

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**  
**B.Tech. in ELECTRICAL AND ELECTRONICS ENGINEERING**  
**COURSE STRUCTURE & SYLLABUS (R18)**

**Applicable From 2018-19 Admitted Batch**

**I YEAR I SEMESTER**

| S. No. | Course Code | Course Title                                  | L         | T        | P         | Credits   |
|--------|-------------|---|-----------|----------|-----------|-----------|
| 1      | MA101BS     | Mathematics - I                               | 3         | 1        | 0         | 4         |
| 2      | CH102BS     | Chemistry                                     | 3         | 1        | 0         | 4         |
| 3      | EE103ES     | Basic Electrical Engineering                  | 3         | 0        | 0         | 3         |
| 4      | ME105ES     | Engineering Workshop                          | 1         | 0        | 3         | 2.5       |
| 5      | EN105HS     | English                                       | 2         | 0        | 0         | 2         |
| 6      | CH106BS     | Engineering Chemistry Lab                     | 0         | 0        | 3         | 1.5       |
| 7      | EN107HS     | English Language and Communication Skills Lab | 0         | 0        | 2         | 1         |
| 8      | EE108ES     | Basic Electrical Engineering Lab              | 0         | 0        | 2         | 1         |
|        |             | Induction Programme                           |           |          |           |           |
|        |             | <b>Total Credits</b>                          | <b>12</b> | <b>2</b> | <b>10</b> | <b>19</b> |

**I YEAR II SEMESTER**

| S. No. | Course Code | Course Title                        | L         | T        | P         | Credits   |
|--------|-------------|-------------------------------------|-----------|----------|-----------|-----------|
| 1      | MA201BS     | Mathematics - II                    | 3         | 1        | 0         | 4         |
| 2      | AP202BS     | Applied Physics                     | 3         | 1        | 0         | 4         |
| 3      | CS203ES     | Programming for Problem Solving     | 3         | 1        | 0         | 4         |
| 4      | ME204ES     | Engineering Graphics                | 1         | 0        | 4         | 3         |
| 5      | AP205BS     | Applied Physics Lab                 | 0         | 0        | 3         | 1.5       |
| 6      | CS206ES     | Programming for Problem Solving Lab | 0         | 0        | 3         | 1.5       |
| 7      | *MC209ES    | Environmental Science               | 3         | 0        | 0         | 0         |
|        |             | <b>Total Credits</b>                | <b>13</b> | <b>3</b> | <b>10</b> | <b>18</b> |

**II YEAR I SEMESTER**

| S. No. | Course Code | Course Title                | L         | T        | P        | Credits   |
|--------|-------------|-----------------------------|-----------|----------|----------|-----------|
| 1      | EE301ES     | Engineering Mechanics       | 3         | 1        | 0        | 4         |
| 2      | EE302PC     | Electrical Circuit Analysis | 3         | 1        | 0        | 4         |
| 3      | EE303PC     | Analog Electronics          | 3         | 0        | 0        | 3         |
| 4      | EE304PC     | Electrical Machines - I     | 3         | 1        | 0        | 4         |
| 5      | EE305PC     | Electromagnetic Fields      | 3         | 0        | 0        | 3         |
| 6      | EE306PC     | Electrical Machines Lab - I | 0         | 0        | 2        | 1         |
| 7      | EE307PC     | Analog Electronics Lab      | 0         | 0        | 2        | 1         |
| 8      | EE308PC     | Electrical Circuits Lab     | 0         | 0        | 2        | 1         |
| 9      | *MC309      | Gender Sensitization Lab    | 0         | 0        | 2        | 0         |
|        |             | <b>Total Credits</b>        | <b>15</b> | <b>3</b> | <b>8</b> | <b>21</b> |

**II YEAR II SEMESTER**

| S. No. | Course Code | Course Title  | L | T | P | Credits |
|--------|-------------|---|---|---|---|---------|
| 1      | MA401BS     | Laplace Transforms, Numerical Methods & Complex variables | 3 | 1 | 0 | 4       |

|   |         |                              |           |          |          |           |
|---|---------|------------------------------|-----------|----------|----------|-----------|
| 2 | EE402PC | Electrical Machines – II     | 3         | 1        | 0        | 4         |
| 3 | EE403PC | Digital Electronics          | 3         | 0        | 0        | 3         |
| 4 | EE404PC | Control Systems              | 3         | 1        | 0        | 4         |
| 5 | EE405PC | Power System - I             | 3         | 0        | 0        | 3         |
| 6 | EE406PC | Digital Electronics Lab      | 0         | 0        | 2        | 1         |
| 7 | EE407PC | Electrical Machines Lab - II | 0         | 0        | 2        | 1         |
| 8 | EE408PC | Control Systems Lab          | 0         | 0        | 2        | 1         |
| 9 | *MC409  | Constitution of India        | 3         | 0        | 0        | 0         |
|   |         | <b>Total Credits</b>         | <b>18</b> | <b>3</b> | <b>6</b> | <b>21</b> |

**III YEAR I SEMESTER**

| S. No. | Course Code | Course Title                              | L         | T        | P        | Credits   |
|--------|-------------|---|-----------|----------|----------|-----------|
| 1      | EE501PE     | Power Electronics                         | 3         | 1        | 0        | 4         |
| 2      | EE502PE     | Power System-II                           | 3         | 1        | 0        | 4         |
| 3      | EE503PE     | Measurements and Instrumentation          | 3         | 1        | 0        | 4         |
| 4      |             | Professional Elective-I                   | 3         | 0        | 0        | 3         |
| 5      | SM504MS     | Business Economics and Financial Analysis | 3         | 0        | 0        | 3         |
| 6      | EE505PC     | Power System Simulation Lab               | 0         | 0        | 2        | 1         |
| 7      | EE506PC     | Power Electronics Lab                     | 0         | 0        | 2        | 1         |
| 8      | EE507PC     | Measurements and Instrumentation Lab      | 0         | 0        | 2        | 1         |
| 9      | EN508HS     | Advanced Communication Skills Lab         | 0         | 0        | 2        | 1         |
| 10     | *MC510      | Intellectual Property Rights              | 3         | 0        | 0        | 0         |
|        |             | <b>Total Credits</b>                      | <b>18</b> | <b>3</b> | <b>8</b> | <b>22</b> |

**III YEAR II SEMESTER**

| S. No | Course Code | Course Title                           | L         | T        | P        | Credits   |
|-------|-------------|--|-----------|----------|----------|-----------|
| 1     |             | Open Elective-I                        | 3         | 0        | 0        | 3         |
| 2     |             | Professional Elective-II               | 3         | 0        | 0        | 3         |
| 3     | EE601PC     | Signals and Systems                    | 2         | 1        | 0        | 3         |
| 4     | EE602PC     | Microprocessors & Microcontrollers     | 3         | 0        | 0        | 3         |
| 5     | EE603PC     | Power System Protection                | 3         | 1        | 0        | 4         |
| 6     | EE604PC     | Power System Operation and Control     | 3         | 0        | 0        | 3         |
| 7     | EE605PC     | Power System Lab                       | 0         | 0        | 2        | 1         |
| 8     | EE606PC     | Microprocessors & Microcontrollers Lab | 0         | 0        | 2        | 1         |
| 9     | EE607PC     | Signals and Systems Lab                | 0         | 0        | 2        | 1         |
| 10    | *MC609      | Environmental Science                  | 3         | 0        | 0        | 0         |
|       |             | <b>Total Credits</b>                   | <b>20</b> | <b>2</b> | <b>6</b> | <b>22</b> |

**IV YEAR I SEMESTER**

| S. No. | Course Code | Course Title  | L | T | P | Credits |
|--------|-------------|---|---|---|---|---------|
| 1      |             | Open Elective-II                                    | 3 | 0 | 0 | 3       |
| 2      |             | Professional Elective-III                           | 3 | 0 | 0 | 3       |
| 3      |             | Professional Elective-IV                            | 3 | 0 | 0 | 3       |
| 4      | SM701MS     | Fundamentals of Management for Engineers            | 3 | 0 | 0 | 3       |
| 5      | EE701PC     | Electrical & Electronics Design Lab                 | 1 | 0 | 4 | 3       |
| 6      | EE702PC     | Industrial Oriented Mini Project/ Summer Internship | 0 | 0 | 4 | 2*      |
| 7      | EE703PC     | Seminar   | 0 | 0 | 2 | 1       |

|  |         |                      |           |          |           |           |
|--|---------|----------------------|-----------|----------|-----------|-----------|
|  | EE704PC | Project Stage - I    | 0         | 0        | 6         | 3         |
|  |         | <b>Total Credits</b> | <b>13</b> | <b>0</b> | <b>16</b> | <b>21</b> |

**IV YEAR II SEMESTER**

| 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       | 0        | 0        | 14        | 7         |
|        |             | <b>Total Credits</b>     | <b>9</b> | <b>0</b> | <b>14</b> | <b>16</b> |

**\*MC - Environmental Science – Should be Registered by Lateral Entry Students Only.**

**\*MC – Satisfactory/Unsatisfactory**

**NOTE:** Industrial Oriented Mini Project/ Summer Internship is to be carried out during the summer vacation between 6th and 7th semesters. Students should submit report of Industrial Oriented Mini Project/ Summer Internship for evaluation.

**Professional Elective - I**

|         |                           |
|---------|---------------------------|
| EE511PE | Computer Architecture     |
| EE512PE | High Voltage Engineering  |
| EE513PE | Electrical Machine Design |

**Professional Elective - II**

|         |                               |
|---------|-------------------------------|
| EE611PE | Optimization Techniques       |
| EE612PE | Power Semiconductor Drives    |
| EE613PE | Wind and Solar Energy systems |

**Professional Elective - III**

|         |                                |
|---------|--------------------------------|
| EE711PE | Digital Control systems        |
| EE712PE | Digital Signal Processing      |
| EE713PE | Electrical and Hybrid Vehicles |

**Professional Elective - IV**

|         |                               |
|---------|-------------------------------|
| EE721PE | HVDC Transmission             |
| EE722PE | Power System Reliability      |
| EE723PE | Industrial Electrical Systems |

**Professional Elective - V**

|         |   |
|---------|---|
| EE811PE | Power Quality & FACTS                   |
| EE812PE | Control Systems Design                  |
| EE813PE | AI Techniques in Electrical Engineering |

**Professional Elective - VI**

|         |                                     |
|---------|-------------------------------------|
| EE821PE | Smart Grid Technologies             |
| EE822PE | Electrical Distribution Systems     |
| EE823PE | Advanced Control of Electric Drives |

**EE711PE: DIGITAL CONTROL SYSTEMS (PE – III)****B.Tech. IV Year I Sem.**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Control Systems**Course Objectives:**

- To understand the fundamentals of digital control systems, z-transforms
- To understand state space representation of the control systems, concepts of controllability and observability
- To study the estimation of stability in different domains
- To understand the design of discrete time control systems, compensators, state feedback controllers, state observers through various transformations

**Course Outcomes:** At the end of this course, students will demonstrate the ability to

- Obtain discrete representation of LTI systems.
- Analyze stability of open loop and closed loop discrete-time systems.
- Design and analyze digital controllers.
- Design state feedback and output feedback controllers.

**UNIT- I**

**Discrete Representation Of Continuous Systems:** Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

**UNIT- II**

**Discrete System Analysis:** Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.

**Stability of Discrete Time System:** Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

**UNIT- III**

**State Space Approach for Discrete Time Systems:** State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

**UNIT- IV**

**Design of Digital Control System:** Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

**UNIT- V**

**Discrete Output Feedback Control:** Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

**TEXT BOOKS:**

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.

**REFERENCE BOOKS:**

1. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
2. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

**EE712PE: DIGITAL SIGNAL PROCESSING (PE – III)****B.Tech. IV Year I Sem.**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Prerequisite:** Signals and Systems**Course Objectives:**

- To provide background and fundamental material for the analysis and processing of digital signals.
- To understand the fast computation of DFT and appreciate the FFT processing.
- To study the designs and structures of digital (IIR and FIR) filters and analyze and synthesize for a given specifications.
- To acquaint in Multi-rate signal processing techniques and finite word length effects.

**Course Outcomes:** Upon completing this course, the student will be able to

- Understand the LTI system characteristics and Multirate signal processing.
- Understand the inter-relationship between DFT and various transforms.
- Design a digital filter for a given specification.
- Understand the significance of various filter structures and effects of round off errors

**UNIT - I**

**Introduction:** Introduction to Digital Signal Processing: Discrete Time Signals & Sequences, conversion of continuous to discrete signal, Normalized Frequency, Linear Shift Invariant Systems, Stability, and Causality, linear differential equation to difference equation, Linear Constant Coefficient Difference Equations, Frequency Domain Representation of Discrete Time Signals and Systems

**Multirate Digital Signal Processing:** Introduction, Down Sampling, Decimation, Up sampling, Interpolation, Sampling Rate Conversion.

**UNIT - II**

**Discrete Fourier series:** Fourier Series, Fourier Transform, Laplace Transform and Z-Transform relation, DFS Representation of Periodic Sequences, Properties of Discrete Fourier Series, Discrete Fourier Transforms: Properties of DFT, Linear Convolution of Sequences using DFT, Computation of DFT: Over-Lap Add Method, Over-Lap Save Method, Relation between DTFT, DFS, DFT and Z-Transform.

**Fast Fourier Transforms:** Fast Fourier Transforms (FFT) - Radix-2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms, Inverse FFT.

**UNIT - III**

**IIR Digital Filters:** Analog filter approximations – Butterworth and Chebyshev, Design of IIR Digital Filters from Analog Filters, Step and Impulse Invariant Techniques, Bilinear Transformation Method, Spectral Transformations.

**UNIT - IV**

**FIR Digital Filters:** Characteristics of FIR Digital Filters, Frequency Response. Design of FIR Filters: Fourier Method, Digital Filters using Window Techniques, Frequency Sampling Technique, Comparison of IIR & FIR filters.

**UNIT - V**

**Realization of Digital Filters:** Applications of Z – Transforms, Solution of Difference Equations of Digital Filters, System Function, Stability Criterion, Frequency Response of Stable Systems, Realization of Digital Filters – Direct, Canonic, Cascade and Parallel Forms.

**Finite Word Length Effects:** Limit cycles, Overflow Oscillations, Round-off Noise in IIR Digital Filters, Computational Output Round Off Noise, Methods to Prevent Overflow, Trade Off Between Round Off and Overflow Noise, Measurement of Coefficient Quantization Effects through Pole-Zero Movement, Dead Band Effects.

**TEXT BOOKS:**

1. Discrete Time Signal Processing – A. V. Oppenheim and R.W. Schaffer, PHI, 2009
2. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.

**REFERENCE BOOKS:**

1. Digital Signal Processing – Fundamentals and Applications – Li Tan, Elsevier, 2008
2. Fundamentals of Digital Signal Processing using MATLAB – Robert J. Schilling, Sandra L. Harris, Thomson, 2007
3. Digital Signal Processing – S. Salivahanan, A. Vallavaraj and C. Gnanapriya, TMH, 2009
4. Digital Signal Processing - A Practical approach, Emmanuel C. Ifeachor and Barrie W. Jervis, 2<sup>nd</sup> Edition, Pearson Education, 2009

**EE713PE: ELECTRICAL AND HYBRID VEHICLES (PE – III)****B.Tech. IV Year 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, types of electric machines that can be used energy storage devices, etc.

**Course Outcomes:** At the end of this course, students will demonstrate the ability 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.



**EE721PE: HVDC TRANSMISSION (PE – IV)****B.Tech. IV Year I Sem.**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Prerequisite:** Power System-I, Power System-II, Power System Protection, Power System Operation and Control, Power Electronics

**Course Objectives:**

- To compare EHV AC and HVDC systems
- To analyze Graetz circuit and also explain 6 and 12 pulse converters
- To control HVDC systems with various methods and to perform power flow analysis in AC/DC systems
- To describe various protection methods for HVDC systems and Harmonics

**Course Outcomes:** After completion of this course the student is able to

- Compare EHV AC and HVDC system and to describe various types of DC links
- Analyze Graetz circuit for rectifier and inverter mode of operation
- Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems
- Describe various protection methods for HVDC systems and classify Harmonics and design different 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, 3<sup>rd</sup> Edition 1999.
2. "Jos Arrillaga", HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2<sup>nd</sup> 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

**EE722PE: POWER SYSTEM RELIABILITY (PE – IV)****B.Tech. IV Year I Sem.**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Prerequisite:** Reliability Engineering, Power System-I, Power System-II, Power System Operation and Control

**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
- To explain the basic and performance reliability indices

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Estimate loss of load and energy indices for generation systems model
- Describe merging generation and load models
- Apply various indices for distribution systems
- 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.

**Inter Connected 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.

**EE723PE: INDUSTRIAL ELECTRICAL SYSTEMS (PE – IV)****B.Tech. IV Year I Sem.**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Utilization of Electric Energy**Course Objectives:**

- To understand the various electrical system components
- To know the residential and commercial electrical systems
- To study the illumination systems
- To discuss about the industrial electrical systems

**Course Outcomes:** At the end of this course, students will demonstrate the ability to

- Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
- Understand various components of industrial electrical systems.
- Analyze and select the proper size of various electrical system components.

**UNIT- I**

**Electrical System Components:** LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

**UNIT- II**

**Residential and Commercial Electrical Systems:** Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

**UNIT- III:**

**Illumination Systems:** Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premise, flood lighting.

**UNIT- IV:**

**Industrial Electrical Systems – I:** HT connect ion, industrial substation, Transformer select ion, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

**UNIT- V:**

**Industrial Electrical Systems – II:** DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

**TEXT BOOKS:**

1. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.

**REFERENCE BOOKS:**

1. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
2. Web site for IS Standards.
3. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

**SM701MS: FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS****B.Tech. IV Year I Sem.**

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**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- I:**

**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 – II:**

**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- III:**

**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- IV:**

**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- V:**

**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:**

- Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.
- 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.C. Sharma, Khanna Publishers.



**EE701PC: ELECTRICAL & ELECTRONICS DESIGN LAB****B.Tech. IV Year I Sem.**

| L | T | P | C |
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**Prerequisite:** Basics of Electrical Engineering**Course Objectives:**

- To enhance practical knowledge related to different subjects
- To develop hardware skills such as soldering, winding etc.
- To develop debugging skills.
- To increase ability for analysis and testing of circuits.
- To give an exposure to market survey for available components
- To develop an ability for proper documentation of experimentation.
- To enhance employability of a student.
- To prepare students for working on different hardware projects.

**Course Outcomes:** After completion of course, student will be able to

- Get practical knowledge related to electrical
- Fabricate basic electrical circuit elements/networks
- Trouble shoot the electrical circuits
- Design filter circuit for application
- Get hardware skills such as soldering, winding etc.
- Get debugging skills.

**Group A:**

1. Design and fabrication of reactor/ electromagnet for different inductance values.
2. Design and fabrication of single-phase Induction/three phase motor stator.
3. Start delta starter wiring for automatic and manual operation.
4. Wiring of distribution box with MCB, ELCB, RCCB and MCCB.
5. Wiring of 40 W tube, T-5, LED, Metal Halide lamps and available latest luminaries.
6. Assembly of various types of contactors with wiring.
7. Assembly of DOL and 3-point starter with NVC connections and overload operation.

**Group B: This group consists of electronic circuits which must be assembled and tested on general purpose PCB or bread boards.**

1. Design and development of 5 V regulated power supply.
2. Design and development of precision rectifier.
3. Design and development of first order/ second order low pass/high pass filters with an application.
4. Microcontroller Interface circuit for temperature/level/speed/current/voltage measurement.
5. Peak detector using op-amplifiers.
6. Zero crossing detector using op-amplifiers.
7. PCB design and layout.

**EE811PE: POWER QUALITY AND FACTS (PE - V)****B.Tech. IV Year II Sem.**

| L | T | P | C |
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**Prerequisite:** Power Electronics, Power System Operation and Control, HVDC Transmission**Course Objectives:**

- Definition of power quality and different terms of power quality.
- Study of voltage power quality issue – short and long interruption.
- Detail study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- Know the behaviour of power electronics loads; induction motors, synchronous motor etc by the power quality issues.
- Overview of mitigation of power quality issues by the VSI converters.
- To understand the fundamentals of FACTS Controllers,
- To know the importance of controllable parameters and types of FACTS controllers & their benefits
- To understand the objectives of Shunt and Series compensation
- To Control STATCOM and SVC and their comparison and the regulation of STATCOM, Functioning and control of GCSC, TSSC and TCSC

**Course Outcomes:** After completion of this course, the student will be able to:

- Know the severity of power quality problems in distribution system
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
- Concept of improving the power quality to sensitive load by various mitigating custom power devices
- Choose proper controller for the specific application based on system requirements
- Understand various systems thoroughly and their requirements
- Understand the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
- Understand the Power and control circuits of Series Controllers GCSC, TSSC and TCSC

**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 and series 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

**EE812PE: CONTROL SYSTEMS DESIGN (PE – V)****B.Tech. IV Year II Sem.**

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**Prerequisite:** Control Systems**Course Objectives:**

- To know the time and frequency domain design problem specifications.
- To understand the design of classical control systems in time-domain
- To analyze the design aspects of classical control systems in frequency-domain
- To know the design of various compensator controllers
- To identify the performance of the systems by design them in state-space
- To study the effects of nonlinearities on various systems performance

**Course Outcomes:** At the end of this course, students will demonstrate the ability to

- Understand various design specifications.
- Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).
- Design controllers using the state-space approach.

**UNIT - I**

**Design Specifications:** Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

**UNIT - II**

**Design of Classical Control System In The Time Domain:** Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

**UNIT - III**

**Design of Classical Control System In Frequency Domain:** Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

**UNIT - IV:**

**Design of PID Controllers:** Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

**UNIT - V:**

**Control System Design in State Space:** Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

**Non-linearities and Its Effect on System Performance:** Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.

**TEXT BOOKS:**

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.

**REFERENCE BOOKS:**

1. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
3. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
4. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
5. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

**EE813PE: AI TECHNIQUES IN ELECTRICAL ENGINEERING (PE – V)****B.Tech. IV Year II Sem.**

| L | T | P | C |
|---|---|---|---|
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**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 feed forward neural networks and about feedback neural networks.
- To practice the 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:** Upon the completion of this course, the student 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 for applications in electrical engineering
- Develop 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-Boltzman 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 point 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.

**EE821PE: SMART GRID TECHNOLOGIES (PE – VI)****B.Tech. IV Year II Sem.**

| L | T | P | C |
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**Pre-requisites:** None**Course Objectives:**

- To group various aspects of the smart grid,
- 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.
- Understand operation and 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.



**EE822PE: ELECTRICAL DISTRIBUTION SYSTEMS (PE - VI)****B.Tech. IV Year II Sem.**

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**Prerequisites:** Power System – I, Power System - II**Course Objectives:**

- To distinguish between transmission and distribution systems
- To understand design considerations of feeders
- To compute voltage drop and power loss in feeders
- To understand protection of distribution systems
- To examine the power factor improvement and voltage control

**Course Outcomes:** After completion of this course, the student able to

- distinguish between transmission, and distribution line and design the feeders
- 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, 3<sup>rd</sup> Edition 2014.
2. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2<sup>nd</sup> edition, 2010.

**REFERENCE BOOKS:**

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

**EE823PE: ADVANCED CONTROL OF ELECTRIC DRIVES (PE – VI)****B.Tech. IV Year II Sem.**

| L | T | P | C |
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**Prerequisites:** Power Electronics, Power Semiconductor Drives**Course Objectives:**

- To know the power electronic converters
- To analyze the various control strategies of power converters for drives control
- To understand the advanced control techniques for DC and AC motor drives
- To go through the control strategies for drives using digital signal processors.

**Course Outcomes:** At the end of this course, students will demonstrate the ability to

- Understand the operation of power electronic converters and their control strategies.
- Understand the vector control strategies for ac motor drives
- Understand the implementation of the control strategies using digital signal processors.

**UNIT - I**

**Power Converters for AC Drives:** PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H Bridge as a 4-Q drive.

**UNIT - II**

**Induction Motor Drives:** Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).

**UNIT - III**

**Synchronous Motor Drives:** Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

**UNIT - IV**

**Permanent Magnet Motor Drives:** Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

**Switched Reluctance Motor Drives:** Evolution of switched reluctance motors; various topologies for SRM drives, comparison, closed loop speed and torque control of SRM.

**UNIT - V**

**DSP Based Motion Control:** Use of DSPs in motion control, various DSPs available, and realization of some basic blocks in DSP for implementation of DSP based motion control.

**TEXT BOOKS:**

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.

**REFERENCE BOOKS:**

1. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.