# NIRMA UNIVERSITY

| | |
|---|---|
| **Institute:** | **Institute of Technology** |
| **Name of Programme:** | **B.Tech. in Electrical Engineering** |
| **Semester:** | **VII** |
| **Course Code:** | **2EEDE13** |
| **Course Title:** | **HVDC Transmission** |
| **Course Type:** | ( □ Core/ □ Value Added Course / √ **Department Elective**/ □ Institute Elective/ □ University Elective/ □ Open Elective/ □ Any other ) |
| **Year of Introduction:** | **2021 – 22** |

**Credit Scheme**

| L | T | Practical component | | | | C |
|---|---|---|---|---|---|---|
| | | LPW | PW | W | S | |
| 3 | 0 | 0 | - | - | - | 3 |

**Course Learning Outcomes (CLOs):**

At the end of the course, students will be able to-

1. select appropriate operational aspects of HVDC systems
2. conceptualize control strategy of HVDC systems
3. analyse the performance of HVDC systems
4. adapt latest developments in HVDC transmission

**Syllabus:** **Total Teaching hours: 45**

| Unit | Syllabus | Teaching hours |
|---|---|---|
| **Unit-I** | **Introduction**<br>Comparison between ac and dc transmission systems, Transmission line trends, Importance of EHV transmission, HVDC worldwide, Advantages of HVDC, Motivation for HVDC. Basic configurations, Main components, Concept of UHVDC. | **05** |
| **Unit-II** | **HVDC with Line Commutated Converters(LCC)**<br>Introduction to line commutated HVDC, LCC-HVDC components, Mass impregnated cables, Low pressure oil filled cables, Extruded cross linked polyethylene cables and overhead lines, Thyristor turn-off mechanism, Line commutated six pulse converter, Basic equations and operating modes, Analysis of Commutation Overlap in a Thyristor Converter, Active and reactive power in a three phase thyristor converter, 12-pulse converter model. | **12** |
| **Unit-III** | **Control of LCC-HVDC System**<br>Rectifier control structure, Constant current and Constant voltage control, Inverter control structure, Extinction angle control, DC voltage and current control at inverter, HVDC equivalent circuit, HVDC V-I operating diagram, HVDC power reversal, Harmonic performance criteria and its limit, Characteristic and non-characteristic harmonics, Tuned and damped filters, Different types of AC and DC faults, Overvoltage and overcurrent protection, HVDC bench mark model, Multi terminal HVDC converters. | **13** |

| | | |
|---|---|---|
| **Unit-IV** | **HVDC with Voltage Source Converters(VSC)**<br>Application of VSC in HVDC, Comparison with LCC HVDC, Overhead and subsea VSC-HVDC, Monopolar and bipolar VSC HVDC systems, VSC HVDC converter topologies, VSC-HVDC components and operation, Two level VSC modelling, control and dynamics, Complete VSC converter controller, AC and DC faults with VSC, VSC HVDC for AC grid support and operation with passive AC systems, Black start capability of VSC-HVDC, VSC-HVDC with offshore wind farms, Multi terminal HVDC with VSC converters, Introduction to MMC for HVDC. | **10** |
| **Unit-V** | **DC Transmission Grid**<br>Introduction to DC grid, DC grid planning, technical challenges, Introduction to DC circuit breaker and its operation, Various DC circuit breaker topologies, DC grid protection strategy. | **05** |

**Self-Study:**

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

**Suggested Readings/ References:**


1. K. R. Padiyar, HVDC Transmission System, New Age Publishers
2. E. W. Kimbark, Direct Current Transmission (Vol-1), Wiley & Sons.
3. Vijay K. Sood, HVDC and FACTS Controllers, Kluwer Academic Publishers
4. Chan-Ki Kim, Vijay K. Sood, Gil-Soo Jang, Seong-Joo Lim, Seok-Jin Lee, HVDC Transmission: Power Conversion Applications in Power Systems, John Wiley & Sons
5. Dragan Jovcic, High Voltage Direct Current Transmission: Converters, Systems and DC Grids, Wiley & Sons
6. Jos Arrillaga, Y. H. Liu, N. R. Watson, Flexible Power Transmission : The HVDC Options, Wiley & Sons
7. Jos Arrillaga, High Voltage Direct Current Transmission, IET Power and Energy Series, IEEE Press
8. Dirk Van Hertem, Oriol Gomis-Bellmunt, Jun Liang, HVDC Grids: For Offshore and Supergrid of the future, Wiley-IEEE Press
9. Zhenya Liu, Ultra High Voltage AC/DC Grids, Academic Press, Springer Publishers
10. Literature available from various competent national and international agencies in the field of electrical transmission, standards, magazines, research papers.


L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. academic year 2021-22 and onwards