



M.Tech COURSE STRUCTURE – R21 - ELECTRICAL POWER SYSTEMS

Semester-I

S.No.	Course Code	Course Name	L-T-P	Credits
1		Economic Operation of Power Systems	3-0-0	3
2		Advanced Power System Protection	3-0-0	3
3		Program Elective I: i) Modelling and Analysis of HVDC Systems ii) Modern Control Theory iii) Solar & Wind Energy Conversion Systems	3-0-0	3
4		Program Elective II: i) Reliability Engineering and Applications to Power Systems ii) Power System Optimization iii) Electric Vehicle Engineering	3-0-0	3
5		Power Systems Protection Lab	0-0-4	2
6		Power Systems Simulation Lab	0-0-4	2
7		Research Methodology and IPR	2-0-0	2
8		Audit Course – I Research Paper Writing Skills	2-0-0	0
Total Credits :				18

Semester-II

S.No.	Course Code	Course Name	L-T-P	Credits
1		Power System Stability and Control	3-0-0	3
2		FACTS Controllers	3-0-0	3
3		Program Elective III: i) Energy Auditing, Conservation & Management ii) Smart Grid Technologies iii) EHVAC Transmission systems	3-0-0	3
4		Program Elective IV: i) Restructured power systems ii) Power Quality iii) Reactive power Compensation & Management	3-0-0	3
5		Renewable Energy Lab	0-0-4	2
6		FACTS Devices Simulation Lab	0-0-4	2
7		Technical Seminar	0-0-4	2
8		Audit Course – II Personality Development Through Life Enlightenment Skills	2-0-0	0
Total Credits :				18

Semester-III

S.No.	Course Code	Course Name	L-T-P	Credits
1		Program Elective V: i) Distributed Generation and Micro grid Control ii) Power System Automation iii) Intelligent Control Techniques	3-0-0	3
2		Open Elective: i) Energy from Waste ii) Cost Management of Engineering Projects iii) Internet of Things (IoT)	3-0-0	3
3		Dissertation Phase -I	0-0-20	10
4		Co-curricular Activities		2
Total Credits :				18

Semester-IV

S.No.	Course Code	Course Name	L-T-P	Credits
1		Dissertation Phase -II	0-0-32	16
Total Credits :				16

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

ECONOMIC OPERATION OF POWER SYSTEMS

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives: Students will be able to

- Understand economic load scheduling problem and unit commitment problem.
- Understand hydro-thermal scheduling problem.
- Understand load frequency control (LFC)
- Understand the optimal power flow (OPF) problem.

UNIT-I: ECONOMIC LOAD SCHEDULING

10 Hrs

Characteristics of Steam Turbine, Variations in steam unit characteristics, Economic dispatch with piecewise linear cost functions, Lambda Iterative method, LP method, Economic dispatch under composite generation production cost function, Base point and Participation factors, Thermal system Dispatching with Network losses.

Learning Outcomes:

At the end of this unit, the student will be able to

- Analyzes the characteristics of steam turbine L4
- Learn about Economic dispatch of thermal units with various methods. L2

UNIT-II: UNIT COMMITMENT

10 Hrs

Unit Commitment – Definition – Constraints in Unit Commitment–Unit Commitment solution methods –Priority–List Methods – Dynamic Programming Solution.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands what unit commitment is. L2
- Understand about various unit commitment methods. L2

Unit-III: HYDRO THERMAL SCHEDULING

10 Hrs

Characteristics of Hydroelectric units, Introduction to Hydrothermal coordination, Long-Range and Short-Range Hydro-Scheduling, Hydroelectric plant models, Hydrothermal scheduling with storage limitations, Dynamic programming solution to hydrothermal scheduling

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands the characteristics of hydroelectric units L2
- Knows the scheduling of the hydrothermal units. L2

UNIT – IV: LOAD FREQUENCY CONTROL

10 Hrs

Control of generation – models of power system elements – single area and two area block diagrams– generation control with PID controllers – implementation of Automatic Generation control (AGC) –AGC features.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands the load frequency control of single area and double area PS. L2
- Implement the AGC features to power system. L4

UNIT – V: OPTIMAL POWER FLOW**10 Hrs**

Introduction to Optimal power flow problem, OPF calculations combining economic dispatch and power flow, OPF using DC power flow, Algorithms for solution of the ACOPTF, Optimal Reactive Power Dispatch.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands what is OPF L2
- Learn about the OPF with DC and AC methods. L2

Text Books:

1. Olle I. Elgerd, "Electric Energy Systems Theory an Introduction", TMH, 2nd Edition, 1983
2. J.J. Grainger & W.D. Stevenson, "Power system analysis", McGraw Hill, 2003.

Reference Books:

1. Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé-Power Generation, Operation and Control-Wiley-Interscience (2013)
2. NPTEL Course, Prof. S. N. Singh, Power System Operation and Control, <https://www.youtube.com/playlist?list=PL4BFB13CCDB954BCF>

Course Outcomes:

At the end of this Course the student will be able to

- Distinguish between economic load dispatch and unit commitment problem L2
- Solve economic load scheduling (with and without network losses) and unit commitment problem L2
- Solve hydro-thermal scheduling problem L3
- Analyzes the single area and two area systems for frequency deviation L4
- Solve the OPF problem using ac and dc load flow methods L3

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

ADVANCED POWER SYSTEM PROTECTION

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives: Student can be able to know

- To know construction of static relays
- To understand the operation of amplitude and phase comparators
- To comprehend the concepts of Static over current, static differential and static distance relays.
- To understand multi-input comparators and concept of power swings on the distance relays.
- To know the operation of microprocessor based protective relays.

UNIT – 1: INTRODUCTION TO STATIC RELAYS & COMPARATORS 10Hrs

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 – Poly phase distance schemes-Phase fault scheme – Three phase scheme – Combined and Ground fault scheme.

Learning Outcomes:

At the end of this unit, the student will be able to

- Define the Basic construction of Static relays L1
- Explain the Level detectors – Replica Impedance-Mixing circuits L2

UNIT – II: STATIC RELAYS 10Hrs

Introduction-Instantaneous over current relay – Time over current relays - Basic principles-Definite time and Inverse definite time over current relays, directional over current relays. Static Differential Relays-Analysis of static differential relays–static relay schemes-Dual bias transformer differential protection – Harmonic restraint relay.

Learning Outcomes:

At the end of this unit, the student will be able to

- Repeat the - Basic principles-Definite time and Inverse definite time over current relays, L1
- Explain the Static Differential Relays L2

UNIT – III: DISTANCE RELAYS AND POWER SWINGS 10Hrs

Static Distance Relays- Static Impedance –reactance - MHO and Angle Impedance relay sampling comparator – Realization of reactance and MHO relay using a sampling comparator.

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Define the Static Impedance –reactance - MHO and Angle Impedance relays L1

- Generalize the Realization of reactance and MHO relay using a sampling comparator L2

UNIT – IV: MICROPROCESSOR BASED PROTECTIVE RELAYS 10Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Reproduce the Impedance relays – Directional relay L1
- Identify the Generalized mathematical expression for distance relays. L2

UNIT – V: NUMERICAL RELAYS: 10Hrs

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

Learning Outcomes:

At the end of this unit, the student will be able to

- Define the Numerical network-Digital Signal processing. L1
- Explain the Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm. L2

Text Books:

1. T.S. Madhava Rao, Power system Protection static relay, 2 nd Edition, Tata McGrawHill Publishing Company limited 2004.
2. Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, 2 nd Edition, Tata McGraw Hill Publication Company limited, 2013.

Reference Books:

1. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd edition, New Delhi, India, 2018
2. Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 2010.

Course Outcomes:

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

- Define the construction of static relay and identify the advantages of static relay over electromagnetic relay. L1
- Explain the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi input comparators, static differential and distance relays L2
- Instruct the instantaneous, definite time and inverse definite minimum time over current relays. L3
- Distinguish the concept of power swings on distance relays and to identify the microprocessor based protective relays and their operation L4
- Implement the Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm. L5

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

MODELLING AND ANALYSIS OF HVDC TRANSMISSION SYSTEMS (PE-I)

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- State HVDC systems
- Understand the concept, planning of DC power transmission.
- Implement HVDC converters to the system
- Compare modeling of Power Flow analysis of AC/DC Systems
- Design digital dynamic simulation of converters and DC systems.

UNIT-I HVDC CONVERTERS AND SYSTEM CONTROL

10 Hrs

Analysis of HVDC Converters: Pulse number – choice of converter configuration – simplified analysis of Graetz circuit – converter bridge characteristics.

Converter and HVDC system control: Principles of DC link control – converter control characteristics – system control hierarchy – firing angle control – current and extinction angle control – starting and stopping of DC link power control.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand converter bridge characteristics L2
- Understand HVDC system control L2

UNIT-II MODELING FOR POWER FLOW ANALYSIS OF AC/DC SYSTEMS

10 Hrs

Modeling of HVDC Components: HVDC Converter model, Converter control, Modeling of DC network, Modeling of AC Networks.

Learning Outcomes:

At the end of this unit, the student will be able to

- Compare the power flow analysis of A.C/D.C systems L4
- Represent solution of A.C/D.C power flow L2

UNIT-III TRANSIENT AND DYNAMIC STABILITY ANALYSIS

10 Hrs

Transient stability Analysis – Converter model – Converter control models – DC network models – solution methodology – Direct methods for stability Evaluation.

Dynamic Stability and power modulation: Power modulation for damping low frequency oscillations – Basic principles – practical consideration in the application of power modulation controllers – Gamma or reactive power modulation – power modulation in MTDC system – voltage stability in AC/DC system

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply direct methods for stability evaluation L3
- Understand the power modulation in MTDC system L2

UNIT-IV HARMONIC AND TORSIONAL INTERACTIONS

10 Hrs

Harmonic and Torsional Interactions: Harmonic Interactions, Torsion Interactions – Torsional interactions with in HVDC systems – counter measures to torsion interactions with DC systems.

Simulation of HVDC systems: System simulation – philosophy & Tools – HVDC system simulation – modeling of HVDC systems Digital dynamic simulation.

Learning Outcomes:

At the end of this unit, the student will be able to

- Analyze harmonic and torsional interactions **L4**
- Develop modeling of HVDC systems and digital dynamic simulation **L5**

UNIT-V MODELING OF HVDC SYSTEMS

10 Hrs

Digital dynamic simulation of converters and DC systems: Valve model, Gate pulse generation – generation of control voltage – transformer model – converter model – transient simulation of DC and AC systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand digital dynamic simulation of converters and D.C systems **L2**
- Develop transient simulation of D.C and A.C systems **L5**

Text Books:

1. K.R. Padiyar, HVDC Power Transmission Systems – Technology & System Interactions, New Age International Publishers, 2017.
2. S Kamakshaiah and V Kamaraju, HVDC Transmission, Tata Mc Graw Hill, New Delhi, 2011.

Course Outcomes:

At the end of this Course the student will be able to

- Identify the electrical requirements for HVDC lines. **L1**
- Understand the different modes of operation for six pulse & twelve pulse converter unit in the context of HVDC system. **L2**
- Apply the knowledge of HVDC transmission in Power networks. **L3**
- Analyze the modeling of A.C/D.C systems **L4**
- Implement transformer model, converter model of HVDC systems **L5**

MODERN CONTROL THEORY (PE- 1)

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To evaluate the solution of state equation and state transition matrix
- To design controllers, access the design through the constraint specifications, and decide whether the initial design is acceptable or can be improved by iterating.
- To design full order observer using Ackermann's formula
- To simulate state equation using MATLAB/ SIMULINK program.
- To identify the solution of a system using Lyapunov stability

UNIT – 1

10 Hrs

Introductory matrix algebra and linear vector space. State space representation of systems. Linearization of a non- linear System. Solution of state equations. Evaluation of State Transition Matrix (STM)

Learning Outcomes:

At the end of this unit, the student will be able to

- | | |
|---|-----------|
| • Understand State space representation of a system | L1 |
| • Evaluate State Transition Matrix for a system | L4 |

UNIT – II

10 Hrs

Similarity transformation and invariance of system properties due to similarity transformations. Minimal realization of SISO, SIMO, MISO transfer functions. Discretization of a continuous time state space model. Conversion of state space model to transfer function model using Fadeeva algorithm. Fundamental theorem of feedback control - Controllability and Controllable canonical form - Pole assignment by state feedback using Ackermann's formula – Eigen structure assignment problem.

Learning Outcomes:

At the end of this unit, the student will be able to

- | | |
|---|-----------|
| • Convert state space model to transfer function model | L4 |
| • Understand the concept of Pole assignment using Ackermann's formula | L2 |

UNIT – III

10 Hrs

Linear Quadratic Regulator (LQR) problem and solution of algebraic Riccati equation using Eigen value and Eigen vector methods, iterative method. Controller design using output feedback.

Observability and observable canonical form - Design of full order observer using Ackermann's formula, Bass Gura algorithm. Duality between controllability and observability - Full order Observer based controller design. Reduced order observer design.

Learning Outcomes:

At the end of this unit, the student will be able to

- | | |
|---|-----------|
| • Determine Eigen values and Eigen vectors | L3 |
| • Understand Linear Quadratic Regulator problem | L2 |

UNIT – IV

10 Hrs

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc; Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

Learning Outcomes:

At the end of this unit, the student will be able to

- Implement basic principles and techniques in designing Non-linear control systems. **L5**
- Understand the concept of Controllability and Observability **L2**

UNIT – V

10 Hrs

Internal stability of a system. Stability in the sense of Lyapunov, asymptotic stability of linear time invariant continuous and discrete time systems. Solution of Lyapunov type equation. Model decomposition and decoupling by state feedback. Disturbance rejection, sensitivity and complementary sensitivity functions.

Learning Outcomes:

At the end of this unit, the student will be able to

- Analyze the concept of Lyapunov stability theorems **L3**
- Understand sensitivity and complementary sensitivity functions **L2**

Text Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall, India 1997
2. T. Kailath, T., Linear Systems, Prentice Hall, Englewood Cliffs, NJ, 1980.
3. N. K. Sinha, Control Systems, New Age International, 3rd edition, 2005.
4. K. Ogata, Modern Control Engineering, Prentice Hall, India 1997

Reference Books:

1. Panos J Antsaklis, and Anthony N. Michel, Linear Systems, New - age international (P) LTD. Publishers, 2009.
2. John J D’Azzo and C. H. Houpis , -Linear Control System Analysis and Design conventional and Modern, McGraw - Hill Book Company, 1988.
3. B.N. Dutta, Numerical Methods for linear Control Systems - , Elsevier Publication, 2007
4. C.T.Chen Linear System Theory and Design - PHI, India, 1984.

Course Outcomes:

At the end of this Course the student will be able to

- Test the controllability and observability of a given system **L4**
- Analyze Linearization of a non linear system **L3**
- Design Pole assignment by state feedback using Ackermann’s formula **L5**
- Identify the Lyapunov stability of a system. **L2**
- Design of Model decomposition and decoupling of system by state feedback. **L5**

SOLAR and WIND ENERGY CONVERSION SYSTEMS (PE-I)

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To introduce photovoltaic systems and principle of wind turbines
- To deal with various technologies of solar PV cells
- To understand details about manufacture, sizing and operating techniques in solar energy conversion systems.
- Understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To have knowledge of design considerations and analyze grid integration issues.

UNIT – 1: SOLAR & WIND FUNDAMENTALS 10 Hrs

Need for sustainable energy sources –solar radiation – the sun and earth movement – angle of sunrays on solar collectors – sun tracking – estimating solar radiation – measurement of solar radiation.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

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about Need for sustainable energy sources L1
- Learn about Types of wind energy conversion devices L2

UNIT – II: SOLAR PHOTOVOLTAIC MODULES 10 Hrs

Solar PV Modules from solar cells – model of a solar cell, effect of series and shunt resistance on efficiency, effect of solar radiation on efficiency - 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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand and estimate Solar PV Modules from solar cells L1
- Understand - series and parallel connection of cells L2

UNIT – III PV SYSTEM DESIGN AND APPLICATIONS 10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the standalone PV system configuration L1
- Distinguish between design of standalone system with battery and AC/DC load L2

UNIT – IV: WIND TURBINE CONTROL SYSTEMS & SITE ANALYSIS**10 Hrs**

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. 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

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand Wind Turbine - Torque speed characteristics L1
- Distinguish between - single output system –double output system with current converter L2

UNIT – V: : WIND GENERATION WITH VARIABLE SPEED TURBINES AND APPLICATIONS**10 Hrs**

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

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand doubly fed induction generator L1
- Understand application in hybrid energy systems – diesel generator and photovoltaic systems – wind photovoltaic systems L2

Text Books:

1. “Solar Photovoltaics Fundamentals, Technologies and Applications” by Chetan singh solanki, PHI publications.
2. S.N.Bhadra, D.Kastha, S.Banerjee, “ wind electrical systems” Oxford University Press

Reference Books:

1. Solar Energy Fundamentals and applications by H.P. Garg, J. Prakash , Tata McGraw- Hillpublishers 1st edition
- 2.S.Rao & B.B.Parulekar, “Energy Technology”, 4th edition, Khanna publishers, 2005
3. “Renewable Energy sources & Conversion Technology” by N.K.Bansal, Manfred Kleemann,Michael Meliss. Tata McGraw Hill Publishers

At the end of this Course the student will be able to

- Understand the basic concepts of solar and wind L1
- Identify the factors affecting of solar and wind L2
- Analyze converters are used in solar and wind L3
- Estimate the generation of solar and wind energy . L4
- Understand the basic concepts of solar and wind L5

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

RELIABILITY ENGINEERING AND APPLICATION TO POWER SYSTEMS (PE – II)

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- The Basic concepts, rules for combining probabilities of events, failure density and distribution functions.
- Evaluation of network Reliability / Unreliability and types of redundancies.
- Evaluation of network Reliability / Unreliability using conditional probability method.
- Expected value and standard deviation of Exponential distribution and Measures of reliability.
- Evaluation of Limiting State Probabilities of one, two component repairable models.

UNIT – 1: Basics of Probability Theory, Distribution & Network Modelling 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about basic rules for probabilities of events L1
- Get detailed information about Probability of failure density and distribution Functions and obtain the expected value and standard deviation for binomial distribution. L2
- How to find the Probability of success and failures of network using different approaches for series-parallel configurations. L1
- To find reliability / unreliability of complex systems using different methods L2

UNIT – II: Reliability Functions 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concepts of time domain functions and relationship between them. and obtain the expected value and standard deviation for exponential distribution. L1
- To obtain probabilistic measures for fully redundant and partially redundant configurations L3

UNIT – III: Markov Modelling And Frequency & Duration Techniques 9 Hrs

Basic concepts – Reliability functions $f(t)$, $Q(t)$, $R(t)$, $h(t)$ – Relationship between these

functions – Bath tub curve – Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution – Measures of reliability – MTTF, MTTR, MTBF – Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems - Partially redundant systems - Evaluation of reliability measure – MTTF for series and parallel systems – Examples.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concepts of Stochastic Transitional Probability Matrix, Limiting State Probability **L1**
- Understand the concept of Frequency balance approach. And To distinguish between Markov chains and Markov processes **L2**

UNIT – IV: Applications To Power Systems - I 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concepts of recursive relation for evaluation of equivalent transitional rates. **L1**
- To know about computation of basic probability indices for series, parallel configurations **L2**

UNIT – V: Applications To Power Systems - II 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Design the reliability composite systems and distribution systems for finding reliability indices. **L3**

Text Books:

1. Reliability Evaluation of Engineering Systems by Roy Billinton and Ronald N. Allan, Reprinted in India B. S. Publications, 2007.
2. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2003.

Reference Books:

1. Introduction to Reliability Engineering by E. E. Lewis by Wiley Publications.
2. Reliability and Maintainability Engineering by Charles E. Ebeling, Tata McGraw Hill, 2000.
3. Reliability and Safety Engineering by Ajit Kumar Verma, Srividya Ajit and Durga Rao Karanki, Springer, Second Edition, 2016. System Reliability Theory Marvin Rausand and Arnljot Hoyland, Wiley Publications.

Course Outcomes:

At the end of this Course the student will be able to

- Understand the concepts for combining Probabilities of events, Bernoulli's trial, and Binomial distribution. **L1**
- Network Reliability/Unreliability using conditional probability, path and cutset based approach, complete event tree and reduced event tree methods. **L2**
- Understanding Reliability functions and to develop relationship between these functions, expected value and standard deviation of Exponential distribution and measures of reliabilities. **L3**
- Analyze the time dependent reliability evaluation of single component repairable model, frequency and duration concepts, Frequency balance approach. **L4**
- Recursive relation for evaluation of equivalent transitional rates, cumulative probability and cumulative frequency and 'n' component repairable model. **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

POWER SYSTEM OPTIMIZATION (PE – II)

I Year M.Tech (EPS) – 1st Semester

L T P C
3 0 0 3

Course Objectives:

- Understand the fundamental concepts of Optimization Techniques.
- Analyze the importance of optimizations in real life scenarios.
- Apply the concepts of various classical and modern methods for constrained and unconstrained problems in both single and multivariable.
- Design the algorithms for different optimizations techniques

UNIT – 1: Fundamentals of Particle Swarm Optimization (PSO) Techniques 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concept of optimality criteria for various type of optimization problems.

L2

UNIT – II: Fundamentals of Ant Colony Search Algorithms 9 Hrs

Introduction – Ant Colony Search Algorithm – Behavior 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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Analyze the concept of different optimization techniques in real world applications.

L3

UNIT – III: Fundamentals of Tabu Search 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Solve various constrained and unconstrained problems in single variable as well as multivariable.

L2

UNIT – IV: Application to power systems 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Design the methods of optimization for real life situation. **L4**

UNIT – V: Power system controls

9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Design the methods of Minimization of losses in IEEE 14 Bus System **L4**

Text Books:

1. Kwang Y. Lee and Mohamed A. El- 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”, IEEE Press, John Wiley & Sons, Inc., *Publication*, 2009.
2. Joshua adam Taylor, “Convex optimization of power systems”, Cambridge University Press, 2015.

Course Outcomes:

At the end of this Course the student will be able to

- Understand the concept of optimality criteria for various type of optimization problems. **L1**
- Analyze the concept of different optimization techniques in real world applications. **L2**
- Solve various constrained and unconstrained problems in single variable as well as multivariable. **L3**
- Design the methods of optimization for real life situation. **L4**
- Design the methods of Minimization of losses in IEEE 14 Bus System **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

ELECTRIC VEHICLE ENGINEERING (PE – II)

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To understand and differentiate between Conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs.
- To remember and understand various configurations in parameters of EV system and dynamic aspects of EV.
- To analyze fuel cell technologies in EV and HEV systems.
- To analyze the battery charging and controls required of EVs.

UNIT – I Introduction to EV Systems and Parameters

10 Hrs

Past, Present and Future of EV - EV Concept- EV Technology- State-of-the Art of EVs- EV configuration- EV system- Fixed and Variable gearing- Single and multiple motor drive- In-wheel drives- EV parameters: Weight, size, force and energy, performance parameters.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about EV Technology **L1**
- Learn about different EV parameters **L2**

UNIT-II EV and Energy Sources

10 Hrs

Electro mobility and the environment- History of Electric power trains- Carbon emissions from fuels- Green houses and pollutants- Comparison of conventional, battery, hybrid and fuel cell electric systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand and estimate the Electric power trains **L1**
- Understand hybrid and fuel cell electric systems **L2**

UNIT-III EV Propulsion and Dynamics

10 Hrs

Choice of electric propulsion system- Block diagram- Concept of EV Motors- Single and multi motor configurations- Fixed and variable geared transmission- In-wheel motor configuration- Classification- Electric motors used in current vehicle applications- Recent EV Motors- Vehicle load factors- Vehicle acceleration.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Concept of EV Motors **L1**
- Distinguish between Single and multi motor configurations **L2**

UNIT-IV Fuel Cells

10 Hrs

Introduction of fuel cells- Basic operation- Model- Voltage, power and efficiency- Power plant system – Characteristics- Sizing - Example of fuel cell electric vehicle.

Introduction to HEV- Brake specific fuel consumption- Comparison of Series-Parallel

hybrid systems- Examples.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the fuel cells L1
- Distinguish between Series-Parallel hybrid systems L2

UNIT-V Battery Charging and Control

10 Hrs

Battery charging: Basic requirements- Charger architecture- Charger functions- Wireless charging- Power factor correction.

Control: Introduction- Modeling of electro mechanical system- Feedback controller design approach- PI controllers designing- Torque-loop, Speed control loop compensation- Acceleration of battery electric vehicle.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Wireless charging L1
- Understand Torque-loop, Speed control loop compensation L2

Text Books:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.
2. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 2017.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
4. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2003.

Reference Books:

1. Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC Press 2005.
2. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015.

Course Outcomes:

At the end of this Course the student will be able to

- To understand and differentiate between Conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs. L1
- To remember and understand various configurations in parameters of EV system and dynamic aspects of EV. L2
- To analyze fuel cell technologies in EV and HEV systems. L3
- To analyze the battery charging and controls required of EV L4
- Understand the fuel cells L5

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

POWER SYSTEM PROTECTION LAB

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
0	0	4	2

Course Objectives:

To make the student learn about:

- Understand the experiments ensuring the safety of equipment and personnel.
- Analyze the power system data fault studies.
- Interpret the experimental results and correlating them with the practical power system.
- Design the relays for power system protection purpose.

List of Experiments

1. Characteristics of Static/Numeric Over Current Relay
2. Characteristics of Static Negative Sequence Relay
3. Characteristics of Static/Numeric Over Voltage Relay
4. Characteristics of Static/Numeric Percentage Biased Differential Relay
5. Testing of Buchholz relay
6. Testing of Frequency Relay.
7. Testing of Reverse Power Relay.
8. Testing of Earth fault Relay
9. Equivalent Circuit of a Three Winding Transformer
10. Determination of Sub transient Reactance of a Salient Pole Machine
11. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine
12. Fault Analysis
i) LG Fault ii) LL Fault iii) LLG Fault iv) LLLG Fault
13. Equivalent Circuit of a Three Winding Transformer
14. Separation of No Load losses of a Three Phase Squirrel Cage Induction Motor
15. Power Angle Characteristics of a Salient Pole Synchronous Machine

Note: From the above list minimum 10 experiments are to be conducted .

Course Outcomes: At the end of the course, student will be able to

- Understand Load balancing using compensators. Understand the concept of different experiments.
- Analyze the data for and compute the data to obtain results.
- Apply the computational results to solve the original power system problems.
- Have the capability to develop advanced relays to identify various faults.

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

POWER SYSTEMS SIMULATION LAB

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
0	0	4	2

Course Objectives:

To make the student learn about:

- Understand how to write the coding in simulation
- Analyze the data related to load flows, economic dispatch problem and transient stability analysis.
- Apply the computational results in real life power system problems.
- Have the capabilities to develop new software's to optimize the results.

List of Experiments

1. Y - Bus Formation
2. Gauss – Seidel Load Flow Analysis
3. Fast Decoupled Load Flow Analysis
4. Fast Decoupled Load Flow Analysis for Distribution Systems
5. Point by Point Method
6. Computation of Available Transfer Capabilities.
7. Contingency analysis.
8. State estimation using Weighted Least Square, linear and non-linear methods.
9. Simulation of power quality problems (Sag/Swell, interruption, transients, harmonics, flickers etc.)
10. Harmonic analysis and Single tuned filter design to mitigate harmonics.
11. Harmonic analysis and Double tuned filter design to mitigate harmonics.
12. Develop Program for Unit Commitment Problem using Forward Dynamic Programming Method.
13. Develop Program for Economic Load Dispatch Problem using Lambda Iterative Method.

Note: From the above list minimum 10 experiments are to be conducted using suitable software.

Course Outcomes: At the end of the course, student will be able to

- Understand the coding in simulation
- Analyze the power system data for load-flow and stability studies.
- Apply computational methods for large scale power system studies.
- Develop software for power system industry to solve various issues

RESEARCH METHODOLOGY & IPR

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
2	0	0	2

Course Objectives:

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

UNIT – 1: RESEARCH FORMULATION AND DESIGN

11 Hrs

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive

vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research.

Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching

the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT – II : DATA COLLECTION AND ANALYSIS

10 Hrs

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically

Package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT – III : INTERPRETATION AND REPORT WRITING

8 Hrs

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance

of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

UNIT – IV : RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING

8 Hrs

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, Citation and acknowledgement, plagiarism, reproducibility and accountability.

UNIT – V

8 Hrs

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.

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

Reference Books:

1. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Outcomes:

At the end of this Course the student will be able to

- Understand research problem formulation. **L4**
- Analyze research related information **L3**
- Follow research ethics **L5**
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. **L2**
- 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. **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

RESEARCH PAPER WRITING SKILLS

(Audit Course - I)

I Year M.Tech (EPS) – 1st Semester

L	T	P	C
2	0	0	0

Course Objectives:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

UNIT – 1:

8 Hrs

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT – II :

8 Hrs

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT – III :

8 Hrs

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT – IV :

8 Hrs

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

UNIT – V

8 Hrs

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Text Books:

1. Goldbort R (2006) Writing for Science
2. Day R (2006) How to Write and Publish a Scientific Paper

Reference Books:

1. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

POWER SYSTEM STABILITY & CONTROL

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives:

- Understand about linear and nonlinear models of multi-machine power systems.
- Analyze various types of stability properties of power systems.
- Identify power system models from dynamic data and simulate excitation mechanisms in synchronous machines.
- Design excitation systems and their state space model equations for further stability applications.
- Understand about Voltage and Angle stability

UNIT-I: The Elementary Mathematical Model

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about model of single and machine system connected to the infinite bus bar **L1**
- Learn about stability of multi machine system **L2**

UNIT – II: System Response to Small Disturbances and Dynamic Stability

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand behavior of unregulated synchronous machine **L1**
- Understand Voltage and Governor regulator with one time lag **L2**
- Understand the concept of Dynamic stability **L3**
- Understand the R-H criterion for dynamic stability **L4**

UNIT – III: Power System Stabilizers

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the supplementary stabilizing signals **L1**
- Understand the approximate model of the complete exciter **L2**
- Understand the lead compensation and stability analysis using eigen value approach **L3**

UNIT – IV: Excitation Systems

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Non – continuous and continuous excitation systems **L1**
- Understand the state space model for excitation systems **L2**
- Understand the various types of excitation systems **L3**

UNIT – V: Stability Analysis

10 Hrs

Review of Lyapunov's stability of non-linear 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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Stability analysis of Non linear systems **L1**
- Understand the various Non linear stability methods **L2**
- Understand the Voltage and Angle stability analysis **L3**

Text Books:

1. Vijay Vittal, James D. McCalley, Paul M. Anderson "Power System Control and Stability", Jhon Willey and Sons, 2019.
2. Prabha Kundur, "Power System Control and Stability", McGraw Hill Education India, 2008.

Reference Books:

1. Dr Jan Machowski, Dr Janusz W. Bialek, Dr Jim Bumby · "Power System Dyanmics: Stability and Control", Jhon willey and Sons, 2nd Edition, 2011.
2. M.A.Pai, Power System Stability-Analysis by the direct method of Lyapunov, North Holland Publishing Company, New York, 1981.
3. L.P. Singh , "Advanced Power System Analysis and Dynamics", New Age International, 2006.

FACTS CONTROLLERS

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

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 deal with the objectives of shunt and series compensation..
- To enhance the transient stability and power oscillation damping by SVC and STATCOM.
- The working principle, structure and control of UPFC.
- The operation, structure and control of IPFC.

UNIT – I: FACTS CONCEPTS, VSI AND CSI

10 Hrs

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

Learning Outcomes:

At the end of this unit, the student will be able to

- | | |
|--|-----------|
| • To learn about basic definitions and power flow in AC systems | L1 |
| • To know about the different types of Facts controllers and their uses. | L2 |

UNIT – II: SHUNT COMPENSATION

10 Hrs

Objectives of shunt compensation - Methods of controllable var generation - variable impedance type static var generators - switching converter type var generators - hybrid var generators – Comparison of SVC and STATCOM.

Learning Outcomes:

At the end of this unit, the student will be able to

- | | |
|--|-----------|
| • To understand voltage source converters and Transformation connections | L1 |
| • To distinguish between SVC and STATCOM | L2 |

UNIT – III: SERIES COMPENSATION

10 Hrs

Objectives of series compensation–GTO Thyristor Controlled Series Capacitor (GCSC)- Thyristor Switched Series Capacitor (TSSC) - Thyristor Controlled Series Capacitor (TCSC) - Control schemes for TCSC, TSSC and TCSC.

Learning Outcomes:

At the end of this unit, the student will be able to

- | | |
|--|-----------|
| • To understand the objectives of series compensation. | L1 |
| • To understand the control method of GCSC,TSSC&TCSC. | L2 |

UNIT – IV: UNIFIED POWER FLOW CONTROLLER (UPFC)**10 Hrs**

Introduction - The Unified Power Flow Controller - Basic Operating Principles - Conventional Transmission Control Capabilities - Independent Real and Reactive Power Flow Control - Control Structure – Basic Control System for P and Q Control-Hybrid Arrangements: UPFC With a Phase Shifting Transformer.

Learning Outcomes:

At the end of this unit, the student will be able to

- To understand the UPFC L1
- To understand the control structure and Hybrid Arrangements L2

UNIT – V: INTER LINE POWER FLOW CONTROLLER (IPFC)**10 Hrs**

Introduction, basic operating principle and characteristics of IPFC, control structure, practical and application considerations, generalized and multi functional fact controllers.

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about IPFC. L1
- To understand the Multi functional facts controllers L2

Text Books:

1. Hingorani HGandGyugyi.L“Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems” NewYork,IEEE Press,2000.
2. Padiyar K.R,“ FACTS Controllers in Power Transmission and Distribution” New Age Int.Publishers,2007

Reference Books:

1. Zhang,Xiao-Ping, Rehtanz,Christian,Pal,Bikash“Flexible AC Transmission Systems: Modeling and Control”,Springer,2012.
1. Yong-Hua Song, AllanJohns, “Flexible AC Transmission Systems”, IET,1999.

Course Outcomes:

At the end of this Course the student will be able to

- Know the basic definitions and different types of Facts controllers and their uses. L1
- Know about the voltage source converter operation and different modulation Techniques with comparison. L2
- Improve the stability of power system by Shunt Compensation and Series Compensation with facts controllers. L3
- The operation of Unified Power Controller and Hybrid Arrangements. L4

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

ENERGY AUDITING, CONSERVATION AND MANAGEMENT (PE-III)

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives: This course enables the students to know

- The growing worldwide concern for conservation of energy has reawakened interest in ecologically

Sustainability, processes and sources of energy.

- The better ways to conserve the energy from energy audit concepts, Representations and energy

Conservation schemes.

- Management skills and communication of energy manager.

- Various operational problems and remedies of motor and electrical devices.

- Evaluation of life time of machine based on time value money and demand.

UNIT – 1: BASIC PRINCIPLES OF ENERGY AUDIT

10
Hrs

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

Learning Outcomes:

At the end of this unit

- Student can understand the concepts of energy audit
- Student can learn process of energy audit

L1
L2

UNIT – II: ENERGY MANAGEMENT

10 Hrs

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.

Learning Outcomes:

At the end of this unit

- Student can able to learn the principles of energy management
- Student can understand the qualities and functions of energy manager

L1
L2

UNIT – III: ENERGY EFFICIENT MOTORS

10 Hrs

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

Learning Outcomes:

At the end of this unit,

- Student can understand the internal and external problems of a motor
- Student can able to learn the making of normal motor in to energy efficient motor

L1
L2

UNIT – IV: POWER FACTOR IMPROVEMENT, LIGHTING AND ENERGY INSTRUMENTS **10 Hrs**

Power factor – methods of improvement, location of capacitors, Pf with non linear loads, effect of harmonics on power factor, power factor motor controllers - Good lighting system design and practice, lighting control ,lighting energy audit - Energy Instruments- wattmeter, data loggers, thermocouples, pyrometers, lux meters, tongue testers and application of PLC's

Learning Outcomes:

At the end of this unit

- Student can understand the importance of power factor ,lighting and energy instruments **L1**
- Student can learn the implementation of energy conservation schemes **L2**

UNIT – V: ECONOMIC ASPECTS AND ANALYSIS **10 Hrs**

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.

Learning Outcomes:

At the end of this unit

- Student can understand the economic aspects and analysis **L1**
- Student can learn the how the economic analysis is related to energy auditing **L2**

Text Books:

1. Energy management by W.R. Murphy AND G. McKay Butter worth, Heinemann
2. publications.
3. Electrical Energy Utilization and Conservation by S.C.Tripathy(Tata Mc Graw Hill)

Reference Books:

1. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition,1998
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995
3. Energy management hand book by W.C. Turner, John wiley and sons
4. Energy management and good lighting practice: fuel efficiency- booklet12-EEO

Course Outcomes:

At the end of this Course the student will have the knowledge on

Current energy scenario and energy management	L1
Energy auditing	L2
conservation and economic analysis	L3
Systematic knowledge and skill about assessing the energy efficiency	L4
Systematic knowledge and skill about assessing the energy auditing and energy Management.	L5

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

SMART ELECTRIC GRID TECHNOLOGIES (PE-III)

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To learn about recent trends in grids as smart grid
- To understand about smart grid architecture and technologies
- To know about smart substations
- To learn about smart transmission systems
- To learn about smart distribution systems

UNIT – 1: INTRODUCTION TO SMART GRID

10 Hrs

Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid Smart Grid Architecture: Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs – Transmission Automation – Distribution Automation – Renewable Integration

Learning Outcomes:

At the end of this unit, the student will be able to

- To understand basic definitions and architecture of Smart grid **L1**
- To understand the need for integration of Renewable energy sources **L2**

UNIT – II: SMART METERS

9 Hrs

Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation .

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about basic characteristic features of smart grid technologies **L1**
- To know about integration requirements, standards of renewable energy sources in Microgrids **L2**

UNIT – III: SMART SUBSTATIONS

9 Hrs

Protection, Monitoring and control devices, sensors, SCADA, Master stations, Remote terminal unit, interoperability and IEC 61850, Process level, Bay level, Station level, Benefits, role of substations in smart grid, Volt/VAR control equipment inside substation

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about protection, monitor and control devices in Smart substations **L1**
- To understand about Volt/VAR control equipment inside substation **L3**

UNIT – IV: SMART TRANSMISSION

10 Hrs

Energy Management systems, History, current technology, EMS for the smart grid, Wide

Area Monitoring Systems (WAMS), protection & Control (WAMPC), needs in smart grid, Role of WAMPC smart grid, Drivers and benefits, Role of transmission systems in smart grid, Synchro Phasor Measurement Units (PMUs)

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about Energy Management Systems in smart transmission systems **L1**
- To know about role of transmission systems in Smart grid **L2**

UNIT – V: Smart Distribution Systems 9 Hrs

DMS, DSCADA, trends in DSCADA and control, current and advanced DMSs, Voltage fluctuations, effect of voltage on customer load, Drivers, objectives and benefits, voltage-VAR control, VAR control equipment on distribution feeders, implementation and optimization, FDIR - Fault Detection Isolation and Service restoration (FDIR), faults, objectives and benefits, equipment, implementation

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about DSCADA in Smart Distribution Systems **L1**
- To understand about VAR control and equipment on distribution feeders **L2**

Text Books:

1. Stuart Borlase, Smart Grids - Infrastructure, Technology and Solutions, CRC Press,1e, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2e,2013.

Reference Books:

1. A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition, 2e, 2017.
2. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2e,2012.

Course Outcomes:

At the end of this Course the student will be able to

- To be able to understand trends in Smart grids **L1**
- To understand the needs and roles of Smart substations **L2**
- To understand the needs and roles of Smart Transmission systems **L3**
- To understand the needs and roles of Smart Distribution systems **L4**
- To distinguish between SCADA and DSCADA systems in practical working environment **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

EHVAC TRANSMISSION (PE-III)

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To understand the basic concepts of EHVAC
- To Identify the factors affecting AC-DC transmission
- To analyze travelling waves and the effects of corona like audible noise
- To estimate field intensity at any point in EHV system with the help of different computational method

UNIT – 1: PRELIMINARIES

10
Hrs

Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses- Mechanical considerations – Resistance of conductors – Properties of bundled conductors – Bundle spacing and bundle radius - Examples

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about Necessity of EHV AC transmission L1
- Learn about Properties of bundled conductors L2

UNIT – II: LINE AND GROUND REACTIVE PARAMETERS

10 Hrs

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

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand and estimate Line inductance and capacitances L1
- Understand potential relations for multi-conductor L2

UNIT – III CORONA EFFECTS

10 Hrs

Power loss and audible noise (AN) – corona loss formulae – Charge voltage diagram – Generation, characteristics - Limits and measurements of AN – Relation between 1-phase and 3 -phase AN levels – Radio interference (RI) - Corona pulses generation, properties, limits – Frequency spectrum – Modes of propagation – Excitation function – Measurement of RI, RIV and excitation functions - Examples.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Relation between 1-phase and 3 -phase AN levels L1
- Distinguish between Measurement of RI, RIV and excitation functions L2

UNIT – IV: ELECTROSTATIC FIELD & TRAVELING WAVE THEORY

10 Hrs

Electrostatic field: calculation of electrostatic field of EHV/AC lines – Effect on humans, animals and plants – Electrostatic induction in un-energized circuit of 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

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the calculation of electrostatic field of EHV/AC lines L1
- Distinguish between - Open circuited and short circuited end - Reflection and refraction coefficients L2

UNIT – V: : VOLTAGE CONTROL

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand Voltage control using synchronous condensers L1
- Understand Static VAR compensating system L2

Text Books:

1. Sanjay Kumar Sharma, “EHV-AC,HVDC Transmission and Distribution Engineering” Edition 2, 2016.
2. R. D. Begamudre, “EHVAC Transmission Engineering”, New Age International (p) Ltd.2013.
3. M. G. Dwek, EHV Transmission, Elsevier Sc., 1991.

Reference Books:

1. R. Padiyar, HVDC Transmission Systems, Wiley Eastern Ltd., New Delhi , 1992.
2. J. Arrilaga, High Voltage Direct Current Transmission, peter pereginver Ltd.London, U.K., 1998.
3. E.W. Kimbark, Direct Current Transmission-vol.1, Wiley Inter science, New York , 1971

Course Outcomes:

At the end of this Course the student will be able to

- Understand the basic concepts of EHVAC L1
- Identify the factors affecting AC-DC transmission L2
- Analyze travelling waves and the effects of corona like audible noise L3
- Estimate field intensity at any point in EHV system with the help of different computational method. L4
- Understand the basic concepts of EHVAC L5

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

RESTRUCTURED POWER SYSTEMS (PE-IV)

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives: Students will be able to

- Understand basic concepts of the restructuring of power industry and market models.
- Analyze about the fundamental concepts of congestion management, Transfer Capability issues and ancillary service management.
- Apply the transmission cost allocation methods to evaluate the cost.
- Develop the operational planning activities in different competitive environment

UNIT – 1: KEY ISSUES IN ELECTRIC UTILITIES

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about restructuring models,ISO L2
- Knows how to manage the Intra&Inter zonal congestional problem. L2

UNIT – II: OPENACCESS SAME-TIME INFORMATION SYSTEM (OASIS) &MARKETPOWER

10 Hrs

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

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands what is OASIS L2
- Apply the market power techniques in RPS. L3

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

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands the transfer capability issues. L2
- Understands the electric pricing,indexes and challenges. L2

UNIT – IV: POWER SYSTEM OPERATION IN COMPETITIVE ENVIRONMENT 10 Hrs

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

Learning Outcomes:

At the end of this unit, the student will be able to

- Understands operational planning activities of ISO in pool & bilateral. **L2**
- Understands the operational planning activities of GENCO in POOL& Bilateral **L2**

**UNIT – V: TRANSMISSION COST ALLOCATION METHODS 10 Hrs
& 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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply the various transmission cost allocation methods. **L3**
- Understands the Ancillary services. **L2**

Text Books:

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

Reference Books:

1. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England, 2001.

Course Outcomes:

At the end of this Course the student will be able to

1. Understand the differences between the conventional power system operation and the restructured one and basics concepts of market power, electricity pricing and competitive environment. **L2**
2. Analyze the concepts of Independent System Operator (ISO) and Open Access Same-Time Information System (OASIS). **L4**
3. Apply the methods to find Available Transfer Capability (ATC) and to allocate the Transmission cost. **L3**
4. Develops power markets and market architectural aspects and short time Price forecasting **L3**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

POWER QUALITY (PE-IV)

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives:

To make the student learn about:

- To learn about voltage disturbances and power transients that is occurring in power systems
- To know about voltage sag and transient over voltages for quality of power supply
- To understand about harmonics and their mitigation
- To study about different power quality measuring and monitoring concepts.
- To know about long duration voltage variations

UNIT – 1 POWER QUALITY ISSUES

10
Hrs

Power quality, voltage quality, The power quality Evaluation procedure, Terms and Definitions, Transients, Long-duration voltage variations, short-duration voltage variations, voltage imbalance, wave form distortion, voltage fluctuation, power frequency variations, power quality terms CBEMA and ITI curves.

Learning Outcomes:

At the end of this unit, the student will be able to

- To learn about various issues of power quality L1
- To know about the evaluation procedure of power quality issues L2

UNIT – II: VOLTAGE SAGS AND TRANSIENT OVER VOLTAGES

10 Hrs

Sources of sags and interruptions, Estimating voltage sag performance, fundamental principles of protection, solutions at the end-use level, Motor-starting sags and utility system fault-clearing issues, sources of over voltages, principles of over voltage protection, devices for over voltage protection, utility capacitor-switching transients, utility system lightning protection.

Learning Outcomes:

At the end of this unit, the student will be able to

- To understand what is meant by voltage sag L1
- To know about voltage sag performance estimations L2

UNIT – III: FUNDAMENTALS OF HARMONICS

10 Hrs

Harmonic sources from commercial and industrial loads, locating harmonic sources, Power system response characteristics, Harmonics Vs transients, Effect of harmonics, harmonic distortion, voltage and current distortion, harmonic indices, inter harmonics, resonance, harmonic distortion evaluation, devices for controlling harmonic distortion, passive and active filters, IEEE and IEC Standards.

Learning Outcomes:

At the end of this unit, the student will be able to

- To understand about effects of harmonics L1
- To distinguish between voltage and current harmonics L2

UNIT – IV: LONG-DURATION VOLTAGE VARIATIONS**10 Hrs**

Principles of regulating the voltage, Devices for voltage regulation, utility voltage regulator Application, capacitors for voltage regulation, End user capacitor applications, flicker.

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about principles of regulating the voltages **L1**
- To understand about the necessity of power electronic devices for voltage regulation **L2**

UNIT – V: POWER QUALITY BENCH MARKING AND MONITORING**10 Hrs**

Benchmarking process, RMS Voltage variation Indices, Harmonic indices Power Quality Contracts, Monitoring considerations, power quality measurement equipment, Power quality Monitoring Standards

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about what is meant by bench marking in power quality issues **L1**
- To identify and able to compute voltage variation indices **L2**

Text Books:

1. Electrical Power Systems Quality by Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, 2nd Edition, TMH Education Pvt. Ltd, 2012
2. Power quality by C. Sankaran, CRC Press, 2017

Reference Books:

1. Electrical systems quality Assessment by J. Arrillaga, N.R. Watson, S. Chen, John Wiley & Sons, 2000.
2. Understanding Power quality problems by Math H. J. Bollen, Wiley-IEEE Press, 2000

Course Outcomes:

At the end of this Course the student will be able to

- To get knowledge about different power quality issues and to mitigate them **L1**
- Analyze voltage disturbances and power transients that are occurring in power systems. **L2**
- Understand the concept of harmonics in the system and their effect on different power system equipment. **L3**
- Able to understand the principles of regulation of long duration voltage variations **L4**
- To get knowledge about different power quality measuring and monitoring concepts **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

REACTIVE POWER COMPENSATION & MANAGEMENT (PE-IV)

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To identify the necessity of reactive power compensation
- To describe load compensation and 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.

UNIT – I LOAD COMPENSATION

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about Reactive power characteristics L1
- Learn about Phase balancing and power factor correction of unsymmetrical loads L2

UNIT-II STEADY – STATE & TRANSIENT STATE REACTIVE 10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand Static compensation and Series capacitor compensation L1
- Understand Types of compensation L2

UNIT-III REACTIVE POWER COORDINATION & DEMAND SIDE MANAGEMENT

10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Concept of quality of power supply L1
- Understand load sharing L2

UNIT-IV DISTRIBUTION & USER SIDE REACTIVE POWER MANAGEMENT 10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the KVAR requirements for domestic appliances **L1**
- Understand Types of capacitors, characteristics and Limitations. **L2**

UNIT-V REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES 10 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Reactive power control requirements **L1**
- Understand Filter requirements – Remedial measures **L2**

Text Books:

1. T.J.E.Miller, “Reactive Power Control in Electric Systems”, JohnWileyandSons,2017.
2. D.M.Tagare,Reactivepower Management,TataMcGrawHill,2004.

Reference Books:

1. Dr. Hidaia alassouli, “Reactive Power Compensation”, Kindle Edition.2018.
2. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just “Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication

Course Outcomes:

At the end of this Course the student will be able to

- Understand the importance of load compensation in symmetrical as well as unsymmetrical loads **L1**
- Analyze various compensation methods in transmission lines **L2**
- Design model for reactive power coordination **L3**
- Distinguish demand side reactive power management & user side reactive power management **L4**
- Understand the Reactive power control requirements **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

RENEWABLE ENERGY LAB

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
0	0	4	2

List of Experiments

1. Draw the I-V and P-V curves of Solar Panel using PV Panel
2. Study of Series and Parallel connection of Solar Panels
3. Study of Sun tracking system
4. Maximum Power Point Tracking Charge Controllers
5. Inverter control for Solar PV based systems
6. Power, Voltage & Frequency Measurement of output of Wind Generator
7. Impact of load and wind speed on power output and its quality
8. Performance of frequency drop characteristics of induction generator at different loading condition
9. Charging and Discharging characteristics of Battery

Simulation Experiments

10. Modeling of PV Cell
11. Effect of temperature variation on Photovoltaic Array
12. Effect of Irradiation on a Photovoltaic Array
13. Design of solar PV boost converter using P&O MPPT technique

Note: From the above list minimum 10 experiments are to be conducted using suitable software.

FACTS DEVICES & SIMULATION LAB

I Year MTECH (EPS)- 2nd Semester

L	T	P	C
0	0	4	2

Course Objectives:

To make the student learn about:

- Understand how to write the coding in MATLAB/Mipower
- Apply the SVC, STATCOM for voltage profile improvements & UPFC in power system networks.
- Analyze the data related to load flows incorporating SVC & STATCOM.
- Analyze operation of TCSC, STATCOM & SSSC for a transmission line fed by an ac supply.

List of Experiments

1. Voltage regulation using shunt and series compensation
2. Load balancing in power system network using compensators
3. Simulation of TCSC
4. Voltage profile improvement using SVC
5. Voltage profile improvement using STATCOM
6. Transient Stability enhancement using STATCOM.
7. Simulation of UPFC with mathematical models
8. Load flow incorporating SVC
9. Load flow incorporating STATCOM
10. Simulation of DVR
11. Transmission Line Characteristics (P vs δ , Q vs δ , P vs Distance, Q vs Distance and V vs Distance) with and without Compensation
12. Sizing- simulation and operation of TCR and FC-TCR for a transmission line fed by an ac supply and feeding
 - (a) Resistive/inductive/capacitive load one at a time
 - (b) A load which can have leading as well as lagging behavior
13. Sizing- simulation and operation of TCSC for a transmission line fed by an ac supply and feeding
 - (a) Resistive/inductive/capacitive load one at a time
 - (b) A load which can have leading as well as lagging behavior
14. Sizing- simulation and operation of STATCOM for a transmission line fed by an ac supply and feeding
 - (a) Resistive/inductive/capacitive load one at a time
 - (b) A load which can have leading as well as lagging behavior
15. Sizing- simulation and operation of SSSC for a transmission line fed by an ac supply and feeding
 - (a) Resistive/inductive/capacitive load one at a time
 - (b) A load which can have leading as well as lagging behavior

Note: From the above list minimum 10 experiments are to be conducted using suitable software.

References

1. Zhang,Xiao-Ping,Rehtanz,Christian,Pal,Bikash“Flexible AC Transmission Systems: Modeling and Control”,Springer,2012.
- 2.HingoraniHGandGyugyi.L“Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems” NewYork,IEEEPress,2000.

Course Outcomes: At the end of the course, student will be able to

- Understand Load balancing using compensators.
- Apply load balancing using Compensators.
- Analyse load flow incorporating SVC & STATCOM.
- Develop a Simulation model for STATCOM & UPFC.

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

DISTRIBUTED GENERATION & MICROGRID CONTROL (PE-V)

II Year MTECH (EPS)- 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- 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 conversionsystems, solar photovoltaic systems & other renewable energy sources.
- Able to analyze the impact of Microgrid & Active distribution network management system onvarious factors.
- Able to know the effect of SCADA & understand the concept of Power quality disturbances,improvement technologies & issues of premium power in DC integration.

UNIT – 1: INTRODUCTION TO DISTRIBUTED GENERATION AND MICROGRID CONCEPT 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- To know about Concept of Microgrid L1
- Understand the concept of distributed generation, distribution network & the concept of Microgrid, its configuration, advantages & limitations. L2

UNIT – II: DISTRIBUTED ENERGY RESOURCES 9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the basic concepts in combined heat and power, Wind energy conversion systems, solar photovoltaic systems & other renewable energy sources. L2
- To Design a Small-scale hydroelectric power generation L3

UNIT – III: MICROGRID AND ACTIVE DISTRIBUTION NETWORK MANAGEMENT SYSTEM 9 Hrs

Introduction - Impact on heat utilization - Impact on process optimization - 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.

Learning Outcomes:

At the end of this unit, the student will be able to

- The impact of Microgrid & Active distribution network management system on various factors is known. **L3**
- Understand the concept of Microsource and Central Controller. **L2**

UNIT – IV: SCADA AND ACTIVE DISTRIBUTION NETWORKS

9 Hrs

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.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the effect of SCADA & understand the concept of Power quality disturbances, improvement technologies & issues of premium power in DC integration. **L2**
- Understand the concepts of Distributed control systems **L2**

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

9 Hrs

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

Learning Outcomes:

At the end of this unit, the student will be able to

- Define the power quality disturbances **L1**
- Understand the concept of power quality improvement technologies **L2**

Text Books:

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

Course Outcomes:

At the end of this Course the student will be able to

- Understand the concept of distributed generation, distribution network & the concept of Microgrid, its configuration, advantages & limitations. **L1**
- Understand the basic concepts in combined heat and power, Wind energy conversion systems, Solar photovoltaic systems & other renewable energy sources. **L2**
- The impact of Microgrid & Active distribution network management system on various factors is known. **L3**
- Understand the effect of SCADA & understand the concept of Power quality disturbances, improvement technologies & issues of premium power in DC integration. **L4**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

POWER SYSTEM AUTOMATION (PE-V)

II Year MTECH (EPS)- 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- Understand the basic concepts of deregulation, power system automation.
- Analyze about the energy control centers and applications of automation.
- Develop the models to control the system and energy control centers.
- To apply the techniques to solve the problems in deregulated system and automation.

UNIT – I POWER SYSTEM CONTROL AND DEREGULATION

10 Hrs

Introduction – Operation of power systems and modes – Organization and operator activities, Investment factor and control centre experiences – Deregulation – need for deregulation and Advantages of deregulation in power system – Restructuring Models PoolCo. Model – Bilateral Model and Hybrid Model – Independent system operator (ISO) – Role of ISO – Congestion Management.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about Operation of power systems and modes L1
- Learn about Independent system operator L2

UNIT-II POWER SYSTEM AUTOMATION

10 Hrs

Evolution of automation systems – SCADA in Power system – Building blocks of SCADA system – Remote terminal unit – Intelligent electronic devices – Data concentrators and merging units – SCADA communication systems – Master station – Human-machine interface – Classification of SCADA systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand SCADA in Power system L1
- Understand Data concentrators and merging units L2

UNIT-III SUBSTATION AUTOMATION

10 Hrs

Substation automation – Conventional automation – New smart devices for substation automation – new integrated digital substation – Technical issues new digital simulation – Substation automation architectures – Substation automation applications functions – Benefits of data warehousing.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Substation automation and Conventional automation L1
- Understand Benefits of data warehousing. L2

UNIT-IV ENERGY CONTROL CENTERS

10 Hrs

Introduction – Energy control centers – EMS framework – Data acquisition and communication – Generation operation and management – Transmission operations –

Real time Study-mode Simulations – Post-event analysis and energy scheduling and accounting – Dispatcher training simulator – Smart transmission.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the EMS framework and Data acquisition and communication L1
- Understand Post-event analysis and energy scheduling and accounting L2

UNIT-V DISTRIBUTION AUTOMATION SYSTEMS AND ARC FURNACES 10 Hrs

Introduction to Distribution automation – Customer, feeder and substation automation – Subsystems in a distribution control center – Distributed Management System (DMS) framework integration with subsystems – Advanced real-time DMS applications – Advanced analytical DMS applications – DMS coordination with other systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the Distributed Management System L1
- Understand feeder and substation automation L2

Text Books:

1. M Shahidehpour, Muwaffaq Alomoush, Restructured electrical power systems operation, trading and volatility, CRC Press, 1st Edition, 2001.
2. Mini S Thomas and John D Mcdonald, Power System SCADA and Smart Grids, CRC Press, 1st Edition 2015.

Reference Books:

1. Torsten cegrell, Power systems control Technology, Prentice Hall, 1st Edition, 1986.
2. James Northcote-Green and Robert Wilson, Control and Automation of Electrical Power Distribution Systems, CRC Press, 1st Edition, 2013.

Course Outcomes:

At the end of this Course the student will be able to

- Understand the concepts of evolution of automation systems, SACADA, Congestion management. L1
- Analyze the techniques to resolve problems in energy control centers, data ware housing. L2
- Apply the techniques to get the optimum control in the system by using automation at the substation level and distribution level. L3
- Develop the real time case studies to solve the critical problems in power system automation. L4
- Understand the Distributed Management System L5

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

INTELLIGENT CONTROL TECHNIQUES (PE-V)

II Year MTECH (EPS)- 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- 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

10
Hrs

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

10 Hrs

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

10 Hrs

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

10 Hrs

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

10 Hrs

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.

Reference Books:

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.

Course Outcomes:

At the end of this Course the student will be able to

- Learn about basic concepts of AI **L1**
- Understand concepts of ANN and various learning algorithms **L2**
- Learn about Genetic Algorithm, ACO and Tabu search concepts **L3**
- Understand the concepts of Fuzzy **L4**
- Learn about Fuzzy logic controller and design using MATLAB **L5**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

ENERGY FROM WASTE (Open Elective)

II Year MTECH (EPS)- 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To understand the concept of waste to energy.
- To analyze technical and management principles for production of energy from waste.
- To apply the best available technologies for waste to energy.
- To develop the process for thermal conversion, bio-chemical and waste to energy conversion.

UNIT – 1: Introduction to Energy from Waste 9 Hrs

Classification of waste as fuel – Agro based – Forest residue – Industrial waste – MSW – Conversion devices – Incinerators – Gasifiers – Digestors.

UNIT – II: Biomass Pyrolysis 9 Hrs

Pyrolysis – Types – Slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases – Yields and applications.

UNIT – III: Biomass Gasification 9 Hrs

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT – IV: Biomass Combustion 9 Hrs

Biomass stoves – Improved challohs – Types, Some exotic designs – Fixed bed combustors– Types – Inclined grate combustors – Fluidized bed combustors – Design – Construction and operation – Operation of all the above biomass combustors.

UNIT – V: Introduction to Biogas 9 Hrs

Properties of biogas (Calorific value and composition) – Biogas plant technology and status – Bio energy system – Design and constructional features – Biomass resources and their classification – Biomass conversion processes – Thermo chemical conversion – Direct combustion – Biomass gasification – Pyrolysis and liquefaction – Biochemical conversion – anaerobic digestion Types of biogas Plants – Applications – Alcohol production from biomass – Bio diesel production – Urban waste to energy conversion – Biomass energy programme in India.

Text Books:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Course Outcomes:

At the end of this Course the student will be able to

- Understand the concept of waste to energy. **L1**
- Analyze technical and management principles for production of energy from waste. **L2**
- Apply the best available technologies for waste to energy. **L3**
- Develop the process for thermal conversion, bio-chemical and waste to energy conversion. **L4**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

COST MANAGEMENT OF ENGINEERING PROJECTS (Open Elective)

II Year MTECH (EPS)- 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- Understand the cost concepts, Project Management for planning to execution of projects.
- Enable them to comprehend the fundamentals of Project execution, Costing, Quantitative techniques.
- Apply the different methods to manage the projects, profit planning and cost.
- Develop the contemporary project management tools and methodologies in Indian context.

UNIT – 1: COST CONCEPTS

9 Hrs

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision – making; Relevant cost – Differential cost Incremental cost and Opportunity cost – Objectives of a Costing System – Inventory valuation – Creation of a Database for operational control – Provision of data for Decision – Making.

UNIT – II: PROJECT MANAGEMENT

9 Hrs

Project: meaning – Different types– Why to manage– Cost overruns centers – Various stages of project execution: conception to commissioning – Project execution as conglomeration of technical and nontechnical activities – Detailed Engineering activities – Pre-project execution main clearances and documents Project team: Role of each member – Importance Project site: Data required with significance – Project contracts – Types and contents. Project execution Project cost control – Bar charts and Network diagram – Project commissioning: mechanical and process.

UNIT – III: COST BEHAVIOR AND PROFIT PLANNING

9 Hrs

Cost Behavior and Profit Planning Marginal Costing – Distinction between Marginal Costing and Absorption Costing – Break-even Analysis – Cost-Volume-Profit Analysis – Various decision – making problems – Standard Costing and Variance Analysis – Pricing strategies – Pareto Analysis – Target costing – Life Cycle Costing – Costing of service sector – Just-in-time approach – Material Requirement Planning – Enterprise Resource Planning – Total Quality Management and Theory of constraints.

UNIT – IV: COST MANAGEMENT

9 Hrs

Activity-Based Cost Management – Bench Marking – Balanced Score Card and Value-Chain Analysis – Budgetary Control – Flexible Budgets – Performance budgets – Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT – V: QUANTITATIVE TECHNIQUES

9 Hrs

Quantitative techniques for cost management – Linear Programming – PERT/CPM – Transportation problems – Assignment problems – Simulation – Learning Curve Theory.

Text Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi.
2. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.

REFERENCE BOOKS:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Outcomes:

At the end of this Course the student will be able to

- Understand the costing system, project characteristics and various stages of a project. **L1**
- Analyze the learning and understand techniques for Project planning, scheduling and Execution Control. **L2**
- Apply different techniques to solve the problems related to project and cost management. **L3**
- Develop the management tools and quantitative techniques in order to obtain the profits. **L4**

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

**Internet of Things (IoT)
(Open Elective)**

II Year MTECH (EPS)- 1st Semester

L	T	P	C
3	0	0	3

Course Objectives:

- To assess the vision and introduction of IoT.
- To Understand IoT Market perspective.
- To Implement Data and Knowledge Management and use of Devices in IoT Technology.
- To Understand State of the Art - IoT Architecture.
- To classify Real World IoT Design Constraints, Industrial Automation in IoT.

UNIT -I: The IoT Networking Core:

Technologies involved in IOT Development:

Internet/Web and Networking Basics

OSI Model, Data transfer referred with OSI Model, IP Addressing, Point to Point Data Transfer, Point to Multi Point Data transfer & Network Topologies, Sub-netting, Network Topologies referred with Web, Introduction to Web Servers, and Introduction to Cloud Computing

Learning Outcomes:

At the end of this unit

- Students can Learn the definitions, topologies of IoT
- students can understand the working principles of Cloud Computing

UNIT -II: IoT Platform overview

Overview of IoT supported Hardware platforms such as: Raspberry pi, ARM Cortex Processors, Arduino and Intel Galileo boards. Network Fundamentals: Overview and working principle of Wired Networking equipment's – Router, Switches, Overview and working principle of Wireless Networking equipment's – Access Points, Hubs etc. Linux Network configuration Concepts: Networking configurations in Linux Accessing Hardware & Device Files interactions.

Learning Outcomes:

At the end of this unit

- Students can Learn the overview of IoT Platform
- students can understand the working of Wireless Networking equipment

UNIT -III: IoT Architecture:

History of IoT, M2M – Machine to Machine, Web of Things, IoT protocols.

Applications: Remote Monitoring & Sensing, Remote Controlling, Performance Analysis.

The Architecture The Layering concepts, IoT Communication Pattern, IoT protocol Architecture, The 6LoWPAN, Security aspects in IoT

Learning Outcomes:

At the end of this unit

- Students can Learn the IoT Architecture
- students can understand various applications

UNIT -IV: IOT Application Development:

Application Protocols MQTT, REST/HTTP, CoAP, MySQL

Back-end Application Designing

Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for dataprocessing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools

Learning Outcomes:

At the end of this unit

- Students can Learn the Application Protocols
- Students can understand the working of Android / IOS App Development tools

UNIT -V: Case Study & advanced IoT Applications:

IoT applications in home, infrastructures, buildings, security, Industries, Home Appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry concepts. Sensors and sensor Node and interfacing using any Embedded target boards(Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)Note: Prior knowledge of basic Wireless & Networking, Wireless Sensor Networks, C Programming, Embedded OS is necessary to study this sub

Learning Outcomes:

At the end of this unit

- Students can Learn the various case studies
- students can understand advanced IoT Applications

Course Outcomes: Upon completion of this training, participants will be able to

- Understand the technology and standards relating to IoTs
- Understand the critical parts of the ICT ecosystem required to mainstream IoTs
- Acquire skills on developing their own national and enterprise level technical strategies

Text Books:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley, 2009.
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers, 2013.
3. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann, 2010.

Reference Books:

1. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning, 2008.
2. Internet of Things (A Hands-on-Approach) , Vijay Madiseti , Arshdeep Bahga, 2014.
3. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally, 2013.
4. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010.
5. Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi,4th Edition, 1981.
6. Data and Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition, 1985.
7. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing,"McGraw Hill, 2009.
8. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010