Semester - I

M.E.	**M19MAT104 - APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS**	**T**	**P**	**TU**	**C**
		4	**0**	**0**	**4**

Course Objectives:

1. To extend matrix theory in the field of electrical systems.
2. This course is designed to enrich the knowledge of calculus of variations.
3. To understand the basic concepts of probability and random variables to introduce some standard distributions applicable to engineering which can describe real life phenomenon..
4. Linear programming will help the students to identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools.
5. To acquaint the student with Fourier series techniques used in wide variety of situations.

UNIT - I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT - II CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functional dependent on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT - III ONE DIMENSIONAL RANDOM VARIABLES 12

Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions

UNI T - IV LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method - Two phase method - Transportation and Assignment models.

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UNIT - V FOURIER SERIES 12

Fourier trigonometric series : Periodic function as power signals – Convergence of series – Even and odd function : Cosine and sine series – Non periodic function : Extension to other intervals - Power signals : Exponential Fourier series – Parseval’s theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm - Liouville systems – Generalized Fourier series.

Total Instructional hours:60

Course Outcomes:

Students will be able to

CO1: Make use of various methods in matrix theory to solve system of linear equations.

CO2: Solve maximizing and minimizing the functional that occur in Electrical engineering disciplines.

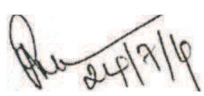
CO3: Identify moments, standard distributions of discrete and continuous random variables.

CO4: Apply the method for solving linear programming models.

CO5: Develop Fourier transforms to initial value, initial–boundary value and boundary value problems in the power signals.

Reference Books :

1. Bronson, R. “Matrix Operation”, Schaum’s outline series, 2nd Edition, McGraw Hill,2011.
2. B.S. Grewal , “Higher Engineering Mathematics”, (Khanna Publishers), 43rd edition, 2014.
3. Elsgolc, L. D. "Calculus of Variations", (Dover Publications), New York,2012.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund’s Probability and Statistics for Engineers", (Pearson Education, Asia), 8th Edition,2015.
5. O'Neil, P.V., "Advanced Engineering Mathematics", (Thomson Asia Pvt. Ltd., Singapore),2012.
6. Taha, H.A., “Operations Research, An Introduction”, (Pearson education, New Delhi), 9th Edition 2016.



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M.E.	M19PST101 - COMPUTER AIDED POWER SYSTEM ANALYSIS	T	P	TU	C
		3	0	1	4

Course Objectives:

1. To introduce different techniques of dealing with sparse matrix for large scale power systems
2. To impart in-depth knowledge on different methods of power flow solutions.
3. To perform optimal power flow solutions in detail.
4. To perform short circuit fault analysis and understand the consequence of different type of faults.
5. To Illustrate different numeric al integration methods and factors influencing transient stability

UNIT-I SOLUTION TECHNIQUE 12

Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays – Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

UNIT-II POWER FLOW ANALYSIS 12

Power flow equation in real and polar forms; Review of Newton‟s method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment.

UNIT-III OPTIMAL POWER FLOW 12

Problem statement; Solution of Optimal Power Flow (OPF) – The gradient method, Newton‟s method, Linear Sensitivity Analysis; LP methods – With real power variables only – LP method with AC power flow variables and detailed cost functions; Contingency Analysis ,Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs.

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UNIT-IV SHORT CIRCUIT ANALYSIS 12

Formation of bus impedance matrix with mutual coupling (single phase basis and three phase basis) - Computer method for fault analysis using Z_{BUS} and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase – symmetrical and unsymmetrical faults.

UNIT-V TRANSIENT STABILITY ANALYSIS 12

Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model; Factors influencing transient stability, Numerical stability and implicit Integration methods.

Total Instructional hours: 60

Course Outcomes:

Students will be able to

CO1 : Ability to apply the concepts of sparse matrix for large scale power system analysis

CO2 : Solve the load flow problem with the help of flowchart

CO3 : Ability to analyse power system studies that needed for the transmission system planning.

CO4 : Solve the balanced & unbalanced three phase faults using various methods.

CO5 : Explain the concept of single machine system under transient, steady state and dynamic condition

Reference Books:

1. Nagrath I.J. and Kothari D.P., ''Modern Power System Analysis'', Tata McGraw-Hill, Fourth Edition, 2011.
2. Wood A.J. and Wollen berg B.F, “Power Generation Operation and Control”, John Wiley and sons, New York, 3rd edition 2013.
3. Hadi Saadat, ''Power System Analysis'', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
4. Olle. I. Elgerd, ''Electric Energy Systems Theory – An Introduction'', Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2012.
5. Kundur P., ''Power System Stability and Control”, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.

BoS CHAIRMAN

M.E.	**M19PST102 - POWER SYSTEM OPERATION AND CONTROL**	**T**	**P**	**TU**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To understand the fundamentals of speed governing system and the concept of control areas.
2. To provide knowledge about Hydro thermal scheduling, Unit commitment and solution techniques.
3. To impart knowledge on the need of state estimation and its role in the day to day operation of power system.

UNIT-I INTRODUCTION 9

System load variation: System load characteristics, load curves - daily, weekly and annual, load-duration curve, load factor, diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves. Overview of system operation: Load forecasting, techniques of forecasting, basics of power system operation and control.

UNIT-II REAL POWER -FREQUENCY CONTROL 9

Fundamentals of speed governing mechanism and modelling: Speed-load characteristics – Load sharing between two synchronous machines in parallel; concept of control area, LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases, Economic Dispatch Control. Multi-area systems: Two-area system modelling; static analysis, uncontrolled case; tie line with frequency bias control of two-area system derivation, state variable model.

UNIT-III HYDROTHERMAL SCHEDULING PROBLEM 9

Hydrothermal scheduling problem: short term and long term-mathematical model, algorithm. Dynamic programming solution methodology for Hydro-thermal scheduling with pumped hydro plant: Optimization with pumped hydro plant-Scheduling of systems with pumped hydro plant during off-peak seasons: algorithm. Selection of initial feasible trajectory for pumped hydro plant- Pumped hydro plant as spinning reserve unit-generation of outage induced constraint-Pumped hydro plant as Load management plant.

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UNIT-IV UNIT COMMITMENT AND ECONOMIC DISPATCH 9

Statement of Unit Commitment (UC) problem; constraints in UC: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; UC solution methods: Priority-list methods, forward dynamic programming approach, numerical problems. Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ-iteration method. Base point and participation factors.- Economic dispatch controller added to LFC control.

UNIT-V STATE ESTIMATION 9

Need for power system state estimation- Network observability – DC state estimation model State estimation of power system – Methods of state estimation: Least square state estimation, weighted least square state estimation, Maximum likelihood- Bad data detection and identification.

Total Instructional hours : 45

Course Outcomes:

Students will be able to

- **CO1 :** Ability to understand system load variations and get an overview of power system operations.
- **CO2 :** Illustrate the power system state estimation.
- **CO3 :** Illustrate the knowledge about hydrothermal scheduling.
- **CO4 :** Explain the significance of unit commitment and different solution methods.
- **CO5 :** Ability to understand the need for state estimation in real time operation

Reference Books:

1. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition,2011
2. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
3. Wood A.J. and Wollenberg B.F, "Power Generation Operation and Control", John Wiley and sons,New York, 3rd edition 2013.
4. Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.
5. Abhijit Chakrabarti, Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
6. Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', Tata McGraw Hill Education Pvt.Ltd., New Delhi, 34th reprint, 2010.

BoS CHAIRMAN

M.E.	M19PST103 - POWER ELECTRONIC APPLICATIONS TO POWER SYSTEMS	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To have a thorough understanding of the construction, theory and characteristics of the Devices like MOSFET, BJT's, IGBT's and SCR.
2. To analysis and modeling of Inverters and converters.
3. To study in detail about the Reactive power compensation and FACTS devices.
4. To study about the definition and issues in power quality

UNIT-I INTRODUCTION 9

Basic Concept of Power Electronics, Different types of Power Electronic Devices - Diodes, Transistors, SCR, MOSFET, IGBT and GTO's.

UNIT-II AC TO DC CONVERTERS 9

Single Phase and three phase bridge rectifiers, half controlled and Fully Controlled Converters With R, RL, AND RLE loads. Free Wheeling Diodes, Dual Converter, Sequence Control of Converters - inverter operation, Input Harmonics and Output Ripple, Smoothing Inductance - Power Factor Improvement effect of source impedance, Overlap, Inverter limit.

UNIT-III DC TO AC CONVERTERS 9

General Topology of single Phase and three phase voltage source and current source inverters- Need for feedback diodes in anti-parallel with switches - Multi Quadrant Chopper viewed as a Single phase inverter- Configuration of Single phase voltage source inverter: Half and Full bridge, Selection of Switching Frequency and Switching Device, Voltage Control and PWM strategies.

UNIT-IV STATIC REACTIVE POWER COMPENSATION 9

Shunt Reactive Power Compensation - Fixed Capacitor Banks, Switched Capacitors, Static Reactor Compensator, Thyristor Controlled Shunt Reactors (TCR) - Thyristor Controlled Transformer- FACTS Technology-Applications of static thyristor Controlled Shunt Compensators for load compensation ,Static Var Systems for Voltage Control, Power Factor Control and Harmonic Control of Converter Fed Systems.

UNIT-V POWER QUALITY 9

Power Quality - Terms and Definitions - Transients - Impulsive and Oscillatory Transients - Harmonic Distortion - Harmonic Indices - Total Harmonic Distortion - Total Demand Distortion- Locating Harmonic Sources Harmonic s from commercial and industrial Loads - Devices for Controlling Harmonics Passive and Active Filters -Harmonic Filter Design- Sources of sags and interruptions.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Analyze Inverters & Converters and Ability to model.

CO2: Analyze the custom power electronic devices.

CO3: Show the understanding of the semiconductor devices like rectifiers, Thyristors and transistors.

CO4: Explain the principle of operation of FACTS devices.

CO5: Summarize the issues like sag and harmonics in power quality.

Reference Books:

1. Frede Blaabjerg ,Tomislav Dragičevic , Pooya Davari , “Applications of Power Electronics” Volume 1 Paperback – Import, 25 Jun 2019.
2. M.L. Soni, P.V.Gupta, U.S. Bhatnagar A.Chakrabarti “A Text Book on Power System Engineering” Dhanpat Rai And Company Private Limited; Reprint 2009 Edition (2009)
3. M.H.Rashid, Power Electronics, Prentice Hall of India,2006.
4. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, ‘Electrical Power Systems Quality’ McGraw Hill, 2003
5. B.K.Bose, Power Electronics and A.C. Drives , Prentice Hall ,2004.

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M.E.	M19PST104 - SYSTEM THEORY	T	P	TU	C
		3	0	1	4

Course Objectives:

1. To understand the fundamentals of physical systems in terms of its linear and nonlinear models.
2. To educate on solving linear and non-linear state equations
3. To exploit the properties of linear systems such as controllability and observability
4. To educate on stability analysis of systems using Lyapunov's theory
5. To educate on modal concepts and design of state and output feedback controllers and estimators

UNIT-I STATE VARIABLE REPRESENTATION 12

Concepts of state, state variables and state model - State model for linear time invariant systems – State space representation using physical, phase and canonical variables – Transfer function from state model – Direct, cascade and parallel decomposition – Solution of state equation – State transition matrix.

UNIT-II SYSTEM MODELS 12

Characteristic equation – Eigen values and Eigen vectors – Invariance of Eigen values – Diagonalization– Jordan canonical form – Concept of controllability and observability– Kalman‟s and Gilbert‟s tests –Controllable and Observable Phase Variable forms for SISO and MIMO systems – Effect of pole-zero cancellation on controllability and observability– Pole placement by state feedback – Full order and reduced order observers.

UNIT-III NONLINEAR SYSTEMS 12

Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions.

UNIT-IV STABILITY 12

Introduction-Equilibrium Points - Stability in the sense of Lyapunov - BIBO Stability - Stability of LTI Systems - Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - Direct Method of Lyapunov - Linear Continuous Time Autonomous Systems - Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems - Krasovskii and Variable - Gradient Method.

UNIT-V ADVANCED CONTROL SYSTEMS 12

Adaptive Control: Model – Reference Adaptive Control - Fundamental concepts – Self tuning Control – Robust Control - Parameter perturbations – Design of robust control system – PID controllers – Fuzzy Logic Control – Neutral Network Controller – Genetic Algorithm.

Total Instructional hours : 60

Course Outcomes:

Students will be able to

CO1: Ability to represent the time-invariant systems in state space form as well as analyze, whether the system is stabilizable, controllable, observable and detectable.

CO2: Ability to design state feedback controller and state observers.

CO3: Ability to describe non-linear behaviors such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos.

CO4: Use the techniques such as describing function, Lyapunov Stability, Popov's Stability Criterion and Circle Criterion to assess the stability of certain class of non-linear system.

CO5: Develop the advanced control systems using controllers.

Reference Books:

1. Katushiko Ogata, "Modern Control Engineering", Pearson Hall of India Private Ltd, New Delhi,V Edition, 2011.
2. Gopal.M, "Modern Control System Theory", New Age International, 2005.
3. Roy Choudhury.D, "Modern Control Systems", New Age International, 2005.
4. Bubnicki.Z, "Modern Control Theory", Springer, 2005.
5. Z. Bubnicki, "Modern Control Theory", Springer, 2005.

BoS CHAIRMAN

M.E.	M19PSP101 - POWER SYSTEM LABORATORY-I	T	P	TU	C
		0	4	0	2

Course Objectives:

1. To have hands on experience on various system studies and different techniques used for system planning using Software packages.
2. To perform the dynamic analysis of power system.

List of Experiments:

Expt. No.	Description of the Experiments
1.	Power flow analysis by Newton-Raphson method and Fast decoupled method.
2.	Transient stability analysis of single machine-infinite bus system using classical machine model.
3.	Contingency analysis: Generator shift factors and line outage distribution factors.
4.	Economic dispatch using lambda-iteration method.
5.	Unit commitment: Priority-list schemes and dynamic programming.
6.	State Estimation (DC).
7.	Analysis of switching surge using EMTP: Energisation of a long distributed-parameter line.
8.	Analysis of switching surge using EMTP: Computation of transient recovery voltage.
9.	Simulation and Implementation of Voltage Source Inverter.
10.	Digital Over Current Relay Setting and Relay Coordination using Suitable software packages.
11.	Co-ordination of over-current and distance relays for radial line protection.

Total Instructional hours: 60

Course Outcomes:

Students will be able to

CO1 : Analyze the power flow using Newton-Raphson method and Fast decoupled Method.
CO2 : Understand the Performs of contingency analysis & economic dispatch.
CO3 : Understand the Digital Over Current Relay and Coordinate Relay.

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Semester - II

M.E.	M19PST201 - POWER SYSTEM DYNAMICS	T	P	TU	C
		3	0	1	4

Course Objectives:

1. To impart knowledge on dynamic modeling of a synchronous machine in detail.
2. To describe the modelling of excitation and speed governing system in detail.
3. To understand the fundamental concepts of stability of dynamic systems without controller and its classification.
4. To understand the fundamental concepts of stability of dynamic systems with controller and its classification.
5. To understand and enhance small signal stability problem of power systems.

UNIT-I SYNCHRONOUS MACHINE MODELLING 9

Schematic Diagram, Physical Description: armature and field structure, machines with multiple pole pairs, mmf waveforms, direct and quadrature axes, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, physical interpretation of dq0 transformation, Per Unit Representations: power invariant form of Park's transformation; Equivalent Circuits for direct and quadrature axes, Steady-state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values, Equations of Motion: Swing Equation, calculation of inertia constant, Representation in system studies, Synchronous Machine Representation in Stability Studies: Simplifications for large-scale studies : Neglect of stator transients, Simplified model with amortisseurs neglected: two-axis model with amortisseur windings neglected, classical model.

UNIT-II MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS 9

Excitation System Requirements; Elements of an Excitation System; Types of Excitation System; Control and protective functions; IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System Modeling: Functional Block Diagram of

Power Generation and Control, Schematic of a hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation), special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modeling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed- governing system model for normal speed/load control function.

UNIT-III SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS 9

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: State-space representation, stability of dynamic system, Linearization, Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, Eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearised system equations, block diagram representation with K- constants; expression for K-constants (no derivation), effect of field flux variation on system stability: analysis with numerical example.

UNIT-IV SMALL-SIGNAL STABILITY ANALYSIS WITH CONTROLLERS 9

Effects Of Excitation System: Equations with definitions of appropriate K-constants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example, Power System Stabilizer: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical a example. Multi-Machine Configuration: Equations in a common reference frame, equations in individual machine rotor coordinates, illustration of formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example. Principle behind small- signal stability improvement methods: delta-omega and delta P-omega stabilizers.

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UNIT-V ENHANCEMENT OF SMALL SIGNAL STABILITY 9

Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta – P- Omega stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal washout stabilizer gain – Stabilizer limits.

Total Instructional hours: 60

Course Outcomes:

Students will be able to

CO1: Able to understand on dynamic modelling of synchronous machine.

CO2: Able to understand the modeling of excitation and speed governing system for stability analysis.

CO3: Attain knowledge about stability of dynamic systems.

CO4: Understand the significance about small signal stability analysis with controllers.

CO5: Understand the enhancement of small signal stability.

Reference Books:

1. Sauer P. W. and Pai, M. A. "Power System Dynamics and Stability", Stipes Publishing Co, 2018.
2. Gupta B.R., Power System Analysis and Design, S.Chand, 2011.
3. Ramunujam R," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2010.
4. Prabha Kundur, Power System Stability and Control, Tata McGraw Hill, 2006.
5. Anderson P.M and Fouad A.A, "Power System Control and Stability", Wiley-IEEE Press 2003.

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		T	P	TU	C
M.E.	**M19PST202 - POWER SYSTEM AUTOMATION**	**3**	**0**	**0**	**3**

Course Objectives:

1. To familiarize the students with the basics of Power System Automation.
2. To familiarize the students with the basics of Supervisory Control and Data Acquisition (SCADA) System.
3. To familiarize the students with the basics of Remote Terminal Units (RTU) and Master Stations.

UNIT-I INTRODUCTION TO SCADA SYSTEMS 9

Evolution of Automation systems, History of Power system Automation, Supervisory Control And Data Acquisition (SCADA) Systems, Components of SCADA systems, SCADA Applications, SCADA in power systems, SCADA basic functions, SCADA application functions in Generation, Transmission and Distribution.

UNIT-II SCADA IN POWER SYSTEMS 9

Advantages of SCADA in Power Systems, The Power system 'Field', Types of data & signals in the Power system, Flow of Data from the field to the SCADA Control center. Building blocks of SCADA systems, Classification of SCADA systems.

UNIT-III REMOTE TERMINAL UNIT (RTU) 9

Evolution of RTUs, Components of RTU, Communication, Logic, Termination and Test/HMI Subsystems, Power supplies, Advanced RTU Functionalities.

UNIT-IV INTELLIGENT ELECTRONIC DEVICES (IEDS) 9

Evolution of IEDs , IED functional block diagram, The hardware and software architecture of IED, IED Communication subsystem, IED advanced functionalities, Typical IEDs, Data Concentrators and Merging Units, SCADA Communication Systems.

UNIT-V MASTER STATION AND CASE STUDIES 9

Master Station, Master station software and hardware configurations, Server systems in the master station, Small, medium and large master station configurations, Global Positioning Systems, Master station performance, Human Machine Interface (HMI), HMI components, Software functionalities, Situational awareness, Case studies in SCADA

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Interpret the concepts of power system automation.

CO2: Interpret the components of SCADA systems.

CO3: Explain the RTU, IED and other components of automation systems

CO4: Understand the transfer of signals from the field to an operator control terminal.

CO5: Model an interoperable powers automation system.

Reference Books:

1. Mini S. Thomas, John D McDonald, “Power Systems SCADA and Smart Grid”, CRC Press, Taylor and Francis.
2. John D. Mc Donald, “Electric Power Substation Engineering”, CRC Press, Taylor and Francis
3. James Northcote- Green, R Wilson, “Control and Automation of Electrical Power Distribution systems”, CRC Press, Taylor and Francis
4. James Momoh, “Electric Power Distribution, Automation”, Protection and Control, CRC press, Taylor and Francis.
5. Related Research papers.

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M.E.	M19PST203 - DIGITAL PROTECTION FOR POWER SYSTEM	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To analysis the Characteristics and functions of relays and protection schemes.
2. To understand the concept of overcurrent protection.
3. To understand the concept of generator protection.
4. To understand the concept of transformer and transmission line protection.
5. To understand the concept of digital and numerical protection.

UNIT-I INTRODUCTION OF A PROTECTIVE RELAYING SYSTEM AND STATIC RELAYS 9

Characteristic functions of protective relays- basic relay terminology. Advantages of static relays over Electromagnetic Relays– Limitations, Basic construction and Basic elements of static relays - Practical non-critical switching circuits and critical level detectors-Influence of protective relays on associated equipment.

UNIT-II COMPARATORS AND ASSOCIATED ELEMENTS AND OVER CURRENT PROTECTION 9

Mixing transformers/circuits-Phase and amplitude comparators - Duality-Different types of comparators-Amplitude, Phase comparators, Vector product devices–Dynamic design of static Comparators. Introduction to over current relays – Basic principles and different types of time-over current relays - Practical circuits for time over current relays - Direct trip devices-Introduction to Relay Co-ordination- Co-ordination of over current relays in an Interconnected power system.

UNIT-III GENERATOR PROTECTIONS 9

Different types of faults and different types of Protective schemes in Synchronous generators – Generator differential protection, Merz-Price protection, Stator earth fault protection, Stator inter-turn fault protection, Rotor earth fault protection, numerical examples for typical generator protection schemes.

UNIT-IV TRANSFORMER AND TRANSMISSION LINE PROTECTION 9

Different types of faults and different types of Protective schemes in transformers Percentage differential protection, Protection against magnetizing in-rush current, incipient fault protection (Buchholz relay), Over-fluxing protection, High resistance ground fault in transformers numerical examples for typical transformers protection schemes. Types of line protection and selection criteria, Introduction to distance protection, Impedance relay, reactance relay, mho(admittance) relay, off-set mho relay, comparison of distance relays, Distance protection of three phase lines, Reasons for inaccuracy of distance relay reach – Three stepped distance protection – Pilot wire protection carrier current protection, numerical example for a typical distance protection scheme for a transmission line.

UNIT-V DIGITAL/ NUMERICAL PROTECTION 9

Introduction to Digital protective relays - over current relay, impedance relay, generalized mathematical expression for distance relays - mho relay, off-set mho, Quadrilateral relay characteristic realization, generalized interfacing for distance relays. Block diagram of numerical relay, Sampling theorem, correlation with a reference wave, digital filtering, numerical over current protection, numerical transformer differential protection, numerical distance protection of transmission lines, Introduction to Fast Fourier Transform (FFT) and Discrete Wavelet Transform (DWT) to digital protection Overview of different algorithms for digital protection.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1:** Discuss the basic elements of static relays.
- **CO2:** Explain the principles of amplitude and phase comparators.
- **CO3:** Discuss the principles of time-over current relays.
- **CO4:** Discuss the different types of faults and protection schemes of synchronous generators.
- **CO5:** Explain the different types of faults and protective schemes of transformers.
- **CO6:** Discuss the different types of protective schemes for transmission lines.
- **CO7:** Discuss the basic components of a digital relay and Realization of different digital relay characteristics using microprocessor.

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Reference Books:

1. Paithankar Y.G. and Bhide S.R, ―Fundamentals of Power System Protection‖, Prentice-Hall of India, Second Edition 2010.
2. Kundur P, 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.
3. Sunil S.Rao, Protection and switchgear , Khanna Publishers-IV th Edition,2010
4. Madhava Rao T.S.,Digital/Numerical Relays‖, Tata McGraw- Hill Publishing Company, 2012.
5. Singh L.P., Digital Protection Protective Relaying from Electromechanical to microprocessor‖,New Age International (P) Limited Publishers ,2018

BoS CHAIRMAN

		T	P	TU	C
M.E.	**M19PST204 - RESTRUCTURED POWER SYSTEM**	**3**	**0**	**0**	**3**

Course Objectives:

1. To understand the restructuring process in power market.
2. To analyse the concepts and terminologies used in power pool.
3. To understand the Indian power system, issues, regulatory and acts.
4. To analyse the available transfer capability.
5. To analyse the congestion management in restructured environment.

UNIT-I POWER SYSTEM RESTRUCTURING: AN OVERVIEW 9

Introduction- Motivation for Restructuring of Power System- Electricity Market Entities and Model- Milestones of Deregulation-International Scenario –Industrialized countries - In the US- The Scene in Europe- The British power pool-Nordic Deregulation process-Developing countries - Benefits of deregulation- Basic Terminologies.

UNIT-II POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT 9

Introduction-Role of Independent system operator - Structure of UK and Nordic Electricity sector market operations –power pools – explanation of single auction power pool & double auction power pool with supply bid and demand - Two bus power system – four utility joint dispatch- Transmission networks and bilateral Electricity markets- bilateral trading in a two bus power system- three bus power system with feasible transactions.

UNIT-III TRANSMISSION OPEN ACCESS AND PRICING ISSUES 9

Introduction-power wheeling -Transmission open access- Types of Transmission services in open access – cost components in transmission – Pricing of power transactions – Embedded cost based Transmission pricing - Postage stamp method - contract path method-MW Mile method – Marginal participation method – Incremental cost based transmission pricing –SRMC and LRMC based pricing.

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UNIT-IV AVAILABLE TRANSFER CAPABILITY & CONGESTION MANAGEMENT 9

Introduction-Definition - Methods of Static ATC Determination - Method based on multiple load flow and continuation power flow - Method based on optimization power flow- method based on linear sensitivity factors. Congestion management –congestion management methods: An overview: Cluster/zone based method – Rescheduling of generation-LMP based congestion management.

UNIT-V INDIAN POWER MARKET 9

Introduction –Indian power sector past and present status-growth of power sector in India - overview - Time line of Indian power sector- Players in the Indian power sector - Availability based tariff - Necessity- working mechanism- Beneficiaries-Day Scheduling process- Deviation from Schedule-unscheduled interchange rate-system marginal rate- trading surplus generation- applications.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1 :** Explain the restructuring process, new entities in power market and benefits.
- **CO2 :** Apply the concepts and terminologies used in interchange evaluation, power pools and transaction issues.
- **CO3 :** Explain the Indian power system, issues, regulatory and policy developments and acts.
- **CO4 :** Demonstrate the transmission open access, congestion management and pricing issues.
- **CO5 :** Apply the available transfer capability in restructured environment.

Reference Books:

1. Venkatesh P, Manikandan B.V, Charles Raja S, and Srinivasan A, Electrical power systems analysis,Security and Deregulation‖, PHI 2012.
2. Kankar Bhattacharya Maath H.J. Bollen and Jaap E.Daalder, Operation of restructured power systems Kluwer academic publishers, USA ,first edition, 2001.
3. Daniel Kirschen and Goran Strbac ,Fundamentals of power system economics, John Wiley sons, 2004.
4. Loi Lei Lai, Power system Restructuring and regulation‖ John Wiley sons, 2002.
5. M.Shahidepour, Hatim Tamin and Zuyi Li, ―Market operations in electric power system forecasting, scheduling and risk management‖, John Wiley sons, 2002.

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M.E.	M19PSP201 – POWER SYSTEM LABORATORY – II	T	P	TU	C
		0	4	0	2

Course Objectives:

1. To analyse the effect of FACTS controllers by performing steady state analysis.
2. To have hands on experience on different wind energy conversion technologies.
3. To analyse the SMIB and MMIB with classical machine model.

List of Experiments:

Expt. No.	Description of the Experiments
1	Small-signal stability analysis of single machine-infinite bus system using classical machine model.
2	Small-signal stability analysis of multi-machine configuration with classical machine model.
3	Induction motor starting analysis.
4	Load flow analysis of two-bus system with STATCOM.
5	Transient analysis of two-bus system with STATCOM.
6	Available Transfer Capability calculation using an existing load flow program.
7	Study of variable speed wind energy conversion system- DFIG.
8	Study of variable speed wind energy conversion system- PMSG.
9	Computation of harmonic indices generated by a rectifier feeding a R-L load.
10	Design of active filter for mitigating harmonics.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Analyse the SMIB and MMIB with classical machine model.

CO2: Analyze the effect of FACTS controllers by performing steady state analysis.

CO3: Demonstrate the different wind energy conversion technologies using software package.

CO4: Analyze the harmonic generation and mitigation.

CO5: Analyze the induction motor and Available Transfer Capability (ATC) calculation.

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M.E.	M19PSP202 - RENEWABLE ENERGY SYSTEMS LABORATORY	T	P	TU	C
		0	4	0	2

Course Objectives:

1. To train the students in Renewable Energy Sources and technologies.
2. To provide adequate inputs on a variety of issues in harnessing Renewable Energy.
3. To recognize current and possible future role of Renewable energy sources.

List of Experiments:

Expt. No.	Description of the Experiments
1.	Simulation study on Solar PV Energy System.
2.	Simulation study on Wind Energy Generator.
3.	Simulation study on Hybrid (Solar-Wind) Power System.
4.	Simulation study on Hydel Power.
5.	Simulation study on Intelligent Controllers for Hybrid Systems.
6.	Experiment on “VI-Characteristics and Efficiency of 1kWp Solar PV System”.
7.	Experiment on “Shadowing effect & diode based solution in 1kWp Solar PV System”.
8.	Experiment on Performance assessment of Grid connected and Standalone 1kWp Solar Power System.
9.	Experiment on Performance assessment of micro Wind Energy Generator.
10.	Experiment on Performance Assessment of Hybrid (Solar-Wind) Power System.
11.	Experiment on Performance Assessment of 100W Fuel Cell.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Ability to understand and analyse Renewable energy systems.

CO2: Ability to provide adequate inputs on a variety of issues in harnessing Renewable Energy.

CO3: Ability to simulate the various Renewable energy sources.

CO4: Analyse the current and possible future role of Renewable energy sources.

CO5: Analyse the basics of Intelligent Controllers.

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PROFESSIONAL ELECTIVES

Semester – I

Elective – I

M.E.	M19PSE101 - ANALYSIS OF ELECTRICAL MACHINES	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
2. To provide the knowledge of theory of transformation of three phase variables to two phase variables.
3. To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.
4. To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.
5. To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

UNIT- I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9

Basics of magnetic circuits – General expression of stored magnetic energy – Energy and Force/Torque equations – Singly and Doubly fed excited systems – Linear and Non-linear magnetic systems – Analysis of magnetic circuits with air gap and permanent magnets.

UNIT- II REFERENCE FRAME THEORY 9

Static and rotating reference frames – Transformation of variables - Transformation between reference frames – Transformation of a balanced set – Balanced steady state phasor and voltage equations – Variables observed from several frames of reference.

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UNIT- III DC MACHINES 9

Voltage and Torque Equations – Dynamic characteristics of permanent magnet and shunt DC motors – State equations - Solution of dynamic characteristics by Laplace transformation.

UNIT- IV INDUCTION MACHINES 9

Voltage and Torque Equations – Transformation for rotor circuits – Voltage and torque equations in reference frame variables – Analysis of steady state operation – Free acceleration characteristics – Dynamic performance for load and torque variations – Dynamic performance for three phase fault – Computer simulation in arbitrary reference frame.

UNIT- V SYNCHRONOUS MACHINES 9

Voltage and Torque Equation - Voltage equation in arbitrary reference frame and rotor reference frame – Park equations - Rotor angle and angle between rotor – Steady state analysis – Dynamic performance for torque variations - Dynamic performance for three phase fault – Transient stability limit – Critical clearing time – Computer simulation

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1.** Ability to understand the various electrical parameters in mathematical form.
- **CO2.** Ability to understand the different types of reference frame theories and transformation relationships.
- **CO3.** Ability to find the electrical machine equivalent circuit parameters and modeling of electrical machines.
- **CO4.** Analyze the Induction Machines using computer simulation.
- **CO5.** Analyze the Synchronous Machines using computer simulation tools.

Reference Books:

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley, Second Edition, 2010.
2. Bimbhra P S, “Generalized Theory of Electrical Machines”, Khanna Publishers, 2018
3. Krishnan R, Electric Motor & Drives: Modeling, Analysis and Control, New Delhi, Prentice Hall of India, 2001.

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M.E.	M19PSE102 - ANALYSIS AND DESIGN OF POWER CONVERTERS	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To obtain the switching characteristic of Power diodes and Thyristors.
2. To determine the operation, characteristics and performance parameters of different converters.
3. To apply switching techniques and basic topologies of DC-DC switching regulators.
4. To Design AC-AC converters for variable frequency applications.
5. To Explain the Single phase and three phase Matrix Converters

UNIT- I POWER DIODES AND THYRISTORS 9

Construction, operation, types, switching and steady state characteristics of Power Diodes, SCRs, TRIACs and GTOs - Gate circuit requirements – Protection – Series and parallel operation – Driver circuit – Design of sunbber circuits – Commutation.

UNIT- II AC-DC CONVERTER 9

Single phase and Three phase half controlled and fully controlled converters – Dual converters - Effect of source impedance and overlap- Performance parameters: harmonics, ripple, distortion, power factor - Design of converter circuits – power factor correction rectifiers – Fourier series Analysis

UNIT- III DC-DC CONVERTERS 8

Principles of step-down and step-up converters – Control strategies –Analysis and design of Buck-Boost, CUK, LUO and SEPIC converters - High frequency isolated DC - DC converters- resonant choppers.

UNIT- IV AC – AC CONVERTERS 10

Principle of phase control and ON-OFF control – Single phase and three phase AC voltage controllers – Various configurations – PWM schemes – Single phase and three phase Cycloconverters - SMPS – types and design.

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UNIT- V MATRIX CONVERTER 9

Single phase and three phase Matrix Converters – types – Analysis of performance parameters: Output Voltage, input current, input and output power factors – PWM schemes for matrix converter – Applications-SVPWM schemes for Matrix converter.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1. Analyze various single phase and three phase power converters

CO2. Select and design dc-dc converter topologies for a broad range of power conversion applications.

CO3. Develop improved power converters for any stringent application requirements.

CO4. Design ac-ac converters for variable frequency applications.

CO5. Explain the Single phase and three phase Matrix Converters

Reference Books:

1. Simon Ang, Alejandro Oliva, "Power-Switching Converters, Second Edition,CRC Press, Taylor & Francis Group, 2010.
2. Marian.K.Kazimierczuk and DariuszCzarkowski, "Resonant Power Converters",John Wiley & Sons limited, 2011.
3. M.D. Singh and K.B.Khanchandani, "Power Electronics", Tata McGraw Hill, 2017.
4. Mohan, Undeland and Robins, "Power Electronics – Concepts, Applications and Design", John Wiley and sons, Singapore, 2000.
5. Ned Mohan,T. MUndeland and Robbin W.P, "Power Electronics: converters, Application and design" John Wiley and sons.Wiley India edition, 2006.
6. S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2014.

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M.E.	M19PSE103 - INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To analyze the motor starting and power factor correction.
2. To perform computer-aided harmonic and flicker analysis and to design filters.
3. To expose various grid grounding methodologies
4. To Illustrate flicker analysis and to minimize the effect of it.
5. To Illustrate the concept of insulation coordination & minimize the effect of transient by the help of EMTP.

UNIT- I MOTOR STARTING STUDIES 9

Introduction - Evaluation Criteria - Starting Methods - System Data - Voltage Drop Calculations - Calculation of Acceleration time - Motor Starting with Limited - Capacity Generators – Computer - Aided Analysis – Conclusions

UNIT- II POWER FACTOR CORRECTION STUDIES 9

Introduction - System Description and Modeling - Acceptance Criteria - Frequency Scan Analysis-Voltage Magnification Analysis - Sustained Overvoltages - Switching Surge Analysis – Back – to - Back Switching - Summary and Conclusions.

UNIT- III HARMONIC ANALYSIS 9

Harmonic Sources - System Response to Harmonics - System Model for Computer - Aided Analysis - Acceptance Criteria - Harmonic Filters - Harmonic Evaluation - Case Study - Summary and Conclusions.

UNIT- IV FLICKER ANALYSIS 9

Sources of Flicker - Flicker Analysis - Flicker Criteria -Data for Flicker analysis - Case Study - Arc Furnace Load - Minimizing the Flicker Effects - Summary.

UNIT- V INSULATION AND COORDINATION 9

Modeling of system; simulation of switching surges; description of EMTP - capabilities; voltage acceptance criteria; insulation coordination case study; methods of minimizing switching transients; conclusions.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1.** Explain the motor starting techniques & design factors of it.
- **CO2.** Develop & compare the different types of power factor corrective methods.
- **CO3.** Explain the computer-aided harmonic analysis & filter
- **CO4.** Illustrate flicker analysis and to minimize the effect of it.
- **CO5.** Illustrate the concept of insulation coordination & minimize the effect of transient by the help of EMTP

Reference Books:

1. Ramasamy Natarajan, “Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2002.
2. George L.Kusic, “Computer-Aided Power System Analysis”, CRC press, 2018.
3. EMTP literature from www.microtran.cm

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M.E.	M19PSE104 - ADVANCED POWER SEMICONDUCTOR DEVICES	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To understand the basics of devices selection.
2. To enable the students for the selection of devices for different power electronics applications.
3. To get the knowledge about the datasheet of power semiconductor Devices.
4. Study about the thermal protection of the Devices
5. To examine heat sinks for semiconductor devices

UNIT- I INTRODUCTION 9

Power switching devices overview; Attributes of an ideal switch, application requirements, and circuit symbols. Power handling capability, Device selection strategy – On-state and switching losses -Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

UNIT- II SILICON POWER ELECTRONIC SEMICONDUCTORS DEVICES AND DRIVER CIRCUITS 9

Construction, static characteristics, switching characteristics and Gate characteristics of Thyristor – GTO – MOSFET- IGBTs – SIC – GAN – FCT – RCT. Converter grade and inverter grade SCR. High Speed Opto-Couplers – Zero Crossing Detectors - Optically Isolated High Voltage and High Current sensing circuits, Driver ICs: MOC series SCR , IR2XXX Series Full Bridge and Half Bridge MOSFET / IGBT Driver ICs.

UNIT- III DATASHEET RATINGS FOR SEMICONDUCTOR DEVICES 9

Standards, Symbols and terms-Maximum ratings – Thermal Impedance and resistance-Component (type) designation system - Mechanical data –Safe Operating Area during switching and short circuit.

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UNIT- IV PROTECTION AND NOISE 9

Over voltage, Over current and gate protections and Design of snubber circuits - Noise generated due to switching-Common noise sources in SMPS-Noises Due to High frequency transformer-Measurement of Noise.

UNIT- V THERMAL PROTECTION 9

Heat transfer – conduction, convection and radiation, Cooling – liquid cooling, vapour – phase cooling, Guidance for heat sink selection- heat sink types and design-Electrical analogy of thermal components– Mounting types.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1.** Explain the operation and characteristics of the semiconductor devices.
- **CO2.** Interpret the gate drive circuits and its necessity.
- **CO3.** Select suitable component for the particular application with the help of data sheet.
- **CO4.** Examine protection circuit for the semiconductor devices.
- **CO5.** Examine heat sinks for semiconductor devices.

Reference Books:

1. Rashid M.H., “Power Electronics circuits, Devices and Applications”, Pearson education limited, Fourth Edition, 2014.
2. M.D. Singh and K.B.Khanchandani, “Power Electronics”, Tata McGraw Hill, 2014.
3. Vedam Subramanyam, "Power Electronics", New Age International (P) Limited, New Delhi, 2006.
4. Ned Mohan, Undcland and Robins, “Power Electronics – Concepts, applications and Design, John Wiley and Sons, Third edition.
5. B.W. Williams, “Power Electronics – Devices, Drivers, Applications and Passive Components”, Tata McGraw Hill, 2017.

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PROFESSIONAL ELECTIVES

Semester – II

Elective – II

M.E.	M19PSE201 - SMART GRID	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
2. To familiarize the power quality management issues in Smart Grid.
3. To familiarize the high performance computing for Smart Grid applications.

UNIT- I INTRODUCTION TO SMART GRID 9

Basics of magnetic circuits – General expression of stored magnetic energy – Energy and Force/Torque equations – Singly and Doubly fed excited systems – Linear and Non-linear magnetic systems – Analysis of magnetic circuits with air gap and permanent magnets.

UNIT- II SMART GRID TECHNOLOGIES 9

Static and rotating reference frames – Transformation of variables - Transformation between reference frames – Transformation of a balanced set – Balanced steady state phasor and voltage equations – Variables observed from several frames of reference.

UNIT- III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Voltage and Torque Equations – Dynamic characteristics of permanent magnet and shunt DC motors – State equations - Solution of dynamic characteristics by Laplace transformation.

UNIT- IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Voltage and Torque Equations – Transformation for rotor circuits – Voltage and torque equations in reference frame variables – Analysis of steady state operation – Free acceleration characteristics – Dynamic performance for load and torque variations – Dynamic performance for three phase fault – Computer simulation in arbitrary reference frame.

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UNIT- V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Voltage and Torque Equation - Voltage equation in arbitrary reference frame and rotor reference frame – Park equations - Rotor angle and angle between rotor – Steady state analysis – Dynamic performance for torque variations - Dynamic performance for three phase fault – Transient stability limit – Critical clearing time – Computer simulation

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1.** Learners will develop more understanding on the concepts of Smart Grid and its present developments.
- **CO2.** Learners will study about different Smart Grid technologies.
- **CO3.** Learners will acquire knowledge about different smart meters and advanced metering infrastructure.
- **CO4.** Learners will have knowledge on power quality management in Smart Grids.
- **CO5.** Learners will develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

Reference Books:

1. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press 2012.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley 2012.
3. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: Communication Technologies and Standards” IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grids, vol. 14, 2012.

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M.E.	M19PSE202 - POWER ELECTRONICS OF RENEWABLE ENERGY SOURCES	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To understand the various Non-Conventional sources of energy.
2. To explain the DC to DC converters for Solar PV source of energy.
3. To explain the inverters and its control techniques for a grid connected system.
4. To understand the characteristics of a solar PV and wind power sources.
5. To explain the types of distributed generators and batteries in DG and micro grid system.

UNIT-I INTRODUCTION TO RENEWABLE SOURCES 9

world energy scenario, Wind, solar, hydro, geothermal-availability and power extraction. Introduction to solar energy: Photovoltaic effect, basics of power generation, P-V &I-V characteristics, effect of insolation, temperature, diurnal variation, shading, Modules, connections, ratings, Power extraction (MPP) tracking and MPPT schemes; standalone systems, grid interface, storage, AC-DC loads.

UNIT-II DC-DC CONVERTERS FOR SOLAR PV 9

buck/boost/buck-boost /flyback /forward/cuk, bidirectional converters, Interleaved and multi-input converters.

UNIT-III GRID CONNECTED INVERTERS 9

1ph,3ph, H6, Multilevel Neutral point clamp, Modular multilevel, CSI; Control schemes: unipolar, bipolar, PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding, harmonics, active/reactive power feeding, unbalance.

UNIT-IV INTRODUCTION TO WIND ENERGY 9

P-V, I-V characteristic, wind power system: turbine-generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. Generators for wind: DC generator with DC to AC converters; Induction generator with & w/o converter.

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UNIT-V SYNCHRONOUS GENERATOR WITH BACK TO BACK CONTROLLED/UNCONTROLLED CONVERTER 9

Doubly fed induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging. Introduction to AC and DC microgrids.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Illustrate knowledge on Non-Conventional energy sources.

CO2: Explain the DC to DC converters for Solar PV source of energy.

CO3: Illustrate knowledge on inverters and its control techniques.

CO4: Explain the various technologies and for renewable energy systems.

CO5: Explain the stand-alone DG sets and micro grid systems from renewable energy sources.

Reference Books:

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration. Springer Science & Business, 2013.
2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems, CRC Press, 2013.T3 - E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.
3. Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.
4. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.
5. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, fourth edition 2014.

M.E.	M19PSE203 - POWER SYSTEM RELIABILITY	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To introduces the objectives of Load forecasting.
2. To study the fundamentals of Generation system, transmission system and distribution system reliability analysis.
3. To illustrate the basic concepts of Expansion planning.
4. To Illustrate the concepts of Expansion planning.
5. To Illustrate the knowledge on the fundamental concepts of the distribution system planning.

UNIT-I LOAD FORECASTING 9

Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

UNIT-II GENERATION SYSTEM RELIABILITY ANALYSIS 9

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served –Determination of reliability of ISO and interconnected generation systems.

UNIT-III TRANSMISSION SYSTEM RELIABILITY ANALYSIS 9

Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT-IV EXPANSION PLANNING 9

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

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UNIT-V DISTRIBUTION SYSTEM PLANNING OVERVIEW 9

Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices. Distribution system reliability evaluation: Reliability analysis of radial systems with perfect and imperfect switching.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1:.Develop the ability to learn about load forecasting

CO2: Explain about reliability analysis of ISO and interconnected systems

CO3: Explain the concepts of Contingency analysis and Probabilistic Load flow Analysis

CO4: Illustrate the concepts of Expansion planning

CO5: Illustrate the knowledge on the fundamental concepts of the Distribution system planning

References Books:

1. T. Gonen, “Electrical Power Distribution Engineering”, McGraw Hill Book Company 2014.
2. B.R. Gupta, “Generation of Electrical Energy”,S.Chand Publications 2017.
3. Roy Billinton & Ronald N. Allan, “Reliability Evaluation of Power Systems” Springer Publication,

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M.E.	M19PSE204 - PRINCIPLES OF SUSTAINABLE GREEN ENERGY DEVELOPMENT	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To understand the concept of various non-conventional energy resources.
2. To acquire in-depth knowledge on the conversion of non-conventional energy resources into electrical power.
3. To become intellectual in new developments of renewable energy studies.
4. To attain knowledge in green energy technologies.
5. To Identify the new developments of renewable energy studies.

UNIT-I SOLAR ENERGY 9

Various solar energy systems and their applications – Solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, daily variation, hour angle – Calculation of angle of incidence – Principle of photovoltaic conversion of solar energy - Types of solar cells and fabrication – Photovoltaic - battery charger, domestic lighting, street lighting, water pumping etc- Solar Photovoltaic power plant – Net metering concept .

UNIT-II WIND ENERGY 9

Nature of the wind – wind power– factors influencing wind -Wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit -site selection, Types of wind turbines – Various control-Tip Speed Ratio – Solidity, Torque on wind-wind thrust calculations-Repowering concepts.

UNIT-III BIO-ENERGY 9

Energy from Biomass - Biomass as Renewable Energy Source - Types of Biomass Fuels - Solid,Liquid and Gas- Biomass Conversion Techniques- Wet Process, Dry Process- Photosynthesis - Biogas Generation- Factors affecting Bio-digestion –Different digesters – Digesters sizing - Advantages and Disadvantages - Digesters power generated and problems - Energy Forming –Pyrolysis.

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UNIT-IV ENERGY FROM OCEANS 9

Ocean Thermal Energy Conversion (OTEC):Principle- Lambert Law of absorption - Open and closed OTEC Cycles -.Major problems and operational experience-Tidal energy: Tide – Spring tide, Neap tide – Tidal range – Tidal Power – Types of Tidal power plant -Single and dual basin schemes- Requirements in tidal power plant-Wave Energy – Wave Characteristics, Different wave energy convertors -Saltor Duck , Oscillating water column and dolphin types.

UNIT-V GEOTHERMAL ENERGY 9

Geothermal Energy – Classification-Fundamentals of geophysics-Dry rock and hot aquifers energy analysis-Estimation of thermal power, Extraction techniques.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Illustrate the concept of various non-conventional energy resources.

CO2: Develop in depth knowledge on the conversion of non-conventional energy resources into Electrical power.

CO3: Build knowledge in green energy technologies.

CO4: Explain the Major problems and operational experience on various non-conventional energy resources.

CO5: Identify the new developments of renewable energy studies.

Reference Books:

1. Rai ,G.D.,"Non Conventional sources of Energy", Khanna Publishers ,5th Edition 2016.
2. Khan. B.H, "Non-Conventional Energy Resources", The McGraw Hills, 2nd Edition, 2016.
3. Rao. S. & Pamlekar Dr.B.B. "Energy Technology ", Khanna Publishers, 3rd Edition 2016.
4. John W Twidell and Tony D Weir, "Renewable Energy Resources", Taylor and Francis, 2nd Edition 2006.
5. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.

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PROFESSIONAL ELECTIVES

Semester – II

Elective – III

M.E.	M19PSE205 - ADVANCED DIGITAL SIGNAL PROCESSING	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To expose the students to the fundamentals of digital signal processing in frequency domain& its application.
2. To teach about the concept of transforms and properties.
3. To expose the adaptive filters and multi signal processing.
4. To explain the application of multirate signal processing

UNIT-I INTRODUCTION 9

Review of DFT, FFT, IIR Filters and FIR Filters: Introduction to filter structures (IIR & FIR). Implementation of Digital Filters, specifically 2nd Order Narrow Band Filter and 1st Order All Pass Filter. Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Back ward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

UNIT-II TRANSFORMS AND PROPERTIES 9

Discrete Fourier transform (DFT): - properties, Fast Fourier transform (FFT), DIT-FFT, and DIF-FFT. Wavelet transforms:Introduction, wavelet coefficients – orthonormal wavelets and their relationship to filter banks, multi-resolution analysis, and Haar and Daubechies wavelet.

UNIT-III ADAPTIVE FILTERS 9

Wiener filters – an introduction. Adaptive filters: Fundamentals of adaptive filters, FIR adaptive filter – steepest descent algorithm, LMS algorithm, NLMS, applications – channel equalization. Adaptive recursive filters – exponentially weighted RLS algorithm.

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UNIT-IV MULTI RATE SIGNAL PROCESSING 9

Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion. Examples of up-sampling using an All Pass Filter.

UNIT-V APPLICATIONS OF MULTI RATE SIGNAL PROCESSING 9

Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Subband Coding of Speech Signals, Quadrature Mirror Filters, Transmultiplexers, Over Sampling A/D and D/A Conversion.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Explains the fundamentals of digital signal processing in time-frequency domain& its application

CO2: Comprehend the DFTs and FFTs, design and Analyze the digital filters, comprehend the Finite word length effects in Fixed point DSP Systems.

CO3: Illustrate the function of filters with algorithm.

CO4: Compare Architectures & features of Programmable DS processors & develop logical functions of DS Processors

CO5: Solve various types of practical problems in DSP

Reference Books:

1. Lonnie C.Ludeman ,"Fundamentals of Digital Signal Processing",Wiley,2013.
2. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', McGraw Hill Edu, 2013.
3. Poorna Chandra S, Sasikala. B, Digital Signal Processing, Vijay Nicole/TMH,2013.
4. Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab", Cengage Learning, 2014.
5. SenM.kuo, woonseng s.gan, "Digital Signal Processors, Architecture, Implementations & Applications, Pearson,2013.
6. Dimitris G.Manolakis, Vinay K. Ingle, applied Digital Signal Processing, Cambridge, 2012.

BoS CHAIRMAN

M.E.	M19PSE206 - SOFT COMPUTING TECHNIQUES	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To expose the concepts of feed forward neural networks.
2. To provide adequate knowledge about feedback neural networks.
3. To teach about the concept of fuzziness involved in various systems.
4. To expose the ideas about genetic algorithm. To provide adequate knowledge about of FLC and NN toolbox.

UNIT-I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems -Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- Mc Culloch Pitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training- applications.

UNIT-II ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY 9

Counter propagation network- architecture- functioning & characteristics of counter Propagation network- Hopfield/ Recurrent network configuration - stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications- Implementation and training - Associative Memory.

UNIT-III FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification inferencing and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

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UNIT-IV GENETIC ALGORITHM 9

Evolutionary programs – Genetic algorithms, genetic programming and evolutionary programming - Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators - Optimization problems using GA-discrete and continuous - Single objective and multi-objective problems - Procedures in evolutionary programming.

UNIT-V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine- Evolutionary Programming-Particle Swarm Optimization - Case study – Familiarization of NN, FLC and ANFIS Tool Box.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Understand the basic ANN architectures, algorithms and their limitations. Also will be able to know the different operations on the fuzzy sets.

CO2: Analyze the ANN based models and control schemes for non-linear system. Will get expertise in the use of different ANN structures and online training algorithm.

CO3: Understand the Fuzzy logic for modeling and control of non-linear systems.

CO4: Understand the genetic algorithm and optimization technoquies.

CO4: Understand the hybrid control schemes and P.S.O and support vector Regressive.

Reference Books:

1. S.N.Sivanandam, and S.N.Deepa, Principles of Soft computing, Second Edition, Wiley India Pvt. Ltd,2013
2. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
3. Ethem Alpaydin, “Introduction to Machine learning (Adaptive Computation and Machine Learning series)’, MIT Press, Second Edition, 2010.
4. George J.Klir and, Bo Yuan, Fuzzy sets and Fuzzy Logic, Second Edition, PHI,2006
5. J.M.Zurada, Introduction to artificial neural systems, Jaico Publishing House, 2006

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M.E.	M19PSE207-RESEARCH METHODOLOGY AND IPR	T	P	TU	C
		3	0	0	3

Course Objectives:

1. The course has been developed with orientation towards research related activities and recognizing the ensuing knowledge as property. It will create consciousness for Intellectual Property Rights and its constituents. Learners will be able to perform documentation and administrative procedures relating to IPR in India as well as abroad.

UNIT-I RESEARCH PROBLEM 9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT-II LITERATURE STUDIES 9

Effective literature studies approaches, analysis Plagiarism, Research ethics.

UNIT-III TECHNICAL WRITING 9

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-IV INTELLECTUAL PROPERTY 9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V PATENT RIGHTS & NEW DEVELOPMENTS IN IPR 9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1:** Understand research problem formulation.
- **CO2:** Analyze research related information follow research ethics
- **CO3:** Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- **CO4:** Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- **CO5:** Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Reference Books:

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy",McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

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		T	P	TU	C
M.E.	**M19PSE208 - ELECTRICAL DISTRIBUTION SYSTEM**	**3**	**0**	**0**	**3**

Course Objectives:

1. To provide knowledge about the distribution system electrical characteristics.
2. To gain knowledge about planning and designing of distribution system.
3. To analyze power quality in distribution system.
4. To analyze the power flow in balanced and unbalanced system.

UNIT- I INTRODUCTION 9

Distribution System-Distribution Feeder Electrical Characteristics-Nature of Loads: Individual Customer Load, Distribution Transformer Loading and Feeder Load-Approximate Method of Analysis: Voltage Drop, Line Impedance, "K" Factors, Uniformly Distributed Loads and Lumping Loads in Geometric Configurations.

UNIT- II DISTRIBUTION SYSTEM PLANNING 9

Factors effecting planning, present techniques, planning models(Short term planning, long term planning and dynamic planning), planning in the future, future nature of distribution planning, Role of computer in Distribution planning. Load forecast, Load characteristics and Load models.

UNIT- III DISTRIBUTION SYSTEM LINE MODEL 9

Exact Line Segment Model-Modified Line Model-Approximate Line Segment Model-Modified "Ladder" Iterative Technique-General Matrices for Parallel Lines.

UNIT- IV VOLTAGE REGULATION 9

Standard Voltage Ratings-Two-Winding Transformer Theory-Two-Winding Autotransformer- Step-Voltage Regulators: Single-Phase Step-Voltage Regulators-Three-Phase Step-Voltage Regulators- Application of capacitors in Distribution system.

BoS CHAIRMAN

UNIT- V DISTRIBUTION FEEDER ANALYSIS 9

Power-Flow Analysis- Ladder Iterative Technique -Unbalanced Three-Phase Distribution Feeder- Modified Ladder Iterative Technique- Load Allocation- Short-Circuit Studies.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

- **CO1:** Ability to understand the concepts of distribution system for utility systems
- **CO2:** Ability to understand the concepts of planning of distribution system for utility systems
- **CO3:** Ability to understand the design of distribution system line model.
- **CO4:** Ability to implement the concepts of voltage control in distribution system.
- **CO5:** Ability to analyze the power flow in balanced and unbalanced system

Reference Books:

1. William H. Kersting," Distribution System Modeling and Analysis " CRC press 3rd edition,2012.
2. Turan Gonen, “Electric Power Distribution System Engineering”, Second Edition CRC Press 2007.
3. James Northcote – Green, Robert Wilson, “Control and Automation of Electrical Power Distribution Systems”, CRC Press, New York, 2007.
4. Pabla H S, “Electrical Power Distribution Systems”, Tata McGraw Hill. 2004

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Semester-III

M.E.	M19PST301- DISTRIBUTED GENERATION AND MICRO-GRID	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To illustrate the concept of conventional generation
2. To illustrate the concept of distributed generation
3. To analyze the impact of grid integration
4. To understand the concept of microgrid and its configuration
5. To analyze the control and operation of microgrid

UNIT- I INTRODUCTION 9

Energy Sources and their availability -Trends in Energy Consumption ,Conventional power generation: advantages and disadvantages, Energy crises, Nonconventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, tidal sources, energy storage Batteries ,ultra capacitors and captive power plants.

UNIT- II DISTRIBUTED GENERATIONS (DG) 9

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation, sitting and sizing of DGs, optimal placement, Optimal Renewable Resources Mix, security issues in DG implementations.

UNIT- III ISSUES IN GRID INTEGRATION 9

Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues. Impact of DGs on Protective Relaying and islanding issues in existing distribution Grid.

UNIT- IV MICROGRIDS 9

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, Energy Management and Protection Control Strategies of a Microgrid - Case Studies.

BOS CHAIRMAN

UNIT-V CONTROL AND OPERATION OF MICROGRID 9

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Explain the various schemes of conventional and nonconventional power generation

CO2: Recognize the need of sitting of distributed generation along with their effect on distribution system

CO3: Explain the requirements for grid interconnection and its impact with NCE sources

CO4: Understand the fundamental concept of Microgrid

CO5: Explain the control and operation of microgrid, islanded ,anti-islanding modes, communication based techniques and regulatory schemes.

Reference Books:

1. Gregory W. Massey, “Essentials of Distributed Generation Systems”, Jones & Bartlett Publishers, 2011.
2. Math H. Bollen, “Integration of Distributed Generation in the Power System”, John Wiley & Sons, 2011.
3. Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, John Wiley & Sons, 2011.
4. Amirnaser Yezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2010.
5. J.F. Manwell, J.G. McGowan “Wind Energy Explained, theory design and applications”, Wiley publication 2010.

Electives – IV

M.E.	**M19PSE301-SOLAR & ENERGY STORAGE SYSTEMS**	**T**	**P**	**TU**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To Study about solar modules and PV system design and their applications
2. To Deal with grid connected PV systems
3. To Discuss about different energy storage systems

UNIT- I INTRODUCTION 9

Characteristics of sunlight – semiconductors and P-N junctions –behaviour of solar cells – cell properties – PV cell interconnection- Solar cell arrays, system analysis and performance prediction, shadow analysis, reliability.

UNIT- II STAND ALONE PV SYSTEM 9

Solar modules – array sizing - storage systems – power conditioning and regulation - MPPT- protection – standalone PV systems design – sizing

UNIT- III GRID CONNECTED PV SYSTEMS 9

PV systems in buildings – Grid-Tie Inverter-design issues for central power stations – safety – Economic aspect – Efficiency and performance - International PV programs

UNIT- IV ENERGY STORAGE SYSTEM 9

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – Super capacitor, Fuel cells, its operation, types, applications - battery sizing.

UNIT- V APPLICATIONS 9

Water pumping – battery chargers – solar car – direct-drive applications –Space – Simulation of energy storage systems and its management, smart park, Electric Vehicle charging facility.

Total Instructional hours: 45

BOS CHAIRMAN

Course Outcomes:

Students will be able to

CO1: Illustrate the solar energy & storage systems.

CO2: Develop basic knowledge on standalone PV system.

CO3: Explain the issues in grid connected PV systems.

CO4: Explain the power converters used for solar energy conversion and the modeling of different energy storage systems.

CO5: Outline the different applications of solar energy.

Reference Books:

1. Solanki C.S., "Solar Photovoltaics: Fundamentals, Technologies And Applications", PHI Learning Pvt. Ltd.,2015.
2. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1-84919-219-4), 2011
3. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016
4. Eduardo Lorenzo G. Araujo, "Solar electricity engineering of photovoltaic systems", Progensa, 1994.
5. John Wiley and sons., "Fuel cell fundamentals", Willey 2016.
6. Francois Beguin and Elzbieta Frackowiak ,"Super capacitors", Wiley, 2013.

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M.E.	M19PSE302 - ENERGY MANAGEMENT AND AUDITING	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To study the concepts behind energy management and auditing.
2. To emphasize the need and type of instruments for energy audit and management.
3. To illustrate the benefits of different energy management techniques.

UNIT- I INTRODUCTION AND DEMAND SIDE MANAGEMENT (DSM) IN POWER UTILITIES 9

Energy Scenario & Conservation -Demand Forecasting Techniques- Integrated Optimal Strategy for Reduction of T&D Losses - DSM Techniques and Methodologies- Loss Reduction in Primary and Secondary Distribution system and capacitors.

UNIT- II ENERGY AUDIT 9

Energy Management – Role of Energy Managers - Energy Audit concepts – Metering. Basic elements and measurements - Mass and energy balances - Scope of energy auditing in industries.

UNIT- III ENERGY AUDIT OF ELECTRICAL EQUIPMENT 9

Evaluation of energy conservation opportunities and environmental management- Preparation and presentation of energy audit reports, case studies for Induction motors, Transformers, Cables, Lighting, AC systems, Pumps, Capacitor banks and potential energy savings.

UNIT- IV ENERGY CONSERVATION 9

Energy conservation in HVAC systems and thermal power plants, Solar systems, Fan and Lighting Systems - Different light sources and luminous efficacy, Energy conservation in electrical devices and systems, Economic evaluation of energy conservation measures, Electric motors and transformers, Inverters and UPS, Voltages stabilizers.

BOS CHAIRMAN

UNIT- V INSTRUMENTATION 9

Evaluation and instrumentation techniques for renewable energy systems (solar thermal, photovoltaic and wind energy); energy management devices; micro controller based systems.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Understand the need and significance of energy audit and management

CO2: Explain basic concepts of energy audit.

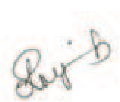
CO3: Identify the equipment for audit in power system

CO4: Assess the need and type of instruments for energy audit and energy Management.

CO5: Analyse the domain of energy conservation and benefits of different energy management techniques.

Reference Books:

1. Amlan Chakrabarti- Energy Engineering and management, PHI, 2018
2. Rajiv Shanker- Energy auditing in Electrical utilities, Viva books Pvt.Ltd., 2015
3. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, "Guide to Energy Management", Seventh Edition, The Fairmont Press Inc., 2012.
4. Craig B. Smith, “Energy Management Principles”, Pergamon Press, 2015.
5. Reay D.A, “Industrial Energy Conservation”, 1st edition, Pergamon Press, 1977.
6. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.



BOS CHAIRMAN

M.E.	M19PSE303- FLEXIBLE AC TRANSMISSION SYSTEMS	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To emphasis the need for FACTS controllers.
2. To learn the characteristics, applications and modeling of series and shunt FACTS controllers.
3. To analyze the interaction of different FACTS controller and perform control coordination and UPFC
4. To understand the knowledge about voltage and phase angle regulators

UNIT- I INTRODUCTION 9

Reactive power control in electrical power transmission lines –Uncompensated transmission line – Fixed series and shunt compensation – Basic types of FACTS controllers – Brief description and definitions of FACTS controllers.

UNIT- II SHUNT COMPENSATORS 9

Objectives of shunt compensation, Variable impedance Devices (TSR, TCR, TSC, FC-TCR, TSC-TCR), Switched converter (STATCOM) and Hybrid shunt compensators.

UNIT- III SERIES COMPENSATORS 9

Concepts of Controlled Series Compensation- Operation of TCSC - Analysis of TCSC operation - Modelling of TCSC for load flow studies - Static synchronous series compensator(SSSC) - Operation of SSSC - Modelling of SSSC for power flow – SSR Mitigation – Introduction to Unified power flow controllers (UPFC).

UNIT- IV VOLTAGE AND PHASE ANGLE REGULATORS 9

Principles of operation-types-Steady state model and characteristics of a static voltage regulators and phase shifters- Thyristor controlled Voltage and phase angle regulators. Switching converter based voltage and phase angle regulators-applications.

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UNIT-V MODELLING OF FACTS CONTROLLERS 9

Modelling of Shunt and Series Controllers for Power Flow and Transient stability. Modelling of UPFC.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Explain the basic principles, characteristics of different types of FACTS controllers.

CO2: Ability to understand the concept about shunt compensator

CO3: Ability to understand the concept about series compensator

CO4: Ability to analyze the performance of voltage regulaors

CO5: Model FACTS controller for power flow and stability applications.

Reference Books:

1. Narain G. Hingorani, 'Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems', Standard Publishers Distributors, Delhi- 110006,2011.
2. R.Mohan Mathur, Rajiv K.Varma,"Thyristor–Based Facts Controllers for Electrical
3. Transmission Systems", IEEE press and John Wiley & Sons, Inc,2002.
4. Padiyar.K.S.'FACTS Controllers in Power Transmission and Distribution', New Age International(P) Limited, Publishers, New Delhi, 2008
5. Sood. V.K,HVDC and FACTS controllers , 'Applications of Static Converters in Power System, Kluwer Academic Publishers, 2004.

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M.E.	M19PSE304- ELECTRICAL TRANSIENTS IN POWER SYSTEM	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To understand the various types of transients and its analysis in power system.
2. To learn about modelling and computational aspects transients computation

UNIT I REVIEW OF TRAVELLING WAVES ON TRANSMISSION LINE 9

Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behaviour of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion-Multi conductor system and Velocity wave.

UNIT II LIGHTNING, SWITCHING AND TEMPORARY OVERVOLTAGES 9

Lightning: Physical phenomena of lightning–Interaction between lightning and power system–Factors contributing to line design–Simple and Abnormal Switching Transients–Transients in three phase circuits–Very Fast Transient Over voltage (VFTO)–IEC standards and wave models.

UNIT III TRANSMISSION SYSTEM RELIABILITYANALYSIS 9

Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT IV EXPANSION PLANNING 9

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

UNIT V DISTRIBUTION SYSTEMPLANNING OVERVIEW 9

Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices. Distribution system reliability evaluation: Reliability analysis of radial systems with perfect and imperfect switching.

Total Instructional hours: 45

BOS CHAIRMAN

Course Outcomes:

Students will be able to

CO1:. Explain the concept of travelling waves on transmission line.

CO2: Illustrate the concept of lightning and overvoltages.

CO3: Explain the concepts of transmission system reliability analysis.

CO4: Illustrate the concepts of Expansion planning.

CO5: Illustrate the knowledge on the Overview of Distribution system planning.

Reference Books:

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.
2. R. Ramanujam, “Computational Electromagnetic Transients: Modeling, Solution Methods and Simulation”, I.K. International Publishing House Pvt. Ltd, New Delhi, 2014.
3. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

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Electives - V

M.E.	M19PSE305 – EMBEDDED SYSTEM DESIGN & PROGRAMMING	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To study about the real time examples of embedded systems.
2. To impart the concepts and architecture of embedded systems and to make the students capable of designing Embedded systems.
3. To achieve the architecture and programming of Embedded Software Development Environments.
4. To achieve and apply the Development For Embedded Systems

UNIT- I INTRODUCTION AND EXAMPLES OF EMBEDDED SYSTEMS 9

Concept of Embedded System Design: Design challenge, Processor technology, IC technology, Design technology, Trade-offs.

UNIT-II CUSTOM SINGLE PURPOSE PROCESSOR HARDWARE, GENERALPURPOSE PROCESSO AND MEMORY 9

Introduction, basic architecture, operation, super-scalar and VLSIIW architecture, application. Specific instruction set processors (ASIPS), microcontrollers, digital signal processors, selecting a microprocessor. Introduction, Memory writes ability, Storage performance, Tradeoff s, Common memory types Memory hierarchy and cache.

UNIT- III AVR 8515 MICROCONTROLLER 9

Architecture and Programming in assembly and C. Interfacing Analog and digital blocks: Analog-to-Digital Converters (ADCs), Digital to-Analog, Converters (DACs).Communication basics and basic protocol concepts, Microprocessor interfacing: I/O addressing, Port and Bus based, I/O, Memory mapped I/O, Standard I/O interrupts, Direct memory access, Advanced communication principles parallel, serial and wireless, Serial protocols I2C, Parallel protocols PCI bus, Wireless protocol IrDA, blue tooth.

UNIT- IV EMBEDDED SOFTWARE DEVELOPMENT ENVIRONMENTS 9

Real time operating systems, Kernel architecture: Hardware, Task/process control subsystem, Device drivers, File subsystem, system calls, Embedded operating systems, Task scheduling in embedded systems: task scheduler, first in first out, shortest job first, round robin, priority based scheduling, Context switch: Task synchronization: mutex, semaphore, Timers, Types of embedded operating systems, Programming languages: assembly languages, high level language.

UNIT- V DEVELOPMENT FOR EMBEDDED SYSTEMS 9

Embedded system development process, Determine the requirements, Design the system architecture, Choose the operating system, Choose the processor, Choose the development platform, Choose the programming language, Coding issues, Code optimization, Efficient input/output, Testing and debugging, Verify the software on the host system, Verify the software on the embedded system

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Understand the real time examples of embedded systems

CO2: Explain about processor and memory

CO3: Explain the concepts of AVR 8515 microcontroller

CO4: Analyses the Embedded Software Development Environments

CO5: Apply the Development For Embedded Systems

Reference Books:

1. Frankvahid/Tony Givargis, “Embedded System Design- A unified Hardware/software Introduction”. John Wiley Publications, 2009.
2. David E Simon, " An embedded software primer ", Pearson education Asia, 2001.
3. Dreamteach Software team,” Programming for Embedded Systems”AVR 8515 manual
4. J.W. Valvano, "Embedded Microcomputor System: Real Time Interfacing" John Wiley & Sons, 2011.
5. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.

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M.E.	M19PSE306 - CYBER SECURITY IN SMART POWER SYSTEMS	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To secure the power system using cyber security in near future.
2. To understand the new techniques for providing secured power system.
3. To understand the regulatory bodies of IOT physical infrastructure

UNIT- I INTRODUCTION TO POWER SYSTEMS CONTROL 9

Characteristics of Power Generating Units and Economic Dispatch-Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints)- Solution techniques of Unit Commitment-Generation Scheduling with Limited Energy-Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations-Interchange Evaluation for Regional Operations, Types of Interchanges-Exchange Costing Techniques-literature survey on Development of Smart grid.

UNIT- II ENERGY MANAGEMENT SYSTEMS (EMS) & SCADA 9

Energy Management Centers and Their Functions-Architectures-recent Developments. Introduction to Supervisory Control and Data Acquisition-SCADA Functional requirements and Components-General features, Functions and Applications, Benefits-Configurations of SCADA- RTU (Remote Terminal Units) Connections-Power Systems SCADA and SCADA in Power System Automation-SCADA Communication requirements-SCADA Communication protocols: Past Present and Future-Structure of a SCADA Communications Protocol.

UNIT- III DIGITAL & IT SECURITIES 9

Introduction-Types of Attacks-Digital Privacy-Online Tracking-Privacy Laws-Types of Computer Security risks (Malware, Hacking, Pharming, Phishing, Ransomware, Adware and Spyware, Trojan, Virus, Worms, WIFI Eavesdropping, Scareware, Distributed Denial-Of-Service Attack, Rootkits, Juice Jacking)-Antivirus and Other Security solution-Password-Secure online browsing-Email Security-Social Engineering-Secure WIFI settings-Track yourself online-Cloud storage security-IOT security-Physical Security Threads.

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UNIT- IV ONLINE ANONYMITY 9

Online Anonymity -Anonymous Networks, Protocols -http-https-FTP Tor Network-I2P Network-Freenet-Darknet-Anonymous OS – Tails-Secure File Sharing-VPN-Proxy Server-Connection Leak Testing-Secure Search Engine- Web Browser Privacy Configuration-Anonymous Payment.

UNIT- V SMART GRID & SMART METERS 9

Smart grid :Introduction-Representative Architecture-Components-Microgrid-Smart grid Communications and Measurement Technology- Renewable energy resources-modeling and basic architecture of wind generation systems-Fuel cell-Small and micro hydropower-Plug in Hybrid vehicles-Demand response and Demand side management-Computational tools for smart grid design-Interoperability-standards-cyber security-Advanced metering infrastructure (AMI) and a meter data management system (MDMS) are basic smart grid components-AMI collects and transmits smart meter data between devices and MDMS facilitates data collection-storage and management..

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Able to know about the control techniques for power system.
CO2: Understand the concepts & applications of EMS, SCADA.
CO3: Ability to identify the digital attacks and provide security for power system.
CO4: Able to know about the online anonymity.
CO5: Ability to understand the concept of smart grid & usage of smart meters.

Reference Books:

1. John R. Vacca (2013): Computer and Information Security Handbook(second edition).
2. Tyson Macaulay & Bryan Singer (2012): Cyber security for Industrial Control Systems.
3. Eric D. Knapp & Joel Thomas Langill (2015):Industrial Network Security:Securing Critical Infrastructure, Network for Smart Grid,SCADA, and other Industrial Control Systems
4. Cyber security for Industrial Control Systems Ralph Langner (2012):Robust Control System Networks.
5. Power Generation, Operation, and Control Hardcover – by Allen J. Wood (Author), Bruce F. Wollenberg (Author) 6 March 1996

BOS CHAIRMAN

M.E.	M19PSE307 - ELECTRIC VEHICLE	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To present a comprehensive overview of Electric and Hybrid Electric Vehicles.
2. To understand the concept of electrical vehicles and its operations.
3. To understand the need for energy storage in hybrid vehicles.
4. To provide knowledge about various possible energy storage technologies that can be used in electric vehicles.

UNIT- I INTRODUCTION TO ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

UNIT-II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 9

Architecture of an Electric Vehicles(EV)'s and Hybrid Electric Vehicles (HEV's), essentials and performance of electric vehicles – Traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations.– Plug-n Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT- III ELECTRIC PROPULSION SYSTEMS 9

DC motor drives, induction motor drives, permanent magnet motor drives and switched reluctance motor drives.

UNIT- IV ENERGY STORAGE DEVICES 9

Electrochemical batteries – Reactions, thermodynamic voltage, Lead-acid batteries, nickel based batteries, lithium based batteries, flywheel and ultra-capacitors, Battery management systems.

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UNIT- V ALTERNATIVE ENERGY STORAGE SYSTEMS 9

Fuel cell thermodynamics, operating principle, fuel cell technologies, fuel reforming, hydrogen production and storage. Photovoltaic cell, maximum power point tracking, solar powered accessories, hybrid solar vehicles, Ultra capacitors. Case study: Volvo XC90 T8 Plug-In Hybrid, Nissan X-Trial hybrid.

Total Instructional hours: 45

Course Outcomes:

Students will be able to

CO1: Explain about the working principle and operation of electric vehicles and Hybrid Electric vehicles.

CO2: Explain the architecture of Electric vehicles, Hybrid Electric vehicles, PHEV and power train components in electric vehicles.

CO3: Explain the construction and working principle of various motors used in electric vehicles.

CO4: Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.

CO5: Explain the various energy storage devices for electrical vehicles.

CO6: Illustrate the various types and working principle of fuel cells.

CO7: Explain the various types and working principle of Ultracapacitors.

Reference Books:

1. Iqbal Husain, —Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.
2. Mehrdad Ehsani, Yi mi Gao, Sebastien E. Gay and Ali Emadi, —"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.
3. Seref Soylu —"Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.
4. AuliceScibioh M. and Viswanathan B., —"Fuel Cells – Principles and Applications", University Press, India, 2006.
5. Barbir F., —"PEM Fuel Cells: Theory and Practice" Elsevier, Burlington, 2005.

BOS CHAIRMAN

M.E.	M19PSE308 - ARTIFICIAL INTELLIGENCE	T	P	TU	C
		3	0	0	3

Course Objectives:

1. To expose the history and foundations of artificial intelligence.
2. To illustrate how heuristic approaches provide a good solution mechanism.
3. To provide the mechanisms for simple knowledge representation and reasoning.
4. To highlight the complexity in working with uncertain knowledge.
5. To discuss the current and future applications of artificial intelligence.

UNIT- I HISTORY AND FOUNDATIONS 9

History – Scope – Influence from life – Impact of computing domains - Agents in environments - Knowledge representation – Dimensions of Complexity – Sample application domains – Agent structure.

UNIT- II SEARCH 9

Problem solving as search – State spaces – Uninformed Search – Heuristic search – Advanced search – Constraint satisfaction - Applications.

UNIT- III KNOWLEDGE REPRESENTATION AND REASONING 9

Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

UNIT- IV REPRESENTING AND REASONING WITH UNCERTAIN KNOWLEDGE 9

Probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference, sample applications.

UNIT- V CASE STUDY AND FUTURE APPLICATIONS 9

Design of a game / Solution for problem in student's domain. Natural Language processing, Robotics, Vehicular automation – Scale, Complexity, Behaviour – Controversies.

Total Instructional hours: 45

BOS CHAIRMAN

Course Outcomes:

Students will be able to

CO1: Summarize the history, current applications, future challenges and the controversies in artificial intelligence.

CO2: Apply the principle of AI in the design of an agent & model its actions and heuristic algorithm for search problems.

CO3: Analyze and represent the fact using logic for a given scenario

CO4: Analyze and represent uncertainty using probabilistic models

CO5: Develop a simple game or solution using artificial intelligence techniques.

Reference Books:

1. Keith Frankish, William M. Ramsey (eds) The Cambridge Handbook of Artificial Intelligence, Cambridge University Press, 2014.
2. Nils J. Nilsson, The Quest for Artificial Intelligence, Cambridge University Press, Online edition, 2013.
3. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2010.
4. David Poole, Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.

BOS CHAIRMAN

M.E.	M19PSP301 - PROJECT WORK (PHASE I)	T	P	TU	C
		0	12	0	6

Course Objectives:

1. To enable a student to do an individual project work which may involve design, modelling, simulation and/or fabrication.
2. To analyse a problem both theoretically and practically.
3. To motivate the students to involve in research activities leading to innovative solutions for industrial and societal problems.

COURSE DESCRIPTION:

Project work shall be carried out by each and every individual student under the supervision of a faculty of this department. A student may however, in certain cases, be permitted to work for the project in association with other departments or in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization. The student shall meet the supervisor periodically and attend the periodic reviews for evaluating the progress.

Project work will be carried out in two phases, Phase-I during the third semester and Phase-2 during the final semester. Phase-I shall be pursued for a minimum of 12 periods per week and Phase – II in 24 periods per week. In each phase, there will be three reviews for continuous internal assessment and one final review and viva voce at the end of the semesters. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

Course Outcomes:

Students will be able to

CO1: Identify the area, narrow dine the problem and understand the problem thoroughly and provide an appropriate solution.

CO2: Conducting a systematic literature survey which helps to build the knowledge in the chosen field by using the existing journal references .

CO3: Derive a mathematical model for the system under study.

CO4: Choose and get proficiency over the software for simulation and analysis.

CO5: Present the findings of the phase I work in conferences/journals.

BOS CHAIRMAN

M.E.	M19PSP401 - PROJECT WORK (PHASE II)	T	P	TU	C
		0	24	0	12

Course Objectives:

1. To enable a student to do an individual project work which may involve design, modelling, simulation and/or fabrication.
2. To analyse a problem both theoretically and practically.
3. To motivate the students to involve in research activities leading to innovative solutions for industrial and societal problems.

Course Description:

Project work shall be carried out by each and every individual student under the supervision of a faculty of this department. A student may however, in certain cases, be permitted to work for the project in association with other departments or in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization. The student shall meet the supervisor periodically and attend the periodic reviews for evaluating the progress.

Project work will be carried out in two phases, Phase-I during the third semester and Phase-2 during the final semester. Phase-II shall be pursued for 24 periods per week. In phase II also, there will be three reviews for continuous internal assessment and one final review and viva voce at the end of the semesters. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

Course Outcomes:

Students will be able to

CO1: Design and develop the project, creativity and choose the most appropriate option for the Phase I project.

CO2: Effectively communicate technical project information in writing/Seminar Presentation/ Technical Discussion.

CO3: Apply modern engineering tools for simulation, analysis and Solution.

CO4: Present the findings of the project by attending conference and communicate to journals for publication.

CO5: Engage in continuously learning the new practices, principles, and techniques in electric Power system.

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