**20EE32E2-HVDC TRANSMISSION SYSTEMS**

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| **Course category:** | Professional Elective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practical:** | 3 - 0 - 0 |
| **Pre-requisite:** | Power Electronics, Converters and Power Systems | **Sessional Evaluation : Univ.Exam Evaluation:**  **Total Marks:** | 40  60  100 |

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| **Course Objectives:** | Students undergoing this course are expected to: | |
| 1. Learn the concept of HVDC Transmission system. 2.Learn the HVDC converters.   1. Learn converter system control. 2. Learn about D.C line and fault prevention. 3. Learn about the importance of reactive power. 4. Learn the harmonics in the system and their prevention. | |
| **Course Outcomes:** | Upon successful completion of the course, the students will be able to: | |
| **CO1** | Develop the knowledge of HVDC transmission over conventional A.C transmission |
| **CO2** | Analyze different converters viz.3,6 and 12 pulse converters. |
| **CO3** | Understand different control schemes as well as starting and stopping of D.C links |
| **CO4** | Understand the nature of faults happening on both the A.C and  D.C sides of the converters and formulate protection schemes for the same. |
| **CO5** | Analyse about reactive power requirement. |
| **CO6** | Analyze the different harmonics generated by the converters and their variation with the change in firing angles. |
| **Course Content:** | **UNIT-I**  **D.C power transmission technology:** Introduction, comparison of A.C & D.C transmission, application of D.C transmission, description of  D.C transmission system, planning of HVDC transmission, modern trends in HVDC technology.  **UNIT-II**  **Analysis of HVDC converters:** Pulse number, choice of converter configuration, simplified analysis of graetz circuit, converter bridge characteristics, characteristics of twelve pulse converter, detailed analysis of six pulse converter.  **UNIT-III**  **Converter and HVDC system control:** Principles of D.C link control, converter control characteristics, system control hierarchy, firing angle control, current and excitation angle control, starting and stopping of  D.C link, power control, higher level controllers. | |

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|  | **UNIT-IV**  **Converter faults and protection:** Protection against over currents, over voltages in a converter station, surge arresters, protection against over voltages.  **Smoothing reactor and D.C Line:** Smoothing reactors, D.C line, transient over voltages in D.C line, protection of D.C line, D.C breakers, monopolar operation.  **UNIT-V**  **Reactive Power Control:** Reactive power requirements in steady state, Sources of reactive power, Static VAR systems, Reactive power control during transients.  **UNIT – VI**  **Harmonics and Filters:** Generation of harmonics, design of AC filters, DC filters, active filters, carrier frequency and RI noise. |
| **Text books &**  **Reference books:** | **TEXT BOOKS:**   1. “HVDC Power Transmission System”, by K.R Padiyar, New academic science Ltd publication, 3rd Edition. 2. “EHV-AC &HVDC Transmission Engineering & Practice”, by S. Rao, Khanna publication, 3rd Edition,.   **REFERENCE BOOKS:**   1. “Direct current Transmission”, by Edward Wilson Kimbark, Wiley Inter science, Volume-I. 2. “HVDC Power Transmission”, by S.Kamakshaiah &V.Kamaraju, Tata Mcgraw Hill publishers. |
| **e-Resources:** | <http://nptel.ac.in/courses> [http://iete-elan.ac.in](http://iete-elan.ac.in/)  <http://freevideolectures.com/university/iitm> |