GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Subject Code: ME02000811
Subject Name: FACTs Devices

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Power Systems and Power Electronics at UG level
Rationale:	With the ever increasing demand of power, the problems of AC transmission have increased at higher level. The need has increased for enhancing the power transfer over existing AC transmission lines along with improved voltage regulation, regulation of power flow over critical lines and system security without adding new lines. The control of reactive power and active power in transmission system in a conventional system is very difficult. The advances in power electronics has made possible to make the power control in transmission system very much flexible. The FACTs devices provide required compensation and make the transmission system control more flexible. FACTs devices provide very fast control of active power and reactive power.

Course Outcomes:
After learning the course, the students should be able to:

Sr. No.	CO statement	BL	Marks%weightage
CO-1	Understand the problems of bulk power transfer over uncompensated long EHV AC transmission lines	Understand	15
CO-2	Apply the fixed series and fixed mid-point shunt compensation to a long EHVAC transmission line for enhancement of power transfer	Apply	20
CO-3	Evaluate the performance of (FC+TCR) and STATCOM applied to a long EHV AC transmission lines for different problems	Evaluate	25
CO-4	Evaluate the performance of TCSC and SSSC applied to along EHV transmission lines for different problems	Evaluate	25
CO-5	Analyze the operation of multi-converter FACTs devices like UPFC and IPFC	Analyze	15

Teaching and Examination Scheme

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

Unit No.	Course content	Hrs	% weightage
1.	Introduction, Background, Electrical Transmission Networks., Conventional Control Mechanisms, Flow of power in an AC system : Power flow in parallel paths, power flow in meshed system, Limits of loading capability, Power flow and dynamic stability considerations of a transmission interconnection, Relative importance of controllable parameters, Basic types of FACTs controllers, Brief description and definitions of FACTs Controllers: Shunt connected controllers, Series connected controllers, Combined shunt and series connected controllers	6	15%
2.	Reactive Power Control in Electric Power Transmission System : Reactive Power, Uncompensated Transmission lines : A Simple Case, Lossless Distributed Parameter Lines, Passive Compensation : Shunt Compensation, Series Compensation, Effect on Power Transfer Capability	6	15%
3.	Static Shunt Compensators: Objectives of Shunt Compensation, Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability, The Thyristor Controlled Reactor (TCR) : Single Phase TCR, 3-phase TCR, 12-pulse TCR, Operating Characteristics of TCR, The Fixed Capacitor–Thyristor-Controlled Reactor(FC–TCR) : Configuration, Operating Characteristics, The Thyristor-Switched Capacitor (TSC) : Switching a Capacitor to a Voltage Source, Switching a Series Connection of a Capacitor andReactor	9	20%
4.	Static Synchronous Compensator (STATCOM):Introduction, Principle of Operation of STATCOM, Simplified analysis of a three phase six pulse STATCOM, Analysis of six pulse VSC using switching functions,applications of STATCOM	6	15%
5.	Series Compensation Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability TCSC: Fixed series compensation, need for variable series compensation, advantages of series compensation, TCSC Controller, Operation of TCSC, Capability Characteristics	6	15%
6.	Static Synchronous Compensator (SSSC) : Introduction, Operation of SSSC and the control of power flow, Modeling and control of SSSC, SSSC with an energy source, applications of SSSC	7	10%
7.	Unified Power Flow Controller and other multi-converter devices: Introduction, operation of a UPFC, Control of UPFC, protection of UPFC, Interline Power Flow Controller (IPFC),	6	10%
	TOTAL	**45**	**100**

Reference Books:

1. Thyristor-basedFACTScontrollersforElectricalTransmissionSystems:R Mohan Mathur, R K Verma, Wiley IEEE Press
2. Understanding FACTS ,N.G. Hingorani and L.Gyugyi,Standard Publishers, Delhi,
3. FACTS Controller sin Power Transmission & Distribution: Padiyar KR,New Age International (P) Limited.
4. Reactive Power Control in Electric Systems: THE Miller, John Willey
5. Power System Stability and Control ,Prabha Kundur,Tata McGrahill

Suggested List of Experiments:

1. To study the problems of uncompensated long EHV AC transmission line
2. To simulate the steady state performance of the long EHV AC transmission line for different operating conditions
3. To simulate the steady state performance of a long EHV AC transmission line withpassive shunt compensation for different operating conditions
4. To simulate the steady state performance of a long EHV AC transmission line withpassive series compensationfor different operating conditions
5. To compare the enhancement of power transfer capability of long EHV AC line with passive series and shunt compensation with the help of derivations of appropriate line equations and to compare with the help of simulation
6. To simulate the performance of long EHV AC line with TCR
7. To simulate the performance of long EHV AC line with TCR and fixed capacitor
8. To simulate the performance of long EHV AC line with STATCOM
9. To simulate the performance of long EHV AC line with TCSC with open loop control
10. To simulate the performance of long EHV AC line with TCSC with closed loop control
11. To simulate the performance of long EHV AC line with SSSC for different operating conditions

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