**Guidelines to interpreting and reading the results**

**1)General Guidelines:** The results currently we are having are those pertaining to the simulations of OPF performed on the IEEE test systems for 14, 30 and 57 bus systems taking into account the constraints of lower and upper limit on generating capability of real and reactive power, real power line flow limit and lower and upper limit on bus voltage magnitudes. The constraints on magnitude of difference of bus voltages, line current flow limit and apparent power line flow limit or any other kind of constraints were not included while running these particular simulations.

**Addition:** For the situations where we have included the constraint on the magnitude of difference of bus voltages, the only difference is that the file names now have an extension (applicable for both the numerical results and graphs) like “212ang”. Files having such extensions are the ones where this constraint have been implemented and the number represents the maximum possible vector difference between voltages at the buses at the two ends of any transmission line taking into account their max/min allowable per unit voltage magnitudes and a maximum allowable angle difference (which can potentially range from 0 degrees to a maximum of 180 degrees).

In each of the cases, we have performed the simulations for different real power line flow limits (we have assumed that this limit is the same for all the transmission lines of the particular scenario considered) and we came up with the different parameters like LMPs for real and reactive power, bus voltages, generation of real and reactive power and also line real power flows along with the optimal primal value which is the Generation Cost and also the Dual Optimal Value.

The whole attachment consists of the Excel spreadsheets for the values of the parameters and also the graphs. For a broad overview, go through the graphs and for a closer look into the values, go through the Excel sheets. The graphs are pretty self-explanatory. So, given below are the guidelines for reading the Excel sheets.

**2)Naming Convention:** Simulation results for the 30, 57 and just one scenario of the 14 bus test systems are written in two Excel sheets for each scenario. One of them is named as:

(Number of Buses)bus\_results\_(MW Limit of Line)MW1.xlsx

and the other is named

(Number of Buses)bus\_results\_(MW Limit of Line)MW2.xlsx

The first one consists of the

Lagrange Multipliers on real power line flow limits, --Page “lambda\_lm”

Lagrange Multipliers on lower and upper real and reactive power generation and bus voltage magnitudes,--Page “Lambda”

Miscellaneous results including number of iterations, dual SDP OPF optimal value, solution tolerance and Minimum Eigenvalue of the network matrix used in the optimization problem,--Page “Others”

Eigenvalues of the network matrix and also the Lagrange Multiplier Matrix (Dual Matrix) of the positive semi definiteness constraint of the Dual OPF,--Page “Eigenvalues”

Eigenvalues and Eigenvectors of the Network Matrix—Page “Eigenvectors”

The second one consists of the

Real and Imaginary parts of the Optimal Bus Voltage schedule in pu corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “v\_comp”

Optimal Bus Voltage Magnitude in pu corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “v\_mod”

Real power injections at buses in pu corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “p”

Reactive power injections at buses in pu corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “q”

Total Cost of Generation or the Optimal Primal Objective Value in $ corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “Gen\_Cost”

Real Power LMP in $/MW corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “lmpp”

Reactive Power LMP in $/MVAr corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “lmpq”

Real Power Generation of Generators at the optimum in pu corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “Gen”

Real Power Line Flows at the Optimum in pu corresponding to each of the 4 lowest Eigenvalues and each upper bus voltage limit constraint, that is binding.—Page “Flows”

The “From”, “To” and the line numbers for the above flows and also that for the lambda\_lm of the first sheet are given in the next page—Sheet 10.

The different values on both the Excel sheets follow the order in which its written above and the individual pages have the names given.

For example, Excel sheets having names, “30bus\_results\_unconstrained1.xlsx” and “57bus\_results\_100MW2.xlsx” contain the first set of parameters for 30 bus test case with each of its lines having very high transmission limit and the second set of parameters for 57 bus test case with each of its lines having the real power line flow limit of 100MW respectively.

For the results of the 14 bus systems, there is only one Excel sheet for all but one scenario with the same naming convention. The difference is that, now we have two pages in this. The first one is “results”, which consists of all the parameters mentioned earlier except the Eigenvectors which appear in the second page named “Eigenvectors”.

**3)Meaning of Symbols:** The following is an explanation of the various symbolical nomenclature used in the different Excel sheets:

**Lambdak\_m:** Lagrange Multiplier corresponding to lower limit on real power generation

**Lambdak\_M:** Lagrange Multiplier corresponding to upper limit on real power generation

**Lambda\_k\_m:** Lagrange Multiplier corresponding to lower limit on reactive power generation

**Lambda\_k\_M:** Lagrange Multiplier corresponding to upper limit on reactive power generation

**Mu\_k\_m:** Lagrange Multiplier corresponding to lower limit on bus voltage magnitude

**Mu\_k\_M:** Lagrange Multiplier corresponding to upper limit on bus voltage magnitude

**Min Eig:** Minimum Eigenvalue of the network matrix at the optimum

**Dual\_Optval:** Optimal value of the dual OPF

**Tolerance:** Solution tolerance; Duality Gap at the end of iterations

**Nth Eig:** Values corresponding to the nth lowest Eigenvalue and corresponding Eigenvector of the Network Matrix at the Optimum.

**Mth Binding:** Values corresponding to the mth binding upper bus voltage limit constraint. Doesn’t mean that the constraint corresponding to the bus numbered “m” is binding.

**4)Graphs:** For the Line power flow, bus pu voltage, Real power generation graphs, the green line (sometimes , when really high not clearly visible because it touches the margin), the red line and the blue line represent the upper limit, lower limit and the optimal values respectively. For the LMP graph, the blue and the green lines represent the real power and the reactive power LMPs respectively. For the Real and reactive power injection and demands graphs, the green and the blue lines represent the demands and injections at the buses respectively.