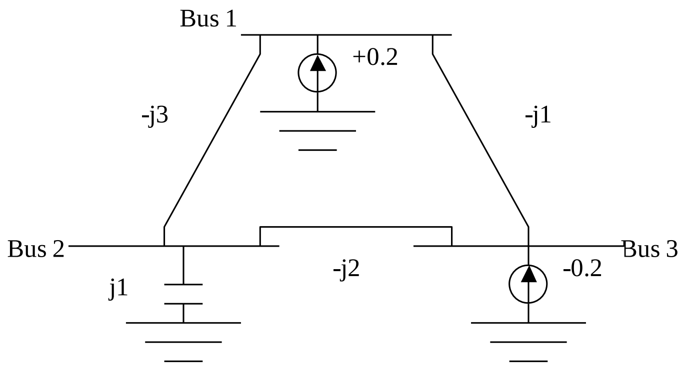
Name: ____

EE 303, Quiz 7, April 4, 2017, closed books, notes, and calculator, 20 minutes

1. (40 pts) Form the matrix equation $\underline{Y}\underline{V}=\underline{I}$ for the network below. The values given beside each branch are admittences.



Answer:

$$\begin{bmatrix} -j4 & j3 & j1 \\ j3 & -j4 & j2 \\ j1 & j2 & -j3 \end{bmatrix}\begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0.2 \\ 0 \\ -0.2 \end{bmatrix}$$

2. A two-bus power system is interconnected by a transmission line having series admittance of y_{12} pu and no line charging and no bus shunts. Bus 2 is a generator bus with specified generation of P_{G2} pu, terminal voltage magnitude of $|V_2|$, and demand of P_{D2} pu and Q_{D2} pu. Bus 1 is a generator bus with specified terminal voltage magnitude of $|V_1|$ pu and must be chosen as the swing bus.
   a. (15) Identify the variables in the solution vector.

   b. (15) It is possible to write a power flow equation for real and reactive injections at buses 1 and 2 (giving a total of four equations). These four equations are given below. From these four equations, identify the minimal set necessary to solve the power flow problem (subscript "sch" means "scheduled" - the quantity represents the numerical value of injection at that bus).

$$g_1 = P_{1,sch} - P_1 = P_{1,sch} - \sum_{j=1}^{2} |V_1||V_j|\left(G_{1j}\cos(\theta_1 - \theta_j) + B_{1j}\sin(\theta_1 - \theta_j)\right) = 0$$

$$g_1 = P_{1,sch} - P_1 = P_{1,sch} - \sum_{j=1}^{2} |V_1||V_j| \left(G_{1j} \cos(\theta_1 - \theta_j) + B_{1j} \sin(\theta_1 - \theta_j) \right) = 0$$

$$g_2 = Q_{1,sch} - Q_1 = Q_{1,sch} - \sum_{j=1}^{2} |V_1||V_j| \left(G_{1j} \sin(\theta_1 - \theta_j) - B_{1j} \cos(\theta_1 - \theta_j) \right) = 0$$

$$g_3 = P_{2,sch} - P_2 = P_{2,sch} - \sum_{j=1}^{2} |V_2||V_j| \left(G_{2j} \cos(\theta_2 - \theta_j) + B_{2j} \sin(\theta_2 - \theta_j) \right) = 0$$

$$g_4 = Q_{2,sch} - Q_2 = Q_{2,sch} - \sum_{j=1}^{2} |V_2||V_j| \left(G_{2j} \sin(\theta_2 - \theta_j) - B_{2j} \cos(\theta_2 - \theta_j) \right) = 0$$

c. (15) Express $P_{2,sch}$ in terms of generation P_{G2} and load P_{D2}.

d. (15) Write down the Jacobian matrix J to be used in the solution procedure. Indicate the elements in the matrix using partial derivative notation; you do not need to differentiate anything or provide any numerical values.

Answers:

a. $$solution = [\theta_2]$$

b. $$g_3 = P_{2,sch} - P_2 = P_{2,sch} - \sum_{j=1}^{2} |V_2||V_j| \left(G_{2j} \cos(\theta_2 - \theta_j) + B_{2j} \sin(\theta_2 - \theta_j) \right) = 0$$

c. $P_{2,sch}=P_{G2}-P_{D2}$

d. $$J = \left[\frac{\partial g_3}{\partial \theta_2} \right]$$