ECEN
666
Spring 2020

Project #1

Project Title: Short Circuit Study

Description: *Stage I*

Complete a short-circuit study for 5 bus test system described in the Appendix I. The system Z matrices are given. Consider two types of faults:

- Single-phase-ground (A phase), fault resistance $R_f = 0.10$ p.u.
- Three-phase fault, or three-phase-ground fault, fault resistance $R_f = 0$ p.u.

Assuming that the fault occurs at each non-source system bus (one at a time), calculate:

- Fault current (all phases)
- All bus voltages (all phases)
- All branch currents (all phases)

Stage II

Develop a computer software for completing a short-circuit study for IEEE-14 bus system described in the Appendix II. The system data are attached. Either Z-bus or Y-bus method can be used. Consider two types of faults:

- Single-phase-ground (A phase), fault resistance R_f=0 p.u.
- Three-phase-ground fault, fault resistance R_f=0 p.u.

Assuming that the fault occurs at each non-source system bus (one at a time), calculate:

- Fault current (all phases)
- All bus voltages (all phases)
- All branch currents (all phases)

Deliverables: *Stage I* - Report consisting of two parts:

- Explanation of the work completed
- The results as described above (see note below as well)

Stage II - Report consisting of three parts:

- Mathematical model used for the short-circuit study
- Developed software descriptions, flowcharts, code listing, source code
- The results as described above (see note below as well)

*****Note: Express all results in polar form. The results in rectangular form will not be acceptable.**

Programming Consideration:
- Matlab 2017a, MathWorks should be used for programming.
- Procedural style of programming should be used (do not write spaghetti code).

Literature: Paul M. Anderson, "Analysis of Faulted Power Systems"
Matlab 2017a Reference Manual, MathWorks

Plagiarism: First page in the report should contain signed and dated statement that confirms that all the work in the report is completed solely by the respective individual.

Total Points: 25 pts. (10 pts. for stage I; 15 pts. for stage II)

Extra Credit: 5 pts. for completing the stage two of the project using both Z-bus and Y-bus method.
Note that the method of building Z-bus or Y-bus matrices is important. Inversion of Y-bus matrix obtained by Y-bus method should yield the same Z-bus matrix as obtained by Z-bus method.

Due Date: March 16, 2020, 4:00pm for both stage I and stage II

Assigned: February 10, 2020

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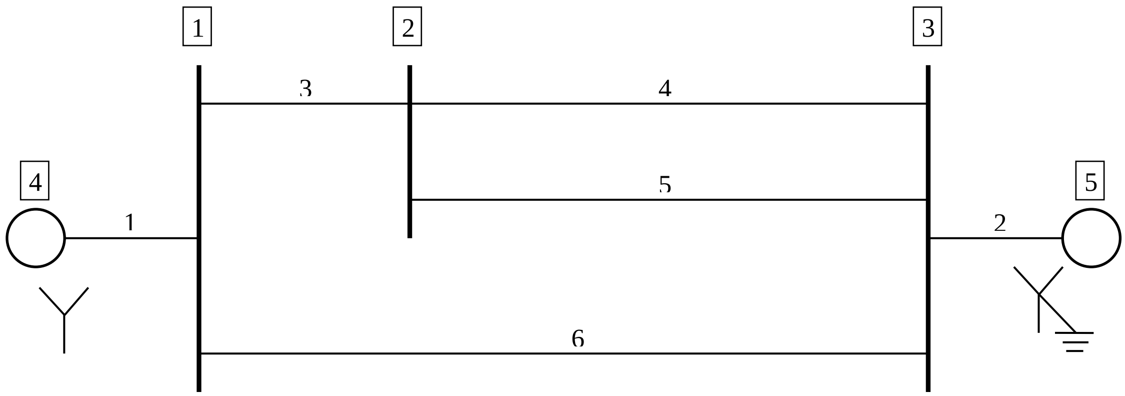
Computer Program for Short-Circuit Studies

Appendix I

INPUT DATA FOR 5-BUS TEST SYSTEM



Parameters of the system are given in the following table:

Impedance Number	Connecting Nodes	Self Impedance			Zero Sequence Mutual Impedance	Mutual Element
		Positive	Negative	Zero		
1	4 - 1	0.25	0.25	0.03	…	…
2	5 - 3	0.20	0.20	0.02	…	…
3	1 - 2	0.08	0.08	0.14	…	…
4	2 - 3	0.06	0.06	0.10	0.05	5
5	2 - 3	0.06	0.06	0.12	0.05	4
6	1 - 3	0.13	0.13	0.17	…	…

The system sequence matrices are also given (all impedances are in p.u.):

$$Z_1 = \begin{bmatrix} j0.1274 & j0.1061 & j0.0981 \\ j0.1061 & j0.1345 & j0.1151 \\ j0.0981 & j0.1151 & j0.1215 \end{bmatrix}$$ Positive-Sequence matrix

$$Z_2 = \begin{bmatrix} j0.1274 & j0.1061 & j0.0981 \\ j0.1061 & j0.1345 & j0.1151 \\ j0.0981 & j0.1151 & j0.1215 \end{bmatrix}$$ Negative-Sequence matrix

$$Z_0 = \begin{bmatrix} j0.1157 & j0.0546 & j0.0200 \\ j0.0546 & j0.0831 & j0.0200 \\ j0.0200 & j0.0200 & j0.0200 \end{bmatrix}$$ Zero-Sequence matrix

Notes:

Assume that pre-fault voltage is flat, $V_f = 1$. All given impedances are in p.u.

Buses 4 and 5 are source buses and they have been eliminated from the system matrices.

All the results should be given in p. u.

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Appendix II

INPUT DATA FOR THE IEEE 14-BUS TEST SYSTEM

- System line-to-line voltage is 230 kV
- Pre-fault voltage profile is assumed to be flat
- Sources are attached at buses 1 and 2, each at 230 kV (line-to-line, Y solidly grounded)
- Assume impedance for the sources to be zero
- Assume negative sequence same as positive sequence
- Assume system frequency 60 Hz
- Assume three-phase/three-phase-ground and single-line-to-ground faults at each bus (except 1 and 2) and give the resulting phase currents into fault and in each line in polar form. Give phase voltages in polar form at each bus

NUMBER OF NODES: 14
NUMBER OF BRANCHES: 19 non-zero impedance branches
2 generator branches with zero impedance (not listed)
INPUT DATA:

Line Number	**Connected Nodes**	**Self Impedance**				**Mutual Impedance**		**Mutual Element**
		Positive sequence		**Zero sequence**		**Zero sequence**		
		R [ohm]	L [mH]	R [ohm]	L [mH]	R [ohm]	L [mH]	
1	1 - 2	2.42	77.95	10.9	205.3	-	-	-
2	1 - 5	3.388	109.13	15.26	287.42	-	-	-
3	2 - 3	0.612	122.4	55.35	405	49.05	207	2 - 4
4	2 - 4	0.612	122.4	55.35	405	49.05	207	2 - 3
5	2 - 5	7.26	233.85	32.7	615.9	-	-	-
6	3 - 4	1.452	46.77	6.54	123.18	-	-	-
7	4 - 5	5.68	187.08	26.16	492.72	-	-	-
8	5 - 6	9.68	311.8	43.6	821.2	-	-	-
9	6 - 11	4.84	155.9	21.8	410.6	-	-	-
10	6 - 12	2.178	70.155	9.81	184.77	-	-	-
11	6 - 13	2.662	85.745	11.99	225.83	-	-	-
12	4 - 7	4.84	155.9	21.8	410.6	-	-	-
13	4 - 9	5.808	187.08	26.16	492.72	-	-	-
14	7 - 8	1.452	46.77	6.54	123.18	-	-	-
15	9 - 10	3.63	116.925	16.35	307.95	-	-	-
16	10 - 11	1.936	62.36	8.72	164.24	-	-	-
17	9 - 14	2.904	93.54	13.08	246.36	-	-	-
18	12 - 13	3.872	124.72	17.44	328.48	-	-	-
19	13 - 14	1.936	62.36	8.72	164.24	-	-	-

Table 1. *Connected nodes, branch current orientation and line parameters*

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IEEE 14 bus system

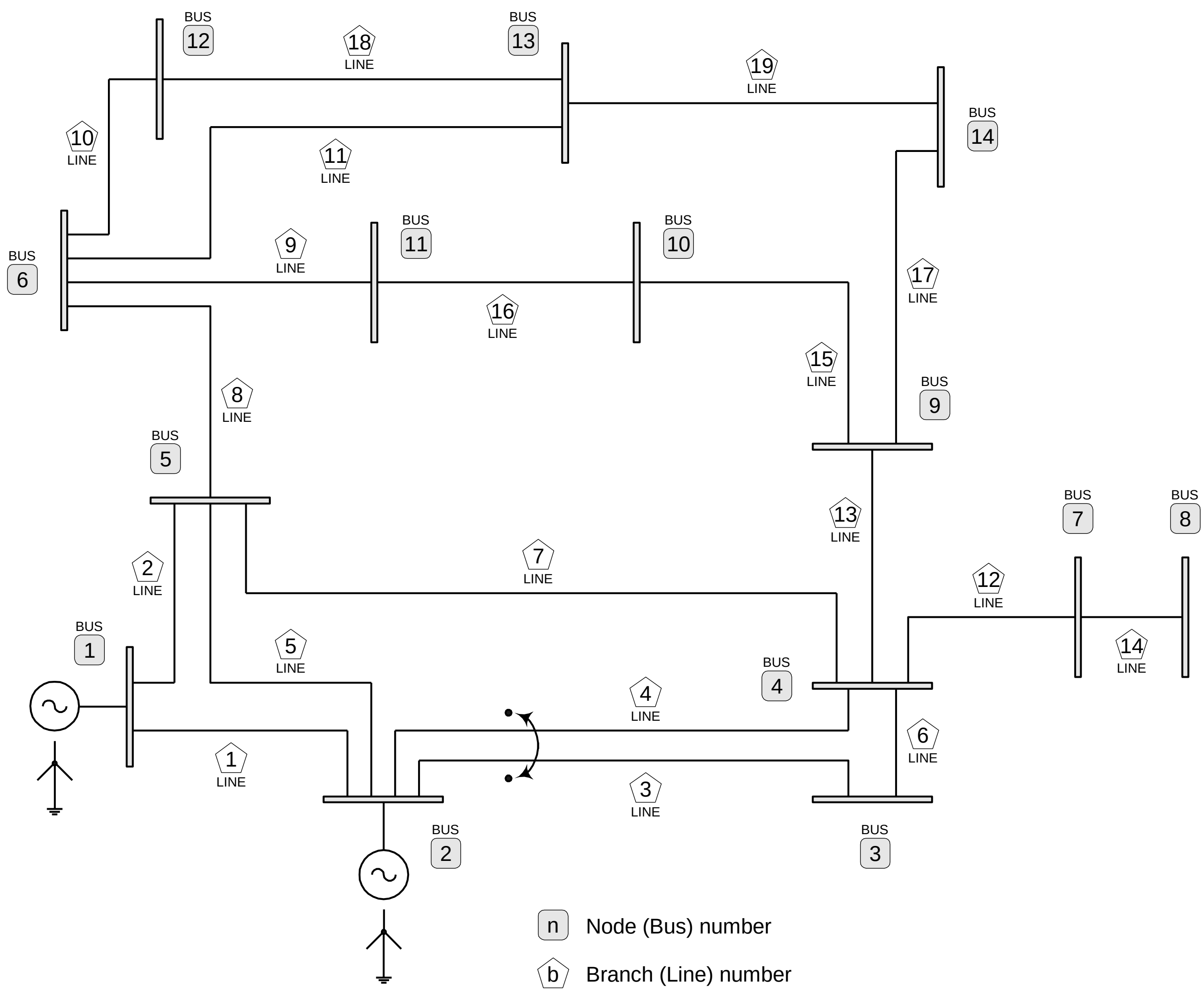

Figure 1. *Power system for fault simulations*

NOTE: Results, computer code, flow charts and related equations
All the results should be given in actual values.
Each student to certify that work is his/her own