Generator Bus Network Equations:

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$$\left(I_{d_i}\sin\delta_i + I_{d_i}\cos\delta_i\right) + \frac{P_{l_i}\cos\theta_i}{V_i} + \frac{Q_{l_i}\sin\theta_i}{V_i} + \sum_{k=1}^a B_k V_k \sin\theta_k = 0$$

$$\left(I_{d_k}\sin\delta_i - I_{d_k}\cos\delta_i\right) + \frac{P_{l_k}\sin\theta_i}{V_i} - \frac{Q_{l_k}\cos\theta_i}{V_i} - \sum_{k=1}^a B_k V_k \cos\theta_k = 0$$

$$DC$$

Generator Differential Equations

$$T'_{do_i} \frac{dE'_{qi}}{dt} = -E'_{qi} - (X_{d_i} - X'_{d_i})I_{d_i} + E_{fd_i}$$

$$T'_{q_{0_i}} \frac{dE'_{di}}{dt} = -E'_{di} - (X_{q_i} - X'_{q_i})I_{q_i}$$

$$\frac{d\delta_i}{dt} = \omega_i - \omega_s$$

$$\frac{2H_i}{dt} \frac{d\omega_i}{dt} = T_{M_i} - E'_{d_i} I_{d_i} - E'_{a_i} I_{a_i}$$

$$-(X'_{q_i}-X'_{d_i})I_{d_i}I_{q_i}-D_i$$

Stator Algebraic Equations

$$E'_{d_{i}} - V_{D_{i}} \sin \delta_{i} + V_{Q_{i}} \cos \delta_{i} - R_{s_{i}} I_{d_{i}} + X'_{q_{i}} I_{q_{i}} = 0$$

$$E'_{q_{i}} - V_{D_{i}} \cos \delta_{i} - V_{Q_{i}} \sin \delta_{i} - R_{s_{i}} I_{q_{i}} - X'_{d_{i}} I_{d_{i}} = 0$$

Load Bus Network Equations:

$$\begin{split} \frac{dO_{i}}{dt} &= \omega_{i} - \omega_{s} \\ \frac{2H_{i}}{\omega_{s}} \frac{d\omega_{i}}{dt} &= T_{M_{i}} - E^{*}_{d_{i}} I_{d_{i}} - E^{*}_{u_{i}} I_{u_{i}} \\ &- \left(X^{*}_{u_{i}} - X^{*}_{d_{i}}\right) I_{d_{i}} I_{u_{i}} - D_{i} \left(\omega_{i} - \omega_{s}\right) \\ \end{split}$$

$$\frac{P_{I_{s}} \cos \theta_{i}}{V_{i}} + \frac{Q_{I_{s}} \sin \theta_{i}}{V_{i}} + \sum_{k=1}^{n} B_{ik} V_{k} \sin \theta_{k} = 0$$

$$\frac{P_{I_{s}} \sin \theta_{i}}{V_{i}} - \frac{Q_{I_{s}} \cos \theta_{i}}{V_{i}} - \frac{Q_{I_{s}} \cos \theta_{i}}{V_{i}} - \sum_{k=1}^{n} B_{ik} V_{k} \cos \theta_{k} = 0$$