Skolkovo Institute of Science and Technology
Center for Energy Science and Technology

Course: Fundamentals of Power Systems
Term 2: 2021
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Homework 5: DistFlow

General Instructions: *The report should contain answers to the questions in the task and short description of every step in your code – in comments or Jupyter markdowns. The Jupyter notebook should be uploaded to canvas. If you have any supplementary materials: functions in a separate file, data, please, submit a compressed folder which includes them as well as the notebook. The logic of the solution to the problem and all notations should be clear. The notebook must work correctly if one restarts and runs all cells. The report (.ipynb file) should be submitted by* ***December 8***

Concepts Covered: *Feasibility problem, DistFlow and its relaxations, Data processing, MATPOWER grid cases, Data visualization*

Name: _____

You are a given single file *data/case*22.*m*. This is a MATPOWER case that represents a distribution grid with 22 buses. You are also given a file *src/parse_matlab.jl* that will help you extract the data from the MATPOWER case. You might would want to take a look into the source code and documentation of this function.

Problem 1 (Data) [45 points]

(a) (**5 pt**) Extract the data (use *src/parse_matlab.jl*) and then store the data in corresponding DataFrames: BusData, BranchData, etc. Keep resistance, reactance, branch flow limits in separate matrices. Assume long term rating. Scale the data in accordance with base values.

(b) (**20 pt**) Visualise the connectivity matrix of this system. In other words, visualize matrix $C : C_{ij} = 1$ if there is a line between i and j, 0 otherwise. Recall that we have a **directed** graph. *Hint: heatmap.*

(c) (**20 pt**) Plot the given power system using *PowerPlots.powerplot* function. Make buses and generators distinguishable (see examples here)

Problem 2 (DistFlow) [55 points]

(a) (**10 pt**) Run NLP DistFlow for given network and print the results as DataFrames in the following form (you can choose your own naming for columns):

- ◇ **BranchData:** *columns:* from bus, to bus, reactive power to, reactive power from, active power to, active power from; *rows:* individual branches.
- ◇ **BusData:** *columns:* voltage magnitude *rows:* individual buses.
- ◇ **GenData:** *columns:* active power, reactive power; *rows:* individual generators.

(b) (**10 pt**) Run SOCP relaxation of DistFlow, print the results in the same way as in (a).

(c) (**10 pt**) Run LinDistFlow, print the results in the same way as in (a).

(d) (**5 pt**) For each result from (a), (b), (c), plot the voltage magnitude profiles in one figure.

(e) (**20 pt**) For each resulting power flows from (a), (b), (c), scale active and reactive power flows at branch (i, j) on $\sqrt{l_{ij} \cdot w_i}$ and plot them on the same figure together with a unit circle.