Islamic University of Technology (IUT)

Electrical and Electronic Engineering Department

Course No.: EEE 4632 **Course Title:** Power System III Lab

Academic Year: 2022 - 2023 **Semester:** Summer

Statement of Problem. (PROJECT) **Marks: 15**

Consider the IEEE 39 bus (New England) test system shown in the next page. For the system, the nominal frequency is 50 Hz. The bus, line, transformer, generator and load data are given below –

Table 1: Bus Data

Bus No.	Voltage (kV)	Bus No.	Voltage (kV)
01	345	21	345
02	345	22	345
03	345	23	345
04	345	24	345
05	345	25	345
06	345	26	345
07	345	27	345
08	345	28	345
09	345	29	345
10	345	30	16.5
11	345	31	16.5
12	138	32	16.5
13	345	33	16.5
14	345	34	16.5
15	345	35	16.5
16	345	36	16.5
17	345	37	16.5
18	345	38	16.5
19	345	39	345
20	230		

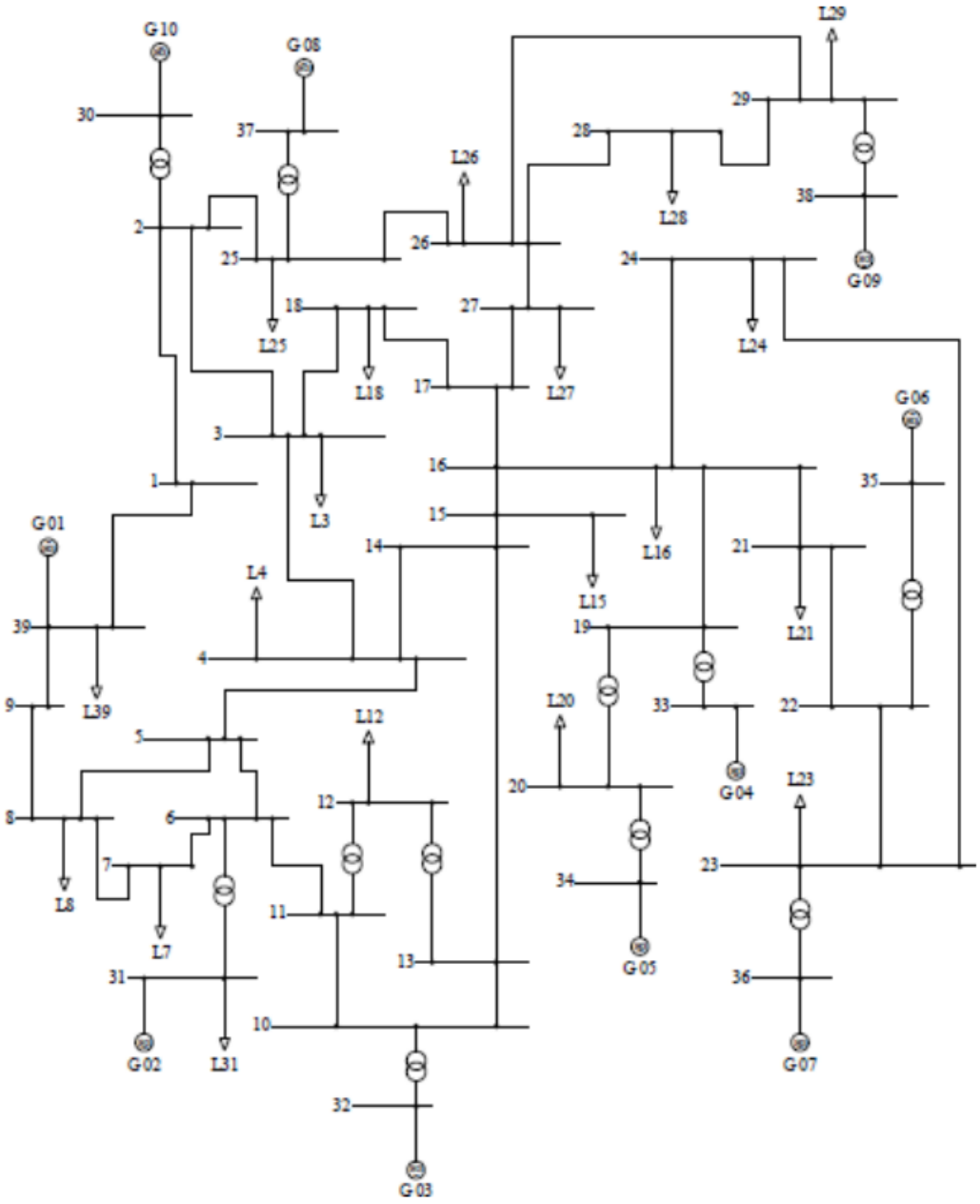

Figure 1: Single line diagram of IEEE 39 bus system

Table 2: Line data

Line no.	From Bus	To Bus	Line voltage (kV)	R (p.u.)	X (p.u.)	B (p.u.)	Distance (km)
1	1	2	345	0.0035	0.0411	0.6987	275.5
2	1	39	345	0.0010	0.0250	0.7500	167.6
3	2	3	345	0.0013	0.0151	0.2572	101.2
4	2	25	345	0.0070	0.0086	0.1460	57.6
5	3	4	345	0.0013	0.0213	0.2214	142.8
6	3	18	345	0.0011	0.0133	0.2138	89.1
7	4	5	345	0.0008	0.0128	0.1342	85.8
8	4	14	345	0.0008	0.0129	0.1382	86.5
9	5	6	345	0.0002	0.0026	0.0434	17.4
10	5	8	345	0.0008	0.0112	0.1476	75.1
11	6	7	345	0.0006	0.0092	0.1130	61.7
12	6	11	345	0.0007	0.0082	0.1389	55
13	7	8	345	0.0004	0.0046	0.0780	30.8
14	8	9	345	0.0023	0.0363	0.3804	243.3
15	9	39	345	0.0010	0.0250	1.2000	167.6
16	10	11	345	0.0004	0.0043	0.0729	28.8
17	10	13	345	0.0004	0.0043	0.0729	28.8
18	13	14	345	0.0009	0.0101	0.1723	67.7
19	14	15	345	0.0018	0.0217	0.3660	145.4
20	15	16	345	0.0009	0.0094	0.1710	63.0
21	16	17	345	0.0007	0.0089	0.1342	59.7
22	16	19	345	0.0016	0.0195	0.3040	130.7
23	16	21	345	0.0008	0.0135	0.2548	90.5
24	16	24	345	0.0003	0.0059	0.0680	39.5
25	17	18	345	0.0007	0.0082	0.1319	55.0
26	17	27	345	0.0013	0.0173	0.3216	116.0
27	21	22	345	0.0008	0.0140	0.2565	93.8
28	22	23	345	0.0006	0.0096	0.1846	64.3
29	23	24	345	0.0022	0.0350	0.3610	234.6
30	25	26	345	0.0032	0.0323	0.5130	216.5
31	26	27	345	0.0014	0.0147	0.2396	98.5
32	26	28	345	0.0043	0.0474	0.7802	317.7
33	26	29	345	0.0057	0.0625	1.0290	418.9
34	28	29	345	0.0014	0.0151	0.2490	101.2

Table 3: Transformer data

Name	S (MVA)	From Bus	To Bus	HV (kV)	LV (kV)	R (p.u.)	X (p.u.)
T01	300	12	11	345	138	0.0048	0.1305
T02	300	12	13	345	138	0.0048	0.1305
T03	700	6	31	345	16.5	0.00001	0.1750
T04	800	10	32	345	16.5	0.00001	0.1600
T05	800	19	33	345	16.5	0.0056	0.1136
T06	2 x 300	20	34	230	16.5	0.0054	0.1080
T07	800	22	35	345	16.5	0.00001	0.1144
T08	700	23	36	345	16.5	0.0035	0.1904
T09	700	25	37	345	16.5	0.0042	0.1624
T10	1000	2	30	345	16.5	0.00001	0.1810
T11	1000	29	38	345	16.5	0.0080	0.1560
T12	1000	19	20	345	230	0.0070	0.1380

Table 4: Generator data

Generator	Bus no.	MVA rating	Dispatched P (MW)	Specified generation voltage V (p.u.)
G 01	39	10000	1000.0	1.0300
G 02	31	700	slack	0.9820
G 03	32	800	650.0	0.9831
G 04	33	800	632.0	0.9972
G 05	34	2x300	508.0	1.0123
G 06	35	800	650.0	1.0493
G 07	36	700	560.0	1.0635
G 08	37	700	540.0	1.0278
G 09	38	1000	830.0	1.0265
G 10	30	1000	250.0	1.0475

Table 5: Load data

Load	Bus no.	P (MW)	Q (MVAR)
L01	03	322.0	2.4
L02	04	500.0	184.0
L03	07	233.8	84.0
L04	08	522.0	176.0
L05	12	7.5	88.0
L06	15	320.0	153.0
L07	16	329.0	32.3
L08	18	158.0	30.0
L09	20	628.0	103.0
L10	21	274.0	115.0
L11	23	247.5	84.6
L12	24	308.6	-92.2
L13	25	224.0	47.2
L14	26	139.0	17.0
L15	27	281.0	75.5
L16	28	206.0	27.6
L17	29	283.5	26.9
L18	31	9.2	4.6
L19	39	1104.0	250.0
Total		6097.1	1408.9

Tasks:

1. Perform the load flow analysis.

2. Perform the frequency response analysis for the outage of G08 (i.e. loss of 540 MW generation). Assume a suitable load shedding scheme to stop the frequency excursion.

3. Repeat the frequency response analysis for the load frequency relief (k_p) of 1%, 2% and 3%.

4. Determine Fast voltage stability index (FVSI) for each load bus. Using FVSI results, rank the buses (weaker to stronger) in terms of voltage stability.

5. Now design a load shedding scheme to apply more load cut to weaker buses following the loss of G08. Use k_p =0. *[Hint: For this, divide the buses in various zones (e.g. 4/5 zones) and apply higher amount of load shedding in relatively weaker zones]*

6. Investigate the impact of load frequency relief (i.e. use kp = 1%, 2% and 3%) on the load shedding scheme designed in task-5.

N.B.: For any missing data, assume standard values. Also, for design problem part, it may not have a unique answer. The solution will depend on your design approach.