Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-611**	**Title of the Course**	**FACTS DEVICES & HVDC TRANSMISSION**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the use of different power electronic devices in HVDC Transmission. • To impart knowledge of different Voltage Source Converters used in HVDC Transmission • To impart knowledge of different Self and Line Commutated Current Sourced Converters used in HVDC Transmission. • To understand working and characteristics of different FACTS devices used in HVDC Transmission. • To understand working and characteristics and comparison of Combined Compensators used in HVDC Transmission. To understand working of Interline power flow controller.						

Course Outcomes	
CO1	Understand the different type power electronic devices and their characteristics, used for FACTS controller, Recognized different issues in ac power transmission, .Implement of different FACTS controller for power flow control
CO2	Impart knowledge of working, control function and behavior under different loading condition of various type of Voltage Source Converters used in power Transmission,
CO3	Developed complete understanding of different type of Self and Line Commutated Current Sourced Converters used power flow control, Analyze between VSC & CSI
CO4	Explain basic objectives of using series and shunt compensator, Understand working, characteristics and control of different FACTS devices used in power transmission.
CO5	Understand working, characteristics and comparison of Combined Compensators used for power flow control, Explain the working and control of Interline power flow controller

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**FACTS concepts and General system considerations**	Introduction to power semiconductor devices: Diode, GTO, MOSFET, IGBT, MOS Controlled Thyristor; Transmission interconnection; Power flow in ac system; Power flow and dynamic stability considerations; Basic of FACTS controllers: Shunt, Series, Combined and other controllers; FACTS technology; HVDC or FACTS.	8	CO1
2	**Voltage Source Converters**	Basic concepts, Single phase full wave bridge converter operation, Three phase full wave bridge converter, Sequence of valve conduction process in each phase leg, Transformer connections for 12 pulse operation, Three level voltage sourced converter, PWM converter	8	CO2
3	**Self and Line Commutated Current Sourced Converters**	Basic concepts, Three phase full wave diode rectifier, Thyristor based converter, Rectifier and inverter operation valve voltage and commutation failure, Current sourced versus voltage sourced converters	8	CO3
4	**FACTS Devices**	Introduction, Objectives of shunt compensation, Methods of controllable VAR Generation, Static VAR Compensators, SVC and STATCOM, Static series compensators, TSSC, TCSC and SSC	8	CO4
5	**Combined Compensators**	Introduction, Unified power flow controller (UPFC), Conventional power control capabilities, Real and reactive power flow control, Comparison of UPFC to series compensators, Control structure, Dynamic performance, Interline power flow controller basic operating principles, Control structure, Application considerations.	8	CO5

Reference Books:

1.N.G. Hingorani and L. Ayugyi, "Understanding FACTS concepts and Technology of Flexible AC Transmission system", Standard Publication, New Delhi, 2001

2.K.R. Padiar, "HVDC power transmission", New Age International, 1990

3.J. Arrillaga, "High voltage direct current Transmission", IET digital library, 2nd Edition, 1998

4.E.W. Kimbark, "Direct Current transmission", Wiley-Blackwell, 1st Edition, 1971.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	1	2	1	2	2	1	1		2	2	1			
CO2	3	3	2	2	2	1	1	2	3	1	1		2	3				
CO3	3	3	1	1	2		1	2	2	1			2	2				
CO4	3	3	2	2	2			2	3	1			2	2	3			
CO5	3	3	2	2	2			2	2	1	1		2	3	2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	EE 612	**Title of the Course**	**POWER SYSTEM OPTIMIZATION**	1	0	4	**C**
Year	**2nd**	**Semester**	3rd	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	**1. Acquaint electric power engineering students with knowledge of optimization techniques** **2. Introduce students to the important Quadratic programming.** **3. Introduce Linear programming** **4. Introduce methods for Application of population based optimization techniques in power systems**						

Course Outcomes	
CO1	Understand the optimization techniques fundamentals
CO2	Develop quadratic programming
CO3	Analyze the performance linear programming problem
CO4	Analyze the performance of optimization algorithm
CO5	Understand the application of population based optimization techniques in power systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fundamentals of optimization techniques	Fundamentals of optimization techniques: Definition, Classification of optimization problems, Unconstrained and Constrained optimization, Optimality conditions, Classical Optimization techniques (Lamda Iteration method, Linear programming, Quadratic programming). Lamda iteration method: Brief introduction to Lamda iteration method, Formulation of the Lagrange function, Lamda iteration method to solve optimal dispatch problem.	8	CO1
2	Quadratic programming	Introduction to quadratic programming, Working principle, Sequential programming, Linear constrained optimization problem, Karush-Kuhn-Tucker conditions and its application to solve various problems, Interior point method, Lagrangian duality.	8	CO2
3	Linear programming	Examples of linear programming problem, The Simplex Method I, Fundamental theorem of linear programming, Weak and strong duality theorems, Integer programming, Network flow, Development of a linear programming model from problem description.	8	CO3
4	Particle Swarm Optimization	Fundamental principle; Velocity Updating; Advanced operators; Parameter selection; Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) - Binary, Discrete and combinatorial	8	CO4
5	Application of population based optimization techniques in power systems	Algorithms and flow chart of various optimization techniques for solving economic load dispatch and hydro-thermal scheduling problem.	8	CO5

Reference Books:

1. S. S. Rao, "Engineering Optimization", New Age International (P) Ltd, 3rd Edition, 2013.

2. S.N.Sivanandam & S.N. Deepa, "Principle of soft computing", 2nd Edition, 2011.

3. Jizhong Zhu, "Optimization on Power system Operation", Wiley-IEEE Press, 2nd Edition, 2015

4. K.P. Chong, Stanislaw H. Zak, "An Introduction to Optimization", Wiley online library, 3rd Edition, 2011.

e-Learning Source:

NPTEL

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	1	3						3	3	2	1	3		
CO2	3	3	3	2	1	1						2	3	2	2	2		
CO3	3	2	1	1	2	2	3					3	2	2	1	3		
CO4	3	2	2	2	3	3						2	3	3	1	2		
CO5	3	1	1	1	1	2	1					2	3	1	2	2		

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	**EE-616**	**Title of the Course**	**SCADA SYSTEMS AND APPLICATIONS**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	3	0	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications. • Investigate various industrial communication technologies.Learn and apply the SCADA Applications in various real life applications.						

Course Outcomes	
CO1	Understand the fundamentals of SCADA systems and its various functions.
CO2	Acquire knowledge regarding SCADA System Components and Programmable Logic Controller (PLC).Learn and discover how to set up industrial data communications networks
CO3	Increase knowledge of the key industrial communication protocols.Understand the different industrial communicationsnetworks used.And make aware of Security system in Communication.
CO4	Make aware students in the field of application.They become familiar to the SCADA system working, maintenance and desiredsecurity modes.

UnitNo.	**Title of the Unit**	**Content of Unit**	**ContactHrs.**	**MappedCO**
1	Introduction	Data acquisition system, Evaluation of SCADA (Supervisory Control and Data Acquisition system), Objectives, Benefits, Functions, Monitoring & Control usingSCADA.	8	CO1
2	SCADA system components	Communication Interface, Remote terminal unit, Intelligent electronic devices, Master station, HMI (Human machine interface system),PLC(Programmable LogicControllers),Sensors.	8	CO2
3	SCADA Communication	General Overview of SCADA Communications, Communications Network Options,Communication Security , Protocols in SCADA Communication, IEC 60870- 5, T101,DNP3 Protocol, Profibus, RP-570, Conitel, Modbus RTU, WebAccess HMI& SCADA features, Typical System Configurations(point to point, point to multipoint), Modes of Communication (Polled System,Interrupt system)	8	CO3
4	SCADA Applications	Automation of Electrical Distribution system, Substation control,Feeder control, EndUser load control automation by SCADA,Advantages of implementing SCADA system for electrical Distribution, Water Pumping Station,Oil & Gas Industry,WaterRecycling Plant Monitoring and Control.	8	CO4

Reference Books:

1. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 4th edition,2009.

2. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

3. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.

4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	1	2	1	2	2	1	1		2	2	1			
CO2	3	3	2	2	2	1	1	2	3	1	1		2	3				
CO3	3	3	1	1	2		1	2	2	1			2	2				
CO4	3	3	2	2	2			2	3	1			2	2	3			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-621**	**Title of the Course**	**SOFT COMPUTING IN SOLAR PV AND WIND ENERGY CONVERSION SYSTEMS**	**L**	**T**	**P**	**C**
Year	**2nd**	**Semester**	**3rd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge and concept of electricity generation through Solar PV system. • Use of soft computing techniques in electricity generation through Solar PV system. • Knowledge and concept of electricity generation through Wind energy conversion system. • Use of soft computing techniques in electricity generation through Wind energy. • Designing of hybrid power generation systems using soft computing						

Course Outcomes	
CO1	Know about the concept of electricity generation through Solar PV system.
CO2	Identify and apply soft computing techniques in electricity generation through Solar PV system
CO3	Know about concept of electricity generation through Wind energy conversion system.
CO4	Identify and apply soft computing techniques in electricity generation through Wind energy
CO5	Design hybrid power generation systems using soft computing.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Solar PV Energy Conversion Systems**	Solar PV Energy Conversion Systems Basics of Solar PV; PV Module Performance Measurements; Balance of System and Applicable Standards; Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System, PV-Hybrid Systems, Stand-Alone Hybrid AC Solar Power System with Generator and Battery Backup; Charge Controller; Batteries in PV Systems; Maximum Power Point Tracking Techniques.	8	CO1
2	**Soft Computing Techniques in Solar PV**	Soft Computing Techniques in Solar PV MPPT Using Fuzzy Logic controller (FLC), Description and Design of FLC, Neural Networks for MPP Tracking, Algorithm for ANN Based MPPT, Neuro-Fuzzy Based MPPT Method, Fuzzy Neural Network Hybrids, Theoretical Background of ANFIS, Architecture of Adaptive NeuroFuzzy Inference System, Hybrid Learning Algorithm.	8	CO2
3	**Wind Energy**	Wind Energy Conversion Systems Wind Characteristics; Wind Turbine; Fixed-Speed Wind Turbines; Variable-Speed Wind Turbines; Components of WECS; Types of Wind Turbine Generators; Power Converter Topologies for Wind Turbine Generators: Permanent Magnet Synchronous Generators, Doubly Fed Induction Generators; Grid Connection.	8	CO3
4	**Soft Computing Techniques in Wind Energy**	Soft Computing Techniques in Wind Energy Conversion Systems Prediction of Wind Turbine Power Factor, Problem Formulation, Artificial Neural Networks, Adaptive Neuro-fuzzy Inference System (ANFIS), Description of Profile Types, Design of the ANN, ANFIS for Prediction of Power Factor, Estimation of the Optimal Power Factor, Pitch Angle Control, Fuzzy Logic Controllers, Genetic Algorithms, Genetic Algorithm Controller for Pitch Angle Control, Fuzzy Logic Based MPPT Controller.	8	CO4
5	**Hybrid Energy Systems**	Hybrid Energy Systems Need for Hybrid Energy System, Architecture of Solar-Wind Hybrid System, Small Domestic Power Grid Based on Hybrid Electrical Power, Small Industrial Power System Based on Hybrid Renewable Energy, Fuzzy Logic Controller for Hybrid Power System, Design Considerations, Intelligent Controller.	8	CO5

Reference Books:

1.S. Sumathi, L. Ashok Kumar, P. Surekha, “Solar PV and Wind Energy Conversion Systems”, Springer International Publishing, Switzerland, 2015.

2. Ashok Desai V., “Non-Conventional Energy”, Wiley Eastern Ltd., 1990.

3. Mittal K.M., “Non-Conventional Energy Systems”, Wheeler Publishing Co. Ltd., 1997.

4. Ramesh R., Kurnar K.U., “Renewable Energy Technologies”, Narosa Publishing House, New Delhi, 1997

5. B. H. Khan, “Non-Conventional Energy Resources”, TMH Education Private Ltd., New Delhi, 2009.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	1	1	3	3	1					3	3	2			
CO2	3	2	2	2	3	3	3						2	3	1			
CO3	3	2	2	1	1	3	3	1					2	3	3			
CO4	3	2	2	2	3	3	3						2	3	2			
CO5	3	3	3	3	3	3	2						2	3	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation