HVDC & FACTS

Course Code: 15EE2212

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Prerequisites: Power Electronics & Power Systems

Course Outcomes: After Completion of this Course, the Student will be able to

CO1: Compare AC and DC systems, Describe the Types of HVDC Links and FACTS devices and Explain various parameters in HVDC.

CO2: Analyze the Graetz circuit with various conditions.

CO3: Describe various control schemes, Analyze the harmonics and design the Filters in HVDC.

CO4: Analyze the Operation of various Shunt devices and their control.

CO5: Analyze the Operation of various Series devices and their control.

UNIT-I (10-Lectures)

BASIC HVDC CONCEPTS:

Introduction, Comparison of AC and DC Transmission (Economics of power transmission, Technical performance and Reliability), Application of DC transmission, Description of DC transmission system (Types of DC links and Converter Station), Planning for HVDC transmission, Modern trends in HVDC technology.

FACTS CONCEPTS:

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, Benefits from FACTS controllers.

UNIT-II (10-Lectures)

ANALYSIS OF HVDC CONVERTERS:

Introduction**,** Analysis of Graetz circuit – with grid control but no overlap- with grid control and overlap less than 60^0- relationship between AC and DC quantities-equivalent circuit of rectifier, Inversion-equation of average direct current and voltage in terms of β and γ– equivalent circuit of inverter, 12 Pulse converters- relations between AC and DC quantities.

UNIT-III (10-Lectures)

HVDC SYSTEM CONTROL & HARMONICS AND FILTERS:

Basic means of control- desired features of control-actual control characteristics-constant minimum ignition angle control- constant current control-constant extinction angle control- tap changer control-power control and current limits, System control hierarchy, firing angle control- IPC- EPC. Introduction, Generation of harmonics (Characteristics and Non characteristics harmonics), Design of DC and AC filters (design and types of filters).

UNIT-IV (10-Lectures)

STATIC SHUNT COMPENSATION:

Objectives of Shunt Compensation, midpoint voltage regulation voltage instability prevention, Improvement of Transient Stability, Power Oscillation Damping, Methods of Controllable VAR Generation – Variable Impedance type only.

UNIT-V (10-Lectures)

STATIC SERIES COMPENSATORS:

Concept of series capacitive compensation, Improvement of Transient Stability, Power Oscillation Damping, Subsynchronous Oscillation damping. Functional requirements of GTO Thyristor Controlled Series Capacitor (GCSC), control schemes of Thyristors Switched Series Capacitor (TSSC), and Thyristor Controlled Series Capacitor (TCSC) control schemes for GCSC, TSSC and TCSC.

TEXT BOOKS:

1. K. R. Padiyar, "*HVDC Transmission Systems*" 2nd edition (in Two Colour), New Age International publishers, 2012.
2. N. G. Hingorani and L. Gyugui "*Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems*", B. S. Publications, Indian Reprint 2000.

REFERENCES:

1. E. Uhlmann, "*Power Transmission by Direct Current"*, Springer 1st edition, 2012.
2. Vijay K. Sood, "*HVDC and FACTS Controller: Application of Static Converters in power systems*", IEEE Power Electronics and Power Systems series, Kluwer Academic publishers, Boston, First edition January 2004.
3. E. W. Kimbark, "*Direct Current Transmission"*, Wiley Inter Science-New York, 1971.
4. R. Mohan Mathur, Rajiv K Varma, "*Thyristor based FACTS Controller for Electrical Power Systems*", John Wiley Sons, 2011.
5. X. P. Zhang, C. Rehtanz, B. Pal, "Flexible *AC Transmission System Modeling and Control*", Springer, 2006.