JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
ANANTHAPURAMU (A.P.)
COURSE STRUCTURE AND SYLLABUS
(For Affiliated Engineering Colleges w.e.f. 2017-18 Admitted Batch)
M.TECH - ELECTRICAL POWER ENGINEERING,
ELECTRICAL POWER SYSTEMS and POWER SYSTEM

M.Tech I Semester

S.No	Subject Code	Subject	L	T	P	C
1.	17D49101	Advanced Power System Protection	4	-	-	4
2.	17D49102	Machine Modeling and Analysis	4	-	-	4
3.	17D49103	Optimization & Heuristic Search Techniques	4	-	-	4
4.	17D49104	Restructured Power Systems	4	-		4
5.	17D49105 17D49106 17D49107	**Elective-I** 1. Modern Control Engineering & Principles of Optimal Control 2. FACTS Controllers 3. Solar Energy Conversion Systems	4	-	-	4
6.	17D49108 17D49109 17D49110	**Elective-II** 1. Power System Wide Area Monitoring & Control 2. Energy Auditing and Management 3. State Estimation Techniques	4	-	-	4
7.	17D49111	Machines & Power Systems Lab	-	-	4	2
		TOTAL	**22**	**-**	**04**	**26**

M.Tech II Semester

S.No	Subject Code	Subject	L	T	P	C
1.	17D49201	Reliability Engineering and Application to Power Systems	4	-	-	4
2.	17D49202	Power Quality	4	-	-	4
3.	17D49203	Smart Grid Technologies	4	-	-	4
4.	17D49204	Power System Stability & Control	4	-		4
5.	17D49205 17D49206 17D49207	**Elective-III** 1. Reactive Power Compensation & Management 2. Power System Optimization 3. HVDC & EHVAC Transmission Systems	4	-	-	4
6.	17D49208 17D49209 17D49210	**Elective-IV** 1. Distributed Generation & Micro grid Control 2. Wind Energy Conversion Systems 3. Intelligent Control Techniques	4	-	-	4
7.	17D49211	Power System Simulation Lab	-	-	4	2
		TOTAL	**22**	**-**	**04**	**26**

M.Tech III Semester

S.No	Subject Code	Subject	L	T	P	C
1.	17D20301 17D20302 17D20303	**Elective – V** 1. Research Methodology 2. Human Values and Professional Ethics 3. Intellectual Property Rights	4	-	-	4
2.	17D49301	**Elective - VI (MOOCS)**	-	-	-	-
3.	17D49302	Comprehensive Viva-Voce	-	-	-	2
4.	17D49303	Seminar	-	-		2
5.	17D49304	Teaching Assignment	-	-	-	2
6.	17D49305	Project Work Part – I	-	-	-	4
		TOTAL	**04**	**-**	**-**	**14**

M.Tech IV Semester

S.No	Subject Code	Subject	L	T	P	C
1.	17D49401	. Project Work Part - II	-	-	-	12

Project Viva Voce Grades:

A: Satisfactory

B: Not Satisfactory

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49101) ADVANCED POWER SYSTEM PROTECTION

COURSE OBJECTIVES:

To make the student learn about:

- Different types of Relays used in the power system.
- Analyzing the different relays and in which circumstances the relays can be used.
- Analyzing Power swings and their impact on power system.
- Implementation of Microprocessor based relays and Numerical relays.

SYLLABUS:

UNIT-I: INTRODUCTION TO STATIC RELAYS & COMPARATORS

Introduction to static relays - Basic construction of static relays – Level detectors – Replica impedance-mixing circuits-general equation for two input phase and amplitude comparators – Their types - Duality between amplitude and phase comparator. Conic section characteristics – Three input amplitude comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes-Phase fault scheme – Three phase scheme – combined and ground fault scheme.

UNIT-II: STATIC RELAYS

Introduction-Instantaneous over current relay – Time over current relays - Basic principles-Definite time and Inverse definite time over current relays.
Static Differential Relays-Analysis of static differential relays – static relay schemes- Dual bias transformer differential protection – Harmonic restraint relay. Static Distance Relays- Static impedance – reactance - MHO and angle impedance relay sampling comparator – realization of reactance and MHO relay using a sampling comparator.

UNIT-III: POWER SWINGS

Effect of power swings on the performance of Distance relays - Power swing analysis – Principle of out of step tripping and blocking relays – Effect of line length and source impedance on distance relays.

UNIT-IV: MICROPROCESSOR BASED PROTECTIVE RELAYS

Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flow chart approach only). Generalized mathematical expression for distance relays - Measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) Basic principle of Digital computer relaying.

UNIT-V: NUMERICAL RELAYS:

Advantages of Numerical Relays- Numerical network- Digital Signal processing – Estimation of Phasors – Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm- practical considerations for selection of Algorithm –Discrete Fourier Transform

REFERENCES:

1. **Power system Protection static relay**, T.S.Madhava Rao, Tata McGraw Hill, 2nd Edition, 1989.
2. **" Power System Protection and Switchgear",** Bhuvanesh A Oza, Nirmal kumar C Nair et.al. Mc Graw Hill
3. **Power system Protection and Switchgear**, Badri Ram and D.N.Vishwakarma, Tata McGraw Hill, First Edition -1995.

COURSE OUTCOMES:

After completing the course, the student should be able to do the following:

CO 1: Understand the basic construction of the relays and comparators and their characteristics.

CO 2: Analyze the impact of Power Swings on various relays and their performances.

CO 3: Implement various types of relays using a single Microprocessor based Relay.

CO 4: Understand the advantages and applications of Numerical Relays.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49102) MACHINE MODELING AND ANALYSIS

COURSE OBJECTIVES:

The student will be able:

• To Identifying the methods and assumptions in modeling of machines.

• To recognize the different frames for modeling of AC machines.

• To write voltage and torque equations in state space form for different machines.

SYLLABUS:

Unit I: Modeling and Analysis of DC Machine
Magnetically coupled circuits, Machine windings and air-gap MMF, winding inductances and voltage equations - Separately excited dc generators, Separately excited dc motors, inter connection of machines, transfer functions of dc machines, dc series motor, dc shunt machines, dc compound machines, linearization techniques for small perturbations, cross field machines, transfer functions of cross field machines, Electric braking of dc motors.

Unit-II: Reference Frame Theory: Introduction to transformations, equations of transformations, change of variables, transformation to an arbitrary reference frame, commonly used reference frames, transformation between reference frames, Steady-state phasor relationships and voltage equations.

Unit III: Modeling of Three Phase Induction Machines: Voltage and torque equations in machine variables, Voltage and torque equations in arbitrary reference frame, Steady-state analysis and its operation. Free acceleration characteristics viewed from various reference frames, dynamic performance during sudden changes in load torque, dynamic performance during a three-phase fault at the machine terminals.

Unit IV: Modeling of Synchronous Machine: Voltage and torque equations in machine variables, Voltage equations in arbitrary and rotor reference frame, torque equations in in substitute variable, Steady-state analysis and its operation - Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria.

Unit V: Modelling of Brushless DC Machines: Voltage and torque equations in machine variables, Voltage and torque equations in rotor reference frame variables, Analysis of steady state operation, dynamic performance.

References:

1. **Analysis of Electric Machinery and Drive Systems**, Paul C.Krause , Oleg wasynezuk, Scott D.Sudhoff, 3rd Edition, WILEY-IEEE Press, 2013.
2. **Electrical Motor Drives: Modelling, Analysis and Control** by R. Krishnan, Prentice-Hall, 2001.
3. **Thyristor control of Electric Drives** by Vedam Subramanyam, TMH, 18th Re-print, 2008.

COURSE OUTCOMES:

After completion of the course, student will be able to:

- Develop the mathematical models of various machines like, induction motor and Synchronous machines using modeling equations.
- Analyze the developed models in various reference frames.

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49103) OPTIMIZATION & HEURISTIC SEARCH TECHNIQUES

COURSE OBJECTIVES:

The student will be able to:

- Learn about optimization problem and basic optimization issues
- Understand the concept of linear programming
- Learn about transportation problem and solution
- Understand unconstrained optimization techniques
- Acquire knowledge about various heuristic optimization techniques

UNIT – I : INTRODUCTION AND CLASSICAL OPTIMIZATION TECHNIQUES:

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II : LINEAR PROGRAMMING

Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

UNIT – III : TRANSPORTATION PROBLEM

Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems. One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method. Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

UNIT – IV: UNCONSTRAINED OPTIMIZATION TECHNIQUES

Univariate method, Random Search methods, Grid Search method, Pattern Directions, Powell's method, Simplex method, Gradient of a function, Steepest Descent (Cauchy) method, Conjugate Gradient (Fletcher-Reeves) method, Newton's method.

UNIT – V: HEURISTIC OPTIMIZATION TECHNIQUES

Meta heuristic search methods: Genetic Algorithm based optimization, Simulated Annealing Techniques, Swarm Intelligent Algorithms, PSO, etc.

TEXT BOOKS:

1. "Modern Heuristic Optimization Techniques" by Kwang Y. Lee, Mohamed A. El-Sharkawi
2."Engineering optimization: Theory and practice"-by S. S.Rao, New Age International (P) Limited, 3rdedition, 1998.
3. "Introductory Operations Research" by H.S. Kasene & K.D. Kumar, Springer(India), Pvt.LTd.

REFERENCES:

1. "Optimization Methods in Operations Research and systems Analysis" – by K.V. Mital and C. Mohan, New Age International (P) Limited, Publishers, 3 rd edition, 1996.
2. Operations Research – by Dr. S.D.Sharma.
3. "Operations Research: An Introduction" by H.A. Taha, PHI Pvt. Ltd., 6thedition
4. Linear Programming by G. Hadley

COURSE OUTCOMES:

After completion of the course, student will be able to:

- Learn about optimization problem and basic optimization issues
- Understand the concept of linear programming
- Learn about transportation problem and solution
- Understand unconstrained optimization techniques
- Acquire knowledge about various heuristic optimization techniques

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49104) RESTRUCTURED POWER SYSTEMS

COURSE OBJECTIVES:

- To introduce the restructuring of power industry and market models.
- To impart knowledge on fundamental concepts of congestion management.
- To analyze the concepts of locational marginal pricing and financial transmission rights.
- To Illustrate about various power sectors in India.

SYLLABUS:

UNIT I: KEY ISSUES IN ELECTRIC UTILITIES

Introduction – Restructuring models – Independent System Operator (ISO) – Power Exchange - Market operations – Market Power – Standard cost – Transmission Pricing – Congestion Pricing – Management of Inter zonal/Intra zonal Congestion.

UNIT II: OPEN ACCESS SAME-TIME INFORMATION SYSTEM (OASIS) &MARKET POWER

Structure of OASIS - Posting of Information – Transfer capability on OASIS. Market Power: Introduction - Different types of market Power – Mitigation of Market Power - Examples.

UNIT III: AVAILABLE TRANSFER CAPABILITY (ATC) &ELECTRICITY PRICING

Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow. Electricity Pricing: Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

UNIT IV: POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT

Introduction – Operational Planning Activities of ISO- The ISO in Pool Markets – The ISO in Bilateral Markets – Operational Planning Activities of a GENCO.

UNIT V: TRANSMISSION COST ALLOCATION METHODS&ANCILLARY SERVICES MANAGEMENT

Introduction - Transmission Cost Allocation Methods : Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods. Ancillary Services Management: Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

TEXT BOOKS:

1. Kankar Bhattacharya, Math H.J. Boller and JaapE.Daalder, Operation of Restructured Power System, Kulwer Academic Publishers, 2001.
2. Mohammad Shahidehpour and Muwaffaqalomoush, Restructured Electrical Power Systems, Marcel Dekker, Inc., 2001.

REFERENCE BOOKS:

1. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England.

COURSE OUTCOMES:

After completion of the course, Students are able to:

- Bring out the differences between the conventional power system operation and the restructured one.
- Design power markets and market architectural aspects.
- Analyze the concepts of locational marginal pricing and financial transmission rights
- Prepare a background with fundamentals of microeconomics.

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49105) MODERN CONTROL ENGINEERING & PRINCIPLES OF OPTIMAL CONTROL (Elective – I)

COURSE OBJECTIVES:

The student will be able to:

- Learn about concepts of controllability, observability and Pole placement design
- Understand concepts of full order and reduced order observer designs
- Learn about model decomposition and robust control
- Understand optimal control problem and various functional
- Learn about state regulator and Riccati equation

Unit I

Review of State-space representation, Controllability - Pole assignment using State feedback – Ackerman's formula for feedback gain determination; Observability. Duality. Effect of state feedback on controllability and observability. Controllable subspace – decomposition of states into controllable and uncontrollable components.

Unit II

Design of full-order observer – Bass Gura algorithm. The separation principle - Combined observer – controller compensator. Design of reduced order observer. Unobservable subspace – decomposition of states into observable and unobservable components – Canonical decomposition theorem.

Unit III

Reducibility – realization of transfer function matrices. Model decomposition and decoupling by state feedback. Design of robust control system for asymptotic tracking and disturbance rejection using State variable equations. Transfer function interpretations – transfer function form of observer and state estimate feedback. State-space interpretation of internal model principle.

Unit IV

Introduction to optimal control, Calculus of variations: Fundamental concepts, functionals of single function, functional involving several independent functions, fixed end point problem, necessary and sufficient conditions for optimal control.

Unit V

Discrete-time linear state regulator – Algorithm for the solution, Use of observer in implementing the control law. Continuous-time linear state regulator – Matrix Riccati equation. Time invariant linear state regulator – the reduced matrix Riccati equation - An iterative method to solve the reduced matrix Riccati equation. Suboptimal linear regulator.

Text Books:

1. Modern Control Engineering, Katsuhiko Ogata, 5th Edition, Prentice Hall India, 1997
2. Modern Control System Theory, M. Gopal, Revised 2nd Edition, New Age International Publishers, 2005.
3. D.S. Naidu, Optimal control systems, CRC Press, First edition, 2002.

References:

1. Linear Systems, Thomas Kailath, Perntice Hall, 1980.
2. Control System Design, Graham C. Goodwin, StefanF. Graebe and Mario E. Salgado, Pearson Education, 2000.
3. Linear System Theory and Design, Chi-Tsong Chen, OXFORD University Press.

4. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 11th Edition, Pearson Edu India, 2009.
5. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition, 1970.

COURSE OUTCOMES:

After completion of the course, student will be able to:

- Learn about concepts of controllability, observability and Pole placement design
- Understand concepts of full order and reduced order observer designs
- Learn about model decomposition and robust control
- Understand optimal control problem and various functional
- Learn about state regulator and Riccati equation

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49106) FACTS CONTROLLERS
(Elective – I)

COURSE OBJECTIVES:

To make the student learn about:

- To know the basic definitions and different types of Facts controllers and their uses.
- To know about the voltage source converter operation and different modulation techniques with comparison.
- To improve the stability of power system by Shunt Compensation and Series Compensation with facts controllers.
- To enhance the transient stability and power oscillation damping by SVC and STATCOM.

UNIT-I: FACTS CONCEPTS

Introduction to FACTS, Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

UNIT-II: VOLTAGE SOURCE CONVERTERS

Single & three phase full wave bridge converters, transformer connections for 12, 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation, basic concept of current source converters, and comparison of current source converters with voltage source converters.

UNIT-III: STATIC SHUNT COMPENSATION

Objectives of shunt compensation, mid-point voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators, hybrid VAR generators.

UNIT-IV: SVC AND STATCOM

The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

UNIT-V: STATIC SERIES COMPENSATORS

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC.

TEXT BOOKS:

1. Hingorani H G and Gyugyi. L " Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems" New York, IEEE Press, 2000.
2. Padiyar.K.R, " FACTS Controllers in Power Transmission and Distribution" New Age Int. Publishers, 2007

REFERENCES:

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012.
2. Yong-Hua Song, Allan Johns, "Flexible AC Transmission Systems", IET, 1999.

COURSE OUTCOMES:

After the end of this course student will:

- Know the basic definitions and different types of Facts controllers and their uses.
- Know about the voltage source converter operation and different modulation techniques with comparison.
- Improve the stability of power system by Shunt Compensation and Series Compensation with facts controllers.
- Enhancement of the transient stability and power oscillation damping by SVC and STATCOM.

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49107) SOLAR ENERGY CONVERSION SYSTEMS
(Elective – I)

COURSE OBJECTIVES:

The student will be able:

- To introduce photovoltaic systems
- To deal with various technologies of solar PV cells
- To understand details about manufacture, sizing and operating techniques
- To have knowledge of design considerations.

SYLLABUS:

UNIT-I: SOLAR CELL FUNDAMENTALS

Introduction to PV, world energy scenario – need for sustainable energy sources – current status of Renewable energy sources – place of photovoltaic in Energy supply – solar radiation – the sun and earth movement – angle of sunrays on solar collectors – sun tracking – estimating solar radiation empirically – measurement of solar radiation.

UNIT-II: DESIGN OF SOLAR CELLS

Introduction to Solar cells, Solar cell design- design for high I_{SC} – design for high V_{OC} – design for high F,F upper limits of cell parameters – short circuit current, open circuit voltage, fill factor, efficiency, losses in solar cells – model of a solar cell, effect of series and shunt resistance on efficiency , effect of solar radiation on efficiency, Analytical techniques.

UNIT-III: SOLAR PHOTOVOLTAIC MODULES

Solar PV Modules from solar cells – series and parallel connection of cells – mismatch in module – mismatch in series connection – hot spots in the module , bypass diode – mismatching in parallel diode – design and structure of PV modules – number of solar cells in a module, wattage of modules, fabrication of PV module – PV module power output.

UNIT-V: BALANCE OF SOLAR PV SYSTEMS

Basics of Electromechanical cell – factors affecting performance – batteries for PV systems – DC to DC converters – charge controllers – DC to AC converters(Inverters) – Maximum Power Point tracking (MPPT) – Algorithms for MPPT.

UNIT V: PV SYSTEM DESIGN AND APPLICATIONS

Introduction to solar PV systems – standalone PV system configuration – design methodology of PV systems – design of PV powered DC fan without battery, standalone system with DC load using MPPT, design of PV powered DC pump, design of standalone system with battery and AC/DC load – wire sizing in PV system – precise sizing of PV systems – Hybrid PV systems – grid connected PV systems.

TEXT BOOKS:

1. "Solar Photovoltaics Fundamentals, Technologies and Applications" by Chetan singh solanki, PHI publications.

REFERENCES:

1. Solar Energy Fundamentals and applications by H.P. Garg, J. Prakash "Tata McGraw- Hill publishers Ist edition"
2. S.Rao & B.B.Parulekar, "Energy Technology", 4th edition, Khanna publishers, 2005.

COURSE OUTCOMES:

After completion of the course, the student will be able to:

- Identify photovoltaic system components and system types
- Calculate electrical energy and power
- Correctly size system components, design considerations of solar equipment
- Design a basic grid-tie PV system.

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M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49108) POWER SYSTEM WIDE AREA MONITORING AND CONTROL
(Elective – II)

COURSE OBJECTIVES:

To make the student learn about:

- To know the necessity of real-time computer control of power systems and wide area measurement system.
- To get the knowledge of different automation systems.
- To know the complete fundamentals of SCADA and its importance in real time power systems.
- To get the knowledge about Substation Automation, New Digital Substation and traditional approach and IED-based approach of Integrated Protective Functions.
- To study about Voltage stability, prevention of voltage collapse and dynamic stability analysis.

SYLLABUS:

UNIT - I: COMPUTER CONTROL OF POWER SYSTEMS

Need for computer control of power systems, Operating states of a power system, Supervisory Control and Data Acquisition system, Energy control centers. Wide Area Measurement system (WAMS): Architecture, Components of WAMS, Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, Wide Area Monitoring Protection & Control, and Remedial Action Scheme.

UNIT - II: POWER SYSTEM AUTOMATION

Introduction, Evolution of Automation Systems, History of Automation Systems, Supervisory Control and Data Acquisition (SCADA) Systems, Components of SCADA Systems, SCADA Applications, SCADA in Power Systems, SCADA Basic Functions, SCADA Application Functions, Advantages of SCADA in Power Systems, Deferred Capital Expenditure, Optimized Operation and Maintenance Costs, Equipment Condition Monitoring (ECM), Sequence of Events (SOE) Recording, Power Quality Improvement, Data Warehousing for Power Utilities, Power System Field, Transmission and Distribution Systems, Customer Premises, Types of Data and Signals in Power Systems, Flow of Data from the Field to the SCADA Control Center

UNIT - III: SCADA FUNDAMENTALS

Introduction, Open System: Need and Advantages, Building Blocks of SCADA Systems, Remote Terminal Unit (RTU), Evolution of RTUs, Components of RTU, Communication Subsystem, Logic Subsystem Termination Subsystem, Testing and Human-Machine Interface (HMI) Subsystem, Power Supplies, Advanced RTU Functionalities, Intelligent Electronic Devices (IEDs), Evolution of IEDs, IED Functional Block Diagram, Hardware and Software Architecture of the IED, IED Communication Subsystem, IED Advanced Functionalities, Tools for Settings, Commissioning, and Testing, Programmable LCD Display, Typical IEDs, Data Concentrators and Merging Units, RTUs, IEDs, and Data Concentrator, Merging Units and IEDs.

UNIT - IV: SUBSTATION AUTOMATION

Substation Automation: Technical Issues, System Responsibilities, System Architecture, Substation Host Processor, Substation LAN, User Interface, Communications Interfaces, Protocol Considerations. The New Digital Substation, Process Level, Protection and Control Level, Station Bus and Station Level, Substation Automation Architectures, Legacy Substation Automation System, Digital Substation Automation Design, New versus Existing Substations. Drivers of Transition, Migration Paths and the Steps Involved, Value of Standards in Substation Automation, Substation Automation (SA) Application Functions, Integrated Protection Functions: Traditional Approach and IED-Based Approach. Automation Functions, Enterprise-Level Application Functions.

UNIT – V: VOLTAGE STABILITY

Basic concepts, Voltage collapse – general characterization, classification, Voltage stability analysis – modeling, dynamic analysis, static analysis, shortest distance to instability, continuation power flow analysis, prevention of voltage collapse – design measures, operating measures.

TEXT BOOKS:

1. Allen J. Wood and Bruce Woolenberg, Power System Generation, Operation and Control, John Wiley and Sons, 1996.
2. P. Kundur, Power System Stability and Control, McGraw Hill.
3. Mini S. Thomas and John Douglas McDonald, Power System SCADA and Smart Grids, CRC Press, 2015.

REFERENCE BOOKS:

1. E. Handschin, Real-time Control of Electrical Power Systems, Elsevier Publications & Co, 1988.
2. Special Issue on Computer Control of Power Systems, IEEE Proc, July 1974.

COURSE OUTCOMES:

After the end of this course student will**:**

- Know the necessity of real-time computer control of power systems and wide area measurement system.
- Get the knowledge of different automation systems.
- Know the complete fundamentals of SCADA and its importance in real time power systems.
- Get the knowledge about Substation Automation, New Digital Substation and traditional approach and IED-based approach of Integrated Protective Functions.
- Study about Voltage stability, prevention of voltage collapse and dynamic stability analysis.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49109) ENERGY AUDITING AND MANAGEMENT
(Elective – II)

COURSE OBJECTIVES:

To make the student learn about:

- Basic Principles of Energy Audit and Management.
- How these principles are applicable to various day to day equipment.
- Various measuring devices by which the energy is measured.
- How energy management and auditing has impacts on the economic aspects.

SYLLABUS:

UNIT I: BASIC PRINCIPLES OF ENERGY AUDIT

Energy audit- Definitions, concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy conservation schemes - Energy audit of industries - Energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT II: ENERGY MANAGEMENT

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, qualities and functions, language, Questionnaire - Check list for top management.

UNIT III: ENERGY EFFICIENT MOTORS, POWER FACTOR IMPROVEMENT

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - Variable speed, variable duty cycle systems, RMS hp - Voltage variation - Voltage unbalance - Over motoring - Motor energy audit. Power factor – Methods of improvement, location of capacitors, p.f. with non linear loads, effect of harmonics on p.f., p.f motor controllers - Good lighting system design and practice, lighting control, lighting energy audit

UNIT IV: ENERGY INSTRUMENTS

Energy Instruments - Wattmeter, Data loggers, Thermocouples, Pyrometers, Lux meters, Tongue testers, Application of PLC's.

UNIT V: ECONOMIC ASPECTS AND ANALYSIS

Economics Analysis-Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis - Energy efficient motors. Calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

TEXT BOOKS:

1. W.R. Murphy & G. Mckay Butter worth, Energy management, Heinemann publications.
2. John, C. Andreas, Energy efficient electric motors, Marcel Dekker Inc. Ltd, 2nd edition, 1995.

REFERENCE BOOKS:

1. Paul O' Callaghan, Energy management, Mc-graw Hill Book company, 1st edition, 1998
2. W.C.Turner, Energy management hand book, John wiley and sons.
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

COURSE OUTCOMES:

After completing the course, the student should be able to do the following:

- Understand the basic principles of Energy Management and Auditing.
- Implement Energy Efficient methods and power factor improvement techniques.
- Use of Various Energy Instruments for measuring the energy consumption.
- Analyze the economic impacts of the energy management and auditing.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
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(17D49110) STATE ESTIMATION TECHNIQUES
(Elective – II)

COURSE OBJECTIVES:

Student will be able:

- To understand the Power system state estimation, WLS estimation theory, Types of measurements, typical results of state estimation.
- To understand concept of tracking, orthogonal decomposition of state estimation, detection of bad measurements, Network observability & Pseudo measurements.
- To understand the concepts Security analysis, contingency analysis for generator and line voltages, concentric relaxation & bounding.
- To understand the concept of 3 state & 5 state operation of power system, SCADA implementation considerations, energy control centers.

SYLLABUS:

UNIT I : Introduction to State Estimation in Power Systems

Introduction, Power system state estimation, Maximum likelihood, Weighted least Square estimation, Weighted least square estimation.

State Estimation of AC Networks: Types of measurements, Linear weighted least square (WLS) estimation theory, DC Load flow based WLS state estimation, Linearised model of WLS state estimation of Non - Linear AC power systems, sequential and non - Sequential methods to process measurements, Typical results of state estimation on an Ac network.

UNIT II: Types of State Estimation and Network Observability

State estimation by conventional WLS (normal equations), Orthogonal decomposition and its algorithm, hybrid method. Tracking of state estimation, Dynamic state estimation. Detection and identification of bad measurements, estimation of quantities not being measured. Network observability and pseudo-measurements, observability by graphical technique and triangularisation approach, Optimal meter placement, Application of power system state estimation.

UNIT III: Introduction to Power System Security

Concept of security, Security analysis and monitoring, factors affecting power system security, detection of network problems, an overview of security analysis.

UNIT IV: Power System Security Analysis

Contingency analysis for generator and line outages by Interactive Linear Power Flow (ILPF) method, Fast decoupled inverse Lemma based approach, network sensitivity factors, Contingency selection, concentric relaxation and bounding.

UNIT V: Computer Control of Power Systems

Need for real - time and computer control of power systems, operating states of a power system - 3 state & 5 states operation of power system - Supervisory Control and Data Acquisition system (SCADA), implementation considerations, energy control centers.

Text Books:

4. Allen J. Wood and Bruce Woolenberg, Power System Generation, Operation and Control, John Wiley and Sons, 1996.
5. John J. Grainger and William D Stevenson Jr, Power System Analysis, McGraw Hill ISE, 1994.

Reference Books:

3. E. Handschin, Real-time Control of Electrical Power Systems, Elsevier Publications & Co, 1988.
4. Special Issue on Computer Control of Power Systems, IEEE Proc, July 1974.

COURSE OUTCOMES:

After completion of the course students able to:

- Know about the Power system state estimation, WLS estimation theory, Types of measurements, typical results of state estimation.
- Understand the concept of tracking, orthogonal decomposition of state estimation, detection of bad measurements, Network observability & Pseudo measurements.
- Understand the concepts Security analysis, contingency analysis for generator and line voltages, concentric relaxation & bounding.
- Understand the concept of 3 state & 5 state operation of power system, SCADA implementation considerations, energy control centers.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year I Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	0	**0**	**4**	**2**

(17D49111) MACHINES & POWER SYSTEMS LAB

COURSE OBJECTIVES:

The student will be able to learn about:

- Fault analysis
- Characteristics of relays
- Different losses
- Various tests on motors and transformers

List of Experiments:

1. Determination of Sub transient Reactance of a Salient Pole Machine
2. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine
3. Fault Analysis
   - i) LG Fault
   - ii) LL Fault
   - iii) LLG Fault
   - iv) LLLG Fault
4. Equivalent Circuit of a Three Winding Transformer
5. Separation of No Load losses of a Three Phase Squirrel Cage Induction Motor
6. Power Angle Characteristics of a Salient Pole Synchronous Machine
7. 3-phase to 2-phase conversion using Scott connection
8. Characteristics of IDMT Over Current Relay (Electro Magnetic Type)
9. Characteristics of Static Negative Sequence Relay
10. Characteristics of Over Voltage Relay
    - i) Electromagnetic Type
    - ii) Microprocessor Type
11. Characteristics of Percentage Biased Differential Relay
    - i) Electromagnetic Type
    - ii) Static Type

COURSE OUTCOMES:

After completion of the course, student will be able to understand:

- Fault analysis
- Characteristics of relays
- Different losses
- Various tests on motors and transformers

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M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49201) RELIABILITY ENGINEERING AND APPLICATION TO POWER SYSTEMS

COURSE OBJECTIVES:

This course enables the students to:

- The Probability Density and Distribution Functions
- Analyse the Decomposition Method.
- Identify the Expected Value and Standard Deviation of Exponential Distribution
- Analyse the Concept of Stochastic Transitional Probability Matrix
- Evaluate the Transition Rates for Merged State Model

SYLLABUS:

UNIT–I BASICS OF PROBABILITY THEORY, DISTRIBUTION & NETWORK MODELLING

Basic Probability Theory – Rules for Combining Probabilities of Events – Bernoulli's Trials – Probability Density and Distribution Functions – Binomial Distribution – Expected Value and Standard Deviation of Binomial Distribution. Analysis of Series, Parallel, Series-Parallel Networks – Complex Networks – Decomposition Method.

UNIT–II RELIABILITY FUNCTIONS

Reliability Functions F(T), F(T), R(T), H(T) and Their Relationships – Exponential Distribution – Expected Value and Standard Deviation of Exponential Distribution – Bath Tub Curve – Reliability Analysis of Series Parallel Networks Using Exponential Distribution – Reliability Measures MTTF, MTTR, MTBF

UNIT–III MARKOV MODELLING AND FREQUENCY & DURATION TECHNIQUES

Markov Chains – Concept of Stochastic Transitional Probability Matrix, Evaluation of Limiting State Probabilities – Markov Processes One Component Repairable System – Time Dependent Probability Evaluation Using Laplace Transform Approach – Evaluation of Limiting State Probabilities Using Stpm – Two Component Repairable Models. Frequency and Duration Concept – Evaluation of Frequency of Encountering State, Mean Cycle time, For One, Two Component Repairable Models – Evaluation of Cumulative Probability and Cumulative Frequency of Encountering of Merged States – Approximate System Reliability analysis – series parallel configuration – Basic probability indices – cutest approach

UNIT–IV APPLICATIONS TO POWER SYSTEMS -I

Generation System Reliability Analysis: Reliability Model of a Generation System– Recursive Relation for Unit Addition and Removal – Load Modeling - Merging of Generation Load Model – Evaluation of Transition Rates for Merged State Model – Cumulative Probability, Cumulative Frequency of Failure Evaluation – LOLP, LOLE, LOEE.

UNIT–V APPLICATIONS TO POWER SYSTEMS - II

Basic Techniques - Radial Networks – Evaluation of Basic Reliability Indices, Performance Indices – Load Point and System Reliability Indices – Customer Oriented, Loss and Energy Oriented Indices -Examples single feeder - parallel configuration RDS – Network reduction technique – cut set approaches – weather effects – repairable and non – repairable effects modeling and evaluation of basic probability indices.

TEXT BOOKS:

1. Reliability Evaluation of Engg. System – R. Billinton, R.N.Allan, Plenum Press, New York, reprinted in India by B.S.Publications, 2007.
2. Reliability Evaluation of Power systems – R. Billinton, R.N.Allan, Pitman Advance Publishing Program, New York, reprinted in India by B.S.Publications, 2007.

REFERENCE BOOKS:

1. System Reliability Concepts by Dr.V.Sankar, Himalaya Publishing House Pvt.Ltd,, Mumbai

COURSE OUTCOMES:

The students will have knowledge on the following concepts:

- The concept of probability theory, distribution, network modeling and reliability analysis.
- Describing the reliability functions with their relationships and Markov-modelling.
- Evaluate reliability models using frequency and duration techniques and generate various reliability models.
- The reliability composite systems and distribution systems.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49202) POWER QUALITY

COURSE OBJECTIVES:

To make the student learn about:

- Understand the different power quality and power frequency problems in the power system.
- Analyzing the types and causes of Electrical transients.
- Various types of Harmonics their causes and effects on Power System.
- The Concept of Electromagnetic Interference and its impacts Power Quality and Power System.

SYLLABUS:

UNIT I: INTRODUCTION TO POWER QUALITY AND POWER FREQUENCY DISTURBANCE

Introduction to Power Quality - Power Quality Issues - Susceptibility Criteria - Role of Power Suppliers and Users - Power Quality Standards. Introduction to Power Frequency Disturbances - Common Power Frequency Disturbances - Cures for Low Frequency Disturbances - Voltage Tolerance Criteria.

UNIT II: ELECTRICAL TRANSIENTS

Introduction to Transients - Transient System Model - Examples of Transient Models and Their Response - Types and Causes of Transients - Examples of Transient Waveforms – Three Phase unbalance – single phase faults – phase to phase faults – two phase to ground faults – seven tips of three phase unbalanced sag.

UNIT III: HARMONICS

Definition of Harmonics - Odd and Even Order Harmonics - Harmonic Phase Rotation and Phase Angle – Causes of Voltage and Current Harmonics – Individual and Total Harmonic Distortion - Harmonic Signatures - Effect of Harmonics on Power System Devices - Guidelines for Harmonic Voltage and Current Limitation - Harmonic Current Mitigation.

UNIT IV: ELECTROMAGNETIC INTERFERENCE

Introduction to EMI - Frequency Classification - Electrical Fields - Magnetic Fields - EMI Terminology - Power Frequency Fields - High Frequency Interference - EMI Susceptibility - EMI Mitigation - Health Concerns of EMI.

UNIT V: POWER QUALITY PROBLEMS – EMI IMPACT

Introduction to Power Quality Measurements - Power Quality Measurement Devices - Power Quality Measurements - Test Locations - Test Duration - Instrument Setup - Instrument Guidelines

TEXT BOOKS:

1. Power quality by C. Sankaran, CRC Press
2. Electrical Power Systems Quality, Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty, 2nd Edition, TMH Education Pvt. Ptd.

REFERENCE BOOKS:

1. Understanding Power quality problems by Math H. J. Bollen IEEE Press
2. Power quality enhancement using custom power devices by Arindam Ghosh,Gerard Ledwich,Kluwer academic publishers

COURSE OUTCOMES:

After completing the course, the student should be able to do the following:

- Understand the concepts of power quality and power frequency problems in the power system.
- Analyze different types of Electrical Transients and Harmonics along with their causes and effects.
- Understand the concept of Electromagnetic interference.
- Analyze the various effects of Electromagnetic Interference on Power Quality.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49203) SMART GRID TECHNOLOGIES

COURSE OBJECTIVES:

To make the student learn about:

- To know the importance of smart grid technology functions over the present grid.
- To get the knowledge about the measurement system and communication technology of Smart grid.
- To make the use of analysis tools to improve the performance and stability of the smart grid.
- To know the knowledge about the renewable energy storage technology associated with smart grid.

SYLLABUS:

UNIT I: SMART GRID ARCHITECTURAL DESIGNS

Introduction – Comparison of Power grid with Smart grid – power system enhancement – communication and standards - General View of the Smart Grid Market Drivers - Stakeholder Roles and Function - Measures - Representative Architecture - Functions of Smart Grid Components-Wholesale energy market in smart grid-smart vehicles in smart grid.

UNIT II: SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS) - Advanced metering infrastructure- GIS and Google Mapping Tools.

UNIT III: PERFORMANCE ANALYSIS TOOLS FOR SMART GRID DESIGN

Introduction to Load Flow Studies - Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods - Load Flow State of the Art: Classical, Extended Formulations, and Algorithms –Load flow for smart grid design-Contingencies studies for smart grid.

UNIT IV: STABILITY ANALYSIS TOOLS FOR SMART GRID

Voltage Stability Analysis Tools-Voltage Stability Assessment Techniques-Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid-Angle stability assessment in smart grid-Approach of smart grid to State Estimation-Energy management in smart grid.

UNIT V: RENEWABLE ENERGY AND STORAGE

Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids-PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

TEXT BOOKS:

1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & sons inc, 2012.

REFERENCE BOOKS:

1. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.
2. Clark W.Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009.

COURSE OUTCOMES:

After the end of this course student will:

- Know the importance of smart grid technology functions over the present grid.
- Get the knowledge about the measurement system and communication technology of Smart grid.
- Make the use of analysis tools to improve the performance and stability of the smart grid.
- Get the knowledge about the renewable energy storage technology associated with smart grid.

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M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49204) POWER SYSTEM STABILITY & CONTROL

COURSE OBJECTIVES:

To make the student learn about:

- To develop linear and nonlinear models of multi-machine power systems.
- To analyze various types of stability properties of power systems.
- To Model and simulate excitation mechanisms in synchronous machines.
- To identify power system models from dynamic data.
- To Design controllers for transient/angle stabilization and voltage regulation.

UNIT-I: THE ELEMENTARY MATHEMATICAL MODEL

Introduction to equal area criteria - Power Angle curve of a Synchronous Machine - model of single machine connected to an infinite bus – model of multimachine system – Problems – Classical Stability Study of multimachine system - Effect of the excitation system on Transient stability.

UNIT-II: SYSTEM RESPONSE TO SMALL DISTURBANCES AND DYNAMIC STABILITY

The unregulated synchronous Machine – Modes of oscillation of an unregulated multimachine system – Regulated synchronous machine – Voltage regulator with one time lag – Governor with one time lag – Problems - Concept of Dynamic stability – State-space model of single machine system connected to infinite bus – Effect of excitation on Dynamic stability – Examination of dynamic stability by Routh-Hurwitz criterions.

UNIT-III: POWER SYSTEM STABILIZERS

Introduction to supplementary stabilizing signals - Block diagram of the linear system - Approximate model of the complete exciter – Generator system – Lead compensation – Stability analysis using eigen value approach.

UNIT-IV: EXCITATION SYSTEMS

Introduction to excitation systems – Non-continuously, Continuously regulated systems – Excitation system compensation – State-space description of the excitation system - Simplified linear model – Effect of excitation on generator power limits. Type –2, Type-3 and Type –4 excitation systems and their state-space modeling equations.

UNIT-V: STABILITY ANALYSIS

Review of Lyapunov's stability of non-liner systems using energy concept – Method based on first concept – Method based on first integrals – Zubov's method – Popov's method, Lyapunov function for single machine connected to infinite bus. Voltage stability – Factors affecting voltage instability and collapse – Comparison of Angle and voltage stability – Analysis of voltage instability and collapse – Control of voltage instability.

TEXT BOOKS:

1. P.M.Anderson, A.A.Fouad, "Power System Control and Stability", IOWA State University Press, Galgotia Publications, Vol-I, 1st Edition.

REFERENCE BOOKS:

2. M.A.Pai, Power System Stability-Analysis by the direct method of Lyapunov, North Holland Publishing Company, New York, 1981.

Course Outcomes:

After the end of this course student will:

- Develop linear and nonlinear models of multi-machine power systems.
- Analyze various types of stability properties of power systems.
- Model and simulate excitation mechanisms in synchronous machines.
- Identify power system models from dynamic data.
- Design controllers for transient/angle stabilization and voltage regulation.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49205) REACTIVE POWER COMPENSATION & MANAGEMENT
(Elective – III)

COURSE OBJECTIVES:

The student will be able:

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management.

SYLLABUS:

UNIT-I: LOAD COMPENSATION

Objectives and specifications – Reactive power characteristics – Inductive and capacitive approximate biasing – Load compensator as a voltage regulator – Phase balancing and power factor correction of unsymmetrical loads - Examples.

UNIT-II: STEADY – STATE & TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM

Uncompensated line – Types of compensation – Passive shunt and series and dynamic shunt compensation – Characteristic time periods – Passive shunt compensation – Static compensation - Series capacitor compensation – Compensation using synchronous condensers –Examples.

UNIT-III: REACTIVE POWER COORDINATION & DEMAND SIDE MANAGEMENT

Objective – Mathematical modeling – Operation planning – Transmission benefits – Basic concepts of quality of power supply – Disturbances - Steady – state variations – Effects of under Voltages – Frequency – Harmonics, radio frequency and electromagnetic interferences. Load patterns – Basic methods - load shaping – Power tariffs - KVAR based tariffs - penalties for voltage flickers and Harmonic voltage levels.

UNIT-IV: DISTRIBUTION & USER SIDE REACTIVE POWER MANAGEMENT

System losses – Loss reduction methods – Examples – Reactive power planning – Objectives – Economics - Planning capacitor placement – Retrofitting of capacitor banks - KVAR requirements for domestic appliances – Purpose of using capacitors – Selection of capacitors – Deciding factors – Types of capacitors, characteristics and Limitations.

UNIT-V: REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES

Typical layout of traction systems – Reactive power control requirements – Distribution transformers - Electric arc furnaces – Furnaces transformer – Filter requirements – Remedial measures – Power factor of an arc furnace.

TEXT BOOKS:

1. J.E.Miller, Reactive Power Control in Electric Power Systems, John Wiley and Sons, 1982 (Units I to IV).
2. D.M.Tagare, Reactive power Management, Tata McGraw Hill, 2004 (Units V toVIII).

COURSE OUTCOMES:

After completion of the course, the student will be able to:

- Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads
- Observe various compensation methods in transmission lines
- Construct model for reactive power coordination
- Distinguish demand side reactive power management & user side reactive power management

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49206) POWER SYSTEM OPTIMIZATION
(Elective – III)

COURSE OBJECTIVES:

This course enables the students to:

- The fundamental concepts of Optimization Techniques
- The importance of optimizations in real scenarios
- The concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

SYLLABUS:

Unit I: Fundamentals of Particle Swarm Optimization (PSO) Techniques

Introduction – Basics of Particle Swarm Optimization – Background of PSO, Original PSO, Variation of PSO – Discrete PSO,PSO for MINLPs, Constriction Factor Approach (CFA), Hybrid PSO (HPSO), Lbest Model, Adaptive PSO (APSO) Evolutionary PSO (EPSO) – Applications.

Unit II: Fundamentals of Ant Colony Search Algorithms

Introduction – Ant Colony Search Algorithm – Behaviour of Real Ants – Ant Colony Algorithms, The Ant System, The Ant Colony System, The Max-Min Ant System – Major Characteristics of Ant Colony Search Algorithm, Distributed Computation: Avoid Premature Convergence, Positive Feedback: Rapid Discovery of Good Solution, Use of Greedy Search and Constructive Heuristic Information: Find Acceptable Solutions in the Early Stage of the Process

Unit III: Fundamentals of Tabu Search

Introduction – Overview of the Tabu Search Approach, Problem Formulation, Coding and Representation, Neighborhood Structure, Characterization of the Neighborhood – Functions and Strategies in Tabu Search, Recency- Based Tabu Search – Basic Tabu Search Algorithm, Candidate List Strategies, Tabu tenure, Aspiration Criteria – The Use of Long Term Memory in Tabu Search, Frequency-Based Memory, Intensification, Diversification - Other TS Strategies, Path Relinking, Strategic Oscillation – Applications of Tabu Search

Unit -IV: Application to power systems

Introduction to power system applications, model identifications—Dynamic load modeling, short term load forecasting, Distribution system applications—Network reconfiguration for loss reduction, optimal protection and switching devices placements—examples.

Unit-V: Power system controls

Introduction, power system controls: Particle Swarm Technique—problem formulation of VVC, state variables, problem formulation – Expansion of PSO for MINLP, voltage security assessment, VVC using PSO—treatment of state variables, VVC algorithm using PSO, Numerical Examples—IEEE 14 Bus system

Textbooks

1. Kwang Y. Lee and Mohamed A. EI- Sharkawi "Modern Heuristic Optimization Techniques Theory and Applications to Power Systems" A John Wiley & Sons. INC.Publication
2. D. P. Kothari and J. S. Dhillon, "Power System Optimization", Second Edition-PHI Learning Private Limited- 2011.

REFERENCE BOOKS:

1. Jizhong Zhu , '' Optimization of power system operation '' Second Edition –Wiley-Blackwell publishers.
2. Joshua adam Taylor,"Convex optimization of power systems'' Cambridge University Press

COURSE OUTCOMES:

The students will have knowledge on the following concepts:

- Formulate optimization problems
- Understand and apply the concept of optimality criteria for various type of optimization problems
- Solve various constrained and unconstrained problems in single variable as well as multivariable
- Apply the methods of optimization in real life situation

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M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49207) HVDC & EHVAC TRANSMISSION SYSTEMS
(Elective – III)

COURSE OBJECTIVES:

To make the student learn about:

- HVDC and EHVAC systems and their applications.
- Different Harmonics suppression filters and their role in power systems.
- Various theories like Electrostatic field and Travelling Wave Theory
- How to control the Voltage in various systems for effective and efficient system.

SYLLABUS:

UNIT- I: INTRODUCTION TO HVDC SYSTEMS

Introduction, Basic means of control-power reversal-constant current versus constant voltage control-Desired features of control- Actual control characteristics - Constant minimum ignition angle control - constant current control - Constant extinction angle control-stability of control - Tap changer control - Frequency control.

UNIT - II: HARMONICS SUPRESSION FILTERS, INTERACTION BETWEEN AC AND DC SYSTEMS

Characteristic Harmonics-troubles caused by harmonics-definitions of wave distortion or ripples –means of reducing harmonics-design of AC filters –Dc side filters- Voltage interaction –DC power modulation – Power frequency control-Large signal modulation – active and reactive power coordination.

UNIT – III: EHVAC TRANSMISSION SYSTEM

Introduction to EHVAC, Line inductance and capacitances – Sequence inductances and capacitances – Modes of propagation – Ground return – Examples. Electrostatics – Field of sphere gap – Field of line changes and properties – Charge – potential relations for multi-conductors – Surface voltage gradient on conductors – Distribution of voltage gradient on sub-conductors of bundle – Examples.

UNIT – IV: ELECTRO STATIC FIELD & TRAVELING WAVE THEORY

Electrostatic field: calculation of electrostatic field of EHV/AC lines – Effect on humans, animals and plants – Electrostatic induction in unenergised double circuit line - Electromagnetic interference - Examples. Traveling wave expression and solution - Source of excitation - Terminal conditions - Open circuited and short circuited end - Reflection and refraction coefficients - Lumped parameters of distributed lines - Generalized constants - No load voltage conditions and charging current.

UNIT –V: VOLTAGE CONTROL

Introduction to Voltage Control - Power circle diagram and its use – Voltage control using synchronous condensers – Cascade connection of shunt and series compensation – Sub synchronous resonance in series capacitor – Compensated lines – Static VAR compensating system.

TEXT BOOKS:

1. R. D. Begamudre, EHVAC Transmission Engineering, New Age International (p) Ltd.
2. S. Rao, HVAC and DC Transmission.
3. HVDC power Transmission systems by K.R.Padiyar 2nd edition, Wiley Eastern limited.

REFERENCE BOOKS:

1. High voltage direct current transmission by J.Arrilaga, IEE power engineering series.
2. Direct current transmission by E.W.Kimbark, Vol-1, Wiley inter science-New york.

COURSE OUTCOMES:

After completing the course, the student should be able to do the following:

- Understand the basics of HVDC and EHVAC systems and their characteristics.
- Analyze different types of Harmonic suppression Filters and also the interaction between AC and DC Systems due to the presence of harmonics.
- Analyze the impacts of electrostatic field and travelling wave on the system.
- Understand the different methods to Control the Voltage of the system at various points of power system.

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M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
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(17D49208) DISTRIBUTED GENERATION & MICROGRID CONTROL (Elective – IV)

COURSE OBJECTIVES: The student able to learn about:

- Able to know about the concept of distributed generation, distribution network & the concept of Microgrid, its configuration, advantages & limitations.
- Able to understand the basic concepts in combined heat and power, Wind energy conversion systems, solar photovoltaic systems & other renewable energy sources.
- Able to analyze the impact of Microgrid & Active distribution network management system on various factors.
- Able to know the effect of SCADA & understand the concept of Power quality disturbances, improvement technologies & issues of premium power in DC integration.

SYLLABUS:

UNIT I: INTRODUCTION TO DISTRIBUTED GENERATION AND MICROGRID CONCEPT

Introduction to distributed generation - Active distribution network - Concept of Microgrid - Microgrid configuration - Interconnection of Microgrids - Technical and economical advantages of Microgrid - Challenges and limitations of Microgrid development - Management and operational issues of a Microgrid - Dynamic interactions of Microgrid with main grid – low voltage DC grid.

UNIT II: DISTRIBUTED ENERGY RESOURCES

Introduction - Combined heat and power (CHP) systems: Micro-CHP systems - Wind energy conversion systems (WECS): Wind turbine operating systems - Solar photovoltaic (PV) systems: Classification of PV cell - Small-scale hydroelectric power generation - Other renewable energy sources - Storage devices.

UNIT III: MICROGRID AND ACTIVE DISTRIBUTION NETWORK MANAGEMENT SYSTEM

Introduction - Impact on heat utilisation - Impact on process optimisation - Impact on market - Impact on environment - Impact on distribution system - Impact on communication standards and protocols - Network management needs of Microgrid - Microsource controller - Central controller.

UNIT IV: SCADA AND ACTIVE DISTRIBUTION NETWORKS

Introduction - Existing DNO SCADA systems - Control of DNO SCADA systems - SCADA in Microgrids - Human–machine interface (HMI) - Hardware components - Communication trends in SCADA - Distributed control system (DCS) - Sub-station communication standardization - SCADA communication and control architectures - Communication devices.

UNIT V: IMPACT OF DG INTEGRATION ON POWER QUALITY AND RELIABILITY

Introduction - Power quality disturbances - Power quality sensitive customers - Power quality improvement technologies - Impact of DG integration - Issues of premium power in DG integration.

TEXT BOOK:

1. S. Chowdhury, S.P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", The Institution of Engineering and Technology, 2009.

COURSE OUTCOMES: Student acquire knowledge about:

- Understand the concept of distributed generation, distribution network & the concept of Microgrid, its configuration, advantages & limitations.
- Understand the basic concepts in combined heat and power, Wind energy conversion systems, Solar photovoltaic systems & other renewable energy sources.
- The impact of Microgrid & Active distribution network management system on various factors is known.
- Understand the effect of SCADA & understand the concept of Power quality disturbances, improvement technologies & issues of premium power in DC integration.

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M.Tech I year II Semester (EPE,EPS and PS)

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(17D49209) WIND ENERGY CONVERSION SYSTEMS
(Elective – IV)

COURSE OBJECTIVES:

The student will be able:

- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To analyze the grid integration issues.

UNIT-I: FUNDAMENTALS OF WIND TURBINES

Historical background - basics of mechanical to electrical energy conversion in wind energy - types of wind energy conversion devices – definition - solidity, tip speed ratio, power coefficient, wind turbine ratings and specifications - aerodynamics of wind rotors - design of the wind turbine rotor.

UNIT-II: WIND TURBINE CONTROL SYSTEMS & SITE ANALYSIS

Wind Turbine - Torque speed characteristics - Pitch angle control – stall control – power electronic control – Yaw control – Control strategy – Wind speed measurements – Wind speed statistics – Site and turbine selection.

UNIT-III: BASICS OF INDUCTION AND SYNCHRONOUS MACHINES

The Induction Machine – constructional features - equivalent circuit model - performance characteristics - saturation characteristics – dynamic d-q model – the wound – field synchronous machine – the permanent magnet synchronous machine – power flow between two synchronous sources – induction generator versus synchronous generator

UNIT-IV: GRID CONNECTED AND SELF-EXCITED INDUCTION GENERATOR OPEARTION

Constant – voltage, constant – frequency- single output system –double output system with current converter & voltage source inverter – equivalent circuits – reactive power and harmonics – reactive power compensation – variable voltage, variable frequency – the self-excitation process – circuit model for the self-excited induction generator – analysis of steady state operation – the excitation requirement – effect of a wind generator on the network .

UNIT-V: WIND GENERATION WITH VARIABLE-SPEED TURBINES AND APPLICATION

Classification of schemes – operating area – induction generators – doubly fed induction generator – wound field synchronous generator – the permanent magnet generator – Merits and limitations of wind energy conversion systems – application in hybrid energy systems – diesel generator and photovoltaic systems – wind photovoltaic systems.

TEXT BOOKS:

1. S.N.Bhadra,D.Kastha, S.Banerjee, " wind electrical systems" Oxford University Press.

REFERENCES:

1. S.Rao & B.B.Parulekar, "Energy Technology", 4th edition, Khanna publishers, 2005.
2. "Renewable Energy sources & Conversion Technology" by N.K.Bansal, Manfred Kleemann, Michael Meliss. Tata Mcgraw Hill Publishers.

COURSE OUTCOMS:

After completion of the course, student will be able to:

- Design and control principles of Wind turbine.
- Understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- Analyze the grid integration issues.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	4	**0**	**0**	**4**

(17D49210) INTELLIGENT CONTROL TECHNIQUES
(Elective – IV)

COURSE OBJECTIVES:

The student will be able to:

- Learn about basic concepts of AI
- Understand concepts of ANN and various learning algorithms
- Learn about Genetic Algorithm, ACO and Tabu search concepts
- Understand the concepts of Fuzzy
- Learn about Fuzzy logic controller and design using MATLAB

UNIT I: Introduction to control techniques, need of intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule - based systems, the AI approach. Knowledge representation. Expert systems. Data Pre - Processing: Scaling, Fourier transformation, principal - component analysis and wavelet transformations.

UNIT II

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch - Pitts neuron model, simple perceptron, Adaline and Madaline, Feed - forward Multilayer Perceptron. Learning and Training the neural network. Networks: Hopfield network, Self - organizing network and Recurrent network. Neural Network based controller, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab / Neural Network toolbox.

UNIT III

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other than GA search techniques like tabu search and ant - colony search techniques for solving optimization problems.

UNIT IV

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to Fuzzy logic modeling and control of a system. Fuzzification, inference and defuzzification. Fuzzy knowledge and rule bases.

UNIT V

Fuzzy modeling and control schemes for nonlinear systems. Self - organizing fuzzy logic control. Implementation of fuzzy logic controller using Matlab fuzzy - logic toolbox. Stability analysis of fuzzy control systems. Intelligent Control for SISO/MIMO Nonlinear Systems. Model Based Multivariable Fuzzy Controller.

Text Books:

1. Simon Haykins, Neural Networks: A comprehensive Foundation, Pearson Edition, 2003.
2. T.J.Ross, Fuzzy logic with Fuzzy Applications, Mc Graw Hill Inc, 1997.
3. David E Goldberg, Genetic Algorithms.

References:

1. M.T.Hagan, H. B. Demuth and M. Beale, Neural Network Design, Indian reprint, 2008.
2. Fredric M.Ham and Ivica Kostanic, Principles of Neurocomputing for science and Engineering, McGraw Hill, 2001.

3. N.K. Bose and P.Liang, Neural Network Fundamentals with Graphs, Algorithms and Applications, Mc - Graw Hill, Inc. 1996.
4. Yung C. Shin and Chengying Xu, Intelligent System - Modeling, Optimization and Control, CRC Press, 2009.
5. N.K.Sinha and Madan M Gupta, Soft computing & Intelligent Systems - Theory & Applications, Indian Edition, Elsevier, 2007.
6. John Yen and Reza Langari, Fuzzy logic Intelligence, Control, and Information, Pearson Education, Indian Edition, 2003.
7. Witold Pedrycz, Fuzzy Control and Fuzzy Systms, Overseas Press, Indian Edition, 2008.

COURSE OUTCOMES:

After completion of the course, student will be able to:

- Learn about basic concepts of AI
- Understand concepts of ANN and various learning algorithms
- Learn about Genetic Algorithm, ACO and Tabu search concepts
- Understand the concepts of Fuzzy
- Learn about Fuzzy logic controller and design using MATLAB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech I year II Semester (EPE,EPS and PS)	**L**	**T**	**P**	**C**
	0	**0**	**4**	**2**

(17D49211) POWER SYSTEM SIMULATION LAB

COURSE OBJECTIVES:

The student will be able to:

- Learn about Load flow analysis
- Understand formation of Y-bus
- Learn about LFC problem
- Learn about performance of transmission lines

List of Experiments:

1. Formation of Y - Bus using Software Simulation
2. Gauss – Seidel Load Flow Analysis using Software Simulation
3. Fast Decoupled Load Flow Analysis using Software Simulation
4. Solution of Swing equation – Point by Point Method using Software Simulation
5. Short circuit analysis using Software Simulation
6. Determination of performance of Transmission Lines (Short, Medium, Long)
7. Step Response of Two Area System with Integral Control and Estimation of Tie Line Power & Frequency Deviation using Software Simulation
8. Economic Load Dispatch Analysis using Software Simulation

COURSE OUTCOMES:

After completion of the course, student will be able to:

- Learn about Load flow analysis
- Understand formation of Y-bus
- Learn about LFC problem
- Learn about performance of transmission lines

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech III semester (EPE,EPS and PS)

L	T	P	C
4	0	0	4

(17D20301) RESEARCH METHODOLOGY

(Elective V-OPEN ELECTIVE)

UNIT I

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II

Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.

Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.

Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III

Correlation and Regression Analysis – Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

UNIT IV

Statistical Inference: Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V

Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text Books:

1. Research Methodology:Methods And Techniques – C.R.Kothari, 2nd Edition,New Age International Publishers.
2. Research Methodology: A Step By Step Guide For Beginners- Ranjit Kumar, Sage Publications (Available As Pdf On Internet)
3. Research Methodology And Statistical Tools – P.Narayana Reddy And G.V.R.K.Acharyulu, 1st Edition,Excel Books,New Delhi.

REFERENCES:

1. Scientists Must Write - Robert Barrass (Available As Pdf On Internet)

2. Crafting Your Research Future –Charles X. Ling And Quiang Yang (Available As Pdf On Internet)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech III semester (EPE,EPS and PS)

L	T	P	C
4	0	0	4

(17D20302) HUMAN VALUES AND PROFESSIONAL ETHICS

(Elective V-OPEN ELECTIVE)

Unit I:

HUMAN VALUES:Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence Character – Spirituality.

Unit II:

ENGINEERING ETHICS: Senses of Engineering Ethics- Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg‟s theory- Gilligan‟s theory- Consensus and controversy – Models of professional roles- Theories about right action- Self interest - Customs and religion –Uses of Ethical theories – Valuing time –Co operation – Commitment.

Unit III :

ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering As Social Experimentation – Framing the problem – Determining the facts – Codes of Ethics – Clarifying Concepts – Application issues – Common Ground - General Principles – Utilitarian thinking respect for persons.

UNIT IV:

ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK: Safety and risk – Assessment of safety and risk – Risk benefit analysis and reducing riskSafety and the Engineer- Designing for the safety- Intellectual Property rights(IPR).

UINIT V:

GLOBAL ISSUES: Globalization – Cross culture issues- Environmental Ethics – Computer Ethics – Computers as the instrument of Unethical behavior – Computers as the object of

Unethical acts – Autonomous Computers- Computer codes of Ethics – Weapons Development - Ethics .

Text Books :

1. “Engineering Ethics includes Human Values” by M.Govindarajan, S.Natarajan and V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009.

2. “Engineering Ethics” by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.

3. “Ethics in Engineering” by Mike W. Martin and Roland Schinzinger – Tata McGrawHill– 2003.

4. “Professional Ethics and Morals” by Prof.A.R.Aryasri, Dharanikota Suyodhana-Maruthi Publications.

5. “Professional Ethics and Human Values” by A.Alavudeen, R.Kalil Rahman and M.Jayakumaran , Laxmi Publications.

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M.Tech III semester (EPE,EPS and PS)

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4	0	0	4

(17D20303) INTELLECTUAL PROPERTY RIGHTS

(Elective V-OPEN ELECTIVE)

UNIT – I

Introduction To Intellectual Property: Introduction, Types Of Intellectual Property, International Organizations, Agencies And Treaties, Importance Of Intellectual Property Rights.

UNIT – II

Trade Marks : Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes.

UNIT – III

Law Of Copy Rights : Fundamental Of Copy Right Law, Originality Of Material, Rights Of Reproduction, Rights To Perform The Work Publicly, Copy Right Ownership Issues, Copy Right Registration, Notice Of Copy Right, International Copy Right Law.

Law Of Patents : Foundation Of Patent Law, Patent Searching Process, Ownership Rights And Transfer

UNIT – IV

Trade Secrets : Trade Secrete Law, Determination Of Trade Secrete Status, Liability For Misappropriations Of Trade Secrets, Protection For Submission, Trade Secrete Litigation.

Unfair Competition : Misappropriation Right Of Publicity, False Advertising.

UNIT – V

New Development Of Intellectual Property: New Developments In Trade Mark Law ; Copy Right Law, Patent Law, Intellectual Property Audits.

International Overview On Intellectual Property, International – Trade Mark Law, Copy Right Law, International Patent Law, International Development In Trade Secrets Law.

TEXT BOOKS & REFERENCES:

1. Intellectual Property Right, Deborah. E. Bouchoux, Cengage Learing.

2. Intellectual Property Right – Nleashmy The Knowledge Economy, Prabuddha Ganguli, Tate Mc Graw Hill Publishing Company Ltd.,