IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Computer aided power system analysis

AC- DC Load Flow

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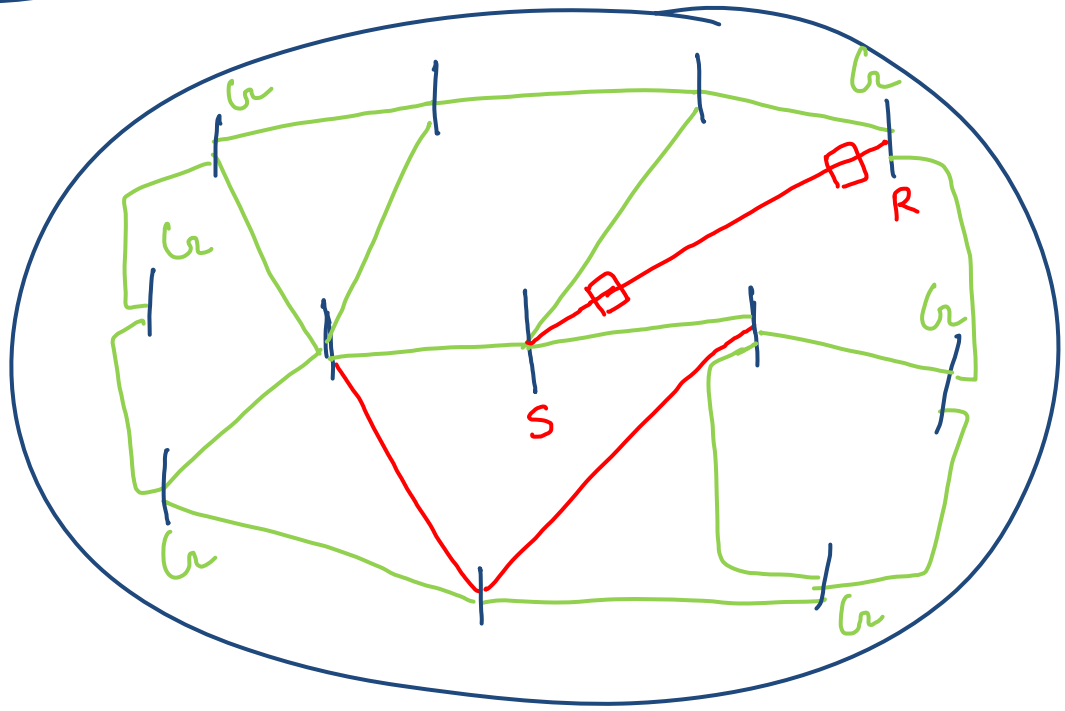
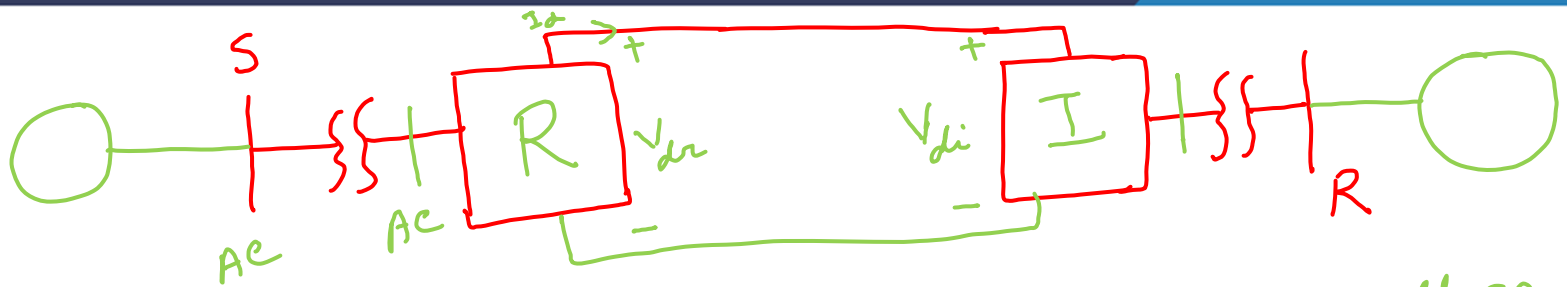
AC-DC LOAD FLOW





LCC-Based HVDC

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Line commutated converter

V_{dr} → DC voltage at rectifier

I_d → DC link current.

V_{di} → DC voltage at inverter

Two approaches of AC-DC load flow

- Simultaneous
- Sequential

DC-link : set of unknown variables → X_{DC}

Set of known quantities — S_{DC}

AC-load-flow (Polar)

$$\begin{bmatrix} \bar{J}_1 & \bar{J}_2 \\ \bar{J}_3 & \bar{J}_4 \end{bmatrix} \begin{bmatrix} \Delta\bar{\theta} \\ \Delta\bar{V} \end{bmatrix} = \begin{bmatrix} \Delta\bar{P} \\ \Delta\bar{Q} \end{bmatrix}$$

$$\begin{bmatrix} \bar{J}_1 & \bar{J}_2 & \bar{J}_5 \\ \bar{J}_3 & \bar{J}_4 & \bar{J}_6 \\ \bar{J}_7 & \bar{J}_8 & \bar{J}_9 \end{bmatrix} \begin{bmatrix} \Delta\bar{\theta} \\ \Delta\bar{V} \\ \Delta X_{DC} \end{bmatrix} = \begin{bmatrix} \Delta\bar{P} \\ \Delta\bar{Q} \\ \Delta S_{DC} \end{bmatrix}$$

$\Delta X_{DC} \rightarrow \Delta\bar{X}_c$

$\Delta S_{DC} \rightarrow \Delta M_c$

$$\bar{J}_5 \rightarrow \frac{\partial\bar{P}}{\partial\bar{X}_{DC}}$$

$$\bar{J}_6 \rightarrow \frac{\partial\bar{Q}}{\partial\bar{X}_{DC}}$$

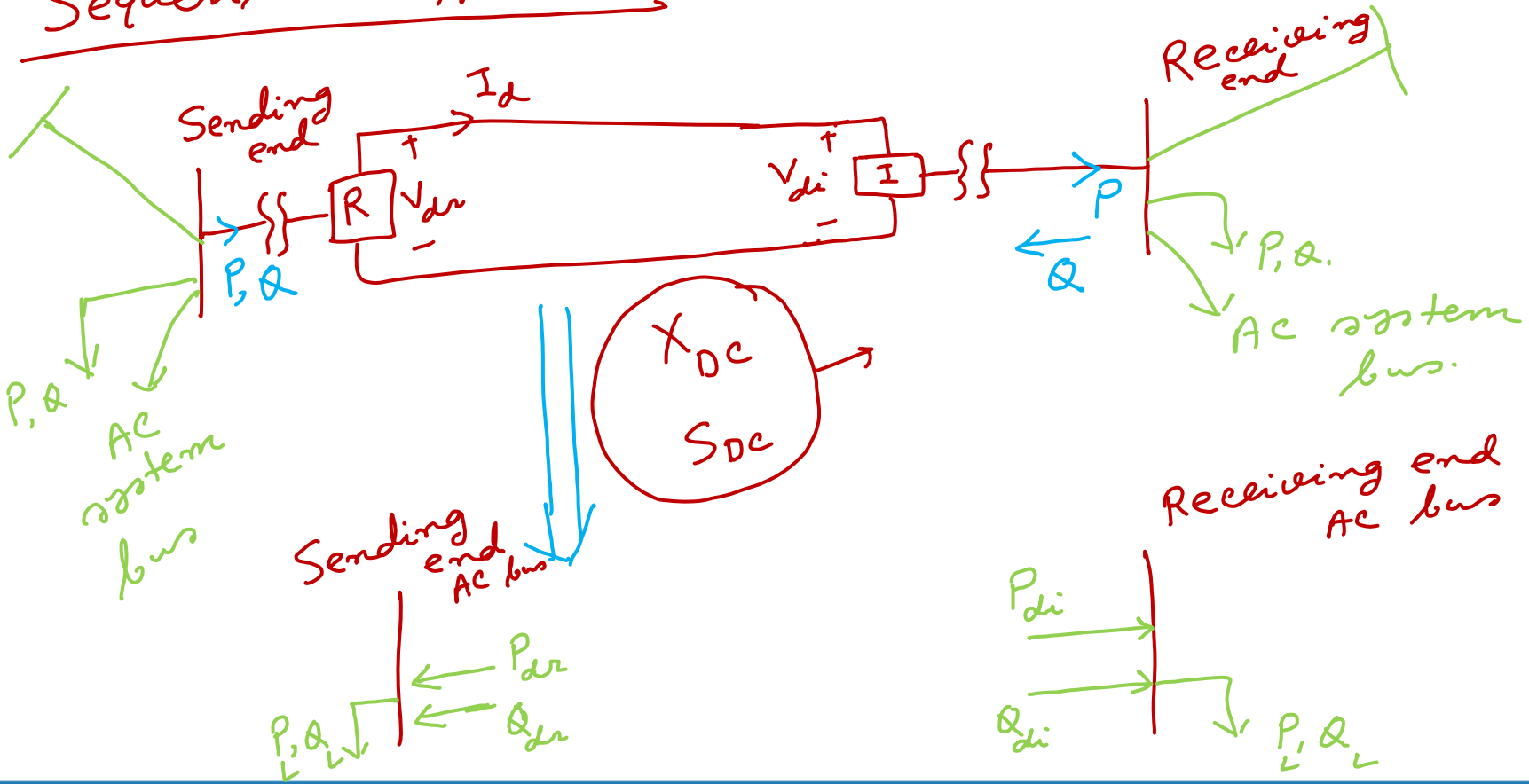
$$\bar{J}_8 \rightarrow \frac{\partial S_{DC}}{\partial\bar{V}}$$

$$J \cdot \Delta\bar{X}_c = \Delta M_c$$

$$\Delta\bar{X}_c = [J]^{-1} \Delta M_c$$

$\Rightarrow$ Computational burden is increased in simultaneous approach.

Sequential approach:



Sending end bus

$$P_{net} = -P + P_{dr}$$

$$Q_{net} = -Q + Q_{dr}$$

Receiving end bus

$$P_{net} = -P + P_{di}$$

$$Q_{net} = -Q + Q_{di}$$

Structure of the sequential method

1. Take initial guess.
2. Solve dc system and calculate $P_{dr}, Q_{dr}, P_{di}, Q_{di}$
3. Solve the AC load-flow
4. check for convergence and repeat.