IV Year II Semester	L	T	P	C
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HV AC & DC TRANSMISSION

Preamble

With the increasing power generation in the country and long distance power transmission, it is necessary that power should be transmitted at extra and ultra-high voltage. The topics dealt in this subject relate to phenomena associated with transmission line at higher voltages, equipment generating high voltage and power control strategy.

Learning objectives:

1. To understand the phenomena associated with transmission line, operating at extra high voltages. The unit gives detail analysis of several phenomena viz. electrostatic field, charges, voltage gradient and conductor configuration.
2. The objective is to discuss phenomena of corona, losses, audible noise, radio interference and measurement of these quantities.
3. To understand the phenomena of HVDC, HVDC equipment comparison with AC and the latest state of art in HVDC transmission.
4. To understand method of conversion of AC to DC, performance of various level of pulse conversion and control characteristics of conversion. It also provides knowledge of effect of source inductance as well as method of power control.
5. To understand the requirements of reactive power control and filtering technique in HVDC system.
6. To understand the harmonics in AC side of power line in a HVDC system and design of filters for various levels of pulse conversion.

Unit – I

Introduction of EHV AC transmission: Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses – Mechanical considerations – Resistance of conductors –Electrostatics – Field of sphere gap – Field of line charges and properties – Charge ~ potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius – Examples – Distribution of voltage gradient on sub conductors of bundle – Examples.

Unit – II

Corona effects: Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN – Relation between 1–phase and 3–phase AN levels – Examples – Radio interference (RI) – Corona pulses generation – Properties and limits – Frequency spectrum – Modes of propagation – Excitation function – Measurement of RI, RIV and excitation functions – Examples.

Unit – III

Basic Concepts of DC Transmission: Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC & DC transmission – Application of DC Transmission System – Planning & Modern trends in DC transmission.

Unit – IV

Analysis of HVDC Converters and System Control : Choice of Converter configuration – Analysis of Graetz – Characteristics of 6 Pulse & 12 Pulse converters – Cases of two 3 phase converters in star – Star mode and their performance – Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system – Starting and stopping of DC link – Power Control.

Unit – V

Reactive Power Control in HVDC: Reactive Power Requirements in steady state – Conventional control strategies –Alternate control strategies sources of reactive power – AC Filters – Shunt capacitors – Synchronous condensers.

Unit – VI

Harmonics and Filters: Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters.

Course Outcomes:

1. To be able to acquaint with HV transmission system with regard to power handling capacity, losses, conductor resistance and electrostatic field associate with HV. Further knowledge is gained in area of bundle conductor system to improve electrical and mechanical performance.
2. To develop ability for determining corona, radio interference, audible noise generation and frequency spectrum for single and three phase transmission lines.
3. To be able to acquire knowledge in transmission of HVDC power with regard to terminal equipment, type of HVDC connectivity and planning of HVDC system.
4. To be able to develop knowledge with regard to choice of pulse conversion, control characteristic, firing angle control and effect of source impedance.
5. To develop knowledge of reactive power requirements of conventional control, filters and reactive power compensation in AC. side of HVDC system.
6. Able to calculate voltage and current harmonics, and design of filters for six and twelve pulse conversion.

Text books:

1. “K. R. Padiyar”, HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, and Publishers, 1990.
2. “S K Kamakshaiah, V Kamaraju”, HVDC Transmission, TMH Publishers, 2011
3. “S.Rao”, EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 1999.

Reference books:

1. “Jos Arrillaga”, HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2nd edition 1998.
2. 2. “E. W. Kimbark”, Direct Current Transmission, John Wiley and Sons, volume 1, 1971.
3. 3. “E. Uhlmann”, Power Transmission by Direct Current, B. S. Publications, 2009.