1.1 Load Flow

Perform a load flow simulation and determine the following:

Task 1: What is the real and reactive power provided by (slack bus) G1 to ensure that the load is matched by generation? 33, 13

Task 2: What is the power loss across transformers T1, T2 and T3? 0.81, 2.35, 1.87 MW

Task 3: What is the voltage at bus 2 & bus 8 in pu and kV? 0.98pu 108.03kV, 0.99pu 37.45kV

Task 4: If the parameters of G7 are adjusted so that it now provides zero reactive power, what impact does this have on the voltage at bus 7? All the voltages at every bus including 7 drop Reset the parameters of G7 to their initial values once the impact of the adjustment has been verified?

Task 5: How would the voltages at the non-generating buses (2, 5 & 8) be maintained at 1 pu? Ideally if you add a generator to all the non-generating buses that will solve the problem and force the voltages to be maintained at 1 pu. Add a capacitor at each due to the fact that they are below 1pu and we nedd to add power (use an inductor if it was above 1) change the transmission lines but very unrealistic. Also you can manipulate the generating buses so that there pu was higher and so the values at the non generating buses increase accordingly.

1.2 Power System Economics

Power system operators must ensure that there is sufficient generation online at all times to match the demand (load) on the system, and must do so in the most economical way possible. Different generators will have different operating costs, determined by the type of fuel used, capacity, etc. Table 5 shows the cost characteristics for the generating units in the assignment. PMAX and PMIN for each unit are as given in Table 1.

No-load costs are incurred every hour while the unit is on load and are independent of the amount of power being supplied to the grid. The hourly cost (€/h) of a generating unit is the product of the generator’s actual output, PGEN, and the incremental fuel cost, and combined with the no-load costs.

Task 6: If generator G4 must always be on (i.e. must always run at least at PMIN), use the unit limits from Table 1 and a decision tree approach to determine the cheapest generation schedule that will meet the system load defined in Table 2 for 1 hour.

• Draw a decision tree.

• Determine the minimum operating cost, if feasible, for each combination of units.

• Prune the decision tree if an infeasible combination of units is found.

• Determine the cheapest combination of units and economic dispatch to meet the demand.

Task 7: Implement the optimal solution of Task 6 on the 8-bus power system, and comment on the results obtained. If we use the minimum solution found by working out our decision tree our power lines between bus 1 and 2 are at 90% also there are losses in the system so we would have to increase our generators to compensate

Task 8: If G4 suddenly failed discuss the problems that would result. How could you dispatch the system to mitigate for such occurrences? The transmission lines between Bus A and Bus B would overload considerably.

1.3 Introducing Wind Power into the Network

A wind farm is now connected to the system, which can be represented by a single generating unit with the following characteristics: active power, PMAX = 200 MW, and operating at 0.95 “constant power factor” wind control mode. The wind farm bus is assumed to be operating at maximum output in our simulation. The wind farm bus nominal voltage is 690 V and is connected to Bus 8 via a 250 MVA transformer, the parameters of which are otherwise the same as T3.

Task 9: Outline 2 advantages and 2 disadvantages of connecting wind farms to the system.

Task 10: How will introducing the wind farm affect the optimal unit commitment for the system?

Task 11: Why are wind farms usually connected at the distribution voltage level?

Perform a load flow simulation for the expanded system, based on the generator dispatch from Task 6 and determine:

Task 12: The real and reactive power provided by G1 to ensure that the load is matched by generation.

Task 13: The reactive power output of the wind farm. Is the wind farm generating or absorbing reactive power?

Task 14: Comment on the load flow results obtained.

Take a screenshot of your network in run mode and display clearly all values necessary to answer Tasks 12-13.

2. Report Requirements

You are required to submit a laboratory report. This report must be submitted within 1 week of completing the lab and should contain as a minimum:

• Screenshots of your single-line diagram from Power System Simulation - Part 1 & 2 (2 screenshots for part 2)

• Answers to the assignment questions, including any necessary calculations from Power System Simulation - Part 2