University of Cape Town Department of Electrical Eng.	EEE3100S, 2022 PowerWorld Assignment

Overview

This assignment draws on the power flow and balanced fault calculation concepts you learned in the lecture materials of weeks four and five. You will now apply these concepts to a typical power system analysis and design project. The power system under consideration is illustrated in Figure 1. You will perform 3 main tasks on the system. You have been paired in groups (2 students in a group) to carry out these tasks and write a report that includes all the key deliverables described under each task.

Please, check the assignment announcement to see your group member. Note that each group's assignment is unique.

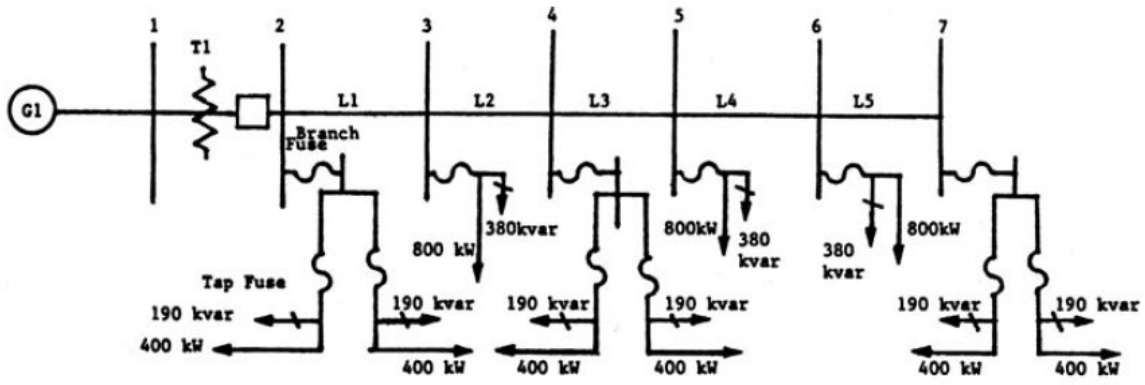
NOTE THE FOLLOWING.

Time Given: 3.5 weeks (Hand-in Deadline: 23h55 Wednesday 21 September 2022)

Approximate Time Required: 20 hours.

Task 1: Power-Flow Preparation

For the single-line diagram of Figure 1, convert all positive-sequence impedance, load, and voltage data to per unit using the given system base quantities. Then using PowerWorld Simulator, create three input data tables: bus input data, line input data, and transformer input data. Note that bus 1 is the swing bus.



Generator Ratings
G1 (infinite bus): 50 MVA, 345 kV, $x'' = x_2 = 0.15$ per unit
The generator neutrals are solidly grounded
Transformer Ratings
T1: 5 MVA, 345 kVΔ/13.8 kVY, x = 0.1 per unit
The transformer neutrals are solidly grounded
Transmission Line Ratings
All Lines: 13.8 kV, z_1 = 0.19 + j0.38 Ω/km,
z_0 = 0.6 + j1.0 Ω/km, y_1 = j4.0 E-6 S/km,
Maximum MVA = 5
Line Lengths: L_1 = 2 km, L_2 assigned by the instructor
$L_3 = L_4 = L_5 = 2$ km.

Circuit Breaker
Fuse

Power Flow Data
Bus 1 : Swing bus, $V_1 = 345$ kV, $\partial_1 = 0°$
Bus 2,3,4,5,6,7 : Load buses
System Base Quantities
S_{base} = 10 MVA (three-phase)
V_{base} = 13.8 kV (line-to-line) in the zone of the lines

Figure 1: Single-line diagram for Design Project 1—radial distribution feeder

Task 2: Power Flow

Case 1

Run the power flow program using the Gauss-Seidel solver, and obtain the bus, line, and transformer output data tables.

Case 2

Suggest one method of increasing the voltage magnitude at bus 4 by 5%. Demonstrate the effectiveness of your method by making appropriate changes to the input data of case 1 and by running the power flow program. Please, explain your method for increasing the voltage at bus 4 by 5%.

Case 3

Based on case 1, increase the loads at buses 3-5 by 100% and run the power flow. Compare the losses in the system with case 1. Check the bus voltages to see if they are within ±5% of the nominal value. If not, please find a way to increase the bus voltages within the required limits while ensuring that the transmission lines and transformers are not overloaded.

Deliverables for Task 2

Your output for task 2 consists of 9 data files: 3 output data tables for each case, along with explanation of your method for increasing the voltage at bus 4 by 5%. In addition, you should discuss your findings after comparing the losses in cases 1 and 3. In case you found that the voltages at buses 3-5 had to be improved to be within the prescribed limits, explain how this was accomplished and include the PowerWorld circuit schematic.

Task 3: Fault Analysis

Case 1

Recall the input data tables for the single-line diagram you were assigned under Task 1. **For synchronous machines, use sub-transient reactance (X_d'').** Create the machine, transmission line, and transformer input data tables. Then using PowerWorld Simulator, run the program to compute sub-transient fault currents for a **three-phase fault** at **each bus of the power system**. Also, for each case, compute bus voltages during the faults. Assume 1.0 per unit pre-fault voltage. Neglect pre-fault load currents and all losses.

Case 2

Assume that the shunt admittances, and the loads are neglected, a 3-phase fault occurs at bus 4, use hand calculation to find the Thevenin equivalent impedance, the fault current at bus 4, and the voltage at buses 3 and 5.

Deliverables for Task 3

Case 1: Three input data tables (machine, transmission line, and transformer) and two output data tables (fault currents and bus voltages). Note that each table should indicate the fault location, as well as the measured parameter (fault current or bus voltage) at the system buses.

Case 2: Report the values from your hand calculations of Z_{Th}, the fault current at bus 4, and

the voltage at buses 3 and 5. Compare the results of case 1 and case 2; discuss any discrepancies and the reasons for these discrepancies.

Note on Presentation of Assignment Report

Your report should be well-structured. It should have:

- A title page with the names and student numbers of group members clearly indicated;
- An abstract (<150 words);
- An introduction (<350 words);
- The deliverables listed under each task with appropriate table and figure labels and captions;
- Conclusions (<250 words)
- References (Use IEEE reference style)