Name of Faculty	:	Faculty of Engineering & Technology
Name of Program	:	Master of Technology (M. Tech)
Course Code	:	2MPS01
Course Title	:	Flexible AC Transmission System & HVDC
Type of Course	:	PC
Year of Introduction	:	2023-24

Prerequisite	:	Power Quality Management, Power Electronics
Course Objective	:	This course aims to understand the operating principles, models and design of various FACTS controllers and their applications in power system and the control aspects of HVDC System.
Course Outcomes	:	At the end of this course, students will be able to:
	CO1	**To Understand** the Modelling, principle of operation and applications of various Shunt and Series FACTS controllers.
	CO2	**To Analyse** the Operation of various Shunt devices and their control.
	CO3	**To Analyse** the Operation of various Series devices and their control.
	CO4	**To Analyse** the different modes of operation for twelve pulse converter unit in the context of HVDC system.
	CO5	**To Understand** knowledge about HVDC transmission Systems and its control aspects.

Teaching and Examination Scheme

Teaching Scheme (Contact Hours)			Credits	Examination Marks				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**SEE**	**CIA**	**SEE**	**CIA**	
4	0	2	5	70	30	30	20	150

*Legends: **L**-Lecture; **T**–Tutorial/Teacher Guided Theory Practice; **P** – Practical, **C** – Credit, **SEE** – Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.))*

Course Content

Unit No.	Topics	Teaching Hours	Weightage	Mapping with CO
1	**Introduction to FACTS** Reactive power flow control in Power Systems, Control of dynamic power unbalances in Power System, Constraints of maximum transmission line loading, Need of FACTs controller in power system, Transmission line compensation, Uncompensated line -Shunt compensation, Series compensation Phase	10	15%	CO1

	angle control, Reactive power compensation Shunt and Series compensation principles, Reactive compensation at transmission and distribution level.			
2	**Static Shunt Compensator** Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM, Operation and control of TSC, TCR and STATCOM - Compensator control, Comparison between SVC and STATCOM	14	25%	CO2
3	**Static Series Compensator** Objectives of Series compensation, Variable impedance type and thyristors switched series capacitors (TCSC), and switching converter type series compensators, static series synchronous compensator (SSSC), power angle characteristics, basic operating control schemes.	14	25%	CO3
4	**HVDC** Comparison of AC-DC transmission systems, application of DC transmission, types of DC links, typical layout of HVDC converter station. HVDC converters, pulse number, analysis of Gratez circuit with and without overlap, converter bridge characteristics, equivalent circuits or rectifier and inverter configurations of twelve pulse converters	10	15%	CO4, CO5
5	**Converter & HVDC system control** Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Extinction angle control, Starting, stopping and power flow reversal of DC link, Power control, Parallel operation of DC link with AC transmission line. Converter faults, commutation failure, valve blocking and bypassing. Protection against over currents, over voltages. DC circuit breakers. Reactive Power Control.	12	20%	CO4

Suggested Distribution of Theory Marks Using Bloom's Taxonomy						
Level	Remembrance	Understanding	Application	Analyse	Evaluate	Create
Weightage	**40**	**20**	**20**	**15**	**05**	**0**

NOTE: This specification table shall be treated as a general guideline for the students and the teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Suggested List of Experiments/Tutorials

Sr. No.	Name of Experiment/Tutorial	Teaching Hours
1	To simulate fixed Series and Shunt Compensated line for different operating condition.	2
2	To simulate 12-pulse Bridge Converter.	2
3	To Simulate Thyristor Switched Capacitor (TSC).	2
4	To Simulate TSC-TCR model.	2
5	To Simulate Static Var Compensators.	2
6	Evaluate the performance of STATCOM/SVC as a shunt compensator.	2
7	To Simulate of Thyristor Controlled Reactor (TCR).	2
8	Modeling of Six Pulse / Twelve Pulse Monopolar / Bipolar HVDC converters with constant voltage / current / power controls by using MiPower.	4
9	Some simulation practices based on HVDC power and voltage stability.	2
10	Study of DC link control in VSC based HVDC transmission system.	2

Major Equipment/ Instruments and Software Required

Sr. No.	Name of Major Equipment/ Instruments and Software
1	Scilab, MATLAB, PSIM etc. along with necessary toolbox
2	Power Electronic Converters
3	CRO/DSO
4	Current/Voltage Probes
5	Isolation transformer

Suggested Learning Websites

Sr. No.	Name of Website
1	https://etap.com/
2	https://electrical-engineering-portal.com/flexible-ac-transmission-system
3	https://nptel.ac.in/courses/108104013
4	https://nptel.ac.in/courses/108107114

Reference Books

Sr. No.	Name of Reference Books
1	K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age InternationalPublishers, 2007
2	R. Mohan Mathur, R K Verma, "Thyristor-based FACTS controllers for Electrical Transmission Systems", Wiley IEEE Press.
3	N.G.Hingorani and L.Gyugyi, "Understanding FACTS", Standard Publishers, Delhi, 2001
4	Vijay K Sood, "HVDC and FACTS Controller" Springer Publication, 2004.
5	S Kamakshaiah, V. Kamaraju, "HVDC Transmission systems", The Mc Graw Hill Companies.