Gyanmanjari Innovative University

Course Syllabus
Gyanmanjari Institute of Technology
Semester-6

Subject: Flexible AC Transmission Systems - BETEE16328

Type of course: Professional Elective Course

Prerequisite: Power Systems and Power Electronics

Rationale:

This course provides a comprehensive understanding of measurement techniques and the principles of various electrical and electronic instruments. It equips students with the essential skills to use, calibrate, and test instruments critical in modern electrical and electronic systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
3	0	2	4	60	30	10	20	30	150

Legends: CI-Classroom Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Unit No.	Course content	Hrs	% Weightage
1.	**FACTS Concepts** Transmission line inter connections, Power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.	05	10%
2.	**Voltage Source Converters** Single phase three phase full wave bridge converters, transformer connections for 12, 24 and 48 pulse operation. Three level voltage source converters, pulse width modulation converter, basic concept of current source Converters, comparison of current source converters with voltage Source converters.	10	20%

3.	**Static Shunt Compensation** Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.	10	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	10	25%
5	**Static Series Compensation** Concept of series capacitive Compensation, improvement of transient stability, power oscillation damping, Functional requirements, GTO Thyristor controlled series capacitor (GSC), Thyristor switched series capacitor (TSSC) and Thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.	10	25%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Industrial Visit on FACTS Technology** Students will visit a power plant or substation equipped with FACTS devices. They will interact with industry engineers regarding FACTS operation. A brief technical report based on the visit will be prepared and submitted on the GMIU Web Portal.	10
2	**Case Study on FACTS for Renewable Energy Integration** Students will study voltage and stability issues due to renewables. Suitable FACTS solutions will be proposed and upload report on GMIU web portal.	10
3	**Research Paper Review on FACTS Technology** Students will Reviw a recent IEEE paper on FACTS technology and prepare a report based on main objectives, methods, and results. And upload it on the GMIU Web Portal.	10
	Total	30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	35%	35%	10%	10%	10%	0

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

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand fundamental concepts of FACTS controllers and their role in improving power flow, stability, and loading capability of AC transmission systems.
CO2	Explain the operation and characteristics of voltage source and current source converters used in FACTS applications.
CO3	Analyze static shunt compensation techniques for voltage regulation, stability enhancement, and reactive power control.
CO4	Describe the working principle, analysis, and applications of STATCOM in power system control.
CO5	Explain static series compensation methods and control schemes for improving power system stability and power transfer capability.

List of Practical:

Sr. No	Descriptions	Unit No	Hrs
1.	Study real and reactive power flow in a transmission line with and without FACTS controllers using MATLAB/Simulink.	1	2
2.	Model and analyze single-phase and three-phase full-bridge VSC operation and output waveforms.	2	2
3.	Simulate 12-pulse and 24-pulse converter configurations and study harmonic reduction.	2	2
4.	Simulate sinusoidal PWM control of a VSC and analyze switching patterns and output voltage.	2	2
5.	Model TCR–TSC based SVC and study voltage regulation and reactive power control.	3	2
6.	Simulate a three-phase STATCOM using VSC and analyze its effect on bus voltage and reactive power.	3	2
7.	Simulate power oscillation damping in a transmission system using STATCOM or TCSC.	4	2
8.	Study classification, operating principles, and applications of different FACTS controllers.	4	2
9.	Study single-pulse, multi-pulse, and multi-level converter topologies used in FACTS.	4	2

10.	Study components, control structure, and practical implementation of STATCOM.	5	2
11.	Study construction, working, and comparison of GSC, TSSC, and TCSC.	5	2
12.	Study of FACTS applications in renewable energy integration.	5	2
13.	Study of real-world FACTS installations in the Indian power grid.	5	2
14.	Study real-world applications of FACTS controllers in transmission and renewable integration.	5	4
	Total		30

Instructional Method:

The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods by black board, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

The internal evaluation will be done on the basis of Active Learning Assignment

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in the laboratory.

Reference Books:

[1] N. G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. New York, NY, USA: IEEE Press, 2000.

[2] R. M. Mathur and R. K. Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems. New York, NY, USA: IEEE Press, 2002.

[3] P. Kundur,iyar, FACTS Controllers in Power Transmission and Distribution. New Delhi, India: New Age Power System Stability and Control. New York, NY, USA: McGraw-Hill, 1994.

[4] K. R. Pad International Publishers, 2007.

[5] M. H. Rashid, Power Electronics: Circuits, Devices and Applications, 4th ed. Noida, India: Pearson Education, 2014.

[6] N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications, and Design, 3rd ed. New Delhi, India: Wiley India, 2009.

[7] H. Saadat, Power System Analysis, 3rd ed. New York, NY, USA: McGraw-Hill Education, 2011.

[8] P. S. Bimbhra, Power Electronics. New Delhi, India: Khanna Publishers, 2012.