



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

Computer aided power system analysis

Line outage sensitivity factor (Contd.)

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$$\Rightarrow \frac{\Delta I_{pq}}{I_{mn}^{(0)}} = \frac{z_L}{z_c} \cdot \frac{(\overbrace{z_{pn}} - \overbrace{z_{pm}}) - (\overbrace{z_{qn}} - \overbrace{z_{qm}})}{\overbrace{z_{Th,mn}} - z_L}$$

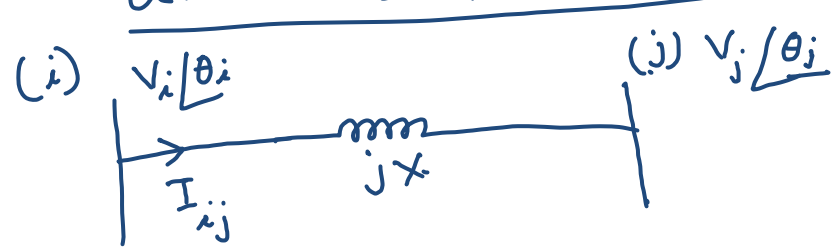
Elements of bus impedance matrix

$x \rightarrow$ impedance of the individual line.

Assumptions of DC load-flow

1. $|V_i| = 1.0$
2. $\theta_i \approx 0$ $(\theta_i - \theta_j) \approx 0$
3. All resistances of the lines are neglected.

Under DC-load flow assumptions:



$$P_{ij} = \frac{V_i V_j}{X} \sin(\theta_i - \theta_j)$$

$$\approx \frac{\theta_i - \theta_j}{X}$$

as $|V_i| = |V_j| = 1$
and $\sin(\theta_i - \theta_j)$
 $\approx (\theta_i - \theta_j)$

$$I_{ij} = \frac{V_i \angle \theta_i - V_j \angle \theta_j}{jX}$$

$$= \frac{(V_i \cos \theta_i - V_j \cos \theta_j) + j(V_i \sin \theta_i - V_j \sin \theta_j)}{jX}$$

$$\approx \frac{\theta_i - \theta_j}{X} \left[\begin{array}{l} \text{as } \cos \theta_i \approx 1 : \cos \theta_j \approx 1 \\ \sin \theta_i \approx \theta_i ; \sin \theta_j \approx \theta_j \end{array} \right]$$

Under DC-load flow assumption, expressions of P_{ij} and I_{ij} are the same.

Under DC-load assumption

$$\frac{\Delta P_{pq}}{P_{mn}^{(0)}} = \frac{x_{pb}}{x_{cb}} \left[\frac{(x_{pn}^{\checkmark} - x_{pm}^{\checkmark}) - (x_{qn}^{\checkmark} - x_{qm}^{\checkmark})}{x_{Th,mn}^{\checkmark} - x_{cb}^{\checkmark}} \right] \rightarrow \text{LOSF}$$

$x \rightarrow$ reactances of individual line
 $\checkmark \rightarrow$ Element of the $[B]^{-1}$ matrix

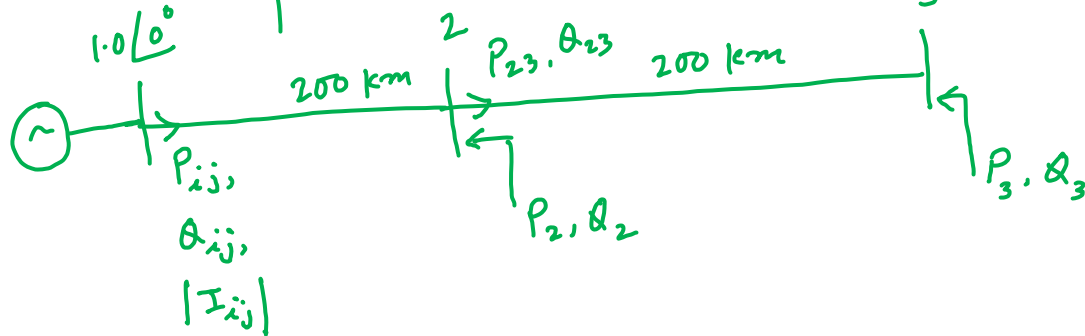
$$P_{pq}^{(\text{new})} = P_{pq}^{(0)} + \Delta P_{pq}$$

STATE ESTIMATION METHOD

In power-flow analysis

Input

$V_i, \theta_i \rightarrow$ slack bus
 $P_i, V_i \rightarrow$ PV bus
 $P_i, Q_i \rightarrow$ PQ bus



Output

$V_i, \theta_i \quad \forall i=1, \dots, N$
 $\Rightarrow I_{ij}, |I_{ij}|, P_{ij}, Q_{ij}, P_i, Q_i$

$V_2, \theta_2, V_3, \theta_3$
 P_2, P_3, Q_2, Q_3



Line outage analysis in IEEE-14 bus system

Line no.	Pline (ori)	For outage of line no. 18				For outage of line no. 2			
		LSOF (2)	P_{18}	Pline (cal)	Pline (ACLF)	LSOF (6)	P_2	Pline (cal)	Pline (ACLF)
1	1.6262	-0.0363	-0.0777	1.6290205	1.6309	1.0113	0.7464	2.381034	2.4451
2	0.7464	0.0351	-0.0777	0.7436727	0.742	—	0.7464	—	—
3	0.8655	-0.0294	-0.0777	0.8677844	0.869	0.1721	0.7464	0.993955	0.9987
4	0.5314	-0.0682	-0.0777	0.5366991	0.5364	0.3597	0.7464	0.799880	0.7986
5	0.3662	0.0574	-0.0777	0.36174	0.362	0.4845	0.7464	0.727830	0.7256
6	-0.358	-0.0363	-0.0777	-0.355179	-0.3545	0.1716	0.7464	-0.22991	-0.2352
7	-0.7068	0.5224	-0.0777	-0.747390	-0.7442	0.4944	0.7464	-0.3377	-0.3481
8	0.2689	-0.4868	-0.0777	0.3067244	0.3014	0.0258	0.7464	0.288157	0.2815
9	0.1063	-0.1923	-0.0777	0.1212417	0.1192	0.0101	0.7464	0.113838	0.1113
10	0.2893	0.6604	-0.0777	0.2379869	0.2433	-0.0288	0.7464	0.267803	0.272
11	0.1156	0.9961	-0.0777	0.038203	0.0351	-0.0166	0.7464	0.103209	0.1046
12	0.0852	-0.0857	-0.0777	0.0918589	0.0925	-0.0024	0.7464	0.083408	0.0842
13	0.2005	-0.325	-0.0777	0.2257525	0.2277	-0.0086	0.7464	0.19408	0.1952
14	0.0025	-0.0125	-0.0777	0.0034713	0.0024	0.0048	0.7464	0.006082	0.0024
15	0.2664	-0.4743	-0.0777	0.3032531	0.2991	0.021	0.7464	0.282074	0.2791
16	0.0123	-1.0039	-0.0777	0.090303	0.0904	0.0168	0.7464	0.024839	0.0234
17	0.0655	0.4085	-0.0777	0.0337596	0.0329	0.011	0.7464	0.073710	0.0719
18	-0.0777	—	-0.0777	—	—	0.0167	0.7464	-0.06523	-0.0666
19	0.0233	-0.1021	-0.0777	0.0312332	0.0305	-0.0025	0.7464	0.02143	0.0224
20	0.0857	-0.4102	-0.0777	0.1175725	0.1192	-0.011	0.7464	0.077489	0.0794