Shahjalal University of Science and Technology (SUST)

Department of Electrical and Electronic Engineering (EEE)

Experiment name: Symmetrical Fault Analysis

Experiment No: 05

Course Title: Power System -I
Course Code: EEE -326

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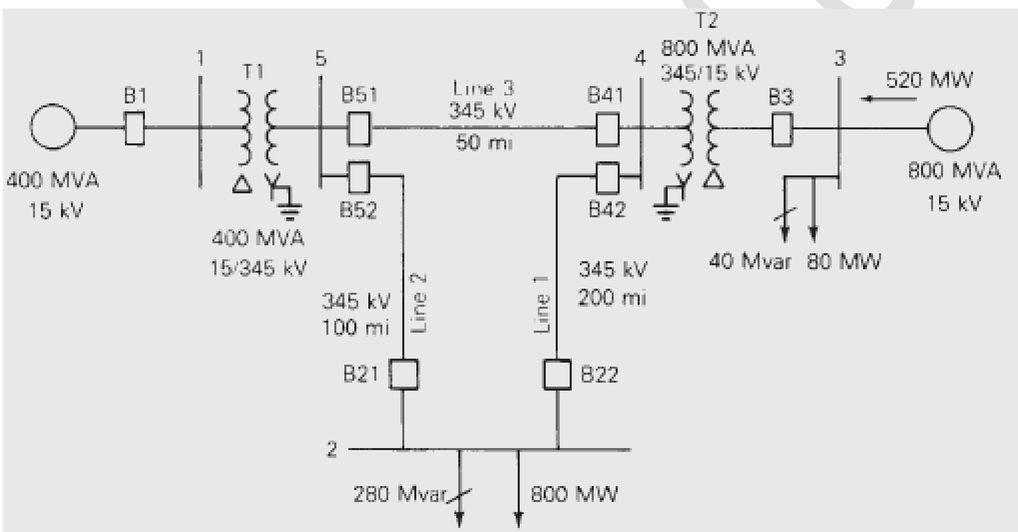
Objective: A 5-bus power system whose one-line diagram is shown in following Figure. Machine, line, and transformer data are given in Tables 7.3, 7.4, and 7.5. This system is initially unloaded. Prefault voltages at all the buses are 1.05 per unit. Use PowerWorld Simulator to determine the fault current for three-phase faults at each of the buses.

Equipment: Power World Simulator v17

Procedure:

Following figure shows a single-line diagram of a five-bus power system. Input data are given in Tables 1, 2, and 3. As shown in Table 1, bus 1, to which a generator is connected, is the swing bus. Bus 3, to which a generator and a load are connected, is a voltage-controlled bus. Buses 2, 4, and 5 are load buses.



The input data and unknowns are listed in Table 4. For bus 1, the swing bus, P1 and Q1 are unknowns. For bus 3, a voltage-controlled bus, Q3 and d3 are unknowns. For buses 2, 4, and 5, load buses, V2, V4, V5 and d2, d4, d5 are unknowns.

The elements of Ybus are computed from the equation described in class. Since buses 1 and 3 are not directly connected to bus 2,

Y21 =Y23= 0

Where, half of the shunt admittance of each line connected to bus 2 is included in Y22 (the other half is located at the other ends of these lines).

Bus	Type	V per unit	δ degrees	P_G per unit	Q_G per unit	P_L per unit	Q_L per unit	Q_{Gmax} per unit	Q_{Gmin} per unit
1	Swing	1.0	0	—	—	0	0	—	—
2	Load	—	—	0	0	8.0	2.8	—	—
3	Constant voltage	1.05	—	5.2	—	0.8	0.4	4.0	−2.8
4	Load	—	—	0	0	0	0	—	—
5	Load	—	—	0	0	0	0	—	—

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

.Table:1 (Bus input data)

Bus-to-Bus	R′ per unit	X′ per unit	G′ per unit	B′ per unit	Maximum MVA per unit
2–4	0.0090	0.100	0	1.72	12.0
2–5	0.0045	0.050	0	0.88	12.0
4–5	0.00225	0.025	0	0.44	12.0

Table:2 (Line input data)

Bus-to-Bus	R per unit	X per unit	G_c per unit	B_m per unit	Maximum MVA per unit	Maximum TAP Setting per unit
1–5	0.00150	0.02	0	0	6.0	—
3–4	0.00075	0.01	0	0	10.0	—

Table:3 (Transformer input data)

Bus	Input Data	Unknowns
1	$V_1 = 1.0, \delta_1 = 0$	P_1, Q_1
2	$P_2 = P_{G2} - P_{L2} = -8$ $Q_2 = Q_{G2} - Q_{L2} = -2.8$	V_2, δ_2
3	$V_3 = 1.05$ $P_3 = P_{G3} - P_{L3} = 4.4$	Q_3, δ_3
4	$P_4 = 0, Q_4 = 0$	V_4, δ_4
5	$P_5 = 0, Q_5 = 0$	V_5, δ_5

Table:4 (Input data and unknowns)

Bus 2 is a load bus. Using the input data and bus admittance values from experiment no:03 calculate V_2, V_3, V_4, V_5 by hand.

To see the complete convergence of this case, open PowerWorld Simulator case draw the power grid system in Power World Simulator. By default, PowerWorld Simulator uses the Newton–Raphson method described. However, the case can be solved with the Gauss–Seidel approach by selecting **Tools, Solve, Gauss–Seidel Power Flow**. To avoid getting stuck in an **infinite loop** if a **case does not converge**, PowerWorld Simulator **places a limit** on the **maximum** number of iterations. Usually for a Gauss–Seidel procedure this number is **quite high**, perhaps **equal to 100** iterations. However, in this example **to demonstrate the convergence characteristics** of the Gauss–Seidel method it **has been set to a single iteration**, **allowing the voltages to be viewed after each iteration**. To step through the **solution one iteration at a time**, just **repeatedly select Tools, Solve, Gauss–Seidel Power Flow.**

A common stopping criteria for the Gauss–Seidel is to use the scaled difference in the voltage from one iteration to the next. When this difference is below a specified convergence tolerance **e** for each bus, the **problem is considered solved.** An alternative approach, implemented in PowerWorld Simulator, is **to examine the real and reactive mismatch equations**, defined as the difference between **the right- and left-hand sides of** (1) and (2) equations. PowerWorld Simulator **continues iterating until** all the bus mismatches are **below an MVA (or kVA) tolerance**. When single-stepping through the solution, **the bus mismatches can be viewed after each iteration** on the **Case Information, Mismatches display**. The solution **mismatch tolerance** can be changed on the Power Flow Solution page of the PowerWorld Simulator **Options dialog (select Tools, Simulator Options, then select the Power Flow Solution category to view this dialog**); the maximum number of iterations can also be changed from this page. A typical convergence tolerance is about 0.5 MVA.