LAMPIRAN I

PEMBENTUKAN MATRIK Z_{bus} dan Y_{bus}

Untuk mendapatkan matrik Y_{bus} dari suatu sistem dilakukan dengan cara merubah diagram segaris dari sistem tenaga listrik menjadi diagram reaktansi lihat gambar. Untuk analisis semua mesin pada setiap bus diperlakukan sebagai satu mesin saja

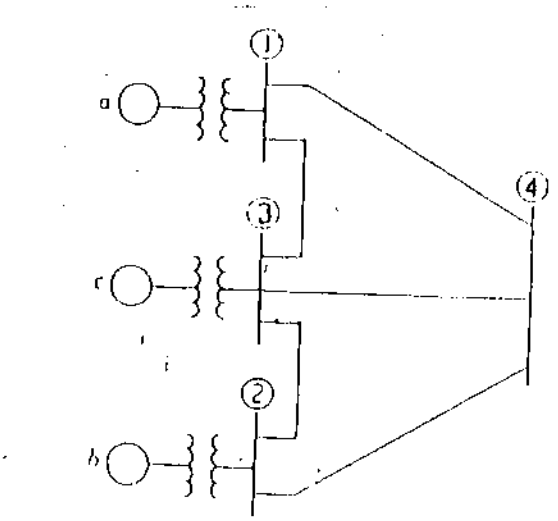


DIAGRAM SEGARIS SUATU SISTEM

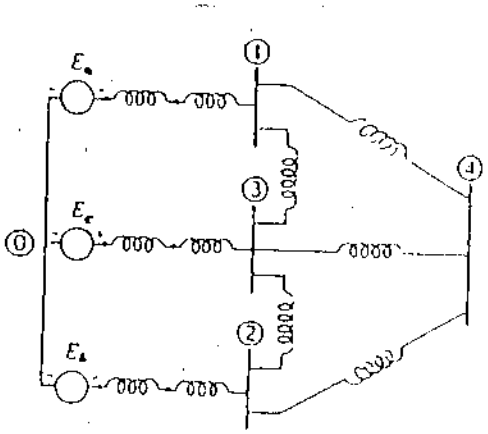
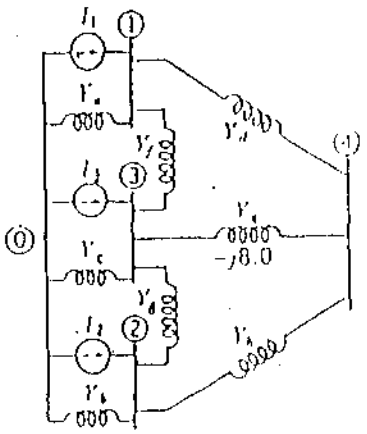


DIAGRAM REAKTANSI DARI SISTEM



RANGKAIAN DENGAN SUMBER ARUS MENGGGANTIKAN SUMBER TEGANGAN EKIVALEN

Jika emf-emf dan impedansi-impedansi seri digantikan dengan sumber arus ekivalen maka hasilnya dapat dilihat pada gambar diatas. Maka dengan menerapkan hukum arus kirchof pada bus-bus didapatkan

$$I_1 = V_1Y_a + (V_1-V_3)Y_f + (V_1-V_4)Y_d$$
$$I_2 = V_2Y_b + (V_2-V_3)Y_g + (V_2-V_4)Y_h$$
$$I_3 = V_3Y_c + (V_3-V_1)Y_f + (V_3-V_2)Y_g + (V_3-V_4)Y_e$$
$$0 = (V_4-V_1)Y_d + (V_4-V_2)Y_h + (V_4-V_3)Y_e$$

$$I_1 = V_1(Y_a+Y_d+Y_f) - V_3Y_f - V_4Y_d$$
$$I_2 = V_2(Y_b+Y_g+Y_h) - V_3Y_g - V_4Y_h$$
$$I_3 = -V_1Y_f - V_2Y_g + V_3(Y_c+Y_e+Y_g+Y_f) - V_4Y_e$$
$$0 = -V_1Y_d - V_2Y_h - V_3Y_e + V_4(Y_e+Y_d+Y_h)$$

Dalam bentuk matrik adalah

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}$$

Matrik bujur sangkar diatas dikenal dengan matrik Y_{bus} dan komponen-komponennya didapat dari

$$Y_{11} = Y_a + Y_d + Y_f$$
$$Y_{22} = Y_b + Y_g + Y_h$$
$$Y_{33} = Y_c + Y_e + Y_g + Y_f$$
$$Y_{44} = Y_d + Y_e + Y_h$$
$$Y_{12} = Y_{21} = 0$$
$$Y_{13} = Y_{31} = -Y_f$$
$$Y_{14} = Y_{41} = -Y_d$$
$$Y_{23} = Y_{32} = -Y_g$$
$$Y_{24} = Y_{42} = -Y_h$$
$$Y_{34} = Y_{43} = -Y_e$$

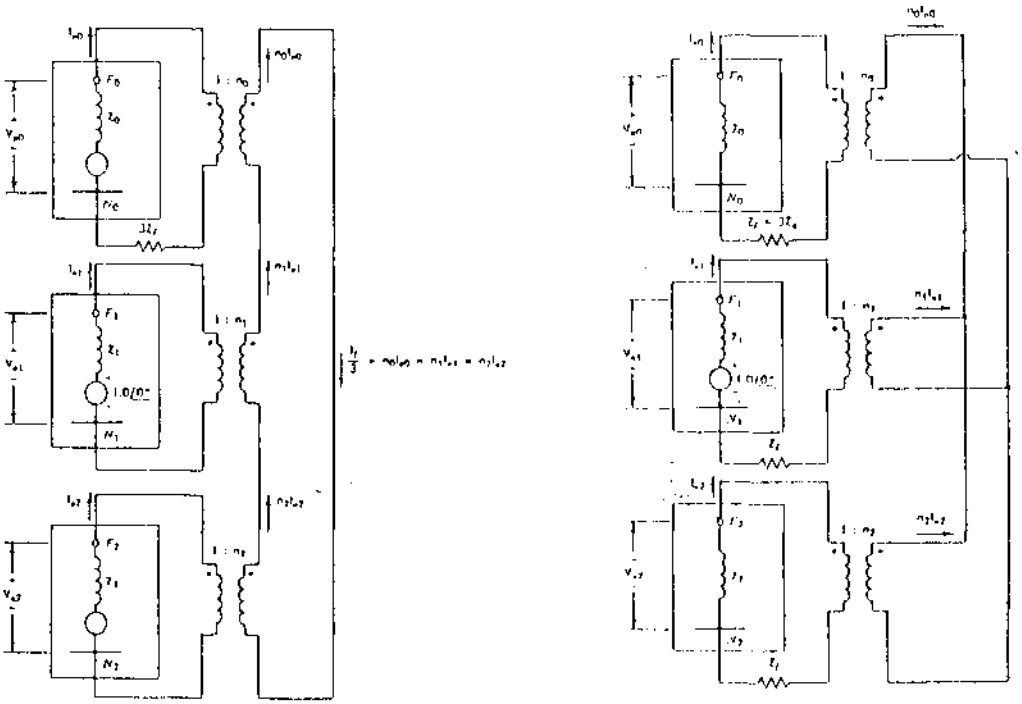
Untuk mendapatkan matrik Z_{bus} dilakukan dengan cara menginvers matrik Y_{bus} seperti berikut

$$Z_{bus} = Y_{bus}^{-1}$$

Matrik Z_{bus} ini penting dan berguna sekali dalam pembuatan program

LAMPIRAN II

DIAGRAM UMUM UNTUK GANGGUAN SHUNT



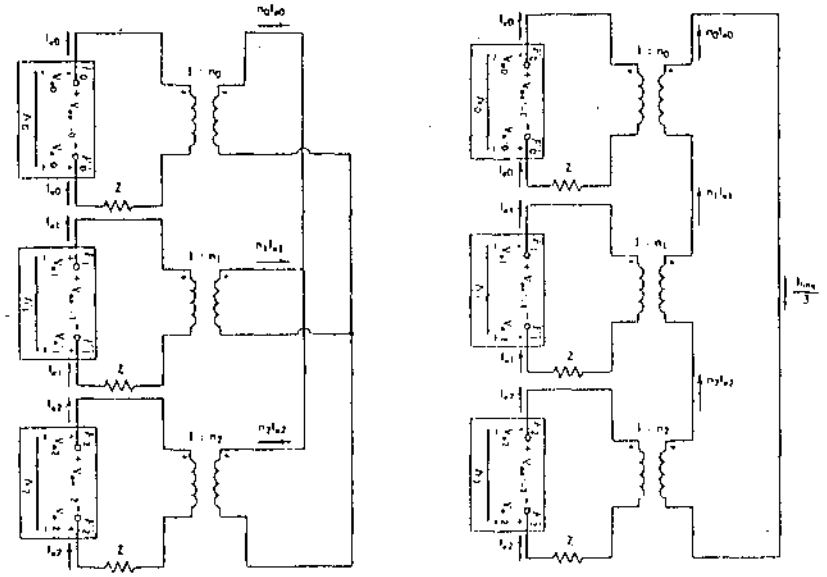
(a). Gangguan satu phasa ketanah, (b) Gangguan dua phasa ketanah

TABEL PERGESERAN PHASA UNTUK GANGGUAN SHUNT

SLG Fault on Phase	DLG Fault on Phases	Phase Shift n_0	n_1	n_2
a	$b-c$	1	1	1
b	$c-b$	1	a^2	a
c	$a-b$	1	a	a^2

LAMPIRAN II

DIAGRAM UMUM UNTUK GANGGUAN SERI



(a). Gangguan satu phasa terbuka, (b) Gangguan dua phasa terbuka

TABEL PERGESERAN PHASA UNTUK GANGGUAN SERI

One Line Open	Two Lines Open	Phase Shift n_a	n_1	n_2
a	$b-c$	1	1	1
b	$c-a$	1	a^2	a
c	$a-b$	1	a	a^2

LAMPIRAN III

DATA JARINGAN SISTEM 150 kV DI JAWA TIMUR

Data jaringan sistem transmisi 150 kV di Jawa Timur diperoleh dari Perusahaan Listrik Negara, dengan besaran dasarnya adalah

- 100 MVA, untuk daya
- 150 kV, untuk tegangan

Untuk mempermudah analisa bus-bus diberi nomor sebagai berikut

BUS	NAMA BUS
1.	BOJONEGORO
2.	BABAD
3.	LAMONGAN
4.	SEGOROMADU
5.	PETROKIMIA
6.	GERSIK P S
7.	SURABAYA BARAT
8.	WARU
9.	TANDES
10.	PERAK
11.	RUNGKUT
12.	SUKOLILO
13.	KENJERAN
14.	BANGIL
15.	KEBON AGUNG
16.	SUTAMI

17.	WLINGI
18.	PROBOLINGGO
19.	LECES
20.	LUMAJANG
21.	JEMBER
22.	BONDOWOSO
23.	SITUBONDO
24.	BANYUWANGI
25.	SEKARPUTIH
26.	KEDIRI BARU
27.	MANIS REJO

Data Impedansi Urutan Positip (Z_1)

BOJONEGORO-BABAD	=	0.0211	+ J	0.0635
BABAD-LAMONGAN	=	0.01848	+ J	0.05561
LAMONGAN-SEGOROMADU	=	0.01686	+ J	0.05073
SEGOROMADU-PETROKIMIA	=	0.00218	+ J	0.00917
SEGOROMADU-GERSIK	=	0.0018	+ J	0.00665
GERSIK-SURABAYA BARAT	=	0.00523	+ J	0.02929
GERSIK-WARU	=	0.00565	+ J	0.00319
SURABAYA BARAT-WARU	=	0.00315	+ J	0.00185
SURABAYA BARAT-SEKAR PUTIH	=	0.0052	+ J	0.03052
WARU-TANDES	=	0.00615	+ J	0.0247
WARU-RUNGKUT	=	0.00101	+ J	0.00567
WARU-SUKOLILO	=	0.00245	+ J	0.01379
WARU-BANGIL	=	0.01446	+ J	0.05546
TANDES-PERAK	=	0.00382	+ J	0.01536

RUNGKUT-SUKOLILO	=	0.00145 +	J 0.00818
SUKOLILO-KENJERAN	=	0.001934 +	J 0.07892
BANGIL-PROBOLINGGO	=	0.0267 +	J 0.0974
BANGIL-KEBON AGUNG	=	0.0227 +	J 0.0887
KEBON AGUNG-SUTAMI	=	0.01226 +	J0.04703
SUTAMI-WLINGI	=	0.02136 +	J 0.04427
PROBOLINGGO-LUMAJANG	=	0.0208 +	J 0.0796
PROBOLINGGO-LECES	=	0.0075 +	J 0.0273
LECES-JEMBER	=	0.0383 +	J 0.1467
LUMAJANG-JEMBER	=	0.0271 +	J 0.1041
JEMBER-BONDOWOSO	=	0.018 +	J 0.0691
JEMBER-BANYUWANGI	=	0.03468 +	J 0.1458
BONDOWOSO-SITUBONDO	=	0.0156 +	J 0.0597
SEKAR PUTIH-KEDIRI BARU	=	0.02696 +	J 0.1134
KEDIRI BARU-MANIS REJO	=	0.02929 +	J 0.1258

Data impedansi urutan negatip (Z_2)

BOJONEGORO-BABAD	=	0.0211 +	J 0.0635
BABAD-LAMONGAN	=	0.01848 +	J 0.055661
LAMONGAN-SEGOROMADU	=	0.01686 +	J 0.05073
SEGOROMADU-PETROKIMIA	=	0.00218 +	J 0.00917
SEGOROMADU-GERSIK	=	0.00176 +	J 0.00665
GERSIK-SURABAYA BARAT	=	0.00523 +	J 0.02929
GERSIK-WARU	=	0.00565 +	J 0.00319
SURABAYA BARAT-WARU	=	0.00315 +	J0.001851
SURABAYA BARAT-SEKAR PUTIH	=	0.0052 +	J 0.03052
WARU-TANDES	=	0.00615 +	J 0.0247

WARU-RUNGKUT	=	0.00101 +	J 0.00587
WARU-SUKOLILO	=	0.00245 +	J 0.01379
WARU-BANGIL	=	0.01446 +	J 0.05546
TANDES-PERAK	=	0.00382 +	J 0.01536
RUNGKUT-SUKOLILO	=	0.00145 +	J 0.00818
SUKOLILO-KENJERAN	=	0.001934 +	J 0.07892
BANGIL-PROBOLINGGO	=	0.0267 +	J 0.0974
BANGIL-KEBON AGUNG	=	0.02267 +	J 0.0887
KEBON AGUNG-SUTAMI	=	0.01226 +	J 0.04703
SUTAMI-WLINGI	=	0.02136 +	J 0.04427
PROBOLINGGO-LUMAJANG	=	0.0208 +	J 0.0796
PROBOLINGGO-LECES	=	0.0075 +	J 0.0273
LECES-JEMBER	=	0.0383 +	J 0.1467
LUMAJANG-JEMBER	=	0.0271 +	J 0.1041
JEMBER-BONDOWOSO	=	0.018 +	J 0.0691
JEMBER-BANYUWANGI	=	0.03468 +	J 0.1458
BONDOWOSO-SITUBONDO	=	0.0156 +	J 0.0597
SEKAR PUTIH-KEDIRI BARU	=	0.02696 +	J 0.1134
KEDIRI BARU-MANIS REJO	=	0.02929 +	J 0.1258

Data impedansi urutan nol (Zo)

BOJONEGORO-BABAD	=	0.05842 +	J 0.195
BABAD-LAMONGAN	=	0.05116 +	J 0.1664
LAMONGAN-SEGOROMADU	=	0.04667 +	J 0.1518
SEGOROMADU-PETROKIMIA	=	0.0077 +	J 0.0278
SEGOROMADU-GERSIK	=	0.00572 +	J 0.02006

GERSIK-SURABAYA BARAT	=	0.02812	+	J 0.1107
GERSIK-WARU	=	0.03165	+	J 0.12032
SURABAYA BARAT-WARU	=	0.01847	+	J 0.07822
SURABAYA BARAT-SEKAR PUTIH	=	0.03046	+	J 0.1158
WARU-TANDES	=	0.01774	+	J 0.07847
WARU-RUNGKUT	=	0.00677	+	J 0.02035
WARU-SUKOLILO	=	0.01646	+	J 0.0455
WARU-BANGIL	=	0.04385	+	J 0.1835
TANDES-PERAK	=	0.01169	+	J 0.0483
RUNGKUT-SUKOLILO	=	0.00968	+	J 0.02911
SUKOLILO-KENJERAN	=	0.00652	+	J 0.02318
BANGIL-PROBOLINGGO	=	0.08024	+	J 0.2896
BANGIL-KEBON AGUNG	=	0.07017	+	J 0.29368
KEBON AGUNG-SUTAMI	=	0.03719	+	J 0.1556
SUTAMI-WLINGI	=	0.04323	+	J 0.1318
PROBOLINGGO-LUMAJANG	=	0.06951	+	J 0.25089
PROBOLINGGO-LECES	=	0.02349	+	J 0.08479
LECES-JEMBER	=	0.12815	+	J 0.46255
LUMAJANG-JEMBER	=	0.09089	+	J 0.32804
JEMBER-BONDOWOSO	=	0.06036	+	J 0.21785
JEMBER-BANYUWANGI	=	0.12241	+	J 0.4418
BONDOWOSO-SITUBONDO	=	0.05215	+	J 0.18824
SEKAR PUTIH-KEDIRI BARU	=	0.09518	+	J 0.34354
KEDIRI BARU-MANIS REJO	=	0.10562	+	J 0.38121

(Note) 1. The impedances are shown in percent on 100MVA base at 150kV.

2. Type of transmission lines and transformers are per-circuit and per-bank values, respectively.

3. Tap of some transformers are assumed.

4. All of 150kV transformers are solidly grounded at their 150kV neutral points.

X"d	j26.2/2
X'd	j33.2/2
Tr	j15.3/2

	20MWx2	100MWx2
X"d	j60/2	j12.0/2
X'd	j112/2	j20.8/2
Tr	j32.8/2	j12.0/2

SOMVAx2	39MVAx4	
j19.7/2	j25.2/3	j26.1/1

X"d	j43.3/2	
X'd	j64.3/2	
Tr	j34.1/2	

X"d	j33.3/3
X'd	j49.5/3
Tr	j24.9/3

PERUSAHAAN UMUM LISTRIK NEGARA

THE GOVERNMENT OF THE REPUBLIC OF INDONESIA

SURABAYA CITY POWER DISTRIBUTION PROJECT

DEPARTMENT: S U B S T A T I O N

150KV Positive - Sequence Impedance

(As of March 1988)

DESIGNED | CHECKED: S.FUJIOKA | APPROVED | SCALE

DATE: Mar.21'88 | DRAWING No. D P | DATE OF REVISION

THE NEW JAPAN ENGINEERING CONSULTANTS INC. | DWG. NO. Impedance Map I

(Note) 1. The impedances are shown in percent on 100MVA base at 150kV.

2. Those of transmission lines and transformers are per-circuit and per-bank values, respectively.

3. Those of some transformers are assumed.

4. All of 150kV transformers are solidly grounded at their 150kV neutral points.

PETROKIMIA
30MVAx2
20KV
J52.4 J42.1
ACSR 330mm2 5.2Km
Z0=0.7701+j7.760
Y00=j0.1917
Y0=j0.1541
Y01=j0.2732
Z00=1.510+j4.067
Z01=0.2182+j1.116

BOJONEGORO
J63.0
20KV
20MVAx1
ACSR 240mm2 35.3Km
Z0=5.842+j19.00
Z00=10.83+j27.78
Z01=2.110+j7.678
Y0=j1.781
Y00=j1.031
Y01=j1.824

BABAD
Y00=j0.9029 Y01=j1.597
Y0 =j1.122
ACSR 240mm2 30.9Km
Z0=5.716+j16.64
Z00=9.486+j24.33
Z01=1.848+j6.723
J63.0
20KV
20MVAx1

LAMONGAN
Y00=j0.8237 Y01=j1.457
Y0=j1.023
ACSR 240mm2 26.2Km
Z0=4.667+j15.18
Z00=8.655+j22.20
Z01=1.685+j6.134
20KV
20MVAx1

SEGOROMADU
Y00=j0.1101 Y01=j0.1958
Y0 =j0.1370
GRESIK P.S.
ACSR 364.1mm2 3.74Km
Z0=0.5718+j2.005
Z00=1.101+j2.936
Z01=0.1769+j0.8056
J28.6
70KV
50MVAx1

J50.4/2 J19.1/2
ACSR 330mm2 Twin 23Km
Z0=2.912+j11.070
Z00=6.149+j16.691
Z01=0.482+j3.834
Y0=j1.014
Y00=j0.794
Y01=j1.540

ACSR 330mm2 Twin 7Km
Z0=3.165+j12.032
Z00=6.684+j18.132
Z01=0.524+j4.167
Y0=j1.103
Y00=j0.863
Y01=j1.674

50KV
SURABAYA BARAT
J4.2
20KV
ACSR 330mm2 Twin 14.59Km
Z0=1.847+j7.022
Z00=3.901+j10.582
Z01=0.306+j2.422
Y0=j0.643
Y00=j0.504
Y01=j0.977

30MVAx2
J19.3
J34.0
PERAK
ACSR 330mm2 8.647Km
Z0=1.169+j4.830
Z00=1.956+j7.772
Z01=0.382+j1.800
Y0=j0.314
Y00=j0.246
Y01=j0.449

TANDES
70KV
50MVAx2
20KV
30MVAx1
50MVAx1
ACSR 330mm2 13.905Km
Z0=1.774+j7.847
Z00=2.933+j12.634
Z01=0.615+j3.06
Y0=j0.384
Y00=j0.500
Y01=j0.716

15.00Km

30MVAx1
20KV
J28.0
KENJERAN
ACSR 330mm2 4.37Km
Z0=0.652+j2.318
Y0=j0.126
Y00=j0.227
Y01=j0.440
6.57Km

50MVAx1
20KV
J28.0
RUNGKUT
4.45Km
Z0=0.677+j2.035
Z00=1.253+j3.301
Z01=0.101+j0.769
Y0=j0.196
Y00=j0.154
Y01=j0.298
Z0=0.968+j2.911
Z00=1.792+j4.722
Z01=0.144+j1.100
Y0=j0.290
Y00=j0.227
Y01=j0.440
6.57Km

ACSR 330mm2 Twin 11.07Km
Z0=1.646+j4.950
Z00=3.047+j8.030
Z01=0.245+j1.870
Y0=j0.488
Y00=j0.382
Y01=j0.741
SUKOLILO
J42.1
J28.0
20KV
30MVAx1
50MVAx1

50MVAx2 39MVAx4
J25.8/2 J34.0/4

WARU
70KV
Z0=9.089+j32.804
Z00=17.817+j47.952
Z01=2.634+j13.168
Y0=j2.261
Y00=j1.818
Y01=j3.224
Z0=5.215+j18.824
Z00=10.224+j27.539
Z01=1.512+j7.556
Y0=j1.298
Y00=j1.043
Y01=j1.850
35.21Km

Z0=6.951+j25.089
Z00=13.627+j36.706
Z01=2.015+j10.071
Y0=j1.730
Y00=j1.391
Y01=j21.466
Z0=6.036+j21.765
Z00=11.833+j31.872
Z01=1.749+j8.745
Y0=j1.502
Y00=j1.208
Y01=j2.141
40.72Km

ACSR 330mm2 32.70Km
Z0=1.446+j6.945
Z00=2.325+j9.975
Z04=4.385+j18.35
Y01=j1.737
Y00=j0.9102
Y0=j1.201

PROBOLINGGO
ACSR 330mm2 46.93Km
LUMAJANG
ACSR 330mm2 61.36Km
ACSR 330mm2 54.17Km

SITUBONDO
BONDOWOSO
ACSR 330mm2 82.64Km
ACSR 330mm2
ACSR 330mm2

20MVAx1
20KV
J49.8
BANYUWANGI
Z0=12.241
+j44.180
Z00=23.996
+j64.636
Z01=3.548
+j17.735
Y0=j3.046
Y00=j2.449
Y01=j4.342
JEMBER

Z0=8.024+j28.960
Z00=15.729+j42.369
Z01=2.325+j11.625
Y0=j1.996
Y00=j1.605
Y01=j2.646
J34.0/2
70KV
35MVAx2
BANGIL
ACSR 330mm2
15.66Km
J34.0
70KV
350MVAx1
LEGES
ACSR 330mm2 86.52Km
Z0=12.815+j46.255
Z00=25.123+j67.671
Z01=3.714+j18.567
Y0=j3.189
Y00=j2.564
Y01=j4.546
J64.0
20KV
20MVAx1

Z0=2.349+j8.479
Z00=4.605+j12.405
Z01=0.681+j3.404
Y0=j0.585
Y00=j0.470
Y01=0.833

TO CENTRAL JAVA
ACSR 240mm2
102.11Km
Z0=16.90+j54.96
Z00=31.34+j80.37
Z01=6.104+j22.21
Y0=j3.706
Y00=j2.983
Y01=j5.277

KEDIRI BARU
ACSR 330mm2 71.30Km
Z0=10.562+j38.121
Z00=20.705+j55.771
Z01=3.061+j15.302
J34.0
70KV
35MVAx1
Y0=j2.628
Y00=j2.113
Y01=j3.746
PANISREJO

SEKAR PUTIH
ACSR 330mm2 64.26Km
Z0=9.518+j34.354
Z00=28.557+j32.840
Z01=2.759+j13.790
Y0=j2.368
Y00=j1.904
Y01=j3.378
J34.0
70KV
35MVAx1

ACSR 330mm2 Twin 24.06Km
Z0=3.046+j11.58
Z00=6.432+j17.450
Z01=0.505+j4.011
Y0=j1.061
Y00=j0.830
Y01=j1.611
J34.0
70KV
35MVAx1

SUTARI
Y01=j1.437
Y00=j0.7787
Y0=j1.019
Z01=1.226+j5.890
Z00=6.217+j25.23
Z0=3.719+j15.56
ACSR 330mm2 52.32Km
Z0=7.017+j29.366
Z00=11.737+j47.595
Z01=2.313+j9.714
Y0=j1.922
Y00=j1.469
Y01=j2.789
ACSR 330mm2 27.73Km

WLINGI
ACSR 160mm2 23.56Km
Z0=4.323+j13.18
Y0=j0.9304
J39.7
30MVAx1
J41.9/2
70KV
27MWx2

39MVAx3
J31.4/3
35MWx2

KEBONAGUNG
J28.0 J34.0
20KV 70KV
35MVAx1

PERUSAHAAN UMUM LISTRIK NEGARA
THE GOVERNMENT OF THE REPUBLIC OF INDONESIA

SURABAYA CITY POWER DISTRIBUTION PROJECT

DEPARTMENT: S U B S T A T I O N

150kV zero-sequence impedance map
(As of March 1988)

DESIGNED | DRAWN: J.FUJIOKA | APPROVED | SCALE
DATE: Mar.21'88 | STAGE: S D P | DATE OF REVISION
THE JAPAN OVERSEAS ELECTRIC POWER CONSULTANTS CO., LTD. | DWG NO: Impedance Map 11

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 14 & 23
GANGGUAN DI BUS 14 : SLG
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 23 : SLG
FASA YANG TERGANGGU : B

DI BUS 14

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-96.6696,	-77.0863) PU =	47.5898 KA

TEGANGAN			
Va = (	.8853,	.2735) PU =	138.9846 KV
Vb = (	-.6147,	-.5926) PU =	128.0731 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

DI BUS 23

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	-219.4350,	-27.9836) PU =	85.1451 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	1.0009,	.0060) PU =	150.1370 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	-.4991,	.8720) PU =	150.7080 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 8 & 19
GANGGUAN DI BUS 8 : SLG
FASA YANG TERGANGGU : a

GANGGUAN DI BUS 19 : SLG
FASA YANG TERGANGGU : c

DI BUS 8

ARUS LINE			
Ia = (	-14.9386,	196.5403) PU =	75.8666 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	-.4766,	-.8938) PU =	151.9341 KV
Vc = (	-.4766,	.8383) PU =	144.6407 KV

DI BUS 19

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	24.6198,	11.3239) PU =	10.4305 KA

TEGANGAN			
Va = (	1.0000,	.0000) PU =	149.9958 KV
Vb = (	-.5000,	-.8661) PU =	150.0081 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 12 & 27
GANGGUAN DI BUS 12 : SLG
FASA YANG TERGANGGU : B

GANGGUAN DI BUS 27 : SLG
FASA YANG TERGANGGU : C

DI BUS 12

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	147.2395,	-63.9644) PU =	61.7883 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.9919,	.0188) PU =	148.8093 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	-.5081,	.8848) PU =	153.0505 KV

DI BUS 27

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-15.1245,	-2.0905) PU =	5.8768 KA

TEGANGAN			
Va = (	1.0000,	.0000) PU =	150.0027 KV
Vb = (	-.5000,	-.8660) PU =	150.0008 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 4 & 26
GANGGUAN DI BUS 4 : SLG
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 26 : SLG
FASA YANG TERGANGGU : C

DI BUS 4

ARUS LINE				
Ia = (	-13.5973,	177.5515)	PU =	68.5397 KA
Ib = (	.0000,	.0000)	PU =	.0000 KA
Ic = (	.0000,	.0000)	PU =	.0000 KA

TEGANGAN				
Va = (	.0000,	.0000)	PU =	.0000 KV
Vb = (	-.5944,	-.8709)	PU =	158.1568 KV
Vc = (	-.5944,	.8612)	PU =	156.9623 KV

DI BUS 26

ARUS LINE				
Ia = (	.0000,	.0000)	PU =	.0000 KA
Ib = (	.0000,	.0000)	PU =	.0000 KA
Ic = (	-15.3327,	-68.8307)	PU =	27.1423 KA

TEGANGAN				
Va = (	1.0004,	-.0001)	PU =	150.0619 KV
Vb = (	-.4996,	-.8661)	PU =	149.9830 KV
Vc = (	.0000,	.0000)	PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 9 & 18
GANGGUAN DI BUS 9 : SLG
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 18 : DLO
FASA YANG TERGANGGU : A & B

DI BUS 9

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-211.7044,	-162.9296) PU =	102.8230 KA

TEGANGAN			
Va = (	1.0571,	-.0467) PU =	158.7133 KV
Vb = (	-.4429,	-.9127) PU =	152.1774 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

DI BUS 18

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-34.4727,	-12.4853) PU =	14.1120 KA

TEGANGAN			
Va = (	1.9022,	-.0034) PU =	285.3280 KV
Vb = (	-.9478,	-1.6488) PU =	285.2740 KV
Vc = (	-.5078,	.8906) PU =	153.7789 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 5 & 23
GANGGUAN DI BUS 5 : SLG
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 23 : DLO
FASA YANG TERGANGGU : A & B

DI BUS 5

ARUS LINE

Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	.0000,	.0000) PU =	.0000	KA
Ic = (	-175.3297,	-145.1100) PU =	87.5996	KA

TEGANGAN

Va = (	1.0981,	-.1177) PU =	165.6554	KV
Vb = (	-.4019,	-.9837) PU =	159.4011	KV
Vc = (	.0000,	.0000) PU =	.0000	KV

DI BUS 23

ARUS LINE

Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	.0000,	.0000) PU =	.0000	KA
Ic = (	-27.2444,	-12.3622) PU =	11.5154	KA

TEGANGAN

Va = (	1.9033,	-.0072) PU =	285.4998	KV
Vb = (	-.9467,	-1.6527) PU =	285.6956	KV
Vc = (	-.5084,	.8843) PU =	153.0083	KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 13 & 26
GANGGUAN DI BUS 13 : SLG
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 26 : DLO
FASA YANG TERGANGGU : B & C

DI BUS 13

ARUS LINE			
Ia = (	-13.0397,	125.9485) PU =	48.7367 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	-.5098,	-.8789) PU =	152.4030 KV
Vc = (	-.5098,	.8532) PU =	149.0808 KV

DI BUS 26

ARUS LINE			
Ia = (	5.7842,	23.4363) PU =	8.2813 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	1.0224,	-.0073) PU =	153.3624 KV
Vb = (	-.9510,	-1.6461) PU =	285.1639 KV
Vc = (	-.9510,	1.6448) PU =	284.9917 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 6 & 22
GANGGUAN DI BUS 6 : DLO
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 22 : SLG
FASA YANG TERGANGGU : C

DI BUS 6

ARUS LINE				
Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	.0000,	.0000) PU =	.0000	KA
Ic = (	-29.6180,	-20.5419) PU =	13.8735	KA

TEGANGAN				
Va = (	1.8779,	-.3978) PU =	287.9369	KV
Vb = (	-.5221,	-1.7835) PU =	278.7528	KV
Vc = (	-1.3354,	2.0580) PU =	367.9945	KV

DI BUS 22

ARUS LINE				
Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	.0000,	.0000) PU =	.0000	KA
Ic = (	-174.4296,	-61.8973) PU =	71.2398	KA

TEGANGAN				
Va = (	1.0028,	-.0078) PU =	150.4252	KV
Vb = (	-.4972,	-.8738) PU =	150.8090	KV
Vc = (	.0000,	.0000) PU =	.0000	KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 10 & 17
GANGGUAN DI BUS 10 : DLO
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 17 : SLG
FASA YANG TERGANGGU : C

DI BUS 10

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-13.2893,	-9.4903) PU =	6.2854 KA

TEGANGAN			
Va = (	1.7289,	-.1768) PU =	260.6800 KV
Vb = (	-.6711,	-1.5624) PU =	255.0694 KV
Vc = (	-.6887,	1.1084) PU =	195.7320 KV

DI BUS 17

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-36.1000,	-14.8929) PU =	15.0309 KA

TEGANGAN			
Va = (	1.0007,	-.0016) PU =	150.1023 KV
Vb = (	-.4993,	-.8876) PU =	150.1582 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 14 & 25
GANGGUAN DI BUS 14 : DLO
FASA YANG TERGANGGU : B & C

GANGGUAN DI BUS 25 : SLG
FASA YANG TERGANGGU : B

DI BUS 14

ARUS LINE				
Ia = (	-1.3186,	8.0425) PU =	3.1369	KA
Ib = (	.0000,	.0000) PU =	.0000	KA
Ic = (	.0000,	.0000) PU =	.0000	KA

TEGANGAN				
Va = (	1.3866,	.0409) PU =	208.0808	KV
Vb = (	-.8359,	-1.4042) PU =	245.1335	KV
Vc = (	-.8359,	1.3671) PU =	240.3576	KV

DI BUS 25

ARUS LINE				
Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	.6613,	-3.1470) PU =	1.2378	KA
Ic = (	.0000,	.0000) PU =	.0000	KA

TEGANGAN				
Va = (	1.0000,	.0000) PU =	150.0069	KV
Vb = (	.0000,	.0000) PU =	.0000	KV
Vc = (	-.5000,	.8661) PU =	150.0006	KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 11 & 16
GANGGUAN DI BUS 11 : DLO
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 16 : DLO
FASA YANG TERGANGGU : B & C

DI BUS 11

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	-10.4467,	-7.5902) PU =	4.9702 KA

TEGANGAN			
Va = (	1.6903,	-.1095) PU =	254.0692 KV
Vb = (	-.7097,	-1.4951) PU =	248.2562 KV
Vc = (	-.6779,	1.0862) PU =	192.0657 KV

DI BUS 16

ARUS LINE			
Ia = (	8.7346,	3.8915) PU =	3.6805 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	1.0006,	-.0012) PU =	150.0898 KV
Vb = (	-1.1254,	-1.9477) PU =	337.4265 KV
Vc = (	-1.1254,	1.9494) PU =	337.6406 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 7 & 21
GANGGUAN DI BUS 7 : DLO
FASA YANG TERGANGGU : B & C

GANGGUAN DI BUS 21 : DLO
FASA YANG TERGANGGU : A & B

DI BUS 7

ARUS LINE				
Ia = (	-1.4869,	13.2798) PU =		5.1433 KA
Ib = (	.0000,	.0000) PU =		.0000 KA
Ic = (	.0000,	.0000) PU =		.0000 KA

TEGANGAN				
Va = (	1.6365,	.0347) PU =		245.5272 KV
Vb = (	-.8604,	-1.4131) PU =		248.1636 KV
Vc = (	-.8604,	1.3582) PU =		241.1701 KV

DI BUS 21

ARUS LINE				
Ia = (	.0000,	.0000) PU =		.0000 KA
Ib = (	.0000,	.0000) PU =		.0000 KA
Ic = (	.6952,	-4.4169) PU =		1.7210 KA

TEGANGAN				
Va = (	2.2502,	.0001) PU =		337.5262 KV
Vb = (	-1.1248,	-1.9485) PU =		337.4766 KV
Vc = (	-.5013,	.8659) PU =		150.0836 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Z (SERI-SERI)
TERJADI DI BUS : 15 & 24
GANGGUAN DI BUS 15 : DLO
FASA YANG TERGANGGU : B & C

GANGGUAN DI BUS 24 : DLO
FASA YANG TERGANGGU : A & B

DI BUS 15

ARUS LINE			
Ia = (	-1.1320,	7.7382) PU =	3.0101 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	1.5486,	.0152) PU =	232.3055 KV
Vb = (	-.7392,	-1.4088) PU =	238.6390 KV
Vc = (	-.7392,	1.3625) PU =	232.5170 KV

DI BUS 24

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	2.5965,	3.5335) PU =	1.6878 KA

TEGANGAN			
Va = (	2.2501,	-.0003) PU =	337.5201 KV
Vb = (	-1.1249,	-1.9489) PU =	337.5294 KV
Vc = (	-.4986,	.8647) PU =	149.7229 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 2 & 24
GANGGUAN DI BUS 2 : OLO
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 24 : OLO
FASA YANG TERGANGGU : C

DI BUS 2

ARUS LINE			
Ia = (	.0000,	6.9565) PU =	.0000 KA
Ib = (	.0000,	5.5609) PU =	3.0833 KA
Ic = (	3.7789,	5.6683) PU =	3.1429 KA

TEGANGAN			
Va = (	.9341,	.5255) PU =	218.9405 KV
Vb = (	.6448,	.3627) PU =	151.1190 KV
Vc = (	.6928,	.3897) PU =	162.3690 KV

DI BUS 24

ARUS LINE			
Ia = (	10.0371,	15.0557) PU =	10.8361 KA
Ib = (	10.0371,	15.0557) PU =	8.3478 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.6438,	.3621) PU =	150.8860 KV
Vb = (	.6912,	.3888) PU =	162.0000 KV
Vc = (	1.1662,	.6560) PU =	273.3180 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 7 & 22
GANGGUAN DI BUS 7 : OLO
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 22 : OLO
FASA YANG TERGANGGU : C

DI BUS 7

ARUS LINE			
Ia = (	.0000,	13.1104) PU =	.0000 KA
Ib = (	.0000,	10.7708) PU =	5.9720 KA
Ic = (	7.1217,	10.6825) PU =	5.9231 KA

TEGANGAN			
Va = (	1.0454,	.5880) PU =	245.0095 KV
Vb = (	.6559,	.3689) PU =	153.7203 KV
Vc = (	.6571,	.3696) PU =	153.9995 KV

DI BUS 22

ARUS LINE			
Ia = (	9.2007,	13.8010) PU =	9.9331 KA
Ib = (	9.2007,	13.8010) PU =	7.6522 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.6445,	.3625) PU =	151.0540 KV
Vb = (	.6534,	.3675) PU =	153.1429 KV
Vc = (	1.1584,	.6516) PU =	271.5043 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 11 & 17
GANGGUAN DI BUS 11 : OLO
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 17 : OLO
FASA YANG TERGANGGU : B

DI BUS 11

ARUS LINE			
Ia = (	9.9195,	14.8793) PU =	8.2500 KA
Ib = (	8.4932,	12.7398) PU =	7.0837 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.6532,	.3674) PU =	153.0909 KV
Vb = (	.6702,	.3770) PU =	157.0817 KV
Vc = (	1.1121,	.6256) PU =	260.6468 KV

DI BUS 17

ARUS LINE			
Ia = (	8.5031,	12.7547) PU =	9.1800 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	9.6899,	14.5348) PU =	8.0591 KA

TEGANGAN			
Va = (	.6457,	.3632) PU =	151.3271 KV
Vb = (	1.1729,	.6598) PU =	274.9055 KV
Vc = (	.6676,	.3755) PU =	156.4708 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 1 & 22
GANGGUAN DI BUS 1 : DLG
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 22 : OLO
FASA YANG TERGANGGU : C

DI BUS 1

ARUS LINE				
Ia = (	47.2357,	70.8536) PU =	39.2857 KA
Ib = (	46.8922,	70.3383) PU =	39.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.6392,	.3595) PU =	149.8117 KV

DI BUS 22

ARUS LINE			
Ia = (	8.8468,	13.2702) PU =	7.3579 KA
Ib = (	2.0378,	3.0567) PU =	1.6948 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.3895,	.7233) PU =	166.9231 KV
Vb = (	.4031,	.7485) PU =	172.7358 KV
Vc = (	.9234,	1.7149) PU =	395.7358 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 5 & 22
GANGGUAN DI BUS 5 : DLG
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 22 : OLO
FASA YANG TERGANGGU : B

DI BUS 5

ARUS LINE			
Ia = (	115.9422,	173.9133) PU =	96.4286 KA
Ib = (	114.2246,	171.3369) PU =	95.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.6360,	.3577) PU =	149.0584 KV

DI BUS 22

ARUS LINE			
Ia = (	8.8468,	13.2702) PU =	7.3579 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	5.2904,	7.9356) PU =	4.4000 KA

TEGANGAN			
Va = (	.3593,	.6672) PU =	153.9732 KV
Vb = (	.3723,	.6913) PU =	159.5358 KV
Vc = (	.3934,	.7306) PU =	168.5929 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 4 & 23
GANGGUAN DI BUS 4 : DLG
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 23 : DLG
FASA YANG TERGANGGU : B & C

DI BUS 4

ARUS LINE			
Ia = (	96.3609,	144.5413) PU =	80.1428 KA
Ib = (	97.3915,	146.0872) PU =	81.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.6368,	.3582) PU =	149.2547 KV

DI BUS 23

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	91.3268,	136.9902) PU =	75.9560 KA
Ic = (	87.1020,	130.6530) PU =	72.4423 KA

TEGANGAN			
Va = (	.6376,	.3586) PU =	149.4286 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 1 & 27
GANGGUAN DI BUS 1 : DLG
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 27 : DLG
FASA YANG TERGANGGU : A & C

DI BUS 1

ARUS LINE				
Ia = (	44.8310,	67.2465) PU =	37.2857 KA
Ib = (	46.8922,	70.3383) PU =	39.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.6392,	.3596) PU =	149.8201 KV

DI BUS 27

ARUS LINE			
Ia = (	108.5747,	162.8620) PU =	90.3010 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	126.5981,	189.8971) PU =	105.2910 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.6229,	.3504) PU =	146.0000 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 8 & 20
GANGGUAN DI BUS 8 : DLG
FASA YANG TERGANGGU : B & C

GANGGUAN DI BUS 20 : DLG
FASA YANG TERGANGGU : A & B

DI BUS 8

ARUS LINE				
Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	65.8525,	98.7788) PU =	54.7692	KA
Ic = (	72.5118,	108.7677) PU =	60.3077	KA

TEGANGAN				
Va = (	.6374,	.3585) PU =	149.3846	KV
Vb = (	.0000,	.0000) PU =	.0000	KV
Vc = (	.0000,	.0000) PU =	.0000	KV

DI BUS 20

ARUS LINE				
Ia = (	96.1891,	144.2837) PU =	80.0000	KA
Ib = (	95.0052,	142.5079) PU =	79.0154	KA
Ic = (	.0000,	.0000) PU =	.0000	KA

TEGANGAN				
Va = (	.0000,	.0000) PU =	.0000	KV
Vb = (	.0000,	.0000) PU =	.0000	KV
Vc = (	.6357,	.3576) PU =	148.9846	KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 10 & 18
GANGGUAN DI BUS 10 : DLO
FASA YANG TERGANGGU : C & B

GANGGUAN DI BUS 18 : DLG
FASA YANG TERGANGGU : A & B

DI BUS 10

ARUS LINE			
Ia = (	12.9855,	19.4783) PU =	10.8000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.3548,	.6589) PU =	152.0652 KV
Vb = (	.7347,	1.3645) PU =	314.8923 KV
Vc = (	.6835,	1.2693) PU =	292.9211 KV

DI BUS 18

ARUS LINE			
Ia = (	86.5702,	129.8553) PU =	72.0000 KA
Ib = (	83.8000,	125.6999) PU =	69.6960 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.3332,	.6188) PU =	142.8000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 13 & 25
GANGGUAN DI BUS 13 : DLO
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 25 : DLG
FASA YANG TERGANGGU : B & C

DI BUS 13

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	5.2770,	7.9156) PU =	4.3889 KA

TEGANGAN			
Va = (	.6210,	1.1533) PU =	266.1351 KV
Vb = (	.6601,	1.2258) PU =	282.8786 KV
Vc = (	.3938,	.7314) PU =	168.7778 KV

DI BUS 25

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	97.3151,	145.9726) PU =	80.9365 KA
Ic = (	90.2778,	135.4167) PU =	75.0836 KA

TEGANGAN			
Va = (	.3306,	.6140) PU =	141.7031 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 10 & 22
GANGGUAN DI BUS 10 : DLO
FASA YANG TERGANGGU : C & B

GANGGUAN DI BUS 22 : DLG
FASA YANG TERGANGGU : A & B

DI BUS 10

ARUS LINE			
Ia = (	13.2702,	19.9054) PU =	11.0368 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.3556,	.6603) PU =	152.3880 KV
Vb = (	.7357,	1.3663) PU =	315.2923 KV
Vc = (	.6474,	1.2024) PU =	277.4666 KV

DI BUS 22

ARUS LINE			
Ia = (	88.4682,	132.7024) PU =	73.5786 KA
Ib = (	85.6373,	128.4559) PU =	71.2241 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.3328,	.6181) PU =	142.6421 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE II
TERJADI DI BUS : 11 & 17
GANGGUAN DI BUS 11 : DLO
FASA YANG TERGANGGU : A & C

GANGGUAN DI BUS 17 : OLO
FASA YANG TERGANGGU : B

DI BUS 11

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	15.5931,	23.3896) PU =	12.9887 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.6122,	1.1369) PU =	262.3687 KV
Vb = (	.3550,	.6593) PU =	152.1566 KV
Vc = (	.6951,	1.2909) PU =	297.8889 KV

DI BUS 17

ARUS LINE			
Ia = (	8.1761,	12.2641) PU =	6.8000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	3.5403,	5.3104) PU =	2.9444 KA

TEGANGAN			
Va = (	.3540,	.6575) PU =	151.7309 KV
Vb = (	.3588,	.6663) PU =	153.7709 KV
Vc = (	.3872,	.7192) PU =	165.9578 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 12 & 24
GANGGUAN DI BUS 12 : DLO
FASA YANG TERGANGGU : A & B

GANGGUAN DI BUS 24 : DLO
FASA YANG TERGANGGU : C

DI BUS 12

ARUS LINE				
Ia = (	.0000,	.0000)	PU =	.0000 KA
Ib = (	.0000,	.0000)	PU =	.0000 KA
Ic = (	10.0197,	15.0295)	PU =	8.3333 KA

TEGANGAN				
Va = (	.6238,	1.1585)	PU =	267.3556 KV
Vb = (	.7781,	1.4450)	PU =	333.4717 KV
Vc = (	.3904,	.7251)	PU =	167.3333 KV

DI BUS 24

ARUS LINE				
Ia = (	9.6511,	14.4766)	PU =	8.0268 KA
Ib = (	13.0436,	19.5654)	PU =	10.8483 KA
Ic = (	.0000,	.0000)	PU =	.0000 KA

TEGANGAN				
Va = (	.3556,	.6604)	PU =	152.4080 KV
Vb = (	.3565,	.6621)	PU =	152.8027 KV
Vc = (	.6708,	1.2457)	PU =	287.4693 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 9 & 21
GANGGUAN DI BUS 9 : DLO
FASA YANG TERGANGGU : B & C

GANGGUAN DI BUS 21 : OLO
FASA YANG TERGANGGU : C

DI BUS 9

ARUS LINE			
Ia = (	10.1336,	15.2005) PU =	8.4281 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.3554,	.6601) PU =	152.3311 KV
Vb = (	1.1753,	2.1828) PU =	503.7179 KV
Vc = (	.6389,	.6389) PU =	273.8184 KV

DI BUS 21

ARUS LINE			
Ia = (	8.4447,	12.6670) PU =	7.0234 KA
Ib = (	12.5481,	18.8222) PU =	10.4362 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.3555,	.6601) PU =	152.3411 KV
Vb = (	.3571,	.6632) PU =	153.0357 KV
Vc = (	.6888,	1.2792) PU =	295.1895 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 8 & 20
GANGGUAN DI BUS 8 : SLG
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 20 : DLG
FASA YANG TERGANGGU : B & C

DI BUS 8

ARUS LINE			
Ia = (	73.2517,	109.8776) PU =	60.9231 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.6308,	.3548) PU =	147.8462 KV
Vc = (	.6355,	.3575) PU =	148.9459 KV

DI BUS 20

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	73.9916,	110.9874) PU =	61.5385 KA
Ic = (	65.7046,	98.5568) PU =	54.6462 KA

TEGANGAN			
Va = (	.3285,	.6101) PU =	140.8000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 15 & 27
GANGGUAN DI BUS 15 : SLG
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 27 : DLG
FASA YANG TERGANGGU : B & C

DI BUS 15

ARUS LINE				
Ia = (	99.1950,	148.7925) PU =	82.5000	KA
Ib = (	.0000,	.0000) PU =	.0000	KA
Ic = (	.0000,	.0000) PU =	.0000	KA

TEGANGAN				
Va = (	.0000,	.0000) PU =	.0000	KV
Vb = (	.6300,	.3544) PU =	147.6667	KV
Vc = (	.6339,	.3566) PU =	148.5724	KV

DI BUS 27

ARUS LINE				
Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	100.1970,	150.2955) PU =	83.3333	KA
Ic = (	88.9749,	133.4624) PU =	74.0000	KA

TEGANGAN				
Va = (	.3272,	.6077) PU =	140.2475	KV
Vb = (	.0000,	.0000) PU =	.0000	KV
Vc = (	.0000,	.0000) PU =	.0000	KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 11 & 23
GANGGUAN DI BUS 11 : SLG
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 23 : DLG
FASA YANG TERGANGGU : A & B

DI BUS 11

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	73.4778,	110.2167) PU =	61.1111 KA

TEGANGAN			
Va = (	.6374,	.3585) PU =	149.3889 KV
Vb = (	.6319,	.3555) PU =	148.1111 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

DI BUS 23

ARUS LINE			
Ia = (	72.0082,	108.0123) PU =	59.8889 KA
Ib = (	73.4778,	110.2167) PU =	61.1111 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.3321,	.6167) PU =	142.3077 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 9 & 19
GANGGUAN DI BUS 9 : SLG
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 19 : OLO
FASA YANG TERGANGGU : A

DI BUS 9

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	76.6224,	114.9337) PU =	63.7265 KA

TEGANGAN			
Va = (	.6370,	.3583) PU =	149.3077 KV
Vb = (	.6308,	.3548) PU =	147.8462 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

DI BUS 19

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	9.5035,	14.2552) PU =	7.9040 KA
Ic = (	10.5765,	15.8647) PU =	8.7964 KA

TEGANGAN			
Va = (	1.1432,	.6430) PU =	267.9281 KV
Vb = (	.6490,	.3651) PU =	152.1111 KV
Vc = (	.6619,	.3723) PU =	155.1238 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE H
TERJADI DI BUS : 14 & 26
GANGGUAN DI BUS 14 : SLG
FASA YANG TERGANGGU : C

GANGGUAN DI BUS 26 : OLO
FASA YANG TERGANGGU : B

DI BUS 14

ARUS LINE			
Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	85.4633,	128.1949) PU =	71.0794 KA

TEGANGAN			
Va = (	.6367,	.3581) PU =	149.2222 KV
Vb = (	.6305,	.3547) PU =	147.7778 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

DI BUS 26

ARUS LINE			
Ia = (	10.8736,	16.3103) PU =	11.7391 KA
Ib = (	.0000,	.0000) PU =	.0000 KA
Ic = (	12.0903,	18.1354) PU =	10.0554 KA

TEGANGAN			
Va = (	.6462,	.3635) PU =	151.4467 KV
Vb = (	1.2660,	.7121) PU =	296.7210 KV
Vc = (	.6646,	.3739) PU =	155.7716 KV

LAMPIRAN V

FAKULTAS TEKNIK
JURUSAN TEHNIK ELEKTRO
UNIVERSITAS KRISTEN PETRA
S U R A B A Y A

USULAN TUGAS AKHIR

Dosen Pembimbing : DR. Ontoseno Penangsang

Nama Mahasiswa : Danny Gandahanindija

NIRM / NRP : 83. 7. 002. 31071. 23744./ 483022

Judul Tugas Akhir : Analisa Gangguan Simultan Dengan Metode "Two-Port Network" Dan Penerapannya Pada Sistem 150 kV Di Jatim

Lampiran Tugas Akhir Meliputi:

1. Latar Belakang Pemilihan Judul
2. Ruang Lingkup Pembahasan
3. Tujuan
4. Metode Yang Digunakan
5. Mata Kuliah Penunjang
6. Uraian Singkat
7. Jadwal Kegiatan
8. Relevansi

Surabaya, 22 Maret 1990

Ketua Jurusan

Ir. Bunawi Gunawidjaja

Dosen Pembimbing I

DR. Ontoseno Penangsang

Ketua Bidang Studi

Ir. Bunawi Gunawidjaja

Dosen Pembimbing II

Ir. Vincent W. Prasetyo

I. JUDUL

ANALISA GANGGUAN SIMULTAN DENGAN METODE "TWO-PORT NETWORK " DAN PENERAPANNYA PADA SISTEM 150 kV DI JATIM

II. LATAR BELAKANG

Sejalan dengan perkembangan tehnologi khususnya dibidang sistem tenaga listrik, maka kita dituntut untuk semakin mampu mengatasi berbagai macam gangguan yang mungkin timbul pada sistem tenaga listrik. Macam gangguan yang mungkin timbul ada dua jenis, pertama dinamakan gangguan shunt yang meliputi gangguan satu phasa ketanah, dua phasa ketanah, antar phasa dan tiga phasa simetris, yang kedua dinamakan gangguan seri yang meliputi gangguan satu phasa terbuka dan dua phasa terbuka. Gangguan-gangguan tersebut dapat terjadi secara bersamaan dan merupakan kombinasi antara gangguan shunt dan gangguan seri, sebagai akibat dari sambaran petir, bencana alam, dan sebagainya. Gangguan semacam ini dikenal dengan nama Gangguan Simultan. Untuk menganalisa gangguan simultan tersebut dipilih suatu metode yang handal dan tepat yaitu metode "Two-Port Network". Dengan metode ini diharapkan persoalan analisa gangguan simultan dapat ditangani dengan baik.

III. RUANG LINGKUP PEMBAHASAN

Menganalisa gangguan simultan dengan metode "Two-Port Network" meliputi:

3.1. Teori Komponen Simetri

3.2. Gangguan-gangguan shunt dan seri

3.3. Metode "Two-Port Network"

3.4. Pengolahan Data

IV. TUJUAN

Memperkenalkan penggunaan metode "Two-Port Network" untuk menganalisa gangguan simultan dalam sistem tenaga listrik.

V. METODE YANG DIGUNAKAN

5.1. Studi Pustaka

5.2. Pengumpulan Data

5.3. Pengolahan Data

5.4. Pengetestan model sistem

VI. MATA KULIAH PENUNJANG

6.1. Analisa Sistem Tenaga

6.2. Penggunaan Komputer Dalam Sistem Tenaga

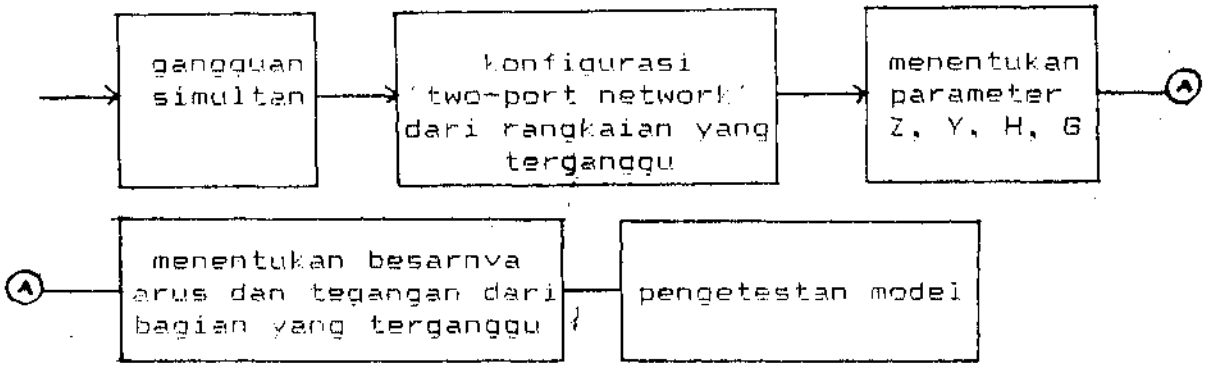
6.3. Rangkaian Listrik

VII. URAIAN SINGKAT

Dalam menganalisa gangguan simultan dengan metode "Two-Port Network", maka setiap titik gangguan digambarkan dengan rangkaian "Two-Port", yaitu rangkaian dengan dua pasang terminal dimana pada setiap pasang terminal terdapat arus yang meninggalkan satu bagian terminal menuju ke bagian terminal yang lain, dimana keduanya memiliki harga arus yang sama. Untuk menjamin syarat ini maka dipasangkan transformator ideal pada masing-masing terminal sebelum dibuat hubungan-hubungan keluar.

Dengan memperhatikan jenis gangguan dan konfigurasi dari rangkaian "Two-Port" maka dapat ditentukan parameter-parameter Z, Y, H. Parameter-parameter ini diperlukan untuk menentukan besarya arus dan tegangan pada titik gangguan. Untuk memudahkan dan mempercepat proses penghitungan dipergunakan komputer sebagai alat bantu.

Karena alasan-alasan praktis maka jenis gangguan simultan dibatasi untuk gangguan-gangguan yang mungkin terjadi (sering terjadi) yaitu, gangguan tipe Z (seri- seri), gangguan tipe Y (paralel-paralel) dan gangguan tipe H (seri-paralel). Untuk lebih memperjelas proses analisa gangguan simultan dengan metode diatas ditunjukkan oleh blok-diagram dibawah ini.



blok-diagram dari analisa gangguan simultan dengan metode 'two-port network'

VIII. JADWAL KEGIATAN

BULAN / KEGIATAN	I	II	III	IV	V	VI
STUDI PUSTAKA	X					
PENGUMPULAN DATA		X				
PENGOLAHAN DATA			X			
PEMROGRAMAN KOMPUTER				X		
PENGETESTAN MODEL					X	
PEJILIDAN BUKU						X

IX. RELEVANSI

Dengan adanya metode "Two-Port Network" maka analisa gangguan dapat ditangani dengan baik sehingga menunjang terciptanya suatu sistem tenaga listrik yang kontinu dan handal

VI. BIODATA

N a m a	:	Danny Gandahanindija
Tanggal lahir	:	Surabaya, 12 Februari 1965
N R P	:	4 8 3 0 2 2
N I R M	:	83. 7. 002. 31071. 23774
Pendidikan	:	- 1976, lulus SD IMKA
		- 1980, lulus SMP IMKA
		- 1983, lulus SMA ST LOUIS
		- 1983, kuliah di UK PETRA
		Jurusan Tehnik Elektro

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 3 & 25
GANGGUAN DI BUS 3 : OLO
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 25 : DLG
FASA YANG TERGANGGU : B & C

DI BUS 3

ARUS LINE				
Ia = (	.0000,	9.6619) PU =	.0000	KA
Ib = (	.0000,	8.1160) PU =	4.5000	KA
Ic = (	6.0290,	9.0435) PU =	5.0143	KA

TEGANGAN				
Va = (	.9982,	.5615) PU =	233.9524	KV
Vb = (	.6469,	.3639) PU =	151.6286	KV
Vc = (	.6779,	.3813) PU =	158.8819	KV

DI BUS 25

ARUS LINE				
Ia = (	.0000,	.0000) PU =	.0000	KA
Ib = (	100.5321,	150.7981) PU =	83.6120	KA
Ic = (	98.5215,	147.7822) PU =	81.9398	KA

TEGANGAN				
Va = (	.3162,	.5872) PU =	135.5072	KV
Vb = (	.0000,	.0000) PU =	.0000	KV
Vc = (	.0000,	.0000) PU =	.0000	KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 6 & 23
GANGGUAN DI BUS 6 : OLO
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 23 : DLG
FASA YANG TERGANGGU : A & B

DI BUS 6

ARUS LINE			
Ia = (	.0000,	10.4051) PU =	.0000 KA
Ib = (	.0000,	8.7403) PU =	4.8462 KA
Ic = (	6.4928,	9.7391) PU =	5.4000 KA

TEGANGAN			
Va = (	.9959,	.5602) PU =	233.4182 KV
Vb = (	.6531,	.3674) PU =	153.0702 KV
Vc = (	.6594,	.3709) PU =	154.5557 KV

DI BUS 23

ARUS LINE			
Ia = (	55.4937,	83.2406) PU =	46.1538 KA
Ib = (	92.4895,	138.7343) PU =	76.9231 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.3321,	.6167) PU =	142.3077 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 10 & 18
GANGGUAN DI BUS 10 : OLO
FASA YANG TERGANGGU : A

GANGGUAN DI BUS 18 : DLG
FASA YANG TERGANGGU : A & B

DI BUS 10

ARUS LINE			
Ia = (	.0000,	17.3418) PU =	.0000 KA
Ib = (	.0000,	14.5671) PU =	8.0769 KA
Ic = (	10.8213,	16.2319) PU =	9.0000 KA

TEGANGAN			
Va = (	1.2089,	.6789) PU =	282.8735 KV
Vb = (	.6670,	.3752) PU =	156.3248 KV
Vc = (	.6533,	.3675) PU =	153.1248 KV

DI BUS 18

ARUS LINE			
Ia = (	92.4895,	138.7343) PU =	76.9231 KA
Ib = (	86.5702,	129.8553) PU =	72.0000 KA
Ic = (	.0000,	.0000) PU =	.0000 KA

TEGANGAN			
Va = (	.0000,	.0000) PU =	.0000 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.3332,	.6188) PU =	142.8000 KV

HASIL PERHITUNGAN
ANALISA GANGGUAN SIMULTAN

TIPE GANGGUAN : TIPE Y (PARALEL-PARALEL)
TERJADI DI BUS : 9 & 19
GANGGUAN DI BUS 9 : DLG
FASA YANG TERGANGGU : B & C

GANGGUAN DI BUS 19 : DLG
FASA YANG TERGANGGU : A

DI BUS 9

ARUS LINE

Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	81.5758,	122.3636) PU =	67.8462 KA
Ic = (	84.0730,	126.1095) PU =	69.9231 KA

TEGANGAN

Va = (	.6370,	.3583) PU =	149.3077 KV
Vb = (	.0000,	.0000) PU =	.0000 KV
Vc = (	.0000,	.0000) PU =	.0000 KV

DI BUS 19

ARUS LINE

Ia = (	.0000,	.0000) PU =	.0000 KA
Ib = (	12.6175,	18.9263) PU =	10.4939 KA
Ic = (	3.5383,	3.8075) PU =	2.1111 KA

TEGANGAN

Va = (	.6280,	1.1663) PU =	269.1422 KV
Vb = (	.3567,	.6624) PU =	152.8711 KV
Vc = (	.3922,	.7283) PU =	168.0677 KV