



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3720738

Semester – II

Subject Name: HVDC - High Voltage Direct Current transmission

Type of course: Program Elective Course

Prerequisite: 1 Power Electronics Converters and Applications

2 Power Systems Analysis

Rationale: The bulk power transmission from HVAC to HVDC has evolved over the years. The state of art of development of HVDC Technology, equipments used in HVDC its modeling analysis and control are covered. The stability study, control strategies and protection of power systems with HVDC transmission for reliable and secure operation of the power in the power systems are also covered. The course is intended to provide the technological development in HVDC it's theory and understanding for operation and control of power systems with HVDC transmission.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content

Sr. No.	Content	Total Hrs	% Weightage
1	Evolution of HVDC Transmission, Comparison of HVAC and HVDC systems, Type of HVDC Transmission systems, Components of HVDC transmission systems.	04	10
2	Analysis of simple rectifier circuits: Required features of converter/inverter circuits for HVDC transmission, Analysis of HVDC converter, Different modes of converter operation, Equivalent electrical circuit	10	25
3	HVDC system control features, Control Modes, Control Schemes, Control comparisons, Equidistant firing controls,	05	12
4	Converter mal-operations, Commutation failure, Starting and shutting down the converter bridge, Converter protection.	05	12
5	Smoothing reactor and DC Lines, Reactive power requirements, Harmonic analysis, Filter design	06	15

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6	Component Models and it's representation for the Power flow analysis of AC-DC systems, Transient stability analysis, Dynamic stability analysis, Multi-terminal HVDC system (MTDC), control of MTDC, Advances in HVDC transmission, HVDC system application in wind power generation, Introduction to the relevant national and international standards of HVDC systems	12	26
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Reference Books:

1. KR Padiyar, "HVDC Power Transmission Systems", Willey Eastern Limited, Second edition.
2. J Arrillaga, "High Voltage Direct current Transmission", Peter Peregrinus Ltd, UK.
3. EW Kimbark, "Direct Current Transmission", Wiley-Interscience, New York. 1971
4. Erich Uhlmann, Power Transmission by Direct Current, B. S. Publications 2004
5. SN Singh, "Electric Power Generation, Transmission and Distribution, PHI, New Delhi 2nd edition, 2008

Course Outcomes:

After learning the course the student will be able to....

Sr. No.	CO statement	Marks % weightage
CO-1	Expose to the state of the art HVDC technology	20
CO-2	Model, Analyse, Select Suitable Control scheme and Protection method for the converter/inverter used in HVDC application.	30
CO-3	Acquire the knowledge for real and reactive power control in various MTDC power systems	30
CO-4	Analyse the interactions and stability of a AC-DC power systems	20

List of Experiments:

This is Just a Suggested list of Experiments. The teachers are encouraged to include the experiments from above topics.

1. Study and compare the basic topologies HVDC transmission
2. Study of basic topologies converter/inverter used for HVDC Power transmission
3. Modelling /Simulation of converter and it's analysis in various operating modes
4. Simulation and study of Real power flow control in AC-DC power systems
5. Simulation and study of Reactive power flow control in AC-DC power systems
6. Stability study of AC-DC power systems
7. Study of Standards of HVDC systems



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8. Design of harmonic filter for the HVDC systems
9. Simulation of smoothing reactor for HVDC transmission systems
10. Prepare a report/Visit on HVDC Project in Gujarat/India.
11. To design transformer used with half bridge converter/ full bridge converter
12. Automatic and manual synchronization of converter station with grid using appropriate simulation software
13. Three-phase display of grid and converter voltages using appropriate simulation software
14. Simulation of Control schemes for converter/inverter output voltage and frequency

Major Equipment:

The Software and hardware/Equipment used in the Power electronics and Power systems lab are sufficient for the performance of above practical.

List of Open Source Software/learning website:

<https://nptel.ac.in/courses/108104013>

<https://www.mathworks.com/>

<https://powersimtech.com>

<https://www.scilab.org/>