Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Fourth Year Bachelor of Engineering (Electrical Branch)

With effect from: Academic Year 2020-21

Subject Code: EE705-N-B	Subject Title: **Advanced Power System - I**

Course Objective:

- To address the underlying concepts and methods behind Advanced Power System
- To impart knowledge of advancement in the field of power system with insight experimental approach.
- The course starts with a review of the fundamentals of power systems and progresses through to advanced topics incorporating the latest FACTS technologies as well as techniques applied in the planning, design and operation of modern power systems within both regulated and liberalized environments.
- It provides students with intense training in research methods, advanced simulation tools and experimental techniques in power systems.

A. Teaching / Examination Scheme

Teaching scheme				Total Credit	Evaluation Scheme					Total Marks
L	T	P	Total		Theory		IE Marks	CIA Marks	Pract. Marks	
Hrs	Hrs	Hrs	Hrs		Hrs	Marks				
4	0	2	6	5	3	70	30	20	30	150

B. Outline of the Course:

1. Introduction:

Background, Electrical Transmission Networks, Conventional Control Mechanisms, Automatic Generation Control (AGC), Excitation Control, Transformer Tap-Changer Control, Phase Shifting Transformers, Flexible ac Transmission Systems (FACTS), Advances in power Electronics, Switching Devices, Principles and Applications of Semiconductor Switches, Emerging Transmission Networks.

2. Reactive Power Control in Electrical Power Transmission Systems:

Reactive Power, Uncompensated Transmission Lines, A simple Case Lossless Distributed Parameter Lines, Passive Compensation, Shunt Compensation, Series Compensation, Effect on power-Transfer Capacity, Series Compensation, Shunt Compensation.

3. Principles of Conventional Reactive Power Compensators

Introduction, Synchronous Condensors, Configuration, Applications, The saturated Reactor, Thyristor Controlled Reactor(TCR), The single phase TCR, The three phase TCR, The segmented TCR, The 12-Pulse TCR, Operating Characteristics of a TCR, Operating Characteristics Without Voltage Control, Operating Characteristics With Voltage Control, The Fixed Capacitor Thyristor

Controlled Reactor (FC-TCR), Configuration, Operating Characteristic, The Mechanically Switched Capacitor-Thyristor-Controlled Reactor(MSCTCR), The Thyristor-Switched Capacitor (TSC), Switching a Capacitor to a Voltage Source. Switching a Series Connection of a Capacitor and Reactor, Turning Off of the TSC Valve, The TSC Configuration, Operating Characteristic, The Thyristor-Switched Capacitor-Thyristor-Controlled Reactor(TSC-TCR), Configuration, Operating Charateristics, Current Characteristic, Susceptance Characteristics, Mismatched TSC-TCR, Comparison of different SVCs.

4. HVDC Transmission-Development

Introduction, Historical Development, Equipment required for HVDC System, Comparison of AC and DC transmission, Limitation of HVDC Transmission Lines, Reliability of HVDC Systems, Standard Rated Voltages of HVDC and EHV AC systems, Choice of EHV AC and UHV AC lines and substation, Comparison of HVDC link with EHV AC link, HVDC-VSC Transmission System.

5. HVDC Convertors

Introduction, Insulated Gate Bipolar Transistor (IGBT), HVDC Convertor Valve and Valve Assembly, HVDC –VSC Operation and Principles, Three Phase Six Pulse Converter using SCRs Twelve Pulse Bridge Converters.

6. Six Pulse Converter Operation and Analysis

Introduction, Conduction Sequence in Six Pulse Converter, Ideal Commutation Process without Gate control, DC output Voltage, Gate control of valve, Analysis of Voltage Waveform with overlap angle, Voltage dropped in PU Quantities, Complete Characteristics Of converter as Rectifier /Inverter, Analysis of Twelve Pulse Converter, Power flow in HVDC Link Operation and Analysis Of VSC converters.

C. Lesson Planning

SR No.	Lectures (Hours)	Weight-age in % in Exam	Topic
1	6	10	**Introduction:** Background, Electrical Transmission Networks, Conventional Control Mechanisms, Automatic Generation Control (AGC), Excitation Control, Transformer Tap-Changer Control, Phase Shifting Transformers, Flexible ac Transmission Systems (FACTS), Advances in power Electronics, Switching Devices, Principles and Applications of Semiconductor Switches, Emerging Transmission Networks.
2	6	10	**Reactive Power Control in Electrical Power Transmission Systems:** Introduction, Types of transformers, position of HV and LV windings, core and yoke cross sectional area, Modern core Construction. Importance of mitered joints, Different types of transformers windings. Different methods for cooling of transformer, Different positions of Tappings and Tap Changing.

3	16	30	**Principles of Conventional Reactive Power Compensators** Introduction, Synchronous Condensors, Configuration, Applications, The saturated Reactor, Thyristor Controlled Reactor(TCR), The single phase TCR, The three phase TCR, The segmented TCR, The 12-Pulse TCR, Operating Characteristics of a TCR, Operating Characteristics Without Voltage Control, Operating Characteristics With Voltage Control, The Fixed Capacitor Thyristor Controlled Reactor (FC-TCR), Configuration, Operating Characteristic, The Mechanically Switched Capacitor-Thyristor-Controlled Reactor(MSCTCR), The Thyristor-Switched Capacitor (TSC), Switching a Capacitor to a Voltage Source. Switching a Series Connection of a Capacitor and Reactor, Turning Off of the TSC Valve, The TSC Configuration, Operating Characteristic, The Thyristor-Switched Capacitor-Thyristor-Controlled Reactor(TSC-TCR), Configuration, Operating Charateristics, Current Characteristic, Susceptance Characteristics, Mismatched TSC-TCR, Comparison of different SVCs.
4	8	20	**HVDC Transmission-Development** Introduction, Historical Development, Equipment required for HVDC System, Comparison of AC and DC transmission, Limitation of HVDC Transmission Lines, Reliability of HVDC Systems, Standard Rated Voltages of HVDC and EHV AC systems, Choice of EHV AC and UHV AC lines and substation, Comparison of HVDC link with EHV AC link, HVDC-VSC Transmission System.
5	8	10	**HVDC Convertors** Introduction, Insulated Gate Bipolar Transistor (IGBT), HVDC Convertor Valve and Valve Assembly, HVDC –VSC Operation and Principles, Three Phase Six Pulse Converter using SCRs Twelve Pulse Bridge Converters.
6	8	20	**Six Pulse Converter Operation and Analysis** Introduction, Conduction Sequence in Six Pulse Converter, Ideal Commutation Process without Gate control, DC output Voltage, Gate control of valve, Analysis of Voltage Waveform with overlap angle, Voltage dropped in PU Quantities, Complete Characteristics Of converter as Rectifier /Inverter, Analysis of Twelve Pulse Converter, Power flow in HVDC Link Operation and Analysis Of VSC converters.
	52	100	

D. Suggested List of Experiments:

1.	Introduction to Sim Power System in Write Simulation.
2.	To simulate fixed Series and Shunt Compensated line for different operating condition.

3.	To Simulate of Thyristor Controlled Reactor (TCR).
4.	To obtain voltage profile of an uncompensated line for loading equal to SIL, more than SIL, less than SIL.
5.	To Simulate Thyristor Switched Capacitor (TSC).
6.	To Simulate FC-TCR model.
7.	To Simulate MSC-TCR model.
8.	To Simulate TSC-TCR model.
9.	To Simulate Static Var Compensators.
10.	To simulate various 6-pulse converter model using Star-Delta and Star-Star Transformer.
11.	To simulate 12-pulse Bridge Converter.
12.	Modeling of Six Pulse / Twelve Pulse Monopolar / Bipolar HVDC converters with constant voltage / current / power controls by using MiPower.
13.	Standard IEEE Static Var Compensator by using MiPower.

E. Instructional Method & Pedagogy

- At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
- Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations.
- Attendance is compulsory in lectures, which may carries five marks in overall evaluation.
- One/Two internal exams may be conducted and total/average/best of the same may be converted to equivalent of 30 marks as a part of internal theory evaluation.
- Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
- Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

F. Students Learning Outcomes

On successful completion of the course

- The student can be acquired the basic knowledge of Power System with the use of Power Electronics Devices.
- The students will be able to effectively employ electrical power systems and lead the exploration of Transmission technology with FACTS devices**.**
- The students will able to the basic knowledge of HVDC technology and its application in Power System.

Reference Books:

1. Thyristor-Based FACTS Controllers for Electrical Transmission Systems- R.M.Mathur/ R.K.Verma, John Wiley & Sons, Inc., 2002
2. HVDC Transmission: S Kamakshaiah, V Kamaraju , McGrawHill, ISBN: 9780071072533
3. Power System Stability and Control – Prabha Kundur, Mc Graw Hill, ISBN: 9780070635159
4. N. Hingorani, L. Gyugyi, Understanding FACTS: Concepts and Technology of
5. Flexible AC transmission Systems, Delhi Publishers, ISBN-13: 9788186308790