

System data for 19-bus and 133-bus distribution networks

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1 19 Bus Distribution System

1.1 Single Line Diagram

The base KV and base KVA of the system are 11 KV and 1000 KVA respectively.

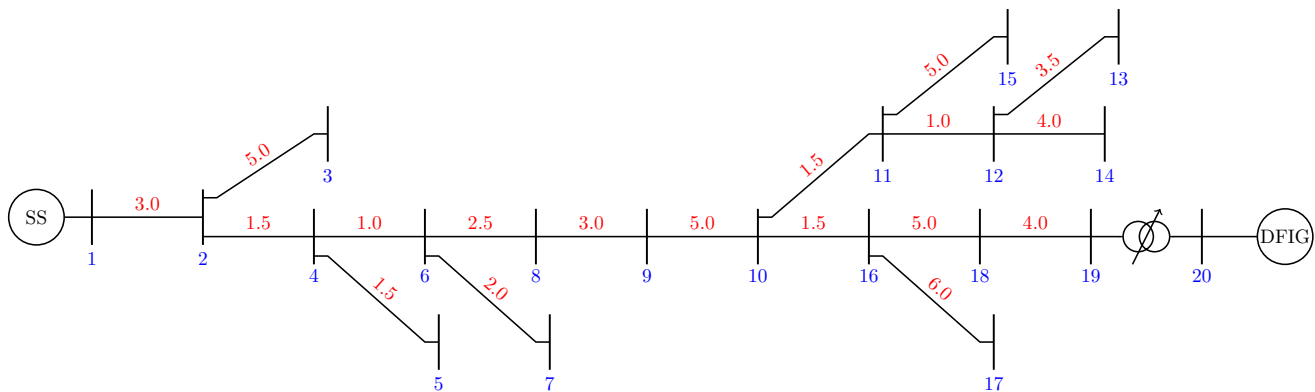


Figure 1: Single line diagram for 19 bus distribution system

1.2 Line data

Table 1: Line Data for 19 Bus Distribution System

From	To	Length(km)	R (p.u/km)	X (p.u/km)	$\frac{b}{2}$ (p.u/km)
1	2	3.0	0.0086	0.0037	0.0011
2	3	5.0	0.0086	0.0037	0.0011
2	4	1.5	0.0086	0.0037	0.0011
4	5	1.5	0.0086	0.0037	0.0011
4	6	1.0	0.0086	0.0037	0.0011
6	7	2.0	0.0086	0.0037	0.0011
6	8	2.5	0.0086	0.0037	0.0011
8	9	3.0	0.0086	0.0037	0.0011
9	10	5.0	0.0086	0.0037	0.0011

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From	To	Length(km)	R (p.u/km)	X (p.u/km)	$\frac{b}{2}$ (p.u/km)
10	11	1.5	0.0086	0.0037	0.0011
11	12	1.0	0.0086	0.0037	0.0011
11	15	5.0	0.0086	0.0037	0.0011
12	13	3.5	0.0086	0.0037	0.0011
12	14	4.0	0.0086	0.0037	0.0011
10	16	1.5	0.0086	0.0037	0.0011
16	17	6.0	0.0086	0.0037	0.0011
16	18	5.0	0.0086	0.0037	0.0011
18	19	4.0	0.0086	0.0037	0.0011

1.3 Load data

The slack bus voltages for scenario-1 and scenario-2 are 1.04 p.u. and 1.01 p.u. respectively.

Table 2: Load Data for 19 Bus Distribution System

Bus Number	Scenario-1		Scenario-2	
	P (KW)	Q (KVAR)	P (KW)	Q (KVAR)
2	129.60	62.77	129.60	62.77
3	172.80	83.69	172.80	83.69
4	43.20	20.92	43.20	20.92
5	129.60	62.77	129.60	62.77
6	43.20	20.92	43.20	20.92
7	172.80	83.69	172.80	83.69
8	129.60	62.77	129.60	62.77
9	216.00	104.61	216.00	104.61
10	64.80	31.38	64.80	31.38
11	129.60	62.77	129.60	62.77
12	43.20	20.92	43.20	20.92
13	86.40	0.00	86.40	0.00
14	108.00	35.50	108.00	35.50
15	86.40	28.40	86.40	28.40
16	129.60	62.77	129.60	62.77
17	129.60	62.77	129.60	62.77
18	129.60	62.77	129.60	62.77
19	108.00	0.00	129.60	62.77

2 133 Bus Distribution System

2.1 Single Line Diagram

The base KV and base KVA of the system are 11 KV and 1000 KVA respectively.

2.2 Line data

Table 3: Line Data for 133 Bus Distribution System

From	To	Length(km)	$R(\text{p.u./km})$	$X(\text{p.u./km})$	$\frac{b}{2}(\text{p.u./km})$
1	2	2	0.0086	0.0037	0.0011
2	3	0.5	0.0086	0.0037	0.0011
2	4	1.5	0.0086	0.0037	0.0011
4	5	0.5	0.0086	0.0037	0.0011
4	6	0.2	0.0086	0.0037	0.0011
6	7	0.1	0.0086	0.0037	0.0011
6	8	0.5	0.0086	0.0037	0.0011
8	9	0.1	0.0086	0.0037	0.0011
8	10	0.2	0.0086	0.0037	0.0011
10	11	1.5	0.0086	0.0037	0.0011
10	12	1.5	0.0086	0.0037	0.0011
12	13	0.1	0.0086	0.0037	0.0011
12	14	1.0	0.0086	0.0037	0.0011
14	15	2.5	0.0086	0.0037	0.0011
15	16	0.1	0.0086	0.0037	0.0011
15	17	1.0	0.0086	0.0037	0.0011
17	18	0.2	0.0086	0.0037	0.0011
17	19	0.4	0.0086	0.0037	0.0011
19	20	0.4	0.0086	0.0037	0.0011
19	21	3.0	0.0086	0.0037	0.0011
14	22	1.5	0.0086	0.0037	0.0011
22	23	0.1	0.0086	0.0037	0.0011
22	24	1.0	0.0086	0.0037	0.0011
24	25	1.5	0.0086	0.0037	0.0011
25	26	0.4	0.0086	0.0037	0.0011
25	27	1.4	0.0086	0.0037	0.0011
27	28	0.4	0.0086	0.0037	0.0011
27	29	0.6	0.0086	0.0037	0.0011
29	30	0.7	0.0086	0.0037	0.0011
29	31	1.8	0.0086	0.0037	0.0011
31	32	0.4	0.0086	0.0037	0.0011
31	33	0.2	0.0086	0.0037	0.0011
31	34	1.5	0.0086	0.0037	0.0011
34	35	0.2	0.0086	0.0037	0.0011
34	36	1.5	0.0086	0.0037	0.0011
36	37	0.5	0.0129	0.0036	0

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From	To	Length(km)	R (p.u/km)	X (p.u/km)	$\frac{b}{2}$ (p.u/km)
36	38	2.0	0.0129	0.0036	0
38	39	0.4	0.0129	0.0036	0
38	40	1.0	0.0129	0.0036	0
40	41	1.0	0.0129	0.0036	0
40	42	2.2	0.0129	0.0036	0
24	43	3.0	0.0086	0.0037	0.0011
43	44	0.1	0.0086	0.0037	0.0011
43	45	1.0	0.0086	0.0037	0.0011
45	46	0.8	0.0086	0.0037	0.0011
45	47	0.7	0.0086	0.0037	0.0011
47	48	0.7	0.0086	0.0037	0.0011
47	49	0.6	0.0086	0.0037	0.0011
49	50	0.2	0.0086	0.0037	0.0011
49	51	0.8	0.0086	0.0037	0.0011
51	52	3.5	0.0086	0.0037	0.0011
52	53	0.1	0.0086	0.0037	0.0011
52	54	2.0	0.0086	0.0037	0.0011
51	55	2.1	0.0086	0.0037	0.0011
55	56	0.2	0.0086	0.0037	0.0011
55	57	1.2	0.0086	0.0037	0.0011
57	58	0.5	0.0086	0.0037	0.0011
57	59	0.5	0.0086	0.0037	0.0011
57	60	1.5	0.0086	0.0037	0.0011
60	61	0.5	0.0086	0.0037	0.0011
60	62	0.5	0.0086	0.0037	0.0011
60	63	2.0	0.0086	0.0037	0.0011
63	64	1.0	0.0129	0.0036	0
63	65	2.0	0.0129	0.0036	0
63	66	0.5	0.0129	0.0036	0
66	67	0.5	0.0129	0.0036	0
66	68	1.5	0.0129	0.0036	0
66	69	1.5	0.0129	0.0036	0
69	70	1.0	0.0129	0.0036	0
69	71	1.5	0.0129	0.0036	0
71	72	0.5	0.0129	0.0036	0
71	73	0.5	0.0129	0.0036	0
71	74	2.0	0.0129	0.0036	0
55	75	2.3	0.0086	0.0037	0.0011
75	76	0.3	0.0086	0.0037	0.0011
75	77	1.3	0.0086	0.0037	0.0011
77	78	0.1	0.0086	0.0037	0.0011
77	79	0.3	0.0086	0.0037	0.0011

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From	To	Length(km)	R (p.u/km)	X (p.u/km)	$\frac{b}{2}$ (p.u/km)
79	80	1.5	0.0086	0.0037	0.0011
80	81	0.5	0.0086	0.0037	0.0011
80	82	0.5	0.0086	0.0037	0.0011
80	83	1.5	0.0086	0.0037	0.0011
83	84	0.5	0.0086	0.0037	0.0011
83	85	1.5	0.0086	0.0037	0.0011
85	86	0.5	0.0129	0.0036	0
85	87	0.5	0.0129	0.0036	0
85	88	1.5	0.0129	0.0036	0
88	89	0.5	0.0129	0.0036	0
88	90	0.5	0.0129	0.0036	0
88	91	1.5	0.0129	0.0036	0
91	92	0.5	0.0129	0.0036	0
91	93	0.5	0.0129	0.0036	0
91	94	1.5	0.0129	0.0036	0
94	95	0.5	0.0129	0.0036	0
94	96	0.5	0.0129	0.0036	0
94	97	2.0	0.0129	0.0036	0
79	98	0.3	0.0086	0.0037	0.0011
98	99	0.6	0.0129	0.0036	0
98	100	1.5	0.0086	0.0037	0.0011
100	101	0.2	0.0086	0.0037	0.0011
100	102	1.2	0.0086	0.0037	0.0011
102	103	0.4	0.0086	0.0037	0.0011
102	104	1.8	0.0086	0.0037	0.0011
104	105	0.5	0.0086	0.0037	0.0011
104	106	2.0	0.0086	0.0037	0.0011
100	107	0.7	0.0086	0.0037	0.0011
107	108	0.4	0.0086	0.0037	0.0011
107	109	2.0	0.0086	0.0037	0.0011
109	110	0.1	0.0086	0.0037	0.0011
109	111	2.2	0.0086	0.0037	0.0011
111	112	0.2	0.0086	0.0037	0.0011
111	113	2.0	0.0086	0.0037	0.0011
113	114	0.2	0.0086	0.0037	0.0011
113	115	0.5	0.0086	0.0037	0.0011
115	116	0.7	0.0086	0.0037	0.0011
115	117	2.5	0.0086	0.0037	0.0011
117	118	1.5	0.0129	0.0036	0
118	119	0.6	0.0129	0.0036	0
118	120	2.0	0.0129	0.0036	0
120	121	1.0	0.0129	0.0036	0

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From	To	Length(km)	R (p.u/km)	X (p.u/km)	$\frac{b}{2}$ (p.u/km)
121	122	0.6	0.0129	0.0036	0
121	123	1.0	0.0129	0.0036	0
120	124	2.1	0.0129	0.0036	0
124	125	0.1	0.0129	0.0036	0
124	126	1.0	0.0129	0.0036	0
126	127	2.4	0.0129	0.0036	0
126	128	2.5	0.0129	0.0036	0
117	129	3.0	0.0086	0.0037	0.0011
129	130	0.5	0.0086	0.0037	0.0011
130	131	1.0	0.0086	0.0037	0.0011
130	132	0.2	0.0086	0.0037	0.0011
132	133	4.0	0.0086	0.0037	0.0011

2.3 Load data

Table 4: Load Data for 133 Bus Distribution System

Bus Number	P KW	Q KVAR	Bus Number	P KW	Q KVAR	Bus Number	P KW	Q KVAR
3	21.25	13.17	58	21.25	13.17	99	21.25	13.17
5	21.25	13.17	59	42.50	26.34	101	31.59	19.58
7	21.25	13.17	61	42.50	26.34	103	12.54	7.77
9	21.25	13.17	62	21.25	13.17	105	31.59	19.58
11	21.25	13.17	64	42.50	26.34	106	12.54	7.77
13	21.25	13.17	65	21.25	13.17	108	12.54	7.77
16	53.55	33.19	67	42.50	26.34	110	12.54	7.77
18	21.25	13.17	68	21.25	13.17	112	31.59	19.58
20	53.55	33.19	70	21.25	13.17	114	12.54	7.77
21	21.25	13.17	71	21.25	13.17	116	12.54	7.77
23	53.55	33.19	72	21.25	13.17	119	12.54	7.77
26	21.25	13.17	73	42.50	26.34	122	12.54	7.77
28	21.25	13.17	74	21.25	13.17	123	25.07	15.54
30	21.25	13.17	76	21.25	13.17	125	12.54	7.77
32	21.25	13.17	78	85.00	52.68	127	31.59	19.58
33	21.25	13.17	81	21.25	13.17	128	31.59	19.58
35	21.25	13.17	82	42.50	26.34	129	31.59	19.58
37	21.25	13.17	84	21.25	13.17	131	12.54	7.77
39	21.25	13.17	86	21.25	13.17	132	12.54	7.77
41	21.25	13.17	87	42.50	26.34	133	12.54	7.77
42	21.25	13.17	89	21.25	13.17			
44	21.25	13.17	90	42.50	26.34			

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Bus Number	P	Q	Bus Number	P	Q	Bus Number	P	Q
	KW	KVAR		KW	KVAR		KW	KVAR
46	21.25	13.17	92	21.25	13.17			
48	53.55	33.19	93	42.50	26.34			
50	21.25	13.17	94	53.12	32.92			
53	21.25	13.17	95	42.50	26.34			
54	21.25	13.17	96	53.12	32.92			
56	212.50	131.70	97	42.50	26.34			

3 1.5 MW Doubly Fed Induction Generator data

Table 5: Data for 1.3 MW doubly fed induction generator

	Actual Value		per unit (p.u.) value
Rated stator voltage	690	V	1.0
Rated stator power	1.3	MW	0.8666
Rated Mechanical power (P_m)	1.5	MW	1.0
Rated stator current (I_s^{max})	1068.2	A	0.8510
Rated rotor current (I_r^{max})	1125.6	A	0.8968
Stator resistance (R_s)	2.65×10^{-3}	Ω	8.34×10^{-3}
Stator leakage inductance ($L_{\sigma s}$)	0.1687×10^{-3}	Ω	0.1669
Rotor resistance (R_r)	2.63×10^{-3}	Ω	8.28×10^{-3}
Rotor leakage inductance ($L_{\sigma r}$)	0.1337×10^{-3}	Ω	0.1323
Mutual inductance ($L_{\sigma m}$)	5.48×10^{-3}	Ω	5.4240
Diameter	77	m	-
Gear box ratio	1 : 80	-	-

The performance coefficient for 1.5 MW turbine is:

$$C_p(\lambda, \beta) = 0.71 \left(\frac{150}{\lambda_o} - 0.6\beta - 0.002\beta^{0.14} - 13.2 \right) e^{-\frac{18.4}{\lambda_o}}$$

$$\text{where } \lambda_o = \left[\frac{1}{\lambda - 0.002\beta} + \frac{0.01}{\beta^3 + 1} \right]^{-1}$$

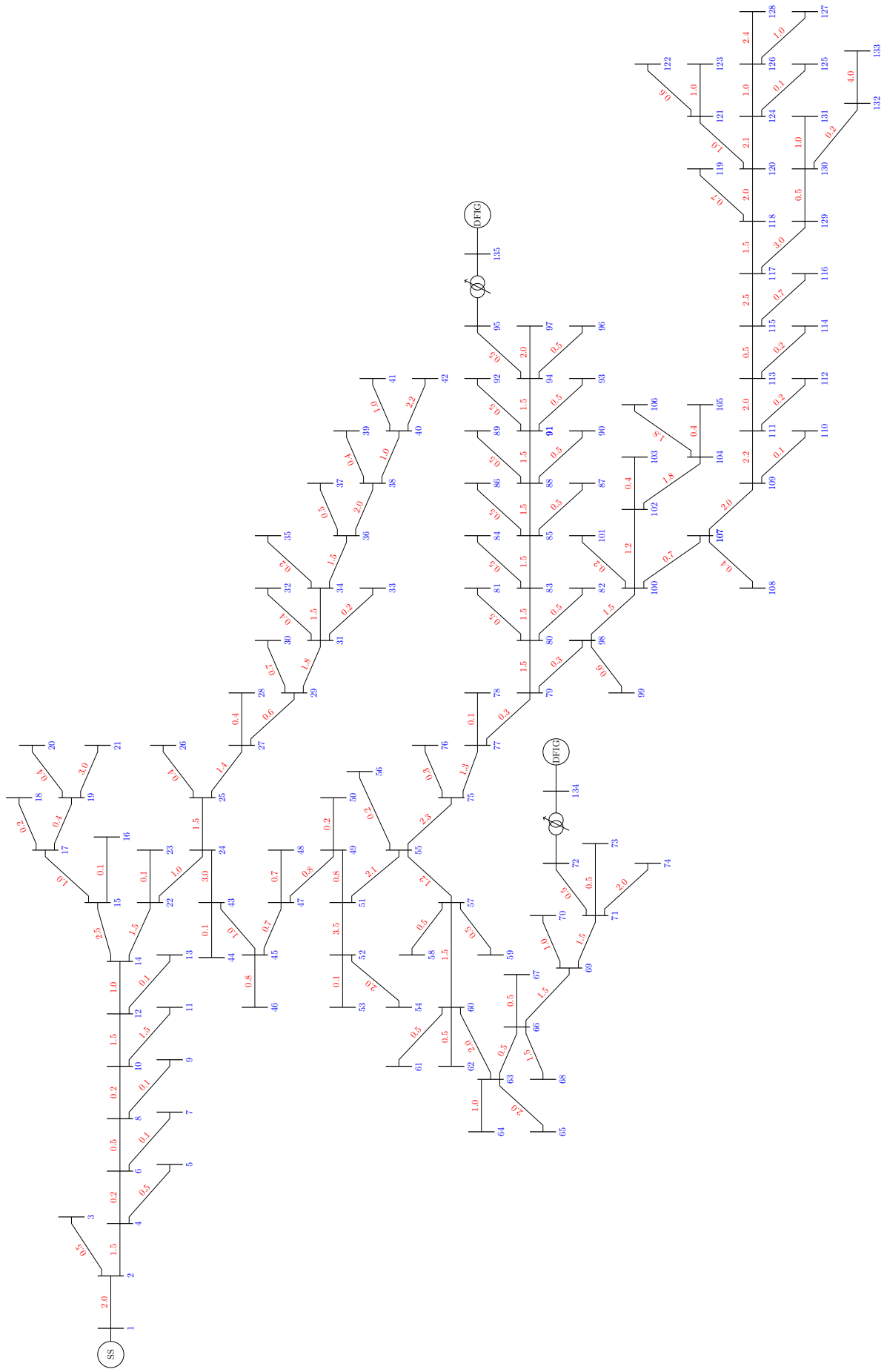


Figure 2: Single line diagram for 133 bus distribution system