ELECTRICAL ENGINEERING M.Tech. 1st Year/1st Semester

				Effective from Session			2017-18	
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), single phase half bridge, full bridge and three phase bridge inverters, PWM modulation strategies, Sinusoidal PWM.	8	CO1
2	**Space Vector Modulation:** Selective Harmonic Elimination method, other inverter switching schemes, blanking time, Current source inverters.	8	CO2
3	**Multi Level Inverter:** Need for multilevel inverters, three level and four level inverter operation and analysis. N level inverter topology. Applications of multilevel inverters and control. Four leg inverters.	8	CO3
4	**Resonant Converters:** Basic resonant circuit concepts, Load resonant converters, series and parallel loaded, resonant switch converters –Zero voltage switching (ZVS), Zero current switching (ZCS), comparison of resonant converters	8	CO4
5	**Miscellaneous Converters:** Synchronous rectifiers, matrix converters, multilevel converters topologies.	8	CO5

References 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.

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/1st Semester

				Effective from Session	2017-18		
Course Code	**EE-514**	Title of The Course	**Power Apparatus & System Modelling**	**L**	**T**	**P**	**C**
Pre-Requisite	None	Co-Requisite	None	4	0	0	4

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

S.No.	**Content**	**Contact Hrs.**	**Mapped CO**
1	**Modeling of synchronous generator:** Schematic diagram, starting method, equivalent circuit, balanced operation, parks transformation, direct-quadrature-zero (dq0) variable.	8	CO1
2	**Modeling of synchronous generator with damper winding:** Representation of synchronous machine dynamics, Harmonic winding distribution, Damper bars, Stator and rotor winding flux linkage equation.	8	CO2
3	**Modeling of transformers transmission line and loads:** single phase and three phase transformer, Transmission line with three conductors and composite conductors, transmission line model, effect of load in transmission line.	8	CO3
4	**Modeling of Governors for thermal and hydro power systems:** Turbine Governor, Steam operations, frequency control action, hydraulic turbine modeling. Model verification.	8	CO4
5	**Modeling of excitation system:** Functions of excitation system, Excitor and Voltage regulator, Excitation system stabilizer, Transient gain reduction (TGR), types of excitation systems: DC, AC and Static.	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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/1st Semester

				Effective from Session	2017-18			
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 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

S.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	8	CO1
2	**Load Flow**: Optimal load flow, Three-phase Admittance Y_{BUS} and Impedance Z_{BUS} matrices; Short circuit studies using three-phase Impedance Z_{BUS}	8	CO2
3	**Power flow solutions**: Gauss-Seidel, Newton-Raphson, Approximation to Newton-Raphson Method, Line flow equations and Decoupled and Fast decoupled techniques.	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

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

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/1st Semester

				Effective from Session		2017-18		
Course Code	**EE517**	Title of The Course	**POWER SYSTEM DYNAMICS & CONTROL**	**L**	**T**	**P**	**C**	
Pre-Requisite	NONE	Co-Requisite	NONE	4	0	0	4	

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;

S.No.	**Content**	**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

References 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.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/2nd Semester

				Effective from Session		2017-18		
Course Code	**EE518**	Title of The Course	**Computer Aided Power System Analysis**	**L**	**T**	**P**	**C**	
Pre-Requisite	None	Co-Requisite	None	4	0	0	4	

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

S.No.	**Content**	**Contact Hrs.**	**Mapped CO**
1	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 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	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 estimator, Method of Least Squares, Statistics, Errors and Estimates, Test for bad data, Network Topology Processing.	8	CO4
5	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

References 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

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/2nd Semester

			Effective from Session	2017-18			
Course Code	**EE-519**	Title of The Course	**ADVANCE RELAYING AND PROTECTION**	**L**	**T**	**P**	**C**
Pre-Requisite	None	Co-Requisite	None	4	0	0	4

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

S.No.	**Content**	**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

References 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.

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/2nd Semester				Effective from Session		2017-18	
Course Code	**EE-520**	Title of The Course	**POWER GENERATION OPERATION AND CONTROL**	**L**	**T**	**P**	**C**
Pre-Requisite	None	Co-Requisite	None	4	0	0	4

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.
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

S.No.	**Content**	**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

References 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.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/2nd Semester

				Effective from Session	2017-18			
Course Code	**EE-521**	Title of The Course	**High Voltage Testing Techniques**	**L**	**T**	**P**	**C**	
Pre-Requisite	None	Co-Requisite	None	4	0	0	4	

Objectives	• Knowledge of different types of HV testing methods used in testing electrical equipments

	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

S.No.	**Content**	**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

References 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.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/2nd Semester

				Effective from Session		2017-18	
Course Code	**EE-522**	Title of The Course	**POWER SYSTEM STABILITY**	**L**	**T**	**P**	**C**
Pre-Requisite	NONE	Co-Requisite	NONE	4	0	0	4

Objectives	• Knowledge of different types of power system stability • To get knowledge of energy function • To attain knowledge of modelling of machines • To study about power system stabilizer • To have the knowledge of voltage stability

	Course Outcomes
CO1	Understand the power system stability
CO2	Understand the energy function
CO3	Knowledge of single and multi-machine system
CO4	Knowledge of power system stabilizer
CO5	Knowledge of voltage stability

S.No.	**Content**	**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

References 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

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
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	

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

ELECTRICAL ENGINEERING M.Tech. 1st Year/2nd Semester

				Effective from Session	2017-18			
Course Code	**EE 523**	Title of The Course	**Advance Electric Drives**		**L**	**T**	**P**	**C**
Pre-Requisite	None	Co-Requisite	None		4	0	0	4

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

S.No.	**Content**	**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

References 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.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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		

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

ELECTRICAL ENGINEERING M.Tech. 2nd Year/3rd Semester

				Effective from Session		2017-18	
Course Code	**EE611**	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

S.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 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

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.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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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ELECTRICAL ENGINEERING 2nd Year/3rd Semester

			Effective from Session		2017-18		
Course Code	**EE621**	Title of The Course	**SOFT COMPUTING IN SOLAR PV AND WIND ENERGY CONVERSION SYSTEMS**	**L**	**T**	**P**	**C**
Pre-Requisite	None	Co-Requisite	None	4	0	0	4

Objective	• 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.

S.No.	**Content**	**Contact Hrs.**	**Mapped CO**
1	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 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 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 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 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

References 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.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO 2	PSO3
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

2

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