BIRZEIT UNIVERSITY

Department of Electrical and Computer Engineering

Power Systems (ENEE4403)

"Power World Simulator Project"

Deadline for Submission (Hard Copy): at the beginning of lecture time on Wednesday 19-12-2018

First semester 2018/2019

Fig.1 below shows an 8-bus power system, parameters and other system modelling information (line impedances, load values … etc.) are given below.

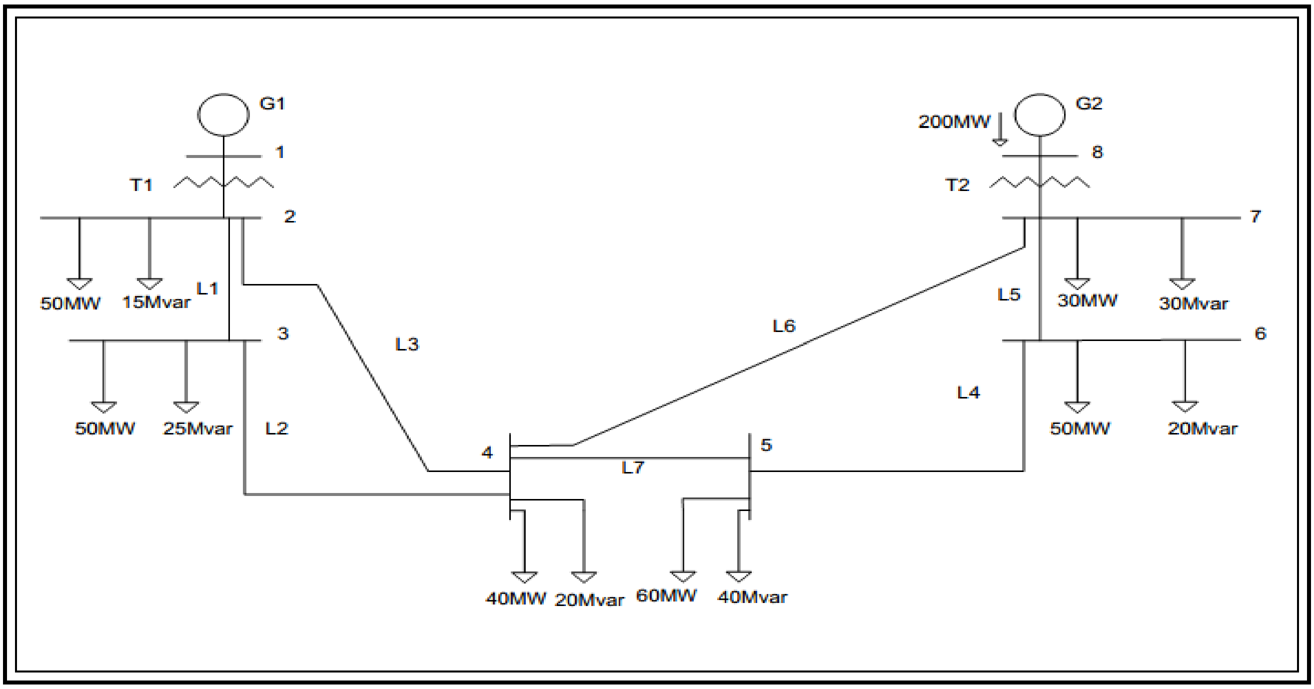

Fig.1: 8-bus Power System

- **Generator Ratings:**

G1: 150 MVA, 13.8 kV, X_1 =0.12, X_2 =0.14, X_0 =0.05 per unit.

G2: 250 MVA, 15 kV, X_1 =0.12, X_2 =0.14, X_0 =0.05 per unit.

Where X_1 is the positive sequence impedance, X_2 is the negative sequence impedance and X_0 is the zero sequence impedance.

- **Transformer Ratings:**

T1: 150 MVA, 13.8 kV/ 230kV, X=0.1 per unit.

T2: 300 MVA, 15 kV/ 230kV, X=0.1 per unit.

- **Transmission Line Ratings:**

All lines: 230 kV, $Z_1 = 0.08 + j(x+0.1)$ Ω/km, $Z_0 = (a+0.1) + j1.5$ Ω/km, $Y_1 = j3.3$ E-6 S/km, maximum MVA = 200.

Where Z_1 is the transmission line impedance (R + jX), Y_1 is the shunt charging (B) and Z_0 is the zero sequence impedance in per length units.

Note that Z_1 and Z_0 contain variable terms (x and a); the values of these terms depend on the last two digits of your university ID Number, the last two digits (each digit divided by 10) correspond to x and a respectively.

Example:

Assume that your ID number is 1120581, then, x = 0.8, a = 0.1 and $Z_1 = 0.08 + j\,(0.9)$ Ω/km,

$Z_0 = (0.2) + j1.5$ Ω/km.

Line Lengths: L1 = 20km, L2 = 60km, L3 = 85km, L4 = 55km, L5 = 20km, L6 = 120km, L7 = 25km.

- **Busses Data:**

Bus 1: Swing bus, V1 = 13.8kV, $\delta = 0^o$

Busses 2, 3, 4, 5, 6, 7: Load busses.

Bus 8: Constant voltage magnitude bus, V_8 = 15 kV and P_8 = 200 MW.

- **System Base Quantities**

S_{base} = 100 MVA, V_{base} = 13.8 kV in the G1 zone.

1. Insert the system in Power World Simulator using the previous data, calculate per unit impedances for all transmission lines using the program and show results in a table (go to model explorer and select “branches input” to get this table).

2. Solve the case showing:
   a) One-line diagram of the system in run mode with the following results:
      - Power flow direction.
      - Transmission lines and transformers MVA loading percentage pie charts.
      - Bus voltages, angles and load values (MW and Mvar) shown beside each bus.

- Power flow, power losses (MW and Mvar) and current flow in the transmission lines and transformers shown in both terminals of transmission lines and transformers.

b) Total load, total generation power and total power losses from case summary tools.

c) Y_{Bus} matrix.

d) The table of bus voltages per unit and angles, and load values on each bus.

e) State tables for all branches (transmission lines and transformers), showing loading values and losses. Discuss results.

3. Increase the value of MW load at bus 3 until that transformer T_1 become full loaded, write the new load value and repeat step (2-a).

4. Reduce the load at bus 3 to 50 MW and 25 Mvar (in order to return the original case as shown in Fig. 1), then add a switched shunt capacitor bank to bus 5 such that per unit voltage for this bus become 1 pu, write this Mvar value, calculate the value of the capacitor required to generate this power, repeat step (2-a and 2-b) and discuss the differences, repeat this step with another two values of Mvar, one of them less than previous value and the other greater than it and discuss the results.

5. Remove shunt capacitor, which inserted in step 4, and perform 3-phase symmetrical fault on bus 4 using fault analysis tool, showing the values of fault current, current in each transmission lines and bus voltages during fault.

The End