EEL4216 Fundamentals of Electric Power Systems, Fall 2023
Department of Electrical and Computer Engineering
University of Central Florida

Final Design Project
Duration: 2 weeks
Due on Monday, Nov. 20th, 2023

This project has content that relies on your in-depth understanding of Chapters 1-6. The system is fairly large, but you will be provided the entire Power World system model. You will rely on your ability to perform self-study regarding the economic impact of your design alternatives/decisions. You will follow a step-by-step procedure outlined in chapter 6, which is also provided here in this document (simply repeated). The only content not repeated here, for which you will need to obtain from the book, is cost data. Aside from an economic study, you will also be required to perform an N-1 contingency analysis.

System Planning to Integrate a New Wind Farm

After months of negotiation, the Cedar Creek Wind (CCW) is close to committing to build a new wind farm in the southeast of the Metropolis urban area. This new wind farm will provide clean energy to the local utility, Metropolis Light and Power (MLP). However, in order to accommodate the new CCW wind farm, a new substation will need to be constructed at the wind farm location. While CCW needs to deliver 200 MW electricity at the 69 kV level, the new substation location is large enough to accommodate a 138/69 kV transformer if needed. Additionally, for reliability purposes CCW needs to have at least two separate feeds into their substation.

As a planning engineer for MLP your job is to make recommendations to ensure that with CCW's new wind farm under peak loading conditions, the transmission system is adequate for any base case or first contingency loading situation. This is also a good opportunity not only to integrate the new wind farm, but also to fix some existing first contingency violations. Table 1 shows the right-of-way distances that are available for the construction of new 69 kV and/or new 138 kV lines. All existing 69 kV only substations are large enough to accommodate 138 kV as well.

Table 1: Available New Rights-of-Ways

Right-of-Way/Substation	Right-of-Way Mileage(miles)
CCW to JO	4.5
CCW to LYNN	5
CCW to ROGER	8
CCW to WOLEN	11
CCW to SHIMKO	4
ROGER to SHIMKO	6.5
WOLEN to SHIMKO	12
SAVOY TO SHIMKO	6
BOB to SHIMKO	6.7

Design Procedure

1. Load the Design Case into PowerWorld Simulator (see Figure 1). Perform an initial power-flow solution to verify the base case system operation without the ***CCW wind farm***. Note that the entire line flows and bus voltage magnitudes are within their limits. Assume all line MVA flows must be at or below 100% of the limit A values, and all voltages must be between 0.95 and 1.10 per unit.

2. Repeat the above analysis considering the impact of any single transmission line or transformer outage. This is known as contingency analysis. To simplify this analysis, PowerWorld Simulator has the ability to automatically perform a contingency analysis

study. Select **Tools, Contingency Analysis** to show the Contingency Analysis display. Note that the 57 single line/transformer contingencies are already defined. Select **Start Run** to automatically see the impact of removing any single element. This system has line violations for three different contingencies.

3. Using the rights-of-way and the transmission line parameters/costs given in Table 1, iteratively determine the least expensive system additions so that the base case and all the contingences result in secure operation points (i.e., one with no violations) with the new ***CCW wind farm***. The parameters of the new transmission lines(s) need to be derived using the tower configurations and conductor types provided by your instructor. The total cost of an addition is defined as the construction costs minus the savings associated with any decrease in system losses over the next 5 years.

4. Write a detailed report discussing the initial system problems, your approach to optimally solving the system problems and the justification for your final recommendation.

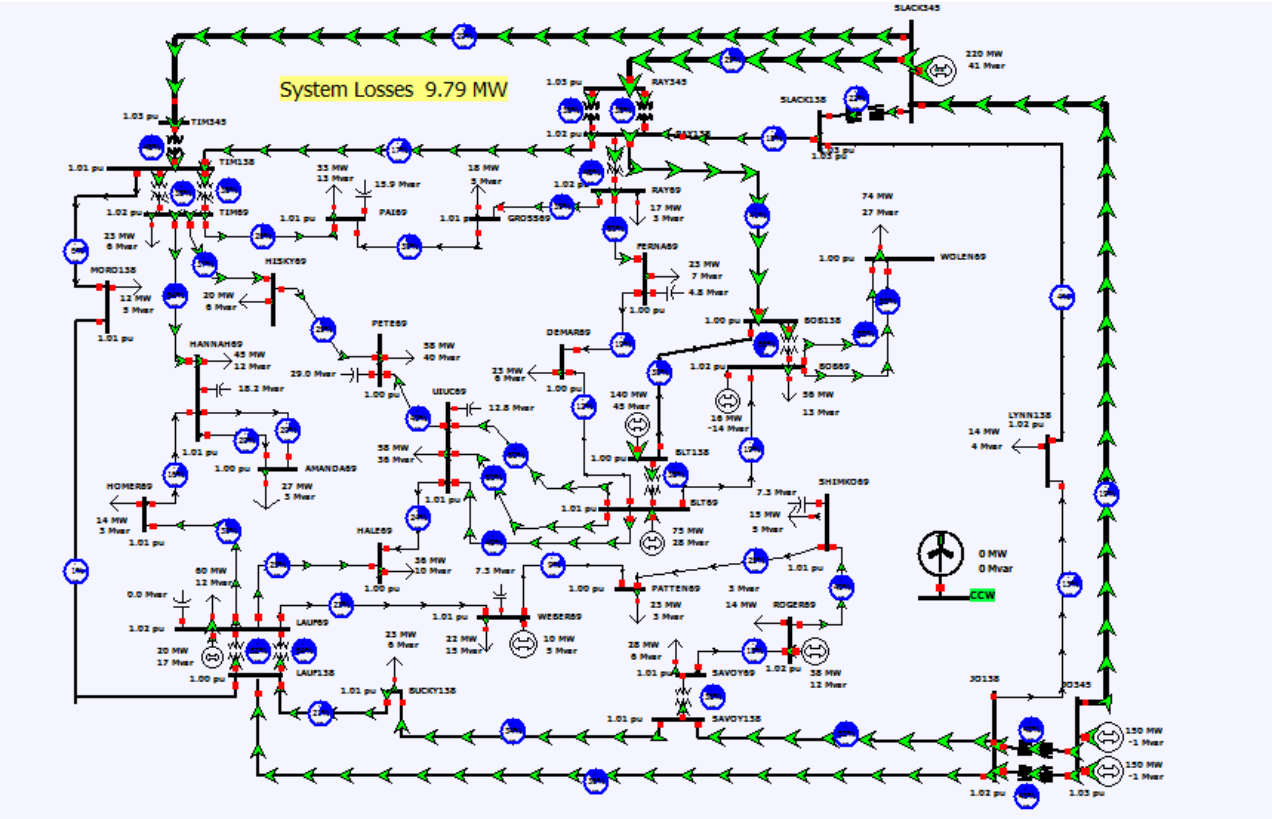

Figure1: System for the Design Case

Project Simplifying Assumptions

To simplify the analysis, several assumptions are made:

1. You need only consider the base case loading level given in the Design Case. In a real design, typically a number of different operating points/loading levels must be considered.

2. You should consider the generator outputs as fixed values; any changes in the losses and the new ***CCW wind farm*** are always picked up by the system slack generator.

3. You should not modify the status of the capacitors or the transformer taps.

4. You should assume that the system losses remain constant over the 5-year period and need only consider the impact and new design has on the base case losses. Electricity is priced at **$55/MWh.**

No need to construct the system since it will be given as PowerWorld file. Refer to page no. 372 (Fifth edition) for transmission line and transformer design costs. The parameters of transmission lines for the particular conductors are given in Table A4 in Appendix of text book.

Project Report

Your report should include followings:

1. Transmission system design

- Design process, steps to design the best alternatives.
- One line diagram and load flow simulation results (voltages, active and reactive power generated by each generator, power flow on each line and reactive power support from the shunt devices) for the best alternatives.
- N-1 contingency report, which shows all possible contingencies.
- Number and length of transmission lines used for the best alternatives.

2. Optimum operation:

- Discuss your design with reference to transmission line cost, transformer cost and other fixed as well as variable costs.
- Discuss the most efficient alternative that you recommend during the analysis of the system.