IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	EE701PC	Power Electronic Applications to Renewable Energy Systems	3	1	0	4
2		Open Elective-II	3	0	0	3
3		Professional Elective-III	3	0	0	3
4		Professional Elective-IV	3	0	0	3
5	EE702PC	Fundamentals of Management for Engineers	2	0	0	2
6	EE703PC	Simulation of Renewable Energy Systems Laboratory	0	0	4	2
7	EE704PC	Project Stage-I	0	0	6	3
		Total Credits	**14**	**1**	**10**	**20**

IVYEARIISEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1		Open Elective-III	3	0	0	3
2		Professional Elective-V	3	0	0	3
3		Professional Elective-VI	3	0	0	3
4	EE801PC	Project Stage– II including Seminar	0	0	22	11
		Total Credits	**9**	**0**	**22**	**20**

Professional Elective - I

EE511PE	IoT Applications in Electrical Engineering
EE512PE	High Voltage Engineering
EE513PE	Computer Aided Electrical Machine Design

Professional Elective-II

EE621PE	Cyber-Physical Systems
EE622PE	Power Semiconductor Drives
EE623PE	Wind and Solar Energy Systems

Professional Elective-III

EE731PE	Mobile Application Development
EE732PE	Signals and Systems
EE733PE	Electric and Hybrid Vehicles

Professional Elective-IV

EE741PE	HVDC Transmission
EE742PE	Power System Reliability
EE743PE	Embedded Systems Applications

Professional Elective-V

EE851PE	Power Quality & FACTS
EE852PE	Solar Power Batteries
EE853PE	AI Techniques in Electrical Engineering

Professional Elective-VI

EE861PE	Smart Grid Technologies
EE862PE	Electrical Distribution Systems
EE863PE	Machine Learning Applications to Electrical Engineering

OPENELECTIVES

Open Elective-I:

EE611OE	Renewable Energy Sources
EE612OE	Fundamental of Electric Vehicles

Open Elective-II:

EE721OE	Utilization of ElectricEnergy
EE722OE	Energy Storage Systems

Open Elective-III:

EE831OE	Charging Infrastructure for Electric Vehicles
EE832OE	Reliability Engineering

EE701PC: POWER ELECTRONIC APPLICATIONS TO RENEWABLE ENERGY SYSTEMS

IV Year B.Tech. EEE I-Sem **L T P C**
3 1 0 4

Prerequisite: Power Electronics, Renewable Energy Sources

Course Objectives:

- To impart knowledge on different types of renewable energy systems.
- To analyze the operation of electrical generators used for the wind energy conversion Systems.
- To know the operation of power converters and PV systems operation.

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

- Proficiently demonstrate various renewable energy technologies utilized for electrical power generation.
- Analyze the operating principles of different types of wind generators and identify suitable converters (AC-DC, DC-DC, AC-AC) for renewable energy systems.
- Interpret and analyze various wind and photovoltaic (PV) systems, including stand-alone, grid- connected, and hybrid configurations, showcasing a comprehensive understanding of renewable energy applications.

UNIT- I:

Solar cell characteristics and their measurement, PV Module, PV array, Partial shading of a solar cell and a module, the diode, Power conditioning unit, maximum power point tracker, Implementation of Perturb and Observe Method, Incremental Conductance Method, Battery charger/discharge controller.

UNIT- II:

Centralized Inverters, String Inverters, Multi-string Inverters, Module Integrated Inverter/Micro-inverters, Inverter Topology, Model of Inverter, Sizing Batteries and Inverters for a Solar PV System.

Types of PV Systems: Grid-Connected Solar PV System, Stand-Alone Solar PV System.

UNIT- III:

Introduction to wind: Characteristics, Wind Turbine, Fixed and Variable-Speed Wind Turbines, Components of WECS, Description of Components, Types of Wind Turbine Generators, Economics of Wind Energy Conversion Systems, Linking Wind Turbines onto the Grid, Power Converter Topologies for Wind Turbine Generators.

UNIT- IV:

Modeling of Permanent Magnet Synchronous Generators, Doubly Fed Induction

Generators, Squirrel cage Induction Generators wind turbine, Control of Power converters for WECS.

UNIT - V:

Hybrid Energy Systems, Need for Hybrid Energy Systems, Range and types of Hybrid systems, Hybrid Solar PV/Wind Energy System, Architecture of Solar-Wind Hybrid System and Grid connected issues.

TEXTBOOKS:

1. S. N. Bhadra, D. Kastha, S. Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.
2. S. N. Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
3. Rashid. M. H, “Power Electronics Hand book”, Academic Press, 2001.

REFERENCE BOOKS:

1. Rai. G. D, “Non- conventional energy sources”, Khanna Publishers, 1993.
2. Rai. G.D,” Solar energy utilization”, Khanna Publishes, 1993.
3. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 1995.
4. B.H.Khan "Non-conventional Energy sources", Mc Graw-hill, 2^{nd} Edition, 2009

EE721OE: UTILIZATION OF ELECTRIC ENERGY
(Open Elective-II.1)

IV Year B.Tech. EEE I-Sem

L	T	P	C
3	0	0	3

Pre-requisites: Electrical Machines-I and Electrical Machines-II

Course Objectives: Objectives of this course are

- To understand the fundamentals of illumination and good lighting practices
- To understand the methods of electric heating and welding.
- To understand the concepts of electric drives and their application to electrical traction systems.

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

- Understand basic principles of electric heating and welding.
- Determine the lighting requirements for flood lighting, household and industrial needs.
- Calculate heat developed in induction furnace and evaluate speed time curves for traction

UNIT-I:

Electrical Heating: Advantages and methods of electric heating, resistance heating, induction heatingand dielectric heating.

UNIT-II:

Electric Welding: Electric welding equipment, resistance welding and arc welding, comparison between AC and DC welding. Electrolysis process: principle of electrolysis, electroplating, metal extraction and metal processing, electromagnetic stirs.

UNIT-III:

Illumination: Terminology, Laws of illumination, coefficient of Utilization and depreciation, Polar curves, Photometry, integrating sphere, sources of light, fluorescent lamps, compact fluorescent lamps, LED lamps discharge lamps, mercury vapor lamps, sodium vapor lamps and neon lamps, comparison between tungsten filament lamps and fluorescent tubes. Basic principles of light control, Types and design of lighting scheme, lighting calculations, factory lighting, streetlighting and flood lighting.

UNIT-IV:

Electric Traction: Systems of electric traction and track electrification- DC system, single phase and 3-phase low frequency and high frequency system, composite system, kando system, comparison between AC and DC systems, problems of single-phase traction with current unbalance and voltage unbalance.

Mechanics of traction movement, speed – time curves for different services, trapezoidal and quadrilateral speed — time curves, tractive effort, power, specific energy consumption, effect of varying acceleration and braking, retardation, adhesive weight and braking retardation, coefficient of adhesion.

UNIT-V:

Systems of Train Lighting: special requirements of train lighting, methods of obtaining unidirectional polarity constant output- single battery system, Double battery parallel block system, coach wiring, lighting by making use of 25KV AC supply.

TEXT BOOKS:

1. H. Partab: Modern Electric Traction, Dhanpat Rai & Co, 2007.
2. E. Openshaw Taylor: Utilisation of Electric Energy, Orient Longman, 2010.

REFERENCE BOOKS:

1. H. Partab: Art & Science of Utilization of Electric Energy, Dhanpat Rai & Sons, 1998.
2. N.V. Suryanarayana: Utilization of Electrical power including Electric drives and Electric Traction,New Age Publishers, 1997.

EE722OE: ENERGY STORAGE SYSTEMS
(Open Elective-II.2)

IV Year B.Tech. EEE I-Sem **L T P C**
3 0 0 3

Course Objectives: to prepare the students to

- To introduce generalized storage techniques and analyze the different features of storage systems
- To know the management and applications of energy storage technologies
- To know about electrical energy storage market potential by different forecasting methods

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

- Understand the role of electrical energy storage technologies in electricity usage
- Know the behavior and features and applications of energy storage system
- Understand the hierarchy, demand for energy storage and valuation techniques.

UNIT- I:

The Roles Of Electrical Energy Storage Technologies In Electricity Use: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable, Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

UNIT- II:

Types And Features Of Energy Storage Systems: Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Lead-Acid Batteries, Lithium-Ion Batteries, Flow batteries, Other Batteries in Development, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG), Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES),Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

UNIT- III:

Applications Of EES: Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), EES installed capacity worldwide, new trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart

House, Electric vehicles,

UNIT- IV:

Management And Control Hierarchy Of EES: Internal configuration of battery storage systems, External connection of EES systems, Aggregating EES systems and distributed generation (Virtual Power Plant), “Battery SCADA” – aggregation of many dispersed batteries.

Demand For Energy Storage: Growth in Variable Energy Resources, Relationship between balancing services and variable energy resources, Energy Storage Alternatives, Variable Generator Control, Demand Management, Market Mechanisms, and Longer-Term Outlook.

Valuation Techniques: Overview, Energy Storage Operational Optimization, Market Price Method, Power System Dispatch Model Method, Ancillary Service Representation, Energy Storage Representation, Survey of Valuation Results.

UNIT-V:

Forecast Of EES Market Potential By 2030: EES market potential for overall applications, EES market estimation by Sandia National Laboratory (SNL), EES market estimation by the Boston Consulting Group (BCG), EES market estimation for Li-ion batteries by the Panasonic Group, EES market potential estimation for broad introduction of renewable energies, EES market potential estimation for Germany by Fraunhofer, Storage of large amounts of energy in gas grids, EES market potential estimation for Europe by Siemens, EES market potential estimation by the IEA, Vehicle to grid concept, EES market potential in the future.

TEXT BOOKS:

1. Power System Energy Storage Technologies, 1st Edition by Paul Breeze, Academic Press
2. Energy Storage: Systems and Components, by Alfred Rufer, CRC Press, 2017

REFERENCE BOOKS:

1. Energy Storage Fundamentals, Materials and Applications, by Huggins and Robert, Springer.
2. www.ecofys.com/com/publications

EE731PE: MOBILE APPLICATION DEVELOPMENT
(Professional Elective-III.1)

IV Year B.Tech. EEE I-Sem **L T P C**
3 0 0 3

Prerequisites

1. Acquaintance with JAVA programming
2. A Course on DBMS

Course Objectives

- To demonstrate their understanding of the fundamentals of Android operating systems
- To improves their skills of using Android software development tools
- To demonstrate their ability to develop software with reasonable complexity on mobileplatform
- To demonstrate their ability to deploy software to mobile devices
- To demonstrate their ability to debug programs running on mobile devices

Course Outcomes

- Understand the working of Android OS Practically.
- Develop Android user interfaces
- Develop, deploy and maintain the Android Applications.

UNIT - I

Introduction to Android Operating System: Android OS design and Features – Android development framework, SDK features, Installing and running applications on Android Studio, Creating AVDs, Typesof Android applications, Best practices in Android programming, Android tools Android application components – Android Manifest file, Externalizing resources like values, themes, layouts, Menus etc, Resources for different devices and languages, Runtime Configuration Changes

Android Application Lifecycle – Activities, Activity lifecycle, activity states, monitoring state changes

UNIT - II

Android User Interface: Measurements – Device and pixel density independent measuring unit - sLayouts – Linear, Relative, Grid and Table Layouts

User Interface (UI) Components –Editable and non-editable Text Views, Buttons, Radio and Toggle Buttons, Checkboxes, Spinners, Dialog and pickers

Event Handling – Handling clicks or changes of various UI components

Fragments – Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities, Multi-screen Activities

UNIT - III

Intents and Broadcasts: Intent – Using intents to launch Activities, Explicitly starting new Activity, Implicit Intents, Passing data to Intents, Getting results from Activities, Native Actions, using Intent to dial a number or to send SMS

Broadcast Receivers – Using Intent filters to service implicit Intents, Resolving Intent filters, finding andusing Intents received within an Activity

Notifications – Creating and Displaying notifications, Displaying Toasts

UNIT - IV

Persistent Storage: Files – Using application specific folders and files, creating files, reading data from files, listing contents of a directory Shared Preferences – Creating shared preferences, saving andretrieving data using Shared Preference

UNIT - V

Database – Introduction to SQLite database, creating and opening a database, creating tables, insertingretrieving and etindelg data, Registering Content Providers, Using content Providers (insert, delete, retrieve and update)

TEXT BOOK:

1. Professional Android 4 Application Development, Reto Meier, Wiley India, (Wrox), 2012.

REFERENCE BOOKS:

1. Android Application Development for Java Programmers, James C Sheusi, Cengage Learning,2013.
2. Beginning Android 4 Application Development, Wei-Meng Lee, Wiley India (Wrox), 2013.

EE732PE: SIGNALS AND SYSTEMS
(Professional Elective-III.2)

IV Year B.Tech. EEE I-Sem

L	T	P	C
3	0	0	3

Prerequisite: Digital Signal Processing, Control Systems, Laplace Transforms, Numerical Methods and Complex variables

Course Objectives:

- To develop ability to analyze linear systems and signals
- To develop critical understanding of mathematical methods to analyze linear systems and signals
- To know the various transform techniques and sampling principles

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

- Understand the concepts of continuous time and discrete time systems.
- Analyze systems in complex frequency domain.
- Understand sampling theorem and its implications.

UNIT- I:

Introduction To Signals And Systems: Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, reliability. Examples.

UNIT- II:

Behaviour of Continuous and Discrete-Time LTI Systems: Impulse response and step response, convolution, input-output behaviour with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

UNIT- III:

Fourier Transforms: Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem.

UNIT- IV:

Laplace and Z- Transforms: Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

UNIT-V:

Sampling And Reconstruction

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

TEXT BOOKS:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India,1997.
2. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.

REFERENCE BOOKS:

1. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
2. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
3. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
4. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
5. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

EE733PE: ELECTRIC AND HYBRID VEHICLES
(Professional Elective-III.3)

IV Year B.Tech. EEE I-Sem **L T P C**
3 0 0 3

Prerequisite: Power Semiconductor Drives, Electrical Drives and Control, Utilization of Electric Energy

Course Objectives:

- To understand the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
- To know the various aspects of hybrid and electric drive train such as their configuration, t
- To have a knowledge on types of electric machines that can be used energy storage devices, etc.

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

- Understand the models to describe hybrid vehicles and their performance.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

UNIT- I:

Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

UNIT- II:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT- III:

Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT- IV:

Energy Storage: Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

UNIT- V:

Energy Management Strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

TEXT BOOKS:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

REFERENCE BOOKS:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

EE741PE: HVDC TRANSMISSION
(Professional Elective-IV.1)

IV Year B.Tech. EEE I-Sem

L	T	P	C
3	0	0	3

Prerequisite: Power System-I, Power System-II, Power System Protection, Power System Operationand Control, Power Electronics

Course Objectives:

- To compare EHV AC and HVDC and understand Graetz circuit with 6 and 12 pulse operation
- To control HVDC systems with various methods and to perform power flow analysis in AC/DCsystems
- To describe various protection methods for HVDC systems and Harmonics

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

- Compare EHV AC and HVDC system and to describe various types of DC links
- Describe various methods for the control of HVDC systems and to perform power flow analysisin AC/DC systems
- Describe various protection methods for HVDC systems and classify Harmonics and designdifferent types of filters

UNIT- I

Basic Concepts Necessity of HVDC systems, Economics and Terminal equipment of HVDC transmission systems, Types of HVDC Links, Apparatus required for HVDC Systems, Comparison of AC and DC Transmission, Application of DC Transmission System, Planning and Modern trends in D.C. Transmission.

Analysis of HVDC Converters: Choice of Converter Configuration, Analysis of Graetz circuit, Characteristics of 6 Pulse and 12 Pulse converters, Cases of two 3 phase converters in Y/Y mode –their performance.

UNIT- II

Converter and HVDC System Control: Principle of DC Link Control, Converters Control Characteristics, Firing angle control, Current and extinction angle control, Effect of source inductance on the system, Starting and stopping of DC link, Power Control.

Reactive Power Control in HVDC: Introduction, Reactive Power Requirements in steady state, sources of reactive power- Static VAR Compensators, Reactive power control during transients.

UNIT- III

Power Flow Analysis in AC/DC Systems: Modelling of DC Links, DC Network, DC Converter, Controller Equations, Solution of DC load flow, P.U. System for DC quantities, solution of AC-DC Power flow-Simultaneous Method-Sequential method.

UNIT- IV

Converter Faults and Protection: Converter faults, protection against over current and over voltage in converter station, surge arresters, smoothing reactors, DC breakers, Audible noise, space charge field, corona effects on DC lines, Radio interference.

UNIT-V:

Harmonics: Generation of Harmonics, Characteristics harmonics, calculation of AC Harmonics, Non- Characteristics harmonics, adverse effects of harmonics, Calculation of voltage and Current harmonics, Effect of Pulse number on harmonics

Filters: Types of AC filters, Design of Single tuned filters –Design of High pass filters.

TEXT BOOKS:

1. "K. R. Padiyar", HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, and Publishers, 1990.
2. "S K Kamakshaiah, V Kamaraju", HVDC Transmission, TMH Publishers, 2011

REFERENCE BOOKS:

1. "S. Rao", EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 1999.
2. "Jos Arrillaga", HVDC Transmission, The institution of electrical engineers, IEE power & energyseries 29, 2nd edition 1998.
3. "E. W. Kimbark", Direct Current Transmission, John Wiley and Sons, volume 1, 1971.
4. "E. Uhlmann", Power Transmission by Direct Current, B. S. Publications, 2009

EE742PE: POWER SYSTEM RELIABILITY
(Professional Elective-IV.2)

IV Year B.Tech. EEE I-Sem

L	T	P	C
3	0	0	3

Prerequisite: Reliability Engineering, Power System-I, Power System-II, Power System Operation andControl

Course Objectives:

- To describe the generation system model and recursive relation for capacitive model building
- To explain the equivalent transitional rates, cumulative probability and cumulative frequency
- To develop the understanding of risk, system and load point reliability indices

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

- Describe merging generation and load models
- Estimate loss of load and energy indices for generation systems model
- Apply various indices for distribution system and evaluate reliability of interconnected systems

UNIT- I:

Basic Probability Theory: Elements of probability, probability distributions, Random variables, Density and Distribution functions- Binomial distribution- Expected value and standard deviation - Binomial distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution.

Definition of Reliability: Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models - Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time between Failures.

UNIT- II:

Generating System Reliability Analysis

Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices –Examples. Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2-level daily load representation - merging generation and load models – Examples.

UNIT- III:

Operating Reserve Evaluation

Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units — Modeling using STPM approach.

Bulk Power System Reliability Evaluation:

Basic configuration – conditional probability approach – system and load point reliability indices – weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

Interconnected System Reliability Analysis

Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads – Expression for cumulative probability and cumulative frequency.

UNIT-IV:

Distribution System Reliability Analysis

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. Basic concepts of parallel distribution system reliability.

UNIT-V:

Substations and Switching Stations

Effects of short-circuits - breaker operation – Open and Short-circuit failures – Active and Passive failures – switching after faults – circuit breaker model – preventive maintenance – exponential maintenance times.

TEXT BOOKS:

1. Reliability Evaluation of Power systems by R. Billinton, R. N. Allan, BS Publications, 2007.
2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978

REFERENCE BOOKS:

1. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications.
2. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMH Publications.
3. Reliability Engineering by E. Balaguruswamy, TMH Publications.
4. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.

EMBEDDED SYSTEMS APPLICATIONS
(Professional Elective-IV.3)

IV Year B.Tech. EEE I-Sem **L T P C**
3 0 0 3

Prerequisite: C Language, I/O, Analog and Digital interfacing, and peripherals.

Course Objectives:

- To equip with the basic concepts of embedded system, applications in which they are used,
- To describe tools and methodologies needed for embedded system design.
- To know RTOS concepts and familiar with the characteristics of latency in real-time systems.

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

- Understand the microprocessor architecture and its components used in embedded systems
- Write the 8051-assembly language code and Embedded 'C' code for interfacing various devices.
- Develop simple embedded systems for real time operations

UNIT-I:

Embedded Systems Basics:

Introduction to Embedded systems, Examples of embedded systems, Typical Hardware, Gates, Timing Diagrams, Memory, Microprocessors, Buses, Direct Memory Access, Interrupts, Microprocessor Architecture, and Interrupt Basics.

UNIT-II:

The 8051 Architecture: Introduction, 8051 Micro controller Hardware, Input/output Pin Ports and Circuits, External Memory, Serial data Input/output, Interrupts.

UNIT-III:

Embedded C Programming: Overview of the C standard library, Embedded System Oriented Topics, MISRA C — Designing Safer C Programs, Basics of event driven programming.

Basic Assembly Language Programming Concepts: The Assembly Language Programming Process, Programming Tools and Techniques, Programming the 8051.

UNIT-IV:

Moving Data: Introduction, Addressing Modes, External Data Moves, Code Memory Read Only Data Moves, Push and Pop Opcodes, Data Exchanges.

Basic Design Using a Real-Time Operating System: Message Queues, Mailboxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment

UNIT-V:

Applications: Introduction, keyboards, Human Factor, Key Switch Factors, Keyboard Configurations, Displays, Seven-Segment Numeric Display, D/A and A/D Conversions.

Embedded Software Development Tools: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded Software into the Target System; Debugging Techniques: Testing on Host Machine, Using Laboratory Tools, An Example System.

TEXT BOOKS:

1. An Embedded Software Primer, David E. Simon, Pearson Education.
2. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.

REFERENCE BOOKS:

1. Embedded Microcomputer Systems Real Time Interfacing, Jonathan W.Valvano, Cengage Learning.
2. 8051 Microcontrollers, Satish Shah, Oxford Higher Education.
3. Micro Controllers, Ajay V Deshmukhi, TMH.
4. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley.
5. Microcontrollers, Raj kamal, Pearson Education. a. http://nptel.ac.in/courses.php b. http://jntuk-coeerd.in/

EE702PC: FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS

IV Year B.Tech. EEE I-Sem

L	T	P	C
2	0	0	2

Course Objective: To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers.

Course Outcome: The students understand the significance of Management in their Profession. The various Management Functions like Planning, Organizing, Staffing, Leading, Motivation and Control aspects are learnt in this course. The students can explore the Management Practices in their domain area.

UNIT- 1: Introduction to Management:
Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioral approach; The Quantitative approach; The Systems Approach; Contingency Approach, IT Approach.

UNIT – 2: Planning and Decision Making:
General Framework for Planning - Planning Process, Types of Plans, Management by Objectives; Production Planning and Control. Decision making and Problem Solving - Programmed and Non Programmed Decisions, Steps in Problem Solving and Decision Making; Bounded Rationality and Influences on Decision Making; Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

UNIT- 3: Organization and HRM:
Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization; Organizational Culture; Organizational Climate and Organizational Change.
Human Resource Management & Business Strategy: Job Satisfaction, Job Enrichment, Job Enlargement, Talent Management, Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.

UNIT- 4: Leading and Motivation:
Leadership, Power and Authority, Leadership Styles; Behavioral Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership

during adversity and Crisis; Handling Employee and Customer Complaints, Team Leadership.

Motivation - Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories - Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.

UNIT- 5: Controlling:

Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non- Budgetary Controls. Characteristics of Effective Controls, Establishing control systems, Control frequency and Methods.

TEXT BOOKS:

1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.
2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.

REFERENCE BOOKS:

1. Essentials of Management, Koontz Kleihrich, Tata Mc - Graw Hill.
2. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.
3. Industrial Engineering and Management: Including Production Management, T. R. Banga, S.CSharma, Khanna Publishers.

EE703PC: SIMULATION OF RENEWABLE ENERGY SYSTEMS LAB

IV Year B.Tech. EEE I-Sem

L	T	P	C
0	0	4	2

Prerequisite: Renewable Energy Systems, Power Electronics

Course Objectives:

- Develop proficiency in modeling the steady-state and dynamic characteristics of photovoltaic (PV), fuel cell, and wind energy sources.
- Understand and analyze power converter topologies for stand-alone and grid-connected PV, fuel cell, and wind energy systems.
- Explore advanced topics in power electronics, including maximum power point tracking, power factor correction, switched capacitor DC-DC converters, ZVS/ZCS configurations, compensation schemes, and new power converter topologies.

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

- Demonstrate the ability to model and analyze the steady-state and dynamic characteristics ofPV, fuel cell, and wind energy sources.
- Apply knowledge to understand, design, and analyze power converter topologies for both stand-alone and grid-connected PV, fuel cell, and wind energy systems.
- Acquire advanced expertise in power electronics, covering topics such as maximum power point tracking, power factor correction, switched capacitor converters, ZVS/ZCS configurations, compensation schemes, and new power converter topologies.

List of experiments:

1. Modelling the steady state and dynamic characteristics of the following
   - (i) PV,
   - (ii) Fuel cell and
   - (iii) Wind energy sources
2. Power converter topologies for stand –alone and grid connected
   - (i) PV,
   - (ii) Fuel cell and
   - (iii) Wind energy sources
3. Maximum Power Point Tracking Schemes
4. Power factor correction techniques for AC to DC systems
5. Switched capacitor DC – DC power converters
6. ZVS, ZCS configurations
7. Compensation Schemes for VAR, harmonics and phase imbalance Power conversion andElectric Drives
8. New power converter topologies and their analysis, modelling and simulation
9. High frequency link power conversion
10. Radiation effects on power electronic systems and components EMI/EMC
11. Analysis, measurement and mitigation of EMI in Electronic and power electronic

systems

12. Microgrid Power Quality

***Note:** Perform the simulation of the above list of experiments with MATLAB/any Simulation software

TEXTBOOKS:

1. S. N. Bhadra, D.Kastha, S.Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.
2. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
3. Rashid.M. H, “Power Electronics Hand book”, Academic Press, 2001.

REFERENCE BOOKS:

1. Rai. G.D, “Non-conventional energy sources”, Khanna Publishers, 1993.
2. Rai. G.D,” Solar energy utilization”, Khanna Publishes, 1993.
3. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 1995.
4. B.H.Khan "Non-conventional Energy sources", Mc Graw-hill, 2nd Edition, 2009

EE831OE: CHARGING INFRASTRUCTURE FOR ELECTRIC VEHICLES
(Open Elective - III.1)

IV Year B.Tech. EEE II-Sem **L T P C**
3 0 0 3

Prerequisite: None, Interest in Electric Vehicles.

Course Objectives:

- Gain understanding of the various components involved in an electric vehicle charging system.
- Comprehend the different types of electric vehicle chargers, along with the applicable standards governing their design and operation.
- Interpret the diverse communication protocols utilized in electric vehicle charging systems andstay familiar with the latest trends in this evolving field.

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

- Understand the various components of Electric vehicle charging system
- Comprehend the different types of Electric vehicle chargers and their standards
- Interpret the various communication protocols and recent trends in Electric vehicle charging

UNIT-I:

Introduction to EV charging:

Electric Vehicle Charging; Charging Modes; Electric Vehicle Supply Equipment (EVSE): Types,Components of EV Battery Chargers; Challenges in Electric Vehicle Charging.

UNIT-II:

Charger sizing and standards:

Charger Classification; Slow Charging and Fast Charging; DC Charging and AC Charging; Selection and Sizing of Chargers: Charger Connectors and Cables; Charging Standards: Connectors, Supply Equipment; EMI/EMC; Testing Methods for Chargers and EVSE

UNIT-III:

EV charger communications protocols:

Open Charge Point Protocol (OCPP); Open System Interconnection Layer Model (OSI); Adapted PWM Signal based Low-level Communication; PLC based High-level Communication; CAN Communication;Billing and Authentication

UNIT-IV:

Public charging infrastructure:

Location, Planning and Implementation of Public Charging Stations; Components; Selection and Sizing

- HT/LT Equipment & Cables; Protection; Safety Standards: Policy and Regulatory Aspects; EVCharging Station and their Business Models; Economic Aspects; Major Challenges

UNIT-V:

Future frontiers in EV charging:

Bulk Charging; Battery Swapping; Wireless Charging; EVs as Distributed Storage Resources: Grid to Vehicle (G2V) and Vehicle to Grid (V2G), V2X Concept, Integration of Charging Station with Renewable Sources and its Impact on the Grid

TEXT BOOKS:

1. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", 3rd Edition, CRC Press, 2021
2. Code of Practice for Electric Vehicle Charging Equipment Installation, 4th Edition, IET, 2020.

REFERENCE BOOKS:

1. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid
2. Electric Vehicles", 1st Edition, Springer, 2013.
3. Tom Denton, "Automotive Electrical and Electronic Systems", 5th Edition, Routledge, 2018.
4. Wolfhard Lawrenz, "CAN System Engineering: From Theory to Practical Applications", Springer, 2nd Edition, 2013.

   Weblink: https://www.udemy.com/course/charging-infrastructure-for-electric-vehicles/

EE832OE: RELIABILITY ENGINEERING
(Open Elective - III.2)

IV Year B.Tech. EEE II-Sem **L T P C**
3 0 0 3

Prerequisite: Mathematics-III (Laplace Transforms, Numerical Methods and Complex variables)

Course Objectives:

- To introduce the basic concepts of reliability, various models of reliability
- To analyze reliability of various systems
- To introduce techniques of frequency and duration for reliability evaluation of repairable systems

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

- model various systems applying reliability networks and evaluation of the same
- estimate the limiting state probabilities of repairable systems
- apply various mathematical models for evaluating reliability of irreparable systems

UNIT-I:

Basic Probability Theory: Elements of probability, probability distributions, Random variables, Density and Distribution functions- Mathematical expected – variance and standard deviation – **BINOMIAL DISTRIBUTION:** Concepts, properties, engineering applications.

UNIT-II:

Network Modeling And Evaluation Of Simple Systems: Basic concepts- Evaluation of network Reliability / Unreliability - Series systems, Parallel systems - Series-Parallel systems- Partially redundant systems- Examples.

Network Modeling And Evaluation Of Complex Systems: Conditional probability method- tie set, Cut-set approach- Event tree and reduced event tree methods- Relationships between tie and cut-sets-Examples.

UNIT-III:

Probability Distributions In Reliability Evaluation: Distribution concepts, Terminology of distributions, General reliability functions, Evaluation of the reliability functions, shape of reliability functions –Poisson distribution – normal distribution, exponential distribution, Weibull distribution.

Network Reliability Evaluation Using Probability Distributions: Reliability Evaluation of Series systems, Parallel systems – Partially redundant systems- determination of reliability measure- MTTF for series and parallel systems — Examples.

UNIT-IV:

Discrete Markov Chains: Basic concepts- Stochastic transitional probability matrix- time dependent probability evaluation- Limiting State Probability evaluation- Absorbing states – Application.

Continuous Markov Processes: Modeling concepts- State space diagrams- Unreliability evaluation of single and two component repairable systems

UNIT-V:

Frequency And Duration Techniques: Frequency and duration concepts, application to multi state problems, Frequency balance approach.

Approximate System Reliability Evaluation: Series systems – Parallel systems- Network reduction techniques- Cut set approach- Common mode failures modeling and evaluation techniques- Examples.

TEXT BOOKS:

1. Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Plenum Press.
2. E. Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited

REFERENCE BOOKS:

1. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications.
2. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMHPublications.
3. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.

EE851PE: POWER QUALITY & FACTS
(Professional Elective-V.1)

IV Year B.Tech. EEE II-Sem **L T P C**
3 0 0 3

Prerequisite: Power Electronics, Power System Operation and Control, HVDC Transmission

Course Objectives:

- Define power quality and explore various terms associated with it. Study voltage-related powerquality issues, focusing on short and long interruptions.
- Conduct a detailed study on characterizing voltage sags, with a specific emphasis on magnitude and three-phase unbalanced voltage sags. Understand how power quality issues affect the behaviour of power electronics loads and rotating machinery.
- Gain an understanding of FACTS controllers, their controllable parameters, and types. Explorethe importance of shunt and series compensation, focusing on the control and comparison of STATCOM and SVC, and the functioning and regulation of other FACTS devices like GCSC, TSSC, and TCSC.

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

- Develop an awareness of the severity of power quality issues in distribution systems, focusingon their impact and challenges.
- Understand the concept of transforming voltage sags from upstream (higher voltages) to downstream (lower voltage) in the distribution system.
- Demonstrate competence in selecting controllers based on specific applications and system requirements. Thoroughly understand various systems and their requirements, including the control circuits of shunt controllers (SVC & STATCOM) and series controllers (GCSC, TSSC, and TCSC) for enhancing transient stability, preventing voltage instability, and damping poweroscillations.

UNIT-I:

Power Quality Problems In Distribution Systems: Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement.

UNIT-II:

Transmission Lines And Series/Shunt Reactive Power Compensation: Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt andseries compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.

UNIT-III:

Static Shunt Compensators: Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics

UNIT-IV:

Static Series Compensators: Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

UNIT-V:

Combined Compensators: Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, independent control of real and reactive power.

TEXT BOOKS:

1. Electrical Power Systems Quality, Dugan Roger C, Santoso Surya, Mc Granaghan, Marks F.Beaty and H. Wayre, Mc Graw Hill
2. Power Systems Quality Assessment, J. Arillaga, N.R. Watson, S.Clon, John Wiley.

REFERENCE BOOKS:

1. Power Quality, C.Sankaran, CRC Press 4. Understanding power quality problems, Math H.Bollen, IEEE press.
2. "Understanding FACTS –Concepts and Technology of Flexible AC Transmission
   Systems"Narain G. Honorani, Laszlo Gyugyi

EE852PE: SOLAR POWER BATTERIES
(Professional Elective-V.2)

IV Year B.Tech. EEE II-Sem

L	T	P	C
3	0	0	3

Prerequisite: Renewable Energy Sources, Energy Storage Systems

Course Objectives:

- To understand the PV systems and the solar power batteries operation
- To analyze the solar PV system storage with batteries.
- To understand Grid Tie vs. Off-Grid Solar Battery System

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

- Know operating principes of different types of solar power batteries
- Use the batteries for effective storage of solar PV.
- Gain the knowledge on environmental impacts of solar power batteries.

UNIT-I:

Introduction to solar PV systems, basics of Storage for solar PV systems, Storage for solar PV systems: the batteries, Introduction to Solar Power Batteries, terminology associated, understanding Solar Battery Specifications, working principle, Series Vs. Parallel, Charging parameters, cycle life, Temperature effects, Battery Design and Construction, Important components in battery construction.

UNIT-II:

Primary and Secondary batteries, Classification of Secondary batteries, i.e Lead-Acid, Lead-Antimony, Lead-Calcium, Lead-Acid Battery Chemistry, Nickel-Cadmium Batteries and their types.

UNIT-III:

AC Coupled Storage vs. DC Coupled Storage, working of Solar Batteries with a Solar Power System and Hybrid Inverter, Main Degradation mechanisms of Solar Batteries, Battery Strengths and Weaknesses, Battery System Design and Selection Criteria, Life Expectancy, Battery standards, Safety precautions,

UNIT-IV:

Solar Battery Costs, Declining Cost, factors contribute to the performance of solar battery, selection of suitable batteries based on the application, Grid Tie vs. Off-Grid Solar Battery System, Benefits and disadvantages of using solar batteries,

UNIT-V:

The environmental impacts of batteries: Introduction, Service life of the components, Energy requirements for production and transport of the PV-battery system components, Contributing components, Influence of different user conditions, Uncertainties, Future research, Energy return factor, The overall battery efficiency, Different efficiency measures and battery design, The Future of Solar Battery Storage.

TEXT BOOKS:

1. S. Sumathi and L. Ashok Kumar, Solar PV and Wind Energy Conversion Systems: An Introduction to Theory, Modeling with MATLAB/SIMULINK, and the Role of Soft Computing Techniques, Springer 2011
2. H.A. Kiehne, "Battery Technology Handbook" by *Publisher:* CRC Press 2003
3. https://core.ac.uk/download/pdf/30044842.pdf
4. Handbook on Battery Energy Storage System
5. https://www.adb.org/sites/default/files/publication/479891/handbook-battery-energy-storage-system.pdf

REFERENCE BOOKS:

1. Cristina Archer and S. Lovejoy, Battery Technology for Electric Vehicles: Public Science and Private Innovation, Springer 2015
2. Soteris A. Kalogirou, "Solar Energy Engineering: Processes and Systems" by, Academic Press, *Year:* 2009
3. https://files.bregroup.com/bre-co-uk-file-library-copy/filelibrary/nsc/Documents%20Library/NSC%20Publications/88031-BRE_Solar-Consumer- Guide-A4-12pp.pdf
4. https://www.sunwize.com/tech-notes/solar-battery-basics/
5. https://palmetto.com/learning-center/blog/how-does-a-solar-battery-work
6. https://www.letsgosolar.com/faq/what-is-a-solar-battery/
7. https://www.purevolt.ie/domestic-solar/equipment/solar-storage-batteries.php

EE853PE: AI TECHNIQUES IN ELECTRICAL ENGINEERING
(Professional Elective-V.3)

IV Year B.Tech. EEE II-Sem

L	T	P	C
3	0	0	3

Pre-requisites: Power Systems Operation and Control

Course Objectives:

- To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
- To observe the concepts of FFN and concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control
- To analyze genetic algorithm, genetic operations and genetic mutations.

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

- Understand feed forward neural networks, feedback neural networks and learning techniques.
- Understand fuzziness involved in various systems and fuzzy set theory.
- Develop fuzzy logic control and genetic algorithm for applications in electrical engineering.

UNIT-I:

Artificial Neural Networks: Introduction, Models of Neuron Network-Architectures –Knowledge representation, Artificial Intelligence and Neural networks–Learning process-Error correction learning, Hebbian learning –Competitive learning-Boltzmann learning, supervised learning-Unsupervised learning–Reinforcement Learning-Learning tasks.

UNIT-II:

ANN Paradigms: Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT-III:

Fuzzy Logic: Introduction –Fuzzy versus crisp, Fuzzy Sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy Cartesian Product, Operations on Fuzzy relations –Fuzzy logic–Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods.

UNIT-IV:

Genetic Algorithms: Introduction-Encoding –Fitness Function-Reproduction operators, Genetic Modeling –Genetic Operators-Cross over-Single site cross over, two points cross over –Multi point cross over Uniform cross over, Matrix cross over-Cross over Rate-Inversion & Deletion, Mutation operator –Mutation – Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm.

UNIT-V:

Applications Of AI Techniques: Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Reactive power control, Speed control of DC and AC Motors.

TEXT BOOKS:

1. S. Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms,
   PHI, New Delhi, 2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011.

REFERENCE BOOKS:

1. P. D. Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York, 1989.
2. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall, 1992
3. D. E. Goldberg, Genetic Algorithms, Addison-Wesley 1999.

EE861PE: SMART GRID TECHNOLOGIES
(Professional Elective-VI.1)

IV Year B.Tech. EEE II-Sem

L	T	P	C
3	**0**	**0**	**3**

Pre-requisites: None

Course Objectives:

- To defend smart grid design to meet the needs of a utility
- To select issues and challenges that remain to be solved
- To analyze basics of electricity, electricity generation, economics of supply and demand, and the various aspects of electricity market operations in both regulated and deregulated environment.

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

- Understand the features of small grid in the context of Indian grid.
- Understand the role of automation in transmission and distribution.
- Apply evolutionary algorithms for smart grid and understand operation, maintenance of PMUs, PDCs, WAMs, and voltage and frequency control in micro grid

UNIT-I:

Introduction To Smart Grid: What is Smart Grid? 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.

UNIT- II:

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

UNIT- III:

Tools And Techniques For Smart Grid: Computational Techniques –Static and Dynamic Optimization Techniques –Computational Intelligence Techniques –Evolutionary Algorithms –Artificial Intelligence techniques.

UNIT-IV:

Distribution Generation Technologies: Introduction to Renewable Energy Technologies –Micro grids –Storage Technologies –Electric Vehicles and plug –in hybrids –Environmental impact and Climate Change –Economic Issues.

Communication Technologies And Smart Grid: Introduction to

Communication Technology –Synchro-Phasor Measurement Units (PMUs) –Wide Area Measurement Systems (WAMS).

UNIT-V:

Control Of Smart Power Grid System

Load Frequency Control (LFC) in Micro Grid System –Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

TEXT BOOKS:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.

REFERENCE BOOKS:

1. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”,Springer Edition, 2010.
2. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2005.

EE862PE: ELECTRICAL DISTRIBUTION SYSTEMS
(Professional Elective-VI.2)

IV Year B.Tech. EEE II-Sem **L T P C**
3 0 0 3

Prerequisites: Power System – I, Power System - II
Course Objectives:
- To understand design considerations of feeders
- To compute voltage, drop and power loss in feeders
- To understand protection, PF improvement and voltage control

Course Outcomes: At the end of this course, students will be able to:
- design the feeders and compute power loss and voltage drop of the feeders
- design protection of distribution systems
- understand the importance of voltage control and power factor improvement

UNIT-I:
General Concepts
Introduction to distribution system, Distribution system planning, Factors effecting the Distribution system planning, Load modelling and characteristics. Coincidence factor - contribution factor - Loss factor - Relationship between the load factor and loss factor. Load growth, Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

Distribution Feeders
Design Considerations of Distribution Feeders: Radial, loop and network types of primary feeders, Introduction to low voltage distribution systems (LVDS) and High voltage distribution systems (HVDS), voltage levels, Factors effecting the feeder voltage level, feeder loading, Application of general circuit constants (A, B, C, D) to radial feeders, basic design practice of the secondary distribution system, secondary banking, secondary network types, secondary mains.

UNIT-II:
Substations: Location of Substations: Rating of distribution substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations. Optimal location of Substations (Perpendicular bisector rule and X, Y co-ordinate method).
System Analysis: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines, analysis of non-three phase systems, method to analyze the distribution feeder cost.

UNIT-III:

Protection: Objectives of distribution system protection, types of common faults and procedure for fault calculations, over current Protective Devices: Principle of operation of Fuses, Auto-Circuit Recloser - and Auto-line sectionalizes, and circuit breakers.

Coordination: Coordination of Protective Devices: Objectives of protection co-ordination, general coordination procedure, Types of protection coordination: Fuse to Fuse, Auto-Recloser to Fuse, Circuit breaker to Fuse, Circuit breaker to Auto-Recloser.

UNIT-IV:

Compensation For Power Factor Improvement: Capacitive compensation for power-factor control - Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), effect of series capacitors, difference between shunt and series capacitors, Calculation of Power factor correction, capacitor allocation - Economic justification of capacitors - Procedure to determine the best capacitor location.

UNIT-V:

Voltage Control: Voltage Control: Importance of voltage control, methods of voltage control, Equipment for voltage control, effect of shunt capacitors, effect of series capacitors, effect of AVB/AVR on voltage control, line drop compensation, voltage fluctuations.

TEXT BOOKS:

1. Turan Gonen, Electric Power Distribution System Engineering, CRC Press, 3rd Edition 2014.
2. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2nd edition, 2010.

REFERENCE BOOKS:

1. G. Ram Murthy, Electrical Power Distribution hand book, 2nd edition, University press 2004.
2. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill Publishing company, 6th edition, 2013.

EE863PE: MACHINE LEARNING APPLICATIONS TO ELECTRICAL ENGINEERING

(Professional Elective-VI.3)

IV Year B.Tech. EEE II-Sem	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Prerequisites: Mathematics, Python

Course Objectives:

- To develop a foundational understanding of machine learning principles and techniques.
- To explore and understand how machine learning can be integrated into various electrical engineering applications.
- To gain hands-on experience in implementing machine learning algorithms to solve real-world electrical engineering problems.

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

- Demonstrate proficiency in applying machine learning algorithms to solve real-world problems in electrical engineering
- Integrate machine learning principles effectively into electrical engineering applications,
- Enhance problem-solving skills by successfully addressing complex issues in electrical engineering through machine learning.

UNIT-I:

Introduction to Machine Learning:

Definition and types of machine learning, Historical perspective, Basic concepts: supervised learning, unsupervised learning, reinforcement learning

UNIT-II:

Fundamentals of Electrical Engineering Relevant to ML:

Overview of electrical circuits and systems, Signal processing basics, Introduction to control systems

UNIT-III:

Data Preprocessing and Feature Engineering:

Data cleaning and handling missing values, Feature scaling and normalization, Feature extraction and selection

UNIT-IV:

Machine Learning Algorithms for Electrical Engineering Applications

Regression and classification algorithms, Decision trees and ensemble methods, Neural networks and deep learning, Support vector machines, Clustering algorithms for pattern recognition

UNIT-V:

Case Studies and Applications in Electrical Engineering

Power system optimization using ML, Fault detection and diagnostics in electrical systems, Smart grid applications, Signal processing with ML, Control system optimization and adaptive control using ML

TEXT BOOKS:

1. C. Aldrin Renold and Sumathi S., Pattern Recognition and Machine Learning, Wiley India, 2015.
2. S. Rajasekaran and G. Aghila, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC,2018
3. Chandra Shekhar Yadav, S. Ramakrishnan, and U. Rajendra Acharya, Machine Learning: Concepts, Methodologies, Tools and Applications, Springer 2018.

REFERENCE BOOKS:

1. Ethem Alpaydin, Introduction to Machine Learning, MIT Press 2010
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press 2012.