Institute of Engineering and Technology Lucknow

M. Tech.

(POWER & ENERGY SYSTEM)

First Year Syllabus

Based on
CHOICE BASED CREDIT SYSTEM (CBCS) & NEP2020
(Effective from the session: 2023-24)

Department of Electrical Engineering
Institute of Engineering and Technology, Lucknow
(Constituent Institute of Dr. A.P.J. Abdul Kalam Technical University, Lucknow)

Semester - I													
S. No.	**Subject Code**	**Name of Subject**	**Periods**				**Evaluation Scheme**						
							Theory			**Practical**		**Subject Total**	
			L	**T**	**P**	**Credit**	**CT**	**TA**	**ESE**	**TA**	**ESE**		
1	MAPE101	Advanced Power System Analysis	4	0	0	4	20	10	70	-	-	**100**	
2	MAPE102	Solar Energy Conversion System	4	0	0	4	20	10	70	-	-	**100**	
3	MAPE011 - MAPE014	Departmental Elective-I	4	0	0	4	20	10	70	-	-	**100**	
4	MARM101	Research Process & Methodology	4	0	0	4	20	10	70	-	-	**100**	
5	MAPE151	Advanced Power System Simulation Lab	0	0	3	2	-	-	-	50	50	**100**	
6	MAPE152	Renewable Energy Lab	0	0	3	2	-	-	-	50	50	**100**	
TOTAL	**Contact Hours: 22**					**20**						**600**	

Semester - II												
S. No.	**Subject Code**	**Name of Subject**	**Periods**				**Evaluation Scheme**					
							Theory			**Practical**		**Subject Total**
			L	**T**	**P**	**Credit**	**CT**	**TA**	**ESE**	**TA**	**ESE**	
1	MAPE201	Advanced Power Electronics	4	0	0	4	20	10	70	-	-	**100**
2	MAPE202	Wind Energy Conversion System	4	0	0	4	20	10	70	-	-	**100**
3	MAPE021-MAPE024	Departmental Elective-II	4	0	0	4	20	10	70	-	-	**100**
4	MAPE031-MAPE034	Departmental Elective-III	4	0	0	4	20	10	70	-	-	**100**
5	MAPE251	Advanced Power Electronics Lab	0	0	3	2	-	-	-	50	50	**100**
6	MAPE252	Seminar -I	0	0	3	2	-	-	-	50	50	**100**
Total Contact Hours: 22						**20**						**600**

DEPARTMENTAL ELECTIVE-I (MAPE011 - MAPE013)	
MAPE011	Power System Reliability and Planning
MAPE012	Electric Power Distribution System
MAPE013	Power System Optimization

DEPARTMENTAL ELECTIVE-II (MAPE021-MAPE023)	
MAPE021	Distributed Generation
MAPE022	Smart Grid
MAPE023	Power Quality

DEPARTMENTAL ELECTIVE-III (MAPE031-MAPE033)	
MAPE031	Power System Deregulation
MAPE032	Electric Vehicles
MAPE033	Smart and Green Building Technology

MAPE 101 ADVANCED POWER SYSTEM ANALYSIS L T P 4 0 0

Prerequisite: Power Systems

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Formation of the bus admittance matrix through inspection method and graph theoretic approach and also formulation of impedance matrix	**3**
CO2	Perform steady state power flow analysis of power system networks using Gauss-Seidel, Newton-Raphson, Decoupled and Fast decoupled iterative methods.	**3**
CO3	Classify the stability issues in power system and to develop the mathematical model for transient stability analysis using swing equation for a single machine connected to infinite bus (SMIB) and for two-machine system.	**3**
CO4	Analyze the transient stability using equal area criterion and numerical methods viz. Euler method, Runga-Kutta method and to identify the factors affecting stability and methods to improve system stability	**4**
CO5	Classify voltage stability in power system and demonstrate the voltage stability analysis using PV curves, QV curves and L-index.	**3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE101.CO1	2	2		3	3
MAPE101.CO2	2	2		3	3
MAPE101.CO3	3	2	1	3	1
MAPE101.CO4	3	2	1	1	1
MAPE101.CO5	3	3	1	1	1

UNIT-I

NETWORK MATRIX: Physical interpretation of bus admittance and impedance matrices, introduction to admittance matrix formulation, formation of admittance matrix due to inclusion of regulating transformer, development of admittance matrix using singular transformation, modification of admittance matrix for branch addition/ deletion. **Formation of ZBUS:** Algorithm for building up of ZBUS, Modification of ZBUS Matrix for addition element -

Modification of Z-Bus for the changes in network.

UNIT-II

COMPLEX POWER FLOW: Analytical formulation of complex power flow solution, Gauss-Seidal method of power flow, Newton Raphson method of power flow, algorithm for solving power flow problem using N-R method in rectangular form, algorithm for solving power flow problem using N-R method in polar form, fast decoupled load flow method, Distribution System Load Flow.

UNIT-III

POWER SYSTEM STABILITY: Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study. Transient stability: Assumptions for transient stability, derivation of swing equation, swing equation for synchronous machine connected to infinite bus, swing equation for a two machine system.

UNIT-IV

Solution of swing equation by Euler and Runge-Kutta method, equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine. Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing, electric braking, voltage regulators, fast governor action, high speed excitation system.

UNIT V

VOLTAGE STABILITY: Definition and classification of voltage stability, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, expression for critical receiving end voltage and critical power angle at voltage stability limit for a two bus power system, PV and QV curves, L index for the assessment of voltage stability.

Reference Books:

1. J.J. Grainger & W.D. Stevenson, “Power System Analysis”, Mc. Graw Hill.
2. A.R. Bergen & Vijay Vittal, “Power System Analysis”, Pearson.
3. L.P Singh, “Advanced Power System Analysis and Dynamics”, New Age International.
4. G.L. Kausic, “Computer Aided Power System Analysis”, Prentice Hall India.
5. A.J. Wood, “Power generation. Operation and control”, John Wiley & Sons.
6. P.M Anderson, “Faulted Power System analysis”, IEEE Press.
7. C. A. Gross, “Power system Analysis”, John Wiley & Sons.

MAPE102	SOLAR ENERGY CONVERSION SYSTEM	L T P 4 0 0

Prerequisite: Renewable Energy Resources

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/BL***
CO1	Describe energy scenario of the word and the country and need to develop new energy technologies.	**1**
CO2	Apply fundamental concept of solar energy based on solar geometry	**3**
CO3	Describe basic concept of solar thermal energy conversion and their application.	**1**
CO4	Apply basic concept of solar photovoltaic energy conversion and their application.	**3**
CO5	Analyze different power conditioning scheme and their requirements for solar connected power system.	**4**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE102.CO1					
MAPE102.CO2					
MAPE102.CO3					
MAPE102.CO4					
MAPE102.CO5					

UNIT-I

INTRODUCTION: Trends in energy consumption-world energy scenario vs Indian energy scenario, energy resources and their availability, conventional and renewable sources, need to development new energy technologies. Importance of Global solar resources. Strength and limitations of solar energy. Measurements of Solar Radiation (Pyranometer, Pyrheliometer, Sunshine recorder).

UNIT-II

SOLAR ENERGY FUNDAMENTALS: The Sun as a Source of Energy, The Earth, Sun and Earth Radiation Spectrums. Extra-terrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation, Solar radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface.

UNIT-III

SOLAR THERMAL ENERGY CONVERSION: Solar Collectors, their classification and working. Solar Water Heater, Solar Passive Space-Heating, and Cooling Systems, Solar Industrial Heating Systems, Solar Thermal Water Pump, Solar Pond Electric Power Plant, Distributed Collector Soar Thermal Electric Power Plant, Central Tower Receiver Power Plant.

UNIT-IV

PHOTOVOLTAIC ENERGY CONVERSION: Semiconductors, photoconduction, solar cell and their characteristics, influence of insolation and temperature, classification of Solar Cells, PV arrays, effect of cell-mismatch and shadowing, maximum power point tracking, MPPT algorithms.

UNIT-V

POWER CONDITIONING SCHEMES: Electrical storage with batteries, switching devices for solar energy conversion, DC power conditioning converters, AC power conditioners, synchronized operation with grid supply, harmonic problem. Solar Power Systems (Grid Connected, Standalone etc.)

Reference Books:

1. Mukund R. Patel, "Wind and Solar Power Systems", CRC Press.
2. G. D. Rai,"Wind Power Energy Resources", Khanna Publishers.
3. Daniel Hunt V, "Wind Power-A Hand Book of WECS", VANNOS TREND CO.
4. Thomas Markvartand Luis Castaser, “Practical Hand-Book of Photovoltaics”, Elsevier.
5. A. Duffie & W.A. Beckman “Solar Engineering of Thermal Process”, Wiley.
6. S.A. Kalogirou, “Solar Energy Engineering”, Academic Press

MAPE011	POWER SYSTEM RELIABILITY & PLANNING	L T P 4 0 0

Prerequisite: Power Systems

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Identify the factors affecting power system planning and its components. Understand the significance of load forecasting and apply different load forecasting methods.	**1**
CO2	Understand the concept of reliability and apply distinct methods to evaluate the reliability of power system.	**2**
CO3	Analyze the methodology for generation system planning and reliability evaluation	**4**
CO4	Analyze the methodology for transmission system planning and reliability evaluation	**4**
CO5	Analyze the methodology for distribution system planning and reliability evaluation	**4**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE011.CO1	1		1	3	
MAPE011.CO2	1		1	3	
MAPE011.CO3	1		1	3	
MAPE011.CO4	1		1	3	
MAPE011.CO5	1		1	3	

UNIT-I

SYSTEM PLANNING: Introduction, Objectives & Factors affecting to System Planning, Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning. **LOAD FORECASTING:** Classification and characteristics of loads, load growth characteristics, peak load forecasting, extrapolation and correlation methods of forecasting, impact of weather on load forecasting.

UNIT-II

Definition of Reliability and Failure, Reliability models, Markov process, Reliability function, Hazard rate function, Bathtub Curve, simple series and parallel system models, Reliability cost, Adequacy indices, Functions of system security, Contingency analysis, Linear sensitivity factors, Hierarchical Levels in Power System Reliability Assessment.

UNIT-III

GENERATION PLANNING AND RELIABILITY: Generation Sources, Integrated Resource Planning,

GENERATING CAPACITY-Basic Probability Methods: The generation system model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods.

GENERATING CAPACITY: Frequency and duration method: The generation model, System risk indices, Practical system studies.

INTERCONNECTED SYSTEM: Factors Affecting Interconnection under Emergency Assistance.

UNIT-IV

TRANSMISSION PLANNING AND RELIABILITY: Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.

Transmission System Reliability Evaluation: Average interruption rate method, The frequency and duration method, Stormy and normal weather effects.

UNIT-V

DISTRIBUTION PLANNING AND RELIABILITY: Radial Networks, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices, Parallel & Meshed Networks, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Breaker Failure.

Reference Books:

1) Roy Billinton & Ronald N. Allan, “Reliability Evaluation of Power System”, Springer Publication.
2) T.W. Berrie, “Electricity Economics & Planning”, Peter Peregrinus Ltd., London.
3) S. Dasari, “Electric Power System Planning”, IBT Publishers.
4) Turan Gonen, “Electric Power Distribution System Engineering”, Taylor & Francis.
5) X. Wang and J. R. McDonald, “Modern Power System Planning”, McGraw-Hill.
6) R.L. Sullivan, “Power System Planning”, Mc Graw-Hill.

MAPE 012 ELECTRIC POWER DISTRIBUTION SYSTEM L T P 4 0 0

Prerequisite: Power Systems

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/BL***
CO1	Classify the various load forecasting methods.	**3**
CO2	Understand DA, AMR and CIS	**2**
CO3	Illustrate and validate optimum switching device placement in distribution systems.	**3**
CO4	Implementation of SCADA for distribution automation and power factor correction.	**3**
CO5	Design an automation system for a Urban and Rural Supply**.**	**5**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE012.CO1	1		3	2	1
MAPE012.CO2		1	2	1	3
MAPE012.CO3	3		2	3	
MAPE012.CO4	1	2	1	3	3
MAPE012.CO5	2		2	2	3

UNIT-I

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting.

UNIT-II

Distribution Automation: Distribution Automation (DA), Project Planning, Definitions, Communication, Sensors, Consumer Information Service (CIS), Geographical Information System (GIS), Automatic Meter Reading (AMR), Automation Systems.

UNIT-III

Optimization: Introduction, Costing of Schemes, Typical Network Configurations, Planning Terms, Network Cost Modelling, Voltage Levels, Synthesis of Optimum Line Networks, Applications of Linear to Network Synthesis, Optimum Phasing Sequence, Economic Loading of Distribution Transformers, Worst-Case Loading of Distribution Transformers, of New Transformer

UNIT-IV

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation.
Supervisory Control and Data Acquisition (SCADA): Introduction, Block Diagram, SCADA Applied to Distribution Automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA. Power Capacitor and power factor compensation technique.

UNIT-V

Urban and Rural Supply and its maintenance: Urban Distribution System, Objectives, Electrical consideration factor for cities, primary systems, High Voltage System, Secondary distribution system, LV System. Rural System, Reliability, Faults and Protection, Improvement of Existing Distribution Systems, Single Wire Earth Return System, Fault Locating, **Constructional Practices,** Future Orientation of Rural System.

Reference Books:

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical Power Distribution Automation", University Science Press, New Delhi.
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press.
4. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press .

MAPE013 POWER SYSTEM OPTIMIZATION TECHNIQUES L T P 4 0 0

Prerequisite: Artificial Intelligence & Power Systems

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Identify different types of optimization techniques and problems.	**1**
CO2	Demonstrate the Elimination methods and Interpolation methods for non-linear problem.	**3**
CO3	Analyze the principles and techniques described in second outcome to solve sample mathematical and practical optimization for the power system problems.	**4**
CO4	Evaluate the performance obtained by applying optimization techniques to solve mathematical programming problems.	**5**
CO5	Apply ANN, fuzzy logic and optimization algorithms to solve the Unit commitment problem.	**3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE013.CO1					
MAPE013.CO2					
MAPE013.CO3					
MAPE013.CO4					
MAPE013.CO5					

UNIT –I

INTRODUCTION TO OPTIMIZATION AND CLASSICAL OPTIMIZATION TECHNIQUES LINEAR PROGRAMMING: Definition-Classification of optimization Problems-Unconstrained and Constrained optimization, Standard form, geometry of LPP, Simplex Method of solving LPP, revised simplex method, duality, decomposition principle, and transportation problem

UNIT –II

NON-LINEAR PROBLEM (NLP): One-dimensional methods, Elimination methods, Interpolation methods, unconstrained optimization Techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods.

UNIT –III

DYNAMIC PROGRAMMING: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem CPM and PERT.

UNIT –IV

EVOLUTIONARY OPTIMIZATION TECHNIQUES: Introduction to genetic Algorithm, working principle, coding of variables, fitness function. GA operators; Similarities and difference's between GAs and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, real coded GAs, Advanced GAs, global optimization using GA. Concept of multi-objective optimization problems (MOOPs), Multi-Objective Evolutionary Algorithm (MOEA).

UNIT –V

APPLICATIONS TO POWER SYSTEM: Economic Load Dispatch in thermal and Hydro-thermal system, Unit commitment problem, reactive power optimization, Optimal power flow using classical optimization techniques and computational intelligence techniques.

Reference Books:

1) Rao S. S, "Optimization: Theory and Application", Wiley Eastern Press.
2) Taha H.A., Operations Research –An Introduction, Prentice Hall of India.
3) Fox, R.L., "Optimization methods for Engineering Design", Addition Wiley.
4) K. Deb, "Multi-objective Optimization using Evolutionary Algorithms", Wiley.

MAPE151 ADVANCED POWER SYSTEM SIMULATION LAB L T P 0 0 3

Prerequisite: Power System

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/BL***
CO1	Analyze load flow solution obtained using GS and NR methods.	**4**
CO2	Elucidate different types of symmetrical and unsymmetrical faults.	**2**
CO3	Analyze transient stability and load frequency deviation in single and two area systems.	**4**
CO4	Calculate the steady-state power flow in a power system.	**3**
CO5	Determine optimal power generation & losses of a power system.	**5**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE151.CO1	2	1	2	2	1
MAPE151.CO2	2	1	2	2	1
MAPE151.CO3	2	1	2	2	1
MAPE151.CO4	2	1	2	2	1
MAPE151.CO5	2	1	2	2	1

LIST OF EXPERIMENTS:

1. Formation of Y-Bus matrix.
2. Formation of Z-Bus matrix.
3. Load Flow Analysis of Power System using Gauss-Seidel Method.
4. Load flow analysis of Power System using Newton – Raphson method.
5. Economic dispatch in power systems.
6. Determination of power angle curve for synchronous machines.
7. To determine (i) swing curve, (ii) critical clearing time for a single machine connected to infinite bus.
8. Small Signal and transient stability analysis of Single-machine Infinite bus system.
9. Small Signal and transient Stability Analysis of Multi machine Power Systems.
10. Symmetrical and unsymmetrical fault studies.
11. Simulation of FACTS controllers.
12. Optimal power flow using PSAT.

NOTE- Minimum of 10 experiments are to be conducted.

MAPE152 RENEWABLE ENERGY LAB L T P 0 0 3

Prerequisite: Renewable Energy Resources

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Identify the main factors affecting the efficiency of renewable energy systems.	**1**
CO2	Explain the relationship between irradiance levels, shadowing effect and solar panel efficiency.	**2**
CO3	Analyze the characteristics and efficiency of wind turbine for various parameters.	**4**
CO4	Apply the Perturb and Observe (P&O) MPPT technique to design a boost converter for a solar PV system.	**3**
CO5	Evaluate the performance of a hybrid energy system in terms of cost-effectiveness and reliability.	**5**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE152.CO1					
MAPE152.CO2					
MAPE152.CO3					
MAPE152.CO4					
MAPE152.CO5					

LIST OF EXPERIMENTS:

1. To determine the efficiency of solar PV panel at different irradiance levels.
2. To study the shadowing effect and diode-based solution in 1kW solar PV system.
3. To study the effect of load on solar PV panel output.
4. To study the effect of temperature on solar panel output.
5. To determine the efficiency of a wind turbine for different wind speeds.
6. Write a program to plot wind speed with respect to time for a site situated at IET, Lucknow for the following:
   (i) 1 day
   (ii) Monthly Average
   (iii) 1 year (hourly)
7. To design a solar PV boost converter using P&O MPPT technique.
8. Design a hybrid system considering of solar panel, wind turbine and batteries using HOMER, the rating and cost of the component used in the system as**:**

Component	**Size**	**Capital**	**Replacement**	**O & M**	**Lifetime**

Solar Panel	**1 kW**	**1000**	**800**	**4**	**20**
Wind Turbine	**1 kW Generic**	**1100**	**1100**	**18**	**20**

MAPE201 ADVANCED POWER ELECTRONICS L T P 4 0 0

Prerequisite: Power Electronics

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Analyze the different dc-dc voltage regulators.	**4**
CO2	Analyze the different resonant converters.	**4**
CO3	Analyze various multi-level inverter configurations.	**4**
CO4	Apply different types of multi-phase converters in power system.	**3**
CO5	Analyze various ac-ac converters including matrix converters.	**4**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE201.CO1					
MAPE201.CO2					
MAPE201.CO3					
MAPE201.CO4					
MAPE201.CO5					

UNIT-I

SWITCHING VOLTAGE REGULATORS: Introduction to the Linear Power Supply (Voltage Regulators); Switching Voltage Regulators; Basic DC-DC Voltage Regulator Configurations -Buck, Boost, Buck-Boost Converters; Other Converter Configurations Like Flyback Converter, Forward Converter, Half Bridge, Full Bridge Configurations, Push-Pull Converter, C'uk Converter, Sepic Converter.

UNIT-II

RESONANT CONVERTERS: Introduction, Need of Resonant Converters, Classification of Resonant Converters, Load Resonant Converters, Resonant Switch Converters, Zero Voltage Switching DC-DC Converters, Zero Current Switching DC-DC Converters, Clamped Voltage Topologies.

UNIT-III

MULTI-LEVEL CONVERTERS: Need for Multi-Level Inverters, Concept of Multi-Level, Topologies for Multi-Level: Diode Clamped, Flying Capacitor and Cascaded H-Bridge Multilevel Converters Configurations; Features and Relative Comparison of These Configurations, Applications.

Introduction to Carrier-Based PWM Technique for Multi-Level Converters.

UNIT-IV

MULTIPULSE CONVERTERS: Concept of Multi-Pulse, Configurations for M-Pulse (M=12,18,24 ….) Converters, Different Phase Shifting Transformer (Y-Δ1, Y-Δ2, Y-Z1 and Y-Z2) Configurations for Multi-Pulse Converters, Applications.

Operation of the 12-pulse converter as receiving and sending terminals of HVDC system, Comparison of AC and DC transmission.

UNIT-V

AC-AC Converters: Introduction, Single-Phase AC-AC Voltage Controller, Three-Phase AC-AC Voltage Controllers, Cyclo-converters, Concept and Classification of Matrix Converters, Applications of AC-AC Converters.

Power Electronics for Renewable Energy Sources.

Reference Books:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics–Converters, Applications and Design”, John Willey & sons.
2. Muhammad H. Rashid, “Power Electronics-Circuits, Devices and Applications”, Prentice Hall of India.
3. Bin Wu, “High Power Converters and AC Drives”, John Willey & sons.
4. Derek A. Paice, “Power Electronic Converter Harmonics–Multi-pulse Methods for Clean Power”, IEEE Press.
5. Muhammad H. Rashid, “Power Electronics Handbook”, Elsevier.
6. Vijay K. Sood, “HVDC and elecrControllers Applications of Static Converters in Power Systems”, Kluwer Academic Publishers, Boston.
7. L. Umanand, “Power Electronics Essentials and Applications”, Wiley India Ltd.

MAPE202	WIND ENERGY CONVERSION SYSTEMS	L T P 4 0 0

Prerequisite: Renewable Energy Resources

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/BL***
CO1	Understand the various terminologies related to wind energy.	**2**
CO2	Understand fundamental concept of wind energy conversion and wind turbine aerodynamics.	**2**
CO3	Apply different power control strategies for wind power plants.	**3**
CO4	Classify different wind power plants based on speed.	**2**
CO5	Resolve the quality and grid integrations issues of WPP.	**3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE202.CO1					
MAPE202.CO2					
MAPE202.CO3					
MAPE202.CO4					
MAPE202.CO5					

UNIT-I

INTRODUCTION TO WIND POWER AND THE WIND RESOURCE: Introduction to Wind Power Plants, Historical Background, Global Wind Power Growth, Indian Wind Power Growth, Drivers and Bottlenecks for Wind Power Development, Strengths and Limitations of Wind Power, Types of Wind, Wind Profiling, Turbulence, Hill and Tunnel Effect, Energy in the Wind, Energy Production, Weibull and Rayleigh Distribution, Wind Rose, Wind Power Density, Energy and Power, Energy Pattern Factor, Siting.

UNIT-II

WIND ENERGY CONVERSION: Introduction to Wind Resource Assessment (Anemometers, SODAR, LIDAR), Construction of the Wind Power Plant, Rotation Principle, Drag Principle, Lift Principle, Forces on a Rotor Blade, Factors affecting Performance of Rotor.

WIND TURBINE AERODYNAMICS: Aerodynamic Power Regulation, Stall Controlled WPP, Pitch Controlled WPP, Active-Stall Controlled WPP, Halting a WPP.

UNIT-III

WIND POWER CONTROL STRATEGIES: Power Control Classification, Integrated Aerodynamic and Electric Control Strategies, Constant Speed Generator Fixed Pitch (CSG-FP) Configuration, Constant Speed Generator Variable Pitch (CSG-VP) Configuration, Variable Speed Generator Fixed Pitch (VSG-FP) Configuration, Variable Speed Generator Variable Pitch (VSG-VP) Configuration, Constant Speed and Variable Speed WPPs, Back-to-Back PEC in WPP.

UNIT-IV

CLASSIFICATION OF WIND POWER PLANTS: Constant Speed Wind Power Plants: Type-A WPP, Type-B WPP, Equivalent Circuit of WRIG of Type-B WPP, Reactive Power in Constant Speed WPP, Features and Limitations of Constant Speed WPPs, Variable Speed Wind Power Plants, Type-C WPP, Equivalent Circuit of DFIG in Type-C WPP, Salient Features and Limitations of Type-C WPP, Type-D WPP.

UNIT-V

QUALITY AND GRID INTEGRATION ISSUES OF WIND POWER: Wind Power Impact, Local Impacts of Wind Power, System wide Impacts of Wind Power, Wind Power Variability, Islanding, WPP Electrical Safety and Grid, WPP Inertia, Plant Load Factor (or Capacity Factor), Capacity Credit, WPP in the Electric Grid, Requirements of Grid Connected WPP, WPP Grid Connections, **Interface Issues:** Short Circuit Power Control, Reactive Power Control, Voltage Control, Operational Issues: Power System Stability, Frequency Control.

Reference Books:

1. Siraj Ahmed, “Wind Energy Theory and Practice”, PHI Learning Pvt. Ltd.
2. Garg L Johnson "Wind Energy Systems" Prentice Hall. Inc.
3. Mukund R Patel, "Wind and Solar Power Systems", CRC press.
4. Rai G. D., "Wind Power Energy Resources", Khanna Publishers.
5. Daniel Hunt V, "Wind Power-A Hand Book of WECS", VANNOSTREND CO.
6. Thomas Markvart and Luis Castaser, "Practical Hand Book of Photovoltaics Elsevier Publications.

MAPE021 DISTRIBUTED GENERATION L T P 4 0 0

Prerequisite: Power System, Renewable Energy Resources

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Understand the current scenario and different technologies of Distributed Generation .	**2**
CO2	Articulate various DGs and energy storage systems and their interconnections.	**2**
CO3	Understand the impact of DG on power system performance.	**2**
CO4	Apply the concepts of Hosting capacity for loading and losses.	**3**
CO5	Summarize various transient and protection issues of micro grid.	**4**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE021.CO1	2	2	2	2	1
MAPE021.CO2	2	2	3	2	2
MAPE021.CO3	3	3	3	3	3
MAPE021.CO4	3	2	3	3	3
MAPE021.CO5	2	3	2	2	2

UNIT-I

DISTRIBUTED GENERATION DEFINITIONS AND STANDARDS, DG POTENTIAL: Definitions and terminologies; current status and future trends, need of distributed generation, Distributed Generation Planning.

DISTRIBUTED GENERATION TECHNOLOGIES: Distributed Generation from renewable energy sources, DG from non-renewable energy sources, Sitting and sizing of Distributed Generation.

UNIT-II

DISTRIBUTED GENERATION AND ENERGY STORAGE APPLICATIONS: Base load; peaking; peak shaving and emergency power Need of Energy Storage Batteries, Flywheels and Super capacitors

INTERFACE WITH THE GRID: Direct Machine Coupling with the Grid, Full Power Electronics Coupling with the Grid, Partial Power Electronics Coupling to the Grid, Distributed Power Electronics Interface, Impact of the Type of Interface on the Power System, Local Control of Distributed Generation

UNIT-III

POWER SYSTEM PERFORMANCE: Impact of Distributed Generation on the Power System, Hosting Capacity Approach, Power Quality, Voltage Quality and Design of Distributed Generation, Hosting Capacity Approach for Events, Increasing the Hosting Capacity

UNIT-IV

OVERLOADING AND LOSSES: Impact of Distributed Generation on; Overloading: Radial Distribution Networks, Overloading: Redundancy and Meshed Operation, Losses**,** Increasing the Hosting Capacity: - loadability, building new connections.

UNIT-V

Micro-Grids Concepts, types, Sizing Modelling & Analysis Modelling & Analysis-with Distributed Generations Power Electronic Interfacing Transient in micro-grids Protection of Micro-grids

Reference Books:

1. Math Bollen and Fainan Hassan, "Integration of Distributed Generation in the Power System" John Wiley & Sons, Inc.
2. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation–Planning and Evaluation', Marcel Decker Press.
3. M. Godoy Simoes, Felix A. Farret, 'Renewable Energy Systems–Design and Analysis with Induction Generators', CRC press.
4. Robert Lasseter, Paolo Piagi, 'Micro-grid: A Conceptual Solution', PESC.
5. F. Katiraei, M. R. Iravani, 'Transients of a Micro-Grid System with Multiple Distributed Energy Resources', International Conference on Power Systems Transients (IPST'05) in Montreal, Canadaon June19-23, 2005.
6. Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson, 'Facility Microgrids', General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

MAPE 022	SMART GRID	L T P 4 0 0

Prerequisite: Power System, Renewable Energy Resources

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Understand the concepts of Smart Grid and its terminologies.	**2**
CO2	Apply the concepts of smart meter, AMR and storage devices	**3**
CO3	Apply the WAMS and PMUs	**3**
CO4	Integrate the renewable energy sources and control the power quality of system.	**3**
CO5	Understand significance of power quality management.	**2**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE022.CO1					
MAPE022.CO2					
MAPE022.CO3					
MAPE022.CO4					
MAPE022.CO5					

UNIT-I

INTRODUCTION TO SMART GRID: Concept of micro grid, and Smart Grid, Need of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid.
Concept of Resilient & Self-Healing Grid. Present development & International policies in Smart Grid. Case study of Smart Grid.

UNIT-II

SMART GRID TECHNOLOGIES: PART 1: Introduction to Smart Meters, Real Time Prizing, Automatic Meter Reading (AMR), Smart Appliances, Introduction to energy storage devices, Different types of energy storage technologies, Concept of Vehicle to Grid.

UNIT-III

SMART GRID TECHNOLOGIES: PART 2: Smart Substations, Substation Automation, Feeder Automation., Intelligent Electronic Devices (IED) & their application for monitoring & protection, Wide Area Measurement System (WAMS). Phasor Measurement Unit (PMU) and its applications, Digital Relays for Smart Grid Protection.

UNIT IV

MICRO GRIDS AND DISTRIBUTED ENERGY RESOURCES: Integration of renewable energy sources and its issues, Different islanding scenarios of interconnected micro-grid, Power Quality issuesof Grid connected to Renewable Energy Sources. Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring.

UNIT V

POWER QUALITY MANAGEMENT IN SMART GRID: Power Quality & EMC in Smart Grid, Power Quality issuesof Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring.

Reference Books:

1. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press.
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRCPress.
3. Jean Claude Sabonnadière, Nouredine Hadjsaïd, “Smart Grids”, Wiley Blackwell.
4. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of ElectricUtilities”, Island Press.
5. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Micrograids and Active Distribution Networks.”Institution of Engineering and Technology

MAPE023 POWER QUALITY L T P 4 0 0

Prerequisite: Power System and Power Electronics

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Identify the issues related to power quality in power systems.	**1**
CO2	Analyze the problems of transient and long duration voltage variations in power systems.	**4**
CO3	Analyze the effects of harmonics and study of different mitigation techniques.	**4**
CO4	Identify the importance of custom power devices and their applications.	**1**
CO5	Acquire knowledge on different compensation techniques to minimize power quality disturbances.	**3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE013.CO1					
MAPE013.CO2					
MAPE013.CO3					
MAPE013.CO4					
MAPE013.CO5					

UNIT I

ELECTRIC POWER QUALITY PHENOMENA: - Impacts of power quality problems on end users, Role of CBEMA and ITI Curves in power quality.
Power Quality Disturbances: - transients, short duration voltage variations, long duration voltage variations, voltage imbalance, wave-form distortions, voltage fluctuations, power frequency variations, power acceptability curves.

UNIT II

POWER QUALITY PROBLEMS: poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage.

UNIT III

TRANSIENTS: Origin and classification- capacitor switching transient-lighting-load switching-impact on users- protection mitigation.
Reliability Indices: - SAIFI, SAIDI, CAIFI, CAIDI, and ASAI.

UNIT IV

HARMONICS: harmonic distortion standards, power system quantities under non sinusoidal conditions- harmonic indices-source of harmonics-system response characteristics-effects of harmonic distortion on power system apparatus –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response-Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.

UNIT V

POWER QUALITY CONDITIONERS: Shunt and series compensators, DSTATCOM-dynamic voltage restorer, Unified Power Quality Conditioners (UPQC). Power quality standards, power quality monitoring.

Reference Books:

1. Ghosh Arindam and Ledwich Gerard, ‘Power quality enhancement using custom power devices’Springer.
2. Arrillaga J., Watson N. R. and Chen S., ‘Power System Quality Assessment’ Wiley.
3. Caramia P, Carpinelli G and Verde P, ‘Power quality indices in liberalized markets’ – Wiley.
4. Angelo Baggini ‘Handbook of Power Quality’ – Wiley.
5. Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso, “Electrical Power System Quality”, Mc GrawHill.
6. C. Sankaran, Power Quality CRC Press, USA 3. Wilson E. Kazibwe, “Electrical Power Quality ControlTechniques”, Van Nostrand Reinhold.

MAPE-031 POWER SYSTEM DEREGULATION L T P 4 0 0

Prerequisite: Power System

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Examine the need for restructuring of Power Systems, discuss different market models, different stakeholders and market power.	**3**
CO2	Apply the fundamentals of economics to power market .	**3**
CO3	Analyze transmission open access pricing issues and congestion management and estimate the transfer capability of a small power systems.	**4**
CO4	Describe ancillary services and understand reactive power as ancillary service and management through synchronous generator.	**2**
CO5	Review the power reforms in India including power exchanges, availability based tariff.	**2**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE031.CO1	3	2		2	0
MAPE013.CO2	3	2		2	0
MAPE013.CO3	3	2		3	1
MAPE013.CO4	3	3	1	3	0
MAPE013.CO5	3	2	1	3	1

UNIT-I

DEREGULATION: Reconfiguring Power systems, unbundling of electric utilities, reasons for restructuring / deregulation of power industry, requirements and key issues – restructuring models – independent system operator (ISO), benefits from a competitive electricity market, after effects of deregulation, current situation in various deregulated markets in the world.

UNIT-II

FUNDAMENTALS OF ECONOMICS: Introduction, Consumer behavior, Supplier behavior, Market Equilibrium, Various costs of production, Perfectly competitive market,
Deregulated Market Models: pool model, pool and bilateral trades model, Multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading.

UNIT-III

TRANSMISSION PRICING: Transmission open access, pricing of power transactions, Transmission Pricing Methods and Loss Allocation Algorithms, Open Access Same Time Information System (OASIS): Introduction, structure, functionality, implementation, posting of information, uses.

CONGESTION MANAGEMENT: Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC), Classification of congestion management methods, calculation of ATC, nodal pricing, fundamentals of Locational Marginal Pricing (LMP), LMP formulation and implementation using DCOPF.

UNIT-IV

ANCILLARY SERVICES: General description of some ancillary services, classification, load-generation balancing related services, voltage control and reactive power support services, black start capability services, ancillary services management in some deregulated electricity markets.

UNIT-V

REFORMS IN INDIAN POWER SECTOR: Framework of Indian Power Sector, The Availability Based Tariff (ABT) and Deviation Settlement Mechanism (DSM), Indian Electricity Act 2003, open access issues, power exchange, discussion of role of RLDC, NLDC and SLDC.

Reference Books:

1. K. Bhattacharya, MHT Bollen and J. C Doolder, “Operation of Restructured Power Systems”, Kluwer Academic Publishers, USA, 2001.
2. Lei Lee Lai, “Power System restructuring and deregulation”, John Wiley and Sons.
3. Fred I Denny and David E. Dismukes, “Power System Operations and Electricity Markets”, CRC Press.

MAPE032 ELECTRIC VEHICLE L T P 4 0 0

Prerequisite: Electric Drives and Electrical Machines

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Describe the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.	**2**
CO2	Describe the use of different power electronics converters and electrical machines in hybrid electric vehicles.	**2**
CO3	Able to interpret the working of different configurations of electric vehicles and its components, hybrid vehicle configurations	**2**
CO4	Elucidate the use of different energy storage systems used for hybrid electric vehicles, their control techniques, and select appropriate energy balancing technology	**2**
CO5	Ability to understand the control and configurations of HEV charging stations.	**2**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE032.CO1					
MAPE032.CO2					
MAPE032.CO3					
MAPE032.CO4					
MAPE032.CO5					

UNIT-I

REVIEW OF CONVENTIONAL VEHICLE: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains.

UNIT-II

ARCHITECTURE OF HYBRID ELECTRIC DRIVE TRAINS: Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor.

UNIT-III

INTRODUCTION TO ENERGY STORAGE REQUIREMENTS IN HYBRID AND ELECTRIC VEHICLES: - Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Battery Modelling, the purpose of battery modelling, Battery equivalent circuit, Modelling battery capacity, Calculating the Peukert Coefficient, Approximate battery sizing.

UNIT-IV

ENERGY MANAGEMENT STRATEGIES: Classification of different energy management strategies, comparison of different energy management strategies, application and implementation issues of energy management strategies, V2G, G2V, V2B, V2H.

UNIT-V

CHARGING INFRASTRUCTURE: Characteristics of EV supply equipment, components and classification of charging infrastructure, selection and sizing of charging station, optimal location, battery swapping, EV charging standards, EV charging policy case studies in India and other countries.

Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley.
4. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc.
5. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer.

MAPE033 SMART AND GREEN BUILDING TECHNOLOGY L T P 4 0 0

Prerequisite:

	Course Outcome	
	Upon the completion of the course, the student will be able to:	***KL/ BL***
CO1	Identify benefits, impacts and driving forces of smart buildings, and its subsystems.	**1**
CO2	Describe the design philosophy at system level, system configurations and building automation systems	**2**
CO3	Learn and understand the principles of communication & security systems in intelligent buildings.	**2**
CO4	Understand the concept of green buildings and ratings for green buildings.	**2**
CO5	Apply the design concept of green buildings with advanced technologies and innovations.	**3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE033.CO1					
MAPE033.CO2					
MAPE033.CO3					
MAPE033.CO4					
MAPE033.CO5					

UNIT-I

SMART BUILDING CHARACTERISTICS: Features and benefits of smart buildings. The anatomy of smart buildings. Environmental aspect, The marketplace and other driving forces behind the emergence of smart buildings.

UNIT-II

BUILDING AUTOMATION SYSTEMS & CONTROLS: Philosophy, system configuration, system modules, distributed systems, communication protocol and on-line measurements. Fire protection, security and energy management. Control objectives. Sensors, controllers and actuators. Control system schematics system design. Microprocessor based controllers & digital controls. Examples of sub-systems such as: Digital Addressable Lighting Interface (DALI)

UNIT-III

COMMUNICATION AND SECURITY SYSTEMS: Voice communication systems, local area network, wireless LAN, Digital TV, CCTV, digital CCTV, teleconferencing, cellular phone system, and CABD. SMATV. Data networking. Short- and long-haul networks. Wideband network. Office automations. Public address/sound reinforcement systems. Digital public address system. Modern security systems

UNIT-IV

CONCEPT OF GREEN BUILDINGS: Definition of Green Buildings, typical features of green buildings, Necessity, Initiatives, Green buildings in India, Green building Assessment-Green Building Rating Systems (BREEAM, USGBC, LEED, IGBC, TERI-GRIHA, GREEN STAR), Criteria for rating, Energy efficient criteria, environmental benefits economic benefits, health and social benefits, Major energy efficiency areas for building, Contribution of buildings towards Global Warming. Life cycle cost of buildings, Codes and Certification Programs

UNIT-V

DESIGN OF GREEN BUILDINGS: Sustainable sites, Impact of building on environment, Life cycle assessment, Principles of sustainable development in Building Design, Design on Bioclimatic and solar passive architecture, Considerations of energy consumption, water use, and system reliability, indoor air quality, noise level, comfort, cost efficiency in building design, Advanced Green building technologies and innovations, Design on ECB codes building rating, Life-cycle analysis of green buildings, Case studies of rated buildings (new and existing).

References/ Reference books:

1. Clements-Croome, Derek, Intelligent Buildings: An introduction, Routledge, 2014.
2. Shengwei Wang, Intelligent Buildings and Building Automation, Spon Press, 2010.
3. Jim Sinopoli, Smart Building Systems for Architectures, Owners and Builders, Elsevier.
4. P. Manolescue, Integrating Security into Intelligent Buildings, Cheltenharn, 2003.
5. A. Dobbelsteen, Smart Building in a Changing Climate, Techne Press, 2009.
6. D. Clements-Croome, Intelligent Buildings: An Introduction, Routledge, 2014.
7. Gevorkian, “Green Buildings”, McGraw hill.
8. Emerald Architecture: case studies in green buildings, The Magazine of Sustainable Design.
9. Understanding Green Building Guidelines: For Students and Young Professionals, Traci Rose Rider, W. W. Norton & Company Publisher.

MAPE251 ADVANCED POWER ELECTRONICS LAB L T P 0 0 3

Prerequisite: Power Electronics

	Course Outcome	***KL/ BL***
	Upon the completion of the course, the student will be able to:	
CO1	Analyze the control circuit and the power circuit for DC-DC converters.	**4**
CO2	Apply and Analyze the multi-level inverters.	**4**
CO3	Apply and Analyze the multi-pulse converter in power system applications.	**4**
CO4	Analyze and understand the AC voltage converter and matrix converter.	**4**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
MAPE251.CO1					
MAPE251.CO2					
MAPE251.CO3					
MAPE251.CO4					
MAPE251.CO5					

LIST OF EXPERIMENTS:

1. Simulation and Analysis of DC Buck Converter.
2. Simulation and Analysis of DC Boost Converter.
3. Simulation and Analysis of DC Buck-Boost Converter.
4. Simulation and Analysis of Load-Resonant Converter.
5. Simulation and Analysis of ZVS/ ZCS Converter.
6. Simulation and Analysis of Diode-Clamped and Capacitor-Clamped Multi-Level Inverter.
7. Simulation of Carrier based Sine PWM control of a CHB multilevel inverter and study of harmonic spectrum.
8. Simulation and Study of Harmonic Spectrum for 12-Pulse and 18-Pulse Converters.
9. Simulation and Analysis of Three-Phase AC-AC converter.
10. Simulation and Analysis of Three-Phase to Three-Phase Matrix Converter.

Note: In addition to the above, the Department can offer a few other experiments. Minimum of 08 experiments are to be conducted.

MAPE252 SEMINAR-I L T P 0 0 3

	Course Outcome	*KL/ BL*
	Upon the completion of the course, the student will be able to:	
CO1	Learn to prepare and deliver a seminar.	
CO2	Come across various research areas in the domain of power and energy systems.	
CO3	Improve the presentation skills.	
CO4	Compose text characterized by clear and careful organization, coherent paragraphs and well-constructed sentences that employ the conventions of Standard Written English and appropriate diction.	
CO5	Evaluate and synthesize information to draw consistent conclusions	

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5
MAPE252.CO1	2	2	2		2
MAPE252.CO2	2	3	3	2	2
MAPE252.CO3	1	1			1
MAPE252.CO4		3	2		
MAPE252.CO5		3		2	2

Internal Evaluation

Review of literature	Subject Knowledge	Presentation • Speaking Skills • Audience Interaction • Visuals • Organization	Conclusions and Future Scope	Report	Answer to Queries	Total
7.5	7.5	20	5	5	5	**50**

External Evaluation

Review of literature	Subject Knowledge	**Presentation** • Speaking Skills • Audience Interaction • Visuals • Organization	Conclusions and Future Scope	Report	Answer to Queries	Total
7.5	7.5	20	5	5	5	**50**