

HIGH VOLTAGE DC TRANSMISSION (3-0-0)

MODULE-I (12 Lectures)

HVDC Transmission: Introduction, Equipment required for HVDC Systems, Comparison of AC and DC Transmission, Limitations of HVDC Transmission Lines, Reliability of HVDC Systems, Comparison of HVDC Link with EHVAC Link, HVDC-VSC Transmission Systems.

HVDC Converters: Introduction, HVDC Converter Valves and Valve Assembly, HVDC-Voltage Source Converters: Principle and Operation, 3-phase 6-pulse Converters using SCRs or Thyristors, 12-pulse Bridge Converters.

6-Pulse Converter Operation and Analysis: Introduction, Conduction Sequence in 6-pulse Converter Configuration, The Ideal Commutation Process without Gate Control, DC Output Voltage, Gate Control (Phase Control) of Valves, Analysis of Voltage Waveforms with Overlap Angle (μ), Complete Characteristics of Converter as Rectifier/Inverter, Analysis of 12-pulse Converter, Power Flow in HVDC Links, Operation and Analysis of VSC Converters (Chapter-1: 1.3 to 1.6 & 1.9 to 1.10, Chapter-2: 2.5 to 2.8 and Chapter-3: 3.2 to 3.6 & 3.8 to 3.11)

MODULE-II (14 Lectures)

Control of HVDC Converter and Systems: Mechanism of AC Power Transmission, Principle of Control, Necessity of Control in case of a DC link, Rectifier Control, Compounding of Rectifiers, Power Reversal in a DC Link, Voltage Dependent Current Order Limit (VDCOL)-Characteristics of the Converter, System Control Hierarchy and Basic Philosophy, Inverter Extinction Angle Control (EAG), Pulse Phase Control, Starting and Stopping of a DC Link, Constant Power Control, Control Systems for HVDC Converters, Inverter Operation Problems, Control of VSC Converters.

Harmonics in HVDC Systems: Importance of Harmonic Study, Generation of Harmonics by Converters, Characteristic Harmonics on the DC Side, Characteristic Current Harmonics, Characteristic variations of Harmonic Currents with Variation of α & μ , Effect of Control modes on Harmonics, Non-Characteristic Harmonics, Harmonics in VSC Converters.

(Chapter-4: 4.2 to 4.16 and Chapter-5: 5.2 to 5.9)

MODULE-III (10 Lectures)

Harmonic Suppression in HVDC System-Filters: Harmonic Model & Equivalent Circuit, Use of Filters, Filter Configurations, Design of a Band-Pass Filter, Design of High-Pass Filters, Protection of Filters, DC Filters.

Faults and Protection Schemes in HVDC Systems: Nature and Types of Faults, Faults on AC Side of Converter Stations, Converter Faults, Faults on DC Side of the System, Protection against Over Currents/ Over Voltages, Protection of Filter Units.

Multi-terminal HVDC Systems : Types of Multi-terminal (MTDC) Systems, Parallel Operation Aspects of MTDC, Paralleling (Disconnecting) of Units or Converter, Control of Power in MTDC, VSC-Multi-level DC Systems.

(Chapter-6: 6.2 to 6.5 & 6.7 to 6.8, 6.10, Chapter-8: 8.2 to 8.7 and Chapter-10: 10.2 to 10.6)

TEXT BOOK:

1. "HVDC Transmission" By S. Kamakshiah & V. Kamaraju, TMH Education Private Ltd., 2011, New Delhi.

Reference Book:

1. "HVDC Power Transmissions Systems: Technology & Systems Interaction", K.R. Padiyar, New Age Publication, 2005