ELL/EEL303 Power Engineering

Minor II **Mar 22, 2016** **Maximum Marks: 2**

One A-4 size "cheat-sheet" is allowed in the exam, with anything written on it. No one is allowed to share anything, includ calculators. Anybody found using unfair means will be expelled from the exam.

1. For any power system (unknown), which of the following Newton-Raphson formulations is possible? 2

(a)

$$\begin{bmatrix}\Delta P_3^{(0)}\\ \Delta Q_2^{(0)}\\ \Delta Q_3^{(0)}\end{bmatrix}=\begin{bmatrix}\left(\partial P_3/\partial\delta_3\right)^{(0)} & \left(\partial P_3/\partial|V_2|\right)^{(0)} & \left(\partial P_3/\partial|V_3|\right)^{(0)}\\ \left(\partial Q_2/\partial\delta_3\right)^{(0)} & \left(\partial Q_2/\partial|V_2|\right)^{(0)} & \left(\partial Q_2/\partial|V_3|\right)^{(0)}\\ \left(\partial Q_3/\partial\delta_3\right)^{(0)} & \left(\partial Q_3/\partial|V_2|\right)^{(0)} & \left(\partial Q_3/\partial|V_3|\right)^{(0)}\end{bmatrix}\begin{bmatrix}\Delta\delta_3^{(0)}\\ \Delta|V_2|^{(0)}\\ \Delta|V_3|^{(0)}\end{bmatrix}$$

(b)

$$\begin{bmatrix}\Delta P_2^{(0)}\\ \Delta P_3^{(0)}\\ \Delta Q_3^{(0)}\end{bmatrix}=\begin{bmatrix}\left(\partial P_2/\partial\delta_2\right)^{(0)} & \left(\partial P_2/\partial\delta_3\right)^{(0)} & \left(\partial P_2/\partial|V_3|\right)^{(0)}\\ \left(\partial P_3/\partial\delta_2\right)^{(0)} & \left(\partial P_3/\partial\delta_3\right)^{(0)} & \left(\partial P_3/\partial|V_3|\right)^{(0)}\\ \left(\partial Q_3/\partial\delta_2\right)^{(0)} & \left(\partial Q_3/\partial\delta_3\right)^{(0)} & \left(\partial Q_3/\partial|V_3|\right)^{(0)}\end{bmatrix}\begin{bmatrix}\Delta\delta_2^{(0)}\\ \Delta\delta_3^{(0)}\\ \Delta|V_3|^{(0)}\end{bmatrix}$$

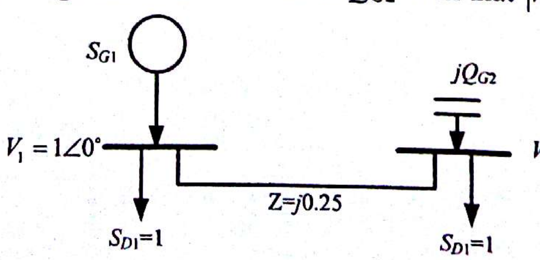
(c)

$$\begin{bmatrix}\Delta P_2^{(0)}\\ \Delta P_3^{(0)}\\ \Delta Q_2^{(0)}\end{bmatrix}=\begin{bmatrix}\left(\partial P_2/\partial\delta_2\right)^{(0)} & \left(\partial P_2/\partial\delta_3\right)^{(0)} & \left(\partial P_2/\partial|V_2|\right)^{(0)}\\ \left(\partial P_3/\partial\delta_2\right)^{(0)} & \left(\partial P_3/\partial\delta_3\right)^{(0)} & \left(\partial P_3/\partial|V_2|\right)^{(0)}\\ \left(\partial Q_3/\partial\delta_2\right)^{(0)} & \left(\partial Q_3/\partial\delta_3\right)^{(0)} & \left(\partial Q_3/\partial|V_2|\right)^{(0)}\end{bmatrix}\begin{bmatrix}\Delta\delta_2^{(0)}\\ \Delta\delta_3^{(0)}\\ \Delta|V_3|^{(0)}\end{bmatrix}$$

(d)

$$\begin{bmatrix}\Delta P_2^{(0)}\\ \Delta Q_2^{(0)}\\ \Delta Q_3^{(0)}\end{bmatrix}=\begin{bmatrix}\left(\partial P_2/\partial\delta_2\right)^{(0)} & \left(\partial P_2/\partial|V_2|\right)^{(0)} & \left(\partial P_2/\partial|V_3|\right)^{(0)}\\ \left(\partial Q_2/\partial\delta_2\right)^{(0)} & \left(\partial Q_2/\partial|V_2|\right)^{(0)} & \left(\partial Q_2/\partial|V_3|\right)^{(0)}\\ \left(\partial Q_3/\partial\delta_2\right)^{(0)} & \left(\partial Q_3/\partial|V_2|\right)^{(0)} & \left(\partial Q_3/\partial|V_3|\right)^{(0)}\end{bmatrix}\begin{bmatrix}\Delta\delta_2^{(0)}\\ \Delta|V_2|^{(0)}\\ \Delta|V_3|^{(0)}\end{bmatrix}$$

2. For the system below, 6+6
   a) Solve the load flow using a *flat start* to find the value of Q_{G2} such that $|V_2|=1$. (*Do not use any other technique to solve this question*). Do at least two iterations.
   b) Using the circle diagram, find the value of Q_{G2} such that $|V_2|=1$.



3. In the bus data for a load flow, the columns for Q_{min} and Q_{max} (PV buses) indicate the minimum and maximum reactive power (limits) that can be injected at that bus. If during the Newton-Raphson (NR) iterations, the required Q injection from a PV bus hits either of the limits, the following occurs 2

a) Model the required Q as an inductor/capacitor and carry on with the NR iterations.
b) PV bus voltage can no longer be *controlled*, and it becomes a PQ bus
c) Impossible situation as the generator AVR can ramp up/down its excitation to inject the required Q.
d) Power factor of the generator will have to be modified to inject the required Q.

4. How is the Q_{MAX} limit of a generator determined? 3

5. In 29 generator, 179 bus system, the size of the Jacobian in the Newton-Raphson formulation is 2

a) 327 x 327
b) 328 x 328
c) 358 x 358
d) 329 x 329

6. Among the ABCD constants for a transmission line of length 250 mi, $A = 0.8180 \angle 1.3^\circ$ and $B = 172.2 \angle 84.2^\circ$. Find the receiving end real and reactive power when $V_s = 132 \angle 0^\circ$, and $V_r = 126 \angle -12^\circ$ (all line to line voltages). 4

Extra Credit (no partial credit)

8. The 2014 Beas river tragedy involved the drowning of some students in Mandi, Himachal Pradesh due to the un-announced opening of floodgates of 2

a. Bhakra hydro-electric project
b. Pong hydro-electric project
c. Larji hydro-electric project
d. Pandoh hydro-electric project