Integral University, Lucknow

ELECTRICAL ENGINEERING

				Effective from Session	2022-2023			
Course Code	**EE 513**	Title of The Course	**Advance Power Electronics**	L	T	P	C	
Pre-Requisite	None	Co-Requisite	None	4	0	0	4	

Objective	Knowledge and concept of voltage source inverter. Use of switching techniques/schemes and current source inverters. Knowledge and concept of multilevel inverters, its applications and control Identify and apply concept of resonant converters. Knowledge of synchronous rectifiers and matrix converters.

	Course Outcomes
CO1	Know about the concepts of voltage source inverter
CO2	Identify and apply switching techniques/schemes and current source inverters
CO3	Know about concept of multilevel inverters, its applications and control.
CO4	Identify and apply concept of resonant converters
CO5	Know about synchronous rectifiers and matrix converters.

S.No.	Content	Contact Hrs.	Mapped CO
1	**Switch-Mode Inverters:** Basic concepts of voltage source inverter (VSI), current source inverters (CSI), single phase half bridge, full bridge and three phase bridge inverters.	8	CO1
2	**Switching Strategies:** PWM switching strategies, Selective Harmonic Elimination method, other inverter switching schemes, Modulation index, Modulation frequency and its effect on switching	8	CO2
3	**Multi Level Inverters:** Need for multilevel inverters, Types, three level, five level inverter operation and analysis. Applications of multilevel inverters and control.	8	CO3
4	**Resonant Converters:** Basic resonant circuit concepts, Load resonant converters, series and parallel, resonant switch converters – Zero voltage switching (ZVS), Zero current switching (ZCS), comparison of resonant converters.	8	CO4
5	**Miscellaneous Converters:** Multilevel converters topologies: Cascaded, NPC, Flying Capacitor MLI, Synchronous rectifiers, matrix converters,	8	CO5
References Books:			

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1. Ned Mohan, "Power Electronics Converters, Applications, and Design" John Wiley (SEA), 3rd Ed 2014.
2. M. H. Rashid "Power Electronics" PHI Learning
3.G. K. Dubey, "Power Semi-Conductor Controllers", Wiley Eastern, 2nd Edition, 2012.
4.R W Erickson and D Maksimovic "Fundamental of Power Electronics" Springer, 2ndEdition.
5. M.H. Rashid, "Hand book of Power Electronics", 4th Edition,2013.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	3	3	1				1	2	2
CO2	3	2	2	2	3	3	3					1	2	2
CO3	3	2	2	1	1	3	3	1				1	2	1
CO4	3	2	2	2	3	3	3					3	2	1
CO5	3	3	3	3	3	3	2					2	3	1

3: Strong contribution, 2: average contribution, 1: Low contribution

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ELECTRICAL ENGINEERING

				L	T	P	C
		Effective from Session	2022-2023				
Course Code	**EE 514**	Title of The Course	**Power Apparatus & System Modelling**				
Pre-Requisite	None	Co-Requisite	None	4	0	0	4

Objective	To develop knowledge on principles ofmodelling ofsynchronous generators To understand the fundamental concepts ofapplication of Parks transformation To provide advanced knowledge and understanding about the models of transmission line, transformer and load To analyze governors for thermal and hydropower plant To evaluate the performance of different excitation systems

	Course Outcomes
CO1	Understands the basic concept of modelling of synchronous generators
CO2	Apply Parks transformation technique
CO3	Understand different models of transmission line, transformer and load
CO4	Analyze governors for thermal and hydro power plant
CO5	Evaluate the performance of AC and DC excitation system

No.	Content	Contact Hrs.	Mapped CO
1	**Synchronous Generator Modeling:** Schematic diagram, equivalent circuit, Starting method, balanced operation, Park's transformation (dqo transformation)	8	CO1
2	**Dynamic Modeling of Synchronous Generator:** Modeling of synchronous generator with damper windings; Synchronous Machine Parameters: operational and standard, Effect of Saturation on Synchronous Machine Modelling.	8	CO2
3	**Modelling of Excitation systems:** Excitation system requirements, Types of Excitation system, Control and protective function of Excitation system, Modelling of various Excitation system, IEEE type various DC, AC and Static models.	8	CO3
	Prime Movers Modelling:	8	CO4

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4	**Steam turbine and Governing system:** Various configurations of Steam turbine of fossil- fueled and nuclear units, Modelling of Steam turbine and its governing systems. **Hydraulic turbine and Governing system :** Hydraulic turbine transfer function, linear and Non- linear turbine model, Modelling of Governors for Hydraulic turbine		
5	**Modelling of Other Power System Components:** Induction Motor, Synchronous Motor, Transformers, transmission lines, Static and Dynamic loads, Selected FACTS Controllers (SVC and TCSC).	8	CO5

References Books:

1. A.A. Foud& P.M. Anderson, "Power System Stability and Control", Galgotia Press, New Delhi, 2014.

2. L.P. Singh, "P.S. Analysis & Dynamics", Wiley Eastern, Delhi, 2014

3. P. Kundur, "Power System Stability and Control", Mc-Graw Hill, 2010

4. K.R. Padiyar, "Power System Dynamics: Stability and Control", B.S. Publications, 2008

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2		1								3	2	3
CO2	3	2						1				3	2	2
CO3	3	1									2	3	2	3
CO4	3	2									1	3	2	2
CO5	3	2						1				3	2	3

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ELECTRICAL ENGINEERING

				Effective from Session		2022-2023		
Course Code	**EE 515**	Title of The Course	**Advance Power System Analysis**	L	T	P	C	
Pre-Requisite	NONE	Co-Requisite	NONE	4	0	0	4	

Objective	Knowledge of graph theory, bus admittance and impedance matrices Knowledge of algorithm of bus impedance matrix and short circuit studies usingthree-phase Impedance ZBUS Knowledge of power flow solutions Knowledge of Contingency and security studies Knowledge of Modern energy control Techniques

	Course Outcomes
CO1	Solve the problem of graph theory, bus admittance and impedance matrices
CO2	Able to attain the knowledge of algorithm of bus impedance matrix and short circuit studies using three-phase Impedance Z_{BUS}
CO3	Able to solve the problems of power flow solutions
CO4	Having knowledge of Contingency and security studies
CO5	Having knowledge of Modern energy control Techniques

No.	Content	Contact Hrs.	Mapped CO
1	Introduction: System graph, loop, cut-set and incidence matrices; Algorithms for the formation of bus admittance and impedance matrices, Three-phase Admittance YBUS and Impedance ZBUS matrices;Optimal load flow	8	CO1
2	Power flow solutions: Gauss-Seidel, Newton-Raphson, Approximation to Newton-Raphson Method, Line flow equations and Decoupled and Fast decoupled techniques.	8	CO2
3	Fault Analysis: Symmetrical faults, Fault calculations using ZBUS, Unsymmetrical faults-Problems on various types of faults.	8	CO3
4	Contingency and security studies: Factors affecting security, State transition diagram, Contingency analysis using network sensitivity method and AC power flow method.	8	CO4
5	Modern energy control Techniques: Modern energy control centres, Introduction to	8	CO5

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	Supervisory Control and Data Acquisition in power systems(SCADA), benefit of SCADA, Remote terminal and connection, Human machine interface		

References Books:

1. G.W. Stagg & A.H. Al-Abiad, "Computer Methods in Power Systems", Mc-Graw Hill, 1998.
2. Haadi Sadat, "Power System Analysis", Tata McGraw Hill, 2002
3. M.A. Pai, "Computer Techniques in Power System Analysis", Tata McGraw Hill, 2014
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill, 2014

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CO1	2	3	3	3		2						2	2	2
CO2	2	3	3	3		2						2	3	2
CO3	1	3	3	3		2						2	2	2
CO4	1	2	3	3		2						1	2	3
CO5	2	3	3	3		2						1	3	3

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ELECTRICAL ENGINEERING

				Effective from Session		2022-2023		
Course Code	**EE 611**	Title of The Course	**FACTS DEVICES & HVDC TRANSMISSION**		L	T	P	C
Pre-Requisite	None	Co-Requisite	None		4	0	0	4

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

No.	Content	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	8	CO2

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	each phase leg, Transformer connections for 12 pulse operation, Three level voltage sourced converter, PWM converter.		
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,SSSC, TSSC & TCSC, Basic concept of phase angle regulator, Power flow control by Phase angle regulators.	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

References 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.

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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

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