

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRICAL ENGINEERING (07)

FACTs

SUBJECT CODE: 2720716

SEMESTER: II

**Type of course:** Engineering

**Prerequisite:**

Power System Analysis and Fundamental knowledge of Power Electronics

**Rationale:** The Power system transmission network is now a days heavily loaded and to enhance the existing active as well as reactive power transmission capacity of the line management and control of active and reactive power is crucial. The subject aims to develop thorough understanding of requirement of power management in power system by employing power electronics based reactive power supplying/absorbing devices.

**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)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

**Content:**

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction, Background, Electrical Transmission Networks, Conventional Control, Mechanisms, Flexible ac Transmission Systems (FACTS), Emerging Transmission Networks.	4	05
2	Reactive-Power Control in Electrical Power Transmission Systems: Reactive Power, Uncompensated Transmission Lines, Passive Compensation	5	10
3	Principles of Conventional Reactive-Power 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	7	15
4	SVC Control Components and Models Measurement Systems , The Voltage Regulator, Gate-Pulse Generation, The Synchronizing System, Additional Control and Protection Functions, Modeling of SVC for Power-System Studies	5	15
5	Concepts of SVC Voltage Control 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, 3 <sup>rd</sup> Harmonic Distortion, Voltage-Controlled Design Studies	5	10
6	Applications Increase in Steady-State Power-Transfer Capacity, Enhancement of Transient Stability, Augmentation of Power-System	6	10

	Damping, SVC Mitigation of Subsynchronous Resonance (SSR), Prevention of Voltage Instability		
7	The Thyristor-Controlled Series Capacitor (TCSC) Series Compensation, The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses. Response of the TCSC, Modeling of the TCSC	6	15
8	TCSC Applications Open-Loop Control, Closed-Loop Control, Improvement of the System- Stability Limit, Enhancement of System Damping,, Sub synchronous Resonance (SSR) Mitigation, Voltage-Collapse Prevention, TCSC Installations	6	10
9	Emerging FACTS Controllers The STATCOM, THE SSSC, The UPFC, Comparative Evaluation of Different FACTS Controllers, Future Direction of FACTS Technology	4	10

### Reference 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. Reactive Power Control in Electric Systems: T J E Miller, John Willey,
4. FACTS Controllers in Power Transmission & Distribution: Padiyar K R, New Age International
5. Power System Stability and Control, Prabha Kundur, Tata McGrawHill,

### Course Outcome:

After learning the course the students should be able to:

1. Analyze reactive power requirement and management.
2. Assess and evaluate various compensators.
3. Simulate and design compensators.
4. Analyze various control schemes in HVDC system.

### List of Experiments / Tutorial:

Course coordinator can offer the assignments which enhance the programming, modeling, analytical and/or design skills. Few assignments for guidelines are suggested here

1. Modeling and analysis of medium and long transmission line in MATLAB/SIMULINK to analyze voltage profile.
2. Modeling and analysis of SVC.
3. Modeling and analysis of STATCOM.
4. Case study on TCSC.

### Design based Problems (DP)/Open Ended Problem:

Course coordinator can assign the design based problem/open ended problem.

### List of Open Source Software/learning website:

www.nptel.ac.in  
www.mathworks.com  
www.scilab.org

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.