Appendix I

Linearized three-phase power flow model

The Equations (I.1)-(I.4) are associated with linear three-phase power flow constraints [143]. The active and reactive power flow in the line connected between i^{th} and j^{th} buses are represented in equations (I.1) and (I.2), respectively. The voltage relationship between the two connected buses (i, j) and corresponding to phase ϕ is expressed in equation (I.3). The constraint (I.4) limits the bus voltage magnitude.

$$P_t^{i,\phi,j,\phi} = \sum_{j^{'}:j\rightarrow j^{'}} P_t^{j,\phi,j^{'},\phi} + P_t^{D,j,\phi} - \sum_{dg=1}^{N_{dg}} x_{dg}^{j,\phi} P_t^{du,dg} + \sum_{m=1}^{N_{MG}} x_m^{j,\phi} P_t^m + \sum_{sop=1}^{N_s} x_{sop}^{j,\phi} P_t^{sop,j,\phi}, \quad \text{(I.1)}$$

$$Q_t^{i,\phi,j,\phi} = \sum_{j^{'}:j\rightarrow j^{'}} Q_t^{j,\phi,j^{'},\phi} + Q_t^{D,j,\phi} + \sum_{sop=1}^{N_s} x_{sop}^{j,\phi} Q_t^{sop,j,\phi} - x_{cap}^{j,\phi} Q_t^{cap,j,\phi}, \quad \text{(I.2)}$$

$$v_t^{j,\phi} = v_t^{i,\phi} - \sum_{\phi^{'}\in A,B,C} 2\Re[S_t^{i,\phi,j,\phi^{'}} (z^{i,\phi,j,\phi^{'}})^*], \quad \text{(I.3)}$$

$$(V^{min})^2 \leq v_t^{i,\phi} \leq (V^{max})^2 \quad \text{(I.4)}$$

Here, $v_t^{i,\phi} = (V_t^{i,\phi})^2$, $S_t^{i,\phi,j,\phi^{'}} = P_t^{i,\phi,j,\phi^{'}} + jQ_t^{i,\phi,j,\phi^{'}}$, and $z^{i,\phi,j,\phi^{'}} = r^{i,\phi,j,\phi^{'}} + jx^{i,\phi,j,\phi^{'}}$. ϕ represents the phase A, B, and C.

If a voltage regulator is connected to phase ϕ between i^{th} and j^{th} buses with turn ratio $a_t^{i,\phi}$, voltage relationship can be defined as

$$v_t^{j,\phi} = (a_t^{i,\phi})^2 v_t^{i,\phi}. \quad \text{(I.5)}$$

The value of $a_t^{i,\phi}$ can be expressed as

$$a_t^{i,\phi} = \sum_{tap=1}^{N_{tap}} X_{tap} \nu_{t,tap}^{i,\phi}, \quad \text{(I.6)}$$

and

$$\sum_{tap=1}^{N_{tap}} \nu_{t,tap}^{i,\phi} = 1. \tag{I.7}$$

Here, N_{tap} is the number of tap-steps, X_{tap} is the value corresponding to tap-step tap, and $\nu_{t,tap}^{i,\phi}$ is the binary variable which indicates the tap position.

The reactive power injection by shunt capacitor connected at phase ϕ and i^{th} bus can be defined as

$$Q_t^{cap,i,\phi} = \nu_{t,cap}^{i,\phi} Q_{cap}^{rated,i,\phi} v_t^{i,\phi} \tag{I.8}$$

Here, $\nu_{t,cap}^{i,\phi}$ is the binary variable which indicates the on/off status of shunt capacitor, $Q_{cap}^{rated,i,\phi}$ is the rated capacity of shunt capacitor, and $Q_t^{cap,i,\phi}$ indicates the reactive power injection from shunt capacitor.

Appendix II

Modified IEEE 33-bus distribution system data

The IEEE-33 bus system is modified to include the MG, DG and SOP for the system studies presented in this thesis. The single line diagram of modified IEEE 33-bus distribution system is depicted in Figure II.1. The line data, load data and type of customers connected at different buses are presented in Table II.1 [144].

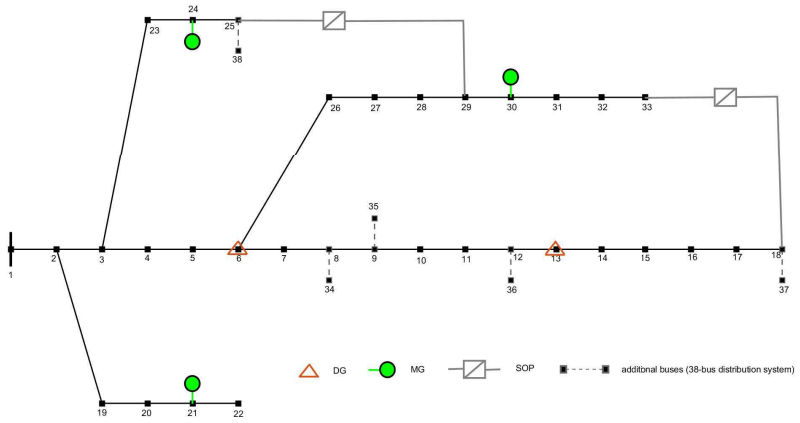

Figure II.1: Modified IEEE 33-bus distribution system

Table II.1: Modified IEEE 33-bus distribution system data

Bus[1]		r (ohm)	x (ohm)	TB Load		Type[2]
FB	TB			P (kW)	Q (kVAR)	
1	2	0.0922	0.047	100	60	R
2	3	0.493	0.2511	90	40	I
3	4	0.366	0.1864	120	80	C
4	5	0.3811	0.1941	60	30	R

Table II.1: Modified IEEE 33-bus distribution system data

Bus[1]		r (ohm)	x (ohm)	TB Load		Type[2]
FB	TB			P (kW)	Q (kVAR)	
5	6	0.819	0.707	60	20	I
6	7	0.1872	0.6188	200	100	C
7	8	0.7114	0.2351	200	100	C
8	9	1.03	0.74	60	20	I
9	10	1.044	0.74	60	20	C
10	11	0.1966	0.065	45	30	C
11	12	0.3744	0.1238	60	35	R
12	13	1.468	1.155	60	35	C
13	14	0.5416	0.7129	120	80	R
14	15	0.591	0.526	60	10	C
15	16	0.7463	0.545	60	20	I
16	17	1.289	1.721	60	20	C
17	18	0.732	0.574	90	40	I
2	19	0.164	0.1565	90	40	R
19	20	1.5042	1.3554	90	40	C
20	21	0.4095	0.4784	90	40	I
21	22	0.7089	0.9373	90	40	R
3	23	0.4512	0.3083	90	50	C
23	24	0.898	0.7091	420	200	C
24	25	0.896	0.7011	420	200	C
6	26	0.203	0.1034	60	25	C
26	27	0.2842	0.1447	60	25	I
27	28	1.059	0.9337	60	20	C
28	29	0.8042	0.7006	120	70	C
29	30	0.5075	0.2585	200	600	C
30	31	0.9744	0.963	150	70	R
31	32	0.3105	0.3619	210	100	R
32	33	0.341	0.5302	60	40	C

Table II.1: Modified IEEE 33-bus distribution system data

Bus[1]		r (ohm)	x (ohm)	TB Load		Type[2]
FB	TB			P (kW)	Q (kVAR)	
8	34	2	2	0	0	
9	35	2	2	0	0	
12	36	2	2	0	0	
18	37	0.5	0.5	0	0	
25	38	0.5	0.5	0	0	

[1]FB- From bus, TB- To bus; [2]C- Commercial, I- Industrial, R- Residential

25-bus unbalanced distribution system data

The 25-bus unbalanced distribution system is used in Chapter 5 for simulation study. The single line diagram and location of DGs, MGs, and SOPs are depicted in Figure II.2. MG1, MG2, and MG3 are connected by bus numbers 5-A, 13-B and 17-C respectively. The location of dispatchable DGs are bus 7-C and 11-B. Two SOPs of 1.5 p.u. rated power are connected between bus pairs 8-15 and 12-25. The line data and base load data is given in Table II.2 [141]. The impedance of lines for different line configurations are shown in Table II.3.

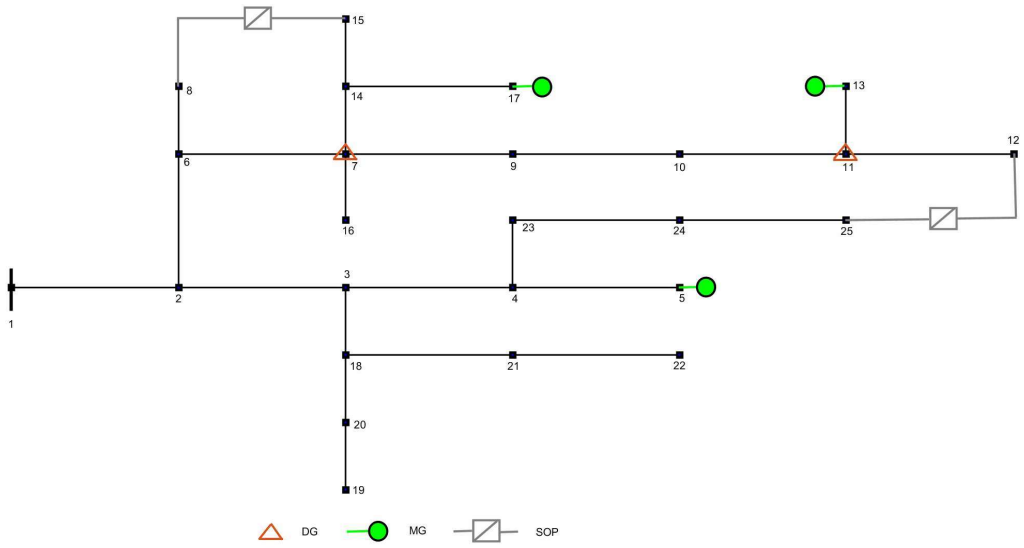

Figure II.2: 25-bus unbalanced distribution system

Table II.2: 25-bus unbalanced distribution line and load data

Bus		Length (ft)	Configuration	TB load (kVA)		
FB	TB			Phase-A	Phase-B	Phase-C
1	2	1000	1	0.00 + 0.00i	0.00 + 0.00i	0.00 + 0.00i
2	3	500	1	36.0 + 21.60i	28.80 + 19.20i	42.0 + 26.40i
2	6	500	2	43.20 + 28.80i	33.60 + 24.0i	30.0 + 30.0i
3	4	500	1	57.60 + 43.20i	4.80 + 3.40i	48.0 + 30.0i
3	18	500	2	57.60 + 43.20i	38.40 + 28.80i	48.0 + 36.0i
4	5	500	2	43.20 + 28.80i	28.80 + 19.20i	36.0 + 24.0i
4	23	400	2	8.60 + 64.80i	4.80 + 3.80i	60.0 + 42.0i
6	7	500	2	0.00 + 0.00i	0.00 + 0.00i	0.00 + 0.00i
6	8	1000	2	43.20 + 28.80i	28.80 + 19.20i	3.60 + 2.40i
7	9	500	2	72.0 + 50.40i	38.40 + 28.80i	48.0 + 30.0i
7	14	500	2	57.60 + 36.0i	38.40 + 28.80i	60.0 + 42.0i
7	16	500	2	57.60 + 4.30i	3.80 + 28.80i	48.0 + 36.0i
9	10	500	2	36.0 + 21.60i	28.80 + 19.20i	42.0 + 26.40i
10	11	300	2	50.40 + 31.70i	24.0 + 14.40i	36.0 + 24.0i
11	12	200	3	57.60 + 36.0i	48.0 + 33.60i	48.0 + 36.0i
11	13	200	3	64.80 + 21.60i	33.60 + 21.10i	36.0 + 24.0i
14	15	300	2	7.20 + 4.30i	4.80 + 2.90i	6.00 + 3.60i
14	17	300	3	57.60 + 43.20i	33.60 + 24.0i	54.0 + 38.40i
18	20	500	2	50.40 + 36.0i	38.40 + 28.80i	54.0 + 38.40i
18	21	400	3	5.80 + 4.30i	3.40 + 2.40i	5.40 + 3.80i
20	19	400	3	8.60 + 6.50i	4.80 + 3.40i	6.00 + 4.80i
21	22	400	3	72.0 + 50.40i	57.60 + 43.20i	60.0 + 48.0i
23	24	400	2	50.40 + 36.0i	43.20 + 30.70i	4.80 + 3.60i
24	25	400	3	8.60 + 6.50i	4.80 + 2.90i	6.00 + 4.20i

Table II.3: Impedance of lines for different configurations

Impedance	Configuration		
(ohm/miles)	1	2	3
z11	0.3686 + 0.6852i	0.9775 + 0.8717i	1.928 + 1.4194i
z12	0.01690 + 0.1515i	0.01670 + 0.1697i	0.01610 + 0.1183i
z13	0.01550 + 0.1098i	0.01520 + 0.1264i	0.01610 + 0.1183i
z22	0.3757 + 0.6715i	0.9844 + 0.8654i	1.9308 + 1.4215i
z23	0.01880 + 0.2072i	0.01860 + 0.2275i	0.01610 + 0.1183i
z33	0.3723 + 0.6782i	0.9810 + 0.8648i	1.9337 + 1.4236i

Modified IEEE 123-bus unbalanced distribution system data

The modified IEEE 123-bus unbalanced distribution system is used in Chapter 5 for simulation study. The single line diagram and location of DGs, MGs, and SOPs are depicted in Figure II.3.

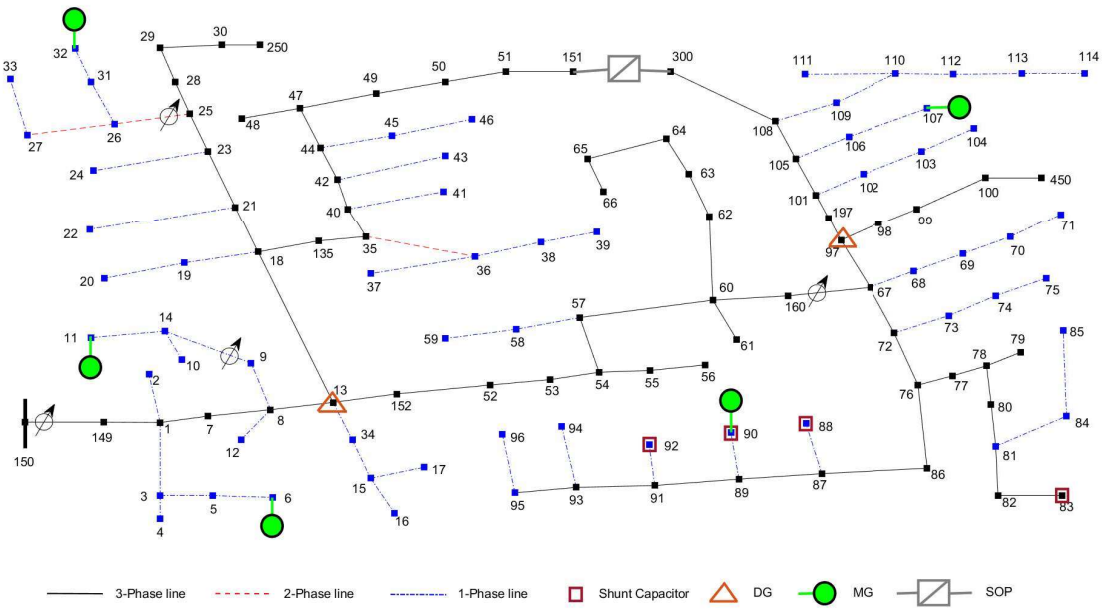

Figure II.3: IEEE 123-bus unbalanced distribution system

MG1, MG2, MG3, MG4, and MG5 are connected by bus numbers 90-B, 11-A, 32-C, 6-C, and 107-B, respectively. The location of dispatchable DGs are bus 13-C and 97-B. The SOP of 1.5 p.u. rated power is connected between bus pair 151-300. The line data and base load data is given in Table II.4 [142]. The impedance of lines for different line configurations are shown in Table II.5.

Table II.4: Modified IEEE 123-bus unbalanced distribution system line and load data

Bus		Length (ft)	Configuration	TB Load (kVA)		
FB	TB			Phase-A	Phase-B	Phase-C
1	2	175	10	0 + 0i	20+ 10i	0 + 0i
1	3	250	11	0 + 0i	0 + 0i	0 + 0i
1	7	300	1	20+ 10i	0 + 0i	0 + 0i
3	4	200	11	0 + 0i	0 + 0i	40+ 20i
3	5	325	11	0 + 0i	0 + 0i	20+ 10i
5	6	250	11	0 + 0i	0 + 0i	40+ 20i
7	8	200	1	0 + 0i	0 + 0i	0 + 0i
8	12	225	10	0 + 0i	20+ 10i	0 + 0i
8	9	225	9	40+ 20i	0 + 0i	0 + 0i
8	13	300	1	0 + 0i	0 + 0i	0 + 0i
9	14	425	9	0 + 0i	0 + 0i	0 + 0i
13	34	150	11	0 + 0i	0 + 0i	40+ 20i
13	18	825	2	0 + 0i	0 + 0i	0 + 0i
14	11	250	9	40+ 20i	0 + 0i	0 + 0i
14	10	250	9	20+ 10i	0 + 0i	0 + 0i
15	16	375	11	0 + 0i	0 + 0i	40+ 20i
15	17	350	11	0 + 0i	0 + 0i	20+ 10i
18	19	250	9	40+ 20i	0 + 0i	0 + 0i
18	21	300	2	0 + 0i	0 + 0i	0 + 0i
19	20	325	9	40+ 20i	0 + 0i	0 + 0i
21	22	525	10	0 + 0i	40+ 20i	0 + 0i
21	23	250	2	0 + 0i	0 + 0i	0 + 0i

Table II.4: Modified IEEE 123-bus unbalanced distribution system line and load data

Bus		Length (ft)	Configuration	TB Load (kVA)		
FB	TB			Phase-A	Phase-B	Phase-C
23	24	550	11	0 + 0i	0 + 0i	40+ 20i
23	25	275	2	0 + 0i	0 + 0i	0 + 0i
25	26	350	7	0 + 0i	0 + 0i	0 + 0i
25	28	200	2	40+ 20i	0 + 0i	0 + 0i
26	27	275	7	0 + 0i	0 + 0i	0 + 0i
26	31	225	11	0 + 0i	0 + 0i	20+ 10i
27	33	500	9	40+ 20i	0 + 0i	0 + 0i
28	29	300	2	40+ 20i	0 + 0i	0 + 0i
29	30	350	2	0 + 0i	0 + 0i	40+ 20i
30	250	200	2	0 + 0i	0 + 0i	0 + 0i
31	32	300	11	0 + 0i	0 + 0i	20+ 10i
34	15	100	11	0 + 0i	0 + 0i	0 + 0i
35	36	650	8	0 + 0i	0 + 0i	0 + 0i
35	40	250	1	0 + 0i	0 + 0i	0 + 0i
36	37	300	9	40+ 20i	0 + 0i	0 + 0i
36	38	250	10	0 + 0i	20+ 10i	0 + 0i
38	39	325	10	0 + 0i	20+ 10i	0 + 0i
40	41	325	11	0 + 0i	0 + 0i	20+ 10i
40	42	250	1	20+ 10i	0 + 0i	0 + 0i
42	43	500	10	0 + 0i	40+ 20i	0 + 0i
42	44	200	1	0 + 0i	0 + 0i	0 + 0i
44	45	200	9	20+ 10i	0 + 0i	0 + 0i
44	47	250	1	35+ 25i	35+ 25i	35+ 25i
45	46	300	9	20+ 10i	0 + 0i	0 + 0i
47	48	150	4	70+ 50i	70+ 50i	70+ 50i
47	49	250	4	35+ 25i	70+ 50i	35+ 20i
49	50	250	4	0 + 0i	0 + 0i	40+ 20i
50	51	250	4	20+ 10i	0 + 0i	0 + 0i

Table II.4: Modified IEEE 123-bus unbalanced distribution system line and load data

Bus		Length (ft)	Configuration	TB Load (kVA)		
FB	TB			Phase-A	Phase-B	Phase-C
51	151	500	4	0 + 0i	0 + 0i	0 + 0i
52	53	200	1	40+ 20i	0 + 0i	0 + 0i
53	54	125	1	0 + 0i	0 + 0i	0 + 0i
54	55	275	1	20+ 10i	0 + 0i	0 + 0i
54	57	350	3	0 + 0i	0 + 0i	0 + 0i
55	56	275	1	0 + 0i	20+ 10i	0 + 0i
57	58	250	10	0 + 0i	20+ 10i	0 + 0i
57	60	750	3	20+ 10i	0 + 0i	0 + 0i
58	59	250	10	0 + 0i	20+ 10i	0 + 0i
60	61	550	5	0 + 0i	0 + 0i	0 + 0i
60	62	250	12	0 + 0i	0 + 0i	40+ 20i
62	63	175	12	40+ 20i	0 + 0i	0 + 0i
63	64	350	12	0 + 0i	75+ 35i	0 + 0i
64	65	425	12	35+ 25i	35+ 25i	70+ 50i
65	66	325	12	0 + 0i	0 + 0i	75+ 35i
67	68	200	9	20+ 10i	0 + 0i	0 + 0i
67	72	275	3	0 + 0i	0 + 0i	0 + 0i
67	97	250	3	0 + 0i	0 + 0i	0 + 0i
68	69	275	9	40+ 20i	0 + 0i	0 + 0i
69	70	325	9	20+ 10i	0 + 0i	0 + 0i
70	71	275	9	40+ 20i	0 + 0i	0 + 0i
72	73	275	11	0 + 0i	0 + 0i	40+ 20i
72	76	200	3	105 + 80i	70+ 50i	70+ 50i
73	74	350	11	0 + 0i	0 + 0i	40+ 20i
74	75	400	11	0 + 0i	0 + 0i	40+ 20i
76	77	400	6	0 + 0i	40+ 20i	0 + 0i
76	86	700	3	0 + 0i	20+ 10i	0 + 0i
77	78	100	6	0 + 0i	0 + 0i	0 + 0i

Table II.4: Modified IEEE 123-bus unbalanced distribution system line and load data

Bus		Length (ft)	Configuration	TB Load (kVA)		
FB	TB			Phase-A	Phase-B	Phase-C
78	79	225	6	40+ 20i	0 + 0i	0 + 0i
78	80	475	6	0 + 0i	40+ 20i	0 + 0i
80	81	475	6	0 + 0i	0 + 0i	0 + 0i
81	82	250	6	40+ 20i	0 + 0i	0 + 0i
81	84	675	11	0 + 0i	0 + 0i	20+ 10i
82	83	250	6	0 + 0i	0 + 0i	20+ 10i
84	85	475	11	0 + 0i	0 + 0i	40+ 20i
86	87	450	6	0 + 0i	40+ 20i	0 + 0i
87	88	175	9	40+ 20i	0 + 0i	0 + 0i
87	89	275	6	0 + 0i	0 + 0i	0 + 0i
89	90	225	10	0 + 0i	40+ 20i	0 + 0i
89	91	225	6	0 + 0i	0 + 0i	0 + 0i
91	92	300	11	0 + 0i	0 + 0i	40+ 20i
91	93	225	6	0 + 0i	0 + 0i	0 + 0i
93	94	275	9	40+ 20i	0 + 0i	0 + 0i
93	95	300	6	0 + 0i	20+ 10i	0 + 0i
95	96	200	10	0 + 0i	20+ 10i	0 + 0i
97	98	275	3	40+ 20i	0 + 0i	0 + 0i
98	99	550	3	0 + 0i	40+ 20i	0 + 0i
99	100	300	3	0 + 0i	0 + 0i	40+ 20i
100	450	800	3	0 + 0i	0 + 0i	0 + 0i
101	102	225	11	0 + 0i	0 + 0i	20+ 10i
101	105	275	3	0 + 0i	0 + 0i	0 + 0i
102	103	325	11	0 + 0i	0 + 0i	40+ 20i
103	104	700	11	0 + 0i	0 + 0i	40+ 20i
105	106	225	10	0 + 0i	40+ 20i	0 + 0i
105	108	325	3	0 + 0i	0 + 0i	0 + 0i
106	107	575	10	0 + 0i	40+ 20i	0 + 0i

Table II.4: Modified IEEE 123-bus unbalanced distribution system line and load data

Bus		Length (ft)	Configuration	TB Load (kVA)		
FB	TB			Phase-A	Phase-B	Phase-C
108	109	450	9	40+ 20i	0 + 0i	0 + 0i
108	300	1000	3	0 + 0i	0 + 0i	0 + 0i
109	110	300	9	0 + 0i	0 + 0i	0 + 0i
110	111	575	9	20+ 10i	0 + 0i	0 + 0i
110	112	125	9	20+ 10i	0 + 0i	0 + 0i
112	113	525	9	40+ 20i	0 + 0i	0 + 0i
113	114	325	9	20+ 10i	0 + 0i	0 + 0i
135	35	375	4	40+ 20i	0 + 0i	0 + 0i
149	1	400	1	40+ 20i	0 + 0i	0 + 0i
152	52	400	1	40+ 20i	0 + 0i	0 + 0i
160	67	350	6	0 + 0i	0 + 0i	0 + 0i
197	101	250	3	0 + 0i	0 + 0i	0 + 0i

Table II.5: Impedance of lines for different configurations

Config-	Impedance (ohm/miles)					
uration	z11	z12	z13	z22	z23	z33
1	0.4576 + 1.0780i	0.1560 + 0.5017i	0.1535 + 0.3849i	0.4666 + 1.0482i	0.1580 + 0.4236i	0.4615 + 1.0651i
2	0.4666 + 1.0482i	0.1580 + 0.4236i	0.1560 + 0.5017i	0.4615 + 1.0651i	0.1535 + 0.3849i	0.4576 + 1.0780i
3	0.4615 + 1.0651i	0.1535 + 0.3849i	0.1580 + 0.4236i	0.4576 + 1.0780i	0.1560 + 0.5017i	0.4666 + 1.0482i
4	0.4615 + 1.0651i	0.1580 + 0.4236i	0.1535 + 0.3849i	0.4666 + 1.0482i	0.1560 + 0.5017i	0.4576 + 1.0780i
5	0.4666 + 1.0482i	0.1560 + 0.5017i	0.1580 + 0.4236i	0.4576 + 1.0780i	0.1535 + 0.3849i	0.4615 + 1.0651i
6	0.4576 + 1.0780i	0.1535 + 0.3849i	0.1560 + 0.5017i	0.4615 + 1.0651i	0.1580 + 0.4236i	0.4666 + 1.0482i
7	0.4576 + 1.0780i	-	0.1535 + 0.3849i	-	-	0.4615 + 1.0651i
8	0.4576 + 1.0780i	0.1535 + 0.3849i	-	0.4615 + 1.0651i	-	-
9	1.3292 + 1.3475i	-	-	-	-	-
10	-	-	-	1.3292 + 1.3475i	-	-
11	-	-	-	-	-	1.3292 + 1.3475i
12	1.5209 + 0.75210i	0.5198 + 0.2775i	0.4924 + 0.2157i	1.5329 + 0.71620i	0.5198 + 0.2775i	1.5209 + 0.7521i

Table II.6: Three-phase switch status

Bus1	Bus2	Status
13	152	closed
18	135	closed
60	160	closed
61	610	closed
97	197	closed
150	149	closed

Table II.7: Shunt capacitor rating (kVAR)

Bus	Phase-A	Phase-B	Phase-C
83	200	200	200
88	50		
90		50	
92			50

MGs' location and generation data (Chapter 5)

The MGs' location and generation data used in Chapter 5 is shown in Table II.8.

Table II.8: MGs' location and generation data

	Bus location			RESs rating (p.u.)			Dispatchable DG rating (p.u.)		
	33-bus	25-bus	123-bus	33-bus	25-bus	123-bus	33-bus	25-bus	123-bus
MG1	21	5-A	90-B	3.5	3.5	3.5	1	1	1
MG2	24	13-B	11-A	4	4	4	0.8	0.8	0.8
MG3	30	17-C	32-C	3	3	3	0.8	0.8	0.8
MG4	-	-	6-C	-	-	4	-	-	0.8
MG5	-	-	107-B	-	-	3.5	-	-	1

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List of Publications

The publications originating from this thesis are:

1. **Singh, A.**, Jha, B. K., Singh, D., & Misra, R. K. (2019). Optimal scheduling of PHEVs and D-BESSs in the presence of DGs in a distribution system. *IET Generation, Transmission & Distribution*, 13(22), 5019-5032.

2. **Singh, A.**, Sethi, B. K., Singh, D., & Misra, R. K. (2022). Shapley Value Method and Stochastic Dantzig–Wolfe Decomposition for Decentralized Scheduling of Multi-microgrid. *IEEE Systems Journal*, 16(2), 2672-2683. doi: 10.1109/JSYST.2021.3119426

3. **Singh, A.**, Sethi, B. K., Kumar, A., Singh, D., & Misra, R. K.. Three-level Hierarchical Management of Active Distribution System with Microgrid Cluster. *IEEE Systems Journal*, 2022, doi: 10.1109/JSYST.2022.3208032.

The other relevant publications during doctoral degree:

1. Jha, B. K., **Singh, A.**, Kumar, A., Misra, R. K., & Singh, D. (2021). Phase unbalance and PAR constrained optimal active and reactive power scheduling of Virtual Power Plants (VPPs). *International Journal of Electrical Power & Energy Systems*, 125, 106443.

2. Sethi, B. K., **Singh, A.**, Mohanty, S. R., Singh, D., & Misra, R. K. Game Theoretic Smart Residential Buildings Energy Management System Under False Data Injection Attack. *IEEE Internet of Things Journal*, vol. 10, no. 1, pp. 110-119, 1 Jan.1, 2023, doi: 10.1109/JIOT.2022.3200474.

3. Sethi, B. K., **Singh, A.**, Singh, D., & Misra, R. K. (2021). Optimal energy management of smart buildings under cyber attack. *International Journal of Energy Research*, 45(14), 19895-19908.

4. Roy, A., Singh, D., Misra, R. K., & **Singh, A.** (2019). Differential protection scheme for power transformers using matched wavelets. *IET Generation, Transmission & Distribution*, 13(12), 2423-2437.