



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

Computer aided power system analysis

Linear Sensitivity Factor

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CONTINGENCY ANALYSIS

Sensitivity factors

Generator
outage
Sensitivity
factor (GOSF)

Line outage
Sensitivity
factor (LOSF)

$$\text{GOSF} = \frac{\Delta P_{ij}}{\Delta P_k} \left. \vphantom{\frac{\Delta P_{ij}}{\Delta P_k}} \right\}$$

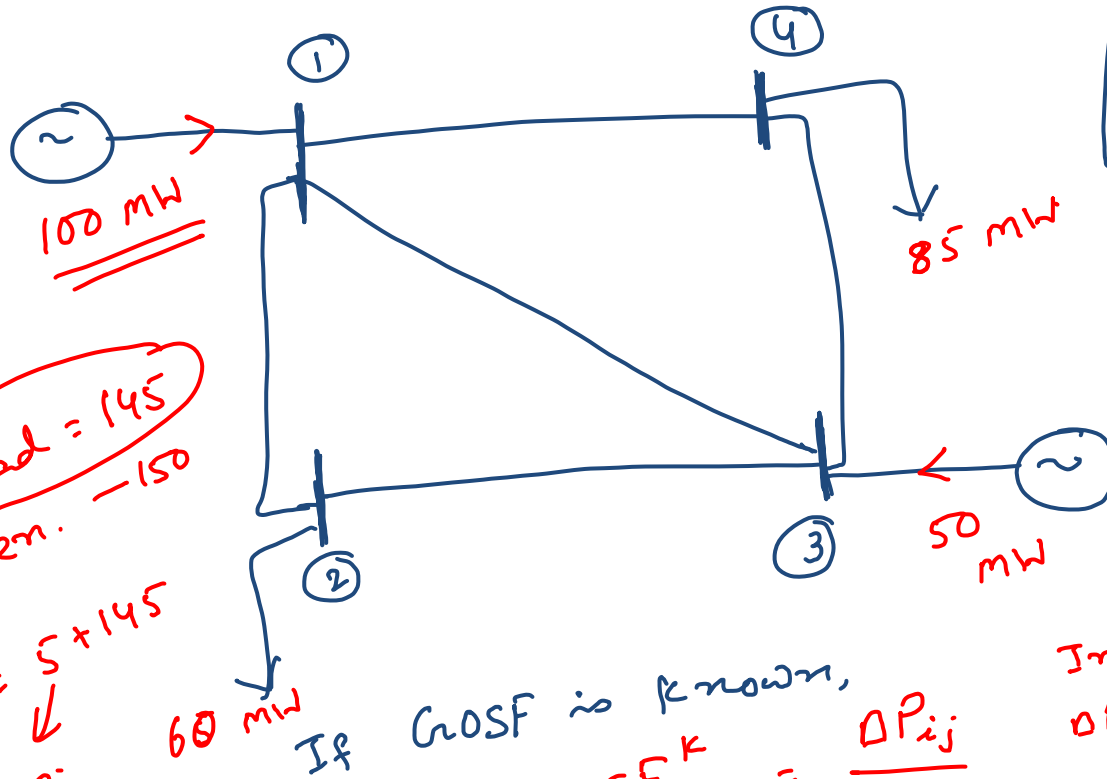
P_{ij} → real power
flow over a line
between bus 'i'
and bus 'j'

ΔP_{ij} → change in
 P_{ij}

P_k → injected power
at bus 'k'

ΔP_k → change in
 P_k





$$GOSF_{ij}^k = \frac{\Delta P_{i4}}{\Delta P_3}$$

changes are measured from the pre-contingency steady state case.

$$\Delta P_k = P_{new} - P_{old} = 0 - 50 = -50 \text{ MW}$$

In p.u.
 $\Delta P_k = -0.5$
 p.u.
 (Base = 100 MVA)

If GOSF is known,
 $GOSF_{ij}^k = \frac{\Delta P_{ij}}{\Delta P_k}$



If all $GOSF_{ij}^k$ are known

$$\Delta P_{ij} = (GOSF_{ij}^k) \Delta P_k \quad \forall$$

↓
New power flow over the line: $P_{ij}^{new} = P_{ij}^{old} + \Delta P_{ij}$
↓

Let: M -Generators in the system

1 → Slack

$M-1$ → PV bus.

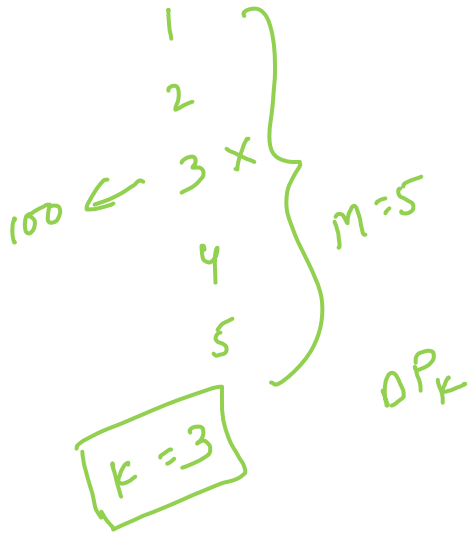
Assumption.

Lost generation
is taken by the
slack bus.



The lost generation is compensated by the other remaining generators combinedly.

5-generators.



$$\gamma_k = \frac{S_k}{\sum_{\substack{i=1 \\ i \neq k}}^M S_i}$$

These
are constant

$$\gamma_1 = \frac{S_1}{S_1 + S_2 + S_4 + S_5} = \frac{S_1}{\sum_{\substack{i=1 \\ i \neq 3}}^5 S_i}$$

$$\begin{aligned} \gamma_2 &\rightarrow \gamma_2 \Delta P_K \\ \gamma_4 &\rightarrow \gamma_4 \Delta P_K \quad \gamma_1 \cdot \Delta P_K \\ \gamma_5 &\rightarrow \gamma_5 \Delta P_K \end{aligned}$$

Therefore new power flow over line between bus 'i' and bus 'j' would be,

$$P_{ij}^{\text{new}} = P_{ij}^{\text{old}} + (\Delta P_k) \times (\alpha_{ij,k}) - \sum_{\substack{l=1 \\ l \neq k}}^m (\alpha_{ij,l}) (\gamma_l) (\Delta P_k)$$

$$\Delta P_k = -0.5 \text{ p.u.} \\ = -50 \text{ p.u.}$$

$$\cos \hat{\theta}_{ij}^k \\ = \alpha_{ij,k}$$

$$\Delta P_k = 0 - P_k \\ = -P_k$$

$$\gamma_1 = 0.1$$

$$\Delta P_1 = 0.1 \times 50 = 5$$

$$\gamma_2 = 0.2$$

$$\Delta P_2 = 0.2 \times 50 = 10$$

$$\gamma_3 = 0.3$$

$$\gamma_5 = 0.2$$

$$P_{ij}^{\text{new}} = P_{ij}^{\text{old}} - P_k (\alpha_{ij,k}) + \sum_{\substack{l=1 \\ l \neq k}}^m (\alpha_{ij,l}) \gamma_l P_k$$

