

Course Objectives:

This course enables the students to

- *Understand the concepts of HVDC Converters.*
- *Study the converter configuration and analysis for the application of high voltage transmission system.*
- *Understand the power flow in AC/DC systems and application of MTDC systems.*
- *Study the reactive power compensation by using different types of FACTS controllers.*

UNIT – I INTRODUCTION

Comparison of AC And DC Transmission Systems, Application of DC Transmission, Types of DC Links, Typical Layout of HVDC Converter Station, Planning for HVDC Transmission, Modern Trends in Dc Transmission.

ANALYSIS OF HVDC CONVERTERS

Pulse Number, Choice of Converter Configuration, Simplified Analysis of Greatz Circuit with and without overlap, Converter Bridge Characteristics, Equivalent Circuits- Rectifier and Inverter Configurations – Twelve Pulse Converters.

UNIT –II CONVERTER AND HVDC SYSTEM CONTROL

Principles of DC Links Control, Converter Control Characteristics, System Control Hierarchy, Firing Angle Control, Current and Extinction Angle Control, Starting and Stopping of DC Link.

HARMONICS, FILTERS AND REACTIVE POWER CONTROL

Introduction, Generation of Harmonics, Design of AC Filters and DC Filters, Reactive Power Requirements at Steady State, Sources of Reactive Power Static Var Systems.

UNIT – III POWER FLOW ANALYSIS IN AC/DC SYSTEMS

Introduction, Modeling of DC/AC Converters, Controller Equations, Solutions of AC/DC Load Flow – Simultaneous Approach and Sequential Approach.

MULTI TERMINAL DC (MTDC) SYSTEMS

Introduction, Potential Applications of MTDC Systems, Types of MTDC Systems – Series, Parallel, Comparison of Series & Parallel MTDC Systems, Control and Protection of MTDC Systems, Study of MTDC Systems.

UNIT – IV FACTS CONCEPTS

Flow of Power in AC Parallel Paths and Meshed Systems, Basic Types of Facts Controllers, Brief Description and Definitions of Facts Controllers.

STATIC SHUNT COMPENSATORS

Objectives of Shunt Compensation, Methods of Controllable Var Generation, Static Var Compensators: SVC and STATCOM, Comparison between SVC and STATCOM.

UNIT – V STATIC SERIES COMPENSATORS

Objectives of Series Compensation, Variable Impedance Type Series Compensators – GTO Thyristor Controlled Series Capacitors (GCSC), Thyristor Switched Series Capacitors (TSSC),

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Thyristor Controlled Series Capacitors (TCSC), Basic Operating Control Schemes for GCSC, TSSC, TCSC. Switching Converter Type Series Compensators – Static Series Synchronous Compensators(SSSC)- Power Angle Characteristics.

COMBINED COMPENSATORS

Introduction, Unified Power Flow Controller (UPFC), Basic Operating Principle, Independent Real and Reactive Power Flow Controller, Control Structure.

Course Outcomes:

The students will have knowledge on the following concepts

- *Advantages and applications of HVDC transmission system.*
- *HVDC converters and its protection.*
- *Effects of harmonics and its suppression using filters.*
- *Compensation of reactive power by using FACTS devices.*
- *Identify the benefits from FACTS.*

Text Books

1. HVDC Power Transmission Systems – K.R. Padiyar, Wiley Eastern Limited.
2. HVDC Transmission by V.Kamaraju, S.Kamakshaih

Reference Books

1. EHV – AC, HVDC Transmission & Distribution Engineering – S.Rao, Khanna Publishers, Third Edition, 2003.
2. FACTS: Modeling and Simulation in Power Networks by Enrique Acha, ClaudisR.Fuerte-Esquivel, Hugo Ambriz-Perez and Cesar Angeles-Camacho, Wiley India Pvt.Ltd
3. High Voltage Direct Current Transmission by Jos Arrillaga, 2nd Edition, The Institute of Engineering & Technology.
4. HVDC & FACTS Controllers by Vijay K.Sood, Klumer Academic Publishers.
5. Understanding of FACTS– N.G. Hingorani&L.Gyugi, IEEE Press.

