Energise New Formulation

On bus "i":

- P_i, Q_i — Net Real / Reactive Power Injection
- V_i — Voltage Magnitude
- θ_i — Voltage phase angle
- G_{ik}, B_{ik} — Conductance and Susceptance

$$-P_i + \sum_{k=1}^{N} V_i \cdot V_k \left(G_{ik}\cos(\theta_i - \theta_k) + B_{ik}\sin(\theta_i - \theta_k)\right) = 0 \quad (1)$$

$$-Q_i + \sum_{k=1}^{N} V_i \cdot V_k \left(G_{ik}\sin(\theta_i - \theta_k) - B_{ik}\cos(\theta_i - \theta_k)\right) = 0 \quad (2)$$

Linearize around $P_i^*, Q_i^*, \theta_i^*, \theta_k^*, V_i^*, V_k^*$

(1) $\Rightarrow$

$$\begin{aligned}
&-(P_i - P_i^*) + \sum_{k=1}^{N} (V_i - V_i^*) V_k^* \left(G_{ik}\cos(\theta_i^* - \theta_k^*) + B_{ik}\sin(\theta_i^* - \theta_k^*)\right) \\
&+ \sum_{k=1}^{N} V_i^* (V_k - V_k^*) \left(G_{ik}\cos(\theta_i^* - \theta_k^*) + B_{ik}\sin(\theta_i^* - \theta_k^*)\right) \\
&+ \sum_{k=1}^{N} V_i^* V_k^* \left(-G_{ik}\sin(\theta_i^* - \theta_k^*) + B_{ik}\sin(\theta_i^* - \theta_k^*)\right)(\theta_i - \theta_i^*) \\
&+ \sum_{k=1}^{N} V_i^* V_k^* \left(G_{ik}\sin(\theta_i^* - \theta_k^*) - B_{ik}\sin(\theta_i^* - \theta_k^*)\right)(\theta_k - \theta_k^*)
\end{aligned}$$

(2) $\Rightarrow$

$$\begin{aligned}
&-(Q_i - \theta_i^*) + \sum_{k=1}^{N} (V_i - V_i^*) V_k^* \left(G_{ik}\sin(\theta_i^* - \theta_k^*) - B_{ik}\cos(\theta_i^* - \theta_k^*)\right) \\
&+ \sum_{k=1}^{N} V_i^* (V_k - V_k^*) \left(G_{ik}\sin(\theta_i^* - \theta_k^*) - B_{ik}\cos(\theta_i^* - \theta_k^*)\right) \\
&+ \sum_{k=1}^{N} V_i^* V_k^* \left(G_{ik}\cos(\theta_i^* - \theta_k^*) + B_{ik}\sin(\theta_i^* - \theta_k^*)\right)(\theta_i - \theta_i^*) \\
&+ \sum_{k=1}^{N} V_i^* V_k^* \left(-G_{ik}\cos(\theta_i^* - \theta_k^*) - B_{ik}\sin(\theta_i^* - \theta_k^*)\right)(\theta_k - \theta_k^*)
\end{aligned}$$