

1. In PowerWorld using the Bus37_PV_HW5 system first open two transmission lines and one generator. You may choose any two lines, except with the requirement that you not isolate any load or island the system. For the generator you may open any one, excepting the slack bus generator. Then, use the **Load Scalar** field to increase the system load until the system reaches voltage collapse. Plot the PV curve, with P being the total system load, and V being the voltage magnitude at the bus that has the lowest voltage magnitude at the point of voltage collapse. Your PV curve should have at least ten fairly uniformly spaced points.
2. Solve the following constrained minimization problem. What is the value of the Lagrange multiplier?

$$\text{Minimize } f(\mathbf{x}) = (x_1 - 3)^2 + (x_2 - 4)^2 \quad \text{such that } x_1 + x_2 = 5$$

3. For the below LP tableau using the Simplex method determine the variable to enter the basis, the one to exit the basis, then do the pivot, giving the updated tableau. Continue until solved (which will take at maximum a few iterations). Give the new basic feasible solution at each iteration.

x_1	x_2	x_3	x_4	
2	2	1	0	10
4	8	0	1	12
-68	-116	0	0	0

4. Start PowerWorld Simulator. Open the AGLOPF_HW5 case. When doing the simulations (i.e., by your selecting the Play button) this case has been setup to automatically do an OPF, changing the output for all ten generators. Also, in the box on the right the display has a button to allow you to easily scale the load in 5% increments of the APL all time system peak load. Initially we'll be starting at 70% of the peak load.

Select **Tools, Play** to start the simulation. Note that now it is doing an OPF, as opposed just a power flow. Record the initial Total Load, Hourly Cost, Losses, Average LMP, and the total generator profit

Click on the Load Multiplier up arrow (now in the box to the left of the oneline) to increase the load by 5% (of the system peak) to 0.75. Again record the Total Load, Hourly Cost, Losses, Average LMP, and the total generator profit.

Then repeat the previous step, going up until the Load Multiplier is 1.0. As you do this, at one load multiplier value (of your choice), verify the profit for one generator (again of your choice, but it must be a generator with a non-zero MW output); include this calculation in your report. Note, because of rounding with the display values, getting with \$10 is close enough.

5. In the case from Problem 4 decrease the Load Multiplier to 0.9. In problem 4 every unit was offering its generation at marginal cost into the LMP market. In this problem you will explore how the profit for the Kyle138 generator would change if they increased their offer. The easiest way to do this is to change the “Cost Multiplier” field, which scales their offer based on their marginal cost. For example, if a generator’s marginal cost is \$20/MWh and their Cost Multiplier is changed to 1.5, this is equivalent to a \$30/MWh offer. To do this use the arrows next to the field on the online, Try various values between 1.0 and 2.0 to try to maximize your profit. Record the value that gives you the maximum profit, save an LMP contour to include in your report, and in your report document the strategy you used to achieve this value. Do you think the variation in your profit with respect to the Cost Multiplier could have multiple local maximums?

6. Using the commercial version of PowerWorld Simulator, open up case TSGC_DCOFF_HW5. This case is a modified version of the earlier 2000 bus case (with several lines outaged) which has been setup to solve a DC OPF. Select **Tools, Play** to start the simulation. The oneline for the case with an LMP contour is shown below. Change the load in the different areas using the Load Scalar arrows. Go between 0.80 and 1.05 in 0.05 increments to try to find what you would define as the worst case conditions. Try various possibilities, and in your writeup provide your definition of worst case conditions and describe your search strategy. The LMP contour and the area LMP averages shown on the oneline will give you a feel for the high LMP situations. To see the specific values, use **Case Information, Buses**, which provides a sorted list of the bus LMPs (in the column labeled MW Marg. Cost).

