

HOW TO SOLVE



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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:

- (a) 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.
- (b) 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.

Table : 1.1					
Bus code	Bus code Impedance				
From - To	R+jX in pu	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

	Table : 1.2								
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 \rightarrow 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

MiP-PSCT

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.

nfiguration Information
Afguration Information Information Voltage Levels Electrical & Currency Information Breaker Ratings New Detabase Name D:Viest.mdb Network Title First Power System Network
Power System Libraries

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.

					In MVA	in kA		in MVA	InkA		In MVA	hkā
Bace MVA	10	1		400.000	IL.	21.651	13.200	350	15.309	15.000	350	13.472
Base Frequency	60	H2		220.000	10000	26.244	11.000	350	18.371	0.233	50	123.85
nuslahar	-			230.000	10000	25.103	10.500	350	19.246	15.000	350	13.47
pro eranas				132.000	5000	21.870	10.000	350	20.208	15.000	50	123.85
 Indicates that all the a common MVA bas 	impedances are s	specified in PU on		110.000	5000	26.244	6.600	250	21.870	0.233	350	13.472
Else the machine im own taking and trans	pedances are sp mission line para	ecified in PU on its meters are		66.000	5000	43.740	3.300	100	17.496	15.000	50	123.85
specified in actuals, B/2 mho/km.	ie Rohms/km,	X ohms/km and		33.000	1500	25.244	0.415	50	63 562	0.233	350	13.472
				15.000	350	13.472	0.233	50	123.899	0.233	50	123.85
Curren	ny Rs						Modf	y All Breaker	Ratings			

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**.

🔝 Bus Base Voltage Configuratio	n		x
Base MVA	100.000000		Color
Bus Wdth	Bus Base Voltage Bus Wdth 13.20 kV 4 ÷	Bus Wdth	Basic colors:
230.0 kV 4 🚍	11.0 KV 4 💼	0.0 kV 4 🗧	
220.0 kV 4 🚎	10.50 kV 4 芸	0.0 kV 4 🛓	
132.0 kV 4 🚔	10.0 kV 4 🚍	0.0 kV 4 芸	
110.0 kV 4 🚍	6.60 kV 4 📑	0.0 kV 4 📩	
66.0 kV 4 🛨	3.30 kV 4 📩	0.0 kV 4 🛨	
33.0 kV 4 📑	0.4150 kV 4 🚊	0.0 kV 4 🚊	Define Custom Colors >>
15.0 kV 4 🛨	0.230 kV 4 🔺	0.0 kV 4 📩	OK Cancel
ОК	Cancel	Default	

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

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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** \square this invokes Network Editor. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Bus	Bus	Nominal
Number	Name	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/Cabl	e Data					
Number 1	Fetch L	ine >>	Name L1 Maintenance	Feed Data Type © Current C Power		
De-Rated MVA	0	1	Structure Ref. No.	Amperes 0		
Rating I	0	MVA	Transmission Line Library >> Line Details >>	pf 0.8		
Rating II	0	MVA	From Breaker	Show Breaker - SLD		
From Bus Number	1 [Bus1] {220.000	•	Not Exists NVA 10000 KA 26.244	SLD Notation		
To Bus Number	2 [Bus2] {220.000	•	From Breaker	C Cable C Breaker		
Number of Circuits	1]	To Breaker Rating	C Isolator		
Line Length	1	km	© Exists MVA 10000 kA 26.244	NUP No		
Contingency Weigh	tage 1]	To Breaker	C From Side C To Side		
Status In Service (Status St					

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

Line and Cable Lib	rary		
Number 3001 Na	ame Line1-2		Fetch >>
Daubius Comunes Daubiumes			Surge Impedance
Pusitive Sequence Resistance	10.02	pu	Z 1.000000 Ohms
Positive Sequence Reactance	0.06	pu	V 6205 714200 here/see
Positive Sequence Susceptance (B/2)	0.03	pu	V JO200.714200 Kills/sec
Zero Sequence Resistance	0	pu	Compute XL, B/2
Zero Sequence Reactance	0	pu	
Zero Sequence Susceptance (B/2)	0	pu	
Thermal Rating	100	MVA Compute	
Line Harmonic Number	0	Harmonic Library >>	
Cost per km	0	Cost Per Unit in	Thermal Curve>>

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.

MG2II - A Power System Network Editor - [Gull.gu]		Generator Data
	SevDarge Lave	Number 1 Fetch Generator >>> Name Gen1 Maintenance Schedule No 0 -
		Bits No. 1 [Bits1] (220.000 Monufacturer Ref. No. W. Library>>> Protection Units in Prostell 0.1 Cospibility Curve No. 0.1 (CAPCURT) Cospibility Curve >>>
Bast [1]	<u>← ■ 3 ≩</u>	Specified Volkage Break-or Flaring Break-or Flaring Break-or Flaring [1.60 pu [220.0000 kV In MVA [10000 In MA [26.244 Umit Protection
22VW1 N N N 22VW1 S		De-Rated MVA 0 Pieactive Power - Minimum 0 MVAc Cost Per Unit in Scheduled Power 0 MVV Pieactive Power - Maximum 74 501664 MVAc
○ N N Element D. III DK ○		Read Power Optimisation Data Cost Confisient C0 Office Select Read Power Maximum 0 Mov Cost Confisient C1 0 C Utility Bidd Read Power Maximum 0 Mov Cost Confisient C1 0 C Utility Bidd
2 o and 2 o an	······································	Status ^C In Service ^C Dut of Service ^C Exercise ^C Proposed Vear 0
Best [[] ZZVIG	平(型)☆(符) (MCN	Nextual Geounders Presidence 0 offers Participation Pactor (1) 0 Nextual Geounders Presidence 0 offers Bear Setting 0 Geounders Theory Through Theory In Territories Calculate 0 0 0
		Model Type AVR Ref No. 0 (007) Type 0 XVITIC/10/201 Christe Bus Modeling (2016 KVg) AVR RPR No. 0 (007) Type 0 XVITIC/10/201 Transie Modeling (2016 KVg) AVR RPR No. 0 (007) Type 0 XVITIC/10/201
Mill Configures: 0 Schedule: 0 Retension X <=>, v <=> bit D : 17005 : 17005 : 17005 : 14 Fmill Ready Snap : 1.000000 IX <=>10, v <=> bit	10 10 10 00 /	Sub Transient Modeling (X*d 5X*g) Tutions Gav Ref Na D. Type 0 (19 Library 20) Tot Governal Name D. Type 0 (19 Library 20)

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.

Generator Library
Ref. Number 30 Fetch Generator Manufacturer Name Gen4
MVA.Rating 100 MW Rating 80 kV Rating 220 Compute X('d,''dn.0)
pu on its Uwin Haling
Imature Hesistance (Ha) 0 pu Poter Heactance (Ap) 0 pu
Jirect Axis Reactance (Xd) 0 P4 Direct Axis Transient Reactance (X'd) 0 pu
Juadrature Axis Reactance (Xq) 0 P4 Quadrature Axis Transient Reactance (X'q) 0 pu
legative Seq. Reactance (Xn) 0 P4 Direct Axis Sub-Transient Reactance (X"d) 0 pu
lero Seq. Reactance (Xo) 0 P4 Quadrature Axis Sub-Transient Reactance (X'q) 0 pu
ect Axis Open Circuit [7.15 Direct Axis Open Circuit 0.039 anient Time Constant [0.039] Inetitia in MJ/MVA (3.31] (1.16)
adrature Axis Open Circuit 2.5 Quadrature Axis Open Circuit ansient Time Constant (T'qo) 0.15
Inding Connections Mass Details Cost Per Unit in
Mass Number 0 0
Y Y Inertia 0 MJ/MVA Counter
C C Damping Factor
Stiffness Co-efficient 0 pu torque/ Elec. Rad Delete

After entering data **Save** \square and close. In **Generator Data** form click **Save** \square . **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 D	ata
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.

A State of Prime Systems Versions' Editions (Last Spat) R File: 18: These Crass: Thereas: The Charge Charge Charges Rul Statemer These That State Primeters: Restal Andrew Quit Statemer R File: 18: These Crass: Thereas: The Charge Charges That Statemer These That State Primeters: Restal Andrew Quit Statemer R File: 18: These Crass: Thereas: The Charge Charges That Statemer These That Statemers: Restal Andrew Quit Statemers	XD. XB. (n mild alm	Load Data
		Number Fetch Load >> Name Martenance Schedule No 0 Y
D But (1) X X X ZZMA V V V		But Number 2 Buck (20:000) No d Consumers MXRB Compension D Pelay Red Power in MV/r 20 Monium Compression in MVAR 0 - Cod Pet Unit in Reachie Power in MVAR 0 Compute Compute Compute 0
		Perior Fator D354272 Load Detail Load Detailer O Cell frogr -Load Type -Unded road -Unded road
No. ZOA2 N. N. 0<	· 관객수류 ICS · · · · · · · · · · · · · · · · · · ·	-Statu Ender Raing Connicion Statu Connicion Statu Connicion Statu Connicion Statu Connicion Statu In MA 10000 In MA 3224
Fat Sady Sec. Limit (clip, ret)	20 1 M	Fpb Path Browse

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

	Load De	etails	
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.

Load Flow Analysis
1. Click on
Case 1 Study Info
Execute After Input File Creation Delete Delete
C 2. After giving Required Information
Network Report . View Bus Graph
3. After executing click here to

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.

Load Flow Studies	\mathbf{X}
Contingency Ranking Analysis Availal General Frequency depend	ble Transfer Capability SubStationWise LFA ent Load Flow Optimal Load Flow
Technique Gauss - Siedel Method Accelerat Newton Raphson Method Fast Decoupled LoadFlow	ion Factor 1.4
Load Flow Type Slack Bus Concept LFA Frequency Dependent LFA Depined Load Flow Analysis	Frequency Dependent LFA Options Flat The Line Control Flat The Line Control Flat Frequency Control Flat Frequency Bias Control
Contingency Analysis Simulation Feed Current Simulation Substation wise LFA	Prinizzion Optiniz Programizzion Contraction Ratings Nominal Rating I Rating I
V - Tolerance 0.0001 D - Tolerance 0.0001 Slack Bus 0 (Max Generation Bus) 💌	Number of Iterations 15 Q - Check Limit Image: Comparison of Comparison
Print Options Data and Results Line Flow Unit MW & Mvar Summary Show Summary After Execution	Tap Mode Use Set Tap Multiplication Factor 1 Reduction Factor 1
	OK Cancel Apply

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: 0Number of Tie Line Schedules: 0Number of Convertors: 0Number 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: 0Number of wtg Detailed Curves: 0Number of solar plants0 · Load Flow With Gauss Seidel Method : 5 Number of Zones: 1Print Option: 3 - Both Data and Results PrintPlot Option: 1 - Plotting with p.u. Voltage No Frequency Dependent Load Flow, Control Option: 0 Base MVA : 100.0 Nominal System Frequency (Hz): 60.0Frequency Deviation (Hz): 0.0Flows in MW and MVAr, Option: 0 : 0 (Max. Generation Bus) Slack 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.): 0.00000Circuit Breaker Reactance (p.u.): 0.00010Transformer R/X Ratio: 0.05000 _____ Annual Percentage Interest Charges : 15.000

Annual Percent Operation & Maintenance Charges : 4.000Life of Equipment in YearsEnergy Unit Charge (KWH): 2.500 RsLoss Load Factor: 0.300Cost Per MVAr in Lakhs: 5.000 Rs													
ZON ZON	NE V	VISE N P LOA	IULTIF DQL	PLICA _OAE	ATION F D P GI	ACTOR EN Q (S GEN	N SH R	EAC	г SH	H CA	P C LC	DAD
0	1.00	00 1.0 1.000	000 1. 1.0	000 00	1.000 1.000	1.000 1 1.000	.00	0 1.000) 1.	000	1	.000	
BUS	DATA												
BUS	S NO.	AREA	ZONE 1	BUS k	.v v	MIN(p.u.) VI	MAX(p.u	.) NA	ME			
	1 2 3 4 5	1 1 1 1	1 1 1 1	220.0 220.0 220.0 220.0 220.0	000 000 000 000	0.980 0.980 0.980 0.980 0.980		1.080 1.080 1.080 1.080 1.080	No Sc I N	orth outh Gake Main Elm			
TRAN	ISMIS	SION L	INE DAT	"A									
STA	CKT	FROM NODE	FROM NAME*	TO NODE	TO NAME*	LI R(p.u	NE .)	PARAMET X(p.u	'ER .) E	8/2(p	.u.)	RATING MVA	KMS
3 3 3 3 3 3 3 3	1 1 1 1 1 1	1 2 2 2 3 4	North North South South South Lake Main	2 3 4 5 4 5	South Lake Lake Main Elm Elm	0.020 0.080 0.060 0.060 0.040 0.040 0.010	00 00 00 00 00 00	0.060 0.240 0.180 0.180 0.120 0.030 0.240	00 00 00 00 00 00 00	0.030 0.029 0.020 0.020 0.019 0.019 0.010	000 500 000 000 500 000 500	100 100 100 100 100 100	1.00 1.00 1.00 1.00 1.00 1.00
Tota Tota Numb Tota Tota	l Li l Li er o l Li l Li	ne Cha: ne Cha: f Line: ne Cha: ne Cha:	rging S rging M s Opene rging s rging M	Susce IVAr ed on susce IVAr	ptance at 1 p. Both t ptance c at 1 p.u	(in p.u u. Volta he Ends of Existi u. Voltag	.) ge ng je o	Lines (f Exist	in p ing	.u.) Lines	:	0.290 29.000 0 0.2900 29.000	00
Tota Tota	l Ca l In	paciti ductiv	ve Sus e Susce	cepta eptan	ince	:		0.00000 0.00000	p.u. p.u.	-	0. 0.	000 MVAr 000 MVAr	
GENE	RATO	r data											
Sl.N	Io*	FROM NODE	FROM NAME*1	REAI POWER	(MW)	Q-MIN MVAr	Q- MV	MAX Ar	V-SPE p.u	IC C2	AP. JRV	MVA RATING	STAT
 1 2	2	1 2	North South	80. 40.	0000	0.0000	6	0.0000	1.0	0600	0 0	100.00 50.00	3 3

LOAD DATA

SI.no. FROM NODE STAT	1 FR NAM	ROM 1E	REAL *MW	REACTIV MV	E COMF Ar	P COM MVA	/IPENS/ r	ATING I MIN	MVAF	r val Ma	UE X	CHAR F/V STEP	NO.	NO.
1	2	South	20.000	10.000	0.000	0.000	0.000	0.000	0	0				
2	3	Lake	45.000	15.000	0.000	0.000	0.000	0.000	0	0				
3	4	Main	40.000	5.000	0.000	0.000	0.000	0.000	0	0				
4	5	Elm	60.000	10.000	0.000 3	0.000 0	0.000	0.000	0	0				
Total Spe Total Min TOTAL M Total Spe Total Spe Total Spe	ecifie imur laxin ecifie ecifie ecifie	ed MW m MV/ num M ed MW ed MV/ ed MV/	Gene Ar Limi IVAr L Load Ar Load Ar Con	ration it of Ger imit of (d npensat	nerato Genera : 1 : 4	120. r : 3 ator 65.00 40.00 : (00000 30.000 : 90.0 000 C 000 C))00)0000 (hang (hang)0 Ch	ed to ed to ang	o 10 o 4 ed t	65.0 0.0	00000 0000 0.00000		
TOTAL (I Total Spe TOTAL M Total Maz Total Spe Total Spe Total Spe	nclu ecifie linim kimu ecifie ecifie ecifie	ding C ed MW num M m MV ed MW ed MV ed MV	Out of S Gene IVAr Li Ar Lim Load Ar Load Ar Con	Service ration mit of G it of Ge d npensat	Units) Senerate enerate : 1 : 4	120. ator : 3 or : 65.00 40.00 : (00000 30.000 90.00 000 C 000 C 0.0000) 000 000 hang 00 Ch	ed to ed to ang	o 10 o 4 ed t	65.0 0.0	00000 0000 0.00000		
GENERA	TOF	R DAT	A FOF	R FREQ	UENC	Y DE	PENI	DENT	LO	AD	FLC	W		
SLNO* F NOD	RON E	M F NAM	rom E* m	P-RAT N N	EP-N 1W C0	AIN MW C1	P-M	AX F C2	%DI AC1	RO(FOR	DP S	PARTICI ETTING	BIAS	
1 1	North	n 80.	000	0.0000	80.0	000	4.000	0 0	.000	00	0.0	000		
2 2 3	Sout	h 80	.000	1 0.0000 1	.0000 40.0 .0000	0.1 0000 0.1	000 4.00 000	0.010 00 (0.010	0).00 0	00	0.0	000		
Accelerat	ion f	actor	: 1.40											
Slack bus	s ang	gle (de	egrees): 0.00)									
TOTAL N TOTAL N SLACK E ISLAND	IUMI IUMI SUSE NO.	BER (BER (ES CC SLAC	DF ISL DF ISL DNSIDE K BUS	ANDS I ANDS I ERED F S NAME	N THE HAVIN OR TI SP	E GIVI IG AT HE S ^T ECIF	EN SY LEAS TUDY IED M	STEI T ON	и ЕG	EN	: ERA	1 TOR : 1		
1	1	No	rth	80.000										
Iteration	cour	nt =	1 Erro	or = 0.0	05253	8 Bus	= 2							

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Iteration count = 2 Error = 0.015724 Bus =	5
Iteration count = 3 Error = 0.007669 Bus = Iteration count = 4 Error = 0.002768 Bus =	5 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	
NODE FROM V-MAG ANGLE MW NO. NAME p.u. DEGREE GEN GE	MVAr MW MVAr MVAr EN LOAD LOAD COMP
1 North 1.0600 0.00 129.535 -7.468 0 2 South 1.0475 -2.81 40.000 30.000 3 Lake 1.0242 -5.00 0.000 0.000 44 4 Main 1.0236 -5.33 0.000 0.000 44 5 Elm 1.0180 -6.15 0.000 0.000 60	0.000 0.000 0.000< 20.000 10.000 0.000 5.000 15.000 0.000 0.000 5.000 0.000 0.000 10.000 0.000
MINIMUM VOLTAGE LIMIT (@ mark): 0 NUMBER OF BUSES EXCEEDING MAXIMUM NUMBER OF GENERATORS EXCEEDING M NUMBER OF GENERATORS EXCEEDING M	NUMBER OF BUSES EXCEEDING I VOLTAGE LIMIT (# mark) : 0 INIMUM Q LIMIT (< mark) : 1 AXIMUM Q LIMIT (> mark) : 0
LINE FLOWS AND LINE LOSSES	
SLNO CS FROM FROM TO TO FORV NODE NAME NODE NAME MW M	VARD LOSS % VAr MW MVAr LOADING
1 1 1 North 2 South 88.825 -8.610 1 2 1 North 3 Lake 40.710 1.141 1. 3 1.2 South 3 Lake 24.690 3.535 0 4 1.2 South 4 Main 27.936 2.957 0 5 1.2 South 5 Elm 54.824 7.346 1. 6 1.3 Lake 4 Main 18.900 -5.167 0. 7 1 4 Main 5 Elm 6.334 -2.280 0.0	.4093 -2.4345 84.2# 1911 -1.8583 38.4^ .3513 -3.2385 24.7& .4413 -2.9660 27.5^ 1253 0.1756 52.8\$ 0357 -1.9898 19.1& .307 -5.1178 6.8&
! NUMBER OF LINES LOADED BEYOND 125 @ NUMBER OF LINES LOADED BETWEEN 1 # NUMBER OF LINES LOADED BETWEEN 7 \$ NUMBER OF LINES LOADED BETWEEN 5	% : 0 00% AND 125% : 0 5% AND 100% : 1 0% AND 75% : 1

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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 MWTOTAL REAL POWER INJECTION (-ve LOAD) : 0.000 MWTOTAL REACT. POWER GENERATION (CONVENTIONAL) : 22.532 MVArGENERATION p.f. : 0.991

TOTAL REAL POWER GENERATION (WIND):0.000 MWTOTAL REACT. POWER GENERATION (WIND):0.000 MVArTOTAL REAL POWER GENERATION (SOLAR):0.000 MWTOTAL REACT. POWER GENERATION (SOLAR):0.000 MVArTOTAL SHUNT REACTOR INJECTION:0.000 MV TOTALSHUNT REACTOR INJECTION:0.000 MVAr
TOTAL SHUNT CAPACIT.INJECTION:0.000 MWTOTAL 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 MVArTOTAL SHUNT FACTS DRAWAL:0.000 MVAr
TOTAL REAL POWER LOAD:165.000 MWTOTAL REAL POWER DRAWAL (-ve gen.):0.000 MWTOTAL REACTIVE POWER LOAD:40.000 MVArLOAD p.f.:0.972TOTAL COMPENSATION AT LOADS:0.000 MVArTOTAL HVDC REACTIVE POWER:0.000 MVAr
TOTAL REAL POWER LOSS (AC+DC) PERCENTAGE REAL LOSS (AC+DC) TOTAL REACTIVE POWER LOSS: 4.584616 MW (4.584616+ 0.000000) : 2.704 : -17.429226 MVAr Zono wico distribution
Description Zone # 1
MW generation 169.5349
MVAr generation 22.5315

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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 - inductive0.0000	
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	

How to solve LFA

MiP-PSCT	
MW loss	4.5846
MVAr loss	-17.4292
MVAr - inductive	0.0000
MVAr - capacitiv	e 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.

Select a Power System Results Plot	file X
Plot File E:\study\LFA\1stagg0.nt0	<u> </u>
Results Layer All Layers 💌	Zone Number 0 🔲 Summary
Voltage Display	Power Flow Displa Select Voltage and Flow
Voltage Unit kV . Angle	Flow Unit My Unit
Precision	Precision 2
Low Normal High	Low Normal High
	From To Loss Flow Direction
ОК	Cancel



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

Select menu option Quick Solve \rightarrow 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

🚰 MICAR & Nower System Network Editor (Euro) N File Edit View Daw Elements Eet Change Object(s) Configure Ruit Constance Salve Tool UntiProtection Partial Acatyois Qual Solie Window Ruil Sorem Help	.0×
	Image: Construction Image: Construction Image: Construction Image: Construction Image: Construction <td< th=""></td<>
Patremont -0-y -0-Stat SSI SSHee	<u>N solutional a</u>
Ready Step: 1.00000 X <25>, Y <167>	0 1 /



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

CONTIGENCY NUMBER	Enter Contingency No. Contingency Description		
Contigency Name Line 1-3 open			
Click OK			

3. Execute Load Flow Analysis

Load Flow Result: -

BUS VOL	TAGES	AND POWEF	S					
NODE FR MVAR	OM	V-MAG	ANGLE	GEN MW	GEN MVAR	OAD MW L	OAD MVAR	COMP
	North	1 0600	0 00	121 620	E 295	0 000	0 000	
0.000#	NOT CI	1.0000	0.00	131.039	5.305	0.000	0.000	
2	South	1.0328	-4.05	40.000	30.000	20.000	10.000	
0.000								
3	Lake	0.9939	-8.09	0.000	0.000	45.000	15.000	
0.000								
4	Main	0.9960	-8.07	0.000	0.000	40.000	5.000	
0.000						<u> </u>		
5	Elm	0.9980	-7.97	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) : 0 NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark) : 0								
 LINE FL	ows an	D LINE LO	SSES					
SLNO CS	FROM	FROM	ΤΟ ΤΟ) I	FORWARD	LC	SS	00
	NODE	NAME	NODE NA	ME I	MW MVA	r MW	MVAR	
LOADING								
	1	North	2 500				0 7 7 7 7 9	
124.3@	Ŧ	NOLCU	∠ SOL	1011 131.03	5.38	5 5.0982	2.7238	
2 1	1	North	3 І	ake I	LINE IS OPP	EN		

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3	1	2	South	3	Lake	43.274	7.150	1.1019	-0.8034
4 4 41.	1.9^	2	South	4	Main	42.883	6.093	1.0725	-0.8997
5 61.	1 2\$	2	South	5	Elm	62.463	9.495	1.5093	1.4339
6 7.5	1 5&	3	Lake	4	Main	-2.682	-6.922	0.0043	-1.9670
7 3.2	1 2&	4	Main	5	Elm	-0.938	-3.015	0.0009	-4.9674

Procedure to add Different Generation Schedules:



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

Number Fetch Generator>> Name Gen1 Maintenance	Schedule No	
Bus No. 1 pscendi (132 000 w) Manufacturer Ref. No. 1 [Gen1] w Library>> Units in Pacellet 1 GT Capability Curve No. 0 0 w Capability Curve No.	Protection Over Current	Add Copy From DischeduleD
Image: Total Control of Control	Unit Protection	Name Schedule1
Real Power Optimization Data NW Preactive Power - Maximum 100 NV/ar Real Power - Maintrum 0 MW Cost Co-efficient CD 1 Real Power - Maintrum 00 MW Cost Co-efficient CD 1	Select C Utility Grid C Generator	Modify Name
Status Commission Status IF In Service 0 ut of Service If Existing Proposed Year 0 Nextral Grounding Resistance 0 offen Participation Factor (k) 0 Minutal Grounding Resistance 0 offen Bios Setting 0 Grounding Resistance 0 offen Dirocp (3) 4		Click to Add Schedule
Model Type C Infinite Bus Modeling (Xd) C Infinite Bus Modeling (Xd) C Infinite Bus Modeling (Xd) AVR RFN None Turbine Gov Rel No D I upp 1 C Click C	CHere	

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.

Current	Schedule And Contin	gency		x	
	Contingency		Schedule		
Name	open line 4-5	Name	Schedule1	8	Select Contingency Schedule Number
Number	1	Number	1]	
	ОК		Cancel		

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



Load Flow Anal	lysis	×
	1. Click on study info	
Case	1 Study Ir	nfo
Execution	e After Input File Creation Dele	te
Only In	put File Creation	
C 2.	After giving equired oformation	e
Network	< Report View Bus Graph	ì
3. Afte	er executing click here to get	report

Procedure for Contingency Ranking Analysis:

-

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

Click Here	
Load Flow Studies	Load Flow Studies
Contingency Ranking Analysis Availability Transfer Capability SubStation/Wrise LFA General Frequency dependent Load Flow Optimal Load Flow	General Frequency dependent Load Flow Optimal Load Flow Contingency Ranking Analysis Availability Transfer Capability SubStationWise LFA
Technique Conting Function Factor 6 Bauss Sided Method Acceleration Factor 6 Newton Righton Method DC Load Flow 6 Load Flow Type First Decoupled LoadFlow PC Load Flow Coaff Flow Type First Decoupled LoadFlow First Decoupled LoadFlow Coaff Flow Type First Decoupled LoadFlow First Decoupled LoadFlow Coaff Flow Type First Decoupled LoadFlow First Decoupled LoadFlow Contingency Dependent LFA First Deprint First Deprint Contingency Analysis First Ties Ine Frequency Deprint Coptimization Contingency Analysis First Deprint Coptimization Coptimization Stack Bits Dimeter Simulation FATC Ratings Rating I Rating I P - Tolerance D.00001 Cottex Limits Image D Cod Model Voltage D Stack Bits D Mass Generation Bus Image Tap Mode Use Set Tap Multiplication Factor Image Summary The Now Unit MW & Mvar Multiplication Factor Image Reduction Factor Image	Selected Symbolics Selected Symbolics Dimensional Line Complet Diversion Completion Diversion Diversion Diversion
OK Cancel Apply	OK Cancel Apply

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

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 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 2 South 3 Lake 2.505e+000 5 0 1.305e+000 3 7 0 2 South 4 Main 2.434e+000 6 0 1.464e+000 4 4 0 2 South 5 Elm 6.250e+000 2 1 2.068e+000 5 3 0 3 Lake 4 Main 2.690e+000 3 0 1.462e+000 5 6 0 7 Main 5 Elm 2.649e+000 4 0 1.361e+000 4 б 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

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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	
0.000	0#<							
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 droop in percentage in generator data form.

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

4. Execute Load Flow Analysis

oad Flow Studies	×
Contingency Ranking Analysis Avail General Frequency deper	ability Transfer Capability SubStationWise LFA Indent Load Flow Dptimal Load Flow
Technique Gauss - Siedel Method Accelet Newton Raphson Method East Decoupled LoadElow ODC	ation Factor 1.6 Select
Load Flow Type Slack Bus Concept LEA Frequence Dependent LFA Optimal Load Flow Analysis Contingency Analysis B Coefficient & Economic Dispatch Simulation Feed Current Simulation Substation wise LEA	Frequency Dependent LFA Options Flat Tie Line Control Flat Frequency Control Flat Tie-line Frequency Bias Control Optimization P - Optimization Ratings Nominal Rating Rating Rating I Rating II
P - Tolerance 0.0001 Q - Tolerance 0.0001 Slack Bus 0 (Max Generation Bus)	Number of Iterations 15 Q - Check Limit 0 Load Model Voltage 0.75
Print Options Data and Results Line Flow Unit MW & Mvar Summary Show Summary After Executi	Tap Mode Use Set Tap Multiplication Factor 1 Reduction Factor 1
	ck OK

Report:-

BUS VOLTAGES AND POWERS

NODE MVAr	FROM V	-MAG AN	GLE	MW I	MVAr	MW I	MVAr
NO. COMP	NAME	p.u. DEG	REE	GEN (GEN	LOAD I	LOAD
 1 North #< 2 South 3 Lake 4 Mair	1.0600 1.0474 1.0242 1.0236	0.00 -2.81 -5.00 -5.33	129.595 40.000 0.000 0.000	-7.416 30.000 0.000 0.000	0.00 20.00 45.00 40.00	0 0.000 0 10.000 0 15.000 0 5.000	0 0.000 0 0.000 0 0.000 0 0.000 0 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 O LIMIT (< mark) : 1 NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark) : 0 _____ LINE FLOWS AND LINE LOSSES SLNO CS FROM FROM TO TO FORWARD LOSS NODE NAME NODE NAME MW MVAr MW MVAr 8 LOADING 1 North 2 South 88.869 -8.575 1.4106 -2.4304 1 1 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 Elm 54.822 7.343 1.1252 0.1757 2 South 5 27.5 5 1 Main 18.874 -5.202 0.0356 -1.9898 3 Lake 4 52.8\$ 6 1 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

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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	
EOAD PREACTIVE POWER LOAD	÷	40:972	MVAr	
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	FROM	V-MAG	ANGLE	MW	MVAr	MM	MVAr	MVAr
NO.	NAME	p.u.	DEGREE	GEN	GEN	LOAD	LOAD	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	1 ТО		то	F	ORW	ARD		LOSS
LOADING		NODE	NAME	e noi	DE 1	NAME	М	W	MVAr	MW	MVAr
1 1 88 1#	1	North	n 2	South	93.	180	-5.	980	1.54	27	-2.0034
2 1 39.2 [^] 3	1 1	North 2	n 3 South	Lake 3	41. Lake	560 24	1. 4.330	711	1.24 3.385	11	-1.6857 .3412 -3.2419
24.3& 4 1 27 2^	2	South	n 4	Main	27.	642	2.	839	0.43	23	-2.9656
5 1 52.8\$	2	South	ı 5	Elm	54.	673	7.	301	1.12	206	0.1830
6 1 19.5&	3	Lake	e 4	Main	19.	308	-4.	977	0.03	870	-1.9732
7 1 7.0&	4	Mair	ı 5	Elm	б.	480	-2.	198	0.03	22	-5.0805
! NUMBER	C OF	LINES	LOADED	BEYOND	125%			:	0		
@ NUMBER	C OF	LINES	LOADED	BETWEEN	100%	AND	125%	:	0		
# NUMBER	COF	LINES	LOADED	BETWEEN	/5%	AND	TOOS	•	1		
\$ NUMBER		LINES	LOADED	BEIWEEN	5U3	AND	/56	:	1		
NUMBER		LINES		DEIWEEN	∠076 1 €	AND	203	:	2		
* NUMBER	R OF	LINES	LOADED	BETWEEN	⊥⊽ 0%	AND	256 18	:	0		
BUSES BI	STWEI	EN WHIC	CH ANGLE	E DIFFERE	ENCE	IS >	30 d	egr	ees ARE	: ZI	ERO
ISLAND H	FREQU	JENCY S	SLACK-BU	JS CONV	/ERGE	D(1)					
1	59.8	34554		1	1						
Summary	ofi	results	3								
TOTAL RI	EAL I	POWER G	ENERATI	ON (CONV	ENTIC	DNAL) :		174.73	9 MV	v
TOTAL RE	EAL I	POWER 1	NJECTIC	N (-ve I	JOAD)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	:		0.00	0 MV	N.
TOTAL RI	EACT	. POWEF	GENERA	ATION (CO	ONVEN.	FION	AL) :		25.731	MVA	Ar

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GENERATION p.f.	:	0.989		
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	:	170.000	MW	
TOTAL REAL POWER DRAWAL (-ve gen.)	:	0.000	MW	
TOTAL REACTIVE POWER LOAD	:	42.500	MVAr	
LOAD p.f.	:	0.970		
TOTAL COMPENSATION AT LOADS	:	0.000	MVAr	
TOTAL HVDC REACTIVE POWER	:	0.000	MVAr	
TOTAL REAL POWER LOSS (AC+DC) 0.000000)	:	4.747187	MW (4.747187+
PERCENTAGE REAL LOSS (AC+DC)	:	2.717		

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:

TOTAL REACTIVE POWER LOSS

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

: -16.767246 MVAr

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

iP-PSCT							How to s	olve LFA
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	
0.00	00							
3	Lake	1.0242	-5.00	0.000	0.000	45.000	15.000	
0.00	00							
4	Main	1.0236	-5.33	0.000	0.000	40.000	5.000	
0.00	00							
5	Elm	1.0179	-6.15	0.000	0.000	60.000	10.000	
0.00	00							

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, Pmax = 150MW and for Gen2, Pmax = 60MW.

3. Select. Frequency dependent Load Flow->Flat Frequency control

Contingency Ranking Analysis	Availability Transfer Capability SubStationWise LFA
Technique Gauss - Siedel Method Newton Raphson Method Fast Decoupled LoadFlow	voceleration Factor 1.6 DC Load Flow
Load Flow Type Slack Bus Concept LFA Slack Bus Concept LFA Coptimal Load Flow Analysis Contingency Analysis B Coefficient & Economic Dispate Simulation Feed Current Simulation	Frequency Dependent LFA Options Flat Tie Line Control Flat Frequency Control Flat Frequency Control Portification Options P - Optimization P - Optimization Flatings Nominal Rating Rating
P - Tolerance 0.0001 Q - Tolerance 0.0001 Slack Bus 0 (Max Generation Bus)	Number of Iterations 15 Q - Check Limit Q Load Model Voltage 0.75
Print Options Data and Results Line Flow Unit MW & Mvar Summary Show Summary After E	Tap Mode Use Set Tap Multiplication Factor 1 Reduction Factor 1

4. Execute Load Flow Analysis

Report:-

BUS	VOL	TAGE	S AND 1	POWERS							
NOI	DE FI	ROM	V-MA	G ANO	GLE	MW		MVAr	MW	MVAr	MVAr
NO.	. IN.	AME	p.u.	DEGI	КЕЕ 	GEN	'	GEN 	LOAD	LOAD	
	-										
1	N	orth	1.06	.0 0.	00 129	.590	-7	.421	0.000	0.000	0.000
#<		_									
2	S	outh	1.04	74 -2.8	81 40	.000	30	.000	20.000	10.000	0.000
3		Lake	1.02	42 -5.0	00 00	.000	0	.000	45.000	15.000	0.000
4		Main	1 01	36 -5. 79 -6 '	33 U 15 O	.000	0	.000	40.000	5.000	0.000
		ьтш 						.000			0.000
	-										
NUN	BER (OF B	USES E	XCEEDIN	G MINIMU	M VOLT	FAGE	LIMIT	[(@ mark]): 0	
NUN	IBER (OF B	USES E	KCEEDIN	G MAXIMU	M VOL	FAGE	LIMIT	[(# mark): 1	
NUN	IBER (OF G	ENERAT	ORS EXCI	EEDING M	INIMUN	4 Q :	LIMIT	(< mark)	: 1	
NUN	IBER (OF G	ENERAT	ORS EXC	EEDING M	IAXIMUN	4 Q :	LIMIT	(> mark)	: 0	
LIN	JE FL	OWS .	AND LI	NE LOSSI	ES						
SLN	IO CS	FRO	M FROM	TO	TO	FC	DRWA	RD	L	OSS	olo
		NOD	E NAME	NODE	NAME	MW		MVAr	MW	MVAr	
LOF	ADING										
1	1	1 N	orth	2	South	88.86	50	-8.58	30 1.41	03 -2.4312	
84.	2#		01 011	-	bouon	00.00		0.50		211012	
2	1	1	North	3	Lake	40.72	23	1.15	58 1.19	19 -1.8555	
38.	4^										
3	1	2	South	3	Lake	24.69	95	3.54	46 0.35	15 -3.2375	
24.	.7& 4	1	2	South	4	Main	27	.937	2.962	0.4414 -2	2.9655
۷/. ۲	1	r	South	F	Flm	E1 01	24	7 2/	10 1 1 0	52 0 1750	
52	1 85	2	South	5	凸上Ш	54.02	54	1.5	±5 1.12	0.1759	
6	1	3	Lake	4	Main	18.87	74	-5.20	0.03	56 -1.9898	
19.	1&										
7	1	4	Main	5	Elm	6.33	33	-2.28	35 0.03	07 -5.1176	
6.8	3&										
	-										
I N	IIIMBEI	R OF	LINES	LOADED	BEYOND	125%			: 0		
@ 1	JUMBE	R OF	LINES	LOADED	BETWEEN	100%	AND	125%	: 0		
# 1	JUMBE	R OF	LINES	LOADED	BETWEEN	75%	AND	100%	: 1		
\$ N	JUMBE	R OF	LINES	LOADED	BETWEEN	50%	AND	75%	: 1		
^ l	JUMBE	R OF	LINES	LOADED	BETWEEN	1 25%	AND	50%	: 2		

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How to solve LFA

3 0

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

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

TOTAL AREA INTERCHANGE ERROR FOR ISLAND 1 :	- 0	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 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.	:	0.972
TOTAL COMPENSATION AT LOADS	:	0.000 MVAr
TOTAL HVDC REACTIVE POWER	:	0.000 MVAr
TOTAL REAL POWER LOSS (AC+DC) 0.000000)	:	4.586773 MW (4.586773+
PERCENTAGE REAL LOSS (AC+DC)	:	2.705
TOTAL REACTIVE POWER LOSS	:	-17.421289 MVAr

---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 FROM V-MAG ANGLE MW MVAr MW NAME p.u. DEGREE GEN GEN LOAD MVAr NODE MVAr LOAD COMP NO. -----_____ ____ _ _ _ North 1.0600 0.00 132.112 -2.027 0.000 0.000 0.000 1 #< South 1.0445 -2.83 47.566 30.000 30.000 15.000 0.000 2 Lake 1.0219 -5.03 0.000 0.000 45.000 15.000 0.000 3 Main 1.0211 -5.36 0.000 0.000 40.000 5.000 0.000 4 Elm 1.0151 -6.19 0.000 0.000 60.000 10.000 0.000 5 _____ 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 NODE NAME NODE NAME MW MVAr LOSS 8 MW MVAr LOADING 1 1 1 North 2 South 90.941 -4.067 1.4722 -2.2272 85.9# 1 North 3 Lake 41.164 2.040 1.2232 -1.7500 2 1 38.9^ 2 South 3 Lake 24.509 3.213 0.3464 -3.2314 3 1 24.5& 2 South 4 Main 27.786 2.704 0.4377 -2.9543 4 1 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% : Ω @ 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

MiP-PSCT			Но	w to solve LFA
^ NUMBER OF LINES LOADED BETWEEN 25% AND 5	0%	: 2		
& NUMBER OF LINES LOADED BETWEEN 1% AND 2	5%	: 3		
* NUMBER OF LINES LOADED BETWEEN 0% AND	1%	: 0		
BUSES BETWEEN WHICH ANGLE DIFFERENCE IS > 30	de	grees ARE	ZERO	
TOTAL AREA INTERCHANGE ERROR FOR ISLAND 1 :	10	.087900 MV	1	
Summary of results				
TOTAL REAL POWER GENERATION (CONVENTIONAL)	:	179.678	3 MW	
TOTAL REAL POWER INJECTION (-ve LOAD)	:	0.000) MW	
TOTAL REACT. POWER GENERATION (CONVENTIONAL)	:	27.97	8 MVAr	
GENERATION p.f.	:	0.988	3	
TOTAL REAL POWER GENERATION (WIND)	:	0.000) MW	
TOTAL REACT. POWER GENERATION (WIND)	:	0.000) MVAr	
TOTAL REAL POWER GENERATION (SOLAR)	:	0.000) MW	
		0.00		
TOTAL REACT. POWER GENERATION (SOLAR)	:	0.000) MVAr	
TOTAL SHUNT REACTOR INJECTION	:	0.000		
IOTAL SHONI REACTOR INJECTION	·	0.000) MVAL	
TOTAL SHUNT CAPACIT.INJECTION	:	0.000) MW	
TOTAL SHUNT CAPACIT.INJECTION	:	0.000) MVAr	
		0.000) NG 70	
IOTAL ICSC REACTIVE DRAWL	•	0.000) MVAL	
TOTAL SPS REACTIVE DRAWL	:	0.000) MVAr	
		0.00		
TOTAL UPFC INJECTION	•	0.000) MVAr	
TOTAL SHUNT FACTS INJECTION	:	0.000) MVAr	
TOTAL SHUNT FACTS DRAWAL	:	0.000) MVAr	
		1 = =		
TOTAL REAL POWER LOAD	:	175.000) MW	
TOTAL REAL POWER DRAWAL (-Ve gen.)	:	0.000		
TOTAL REACTIVE POWER LOAD	:	45.000) MVAr	
LOAD P.I.	:	0.968) MT77.~~	
TOTAL HVDC REACTIVE POWER	:	0.000) MVAI	
		0.000		
TOTAL REAL POWER LOSS (AC+DC)	:	4.675263	. MW (4.675261+
0.00000)				
PERCENTAGE REAL LOSS (AC+DC)	:	2.602	2	
TOTAL REACTIVE POWER LOSS	:	-17.027382	2 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 sys	tem
---	-----

Buscode	Admitance	Line charging
	Үрд	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

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

Generation, loads and bus voltages for sample sys

Buscode	Inertia (H)	Xdʻ
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** \rightarrow **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.

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1	🚑 Open	×.	
	Look in: 🚺 optimal	- 🗢 🗈 🔶	
	Name 🔺	Date modified Type	
	File name: Files of type: Datab	No tems match your search.	
		n as <u>r</u> ead-only	
			_
Config	ure Databas	e	×
	Database Nan	ne D:\optimal\optimal.mdb	
		Connect	
	ОК	Cancel Clear Path Browse	

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.

field Diff. Ander Nat	40 I		
D:Vest.mdb			
Network Title			
Fest Power System Network			
Power System Litranes			
Standard Relay Libraries 🗖			

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MiP-PSCT	How to solve LFA
Configuration Information	Configuration Information
General Information Voltage Levels Electrical & Currency Information Breaker Ratings	General Information Voltage Levels Bectrical & Currency Information Breaker Ratings
Base MVA 100	h MVA h kA h MVA h kA h MVA h kA h MVA h kA 400.000 15000 21.651 13.200 350 15.309 15.000 350 13.472
Base Frequency 60 Hz	220.000 10000 26.244 11.000 350 18.371 0.233 50 123.899
pu status	230.000 10000 25.103 10.500 350 19.246 15.000 350 13.472
 Indicates that all the immediances are specified in PII on 	132.000 5000 21.870 10.000 350 20.208 15.000 50 123.899
a common MVA base.	110.000 5000 26.244 6.600 250 21.870 0.233 350 13.472
Else the machine impedances are specified in PU on its own rating and transmission line parameters are	66.000 5000 43.740 3.300 100 17.496 15.000 50 123.899
specified in actuals, i.e. R ohms/km, X ohms/km and B/2 mho/km.	33.000 1500 26.244 0.415 50 69.562 0.233 350 13.472
	15.000 350 13.472 0.233 50 123.899 0.233 50 123.899
Currency	Modfy Al Breaker Ratings
OK Cancel Apply Help	OK Cancel Apply Help

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**.

Bus Base Voltage Configuration			x
Base MVA	100.000000		Color
Bus Wdth	Bus Base Voltage Bus Wdth 13.20 kV	0.0 KV 4	Basic colors:
230.0 kV 4 📑	11.0 KV 4 🚍	0.0 kV 4 🛓	
220.0 kV 4 🛓	10.50 kV 4	0.0 kV 4 🚔	
132.0 kV 4 🛨	10.0 kV 4 🐳	0.0 kV 4 🗧	
110.0 kV 4 🔅	6.60 kV 4 🛨	0.0 kV 4 👘	Custom colors:
66.0 kV 4 芸	3.30 kV 4	0.0 kV 4 👘	
33.0 kV 4 🛨	0.4150 kV 4 芸	0.0 kV 4 🛨	Define Custom Colors >>
15.0 kV 4 🗄	0.230 kV 4 🔹	0.0 kV 4 👘	OK Cancel
ОК	Cancel	Default	

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

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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.**

Martinet Anno Martine Anno Martinet Anno Martinet<	Bus Data
	Bus Number 1 Fetch Bus >> Bus Name Bus 1 Description Bus 1 Nominal Voltage 11.000 • Nominal Voltage 11.000 • kV Area Number I Select 1 Area1 • Cone Number I Select 1 Area1 • Owner Number I Select 1 Zone1 • Owner Number I Select 1 Zone1 • Owner Number I Select 1 Zone1 • Contingency Weightage 1 Select Select Voltage Limits in KV Max 11.550000 Cost Bitray O Cost Bitray I Select Bus Detifierential Bus Bar Differential Bus Details Bus Details
5m 1000 1000,1000 1 1	Global Change Load Details Costlib >> GPS

After entering data click **Save** \square 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.

Number Fetch L		ine >>	Name UI Mantenance	Type Current C Power	
De Rated MilA Rating F	[100		Structure Ref. No. 1	Ampenes 0 pt 0.8	
Rating II	100	MA	Fion Decelar Bating	Show Breaker - SLD IT Yes	
From Bus Number	1 [Bue1]-{11.000 2 [Bue2]-{11.000	•	Kost Events Milk 250 AA 18.371 Foots Foots Foots Foots	SLD Notation C Line C Cable C Reador	
Aunities of Circuits	1	km	To Breaker Rating © Not Exists Rating © Exists MVA [350] 8A [18.371]	C Isolator	
Contingency Weight	nge 1		To Breaker	C From Side C To Side	

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

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Line and Cable Lib	o rary ame Line1			Fetch >>
Positive Sequence Resistance Positive Sequence Reactance Positive Sequence Resistance Zero Sequence Resistance Zero Sequence Reactance Zero Sequence Susceptance (8/2) Thermal Rating Line Harmonic Number Cost ner km	0.04 0.16006 0.15 0 0 0 250 0 0 0	pu pu pu pu MVA <u>Compute</u> Hamonic Libray >> Cost Per Unit in	Z V	ge Impedance 9993.000000 Ohms 0.000000 kms/sec Compute XL, B/2 Thermal Curve>>

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	Admitance	Line charging
	Үрд	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 D	ata					
Number 1	Fetch Genera	tor>> Name Gen1		Maintenan	se S	chedule No 🛛 💌
Bus No. 1 [Bus1] (11.0 Units in Parallel 1	00 •	Manufacturer Ref. No 「 Capability Curve No 」	1 (Gen) 0 (CAPCUR) 💌	Library >>	>	Protection Over Current
Specified Voltage	11.440	- Breaker P	ating [350	In kA 18.371		Relay Unit Protection
De-Rated MVA 300 Scheduled Power 250	о о му	/ Reactive F	ower - Minimum ower - Maximum	0		Cost Per Unit in
Real Power Optimization Real Power - Minimum Real Power - Maximum	Data 1 250	MW Cost MW Cost MW Cost	Co-efficient C0	100 10 0		Select C Utility Grid Generator
Status In Service C	Out of Service	Commission Status	Proposed Yea	w 0		
Neutral Grounding Resist. Neutral Grounding React. Grounding Through Trans	ance 0 ance 0 stormer Calc	ohms Partic ohms Bias 1 ulate Droo	ipation Factor (%) Setting (%)	0 0 4		
Model Type C Infinite Bus Modelling () C Transient Modelling () C Sub Transient Modellin <u>Global Change</u>	(X'd) (d&X'q) ng(X'd&X''q)	AVR Ref No. AVR FPB Name Turbine Gov Ref No Tur Governor Name	0 (AVR) Type 0 0 Type 0	TG Libra		AVB File:

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.

Generator Library						
Ref. Number 1	Fetch Generator Manufacturer Name Thermal120MW					
MVA Rating 300 MW Rating	250 kV Rating 11 Compute X('d,''d,n,0)					
	pu on its Own Rating					
Armature Resistance (Ra)	pu Potier Reactance (Xp) 0 pu					
Direct Axis Reactance (Xd) 0.0001	pu Direct Axis Transient Reactance (X'd) 0.1 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 Tradie Trad						
Quadrature Axis Open Circuit 2.5 Quadrature Axis Open Circuit Damping Factor Transient Time Constant (T'qo) 0.15 0						
Winding Connections Mass Details	Cost Per Unit in					
Mass Number	0 Next >> 0					
Y Y 🛆 Inertia	0 MJ/MVA Counter					
 O O Damping Factor 	0 << Back Thermal Curves					
Stiffness Co-efficient	0 pu torque/ Delete Thermal>>					

After entering data **Save** \square and close. In **Generator Data** form click **Save** \square . **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			

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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 1 Fetch Load >> Name LD1	Maintenance Schedule No 0	Helay
Bus Number 2 [Bus2] (11.000 Real Power in MW 250	MVAR Compensation 0 Minimum Compensation in MVAR 0 Maximum Compensation in MVAR 100	Give the compensation details
Reactive Power in MVAR 149.999951 Compute Power Factor 0.857493 Load Details	Compensation Step in MVAR	Cost library
Load Type Unbalanced Load Unbalanced Load Unbalanced Load Deta	ils	Lib >>
O Commission Status In Service Out of Service	Global Change Breaker Rating In MVA 350 In kA 18.371	
Control Block Fpb Path	Browse	

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.

Load Flow Analysis	×
1. Click on study info	
Case 1 🔽	Sudy Info
Execute After Input File Creation	Delete
2. After giving required information execute	Execute
Results	
Network Report View Bus	Graph
3. After executing click here	e to get report

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

Contingency Banki	ng Analysis	Availability	Transfer Capability	SubStationWise	LEA Ì	<u></u>
General	Freque	ency dependent l	Load Flow	Optimal Load Flow		Click here
Technique			·			
Gauss - Siede	IMethod		Factor 1.6		L Fr	
O Newton Raph	son Method	CIDCLand				
 Fast Decouple 	d Loadhlow	O DC LUaur	-1000			
Load Flow Type						
Slack Bus Co	ncept LFA		Flat Tie Line Control			
C Frequency D	ependent LFA		Flat Frequency Cor			
C Contingener	Analysis Analysis		Flat Tie-line Freque			
C B Caefficient	Analysis 8 Essensenia Dia		ptimization Options	7 0. 0- <i>1</i> -1-1-1-1-1		
Circulation Coefficient	a Economic Dis	paten	P · Uptimization	 Q - Optimization 		
Simulation	u dation		latings	-		
Substation wise I	_FA		Nominal C Ra	ting I 🔿 Rating II		
-						
P · Tolerance JU.U.	101		Number of Iterations	15		
Q · Tolerance 0.00	001		Q - Check Limit 🛛 🔽	0		
Slack Bus	lotth]		Load Model Voltage	0.75		
Julia	lolarij			1	- 1	
Print Options Data	and Results	-	Tap Mode	Lise Nominal Tan	1	
					-	
Line Flow Unit MW	& Mvar	•	Multiplicatio	n Factor 🕴 🗾		
Summary			Deduction	Easter 1 💌	1	
1 51	now Summary Al	ter Execution	neduction	rractor p		
					1	

Contingency Ranking Analysis	Availability	Transfer Capability	SubStationWise LFA
General Frequency	dependent	Load Flow	Optimal Load Flow
	10		
Cost per MVAH. (in Lakhs)	12	Ba	
% Operation and Maintainance Charge	4		
% Interest Charge	15	_	
Loss Load Factor	0.3		
Life of Equipment in Years	20	_	
Energy Charge	25	R⊯/KWH	

Enter all the details and click ok. Then execute.

Report

 #NO	BUS-NO	BUS-NAME	ORG-COMP MVAr	FINAL-COMP MVAr	FINAL-VOLT p.u.	-VOLT p.u.		
1 2	3 2	Bus3 Bus2	0.000	0.927 1.020	30.000	0.949 1.034		
		CONDENCAR	TON DROVA			20.000	1072	
	TITONAL	COMPENSAL	LION PROVI	DED IN IF	HE SISIEM .	12 100	MUAL	
CUIDE	עם עראות בי סביאריים כ	JSS IN IHE	SISIEM VOTEM			12.190	IVI VV MITAT	
DEDI		JSS IN IHE	SISIEM I TUR OVOT	тм		1 522	IVI VV MITAT	
ANNT	INT. TNC	IN LOSS II	TO PEDICT	TON TN T		10072539	Pr	
7 NINI	INI. FYDI	ENGE TOWNE	DG OEM	ION IN I		600000	R5 Dc	
7 NTNTT	INT CNV	INC DIE TO	COMDENSA	TTON		0/72520	Ra	
DDDC	AL SAV. TRNT W∩I	ING DUE IC	TNC			59291763	RS	
	T. TNIVE	STILLOF SAV			тор ·	15000000	R5 Dc	
NET	DDFCFN	F WORTH (C		AL CAPACI	. IIOR	14201762	RS	
INEL	PRESEN	I WORIN (3	AVING)		•	44291703	КS	
BUS	VOLTAG	es and pov	VERS					
NOI NC	DE FRO	OM V-MAG ME p.u.	ANGLE DEGREE	MW GEN	MVAr GEN	MW I LOAD I	MVAr LOAD	MVAr COMP

1	Busl	1.0400	0.00	210	.657		56.462		0.000	0.0	000
2	Bus2	1.0338	-3.21	100	0.000)	70.000	5	0.000	20.0	000
3 30.000 @	Bus3	0.9490	-7.12		0.00	0	0.000	2	50.000	150.0	000
 NUMBER OF	BUSES	EXCEEDING	MINIMUN	I VOL	TAGE	LIMI	T (@ mar]	c) :	1		
NUMBER OF	BUSES	EXCEEDING	MAXIMUN	I VOL	TAGE	LIMI	T (# mar]	c) :	0		
NUMBER OF	GENERA	TORS EXCE	EDING MI		MQI	LIMIT	(< mark) :	0		
 LINE FLOW	s and l	INE LOSSE	S								
SLNO CS FI	ROM FRO	M TO	ΨO	म	ORWAI	מפ		LOS	35	0	
N N	ODE NAM	ie node	I NAME	1.	MW	0	MVAr	HOL	MW	MV	/Ar
LOADING											
1 1	1 1	Busl 2	Βι	ıs2	36	.629	-20.323	3	0.5024	-30.24	162
40.3	2	D	D		1 6 7	110			c 01 C 0	10 70	
73.2\$	3	BUS3 I	В	usi -	-10/.	112	-02.990	,	5.9160	13.70	390
3 1	3 Bu	us3 2	Bu	ıs2	-82.	888	-57.004	3	8.2388	2.93	L85
40.6^											
! NUMBER (OF LINE	S LOADED	BEYOND	125%		1050	: 0				
@ NUMBER (OF LINE	S LOADED	BETWEEN	1008 75%	AND	100%	: 0				
\$ NUMBER (OF LINE	S LOADED	BETWEEN	50%	AND	75%	: 1				
^ NUMBER (OF LINE	S LOADED	BETWEEN	25%	AND	50%	: 2				
& NUMBER (OF LINE	S LOADED	BETWEEN	1%	AND	25%	: 0				
* NUMBER (OF LINE	S LOADED	BETWEEN	%0 	AND	1%	: 0				
BUSES BET	WEEN WH	ICH ANGLE	DIFFERE	ENCE	IS >	30 d	egrees A	RE: Z	ZERO		
ISLAND FR	EQUENCY	SLACK-BU	S CONV	VERGEI	D(1)						
1 6	0.00000		1	1							
Summary of	f resul	ts									
TOTAL REAL	L POWER	GENERATI	ON (CONV	ENTIC) ONAL	:	310.	657 M	IW		
TOTAL REA	L POWER CT. POW	ER GENERA	N (-VEL TION (CC	NVEN	LION4	: (L	0. 126.	uuu № 462 №	iw IVAr		
						.,					

How	to	solve	LFA

MiP-PSCT		How to solve LFA
GENERATION p.f.	:	0.926
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	:	300.000 MW
TOTAL REAL POWER DRAWAL (-ve gen.)	:	0.000 MW
TOTAL REACTIVE POWER LOAD	:	170.000 MVAr
LOAD p.f.	:	0.870
TOTAL COMPENSATION AT LOADS	:	30.000 MVAr
TOTAL HVDC REACTIVE POWER	:	0.000 MVAr
TOTAL REAL POWER LOSS (AC+DC) 0.000000)	:	10.657196 MW (10.657196+
PERCENTAGE REAL LOSS (AC+DC)	:	3.431
TOTAL REACTIVE POWER LOSS	: -	-13.538651 MVAr

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/Cab	e Data			
Number 4	Fetch Li	ne >>	Name Line4 Maintenance	Feed Data Type Current C Power
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 Breaker	Show Breaker - SLD
From Bus Number	1 [Bus1] {11.000	•	Not Exists MVA 350 KA 18.371	SLD Notation
To Bus Number	2 [Bus2] {11.000	•	From Breaker	C Cable C Breaker
Number of Circuits	1		To Breaker Mat Fuista Rating	C Isolator
Line Length	1	km	C Exists MVA 350 kA 18.371	NOP No
Contingency Weigh	itage 1		To Breaker	C From Side C To Side
Status	2 F F 10 /		Commission Status	
• In Service	From End Upen	TOF	na upen C uut or Service C Existing C Proposed	Year U

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

Contingency Ranking Analysis	Availability Transfer Capability	SubStationWise LFA	<u> </u>
Technique	dependent Lodd How	optinial coad now	
C Gauss Siedel Method A	oceleration Factor 1.6		
Newton Raphson Method			
C Fast Decoupled LoadFlow			
Load Flow Type	Frequency Dependent	LFA. Options	
Slack Bus Concept LFA	C Flat Tie Line Cont		
Frequency Dependent LFA.	Flat Frequency Co	introl	
Optimal Load Flow Analysis	💭 Flat Tie-line Frequ	ency Bias Control	
Contingency Analysis	- Optimization Options-		
B Coefficient & Economic Dispatch	n 🔲 P - Optimization	🔲 Q - Optimization	
- Simulation	Ratings		
Feed Current Simulation A	TC Nominal R	ating I 🔿 Rating II	
Substation wise LFA			
P - Tolerance 1e-005	Number of Iterations	15	
D. Televenez I. cot	0 - Check Limit		
Q - Tolerance Te-005			
Slack Bus 1 [North]	Load Model Voltage	0.75	
Print Options Data and Davids			
Data and Hesuits		Use Set Tap	
Line Flow Unit MW & Myar	Multiplicati	on Factor 1	Select line flow
Summary			unit as Amp
	xecution Reduction	on Factor 1	
Show Summary After E			
I Show Summary After E			

5. 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 gspece 1.143154 psum 3.000000 gsum 1.452966 i 1 pmult force 0.508068 gmult force 0.786772 k 2 after pload gload 0.050807 0.038105 k 3 after pload qload 0.050807 0.038105 k 4 after pload gload 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 gload 0.049830 0.037522 k 3 after pload qload 0.049830 0.037522 k 4 after pload gload 0.049830 0.037522 Iteration count 0 maxp 0.000977 maxg 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 gload 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 _____ ____ Bus1 2 Bus2 1.524 3 1 1.143 _____ _ _

	BUS V	OLTAGE	S AND E	POWERS							
	NODE	FROM	V-MAG	G ANG	LE	AMPS		ANG-D	EG	AMPS	ANG-DEG
	NO. COMP	NAME	P.U.	DE	GREE	GEN		GEI	1	LOAD	LOAD
	 1	Busl	. 1.0	000	0.00	100.00)1	-36.8	70	0.000	-90.000
	2	Bus2	0.9	888	0.07	0.0	00	-90.0	000	33.122	-36.910
	3	Bus3	0.9	775	0.14	0.0	00	-90.0	000	33.503	-36.838
	4 0.000	Bus4	0.9	813	0.12	0.0	00	-90.0	000	33.375	-36.862
	NUMBE NUMBE LINE	R OF G R OF G 	ENERATO	VRS EXC DRS EXC	EEDING M EEDING M 	INIMUN AXIMUN	1 Q 1 1 Q 1	LIMIT LIMIT	(< mai (> mai	ck) : ck) :	0 0
	SLNO LOADI	CS FROM NOD NG	M FROM E NAME	TO NODE	TO NAME 	FORV AMPS	VARD	ANG-DE	2G	LOSS MW	% MVAR
	- 1	1	2 B [.]	us2 4	Bus4	66.	879	-36	.850	0.0083	0.0049
	36.5^ 2	1	3 В	us3 4	Bus4	33.	503	143	.162	0.0021	0.0012
18.	3& 3 54.6\$	1	1 В	usl 2	Bus2	100.	001	-36.	870	0.0185	0.0110
	 ! NUM @ NUM # NUM \$ NUM & NUM * NUM ISLAN	BER OF BER OF BER OF BER OF BER OF BER OF D FREO	LINES LINES LINES LINES LINES LINES LINES	LOADED LOADED LOADED LOADED LOADED LOADED LOADED LOADED	BEYOND BETWEEN BETWEEN BETWEEN BETWEEN US CON	125% 100% 75% 50% 25% 1% 0%	AND AND AND AND AND AND (1)	125% 100% 75% 50% 25% 1%		0 0 1 1 1 0	
		 1 50.									

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 : TOTAL SHUNT CAPACIT.INJECTION : 0.000 MW 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.

Table 1: Transmission Line Data						
Bus - code Impedance Zpq Line chargi						
p-q	Zpq	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 \rightarrow Configure. Configure Database dialog is popped up. Click Browse button.

MIGUI - A Power System N	etwork Editor - [GuiZ.gui] ments Set Chenge Object(s) Configure PLot Database Solve 1	Tool Unit Protection Partial Analysis Quick Solve Window 니운(x)
R B B B	Layer Control Select	
	Configure Database Database Name	X
	Crowed	
		IVDC
	name of the database	[理]□[型]□[[]][[]][[]][[]][[]][]][[]][[]][]][[]][]][[]][]][[]][]][[]][]][[]][[]][]][[]][[]][[]][]][[]][[]][[]][[]][[]][]][[]][[]][[]][[]][[]][[]][]][[][]
Fm	Reference X <0>,Y <0> Dist. 636.717 Kin Snap :	

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.

Power Research and Development Consultants Pvt. Ltd.

Open ?X	Configure Database	X
Look in: 🗀 Test 💽 🖙 🖽 🗸		
	Database Name E:\Scsstudy\SCS.mdb	
Select the folder and give database name in File <u>n</u> ame window with .Mdb	Connect	
extension. and now click on Open.	OK Cancel Clear Path Browse	
Files of lung: Detabase Files Youth	Click OK	
Upen as read-only		

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

Configuration Information	X Configuration Information	×
Enversionation Status Lands Excited & Carriery Internation Beads & Harry FreeDeferring - FreeDefer	Energy Hotmatory Valage Level Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical Electrical	
UN Lances hep	OK Cancel 2019	Help

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.

	In MVA	hkA		In MVA	hkA		h MVA	InkA
400.000	15000	21.651	13.200	350	15.309	15.000	350	13.472
220.000	10000	26.244	11.000	350	18.371	0.233	50	123.899
230.000	10000	25.103	10.500	350	19.246	15.000	350	13.472
132.000	5000	21.870	10.000	350	20.208	15.000	50	123.899
110.000	5000	26.244	6.600	250	21.870	0.233	350	13.472
65.000	5000	43.740	3.300	100	17.496	15.000	50	123.899
33.000	1500	26.244	0.415	50	69.562	0.233	350	13.472
15 000	350	13.472	0.233	50	123.899	0.233	50	123.899

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**.

an and an fam.	(dan-jun) 14 Gener (bett) taken Rit Jacon ten Ten Strenets versionen (unt	ADA A Mile Allow on JAX	Bus Data
		Texter(An) ■ (2/2) Sec ■ (2/2)	Bus Number Tetch Bus >>> Bus Name Bus Name Bus 1 Description Bus1 Description Bus1 Nominal Voltage Towner Number Tetch Select Convert Tetch Select Contingency Weightage Voltage Linits in KV Mas T1550000 Mas T1550000 Mas T1550000
	X Lee Memol 4/ 4 3z X-En	1 년 소/**** 9 전 4 전 2 2 전 전 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Cost Break Relay Bus Bar Differential Global Change Load Deteils CostIb>> GPS Attachments

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

Number 1 N	ate Lre	34156	Felch>>
Postive Sequence Resistance	0		Suge Inpedance
Positive Sequence Reactance	0.15	pu	~ [3333.00000 Units
Positive Sequence Succeptance (8/2)	0	pu	V 0.000000 kmu/set
Zero Sequence Resistance	0	 2V	Compute XL, B/2
Zero Sequence Reactance	0	pu	
Zero Sequence Susceptance (8/2)	0	pu	
Themal Rating	100	MVA Conpute	
Line Hamonic Number	0	Hamoric Library >>	
Cost per km	0	Cost Per Unit in	Themal Curvess

Tran	smission Li	ne Element	t 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.

Transformer Number 1	Fetch Transform	er >> Name 211	Maintenance	Global Change	T Zig Zag Transformer
Secondary Voltage 11.000 kV De-Flated MVA [100 Raing 1 [100 Raing 1 [100 From Bux Number 3 (Bucs) To Bux Number 1 (Bucs) Control Bux Number 1 (Bucs) No. of Units in Panalel 1 Controgency Weightage 1	Mvs Nvs (110.000 ¥ (11.000 ¥ (11.000 ¥	Manufactuer Ref Number From Booker Patro C Not Exits MVA 5000 C Exits MVA 5000 C Exits MVA 5000 Set Tap Poston Computer 5 Nominal Tap Poston 0 Phose Shill Angle 0	IA 36.244 IA 36.244 IA 36.244 IA 36.244	Und Protection Relays Differential Relay Go Lath DvmCurrent Relay Cost Dvm Current Relay Cost Per Unit in Cost (0)	Remicted Earth Fault
Status Film Service C Dut of Servic	e Commission Sta	Nis Proposed Year 0			
Pri Grounding Resistance 0 Sec Grounding Resistance 0	ohms ohms	Pil Grounding Reactance 0 Sec Grounding Reactance 0	ohma Ground Prin ohma Sec	ding Transformer nary <u>Compute</u> condary <u>Compute</u>	
Transformer 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 Tran	sformer Library	
Manufacturer 30	Fetch >> Manufacturer 2T30 Transf. Parameter	
MVA Rating 100	Primary 110 kV Secondary 11 kV Voltage	
Minimum Tap 1 1	TapStep Off-Load Tap Change pute On-Load Tap Change Maximum Tap 9 9 Number Number	ute
pu on Common MVA Base	Transformer losses Winding Configuration	
Pos. Seq. Impedance 0.05 Pos. Seq. X to R Ratio 9999	PU Noload W Primary C C C	
Zero Seq. Impedance 0.05 Zero Seq. X to R Ratio 9999	pu loss ' Secondary C C Update X/R ratio Phase displacement 0 [0]	

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

2 nd 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 Image: Comparison of the state of the	Protection Over Current
Specified Voltage Breaker Rating [1.0000] pu [11] kV	Relay Unit Protection
De-Rated MVA 100 Reactive Power · Minimum 0 MVAr Scheduled Power 80 MW Reactive Power · Maximum 60 MVAr	Cost Per Unit in Rs
Real Power Optimization Data Cost Co-efficient C0 0 Real Power - Minimum 0 MW Cost Co-efficient C1 0 Real Power - Maximum 80 MW Cost Co-efficient C1 0	Select C Utility Grid C Generator
Status Commission Status © In Service © Dut of Service	

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

Generator L	ibrary		
Ref. Number 20		Fetch Generator Manufacturer Name Gen14	
MVA Rating 100	MW Rating	80 kV Rating 11 Compute X('d,''d,n,0)	
		pu on Common MVA Base	
Armature Resistance (Ra	a) 0	pu Potier Reactance (Xp) 0 pu	
Direct Axis Reactance ()	(d) 0	pu Direct Axis Transient Reactance (X'd) 0.1 pu	
Quadrature Axis Reacta	nce (Xq) 0	pu Quadrature Axis Transient Reactance (X'q) 0 pu	
Negative Seq. Reactand	ce (Xn) 0	pu Direct Axis Sub-Transient Reactance (X''d) 0 pu	
Zero Seq. Reactance (>	io) 0	pu Quadrature Axis Sub-Transient Reactance (X''q) 0 pu	
Direct Axis Open Circuit Transient Time Constant (T'do) Quadrature Axis Open Circ Transient Time Constant (7.15 2.5	Direct Axis Open Circuit Sub-Transiert Time Constant (T'do) Quadrature Axis Open Circuit Sub-Transiert Time Constant (T'qo) 0.15	
Winding Connections	- Mass Dataila	- Cost Per Unit in Pe	
	Mass Number Inertia	Image: Next >> > <th image:<="" td=""></th>	
0 • C	Damping Factor	0 << Back Thermal Curves	
	Stiffness Co-efficient	t 0 pu torque/ Delete Thermal>>	

Save \square and **Close** the library screen. Generator data screen will be reopened. Click **Save** \square 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

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2.5 Solve Short Circuit Studies

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

Short Ci 1 Click here to select case	2 Click here to open short circuit studies
Case Case Execute After Input File Creation Only Input File Creation Execute with old Input File	Study Info Delete Execute
Results	
Network Report View B	us Graph
Close	

Study Information.

3. Click	1. Click
Short Circuit Data Short Cacuit Output Option: Fault Type Three phase to ground fault Fault Registance 0 pu Fault Resistance 0 pu Ground Resistance 0 pu Ground Resistance 0 pu Ground Resistance 0 pu Ground Resistance (X'd) pu Cartier Resolance (X'd) Pie-Fault Vollages Flat Start Flat Start Vge. Value 1 Multiplication Factor Number 1 Multiplication Factor Number 1 Cable/Shunt Capacitance	Iterative SC Data Frequence SC Data Frequence SC Data Buz number Buz name 2. Click 1 Bu1 2 Bu2 3 Bu3 5 Bu3 5 Bu3 6 Bu3 6 Bu3 6 Bu3 7 Fault on Line
	OK Cancel Apply
In Short Circuit Output Options select the following.

Short Circuit Studies	×
Short Circuit Data Short Circuit Output Options Iterative SC Data	
Output Print Options Data and Results	▼
Output Plot Options Phase A Fault MVA Level	
Post Flow Options Fault Contribution from Adj. Buses are Con	nputed
Post Fault Voltages Computed (in pu)	
Select Detail Data	
and Results to plot	
graph	
	Click OK
	OK Cancel Apply

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

Short Circuit Analysis	×
Case 1	Study Info]
 Execute After Input File Creation Only Input File Creation 	Delete
C Execute with old Input File	1. Click here to execute
Network Report View B	us Graph
Close	2. Click here for report

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 = $k \times sqrt(2) \times lf$, 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.

	Short Circuit Studies
Short Circuit Analysis	Sher Crout Data Sher Crout Budy Option: Revalue Single to ground read: Fault Revalues Fault Revalues Ground Revalues Gro
C Execute with old input File Execute	Transient Reactance (Xd) pu Fault on Line
	Sub Transient Reactance (X*d) Pre-Fault Voltages Input from load fit 1 3 1 3 3 4 9 1 3 4 9 1 3 4 9 1 3 4 9 1 3 4 1 3 4 1 3 4 1 1 3 1 4 1 1 3 1 4 1 1 3 1 4 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 3 1 4 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 3 1 4 1 1 1 1 1 3 1 1 1 3 1 4 1 1 3 1 4 1 1 1 3 1 4 1
Recult	Flot Start Vge. Volue 7 4 L4 (5 Bus5 6 Bus6) 5 L5 [4 Bus4 6 Bus6]
Network Report View Bus Graph	Multiplication Factor Jumber
Close	Select Input from Load Flow
	OK Cancel Apply

Report: -

FAULT AT E	SUS NUMBER	R 3 : NA	ME	в3			
CURF	ENT (AMPS	S/DEGREE)			F	AULT MVA	
SEQUENCE	(1, 2,0)	PHASE	(A,B,C)		SEQUENCE	(1,2,0)	PHASE
(A,B,C)							
MAGNITUDE	ANGLE	MAGNITUDE	ANGLE		MAGNITUDE	MAG	NITUDE
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 \rightarrow 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	Generation		Load		Specified
Code 'p'	MW	Mvar	MW	Mvar	Voltage in pu
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** \rightarrow **Configure**. Configure Database dialog is popped up as shown below. Click **Browse** button.

File Edit Vew Draw Elemen Full Screen Help	vork Edittor - [Guit2.gui] nts Set Change Object(s) Configure PLot Database	Salve Tool Unit	Protection Partial Analysis	Quick Solve Window
	B B P P 7 5 E I S L F :	K 🖪 🗰	8 8 8 2 1	🗣 🗛 🚟 🚟 🔀 🖻
Set/Change Layer Static	Layer Control Select			
<u>_</u>				SHUNT
9				H. MIKIO
				₽ 2 3
	Configure Database	<u>×</u>		SERIES
0	Data Marco	_		
r		_		* 0 •
0	Convect			ETA
0	OK Cancel Oear Path B	owne		
			1	Y & AF @
	Click hard to specif	v tho		HVDC
0	Click here to speci	y uie		●●●
A	name of the databa	ise		FACTS
			<u> </u>	
Fm		inap :	1.000000 × <628>, Y <105:	>

MiP-PSCT

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.

Open	? ×		
Look jn: 🗀 Test 🔪 🖛 🖬 🖝		Configure Database	×
Select the folder and give database name in File <u>n</u> ame window with .Mdb extension. And now click on <u>Open</u> .		Database Name E:\study\TRS.mdb Connect Of Cancel Clear Path Browse	
Files of type: Database Files *.mdb Cano	el	Click OK This button is to clear the Database Name field	;

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

Configuration Information	Configuration Information
Base MVA Ito Beneral information Watage Levels Decisiol & Currency Information Beaker Rainge Base MVA Ito Ito Ito Ito Base Frequency SQL Ht Ito Ito p ut status Ito Ito Ito Ito - Indicates that all the impedances are specified in PU on a common MVA beam. Bea the machine impedances are specified in PU on ta common MVA beam. Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito Ito	
E/2 mtoken.	Power System Likawier

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

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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**.

Configuration Information	Bus Base Voltage Configuration	x
General Information Votage Levels Electrical & Currency Information Breaker Ratings	Base MVA 100.000000	Color
In MIA 400.000 IB200 211551 13.200 550 15.309 15000 350 13.472 220.000 10000 25.244 11.000 550 13.237 0.233 50 12.289 230.000 10000 25.103 10.500 550 13.246 15.000 350 13.472	Bur Noth Bur Stere Volgen 400.0 W/4 13.0 M/4 230.0 W/4 13.0 M/4	Bar Ven 00 V/ 4 3 00 V/ 4 3
132.000 5500 21.870 10.000 550 20.288 15.000 50 12.889 110.000 500 25.244 6.600 250 21.870 0.233 350 13.472 66.000 5000 43.740 3.300 100 17.496 15.000 50 12.879	■ 220 W 4 3 100 W 4 3 120 W 4 3 100 W 4 3 110 W 4 3 650 W 4 3	
33.000 150.0 25.244 0.415 50 55.562 0.233 350 13.472 15.000 350 13.472 0.223 50 123.859 0.233 50 123.859 Modify All Breaker Ratings Modify All Breaker Ratings 123.851 123.851 123.855	■ 660 W/4 = 330 W/4 = 330 W/4 = 330 W/4 = 150 W/4 = 0230 W/4 = 02	0.0 6/4 B 0.0 6/4 B
OK Carcel Activ Help	OK Cancel	Dels.k

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**

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			· A B E F ?	Bus Number Bus Name	1 Fetch Bus >>
et/Change Layer General	Layer Control Select	•		Description	North
		2	SHUNT	Nominal Voltage	20.000 💌 kV
				Area Number	
				p	Select 1 Area1
	🖪 Bus Data	×	S2005	2 2 One Number	Select 1 Zone1
	The second se			Owner Number	Sales Inc
	Bus ID		- 0 - 00	1 II	select it Uwhen
	Bus Name Bus1		Helfer =	Contingency Wei	ightage 1
	From Database		ETA	Min 19.000000	Max 21.000000
	C Al Values		FITTE	- Cost Per Unit in -	Cost library
	G Selected Volta;	-	VIANE	0	
				Fielay	Arc Flash
D 2 3	OK Cancel		nvbc	Bus Bar Differe	Bus Details
		-4	輕 四 型 型	Global Change L	.oad Details Costlib >> Gi
			FACTS		
r				Attachindriks	- I Fremanks

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 D	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.

	Bet 77 2200		
--	----------------	--	--

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.

Number 1	Fetch Li	ne >>	Name L1 Maintenance	Feed Data Type © Current © Powe
De-Rated MVA	100		Structure Ref. No.	Amperes 0
Rating I	100	MVA	Transmission Line Library >> Line Details >>	pf 0.8
Rating II	100	MVA	From Breaker Bating	Show Breaker - SLD — Yes
From Bus Number	4 [Bus4] {230.000	¥	C Exists MVA 10000 kA 25.103	SLD Notation
To Bus Number	3 [Bus3] {230.000	•	From Breaker	C Cable C Breaker
Number of Circuits	1		To Breaker Rating	C Isolator
Line Length	1	km	© Not Exists C Exists MVA 10000 kA 25.103	NOP © No
Contingency Weigh	itage 1		To Breaker	C From Side C To Side

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		

Line and Cable Lib	rary		
Structure Reference			
Number 1 N	ame MTL1		Fetch >>
			- Surge Impedance
Positive Sequence Resistance	0.07	pu	Z 0.698430 Obms
Positive Sequence Reactance	0.04	pu	E407 CCC10
Positive Sequence Susceptance (B/2)	0.041	pu	V 5487.666610 kms/sec
Zero Sequence Resistance	0	pu	Compute XL, B/2
Zero Sequence Reactance	0	pu	
Zero Sequence Susceptance (B/2)	0	pu	
Thermal Rating	100	MVA Compute	
Line Harmonic Number	0	Harmonic Library >>	
Cost per km	0	Cost Per Unit in	Thermal Curve>>

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.

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Fransformer Number 1 Fetch Transfor	ier >> Name 2T1 Maintene	ance Global Change	Zig Zag Transformer
Seconday Voltage 20.000 KV DeRlated MVA 400 Retina I 400 Reting II 400 Fiom Bus Number 4 (Brund) (230.000	Manufacturer Ref Number 30 (2130) From Breaker Transformer Library © Not Events Raling © Existe MVA [10000.000 kA [25:103 Th Rineaker Rules	Unit Protection Relays Differential Relay Go Torys CiverCurrent Relay	Restricted Earth Fault Go Toty SI.D - Show Breaker
To Run Number 1 (Dust) (20.000 - Control Buo Number 0 (Bunt)) - No. of Units in Parallel 1 Controgency Weightage 1	C Nu Exists Harry C Exists MVA \$50.003 kA \$10.104 Set Tap Position Computer 0 ++3 \$30.003 kA \$10.104 Nominal Tap Position In In 1 \$10.104 \$10.1	Cost Per Unit in	Contingency : 0 Schedule : 0
hatus Tin Service C Dut of Service C Existing (Tin Service C Dut of Service) C Existing (Tin Service C Dut of Service) Commission Stu F Existing (Service) C Dut of Service C Dut of Service Commission Stu F Existing (Service) C Dut of Service C Dut o	atur Thoposed Year 0 Philirounding Reactance 0 ohmo Sec Grounding Reactance 0 ohmo	Grounding Transformer Primary Compute Secondary Compute	

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

Two Winding Transformer Library
Manufacturer 30 Fetch >> Manufacturer 2T30 Transf. Parameter Ref. Number 30 Fetch >> Name Transf. Parameter Transf. Parameter
MVA Rating 400 Primary Voltage 230.000 kV Secondary Voltage 20.000 kV
Minimum Tap TapStep Maximum Tap 9 Number © 0ff4.cod Tap Change Number Minimum Tap 218.500 kV Compute
pu on its Own Rating Transformer losses Winding Configuration Pos. Seq. Impedance 0.022 pu Noload W Pos. Seq. X to R Ratio 9393 V Primary C C Zero Seq Impedance 0.022 pu Update X/R ratio Secondary C C Zero Seq X to R Ratio 9393 Update X/R ratio Phase displacement 0 (0) Image: Configuration
Magnetization Curve Data in pu on its Own Rating Thermal Curve Magnetization Curve Primary Winding C Secondary Winding Residual Flux IV Characteristics In % Phase A 0 Add Phase B 0 Delete Phase C 0 Delete

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.

Number 1	Fetch Genera	tor>> N	lame Gen1	Maint	enance	Schedule No 0
Bus No. 1 [Bus1] (20.000 Units in Parallel 1	• 61	Manufactur Copobility C	er Ref. No 30 Curve No 0 (CAPCUR)	Lib Capability C	ary>>	Protection Over Current
Specified Voltage	20.000	kV	Breaker Rating In MVA 50.00000	In kA 1.4	43	Relay Unit Protection
De Rated MVA 400 Scheduled Power 350	Mw	,	Reactive Power - Minimur Reactive Power - Maximur	71.2 m 71.2	MVAr MVAr	Cost Per Unit in
Real Power Optimization D a Real Power - Minimum 0 Real Power - Maximum 3	ta 1	MW MW	Cost Co-efficient C0 Cost Co-efficient C1 Cost Co-efficient C2	0	-	Select C Utility Grid Generator
Status In Service C. Du	t of Service	Com	nssion Status Existing C Proposed	Year 0	-	
Neutral Grounding Resistanc Neutral Grounding Reactanc Grounding Through Transfor	e [0 e [0 mer Calc	ch ch ulate	hms Participation Factor (hms Bias Setting Disop (%)	X) 0 0 4	_	
Model Type Infinite Bus Modelling (20 Transient Modelling (20 Sub Transient Modelling (Global Channel	5) 6×q) ×*d8×*q)	AVB Rel AVB FPI Turbine I	f No. [0. [AVR] Typ 8 Name Gov Ref No. [0. Type 0		Libray >> Libray >>	Edit Files AVR File Open

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

Generator Library
Ref. Number 30 Fetch Generator Manufacturer Name Gen14
MVA Rating 400 MW Rating 350 kV Rating 20 Compute X(*d.*d.n.0)
pu on its Uwn Hating
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 P4 Quadrature Axis Transient Reactance (X'q) 0 pu
Negative Seq. Reactance (Xn) 0 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 7.15 Direct Axis Open Circuit 0.039 Inertia in MJ/MVA (11.2 (11.2)
Quadrature Axis Open Circuit 2.5 Quadrature Axis Open Circuit Damping Factor Transient Time Constant (I"qo) 0.15 0
-Winding Connections Mass Details Cost Per Unit in
Mass Number 0 0
Y Y A Inetia 0 MJ/MVA Counter
C C Damping Factor 0
Stiffness Co-efficient 0 pu torque/ Delete

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		
Хо	0	0	0		
Хр	0	0	0		
X'd	0.067	0.10	0.00001		
X'q	0	0	0		
Xd	0	0	0		
Xq	0	0	0		
Inertia MJ/MVA	11.2	8.0	1000		

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

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**.

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		Matr 😂 🗮 🔀 🔤 put Sel Change Law General	Layer Control Select
Bet [7] Zon Zon Zon Zon Zon Zon Zon Zon Zon Zon	Busk (P) 2008 2008 2008 2008 2008 2008 2008 200	Best (2) Excess Excess Excess Excess	
 	a construction	Francisco -	So the contraction of

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

Number 1 Fetch Load	>> Name LD1	Maintenance	Schedule No 0	
Bus Number 4 [Bus 4] (230.000 Real Power in MW 100 Reactive Power in MVAR 44.0000 Power Factor 0.915315	No of Consumers	MVAR Compensation Minimum Compensation Maximum Compensation Compensation Step in Load Eneroctematics	n D ion in MVAR 0 tion in MVAR 0 n MVAR 0 No. 0	Relay Cost Per Unit in 0 Cost library
Load Type © Linear C Non Linear	Unbalanced Load	. ° Y .	Library Load Characteristics >>	Ref Na.
0	Unbalanced Load Del	= ·	Global Change	1
Status In Service C Dut of Service	Commission Status	Yes 0	Breaker Rating In MVA 10000.00000 In kA 25.103	
Control Block	1		Proven	1

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

To solve load flow studies choose menu option Solve \rightarrow 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
_____ _____

        Busl
        1.0300
        0.155
        0.0099

        Bus2
        1.0200
        0.112
        -0.0003

                                     0.0014
                                    -0.0001
     Bus3 1.0000 0.000 1180.5015
  3
                                     -0.0272

        Bus4
        1.0175
        0.082
        -0.0032
        -0.0002

        Bus5
        1.0109
        0.040
        -0.0016
        0.0001

  4
  5
Number of p iterations : 3 and Number of q iterations :
                                               5
_____
BUS VOLTAGES AND POWERS
            V-MAG ANGLE
                              MW MVAR
NODE
    FROM
                                             MW
                                                      MVAR
MVAR
     NAME P.U. DEGREE
                              GEN
NO.
                                     GEN
                                             LOAD
                                                      LOAD
COMP
____ _____
     Busl 1.0300 8.90 350.000 71.200 0.000 0.000
 1
0.000
       Bus2 1.0200 6.39 185.000 29.800
                                             0.000
 2
                                                     0.000
0.000
  3 Bus3 1.0000 0.00 -380.502 -26.497 0.000 0.000 0.000
<
 4
       Bus4 1.0175 4.68 0.000
                                    0.000 100.000 44.000
0.000
5
       Bus5 1.0109 2.27 0.000 0.000 50.000 16.000
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
_____
TRANSFORMER FLOWS AND TRANSFORMER LOSSES
SLNO CS FROM FROM TO TO FORWARD LOSS
NODE NAME NODE NAME MW MVAR MW
SLNO CS FROM FROM TO TO FORWARD
                                                       8
                                                      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% : Ο @ 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 S FROM FROM TO TO FORWARD NODE NAME NODE NAME MW MVAR SLNO CS FROM FROM LOSS ÷ MW MVAR MW MVAR LOADING Bus43Bus3210.57311.9603.01578.88753Bus35Bus5-86.472-11.7120.6019-4 3 1 207.3! 4 1 6.3713 87.3# 5 Bus5 -86.472 -11.712 0.6019 -6.3713 5 1 3 Bus3 87.3# 4 Bus4 5 Bus5 39.418 -11.215 0.2702 -21.5963 6 1 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% : Ω ^ 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 18 : 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.

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Transient Stability Analysis	×	
Case 1 Study Info		1. Click here to open study information
Execute After Input File Creation Only Input File Creation Execute with old Input File		2. Click here to 4. Click here to enter
Results Network Report View Bus Graph		3. Click here to

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

INSIENT STABILITY STUDIES	×
Load Type Constant Impedance T Multiplication Factor Number 1	Swing Bus 3 Gen24/2 (Bus 31) V Z Load Flow Print Option Load Flow Case
Simulation Time Step Stat End Step I 0.5 0.001 VI-2S Option IF 0.4put plot option Select Buses of Interest 1 Bus1 2 Bus2 3 3 Bus3 4 4 Bus4 5	Tolerences No. of Load Flow 10 Reactive Power (Initial) 0.001 Reactive Power (Post Dist.) 0.01 React Power (Post Dist.) 0.01 Data Print Option 1 Data Print Option 1 List of disturbances 1 Si No Disturbance Yes/No 1 3 Ph to GND Fault at Bus no 4 from 0.000 s to 0.225 s 2 change in Line Parameters 2 at 0.225 s
Disturbances Change in Transmiss Elements Considered C W/B Considered 2. Click here to select disturbance type	Distubunce Info Machine Type Free Programmetric Distubunce Info Image Description Free Programmetric Block: Image Description Cancel 3. Chick here to enter disturbance

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.

CON Bus O On Transmi Select an Element	ULT ssion Line 🤅) From Bus C	Click here to select bus no
J 4 Bus4	-		New 22
Disturbance Starting Time	0	Secs	Next >>
Disturbance Clearing Time	0.225	Secs	Delete
Fault Impedance			
Fault Resistance	0	p.u	Counter
Fault Reactance	1.0e-04	p.u	1
Pole Reclosure Option	No Reclos		<< Back
Reclosure Time	0	Secs	
0	k	Cancel	Reactance value should not be zer

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).

CHANGE IN TRANSMISSION LINE PARAMETER	S	×		
Select Line	Next >>		1. Click h	here to select the
4 L4 [4 [Bus4]· 5 [Bus5]]	Back</td <td></td> <td>line</td> <td></td>		line	
Disturbance Starting Time 0.225 Set	cs Counter 1			
Postive Sequence	Actual Parameters			
Resistance 0 pu	R1 → 1.800000e-002 p.u	Parameter Calculation	×	
Reactance 999 pu	X1 -> 1.100000e-001 p.u	Existing Number of Circuits	1	
Suceptance (B/2) 0 pu	B1/2 → 1.130000e-001 p.u	New Number of Circuits	0	3.Click
Zero Sequence Resistance 0 pu	R0 -> 0.000000e+000 p.u	OK	Cancel	
Reactance 999 pu	X0 → 0.000000e+000 p.u			
Suceptance (B/2) 0 pu	B0/2 → 0.000000e+000 p.u			
	No. of Ckts #1		2.Cli	ck here to select
Ok Cancel Delete	Compute			
		F 81		

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.

Load Type Constant Impedance Ty	pe 🗾 Swing Bus 2 Gen2 [3 (Bus3)]	•
Multiplication Factor Number Simulation Time Stat End Stat I 0.5 0.20 VL2S Option I Output plot option Select Buses of Interest 2 0 2 0 2 0 2 0 0	Contract Contex Contract Contract Contract Contract Contract Contract Contract	se 1 se 1 se 10 se
Disturbances Change in Transmissic Elements Considered	n Line Parameter:	e Voltage behind Xd [*]

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.

Transient Stability Analysis	
Case Study Info © Execute After Input File Creation © Only Input File Creation © Execute with old Input File	1. Click here to execute
Results	3. Click here for graph
Close	
2. Click here for results	

Part of Report is Shown below :

Time	= 0.	00000 Secon	ds					
Inter	rmediat	e results f	or Machin	es				
GNo 1	Name	Voltage An	qle D	elta B	Freq	Pgen	Qgen	Pmech
Efd/S	Slip		-		-	-		
	- F	ou Degr	ee Degr	ee Hzs.	MW	MVAR	MW	pu/PU
1	Busl	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 dpmax 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
pu/P.U.
____ _____
____
1
  Busl 0.275 20.1 20.8 60 5.93 339 350
1.1
2 Bus2 0.908 6.55 16.2 60 162 129 185
1.06
3 Bus3 1 -0.00455 -0.0022 60 414 3.02e+003 -381
1
_____
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** \rightarrow **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.

🙀 Open	×	Configure Database	×
Look in: study stu		Database Name E:\study\TRS.mdb Image: Connect Image: Connect Image: Cancel Clear Path Image: Click OK This button is to clear the Database Name field	
	111		

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

ng Momaton Bhuker Ratinge

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.

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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**.

	Bus Number Bus Number Bus Name Bus Name Bus Name Bus Same Bus Same Bu
Internet in the second se	

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 1 Fetch Line >>	Name L1 Maintenance	Feed Data Type © Current © Power
De-Rated MVA 4.2344	Structure Ref. No. 1141 [3Cx300sqmm(6.35/11kV)]	Amperes 0
Rating I 4.2344 MVA	Transmission Line Library >> Line Details >>	pf 0.8
Rating II 4.2344 MVA	From Breaker	Show Breaker - SLD
From Bus Number 1 [Bus1] (6.600	Not Exists NVA 250.0000 kA 21.870	SLD Notation
To Bus Number 2 [Bus2] (6.600	From Breaker	C Cable C Breaker
Number of Circuits 3	To Breaker Rating	C Isolator
Line Length 0.5 km	O Exists MVA 250.0000 kA 21.870	© No
Contingency Weightage	To Breaker	C From Side C To Side
Status © In Service C From End Open C To En	d Open C Out of Service Commission Status	I Year 0

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.

Par FAL	ner System Schools Ed	liter - [Guil.quil] Charge Objectio) Configure Rol	Database Tobe 1	out Unit Protection, Easted Analysis - Out	th Solar Window Full Screen H	
			INSE		Atty 22 12 20 10 port 5	et/Change Layer General
P					2	SHUNT
						+ ₩ ≥ ±
0 0 0		Bust [1] ZZVM1 ZZVA1		Bus2 [2] ZZVM2 ZZVA2		50005
01		ZZLP1-2		ZLP2-1		
9		ZZL01-2	3	ZL02-1		<u>→→→→</u>
20		Element ID	-			
A		Element ID From Database		OK.		
Fm			<u> </u>	anost		PROTICTION
						SYMIOL
1 Contract	Schedate	D Reference V alls V alls D	at 416 E75 Km	DITERUS ITERIS INA	F DataShith ride	T 17 2 + 1
Ready	Jacobian Jacobian		Snap :	1.000000 X <350>, Y <226>		180 1 Ortho

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

Generator Data				
Number 1 Fetch Generat	or>> Name Gen1	Maintenance	Schedule No 🛛 💌	
Bus No. 1 (Bus1) (6.600 T Units in Parallel 1 GT (Manufacturer Ref. No 1 (Thermal Capability Curve No 0 (CAPCUF	120MW] Library >> Capability Curve >>	Protection Over Current	
Specified Voltage	kV Breaker Rating	ln kA 21.870	Relay Unit Protection	
De-Rated MVA 31.25 Scheduled Power 25 MW	Reactive Power - Mini Reactive Power - Max	mum 0 MVAr imum 9 MVAr	Cost Per Unit in	
Real Power Optimization Data Real Power - Minimum 0 Neal Power - Maximum 25	IW Cost Co-efficient IW Cost Co-efficient IW Cost Co-efficient	C0 0 C1 0 C2 0	Select C Utility Grid C Generator	
Status © In Service © Out of Service	Commission Status © Existing © Proposed	d Year 0		ck here to browse
Neutral Grounding Resistance 0 Neutral Grounding Reactance 0 Grounding Through Transformer Calcutered	ohms Participation Fac ohms Bias Setting Jate Droop (%)	tor (%) 0 0 4	AV da	rR and Governor ta files
Model Type C Infinite Bus Modelling (Xd) C Transient Modelling (Xd &Xq) G Sub Transient Modelling (Xd &Xq) G Global Change	AVR Ref No. 0 [AVR] AVR FPB Name E:\Share Turbine Gov Ref No 0 Type 0 Tur Governor Name E:\Share	Type 0 AVR Library >> dDocs\Examples\Example TG Library >> dDocs\Examples\Example	Edit Files AVR File Open	

Generator Library Details:

Ref. Number	1		Fetch Generator	Man	utacturer Name	Thermal120MW
MVA Rating	31.25	MW Flating	25	kV Rati	ng 6.6	Compute X("d,"d,n,0)
		- and the second	pu on its Own	Rating		
Armature Resistan	ce (Ra)	0	py Potier Re	actance (P(p)		0.2 pu
Direct Axis Fleacte	ince (Kd)	2	pu Direct Axi	Transient B	eactance (%d)	0.25 pu
Quadrature Axis R	eactance (Kg)	2	pu Quadratu	e Axis Transi	ent Reactance D	al 0.25 pu
Negative Sea Be	enterne (Ve)	0.2	DU Direct Avi	· Sub-Termin	nt Beautance M	v0 0.2 m
They are seen in	octorice party	10.2			in Houseners pr	of for pu
Zero Seq. Heacta	nce proj	los	pu Quadratu	e Axis Sub-T	ransient Heactan	ce pr d) lo.2 pu
Direct Axis Open Cir Transient Time Con	cuit 7		Direct Axis Open Sub-Transient Ti	Circuit me Constant	0.04	Inertia in MJ/MVA
1 00) Numbrature Anio Oco			(1 doj	Onen Church		Damping Factor
Transient Time Con	stant (T'qo)	2.5	Sub-Transient Ti	me Constant	(T''qo) [0.2	0
Winding Connectio	ns Mass	Details				Cost Per Unit in
	Marr	hlumhar	10		Next >>	0
V YA	Inertia	ritaniber			Counter	10
	- merce	0.000000	In	MJ/MVA	I	Thermal Curves
· · · ·	Damp	ing Factor	0		CC Back	Thomato
	Stilfne	ess Co-efficient	0	pu torque/	Delete	Tremaczz

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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



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**

4	GJT - A Power System Network Islator - [Coll-gal]	_ D ×
	is the very base tensors be Charge Charles Configure Fluid batchase take had but histories Participant and the window full inter-	Sat/Daros Laser Gaunal
		AUEN AUEN 2 Standard Standard 2 Standard Standard Standard 2 Standard Standard Standard 3 Standard Standard Standard 3
		YNBOL
	Confingency: 0 Schedule: 0 Reference X <0x, Y <0x: Dist: 770.347 Km ID: 1 F BUS: 2 T BUS: NA. E: DistarSMdb mdb	2 - and and and and and
	Ready Snap : 1.000000 X <703>, Y <315>	0 1 Ortho

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

Motor Data	
Motor Number 1 Fetch Motor >>	Name Mot1 Maintenance Motor Protection Relay
De-Rated MVA 4.6875 Bus Number 2 [Bus2] (6.600 💌 Units in Parallel 1	Manufacturer Ref. No. 1 [Mot1] r Relay Breaker Rating
	-Motor Torque
Winding Type Y A Neutral Resistance Neutral Reactance 0 ohms	Formula Characteristics Torque Constant (Tc) 0.6 Motor Load Library Constant Torque Component (C1) 0 Torque Component (C2) 0 Load Library>> Torque Component Propolonal to Square of Speed (C3) Speed Vs Torque Characteristics
Status Motor deta If In Service Dut of Service Det Stating Mode Image: Comparison of the service Det Autor Transformer Image: Comparison of the service Image: Comparison of the service Resistance Image: Comparison of the service Image: Comparison of the service Image: Comparison of the service Stat-Deta R Statt R End Image: Comparison of the service Image: Comparison of the service	Auto Tap Value

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

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

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

PowerFPB - [avr]				
🎦 Eile Edit ⊻iew Draw Elements S	<u>è</u> et <u>O</u> bject S <u>p</u> ecifications	E <u>x</u> ecute <u>W</u> indow	<u>H</u> elp	
	<u>n c 8 ? R</u>	<u>Prepare Data file</u> Simulate FPB Plot <u>G</u> raph View File	► <u>F</u> or Simulation For <u>I</u> RS	
	Save As Save jn: 🔁 Avr-gov		? ×	
		S	elect the location and nter file name	
	File <u>n</u> ame: avl Save as <u>type</u> : FPB Data File for ☐ Open as <u>r</u> ead-	Transient Stability *.fpd	∑ave Cancel	

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

ITERATIC	N MA	X P BUS	MAX P	MAX Q			
BUS	MA	X Q COUNT	NUMBER	PER UNIT	NUME	BER PER UNI	T
Number c	1 2 3 4 f p ite:	2 2 2 2 rations :	0.090 0.080 0.001 0.001 3 and 3	Number of	2 0.09 2 0.03 2 0.00 2 0.00 q iteration	 97 36 01 01 01 05 : 2	
BUS VOLT	AGES AN	D POWERS					
NODE FRO	M	V-MAG	ANGLE	MW	MVAR	MW	MVAR
NO. NAM COMP	ſΕ	P.U.	DEGREE	GEN	GEN	LOAD	LOAD
 1 0.000	Busl	1.0000	0.00	9.140	5.607	0.000	0.000
2 0.000	Bus2	0.9936	-0.02	0.000	0.000	9.000	5.500
NUMBER C	F BUSES	EXCEEDIN	G MINIMUM	VOLTAGE I	JIMIT (@ mar	rk): 0	

MiP-PSCT			How to	solve TRS
NUMBER OF BUSES EXCEEDING MAXIMUM	VOLTAGE LI	MIT (# mark)	: 0	
NUMBER OF GENERATORS EXCEEDING MIN	IMUM Q LIM	IIT (< mark)	: 0	
NUMBER OF GENERATORS EXCEEDING MAX	IMUM Q LIM	IIT (> mark)	: 0	
LINE FLOWS AND LINE LOSSES				
SLNO CS FROM FROM TO TO		FORWARD		LOSS
% NODE NAME NODE NAME	MW	MVAR	MW	MVAR
LOADING	110	TIVIII.	110	mm
1 3 1 Bus1 2 Bus	2 9.14	0 5.607	0.0572	0.0286
84.4#				
! NUMBER OF LINES LOADED BEYOND	125%	: 0		
@ NUMBER OF LINES LOADED BETWEEN 1	00% AND 12	5% : 0		
# NUMBER OF LINES LOADED BETWEEN S NUMBER OF LINES LOADED BETWEEN	75% AND 10 50% AND 7	0∛ : ⊥ 5% : 0		
^ NUMBER OF LINES LOADED BETWEEN	25% AND 5	0%: 0		
& NUMBER OF LINES LOADED BETWEEN	1% AND 2	5%: 0		
* NUMBER OF LINES LOADED BETWEEN	0% AND	1% : 0		
ISLAND FREQUENCY SLACK-BUS CONVE	RGED(1)			
1 50.00000 1	0			
Summary of results				
TOTAL REAL POWER GENERATION :	9.140 M	IW		
TOTAL REAL POWER INJECT,-ve L :	0.000 M	IW		
TOTAL REACT. POWER GENERATION :	5.607 M	IVAR		
GENERATION PI	0.852			
TOTAL CULTURE DED CHOOD INTEGRICAN .	0.000 M	T. .T		
TOTAL SHUNT REACTOR INJECTION : TOTAL SHUNT REACTOR INJECTION :	0.000 M	IW IVAR		
TOTAL SHUNT CAPACIT.INJECTION :	0.000 M	IW		
IOTAL SHOWL CAPACIT. INDECITOR .	0.000 1	IVAIC		
TOTAL TCSC REACTIVE DRAWL :	0.000 M	IVAR		
TOTAL SPS REACTIVE DRAWL :	0.000 M	IVAR		
TOTAL UPFC FACTS. INJECTION :	0.0000 MV	AR		
TOTAL SHUNT FACTS.INJECTION :	0.000 M	VAR		

MiP-PSCT					How to solve TRS
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		
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.

Transient Stability Analysis	
Case 1 Study Info	1. Click here to open study information screen
Execute After Input File Creation Only Input File Creation Execute	2. Click here to execute
Results	4. Click here to enter into graph
Network Repoet View Bus Graph	3. Click here to view report

fultiplication Factor Number ▼ Load Flow Print Option Load Flow Case 1 imulation Time Step Tolerences No. of Load Flow 10 0 0.5 0.02 Real Power (Initial) 0.001 No. of Load Flow 10 12S Option Real Power (Initial) 0.001 Reactive Power (Initial) 0.001 Print Step Option 1 Select Buses of Interest Real Power (Post Dist.) 0.01 Data Print Option With Data Image: Step Option Image: Step Option	fultiplication Factor Number Image: Constant Voltage behind Xdt Statt End Step 0 0.5 0.02 12S Option Real Power (Initial) 0.001 IV: Output plot option Real Power (Post Dist.) 0.01 Select Buses of Interest Reactive Power (Post Dist.) 0.01 1 Busing List of disturbances Yes/No 1 Motor Start/Stop Image: Constant Voltage behind Xdt Disturbances Motor Start/Stop Disturbance Info Constant Voltage behind Xdt Constant Voltage behind Xdt Elements Onsidered Real Power VR Governor Free Programmable Bock Relay Cyclic Load 0k Cancel 3. Click 3. Click 3. Click	fultiplication Factor Number Image: Construct of Construction Time Statt End Step Image: Instruction Time Image: Construction Time Image: Construction Time Statt End Step Image: Instruction Time Image: Construction Time Image: Construction Time Image: Image: Image: Construction Time Image: Construction Time Image: Construction Time Image: Ima	Load Flow Print Option nces Power (Initial) 0.001 tive Power (Initial) 0.001 Power (Post Dist.) 0.01 trower (Post Dist.) 0.01 turbances isturbance otor Start/Stop Event 1 at 1.4 Select Motor	Load Flow Case 1 No. of Load Flow 10 Iterations Print Step Option 1 Data Print Option With Data Yes/No 000 s Yes/No 2. Uncheck the Machine Type Constant Voltage behind Xd'
imulation Time Step Tolerences Stat End Step 0 0.5 0.02 H-ZS Option Real Power (Initial) 0.001 I Bus1 Real Power (Post Dist.) 0.01 I Bus1 List of disturbances Yes/No Start/Stop Ves/No I Motor Start/Stop Ves/No I Select Motor 2. Uncheck the I Bus1 Ves/No I Motor Start/Stop Ves/No I Motor Start/Stop Ves/No I Motor Start/Stop Constant Voltage behind Xd'	imulation Time Start End Step 0.5 0.02 No. of Load Flow 10 Real Power (Initial) 0.001 Reactive Power (Initial) 0.001 Print Step Option 1 Data Print Option React Power (Post Dist.) 0.01 With Data ▼ List of disturbances SINO Disturbance SINO DISTURBANCE	imulation Time Start End Step 0.5 0.02 I-ZS Option F Output plot option Select Buses of Interest 1 Bus1 2 Bus2 Disturbances Motor Start/Step Elements Considered F AVR F Governor F Free Program	nces Power (Initial) [0.001 tive Power (Initial) [0.001 Power (Post Dist.) [0.01 t Power (Post Dist.) [0.01 urbances isturbance lotor Start/Stop Event 1 at 1.1 Select Motor Disturbance Info ammable Book	No. of Load Flow 10 Iterations Print Step Option 1 Data Print Option With Data V Yes/No 000 s Ves/No 000 s Ves/No 000 s Ves/No 000 s
1. Select Motor 2. On check Disturbances Motor Start/Stop Disturbances Motor Start/Stop Obsturbance Info Constant Voltage Constant Voltage	1. Select Motor 2. On Check Disturbances Motor Start/Stop Disturbances Motor Start/Stop Disturbance Info Constant Voltage behind Xd' Considered Considered VR Governor VR Cancel 4. Uncheck 3. Click	Disturbances Motor Start/Stop	Disturbance Info	Machine Type Constant Voltage behind Xd'
4. Uncheck 3. Click	4. Uncheck 3. Click			y 🥅 Cyclic Load
		4. Uncheck 3.		
tor Start/ Stop		Motor Number 1 Mot1 [2 (Bus2)]	Next >>	
Motor Number 1 Mot1 [2 (Bus2)]	Motor Number [1 Mot1 [2 (Bus2)]	Start Stop Disturbance Starting Time	Counter	Select the and enter Disturband

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

SI. 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

			Positive Sequence			
SI. No.	From Bus	To Bus	Resistance	Reactance	Susceptance	
			R(P.U.)	X(P.U.)	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.

Bus Number	1	1	Fetch Bus >>	1
Bus Name	Dus1	-	-	-
Description	Bus1		1	
Nominal Volta	11.000	-	V	
Area Number				-
1	Select	1 Area1	*	
Zone Numbe	(
1	Select	1 Zone1	-	
Owner Numb	er Select	1 Owner		
Voltage Limit Min 10.450	in kV 100 Ma	1 × 11.550	000	1
Cost Per Unit	in	Cost libra	iy 👻	
Relay Bus Bar Di	ferential	Arc Flash Bu	Details	
ilobal Change	Load De	etails C	settilb >> G	PS
				-

4.2 Procedure to enter Transmission line details:

Select main menu "Libraries -> Series Elements -> Transmission Line"

Line and Cable Lil	orary ame LN1		Fetch Line
Positive Sequence Resistance Positive Sequence Reactance Positive Sequence Susceptance (B/2) Zero Sequence Resistance Zero Sequence Reactance Zero Sequence Susceptance (B/2)	0.0043 0.0477 0.637 0.0086 0.0954 0.5	ри ри ри ри ри	Surge Impedance Z 0.193497 Ohms V 1274.913551 kms/sec Compute XL, B/2
Thermal Rating Line Harmonic Number Cost per km	400 0 0	MVA Compute Harmonic Library >> Cost Per Unit in Rs	Thermal Curve>>

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

Procedure to enter Element detail:

Number 1	Fetch I	ine >>	Name [it1 Maintenance	Type • Current C Power
De-Rated MVA Rating I From Bus Number T To Bus Number T Number of Circuits Line Length Contingency Weighta	400 400 5 (Bus15) (400.00 4 (Bus14) (400.00 1 1 1 1 2 9 1	MVA MVA	Structure Ref. No. 1 [LN] Transmission Line Library >> Line Details >> From Breaker Not Exists MVA 50 kA 0.072 From Breaker To Breaker To Breaker Exists MVA 50 kA 0.072 To Breaker To Breaker To Breaker	Amperes 0 pf 0.8 Show Breaker - SLD Yes SLD Notation C Line C Dable C Breaker C Isolator NDP C No C From Side C To Side
Status ● In Service O	From End Open	C To E	nd Open C Out of Service Commission Status	Year 0
From Side Open			To Side Open	C 01

Select main menu Elements -> Series Elements -> Transmission Line ->

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

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

4.3 Procedure to enter Transformer details

Select menu option Libraries -> Series Element -> Two winding Transformer

Manufacturer Transf. Parameter Ref. Number 1
MVA Rating 250 Primaty Voltage 11 kV Secondary Voltage 400 kV
Minimum Tap 1 TapStep >> 0.016667 p.u. Maximum Tap 7 3 Minimum Tap 9.9 kV Compute O Inf-Load Tap Change Number Number Voltage 0 0n-Load Tap Change Naximum Tap 11.55 kV Compute
pu on Common MVA Base Transformer losses Winding Configuration
Pos. Seq. Impedance 0.05616 pu Noload W Y Y A Pos. Seq. X to R Ratio 20 Copper 0 W Primary C <td< td=""></td<>
Zero Seq. Impedance 0.05616 pu loss 'Seconday C C C Zero Seq. X to R Ratio 20 Update X/R ratio

R and X data given in Transformer details table. Impedance Z = $\sqrt{R^2 + X^2}$

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

2	3	4	5
14-11	5-1	2-18	3-22
475.00	704.63	156.25	237.50
0.01252	0.11112	0.06977	0.05616
19.8413	19.988	20	20.0036
400	220	11	11
220	11	220	220
1	1	1	1
7	13	7	7
360	198	10.45	10.45
420	231	12.1	12.1
	2 14-11 475.00 0.01252 19.8413 400 220 1 7 360 420	$\begin{array}{c cccc} 2 & 3 \\ \hline 14-11 & 5-1 \\ 475.00 & 704.63 \\ \hline 0.01252 & 0.11112 \\ \hline 19.8413 & 19.988 \\ \hline 400 & 220 \\ \hline 220 & 11 \\ \hline 1 & 1 \\ \hline 7 & 13 \\ \hline 360 & 198 \\ \hline 420 & 231 \\ \end{array}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

Transformer Element details

Select menu option Element -> Series Element -> Two winding Transformer

Two Winding Transformer	Data		
Transformer Number 1 Fetch Transform	er >> Name 2w/T1 Maintenance	Global Change	🗌 7ig7ag Transformer
Soconday Voltop- 400 000 kV DeRated MVA 220 Raing I 250 Mva From Dus Number 4 (Bus4) (11.000 ¥ To Dus Number 15 (Bus15) (400.000 ¥ Control Dus Number 15 (Bus15) (400.000 ¥ Control Dus Number 15 (Bus15) (400.000 ¥ Control Dus Number 15 (Bus15) (400.000 ¥ No. of Units in Parallel 2 2	Manufacturer Ref Number 1 [271] Finn Reveker C Not Exists MVA 50 kA 2.624 To Reveker C Not Exists MVA 50 kA 0.0072 Set Tap Position Compute 5 Nominal Tap Position 30	Unit Petoclon Rolyo Differential Relay Gutton OverCurrent Relay Cost Current Relay Cost Pet Unit in	SUD - Show Breaker
Statue Commission Stat	Phase Shill Angle U deg	Cost [0	Schedule :0
In Service C Uut of Service Existing C	Proposed Year 0		_
Pri Grounding Resistance U ohms	Histounding Heactance U ohms Print	nary Compute	
Sec Grounding Resistance 0 ohms	Sec Grounding Reactance 0 ohms Sec	condary Compute	
Transformer Details Curvivul Bluck.	Browse		

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

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

4.4 Generator Capability Curve

Select menu option Libraries -> Capability Curve



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 TM Shunt Elements TM Generator

Generator Li	brary				
Ref. Number 1		Fetch Generator	Manufactur	er Name GN1	
MVA Rating 99	MW Rating	89	kV Rating 11		Compute X('d,''d,n,0)
		∙pu on Common M\	/A Base		
Armature Resistance (Ra)	0.01	pu Potier Read	stance (Xp)		0.1515 pu
Direct Axis Reactance (Xd)	0.98	pu Direct Axis	Transient Reactan	ce (X'd)	0.2727 pu
Quadrature Axis Reactance	e (Xq) 0.5657 I	pu Quadrature	Axis Transient Re	actance (X'q)	0.2525 pu
Negative Seq. Reactance	(Xn) 0.2727 I	pu Direct Axis	Sub-Transient Rea	ictance (X''d)	0.2121 pu
Zero Seq. Reactance (Xo)	0.2727	pu Quadrature	Axis Sub-Transien	t Reactance (>	("q) 0.2121 pu
Direct Axis Open Circuit Transient Time Constant (T'do)	9	Direct Axis Open C Sub-Transient Tim (T''do)	ìrcuit e Constant	0.045	Inertia in MJ/MVA 4.3164
Quadrature Axis Open Circuit Image: Circuit Ci					
-Winding Connections	Mass Details				Cost Per Unit in
YYA	Mass Number Inertia	2	Ni M.I/MVA Count	ext >>	0
0 0 0	Damping Factor	1	<<	Back	Thermal Curves
:	- Stiffness Co-efficient	50 E	u torque/)elete	Thermal>>

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

MiP-PSCT

How to solve YBR

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 2 Fetch Generat	or >> Name get2AT1 Maintenance	Schedule No 0
Bus No. 1 [Bus1] (11.000 H Units in Parallel 8 GT 0	danufacturer Ref. No 1 [GNT] Library >> Capability Curve No 2 Capability Curve >>	Protection Over Current
Specified Voltage 1.0200 Pu	kV Breaker Rating In MVA 50 In kA 2.624	Relay Unit Protection
De-Rated MVA 99 Scheduled Power 70.4625 MW	Reactive Power - Minimum -71.25 Mvar Reactive Power - Maximum 71.25 Mvar	Cost Per Unit in
Real Power Optimization Data Real Power - Minimum 50 Real Power - Maximum 35	Cost Co-efficient C0 6390 //W Cost Co-efficient C1 35007 //W Cost Co-efficient C2 1617	Select C Utility Grid C Generator
Status In Service C Dut of Service	Commission Status © Existing C Proposed Year	
Neutral Grounding Resistance 0 Neutral Grounding Reactance 0 Grounding Through Transformer Calcutered	ohms Participation Factor (%) 0 ohms Bias Setting 0 Jate Droop (%) 5	
Model Type C Infinite Bus Modelling (X'd.) C Transient Modelling (X'd.&X'q.) C Sub Transient Modelling (X''d.&X''q.) C Label Channel	AVR Ref No. 1 [AVR1] Type 1 AVR Library >> AVR FPB Name Turbine Gov Ref No 2 Type 2 TG Library >>	Edit Files AVR 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 Fetch Load >> Name LD1 Maintenance Schedule No 0 Image: Comparison of the second sec	Relay 📃
Bus Number 11 [Bus11] (220.000 Image: Compute station 0 Real Power in MW 35 Image: Compute station MVAR 0 Reactive Power in MVAR 15.000003 Compute station MVAR 0 Power Factor 01913145 Load Details Load Characteristics No. 2 V	Cost Per Unit in Cost library
Load Type C Linea C Non Linear Motor Load Percentage 0 Silobal Change	Ref No.
Status Breaker Rating In Service Out of Service Existing Proposed Year In MVA In AA 0.131	
Fpb Path Browse	

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".

Load Flow Analysis	×	ad Flow Studies			
		Contingency Rankin	g Analysis	Availability Transfer Capability	SubStationWise LFA
Case 1	Study Info	C Gauss - Siedel	Method A	cceleration Factor 1.6	Uptimal Load Flow
Execute After Input File Creation	Delete	Rewton Raphs Fast Decouple	on Method d LoadFlow	DC Load Flow	
Only Input File Creation Execute with old Input File	Execute	Load Flow Type Slack Bus Co Frequency De Optimal Load	ncept LFA pendent LFA Flow Analysis	Frequency Dependent I O Flat Tie Line Contre O Flat Frequency Cor O Flat Tie-line Freque	
Results		C Contingency A	Analysis & Economic Dispatch	h Optimization Options-	🔲 Q - Optimization
Network Report View Bus.	. Graph	Simulation Feed Current Sim Substation wise L	ulation 🗖 A FA	ATC Ratings	ating I O Rating II
Close		P - Tolerance 0.00 Q - Tolerance 0.00 Slack Bus 0 (M	01 01 ax Generation Bus)	Number of Iterations Q - Check Limit J Load Model Voltage	15 0 0.75
		Print Options Data	and Results	Tap Mode	Use Set Tap
		Summary Sh	ow Summary After E:	ixecution Reduction	n Factor 1
				OK	Cancel Apply

Report

Load flow results are given below. BUS VOLTAGES AND POWERS

NODE	FROM NAME	V-MAG P.U.	ANGLE	MW GEN	MVAR GEN	MV LOAI	MVAR	MVAR			
 1 2	BUS1 BUS2	1.0200	0.00	563.711	19.574	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 7	BUS6	1.0050	10.41	0.000	0.000	146 626	E 30.104	30.000			
/ 0	BUS /	0.90//	-19.05	0.000	0.000	140.030	0 000	30.000			
o Q	BUSO	0.9730	-14.54	0.000	0.000	29 453	0.000	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			
NUMBI	ER OF BUSES	S EXCEEI	DING MIN	IMUM VOLTAC	GE LIMIT	(@ mark)	: 1				
NUMBI	ER OF BUSES	S EXCEEI	DING MAX	IMUM VOLTAC	GE LIMIT	(# mark)	: 0				
NUMBI	ER OF GENER	RATORS I	EXCEEDIN	G MINIMUM () LIMIT (< mark)	: 0				
NUMBI	ER OF GENER	RATORS I	EXCEEDIN	G MAXIMUM 🤇) LIMIT (> mark)	: 0				
	TEODMED EL			DMED LOCCES	 7						
IRANG	FORMER FLC	JWS AND	INANSFO	KMER LOSSES	5						
SLNO	CS FROM FI	ROM	το το		FORWA	ARD	LOSS		00		
	NODE NA	AME	NODE NA	ME	MW	MVAR	MW	MVAR LOAI	DING		
1	2 4	BUS4	15	BUS15 38	0.000 3	35.241	1.9630 39	.2592	74.8\$		
2	1 14	BUS14	11	BUS11 371	L.856 5	53.910	0.9237 18	.3278	76.6#		
3	8 5	BUS5	1	BUS1 -56	1.589 2	22.848	2.1224 42	.4223	69.8\$		
4	1 2	BUS2	18	BUS18 12	5.000 2	22.496	0.5402 10	.8041	75.5#		
5	1 3	BUS3	22	BUS22 19	0.000 3	39.568	1.0151 20	.3063	76.1#		
אדואסיד הביאאקער גראקער איז											
INUMBER OF TRANSFORMERS LOADED BEYOND 125% : U											
W INON	@ NUMBER OF TRANSFORMERS LOADED BETWEEN 100% AND 125% : 0										

MiP-PSCT

How to solve YBR

#	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

SI	LNO	CS	FROM	I FROM		то	TO			FORW	IARDI	LOSS			% NOI	ЭE
			NAME LOAI	I DING	NO	DE	NAME			MW	Ν	IVAR	М	M	MVAR	
	 6	 1		 5 В	 US15	 14	BUS	 514	 378.	 034		.006	6.175	 5 -5	7.8906	93.5#
	7	1	7	,	BUS7	11	BUS	S11	-61.	752	0.	.900	1.024	2 -1	4.2262	55.3\$
	8	1	12	2 В	US12	13	BUS	S13	-29.	102	-9	.699	0.125	3 –	9.6166	26.7^
	9	2	13	B B	US13	11	BUS	s11 -	153.	297	-28	.633	0.812	8 –	5.8370	67.4\$
	10	1	13	B B	US13	16	BU	S16	18.	655	-4	.839	0.022	1 -	4.4042	16.7&
	11	1	16	5 B	US16	11	BU	s11 -	118.	921	-13	.271	0.760	4 –	0.0999	103.1@
	12	1	16	5 В	US16	17	BUS	s17	58.	415	22	. 899	0.106	3 –	1.3940	54.9\$
	13	4	5	5	BUS5	6	B	US6	477.	840	-49	.588	9.960	9 -1	1.9946	98.5#
	14	1	6	5	BUS6	7	B	US7	87.	746	-6	.062	2.867	6 -1	6.0514	72.9\$
	15	1	6	5	BUS6	13	BUS	S13	41.	800	-12	.309	0.941	7 - 3	7.4225	41.5^
	16	3	e	5	BUS6	16	BUS	S16	148.	596	-26	.153	3.503	2 - 9	4.7018	46.2^
	17	2	6	5	BUS6	8	B	US8	119.	493	6.	806	1.846	7 - 3	1.6140	52.9\$
	18	2	8	3	BUS8	9	B	US9	29.	486	-1	.617	0.033	8 -1	1.4338	13.3&
	19	2	8	3	BUS8	10	BUS	S10	88.	160	40	.038	0.340	7 –	8.7495	43.4^
	20	2	18	B B	US18	19	BUS	S19	124.	460	11.	.692	0.848	3 -1	3.7340	53.0\$
	21	2	19) B	US19	5	B	US5	-27.	772	-53	.132	0.232	1 -4	1.6860	25.2^
	22	2	19) B	US19	20	BUS	S20	22.	088	-20	.899	0.056	б -3	7.1160	12.8&
	23	1	20) B	US20	24	BUS	524	38.	691	3.	175	0.328	1 -1	4.4170	36.2^
	24	1	24	E B	US24	5	B	US5	-54.	831	-31	.457	0.914	9 -1	6.1647	54.2\$
	25	1	22	2 В	US22	23	BUS	523	49.	205	5.	.164	1.033	9 - 2	3.7399	49.4^
	26	2	22	2 B	US22	20	BUS	S20	67.	132	-32	.016	0.785	5 -5	3.7550	31.0^
	27	1	22	2 B	US22 	21	BUS	521 	72.	648 	46	.114	0.249	4 -	1.4903	73.1\$
!	NUN	1BEF	OF	LINES	LOADED	BI	EYOND	125%			:	0				
@	NUN	1BEF	l OF	LINES	LOADED	B	ETWEEN	100%	AND	125%	:	1				
#	NUN	1BEF	l OF	LINES	LOADED	B.	ETWEEN	75%	AND	100%	:	2				
\$	NUN	4BEF	l OF	LINES	LOADED	B	ETWEEN	50%	AND	75%	:	8				
^	NUN	1BEF	l OF	LINES	LOADED	B	ETWEEN	25%	AND	50%	:	8				
&	NUN	4BEF	l OF	LINES	LOADED	BI	ETWEEN	1%	AND	25%	: :	3				
*	NUN	4BEF	l OF	LINES	LOADED	BI	STWEEN	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

Network Reduction	×
Type 1 here	
Case 1	Study Info
 Execute After Input File Creation 	Delete
Only Input File Creation Execute with old Input File	Execute
- Results	
Network Report View	Bus Graph
Close]

Study Information

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

NETWORK REDUCTIOIN	×
C Zone Reduction	Bus Reduction
Zone Number(s) Generator Selected Zones to be reduced and Generators	Bus Number(s) to be retained
1 getlAT4[4] 2 get2AT1[1] Select only generator buses	1 BUS1* 2 BUS2* 3 BUS3* 4 BUS4* 5 BUS5 6 BUS5 6 BUS5 8 BUS6 *
Give Network name	
Z Bus Print Option (Y/N)	
Print Option Data and Results Bus Names Reduced Network Name CASE 1 Reduction	: marked with " are generator buses. es must be selected if it is Bus
Multiplication Factor Ref. 1	
OK Cancel	

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 _____ 응응 : 24 ACTUAL NUMBER OF BUSES : TOTAL 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:0NUMBER OF SHUNT CAPACITORSNUMBER OF SHUNT IMPEDANCES:0NUMBER OF GENERATORS : 0 : 4 : 14 NUMBER OF LOADS NUMBER OF FILTERS : 0 : 0 NUMBER OF HVDC CONVERTORS _____ NUMBER OF ZONES : 2 : 3 <u>,</u> : 100.000 -0.000 PRINT OPTION : 3 (BOTH DATA AND RESULTS PRINT) BASE MVA 50.000 NOMINAL SYSTEM FREQUENCY: PREFAULT VOLTAGE OPTION : 1 (READ FROM THE FILE) ZONE NUMBER RETAINED : 0 ZBUS PRINT OPTION : 0

YBUS RI	EDUCT	ION	OPTION	: 1 (NET	WORK RED	UCTION)			
4 1	2		3 4						
CIRCUIT CIRCUIT TRANSFO TRANSFO	G BRE G BRE ORMER ORMER	AKER AKER R/X ZER	RESISTAN REACTANC RATIO O SEQUENC	ICE (PU) CE (PU) CE IMPEDAN	NCE MULT H	FACTOR	: 0.0 : 0.0 : 0.0 : 0.9	000000 000100 050000 000000	
NUMBER TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI TRANSMI GENERAT GENERAT GENERAT GENERAT LOAD LOAD SERIES SHUNT	OF T ISSIC I	RANS N LI N LI N LI N LI N LI N LI N LI N LI	MISSION V NE VOLTAG INE ZERO INE ZERO INE ZERO INE ZERO INE ZERO INE ZERO INE ZERO INE ZERO INE ZERO SEQUENCE SEQUENCE SEQUENCE QUENCE I ZERO SEQ ZERO SEQ	YOLTAGE LE YE - KV SEQUENCH SEQUENCH SEQUENCH SEQUENCH SEQUENCH SEQUENCH SEQUENCH SEQUENCH SEQUENCH SEQUENCE REA CE RESISY REACTANC CE IMPEDANCE QUENCE IMPH JENCE IMPH	VELS CRES. M CRES.	ULT. FACT ULT. FACT ULT. FACT ULT. FACT ULT. FACT ULT. FACT ULT. FACT . FACTOR MULT. FACT FACTOR FACTOR FACTOR FACTOR MULT. FACT MULT. FACT FACTOR	: 3 : 11.0 COR : 0.0 COR : 0.0 COR : 0.0 COR : 220.0 COR : 2.5 COR : 0.0 COR : 0	000000 000000 000000 000000 000000 00000	
BUS DAI NODE SI	TA TAT Z	ONE	BUS-KV	NAME	VMAG-PU	VANG-DEG PLOAD-MW	PGEN-MW QLOAD-MR	QGEN-MR QCOMP-MR	
1	1	1	11.000	BUS1	0.0000	0.000	0.000	0.000	
2	1	2	11.000	BUS2	0.0000	0.000	0.000	0.000	
3	1	2	11.000	BUS3	0.0000	0.000	0.000	0.000	
4	1	1	11.000	BUS4	0.0000	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 0.000	
б	1	1	220.000	BUS6	0.0000	0.000	0.000	0.000 0.000	

MiP-F	PSCT										How t	o solve YBI	R
													-
7	1	1	220.000	BUS	70.	0000	0.	000	0.	000	0.	000	
							0	.000	0.	000	0.	000	
8	1	1	220.000	BUS	80.	0000	0.	.000	0.	000	Ο.	000	
							0	.000	0.	000	0.	000	
9	1	1	220.000	BUS	90.	0000	0.	.000	0.	000	0.	000	
							0	.000	0.	000	0.	000	
10	1	1	220.000	BUS1	0 0.	0000	0.	.000	0.	000	0.	000	
	1	-		DITAL	1 0		0	.000	0.	000	0.	000	
ΤT	T	T	220.000	BUSI.	1 0.	0000	0.	.000	0.	000	0.	000	
10	1	1	220 000	1 סווס	2 0	0000	0	000	0.	000	0.	000	
12	Ŧ	T	220.000	BUSI.	2 0.	0000	0	000	0.	000	0.	000	
13	1	1	220.000	BUS1	3 0.	0000	0	000	0.	000	0.	000	
10	-	-	2201000	2001			0	.000	0.	000	0.	000	
14	1	1	400.000	BUS14	4 0.	0000	0	000	0.	000	0.	000	
							0	.000	0.	000	0.	000	
15	1	1	400.000	BUS1	50.	0000	0.	.000	0.	000	Ο.	000	
							0	.000	0.	000	0.	000	
16	1	1	220.000	BUS1	60.	0000	0	.000	0.	000	0.	000	
	_						0	.000	0.	000	0.	000	
17	1	1	220.000	BUS1	7 0.	0000	0.	.000	0.	000	0.	000	
1.0	1	2	220 000	DUCI	0	0000	0	.000	0.	000	0.	000	
18	T	2	220.000	BUSI	8 0.	0000	0.	000	0.	000	0.	000	
19	1	2	220 000	BIIS1	9 0	0000	0	000	0.	000	0.	000	
10	-	2	220.000	DODI		0000	0	.000	0.	000	0.	000	
20	1	2	220.000	BUS2	0 0.	0000	0	000	0.	000	0.	000	
							0	.000	0.	000	0.	000	
21	1	2	220.000	BUS2	1 0.	0000	0	.000	0.	000	0.	000	
							0	.000	0.	000	0.	000	
22	1	2	220.000	BUS22	2 0.	0000	0.	.000	0.	000	0.	000	
	_	-					0	.000	0.	000	0.	000	
23	1	2	220.000	BUS2	3 0.	0000	0.	.000	0.	000	0.	000	
24	1	2	220 000	DUCO	1 0	0000	0	.000	0.	000	0.	000	
24	T	2	220.000	BUSZ.	4 0.	0000	0	000	0.	000	0.	000	
TRANS	SFORM	er da'	ГА										
STAT	CKTS	FROM	FROM	TO TO			PC	SITI	VE	D / D		ZERO	
		NODE	NAME	NODE NAI	ME	R (P.U)	X(P	.0.)	R(P.	U.) X	(P.U.)	
							TAP	P	HASE	FВ-	MVA	1B-MVA	
3	2	4	BUS4	15	BUS15	0.0	0140	0.0	2804	0.0	0140	0.02804	
5	2	1	2001		20010	1.0	00000	0.0	.000	5.0	50	5.02001	S
3	1	14	BUS14	11	BUS11	0.0	0063	0.0	1250	0.0	0063	0.01250	1
						1.0	00000	0	.000		50	50	G
3	8	5	BUS5	1	BUS1	0.0	0069	0.0	1387	0.0	0069	0.01387	
						1.0	00000	0	.000		50	50	G
3	1	2	BUS2	18	BUS18	0.0	0348	0.0	6968	0.0	0348	0.06968	
						1.0	00000	0	.000		50	50	G

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MiP-PSC	СТ							How t	o solve YBR	
3	1	3	BUS3	22	BUS22	0.00280 1.00000	0.05609 0.000	0.00280 50	0.05609 50 G	G

TRANSMISSION LINE DATA

STAT	CKTS	FROM	FROM	TO	то					
		NODE	NAME	NODE	NAME	RP(P.U)	XP(P.U)	BP/2(PU)		
						RZ(P.U)	XZ(P.U)	BZ/2(PU)	FC-MVA	TC-MVA
3	T	15	BOSI2	14	BUSI4	0.00430	0.04770	0.63700	50	5.0
2	1	-	DUGT	1 1	DIIG11	0.00860	0.09540	0.50000	50	50
3	T	/	BOS /	ΤT	BOSIT	0.02444	0.12226	0.102/2	го	F 0
2	1	10	DIIG1 0	1 2	DI1010	0.07332	0.36677	0.07190	50	50
3	T	12	BUSIZ	13	BOSI3	0.01321	0.06608	0.05552	го	F 0
2	2	10	011012	11	DII011	0.03963	0.19825	0.03887	50	50
3	Z	13	BOSI3	ΤT	BUSII	0.00314	0.01570	0.052/5	EO	FO
2	1	10	01012	16	DUCIE	0.00941	0.04/14	0.03692	50	50
5	T	13	BUSIS	TO	BUSIO	0.00576	0.02091	0.02429	۶O	FO
2	1	16	DITC16	11	DI1011	0.01/34	0.03074	0.01/00	50	50
2	Т	10	POSTO	ΤT	BUSIT	0.00495	0.02478	0.02082	ΕO	FO
2	1	16	DUCIE	17	DII017	0.01466	0.07434	0.01457	50	50
5	T	10	BUSIO	1/	BUSI/	0.00248	0.01239	0.01041	EO	FO
2	4	F	DUCE	E	DUCK	0.00743	0.03717	0.00729	50	50
5	4	5	B055	0	BUSO	0.00450	0.02251	0.30200	۶O	FO
2	1	6	DUCK	7	DIICZ	0.01350	0.00755	0.21180	50	50
3	T	0	BUS6	/	BO2 /	0.03/10	0.18580	0.15010	EO	FO
2	1	6	DUCK	1 2	01012	0.11147	0.55759	0.10930	50	50
5	T	0	BUSO	13	BUSIS	0.05169	0.23650	0.21723	EO	FO
2	2	6	DUCK	16	DUCIE	0.15500	0.77567	0.15210	50	50
2	3	0	BUSU	TO	BUSIO	0.01530	0.07055	0.37882	۶O	۶O
2	2	6	DUCK	0	DIICO	0.04391	0.22904	0.40530	50	50
2	2	0	BUSU	0	B020	0.01239	0.00195	0.20822	۶O	۶O
2	2	0	סוופס	٥	DIICO	0.03710	0.10500	0.14572	50	50
2	2	0	B030	9	B039	0.00303	0.01817	0.00107	۶O	۶O
2	2	0	סוופס	10	DITC10	0.01090	0.05452	0.04270	50	50
5	2	0	B050	10	BOSTO	0.00330	0.01052	0.03886	50	50
3	2	1.8	DIIG18	10	DIIG10	0.00991	0.04950	0.03000	50	50
5	2	10	DODIO	19	BOSTA	0.00557	0.02005	0.09022	50	50
3	2	19	BIIG10	5	BIICE	0.01010	0.06319	0.00310	50	50
J	2	19	BOSTA	J	B055	0.01203	0.00519	0.21257	50	50
3	2	19	BIIG19	20	BIIS20	0.03790	0.10950	0.14000	50	50
5	2	17	DODIJ	20	00020	0.01131	0.05050	0.13310	50	50
3	1	20		24	DIIC 24	0.03391	0.10973	0.13310	50	50
J	Ŧ	20	D0520	21	D0524	0.01902	0.09913	0.05320	50	50
З	1	24	BIIG24	5	BUSS	0.03313	0.20730	0.00002	50	50
5	1	21	00021	5	0000	0.02191	0.12175	0.10100	50	50
٦	1	22	BUS22	23	BUS23	0.03633	0.18173	0.15269	50	50
5	-		20022	23	20023	0 10899	0 54520	0 10690	50	50
٦	2	22	BUS22	20	BUS20	0.01734	0.08674	0.29149	50	50
5	2		20022	20	20020			5.27217		

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MiP-I	PSCT									ŀ	low to s	olve YBR	
3	1	L 2	2 В	US22	21	BUS21	0.0520 0.0033	2 0 0 0	.26021 .01652	0.204 0.013	100 388	50	50
							0.0099	1 0	.04956	0.009	72	50	50
GENE	RATOF	R DAT	 A										
FROM NODE	FRON NAME	4 C 	R(P 	POSI .U)	ITIVE X(P.U.	N .) R(P.U	IEGATIVE J.) X(P	.U.)	R(P.U	ZERO J.) X((P.U.)	CB-MVA	-
4	BUS	54 0	.00050	0.0)2625	0.00050	0.0262	50	.00050	0.026	25	50	
1 2 3	BUS	31 0 BUS2 BUS3	.00125 0.00 0.00	0.0 100 050	03409 0.0747 0.0373	0.00125 70 0.001 35 0.000	0.0340 .00 0.0 950 0.0	9 0 7480 3740	.00125 0.001 0.000	0.034 .00 0.)50 0.	09 07480 03740	50 50 50)
DATA													LOAD
NODE	NAME	C											
11 17 7 12 13 6 9 10 20 23 21 16 19 24 Numb	F F F F F F F F F F F F F F F F F F F	3US11 3US17 BUS7 3US12 3US13 BUS6 BUS9 3US10 3US20 3US20 3US21 3US26 3US21 3US16 3US19 3US24 5 red	uced b	uses	: 4								
Redu 1	ced k	ous a 2	rray: 3	4									
POSI	TIVE	SEQU	ENCE A	DMIT	FANCE N	MATRIX EI	LEMENTS	FOR '	THE GIV	VEN SYS	STEM		_
ROW	NO CO	DLUMN	NO	F	REAL	IMAGINARY	 [_						
	1 1 1 2		1 2 3 4 1	1.5 -0.5 -0.4 -0.5	7674 5642 8112 4116 5642	-9.97533 5.07156 3.10001 5.82485 5.07156	3 5 5 5						
	2		2	0.8	0100	-6.49955	5						_

MiP-PSC	Т			How to solve YBR
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
SEQUENO	CE ADMITTAN	NCE MATRIX I	ELEMENTS FOR	THE GIVEN SYSTEM
ROW NO	COLUMN NO	REAL	IMAGINARY	
1	1	1.57674	-9.97533	
1	2	-0 55642	5 07156	
1	2	-0.33042	2 10001	
1	4	-0.48112	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
SEQUENC	CE ADMITTAN	NCE MATRIX I	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	

How to solve YBR

								11011	0000000 I BIG	
	4	1	-0.00000	-0.	00000					i i
	4	2	-0.00000	-0.	00000					
	4	3	-0.00000	-0.	00000					
	4	4	0.00000	0.	00000					
										·
RETAI	NED Z	ONE :	0							
NUMBE	ROF	SERIES EL	EMENTS IN	I THE	REDUCED 2	ZONES :	6			
SLNO	FROM	NAME	ТО	NAME	RP	XP	В	P/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
б	3	BUS3	4	BUS4	0.717003	3.299303	0.0	0.00000	9999.000	0.0
NUMBE	R OF :	SHUNT ELE	MENTS IN	THE R	EDUCED Z	ONES :	4			· _
SHUNT	CONN	ECTIONS I	N (G+JB)	FORMA	T – PU					
SLNO	FROM	NAME	GP	В	P (GZ	ΒZ			
			0 00106	4 02	100 1 2		0 5 1 5			
2	2	BUSI BUSI	-0.00198	4.02	137 0 0	3259 0 6	9515			
2	2	B052	-0.00550	0.72	137 0.0.	3239 0.0.	5550			
3	3	BUS3 0	.00497 ().9849	1 0.017	88 0.7728	80			
4	4	BUS4 0	09307 3	2059	3 _0 000		0.0			

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

Network Reduction	×
Туре 2	Click here
Case 2	Study Info
Execute After Input File Creation	Delete
Only Input File Creation	
C Execute with old Input File	Execute
Results	
Network Report View Bus	s Graph
Close	

Study Information

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

NETWORK REDUCTIOIN	×
C Zone Reduction	Bus Reduction
Zone Number(s) Generator Selected Zones to be reduced and Generators	Bus Number(s) to be retained
1 get1AT4[4] 2 get2AT1[1] Select buses here Give	11 BUS11 12 BUS12 13 BUS13 14 BUS14 15 BUS15 16 BUS16 17 BUS17 18 BUS18
Z Bus Print Option (Y/N) Note: Print Option Data and Results Sector Sec	s marked with * are generator buses. es must be selected if it is Bus
Multiplication Factor Ref. 1 Cancel	

Executing and viewing the report:

Network Reduction	×
Case 2	Study Info
C Execute After Input File Creation	Delete
C Only Input File Creation	Execute .
	Click here
Hesuits	
Network Report View Bo	is Graph
After execution, click here to view report	

Network Reduction Report for case 2

NETWORK REDUCTION

CASE NO : 12 CONTINGENCY : 0 SCHEDULE NO : (CONTINGENCY NAME : Base Case)
%% TOTAL NUMBER OF BUSES : 24 ACTUAL NUMBER OF 2 WIND. TRANSFORMERS : 5 NUMBER OF	MBER OF BUSES : 24 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 IMPEDANCES : 0 NUMBER OF LOADS : 14 NUMBER OF FILTERS : 0	SHUNT CAPACITORS : 0 GENERATORS : 4
NUMBER OF HVDC CONVERTORS : 0	
NUMBER OF ZONES:2PRINT OPTION:3 (BOTH DATA AND RESULTSBASE MVA:100.000NOMINAL SYSTEM FREQUENCY:50.000PREFAULT VOLTAGE OPTION:1 (READ FROM THE FILE)ZONE NUMBER RETAINED:0ZBUS PRINT OPTION:0YBUS REDUCTION OPTION:1 (NETWORK REDUCTION)	S PRINT)
17 1 2 3 4 5 6 7 8 11 12 13 14 15 16 17	9 10
CIRCUIT BREAKER RESISTANCE (PU) CIRCUIT BREAKER REACTANCE (PU) TRANSFORMER R/X RATIO TRANSFORMER ZERO SEQUENCE IMPEDANCE MULT FACTOR	: 0.000000 : 0.000100 : 0.050000 : 0.900000
NUMBER OF TRANSMISSION VOLTAGE LEVELS TRANSMISSION LINE VOLTAGE - KV TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR TRANSMISSION LINE VOLTAGE - KV TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR	: 3 : 11.000000 : 0.000000 : 0.000000 : 220.000000 : 2.500000
TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR	: 2.500000

TRANSMISSION LINE ZERO SEQUENCE ADM. MULT. FACTOR : 0.025000 : 400.000000 TRANSMISSION LINE VOLTAGE - KV 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 11 12 13 14 15 16 17 7 8 9 10 _____ _____ _____ RETAINED ZONE : 0 NUMBER OF SERIES ELEMENTS IN THE REDUCED ZONES : 3 SERIES CONNECTIONS NAME RP XP BP/2 RZ XZ BZ/2 SLNO FROM NAME TO ____ ____ BUS3 0.052959 0.698685 0.0 0.144805 1.117180 0.0 1
 2
 BUS2
 3
 BUS3
 0.052959
 0.698685
 0.0
 0.144805
 1.117180
 0.0

 2
 BUS2
 5
 BUS5
 0.021307
 0.167338
 0.0
 0.053638
 0.341475
 0.0
 2 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 GP SLNO FROM NAME 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.

		<u>×</u>
Case 3		Study Info
Execute Aft	er Input File Creation	Delete
C Execute wit	ile Creation h old Input File	Execute
Results		
Maturali	Report View Bu	is Graph

Select menu option Solve ->Network Reduction

MiP-PSCT

Study Information

Following study information screen will open.

	×	
© Zone Reduction	O Bus Reduction	
Zone Number(s) Generator Selected Zones to be reduced and Generators	Bus Number(s) to be retained	
1 1 get1AT4(4) 2 get2AT1(1) 2Zone > 4 get4AT3	1 BUS1* 2 BUS2* 3 BUS3* 4 BUS4* 5 BUS5 6 BUS6 7 BUS6 7 BUS7 8 BUS8 ▼	
Z Bus Print Option (Y/N)		
Print Option Data and Results Print Option Data and Results Print Option Bus Name Reduced Network Name CASE 3 Reduction	s marked with * are generator buses. es must be selected if it is Bus	
Multiplication Factor Ref. 1		
OK		

Executing and Viewing the Report

Case 3 Study Info	
Execute After Input File Creation Delete	
C Only Input File Creation	
C Execute with old Input File	
Results	
Network Report View Bus Graph	
After execution click here to view report	/

Network Reduction Report for Case 3:

NETWORK REDUCTION CASE NO : 13 CONTINGENCY : 0 SCHEDULE NO : 0 CONTINGENCY NAME : Base Case

_____ 응응 : 24 TOTAL NUMBER OF BUSES 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:0NUMBER OF SHUNT CAPACITORSNUMBER OF SHUNT IMPEDANCES:0NUMBER OF GENERATORS : 0 : 4 : NUMBER OF LOADS 14 NUMBER OF FILTERS : 0 NUMBER OF HVDC CONVERTORS : 0 _____ : 2 NUMBER OF ZONES PRINT OPTION : 3 (BOTH DATA AND RESULTS PRINT) : 100.000 BASE MVA 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 _____ _____ : 0.000000 CIRCUIT BREAKER RESISTANCE (PU) 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 : 220.000000 TRANSMISSION LINE VOLTAGE - KV TRANSMISSION LINE ZERO SEQUENCE RES. MULT. FACTOR : 2.500000 TRANSMISSION LINE ZERO SEQUENCE REA. MULT. FACTOR : 2.500000
TRANS TRANS TRANS TRANS GENEI GENEI GENEI LOAD LOAD SERII SHUN	SMISSI SMISSI SMISSI SMISSI RATOR RATOR RATOR RATOR RATOR RATOR CES REL F REL	ION L. ION L. ION L. ION L. ION L. NEGA NEGA ZERO ZERO NEGA ZERO ACTOR	INE ZERO S INE VOLTAG INE ZERO S INE ZERO S INE ZERO S TIVE SEQUI SEQUENCE SEQUENCE SEQUENCE ZERO SEQUENCE ZERO SEQUENCE	SEQUENCE . GE - KV SEQUENCE . SEQUENCE . ENCE RESI ENCE REAC RESISTAN REACTANC ENCE IMPE IMPEDANC: UENCE IMP UENCE IMP	ADM. MULT RES. MULT REA. MULT STANCE MU STANCE MU CE MULT. F DANCE MU E MULT. F EDANCE MU EDANCE MU	FACTOR FACTOR FACTOR FACTOR LT. FACTOF FACTOR ACTOR LT. FACTOF FACTOR LT. FACTOF LT. FACTOF	: 0. : 400. : 2. : 2. : 0. 2 : 0.	025000 000000 500000 025000 175000 037500 037500 810000 600000 600000 525000	
BUS I	DATA								
NODE	STAT	ZONE	BUS-KV	NAME	VMAG-PU	VANG-DEG PLOAD-MW	PGEN-MW QLOAD-MR	QGEN-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	
•	-	-		51100	0 0 0 0 0 0	0.000	0.000	0.000	
9	Ţ	Ţ	220.000	BOSA	0.9737	-14.852 29.450	9.820	0.000	
10	1	1	220.000	BUS10	0.9650	-15.333	0.000	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	

MiP-P	SCT											How	to solve Y	BR	
1.0	-	1			7016	0.0		0.	.000	0	.000	0	.000		
16	T	T	220.000	B	JSI6	0.9	638	-16	.860	0	.000	0	.000		
1.0	-	-			-01 -	0.0		224	.240	58	.500	0	.000		
17	Ţ	1	220.000	BI	JSI7	0.9	1593	-17	.271 .310	0 24	.300	0	.000		
18	1	2	220.000	BI	JS18	1.0	039	-3	.226	0	.000	0	.000		
10	1	2	220 000	זס	1010	0 0	0000	0. 5	.000	0	.000	0	.000		
19	Ŧ	2	220.000	ы	1919	0.5	922	129	.290	99	.460	0	.000		
20	1	2	220.000	BI	JS20	0.9	910	-5	.827	0	.000	0	.000		
21	1	2	220.000	BI	IS21	0.9	882	49 - 3	.690	34 0	.780	0	.000		
21	-	2	220.000	20	0011	0.9	002	72	.400	47	.600	0	.000		
22	1	2	220.000	BI	JS22	0.9	984	-2	.423	0	.000	0	.000		
23	1	2	220.000	BI	JS23	0.9	470	-7	.000	0	.000	0	.000		
								48	.170	28	.900	0	.000		
24	1	2	220.000	BI	JS24	0.9	726	-7	.973	0	.000	0	.000		
										49			.000		-
TRANS	SFORM	ER DA	ГА												
STAT	CKTS	FROM	FROM	то	то			PC	SIT	IVE					
				ZERO	NODE	NAME	NC	DE NA	AME						
				R(P.U	J) X(P.U.) R(P.U.)	Х(P.U.)		10773			
										PHASE	F.B.	-MVA			
3	2	4	BUS4	15	BU	IS15	0.0	0140	0.	02804	0.0	00140	0.0280	04	
З	1	14	BIIG14	11	BI	1911	1.0	0000	0	0.000	0 1	50 10063	50 0 012	50 50	D
5	1		DODII		DC	DII	1.0	0000	0.	0.000	0.	50	50	G	G
3	8	5	BUS5	1	E	SUS1	0.0	0069	0.	01387	0.0	00069	0.0138	37	~
3	1	2	BUS2	18	BU	JS18	0.0	0348	0.	0.000	0.0	50 00348	0.0696	G 58	G
							1.0	0000		0.000		50	50	G	G
3	1	3	BUS3	22	BU	IS22	0.0	0280	0.	05609	0.	00280	0.056	29	a
							1.0	0000		0.000		50	50	G	G
															-
IKANG	1201	LOIN L.	INE DAIA												
STAT	CKTS	FROM	FROM	TO	ТО										
		NODE	NAME	NODE	NAME		RP(P.U)	XP X7	(P.U)	BP/2	2(PU) 2(DII)		тC-	-M172
3	1	15	BUS15	14	BU	JS14	0.0	0430	0.	04770	0.	63700	50		F 0
							0.0	0860	0.	09540	0.	50000	50		50
3	1	7	BUS7	11	BU	/S11	0.0	2444	0.	12226	0.1	10272	EO		E 0
3	1	12	BUS12	13	BU	JS13	0.0	1321	0.	06608	0.0	05552	50		50

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MiP-F	MiP-PSCT How to solve YBR										
						0.03963	0.1982	50.	03887	50	50
3	2	2 13	BUS13	11	BUS11	0.00314	0.01570	0.	05275		
						0.00941	0.04714	1 0.	.03692	50	50
3	1	L 13	BUS13	16	BUS16	0.00578	0.02891	L 0.	.02429		
2			57616		5	0.01734	0.08674	1 0	.01700	50	50
3	1	L 16	BUS16	ΤT	BUSII	0.00495	0.02478	3 0	.02082	50	F 0
2	-	1 1 0	Dugle	1 🗆	DIIG17	0.01486	0.0/43	± 0	.0145/	50	50
3	_	L 10	BUSI6	1/	BOSI/	0.00248	0.01239	9 U 7 O	.01041	EO	ΕO
3		1 5	BIIGE	6	BIICE	0.00743	0.0371	/ 0 I 0	30260	50	50
5		1 5	0000	0	DODO	0.001350	0 0675	3 0	21180	50	50
3	1	6	BUS6	7	BUS7	0.03716	0.18586	5 0	.15616	50	50
-	_					0.11147	0.55759	 	.10930	50	50
3	1	L 6	BUS6	13	BUS13	0.05169	0.25856	5 0	.21723		
						0.15506	0.77567	0.1	L5210	50	50
3	3	36	BUS6	16	BUS16	0.01530	0.07655	5 0	.57882		
						0.04591	0.22964	1 0	.40530	50	50
3	2	2 6	BUS6	8	BUS8	0.01239	0.0619	5 0	.20822		
						0.03716	0.1858	50	.14572	50	50
3	2	2 8	BUS8	9	BUS9	0.00363	0.0181	70	.06107		
						0.01090	0.05452	2 0	.04276	50	50
3	2	2 8	BUS8	10	BUS10	0.00330	0.01652	2 0	.05552		
2		. 10	57761.0	1.0	5	0.00991	0.04950	5 0	.03886	50	50
3	4	2 18	BUSI8	19	BOSI3	0.00537	0.02685		.09022	50	F 0
2		2 10	Duglo	-	DUGE	0.01610	0.0805	± 0	.06316	50	50
3	4	2 19	BOSIA	5	BUSS	0.01263	0.00313		14966	EO	ΕO
3		D 10		20		0.03790	0.10956	3 0	19016	50	50
2	2	2 19	BUSIS	20	BU320	0.01131	0.05050	5 0	13310	50	50
3	1	1 2.0	BUS20	2.4	BUS24	0.01982	0.0991	3 0	.08328	50	50
5	-		20020		20021	0.05945	0.2973	3 0	05832	50	50
3	1	L 24	BUS24	5	BUS5	0.02494	0.1247	3 0	.10480	00	50
						0.07418	0.37420	0 0	.07336	50	50
3	1	L 22	BUS22	23	BUS23	0.03633	0.18173	3 0	.15269		
						0.10899	0.54520	0 0	.10690	50	50
3	2	2 22	BUS22	20	BUS20	0.01734	0.08674	1 0	.29149		
						0.05202	0.26023	L 0	.20400	50	50
3	1	L 22	BUS22	21	BUS21	0.00330	0.01652	2 0	.01388		
						0.00991	0.0495	5 0	.00972	50	50
CENE	 > \\ TT \\ L	 גידיגרו כ									-
GENEI	(AIOI	DAIA									
FROM	FROM	л	POS	TTTVE	ı	VEGATIVE		ZEF	20		
NODE	NAME	2	R(P.U)	X(P.U.)	R(P.I	J.) X(P.I	U.) R(P	.U.)	X(P.U.)	CB-MVA	
4		BUS4	0.00050	0.02625	0.000	0.026	525 0.00	050	0.02625	50	
1		BUS1	0.00125	0.03409	0.001	125 0.034	409 0.00	125	0.03409	50	
2		BUS2	0.00100	0.07470	0.001	100 0.074	480 0.00	100	0.07480	50	
3		BUS3	0.00050	0.03735	0.000	0.03	740 0.00	050	0.03740	50	

MiP-P	SCT							How to solve YBR
LOAD	DATA		J					
NODE	NAME							
17	BUS	517						
7	BU	JS7						
12	BUS	512						
13	BUS	313						
6 9	BI	120						
10	BUS	S10						
20	BUS	520						
23	BUS	323						
21	BUS	321						
16	BUS	S16						
19 24	BUS	519 204						
EXTER	NAL GE	ENERATOR	DATA					
SLNO	BUSNO	NAME	INERT	LA-H-PU				
1	2	BUS2		11.413				
2	3	BUS3		11.413				
Numbe	er of 1	educed b	uses :	4				
Reduc	ed bus	s array :						
26	25	19	24					
RETAI	NED ZO	 NE: 1						
NUMBE	ROFS	SERIES EL	EMENTS	IN THE	REDUCED 2	ZONES:	3	
SERIE	S CONN	NECTIONS						
SLNO	FROMNA	ME	TO	NAME	RP	XP	BP/2	RZ
XZ 	B2	4/2						
1	26	GEN3	19	BUS19	0.005764	0.110167	0.0	0.035423
0.769	343 C	0.0						
2	26	GEN3	24	BUS24	0.032432	0.587300	0.0	0.062020
1.347	783 0	0.0	0.4	5110.04	0 005150	0 100400	0 0	0.000460
3	110 C	BUSIA	24	BUS24	0.035152	0.187472	0.0	0.099468
NUMBE	ROFS	SHUNT ELE	MENTS	IN THE F	REDUCED ZO	ONES :	3	
SHUNI	CONNE	ECTIONS I	N (G+J]	B) FORMA	AT - PU		_	
SLNO	FROM	NAME	GP	BI	G. G.	Z B2	Ζ	
	19	BUS19	1,909	 70 -0.24	1798 2.1	0356 -5.24	444	
2	24	BUS24	1.312	95 -0.34	1366 1.2	0133 -0.48	3369	
3	26	GEN3	0.829	39 -0.61	1373 0.9	1642 -0.43	3791	
	-	an					0.400	
EQUIV	ALENT	GENERATO	R INER	TIA CONS	STANT - PU	J: 22.8	32422	

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EQUIVALENT	GENERATOR	REAL POWE	R	– 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	RESISTANC	E PU	:	0.00000
EQUIVALENT	GENERATOR	REACTANCE	PU	:	0.00001



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ordina	tion)	163
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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 Zpq in pu	Line charging in pu
p-q	Zpq	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 Configuration

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

MIGUT - A Pow	er System Network Edito n Draw Elements Set (- [Gui2.gui] hange Object(s) Configure	PLot Detabase	Salve Tool	Unit Protection	Partial Analysis	Quick Solve	LIX Window
			91 🖷 5	EA		8 8 21	Attr 🚝	
Set/Change	Layer Static	Layer Control Select						
믱						-	SHUNT	
0	Configu	e Database		×			SERIES	
0		stabase Name		-				5~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
0		Convect						•
0		OK Cancel	OearPah Br	xere _				· ~ +
2	L						12114	} AF ⊕
7							HVDC	्राज्या
A	Click he	re to specit	fy the r	name	of		「♥」「単」 [™] FACTS	~[67]
Uf U	the data	base					t	
Ready						< <628>, Y <105:	•	

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 <u>Open button after entering the desired database name</u>. Configure Database dialog will appear with path chosen.

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🚣 Open	X Configure Database X
Look in: J study Name Name Name No items match your search.	Database Name E:\study\Relay.mdb
Select the folder and give database name. and click open	OK Cancel Clear Path Browse
	Click OK To clear the database path name
File name: Relay	
Files of type: Database Files *.mdb Cancel	
Open as read-only	

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

Configuration Information	x
General Information Voltage Levels Electrical & Currency Information Breaker Ratings	
New Database Name	
Network Title	
First Power System Network	
Power System Libraries Standard Relay Libraries	
OK Cancel Apply He	p

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

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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.

Configuration Information	Configuration	Informat	tion						X
General Information Voltage Levels Electrical & Currency Information Breaker Ratings	General Infor	mation Vol	tage Levels	Electrical &	Currency Inf	omation I	Breaker Hatin	gs	
Base MVA	400.000	In MVA	In kA	13.200	in MVA 350	In kA	15.000	In MVA	In kA
Base Frequency 50 Hz	220.000	10000	26.244	11.000	350	18.371	0.233	50	123.899
p u status 🔽	230.000	10000	25,103	10.500	350	19.246	15 000	350	13.472
A Indicates that all the immediances are specified in PI I on	132.000	5000	21.870	10.000	350	20.208	15.000	50	123.899
a common MVA base.	110.000	5000	26.244	6.600	250	21.870	0.233	350	13.472
Else the machine impedances are specified in PU on its own rating and transmission line parameters are	66.000	5000	43.740	3.300	100	17.496	15.000	50	123.899
specfied in actuals, i.e. R ohms/km, X ohms/km and B/2 mho/km.	.33,000	1500	26.244	0.415	50	69.562	0.233	350	13.472
	15 000	350	13.472	0.233	50	123.899	0.233	50	123.899
Currency				Modity	r All Breaker	Ratings			
OK Cancel Apply Help				[OK	G	ncd	<u>A</u> sply	Help

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.

Bus Base Voltage Configuration Base MVA	100.000000		Color
Bus Wdth	Bus Base Voltage Bus Wdth 13.20 kV 4 +	0.0 KV 4 =	Basic colors:
230.0 kV 4	110 KV 4 💼	0.0 kV 4 🗄	
220.0 kV 4 🔅	10.50 kV 4 💼	0.0 kV 4 💽	
132.0 kV 4 🗮	10.0 kV 4 🛨	0.0 kV 4 🛨	
110.0 kV 4	6.60 kV 4 🛨	0.0 kV 4 🛫	
66.0 kV 4 👘	3.30 kV 4 🛬	0.0 kV 4 🐳	
33.0 kV 4 🗄	0.4150 kV 4 🛨	0.0 kV 4 🚊	Define Custom Colors >>
15.0 kV 4 📑	0.230 kV 4 🔺	0.0 kV 4 🗧	OK Cancel
ОК	Cancel	Default	

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 \square , which invokes Network Editor. Follow the same procedure for remaining buses. Following table gives the data for other buses.

Calculation of Xd, Xd', Xd" :

For maximum fault level, Xd = Xd' = Xd'' = 100 / 1000 = 0.1 pu = Xn = X0

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	1	1	1	1	1
weightage					

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.



Line and Cable Library							
Structure Reference							
Number 1 No	ame Line1		Fetch >>				
			Surge Impedance				
Positive Sequence Resistance	0	pu	Z 9999.000000 Ohms				
Positive Sequence Reactance	0.1	pu					
Positive Sequence Susceptance (B/2)	0	pu	V 0.000000 kms/sec				
Zero Sequence Resistance	0	pu	Compute XL, B/2				
Zero Sequence Reactance	0.1	pu					
Zero Sequence Susceptance (B/2)	0	pu					
Thermal Rating	100	MVA Compute					
Line Harmonic Number	0	Harmonic Library >>					
Cost per km	d	Cost Per Unit in	Thermal Curve>>				

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

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

		JIE KCAP		Number Fetch Generator >>	Name Gen1	Schedule No 0
StOmp Leg Great	LipeCond Stee Dart 11 ZXM ZXM ZXM ZXD+2 ZZ.0+2 ZZ.0+2 ZZ.0+2 ZZ.0+2 ZZ.0+2	222921 22392 22392 22392 22392 223921 223921 0K	·····································	Bur No 1 (Burt) (11.000 Y Manufa Units in Paskel G GT Capabil - Specified Voltage 11.000 Pu 111 KV De Rated MiA 100 Scheckled Power (80 MW Read Power (90 MW Read Power - Minimum 0 MW Read Power - Minimum 0 MW	clue Ref. No. 30 Libray>>> Up Curre No. 0 [CAFCUR] Deskier Rating In M1A 250 In NA 19371 Reactive Power - Minimum 0 Mive Reactive Power - Minimum 50 Mive Cost Coefficient C0 0 Cost Coefficient C1 0 Cost Coefficient C2 0 minimin Status	Poleción Over Current I I I I I I I I I I I I I I I I I I I

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 L	ibrary.			
Ref. Number 30		Fetch Generator	Manufacturer Name	Gen30
MVA Bating 100	MW Bating	00	kV Rating 11	Compute X("d,"d,n,0)
[– pu on Common MV/	\ Base	
Armature Resistance (Ra	a) 0	pu Potier React	ance (Xp)	0 pu
Direct Axis Reactance (>	(d) 0.1	PU Direct Axis T	ransient Reactance (K*d)	0.1 PV
Quadrature Axis Reactar	nce (Xq) 0	PU Quadrature A	Axis Transient Reactance	(×"q) 0 pu
Negative Seq. Reactand	æ (Xn) 0.1	pu Direct Axis S	ub-Transient Reactance	(X"d) 0.1 pu
Zero Seq. Reactance 🕅	o) 0.1	pu Quadrature /	Axis Sub-Transient Reacts	ance (X"q) 0 pu
Direct Axis Open Circuit Transient Time Constant (T'do)	0	Direct Axis Open Ci Sub-Transient Time (T"do)	rcuit Constant 0	Inertia in MJ/MVA 3.31
Quadrature Axis Open Circ Transient Time Constant (uit (q Pqo) (q	Quadrature Axis Op Sub-Transient Time	en Circuit Constant (T''qo) 0	Damping Factor
Winding Connections	Mass Details			Cost Per Unit in
	Mass Number	0	Next >>	
ΥYA	Inertia	0 6	IJ/MVA Counter	
C C C	Damping Factor	0	<< Back	Thermal Curves
	Stiffness Co-efficient	0 El	ec. Rad Delete	Thermab>

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.

telay Type	
Display Text	
Relay Types • [DMT Over Current (51)]	C Distance Relay (21)
C IDMT Earth Fault (51N)	C Line Pilot (87P)
C Instantaneous Over Current (50)	C Transformer Differential (87T)
C Instantaneous Earth Fault (50N)	C Restricted Earth Fault (87N)
C Directional IDMT Over Current (67)	C Bus Bar Differential (87B)
C Direction IDMT Earth Fault (67N)	C Partial Bus Bar (87PB)
C Stand By Earth Fault (51G)	C Line/Cable Differential (87L)
C Others (Specify)	
ŌK	Cancel

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

Number 100	Relay Name Relay1 Fetch Relay
Setting Overcurrent Phase C Eath C Phase Fault I. Click here for Phase setting C Short Time Delay C Earth C Earth C Earth Time Time Dial C TDS C Seconds	Current Setting Maximum Minimum Rated 12.5 Amps 2.5 Amps 5 Amps Vext>> Variation Counter 1 1 0 0.01 0.
Relay Characteristics Standard Curves Characteristic Curve Name	1 - 3 Second Relay Relay Thermal Capacity 3Sec 100
Curve Type t = C1/log(M) Constant C1 3	Constant C2 0
Relay Type Not Motor Pro	Hot To Cold Ratie 2. Select t = C1 / log (M) here (3 sec relay)
Niel here to Colect TDC	characteristics)

Enter relay number as 100 and other details as shown below

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



If you have one more setting click $\underline{Y}es$ to add next setting. If not, say $\underline{N}o$ first setting will be saved

Relay rated current = 5 Amps

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

Uniform variation step = 0.25

Enter time dial setting as below

Relay Database	
Number 100 Relay Name Relay100 Fetch Relay	
Setting Time Setting Maximum Minimum Step Phase Earth TMS 0.05 TMS 0.01 TMS Nextain Phase Finase Continuous Image: Conti	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	le l
Relay Number 1	Fetch Relay Relay Name R1	
	Connected To	1
Element Type	Element ID	Location
Three Winding Transformer	1 Line1 [1 to 2]	2 TO SIDE
Transmission Line]	
		l ikoning
- Belay Tune		Database Number
Directional C Non-directional	Load Current 800 A	C p. 100 [Relav1]
Connection Sense	Discrimination Time 0.4 s	Files Database Library 33
A Looking Away from the Pue.	Overload Factor 1	
C Looking Away from the bus	Unbalance Factor	Relay Database Library >>
C Looking I owards the Bus	0.1	Append Relay Code
Phase Setting Options	Earth Setting Options	Global Change - Append Relay Code
Phase	Earth	Current Terrer (current Data (d))
Instantaneous	Instantaneous	Primary Bating 1
TMS Setting Computed	IMS Setting Computed	Primary Bating 2
User Defined Plug Setting 🗍	User Defined Plug Setting 厂	800
User Defined Inst Setting	User Defined Inst Setting	Primary Rating 3 800
		Primary Rating 4 800
Phase Setting	Earth Setting	Secondary Rating 5
Plug Setting 0 A	Plug Setting 0 A	CT Rating Rating 1
TMS 0	TMS	Connection & Charles C. D. H.
Inst factor	Inst factor	CT No.
Inst Time 0 s	Inst Time U S	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 \rightarrow Over Current Relay Co-ordination

Overcurrent Relay Co-ordination Image: Case Image	
OVER CURRENT RELAY CO-ORDINATION Simulation Option Only Co-ordination and Relay Setting (Computed) Fault Type Three Phase to Ground Far Print Options Both data and results printin Fault Impedance Fault Resistance Ground Resistance O Ground Resistance	
 Fault on Bus Find Bus Bus Numbers 1 Bus1 2 Bus2 3 Bus3 4 Bus4 5 Bus5 De Select Buses Voltage Initialization by Flat Start Transient Reactance Xd (1) 	
Voltage Initialization by Load Flow Sub Transient Reactance (X"d) Multiplication Factor Number Image: Consider Consider Motor Contribution Ok 3. Click OK	

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

lay Co-ordination Data		PowerRCD	X
Relay Co-ordin	ation Data	Phase Relay Po Phase relay pair reneration file	airs m\ORCD\vcdpair.phs Open _
Automatic Phase Relay Pair	Automatic Earth Relay Pair	Phase relay pairs exist. Do you want to re rodpair.phs ?	ead from the file © No C Yes
2. For Phase	Phase R Earth	Do you want to generate rcdpair.phs ?	© No O Yes
Display Fails of the provided and the pr	1. Deselect & go for Phase Relay Pairs © Yes © Close in Fault Current	OK Select Relay Relay Pairs [R2]- [R1] [R3]- [R2] [R1] [R4]- [R3] 2. Click	OK
Do you want to consider Motor contribution during simulation ?	C No C Yes	Select >> Select All >>	<c <<="" all<="" remove="" th=""></c>
Compute Discrimination Time		[R2] · [R1] [R3] · [R2]	
Read Relay Settings from the file	© No © Yes	[R4] [R3] 1. Select a	
OK	Cancel		

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 PHAS	E FAUI	JTS									
		RELAY C NAME	LOSE I CURREI	IN FAU IT (Amj	LT ps)	PLUG SI (Amps)	ETTI)	NG RA	TIO	RI	ELAY CAPA	ACITY	ARKS
Limit		Rl	!	52486.	3881		800	.0000	6	55.60	8(100.00) Within
		R2	-	26243.	1941		400	.0000	e	65.60	8(100.00) Within
Limit		R3		L7495.	4627		200	.0000	8	37.47	7	100.00) Within
Limit		5.4	-	2101			100		1.0.1	0.1	-	100.00	- 1
Limit		R4	T	3121.5	5970		100.	0000	13.	1.210	0	100.00	Exceeds
SL. PLUG	T.D.S	RI CLOSE IN	ELAY OP.	From TIME	Bus	To Bu REMOI	us TE	CT OP.	PRIM TIME	СТ	SEC	PLUG	PLUG PRIMARY
NO. SETTIN	G NAME	NAME FAULI	F FOR	CLOSE	BU	IS FAU	LT	CHOS RE	SEN MOTE			SETTING	SETTING RELAY
001111	G INITIE						(Am	ps)				((PRIM)
(SEC)		CURRENT	'IN FA	ULT	C	URRENT	BUS	FAUL	Τı			(A)	
(A)		(Amps)	Sec	s)	(A	mps)	(S	ecs)				()	(%)
1 5.00 ****	0.59 52 Relav1	2486.39 3S-RELAY	R1 1.3	605	1 262	243.19	2	1.36	800 05		5	100.00	800.00 R2
2			R2		2		3		400		5	100.00	400.00
5.00 ****	0.41 20 Relay1	5243.19 3S-RELAY	0.9	9454	174	195.46		0.94	54				R3
3			R3	2.0.2	3	01 60	4	0 50	200		5	100.00	200.00
5.00 ****	Relay1	/495.46 3S-RELAY	0.5	303	131	21.60		0.53	50				R4
4	0 05 1	2121 60	R4	1152	4	DOEC N	5		100		5	100.00	100.00
****	Relay1	3S-RELAY		1733		DOF2 N	OI B	ACK-I	שנ				

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





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



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

💤 MiGUI - A Power System Network Ed	tor - [Gui1]				
The Edit New Draw Elements Set	Change Object(s) Configure PLot		Dif Protection Partial Analysis	Carlos zonver Window	Pull Screen Help 10/3
	Click next to se he relay trip sequence	ee		2	SULDAY SUL
UI Ready		Snap :	1.000000 X <825>, Y <223	>	0 1

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6.1	Procedure to Draw First Element - Bus	
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6.3	Procedure to Draw Generator	
6.4	Procedure to Draw Relay	
6.5	Procedure to Enter Load Data	
6.6	Executing Distance Relay Co - ordination	

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

MiP	P-PSCT				How to solv	ve DRCD
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

	Positive se	equence	Zero sec	quence
Bus- code	Impedance Zpq in pu	Line charging B/2 in pu	Impedance Zpq 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** \rightarrow **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.

Configuration Information	X
General Information Voltage Levels Electrical & Currency Information Breaker Ratings	
New Database Name	
E\DRCD\DRCDsample.mdb	
Network Title	
First Power System Network	
Power System Libraries 🔽	
Standard Relay Libraries	
OK Cancel Apply	Help

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.

juration Information		X Configu	ration	Informatio	n				
General Information	ation Voltage Levels General Information					1	Voltage Levels		
Electrical Information	al Information Breaker Ratings		Electrical Information				Breaker Ratings		
Base MVA	100	400).000	15000	MVA	13.200	350	 мv/	
Base Frequency	50 Hz	220).000	10000	MVA	11.000	350	MV/	
p.u status	ম	230	0.000	10000	MVA	10.500	350	MV/	
		132	2.000	5000	MVA	10.000	350	MV	
 Indicates that all the imper a common MVA base. 	dances are specified in PU on	110).000	5000	MVA	6.600	250	 MV/	
Else the machine impeda own rating and transmissi	nces are specified in PU on its on line parameters are	66.0	000	5000	MVA	3.300	100	_ мv/	
specified in actuals, i.e R B/2 mho/km.	ohms/km, X ohms/km and	33.0	000	1500	MVA	0.415	50	MVA	
					Modify All B	reaker Batings	1		

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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.

2	The P	Ren Vrienk Max (Gal)	Bus Data
	4000 2308 2200 122.0 110.0		Bus Number 1 Fetch Bus >> Bus Name Bus1 Bus1 Description Bus1 Bus1
	66.0 33.0 15.0 13.20 11.0 5.50		Adminia Volicije 32000 _ kv Area Number 1 Select Area1 _ Zone Number 1 Select Zone1 _
0141410	100 100 550 330 04150 0228	$\begin{bmatrix} B_{0} \text{ None} & B_{0} \text{ I} \\ \hline $	Owner Number
0 0 0 0	00 00 00 00 00	<u> </u>	Cost libray 0 Cost libray Cost libray Cost libray Arc Flash Bus Bar Differential Bus Details
H U Fa	00 00 00	j IACR [Reverse 1 < 0 > 0 ≤ 25 (0 × 10 × 10 × 10 × 10 × 10 × 10 × 10 ×	Global Change Load Details Costib >> GPS

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 fiel d 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.



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

De-Rated MVA 100 Rating I 100 From Bus Number 1 (Bus1) (132.000 To Bus Number 2 (Bus2) (132.000 Number of Circuits 1 Line Length 1 Contingency Weightage 1	MVA MVA	Structure Ref. No. 1 Image: Constraint of the second seco
Rating II 100 From Bus Number 1 (Bus1) (132.000 To Bus Number 2 (Bus2) (132.000 Number of Circuits 1 Line Length 1 Contingency Weightage 1	MVA	
To Bus Number 2 (Bus2) (132.000 Number of Circuits 1 Line Length 1 Contingency Weightage 1		From Breaker - SLD - Show Breaker - SLD - Yes
Line Length 1 Contingency Weightage 1		Exists MVX 5000 C Ine Cable Cable Cable CBreaker Clocker Cloc
	km	Not Exists To Breaker To Breaker
Status In Service O From End Open	C To E	I Consider Consistence Commission Status Commission Status Commission Status Commission Status Commission Status Commission Status Commission Status Commission Status Commission Status Commission Status

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 Lib Structure Reference Number	orary ame Line1			Fetch Line
Positive Sequence Resistance	0.02009	pu	- Surge In	npedance
Positive Sequence Reactance Positive Sequence Susceptance (B/2)	0.05997	pu pu	Z 0.9	99750 Ohms 39.405253 kms/sec
Zero Sequence Resistance Zero Sequence Reactance	0.04017	pu pu	Co	mpute XL, B/2
Zero Sequence Susceptance (B/2) Thermal Rating	0.02316	pu MVA Compute		
Line Harmonic Number Cost per km	0	Harmonic Library >> Cost Per Unit in Rs		Thermal Curve>>

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 >> N	ame Gen1 Maintenance	Schedule No 💌
Bus No. 1 (Bus1) (132.000 Y Manufactur Units in Parallel 1 GT Capability C Specified Voltage	er Ref. No 30 [Gen14] Library >> urve No 0 [CAPCUR] Capability Curve >> Breaker Rating	Protection Over Current Relay
1.0000 Pu 132 KV De-Rated MVA 100 Scheduled Power 80 MW	In MVA 5000 In kA 21.870 Reactive Power - Minimum 0 Mvar Reactive Power - Maximum 60 Mvar	Cost Per Unit in Rs
Real Power Optimization Data Real Power - Minimum 0 MW Real Power - Maximum 80 MW	Cost Co-efficient C0 0 Cost Co-efficient C1 0 Cost Co-efficient C2 0	C Utility Grid
Status Comm	iission Status Existing O Proposed Year 0]
Neutral Grounding Resistance 0 of Neutral Grounding Reactance 0 of Grounding Through Transformer Calculate 0	ms Paticipation Factor (%) 0 ms Bias Setting 0 Droop (%) 4	
MiP-PSCT

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 10) MW Rating	9 80	kV Rating 132	Compute X("d,"d,n,0)					
		pu on Common M	VA Base						
Armature Resistance (Ra) 0	pu Potier Rea	ctance (Xp)	0 pu					
Direct Axis Reactance	(Xd) 0	pu Direct Axis	Transient Reactance (X"d)	0.25 pu					
Quadrature Axis Read	ance (Xq) 0	pu Quadrature	e Axis Transient Reactance (>	(d) 0 bn					
Negative Seq. Reacta	nce (Xn) 0.01	pu Direct Axis	Sub-Transient Reactance 🕅	"d) 0 pu					
Zero Seq. Reactance	(Xo) 0.01	pu Quadrature	e Axis Sub-Transient Reactan	ce (X"q) 0 pu					
Direct Asis Open Circuit Transient Time Constant (Tdo) Quadature Asis Open Circuit (Tdo) Quadature Asis Open Circuit (Tdo) (Td									
Winding Connections -	Mass Details			Cost Per Unit in Rs					
V V A	Mass Number	0	Next >>	0					
	Inertia	0	MJ/MVA						
0 0 0	Damping Factor	0	<< Back	Thermal Curves					
	Stiffness Co-efficier	nt 0	pu torque/ Elec. Rad Delete	Thermal>>					

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.

CT Number	1	Fe	ch >>	Feeder Number		
TagNumber	C11.	_		Switch Board		_
Sub Station	-	_		Serial Number	-	_
Make	ľ.	-		Class	-	_
Bato	-			CT Burden	0	VA
Knee point Vokage	0	- v		PF (Burden)	0	_
Magnetizing Custent	0	A		R Sec	0	Ohm
Number of Cores	1	_		XSec	0	Ohns
Primary Rating 1	400	- A		Themal Current	0	A
Primary Rating 2	400	- A		Secondary Rating	15	A
Primary Rating 3	400	A	Selec	ted Rating	7.0.	
Primary Rating 4	400	- A	FR	aling1 (C Rating2	C Rating 2	C Raing4
Magnetisation	Characteristics of	Core				
T Magnetica	Kon Curve		Curren	v(me) Vohage	imal	
						TAR
[Core Loss]	0 0	hes				
						Delete



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

Bus1 [1] ZZVM1	Relay Type								
ZZGP1 ZZVA1	Display Text								
÷.	C IDMT Over Current (51)	O Distance Relay (21)							
	C IDMT Earth Fault (51N)	C Line Pilot (87P)							
	C Instantaneous Over Current (50)	C Transformer Differential (87T)							
	C Instantaneous Earth Fault (50N)	C Restricted Earth Fault (87N)							
	C Directional IDMT Over Current (67)	C Bus Bar Differential (87B)							
Bus2 [2] ZZVM2	C Direction IDMT Earth Fault (67N)	C Partial Bus Bar (87PB)							
ZZVA2	C Stand By Earth Fault (51G)	C Line/Cable Differential (87L)							
	O Others (Specify)								
	ОК	Cancel							

Then it will invoke Distance Relay Database

Distance Relay Data											
Number 1 Fetch Distance Relay Relay Name Dr1											
Connected To Transmission Line ID	Distance Re	lay Details >>									
1 1.0000 [1-2]	CT High	400	Amps								
Zone 2 C Line C Two Winding Transformer	CT Low CT No.	5	Amps								
5 1.0000 [2-5]			PT High	132	kV						
Line C Two Winding Transformer	C Three Winding	Transformer	PT Low	Volts							
3 1.0000 [2-3]		_	CVT No.								
Zone 1 Reach (%) 80 Zo	one 2 Time Disc	0.5	sec	Relay Library 0 [RED670]	•						
Zone 2 Reach (%) 40 Zo	one 3 Time Disc	0.8	sec	Library>:	>						
Zone 3 Heach (%) 100 Zo Zone 4 Reach (%) 20	one 4 Time Disc	1	sec	Maintena	nce						

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	
r Rela	lay
Number 1 Fetch Load >>> Name Load1 Maintenance Schedule No Image: Control of the schedule No Image: Co	•
Bus Number 4 (Bus4) (132.000 V No of Consumers MVAR Compensation 0	Relay
Real Power in MW/ 00 Cost	st Per Unit in Rs
Maximum Compensation in MVAR 0	0
Reactive Power in MVAR 49.579547 Compute Compensation Step in MVAR 0	,
Power Factor 0.850000 Load Details Load Characteristics No.	st library
Lond Ture Ref N	No.
Cload Type Unbalanced Load Library Library	Lib >>
Motor Load Percentage Unbalanced Load Details	
0 Global Change	
Status Breaker Rating Breaker Rating	
In MVA 5000.007	
In kA 21.870	
Control Block	
Fpb Path Browse	

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 Case Case Case Case Case Case Case Case	Study Info	1. Click here
Results Network Report View Bus Close	. Graph	3. To view Report

STANCE RELAY CO-ORDINATION			
Simulation Option Fault Creation an	d Impedance Determination	Select Simulat	ion option
Fault Type Three Phase to G	iround Fault		
Fault Impedance Fault Resistance 0 Fau Ground Resistance 0 Gro	ult Reactance 0 Cre und Reactance 0 def	lect Fault type fo eation and impe termination sim	or fault edance sulation option
C Fault on Bus Final C Final	ault on Line Line Numbers [1 to 2] [1 to 3] [2 to 3] [2 to 4] [2 to 5]	% Distance	
 Voltage Initialization by Flat Start Voltage Initialization by Load Flow 	 Transient Reacta Sub Transient Re 	ance (X'd) sactance (X''d)	
Multiplication Factor Number 1			
Discrimination Time 0.4 Print	Option Data and Result	is 🔽	
Ok	Cancel		

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-ORDIN CASE NO : 1	IOITAI	I SCI	HEDULE		
NO : U 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			

MiP-PSCT How to solve DRCD NUMBER OF SERIES REACTORS : 0 NUMBER OF SERIES CAPACITORS 0 NUMBER OF BUS COUPLERS : Ο 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) : 100.000 BASE MVA NOMINAL SYSTEM FREQUENCY Hz : 50.000 PREFAULT VOLTAGE OPTION : 0 (VOLTAGE OF 1.0 PU IS ASSUMED) _____ ____ FAULT RESISTANCE - PHASE0.000000 (PU)FAULT REACTANCE - PHASE0.000000 (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-P	SCT									How	v to	solve DRCD
1	1	1	132.000	Bus1	1.0	000	0.0	000	0.	000	0	.000
							0.0	000	0.	000	0	.000
2	1	1	132.000	Bus2	1.0	000	0.0	000 (000	0	.000
							0.0	000	0.	000	0	.000
3	1	1	132.000	Bus3	1.0	000	0.0	000	0.	000	0	.000
	1	-	120 000		1 0		0.0	000	0.	000	0	.000
4	T	T	132.000	Bus4	1.0	000	0.0	000	0.	000	0	.000
5	1	1	132.000	Bus5	1.0	000	0.0	000	0.	000	0	.000
							0.0	000	0.	000	0	.000
TRAN	SMISS	ION L	INE DATA									
STAT	CKTS	FROM	FROM	то то								
		NODE	NAME	NODE NAM	2	RP(P.	U)	XP(P.U)	BP/2(P	U)	THERMAL
						RZ(P.	U)	XZ(P.U)	BZ/2(P	U)	RATING
MVA												
			 D#1		 D				-			
3	T	T	Busi	2	Bus2	0.0200	09 17	0.0599	/ 5	0.000	00	100 00
3	1	1	Busl	З	Bus3	0.0800	00	0.2399	6	0.000	0.0	100.00
5	-	-	Dubi	5	Dubb	0.154	96	0.4820	9	0.000	00	100.00
3	1	2	Bus2	3	Bus3	0.0599	97	0.1799	8	0.000	00	
						0.1199	95	0.3673	1	0.000	00	100.00
3	1	2	Bus2	4	Bus4	0.0599	97	0.1799	8	0.000	00	
2	1	0	D	-	D	0.1199	95	0.3673	1	0.000	00	100.00
3	T	2	Bus2	5	Bus 5	0.0393	94 25	0.1200	1 5	0.000	00	100 00
3	1	3	Bus3	4	Bus4	0.0099	99	0.0299	6	0.000	00	100.00
						0.020	09	0.0599	2	0.000	00	100.00
3	1	4	Bus4	5	Bus5	0.0800	00	0.2399	6	0.000	00	
						0.1549	96	0.4820	9	0.000	00	100.00
GENE	ROTAR	рата										
ODIVE.		DIIIII										
FROM	FROM		POSITIVI	Ξ	NEGAT	IVE		ZE	RO			MVA
NODE	NAME	R	(P.U) X(1	P.U.) R(1	P.U.)	X(P.U	.)	R(P.U.)	X(P.U	.)	RATING
STAT												
1		Bus1	0.00000	0.25000	0.000	00 0	0100	00 0.0	00	00 0	010	000 100
3			5.00000	2.23000	0.000						0 1 1	200 200
2]	Bus2	0.00000	0.25000	0.000	00 0.0	0100	0.0	00	00 0.	010	00 100
3												
 T.OAD	איייעת											
TOVD	DAIA											
NODE	NAME		STATUS									

____ _____ 2 Bus2 3 3 3 Bus3 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.) R(P.U.) X(P.U.) RATING STAT - -Bus1 0.00000 0.25000 0.00000 0.01000 0.00000 0.01000 1 100 3 Bus2 0.00000 0.25000 0.00000 0.01000 0.00000 0.01000 2 100 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. : Current transformer secondary rating in amperes. CTSE 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. : Percentage of the primary line impedance for which the Z1 REACH relay should operate instantaneously. Z2 REACH : Percentage of shortest line impedance in the adjacent

MiP-I	PSCT										How	to so	lve DR(CD
sect	ion													
Z3 F	REACH :	f Pero r	or whi centag emote elay p	ch the e of bus o: rowide	e rela the l f the	ay pro onges short	ovides t lir test a	s back ne imp adjace	cup pro pedance ent sec	otect e cor ction	ion. necte for	d to whic	o the h the	
Z2 D	Z2 DIS TIME : The co-ordination time interval between zonel and zone2 in seconds.													
Z3 DIS TIME : The co-ordination time interval between zone2 and zone3 in seconds.														
RELA	Y DBAS	Е : Т	he rel	ay ty	pe nur	mber.								
DIST	ANCE R	ELAY	DATA											
RELA	Y 'H	ELMN	LINE	FOR/	CTPR	CTSE	PTPR	PTSE	LOAD) IMP	Z1 R	EACH	Z2	
NAM	IE 'ENT	NUMB	LNTH	REV	AMPS	AMP	KV	VOLT	R(P.	U) X	(P.U)	PE	RCENT	
Z4 R	EACH Z	4	RELAY						Z3 REA	ACH Z	2 DIS	Z	3 DIS	
PERC	ENT T	IME	DBASE						PERCE	INT	TIME		TIME	
														-
80	4	0	Dr1	1	1.00	1	400	5	132	110	999.	990	999.9	9
20	1 000	n	0						100	0.5	00	0.8	00	
20	1.00	5	Dr2	1	1.00	2	400	5	132	110	999.	990	999.9	9
80	4	0							100	0.5	00	0.8	00	
20	1.00	D	0 Dr3	2	1 00	1	400	5	132	110	999	990	999 9	9
80	4	0	DIJ	2	1.00	-	100	5	100					2
29	1.00	D	0						100	0.5	00	0.8	00	
80	4	0	Dr4	2	1.00	2	400	5	132	110	999.	990	999.9	9
20	1 00	n	0						100	0.5	00	0.8	00	
20	1.00	0	Dr5	3	1.00	1	400	5	132	110	999.	990	999.9	9
80	4	U							100	0.5	00	0.8	00	
20	1.00	D	0 Dr6	3	1.00	2	400	5	132	110	999.	990	999.9	9
80	4	0	-						100	0 5	00	0 0	0.0	
20	1.00	0	0						100	0.5		0.0		

MiP-PSCT How to solve DRCD											
1 400 5	2 110 999.990 999.99										
	.00 0.500 0.800										
2 400 5	2 110 999.990 999.99										
	00 0.500 0.800										
1 400 5	2 110 999.990 999.99										
	.00 0.500 0.800										
1 400 5	2 110 999.990 999.99 .00 0.500 0.800										

00	4.0	Dr10	6	1.00	1	400	5	5	132	110	999.	.990	999.99
80	40								100	0.5	00	0.8	00
20	1.000	0 Dr11	6	1.00	2	400	5	5 3	132	110	999.	.990	999.99
80	40								100	0.5	0.0	0.8	0.0
20	1.000	0	7	1 0 0	1	400	-		120	110	000	000	
80	40	Driz	/	1.00	T	400	5	о ₋	132	TTO	999.	.990	999.99
20	1.000	0							100	0.5	00	0.8	00
80	4.0	Dr13	7	1.00	2	400	5	5 3	132	110	999.	.990	999.99
00	1 000	0							100	0.5	00	0.8	00
20	1.000	U											
80	40	Dr14	5	1.00	2	400	5	5	132	110	999.	.990	999.99
20	1.000	2							100	0.5	00	0.8	00
DISCF	RIMINATIO	N TIME				:	C	0.40	D				
NUMBE	ER OF FAU	LTS SIMUL	ATED			:	1	L 					
 SERIE N	ES ELEMEN JUMBER	T PERCENT LINE	FAUI	JTTYPE									
		1 50.00		1	(3 E	HASE	то с	GRO	UND F	AULT)		
LOCAT	TION	KELAY EL	ENTEN'I	FROM	ROR	FROM	ROS	1.0	ROR	.1.0	ROR	КЕГЧ	ĭ
(FROM	I/TO)	NAME	NUMBE	R N	UMBER		NAME	E NU	JMBEI	2	NAME	C	
											BUS	S NAM	E

	MiP-PSCT								How to solve DRCD
- 1		Drl	1	1	Bus	31	2	Bus	32
Busl		Dr2	1	1	Bus	s1	2	Bus	32
Bus2		Dr3	2	1	Bus	31	3	Bus	3
Busl		D4	-	-	Dui	. 1	2	Dui	- 2
Bus3		Dr4	2	Ţ	Bus	31	3	Bus	33
Bus2		Dr5	3	2	Bus	32	3	Bus	33
		Dr6	З		2	Bus2		З	Bus 3
Bus3			5		2				
Bus2		Dr7	4		2	Bus2		4	Bus4
Bug4		Dr8	4		2	Bus2		4	Bus4
		Dr9	5		2	Bus2		5	Bus5
Bus2		Dr10	6		3	Bus3		4	Bus4
Bus3									
- 4		Dr11	б		3	Bus3		4	Bus4
Bus4		Dr12	7		4	Bus4		5	Bus5
Bus	4								
		Dr13	7		4	Bus4		5	Bus5
Bus5		Dr14	5		2	Bus2		5	Bus5
Bus5									
1	C 1	7 14		c				<u>_</u>	
Numb	er of phase :	relays 14	Number o	t ea:	rth fai	ilt rel	ays	0	
DIST	ANCE RELAY P.	AIRS							
PRIM	ARY	RELAY NA	ME BACK	UP		RELA	Y NA	ME	
	5	D	 r5	1			 D	 r1	
	7	D	r7	1			D	r1	
	3	D D	r3	2			D	r2	
	6	D	r6	3			D	r3	
	10	Dr	10	3			D	r3	
	1	D	r1	4			D	r4	
	4 10	ע ית	10	с 5			ע ת	r5	
	2	D	r2	6			D	r6	
	7	D	r7	6			D	rб	
	9	D	r9	б			D	rб	

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MiP-PSCT				How to solve DRCD
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	

PHASE/ZEROMONE CHEAD	háserai	fæl)Ear	th rela	ay read	ch (set	. Value	es) ar	e give	n bel	low	
RELAY NAME	ZONE1 SETTING PH-PH	ZONE2 SETTING PH-PH	ZONE3 SETTING PH-PH	ZONE4 SETTING PH-PH	ZONE1 SETTING PH-E	ZONE2 SETTING PH-E	ZONE3 SETTING PH-E	ZONE4 SETTING PH-E	ZONE2 TIME (s)	ZONE3 TIME (s)	ZONE4 TIME (s)
Dr1 Dr3 Dr3 Dr5 Dr6 Dr7 Dr8 Dr10 Dr11 Dr12 Dr13 Dr14	0.5877 0.5877 2.3506 1.7629 1.7629 1.7629 1.7629 1.1754 0.2935 0.2935 2.3506 2.3506 1.1754	$\begin{array}{c} 1.3223\\ 1.9099\\ 3.0849\\ 3.2321\\ 2.3504\\ 2.4975\\ 2.3504\\ 2.4975\\ 2.6445\\ 1.2483\\ 3.5259\\ 3.0849\\ 1.7631 \end{array}$	$\begin{array}{c} 5.1421\\ 5.8765\\ 6.2433\\ 5.8765\\ 5.5087\\ 5.8765\\ 5.5087\\ 5.8765\\ 6.6111\\ 4.7742\\ 4.7742\\ 4.7742\\ 6.6111\\ 6.2433\\ 5.1421 \end{array}$	-0.147 -0.147 -0.852 -0.588 -0.441 -0.441 -0.441 -0.294 -0.073 -0.073 -0.588 -0.588 -0.294	1.1755 1.1755 4.7057 3.5907 3.5907 3.5907 2.3612 0.5873 4.7057 4.7057 2.3612	2.6500 3.8222 6.1758 6.4699 4.7821 5.0762 4.7821 5.0762 5.3043 2.5295 7.0627 6.1758 3.5393	10.3030 11.8398 12.4983 11.8399 11.1046 11.8399 11.1046 11.8399 13.3219 9.7109 9.7109 13.3219 12.4983 10.3030	$\begin{array}{c} -0.294\\ -0.294\\ -1.706\\ -1.176\\ -0.898\\ -0.898\\ -0.898\\ -0.898\\ -0.898\\ -0.590\\ -0.147\\ -0.147\\ -1.176\\ -1.176\\ -0.590\end{array}$	$\begin{array}{c} 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ 0.500\\ \end{array}$	1.300 1.300 1.300 1.300 1.300 1.300 1.300 1.300 1.300 1.300 1.300 1.300	2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300 2.300

ZONE1	ZONE2	ZONE3	ZONE4	REMARKS
EARTH SETTING	EARTH SETTING	EARTH SETTING	EARTH SETTING	
0.3800 1.120 0.3800 1.120 1.4500 4.480 1.4500 3.420 1.1200 3.420 1.1200 3.420 1.1200 3.420 0.1200 3.420 0.1900 0.560 0.1900 0.560 1.4500 4.480 1.4500 4.480 0.7500 2.250	0.8400 2.52 1.1900 3.64 1.9000 5.88 1.9900 6.16 1.4900 4.55 1.5800 4.83 1.4900 4.55 1.5800 4.83 1.6600 5.05 0.8000 2.41 0.8000 2.41 2.1800 6.72 1.9000 5.88 1.1200 3.36	3.2100 9.8000 3.6900 11.2600 3.8300 11.9000 3.6500 11.2700 3.4300 10.5700 3.4300 10.5700 3.6600 11.2700 3.4300 10.5700 3.6600 11.2700 3.3000 9.2300 3.0300 9.2300 3.0300 9.2300 3.8300 11.9000 3.8300 12.6800 3.8300 19.9000 3.8300 19.9000	0.1000 0.290 0.5300 1.630 0.3700 1.120 0.2900 0.860 0.2900 0.860 0.2900 0.860 0.2900 0.860 0.2900 0.860 0.2900 0.860 0.2900 0.860 0.1900 0.570 0.0500 0.150 0.3700 1.120 0.3700 1.120 0.3700 1.220	RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT

RELAY	RELAY	QUANTITY	ZONE	1	ZONE	2	ZONE	3	ZONI	E4
NAME	TYPE		PHASE SET	TING	PHASE SET	TING	PHASE SET	TING	PHASE SE	TTING
Dr1 Dr2 Dr3 Dr4 Dr5 Dr6 Dr7 Dr8	RED670 RED670 RED670 RED670 RED670 RED670 RED670 RED670	RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT RES\REACT	0.1900 0.1900 0.7500 0.7500 0.5600 0.5600 0.5600 0.5600	0.5600 0.5600 2.2300 2.2300 1.6800 1.6800 1.6800 1.6800	0.4200 0.6100 0.9800 1.0300 0.7500 0.7500 0.7500 0.7500 0.7500	1.260 1.820 2.930 3.070 2.230 2.370 2.230 2.370 2.370	1.6300 1.8700 1.9800 1.8600 1.7500 1.8600 1.7500 1.8600	4.8800 5.5800 5.9300 5.5800 5.2300 5.5800 5.2300 5.2300 5.5800	0.0500 0.0500 0.2800 0.1900 0.1500 0.1500 0.1500 0.1500 0.1500	0.150 0.150 0.810 0.560 0.430 0.430 0.430 0.430 0.430
Dr9	RED670	RES\REACT	0.3800	1.1200	0.8400	2.510	2.0900	6.2800	0.1000	0.29
Dr10	RED670	RES\REACT	0.1000	0.2800	0.4000	1.190	1.5100	4.5300	0.0300	0.10
Dr11	RED670	RES\REACT	0.1000	0.2800	0.4000	1.190	1.5100	4.5300	0.0300	0.10
Dr12	RED670	RES\REACT	0.7500	2.2300	1.1200	3.350	2.1000	6.2800	0.1900	0.56
Dr13	RED670	RES\REACT	0.7500	2.2300	0.9800	2.930	1.9800	5.9300	0.1900	0.56
Dr14	REL521	RES\REACT	0.3800	1.1200	0.5600	1.680	1.6300	4.8800	0.1900	0.29

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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:



Co	onductor In	formation					×
	Diameter	0.02811	m	DC Resistance	0.07309	ohm	
	Width	4.4	m	Temperature1	20	^o celsius	
	Height	17.6	m	Temperature2	65	^o celsius	
	Sag	7.6	m				
				Line Number			
	<< Ba	ck N	ext>>	1 of 4	Save	Delete	
				OK			

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 CALCULATI CASE NO: 300	ION	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 (TRANSPOSED)

MiP-PSCT				How to solv	e LPC-CPC	
BASE MVA		: 1	00.000			
BASE KV		: 21	20.000			
UNIT TYPE OUT TYPE CONDUCTOR MATERIAL FREQUENCY BUNDLE SPACE EARTH RESISTIVITY LINE LENGTH CARSON CORRECTION C FREQUENCY STARTING FREQUENCY STARTING FREQUENCY STEP VALU	TYPE OPTION VALUE ALUE JE	: : : 5 : 0. : 10 : : : :	0 (MKS SYS 0 - Ohm(Ml 2 - ALUMII 0.000 hert: 0.000 ohm-t 1.000 km 1 - SINGLI 50.00 Hzs 50.00 Hzs 50.00 Hzs	TEM) no)/km NUM z c neter E TERM CORRE	ECTION	
NOTATION USED FOR C RDC : DC resistance T1 : Temperature i T2 : Temperature i CD : Diameter of t CH : Height of the CW : Distance betw Sag : Conductor sag	conductor 1 e of conduc in degree C in degree C the conduct e conductor ween conduc g at the mi	NFORMATI tor in o elsius a elsius a or in th above g tor and d way of	ON hms at T1 o t which RDO t which res e given uni round in g centre of t the span :	degree Cels: C value is p sistance to ts. iven units. the tower in in given uni	ius. provided. be comput ngiven un its.	ed. its.
COND. RDC (no.)* (ohm) (degre	Tl ee-c) (degro	T2 ee-c)	CD (metre)	CH (metre)	CW (metre)	Sag (mtr)
1 0.07309 20.0 7.600 2 0.07309 20.0	00000 65. 00000 65.	00000	0.02811 0.02811	17.60000 25.60000	4.40000 4.40000	
7.600 3 0.07309 20.0 7.600 4 3.37500 20.0 0.000	00000 65. 00000 20.	00000	0.02811 0.00945	21.60000 27.40000	-4.40000	
COMMUNICATION LINE	HEIGHT FROI WIDTH FROM	M GROUND CENTRE	: OF TOWER :	0.00000	metre metre	
 COMPUTED VALUES ARE	E FOR AC SY	STEM				

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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 0.00000e+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+i4.294738e-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+i4.629791e-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+i4.294738e-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-014j1.412900e-013 7.064500e-014-j3.532250e-014 -1.412900e-013-j3.532250e-014 -4.001377e-014+i2.725994e-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- 013j1.412900e-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 = -0.000000000 + j = 0.0000027260 (Mho)D = 0.999994040 + j0.000001186 _____ ATTENUATION CONSTANT (Line-to-Line mode) : 0.00011 neper/km : 0.00109 rad/km PHASE CONSTANT (Line-to-Line mode)

MiP-PSCT How to solve LPC-CPC 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 Хp %CS Type Rp 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		

ove Type	Fetch Record >> Conductor Type	Cobie Name CABLE-1 Earth Return Path	3. Select earth return path¶
C Single Core Cable Three Of Cable held Type Unshielded	1 1005 Conducting Cardin C 97.3 % Copper Plad Drawel	C Ground and Math C Sheath Units Type C MKS	5. Select unit type¶
4. Select Shield type¶ ktness 1	volts Length of Cable 10 Overall Diameter 1.732 Distance brin 1.732 Distance brin 0.604 Conductors briand bri 0.604 Free Hoster 0.109 P Celesa 9	nie Lagers of Stands inch Aciel Spacing b/n the Conductors 0.604 inch Conductors 's and 's' 0.604 inch Conductors 's and 's' 0.604 inch inch Bhildhores 0.0076 inch	6. Enter Input Parameters of Cable
Resistivity of the Cable Materia Resistivity of the Insulator	1.53145e 011 ohm-mile Resid 100000 ohm-mile Diele	chicky of the Earth 100 Chevende	
	Value per Unit Length C. P. u. Value p	er Unit Length	
Part Options	IValue for Entire Length C. P.u. Value fo	or Entire Length	

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 calculate	d : 20.0 degree celsi	us
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	

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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 :	0.0008

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8.7	Electromagnetic Transient Analysis:	
8.8	Plot Graph	

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** \rightarrow **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 **<u>Open</u>** button after entering the desired database name. **Configure**

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Database dialog will appear with path chosen.



	👫 Open 🔀
	Look in: 🕕 EMTA 🗾 🗢 🔁 📸 🖽 -
	No items match your search.
	Select the folder name and give the data base name
	File name: EMTA Qpen
	Files of type: Database Files *.mdb Cancel
	Open as read-only
	Configure Database
	Database Name E:\EMTA\EMTA.mdb
Click OK	OK Cancel Clear Path Browse

Configuration Information	X Configuration Information	2
Contiguration Information General Information Volkage Levels Dedition & Cumercy Information Breaker Retirgs New Detabase Name E-LEMTA-LEMTA-mob Network Title	Contiguration Information General Information Volkage Levels Bootrical & Curroncy Information Breaker Ratings Dase MVA 100 Base Frequency 50 Hz p II status v Indicates that all the impedances are specified in PUI on	2
Fritt Power System Hetwork Power System Libraries	e common MVA base. Base the machine impedances are specified in PU on its own inding and transmission ine parameters are specified in actuals in R ohms./km. X ohms./km and B/2 inflo/km. Quirency	
OK Cancel Accily He	eb OK Cancel Accel	Help

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.

eneral Infor	mation Vol	tage Levels	Bectrical &	Ourrency Inf	ormation Br	eaker Ratin	ge	
	in MVA	in kA		In MVA	ln kA		In MVA	InkA
400.000	15000	21.651	13.200	350	15.309	15.000	350	13,472
220.000	10000	26.244	11.000	350	18.371	0.233	50	123.899
230.000	10000	25.103	10.500	350	19.246	15.000	350	13.472
132.000	5000	21.870	10,000	350	20.208	15.000	50	123.899
110.000	5000	26.244	6.600	250	21.870	0.233	350	13.472
66.000	5000	43.740	3.300	100	17.496	15.000	50	123.899
33.000	1500	26.244	0.415	50	69.562	0.233	350	13.472
15.000	350	13.472	0.233	50	123.899	0.233	50	123.899
			Modifi	Al Breaker	Ratings			

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.

Instormer Number 1	Fetch Transform	ser >> Name 211	Maintenance	Global Change	T Zig Zag Transforme
condary Voltage-11.000 kV erRated MVA 315 ating 1 315 ating II 315	Mva	Manufacturer Ref Number 30 [2130] From Breaker Transfo	mer Library >>	Unit Protection Relays Differential Relay	Restricted Earth Fau
om Bus Number 2 (Bus2) (22 o Bus Number 1 (Bus1) (11 ontrol Bus Number 2 (Bus2) (22		C Exists MVA 10000 k2 To Breaker IP Not Exists Rating C Exists MVA 350 k2 Set Tap Portion Dominated 5	126 244	OverCurrent Relay	SLD - Show Breaks
o of Units in Parallel 1 onlingency Weightage 1	_	Nominal Tap Position 5 Phase Shift Angle 0	deg	Cost Per Unit in	Contingency: 0 Schedule : 0
atus In Service C Out of Service	Commission Sta Existing (atus ^ Proposed Year U			
Grounding Resistance	ohms ohms	Pri Grounding Reactance 0	ohens Ground Prim ohens Sec	ing Transformer any <u>Compute</u>	

Transformer library form will be open. Enter the data as shown below. Save \blacksquare 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.

Manufacturer 30 Ref. Number	Fetch	Name Name	#er 2T30		Transf.	Parameter
MVA Flating 315		Primary Voltage	kv	Secondary Voltage	11	kV
Minimum Tap 1 Number Minimum Tap 209 KV	Compute	TapStep > 0.01250	hange M hange M hange V	asimum Tap 9 umber asimum Tap 231 Mage	_	V Compute
pu on its Own Ratin Pos. Seq. Impedance 0.14 Pos. Seq. X to R Ratio 20 Zero Seq. Impedance 0.14 Zero Seq. X to R Ratio 20	0 pu	Transformer losses Noload C loss Copper C loss Update X/R ratio	W Prim W Seci Phas	Winding ary C ondary C e displacement	Configuration (C (C) (O) (O)	
Magnet Magnetization Curve Residual Flux Phase A 0 Phase B 0 Phase C 0	Pirmit Curve	Data in pu on its Own R any Winding C Secon acteristics n % V in pu	ating day Windar	Add Driete	Then Th Cost Per	mal Curve ermab>> Unit in

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**.

2	Set/Thance I aver Gameral	× Laure Control Cutous		
	Second Second Cluster	Testa connel 2660	2	
		Rest (1)	Rus:2 (21	- SHUNT
		ZZVM1 77541	ZZVM2	
5			1	4- 2 - 3 3
5	~	ZZLP1-2 ZZLT2-1 Z	ZLP2-1	SERIES
2		ZZL01-2 2	ZL02-1	
1		315.00 MVA	······	
2		Element ID		140-0-1
		ſ		EIA
		Element ID	OK	2773
		Construction of the		12 1 # 14 1A
		From Database		HVDC
		1 1	Cancel	直直 ∞ 2
à				PACTS
-				*

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 Generat	or>> Name Gen1 Maintenance	Schedule No 🛛 💌
Bus No. 1 [Bus1] (11.000 M Units in Parallel 1 GT 0	Aanufacturer Ref. No 1 [Thermal120MW] Library >> Library >> Capability Curve No 0 (CAPCUR) Capability Curve >>	Protection Over Current
Specified Voltage	Breaker Rating kV In MVA 350 In kA 18.371	Relay Unit Protection
De-Rated MVA 315 Scheduled Power 300 MW	Reactive Power - Minimum 0 Mvar Reactive Power - Maximum 200 Mvar	Cost Per Unit in
Real Power Optimization Data Real Power - Minimum Real Power - Maximum 300 N	Cost Co-efficient C0 0 Gost Co-efficient C1 0 GW Cost Co-efficient C1 0 GW Cost Co-efficient C2 0	Select O Utility Grid O Generator
Status In Service C Dut of Service	Commission Status © Existing © Proposed Year 0	
Neutral Grounding Resistance 0 Neutral Grounding Reactance 0 Grounding Through Transformer Calcuter	ohms Participation Factor (%) 0 ohms Bias Setting 0 Jate Droop (%) 4	
Model Type for Infinite Bus Modelling (X'd) for Transient Modelling (X'd & X'q) for Sub Transient Modelling (X'd & X'q) <u>Giobal Change</u>	AVR Ref No. 0 (AVR) Type 0 Y AV/7 Litrary>> AVR FPB Name Tubine Gov Ref No 0 Type 0 Y TG Litrary>> Tur Governor Name	Edit Files AVR File Open

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

Generator Library	
Ref. Number 1	Fetch Generator Manufacturer Name Thermal120MW
MVA Rating 315 MW	/ Rating 300 kV Rating 11 Compute X('d,''d,n,0)
	pu on its Uwn Hating
Armature Resistance (Ra)	pu Potier Reactance (Xp) 0.2 pu
Direct Axis Reactance (Xd) 2	pu Direct Axis Transient Reactance (X'd) 0.3 pu
Quadrature Axis Reactance (Xq) 2	pu Quadrature Axis Transient Reactance (X'q) 0.3 pu
Negative Seq. Reactance (Xn) 0.2	pu Direct Axis Sub-Transient Reactance (X"d) 0.2 pu
Zero Seq. Reactance (Xo)	ри Quadrature Axis Sub-Transient Reactance (X''q) 0.2 ри
Direct Axis Open Circuit Transient Time Constant (T'do)	Direct Axis Open Circuit Sub-Transient Time Constant 0.039 3.31 3.31
Quadrature Axis Open Circuit Transient Time Constant (T'qo)	Quadrature Axis Open Circuit Sub-Transient Time Constant (T''qo) 0.15
-Winding Connections - Mass Detai	Is Cost Per Unit in
Mass Numb	er 0 0
Y Y 🛆 Inertia	0 MJ/MVA Counter
O O O Damping Fa	ctor 0
Stiffness Co	efficient 0 pu torque/ Delete Thermal>>

Save \square and **Close** the library screen. Generator data screen will be reopened. Click **Save** \square 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.

MiGUE-A Power System Network (cherr-[Grill.gu) Min Ed. Vew Daw Emerits Set Charge Operation Configure Plat Database Solve. Tool Unit Protection Partie	Analysis Quick Solver Window
	نا <u>ها .</u> کارد ای اسماره ای ای
	A SHOW
Bust (1) Bus2 (2) ZZVM1 ZZVM2	FIGURINIS
ZZVA1 ZZVA2	
770P1 771P1-2 ZZLT2-1 ZZLP2-1	SERIES
ZZ001 ZZL01-2 2ZL02-1	
JT5.00 MVA	
Element ID	ша
	1 F A AF 2
From Database	HVDC
	通道会社
	FACTS
UI Contingency: 0 Schedule: 0 Reference X =0+,Y =0+ Dist. 440.883 Km D: 1 F BUS: 2 T BUS: h	IA E'Ont
Fm Ready (Snap : 1.000000 X <433	>, Y <83>
Number 1 Fetch Load >> Name LD1 Maintenance Schedule No 0 Bus Number 2 [Bus2] (220,000 No of Consumers MVAR Compensation 0 Beal Power in MW 200 Compute Minimum Compensation in MVAR 0 Reactive Power in MWAR 150 Compute Maximum Compensation in MVAR 0 Power Factor 0.800000 Load Details Compensation Step in MVAR 0 Load Type C Unbalanced Load Load Characteristics No. 0 Image Construct Control Percentage Unbalanced Load Details Compression Status Biobal Change Biobal Change Status Commission Status Commission Status Biobal Change Image Image	Fieldy Relay Cost Per Unit in Rs 0 Cost library Ref No.
- Control Block	
Hpb Path Browse	

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 1 Fetch >> Name Sh	C1 Maintenance
De-Rated MVA 5	
Bus Number 2 [Bus2] (220.000	Shunt Capacitor >> 0
Status Commission Status	Breaker Rating
In Service Out of Service Existing C Proposed	Year 0 In MVA 10000.00(kA 26.244
Enter Structure Ref No. as 1 [MANF1] and click on Shunt Capacitor Library >> button.

Shunt Capacitor Library	
pu on its Own Rating	- Capacitor Type
Reference No 1 Fetch Shunt Capacitor >>	Fixed C Switched
Cost Paul Initia	Switched Capacitor Details
MVA Rating 5 kV Rating 220 0	C Voltage Control 0 pu
- Positive Sequence	Type of Variation 💿 Continuous
Conductance 0 pu Susceptance 1 pu	O Uniform
-Zero Sequence	Switched Capacitor Details>>
Conductance 0 pu Susceptance 1 pu	

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.

Case 1 Study Info 1. Click on study info 1. Click on study info Case 1 Case 1	×
C Execute After Input File Creation Only Input File Creation Execute with old Input File Execute After giving required	1. Click on study info
C Only Input File Creation C Execute with old Input File Execute 2. After giving required 2. After organizing	e
Execute with old Input File Execute required	2. After giving
Benuts 2. After executing	required
- Besults	
3. After executing	3. After executing
Network Report View Bus Graph Click here to get report	click here to get report
Close	

_ _ _

Load flow Results:

BUS VOLT	AGES ANI	D POWERS								
NODE FRO	М	V-MAG	ANGLE		MW		MVAR		MW	MVAR
NO. NAM COMP	E	P.U.	DEGREE		GEN		GEN		LOAD	LOAD
1		1 0000	0 00	201	526	177	721		0 000	0 000
0.000	DUSI	1.0000	0.00	201	. 550	1//	. / 51		0.000	0.000
2 0.000 @	Bus2	0.9206	-5.33		0.000		0.000		200.000	150.000
NUMBER OI NUMBER OI NUMBER OI NUMBER OI	F BUSES F BUSES F GENERA F GENERA	EXCEEDIN EXCEEDIN ATORS EXC ATORS EXC	G MINIMU G MAXIMU EEDING N EEDING N	JM VOLT JM VOLT IINIMUM IAXIMUM	AGE LI AGE LI Q LIM Q LIM	MIT MIT IT (* IT (*	(@ maı (# mar < mark > mark	ck) ck) c) c)	: 1 : 0 : 0 : 0	
TRANSFORI	MER FLO	WS AND TR	ANSFORME	ER LOSS	ES					
SLNO CS	FROM FR	NOM	то то				FORWA	RD		LOSS
8]	NODE NAI	ME NO	DDE NAME		Ν	4W	MVZ	AR	MW	MVAR
LOADING 1 1 85.3#	2	Bus2	1	Busl	-199.9	34 -	145.6	80	1.6026	32.0512
! NUMBER	OF TRA	NSFORMERS	LOADED	BEYOND	125%			:	0	
@ NUMBER	OF TRA	NSFORMERS	LOADED	BETWEE	N 100%	AND	125%	:	0	
# NUMBER	OF TRA	NSFORMERS	LOADED	BETWEE	N 75%	AND	100%	:	1	
\$ NUMBER	OF TRA	NSFORMERS	LOADED	BETWEE	N 50%	AND	75%	:	0	
^ NUMBER	OF TRA	NSFORMERS	LOADED	BETWEE	N 25%	AND	50%	:	0	
& NUMBER	OF TRA	NSFORMERS	LOADED	BETWEEL	N 1%	AND	25%	:	0	
* NUMBER	OF TRA	NSFORMERS	LOADED	BEIMEEI	N 0%	AND	18	:	0	
I MIMBER	OF LIN	ES LOADED	BEVOND	125%			0			
@ NUMBER	OF LIN	ES LOADED	BETWEEN	J 100%	AND 12	5% :	0			
# NUMBER	OF LIN	ES LOADED	BETWEEN	J 75%	AND 10	0% :	0			
\$ NUMBER	OF LIN	ES LOADED	BETWEEN	J 50%	AND 7	5% :	0			
^ NUMBER	OF LIN	ES LOADED	BETWEEN	J 25%	AND 5	0% :	0			
& NUMBER	OF LIN	ES LOADED	BETWEEN	1%	AND 2	5% :	0			
* NUMBER	OF LIN	ES LOADED	BETWEEN	I 0%	AND	1% :	0			

MiP-PSCT

_____ SHUNT CAPACITOR AND REACTOR INJECTION NODE FROM V-MAG ANGLE MW MVAR NO. NAME P.U. DEGREE GEN GEN ____ ____ ----- ----- ------ -------Bus2 0.921 -5.33 -0.000 4.238 2 _____ ____ ISLAND FREQUENCY SLACK-BUS CONVERGED(1) _____ _____ 1 0 1 50.00000 _____ _____ 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 -0.000 MW TOTAL SHUNT REACTOR INJECTION : TOTAL SHUNT REACTOR INJECTION : -0.000 MVAR TOTAL SHUNT CAPACIT.INJECTION : -0.000 MW 4.238 MVAR TOTAL SHUNT CAPACIT.INJECTION : 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.

Electro Magnetic Transient Analysis	1. Click on Study info
Execute After Input File Creation Only Input File Creation Execute with old Input File	2. To execute click on this icon
Results Network Report View Bus Graph Close	
Over Voltage Studies Over Voltage Studies Output Options Fault Type Fault Type Fault Details Ground to Neutral Resistance 0 Phase to Neutral Resistance 0 Output does 0 Switching Info. Consider Magnetizing data for Switching and Pre-insertion Timings Colspan="2">Consider Magnetizing data for Phase A Closing with Resistor 0.002 Switching and Pre-insertion Timings Tolerance for Phase B Closing with Resistor 0.003 Phase B Closing with Resistor 0.004 Phase C Closing with Resistor 0.003 Phase C Closing with Resistor 0.003 Phase B Pole Opening 2 Phase C Closing with Resistor 0.003 Sec Phase A Pole Opening Phase B Role Opening 2 Phase B Pole Opening 2 Phase B Diagong 0.11 Sec Phase B Phase C 0.9 Phase B 0.9 Phase B 0.9	PU PU PU PU PU PU PU PU PU
OK Cancel	

Over Voltage Studies	Output Options	Enter the simulation time, fault starting and clearing time and plot options	×
Simulation Time	0.5 Sect	Time Step 5e-005 Secs	
Fault Starting Time	0.1 Secs	Fault Clearing Time 0.2 Secs	
Plot Steps		Plot Buses 1 Bus1 2 Bus2	
Plot End Time	0.5 Secs		
	Options	ified at Primary V	
Recording Time S	itap 5e-005	Secs	
		OK Cancel Apply	

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

Case 1	-	Study Info
Execute After Execute After	er Input File Creation	Delete
 Only Input Fi Execute with 	le Creation old Input File	Execute
D 1	i ola nipat i no	Click here to plot the graph
Network	Report View	Bus Graph



Voltage at bus no 2



Voltage at bus no 1







Power System Network Editor



Graph Utility

Database Manager



COMTRADE

Free Programmable



Power Research & Development Consultants Pvt. Ltd.

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