

A. Network Parameters

Network parameters and general data for the IEEE 118-bus test system are described as follows.

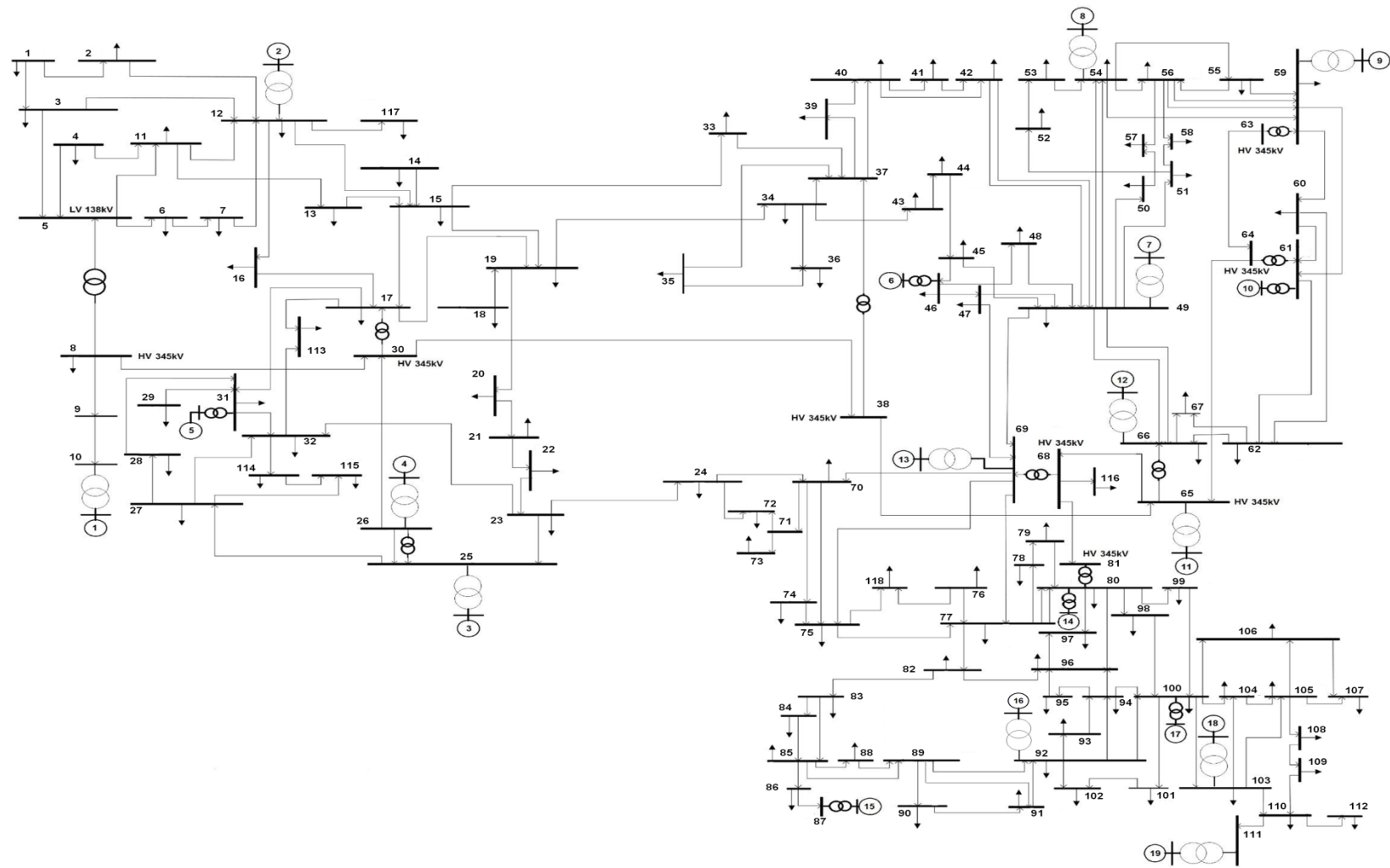


Fig. 1. IEEE 118-Bus Test System One-Line Diagram

TABLE I
GENERATOR DATA

U	Bus No.	P _g (MW)	Q _g (MVar)	Marginal Cost (\$/MWh)	P _{max} (MW)	P _{min} (MW)	Q _{max} (MVar)	Q _{min} (MVar)
1	10	450	-5	0.217	550	0	200	-147
2	12	85	91.27	1.052	185	0	120	-35
3	25	220	49.72	0.434	320	0	140	-47
4	26	314	9.89	0.308	414	0	1000	-1000
5	31	7	31.57	5.882	107	0	300	-300
6	46	19	-5.25	3.448	119	0	100	-100
7	49	204	115.63	0.467	304	0	210	-85
8	54	48	3.9	1.724	148	0	300	-300
9	59	155	76.83	0.606	255	0	180	-60
10	61	160	-40.39	0.588	260	0	300	-100
11	65	391	80.76	0.2493	491	0	200	-67
12	66	392	-1.95	0.2487	492	0	200	-67
13	69	513.48	-82.39	0.1897	805.2	0	300	-300
14	80	477	104.9	0.205	577	0	280	-165
15	87	4	11.02	7.142	104	0	1000	-100
16	92	607	0.49	10	1100	0	9	-3
17	100	252	108.87	0.381	352	0	155	-50
18	103	40	41.69	2	140	0	40	-15
19	111	36	-1.84	2.173	136	0	1000	-100

TABLE II
BUS DATA

Bus No.	Conductance (G) (mhos)	Susceptance (B) (mhos)	Base Voltage (kV)	Voltage-Max (pu)	Voltage-Min (pu)
1	0	0	138	1.06	0.94
2	0	0	138	1.06	0.94
3	0	0	138	1.06	0.94
4	0	0	138	1.06	0.94
5	0	-40	138	1.06	0.94
6	0	0	138	1.06	0.94
7	0	0	138	1.06	0.94
8	0	0	345	1.06	0.94
9	0	0	345	1.06	0.94
10	0	0	345	1.06	0.94
11	0	0	138	1.06	0.94
12	0	0	138	1.06	0.94

13	0	0	138	1.06	0.94
14	0	0	138	1.06	0.94
15	0	0	138	1.06	0.94
16	0	0	138	1.06	0.94
17	0	0	138	1.06	0.94
18	0	0	138	1.06	0.94
19	0	0	138	1.06	0.94
20	0	0	138	1.06	0.94
21	0	0	138	1.06	0.94
22	0	0	138	1.06	0.94
23	0	0	138	1.06	0.94
24	0	0	138	1.06	0.94
25	0	0	138	1.06	0.94
26	0	0	345	1.06	0.94
27	0	0	138	1.06	0.94
28	0	0	138	1.06	0.94
29	0	0	138	1.06	0.94
30	0	0	345	1.06	0.94
31	0	0	138	1.06	0.94
32	0	0	138	1.06	0.94
33	0	0	138	1.06	0.94
34	0	14	138	1.06	0.94
35	0	0	138	1.06	0.94
36	0	0	138	1.06	0.94
37	0	-25	138	1.06	0.94
38	0	0	345	1.06	0.94
39	0	0	138	1.06	0.94
40	0	0	138	1.06	0.94
41	0	0	138	1.06	0.94
42	0	0	138	1.06	0.94
43	0	0	138	1.06	0.94
44	0	10	138	1.06	0.94
45	0	10	138	1.06	0.94
46	0	10	138	1.06	0.94
47	0	0	138	1.06	0.94
48	0	15	138	1.06	0.94
49	0	0	138	1.06	0.94
50	0	0	138	1.06	0.94
51	0	0	138	1.06	0.94
52	0	0	138	1.06	0.94
53	0	0	138	1.06	0.94

54	0	0	138	1.06	0.94
55	0	0	138	1.06	0.94
56	0	0	138	1.06	0.94
57	0	0	138	1.06	0.94
58	0	0	138	1.06	0.94
59	0	0	138	1.06	0.94
60	0	0	138	1.06	0.94
61	0	0	138	1.06	0.94
62	0	0	138	1.06	0.94
63	0	0	345	1.06	0.94
64	0	0	345	1.06	0.94
65	0	0	345	1.06	0.94
66	0	0	138	1.06	0.94
67	0	0	138	1.06	0.94
68	0	0	345	1.06	0.94
69	0	0	138	1.06	0.94
70	0	0	138	1.06	0.94
71	0	0	138	1.06	0.94
72	0	0	138	1.06	0.94
73	0	0	138	1.06	0.94
74	0	12	138	1.06	0.94
75	0	0	138	1.06	0.94
76	0	0	138	1.06	0.94
77	0	0	138	1.06	0.94
78	0	0	138	1.06	0.94
79	0	20	138	1.06	0.94
80	0	0	138	1.06	0.94
81	0	0	345	1.06	0.94
82	0	20	138	1.06	0.94
83	0	10	138	1.06	0.94
84	0	0	138	1.06	0.94
85	0	0	138	1.06	0.94
86	0	0	138	1.06	0.94
87	0	0	161	1.06	0.94
88	0	0	138	1.06	0.94
89	0	0	138	1.06	0.94
90	0	0	138	1.06	0.94
91	0	0	138	1.06	0.94
92	0	0	138	1.06	0.94
93	0	0	138	1.06	0.94
94	0	0	138	1.06	0.94

95	0	0	138	1.06	0.94
96	0	0	138	1.06	0.94
97	0	0	138	1.06	0.94
98	0	0	138	1.06	0.94
99	0	0	138	1.06	0.94
100	0	0	138	1.06	0.94
101	0	0	138	1.06	0.94
102	0	0	138	1.06	0.94
103	0	0	138	1.06	0.94
104	0	0	138	1.06	0.94
105	0	20	138	1.06	0.94
106	0	0	138	1.06	0.94
107	0	6	138	1.06	0.94
108	0	0	138	1.06	0.94
109	0	0	138	1.06	0.94
110	0	6	138	1.06	0.94
111	0	0	138	1.06	0.94
112	0	0	138	1.06	0.94
113	0	0	138	1.06	0.94
114	0	0	138	1.06	0.94
115	0	0	138	1.06	0.94
116	0	0	138	1.06	0.94
117	0	0	138	1.06	0.94
118	0	0	138	1.06	0.94

TABLE III
TRANSMISSION LINE DATA

Line No.	From Bus	To Bus	R (pu)	X (pu)	β (pu)	Flow Limit (MW)
1	1	2	0.0303	0.0999	10.01001001	270
2	1	3	0.0129	0.0424	23.58490566	270
3	2	12	0.0187	0.0616	16.23376623	270
4	3	5	0.0241	0.108	9.259259259	270
5	3	12	0.0484	0.16	62.5	270
6	4	5	0.0017	0.00798	125.3132832	490
7	4	11	0.0209	0.0688	14.53488372	270
8	5	6	0.0119	0.054	18.51851852	270
9	5	11	0.0203	0.0682	14.6627566	270
10	6	7	0.0045	0.0208	48.07692308	270
11	7	12	0.0086	0.034	29.41176471	270
12	8	9	0.0024	0.0305	32.78688525	1150

13	8	5	0	0.0267	37.45318352	930
14	8	30	0.0043	0.0504	19.84126984	270
15	9	10	0.0025	0.0322	31.05590062	1150
16	11	12	0.0059	0.0196	51.02040816	270
17	11	13	0.0222	0.0731	13.67989056	270
18	12	15	0.0215	0.0707	14.14427157	270
19	12	17	0.0212	0.0834	11.99040767	270
20	12	117	0.0329	0.14	7.142857143	270
21	13	15	0.0744	0.2444	4.091653028	270
22	14	15	0.0595	0.195	5.128205128	270
23	15	17	0.0132	0.0437	22.88329519	490
24	15	19	0.012	0.0394	25.38071066	270
25	15	33	0.038	0.1244	8.038585209	270
26	16	17	0.0454	0.1801	5.55247085	270
27	17	19	0.0123	0.0505	19.8019802	270
28	17	31	0.0474	0.1563	6.397952655	270
29	17	113	0.0091	0.0301	33.22259136	270
30	18	19	0.0111	0.0493	20.28397566	270
31	19	20	0.0252	0.117	8.547008547	270
32	19	34	0.0752	0.247	4.048582996	270
33	20	21	0.0183	0.0849	11.77856302	270
34	21	22	0.0209	0.097	10.30927835	270
35	22	23	0.0342	0.159	6.289308176	270
36	23	24	0.0135	0.0492	20.32520325	270
37	23	25	0.0156	0.080	12.5	490
38	23	32	0.0317	0.1153	8.673026886	270
39	24	70	0.0022	0.4115	2.430133657	270
40	24	72	0.0488	0.196	5.102040816	270
41	25	27	0.0318	0.163	6.134969325	490
42	26	25	0	0.0382	26.17801047	370
43	26	30	0.0079	0.086	11.62790698	710
44	27	28	0.0191	0.0855	11.69590643	270
45	27	32	0.0229	0.0755	13.24503311	270
46	27	115	0.0164	0.0741	13.49527665	270
47	28	31	0.0237	0.0943	10.60445387	270
48	29	31	0.0108	0.0331	30.21148036	270
49	30	17	0	0.0388	25.77319588	710
50	30	38	0.0046	0.054	18.51851852	270
51	31	32	0.0298	0.0985	10.15228426	270
52	32	113	0.0615	0.203	4.926108374	270
53	32	114	0.0135	0.0612	16.33986928	270

54	33	37	0.0415	0.142	7.042253521	270
55	34	36	0.0087	0.0268	37.31343284	270
56	34	37	0.0025	0.00940	106.3829787	490
57	34	43	0.0413	0.1681	5.948839976	270
58	35	36	0.0022	0.0102	98.03921569	270
59	35	37	0.011	0.0497	20.12072435	270
60	37	39	0.0321	0.106	9.433962264	270
61	37	40	0.0593	0.168	5.952380952	270
62	38	37	0	0.0375	26.66666667	710
63	38	65	0.009	0.0986	10.14198783	490
64	39	40	0.0184	0.0605	16.52892562	270
65	40	41	0.0145	0.0487	20.5338809	270
66	40	42	0.0555	0.183	5.464480874	270
67	41	42	0.041	0.135	7.407407407	270
68	42	49	0.0715	0.323	3.095975232	270
69	42	49	0.0715	0.323	3.095975232	270
70	43	44	0.0608	0.2454	4.074979625	270
71	44	45	0.0224	0.0901	11.09877913	270
72	45	46	0.04	0.1356	7.374631268	270
73	45	49	0.0684	0.186	5.376344086	270
74	46	47	0.038	0.127	7.874015748	270
75	46	48	0.0601	0.189	5.291005291	270
76	47	49	0.0191	0.0625	16	270
77	47	69	0.0844	0.2778	3.599712023	270
78	48	49	0.0179	0.0505	19.8019802	270
79	49	50	0.0267	0.0752	13.29787234	270
80	49	51	0.0486	0.137	7.299270073	270
81	49	54	0.073	0.289	3.460207612	270
82	49	54	0.0869	0.291	3.436426117	270
83	49	66	0.018	0.0919	10.88139282	490
84	49	66	0.018	0.0919	10.88139282	490
85	49	69	0.0985	0.324	3.086419753	270
86	50	57	0.0474	0.134	7.462686567	270
87	51	52	0.0203	0.0588	17.00680272	270
88	51	58	0.0255	0.0719	13.90820584	270
89	52	53	0.0405	0.1635	6.116207951	270
90	53	54	0.0263	0.122	8.196721311	270
91	54	55	0.0169	0.0707	14.14427157	270
92	54	56	0.0027	0.00955	104.7120419	270
93	54	59	0.0503	0.2293	4.361098997	270
94	55	56	0.0048	0.0151	66.22516556	270

95	55	59	0.0473	0.2158	4.633920297	270
96	56	57	0.0343	0.0966	10.35196687	270
97	56	58	0.0343	0.0966	10.35196687	270
98	56	59	0.0825	0.251	3.984063745	270
99	56	59	0.0803	0.239	4.184100418	270
100	59	60	0.0317	0.145	6.896551724	270
101	59	61	0.0328	0.150	6.666666667	270
102	60	61	0.00260	0.0135	74.07407407	490
103	60	62	0.0123	0.0561	17.82531194	270
104	61	62	0.0082	0.0376	26.59574468	270
105	62	66	0.0482	0.218	4.587155963	270
106	62	67	0.0258	0.117	8.547008547	270
107	63	59	0	0.0386	25.90673575	490
108	63	64	0.0017	0.0200	50	490
109	64	61	0	0.0268	37.31343284	270
110	64	65	0.0026	0.0302	33.11258278	490
111	65	66	0	0.0370	27.02702703	270
112	65	68	0.0013	0.016	62.5	270
113	66	67	0.0224	0.1015	9.852216749	270
114	68	69	0	0.0370	27.02702703	490
115	68	81	0.0017	0.0202	49.5049505	270
116	68	116	0.0003	0.00405	246.9135802	490
117	69	70	0.03	0.127	7.874015748	490
118	69	75	0.0405	0.122	8.196721311	490
119	69	77	0.0309	0.101	9.900990099	270
120	70	71	0.0088	0.0355	28.16901408	270
121	70	74	0.0401	0.1323	7.558578987	270
122	70	75	0.0428	0.141	7.092198582	270
123	71	72	0.0446	0.180	5.555555556	270
124	71	73	0.0086	0.0454	22.02643172	270
125	74	75	0.0123	0.0406	24.63054187	270
126	75	77	0.0601	0.1999	5.002501251	270
127	75	118	0.0145	0.0481	20.79002079	270
128	76	77	0.0444	0.148	6.756756757	270
129	76	118	0.0164	0.0544	18.38235294	270
130	77	78	0.0037	0.0124	80.64516129	270
131	77	80	0.017	0.0485	20.6185567	490
132	77	80	0.0294	0.105	9.523809524	270
133	77	82	0.0298	0.0853	11.72332943	370
134	78	79	0.0054	0.0244	40.98360656	270
135	79	80	0.0156	0.0704	14.20454545	270

136	80	96	0.0356	0.182	5.494505495	270
137	80	97	0.0183	0.0934	10.70663812	270
138	80	98	0.0238	0.108	9.259259259	270
139	80	99	0.0454	0.206	4.854368932	270
140	81	80	0	0.0370	27.02702703	270
141	82	83	0.0112	0.03665	27.2851296	370
142	82	96	0.0162	0.0530	18.86792453	270
143	83	84	0.0625	0.132	7.575757576	270
144	83	85	0.0430	0.148	6.756756757	270
145	84	85	0.0302	0.0641	15.60062402	270
146	85	86	0.0350	0.123	8.130081301	270
147	85	88	0.0200	0.102	9.803921569	270
148	85	89	0.0239	0.173	5.780346821	270
149	86	87	0.0282	0.2074	4.821600771	270
150	88	89	0.0139	0.0712	14.04494382	490
151	89	90	0.0518	0.0320	31.25	810
152	89	91	0.00990	0.0320	31.25	270
153	89	92	0.00990	0.0505	19.8019802	370
154	90	91	0.0254	0.0505	6.325110689	710
155	91	92	0.0387	0.1272	19.8019802	470
156	92	93	0.0258	0.0320	7.86163522	270
157	92	94	0.0481	0.158	31.25	810
158	92	100	0.0648	0.295	6.329113924	270
159	92	102	0.0123	0.0559	3.389830508	270
160	93	94	0.0223	0.0732	17.88908766	270
161	94	95	0.0132	0.0434	13.66120219	270
162	94	96	0.0269	0.0869	23.04147465	370
163	94	100	0.0178	0.0580	11.50747986	270
164	95	96	0.0171	0.0547	17.24137931	270
165	96	97	0.0173	0.0885	18.28153565	570
166	98	100	0.0397	0.179	11.29943503	270
167	99	100	0.0180	0.0813	5.586592179	270
168	100	101	0.0277	0.1262	12.300123	270
169	100	103	0.0160	0.0525	7.923930269	490
170	100	104	0.0451	0.204	19.04761905	270
171	100	106	0.0605	0.229	4.901960784	270
172	101	102	0.0246	0.112	4.366812227	270
173	103	104	0.0466	0.1584	8.928571429	270
174	103	105	0.0535	0.1625	6.313131313	270
175	103	110	0.0390	0.1813	6.153846154	270
176	104	105	0.00990	0.0378	5.515719801	270

177	105	106	0.0140	0.0547	26.45502646	270
178	105	107	0.0530	0.183	18.28153565	270
179	105	108	0.0261	0.0703	5.464480874	270
180	106	107	0.0530	0.183	14.22475107	270
181	108	109	0.0105	0.0288	5.464480874	270
182	109	110	0.0278	0.0762	34.72222222	270
183	110	111	0.0220	0.0755	13.12335958	370
184	110	112	0.0247	0.0640	13.24503311	270
185	114	115	0.0023	0.0104	15.625	270

TABLE IV
TAP CHANGING TRANSFORMER DATA

Transformer No.	From Bus	To Bus	Circuit ID	Tap Initial	Tap Max	Tap Min	Angle Initial	Angle Max	Angle Min
1	8	5	1	0.985	0	0	0	0	0
2	26	25	1	0.96	0	0	0	0	0
3	30	17	1	0.96	0	0	0	0	0
4	38	37	1	0.935	0	0	0	0	0
5	63	59	1	0.96	0	0	0	0	0
6	64	61	1	0.985	0	0	0	0	0
7	65	66	1	0.935	0	0	0	0	0
8	68	69	1	0.935	0	0	0	0	0
9	81	80	1	0.935	0	0	3.57	-15	15

TABLE V
LOAD DATA

Bus No.	P _d (MW)	Q _d (MVar)	VOLL (\$/MWh)
1	51	27	4822.6
2	20	9	5600.331
3	39	10	3144.692
4	39	12	5017.304
6	52	22	4691.259
7	19	2	3715.387
8	28	0	4239.845
11	70	23	4705.575
12	47	10	6647.038
13	34	16	6161.662
14	14	1	3690.068

15	90	30	6320.954
16	25	10	4935.243
17	11	3	4462.167
18	60	34	4928.846
19	45	25	4377.02
20	18	3	4425.513
21	14	8	5393.819
22	10	5	5345.421
23	7	3	5350.315
24	13	0	4902.898
27	71	13	3775.508
28	17	7	4930.343
29	24	4	2478.141
31	43	27	4793.336
32	59	23	5120.816
33	23	9	4936.131
34	59	26	4317.935
35	33	9	4676.323
36	31	17	4027.63
39	27	11	5033.037
40	66	23	3811.758
41	37	10	3858.678
42	96	23	4014.301
43	18	7	2733.43
44	16	8	2363.028
45	53	22	4695.114
46	28	10	4047.043
47	34	0	5322.179
48	20	11	3473.09
49	87	30	4438.655
50	17	4	4355.132
51	17	8	4691.524
52	18	5	4687.715
53	23	11	3981.072
54	113	32	4481.969
55	63	22	4401.073
56	84	18	4876.624
57	12	3	5155.959
58	12	3	5165.564
59	277	113	3981.808
60	78	3	4546.415

62	77	14	3771.53
66	39	18	3831.9
67	28	7	4495.89
70	66	20	5419.578
72	12	0	4038.2
73	6	0	4722.827
74	68	27	2364.649
75	47	11	5170.414
76	68	36	3846.561
77	61	28	2519.534
78	71	26	3831.516
79	39	32	5160.366
80	130	26	5426.527
82	54	27	4551.559
83	20	10	3605.046
84	11	7	4054.619
85	24	15	3863.051
86	21	10	5910.274
88	48	10	4130.639
90	440	42	4948.846
91	10	0	4384.549
92	65	10	5033.166
93	12	7	4041.09
94	30	16	3658.639
95	42	31	3646.574
96	38	15	3792.916
97	15	9	4393.575
98	34	8	4382.368
99	42	0	5351.586
100	37	18	4674.951
101	22	15	4618.687
102	5	3	5452.619
103	23	16	2017.32
104	38	25	4917.975
105	31	26	5001.053
106	43	16	4353.771
107	50	12	2629.402
108	2	1	3800.494
109	8	3	3811.228
110	39	30	4562.925
112	68	13	4933.352

113	6	0	5051.295
114	8	3	4099.866
115	22	7	4612.399
116	184	0	3450.503
117	20	8	1340.186
118	33	15	4236.62

B. Dynamic Data

The generator stability and ramping data employed is presented in Table VI.

TABLE VI
GENERATOR PARAMETERS USED IN THE ANALYSIS OF THE IEEE 118-BUS TEST SYSTEM [2]

Parameter	Value	Parameter	Value
X_d (p.u.)	1.8	X_q (p.u.)	1.7
X_d' (p.u.)	0.3	X_q' (p.u.)	0.55
X_d'' (p.u.)	0.25	X_q'' (p.u.)	0.25
T_{do}' (p.u.)	8	T_{qo}' (p.u.)	0.4
T_{do}'' (p.u.)	0.03	T_{qo}'' (p.u.)	0.05
H (sec.)	3.4 for all the generators except for generators at bus#69 and bus#89. 5 & 4 for generators at bus#69 and bus#89, respectively.		

Generator #	Bus #	MVA Ratings (MW)	Minutes to Fully Ramp	Generator Type
1	10	591	30	S*
2	12	300	12	G**
3	25	300	20	CC***
4	26	591	30	S
5	31	192	12	G
6	46	192	12	G
7	49	300	20	CC
8	54	155	12	G
9	59	300	20	CC
10	61	300	20	CC
11	65	591	30	S
12	66	591	30	S

13	69	800	60	S
14	80	591	30	S
15	87	155	12	G
16	89	620	12	G
17	100	400	20	CC
18	103	155	12	G
19	111	155	12	G

* S: Steam Turbine

** G: Gas Turbine

*** CC: Combined-Cycle

- [1] H. B. Plittgen, "Computational Cycle Time Evaluation for Steady State Power Flow Calculations," Report Prepared for Thomson-CSF, Division Simulateurs, School of Electrical Engineering, Georgia Institute of Technology, Dec. 1985, [Online]. Available: https://smartech.gatech.edu/jspui/bitstream/1853/35556/2/e-21-675_302129_fr.pdf.
- [2] P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1994.

C. Reliability Data

TABLE VII
GENERATING UNIT RELIABILITY DATA

U	FOR (%)
1	0.10
2	0.10
3	0.02
4	0.02
5	0.10
6	0.10
7	0.02
8	0.02
9	0.04
10	0.04
11	0.04
12	0.05
13	0.05
14	0.05
15	0.02
16	0.02
17	0.02
18	0.02
19	0.04

TABLE VIII
TRANSMISSION LINE RELIABILITY DATA

Line No.	From Bus	To Bus	FOR (%)
1	1	2	0.000438
2	1	3	0.000582
3	2	12	0.000376
4	3	5	0.000445
5	3	12	0.000548
6	4	5	0.000434
7	4	11	0.00175
8	5	6	0.00041
9	5	11	0.000388
10	6	7	0.001317
11	7	12	0.000342
12	8	9	0.000502
13	8	5	0.000502
14	8	30	0.00175
15	9	10	0.00175
16	11	12	0.00175
17	11	13	0.00175
18	12	15	0.000502
19	12	17	0.000489
20	12	117	0.000502
21	13	15	0.000652
22	14	15	0.000615
23	15	17	0.000477
24	15	19	0.000414
25	15	33	0.000514
26	16	17	0.000514
27	17	19	0.000514
28	17	31	0.000439
29	17	113	0.000427
30	18	19	0.000402
31	19	20	0.000678
32	19	34	0.000439
33	20	21	0.000439
34	21	22	0.000477
35	22	23	0.000477
36	23	24	0.000427

37	23	25	0.000427
38	23	32	0.000565
39	24	70	0.000438
40	24	72	0.000582
41	25	27	0.000376
42	26	25	0.000445
43	26	30	0.000548
44	27	28	0.000434
45	27	32	0.00175
46	27	115	0.00041
47	28	31	0.000388
48	29	31	0.001317
49	30	17	0.000342
50	30	38	0.000502
51	31	32	0.000502
52	32	113	0.00175
53	32	114	0.00175
54	33	37	0.00175
55	34	36	0.00175
56	34	37	0.000502
57	34	43	0.000489
58	35	36	0.000502
59	35	37	0.000652
60	37	39	0.000615
61	37	40	0.000477
62	38	37	0.000414
63	38	65	0.000514
64	39	40	0.000514
65	40	41	0.000514
66	40	42	0.000439
67	41	42	0.000427
68	42	49	0.000402
69	42	49	0.000678
70	43	44	0.000439
71	44	45	0.000439
72	45	46	0.000477
73	45	49	0.000477
74	46	47	0.000427
75	46	48	0.000427
76	47	49	0.000565
77	47	69	0.000438

78	48	49	0.000438
79	49	50	0.000582
80	49	51	0.000376
81	49	54	0.000445
82	49	54	0.000548
83	49	66	0.000434
84	49	66	0.00175
85	49	69	0.00041
86	50	57	0.000388
87	51	52	0.001317
88	51	58	0.000342
89	52	53	0.000502
90	53	54	0.000502
91	54	55	0.00175
92	54	56	0.00175
93	54	59	0.00175
94	55	56	0.00175
95	55	59	0.000502
96	56	57	0.000489
97	56	58	0.000502
98	56	59	0.000652
99	56	59	0.000615
100	59	60	0.000477
101	59	61	0.000414
102	60	61	0.000514
103	60	62	0.000514
104	61	62	0.000514
105	62	66	0.000439
106	62	67	0.000427
107	63	59	0.000402
108	63	64	0.000678
109	64	61	0.000439
110	64	65	0.000439
111	65	66	0.000477
112	65	68	0.000477
113	66	67	0.000427
114	68	69	0.000427
115	68	81	0.000565
116	68	116	0.000438
117	69	70	0.000438
118	69	75	0.000582

119	69	77	0.000376
120	70	71	0.000445
121	70	74	0.000548
122	70	75	0.000434
123	71	72	0.00175
124	71	73	0.00041
125	74	75	0.000388
126	75	77	0.001317
127	75	118	0.000342
128	76	77	0.000502
129	76	118	0.000502
130	77	78	0.00175
131	77	80	0.00175
132	77	80	0.00175
133	77	82	0.00175
134	78	79	0.000502
135	79	80	0.000489
136	80	96	0.000502
137	80	97	0.000652
138	80	98	0.000615
139	80	99	0.000477
140	81	80	0.000414
141	82	83	0.000514
142	82	96	0.000514
143	83	84	0.000514
144	83	85	0.000439
145	84	85	0.000427
146	85	86	0.000402
147	85	88	0.000678
148	85	89	0.000439
149	86	87	0.000439
150	88	89	0.000477
151	89	90	0.000477
152	89	91	0.000427
153	89	92	0.000427
154	90	91	0.000565
155	91	92	0.000438
156	92	93	0.000438
157	92	94	0.000582
158	92	100	0.000376
159	92	102	0.000445

160	93	94	0.000548
161	94	95	0.000434
162	94	96	0.00175
163	94	100	0.00041
164	95	96	0.000388
165	96	97	0.001317
166	98	100	0.000342
167	99	100	0.000502
168	100	101	0.000502
169	100	103	0.00175
170	100	104	0.00175
171	100	106	0.00175
172	101	102	0.00175
173	103	104	0.000502
174	103	105	0.000489
175	103	110	0.000502
176	104	105	0.000652
177	105	106	0.000615
178	105	107	0.000477
179	105	108	0.000414
180	106	107	0.000514
181	108	109	0.000514
182	109	110	0.000514
183	110	111	0.000439
184	110	112	0.000427
185	114	115	0.000402

D. Wind Data

TABLE IX
WIND FARMS AND WIND POWER FORECAST

Wind Farm #	Host Bus	Wind Power Forecast (μ) (MW)	Wind Power Standard Deviation (MW)
1	57	225.95	22.8
2	78	225.95	22.8
3	97	225.95	22.8
4	111	225.95	22.8