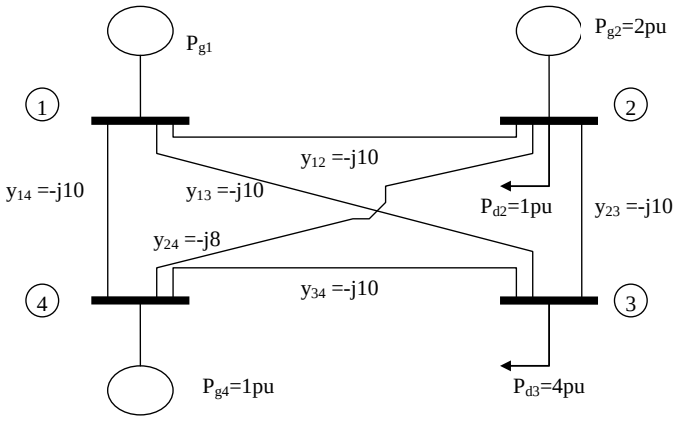
EE 458, HW 7 – Due Thursday, October 24, 2019

1. For the system below:
    a. Obtain the Y-bus.
    b. Obtain the B' matrix.
    c. Set up and solve the DC power flow relation $\underline{P}=\underline{B}'\underline{\theta}$. Give all four angles.
    d. Obtain the $\underline{D}$ matrix and the node-arc incidence matrix $\underline{A}$.
    e. Compute all line flows. Compare the line flows to those for the solution given in the class notes, and comment on the effect of the added line in terms of loading in other lines.



2. Using the same system you analyzed in problem 1, set up the optimal power flow as a linear program. Assume the objective function is exactly the same as used in the example in class, i.e., $Z = 1307P_{g1} + 1211P_{g2} + 1254P_{g4}$. Also, assume each unit has a lower limit of 100 MW and an upper limit of 300 MW, which will be (in per unit):

$1 \le P_{g1} \le 3$

$1 \le P_{g2} \le 3$.

$1 \le P_{g3} \le 3$

    a. Write down the optimization problem you must solve. Assume infinite transmission capacity.
    b. Provide your CPLEX code used to solve the above optimization problem.
    c. Use CPLEX to solve the LP stated in part b. In answering the below questions, make sure you specify the units.

i. Provide the value of the objective function at the optimal solution.
ii. Provide the values of the decision variables at the optimal solution. Typing “display solution variables - ” provides
iii. Provide the values of the auxiliary variables (angles and line flows) at the optimal solution. Make sure you specify line flows as $P_{bk}=P_{ij}$ where the flow direction is defined positive from bus i to bus j.
iv. Identify the locational marginal prices (LMPs) at each bus.
v. How much will the objective function increase if the load at bus 2 changes from 1.0 pu to 1.01 pu?
vi. How much will the objective function increase if the load at bus 3 changes from 4.0 pu to 4.01 pu?
vii. How much will the objective function increase if the lower generation limit for P_{g1} is increased to 101 MW?

d. Constrain the flow limit on $P_{b3}=P_{23}$ to 1.4 pu and resolve using CPLEX.
i. Provide the value of the objective function at the optimal solution.
ii. Provide the values of the decision variables at the optimal solution. Typing “display solution variables - ” provides
iii. Provide the values of the auxiliary variables (angles and line flows) at the optimal solution. Make sure you specify line flows as $P_{bk}=P_{ij}$ where the flow direction is defined positive from bus i to bus j.
iv. Identify the locational marginal prices (LMPs) at each bus.
v. How much will the objective function increase if the load at bus 2 changes from 1.0 pu to 1.01 pu?
vi. How much will the objective function increase if the load at bus 3 changes from 4.0 pu to 4.01 pu?
vii. How much will the objective function increase if the transmission limit on $P_{b3}=P_{23}$ is increased by 1 MW from 1.4 to 1.41 pu?