Control and Optimization for Power Systems (IEOR 258)
Homework 2

Consider a power system with 10 buses forming a cycle. In other words, there are transmission lines connecting the following pairs of buses: (1,2), (2,3), (3,4), (4,5), (5,6), (6,7), (7,8), (8,9), (9,10), (10,1). For each line, assume an equivalent Π-model with R (resistance) = 0.1, X (reactance) = 1 and C (capacitance) = 0. Assume that Bus 1 is the slack, Bus 2 is PV and the remaining buses are PQ.

Question 1: Using the fixed-point technique, write a Matlab code that takes the input data $(P_2, |V_2|, P_3, Q_3, ..., P_{10}, Q_{10})$ and returns a voltage vector $\tilde{v} \in \mathbb{C}^n$ that aims to fit the data for an AC model of the power flow equations (note that $|V_1| = 1$). The code should be initialized at $v^{(0)} = [1\ 1\ \cdots 1]^T$.

Question 2: Repeat the following experiments 10 times for each value of α in the set $\{10, 20, 30, 40, 50, 60\}$.

- Generate a vector of complex voltages $v = (1, V_2, \ldots, V_{10})$ for the entire power system by uniformly sampling the voltage magnitudes for buses 2-10 from the interval $[0.95, 1.05]$ and their phases from the interval $[-\alpha^\circ, \alpha^\circ]$.
- Find the data $(P_2, |V_2|, P_3, Q_3, ..., P_{10}, Q_{10})$ associated with v.
- Using the code in Question 1, solve the power flow problem to obtain a vector $\tilde{v}$.
- Check whether $\tilde{v}$ fits the data.
- Check whether $\tilde{v}$ is equal to v.

Question 3: Draw a (discrete) curve that shows the empirical success rate of your solver in finding a feasible solution (by averaging over 10 trials) as a function of α.

Question 4: Draw a (discrete) curve that shows the empirical success rate of your solver in finding the correct solution (by averaging over 10 trials) as a function of α.