CS	FROM NODE	FROM NAME	TO NODE	TO NAME	FORWARD		LOSS		%
						MW	MVAR	MW	MVAR	LOADING
1	2	4	BUS4	15	BUS15	380.000	35.241	1.9630	39.2592	74.8\$
2	1	14	BUS14	11	BUS11	371.856	53.910	0.9237	18.3278	76.6#
3	8	5	BUS5	1	BUS1	-561.589	22.848	2.1224	42.4223	69.8\$
4	1	2	BUS2	18	BUS18	125.000	22.496	0.5402	10.8041	75.5#
5	1	3	BUS3	22	BUS22	190.000	39.568	1.0151	20.3063	76.1#

! NUMBER OF TRANSFORMERS LOADED BEYOND 125% : 0

@ NUMBER OF TRANSFORMERS LOADED BETWEEN 100% AND 125% : 0

```

# NUMBER OF TRANSFORMERS LOADED BETWEEN 75% AND 100% : 3
$ NUMBER OF TRANSFORMERS LOADED BETWEEN 50% AND 75% : 2
^ NUMBER OF TRANSFORMERS LOADED BETWEEN 25% AND 50% : 0
& NUMBER OF TRANSFORMERS LOADED BETWEEN 1% AND 25% : 0
* NUMBER OF TRANSFORMERS LOADED BETWEEN 0% AND 1% : 0

```

LINE FLOWS AND LINE LOSSES

SLNO	CS	FROM	FROM	TO	TO	FORWARDLOSS		% NODE				
		NAME	NAME	NODE	NAME	MW	MVAR	MW	MVAR			
		LOADING										
6	1	15	BUS15	14	BUS14	378.034	-4.006	6.1755	-57.8906	93.5#		
7	1	7	BUS7	11	BUS11	-61.752	0.900	1.0242	-14.2262	55.3\$		
8	1	12	BUS12	13	BUS13	-29.102	-9.699	0.1253	-9.6166	26.7^		
9	2	13	BUS13	11	BUS11	-153.297	-28.633	0.8128	-5.8370	67.4\$		
10	1	13	BUS13	16	BUS16	18.655	-4.839	0.0221	-4.4042	16.7&		
11	1	16	BUS16	11	BUS11	-118.921	-13.271	0.7604	-0.0999	103.1@		
12	1	16	BUS16	17	BUS17	58.415	22.899	0.1063	-1.3940	54.9\$		
13	4	5	BUS5	6	BUS6	477.840	-49.588	9.9609	-11.9946	98.5#		
14	1	6	BUS6	7	BUS7	87.746	-6.062	2.8676	-16.0514	72.9\$		
15	1	6	BUS6	13	BUS13	41.800	-12.309	0.9417	-37.4225	41.5^		
16	3	6	BUS6	16	BUS16	148.596	-26.153	3.5032	-94.7018	46.2^		
17	2	6	BUS6	8	BUS8	119.493	6.806	1.8467	-31.6140	52.9\$		
18	2	8	BUS8	9	BUS9	29.486	-1.617	0.0338	-11.4338	13.3&		
19	2	8	BUS8	10	BUS10	88.160	40.038	0.3407	-8.7495	43.4^		
20	2	18	BUS18	19	BUS19	124.460	11.692	0.8483	-13.7340	53.0\$		
21	2	19	BUS19	5	BUS5	-27.772	-53.132	0.2321	-41.6860	25.2^		
22	2	19	BUS19	20	BUS20	22.088	-20.899	0.0566	-37.1160	12.8&		
23	1	20	BUS20	24	BUS24	38.691	3.175	0.3281	-14.4170	36.2^		
24	1	24	BUS24	5	BUS5	-54.831	-31.457	0.9149	-16.1647	54.2\$		
25	1	22	BUS22	23	BUS23	49.205	5.164	1.0339	-23.7399	49.4^		
26	2	22	BUS22	20	BUS20	67.132	-32.016	0.7855	-53.7550	31.0^		
27	1	22	BUS22	21	BUS21	72.648	46.114	0.2494	-1.4903	73.1\$		

```

! NUMBER OF LINES LOADED BEYOND 125% : 0
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% : 1
# NUMBER OF LINES LOADED BETWEEN 75% AND 100% : 2
$ NUMBER OF LINES LOADED BETWEEN 50% AND 75% : 8
^ NUMBER OF LINES LOADED BETWEEN 25% AND 50% : 8
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% : 3
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% : 0

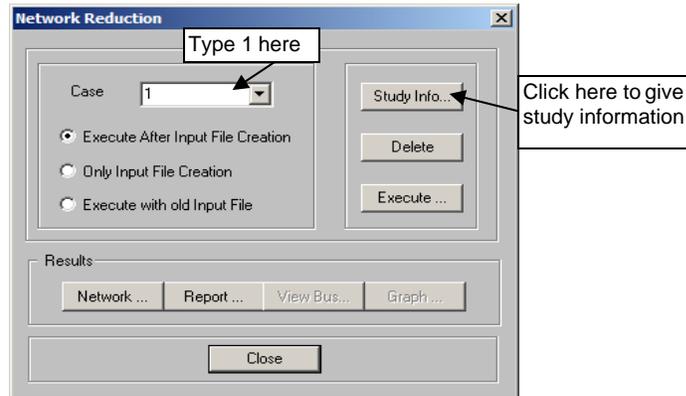
```

4.8 To solve Y-Bus Reduction (Network Reduction)

CASE 1: Retaining all generator buses

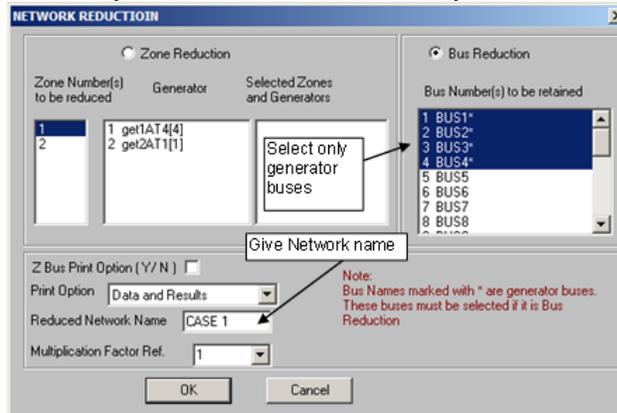
24 Bus sample systems are reduced with retaining all the buses to which the generators are connected, such as buses 1,2,3 and 4. All other connections are reduced as equivalent series impedance between the retained buses and shunt admittance at the retained buses.

Select menu option
"Solve -> Network Reduction"
Following screen appears



Study Information

Following screen shows study information for **Case 1**. Similarly select buses 1, 2, 3, & 4.



Click **OK** after entering information. **Execute** Network Reduction. Click **Report** button to view the **report**.

Network Reduction Report for case 1

NETWORK REDUCTION

CASE NO : 11 CONTINGENCY : 0 SCHEDULE NO : 0

CONTINGENCY NAME : Base Case

%%

TOTAL NUMBER OF BUSES	:	24	ACTUAL NUMBER OF BUSES	:	24
NUMBER OF 2 WIND. TRANSFORMERS	:	5	NUMBER OF 3 WIND. TRANSFORMERS	:	0
NUMBER OF TRANSMISSION LINES	:	22			
NUMBER OF SERIES REACTORS	:	0	NUMBER OF SERIES CAPACITORS	:	0
NUMBER OF BUS COUPLERS	:	0			
NUMBER OF SHUNT REACTORS	:	0	NUMBER OF SHUNT CAPACITORS	:	0
NUMBER OF SHUNT IMPEDANCES	:	0	NUMBER OF GENERATORS	:	4
NUMBER OF LOADS	:	14			
NUMBER OF FILTERS	:	0			
NUMBER OF HVDC CONVERTORS	:	0			

NUMBER OF ZONES : 2

PRINT OPTION : 3 (BOTH DATA AND RESULTS PRINT)

BASE MVA : 100.000

NOMINAL SYSTEM FREQUENCY: 50.000

PREFault VOLTAGE OPTION : 1 (READ FROM THE FILE)

ZONE NUMBER RETAINED : 0

ZBUS PRINT OPTION : 0

YBUS REDUCTION OPTION : 1 (NETWORK REDUCTION)

```

-----
4
1      2      3      4
-----
CIRCUIT BREAKER RESISTANCE (PU)           : 0.000000
CIRCUIT BREAKER REACTANCE (PU)           : 0.000100
TRANSFORMER R/X RATIO                     : 0.050000
TRANSFORMER ZERO SEQUENCE IMPEDANCE MULT FACTOR : 0.900000

NUMBER OF TRANSMISSION VOLTAGE LEVELS     : 3
TRANSMISSION LINE VOLTAGE - KV            : 11.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR : 0.000000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR : 0.000000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.000000
TRANSMISSION LINE VOLTAGE - KV            : 220.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000
TRANSMISSION LINE VOLTAGE - KV            : 400.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000

GENERATOR NEGATIVE SEQUENCE RESISTANCE MULT. FACTOR : 0.175000
GENERATOR NEGATIVE SEQUENCE REACTANCE MULT. FACTOR : 0.175000
GENERATOR ZERO SEQUENCE RESISTANCE MULT. FACTOR : 0.037500
GENERATOR ZERO SEQUENCE REACTANCE MULT. FACTOR : 0.037500
LOAD NEGATIVE SEQUENCE IMPEDANCE MULT. FACTOR : 0.810000
LOAD ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.600000
SERIES REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.000000
SHUNT REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 0.625000
-----

```

BUS DATA

NODE	STAT	ZONE	BUS-KV	NAME	VMAG-PU	VANG-DEG	PGEN-MW	QGEN-MR
						PLOAD-MW	QLOAD-MR	QCOMP-MR
1	1	1	11.000	BUS1	0.0000	0.000	0.000	0.000
						0.000	0.000	0.000
2	1	2	11.000	BUS2	0.0000	0.000	0.000	0.000
						0.000	0.000	0.000
3	1	2	11.000	BUS3	0.0000	0.000	0.000	0.000
						0.000	0.000	0.000
4	1	1	11.000	BUS4	0.0000	0.000	0.000	0.000
						0.000	0.000	0.000
5	1	1	220.000	BUS5	0.0000	0.000	0.000	0.000
						0.000	0.000	0.000
6	1	1	220.000	BUS6	0.0000	0.000	0.000	0.000
						0.000	0.000	0.000

7	1	1	220.000	BUS7	0.0000	0.000	0.000	0.000	0.000
8	1	1	220.000	BUS8	0.0000	0.000	0.000	0.000	0.000
9	1	1	220.000	BUS9	0.0000	0.000	0.000	0.000	0.000
10	1	1	220.000	BUS10	0.0000	0.000	0.000	0.000	0.000
11	1	1	220.000	BUS11	0.0000	0.000	0.000	0.000	0.000
12	1	1	220.000	BUS12	0.0000	0.000	0.000	0.000	0.000
13	1	1	220.000	BUS13	0.0000	0.000	0.000	0.000	0.000
14	1	1	400.000	BUS14	0.0000	0.000	0.000	0.000	0.000
15	1	1	400.000	BUS15	0.0000	0.000	0.000	0.000	0.000
16	1	1	220.000	BUS16	0.0000	0.000	0.000	0.000	0.000
17	1	1	220.000	BUS17	0.0000	0.000	0.000	0.000	0.000
18	1	2	220.000	BUS18	0.0000	0.000	0.000	0.000	0.000
19	1	2	220.000	BUS19	0.0000	0.000	0.000	0.000	0.000
20	1	2	220.000	BUS20	0.0000	0.000	0.000	0.000	0.000
21	1	2	220.000	BUS21	0.0000	0.000	0.000	0.000	0.000
22	1	2	220.000	BUS22	0.0000	0.000	0.000	0.000	0.000
23	1	2	220.000	BUS23	0.0000	0.000	0.000	0.000	0.000
24	1	2	220.000	BUS24	0.0000	0.000	0.000	0.000	0.000

 TRANSFORMER DATA

STAT	CKTS	FROM	FROM	TO	TO	POSITIVE		ZERO	
						R(P.U)	X(P.U.)	R(P.U.)	X(P.U.)
		NODE	NAME	NODE	NAME	TAP	PHASE	FB-MVA	TB-MVA
3	2	4	BUS4	15	BUS15	0.00140	0.02804	0.00140	0.02804
						1.00000	0.000	50	50 S D
3	1	14	BUS14	11	BUS11	0.00063	0.01250	0.00063	0.01250
						1.00000	0.000	50	50 G G
3	8	5	BUS5	1	BUS1	0.00069	0.01387	0.00069	0.01387
						1.00000	0.000	50	50 G G
3	1	2	BUS2	18	BUS18	0.00348	0.06968	0.00348	0.06968
						1.00000	0.000	50	50 G G

3	1	3	BUS3	22	BUS22	0.00280	0.05609	0.00280	0.05609		
						1.00000	0.000	50	50	G	G

TRANSMISSION LINE DATA

STAT	CKTS	FROM	FROM	TO	TO	RP(P.U)	XP(P.U)	BP/2(PU)	FC-MVA	TC-MVA
		NODE	NODE	NODE	NODE	RZ(P.U)	XZ(P.U)	BZ/2(PU)		
3	1	15	BUS15	14	BUS14	0.00430	0.04770	0.63700		
						0.00860	0.09540	0.50000	50	50
3	1	7	BUS7	11	BUS11	0.02444	0.12226	0.10272		
						0.07332	0.36677	0.07190	50	50
3	1	12	BUS12	13	BUS13	0.01321	0.06608	0.05552		
						0.03963	0.19825	0.03887	50	50
3	2	13	BUS13	11	BUS11	0.00314	0.01570	0.05275		
						0.00941	0.04714	0.03692	50	50
3	1	13	BUS13	16	BUS16	0.00578	0.02891	0.02429		
						0.01734	0.08674	0.01700	50	50
3	1	16	BUS16	11	BUS11	0.00495	0.02478	0.02082		
						0.01486	0.07434	0.01457	50	50
3	1	16	BUS16	17	BUS17	0.00248	0.01239	0.01041		
						0.00743	0.03717	0.00729	50	50
3	4	5	BUS5	6	BUS6	0.00450	0.02251	0.30260		
						0.01350	0.06753	0.21180	50	50
3	1	6	BUS6	7	BUS7	0.03716	0.18586	0.15616		
						0.11147	0.55759	0.10930	50	50
3	1	6	BUS6	13	BUS13	0.05169	0.25856	0.21723		
						0.15506	0.77567	0.15210	50	50
3	3	6	BUS6	16	BUS16	0.01530	0.07655	0.57882		
						0.04591	0.22964	0.40530	50	50
3	2	6	BUS6	8	BUS8	0.01239	0.06195	0.20822		
						0.03716	0.18586	0.14572	50	50
3	2	8	BUS8	9	BUS9	0.00363	0.01817	0.06107		
						0.01090	0.05452	0.04276	50	50
3	2	8	BUS8	10	BUS10	0.00330	0.01652	0.05552		
						0.00991	0.04956	0.03886	50	50
3	2	18	BUS18	19	BUS19	0.00537	0.02685	0.09022		
						0.01610	0.08054	0.06316	50	50
3	2	19	BUS19	5	BUS5	0.01263	0.06319	0.21237		
						0.03790	0.18958	0.14866	50	50
3	2	19	BUS19	20	BUS20	0.01131	0.05658	0.19016		
						0.03394	0.16975	0.13310	50	50
3	1	20	BUS20	24	BUS24	0.01982	0.09913	0.08328		
						0.05945	0.29738	0.05832	50	50
3	1	24	BUS24	5	BUS5	0.02494	0.12473	0.10480		
						0.07418	0.37420	0.07336	50	50
3	1	22	BUS22	23	BUS23	0.03633	0.18173	0.15269		
						0.10899	0.54520	0.10690	50	50
3	2	22	BUS22	20	BUS20	0.01734	0.08674	0.29149		

MiP-PSCT

How to solve YBR

3	1	22	BUS22	21	BUS21	0.05202	0.26021	0.20400	50	50
						0.00330	0.01652	0.01388		
						0.00991	0.04956	0.00972	50	50

GENERATOR DATA

FROM NODE	FROM NAME	POSITIVE R(P.U.) X(P.U.)		NEGATIVE R(P.U.) X(P.U.)		ZERO R(P.U.) X(P.U.)		CB-MVA
4	BUS4	0.00050	0.02625	0.00050	0.02625	0.00050	0.02625	50
1	BUS1	0.00125	0.03409	0.00125	0.03409	0.00125	0.03409	50
2	BUS2	0.00100	0.07470	0.00100	0.07480	0.00100	0.07480	50
3	BUS3	0.00050	0.03735	0.00050	0.03740	0.00050	0.03740	50

----- LOAD

DATA

NODE NAME

- 11 BUS11
- 17 BUS17
- 7 BUS7
- 12 BUS12
- 13 BUS13
- 6 BUS6
- 9 BUS9
- 10 BUS10
- 20 BUS20
- 23 BUS23
- 21 BUS21
- 16 BUS16
- 19 BUS19
- 24 BUS24

Number of reduced buses: 4

Reduced bus array:

- 1 2 3 4

POSITIVE SEQUENCE ADMITTANCE MATRIX ELEMENTS FOR THE GIVEN SYSTEM

ROW NO	COLUMN NO	REAL	IMAGINARY
1	1	1.57674	-9.97533
1	2	-0.55642	5.07156
1	3	-0.48112	3.10001
1	4	-0.54116	5.82485
2	1	-0.55642	5.07156
2	2	0.80100	-6.49955

2	3	-0.16692	1.67456
2	4	-0.08116	0.47480
3	1	-0.48112	3.10001
3	2	-0.16692	1.67456
3	3	0.71590	-4.07908
3	4	-0.06290	0.28943
4	1	-0.54116	5.82485
4	2	-0.08116	0.47480
4	3	-0.06290	0.28943
4	4	0.77828	-4.28315

----- NEGATIVE

SEQUENCE ADMITTANCE MATRIX ELEMENTS FOR THE GIVEN SYSTEM

ROW NO	COLUMN NO	REAL	IMAGINARY
1	1	1.57674	-9.97533
1	2	-0.55642	5.07156
1	3	-0.48112	3.10001
1	4	-0.54116	5.82485
2	1	-0.55642	5.07156
2	2	0.80100	-6.49955
2	3	-0.16692	1.67456
2	4	-0.08116	0.47480
3	1	-0.48112	3.10001
3	2	-0.16692	1.67456
3	3	0.71590	-4.07908
3	4	-0.06290	0.28943
4	1	-0.54116	5.82485
4	2	-0.08116	0.47480
4	3	-0.06290	0.28943
4	4	0.77828	-4.28315

----- ZERO

SEQUENCE ADMITTANCE MATRIX ELEMENTS FOR THE GIVEN SYSTEM

ROW NO	COLUMN NO	REAL	IMAGINARY
1	1	1.85798	2.79557
1	2	-0.38654	2.97755
1	3	-0.20996	1.32202
1	4	-0.00000	-0.00000
2	1	-0.38654	2.97755
2	2	0.54724	-3.25450
2	3	-0.12810	0.93226
2	4	-0.00000	-0.00000
3	1	-0.20996	1.32202
3	2	-0.12810	0.93226
3	3	0.35595	-1.48148
3	4	-0.00000	-0.00000

4	1	-0.00000	-0.00000
4	2	-0.00000	-0.00000
4	3	-0.00000	-0.00000
4	4	0.00000	0.00000

RETAINED ZONE : 0

NUMBER OF SERIES ELEMENTS IN THE REDUCED ZONES : 6

SERIES CONNECTIONS

SLNO	FROM	NAME	TO	NAME	RP	XP	BP/2	RZ	XZ	BZ/2
1	1	BUS1	2	BUS2	0.021376	0.194833	0.0	0.042877	0.330280	0.0
2	1	BUS1	3	BUS3	0.048886	0.314993	0.0	0.117178	0.737806	0.0
3	1	BUS1	4	BUS4	0.015813	0.170209	0.0	0.000000	9999.000	0.0
4	2	BUS2	3	BUS3	0.058939	0.591298	0.0	0.144667	1.052787	0.0
5	2	BUS2	4	BUS4	0.349794	2.046351	0.0	0.000000	9999.000	0.0
6	3	BUS3	4	BUS4	0.717003	3.299303	0.0	0.000000	9999.000	0.0

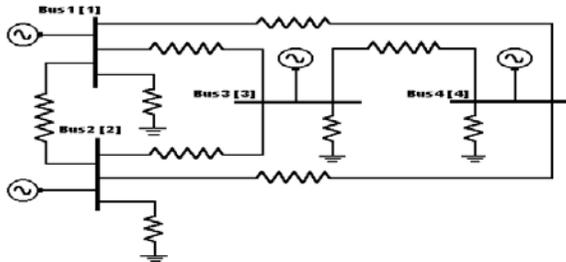
NUMBER OF SHUNT ELEMENTS IN THE REDUCED ZONES : 4

SHUNT CONNECTIONS IN (G+JB) FORMAT - PU

SLNO	FROM	NAME	GP	BP	GZ	BZ
1	1	BUS1	-0.00196	4.02109	1.26147	7.09515
2	2	BUS2	-0.00350	0.72137	0.03259	0.65530
3	3	BUS3	0.00497	0.98491	0.01788	0.77280
4	4	BUS4	0.09307	2.30593	-0.00000	-0.00000

Reduced system

Retaining all generator buses

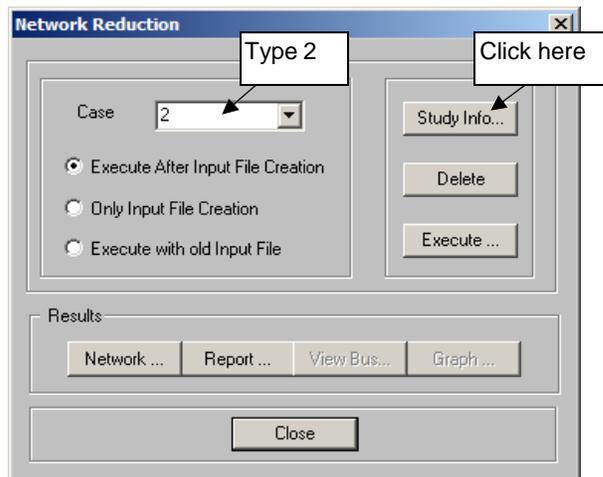


4.9 Procedure to do Case 2

CASE 2 : Retaining all generator buses and zone 1 buses

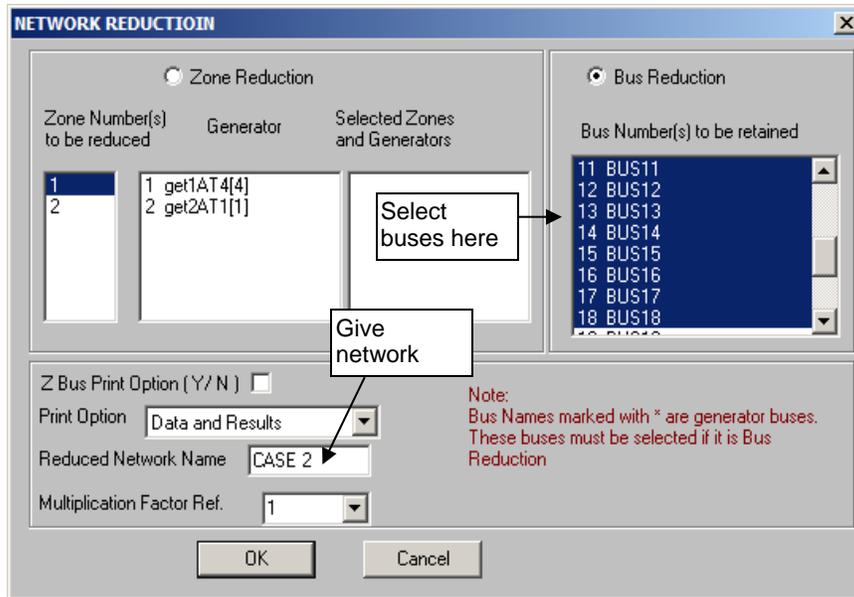
Fig 1 24Bus system is reduced with retaining all the buses to which the generators are connected, and buses belonging to Zone1, such as 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17 are also retained. All connections in zone 2 are reduced as equivalent series impedance and shunt admittance.

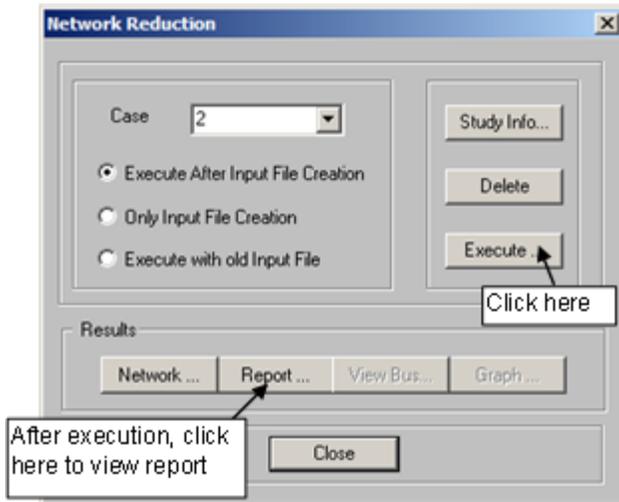
Select menu option **Solve -> Network Reduction**



Study Information

Following study information screen will open. In that select zone 1 buses and all generator buses.



Executing and viewing the report:

Network Reduction Report for case 2

NETWORK REDUCTION

CASE NO : 12 CONTINGENCY : 0 SCHEDULE NO : 0
 CONTINGENCY NAME : Base Case

 %%

TOTAL NUMBER OF BUSES	:	24	ACTUAL NUMBER OF BUSES	:	24
NUMBER OF 2 WIND. TRANSFORMERS	:	5	NUMBER OF 3 WIND. TRANSFORMERS	:	0
NUMBER OF TRANSMISSION LINES	:	22			
NUMBER OF SERIES REACTORS	:	0	NUMBER OF SERIES CAPACITORS	:	0
NUMBER OF BUS COUPLERS	:	0			
NUMBER OF SHUNT REACTORS	:	0	NUMBER OF SHUNT CAPACITORS	:	0
NUMBER OF SHUNT IMPEDANCES	:	0	NUMBER OF GENERATORS	:	4
NUMBER OF LOADS	:	14			
NUMBER OF FILTERS	:	0			
NUMBER OF HVDC CONVERTORS	:	0			

 NUMBER OF ZONES : 2
 PRINT OPTION : 3 (BOTH DATA AND RESULTS PRINT)
 BASE MVA : 100.000
 NOMINAL SYSTEM FREQUENCY: 50.000
 PREFault VOLTAGE OPTION : 1 (READ FROM THE FILE)
 ZONE NUMBER RETAINED : 0
 ZBUS PRINT OPTION : 0
 YBUS REDUCTION OPTION : 1 (NETWORK REDUCTION)

17										
1	2	3	4	5	6	7	8	9	10	
11	12	13	14	15	16	17				

 CIRCUIT BREAKER RESISTANCE (PU) : 0.000000
 CIRCUIT BREAKER REACTANCE (PU) : 0.000100
 TRANSFORMER R/X RATIO : 0.050000
 TRANSFORMER ZERO SEQUENCE IMPEDANCE MULT FACTOR : 0.900000

NUMBER OF TRANSMISSION VOLTAGE LEVELS	:	3
TRANSMISSION LINE VOLTAGE - KV	:	11.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR	:	0.000000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR	:	0.000000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR	:	0.000000
TRANSMISSION LINE VOLTAGE - KV	:	220.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR	:	2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR	:	2.500000

```

TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000
TRANSMISSION LINE VOLTAGE - KV : 400.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000
GENERATOR NEGATIVE SEQUENCE RESISTANCE MULT. FACTOR : 0.175000
GENERATOR NEGATIVE SEQUENCE REACTANCE MULT. FACTOR : 0.175000
GENERATOR ZERO SEQUENCE RESISTANCE MULT. FACTOR : 0.037500
GENERATOR ZERO SEQUENCE REACTANCE MULT. FACTOR : 0.037500
LOAD NEGATIVE SEQUENCE IMPEDANCE MULT. FACTOR : 0.810000
LOAD ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.600000
SERIES REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.000000
SHUNT REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 0.625000

```

Number of reduced buses : 17

Reduced bus array :

```

  1   2   3   4   5   6   7   8   9   10
 11  12  13  14  15  16  17

```

RETAINED ZONE : 0

NUMBER OF SERIES ELEMENTS IN THE REDUCED ZONES : 3

SERIES CONNECTIONS

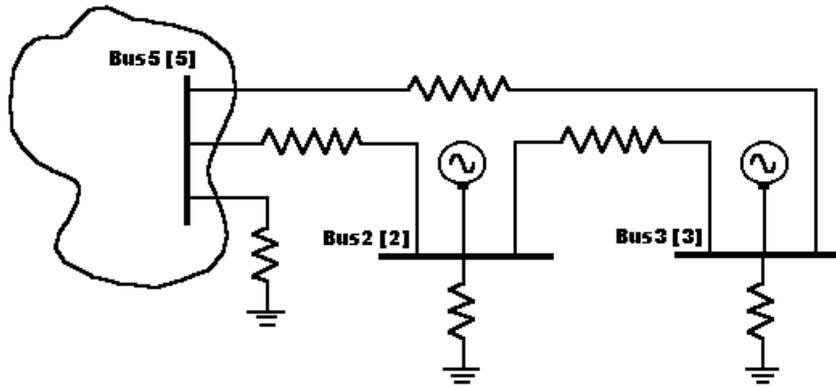
SLNO	FROM	NAME	TO	NAME	RP	XP	BP/2	RZ	XZ	BZ/2
1	2	BUS2	3	BUS3	0.052959	0.698685	0.0	0.144805	1.117180	0.0
2	2	BUS2	5	BUS5	0.021307	0.167338	0.0	0.053638	0.341475	0.0
3	3	BUS3	5	BUS5	0.046777	0.270327	0.0	0.142020	0.762220	0.0

NUMBER OF SHUNT ELEMENTS IN THE REDUCED ZONES : 3

SHUNT CONNECTIONS IN (G+JB) FORMAT - PU

SLNO	FROM	NAME	GP	BP	GZ	BZ
1	2	BUS2	0.02202	0.39125	0.01230	0.36643
2	3	BUS3	0.02972	0.78283	0.01249	0.64382
3	5	BUS5	-0.03960	1.19377	-0.01182	0.66770

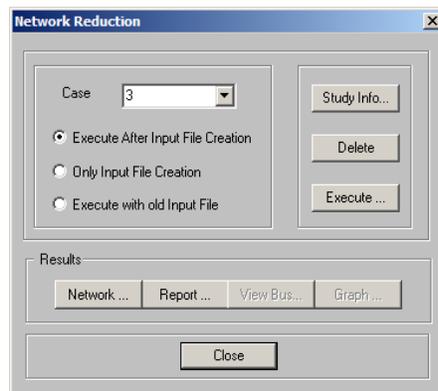
Reduced network retaining all generator buses and zone 1 buses is shown below.



4.10 Case 3 : Retaining all zone 1 buses

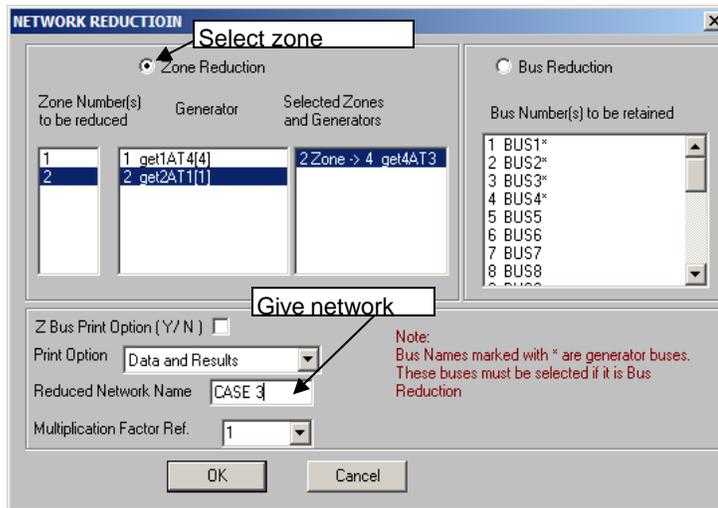
24 Bus Typical System Network reduced with retaining all the Zone1 buses, such as 1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17.

Select menu option **Solve ->Network Reduction**

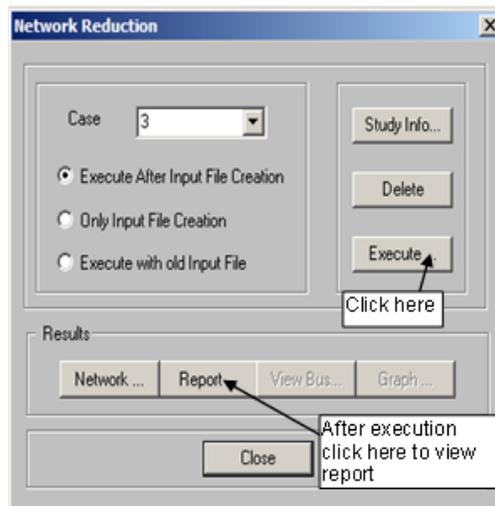


Study Information

Following study information screen will open.



Executing and Viewing the Report



Network Reduction Report for Case 3:

NETWORK REDUCTION

CASE NO : 13 CONTINGENCY : 0 SCHEDULE NO : 0

CONTINGENCY NAME : Base Case

%%

TOTAL NUMBER OF BUSES	:	24	ACTUAL NUMBER OF BUSES	:	24
NUMBER OF 2 WIND. TRANSFORMERS	:	5	NUMBER OF 3 WIND. TRANSFORMERS	:	0
NUMBER OF TRANSMISSION LINES	:	22			
NUMBER OF SERIES REACTORS	:	0	NUMBER OF SERIES CAPACITORS	:	0
NUMBER OF BUS COUPLERS	:	0			
NUMBER OF SHUNT REACTORS	:	0	NUMBER OF SHUNT CAPACITORS	:	0
NUMBER OF SHUNT IMPEDANCES	:	0	NUMBER OF GENERATORS	:	4
NUMBER OF LOADS	:	14			
NUMBER OF FILTERS	:	0			
NUMBER OF HVDC CONVERTORS	:	0			

NUMBER OF ZONES	:	2
PRINT OPTION	:	3 (BOTH DATA AND RESULTS PRINT)
BASE MVA	:	100.000
NOMINAL SYSTEM FREQUENCY	:	50.000
PREFault VOLTAGE OPTION	:	1 (READ FROM THE FILE)
ZONE NUMBER RETAINED	:	1
ZBUS PRINT OPTION	:	0

YBUS REDUCTION OPTION : 1 (NETWORK REDUCTION)

NUMBER OF GENERATORS IN THE EXTERNAL SYSTEM	:	2
RETAINED GENERATOR BUS IN THE EXTERNAL SYSTEM	:	3

CIRCUIT BREAKER RESISTANCE (PU)	:	0.000000
CIRCUIT BREAKER REACTANCE (PU)	:	0.000100
TRANSFORMER R/X RATIO	:	0.050000
TRANSFORMER ZERO SEQUENCE IMPEDANCE MULT FACTOR	:	0.900000
NUMBER OF TRANSMISSION VOLTAGE LEVELS	:	3
TRANSMISSION LINE VOLTAGE - KV	:	11.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR	:	0.000000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR	:	0.000000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR	:	0.000000
TRANSMISSION LINE VOLTAGE - KV	:	220.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR	:	2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR	:	2.500000

```

TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000
TRANSMISSION LINE VOLTAGE - KV : 400.000000
TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000

GENERATOR NEGATIVE SEQUENCE RESISTANCE MULT. FACTOR : 0.175000
GENERATOR NEGATIVE SEQUENCE REACTANCE MULT. FACTOR : 0.175000
GENERATOR ZERO SEQUENCE RESISTANCE MULT. FACTOR : 0.037500
GENERATOR ZERO SEQUENCE REACTANCE MULT. FACTOR : 0.037500
LOAD NEGATIVE SEQUENCE IMPEDANCE MULT. FACTOR : 0.810000
LOAD ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.600000
SERIES REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.000000
SHUNT REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 0.625000

```

BUS DATA

NODE	STAT	ZONE	BUS-KV	NAME	VMAG-PU	VANG-DEG	PGEN-MW	QGEN-MR
						PLOAD-MW	QLOAD-MR	QCOMP-MR
1	1	1	11.000	BUS1	1.0200	0.000	563.710	19.590
						0.000	0.000	0.000
2	1	2	11.000	BUS2	1.0200	1.609	125.000	22.500
						0.000	0.000	0.000
3	1	2	11.000	BUS3	1.0200	3.521	190.000	39.570
						0.000	0.000	0.000
4	1	1	11.000	BUS4	1.0200	3.906	380.000	35.270
						0.000	0.000	0.000
5	1	1	220.000	BUS5	1.0164	-4.319	0.000	0.000
						0.000	0.000	0.000
6	1	1	220.000	BUS6	1.0050	-10.410	0.000	0.000
						70.240	30.100	30.000
7	1	1	220.000	BUS7	0.9676	-19.848	0.000	0.000
						146.630	39.100	30.000
8	1	1	220.000	BUS8	0.9756	-14.538	0.000	0.000
						0.000	0.000	0.000
9	1	1	220.000	BUS9	0.9737	-14.852	0.000	0.000
						29.450	9.820	0.000
10	1	1	220.000	BUS10	0.9650	-15.333	0.000	0.000
						87.820	48.790	0.000
11	1	1	220.000	BUS11	0.9733	-15.094	0.000	0.000
						34.350	14.720	0.000
12	1	1	220.000	BUS12	0.9567	-17.674	0.000	0.000
						29.100	9.700	0.000
13	1	1	220.000	BUS13	0.9641	-16.518	0.000	0.000
						146.270	58.510	0.000
14	1	1	400.000	BUS14	0.9814	-12.324	0.000	0.000
						0.000	0.000	0.000
15	1	1	400.000	BUS15	1.0104	-2.002	0.000	0.000

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16	1	1	220.000	BUS16	0.9638	0.000	0.000	0.000	
						-16.860	0.000	0.000	
						224.240	58.500	0.000	
17	1	1	220.000	BUS17	0.9593	-17.271	0.000	0.000	
						58.310	24.300	0.000	
18	1	2	220.000	BUS18	1.0039	-3.226	0.000	0.000	
						0.000	0.000	0.000	
19	1	2	220.000	BUS19	0.9922	-5.084	0.000	0.000	
						129.290	99.460	0.000	
20	1	2	220.000	BUS20	0.9910	-5.827	0.000	0.000	
						49.690	34.780	0.000	
21	1	2	220.000	BUS21	0.9882	-3.029	0.000	0.000	
						72.400	47.600	0.000	
22	1	2	220.000	BUS22	0.9984	-2.423	0.000	0.000	
						0.000	0.000	0.000	
23	1	2	220.000	BUS23	0.9470	-7.400	0.000	0.000	
						48.170	28.900	0.000	
24	1	2	220.000	BUS24	0.9726	-7.973	0.000	0.000	
						93.190	49.050	0.000	

 TRANSFORMER DATA

STAT	CKTS	FROM	FROM	TO	TO	POSITIVE						
						ZERO	NODE	NAME	NODE	NAME		
						R(P.U.)	X(P.U.)	R(P.U.)	X(P.U.)			
						TAP		PHASE		FB-MVA	TB-MVA	
3	2	4	BUS4	15	BUS15	0.00140	0.02804	0.00140	0.02804			
						1.00000	0.000	50	50	S	D	
3	1	14	BUS14	11	BUS11	0.00063	0.01250	0.00063	0.01250			
						1.00000	0.000	50	50	G	G	
3	8	5	BUS5	1	BUS1	0.00069	0.01387	0.00069	0.01387			
						1.00000	0.000	50	50	G	G	
3	1	2	BUS2	18	BUS18	0.00348	0.06968	0.00348	0.06968			
						1.00000	0.000	50	50	G	G	
3	1	3	BUS3	22	BUS22	0.00280	0.05609	0.00280	0.05609			
						1.00000	0.000	50	50	G	G	

 TRANSMISSION LINE DATA

STAT	CKTS	FROM	FROM	TO	TO					
						RP(P.U.)	XP(P.U.)	BP/2(PU)		
		NODE NAME		NODE NAME		RZ(P.U.)	XZ(P.U.)	BZ/2(PU)	FC-MVA	TC-MVA
3	1	15	BUS15	14	BUS14	0.00430	0.04770	0.63700		
						0.00860	0.09540	0.50000	50	50
3	1	7	BUS7	11	BUS11	0.02444	0.12226	0.10272		
						0.07332	0.36677	0.07190	50	50
3	1	12	BUS12	13	BUS13	0.01321	0.06608	0.05552		

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3	2	13	BUS13	11	BUS11	0.03963	0.19825	0.03887	50	50
						0.00314	0.01570	0.05275		
						0.00941	0.04714	0.03692	50	50
3	1	13	BUS13	16	BUS16	0.00578	0.02891	0.02429		
						0.01734	0.08674	0.01700	50	50
3	1	16	BUS16	11	BUS11	0.00495	0.02478	0.02082		
						0.01486	0.07434	0.01457	50	50
3	1	16	BUS16	17	BUS17	0.00248	0.01239	0.01041		
						0.00743	0.03717	0.00729	50	50
3	4	5	BUS5	6	BUS6	0.00450	0.02251	0.30260		
						0.01350	0.06753	0.21180	50	50
3	1	6	BUS6	7	BUS7	0.03716	0.18586	0.15616		
						0.11147	0.55759	0.10930	50	50
3	1	6	BUS6	13	BUS13	0.05169	0.25856	0.21723		
						0.15506	0.77567	0.15210	50	50
3	3	6	BUS6	16	BUS16	0.01530	0.07655	0.57882		
						0.04591	0.22964	0.40530	50	50
3	2	6	BUS6	8	BUS8	0.01239	0.06195	0.20822		
						0.03716	0.18586	0.14572	50	50
3	2	8	BUS8	9	BUS9	0.00363	0.01817	0.06107		
						0.01090	0.05452	0.04276	50	50
3	2	8	BUS8	10	BUS10	0.00330	0.01652	0.05552		
						0.00991	0.04956	0.03886	50	50
3	2	18	BUS18	19	BUS19	0.00537	0.02685	0.09022		
						0.01610	0.08054	0.06316	50	50
3	2	19	BUS19	5	BUS5	0.01263	0.06319	0.21237		
						0.03790	0.18958	0.14866	50	50
3	2	19	BUS19	20	BUS20	0.01131	0.05658	0.19016		
						0.03394	0.16975	0.13310	50	50
3	1	20	BUS20	24	BUS24	0.01982	0.09913	0.08328		
						0.05945	0.29738	0.05832	50	50
3	1	24	BUS24	5	BUS5	0.02494	0.12473	0.10480		
						0.07418	0.37420	0.07336	50	50
3	1	22	BUS22	23	BUS23	0.03633	0.18173	0.15269		
						0.10899	0.54520	0.10690	50	50
3	2	22	BUS22	20	BUS20	0.01734	0.08674	0.29149		
						0.05202	0.26021	0.20400	50	50
3	1	22	BUS22	21	BUS21	0.00330	0.01652	0.01388		
						0.00991	0.04956	0.00972	50	50

 GENERATOR DATA

FROM NODE	FROM NAME	POSITIVE		NEGATIVE		ZERO		CB-MVA
		R(P.U.)	X(P.U.)	R(P.U.)	X(P.U.)	R(P.U.)	X(P.U.)	
4	BUS4	0.00050	0.02625	0.00050	0.02625	0.00050	0.02625	50
1	BUS1	0.00125	0.03409	0.00125	0.03409	0.00125	0.03409	50
2	BUS2	0.00100	0.07470	0.00100	0.07480	0.00100	0.07480	50
3	BUS3	0.00050	0.03735	0.00050	0.03740	0.00050	0.03740	50

LOAD DATA

NODE NAME

```

-----
 11   BUS11
 17   BUS17
  7   BUS7
 12   BUS12
 13   BUS13
  6   BUS6
  9   BUS9
 10   BUS10
 20   BUS20
 23   BUS23
 21   BUS21
 16   BUS16
 19   BUS19
 24   BUS24
-----

```

EXTERNAL GENERATOR DATA

SLNO BUSNO NAME INERTIA-H-PU

```

-----
  1   2   BUS2   11.413
  2   3   BUS3   11.413

```

Number of reduced buses : 4

Reduced bus array :

```

 26   25   19   24
-----

```

RETAINED ZONE: 1

NUMBER OF SERIES ELEMENTS IN THE REDUCED ZONES: 3

SERIES CONNECTIONS

SLNO FROMNAME TO NAME RP XP BP/2 RZ

XZ BZ/2

```

-----
  1  26   GEN3  19   BUS19 0.005764 0.110167 0.0   0.035423
0.769343 0.0
  2  26   GEN3  24   BUS24 0.032432 0.587300 0.0   0.062020
1.347783 0.0
  3  19   BUS19  24   BUS24 0.035152 0.187472 0.0   0.099468
0.620119 0.0
-----

```

NUMBER OF SHUNT ELEMENTS IN THE REDUCED ZONES : 3

SHUNT CONNECTIONS IN (G+JB) FORMAT - PU

SLNO FROM NAME GP BP GZ BZ

```

-----
  1  19   BUS19 1.90970 -0.24798 2.10356 -5.24444
  2  24   BUS24 1.31295 -0.34366 1.20133 -0.48369
  3  26   GEN3  0.82939 -0.61373 0.91642 -0.43791
-----

```

EQUIVALENT GENERATOR INERTIA CONSTANT - PU : 22.82422

EQUIVALENT GENERATOR REAL POWER - MW : 315.55176
EQUIVALENT GENERATOR REACTIVE POWER - MVAR : 86.34813
EQUIVALENT GENERATOR TERMINAL VOLTAGE MAG : 1.00000

EQUIVALENT GENERATOR TERMINAL VOLTAGE ANG-D: 6.99663
EQUIVALENT GENERATOR RESISTANCE PU : 0.00000
EQUIVALENT GENERATOR REACTANCE PU : 0.00001

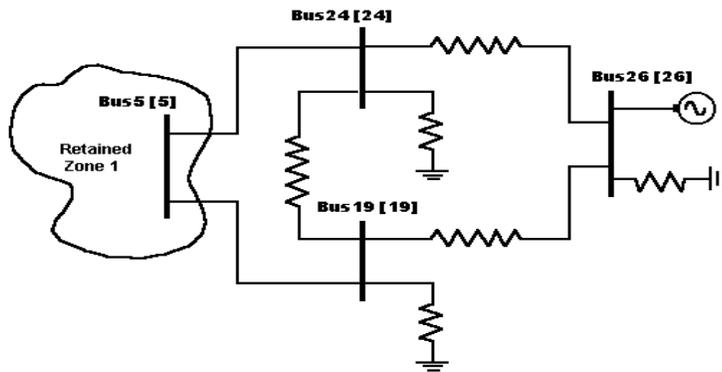
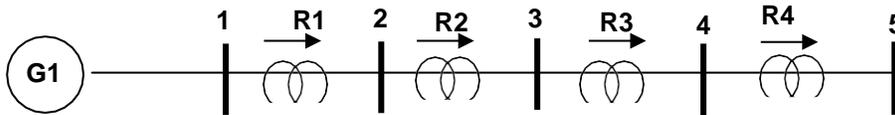


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5. How to solve Relay Co-ordination

Perform relay co -ordination study for the radial system shown below.



The relay make is as follows

Relay rated current = 5 Amps

Plug setting = 50% to 250% in steps of 25%

Time setting multiplier = 0.05 to 1.0 in steps of 0.01

Relay details

Relay Name	R1	R2	R3	R4
Primary Rating (1,2,3,4)	800	400	200	100
Secondary Rating in A	5	5	5	5
Load Current in A	800	400	200	100
Relay type	3sec	3sec	3sec	3sec

Transmission line details on 100 MVA base:

Bus - code	Impedance Z_{pq} in pu	Line charging in pu
p-q	Z_{pq}	$Y'_{pq}/2$
1-2	$0.00 + j0.1$	0
2-3	$0.00 + j0.1$	0
3-4	$0.00 + j0.1$	0
4-5	$0.00 + j0.1$	0

Generator Details:**G1 = 100 MVA, 11kV****Maximum fault level = 1000 MVA.**

Interpretation according to MiP-PSCT:

Observe transmission line details. You find that all lines have similar parameters.

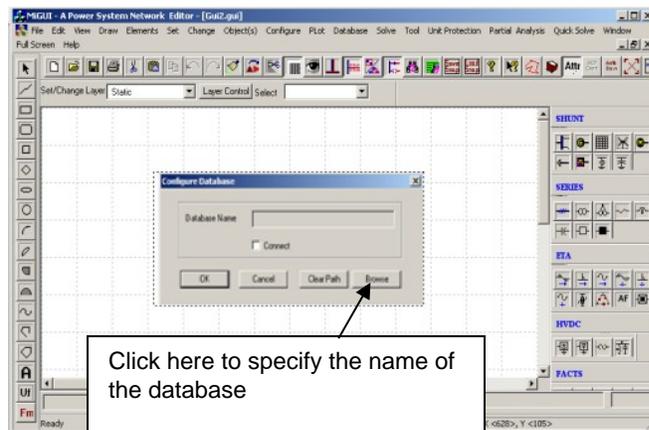
Therefore no. of transmission line libraries = 1

No of generator libraries = 1**As all the relays are of 3 sec type, no of relay libraries = 1**

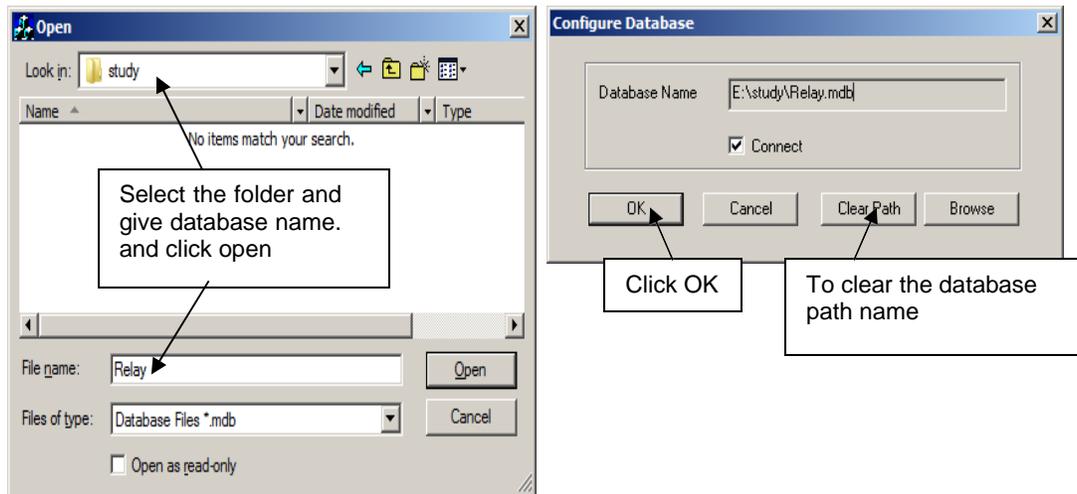
Procedure to enter the data for performing studies using MiP-PSCT.

MiP-PSCT - Database ConfigurationOpen power system network editor. Select menu option **Database → Configure**.

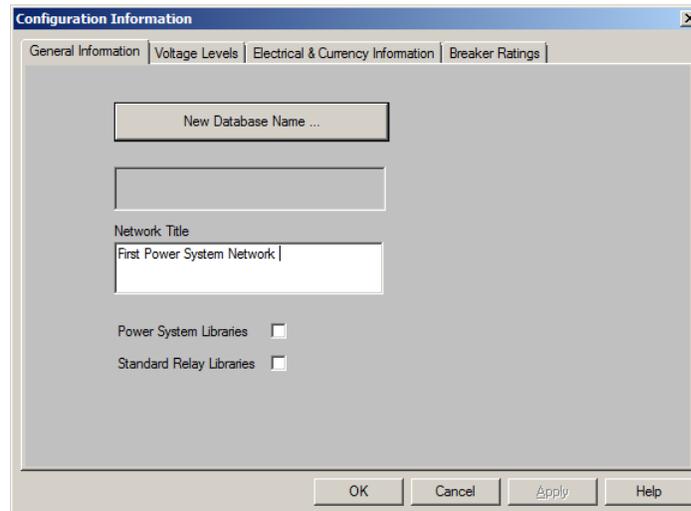
Configure Database dialog is popped up as shown below. Click Browse button.



Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click **O**pen button after entering the desired database name. Configure Database dialog will appear with path chosen.

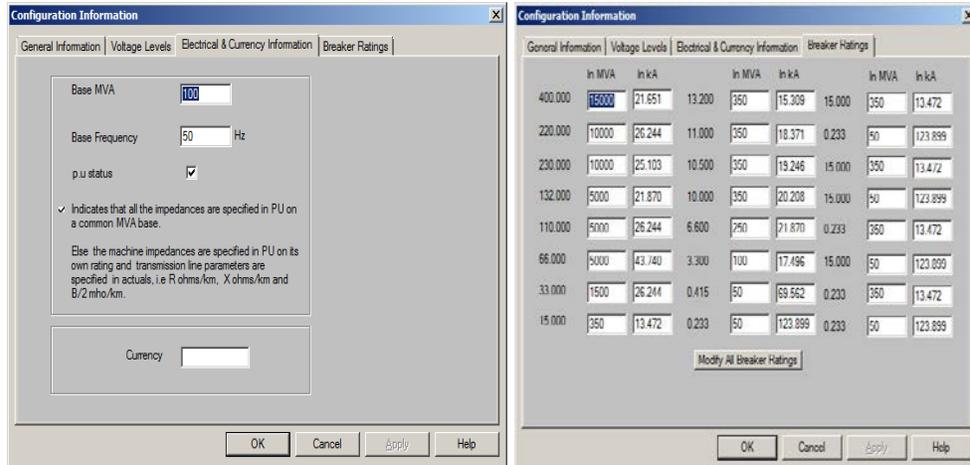


Click OK button on the **Configure database** dialog, the dialog shown below appears.



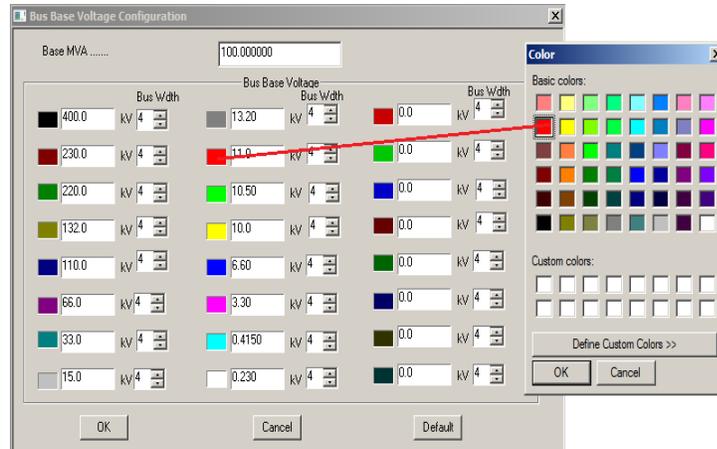
Uncheck the Power System Libraries and Check Standard Relay Libraries. If libraries are selected, standard libraries will be loaded along with the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base check the pu status

as shown below. Enter the Base MVA and Base frequency as shown below. Click **OK** button to create the database to return to Network Editor.



Bus Base Voltage Configuration

In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure**→**Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click OK.

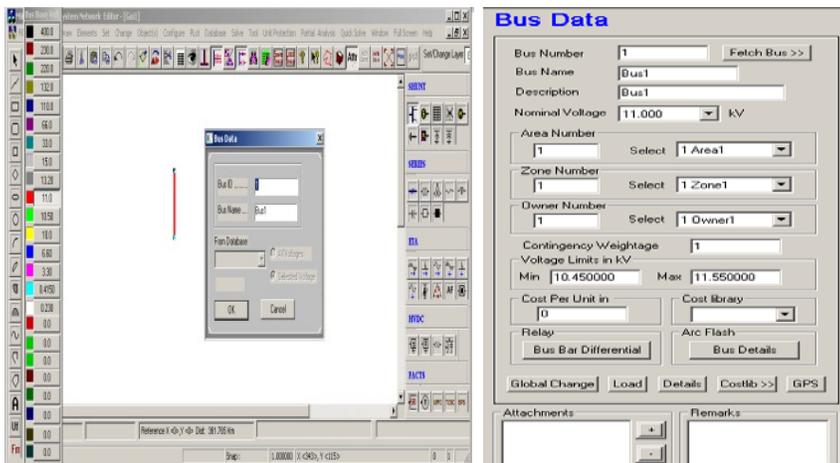


5.1 Procedure to Draw First Element - Bus

Click on Bus icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID number and Bus Name. Click OK. Database manager with corresponding Bus Data form will appear.

Modify the Area number, Zone number and Contingency Weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are other than this, modify these fields. Otherwise keep the default values.

Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is Northeast, then bus name can be given as NE and the bus description field can be North East.



After entering data click Save , which invokes Network Editor. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Calculation of X_d , X_d' , X_d'' :

For maximum fault level, $X_d = X_d' = X_d'' = 100 / 1000 = 0.1 \text{ pu} = X_n = X_0$

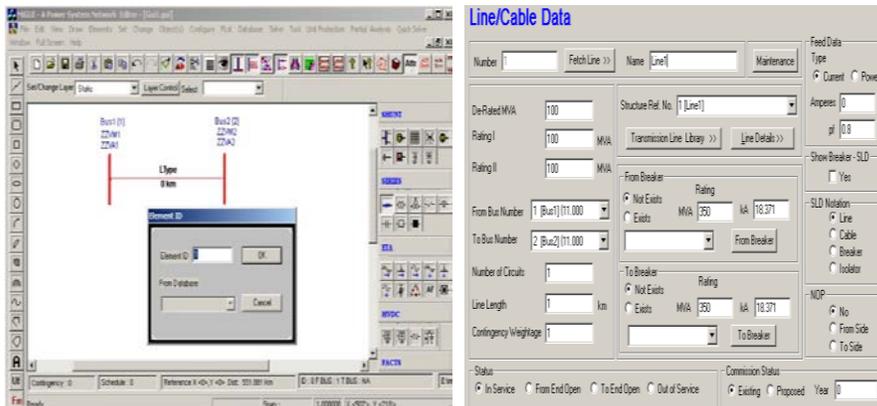
Bus Data					
Bus Number	1	2	3	4	5
Bus Name	Bus-1	Bus-2	Bus-3	Bus-4	Bus-5
Nominal voltage in kV	11	11	11	11	11
Area number	1	1	1	1	1
Zone number	1	1	1	1	1
Contingency weightage	1	1	1	1	1

5.2 Procedure to Draw Transmission Line

Click on Transmission **Line** icon provided on power system tool bar. Draw the line by double clicking LMB (Left Mouse Button) first on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. The **Element ID** dialog will appear.

Enter **Element ID** number and click OK. Database manager with corresponding **Line\Cable Data** form will be open.

Enter the details of that line as shown. Enter **Structure Ref No. as 1** and click on **Transmission Line Library >>** button. **Line & Cable Library** form will appear.



Enter transmission line library data in the form as shown below for Line1-2.

Line and Cable Library

Structure Reference

Number Name

Positive Sequence Resistance pu

Positive Sequence Reactance pu

Positive Sequence Susceptance (B/2) pu

Zero Sequence Resistance pu

Zero Sequence Reactance pu

Zero Sequence Susceptance (B/2) pu

Thermal Rating MVA

Line Harmonic Number

Cost per km Cost Per Unit in

Surge Impedance

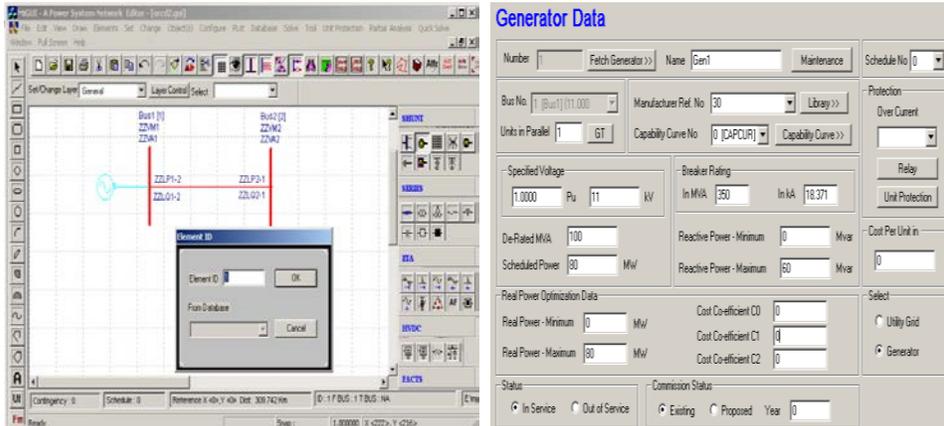
Z Ohms

V kms/sec

Element Details				
Line Number	1	2	3	4
Line Name	Line1-2	Line2-3	Line3-4	Line4-5
De-Rated MVA	100	100	100	100
No. Of Circuits	1	1	1	1
From Bus No.	1	2	3	4
To Bus No.	2	3	4	5
Line Length in km	1	1	1	1
From Breaker Rating in MVA	5000	5000	5000	5000
To Breaker Rating in MVA	5000	5000	5000	5000
Structure Reference No.	1	1	1	1

5.3 Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Connect it to Bus 1 by clicking the LMB on Bus 1. **Element ID** dialog will appear. Enter ID number and click OK. Database with corresponding **Generator Data** form will appear. Enter details as shown



The screenshot shows the 'Generator Data' dialog box with the following fields and values:

- Number: Gen1
- Name: Gen1
- Schedule No: 0
- Bus No: Bus1 (11.000)
- Manufacturer Ref. No: 30
- Units in Parallel: 1
- Capacity Curve No: 0 (CAPCUR)
- Specified Voltage: 1.000 pu, 11 kV
- Breaker Rating: In MVA 30, In IA 18.371
- De-Rated MVA: 100
- Scheduled Power: 30 Mw
- Reactive Power - Minimum: 0 Mvar
- Reactive Power - Maximum: 50 Mvar
- Real Power Optimizer Data: Real Power - Minimum 0 Mw, Real Power - Maximum 30 Mw
- Cost Coefficient C0: 0, Cost Coefficient C1: 0, Cost Coefficient C2: 0
- Status: In Service (selected), Out of Service, Existing, Proposed, Year 0

The 'Element ID' dialog box shows:

- Element ID: []
- Fun Database: []

below.

Enter Manufacturer Ref. No. as 30 and click on **Generator Library** button. Generator library form will appear. Click compute button to enter 3 phase and SLG fault level as 1000 MVA.

Generator Library

Ref. Number: 30 Fetch Generator Manufacturer Name: Gen30

MVA Rating: 100 MW Rating: 30 kV Rating: 11 Compute >[d,"d,n,0]

pu on Common MVA Base	
Armature Resistance (R _a)	0 pu
Direct Axis Reactance (X _d)	0.1 pu
Quadrature Axis Reactance (X _q)	0 pu
Negative Seq. Reactance (X _n)	0.1 pu
Zero Seq. Reactance (X ₀)	0.1 pu
Direct Axis Open Circuit Transient Time Constant (T' _{do})	0
Quadrature Axis Open Circuit Transient Time Constant (T'' _{qo})	0
Direct Axis Open Circuit Sub-Transient Time Constant (T'' _{do})	0
Quadrature Axis Open Circuit Sub-Transient Time Constant (T'' _{qo})	0
Inertia in MJ/MVA	3.31
Damping Factor	0

Winding Connections: Y Δ Z

Mass Details:

Mass Number: 0 Inertia: 0 MJ/MVA Damping Factor: 0 Stiffness Co-efficient: 0 pu torque/Elec. Rad

Cost Per Unit in: 0

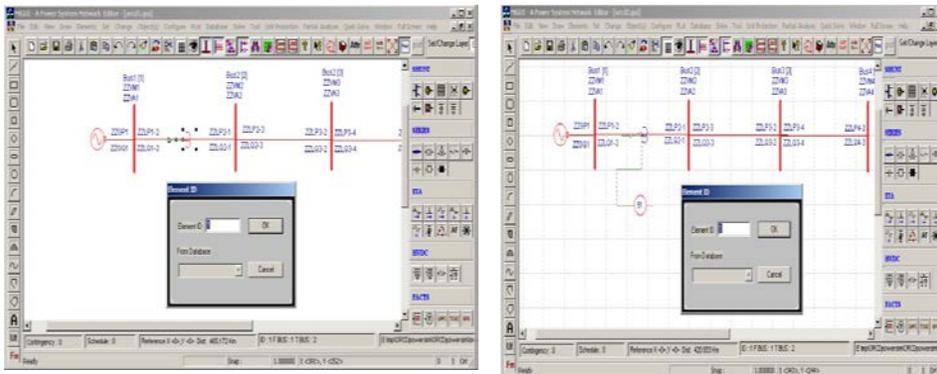
Thermal Curves: Thermob >

Buttons: Next >>, << Back, Delete

After entering data **Save**  and **close**. In **Generator Data** form, click **Save** . **Network Editor** screen will be invoked.

5.4 Procedure to Draw Relay

Select current transformer from power system tool bar and place it on from side of the line as shown in the following diagram. Select relay element from power system tool bar or from the main menu select **Power system->Relay** and click on GUI. Relay type dialog appears



Select IDMT Over Current (51) and click OK. Terminate the relay on current transformer which invokes Relay Database form.

Relay Type

Display Text

Relay Types

<input checked="" type="radio"/> IDMT Over Current (51)	<input type="radio"/> Distance Relay (21)
<input type="radio"/> IDMT Earth Fault (51N)	<input type="radio"/> Line Pilot (87P)
<input type="radio"/> Instantaneous Over Current (50)	<input type="radio"/> Transformer Differential (87T)
<input type="radio"/> Instantaneous Earth Fault (50N)	<input type="radio"/> Restricted Earth Fault (87N)
<input type="radio"/> Directional IDMT Over Current (67)	<input type="radio"/> Bus Bar Differential (87B)
<input type="radio"/> Direction IDMT Earth Fault (67N)	<input type="radio"/> Partial Bus Bar (87PB)
<input type="radio"/> Stand By Earth Fault (51G)	<input type="radio"/> Line/Cable Differential (87L)
<input type="radio"/> Others (Specify) <input type="text"/>	

Select menu option **Libraries -> Protection ->Relay Database.**

Enter relay number as 100 and other details as shown below

Overcurrent Relay Library

Number Relay Name IEEE Code

Setting

Overcurrent

Phase

Earth

Phase Fault

Inst

Short Time Delay

Earth

Earth Time

Time Dial

TDS Seconds

1. Click here for Phase setting

5. Click here to Select TDS

Current Setting

Maximum Amps Minimum Amps Rated Amps

Variation

Continuous

Uniform Uniform Step

Discrete

Counter

Phase Setting Range

Sl No.	Maximum	Minimum	Rated	Variation
1	12.50	2.50	5.00	U
2	2.50	0.50	1.00	U

Relay Characteristics

Standard Curves

Characteristic Curve Name

Curve Type

Constant C1 Constant C2

Relay Thermal Capacity

Saturation (PSM)

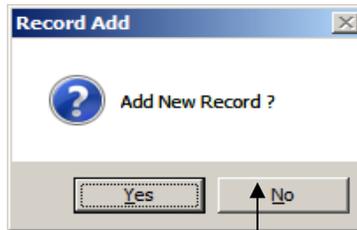
Relay Type Hot To Cold Ratio

2. Select $t = C1 / \log (M)$ here (3 sec relay characteristics)

Type 3 here

4. After entering all data click Next compulsory to save. A dialog as below is displayed

When Next button on relay database form is clicked, record add dialog box appears.



If you have one more setting click **Yes** to add next setting.
If not, say **No** first setting will be saved

Relay rated current = 5 Amps

Current setting Max = 250 % of % 5 amps = $2.5 \times 5 = 12.5$
Min = 50 % of % 5 amps = $0.5 \times 5 = 2.5$

Uniform variation step = 0.25

Enter time dial setting as below

Relay Database

Number: Relay Name: Fetch Relay: IEEE Code:

Setting:

- Overcurrent
 - Phase
 - Earth
 - Phase Fault
- Instantaneous
 - Phase
 - Phase Time
 - Short Time Pickup
 - Short Time Delay
 - Earth
 - Earth Time
- Time Dial
 - TDS Seconds

Time Setting:

Maximum: TMS Minimum: TMS Step: TMS

Variation:

- Continuous
- Uniform
- Discrete

Counter:

Sl. No.	Maximum	Minimum	Rated	Variation
1	1.00	0.05	0.01	U
2	0.00	0.00	0.00	C

Time Dial Setting Range

Relay Characteristics:

Standard Curves:

Characteristic Curve Name:

Curve Type:

Constant C1: Constant C2:

Relay Thermal Capacity:

Saturation (PSM):

Relay Type: Hot To Cold Ratio:

Click Next, a dialog displayed as above, to **Add** record. If No button is clicked first setting will be **Saved**.

Time setting multiplier = 0.05 to 1.0 in steps of 0.01

After entering the details save it and close it Over current Relay Data form appears. Enter the IDMT1 relay data as shown below. Select relay database library number 100 from the drop down list.

Over Current Relay Data

Relay Number Relay Name

Element Type: Connected To: Location:

Relay Type: Directional Non-directional

Connection Sense: Looking Away from the Bus Looking Towards the Bus

Load Current: A

Discrimination Time: s

Overload Factor:

Unbalance Factor:

Libraries: Fuse Relay

Phase Setting Options: Phase Instantaneous

TMS Setting:

User Defined Plug Setting:

User Defined Inst Setting:

Earth Setting Options: Earth Instantaneous

TMS Setting:

User Defined Plug Setting:

User Defined Inst Setting:

Phase Setting: Plug Setting [CT Primary]: A

TMS:

Inst factor:

Inst Time: s

Earth Setting: Plug Setting [CT Primary]: A

TMS:

Inst factor:

Inst Time: s

Current Transformer Data (A):

Primary Rating 1:

Primary Rating 2:

Primary Rating 3:

Primary Rating 4:

Secondary Rating:

CT Rating:

Connection: Star Delta

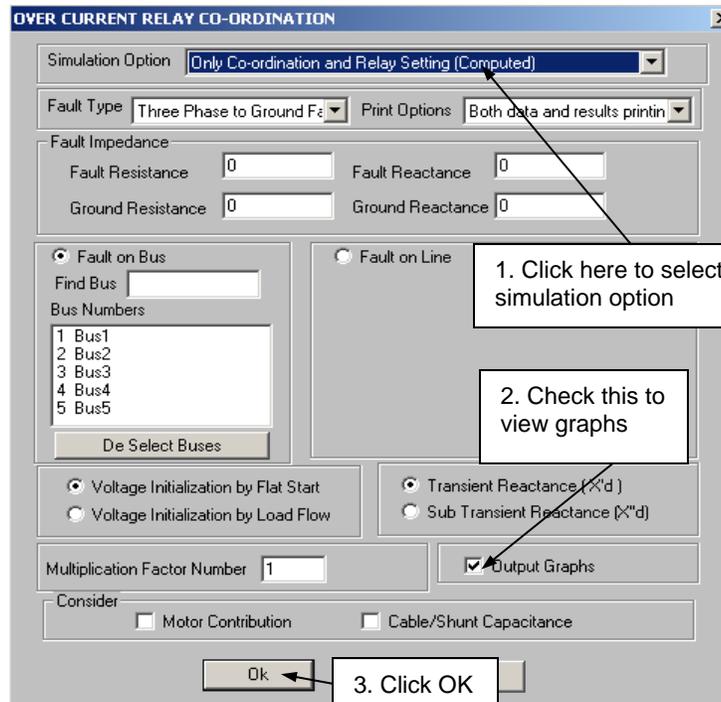
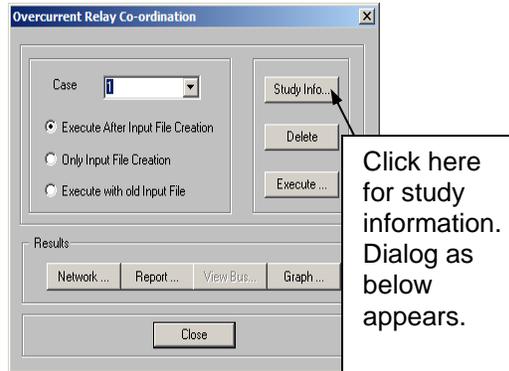
CT No.:

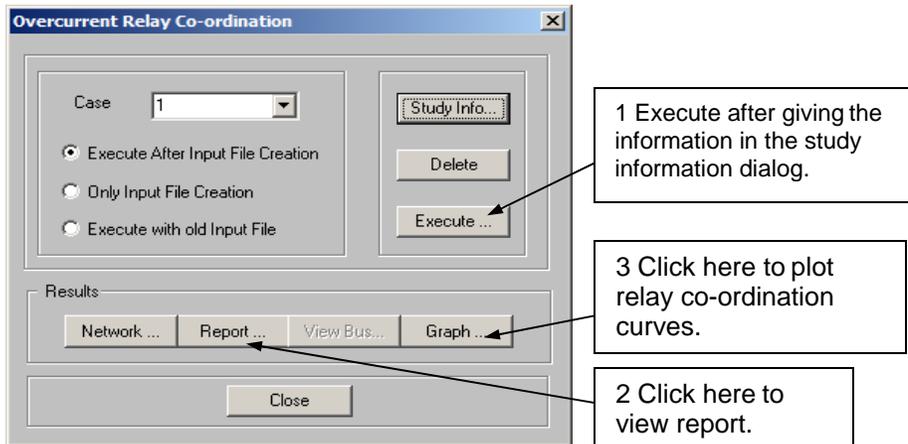
CVT No.:

After entering the details click save button which invokes Network editor. Enter other three relays details.

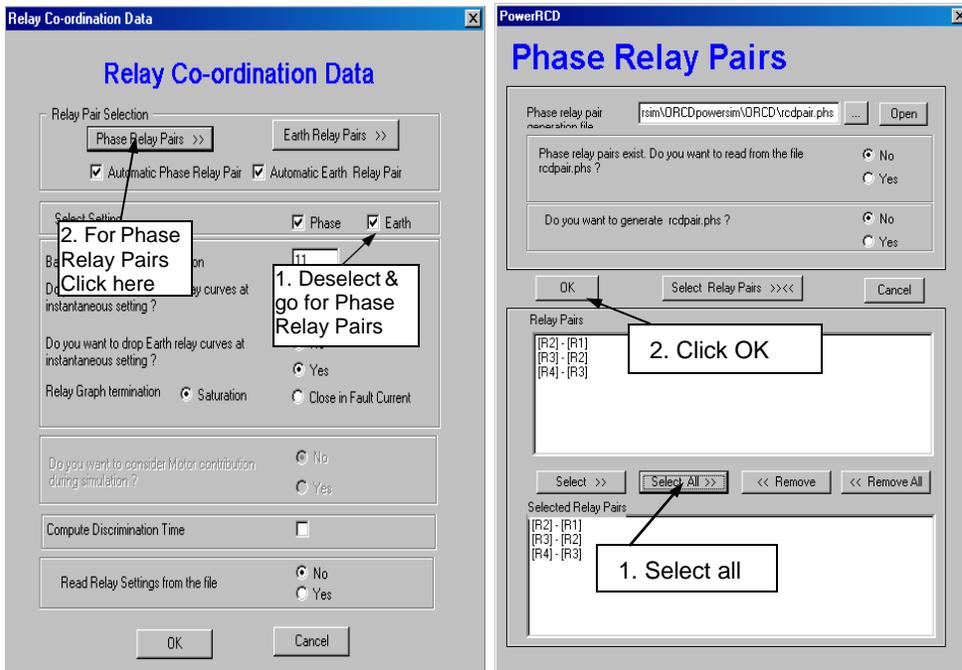
5.5 Executing Over Current Relay Co - ordination

Select the menu option **Solve** → **Over Current Relay Co-ordination**





Then click on execute button. While executing, following dialogs will be displayed.



The relay co - ordination will be executed. Go to graph and plot Current in X - axis and Time in Y - Axis.

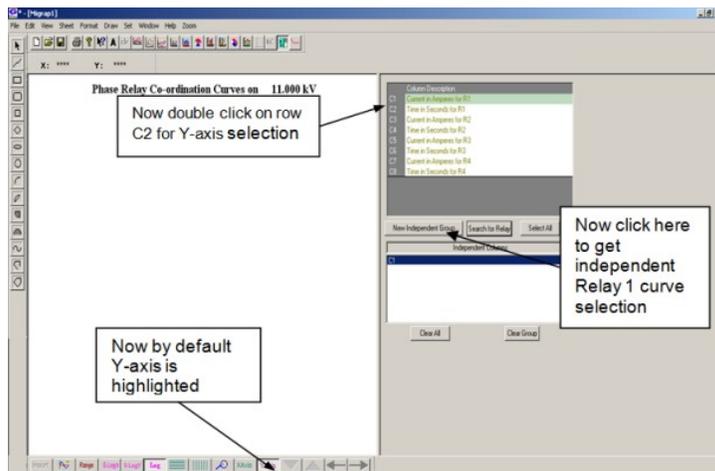
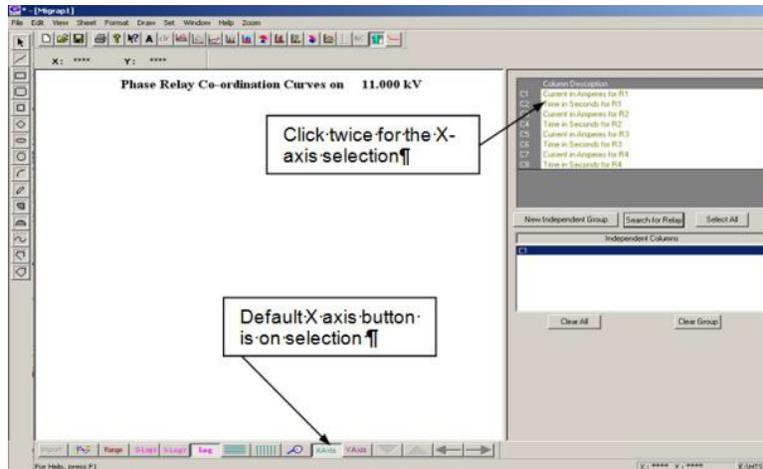
Results of Relay Co - ordination: (For maximum fault condition)

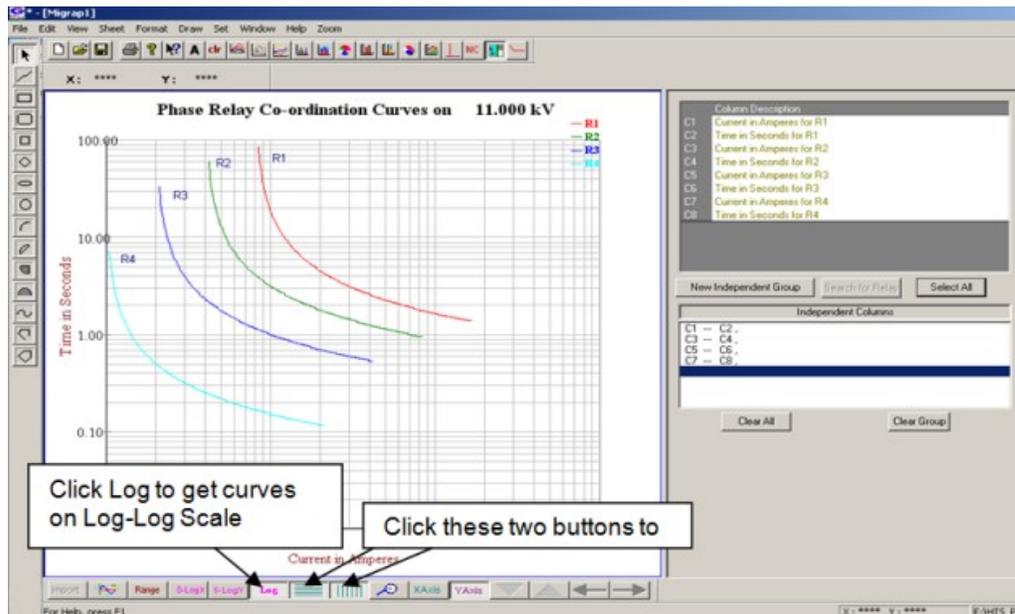
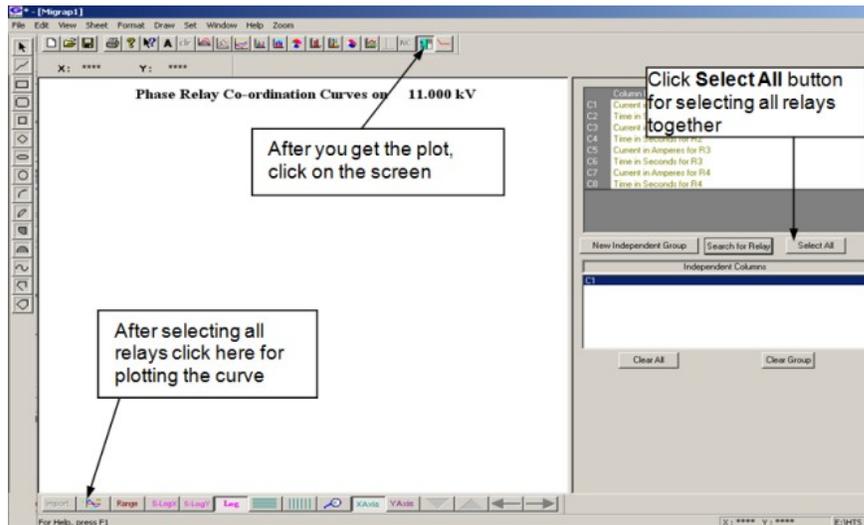
RELAY SETTINGS FOR PHASE FAULTS

	RELAY NAME	CLOSE IN CURRENT (Amps)	FAULT (Amps)	PLUG SETTING (Amps)	RATIO	RELAY CAPACITY	REMARKS
Limit	R1	52486.3881		800.0000		65.608	100.00 Within
Limit	R2	26243.1941		400.0000		65.608	100.00 Within
Limit	R3	17495.4627		200.0000		87.477	100.00 Within
Limit	R4	13121.5970		100.0000	131.216	100.00	Exceeds

SL. PLUG INSTANT NO. SETTING SETTING	T.D.S RELAY NAME	RELAY DB NAME	From Bus OP. TIME	To Bus REMOTE	CT PRIM OP.TIME	CT SEC	PLUG SETTING	PLUG PRIMARY SETTING RELAY
(SEC)	NAME	FAULT	FOR CLOSE	BUS FAULT	(Amps)		(%)	(PRIM)
(A)		(Amps)	(Secs)	(Amps)	(Secs)		(A)	(%)
1 5.00 *****	0.59 Relay1	52486.39	R1 1.3605	1 26243.19	2 1.3605	800	5 100.00	800.00 R2
2 5.00 *****	0.41 Relay1	26243.19	R2 0.9454	2 17495.46	3 0.9454	400	5 100.00	400.00 R3
3 5.00 *****	0.23 Relay1	17495.46	R3 0.5303	3 13121.60	4 0.5303	200	5 100.00	200.00 R4
4 5.00 *****	0.05 Relay1	13121.60	R4 0.1153	4 DOES NOT	5 BACK-UP	100	5 100.00	100.00 ****

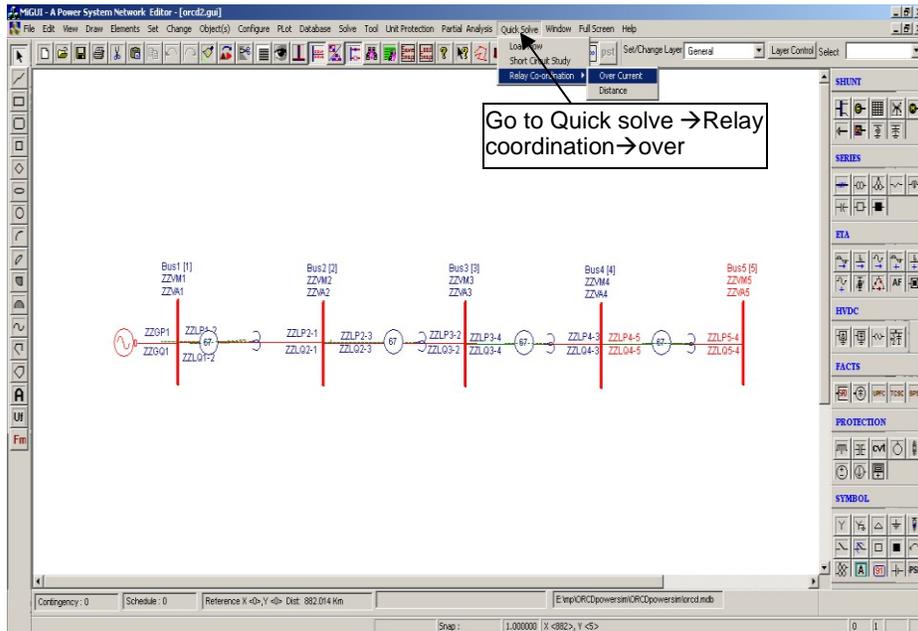
To plot relay co-ordination curves click on **Graph** as shown in **Over-Current Relay Co-ordination** dialog.





5.6 Quick Solve (Shortcut method for Executing Over Current Relay Co – ordination)

Select menu option: **Quick Solve → Relay Co-ordination → Overcurrent**

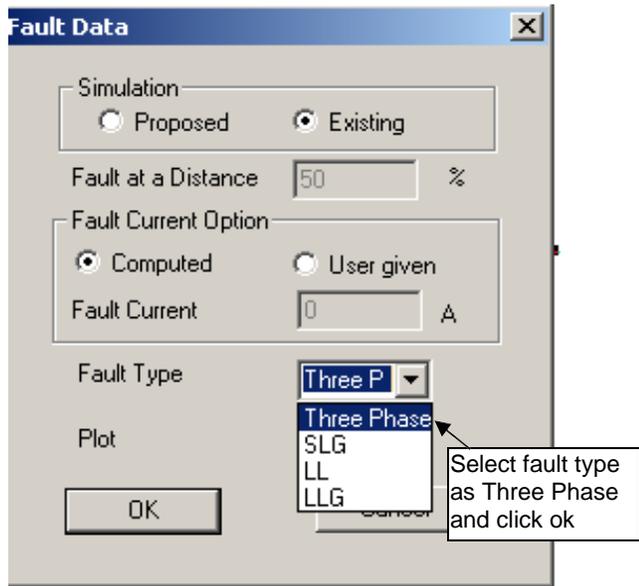
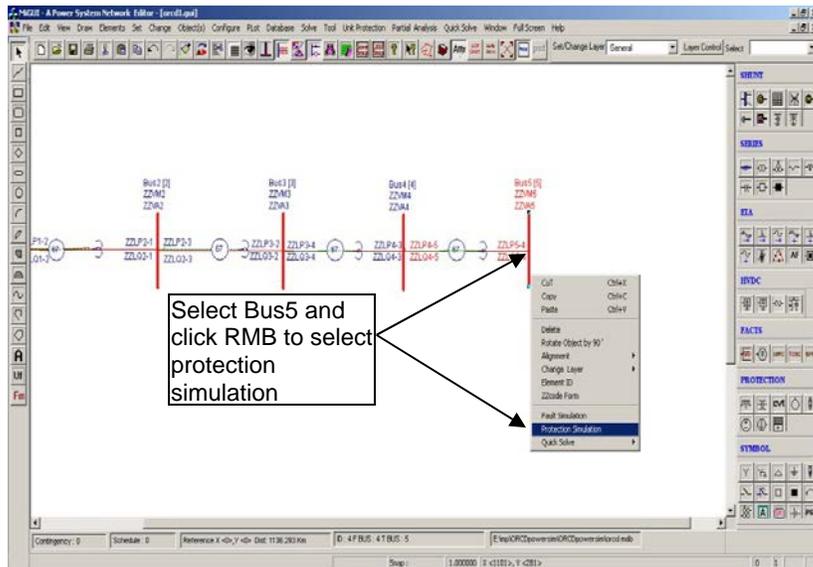


5.7 Protection Simulation

After executing relay coordination, protection simulation can be performed to see which relay operates first when fault is created on a bus or a line.

Procedure to perform Protection Simulation:

Select the last bus i.e., Bus5, right click on the bus and select protection simulation as shown below. Select fault type as three phase and click ok. Element property window appears on the screen, go on clicking next to see the relay trip sequence. The last relay (R4) operates first since it is near to the fault and back up for that will be R3 followed by R2 and finally R1



Fault symbol will appear on faulted bus as shown below. As per the backup trip sequence of the relays can be viewed on the GUI by clicking the next button of the element property window

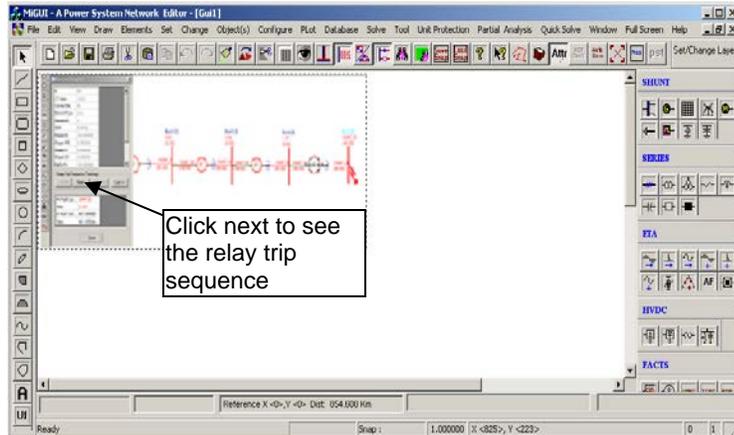
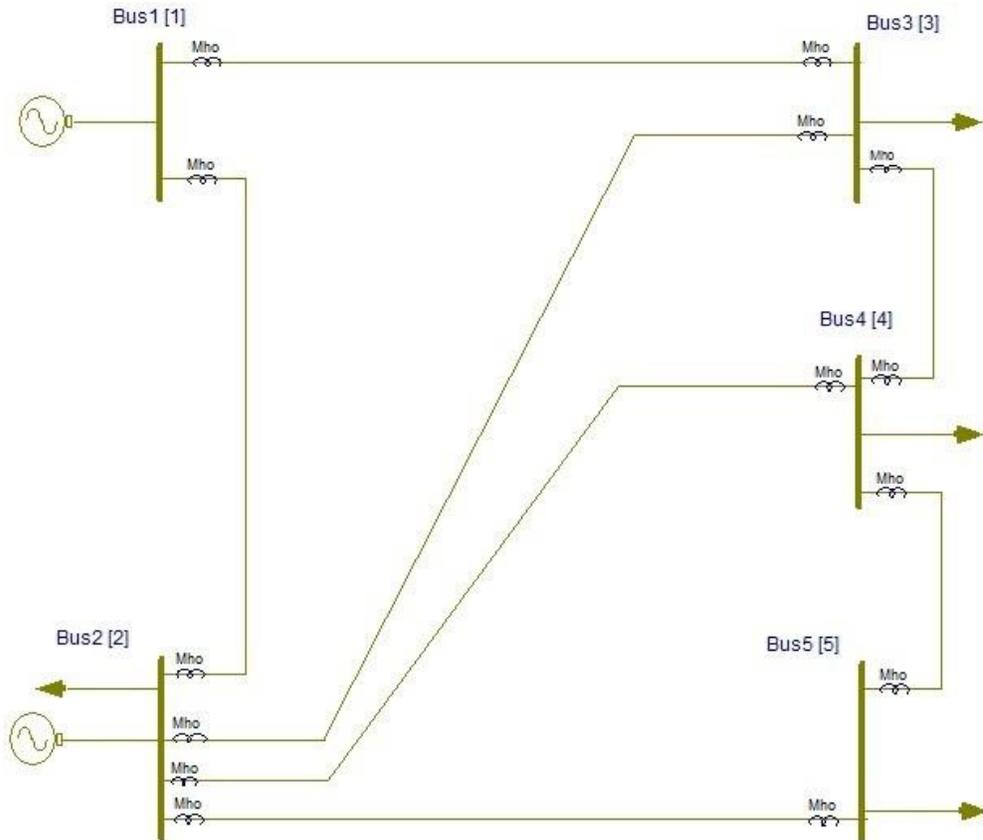


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6. How to solve Distance Relay Co-Ordination

Perform distance relay co-ordination study for the system shown below.



Relay details are given below

Relay Name	Zone1 Reach(%)	Zone2 Reach(%)	Zone3 Reach(%)	Zone4 Reach(%)	Zone2 time disc (sec)	Zone3 time disc (sec)	Zone4 time disc (sec)
DISRL1	80	40	100	20	0.5	0.8	1
DISRL2	80	40	100	20	0.5	0.8	1
DISRL3	80	40	100	20	0.5	0.8	1
DISRL4	80	40	100	20	0.5	0.8	1
DISRL5	80	40	100	20	0.5	0.8	1
DISRL6	80	40	100	20	0.5	0.8	1
DISRL7	80	40	100	20	0.5	0.8	1
DISRL8	80	40	100	20	0.5	0.8	1
DISRL9	80	40	100	20	0.5	0.8	1
DISRL10	80	40	100	20	0.5	0.8	1
DISRL11	80	40	100	20	0.5	0.8	1
DISRL12	80	40	100	20	0.5	0.8	1
DISRL13	80	40	100	20	0.5	0.8	1
DISRL14	80	40	100	20	0.5	0.8	1

Relay Name	CT Rating (Amps)	PT Rating (kV/Volt)	Connected Zone 1 Line	Connected Zone 2 Line	Connected Zone 3 Line	Location
DISRL1	400/5	132/110	1-2	2-5	2-3	From Side
DISRL2	400/5	132/110	1-2	1-3	1-3	To Side
DISRL3	400/5	132/110	1-3	3-4	2-3	From Side
DISRL4	400/5	132/110	1-3	1-2	1-2	To Side
DISRL5	400/5	132/110	2-3	3-4	1-3	From Side
DISRL6	400/5	132/110	2-3	1-2	2-4	To Side
DISRL7	400/5	132/110	2-4	3-4	1-3	From Side
DISRL8	400/5	132/110	2-4	1-2	2-3	To Side
DISRL9	400/5	132/110	2-5	4-5	4-5	From Side
DISRL10	400/5	132/110	3-4	4-5	2-4	From Side

DISRL11	400/5	132/110	3-4	1-3	2-3	To Side
DISRL12	400/5	132/110	4-5	2-5	2-5	From Side
DISRL13	400/5	132/110	4-5	3-4	2-4	To Side
DISRL14	400/5	132/110	2-5	1-2	2-3	To Side

Transmission line details: Table B

Bus- code	Positive sequence		Zero sequence	
	Impedance Z _{pq} in pu	Line charging B/2 in pu	Impedance Z _{pq} in pu	Line charging B/2 in pu
1-2	0.02009+j0.05997	0.03000	0.04017+j0.11995	0.2316
1-3	0.08000+j0.23996	0.02499	0.15496+j0.48209	0.01874
2-3	0.05997+j0.17998	0.02004	0.11995+j0.36731	0.01503
2-4	0.05997+j0.17998	0.02004	0.11995+j0.36731	0.01503
2-5	0.03994+j0.12001	0.01500	0.08035+j0.24105	0.01125
3-4	0.00999+j0.02996	0.01000	0.02009+j0.05992	0.00750
4-5	0.08000+j0.23996	0.02499	0.15496+j0.48209	0.01874

Generator details: Table C

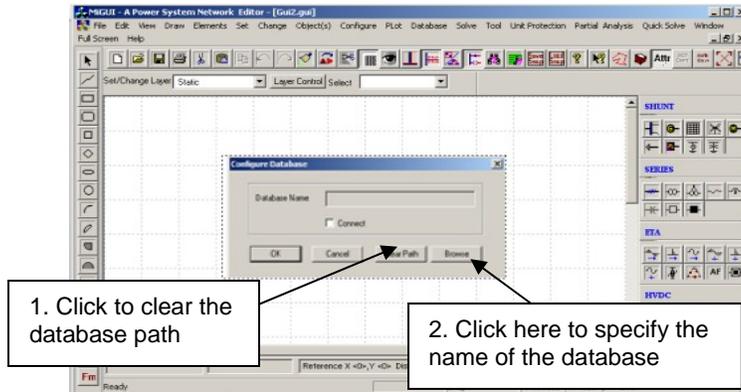
Bus no	MVA	MW	MVAR
Bus1	100	80	60
Bus2	100	80	60

Load details: Table D

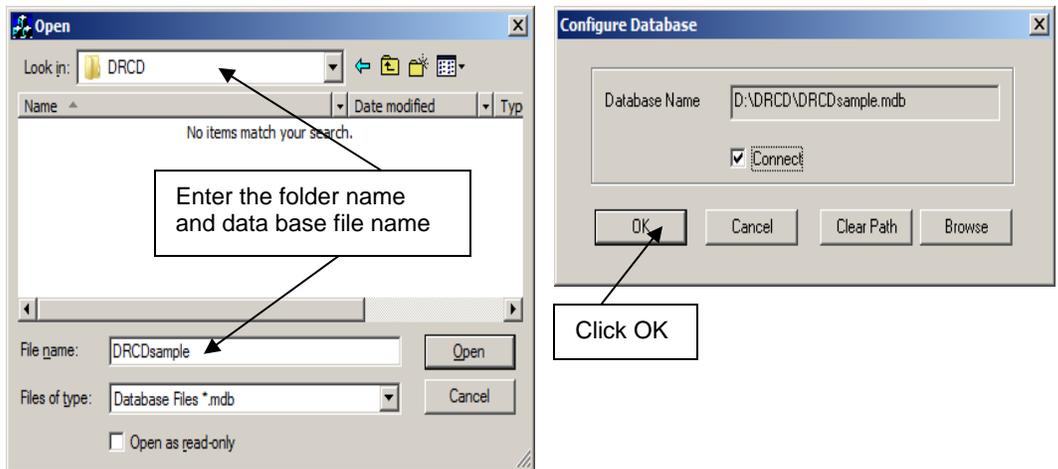
Bus no	MW	P.F
Bus2	80	0.85
Bus3	50	0.85
Bus4	50	0.85
Bus5	50	0.85

Procedure follows:

Open power system network editor. Select menu option **Database** → **Configure**. Configure Database dialog is popped up as shown below. Click **Browse** button.



Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click **Open** button after entering the desired database name. **Configure Database** dialog will appear with path chosen.



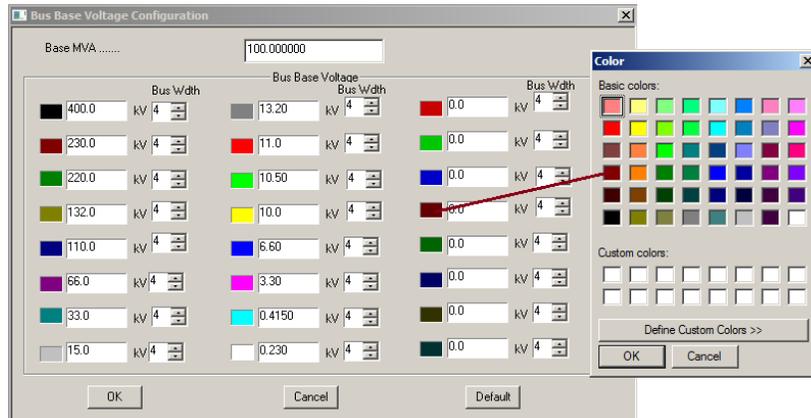
Click OK button on the **Configure database** dialog, the dialog shown below appears.

Uncheck the Power System Libraries and Check Standard Relay Libraries. If libraries are selected, standard libraries will be loaded along with the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base check the pu status as shown below. Enter the Base MVA and Base frequency as shown below. Click **OK** button to create the database to return to Network Editor.

Component	Base MVA	Value	Unit	Component	Value	Unit
400.000	15000	13.200	MVA	350	350	MVA
220.000	10000	11.000	MVA	350	350	MVA
230.000	10000	10.500	MVA	350	350	MVA
132.000	5000	10.000	MVA	350	350	MVA
110.000	5000	6.600	MVA	250	250	MVA
66.000	5000	3.300	MVA	100	100	MVA
33.000	1500	0.415	MVA	50	50	MVA

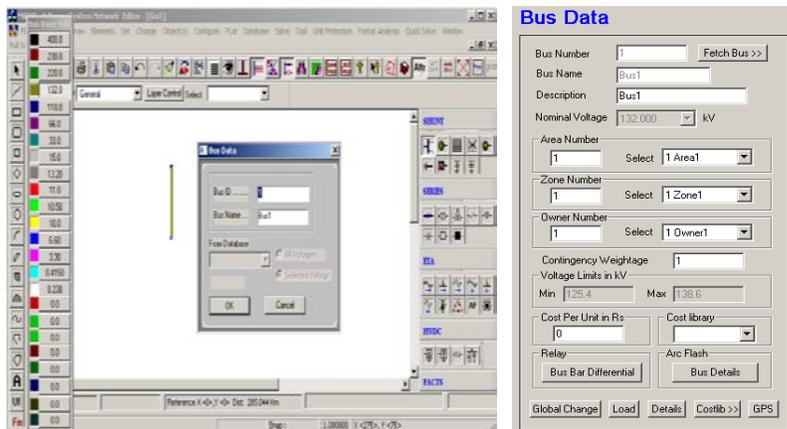
Bus Base Voltage Configuration

In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure**→**Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click OK.



6.1 Procedure to Draw First Element - Bus

Click on **Bus** icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID number and Bus Name. Click OK. Database manager with corresponding **Bus Data** form will appear.



Modify the Area number, Zone number and Contingency Weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are other than this, modify these fields. Otherwise keep the default values.

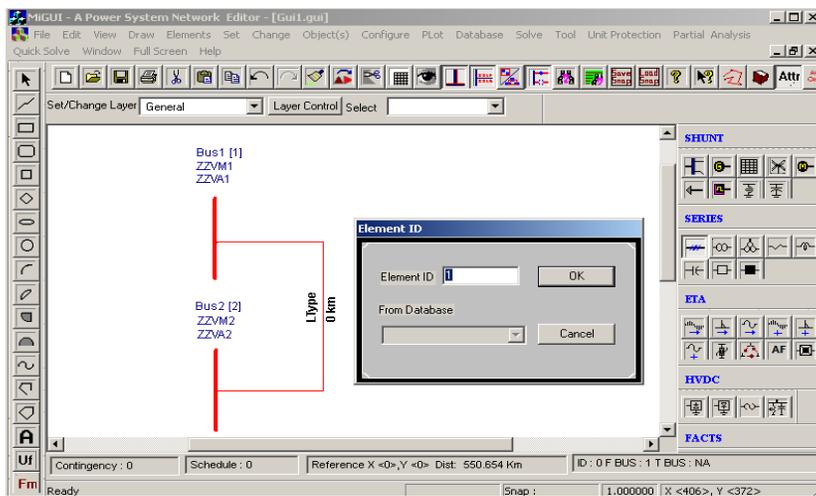
Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is Northeast, then bus name can be given as NE and the bus description field can be North **East**.

After entering data click **Save** , which invokes **Network Editor**. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Bus Number	2	3	4	5
Bus Name	Bus-2	Bus-3	Bus-4	Bus-5
Nominal voltage kV	132	132	132	132

6.2 Procedure to Draw Transmission Line

Click on Transmission **Line** icon provided on power system tool bar. Draw the line by double clicking LMB (Left Mouse Button) first on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. The **Element ID** dialog will appear.



Enter **Element ID** number and click OK. Database manager with corresponding **Line/Cable Data** form will be open.

Line/Cable Data

Number <input type="text" value="1"/>	<input type="button" value="Fetch Line >>"/>	Name <input type="text" value="Line1"/>	<input type="button" value="Maintenance"/>
De-Rated MVA <input type="text" value="100"/>	Structure Ref. No. <input type="text" value="1 [Line1]"/>		
Rating I <input type="text" value="100"/> MVA	<input type="button" value="Transmission Line Library >>"/> <input type="button" value="Line Details >>"/>		
Rating II <input type="text" value="100"/> MVA	From Breaker Rating <input type="radio"/> Not Exists <input checked="" type="radio"/> Exists MVA <input type="text" value="5000"/> kA <input type="text" value="21.870"/> <input type="button" value="From Breaker"/>		
From Bus Number <input type="text" value="1 [Bus1] {132.000}"/>	To Breaker Rating <input type="radio"/> Not Exists <input checked="" type="radio"/> Exists MVA <input type="text" value="5000"/> kA <input type="text" value="21.870"/> <input type="button" value="To Breaker"/>		
To Bus Number <input type="text" value="2 [Bus2] {132.000}"/>	Show Breaker - SLD <input type="checkbox"/> Yes SLD Notation <input checked="" type="radio"/> Line <input type="radio"/> Cable <input type="radio"/> Breaker <input type="radio"/> Isolator		
Number of Circuits <input type="text" value="1"/>	NDP <input checked="" type="radio"/> No <input type="radio"/> From Side <input type="radio"/> To Side		
Line Length <input type="text" value="1"/> km	Status <input checked="" type="radio"/> In Service <input type="radio"/> From End Open <input type="radio"/> To End Open <input type="radio"/> Out of Service Commission Status <input checked="" type="radio"/> Existing <input type="radio"/> Proposed Year <input type="text" value="0"/>		
Contingency Weightage <input type="text" value="1"/>	From Side Open <input type="radio"/> TNDP <input checked="" type="radio"/> Maintenance <input type="radio"/> Fault <input type="radio"/> Others <input type="text" value=""/> To Side Open <input type="radio"/> TNDP <input checked="" type="radio"/> Maintenance <input type="radio"/> Fault <input checked="" type="radio"/> Others <input type="text" value=""/>		

Enter the details of that line as shown. Enter **Structure Ref No.as 1** and click on **Transmission Line Library >>** button. **Line & Cable Library** form will appear. Enter transmission line library data in the form as shown below for Line1

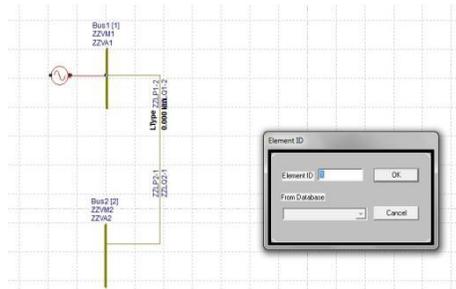
Line and Cable Library

Structure Reference	
Number <input type="text" value="1"/>	Name <input type="text" value="Line1"/>
<input type="button" value="Fetch Line"/>	
Positive Sequence Resistance <input type="text" value="0.02009"/> pu	Surge Impedance Z <input type="text" value="0.999750"/> Ohms V <input type="text" value="5239.405253"/> kms/sec <input type="button" value="Compute XL, B/2"/>
Positive Sequence Reactance <input type="text" value="0.05997"/> pu	
Positive Sequence Susceptance (B/2) <input type="text" value="0.03"/> pu	<input type="button" value="Thermal Curve>>"/>
Zero Sequence Resistance <input type="text" value="0.04017"/> pu	
Zero Sequence Reactance <input type="text" value="0.11995"/> pu	<input type="button" value="Harmonic Library >>"/>
Zero Sequence Susceptance (B/2) <input type="text" value="0.02316"/> pu	
Thermal Rating <input type="text" value="100"/> MVA <input type="button" value="Compute"/>	<input type="button" value="Cost Per Unit in Rs"/>
Line Harmonic Number <input type="text" value="0"/>	
Cost per km <input type="text" value="0"/>	

After entering data click **Save** , which invokes **Cable\Line data** and **Save** . Follow the same procedure for remaining lines.

6.3 Procedure to Draw Generator

Click on Generator icon provided on power system tool bar. Connect it to Bus 1 by clicking the LMB on Bus 1. Element ID dialog will appear. Enter ID number and click OK. Database with corresponding Generator Data form will appear. Enter details as shown.



Enter Manufacturer Ref. No. as 30 and click on **Generator Library** button. Generator library form will appear.

Generator Data			
Number: 1	Fetch Generator >>	Name: Gen1	Maintenance
Bus No.: 1 [Bus1] (132.000)	Manufacturer Ref. No: 30 [Gen14]	Library >>	Schedule No: [v]
Units in Parallel: 1	GT	Capability Curve No: 0 [CAPCUR]	Capability Curve >>
Specified Voltage: 1.0000 Pu, 132 kV	Breaker Rating: In MVA 5000, In kA 21.870	Reactive Power - Minimum: 0 Mvar	Reactive Power - Maximum: 60 Mvar
De-Rated MVA: 100	Scheduled Power: 80 MW	Cost Co-efficient C0: 0	Cost Co-efficient C1: 0
Real Power - Minimum: 0 MW	Real Power - Maximum: 80 MW	Cost Co-efficient C2: 0	Cost Per Unit in Rs: 0
Status: <input checked="" type="radio"/> In Service <input type="radio"/> Out of Service	Commission Status: <input checked="" type="radio"/> Existing <input type="radio"/> Proposed	Year: 0	Select: <input type="radio"/> Utility Grid <input checked="" type="radio"/> Generator
Neutral Grounding Resistance: 0 ohms	Participation Factor (%): 0	Neutral Grounding Reactance: 0 ohms	Bias Setting: 0
Grounding Through Transformer: Calculate	Droop (%): 4		

After entering data **Save**  and **close**. In **Generator Data** form, click **Save** . **Network Editor** Screen will be invoked.

Generator Library

Ref. Number: 30 Fetch Generator Manufacturer Name: Gen14

MVA Rating: 100 MW Rating: 80 kV Rating: 132 Compute X(d,'d,n,0)

pu on Common MVA Base

Armature Resistance (Ra): 0 pu Potier Reactance (Xp): 0 pu
 Direct Axis Reactance (Xd): 0 pu Direct Axis Transient Reactance (X'd): 0.25 pu
 Quadrature Axis Reactance (Xq): 0 pu Quadrature Axis Transient Reactance (X'q): 0 pu
 Negative Seq. Reactance (Xn): 0.01 pu Direct Axis Sub-Transient Reactance (X''d): 0 pu
 Zero Seq. Reactance (Xo): 0.01 pu Quadrature Axis Sub-Transient Reactance (X''q): 0 pu

Direct Axis Open Circuit Transient Time Constant (T'do): 7.15 Direct Axis Open Circuit Sub-Transient Time Constant (T'dso): 0.039 Inertia in MJ/MVA: 3.31
 Quadrature Axis Open Circuit Transient Time Constant (T'qo): 2.5 Quadrature Axis Open Circuit Sub-Transient Time Constant (T'qso): 0.15 Damping Factor: 0

Winding Connections:  Mass Details: Mass Number: 0 Next >> Counter: Cost Per Unit in Rs: 0
 Inertia: 0 MJ/MVA: Damping Factor: 0 << Back Thermal Curves: Thermalab >
 Stiffness Co-efficient: 0 pu torque/Elec. Rad: Delete

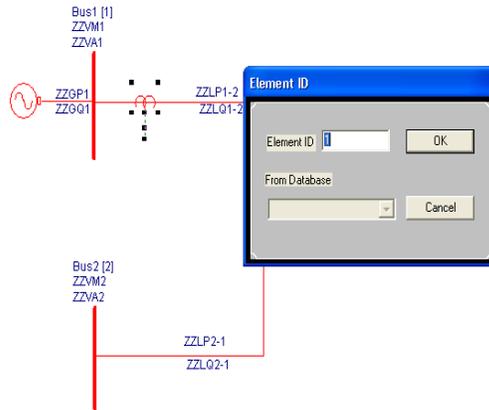
6.4 Procedure to Draw Relay

Select **current transformer** from power system tool bar and place it on from side of the line as shown in the following diagram. Click on **Distance Relay** icon provided on power system tool bar. Put it on the transmission line as shown below.

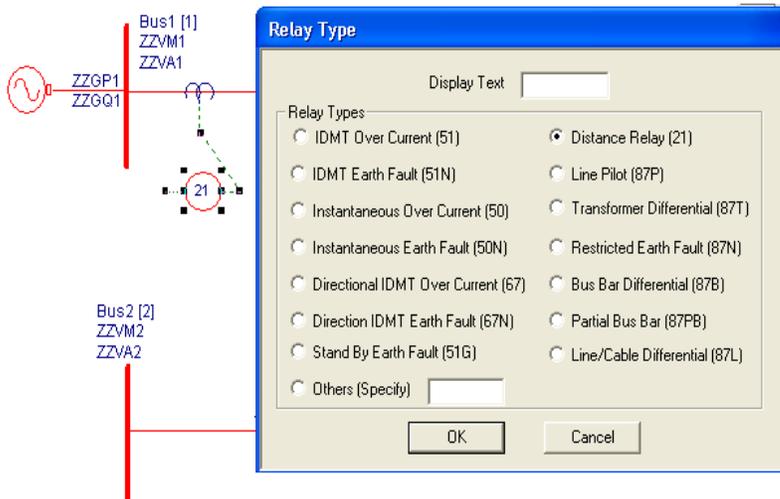
Current Transformer

CT Number: 1 Fetch >> Fender Number: Switch Board Name: Serial Number: Class: CT Burden: 0 VA
 Tap Number: CT1 Make: Ratio: Knee point Voltage: 0 V PF (burden): 0 R1 Sec: 0 Ohms
 Sub Station: Magnetizing Current: 0 A Number of Cores: 1 X Sec: 0 Ohms
 Primary Rating 1: 400 A Primary Rating 2: 400 A Primary Rating 3: 400 A Primary Rating 4: 400 A Selected Rating: Rating 1 Rating 2 Rating 3 Rating 4
 Thermal Current: 0 A Secondary Rating: 5 A

Magnetisation Characteristics of Core
 Magnetisation Curve Current [m] in A Voltage [m] in V Add
 Resistance (Core Loss): 0 Ohms Delete



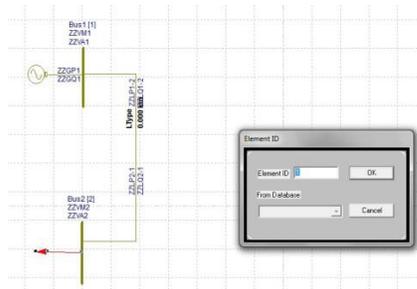
Then select relay from power system tool bar, it will invoke Relay Type -
 > select Distance Relay



Then it will invoke Distance Relay Database

6.5 Procedure to Enter Load Data

Click on **Load** icon provided on power system tool bar. Connect load 1 at BUS2 by clicking the LMB on Bus 2. **Element ID** dialog will appear. Give ID No as 1 and say OK. **Load Data** form will appear. Enter load details as shown below. Then click **Save** button, which invokes Network Editor.



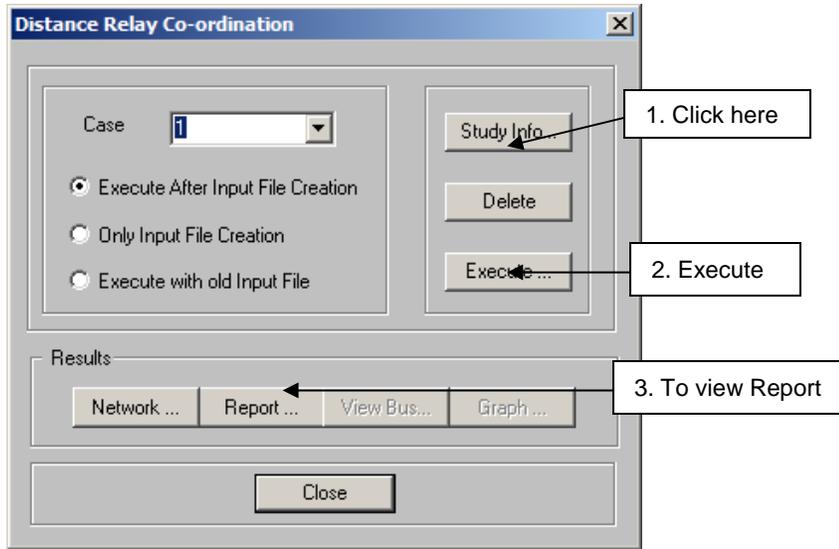
Load Data

Number: 1	Fetch Load >>	Name: Load1	Maintenance	Schedule No: [v]	Relay: [v]
Bus Number: 4 [Bus4] (132.000)	No of Consumers: 1	MVAR Compensation: 0	Minimum Compensation in MVAR: 0	Maximum Compensation in MVAR: 0	Compensation Step in MVAR: 0
Real Power in MW: 80	Compute	MVAR Compensation: 0	Minimum Compensation in MVAR: 0	Maximum Compensation in MVAR: 0	Compensation Step in MVAR: 0
Reactive Power in MVAR: 49.579547	Load Details	MVAR Compensation: 0	Minimum Compensation in MVAR: 0	Maximum Compensation in MVAR: 0	Compensation Step in MVAR: 0
Power Factor: 0.850000		Load Characteristics No.: 0			
Load Type: <input checked="" type="radio"/> Linear <input type="radio"/> Non Linear	Unbalanced Load: <input checked="" type="radio"/> Y <input type="radio"/> Δ	Library: Load Characteristics >>			
Motor Load Percentage: 0	Unbalanced Load Details	Global Change			
Status: <input checked="" type="radio"/> In Service <input type="radio"/> Out of Service	Commission Status: <input checked="" type="radio"/> Existing <input type="radio"/> Proposed Year: 0	Breaker Rating: In MVA: 5000.007 In kA: 21.870			
Control Block: Fpb Path: []					

Connect other loads at other buses. Enter other load details as given in the following **Table D**.

6.6 Executing Distance Relay Co - ordination

Select the menu option **Solve → Distance Relay Co-ordination**



DISTANCE RELAY CO-ORDINATION

Simulation Option: **Fault Creation and Impedance Determination** Select Simulation option

Fault Type: **Three Phase to Ground Fault** Select Fault type for **fault creation and impedance determination** simulation option

Fault Impedance

Fault Resistance: Fault Reactance:

Ground Resistance: Ground Reactance:

Fault on Bus Fault on Line

Line Numbers

1	L1 [1 to 2]
2	L2 [1 to 3]
3	L3 [2 to 3]
4	L4 [2 to 4]
5	L5 [2 to 5]

% Distance:

Voltage Initialization by Flat Start Voltage Initialization by Load Flow

Transient Reactance (X'd) Sub Transient Reactance (X"d)

Multiplication Factor Number:

Discrimination Time: Print Option: **Data and Results**

Note: If fault creation and impedance determination simulation option is selected then fault line number and distance are to be selected and then execute distance relay coordination

```

-----
          DISTANCE RELAY CO-ORDINATION
          CASE NO : 1          SCHEDULE
NO : 0 CONTINGENCY NAME : Base Case
-----
VERSION NUMBER : 8.0
%% First Power System Network
LARGEST BUS NUMBER USED : 5 ACTUAL NUMBER OF BUSES :
5
NUMBER OF 2 WIND. TRANSFORMERS : 0 NUMBER OF 3 WIND. TRANSFORMERS :
0
NUMBER OF TRANSMISSION LINES : 7

```

```

NUMBER OF SERIES REACTORS      :    0    NUMBER OF SERIES CAPACITORS      :
0
NUMBER OF BUS COUPLERS         :    0
NUMBER OF SHUNT REACTORS       :    0    NUMBER OF SHUNT CAPACITORS       :
0
NUMBER OF SHUNT IMPEDANCES     :    0    NUMBER OF GENERATORS           :
2
NUMBER OF MOTORS               :    0    NUMBER OF LOADS               :
4
NUMBER OF FILTERS              :    0
NUMBER OF HVDC CONVERTORS      :    0
NUMBER OF PARTIAL BUS BAR DIFFERENTIAL RELAYS :    0
-----

```

```

-----
NUMBER OF ZONES                 :    1
PRINT OPTION                    :    3 (BOTH DATA AND RESULTS PRINT)
GRAPH OPTION                    :    0 (NO GRAPH FILE GENERATION)
BASE MVA                        : 100.000
NOMINAL SYSTEM FREQUENCY Hz    :  50.000
PREFault VOLTAGE OPTION        :    0 (VOLTAGE OF 1.0 PU IS ASSUMED)
-----

```

```

-----
FAULT RESISTANCE - PHASE       :    0.000000 (PU)
FAULT REACTANCE - PHASE       :    0.000000 (PU)
FAULT RESISTANCE - GROUND     :    0.000000 (PU)
FAULT REACTANCE - GROUND     :    0.000000 (PU)
-----

```

```

-----
CIRCUIT BREAKER RESISTANCE (PU) : 0.000000e+000
CIRCUIT BREAKER REACTANCE (PU)  : 1.000000e-004
TRANSFORMER R/X RATIO           : 0.050000
TRANSFORMER ZERO SEQUENCE IMPEDANCE MULT FACTOR : 0.900000

```

```

NUMBER OF TRANSMISSION VOLTAGE LEVELS : 1
TRANSMISSION LINE VOLTAGE - KV        : 132.000000
TRANSMISSION LINE ZERO SEQUENCE IMP. MULT. FACTOR : 2.500000
TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.800000

```

```

GENERATOR NEGATIVE SEQUENCE RESISTANCE MULT. FACTOR : 0.175000
GENERATOR NEGATIVE SEQUENCE REACTANCE MULT. FACTOR : 0.175000
GENERATOR ZERO SEQUENCE RESISTANCE MULT. FACTOR : 0.037500
GENERATOR ZERO SEQUENCE REACTANCE MULT. FACTOR : 0.037500
LOAD NEGATIVE SEQUENCE IMPEDANCE MULT. FACTOR : 0.810000
LOAD ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.600000
SERIES REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 1.000000
SHUNT REACTOR ZERO SEQUENCE IMPEDANCE MULT. FACTOR : 0.625000
-----

```

BUS DATA

```

NODE STAT ZONE BUS-KV  NAME      VMAG-PU  VANG-DEG  PGEN-MW  QGEN-MVAR
                                PLOAD-MW  QLOAD-MVAR  QCOMP-MVAR
-----

```

MiP-PSCT

How to solve DRCD

Line	From Bus	To Bus	From Node	To Node	From Node				
1	1	1	132.000	Bus1	1.0000	0.000	0.000	0.000	0.000
2	1	1	132.000	Bus2	1.0000	0.000	0.000	0.000	0.000
3	1	1	132.000	Bus3	1.0000	0.000	0.000	0.000	0.000
4	1	1	132.000	Bus4	1.0000	0.000	0.000	0.000	0.000
5	1	1	132.000	Bus5	1.0000	0.000	0.000	0.000	0.000

TRANSMISSION LINE DATA

STAT	CKTS	FROM	FROM	TO	TO	RP (P.U)	XP (P.U)	BP/2 (PU)	THERMAL
		NODE	NAME	NODE	NAME	RZ (P.U)	XZ (P.U)	BZ/2 (PU)	RATING
MVA									
3	1	1	Bus1	2	Bus2	0.02009	0.05997	0.00000	100.00
3	1	1	Bus1	3	Bus3	0.08000	0.23996	0.00000	100.00
3	1	2	Bus2	3	Bus3	0.05997	0.17998	0.00000	100.00
3	1	2	Bus2	4	Bus4	0.05997	0.17998	0.00000	100.00
3	1	2	Bus2	5	Bus5	0.03994	0.12001	0.00000	100.00
3	1	3	Bus3	4	Bus4	0.00999	0.02996	0.00000	100.00
3	1	4	Bus4	5	Bus5	0.02009	0.05992	0.00000	100.00

GENERATOR DATA

FROM	FROM	POSITIVE		NEGATIVE		ZERO		MVA
NODE	NAME	R (P.U)	X (P.U.)	R (P.U.)	X (P.U.)	R (P.U.)	X (P.U.)	RATING
STAT								
1	Bus1	0.00000	0.25000	0.00000	0.01000	0.00000	0.01000	100
2	Bus2	0.00000	0.25000	0.00000	0.01000	0.00000	0.01000	100

LOAD DATA

NODE	NAME	STATUS
------	------	--------

```

-----
  2   Bus2   3
  3   Bus3   3
  4   Bus4   3
  5   Bus5   3
-----

```

```

-----
---
GENERATOR DATA FOR MINIMUM GENERATION

```

FROM	FROM	POSITIVE	NEGATIVE	ZERO	MVA
NODE NAME	R(P.U)	X(P.U.)	R(P.U.)	X(P.U.)	RATING
STAT					
1	Bus1	0.00000	0.25000	0.00000	0.01000
100 3					
2	Bus2	0.00000	0.25000	0.00000	0.01000
100 3					

```

-----
CO-ORDINATION TYPE : 0 (DISTANCE RELAY CO-ORDIN)
-----

```

```

---
NUMBER OF DISTANCE RELAYS : 14
-----

```

```

---
SIMULATION STATUS : 1 (SIMULATION)
-----

```

```

---
The entries in different columns of Distance relay data
are as follows -

```

```

RELAY NAME : Name of the relay, the size should not exceed 8 characters.
ELMN-NUMB : Series element number on which the relay is located.
LINE-LNTH : The length of the transmission line on which the relay is
            located.
FOR/REV : 1 if relay is located on from side of the series element.
          2 if relay is located on to side of the series element.
CTPRI : Current transformer primary rating in amperes.
CTSE : Current transformer secondary rating in amperes.
PTPR : Potential transformer primary rating in kV.
PTSE : Potential transformer secondary rating in volts.
LOAD IMP
R (P.U) : Apparent load resistance in p.u determined using load flow
          results.
X (P.U) : Apparent load reactance in p.u determined using load flow
          results.
Z1 REACH : Percentage of the primary line impedance for which the
          relay should operate instantaneously.
Z2 REACH : Percentage of shortest line impedance in the adjacent

```

section

for which the relay provides backup protection.

Z3 REACH : Percentage of the longest line impedance connected to the remote bus of the shortest adjacent section for which the relay provides backup protection.

Z2 DIS TIME : The co-ordination time interval between zone1 and zone2 in seconds.

Z3 DIS TIME : The co-ordination time interval between zone2 and zone3 in seconds.

RELAY DBASE : The relay type number.

DISTANCE RELAY DATA

RELAY REACH NAME PERCENT	ELMN LINE NUMB LNTH	FOR/ REV	CTPR AMPS	CTSE AMP	PTPR KV	PTSE VOLT	LOAD R(P.U)	IMP X(P.U)	Z1 REACH PERCENT	Z2 DIS TIME	Z3 DIS TIME
Z4 REACH PERCENT	Z4	RELAY DBASE					Z3 REACH PERCENT	Z2 DIS TIME	Z3 DIS TIME		
80	40	Dr1	1	1.00	1	400	5	132	110	999.990	999.99
20	1.000	0					100	0.500	0.800		
80	40	Dr2	1	1.00	2	400	5	132	110	999.990	999.99
20	1.000	0					100	0.500	0.800		
80	40	Dr3	2	1.00	1	400	5	132	110	999.990	999.99
29	1.000	0					100	0.500	0.800		
80	40	Dr4	2	1.00	2	400	5	132	110	999.990	999.99
20	1.000	0					100	0.500	0.800		
80	40	Dr5	3	1.00	1	400	5	132	110	999.990	999.99
20	1.000	0					100	0.500	0.800		
80	40	Dr6	3	1.00	2	400	5	132	110	999.990	999.99
20	1.000	0					100	0.500	0.800		

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80	40	Dr7	4	1.00	1	400	5	132	110	999.990	999.99
								100	0.500	0.800	
20	1.000	0									
		Dr8	4	1.00	2	400	5	132	110	999.990	999.99
80	40							100	0.500	0.800	
20	1.000	0									
		Dr9	5	1.00	1	400	5	132	110	999.990	999.99
80	40							100	0.500	0.800	
20	1.000	0									

```

80      40      Dr10      6  1.00      1  400      5  132  110  999.990  999.99
100     0.500     0.800
20     1.000      0      Dr11      6  1.00      2  400      5  132  110  999.990  999.99
80      40
100     0.500     0.800
20     1.000      0      Dr12      7  1.00      1  400      5  132  110  999.990  999.99
80      40
100     0.500     0.800
20     1.000      0      Dr13      7  1.00      2  400      5  132  110  999.990  999.99
80      40
100     0.500     0.800
20     1.000      0
80      40      Dr14      5  1.00      2  400      5  132  110  999.990  999.99
100     0.500     0.800
20     1.000      2

```

```

-----
---
DISCRIMINATION TIME                :    0.40
-----

```

```

---
NUMBER OF FAULTS SIMULATED         :    1
-----

```

```

---
SERIES ELEMENT PERCENT FAULTTYPE
NUMBER      LINE
-----
1      50.00      1 (3 PHASE TO GROUND FAULT)
-----

```

```

---
RELAY ELEMENT FROM BUS FROM BUS TO BUS    TO BUS RELAY
LOCATION
      NAME  NUMBER  NUMBER  NAME NUMBER  NAME
(FROM/TO)
                        BUS NAME

```

Bus1	Dr1	1	1	Bus1	2	Bus2
Bus2	Dr2	1	1	Bus1	2	Bus2
Bus1	Dr3	2	1	Bus1	3	Bus3
Bus3	Dr4	2	1	Bus1	3	Bus3
Bus2	Dr5	3	2	Bus2	3	Bus3
Bus3	Dr6	3	2	Bus2	3	Bus3
Bus2	Dr7	4	2	Bus2	4	Bus4
Bus4	Dr8	4	2	Bus2	4	Bus4
Bus2	Dr9	5	2	Bus2	5	Bus5
Bus3	Dr10	6	3	Bus3	4	Bus4
Bus4	Dr11	6	3	Bus3	4	Bus4
Bus4	Dr12	7	4	Bus4	5	Bus5
Bus5	Dr13	7	4	Bus4	5	Bus5
Bus5	Dr14	5	2	Bus2	5	Bus5

Number of phase relays 14 Number of earth fault relays 0

DISTANCE RELAY PAIRS

PRIMARY	RELAY NAME	BACK UP	RELAY NAME
5	Dr5	1	Dr1
7	Dr7	1	Dr1
9	Dr9	1	Dr1
3	Dr3	2	Dr2
6	Dr6	3	Dr3
10	Dr10	3	Dr3
1	Dr1	4	Dr4
4	Dr4	5	Dr5
10	Dr10	5	Dr5
2	Dr2	6	Dr6
7	Dr7	6	Dr6
9	Dr9	6	Dr6

11	Dr11	7	Dr7
12	Dr12	7	Dr7
2	Dr2	8	Dr8
5	Dr5	8	Dr8
9	Dr9	8	Dr8
13	Dr13	9	Dr9
8	Dr8	10	Dr10
12	Dr12	10	Dr10
4	Dr4	11	Dr11
6	Dr6	11	Dr11
14	Dr14	12	Dr12
8	Dr8	13	Dr13
11	Dr11	13	Dr13
2	Dr2	14	Dr14
5	Dr5	14	Dr14
7	Dr7	14	Dr14

Completed Phase Parameters Earth relay reach (set Values) are given below

RELAY NAME	ZONE1 PH-PH SETTING	ZONE2 PH-PH SETTING	ZONE3 PH-PH SETTING	ZONE4 PH-PH SETTING	ZONE1 PH-E SETTING	ZONE2 PH-E SETTING	ZONE3 PH-E SETTING	ZONE4 PH-E SETTING	ZONE2 TIME (s)	ZONE3 TIME (s)	ZONE4 TIME (s)
Dr1	0.5877	1.3223	5.1421	-0.147	1.1755	2.6500	10.3030	-0.294	0.500	1.300	2.300
Dr2	0.5877	1.9099	5.8765	-0.147	1.1755	3.8222	11.8398	-0.294	0.500	1.300	2.300
Dr3	2.3506	3.0849	6.2433	-0.852	4.7057	6.1758	12.4983	-1.706	0.500	1.300	2.300
Dr4	2.3506	3.2321	5.8765	-0.588	4.7057	6.4699	11.8399	-1.176	0.500	1.300	2.300
Dr5	1.7629	2.3504	5.5087	-0.441	3.5907	4.7821	11.1046	-0.898	0.500	1.300	2.300
Dr6	1.7629	2.4975	5.8765	-0.441	3.5907	5.0762	11.8399	-0.898	0.500	1.300	2.300
Dr7	1.7629	2.3504	5.5087	-0.441	3.5907	4.7821	11.1046	-0.898	0.500	1.300	2.300
Dr8	1.7629	2.4975	5.8765	-0.441	3.5907	5.0762	11.8399	-0.898	0.500	1.300	2.300
Dr9	1.1754	2.6445	6.6111	-0.294	2.3612	5.3043	13.3219	-0.590	0.500	1.300	2.300
Dr10	0.2935	1.2483	4.7742	-0.073	0.5873	2.5295	9.7109	-0.147	0.500	1.300	2.300
Dr11	0.2935	1.2483	4.7742	-0.073	0.5873	2.5295	9.7109	-0.147	0.500	1.300	2.300
Dr12	2.3506	3.5259	6.6111	-0.588	4.7057	7.0627	13.3219	-1.176	0.500	1.300	2.300
Dr13	2.3506	3.0849	6.2433	-0.588	4.7057	6.1758	12.4983	-1.176	0.500	1.300	2.300
Dr14	1.1754	1.7631	5.1421	-0.294	2.3612	3.5393	10.3030	-0.590	0.500	1.300	2.300

ZONE1 EARTH SETTING		ZONE2 EARTH SETTING		ZONE3 EARTH SETTING		ZONE4 EARTH SETTING		REMARKS
0.3800	1.120	0.8400	2.520	3.2100	9.8000	0.1000	0.290	RES\REACT
0.3800	1.120	1.1900	3.640	3.6900	11.2600	0.1000	0.290	RES\REACT
1.4500	4.480	1.9000	5.880	3.8300	11.9000	0.5300	1.630	RES\REACT
1.4500	4.480	1.9900	6.160	3.6500	11.2700	0.3700	1.120	RES\REACT
1.1200	3.420	1.4900	4.550	3.4300	10.5700	0.2900	0.860	RES\REACT
1.1200	3.420	1.5800	4.830	3.6600	11.2700	0.2900	0.860	RES\REACT
1.1200	3.420	1.4900	4.550	3.4300	10.5700	0.2900	0.860	RES\REACT
1.1200	3.420	1.5800	4.830	3.6600	11.2700	0.2900	0.860	RES\REACT
0.7500	2.250	1.6600	5.050	4.1700	12.6600	0.1900	0.570	RES\REACT
0.1900	0.560	0.8000	2.410	3.0300	9.2300	0.0500	0.150	RES\REACT
0.1900	0.560	0.8000	2.410	3.0300	9.2300	0.0500	0.150	RES\REACT
1.4500	4.480	2.1800	6.720	4.1100	12.6800	0.3700	1.120	RES\REACT
1.4500	4.480	1.9000	5.880	3.8300	11.9000	0.3700	1.120	RES\REACT
0.7500	2.250	1.1200	3.360	3.2000	9.8000	0.1900	0.570	RES\REACT

PHASE/ZERO ZONE REACH (SET VALUES)											
RELAY NAME	RELAY TYPE	QUANTITY	ZONE1 PHASE SETTING		ZONE2 PHASE SETTING		ZONE3 PHASE SETTING		ZONE4 PHASE SETTING		
Dr1	RED670	RES\REACT	0.1900	0.5600	0.4200	1.260	1.6300	4.8800	0.0500	0.150	
Dr2	RED670	RES\REACT	0.1900	0.5600	0.6100	1.820	1.8700	5.5800	0.0500	0.150	
Dr3	RED670	RES\REACT	0.7500	2.2300	0.9800	2.930	1.9800	5.9300	0.2800	0.810	
Dr4	RED670	RES\REACT	0.7500	2.2300	1.0300	3.070	1.8600	5.5800	0.1900	0.560	
Dr5	RED670	RES\REACT	0.5600	1.6800	0.7500	2.230	1.7500	5.2300	0.1500	0.430	
Dr6	RED670	RES\REACT	0.5600	1.6800	0.7900	2.370	1.8600	5.5800	0.1500	0.430	
Dr7	RED670	RES\REACT	0.5600	1.6800	0.7500	2.230	1.7500	5.2300	0.1500	0.430	
Dr8	RED670	RES\REACT	0.5600	1.6800	0.7900	2.370	1.8600	5.5800	0.1500	0.430	
Dr9	RED670	RES\REACT	0.3800	1.1200	0.8400	2.510	2.0900	6.2800	0.1000	0.290	
Dr10	RED670	RES\REACT	0.1000	0.2800	0.4000	1.190	1.5100	4.5300	0.0300	0.100	
Dr11	RED670	RES\REACT	0.1000	0.2800	0.4000	1.190	1.5100	4.5300	0.0300	0.100	
Dr12	RED670	RES\REACT	0.7500	2.2300	1.1200	3.350	2.1000	6.2800	0.1900	0.560	
Dr13	RED670	RES\REACT	0.7500	2.2300	0.9800	2.930	1.9800	5.9300	0.1900	0.560	
Dr14	REL521	RES\REACT	0.3800	1.1200	0.5600	1.680	1.6300	4.8800	0.1000	0.290	

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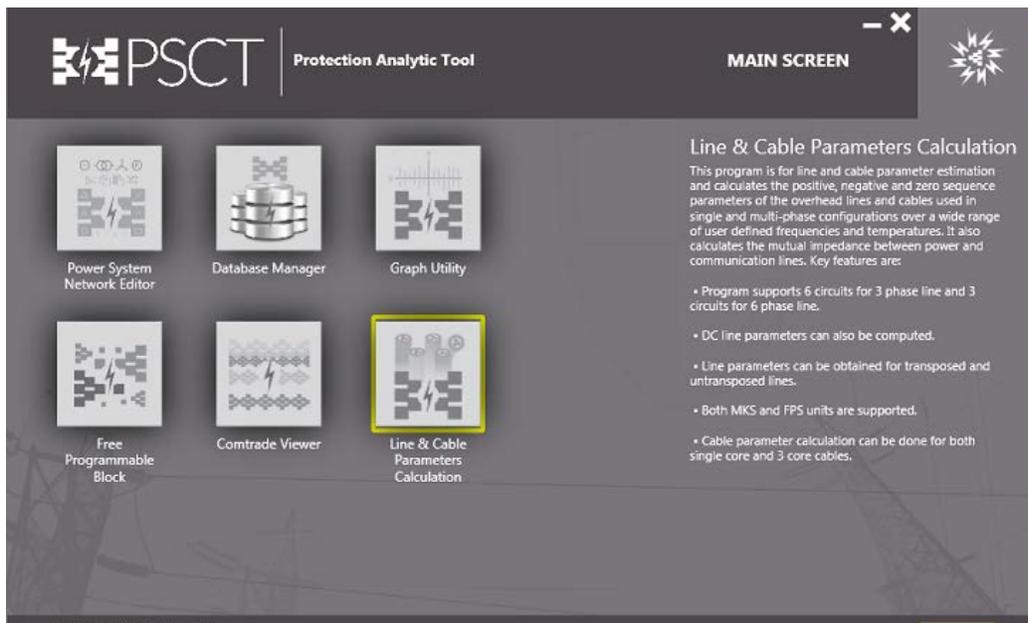
7. How to solve Line-Cable Parameter Calculation

7.1 Line Parameter Calculation

No of circuits	1
No of ground wires	1
No of bundles/ph	1
Length of line	1m
Spacing between bundle conductor	0m
Earth resistivity	100ohm-m
Operating frequency	50Hz

* 100MVA base at 220kV

To solve line and cable parameter calculation by using MiP-PSCT package invokes “**Line & Cable Parameter Calculation**” in the MiP-PSCT main screen.



Open **view menu**, select **cable** or **line** which ever is necessary.

Line Parameter Calculation:

The screenshot shows the 'Line Parameter Data' window of the software. The interface includes a menu bar (File, Edit, Record, View, Execute, Window, Help) and a title bar (Line & Cable - [E:\MiPower\MILINE:[Line Data]]). The main area contains several sections for data entry:

- Case Information:** Case Number (300), Line Name (Drake220-S/C), and a 'Fetch Record >>' button.
- Number of Phases:** Radio buttons for 1 Phase, 2 Phase, 3 Phase, and 6 Phase. Callout 1 points to this section.
- Unit Type:** Radio buttons for MKS (selected) and FPS. Callout 3 points to this section.
- Line Parameters:** Number of Circuits (1), Number of Ground Wires (1), Number of Bundles per Circuit per Phase (1), Length of the Line (1 km), and Spacing b/n. the Bundle Conductors (0 m). Callout 2 points to these fields.
- Positioning:** Radio buttons for Transposed (selected) and Untransposed. Callout 4 points to this section.
- Base and Frequency:** Base kV (220), Earth Resistivity (100 ohm-m), MVA (100), and Operating Frequency (50 Hz).
- Conductor and Correction:** Conductor Type (Aluminium Conductor selected), Carson's Correction Factor (Single Term Correction added selected). Callout 5 points to the conductor type, and callout 6 points to the correction factor.
- Communication Line Data:** Conductor Height (0 m) and Conductor Width (0 m). Callout 7 points to this section.
- Frequency Range and Output Options:** Freq. Range for Line Param. Evaluation (Maximum: 500 Hz, Minimum: 50 Hz, Step: 50 Hz) and Output Options (Actual Value per Unit Length selected). Callout 8 points to the frequency range, and callout 9 points to the output options.
- Line Info:** A 'Line Info >>' button. Callout 10 points to this button.

After entering all the data click on **Save** and to add next record click on **Next**

Conductor Information:

	Conductor 1	Conductor 2	Conductor 3	Conductor 4
Diameter in meter	0.02811	0.02811	0.02811	0.00945
Width in meter	4.4	4.4	-4.4	0
Height in meter from ground level	17.6	25.6	21.6	27.4
Sag in meter	7.6	7.6	7.6	0
DC Resistance in ohm	0.07309	0.07309	0.07309	3.375
Temperature1 in °Celsius	20	20	20	20
Temperature2 in Degree Celsius	65	65	65	20

Invoke **Execute** → **Line parameter calculation**. A part of the report is shown.

```

-----
                LINE PARAMETER CALCULATION
CASE NO:      300                      SCHEDULE NO: 0
-----
NUMBER OF PHASES PER CIRCUIT      :      3
NUMBER OF CIRCUITS                 :      1
NUMBER OF GROUND WIRES            :      1
NUMBER OF CONDUCTORS PER BUNDLE   :      1
LINE TRANSPOSITION STATUS         :      1 (TRANPOSED)

```

```

BASE MVA           : 100.000
BASE KV            : 220.000

UNIT TYPE          : 0 (MKS SYSTEM)
OUT TYPE           : 0 - Ohm(Mho)/km
CONDUCTOR MATERIAL TYPE : 2 - ALUMINUM
FREQUENCY          : 50.000 hertz
BUNDLE SPACE      : 0.00000 meter
EARTH RESISTIVITY : 100.000 ohm-meter
LINE LENGTH       : 1.000 km
CARSON CORRECTION OPTION : 1 - SINGLE TERM CORRECTION
FREQUENCY STARTING VALUE : 50.00 Hzs
FREQUENCY ENDING VALUE   : 50.00 Hzs
FREQUENCY STEP VALUE    : 50.00 Hzs

```

NOTATION USED FOR CONDUCTOR INFORMATION

```

RDC : DC resistance of conductor in ohms at T1 degree Celsius.
T1  : Temperature in degree Celsius at which RDC value is provided.
T2  : Temperature in degree Celsius at which resistance to be computed.
CD  : Diameter of the conductor in the given units.
CH  : Height of the conductor above ground in given units.
CW  : Distance between conductor and centre of the tower in given units.
Sag : Conductor sag at the mid way of the span in given units.

```

COND. (no.)*	RDC (ohm)	T1 (degree-c)	T2 (degree-c)	CD (metre)	CH (metre)	CW (metre)	Sag (mtr)
1	0.07309	20.00000	65.00000	0.02811	17.60000	4.40000	
7.600							
2	0.07309	20.00000	65.00000	0.02811	25.60000	4.40000	
7.600							
3	0.07309	20.00000	65.00000	0.02811	21.60000	-4.40000	
7.600							
4	3.37500	20.00000	20.00000	0.00945	27.40000	0.00000	
0.000							

```

COMMUNICATION LINE HEIGHT FROM GROUND : 0.00000 metre
COMMUNICATION LINE WIDTH FROM CENTRE OF TOWER : 0.00000 metre

```

```

COMPUTED VALUES ARE FOR AC SYSTEM

```

SERIES PHASE IMPEDANCE MATRIX FOR ALL THE CONDUCTORS IN SELECTED UNIT
CONVENTION (A1 B1 C1),(A2 B2 C2),..., (G1 G2..)

1.363704e-001+j7.133706e-001 4.935159e-002+j2.838968e-001 4.935159e-002+j2.838968e-001
4.935159e-002+j2.838968e-001

4.935159e-002+j2.838968e-001 1.363704e-001+j7.133706e-001 4.935159e-002+j2.838968e-001
4.935159e-002+j2.838968e-001

4.935159e-002+j2.838968e-001 4.935159e-002+j2.838968e-001 1.363704e-001+j7.133706e-001
4.935159e-002+j2.838968e-001

4.935159e-002+j2.838968e-001 4.935159e-002+j2.838968e-001 4.935159e-002+j2.838968e-001
3.424352e+000+j7.818725e-001

SERIES PHASE IMPEDANCE MATRIX AFTER GROUND WIRE ELIMINATION IN SELECTED UNIT
CONVENTION (A1 B1 C1),(A2 B2 C2),...

1.562888e-001+j7.006396e-001 6.927006e-002+j2.711659e-001 6.927006e-002+j2.711659e-001

6.927006e-002+j2.711659e-001 1.562888e-001+j7.006396e-001 6.927006e-002+j2.711659e-001

6.927006e-002+j2.711659e-001 6.927006e-002+j2.711659e-001 1.562888e-001+j7.006396e-001

SERIES SEQUENCE IMPEDANCE MATRIX AFTER GROUND WIRE ELIMINATION IN SELECTED UNIT
CONVENTION (0 1 2),(0 1 2),...

2.948289e-001+j1.242972e+000 0.000000e+000-j1.851916e-008
0.000000e+000+j1.851916e-008

-9.259582e-009-j2.777874e-008 8.701877e-002+j4.294737e-001 -9.259582e-009+j2.314895e-008

0.000000e+000-j4.629791e-009 -9.259582e-009+j2.777874e-008 8.701876e-002+j4.294738e-001

SERIES SEQUENCE IMPEDANCE MATRIX - EQUIVALENT CIRCUIT (0 1 2) IN SELECTED UNIT

CONVENTION (0 1 2)

2.948290e-001+j1.242972e+000 9.259582e-009+j9.259582e-009 1.851916e-008+j4.629791e-008

0.000000e+000-j0.000000e+000 8.701876e-002+j4.294737e-001 -1.851916e-008+j9.259582e-009

0.000000e+000+j9.259582e-009 -9.259582e-009+j9.259582e-009 8.701876e-002+j4.294738e-001

SHUNT PHASE ADMITTANCE MATRIX FOR ALL THE CONDUCTORS IN SELECTED UNIT

CONVENTION (A1 B1 C1), (A2 B2 C2), ..., (G1 G2..)

0.000000e+000+j2.409543e-006 0.000000e+000-j3.164514e-007
 0.000000e+000-j3.164514e-007
 0.000000e+000-j2.527685e-007

0.000000e+000-j3.164514e-007 0.000000e+000+j2.409543e-006
 0.000000e+000-j3.164514e-007
 0.000000e+000-j2.527685e-007

0.000000e+000-j3.164514e-007 0.000000e+000-j3.164514e-007
 0.000000e+000+j2.409543e-006
 0.000000e+000-j2.527685e-007

0.000000e+000-j2.527685e-007 0.000000e+000-j2.527685e-007
 0.000000e+000-j2.527684e-007
 0.000000e+000+j1.975512e-006

SHUNT PHASE ADMITTANCE MATRIX AFTER GROUND WIRE ELIMINATION IN SELECTED UNIT

CONVENTION (A1 B1 C1), (A2 B2 C2), ...

0.000000e+000+j2.409543e-006 0.000000e+000-j3.164514e-007
 0.000000e+000-j3.164513e-007

0.000000e+000-j3.164514e-007 0.000000e+000+j2.409543e-006
 0.000000e+000-j3.164514e-007

0.000000e+000-j3.164513e-007 0.000000e+000-j3.164514e-007
 0.000000e+000+j2.409543e-006

 SHUNT SEQUENCE ADMITTANCE MATRIX AFTER GROUND WIRE ELIMINATION IN
 SELECTED UNIT
 CONVENTION (0 1 2),(0 1 2),...

-2.393917e-014+j1.776640e-006 7.064500e-014-j0.000000e+000 -3.532250e-
 014+j7.064500e-014

-7.064500e-014-j7.064500e-014 5.298375e-014+j2.725994e-006 7.064500e- 014-
 j1.412900e-013

7.064500e-014-j3.532250e-014 -1.412900e-013-j3.532250e-014 -4.001377e-
 014+j2.725994e-006

 SHUNT SEQUENCE ADMITTANCE MATRIX - EQUIVALENT CIRCUIT (0 1 2) IN SELECTED UNIT
 CONVENTION (0 1 2)

-2.393917e-014+j1.776640e-006 7.064500e-014-j3.532250e-014 -7.064500e-
 014+j3.532250e-014

-3.532250e-014-j3.532250e-014 6.374607e-014+j2.725994e-006 1.412900e- 013-
 j1.412900e-013

3.532250e-014-j1.766125e-014 -1.412900e-013-j3.532250e-014 -5.319072e-
 014+j2.725994e-006

 A,B,C and D constants :

A = 0.9999994040 +j 0.0000001186
 B = 0.0870187283 +j 0.4294736385 (Ohm)
 C = -0.0000000000 +j 0.0000027260 (Mho)
 D = 0.9999994040 +j 0.0000001186

 ATTENUATION CONSTANT (Line-to-Line mode) : 0.00011 neper/km
 PHASE CONSTANT (Line-to-Line mode) : 0.00109 rad/km

```

CHARACTERISTIC WAVELENGTH (Line-to-Line mode) 5777.68708 Km
PROPAGATION VELOCITY (Line-to-Line mode)      : 288884.35377 km
SURGE IMPEDANCE (REAL, including losses)      : 398.93393 Ohms
SURGE IMPEDANCE (IMAGINARY, including losses) : -40.00894 Ohms
ATTENUATION CONSTANT (Line-to-Ground mode)   : 0.00018 neper/km
PHASE CONSTANT (Line-to-Ground mode)         : 0.00150 rad/km
CHARACTERISTIC WAVELENGTH (Line-to-Ground mode) : 4199.11477 km
PROPAGATION VELOCITY (Line-to-Ground mode)   : 209955.73869 km

```

MUTUAL INDUCTANCE IN SELECTED UNIT

```

BETWEEN PHASE LINE 1 & COMMUNICATION LINE 0.26713
BETWEEN PHASE LINE 2 & COMMUNICATION LINE 0.23835
BETWEEN PHASE LINE 3 & COMMUNICATION LINE 0.25123

```

% Line parameters per circuit

```

%CS Type Rp      Xp      Bp/2
%      Rz      Xz      Bz/2

```

```

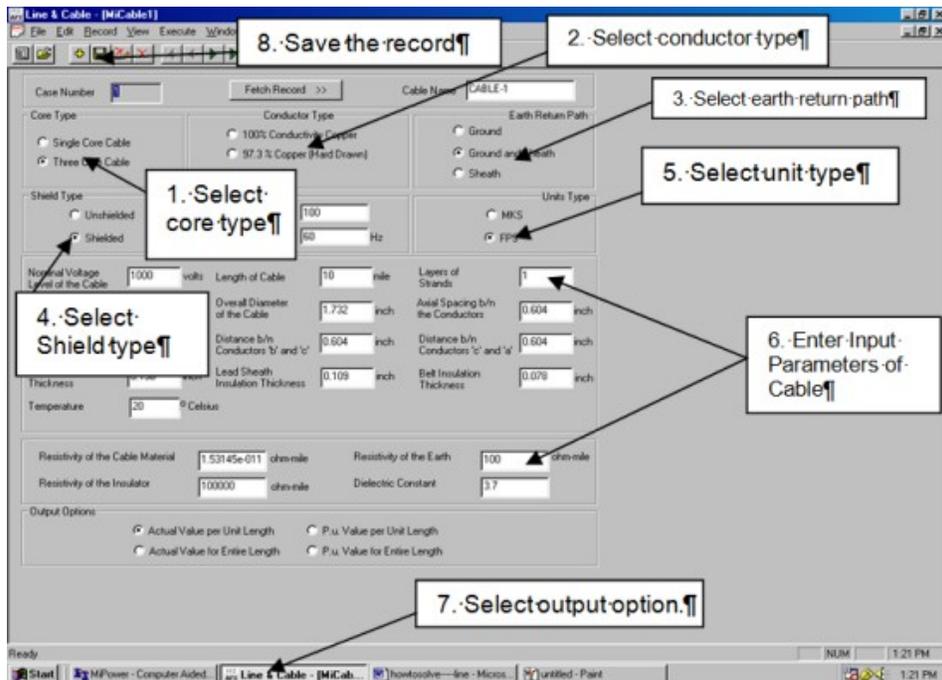
LN 0      8.701877e-002 4.294737e-001 1.362997e-006
      2.948289e-001 1.242972e+000 8.883201e-007

```

7.2 Cable Parameter Calculation:

Calculate the cable parameters for the aluminum shielded 3-core cable with ground and sheath as the path for earth return with the details given below.

Nominal voltage level of the cable	1kV	Lead sheath thickness	0.156 inch
Length of cable	10mile	Lead sheath insulation thickness	0.109 inch
Layer of strands	1	Belt insulation thickness	0.078 inch
Diameter of single strands	0.0973 inch	Temperature	20deg-cel
Overall diameter of cable	1.732 inch	Resistivity of the cable material	1.532e-11ohm-mile
Axial spacing b/n the conductor	0.604 inch	Resistivity of the insulator	100000 ohm-mile
Distance b/n conductor 'a' & 'b'	0.604 inch	Resistivity of the earth	100 ohm-mile
Distance b/n conductor 'b' & 'c'	0.604 inch	Dielectric constant	3.7
Distance b/n conductor 'c' & 'a'	0.604 inch		



Invoke **Execute** → **Cable parameter calculation**. The report is shown below.

CABLE PARAMETER CALCULATION

CASE NO : 1 SCHEDULE NO : 0

```

-----
Temperature at which the R is calculated : 20.0 degree celsius
Units : 1 (FPS system)
Diameter of the strand : 0.0973 inch
Number of layers of stranded conductors : 1
Length of the conductor : 10.000 mile
Resistivity at zero degree celsius : 1.53145e-011 ohm-mile
Lead sheath insulation : 0.1090 inch
Axial spacing between conductors : 0.6040 inch
Frequency : 60.0 hertz
Number of cores : 3

```

Resistivity of the insulation	:	100000.0 ohm-mile
Diameter over insulation	:	1.7320 inch
Conductor Insulation Thickness	:	0.1560 inch
Return path	:	Through both ground and sheath
Return path	:	Through ground
Conductor type	:	2
(Material used for the conductor	- Aluminium)	
Distance among conductor centers (a-b)	:	0.6040 inch
Distance among conductor centers (b-c)	:	0.6040 inch
Distance among conductor centers (c-a)	:	0.6040 inch
System voltage	:	1000 volts
Earth resistivity	:	100.0 ohm-m
Dielectric constant	:	3.7
Shield	:	1
(3 core ,shielded cable)		
Belt insulation	:	0.0780 inch
Output option	:	0 - Ohm(Mho)/mile
Base MVA	:	100.000

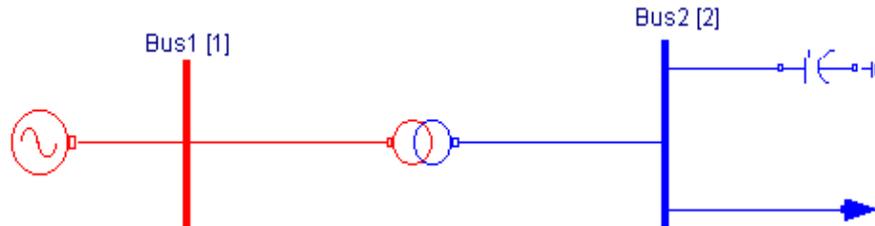
POSITIVE SEQUENCE IMPEDANCE	:	0.98961+j0.20265
POSITIVE SEQUENCE SUSCEPTANCE	:	0.00008
NEGATIVE SEQUENCE IMPEDANCE	:	0.98961+j0.20265
NEGATIVE SEQUENCE SUSCEPTANCE	:	0.00008
ZERO SEQUENCE IMPEDANCE	:	2.89518+j1.87208
ZERO SEQUENCE SUSCEPTANCE	:	0.00008

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8. How to solve EMTA

For the two bus system shown below conduct Electro-magnetic Transient Analysis for a three phase to ground fault at Bus 2



Generator details

315 MVA, 11 kV with $X_d = X_q = 2$, $X'_d = X'_q = 0.3$, $X''_d = X''_q = 0.2$, $X_n = X_0 = X_p = 0.2$

Transformer details

315 MVA, 220/11 kV, leakage reactance = $x = 14\%$

Load details

200MW at 0.8 p.f lag

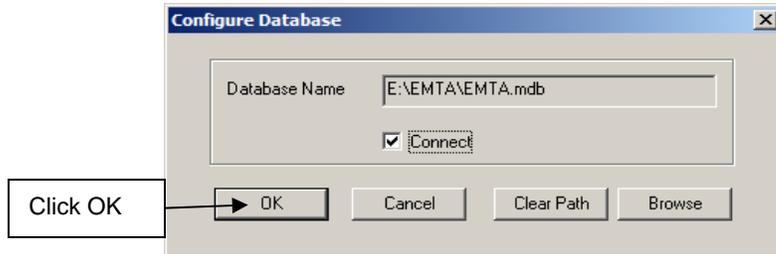
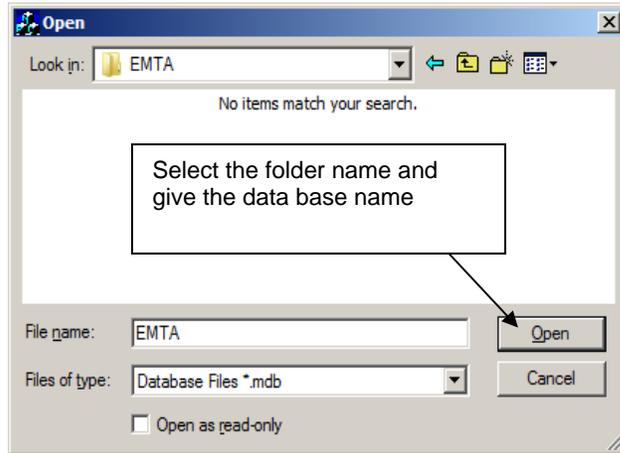
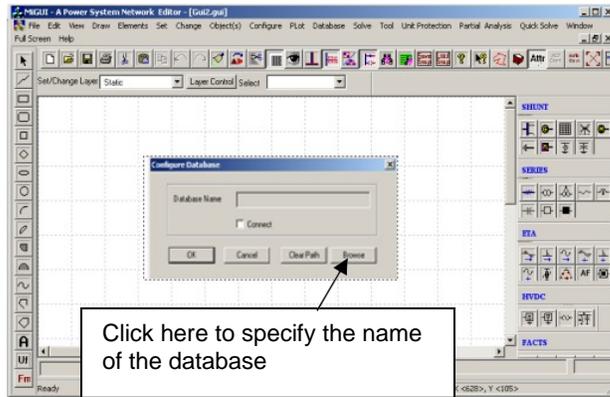
Shunt capacitor data: 5MVA, 220kV, susceptance=1

MiP-PSCT - Database Configuration

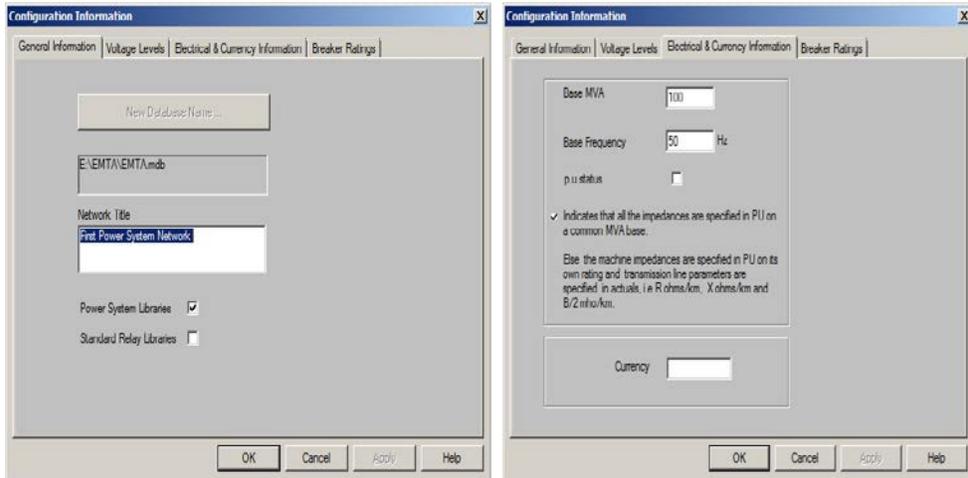
Open Power System Network Editor. Select menu option **Database → Configure**. Configure Database dialog is popped up. Click **Browse** button.

Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click **Open** button after entering the desired database name. **Configure**

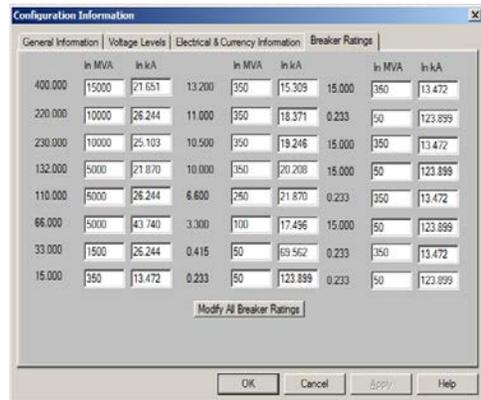
Database dialog will appear with path chosen.



Click on **OK** button in the **Configure database** dialog, the following dialog appears.



Click **Electrical Information** tab. Since the impedances are given on 100 MVA base, check the pu status. Enter the Base MVA and Base frequency as shown below. Click **Breaker Ratings** tab. If the data is furnished, modify the breaker ratings for required voltage levels. Otherwise accept the default values. Click **OK** button to create the database to return to Network Editor.



Bus Base Voltage Configuration

In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure→Base voltage**.

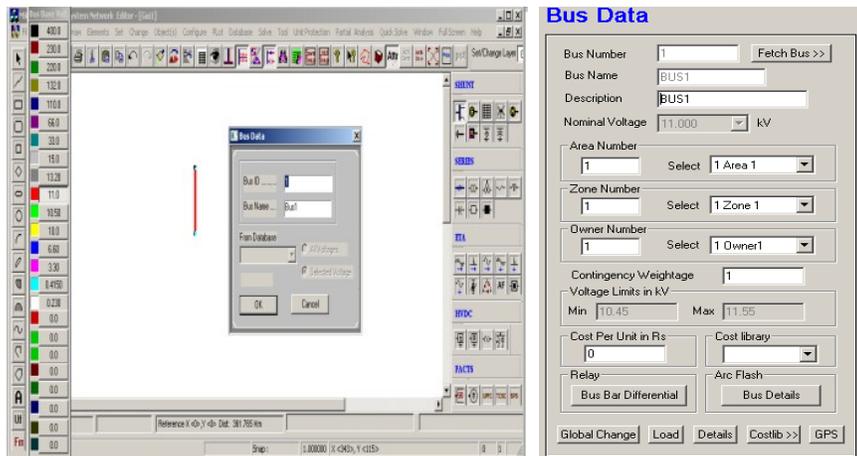
Dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click **OK**.

8.1 Procedure to Draw First Element - Bus

Click on **Bus** icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click **OK**. Database manager with corresponding **Bus Data** form will appear. Modify the Area number, Zone number and

Contingency Weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are $\pm 5\%$ of the rated voltage. If these ratings are other than this, modify these fields. Otherwise keep the default values.

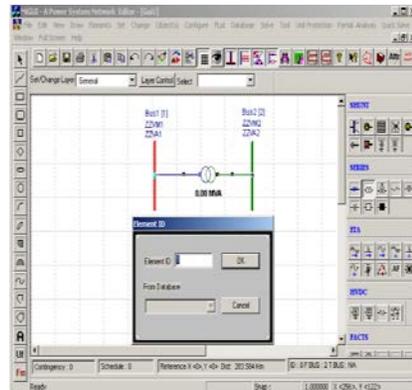
Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is **Northeast**, then bus name can be given as **NE** and the bus description field can be **North East**.



After entering data click **save** , which invokes **Network Editor**. Follow the same procedure for second bus with bus voltage as 220 kV.

8.2 Procedure to Draw Transformer

Click on **Two Winding Transformer** icon provided on power system tool bar. To draw the transformer click in between two buses and to connect to the from bus, double click LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear. Click **OK**.



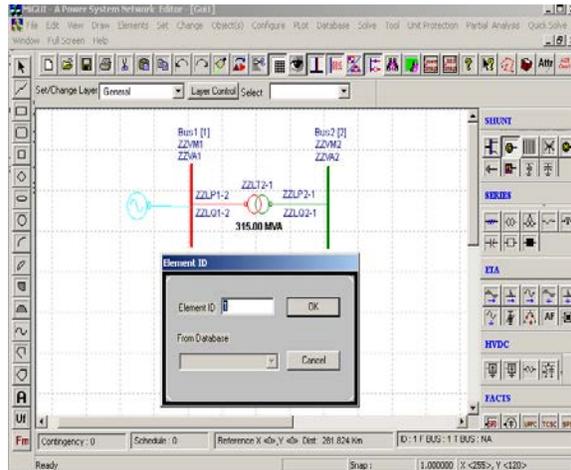
Transformer Element Data form will be open. Enter the **Manufacturer Ref. Number** as **30**. Enter transformer data in the form as shown below. Click on **Transformer Library** >> button.

Transformer library form will be open. Enter the data as shown below. **Save** and **close** library screen.

Transformer element data form will appear. Click **Save** button, which invokes network editor. In the similar way enter other transformer details.

8.3 Procedure to Draw Generator

Click on **Generator** icon provided on power system tool bar. Draw the generator by clicking LMB (Left Mouse Button) on the **Bus1**. **Element ID** dialog will appear. Click **OK**.



Generator Data form will be opened. Enter the **Manufacturer Ref. Number** as 1. Enter Generator data in the form as shown below.

Generator Data			
Number: 1	Fetch Generator >>	Name: Gen1	Maintenance
Bus No.: 1 [Bus1] (11.000)	Manufacturer Ref. No.: 1 [Thermal20Mw]	Library >>	Schedule No.: 0
Units in Parallel: 1	Capability Curve No.: 0 [CAPCUR]	Capability Curve >>	Protection: Over Current
Specified Voltage: 11.000 Pu, 11 kV	Breaker Rating: In MVA: 350, In kA: 18.371	De-Rated MVA: 315	Relay
Scheduled Power: 300 MW	Reactive Power - Minimum: 0 Mvar	Reactive Power - Maximum: 200 Mvar	Unit Protection
Real Power Optimization Data:	Cost Co-efficient C0: 0	Cost Co-efficient C1: 0	Cost Per Unit in: 0
Real Power - Minimum: 0 MW	Cost Co-efficient C2: 0	Real Power - Maximum: 300 MW	Select: Utility Grid, Generator
Status: In Service	Commission Status: Existing	Year: 0	Out of Service
Neutral Grounding Resistance: 0 ohms	Participation Factor (%): 0	Neutral Grounding Reactance: 0 ohms	Bias Setting: 0
Grounding Through Transformer: Calculate	Droop (%): 4		
Model Type: Infinite Bus Modelling (X'd)	AVR Ref. No.: 0 [AVR] Type 0	AVR Library >>	AVR File Open
Transient Modelling (X'd & X'q)	AVR FPG Name:		
Sub Transient Modelling (X'd & X'q)	Turbine Gov Ref No.: 0 Type 0	TG Library >>	GOV File Open
Global Change	Tur Governor Name:		

Click on **Generator Library >>** button. Enter generator library details as shown below.

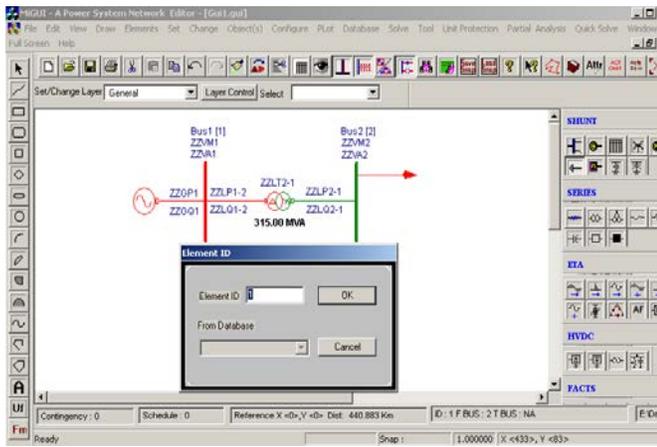
Generator Library

Ref. Number <input type="text" value="1"/>		<input type="button" value="Fetch Generator"/>		Manufacturer Name <input type="text" value="Thermal120MW"/>	
MVA Rating <input type="text" value="315"/>	MW Rating <input type="text" value="300"/>	kV Rating <input type="text" value="11"/>	<input type="button" value="Compute X'd,d,n,0"/>		
pu on its Own Rating					
Armature Resistance (Ra) <input type="text" value="0"/>	pu	Potier Reactance (Xp) <input type="text" value="0.2"/>	pu		
Direct Axis Reactance (Xd) <input type="text" value="2"/>	pu	Direct Axis Transient Reactance (X'd) <input type="text" value="0.3"/>	pu		
Quadrature Axis Reactance (Xq) <input type="text" value="2"/>	pu	Quadrature Axis Transient Reactance (X'q) <input type="text" value="0.3"/>	pu		
Negative Seq. Reactance (Xn) <input type="text" value="0.2"/>	pu	Direct Axis Sub-Transient Reactance (X''d) <input type="text" value="0.2"/>	pu		
Zero Seq. Reactance (Xo) <input type="text" value="0.2"/>	pu	Quadrature Axis Sub-Transient Reactance (X''q) <input type="text" value="0.2"/>	pu		
Direct Axis Open Circuit Transient Time Constant (T'do) <input type="text" value="7.15"/>		Direct Axis Open Circuit Sub-Transient Time Constant (T''do) <input type="text" value="0.039"/>		Inertia in MJ/MVA <input type="text" value="3.31"/>	
Quadrature Axis Open Circuit Transient Time Constant (T'qo) <input type="text" value="2.5"/>		Quadrature Axis Open Circuit Sub-Transient Time Constant (T''qo) <input type="text" value="0.15"/>		Damping Factor <input type="text" value="0"/>	
Winding Connections		Mass Details		Cost Per Unit in	
		Mass Number <input type="text" value="0"/>	<input type="button" value="Next >>"/>	<input type="text" value="0"/> <input type="button" value="Thermal >>"/>	
		Inertia <input type="text" value="0"/>	MJ/MVA Counter		
		Damping Factor <input type="text" value="0"/>	<input type="button" value="Back <<"/>		
		Stiffness Co-efficient <input type="text" value="0"/>	pu torque/Elec. Rad <input type="button" value="Delete"/>		

Save  and **Close** the library screen. Generator data screen will be reopened. Click **Save**  button, which invokes Network Editor.

8.4 Procedure to enter Load Data

Click on **Load** icon provided on power system tool bar. Connect load 1 at BUS2 by clicking the LMB on Bus 2. **Element ID** dialog will appear. Give ID No as 1 and say OK. **Load Data** form will appear. Enter load details as shown below. Then click **Save** button, which invokes Network Editor.

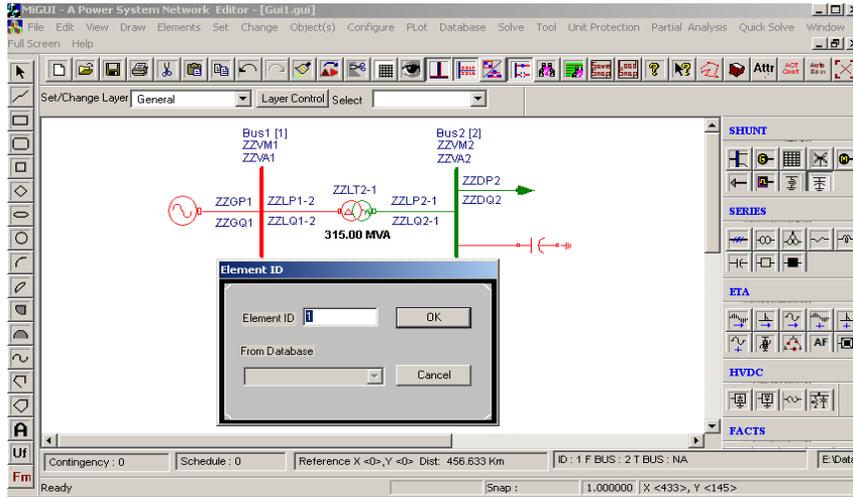


Load Data

Number: 1	Fetch Load >>	Name: LD1	Maintenance	Schedule No: 0	Relay
Bus Number: 2 (Bus2) (220.000)	No of Consumers: 1	MVAR Compensation: 0	Minimum Compensation in MVAR: 0	Maximum Compensation in MVAR: 0	Relay
Real Power in MW: 200	Compute	Compensation Step in MVAR: 0	Load Characteristics No.: 0	Cost Per Unit in Rs: 0	Cost library
Reactive Power in MVAR: 150	Load Details	Unbalanced Load: <input checked="" type="radio"/> Y <input type="radio"/> N	Library: Load Characteristics >>	Ref No.:	Lib >>
Power Factor: 0.800000	Global Change	Motor Load Percentage: 0	Commission Status: Existing <input checked="" type="radio"/> Proposed <input type="radio"/> Year: 0	Breaker Rating: In MVA: 10000	
Load Type: <input checked="" type="radio"/> Linear <input type="radio"/> Non Linear	Unbalanced Load Details	Control Block: Fpb Path: <input type="text"/>	Breaker Rating: In kA: 26.244		

8.5 Procedure to Draw Shunt Capacitor

Click on Shunt **Reactor** icon provided on power system tool bar. To draw the shunt reactor click on the Bus. **Element ID** dialog will appear.



Enter **Element ID** number and click **OK**. Database manager with corresponding **Shunt Reactor Data** form will be open. Enter the details of that line as shown below.

Shunt Capacitor Data

Number <input type="text" value="1"/>	Fetch >>	Name <input type="text" value="ShC1"/>	Maintenance	Relay <input type="text" value=""/>
De-Rated MVA <input type="text" value="5"/>	Library	Manufacturer Ref. No. <input type="text" value="1 [ShC1]"/>	Relay <input type="text" value=""/>	
Bus Number <input type="text" value="2 [Bus2] (220.000)"/>	Shunt Capacitor >>		Cost Per Unit in <input type="text" value="0"/>	
Status <input checked="" type="radio"/> In Service <input type="radio"/> Out of Service	Commission Status <input checked="" type="radio"/> Existing <input type="radio"/> Proposed Year <input type="text" value="0"/>	Breaker Rating In MVA <input type="text" value="10000.00"/> kA <input type="text" value="26.244"/>		

Enter **Structure Ref No.** as **1 [MANF1]** and click on **Shunt Capacitor Library >>** button.

Shunt Capacitor Library form will appear. Enter Shunt Capacitor Library data in the form as shown below for MANF1

After entering data **save** and **Close**. **Shunt Reactor Data** form will appear. Click **Save**, which invokes Network Editor to update next element.

8.6 Solve Load Flow Analysis

Select Menu option **Solve**→**Load Flow Analysis**. Following dialog will appear.

Load flow Results:

```

-----
-----
BUS VOLTAGES AND POWERS

NODE FROM          V-MAG  ANGLE          MW      MVAR          MW      MVAR
MVAR
NO.  NAME          P.U.  DEGREE          GEN      GEN      LOAD      LOAD
COMP
-----
--
  1      Bus1  1.0000   0.00   201.536  177.731    0.000    0.000
0.000
  2      Bus2  0.9206  -5.33    0.000    0.000   200.000   150.000
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) :    0
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark) :    0
-----
-----
TRANSFORMER FLOWS AND TRANSFORMER LOSSES

SLNO CS FROM FROM          TO TO          FORWARD          LOSS
%
      NODE NAME      NODE NAME          MW      MVAR          MW      MVAR
LOADING
  1  1      2      Bus2      1      Bus1 -199.934 -145.680    1.6026   32.0512
85.3#
-----
-----
! NUMBER OF TRANSFORMERS LOADED BEYOND 125%          :    0
@ NUMBER OF TRANSFORMERS LOADED BETWEEN 100% AND 125% :    0
# NUMBER OF TRANSFORMERS LOADED BETWEEN 75% AND 100% :    1
$ NUMBER OF TRANSFORMERS LOADED BETWEEN 50% AND 75% :    0
^ NUMBER OF TRANSFORMERS LOADED BETWEEN 25% AND 50% :    0
& NUMBER OF TRANSFORMERS LOADED BETWEEN 1% AND 25% :    0
* NUMBER OF TRANSFORMERS LOADED BETWEEN 0% AND 1% :    0
-----
-----
! 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% :    0
& NUMBER OF LINES LOADED BETWEEN 1% AND 25% :    0
* NUMBER OF LINES LOADED BETWEEN 0% AND 1% :    0

```

```

SHUNT CAPACITOR AND REACTOR INJECTION
NODE FROM      V-MAG ANGLE      MW      MVAR
NO.  NAME      P.U. DEGREE     GEN     GEN
-----
   2   Bus2    0.921  -5.33    -0.000  4.238
-----

```

```

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

```

Summary of results

```

TOTAL REAL POWER GENERATION : 201.536 MW
TOTAL REAL POWER INJECT,-ve L : 0.000 MW
TOTAL REACT. POWER GENERATION : 177.731 MVAR
GENERATION pf : 0.750
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 : 4.238 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

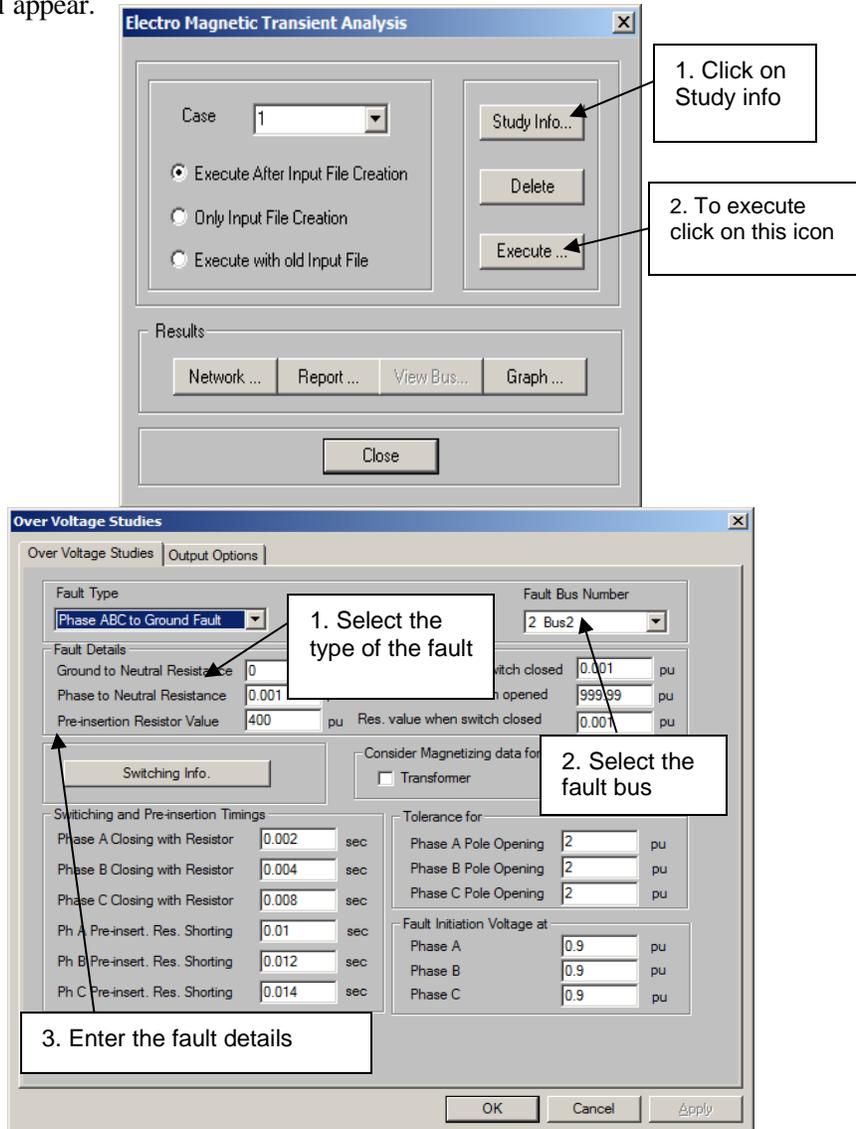
TOTAL REAL POWER LOAD : 200.000 MW
TOTAL REAL POWER DRAWAL -ve g : 0.000 MW
TOTAL REACTIVE POWER LOAD : 150.000 MVAR
LOAD pf : 0.800
TOTAL COMPENSATION AT LOADS : 0.000 MVAR
TOTAL HVDC REACTIVE POWER : 0.000 MVAR

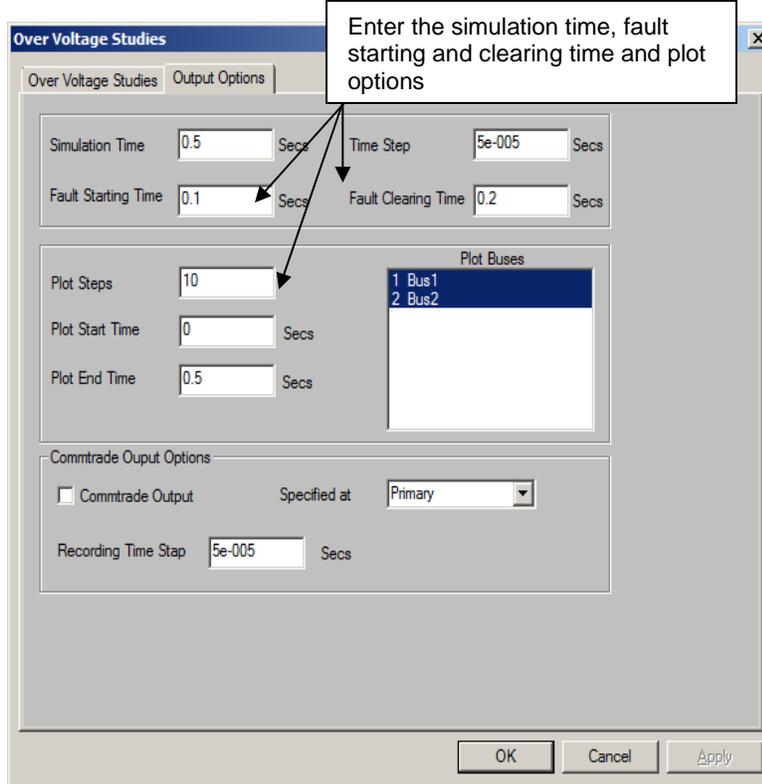
TOTAL REAL POWER LOSS (AC+DC) : 1.602559 MW ( 1.602559+ 0.000000)
PERCENTAGE REAL LOSS (AC+DC) : 0.795
TOTAL REACTIVE POWER LOSS : 32.051174 MVAR
-----

```

8.7 Electromagnetic Transient Analysis:

Select Menu option **Solve**→ **Electromagnetic Transient Analysis**. Following dialog will appear.





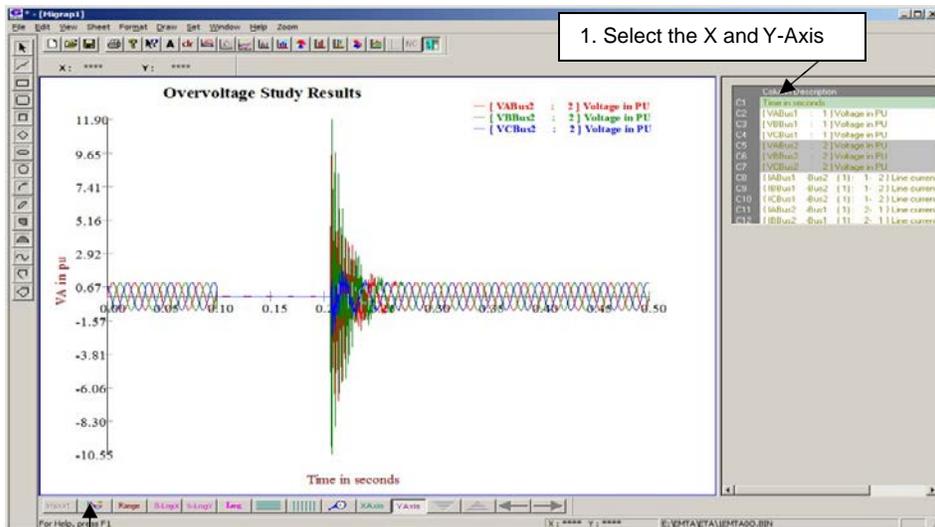
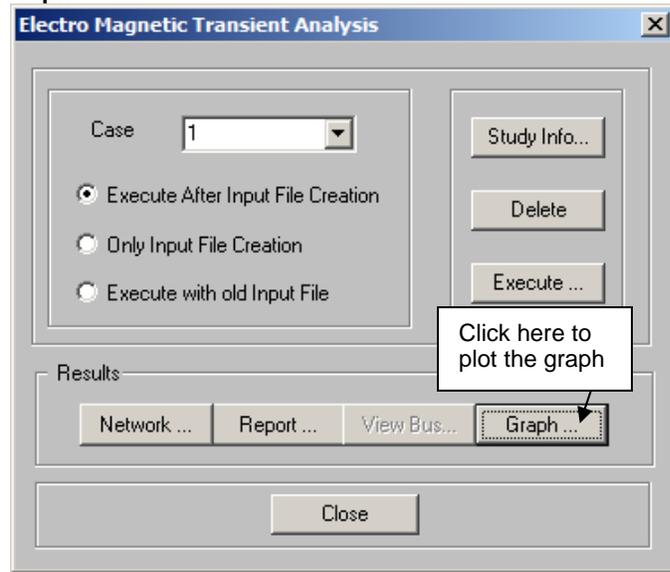
RESULTS:

```

-----
-----
BUS  NAME      VA-PEAK  A-PEAK-T  VB-PEAK  B-PEAK-T  VC-PEAK  C-PEAK-T
          PU      mili Sec  PU      mili Sec  PU      mili Sec
-----
CASE-1  : tmin =  0.00000, tmax =  0.50000
=====
   1   Bus1  6.99001  206.90000  -7.37604  206.85000  -2.13945  207.40000
          62.78048                -66.24759                -19.21536
   2   Bus2 11.26962  206.90000 -12.64490  206.85000 -2.86584  207.40000
          2024.35340                -2271.39389                -514.78928
=====
=====
=====

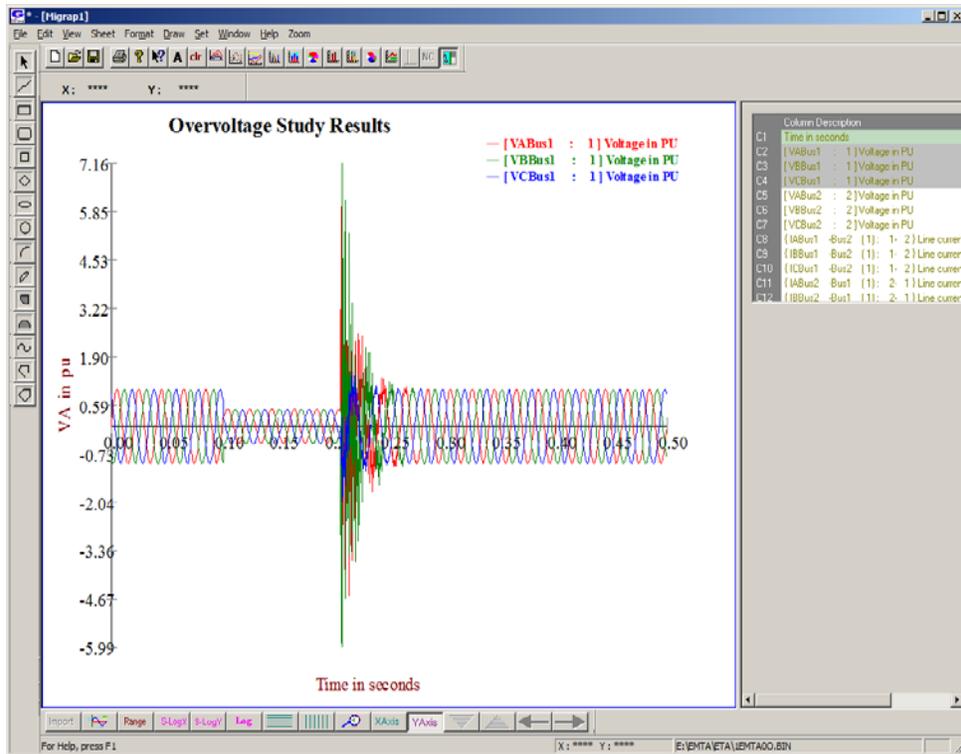
```

8.8 Plot Graph



2. To plot the graph click here

Voltage at bus no 2



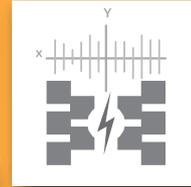
Voltage at bus no 1

Protection Suite

 PSCT | Protection Analytic tool



Power System
Network Editor



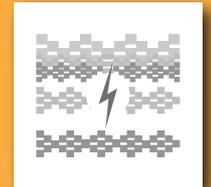
Graph Utility



Database Manager



Free Programmable
Block



COMTRADE
Viewer



LPC/CPC



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