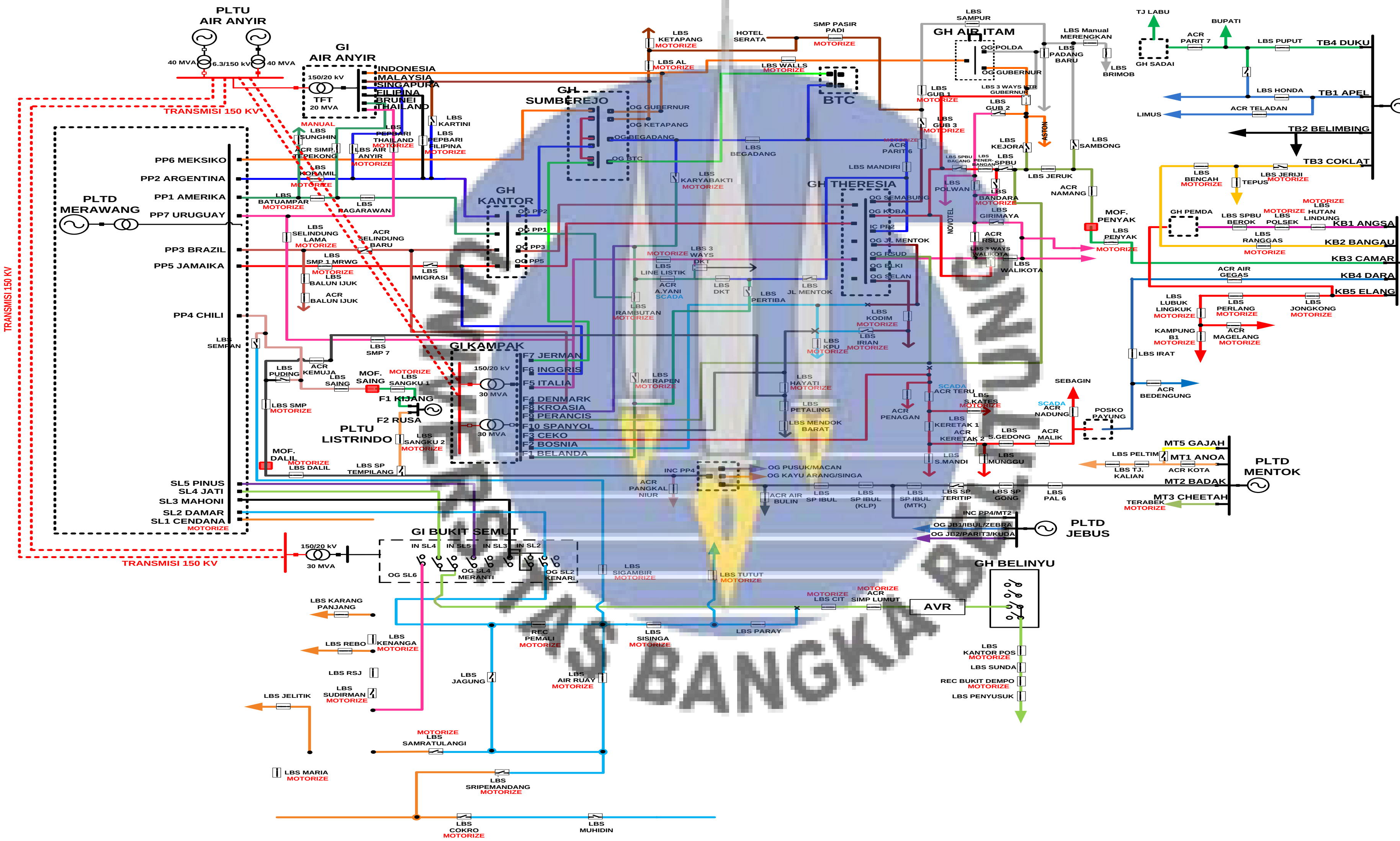
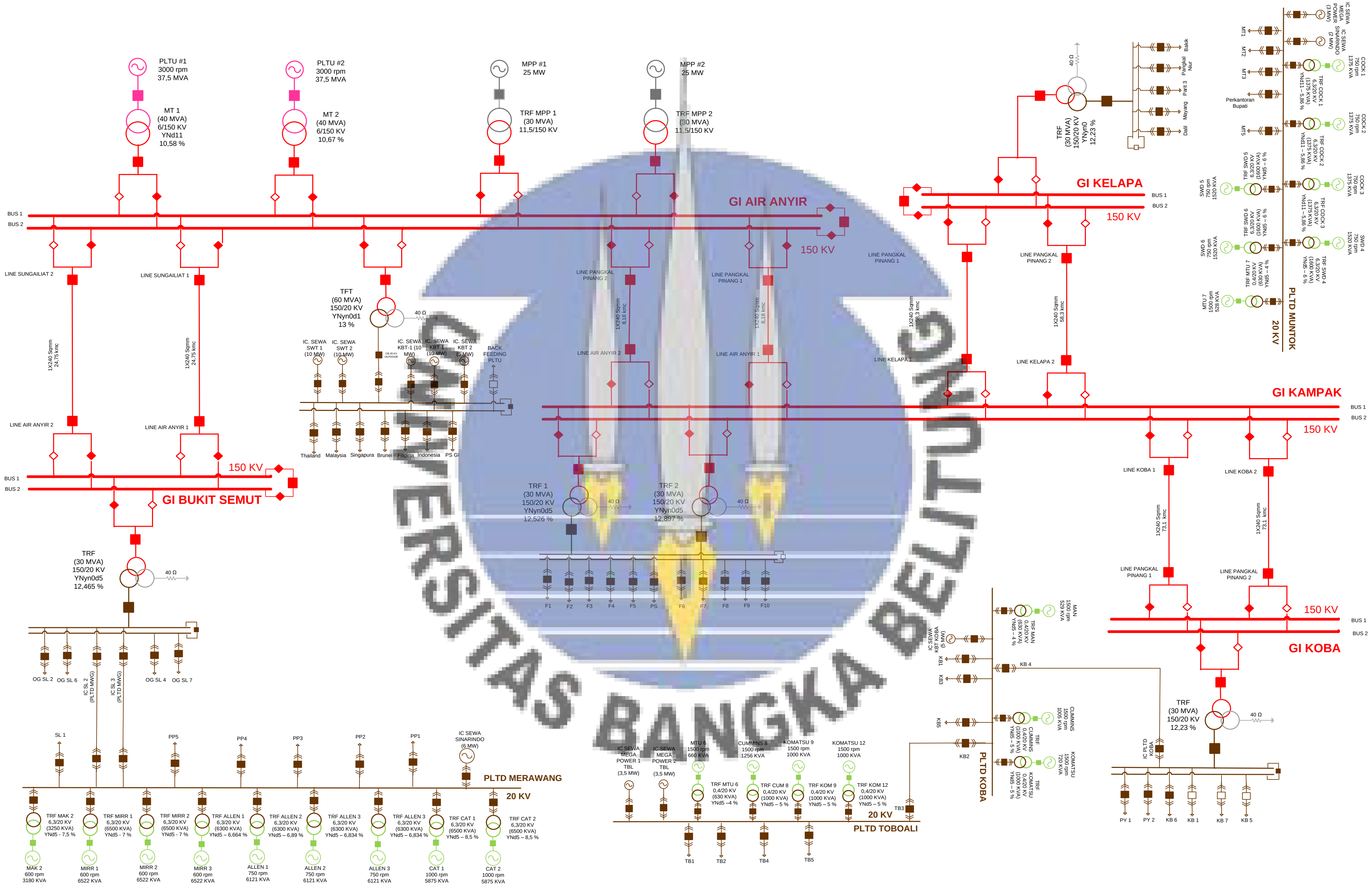
SINGLE LINE DIAGRAM
PT PLN (Persero) WILAYAH BANGKA BELITUNG
AREA BANGKA




UNIVERSITAS BANGKA BELITUNG



PLTU #1
3000 rpm
37,5 MVA
MT 1
(40 MVA)
6/150 KV
YNd11
10,58 %
PLTU #2
3000 rpm
37,5 MVA
MT 2
(40 MVA)
6/150 KV
10,67 %
MPP #1
25 MW
TRF MPP 1
(30 MVA)
11,5/150 KV
MPP #2
25 MW
TRF MPP 2
(30 MVA)
11,5/150 KV
BUS 1
BUS 2
GI AIR ANYIR
150 KV
LINE SUNGAILIAT 2
LINE SUNGAILIAT 1
1X240 Sqmm
24,75 kmc
LINE AIR ANYIR 2
LINE AIR ANYIR 1
GI BUKIT SEMUT
TRF
(30 MVA)
150/20 KV
YNyn0d5
12,465 %
40 Ω
OG SL 2
OG SL 6
OG SL 4
OG SL 7
TFT
(60 MVA)
150/20 KV
YNyn0d1
13 %
Thailand
Malaysia
Singapura
Brunei
Filipina
Indonesia
PS GI
BACK FEEDING PLTU
LINE PANGKAL PINANG 2
LINE PANGKAL PINANG 1
TRF 1
(30 MVA)
150/20 KV
YNyn0d5
12,526 %
TRF 2
(30 MVA)
150/20 KV
YNyn0d5
12,897 %
F1
F2
F3
F4
F5
PS
F6
F7
F8
F9
F10
GI KELAPA
TRF
(30 MVA)
150/20 KV
YNyn0
12,23 %
LINE KELAPA 1
LINE KELAPA 2
GI KAMPAK
LINE KOBA 1
LINE KOBA 2
1X240 Sqmm
73,1 kmc
GI KOBA
TRF
(30 MVA)
150/20 KV
12,23 %
PLTD MUNTOK
20 KV
PLTD KOBA
PY 1
PY 2
KB 6
KB 1
KB 7
KB 5
PLTD MERAWANG
20 KV
SL 1
PP5
PP4
PP3
PP2
PP1
IC SEWA SINARINDO (6 MW)
MAK 2
600 rpm
3180 KVA
MIRR 1
600 rpm
6522 KVA
MIRR 2
600 rpm
6522 KVA
MIRR 3
600 rpm
6522 KVA
ALLEN 1
750 rpm
6121 KVA
ALLEN 2
750 rpm
6121 KVA
ALLEN 3
750 rpm
6121 KVA
CAT 1
1000 rpm
5875 KVA
CAT 2
1000 rpm
5875 KVA
PLTD TOBOALI
20 KV
TB1
TB2
TB4
TB5

DATA PARAMETER SALURAN TRANSMISI TEGANGAN TINGGI

termasuk apabila terdapat reaktor seri

Section		Tegangan Kerja (kV)	JENIS / PENAMPANG	Single/Bundle Cond	Type Tower	Circuit Breaker				JARAK (km)	Impedansi per km			Impedansi Total		
						Asal		Tujuan			R+	X+	B+	R+	X+	B+
Asal	Tujuan					Amp	kA	Amp	kA		ohm	ohm	mS	ohm	ohm	mS
1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18
GI Air Anyir (Pangkal Pinang 1)	GI Pangkal Pinang (Air Anyir 1)	150	ACSRr 1x240 mm2	Single		3150	40	3150	40	8,18	0,122	0,407	2,898	1,000	3,332	23,706
GI Air Anyir (Pangkal Pinang 2)	GI Pangkal Pinang (Air Anyir 2)	150	ACSRr 1x240 mm2	Single		3150	40	3150	40	8,18	0,122	0,407	2,898	1,000	3,332	23,706
GI Air Anyir (Sungailiat 1)	GI Sungailiat (Air Anyir 1)	150	ACSRr 1x240 mm2	Single		3150	40	3150	40	24,75	0,122	0,407	2,898	3,024	10,081	71,725
GI Air Anyir (Sungailiat 2)	GI Sungailiat (Air Anyir 2)	150	ACSRr 1x240 mm2	Single		3150	40	3150	40	24,75	0,122	0,407	2,898	3,024	10,081	71,725
GI Kampak (Kelapa 1)	GI Kelapa (Pangkal Pinang 1)	150	ACSRr 1x240 mm2	Single		3150	40	3150	40	58,3	0,122	0,407	2,898	7,124	23,746	168,953
GI Kampak (Kelapa 2)	GI Kelapa (Pangkal Pinang 2)	150	ACSRr 1x240 mm2	Single		3150	40	3150	40	58,3	0,122	0,407	2,898	7,124	23,746	168,953

DATA TRAFO DAYA GARDU INDUK DAN PEMBANGKIT

No	Lokasi	Unit	Merk	Kapasitas	Tegangan		Circuit Breaker		Vector	Impedansi	Pentanahan
				(MVA)	(kV)		Primer	Sekunder	Group	(%)	(ohm)
					Primer	Sekunder	kA	kA			
	1	2	3	4	5	6	7	8	9	10	11
	PLTD Merawang										
1	MAK		UNINDO	3,250	6,300	20,500		16,000	YNd5	7,5	0
2	MIRRLEES 1		UNINDO	6,500	6,300	21,000		16,000	YNd5	7	0
3	MIRRLEES 2		UNINDO	6,500	6,300	21,000		16,000	YNd5	7	0
4	ALLEN 1		PAUWELS	6,300	6,300	20,000		63,000	YNd5	6,664	0
5	ALLEN 2		PAUWELS	6,300	6,300	20,000		63,000	YNd5	6,89	0
6	ALLEN 3		PAUWELS	6,300	6,300	20,000		63,000	YNd5	6,834	0
7	CATERPILLAR 1		TRAFINDO	6,500	6,300	20,000		40,000	YNd5	8,5	0
8	CATERPILLAR 2		TRAFINDO	6,500	6,300	20,000		40,000	YNd5	8,5	0
9	MIRRLEES 3		UNINDO	6,500	6,300	21,000		16,000	YNd5	7	0

Data Pembangkit

No.	PEMBANGKIT	BASIC DATA			LOAD FLOW					
		S (MVA)	V (kV)	pF	xd (pu)	xq (pu)	x0 (pu)	r0 (pu)	x2 (pu)	r2 (pu)
AIR ANYIR										
1	PLTU Unit 1	37.500	6300	0,85	2,297		0,073		0,1696	
2	PLTU Unit 2	37.500	6300	0,85	2,297		0,073		0,1696	
PLTGU										
3	PLTG MPP Unit 1	30800	11500	0,9	2,65	2,12	0,132	0,0162	0,2620	0,0532
4	PLTG MPP Unit 2	30800	11500	0,9	2,65	2,12	0,132	0,0162	0,2620	0,0532
PLTD MERAWANG										
5	MAK	3,180	6,300	0,80						
6	MIRRLEES 1	6,522	6,300	0,80						
7	MIRRLEES 2	6,522	6,300	0,80						
8	ALLEN 1	6,121	6,300	0,80						
9	ALLEN 2	6,121	6,300	0,80						
10	ALLEN 3	6,121	6,300	0,80						
11	CATERPILLAR 1	5,875	6,300	0,80						
12	CATERPILLAR 2	5,875	6,300	0,80						
13	MIRRLEES 3	6,522	6,300	0,80						

NO	PENYULANG	PEMBANGKIT / GI	R	S	T	ARUS RATA-RATA		BEBAN (KW)
1	Selindung (PP1)	PLTD MERAWANG	89	89	93	90	90	2.657
2	Riding Panjang (PP2)		0	0	0	-	-	-
3	Greenland (PP3)		62	64	64	63	63	1.863
4	Sempan (PP4)		75	77	82	78	78	2.294
5	Pangkalan baru (PP5)		69	68	69	69	68	2.019
6	Metro (PP6)		0	0	0	-	-	-
7	Girimaya(PP7)		0	0	0	-	-	-
8	Parit padang (SL1)		86	83	81	83	83	2.451
9	Lubuk kelik (SL2)		41	44	48	44	44	1.304
10	A Yani (SL3)		50	46	45	47	47	1.382
11	Batu rusa (OG A. Anyir)	GI AIR ANYIR	0	0	0	-	-	-
12	Jembatan Emas (OG Batu rusa)		0	0	0	-	-	-
13	Pangkal balam (OG PKL balam)		158	160	163	160	160	4.715
14	Propinsi (OG Propinsi)		153	155	158	155	155	4.568
15	Soekarno hatta (Thailand)		0	0	0	-	-	-
16	Gabek (Pilipina)		0	0	0	-	-	-
17	Kacang Pedang (F1)	GI PANGKALPINANG	109	108	106	108	107	3.166
18	Gandaria (F2)		91	97	89	92	92	2.716
19	Lampur (F3)		135	136	127	133	132	3.902
20	Kodim (F4)		158	158	161	159	195	5.755
21	Bukit Intan (F5)		197	195	195	152	151	4.461
22	Siloam (F6)		151	154	150	36	36	1.059
23	BTC (F7)		37	37	34	57	57	1.676
24	pasar pagi (F8)		55	53	58	45	45	1.333
25	Kampung jeruk (F9)		46	44	46	48	48	1.421
26	Cengkong abang (F10)		49	47	49	48	48	1.421

27	Air ruay (OG SL2)	GI SUNGAILIAT	116	116	116	116	116	3.412
28	Belinyu (OG SL4)		116	116	116	116	116	3.412
29	Tanjung Pesona (OG SL6)		160	160	160	160	160	4.706
30	Parai (OG SL7)		97	97	97	97	97	2.853
31	Berok (KB1)	PLTD KOBA	35	33	34	34	34	1.000
32	Nibung(KB2)		58	59	60	59	59	1.735
33	Terentang (KB3)		38	38	39	38	38	1.127
34	Kopling GI Koba		36	33	36	35	35	1.029
35	Beriga (KB5)		32	32	33	32	32	951
36	Kulur (KB6)	GI KOBA	39	40	39	39	39	1.157
37	Padang Mulia (KB7)		19	18	18	18	18	539
38	INC PLTD		33	30	33	32	32	941
39	Palas (PY 1)		51	49	49	50	49	1.461
40	Paku (PY 2)		118	118	119	118	118	3.480
41	Kota (TB1)	TOBOALI	86	88	89	88	87	2.578
42	Rindik (TB2)		28	29	30	29	29	853
43	Bikang (TB3)		20	19	20	20	19	578
44	Sadai (TB4)		53	49	54	52	52	1.529
45	Suka damai (TB5)		43	38	43	41	41	1.216
46	Tanjung Ular (MT1)	MENTOK	68	69	70	69	69	2.029
47	Air Belo (MT2)		38	41	41	40	40	1.176
48	Kundi (MT3)		42	41	41	41	41	1.216
49	Teluk Rubia (MT5)		33	35	34	34	34	1.000
50	Kotawaringin (F1)	PLTD LISTRINDO	60	60	59	59	59	1.755
51	Penyampak (F2)		10	11	11	10	10	314
52	PLTD PONGOK					#DIV/0!	#DIV/0!	#DIV/0!
53	PLTD CELAGEN					#DIV/0!	#DIV/0!	#DIV/0!
54	Dalil	GI KELAPA	45	43	43	44	43	1.284
55	Mayang		19	23	23	22	21	637
56	Parit 3		111	113	115	113	113	3.323
57	Pkl Niur		49	49	48	49	48	1.431
58	Bakik		27	26	26	26	26	774

Proses konversi reaktansi peralihan generator PLTD Merawang dengan menggunakan persamaan 2.37

Ket:

X'd : Reaktansi peralihan DDB : Daya Dasar Baru

TDL : Tegangan Dasar Lama DDB : Daya Lama

TDB : Tegangan Dasar Baru X Trafo: Reaktansi Trafo

Persamaan dasar daya dan tegangan untuk reaktansi peralihan generator disaat 9 generator beroperasi

Generator	X'd	TDL	TDB	DDB	DDL	X'd (baru)	Pers.2.37	X'd total (baru)
Mak	0,28	6,3	6,3	100	3,18	8,8050	0,113571	
Mirrless1	0,28	6,3	6,3	100	6,522	4,2932	0,232929	
Mirrless2	0,28	6,3	6,3	100	6,522	4,2932	0,232929	
Allen1	0,28	6,3	6,3	100	6,121	4,5744	0,218607	
Allen2	0,28	6,3	6,3	100	6,121	4,5744	0,218607	0,5322
Allen3	0,28	6,3	6,3	100	6,121	4,5744	0,218607	
Caterpillar1	0,28	6,3	6,3	100	5,75	4,8696	0,205357	
Caterpillar2	0,28	6,3	6,3	100	5,75	4,8696	0,205357	
Mirrless3	0,28	6,3	6,3	100	6,522	4,2932	0,232929	
Hasil perhitungan paralel							1,878893	

Persamaan dasar daya dan tegangan untuk reaktansi Transformator PLTD Merawang 9 generator beroperasi

Merek Trafo	X Trafo	TDL	TDB	DDB	DDL	X Trafo (baru)	Pers.2.37	X Total Trafo Baru
Mak	0,075	20	20	100	3,25	2,307692	0,433333	
Mirrless1	0,07	20	20	100	6,5	1,076923	0,928571	
Mirrless2	0,07	20	20	100	6,5	1,076923	0,928571	
Allen1	0,06664	20	20	100	6,3	1,057778	0,945378	
Allen2	0,0689	20	20	100	6,3	1,093651	0,914369	0,13280
Allen3	0,06834	20	20	100	6,3	1,084762	0,921861	
Caterpillar1	0,085	20	20	100	6,5	1,307692	0,764706	
Caterpillar2	0,085	20	20	100	6,5	1,307692	0,764706	
Mirrless3	0,07	20	20	100	6,5	1,076923	0,928571	
Hasil perhitungan Paralel							7,530067	

Persamaan dasar daya dan tegangan untuk reaktansi Tranformator Gardu Induk Bukit Semut

Merek Trafo	X Trafo	TDL	TDB	DDB	DDL	X Trafo (baru)
Mak	0,12465	150	150	100	30	0,4155

Persamaan dasar daya dan tegangan untuk reaktansi Tranformator Pembangkit Air Anyir

Merek Trafo	X Trafo	TDL	TDB	DDB	DDL		X Trafo B	X Total Trafo Baru
MTT1	0,1058	6,3	6,3	100	40	0,2645	3,7807	0,07391
MTT2	0,1067	6,3	6,3	100	40	0,2667	3,7488	
TRFMPP1	0,1	11,5	11,5	100	30	0,3333	3	
TRFMPP2	0,1	11,5	11,5	100	30	0,3333	3	
Hasil perhitungan Paralel							13,529	

Persamaan dasar Impedansi

Dasar Tegangan	Dasar Daya	Z Dasar(ohm)
150	100	225
20	100	4

Perubahan impedansi dasar saluran kedalam persatuan

saluran	Impedansi dasar (Ohm)	R dasar (Ohm)	X dasar (Ohm)	R Baru (pu)	X Baru (pu)
gi air anyer - Gi kampak	225	1	3,332	0,0044	0,0148
gi air anyer - Gi kampak	225	1	9,996	0,0044	0,0148
gi air anyer - Gi sungailiat	225	3,024	10,081	0,0134	0,0686
gi air anyer-GI sungailiat	225	3,024	10,081	0,0134	0,0686
pltd merawang - GI sungailiat	4	0,2162	0,2754	0,0541	0,0686
pltd merawang - GI sungailiat	4	1	2,7766	0,25	0,6942

Perubahan impedansi dasar admitansi *Shunt* kedalam persatuan

saluran	Impedansi dasar (Ohm)	Y Shunt dasar (Ohm)	Y Shunt baru (pu)
gi air anyer - Gi kampak	225	23,706	0,10536
gi air anyer - Gi kampak	225	23,706	0,10536
gi air anyer - Gi sungailiat	225	71,725	0,318778
gi air anyer-GI sungailiat	225	71,725	0,318778

Perubahan konstanta kelembaman (H awal) menjadi konstanta kelembaman (H baru) disaat 9 generator Beroperasi dengan persamaan

$$H\ (Baru) = \frac{H\ (Awal) x\ DDL}{DDB}$$

Generator	H (awal)	DDB	DDL	H (Baru)
Mak	0,25	100	3,18	0,00795
Mirrless1	0,54	100	6,522	0,035219
Mirrless2	0,54	100	6,522	0,035219
Allen1	0,51	100	6,121	0,031217
Allen2	0,51	100	6,121	0,031217
Allen3	0,51	100	6,121	0,031217
Caterpillar1	0,49	100	5,75	0,028175
Caterpillar2	0,49	100	5,75	0,028175
Mirrless3	0,54	100	6,522	0,035219
	Total H (baru)			0,263608

Persamaan dasar daya dan tegangan untuk reaktansi peralihan generator disaat 7 generator beroperasi

Generator	X'd	TDL	TDB	DDB	DDL	X'd (baru)	Pers.2.37	X'd total (baru)
Mak	0,28	6,3	6,3	100	3,18	8,8050	0,113571429	0,6942
Mirrless2	0,28	6,3	6,3	100	6,522	4,2932	0,232928571	
Allen1	0,28	6,3	6,3	100	6,121	4,5744	0,218607143	
Allen2	0,28	6,3	6,3	100	6,121	4,5744	0,218607143	
Allen3	0,28	6,3	6,3	100	6,121	4,5744	0,218607143	
Caterpillar2	0,28	6,3	6,3	100	5,75	4,8696	0,205357143	
Mirrless3	0,28	6,3	6,3	100	6,522	4,2932	0,232928571	
Hasil perhitungan paralel							1,440607143	

Persamaan dasar daya dan tegangan untuk reaktansi Transformator PLTD Merawang 7 generator beroperasi

Merek Trafo	X Trafo	TDL	TDB	DDB	DDL	X Trafo (baru)	Pers.2.37	X Trafo B
Mak	0,075	20	20	100	3,25	2,3076	0,4333	0,17133
Mirrless2	0,07	20	20	100	6,5	1,0769	0,9285	
Allen1	0,06664	20	20	100	6,3	1,0577	0,9453	
Allen2	0,0689	20	20	100	6,3	1,0936	0,9143	
Allen3	0,06834	20	20	100	6,3	1,0847	0,9218	
Caterpillar2	0,085	20	20	100	6,5	1,3076	0,7647	
Mirrless3	0,07	20	20	100	6,5	1,0769	0,9285	
Hasil perhitungan Paralel							5,8367	

(H baru) disaat 7 generator Beroperasi dengan persamaan

$$H\ (Baru) = \frac{H\ (Awal) x\ DDL}{DDB}$$

Generator	H (awal)	DDB	DDL	H (Baru)
Mak	0,25	100	3,18	0,00795
Mirrless2	0,54	100	6,522	0,035219
Allen1	0,51	100	6,121	0,031217
Allen2	0,51	100	6,121	0,031217
Allen3	0,51	100	6,121	0,031217
Caterpillar2	0,49	100	5,75	0,028175
Mirrless3	0,54	100	6,522	0,035219
Total H (baru)				0,200214

Perhitungan Arus yang mengalir, Tegangan Peralihan dan Admitansi Beban disaat 9 Generator Beroperasi

A. Menghitung Arus

$I_1 = \frac{(P+jQ)^*}{V_t^*}$

$I_1 = \frac{(0{,}42287 - j0{,}16265)}{1\angle 11{,}4°} = \frac{0{,}4531\angle -21{,}0384°}{1\angle 11{,}4°}$ = 0,4531∠-32,44° pu

B. Menghitung Tegangan Peralihan

$E'_1 = V_t + X'_d I$ (Persamaan 2.23)

E'_1= 1∠11,4° + j0,53223 x 0,4531∠-32,44°

E'_1= 1∠11,4° + 0,53223∠90° x 0,4531∠-32,44°

E'_1= 0,9803 + j0,1976 + 0,24115∠57,56°

E'_1 = 0,9803 + j0,1976 + 0,12936 + j0,2035 = 1,1097 + j0,4011

E'_1 = 1,179∠19,8°

C. Menghitung Beban Setiap Bus

$Y_L = \frac{P-jQ}{|V_L^2|}$ (Persamaan 2.24)

$Y_{L1} = \frac{0{,}13764 - j0{,}10322}{(0{,}98045)^2} = \frac{0{,}172044\angle 36{,}87°}{0{,}96128}$ = 0,17897∠36,87° = 0,1432-j0,10738 pu

$Y_{L2} = \frac{0{,}15087 + j0{,}11314}{(0{,}90832)^2} = \frac{0{,}18858\angle 36{,}87°}{0{,}825}$ = 0,22858∠36,87° = 0,18286-j0,13715 pu

$Y_{L3} = \frac{0{,}09147 + j0{,}05668}{(0{,}95927)^2} = \frac{0{,}10761\angle 31{,}78°}{0{,}9202}$ = 0,11694∠31,78° = 0,0994-j0,062 pu

$Y_{L4} = \frac{0{,}39243 + j0{,}029428}{(0{,}95779)^2} = \frac{0{,}4905\angle 36{,}87°}{0{,}91736}$ = 0,5347∠36,87° = 0,4277-j0,3208 pu

Perhitungan Arus yang mengalir, Tegangan Peralihan dan Admitansi Beban disaat 7 Generator Beroperasi

A. Menghitung Arus

$I_1 = \frac{(P+jQ)^*}{V_t^*}$

$I_1 = \frac{(0{,}3227 - j0{,}16499)}{1\angle 6{,}1°} = \frac{0{,}3624\angle -27{,}1°}{1\angle 6{,}1°}$ = 0,3624∠-33,2° pu

B. Menghitung Tegangan Peralihan

$E'_1 = V_t + X'_d I$ (Persamaan 2.23)

E'_1= 1∠6,1° + j0,6442 x 0,3624∠-33,2°

E'_1= 1∠6,1° + 0,6442 ∠90° x 0,3624∠-33,2°

E'_1= 0,9943 + j0,1063 + 0,2334∠56,8°

E'_1 = 0,9803 + j0,1976 + 0,12936 + j0,2035 = 1,1221 + j0,3016

E'_1 = 1,1619∠15,04°

C. Menghitung Beban Setiap Bus

$Y_L = \frac{P-jQ}{|V_L^2|}$ (Persamaan 2.24)

$Y_{L1} = \frac{0{,}13764 - j0{,}10322}{(0{,}97405)^2} = \frac{0{,}172044\angle 36{,}87°}{0{,}9488}$ = 0,18132∠36,87° = 0,14505-j0,10879 pu

$Y_{L2} = \frac{0{,}15087 + j0{,}11314}{(0{,}91918)^2} = \frac{0{,}18858\angle 36{,}87°}{0{,}8449}$ = 0,2232∠36,87° = 0,1786-j0,13383 pu

$Y_{L3} = \frac{0{,}09147 + j0{,}05668}{(0{,}95885)^2} = \frac{0{,}10761\angle 31{,}78°}{0{,}8751}$ = 0,11704∠31,78° = 0,0994-j0,062 pu

$Y_{L4} = \frac{0{,}39243 + j0{,}029428}{(0{,}95737)^2} = \frac{0{,}4905\angle 36{,}87°}{0{,}9165}$ = 0,5352∠36,87° = 0,4282-j0,3211 pu

Proses Reduksi Matriks Sebelum Terjadi Gangguan

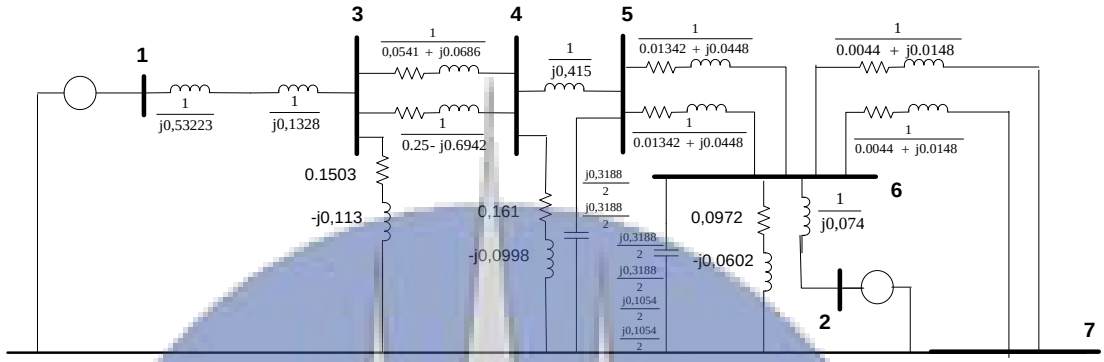
```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1503-0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0972-
0.0602i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4193-0.258i+...
    0.1054i/2+0.1054i/2;

Matriks_Sebelumgangguan= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
```

```
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan dan Simulasi Analisis Transien disaat 9 Generator Beroperasi

1. Pada Saat Terjadi Gangguan Pada Bus 7

Kondisi rangkaian admitansi selama gangguan pada bus 7

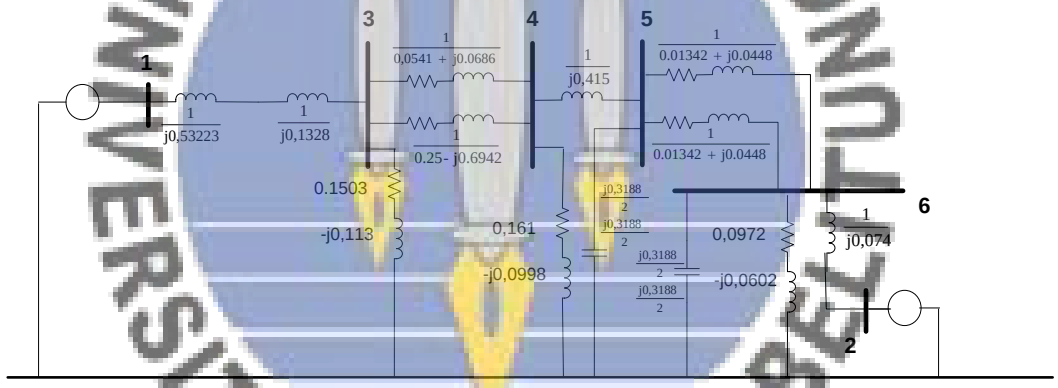


Proses Reduksi Matriks selama Gangguan pada Bus 7

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1503-0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
```

```
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0972-
0.0602i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;

Matriks_selamagangguanbus7= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian reaktansi setelah gangguan pada bus 7



Proses Reduksi matriks admitansi setelah gangguan pada bus 7

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1503-0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
```

```
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+...
   1/(0.074i)+ 0.0972-0.0602i+0.3188i/2+0.3188i/2;

Matriks_setelahgangguanbus7= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada bus 7

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,8973) cos (-84,5569$-\delta_1 + \delta_1$) + (1,179)(1)(0,0759) cos (72,5632$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}2727 + 0{,}0895 \cos (72{,}5632-\delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8560) cos (-84,0993$-\delta_1 + \delta_1$) + (1,179)(1)(0,7793) cos (86,57688$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}1223 + 0{,}91879 \cos (86{,}57688 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada bus 7

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}30457 - (0{,}0886 + 0{,}0895 \cos(72{,}5632 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}33427 - 0{,}0895 \cos(72{,}5632 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}42287 - 0{,}91879 \cos(86{,}57688 - \delta_1))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}30057 - 0{,}91879 \cos(86{,}57688 - \delta_1))$$

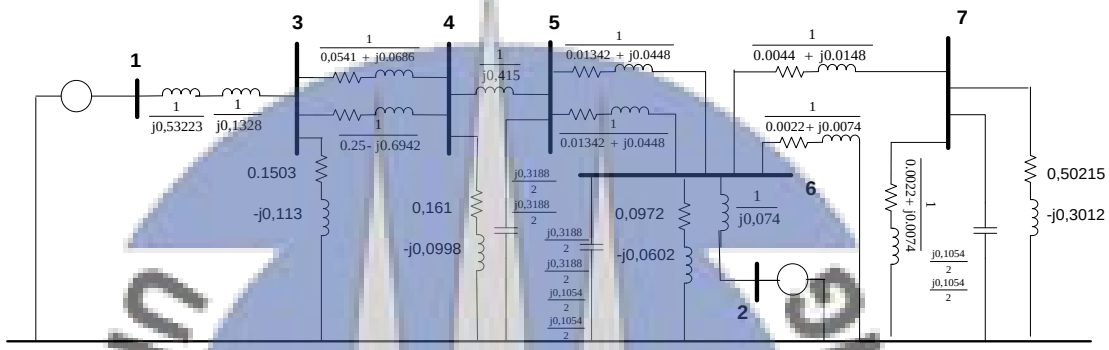
Simulasi Kurva Ayunan disaat terjadi gangguan di bus 7

```
function xdot = persamaan_differensialbus7(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.26 *  (0.30457 - 0.0895 *cos(72.5632/180*pi  - x(1)))]
;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.30057 - 0.91879 *cos(86.7688/180*pi  - x(1)))]
;

end

close;clc;clear all
```

```
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.12
nilai_awal = [23.09/180*pi ; 0]
t = [0:0.25:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialbus7', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

2. Pada Saat Terjadi Gangguan Pada Salah Satu Saluran bus 6 Ke 7

Kondisi rangkaian admitansi selama gangguan pada salah satu saluran bus 6 ke 7

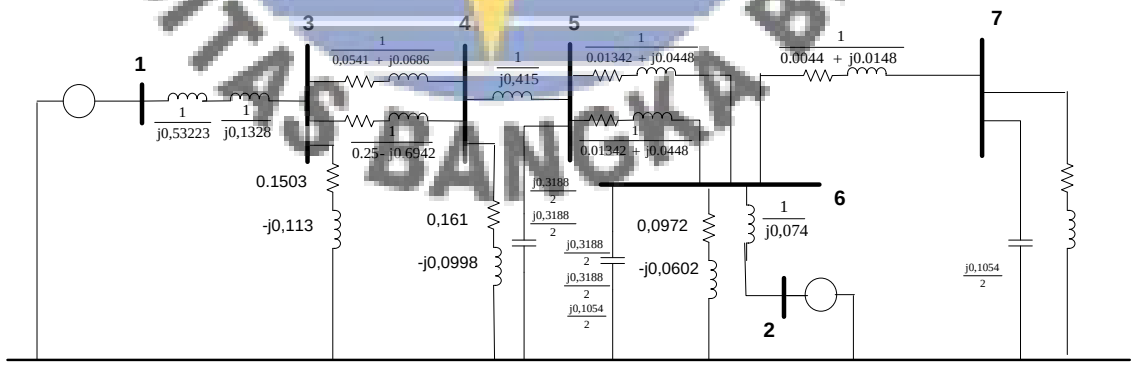


Proses reduksi matriks admitansi selama gangguan pada salah satu saluran bus 67

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1503-0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
```

```
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=(1/(0.01342+0.0448i)+1/(0.01342+0.0448i))+(1/(0.00444+0.0148i)+...
    1/(0.00222+0.0074i))+1/(0.074i)+ 0.0972-
0.0602i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00222+0.0074i)+0.4193-0.258i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguan67= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada salah satu saluran bus 67



Proses reduksi matriks admitansi selama gangguan pada salah satu saluran bus 67

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
```

```
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i))+ 0.1503-
0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= (1/(0.0541+0.0686i)+1/(0.25 + 0.6942i))+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=(1/(0.01342+0.0448i)+1/(0.01342+0.0448i))+1/(0.00444+0.0148i)+...
    +1/(0.074i)+ 0.0972-0.0602i+0.3188i/2+0.3188i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+0.4193-0.258i+...
    0.1054i/2;

Matriks_Setelahgangguan67= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran 6 ke 7

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)$+ $|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,8983) cos(-84,5839$-\delta_1 +\ \delta_1$)+(1,179)(1)(0,0582)

cos (72,2035$-\delta_1 + \delta_2$)

$P_{e1} =$ 0,1178 + 0,06862 cos (72,2035$-\delta_1$)

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8571) cos(-84,0208$-\delta_1 +\ \delta_1$)+(1,179)(1)(0,7667)

cos (85,0650$-\delta_1 + \delta_2$)

$P_{e1} =$ 0,1241 + 0,90394 cos (85,0650$-\delta_1$)

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran 6 ke 7

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}42287 - (0{,}1178 + 0{,}06862\cos(72{,}2035 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}30507 - 0{,}06862\cos(72{,}2035 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}42287 - (0{,}1241 + 0{,}90394\cos(85{,}0650 - \delta_1)))$$

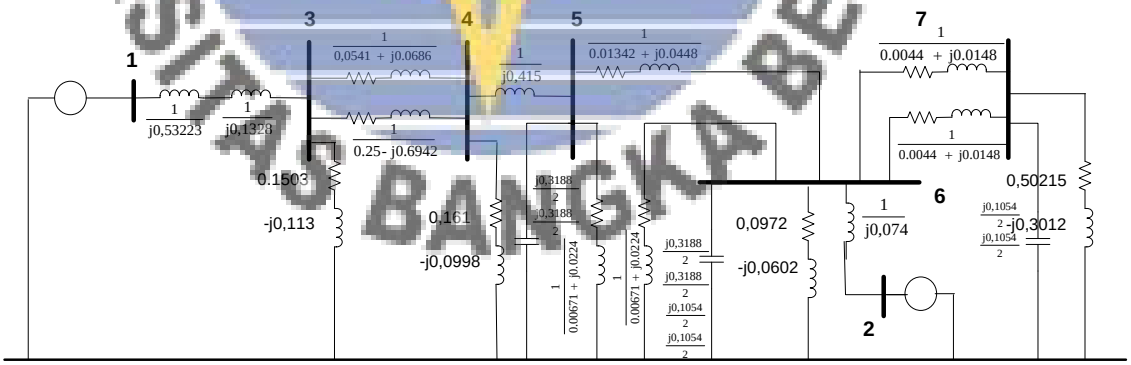
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}29877 - 0{,}90394\cos(85{,}0650 - \delta_1))$$

Simulasi Kurva Ayunan disaat terjadi gangguan di bus 7

```
function xdot = persamaan_differensial67(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.26 *  (0.30507 - 0.081 *cos(72.2035/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.29877 - 1.0659 *cos(85.0650/180*pi  - x(1)))] ;

end

close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.12
nilai_awal = [23.09/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensial67', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

3. Pada Saat Terjadi Gangguan Pada salah satu Saluran Bus 5 ke 6

Kondisi rangkaian admitansi selama gangguan pada salah satu saluran bus 5 ke 6

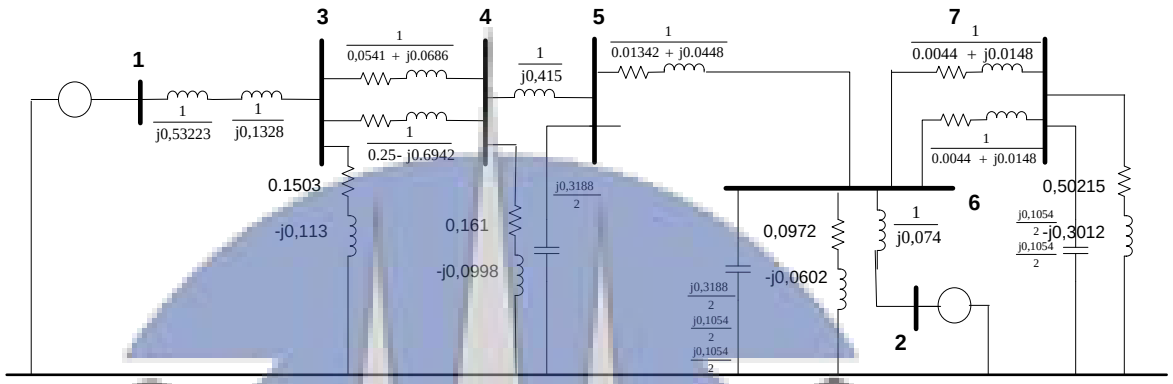


Proses reduksi matriks admitansi selama gangguan pada salah satu saluran bus 56

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
```

```
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i))+ 0.1503-
0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.0671+0.0224i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.0671+0.0224i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0972-
0.0602i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4193-0.258i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguan56= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
     Y63 Y64 Y65 Y66 Y67;
     Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
     Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada salah satu saluran bus 5 ke 6



Proses reduksi matriks admitansi setelah gangguan pada salah satu saluran bus 56

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1503-0.113i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.161-0.0998;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+ 0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
```

```
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0972-0.0602i+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4193-0.258i+...
    0.1054i/2+0.1054i/2;

Matriks_Setelahgangguan56= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran 5 ke 6

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,9050) cos(-84,7941 - δ_1 + δ_1)+(1,179)(1)(0,0517)

cos (73,7959$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}1141 + 0{,}06095 \cos(73{,}7959-\delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8465) cos(-83,6377$-\delta_1 +$ δ_1)+(1,179)(1)(0,7398)

cos (85,2738$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}1304 + 0{,}8722 \cos(85{,}2738 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}42287 - (0{,}1141 + 0{,}06095 \cos(73{,}7959 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}30877 - 0{,}06095 \cos(73{,}7959 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}42287 - (0{,}1304 + 0{,}8722 \cos(85{,}2738 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}29247 - 0{,}8722 \cos(85{,}2738 - \delta_1))$$

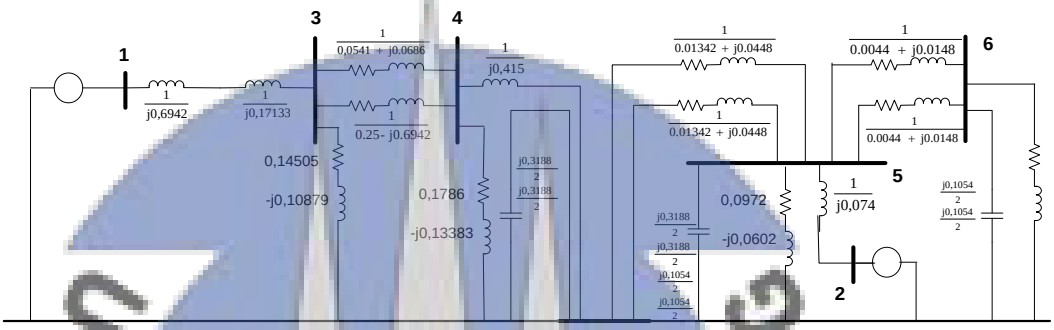
Simulasi Kurva Ayunan disaat terjadi gangguan di saluran bus 56

```
function xdot = persamaan_diferensialbus56(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.26 *  (0.30877 - 0.07186 *cos(73.7959/180*pi  - x(1)))]
;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.29247 - 1.02835 *cos(85.2738/180*pi  - x(1)))]
;

end

close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0
nilai_awal = [23.09/180*pi ; 0]
t = [0:0.3:15] ;
```

```
[t,delta_dan_omega] = ode45('persamaan_differensialbus56', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

4. Pada Saat Terjadi Gangguan Pada Saluran di Titik D

Kondisi rangkaian admitansi selama gangguan pada saluran di titik D

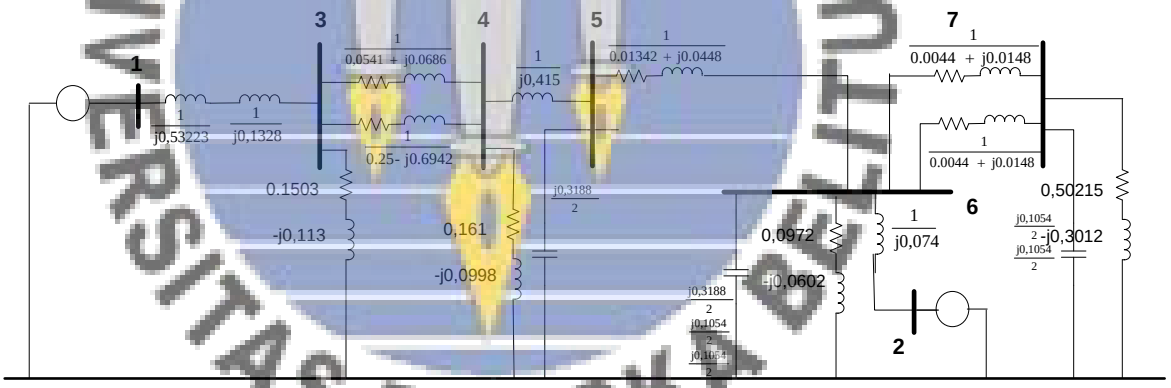


Proses reduksi matriks admitansi selama gangguan pada saluran di titik D

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45=0;
Y46=0;
Y51=0;
Y52=-(1/(0.074i));
Y53=0;
Y54=0;
Y55=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y56=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
```

```
Y61=0;
Y62=0;
Y63=0;
Y64=0;
Y65=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y66=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguansalbus5= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik D



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik D

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
```

```
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2+0.1054i/2;

Matriks_Setelahgangguansalbus5= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik D

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,9151) cos(-85,1049 - δ_1 + δ_1)+(1,179)(1)(0)

cos (0$-\delta_1 + \delta_2$)

P_{e1} = 0,1085 + 0 cos (0$-\delta_1$)

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8465) cos(-83,6377$-\delta_1$ + δ_1)+(1,179)(1)(0,7398)

cos (85,2738$-\delta_1 + \delta_2$)

P_{e1} = 0,1304 + 0,8722 cos (85,2738$-\delta_1$)

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran di titik D

C. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,42287 - (0,1085 + 0\cos(0-\delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,31437 - 0\cos(0-\delta_1))$$

D. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,42287 - (0,1304 + 0,8722\cos(85,2738-\delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,29247 - 0,8722\cos(85,2738-\delta_1)))$$

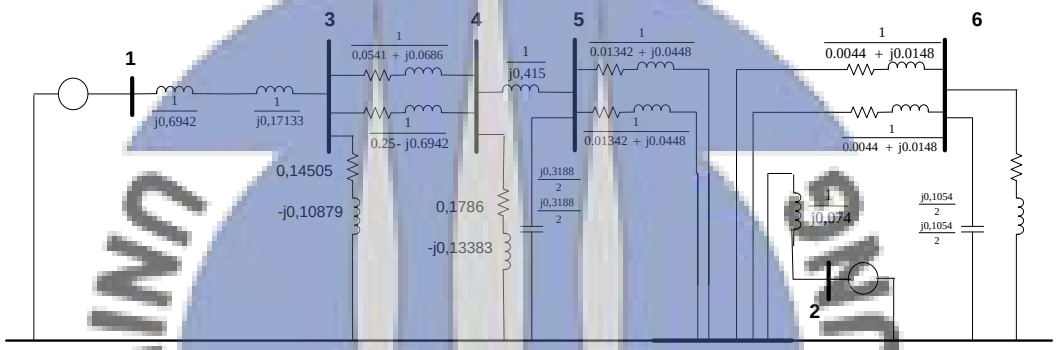
Simulasi Kurva Ayunan disaat terjadi gangguan di titik D

```
function xdot = persamaan_differensialsalbus5(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
```

```
    xdot = [x(2) ; 50*pi/0.26 *  (0.31437 - 0 *cos(0/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.2927 - 0.8722 *cos(86.7688/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [19.8/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsalbus5', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

5. Pada Saat Terjadi Gangguan Pada Saluran di Titik E

Kondisi rangkaian admitansi selama gangguan pada saluran di titik E

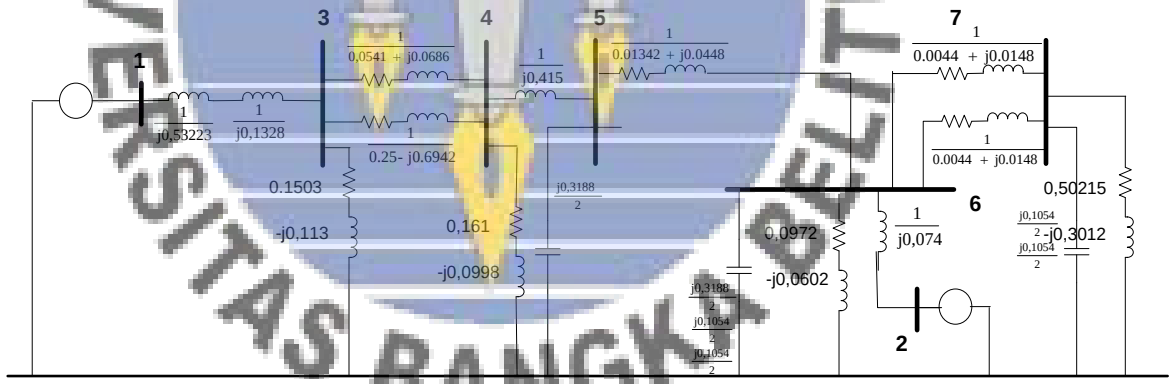


Proses reduksi matriks admitansi selama gangguan pada saluran di titik E

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
```

```
Y56=0;
Y61=0;
Y62=0;
Y63=0;
Y64=0;
Y65=0;
Y66=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguansal1bus6= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik E



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik E

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
```

```
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2+0.1054i/2;

Matriks_Setelahgangguansalbus5= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik E

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)$+ $|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,9014) cos(-84,6703 - δ_1 + δ_1)+(1,179)(1)(0)

cos (0$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}1164 + 0 \cos(0-\delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8465) cos(-83,6377$-\delta_1$ + δ_1)+(1,179)(1)(0,7398)

cos (85,2738$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}1304 + 0{,}8722 \cos(85{,}2738-\delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}42287 - (0{,}1164 + 0\cos(0-\delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}30647 - 0\cos(0-\delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}42287 - (0{,}1304 + 0{,}8722\cos(85{,}2738-\delta_1)))$$

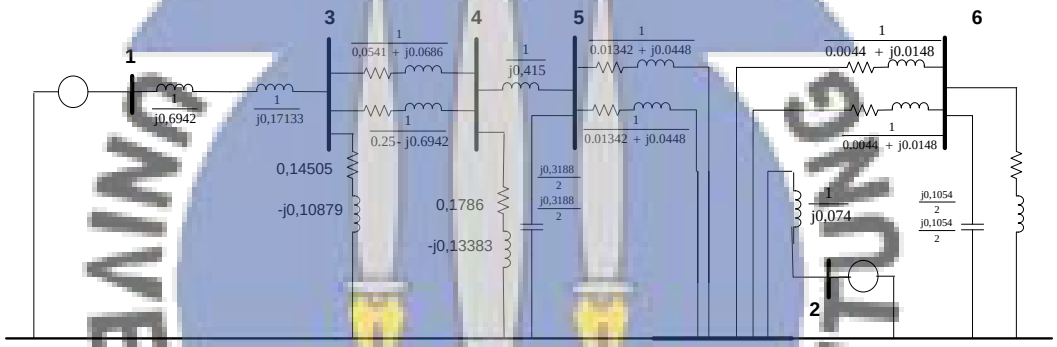
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}29247 - 0{,}8722\cos(85{,}2738-\delta_1)))$$

Simulasi Kurva Ayunan disaat terjadi gangguan di titik E

```
function xdot = persamaan_differensialsal1bus6(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.26 *  (0.30647 - 0 *cos(0/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.2927 - 0.8722 *cos(86.7688/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [19.8/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsal1bus6', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

6. Pada Saat Terjadi Gangguan Pada Saluran di Titik F

Kondisi rangkaian admitansi selama gangguan pada saluran di titik F

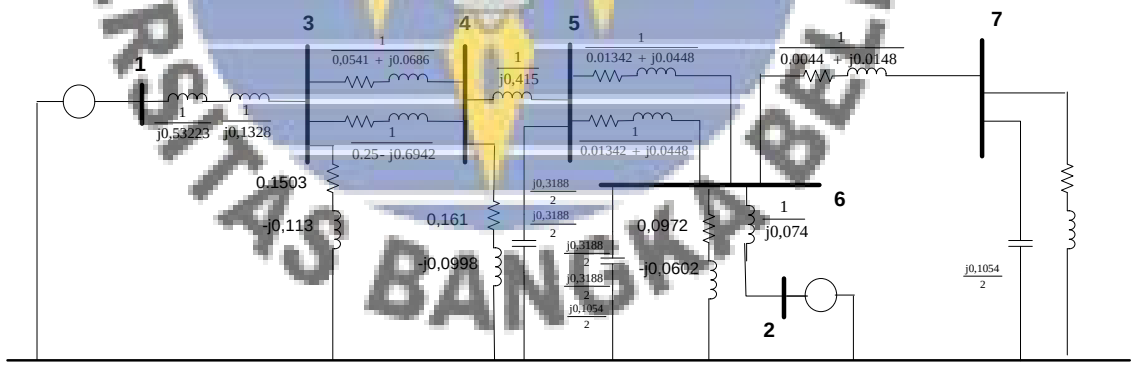


Proses reduksi matriks admitansi selama gangguan pada saluran di titik F

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;
Y51=0;
```

```
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56=0;
Y61=0;
Y62=0;
Y63=0;
Y64=0;
Y65=0;
Y66=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguansal1bus6= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik F



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik F

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
```

```
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.3188i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2;

Matriks_Setelahgangguansal2bus6= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77];
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik F

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)$+ $|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,9014) cos(-84,6703 - δ_1 + δ_1)+(1,179)(1)(0)

cos (0$-\delta_1 + \delta_2$)

P_{e1} = 0,1164 + 0 cos (0$-\delta_1$)

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8571) cos(-84,0208$-\delta_1$ + δ_1)+(1,179)(1)(0,7667)

cos (85,0650$-\delta_1 + \delta_2$)

P_{e1} = 0,1241 + 0,90394 cos (85,0650$-\delta_1$)

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

C. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}42287 - (0{,}1164 + 0\cos(0-\delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}30647 - \ 0\cos(0-\delta_1))$$

D. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}42287 - (0{,}1241 + 0{,}90394\cos(85{,}0650-\delta_1)))$$

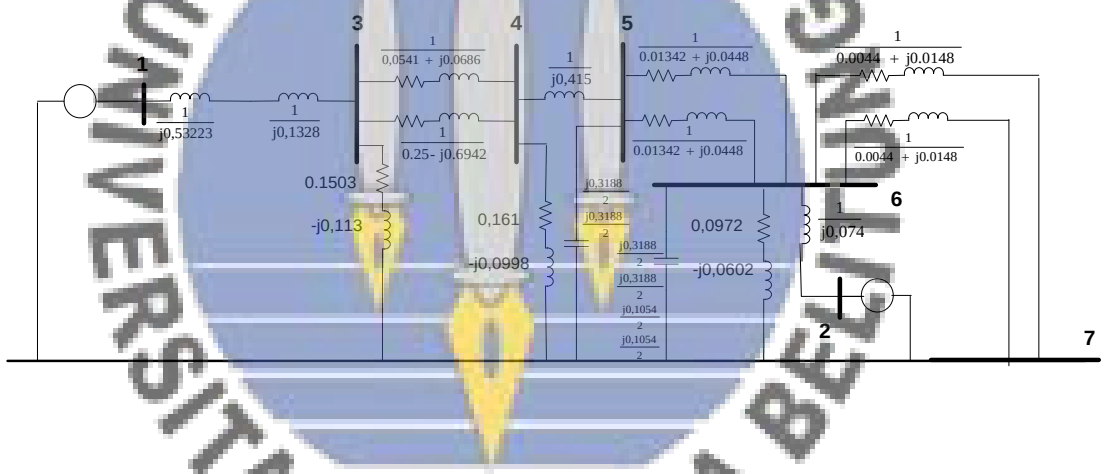
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}29877 - \ 0{,}90394\cos(85{,}0650-\delta_1)))$$

Simulasi Kurva Ayunan disaat terjadi gangguan di titik F

```
function xdot = persamaan_differensialsal1bus6(t,x)
function xdot = persamaan_differensialsal2bus6(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.26 *  (0.30647 - 0 *cos(0/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.29877 - 0.9039 *cos(85.0650/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [19.8/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsal2bus6', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

7. Pada Saat Terjadi Gangguan Pada Saluran di Titik G

Kondisi rangkaian admitansi selama gangguan pada saluran di titik G

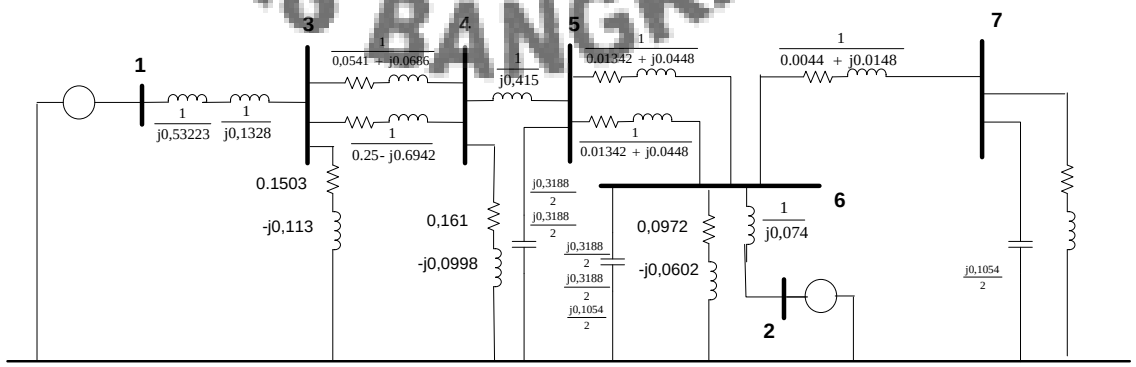


Proses reduksi matriks admitansi selama gangguan pada saluran di titik G

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
```

```
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;

Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;

Matriks_Selamagangguansalbus7= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik G



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik F

```
Y11= 1/(0.53223i + 0.1328i);
Y12= 0;
Y13= -(1/(0.53223i + 0.1328i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.53223i + 0.1328i));
Y32= 0;
Y33= 1/(0.53223i + 0.1328i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.1432-
0.10738i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1829-0.1372i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.3188i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+0.4277-0.3208i+...
    0.1054i/2;

Matriks_Setelahgangguansal2bus6= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
```

```
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik F

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)$+ $|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,179)(1,179)(0,8973) cos (-84,5569$-\delta_1 + \delta_1$) + (1,179)(1)(0,0759) cos (72,5632$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}2727$ + 0,0895 cos (72,5632$-\delta_1$)

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,179)(1,179)(0,8571) cos(-84,0208$-\delta_1 + \delta_1$)+(1,179)(1)(0,7667) cos (85,0650$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}1241$ + 0,90394 cos (85,0650$-\delta_1$)

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}42287 - (0{,}2727 + 0{,}0895\cos(72{,}5632 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}30457 - \ 0{,}0895\cos(72{,}5632 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}42287 - (0{,}1241 + 0{,}90394\cos(85{,}0650 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}\,(0{,}29877 - \ 0{,}90394\cos(85{,}0650 - \delta_1)))$$

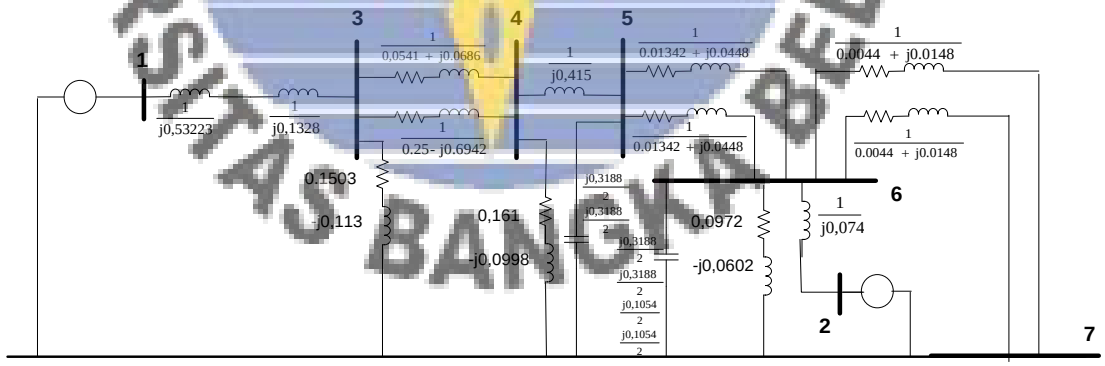
Simulasi Kurva Ayunan disaat terjadi gangguan di titik F

```
function xdot = persamaan_differensialsalbus7(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.26 *  (0.30457 - 0.0895 *cos(72.5632/180*pi  - x(1)))]
;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.26 *  (0.29877 - 0.9039 *cos(85.0650/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [19.8/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsalbus7', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

Perhitungan dan Simulasi Analisis Transien disaat 7 Generator Beroperasi

1. Pada Saat Terjadi Gangguan Pada Bus 7

Kondisi rangkaian admitansi selama gangguan pada bus 7

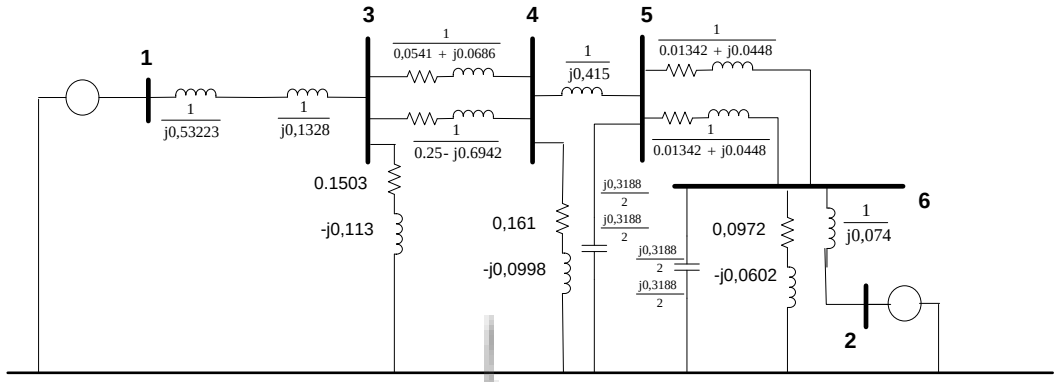


Proses Reduksi Matriks selama Gangguan pada Bus 7

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
```

```
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;

Matriks_selamagangguanbus7= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian reaktansi setelah gangguan pada bus 7



Proses Reduksi matriks admitansi setelah gangguan pada bus 7

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+...
   1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.3188i/2;

Matriks_setelahgangguanbus7= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]
```

```
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada bus 7

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,7608) cos (-85,3985$-\delta_1 + \delta_1$) + (1,1619)(1)(0,0644) cos (71,7686$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}0824 + 0{,}0748 \cos (71{,}7686 - \delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,1619)(1,1619)(0,8560) cos (-84,9780$-\delta_1 + \delta_1$) + (1,1619)(1)(0,7793) cos (85,9432$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}0863 + 0{,}7738 \cos (85{,}9432 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada bus 7

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}3227 - (0{,}0824 + 0{,}0748 \cos (71{,}7686 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}2403 - \ 0{,}0748\cos(71{,}7686 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}3227 - 0{,}0863 + 0{,}7738\cos(85{,}9432 - \delta_1)))$$

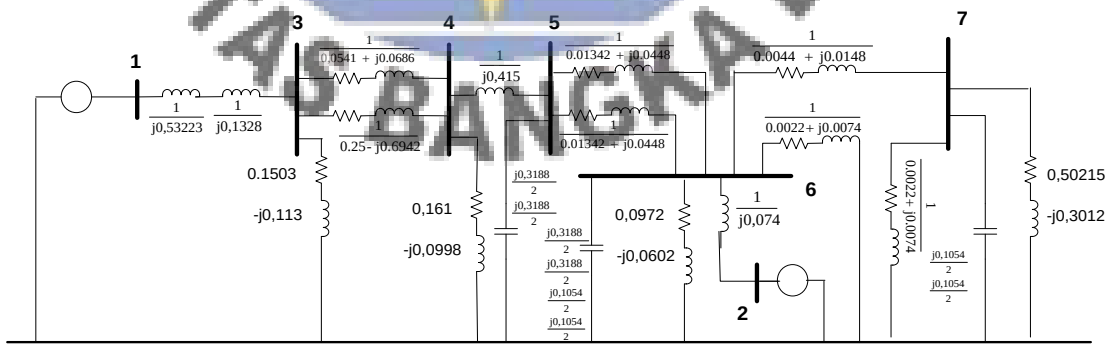
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}2364 - \ 0{,}7738\cos(85{,}9432 - \delta_1))$$

Simulasi Kurva Ayunan disaat terjadi gangguan di bus 7

```
function xdot = persamaan_differensialbus7(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 *  (0.2403 - 0.0748 *cos(71.7686/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 *  (0.2364 - 0.7738 *cos(85.9432/180*pi  - x(1)))] ;

end

close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.12
nilai_awal = [15.04/180*pi ; 0]
t = [0:0.25:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialbus7', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

2. Pada Saat Terjadi Gangguan Pada Salah Satu Saluran bus 6 Ke 7

Kondisi rangkaian admitansi selama gangguan pada salah satu saluran bus 6 ke 7



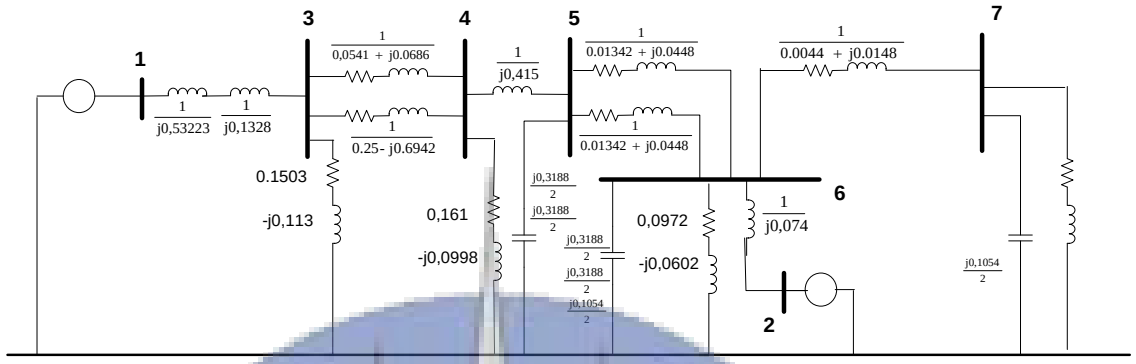
Proses reduksi matriks admitansi selama gangguan pada salah satu saluran bus 67

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
```

```
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=(1/(0.01342+0.0448i)+1/(0.01342+0.0448i))+(1/(0.00444+0.0148i)+...
    1/(0.00222+0.0074i))+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00222+0.0074i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguan67= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
```

```
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada salah satu saluran bus 67



Proses reduksi matriks admitansi setelah gangguan pada salah satu saluran bus 67

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=(1/(0.01342+0.0448i)+1/(0.01342+0.0448i))+1/(0.00444+0.0148i)+...
    +1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.3188i/2+0.1054i/2;
```

```
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2;

Matriks_Setelahgangguan67= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran 6 ke 7

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,7615) cos(-85,4222$-\delta_1 + \delta_1$)+(1,1619)(1)(0,0494)

cos (71,4122$-\delta_1 + \delta_2$)

$P_{e1} =$ 0,08205+ 0,05739 cos (71,4122$-\delta_1$)

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,1619)(1,1619)(0,7317) cos(-84,9116$-\delta_1 + \delta_1$)+(1,1619)(1)(0,6551)

cos (84,2249$-\delta_1 + \delta_2$)

P_{e1} = 0,0876 + 0,7612 cos (84,2249$-\delta_1$)

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran 6 ke 7

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}08205 + 0{,}05739\cos(71{,}4122 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}24065 - 0{,}05739\cos(71{,}4122 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}0876 + 0{,}7612\cos(84{,}2249 - \delta_1)))$$

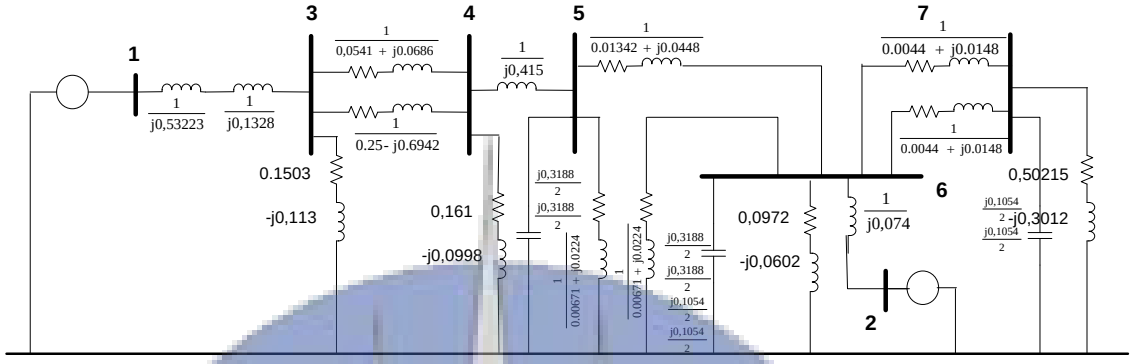
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}2351 - 0{,}7612\cos(84{,}2249 - \delta_1))$$

Simulasi Kurva Ayunan disaat terjadi gangguan pada saluran di bus 67

```
function xdot = persamaan_differensial67(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 *  (0.24065 - 0.0539 *cos(72.2035/180*pi  - x(1)))]
;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 *  (0.2351 - 0.7612 *cos(85.0650/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.12
nilai_awal = [15,04/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensial67', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

3. Pada Saat Terjadi Gangguan Pada salah satu Saluran Bus 5 ke 6

Kondisi rangkaian admitansi selama gangguan pada salah satu saluran bus 5 ke 6

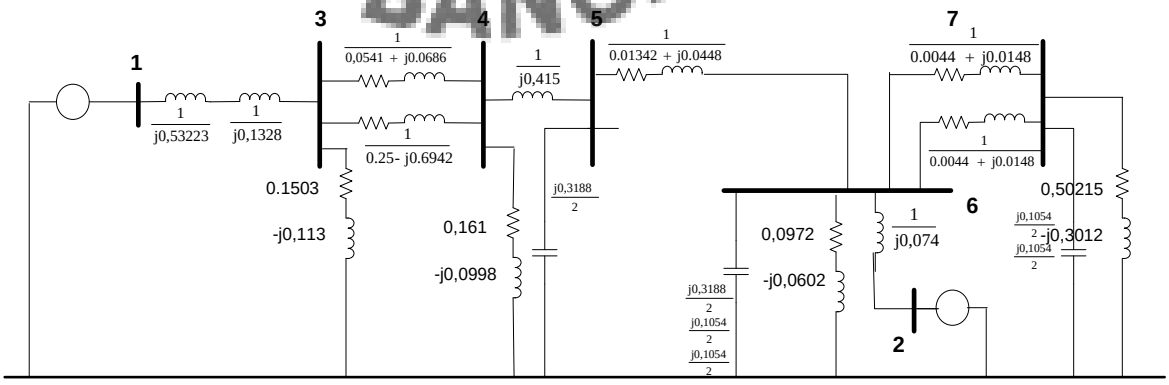


Proses reduksi matriks admitansi selama gangguan pada salah satu saluran bus 56

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.00671+0.0224i)+0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00671+0.0224i)+1/(0.00444+0.0148i)+...
```

```
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguan56= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada salah satu saluran bus 5 ke 6



Proses reduksi matriks admitansi setelah gangguan pada salah satu saluran bus 56

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+ 0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Setelahgangguan56= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
```

```
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran 5 ke 6

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)$+ $|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,9050) cos(-85,6051 - δ_1 + δ_1)+(1,1619)(1)(0,0438) cos (73,0309$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}07927 + 0{,}0509 \cos(73{,}0309 - \delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,1619)(1,1619)(0,8465) cos(-83,6377$-\delta_1$ + δ_1)+(1,1619)(1)(0,6334) cos (84,3876$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}0925 + 0{,}7359 \cos(84{,}3876 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}3227 - (0{,}07927 + 0{,}0509\cos(73{,}0309 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}24343 - \ 0{,}0509\cos(73{,}0309 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}3227 - (0{,}0925 + 0{,}7359\cos(84{,}3876 - \delta_1)))$$

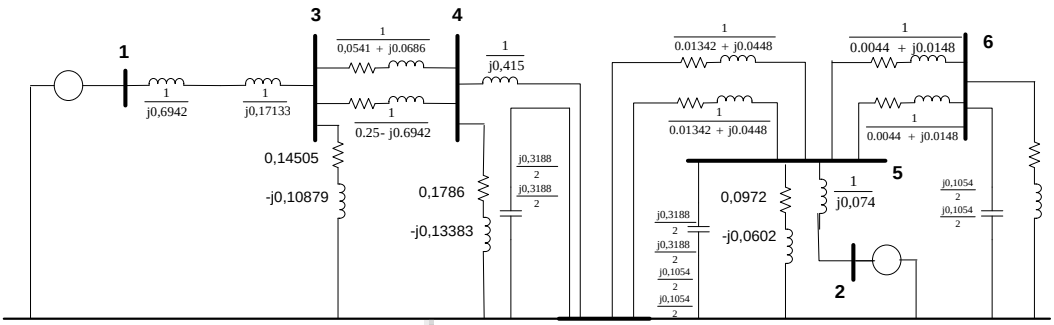
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}\,(0{,}2302 - \ 0{,}7359\cos(84{,}3876 - \delta_1))$$

Simulasi Kurva Ayunan disaat terjadi gangguan di saluran bus 56

```
function xdot = persamaan_differensialbus56(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 *  (0.2434 - 0.0509 *cos(73.0309/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 *  (0.2302 - 0.7359 *cos(84.3876/180*pi  - x(1)))] ;

end

close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0
nilai_awal = [15,04/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialbus56', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

4. Pada Saat Terjadi Gangguan Pada Saluran di Titik D

Kondisi rangkaian admitansi selama gangguan pada saluran di titik D

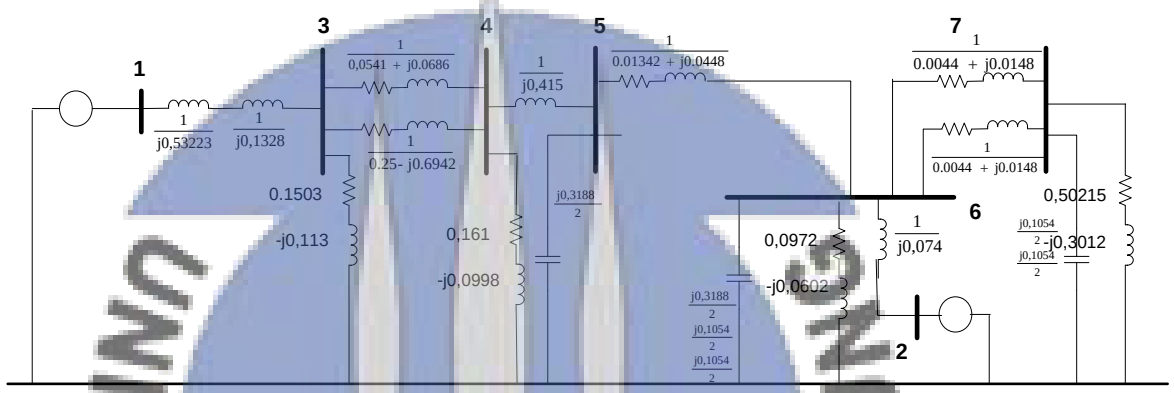


Proses reduksi matriks admitansi selama gangguan pada saluran di titik D

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45=0;
Y46=0;
Y51=0;
Y52=-(1/(0.074i));
Y53=0;
Y54=0;
Y55=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
Y56=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y61=0;
Y62=0;
Y63=0;
Y64=0;
Y65=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y66=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguansalbus5= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]
```

```
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik D



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik D

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
```

```
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Setelahgangguansalbus5= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik D

A. Persamaan daya elektrik selama gangguan

P_{e1}= $|E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+|E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,7735) cos(-85,8749 - δ_1 + δ_1)+(1,1619)(1)(0)

cos (0−δ_1 + δ_2)

P_{e1} = 0,07604 + 0 cos (0−δ_1)

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,1619)(1,1619)(0,7637) cos(-84,5717$-\delta_1 + \delta_1$)+(1,1619)(1)(0,6334)

cos (84,3876$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}09246 + 0{,}73595 \cos(84{,}3876-\delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran di titik D

C. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}07604 + 0\cos(0-\delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}24667 - 0\cos(0-\delta_1))$$

D. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}09246 + 0{,}73595\cos(84{,}3876-\delta_1)))$$

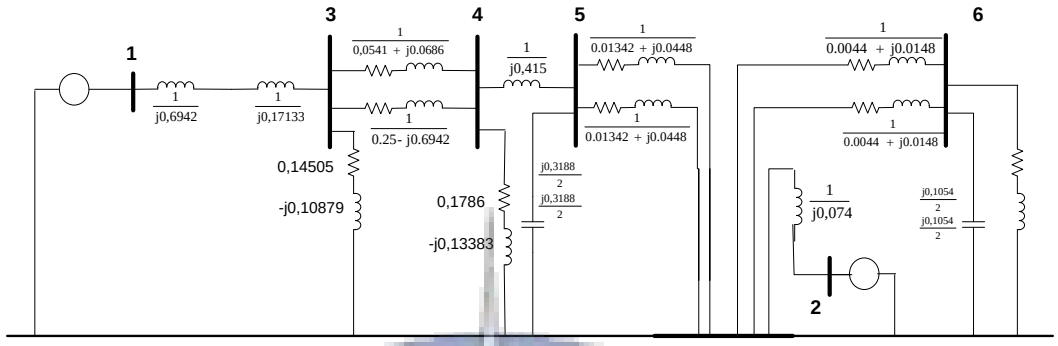
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}23024 - 0{,}73595\cos(84{,}3876-\delta_1))$$

Simulasi Kurva Ayunan disaat terjadi gangguan di titik D

```
function xdot = persamaan_differensialsalbus5(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 * (0.24667 - 0 *cos(0/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 * (0.23024 - 0.73595 *cos(84.3876/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [15,04/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsalbus5', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

5. Pada Saat Terjadi Gangguan Pada Saluran di Titik E

Kondisi rangkaian admitansi selama gangguan pada saluran di titik E

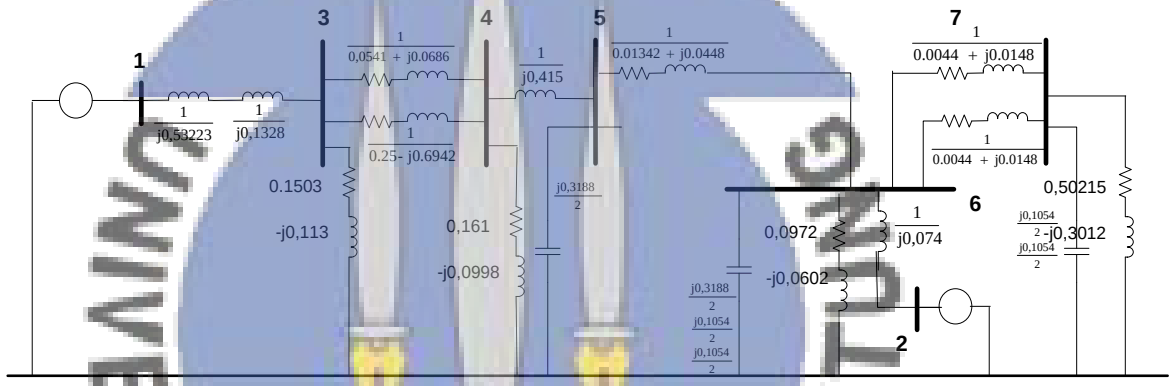


Proses reduksi matriks admitansi selama gangguan pada saluran di titik E

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56=0;
Y61=0;
Y62=0;
Y63=0;
Y64=0;
Y65=0;
Y66=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguansal1bus6= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
```

```
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik E



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik E

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
```

```
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+0.3188i/2;
Y56= -(1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.1054i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i)+1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Setelahgangguansal1bus6= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik E

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,7637) cos(-85,5044 - δ_1 + δ_1)+(1,1619)(1)(0)

cos (0−$\delta_1 + \delta_2$)

$P_{e1} = 0{,}0808 + 0 \cos(0 - \delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,1619)(1,1619)(0,7240) cos(-84,5717$-\delta_1 + \delta_1$)+(1,1619)(1)(0,6334)

cos (84,3876$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}09256 + 0{,}73595 \cos(84{,}3876 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

C. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}0808 + 0\cos(0 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}2419 - 0\cos(0 - \delta_1))$$

D. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}09256 + 0{,}73595\cos(84{,}3876 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}23024 - 0{,}73595\cos(84{,}3876 - \delta_1))$$

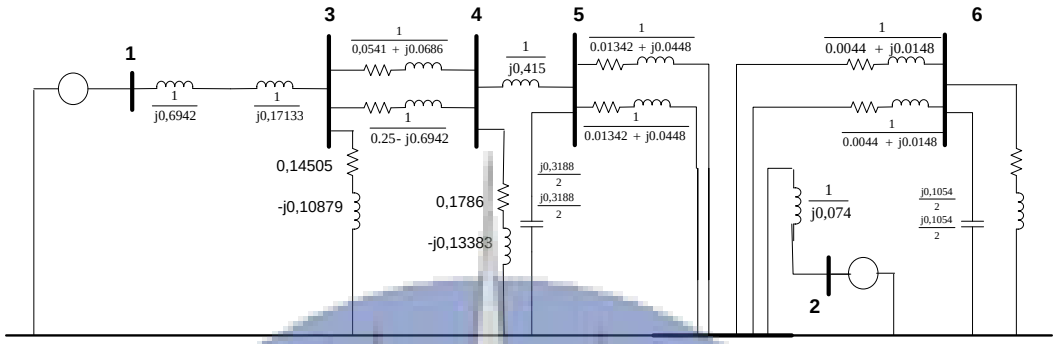
Simulasi Kurva Ayunan disaat terjadi gangguan di titik E

```
function xdot = persamaan_differensialsal1bus6(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 * (0.2419 - 0 *cos(0/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 * (0.23027 - 0.73595 *cos(84.3875/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [19.8/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsal1bus6', t,nilai_awal);
```

```
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

6. Pada Saat Terjadi Gangguan Pada Saluran di Titik F

Kondisi rangkaian admitansi selama gangguan pada saluran di titik F

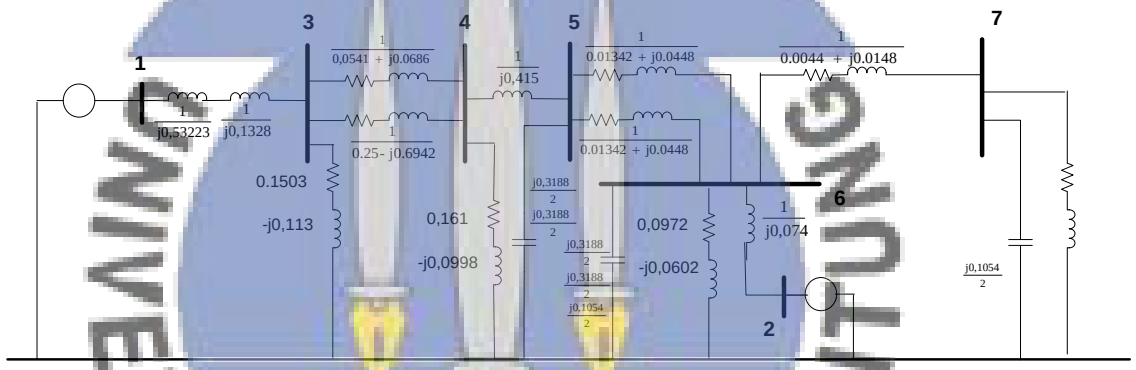


Proses reduksi matriks admitansi selama gangguan pada saluran di titik F

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56=0;
Y61=0;
Y62=0;
Y63=0;
Y64=0;
Y65=0;
Y66=1/(0.00444+0.0148i)+1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2+0.1054i/2;

Matriks_Selamagangguansal2bus6= [Y11 Y12 Y13 Y14 Y15 Y16;
```

```
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik F



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik F

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
Y42=0;
```

```
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.3188i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2;

Matriks_Setelahgangguansal2bus6= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik F

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,7637) cos(-85,5044- $\delta_1 + \delta_1$)+(1,1619)(1)(0)

cos (0$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}0808 + 0 \cos(0 - \delta_1)$

B. Persamaan daya elektrik setelah gangguan

$P_{e1} = (1{,}1619)(1{,}1619)(0{,}7317) \cos(-84{,}9116 - \delta_1 + \delta_1) + (1{,}1619)(1)(0{,}6551) \cos(84{,}2249 - \delta_1 + \delta_2)$

$P_{e1} = 0{,}23509 + 0{,}7612 \cos(84{,}2249 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

A. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}0808 + 0\cos(0 - \delta_1))))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}2419 - 0\cos(0 - \delta_1))$$

B. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}23509 + 0{,}7612\cos(84{,}2249 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}23509 - 0{,}7612\cos(84{,}2249 - \delta_1)))$$

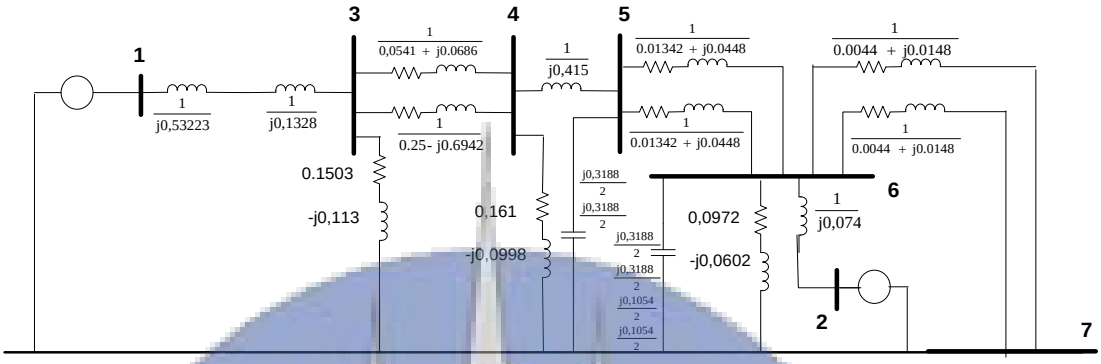
Simulasi Kurva Ayunan disaat terjadi gangguan di titik F

```
function xdot = persamaan_differensialsal2bus6(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 *  (0.2419 - 0 *cos(0/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 *  (0.23509 - 0.7612 *cos(84.2249/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [15.04/180*pi ; 0]
t = [0:0.3:15] ;
```

```
[t,delta_dan_omega] = ode45('persamaan_differensialsal2bus6', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

7. Pada Saat Terjadi Gangguan Pada Saluran di Titik G

Kondisi rangkaian admitansi selama gangguan pada saluran di titik G

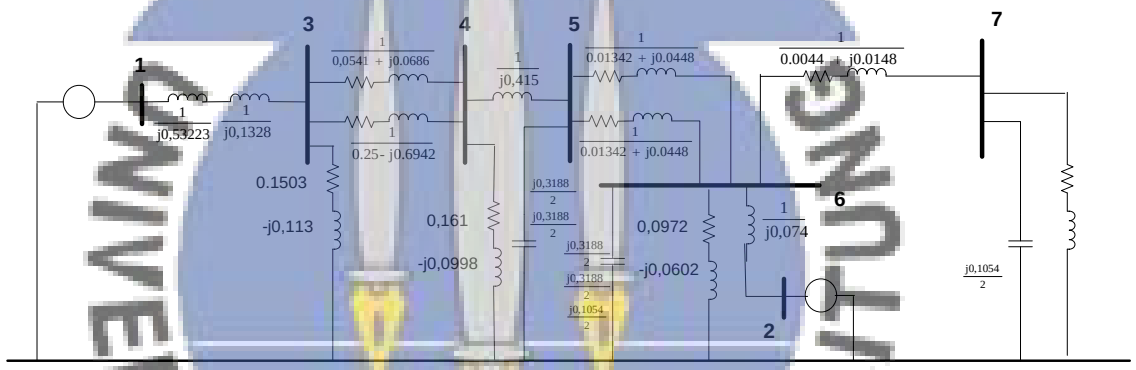


Proses reduksi matriks admitansi selama gangguan pada saluran di titik G

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y41=0;
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.00444+0.0148i)+1/(0.074i)+ 0.0994-
0.0616i+0.3188i/2+0.3188i/2+0.1054i/2+0.1054i/2;
```

```
Matriks_Selamagangguansalbus7= [Y11 Y12 Y13 Y14 Y15 Y16;
        Y21 Y22 Y23 Y24 Y25 Y26;
        Y31 Y32 Y33 Y34 Y35 Y36;
        Y41 Y42 Y43 Y44 Y45 Y46;
        Y51 Y52 Y53 Y54 Y55 Y56;
        Y61 Y62 Y63 Y64 Y65 Y66]

K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36;
    Y43 Y44 Y45 Y46;
    Y53 Y54 Y55 Y56;
    Y63 Y64 Y65 Y66];

L = [Y13 Y14 Y15 Y16;
    Y23 Y24 Y25 Y26];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Kondisi rangkaian admitansi setelah gangguan pada saluran di titik G



Proses reduksi matriks admitansi setelah gangguan pada saluran di titik G

```
Y11= 1/(0.6942i + 0.17133i);
Y12= 0;
Y13= -(1/(0.6942i + 0.17133i));
Y14= 0;
Y15= 0;
Y16= 0;
Y17= 0;
Y21= 0;
Y22= 1/(0.074i);
Y23= 0;
Y24= 0;
Y25= 0;
Y26= -(1/(0.074i));
Y27= 0;
Y31= -(1/(0.6942i + 0.17133i));
Y32= 0;
Y33= 1/(0.6942i + 0.17133i)+1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 0.14505-
0.10879i;
Y34= -(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y35= 0;
Y36= 0;
Y37= 0;
Y41=0;
```

```
Y42=0;
Y43=-(1/(0.0541+0.0686i)+1/(0.25 + 0.6942i));
Y44= 1/(0.0541+0.0686i)+1/(0.25 + 0.6942i)+ 1/(0.4155i)+ 0.1786-0.1338i;
Y45= -(1/(0.4155i));
Y46=0;
Y47=0;
Y51=0;
Y52=0;
Y53=0;
Y54= -(1/(0.4155i));
Y55= 1/(0.4155i)+1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+ 0.3188i/2+0.3188i/2;
Y56= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y57=0;
Y61=0;
Y62=-(1/(0.074i));
Y63=0;
Y64=0;
Y65= -(1/(0.01342+0.0448i)+1/(0.01342+0.0448i));
Y66=1/(0.01342+0.0448i)+1/(0.01342+0.0448i)+1/(0.00444+0.0148i)+...
    1/(0.074i)+ 0.0994-0.0616i+0.3188i/2+0.3188i/2+0.1054i/2;
Y67=-(1/(0.00444+0.0148i));
Y71=0;
Y72=0;
Y73=0;
Y74=0;
Y75=0;
Y76=-(1/(0.00444+0.0148i));
Y77=1/(0.00444+0.0148i)+0.4282-0.3211i+...
    0.1054i/2;

Matriks_Setelahgangguansalbus7= [Y11 Y12 Y13 Y14 Y15 Y16 Y17;
        Y21 Y22 Y23 Y24 Y25 Y26 Y27;
        Y31 Y32 Y33 Y34 Y35 Y36 Y37;
        Y41 Y42 Y43 Y44 Y45 Y46 Y47;
        Y51 Y52 Y53 Y54 Y55 Y56 Y57;
        Y61 Y62 Y63 Y64 Y65 Y66 Y67;
        Y71 Y72 Y73 Y74 Y75 Y76 Y77]
K = [Y11 Y12;
    Y21 Y22 ];

M = [Y33 Y34 Y35 Y36 Y37;
    Y43 Y44 Y45 Y46 Y57;
    Y53 Y54 Y55 Y56 Y57;
    Y63 Y64 Y65 Y66 Y67;
    Y73 Y74 Y75 Y76 Y77];
L = [Y13 Y14 Y15 Y16 Y17;
    Y23 Y24 Y25 Y26 Y27];

Yred = K - L*inv(M)*L.'
magnitude_Yred = abs(Yred)
sudut_Yred = angle(Yred)*180/pi
```

Perhitungan Persamaan daya elektrik selama dan setelah gangguan pada saluran di titik F

A. Persamaan daya elektrik selama gangguan

$P_{e1}= |E_1'||E_1'||Y_{12}|\cos(\theta_{11} - \delta_1 + \delta_1)+ |E_1'||E_2'||Y_{12}|\cos(\theta_{12} - \delta_1 + \delta_2)$

P_{e1} =(1,1619)(1,1619)(0,7608) cos (-85,3985$-\delta_1 + \delta_1$) + (1,1619)(1)(0,0644) cos (71,7686$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}0824 + 0{,}0748 \cos (71{,}7686-\delta_1)$

B. Persamaan daya elektrik setelah gangguan

P_{e1} =(1,1619)(1,1619)(0,7317) cos(-84,9116$-\delta_1 + \delta_1$)+(1,1619)(1)(0,6551) cos (84,2249$-\delta_1 + \delta_2$)

$P_{e1} = 0{,}08761 + 0{,}7612 \cos(84{,}2249 - \delta_1)$

Perhitungan persamaan ayunan selama dan setelah gangguan pada saluran bus 5 ke 6

C. Persamaan ayunan selama gangguan

$$\frac{2H_i}{\omega_s}\frac{d^2\delta_i}{dt^2} = (P_{mi} - P_{ei})$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}3227 - (0{,}0824 + 0{,}0748\cos(71{,}7686 - \delta_1)))$$

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}20}(0{,}2403 - 0{,}0748\cos(71{,}7686 - \delta_1))$$

D. Persamaan ayunan setelah gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}3227 - (0{,}08761 + 0{,}7612\cos(84{,}2249 - \delta_1))$$

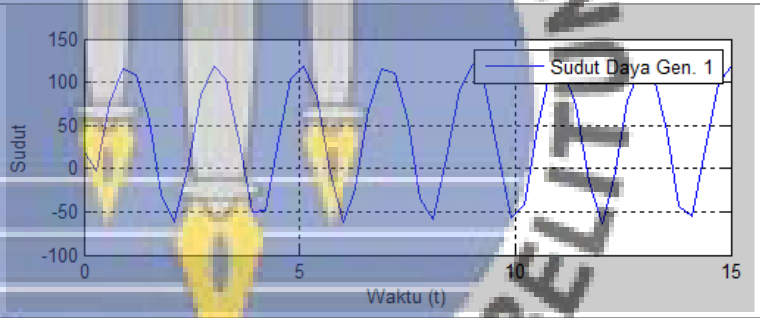
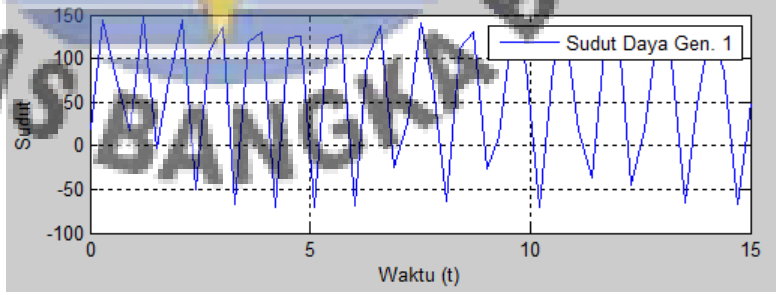
$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0{,}26}(0{,}23509 - 0{,}7612\cos(84{,}2249 - \delta_1))$$

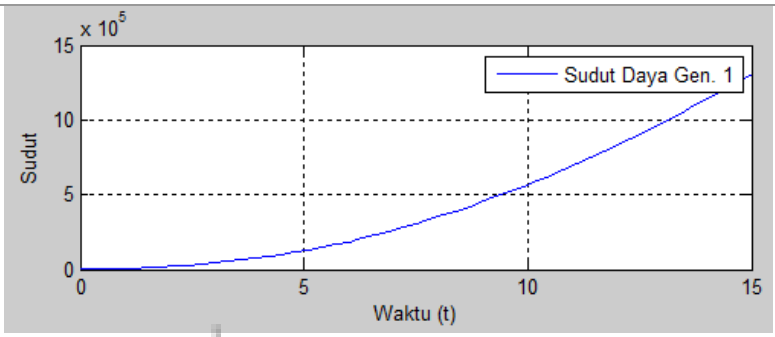
Simulasi Kurva Ayunan disaat terjadi gangguan di titik F

```
function xdot = persamaan_differensialsalbus7(t,x)
global t_pemutusan_gangguan

if t < t_pemutusan_gangguan
    xdot = [x(2) ; 50*pi/0.20 *  (0.2403 - 0.0748 *cos(71.7686/180*pi  - x(1)))] ;

end
if t >= t_pemutusan_gangguan
   xdot = [x(2) ; 50*pi/0.20 *  (0.23509 - 0.7612 *cos(84.2249/180*pi  - x(1)))] ;

end
close;clc;clear all
global t_pemutusan_gangguan
t_pemutusan_gangguan = 0.14
nilai_awal = [15,04/180*pi ; 0]
t = [0:0.3:15] ;
[t,delta_dan_omega] = ode45('persamaan_differensialsalbus7', t,nilai_awal);
subplot (2,1,1)
plot(t,(delta_dan_omega(:,1))*180/pi);legend 'Sudut Daya Gen. 1';grid on
```

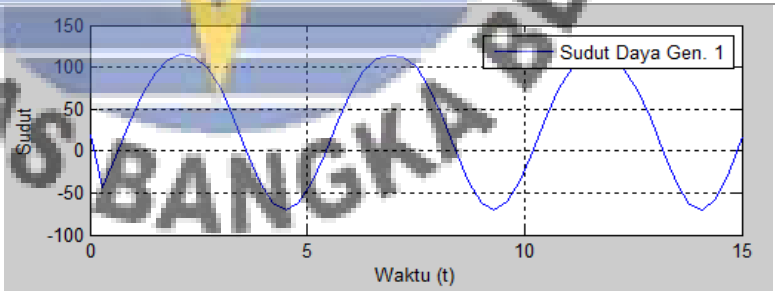
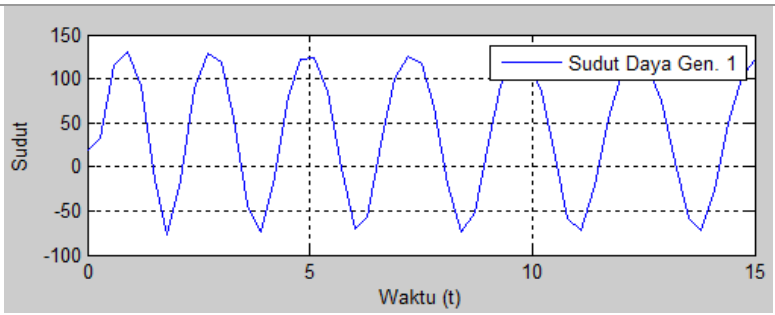
Tabulasi Grafik (Kurva Ayunan) Disaat 9 Generator Beroperasi

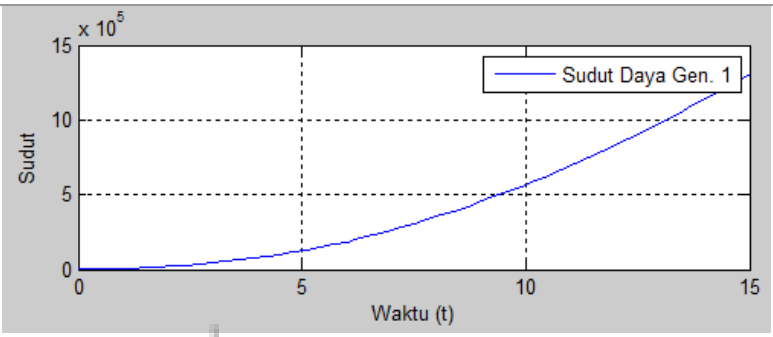
Tabel kurva ayunan Gangguan pada Bus 7

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,30457 - 0,0895\,\cos(72,5632 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,0057 - 0,91879\,\cos(86,7688 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.13	
0.14	

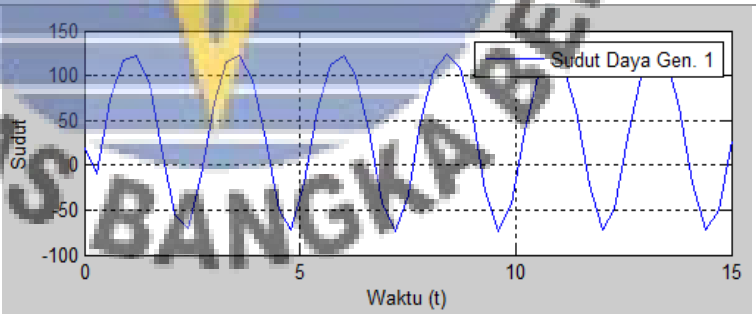
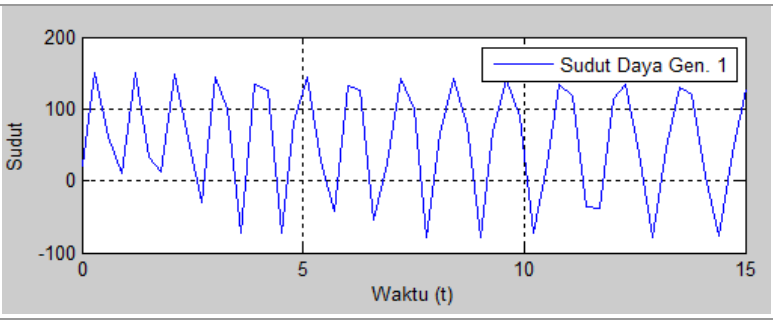
0.15	

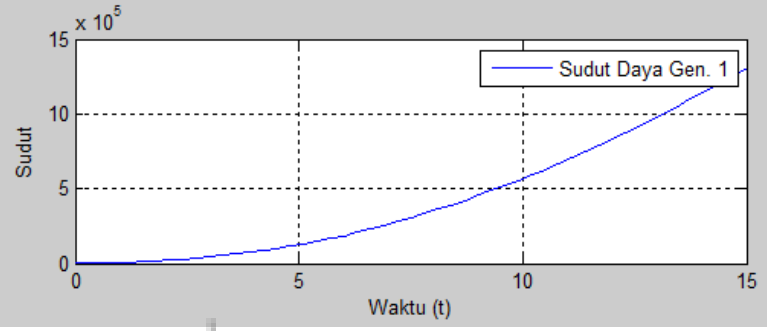
Tabel kurva ayunan Gangguan pada pertengahan salah satu saluran bus 6 ke 7

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,30507 - 0,06862\cos(72,2035 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,29877 - 0,90394\cos(85,0650 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.13	
0.14	

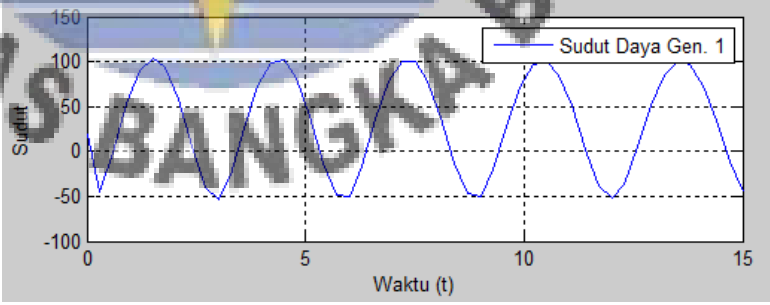
0.15	

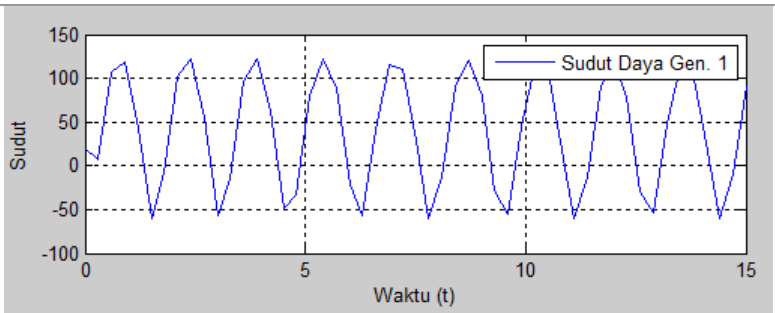
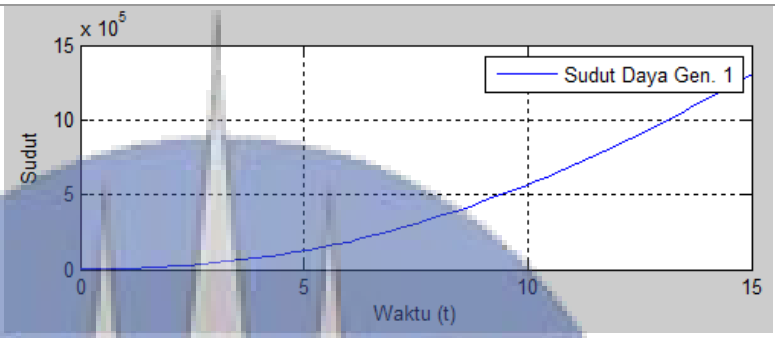
Tabel kurva ayunan Gangguan pada Pertengahan Saluran Bus 5 ke 6

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,30877 - 0,06095\cos(73,7959 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,29247 - 0,8722\cos(85,2738 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.13	
0.14	

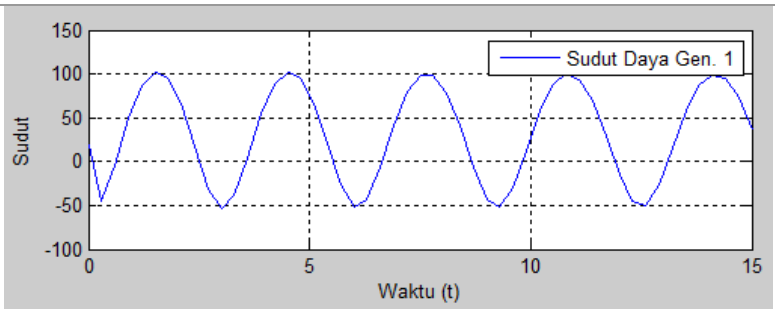
0.15	

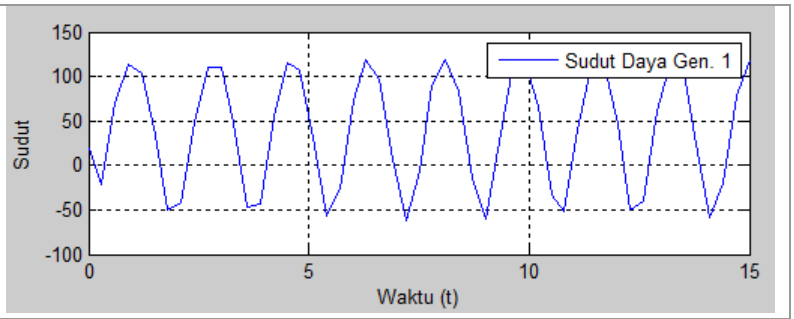
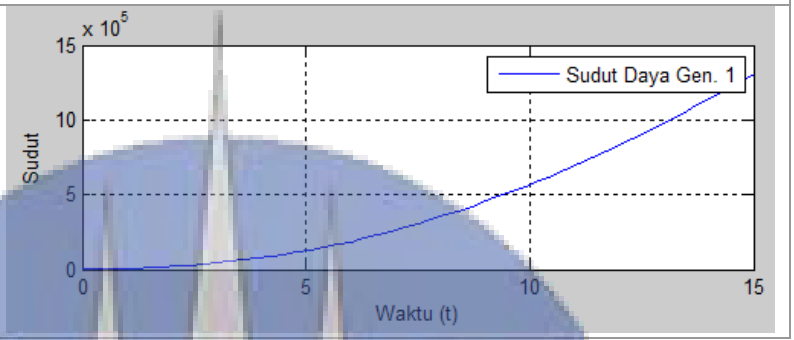
Tabel kurva ayunan Gangguan pada Saluran di Titik D

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,31437 - 0\cos(0 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,29247 - 0,8722\cos(85,2738 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.10	

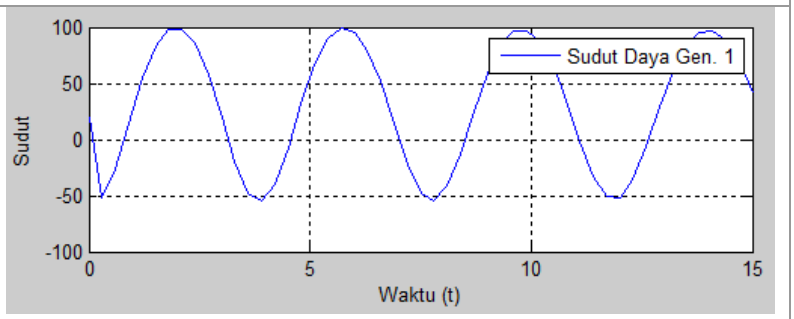
0.11	
0.12	

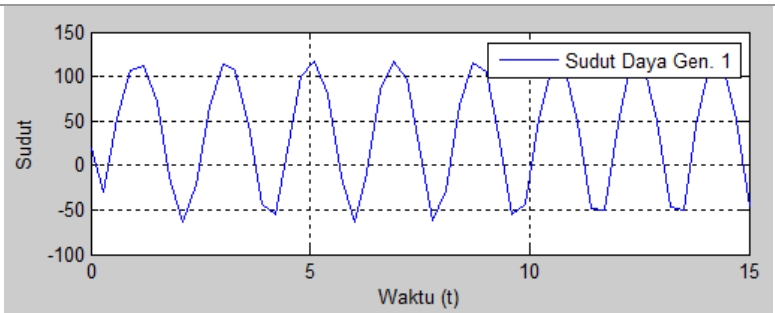
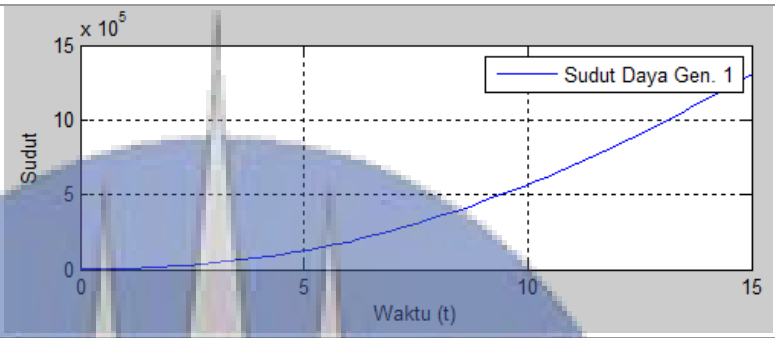
Tabel kurva ayunan Gangguan pada Saluran di Titik E

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,30647 - 0\cos(0 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,29247 - 0,8722\cos(85,2738 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.10	

0.11	
0.12	

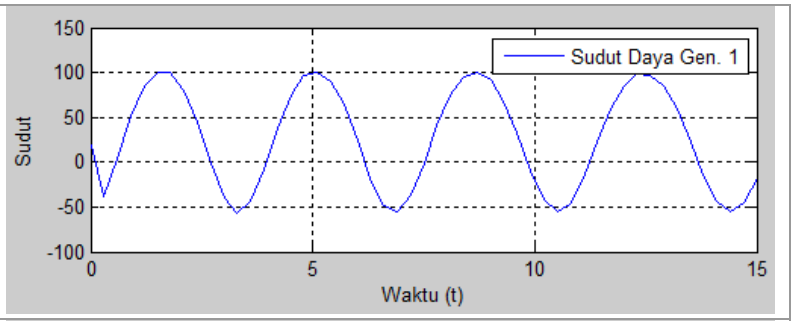
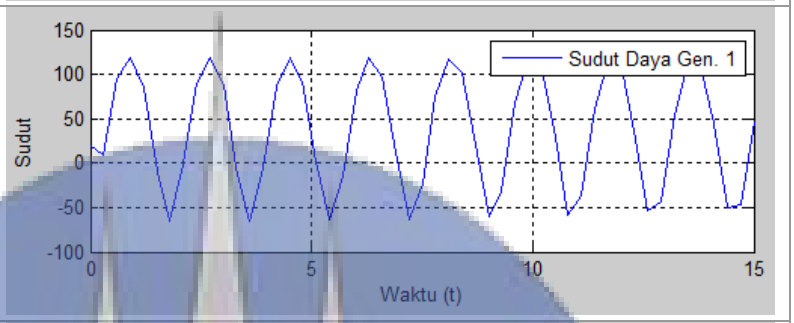
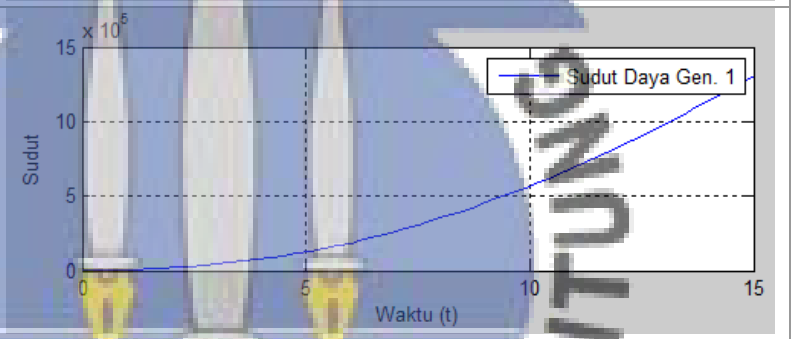
Tabel kurva ayunan Gangguan pada Saluran di Titik F

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,30647 - 0\cos(0 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}(0,29877 - 0,9039\cos(85,0650 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.10	

0.11	
0.12	

Tabel kurva ayunan Gangguan pada Saluran di Titik G

Persamaan Ayunan selama Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,30457 - 0,0895\,\cos\,(72,5632 - \delta_1))$	
Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,26}\,(0,29877 - 0,9039\,\cos\,(85,0650 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**

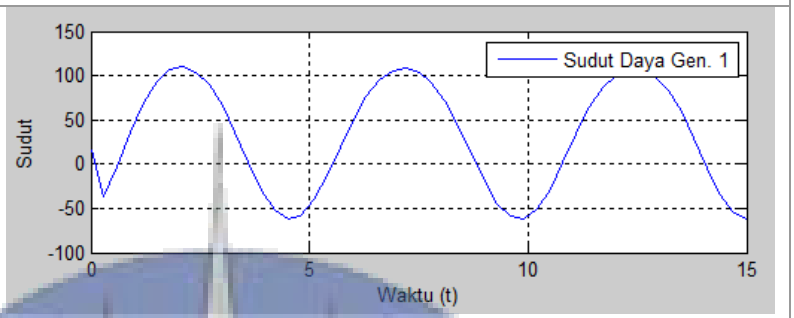
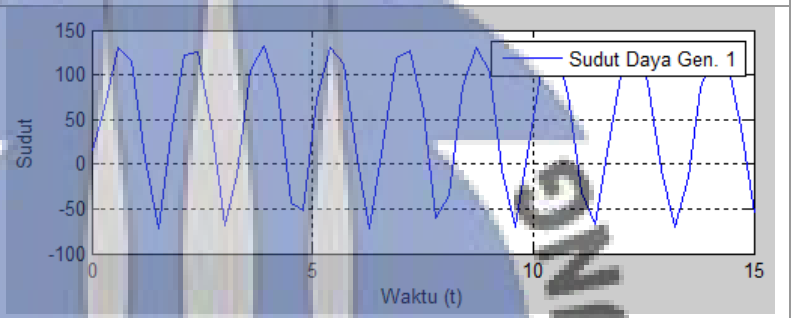
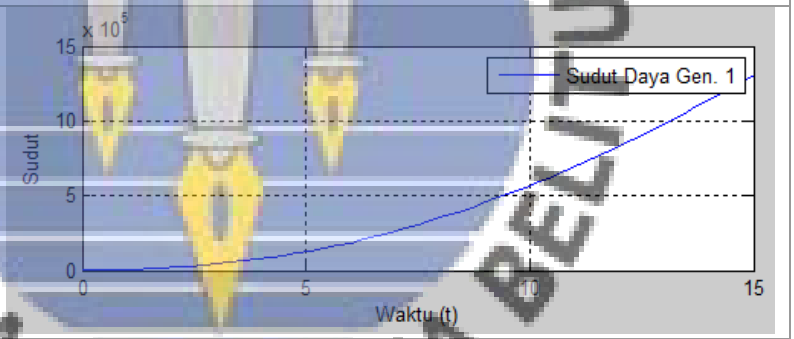
0.12	
0.13	
0.14	

Tabulasi Grafik (Kurva Ayunan) Disaat 7 Generator Beroperasi

Tabel kurva ayunan Gangguan pada Bus 7

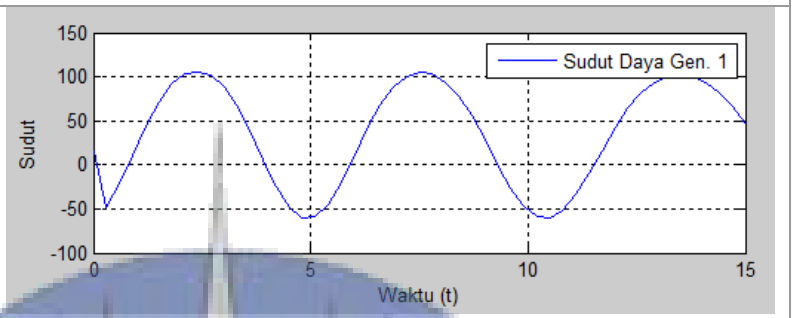
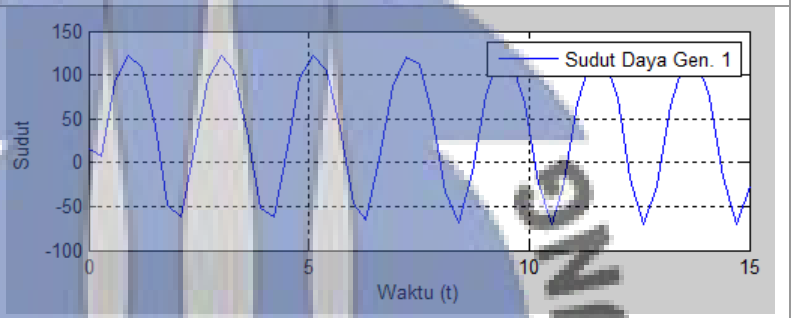
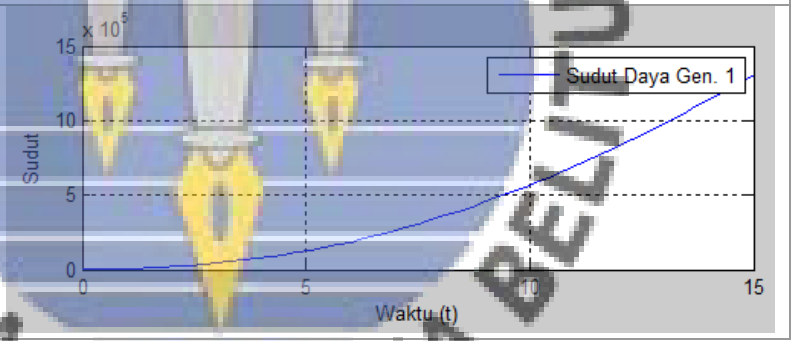
Persamaan Ayunan selama Gangguan
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,2403 - \,0,0748\cos(71,7686 - \delta_1))$
Persamaan Ayunan setelah Gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,2364 - \,0,7738\cos(85,9432 - \delta_1))$$

Waktu Pemutusan	Grafik (Kurva Ayunan)
0.13	
0.14	
0.15	

Tabel kurva ayunan Gangguan pada pertengahan salah satu saluran bus 6 ke 7

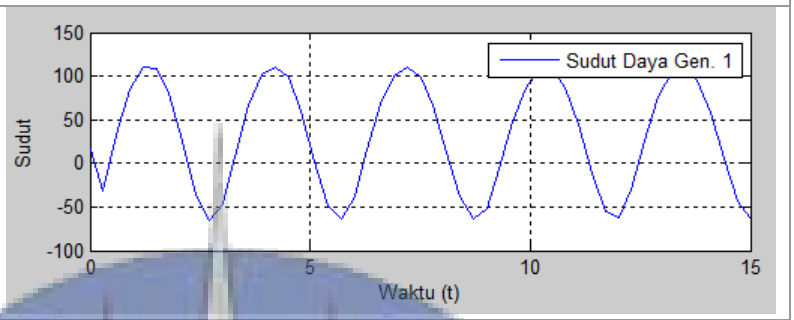
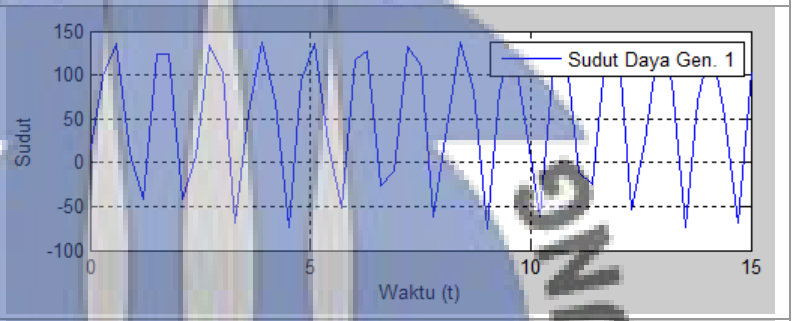
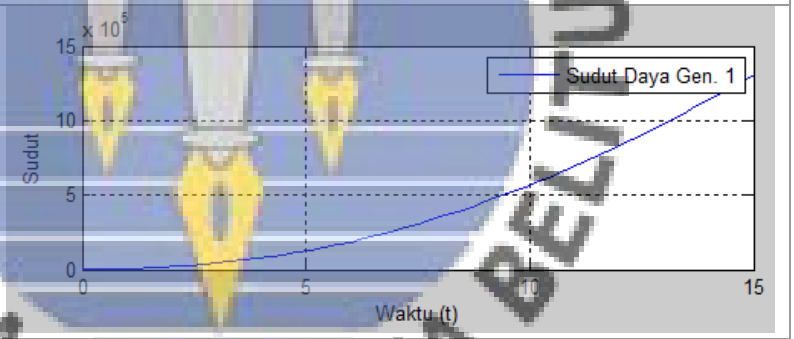
Persamaan Ayunan selama Gangguan
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,24065 - \,0,05739\cos(71,4122 - \delta_1))$
Persamaan Ayunan setelah Gangguan

$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,2351 - \ 0,7612\cos(84,2249 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.12	
0.13	
0.14	

Tabel kurva ayunan Gangguan pada Pertengahan Saluran Bus 5 ke 6

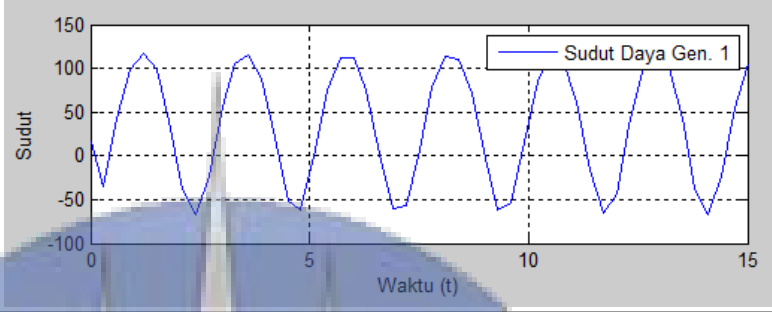
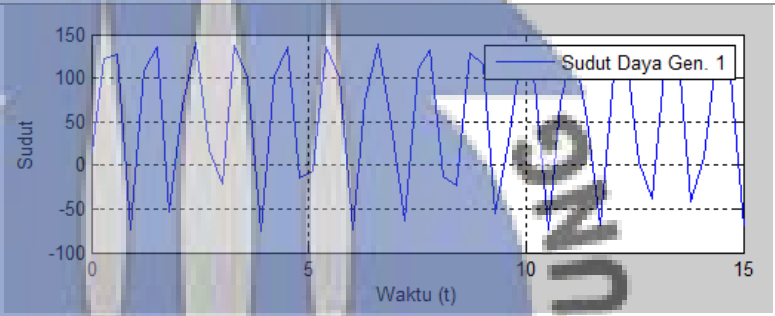
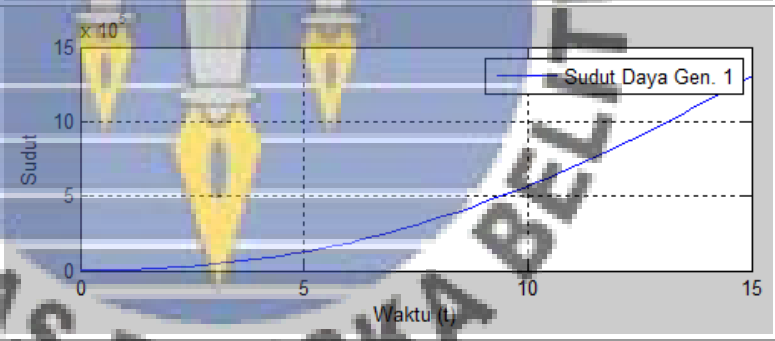
Persamaan Ayunan selama Gangguan
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,30877 - 0,0509\cos(73,0309 - \delta_1))$
Persamaan Ayunan setelah Gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,29247 - \,0,7359\cos(84,3876 - \delta_1))$$

Waktu Pemutusan	Grafik (Kurva Ayunan)
0.12	
0.13	
0.14	

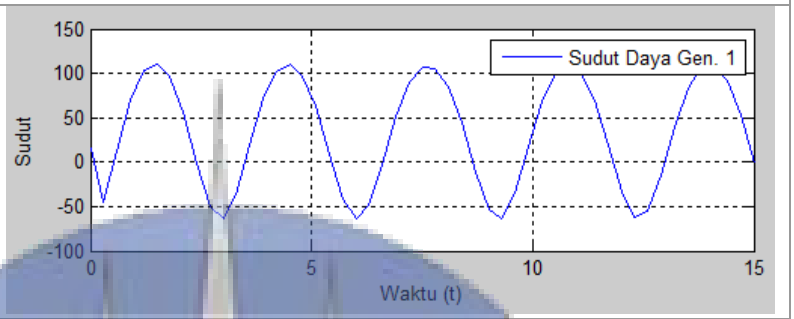
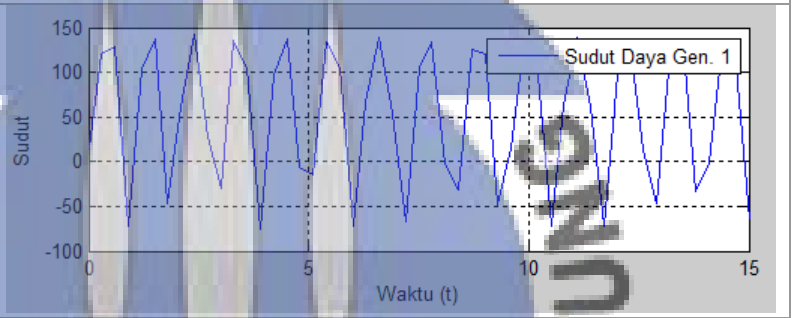
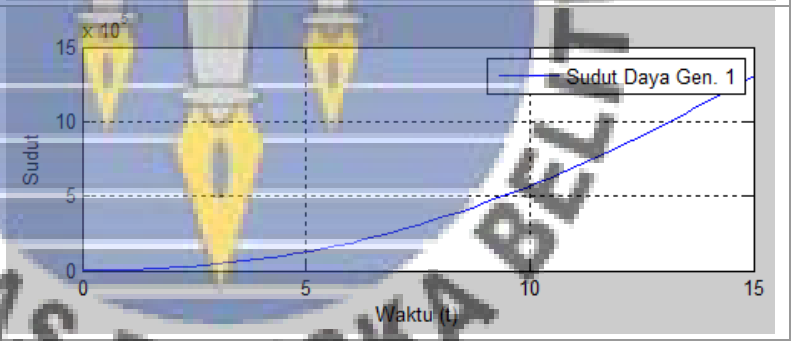
Tabel kurva ayunan Gangguan pada Saluran di Titik D

Persamaan Ayunan selama Gangguan
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,24667 - 0\cos(0 - \delta_1))$

Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,23024 - \ 0,73595\cos(84,3876 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.11	
0.12	
0.13	

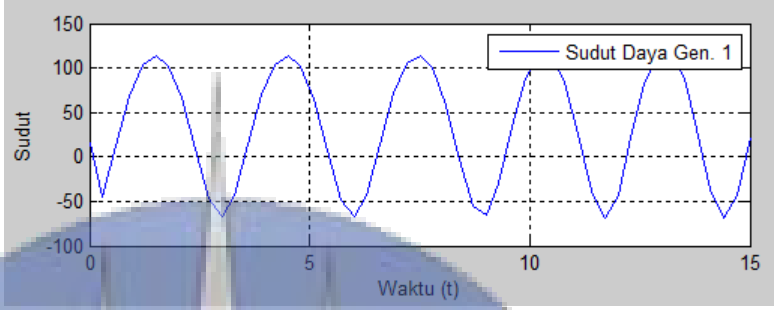
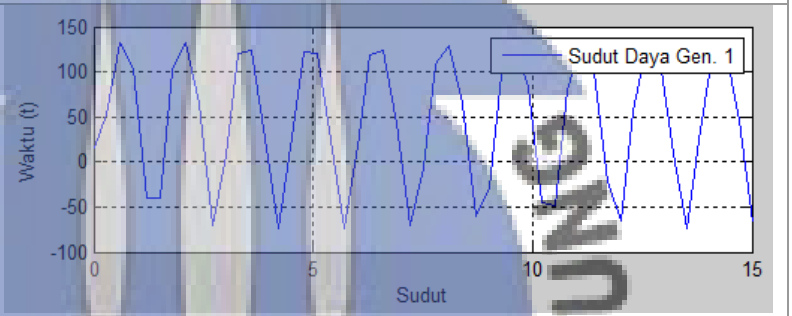
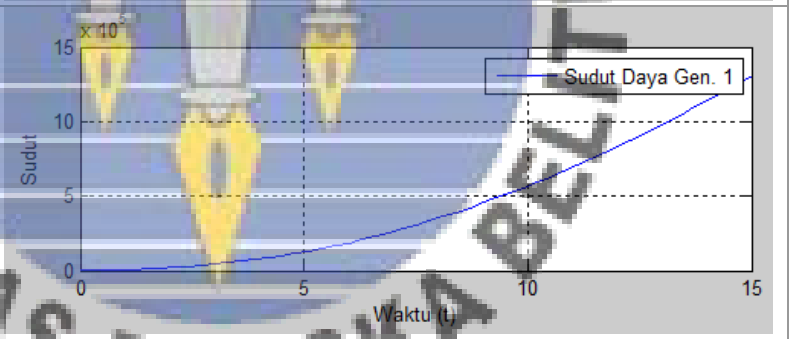
Tabel kurva ayunan Gangguan pada Saluran di Titik E

Persamaan Ayunan selama Gangguan
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,2419 - 0\cos(0 - \delta_1))$

Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,29247 - \ 0,73595\cos(84,3876 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.11	
0.12	
0.13	

Tabel kurva ayunan Gangguan pada Saluran di Titik F

Persamaan Ayunan selama Gangguan
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,2419 - 0\cos(0 - \delta_1))$

Persamaan Ayunan setelah Gangguan	
$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,23509 - \ 0,7612\cos(84,2249 - \delta_1))$	
Waktu Pemutusan	**Grafik (Kurva Ayunan)**
0.11	
0.12	
0.13	

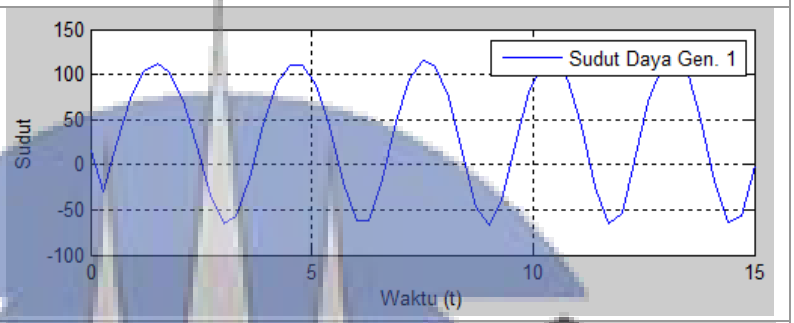
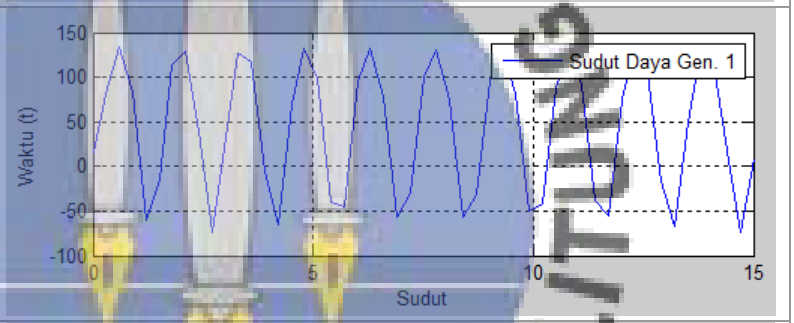
Tabel kurva ayunan Gangguan pada Saluran di Titik G

Persamaan Ayunan selama Gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,2403 - \ 0,0748\cos(71,7686 - \delta_1))$$

Persamaan Ayunan setelah Gangguan

$$\frac{d^2\delta_1}{dt^2} = \frac{50\,\pi}{0,20}\,(0,23509 - \ 0,7612\cos(84,2249 - \delta_1))$$

Waktu Pemutusan	Grafik (Kurva Ayunan)
0.13	
0.14	
0.15