Lecture 12

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- Contingency Analysis (Lab 6)

  1. Bus load for the next hour $\rightarrow P_{Dk}, Q_{Dk}$ (PQ Buses)
  2. Scheduled generation for the next hour $\rightarrow P_{Gk}, Q_{Gk}$ (PV Buses)
  3. Run PF $\rightarrow V_k, \theta_k$ for $k = 1, \cdots, n$
  4. Compute the line flows P_f for all lines in the system
  5. Check if $|P_{fk}| <$ limits, and $|V_k| <$ limits for all lines and buses
  6. Contingencies: line, generator, load outages
  7. Run PF for each contingency (return to step 4 and keep repeating)

  – Note that every generator has a maximum and minimum reactive power limit
  – We once again use the Newton-Raphsson method to solve:
    1. Assume $X^o = [\hat{\theta}, V]^T$ and $\theta = 0, V = 1[p.u.]$
    2. $\Delta P = P(X) - P^{sch}$ for all buses but slack bus, and $\Delta Q = Q(x) - Q^{sch}$ for PQ buses (n_{PQ})
    3. We compute the Jacobian:

$$J(X) = \frac{\partial F}{\partial X}, \quad X^{k+1} = X^k - [J]^{-1}F(X^k)$$

    4. $Q_G(X^{k+1})$: if $Q_{Gi}(X^{k+1})$ violates its Q limits, then convert bus i from PV to PQ-type and set its reactive power to the violated limit

- Steps of Fast Decoupled Load Flow (special case of Newton-Raphsson, provides faster solution):

  1. Build B', B'' (factorize $B' = L_1U_1$ and $B'' = L_2U_2$); Initialize $V_i = 1[p.u.], \theta_i = 0$ if i is not a slack bus or PV bus. We get $P_{flag} = 0; Q_{flag} = 0$
  2. Compute $\Delta P/V \rightarrow \Delta P_k/V_k = (P_k(X) - P_k^{sch})/V_k$ with $k = 1, 2, \cdots, n$; Set $P_{flag} = 1$ if $||\Delta P|| < \varepsilon = 10^{-4}$; stop if $Q_{flag} = 1$ and $P_{flag} = 1$

3. $L_1U_1\Delta\theta = [\Delta P/V] \rightarrow$ For/back substitution ($\theta \Leftarrow \theta + \Delta\theta$)
4. Compute $[\Delta Q/V] \rightarrow \Delta Q_k/V_k = (Q_k(X) - Q_k^{sch})/V_k$, for $k : n_{PQ}$ to keep the PQ buses; Set $Q_{flag} = 1$ if $||\Delta Q|| < \varepsilon = 10^{-4}$; stop if $P_{flag} = 1$ and $Q_{flag} = 1$
5. $L_2U_2\Delta V = [\Delta Q/V] \rightarrow$ For/back substitution ($V \Leftarrow V + \Delta V$)