Πανεπιστήμιο Θεσσαλίας
Τμήμα Ηλεκτρολόγων Μηχανικών και Μηχανικών Υπολογιστών
Μάθημα: **Συστήματα Ηλεκτρικής Ενέργειας ΙΙ**
Ακ. έτος 2019-20, χειμερινό εξάμηνο

Εργασία/project (Προαιρετική): Χρήση simulator στην ανάλυση ΣΗΕ
Κάνετε χρήση του PowerWorld (free version in internet) ή PSS (free version in internet) όπου απαιτείται χρήση simulator.

Ατομική παράδοση λύσεων (σε μορφή τεχνικής έκθεσης (technical report) και παρουσίαση των λύσεων (στον διδάσκοντα) στον simulator/ΗΥ το αργότερο έως **Τρίτη 7 Ιανουαρίου 2020, ώρα 12 μεσημέρι.**

Συμβολή στην αξιολόγηση/βαθμολογία του μαθήματος:

- Έως +2,5 βαθμοί στην τελική βαθμολογία εφόσον ο βαθμός της τελικής εξέταση είναι >= 4
- Μηδέν εφόσον ο βαθμός της τελικής εξέταση είναι < 4.

PROBLEM 1: Faults

A. Symmetrical 3phase faults

Figure 1.1 shows a single-line diagram of a five-bus power system. Machine, line, and transformer data are given in Tables 1.1, 1.2, and 1.3. This system is initially unloaded. Prefault voltages at all the buses are 1.05 per unit. Use PowerWorld Simulator to determine the fault current for three-phase faults at each of the buses.

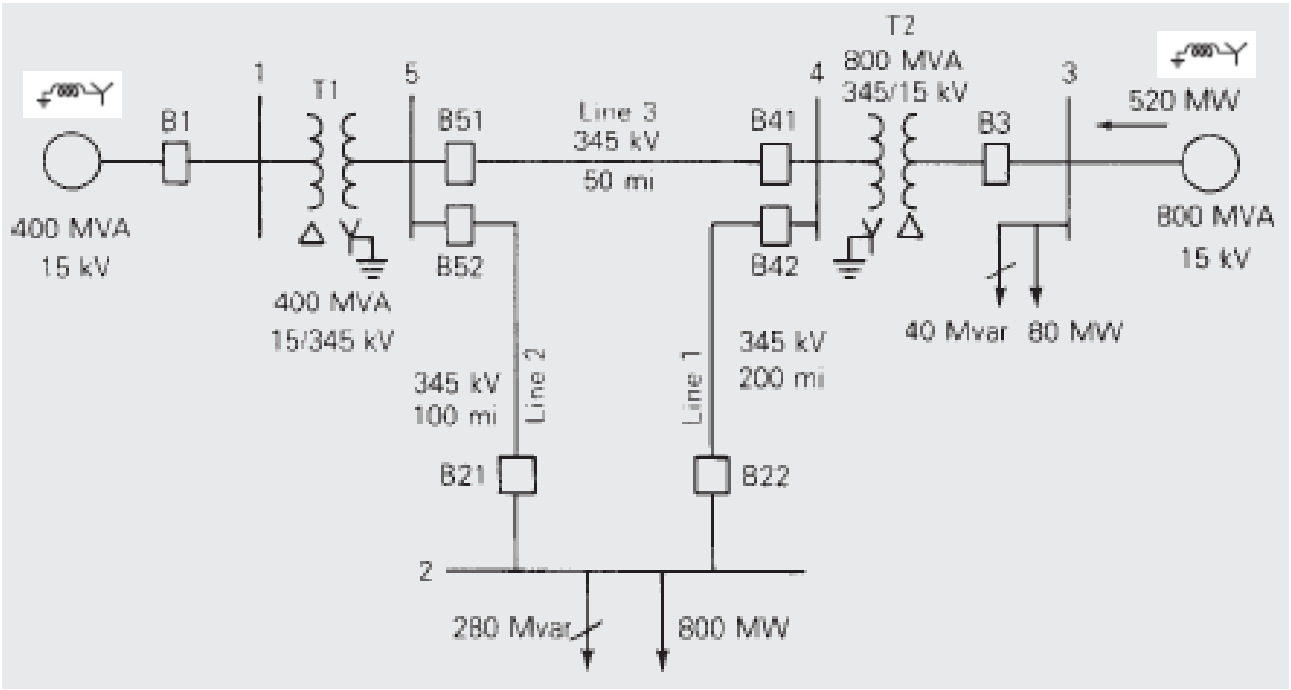

Figure 1.1: Single-line diagram of a five-bus power system

Table 1.1: Synchronous machine input data for symmetrical faults

Bus	Machine Subtransient Reactance—X''_d (per unit)
1	0.045
3	0.0225

* $S_{base} = 100$ MVA
$V_{base} = 15$ kV at buses 1, 3
$= 345$ kV at buses 2, 4, 5

Table 1.2: Line input data for symmetrical faults

Bus-to-Bus	Equivalent Positive-Sequence Series Reactance (per unit)
2–4	0.1
2–5	0.05
4–5	0.025

Table 1.3: Transformer input data for symmetrical faults

Bus-to-Bus	Leakage Reactance—X (per unit)
1–5	0.02
3–4	0.01

B. Symmetrical 3phase faults without the generator at bus 3
Redo A, except first open the generator at bus 3.

C. Symmetrical 3phase faults with an additional line installed
Redo A with an additional line installed between buses 2 and 4. This line, whose reactance is 0.075 per unit, is not mutually coupled to any other line.

D. Unsymmetrical faults – Line to ground
Consider the five-bus power system whose single-line diagram is shown in Figure 1.1. Machine, line, and transformer data are given in Tables 1.4, 1.5, and 1.6. Note that the neutrals of both transformers and generator 1 are solidly grounded, as indicated by a neutral reactance of zero for these equipments. However, a neutral reactance = 0.0025 per unit is connected to the generator 2 neutral. The prefault voltage is 1.05 per unit. Using PowerWorld Simulator, determine the fault currents (fault currents and contribution currents of all lines, for all phases) and bus voltages (for all phases) for a bolted single line-to-ground fault at bus 1, then bus 2, and so on to bus 5.

Table 1.4: Synchronous machine input data for unsymmetrical faults

Bus	X_0 per unit	$X_1 = X_d''$ per unit	X_2 per unit	Neutral Reactance X_n per unit
1	0.0125	0.045	0.045	0
3	0.005	0.0225	0.0225	0.0025

Table 1.5: Line input data for unsymmetrical faults

Bus-to-Bus	X_0 per unit	X_1 per unit
2–4	0.3	0.1
2–5	0.15	0.05
4–5	0.075	0.025

Table 1.6: Transformer input data for unsymmetrical faults

Low-Voltage (connection) bus	High-Voltage (connection) bus	Leakage Reactance per unit	Neutral Reactance per unit
1 (Δ)	5 (Y)	0.02	0
3 (Δ)	4 (Y)	0.01	0

$S_{base} = 100$ MVA

$V_{base} = \begin{cases} 15 \text{ kV at buses } 1,\ 3 \\ 345 \text{ kV at buses } 2,\ 4,\ 5 \end{cases}$

E. Unsymmetrical faults - Line to line

Redo D for a line-to-line fault at each of the buses. Compare the fault currents with the values in D. Are the fault currents larger or smaller than the values in D?

F. Unsymmetrical faults – Double Line to ground

Redo D for a double line to ground fault at each of the buses. Compare the fault currents with the values in D. Are the fault currents larger or smaller than the values in D?

G. Unsymmetrical faults – Line to ground. Additional line installed

Re-work D, except with a new line installed between buses 2 and 4. The parameters for this new line should be identical to those of the existing line between buses 2 and 4. The new line is not mutually coupled to any other line. Are the fault currents larger or smaller than the values in D?

H. Unsymmetrical faults – Line to ground. Addition of generator

Re-work D, except with a second generator added at bus 3. The parameters for the new generator should be identical to those of the existing generator at bus 3. Are the fault currents larger or smaller than the values in D?