

IEEE Tutorial on Voltage Stability

An Overview: This tutorial covers various aspects of voltage stability in power system networks. It provides examples of real voltage instability incidents worldwide. It describes the components that effect voltage stability. It includes fundamentals of voltage instability mechanisms, various analysis methods, voltage security analysis against contingencies, and counter measures against voltage instability.

Summary of the Topics:

1. Introduction (Carson Taylor 1.0-1.5 h)

- review of reactive power transmission
- voltage stability introduction, terms and definitions
- examples of real incidents
- reliability criteria

2. Short-term voltage instability and countermeasures (Carson Taylor 0.5 h)

- static and motor loads, residential air conditioners
- delayed voltage recovery
- countermeasures
- compensation: switched capacitors and reactors, SVC, STATCOM

3. Long-term voltage instability and countermeasures (Thierry Van Cutsem 2 h)

- transmission aspects : maximum deliverable power in 2-bus system, PV curves, effect of shunt compensation
- generators : capability curves, impact of generator limits on deliverable power
- load power restoration

- instability mechanisms illustrated through time-domain simulation of a simple system: smooth load increase, large disturbance.
- countermeasures : compensation switching, generator voltage increase, tap changer blocking/locking, load shedding
- undervoltage load shedding design aspects : undervoltage SIPS, detecting impending instability, closed-loop/distributed schemes, etc.

4. Analysis methods assuming smooth parameter changes (Venkataramana Ajjarapu 2 h)

- VQ curve analysis
- loadability limits, load power margins
- bifurcation analysis
- methods to compute limits and margins: continuation power flow, constrained optimisation
- small disturbance analysis: sensitivity of margins to parameters, diagnosis through eigenvalue analysis
- reactive reserves
- preventive control to restore margins

5. Voltage security analysis against contingencies (Costas Vournas 2 h)

- ways of assessing security: contingency analysis, post-contingency loadability limits, secure operation limits, nomograms
- methods for contingency analysis : post-contingency power flow, full time-scale simulation, quasi steady-state time simulation, contingency screening
- examples of on-line VSA implementation
- event-driven protection schemes
- application to Greek system