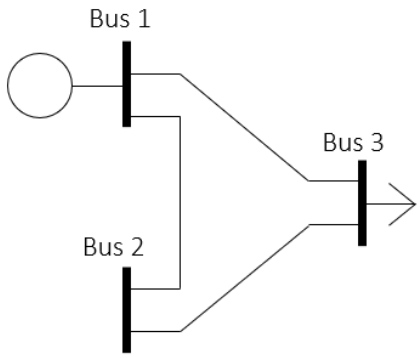
ECEN 460 SPRING 2024 (Birchfield) Quiz 12 5 Mar 2024

Name: _____ UIN: _____ Section: _____ Score: _____



In this three-bus system

- The line from bus 1 to bus 2 has an impedance $Z = 0.05 + j0.1$
- The other two lines (1-3 and 2-3) both have an impedance $Z = j0.25$
- The load at bus 3 is consuming 150 MW and 87 Mvar
- The generator at Bus1 has a voltage setpoint of 1.03 per-unit

$$\mathrm{P_i} = \sum_{k=1}^{n} |V_i||V_k|\,(g_{ik}\cos\theta_{ik} + b_{ik}\sin\theta_{ik}) = P_{Gi} - P_{Di}$$

$$\mathrm{Q_i} = \sum_{k=1}^{n} |V_i||V_k|\,(g_{ik}\sin\theta_{ik} - b_{ik}\cos\theta_{ik}) = Q_{Gi} - Q_{Di}$$

$$Y_{bus} = \begin{bmatrix} 4 - j12 & -4 + j8 & j4 \\ -4 + j8 & 4 - j12 & j4 \\ j4 & j4 & -j8 \end{bmatrix}$$

Given the Y-bus above, with Bus1 as slack bus and Buses 2 and 3 as PQ buses, write the real and reactive power balance equations for Bus 3 only, in terms of θ_2, θ_3, V_2, and V_3. You do not need to find the Jacobian or solve the equations. Include the load P and Q.

$$P_3: \quad V_3V_1b_{31}\sin\theta_{31} + V_3V_2b_{32}\sin\theta_{32} + V_3V_3b_{33}\sin\theta_{33} = -P_{d3}$$
$$4.12V_3\sin\theta_3 + 4V_3V_2\sin\theta_{32} = -1.5$$
$$Q_3: \quad -V_3V_1b_{31}\cos\theta_{31} - V_3V_2b_{32}\cos\theta_{32} - V_3V_3b_{33}\cos\theta_{33} = -Q_{d3}$$
$$-4.12V_3\cos\theta_3 - 4V_3V_2\cos\theta_{32} + 8V_3^2 = -0.87$$