Simulation Project 1 **CS/EE 146** **Spring 2012**

Reports are due on Wednesday Feb 8, in class.

0. Getting Started

a) Download the educational demo version of the PowerWorld software from the course website and install it on your machine. Note that this software is only compatible with windows operating system. The reference manual is available at `http://www.powerworld.com/Document%20Library/version.160/Simulator16_Help_Printed.pdf`

b) Download the "37Bus.pwb" file from the course website and load it in PowerWorld. The following questions are based on this test case [1].

1. Base Case

a) Briefly describe this power network (number of generation, load, lines, shunt capacitors, voltage levels, ...) [2]

b) Determine the total active and reactive load in the system, total active and reactive generation and real power losses in the system? What is the real loss to generation ratio?

c) Determine the lowest and highest per unit voltage. Does this system satisfy voltage and line loading limits? Assume Vmin = 0.95 p.u and Vmax = 1.05 p.u

d) Try opening different circuit breakers in the system and observe the change in total real power loss of the system. Can you justify your observations?

e) Does the system satisfy the N-1 contingency requirement for the lines, i.e., can opening a single line of the system result in violating voltage and line limits [3]?

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[1] This test case is taken from "Power system analysis and design" by J. Glover, M. Sarma, T. Overbye.

[2] Use the model explorer feature of the software.

[3] Use the contingency analysis feature of the software (all line contingencies have been already defined in the file).

f) Identify the weakest bus of the system. We say a bus is weak when a small change in loading condition of that bus causes a significant change in voltage magnitude of that bus [4].

2. Loading Effects

Locate the PQ load attached to 'DEMAR69' bus in the system (P= 20MW, Q=18Mvar) and answer the following questions.

a) Add 100MW to this load and observe the voltage drop. Repeat this by adding 100Mvar instead. Which case results in more voltage drop? Can you justify this[5]?

b) Suppose this load grows by 4 times, i.e., (20,18)→(80,72). Report the violation of voltage and line limits. Place an appropriate shunt capacitor at this bus in order to bring the DEMAR69 voltage back to its initial value and resolve line congestions.

3. Generation Retirement

We are asked to retire the 75MW generator attached to the 'SANDER69' bus for environmental concerns.

a) Does disconnecting this generator violate voltage and line limits of the system?

b) Does it harm N-1 contingency condition? If so, suggest a solution to remedy this.

4. Planning for a New Generation

As you can see in the '37bus.pwb' file, there exist an isolated wind generator called 'KWW' in the middle of the following 8 buses: GROSS, PAI, PETE, ZEB, Hisky, DEMAR, TIM, RAY. This new generator is a 200MW generator, with a voltage setpoint of 1.05 per unit, and reactive power limits of ± 100 Mvar. The distances of the new generator and its neighboring buses are given in the following table.

[4] Use the sensitivity analysis feature of the software.

[5] Hint: Write down voltage drop equation for a single line carrying (P,Q)

Path	Distance
KWW to GROSS	5 mi
KWW to PAI	8 mi
KWW to PETE	10 mi
KWW to ZEB	12 mi
KWW to Hisky	15 mi
KWW to DEMAR	18 mi
KWW to TIM	20 mi
KWW to RAY	25 mi

Assume that all possible new lines will have a $r = 0.0008, x = 0.003, B = 0.0001$ per mile.

a) If you were to build shortest possible transmission line/lines for the new wind generator considering voltage and line limits, what would you do?

b) How would you design change if you had an additional N-1 contingency constraint for the transmission lines.

b) Repeat part (a) considering total cost of constructing new lines and the cost of real power loss in the system for the next 5 years. Let the price for losses be \$50/MWh, and the cost of new lines to be \$200,000/mile.