SCHEME OF COURSE WORK

Course Details:

Course Title	**: HVDC & FACTS**		
Course Code	**: 15EE2212**	**L P C**	**: 4 0 3**
Program:	**: Master of Technology.**		
Specialization:	**: Power System and Control Automation & Power Electronics and Drives**		
Semester	**: II**		
Prerequisites	**: Power System & Power Electronics**		
Courses to which it is a prerequisite	**Research**		

Course Outcomes (COs):

CO1	Compare AC and DC systems, Describe the Types of HVDC Links and FACTS devices and Explain various parameters in HVDC.
CO2	Analyze the Graetz circuit with various conditions.
CO3	Describe various control schemes, Analyze the harmonics and design the Filters in HVDC.
CO4	Analyze the Operation of various Shunt devices and their control.
CO5	Analyze the Operation of various Series devices and their control.

Program Outcomes (POs):)(PSCA)

A graduate of Electrical & Electronics Engineering will be able to

1	Acquire in depth knowledge in the area of power system control and automation.
2	Prepare models with respect to any kind of problem on hand and try to solve related to power system control and automation
3	Obtain the capability of problem solving and original thinking to arrive at feasible and optimal solutions considering societal and environmental factors
4	Have sufficient knowledge base, sufficient to apply the techniques and tools to solve power system problems
5	Use the state-of-the-art tools for modeling, simulation and analysis of problems related to power systems
6	Attain the capability to contribute positively to collaborative and multidisciplinary research to achieve common goals
7	Demonstrate knowledge and understanding of power system engineering and management principles and apply the same for efficiently carrying out projects with due consideration to economical and financial factors
8	Communicate confidently, make effective presentations and write good reports to engineering community and society
9	Recognize the need for life-long learning and have the ability to do it independently
10	Become socially responsible and follow ethical practices to contribute to the community for sustainable development of society
11	Independently observe and examine critically the outcomes of his actions and reflect on to make corrective measures and move forward positively

Course Outcome Versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S	S	S	M	S	W	W	W	S	W	W
CO-2	S	M	S	S	M	S	W	W	S	W	W
CO-3	S	S	S	S	S	S	W	W	S	W	W
CO-4	S	M	S	S	S	S	W	W	S	W	W
CO-5	S	S	S	S	S	S	W	W	S	W	W

S - Strongly correlated, *M - Moderately* correlated, *W-Weakly correlated*

Program Outcomes (POs):(PED)

A graduate of Electrical & Electronics Engineering will be able to

1	A professional workforce in the areas of "Static Power Electronics Converters", "Power Electronic Converter fed Electrical Drives" and "Power Quality"
2	Apply soft computing techniques for Power Electronic Systems and Electric Drives
3	Understand large scale Power Electronic Converter Systems, Electric Drives and issues involved through modeling, analysis and simulation
4	Apply present day techniques and tools to solve Power electronic and electric drives problems relevant to India and other countries
5	Use state-of-the-art simulation tools such as PLEXIM, SABER, OPAL-RT Lab, DSPACE, MULTISIM, LABVIEW and other Tools
6	Capable of contributing positively to collaborative and multidisciplinary research to achieve common goals
7	Demonstrate knowledge and understanding of power system engineering and management principles and apply the same for efficiently carrying out projects with due consideration to economical and financial factors
8	Communicate confidently, make effective presentations and write good reports to engineering community and society
9	Recognize the need for life-long learning and have the ability to do it independently
10	Become aware of social issues and shall contribute to the community for sustainable development of society
11	Independently observe and examine critically the outcomes of his/her actions and apply corrective measures subsequently and move forward positively through a self corrective approach

Course Outcome Versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S	S	S	M	S	W	W	W	S	W	W
CO-2	S	M	S	S	M	S	W	W	S	W	W
CO-3	S	S	S	S	S	S	W	W	S	W	W
CO-4	S	M	S	S	S	S	W	W	S	W	W
CO-5	S	S	S	S	S	S	W	W	S	W	W

S - Strongly correlated, *M - Moderately* correlated, *W-Weakly correlated*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	Evolution of HVDC Transmission. Comparison of HVAC and HVDC systems.	CO-1	Compare HVAC and HVDC in all aspects	▫ Lecture through Black Board & LCD ▫ Discussion	Seminar/Mid Test (Week 9-10)
2	Type of HVDC Transmission systems. Components of HVDC transmission systems	CO-1	Types of HVDC Systems What are the different components of HVDC Systems Modern Trends HVDC Systems	▫ Lecture through Black Board & LCD ▫ Discussion	Seminar/Mid Test (Week 9-10)
3	Transmission interconnections power flow in an AC system, loading capability limits. Dynamic Stability Considerations. Importance of Controllable parameters. Basic types of FACTS controllers,	CO-1	Explain the dynamic Stability Considerations of FACTS Devices Explain the Power Flow in an AC Network What are the different Types of FACTS Devices	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 9-10)
4	Analysis of simple rectifier circuits. Required features of rectification circuits for HVDC transmission	CO-2	Required Features of HVDC Converter	▫ Lecture through Black Board & LCD ▫ Discussion	Seminar/Mid Test (Week 9-10)
5	Analysis of HVDC converter. a. Different modes of converter operation. b. Output voltage waveforms and DC voltage in rectification.	CO-2	Analyze the Greatz Circuit Analyze the Rectifier Voltage and Valve Voltages	▫ Lecture through Black Board & LCD ▫ Problem solving	Seminar/Mid Test (Week 9-10)
6	Analysis of HVDC converter a. Output voltage waveforms and DC in inverter operation. b. Thyristor voltages.	CO-2	Analyze the 12 Pulse Converter With necessary Diagrams and equations	▫ Lecture through Black Board & LCD Problem solving	Seminar/Mid Test (Week 9-10)
7	Equivalent Electrical Circuit of HVDC 12 Pulse Converter Operation	CO-2	derive the Equivalent Circuit of HVDC System	▫ Lecture through Black Board & LCD Problem solving	Seminar/Mid Test (Week 9-10)
8	Smoothing reactor and DC Lines. Reactive power requirements.	CO-2	What is the need for Requirement of Reactive Power Write about different types of Reactive Power sources	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 9-10)
9	HVDC system control features. Control Modes. Control Schemes. Control comparisons	CO-3	Explain the different control Strategies applied for HVDC system Explain and differentiate about the IPC and EPC modes of Firing	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 9-10)
10	**Seminar by the Students**				Seminar (Week 10)
11	**Mid-Test 1**				
12	Harmonic analysis. Filter design	CO-3	How harmonics are generated and what are the different Harmonics present in HVDC system and how are they eliminated	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 17-18)
13	Benefits from FACTS controllers. Objectives of Shunt Compensation. Midpoint Voltage Regulation. Voltage Instability Prevention, Improvement of transient stability. Power oscillation damping.	CO-4	Benefits of FACTS devices Define the Term Compensation and what are the Objectives of Shunt Compensations How a shunt Controller can Compensate	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 17-18)
14	Methods of controllable VAR generation. 1. Variable Impedance Type Static VAR Generators 2. Switching Converter Type VAR Generators 3. Hybrid VAR Generators.	CO-4	Explain about Variable Type of VAR Generators Explain about Switching Type of VAR Generators Explain about Hybrid Type of VAR Generators	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 17-18)
15	Concept of series capacitive compensation. Improvement of Transient Stability. Power oscillation and damping, sub-synchronous oscillation damping.	CO-5	Define the Term Compensation and what are the Objectives of Series Compensations How a Series Controllers improve Transient Stability, Power Oscillations damping and sub-synchronous Resonance	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 17-18)
16	Functional requirements of GTO Thyristor Controlled Series Capacitor(GCSC), Thyristor Switched Series Capacitor(TSSC) Thyristor Controlled Series Capacitor(TCSC) control schemes for GCSC TSSC and TCSC	CO-5	Explain about the control Schemes of GCSC,TSSC and TCSC	▫ Lecture through Black Board & LCD Discussion	Seminar/Mid Test (Week 17-18)
17	**STUDENTS SEMINAR**				Seminar (Week 17)
18	**Mid-Test 2**				
19/20	**END EXAM**				