Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-513**	**Title of the Course**	**Advance Power Electronics**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• 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.

Unit No.	**Title of the Unit**	**Content of Unit**	**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

Reference Books:

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.

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					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			

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

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-514**	**Title of the Course**	**Power Apparatus & System Modelling**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To develop knowledge on principles of modelling of synchronous generators • To understand the fundamental concepts of application of Parks transformation • To provide advanced knowledge and understanding about the models of transmission line, transformer and load • To analyze governors for thermal and hydro power 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

Unit No.	**Title of the Unit**	**Content of Unit**	**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
4	**Prime Movers Modelling**	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	8	CO4
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
Reference 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				
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		1								3	3	2	3			
CO2	3	2						1				3	3	2	2			
CO3	3	1									2	3	3	2	3			
CO4	3	2									1	3	3	2	2			
CO5	3	2						1				3	3	2	3			

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

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE-515**	**Title of the Course**	**Advance Power System Analysis**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of graph theory, bus admittance and impedance matrices • Knowledge of algorithm of bus impedance matrix and short circuit studies using three-phase Impedance Z_{BUS} • 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

Unit No.	**Title of the Unit**	**Content of Unit**	**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 Supervisory Control and Data Acquisition in power systems(SCADA), benefit of SCADA, Remote terminal and connection, Human machine interface	8	CO5

Reference 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

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	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			

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-517**	**Title of the Course**	**POWER SYSTEM DYNAMICS & CONTROL**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**1st**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand the students about dynamics of Power systems. To develop ability for analysis of system stability and obtain the solution of transient problems. • To analyze the modeling of synchronous machine by applying fundamental law's. • To realize and examine the excitation systems and response the behavior of prime mover controllers in different system. • To recognize the concepts of dynamics of synchronous generator Connected to Infinite Bus by investigation in real time domain. • To execute the analysis of transient and voltage stability by various parameters and comparison with angle stability.						

Course Outcomes	
CO1	Given a Power System Dynamics Problems, students shall be able to represent this in various conventional models, identify type of system, apply vector algebra, and formulate the expression in different System Model and solve using mathematical terms.
CO2	Given a Modeling of Synchronous Machine with sources, student shall be able to analyze System Simulation and evaluate the Steady State Performance using Equivalent Circuit of Synchronous Machine
CO3	For a Excitation systems & Prime Mover Controllers, student shall be able to generate its analytical response by Standard Block Diagram and examine, analyze and evaluate the characteristics by State Equations and Load Modeling.
CO4	For Stator Equation, select suitable design of application of Network Equation, develop various combination for System Simulation Small Signal and large signal analysis with Block Diagram Representation for Single Machine System,
CO5	Given a Modeling and Analysis of Transient and Voltage Stability, student shall be able to define its Stability Evaluation, solve/ analyze, and modify energy functions for direct stability evaluation;

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Analysis of Dynamical Systems**	Concept of Equilibrium, Small and Large Disturbance Stability, Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using Numerical Integration Techniques, Issues in Modelling: Slow and Fast Transients, Stiff Systems.	8	CO1
2	**Modelling of a Synchronous Machine**	Physical Characteristics, Rotor Position Dependent model, D-Q Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, and Synchronous Machine Connected to Infinite Bus.	8	CO2
3	**Modelling of Excitation and Prime Mover Systems**	Physical Characteristics and Models, Control system components, Excitation System Controllers, Prime Mover Control Systems.	8	CO3
4	**Modelling of Transmission Lines and Loads**	Transmission Line Physical Characteristics, Transmission Line Modelling, Load Models - induction machine model, Other Subsystems - HVDC, protection systems.	8	CO4
5	**Stability Issues in Interconnected Power Systems**	Single Machine Infinite Bus System, Multi-machine Systems, Stability of Relative Motion. Frequency Stability: Centre of Inertia Motion, Single Machine Load Bus System: Voltage Stability, Torsional Oscillations, Real-Time Simulators.	8	CO5

Reference Books:

1. K.R.Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.

2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.

3. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

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

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-518**	**Title of the Course**	**Computer Aided Power System Analysis**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Determination of network sensitivity, • Analyze load flow using iterative methods • Fault analysis estimation						

Course Outcomes	
CO1	Analysis of power system network in term of matrices
CO2	Load flow analysis using iterative methods
CO3	Analysis of fault under balance and unbalanced condition
CO4	Estimation of the state of the power system using statistical tools
CO5	Analysis of load frequency control for single area and multi area system

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Solution of Linear Systems and Contingency Analysis, Matrix representation of power systems, Triangularization, Gaussian elimination, LU and LDU factorization LDLT decomposition for sparse Matrices, Optimal ordering, Overview of Security Analysis, Linear Sensitivity Factors, Contingency Selection, Calculation of Network Sensitivity Factors.	8	CO1
2	**Load Flow**	Load Flow Analysis Newton–Raphson iteration, Power system applications: Power flow, Formulation of Bus admittance matrix, regulating transformers, Gauss-Seidel, Newton-Raphson and Fast Decoupled methods of power flow, Treatment of voltage-controlled buses, Accelerating factors, DC load flow.	8	CO2
3	**Power flow solutions**	Short Circuit Studies, System Representation, Algorithm for formation of bus impedance matrix, Balanced fault, Sequence impedances of power system components, Unbalanced fault Analysis.	8	CO3
4	**Power System State Estimation**	Power System State Estimation, Power system state estimator, Method of Least Squares, Statistics, Errors and Estimates, Test for bad data, Network Topology Processing.	8	CO4
5	**Modern control Techniques**	Unit Commitment and Load Frequency Control, Constraints in UC, Solution Methods of UC, Automatic Load Frequency Control of Single Area System and Multi Area System, Steady State Instabilities.	8	CO5

Reference Books:

1. Hadi Saadat, “Power System Analysis”, Tata Mc Graw Hill, 2003.

2. A. J. Wood and B.F.Wollenberg, “Power Generation Operation and Control”, John Wiley & Sons, ICN., 2nd Edition.

3. A. K.Mahalanabis, “Computer Aided Power system analysis and control”, Tata McGraw Hill 1991 4. John J. Grainger, William D. Stevenson, JR. “Power System Analysis”, McGraw Hill, 1994.

5. Elgerd olleI, “Electric Energy Sytems Theory- An Introduction”, Tata Mc Graw Hill, 2ed. 1995.

6. I. J. Nagrath & D.P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill,1989

7.Wadhwa C L, “Electrical Power Systems”, New Age Publication, 3ed., 2002

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

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-519**	**Title of the Course**	**ADVANCE RELAYING AND PROTECTION**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Apply the knowledge of relays in power system protection						

Course Outcomes	
CO1	To learn the basics of relays
CO2	Knowledge of relay applications
CO3	Knowledge of protection of generator, motors and transformers
CO4	Study of different types of system grounding, faults and protection
CO5	Knowledge of digital relays

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Protective Relaying**	Relay terminology, Definitions, Classification, electromechanical, static and digital-numerical relays. Design-factors affecting performance of a protection scheme; faults-types and evaluation, Instrument transformers for protection.	8	CO1
2	**Relay Schematics and Analysis**	Over Current Relay- Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays- Restraining Characteristics; Distance Relays: Types- Characteristics.	8	CO2
3	**Protection of Power System Equipments**	Generator, Transformer, Transmission Systems, Busbars, Motors; Pilotwire and Carrier Current Schemes.	8	CO3
4	**System Grounding**	Ground faults and protection; Load shedding and frequency relaying; Out of step relaying; Re-closing and synchronizing.	8	CO4
5	**Basic Elements Of Digital Protection**	Digital signal processing, Digital filtering in protection relay, Digital Data transmission, Numeric relay hardware, relay algorithm, distance relays, direction comparison relays, differential relays, software considerations, numeric relay testing.	8	CO5

Reference Books:

1. A T John and A K Salman-Digital protection for power systems-IEEE power series-15, Peter Peregrines Ltd, UK,1997
2. C.R. Mason, The art and science of protective relaying, John Wiley &sons, 2002
3. Donald Reimert, Protective relaying for power generation systems, Taylor & Francis-CRC press 2006
4. Gerhard Ziegler-Numerical distance protection, Siemens, 2nd ed, 2006
5. A.R.Warrington, Protective Relays, Vol .1&2, Chapman and Hall, 1973
6. T S.Madhav Rao, Power system protection static relays with microprocessor applications, Tata McGraw Hill, 1994
7. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marce Dekker, Inc. 1995
8. Badri Ram , D.N. Vishwakarma, Power system protection and switch gear, Tata McGraw Hill, 2001.

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

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-520**	**Title of the Course**	**ADVANCE RELAYING AND PROTECTION**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To provide students the knowledge of optimization techniques used in the power system and Load Frequency Control (LFC) • To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models. • To provide the knowledge of Hydrothermal scheduling, reactive power control,basic objective of security in power generation operation and control, review of optimization, economic dispatch problems, formulation of optimal power flow problems, and their solution methods.						

Course Outcomes	
CO1	Optimization, network and economic analysis of power system network.
CO2	Analyze and implement the power flow problem and its solution. Introduce the coordination equations, incremental losses, and penalty factors.
CO3	Understand the constraints in unit commitment and implementation these constraints for solving the different solution methods for unit commitment problem.
CO4	Understand, analyze hydro generator coordination problem and generation rescheduling
CO5	Knowledge of modern power system and the factors needed for updation

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Characteristics of power generation units(thermal, nuclear, hydro, pumped hydro), variation in thermal unit characteristics with multiple valves, Economic dispatch with and without line losses, lambda iteration method, gradient method, Newton's method, base point and participation factor	8	CO1
2	**Transmission losses**	Co-ordination equations, incremental losses, penalty factors, B matrix loss formula (without derivation), methods of calculating penalty factors.	8	CO2
3	**Unit commitment**	Constraints in unit commitment, priority list method, Dynamic programming method and Lagrange relaxation methods. Generation with limited energy supply, take or pay fuel supply contract, composite generation production cost function, gradient search techniques.	8	CO3
4	**Hydrothermal co-ordination:**	Scheduling energy, short term hydrothermal scheduling, lambda-gamma iteration method, gradient method, cascaded hydro plants, pumped storage hydro scheduling.	8	CO4
5	**Optimal power flow formulation**	Gradient and Newton method, linear programming methods. Automatic voltage regulator, load frequency control, single area system, multi-area system, tie line control.	8	CO5
Reference Books:				

1. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc.,2003.
2. Olle.I.Elgerd, 'Electric Energy Systems theory – An introduction', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
3. Abhijit Chakrabarti, Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
4. Abhijit Chakrabarti, Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
5. N.V.Ramana, "Power System Operation and Control," Pearson, 2011.

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

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-521**	**Title of the Course**	**High Voltage Testing Techniques**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of different types of HV testing methods used in testing electrical equipment's						

Course Outcomes	
CO1	Determination of switching surges using impulse testing on generators
CO2	Determination of voltage time characteristics for different specimens
CO3	Determination of voltage time characteristics for insulators, bushings etc.
CO4	Analyze the results of impulse and p.f. tests on dielectrics
CO5	Analyze the transformers, capacitors and cables with different types of HV tests

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Generation of High Voltages and Currents**	Need and importance of impulse testing. Study of impulse voltage and current generators -- Generators for Lightning and Switching Impulse Voltages, Chopped Impulse Voltages, Steep-Front Impulse Voltages, Exponential Impulse Currents, Rectangular Impulse Currents. .	8	CO1
2	**Volt-time characteristics I**	Method of wave shaping and oscillographic measurement; Volt-time characteristics of rod-rod, sphere-sphere, rod-plane gaps.	8	CO2
3	**Volt-time characteristics II**	Volt-time characteristics of insulators, bushings, gaps of positive and negative polarity, horn gap, rod gap, lightning arresters – expulsion type, valve type.	8	CO3
4	**Testing Techniques I**	Current testing of lightning arresters – Long duration impulse current test, Operating Duty Cycle Test; Testing of dielectrics – Power frequency tests, Impulse tests; Applications of insulating materials.	8	CO4
5	**Testing Techniques II**	Testing of transformers – Induced over voltage test, Partial discharge test, Impulse test; Testing of Capacitors; Testing of Cables - Dielectric Power Factor Test, High Voltage Tests, Partial discharge measurement.	8	CO5
Reference Books:				
1. M.S. Naidu & V. Kamaraju, "High Voltage Engineering", McGraw-Hill, 2014				
2. C.L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2014				
3. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India, 2004.				
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	2	2	3										1	2	1			
CO2	2	3	2										1	1	1			
CO3	3	2	2										1	1	1			
CO4	2	2	3										1	1	1			
CO5	3	2	3										1	1	1			

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-522**	**Title of the Course**	**High Voltage Testing Techniques**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of different types of HV testing methods used in testing electrical equipment's						

Course Outcomes	
CO1	Knowledge of different types of power system stability
CO2	To get knowledge of energy function
CO3	To attain knowledge of modelling of machines
CO4	To study about power system stabilizer
CO5	To have the knowledge of voltage stability

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power System Stability**	States of operation, Basic concepts of angular and voltage stability. Angular stability: Analysis of single machine and multi-machine systems for transient stability.	8	CO1
2	**Energy function**	Digital simulation and energy function methods. Energy function analysis of single machine system. Small signal stability (dynamic stability)	8	CO2
3	**Modeling of machines**	Modeling for single machine and multi-machine systems, Synchronizing and damping torque analysis, Eigen value and time domain analysis.	8	CO3
4	**Power System Stabilizer (PSS)**	Mitigation using power system stabilizer and FACTS controllers. Basic concepts in applying PSS, Control Signals, Structure and tuning of PSS Introduction to sub synchronous resonance.	8	CO4
5	**Voltage stability**	Power-Voltage (P-V) and Reactive Power-Voltage (Q-V) curves, static analysis, sensitivity and continuation method. Dynamic analysis.	8	CO5
Reference Books:				
1. P. Kundur Power System Stability and Control, Mc - Graw Hill .				
2. K. R. Padiyar Power System Dynamics, Stability & Control, Interline Publishers, Bangalore				
3. P. Saur and M. A. Pai Power System Dynamics & Stability, Prentice Hall				
4. G.W. Stagg & A.H. Al Abiad Computer Methods in Power System, Mc - Graw Hill				
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	1	1	1	1	1	1				3			2	2			
CO2	3	3	3	2	2	1					3		1	2				
CO3	3	2	2	2	2	1					3		2	3				
CO4	3	1	1	1	1	1	1				3			2	3			
CO5	3	1	1	1	1	1	1				3			2				

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE-523**	**Title of the Course**	**Advance Electric Drives**	**L**	**T**	**P**	**C**
Year	**1st**	**Semester**	**2nd**	4	0	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of AC and DC drives • Evaluate performance of drives • Modelling of drives using software						

Course Outcomes	
CO1	Analyze the motoring and braking operation in drives
CO2	Control the motors using different methods
CO3	Mathematical modelling of different drives topologies
CO4	Analyze the drives under unbalanced condition
CO5	Analyze different types of SM drives

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**DC Motor Drive**	Characteristics of different dc motors: their speed control and braking operations: Converter fed dc motor drives: Analysis for motoring and braking operations. Dynamic modelling of dc motor drives; Closed-loop control; Dual converter fed dc motor drives.	8	CO1
2	**Induction Motor Drive I**	Equivalent circuit; Performance & Characteristics under motoring and braking operations. Speed control methods and their analysis: voltage control, V/f control, static-rotor resistance control	8	CO2
3	**Induction Motor Drive II**	Field Oriented Control of IM: configurations, mathematical modelling. VSI- and CSI- based schemes, Slip-power recovery schemes: static Scherbius and Kramer drives, Doubly-fed IM drive.	8	CO3
4	**Synchronous Motor Drives I**	Equivalent circuit, motoring and braking operations, Operations with non-sinusoidal power supplies; Speed control	8	CO4
5	**Synchronous motor drives II**	Load Commuted Inverter (LCI) fed synchronous motor drives, Switched and Synchronous reluctance motor drives	8	CO5

Reference Books:

1. "Power Electronics and Motor Drives – Advances and Trends" IEEE Press, 2006 by B.K. Bose.
2. "Power S.C.drives" Prentice-Hall 1989 by G.K. Dubey.
3. "Electric Motor Drives", , Modeling, Analysis and Control", Prentice Hall of India, 2002 by R. Krishnan
4. "High Power Converters and AC Drives"IEEE Press, A John Wiley and Sons, Inc., 2006 by Bin Wu.

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

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

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE524**	**Title of the Course**	**Advance Power Electronics Lab**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	II	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with the Phase control of SCR using RC triggers circuit • To understand the working of SMPS and its output characteristics • To understand the DC Converters and dual converters • To understand the use of single phase converter. • To understand the application of VSI in three phase machines.						

Course Outcomes	
CO1	Adopt, perform, analyze the use of Phase control of SCR using RC triggers circuit
CO2	Adopt, perform, analyze the working of SMPS and its output characteristics
CO3	Adopt, perform, analyze the DC Converters and dual converters
CO4	Adopt, perform, analyze the use of single phase converter.
CO5	Adopt, perform, analyze the application of VSI in three phase machines.

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study the Phase control of SCR using RC triggers circuit	2	1
2		To study the working of SMPS and plot output characteristics	2	2
3		To study the speed control of single phase dual converter	2	3
		To obtain the output of chopper (step-down) based on DC shunt motor Drive using SIMULINK	2	3
4		To study the speed control of separately excited DC motor by using single phase full bridge converter	2	4
5		To study speed control of 1- phase induction motor using single phase AC voltage converter	2	4
6		Obtain the output of half wave converter (single phase) based on DC shunt motor Drive using SIMULINK	2	4
7		To study the speed control of three phase squirrel cage induction motor using VSI	2	5

Reference Books:

1. Ned Mohan, Tore M, Undelnad, William P, Robbins (3rd Edition), "Power Electronics: Converters, Applications and Design," Wiley 2002.

2. L. Umanand, Power Electronics - Essentials and Applications; Wiley India Pvt. Ltd, Reprint Edithion, 2014

3. P.C Sen.,' Modern Power Electronics ', Wheeler publishing Co, First Edition, New Delhi, 1998.

4. M H Rashid, Power Electronics - Circuits, Devices and Applications; PHI, New Delhi, 3rd Edition, 2004

e-Learning Source:

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

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