

Branch Name:	Electrical Engineering
ProgramCode:	ET213
CourseName:	HVDC & FACTS
CourseCode:	2ET2130202T
Pre-requisiteCourse:	Interconnected Power System, Power Electronics

Course Objectives:

1. To understand the working, analysis and control of HVDC transmission lines.
2. To understand different concepts about reactive power and compensators.
3. To identify working, analysis, control and characteristics of various FACTS controllers.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								Total (Marks)
					Theory (Marks)				Practical (Marks)				
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	4	-	-	4	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Introduction: Background, Electrical Transmission Networks, Conventional Control, Mechanisms, Flexible ac Transmission Systems (FACTS), Emerging Transmission Networks. HVDC transmission and Converter Circuit Comparison of AC and DC transmission, Advantages and Disadvantages of DC transmission, Kinds of DC links and its applications, MTDC System, Components of HVDC transmission, HVDC systems in world and India Valve Characteristics, Single phase converters, Three phase converters, Graetz Circuit, Additional six pulseconverter circuits and twelve pulse converter.	10	18 %
2	Principles of Reactive-Power Compensators: Shunt Compensators: Synchronous Condensers, The Saturated Reactor (SR), The Thyristor-Controlled Reactor (TCR), The Thyristor-Controlled Transformer (TCT), The Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), The Mechanically Switched Capacitor-Thyristor-Controlled Reactor (MSC-TCR), The Thyristor-Switched capacitor and Reactor, The Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSC-TCR), A Comparison of Different SVCs-Summary. Series Compensators : The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Open-Loop Control, Closed-Loop Control, Improvement of the System-Stability Limit, Enhancement of System Damping, Sub synchronous Resonance (SSR) Mitigation, Voltage-Collapse Prevention.	15	28%

3	Concepts of SVC Voltage Control & its Application: Voltage Control, Effect of Network Resonances on the Controller Response, The 2nd Harmonic Interaction between the SVC and ac Network, Application of the SVC to Series-Compensated ac Systems, 3rd Harmonic Distortion, Voltage-Controlled Design Studies, Increase in Steady-State Power-Transfer Capacity, Enhancement of Transient Stability, Augmentation of Power-System Damping, SVC Mitigation of Subsynchronous Resonance (SSR), Prevention of Voltage Instability.	10	18%
4	Emerging FACTS Controllers The STATCOM, The SSSC, The UPFC, Comparative Evaluation of Different FACTS Controllers, Future Direction of FACTS Technology.	10	18 %
5	Grid Control, Harmonics and Filters: Grid control and its characteristics, limitations of manual control, constant current versus constant voltage system, Actual control characteristics, Measurement of DC current, voltage, power Reactive power requirements, Sources of reactive power, SVS Generation of AC and DC harmonics, Characteristic Harmonics and uncharacteristic harmonics, Fourier analysis of valve currents and line currents on valve side Means of reducing harmonics, AC filters and DC filters.	10	18 %

Text Books:

1. Thyristor-based FACTS controllers for Electrical Transmission Systems: R Mohan Mathur, R K Verma, Wiley IEEE Press.
2. Understanding FACTS, N.G.Hingorani and L.Gyugyi, Standard Publishers, Delhi,2001.
3. FACTS Controllers in Power Transmission & Distribution: Padiyar K R, New Age International (P)Limited.

Reference Books:

1. Reactive Power Control in Electric Systems: T J E Miller, JohnWiley.
2. Power System Stability and Control, PrabhaKundur, TataMcGrahill.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom'sTaxonomyLevel
CLO1	Understand regarding the different compensating systems that affect the performance of the system.	2 Understanding
CLO2	Understand the basic construction and applications of HVDC transmission lines.	2 Understanding
CLO3	Know about the analysis and requirement of reactive power in power transmission.	1Remembering
CLO4	Analyze the function and requirement of different FACTS controllers.	4Analyze
CLO5	Know about characteristics of static var compensator.	1Remembering
CLO6	Acquire the knowledge of FACTS devices modelling for the improvement of performance of the system.	1Remembering 2 Understanding

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1				M			L				M		M			L
CLO2	M			M			L				M		M			L
CLO3				L		H			M			M				L
CLO4	L		L		M			M		L		M		M	H	
CLO5		M		L		H			M			M				L
CLO6				L		H	L		M		M	M	M			L

H: High, M: Medium, L: Low