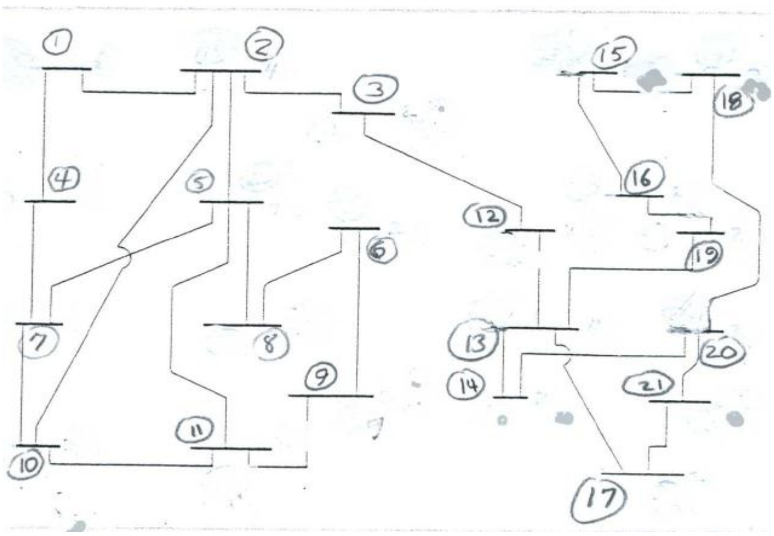
Homework #2, EE 553, Fall 2012, Dr. McCalley, Due Monday, September 17, 2012

1. Solve for x in the below by hand, using LU-decomposition.

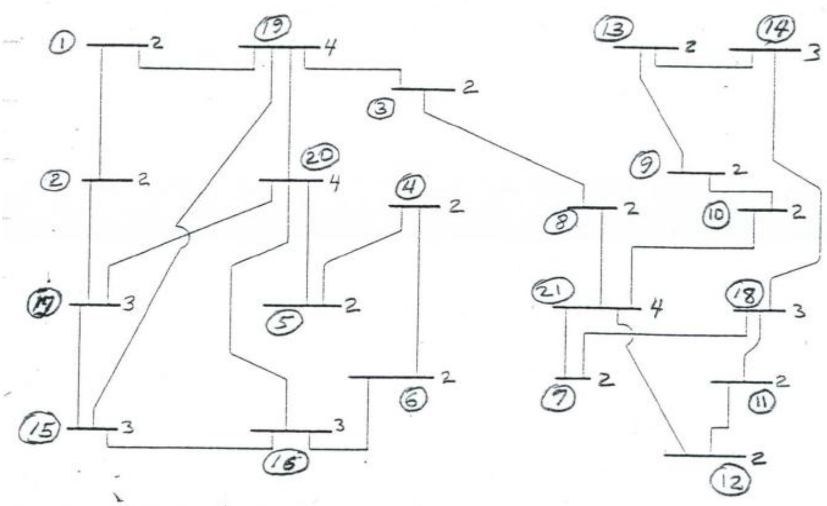
$$\begin{bmatrix} 4 & 1 & 1 & 1 \\ 0 & 2 & -1 & -2 \\ 1 & 0 & 3 & 1 \\ 0 & 1 & 1 & 6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 3 \\ -1 \\ 4 \\ 8 \end{bmatrix}$$

2. Consider the two different numbering systems for the network given below. For each numbering system, determine the number of fill-ups and the number of row operations assuming no re-ordering is performed after the first row operation. Indicate which scheme is better and why. Describe a better scheme.

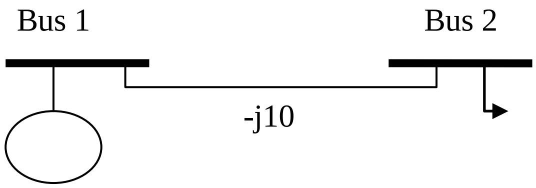
(a)



(b)



3. For the lossless network shown below, the following data are given:



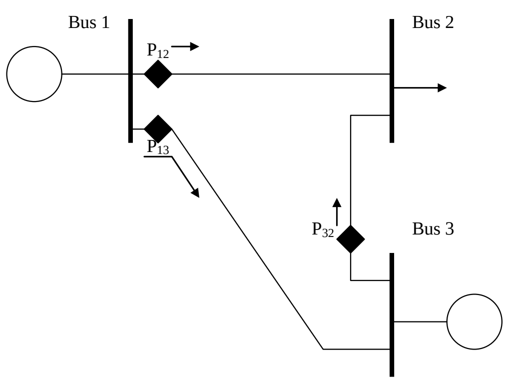
z1=V1=1.02, σ1=0.1
z2=V2=1.0, σ2=0.1
z3=P12=2.0, σ3=0.05
z4=Q12=0.2, σ4=0.05

Let

$$\underline{x}^{(0)} = \begin{bmatrix} x_1^{(0)} \\ x_2^{(0)} \\ x_3^{(0)} \end{bmatrix} = \begin{bmatrix} \theta_2^{(0)} \\ V_1^{(0)} \\ V_2^{(0)} \end{bmatrix} = \begin{bmatrix} 0 \\ 1.02 \\ 1.0 \end{bmatrix}$$

and perform one iteration of the least squares state estimation solution procedure to find $x^{(1)}$.

4. Consider the system below. Real power measurements taken as follows: P_{12}=0.62 pu , P_{13}=0.06 pu, and P_{32}=0.37 pu . All voltages are 1.0 per unit, and all measurement devices have σ=0.01. Assume the bus 3 angle is reference. So the state vector is therefore $\underline{x}=[\theta_1\ \ \theta_2]^T$. Your textbook solves this problem using DC power flow equations on pp. 467-471. Repeat, following the indicated steps below, but use AC power flow equations.



a) Determine the vector of measurement expressions $\underline{h}(\underline{x})$, the derivative expressions $\underline{H} = \frac{\partial \underline{h}(\underline{x})}{\partial \underline{x}}$, and the weighting matrix $\underline{R}$.

b) Compute $\underline{H}(\underline{x}^{(0)})$, $\underline{h}(\underline{x}^{(0)})$ for an estimate of $\underline{x}^{(0)}$ =[0.024 -0.093]^T (units of radians).

c) Compute $\underline{A} = \underline{H}^T(\underline{x})\underline{R}^{-1}\underline{H}(\underline{x})\Big|_{\underline{x}^{(0)}}$, $\underline{b} = \underline{H}^T(\underline{x})\underline{R}^{-1}\left[\left(\underline{z} - \underline{h}(\underline{x})\right)\right]_{\underline{x}^{(0)}}$

d) Solve $\underline{A}\Delta\underline{x}=\underline{b}$ for $\Delta\underline{x}$.

5. Work problem 12.3 in your W&W textbook.