Department: Electrical Engineering **Rev:** Course Structure/00/2021-22

Class: Final Year B. Tech **Semester:** VII

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CA1	CA2	MSE	ESE	Total	
EE701	PCC	High Voltage Engineering	3	-	-	3	10	10	30	50	100	3
EE702	PCC	Electrical System Design	2		-	2	10	10	30	50	100	2
EE703	PEC	Elective-IV	3	-	-	3	10	10	30	50	100	3
EE704	PEC	Elective-V	3	-	-	3	10	10	30	50	100	3
OEXXX	OEC	Open Elective-III	3	-	-	3	10	10	30	50	100	3
EE705	PCC	Electrical System Design Laboratory	-	-	2	2	25	25	-	-	50	1
EE706	PCC	High Voltage Engineering Laboratory	-	-	2	2	15	15	-	20	50	1
PRJ06	PROJ	Mega Project Phase -II	-	-	8	8	25	25	-	50	100	4
PRJ07	PROJ	Seminar	-	-	2	2	-	-	-	50	50	1
HMS09	HSMC	Human Values & Ethics	2	-	-	2	25	25	-	-	50	Audit
Total			16	-	14	30	140	140	150	370	800	21

Elective-IV: A. Advanced Control Theory
B. Data Analytics
C. FACTS and HVDC
D. EV Charging Station Design

Elective-V: A. Digital Control Systems
B. Artificial Intelligence and Machine Learning
C. Optimization in Power Systems
D. Grid Integrated Renewable Energy Sources

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High Voltage Engineering

EE701	PCC	High Voltage Engineering	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week Tutorial: --	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Electrical Engineering Materials, Power Systems

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

CO1	Explain electric Stress with conduction and breakdown in gases.
CO2	Explain conduction and breakdown in liquid dielectrics.
CO3	Explain conduction and breakdown in solid dielectrics.
CO4	Compare different techniques of generation in high voltages and currents.
CO5	Illustrate different techniques employed for measurement of high voltages and currents
CO6	Explain insulation coordination and high voltage testing of electrical equipment's.

Course Contents:

Unit 1: Conduction and Breakdown in gaseous dielectrics: Electric Field Stresses, Finite Difference Method for electric field computation, Gases as insulating media, Collision Processes, Ionization Processes, Townsend Current Growth Equation, Current Growth in the presence of secondary processes, Townsend's Criterion for Breakdown, Time lags for Breakdown. Streamers Theory for breakdown on gases, Paschens Law, Breakdown in non-uniform fields and Corona discharges.	[7]
Unit 2: Conduction and Breakdown in Liquid dielectrics: Liquids as Insulators- Pure and Commercial liquids, Conduction and Breakdown in Commercial liquids- Purification of Transformer fluids, Conduction and Breakdown in Commercial Liquids, Testing of Insulating Oils (Transformer Fluids).	[6]
Unit 3:Conduction and Breakdown in Solid Dielectrics:	

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Breakdown mechanisms in Solid Dielectrics -Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown, Chemical & Electrochemical Deterioration and Breakdown, Breakdown due to Treeing and Tracking and Internal discharges, Breakdown in Composite Dielectrics- Properties of Composite Dielectrics, Examples of Solid Dielectrics used in practice.	[7]
Unit 4: Generation of High Voltages and Currents: Generation of High Direct Current Voltages- Half & Full wave rectifiers, Voltage Doublers Circuits, Voltage Multiplier Circuits- Cockcroft Walton voltage multiplier, Generation of High Alternating Voltages- Cascaded Transformer Connection, Resonant Transformers, Generation of High Frequency AC High Voltages, Multistage Impulse Generators- Marx Circuit.	[7]
Unit5: Measurement of High Voltages and Currents- High Ohmic Series Resistance with Micro ammeter, Resistance Potential Divider for DC Voltages, Measurement of High AC and Impulse voltages, Measurement of High-Power frequency alternating currents.	[3]
Unit 6: High Voltage Testing in Electrical Apparatus. Overvoltage's due to Lightning phenomenon & Switching Surges, Principles of Insulation Coordination on High Voltage power systems, Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers and Surge Arresters.	[6]

Text Books

1. M S Naidu & V Kamaraju, High Voltage Engineering, Mc Graw Hill Publishing Company Ltd.-Sixth Edition.
2. C L Wadhwa, High Voltage Engineering, NEW AGE INTERNATIONAL PUBLISHERS-III Edition.

Reference Books:

1. Subir Ray, An Introduction to High Voltage Engineering, PHI-Second Edition.
2. E Kuffel, W.S.Zaengl, J Kuffel, High Voltage Engineering Fundamentals, Newnes,-Second Edition.
3. Ravindra Arora & Wolfgang Mosch, High Voltage Insulation Engineering, NEW AGE INTERNATIONAL PUBLISHERS-
4. Rakosh Das Begamudre, High Voltage Engineering Problems and Solutions, NEW AGE INTERNATIONAL PUBLISHERS-

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Electrical System Design

EE702	PCC	**Electrical System Design**	2-0-0	2 Credits

Teaching Scheme	Examination Scheme
Lecture: 2 hrs/week	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Electrical Engineering, Power System

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

CO1	Design electrical circuits for various applications, considering voltage, current, power factor, and efficiency to meet specified objectives.
CO2	Design Internal electrical system.
CO3	Select Cable Size for single Phase and Three Phase electrical systems.
CO4	Design electrical Lighting system.
CO5	Design earthing system.
CO6	Design Solar PV System

Course Contents:

Unit 1: System planning Role of Acts in Electrical system Design, Electricity Act 2003,General awareness of IS Codes (IS 3043, IS 732, IS 2675, IS 5216-P1- 2, IS 2309), The Indian Electricity Act 1910, The Indian Electricity supply Act 1948, Indian Electricity Rules 1956, The Electricity Regulatory Commission Act 1998, Indian standard codes , Bureau of Energy Efficiency (BEE) and its labeling. National Electric Code (NEC) - scope and safety aspects applicable to low and medium (domestic) voltage installations, Electric services in buildings, Classification of voltages, standards and specifications.	[4]
Unit 2: Internal Electrification design General aspects of the design of electrical installations for domestic dwellings as per NEC guidelines (low and medium voltage installations)–connected load calculation, sub circuit determination, selection of main distribution board, sub distribution board, MCB, ELCB,	[4]

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MCCB and cables for sub circuits. Pre-commissioning tests of domestic installations.	
Unit 3: Cable Sizing and Selection of single Phase and Three Phase: Medium and HV installations – selection of cables and cable glands, guidelines for cable installation in detail. Panel boards: LT & HT control panel boards. Installation of induction motors: Design of distribution systems with light power and motor loads	[4]
Unit 4: Design of illumination systems – Yard lighting, street lighting and flood lighting. Design and layout of installation for recreational or assembly buildings, cinema theatre and high rise building. Design of Electrical system related to firefighting, lifts and escalators	[4]
Unit 5: **Earthing Design and Calculation of Power Plants** Design of earthing system for an HT consumer, Dimensions and drawings of typical earth electrodes (1) Pipe Earthing, (2) Plate Earthing. Touch, Step and Transfer potentials at EHT Sub-Stations, Earth-mat, installations of special equipment like X-Ray, Neon-Sign, Basics of lightning arresters.	[4]
Unit 6: Solar PV System Sizing Determine power consumption demands, Size of the PV modules, Inverter sizing, Battery sizing, Solar charge controller sizing, Grid Connected PV System, Grid Connected Net Metering, Simplified Grid Connected PV System, Grid Connected System with Batteries	[4]

Text Books: Reference books

1. Integration of Alternative sources of Energy, Felix A. Farret and M. Godoy Simoes, IEEE Press –Wiley-Interscience publication, 2006.
2. M.K.Giridharan, Electrical Systems Design, , M/s I K International Publishers, New Delhi, 2nd edition, 2016
3. J. B. Gupta, A Course in Electrical Installation Estimating and Costing, S.K. Kataria & Sons; Reprint 2013 edition (2013).

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A. Advanced Control Theory

EE703A	PEC	Advanced Control Theory	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs./week Tutorial: -- Practical: --	CA I-10 Marks CA II-10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Control Systems

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

CO1	Estimate State Feedback Gain Matrix and Observer Gain matrix with pole placement techniques.
CO2	Design of Lag, Lead, Lag-Lead Compensator Design Using Bode Plot and Root Locus Technique
CO3	Explain Linear Models of Physiological Systems
CO4	Analyze nonlinear system using Describing function approach and Phase plane analysis

Course Contents:

UNIT-1: POLE PLACEMENT TECHNIQUE Introduction, Pole Placement Design, Necessary and Sufficient conditions for Arbitrary Pole Placement, Evaluation of State Feedback Gain Matrix-using Transformation Matrix, Direct Substitution Method, Ackermann's Formula; Concept of State Observer, Selection of suitable value of Observer Gain matrix-Numerical problems.	[7]
UNIT-2: COMPENSATORS-1: Introduction, Classification: Series or cascade compensation, Feedback or parallel compensation, Load or series-parallel compensation, State feedback compensation, Forward compensation with series compensation, Feed-forward compensation **Lag Compensator:** Determination of Maximum Phase Angle, Electrical Representation, Effects, Limitations, Design of Lag Compensator Design Using Bode Plot, Design of Lag Compensator Using Root Locus Technique.	[7]

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UNIT-3: COMPENSATORS-2: **Lead Compensator:** Determination of Maximum Phase Angle, Electrical Representation, Effects, Limitations, Design of Lead Compensator, Design of Lead Compensator Using Bode Plot, Design of Lead Compensator Using Root Locus Technique. **Lag–Lead Compensator**: Electrical Representation, Effects, Design of Lag–Lead Compensator, Design of Lag–Lead Compensator Using Bode Plot, Design of Lag–Lead Compensator Using Bode Plot.	[7]
UNIT-4: PHYSIOLOGICAL CONTROL SYSTEMS: Introduction, Properties of Physiological Control Systems: Target of the Homeostasis, Imbalance in the Homeostasis, Homeostasis Control Mechanisms, Block Diagram of the Physiological Control System: Types of Control Mechanism, Differences between Engineering and Physiological Control Systems, Linear Models of Physiological Systems: Lung Mechanism, Skeletal Muscle	[6]
UNIT-5: DESCRIBING FUNCTION ANALYSIS: Introduction to nonlinear systems, Types of nonlinearities, Non Linear Systems – Types of Nonlinearities – Saturation – Dead-Zone – Backlash – Jump Phenomenon, Linearization of nonlinear systems, Singular Points and its types describing functions, describing function analysis of nonlinear control systems.	[6]
UNIT-6: PHASE-PLANE ANALYSIS: Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.	[6]

Text Books:

1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2^{nd} edition, 1996.
2. Control Systems Engineering by S. Salivahanan, R. Rengaraj, G.R.Venkatakrishnan, Pearson Education.
3. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3^{rd} edition, 1998
4. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
5. Modern Control Theory, U A Bakshi, M V Bakshi, Technical Publications

Reference Books:

1. Subir Ray, An Introduction to High Voltage Engineering, PHI-Second Edition.

2. E Kuffel, W.S.Zaengl, J Kuffel, High Voltage Engineering Fundamentals, Newnes,-Second Edition.
3. Ravindra Arora & Wolfgang Mosch, High Voltage Insulation Engineering, NEW AGE INTERNATIONAL PUBLISHERS
4. Rakosh Das Begamudre, High Voltage Engineering Problems and Solutions, NEW AGE INTERNATIONAL PUBLISHERS-

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B. Big Data Analytics

EE703B	PEC	Big Data Analytics	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week Tutorial: 1hr/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: C Programming

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

CO1	Outline Data Analytics and Decision Making
CO2	Illustrate Distribution of a Single Variable.
CO3	Identify Relationships among Variables.
CO4	Illustrate Probability and Probability Distributions
CO5	Explain Normal, Binormal & Poisson Distributions
CO6	Apply Exponential Distribution to solve real time problems.

Course Contents:

Unit 1: Introduction to Data Analytics and Decision Making Introduction, Overview of the Book, The Methods, The Software, Modeling and Models, Graphical Models, Algebraic Models, Spreadsheet Models, Seven-Step Modeling Process.	[6]
Unit 2: Describing the Distribution of a Single Variable Introduction, Basic Concepts, Populations and Samples, Data Sets, Variables, and Observations, Types of Data, Descriptive Measures for Categorical Variables, Descriptive Measures for Numerical Variables, Numerical Summary Measures, Numerical Summary Measures with Stat Tools, Charts for Numerical Variables, Time Series Data, Outliers and Missing Values, Outliers, Missing Values, Excel Tables for Filtering, Sorting, and Summarizing.	[6]
Unit 3: Finding Relationships among Variables	[6]

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Introduction, Relationships among Categorical Variables, Relationships among Categorical Variables and a Numerical Variable, Stacked and Unstacked Formats, Relationships among Numerical Variables, Scatterplots, Correlation and Covariance, Pivot Tables.	
Unit 4: Probability and Probability Distributions Introduction,Probability Essentials, Rule of Complements, Addition Rule, Conditional Probability and the Multiplication Rule, Probabilistic Independence, Equally Likely Events, Courseive Versus Objective Probabilities, Probability Distribution of a Single Random Variable, Summary Measures of a Probability Distribution, Conditional Mean and Variance, Introduction to Simulation.	[6]
Unit 5: Normal, Binormal, Poisson Distributions Introduction, The Normal Distribution, Continuous Distributions and Density Functions, The Normal Density,Standardizing:Z-Values,Normal Tables and Z-Values, Normal Calculations in Excel, Empirical Rules Revisited, Weighted Sums of Normal Random Variables,	[6]
Unit 6: Exponential Distributions The Binomial Distribution, Mean and Standard Deviation of the Binomial Distribution, The Binomial Distribution in the Context of Sampling, The Normal Approximation to the Binomial, Applications of the Binomial Distribution, The Poisson and Exponential Distributions, The Poisson Distribution, The Exponential Distribution, Applications of the Normal Random Distribution	[6]
Text Books: 1. S C Albright and W L Winston, Business analytics: data analysis and decision making, 5/e Cengage Learning	
Reference Books: 1. ArshdeepBahga, Vijay Madisetti, "Big Data Analytics: A Hands-On Approach", 1st Edition, VPT Publications, 2018. ISBN-13: 978-0996025577 2. Raj Kamal and Preeti Saxena, "Big Data Analytics Introduction to Hadoop, Spark, and Machine Learning", McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966	

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C. FACTS and HVDC

EE703C	PEC	FACTS and HVDC	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Power system, Power Electronics

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

CO1	Classify different types of FACTS devices.
CO2	Explain the Static shunt compensators.
CO3	Explain the Static series compensators.
CO4	Explain the combined compensators.
CO5	Compare AC and DC transmission system.
CO6	Explain the control schemes for HVDC transmission systems.

Course Contents:

Unit 1: Introduction to FACTS Opportunities for FACTS, Flow of power in AC system, Basic types of FACTS Controllers, Brief description and definitions of FACTS controllers: Shunt connected controllers, Series connected controllers, Combined Shunt and Series connected controllers, Benefits from FACTS Technology	[6]
Unit 2: Static shunt compensators Objectives of shunt compensation, Methods of controllable VAR generation: Variable Impedance Type, Switching Converter Type, Construction and Working of : Hybrid VAR Generators, Static VAR compensators - SVC and STATCOM, Comparison between SVC and STATCOM	[6]

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Unit 3: Static Series Compensators: Objectives of Series compensation, Construction and Working of : Thyristor switched series capacitor (TSSC), Thyristor Controlled series capacitor (TCSC), GTO Thyristor Controlled series capacitor (GCSC), Switching converter type series compensators: Static synchronous series compensator (SSSC), Power angle characteristics, Basic operating control schemes	[7]
Unit 4: Combined Compensators Introduction, unified power flow controller (UPFC): Basic operating principle, independent real and reactive power flow control, control structure, Unified Power Quality Conditioner (UPQC), Interline power flow controller (IPFC): Basic operating principle, control structure	[6]
Unit 5: HVDC System and Converters: Comparison of AC-DC transmission systems, Benefits of DC transmission, Types of DC Links, Typical layout of HVDC converter station, Line commutated converter, Voltage source converter	[6]
Unit 6: HVDC system control Principles of DC Link control, converter control characteristics, system control hierarchy, firing angle control, current and excitation angle control, starting and stopping of DC Link, Generation of Harmonics, Introduction of Filters	[8]

Text Books:

1. Understanding FACTS, Concepts and Technology of Flexible AC Transmission systems, Narain. G.Hingorani, Laszlo Gyugyi, IEEE press, Wiley India
2. HVDC Power transmission systems, K R Padiyar, New Age International.

Reference Books:

1. Thyristor Basd Controllers for Electrical Transmission Systems, R. Mohan Mathur, Rajiv K. Varma. Wiley India.
2. HVDC and FACTS Controllers applications of static converters in power systems, Vijay K. sood, Kluwer Accademic Publishers.

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D. EV Charging Station Design

EE703D	PEC	EV Charging Station Design	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week Tutorial: 1hr/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Power Electronics

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

CO1	Understand Electric Vehicle Growth
CO2	Demonstrate EV Charging Infrastructure
CO3	Explain the concept of Charging station design.
CO4	Design Electrical architecture of EV charging station
CO5	Apply Energy and Asset Management
CO6	Explain Smart charging perspectives for optimal EV integration

Course Contents:

Unit 1: Electric Vehicle Growth Trends 2020 to 2030 – Electric vehicle sales penetration, annual electric vehicle electricity consumption, Global cumulative number of charging connectors; Different global initiatives – EV30@30, C40 CITIES, EV100, EVAPP, FAME-II, PLI-ACC Scheme, Battery Swapping Policy, Duty Reduction on Electric Vehicles, Special E-mobility Zone	[6]
Unit 2: EV Charging Infrastructure Hardware infrastructure; Data management; Maintenance and service; Battery Specifications of different EV segments; Types of charger - Slow AC charging, Moderate AC charging, DC fast charging; Power ratings of charger types; Modes of charging and connectors; Charging time calculation; Charging capacity for different battery type; IS 17017: EV charging standard in India; Private Charging; Semi-Public Charging; Public	[6]

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Charging	
Unit 3: Charging station design IEC 61851 Part 1, Part 21-2, Part 23, Part 24; Public charging locations; Charging station design - Environmental characteristics, Charging station output, Authentication, Charging station communication;	[6]
Unit 4: Electrical Design Electrical installation design - Types of Earthing Systems (TT, IT, TN), Protection against electric shocks, Protection against transient over voltages; electrical architectures - Integration of EV supply equipment into an existing installation, Use of local energy supplies to compensate for the EV charging power demand, architecture with mode 3 charging stations according to different load management strategies, Example of EV charging infrastructure design	[8]
Unit 5: energy and asset management EV charging Energy Management, EV charging with STATIC Load Management, EV charging with DYNAMIC Load Management, Dynamic load management with additional power from local production, Demand Response - Peak Shaving applied to EV charging, EV charging - Artificial Intelligence-based Load Management, Integration of EV charging into a Building Management System, EVSE Asset management - Preventive maintenance vs Predictive maintenance	[8]
Unit 6: Smart charging perspectives for optimal EV integration Definition of smart charging; Advanced smart charging: V1G, V2x options; Value of smart charging; Strong barriers for smart charging	[6]

Text Books:

1. Electric vehicle charging infrastructure guide for DISCOM readiness a NITI AAYOG, RMI INDIA.

Reference Books:

1. Handbook of electric vehicle charging infrastructure implementation
2. An Overview on Electric Vehicle Charging Infrastructure Manoz Kumar M Tirupati, TATA ELXSI

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A. Digital Control Systems

EE704A	PEC	Digital Control Systems	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Feedback Control System, Control system design.

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

CO1	Understand basic concepts of Z & Laplace transform related to digital control systems.
CO2	Design of digital control system using Root locus, Controllers, compensators.
CO3	Explain state space representation & its forms.
CO4	Study state space equations, state transition matrix.
CO5	Design of controller by using Pole placement.
CO6	Design of observer by using Pole placement.

Course Contents:

Unit 1 - Digital Control System Review of Z transforms, Z transform method for solving difference equation, Impulse Sampling and Data Hold, Pulse Transfer Function, Sampling Theorem, Mapping between S Plane and Z Plane, Stability Analysis, Transient and Steady State Analysis	[6]
Unit 2 - Design of Digital Control System Construction of Root Locus, Design based on Root Locus, P,PI,PD,PID Controllers, Lead, Lag, Lead-Lag Compensators, Frequency Response Analysis, Bode Diagram.	[6]
Unit 3 - State Space Analysis of Digital Control System I	[6]

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State Space representation of Digital System, Controllable Canonical form, Observable Canonical form, Diagonal form, Jordan form.	
Unit 4- State Space Analysis of Digital Control System II State Space Equations, solving State Space Equations, State Transition Matrix, Properties of State Transition Matrix, Pulse Transfer Function Matrix. Discretization of Continuous Time State Space Equation.	[6]
Unit 5 - State Space Design for Controller Controllability, Controller Design in State Space, Design via Pole Placement for Controller Design, Ackermann's Formula for Controller Design.	[6]
Unit 6 – State space Design for Observer Observability, Observer Design, Design via Pole Placement for Observer Design, Ackermann's Formula for Observer Design, Deadbeat Design, Design for Deadbeat Response.	[6]

Text Books:

1. K. Ogata, "Discrete Time Control Systems", Second Edition, Pearson Education, 2005, ISBN: 9788120327603
2. C.L. Phillips, J.M. Parr, "Feedback Control Systems", Fifth Edition, Pearson Education,2013, ISBN: 9789332507609

Reference Books:

1. I.J. Nagrath, M.Gopal "Control Systems Engineering", New Age International, Sixth Edition, 2018, ISBN: 9789386070111.
2. B.C. Kuo, "Digital Control Systems", Oxford University Press, Second Edition, 2012, ISBN: 9780198083542

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B. Artificial Intelligence and Machine Learning

EE704B	PEC	Artificial Intelligence and Machine Learning	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

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

CO1	Explain the concept of Artificial Intelligence.
CO2	Interpret the concept of agent architectures and hierarchical control.
CO3	Explain the States, Searching, Features and Control of Artificial Intelligence.
CO4	Explain the concept of Machine Learning.
CO5	Interpret the concept learning and general to specific ordering.
CO6	Explain decision tree learning.

Course Contents:

Unit 1:Introduction to Artificial Intelligence Introduction, Foundation of Artificial Intelligence, History of Artificial Intelligence, Agents Situated in Environments, Prototypical Applications	[6]
Unit 2: Agent Architectures and Hierarchical Control Agents, Agent Systems, Hierarchical Control, Embedded and Simulated Agents, Acting with Reasoning	[6]
Unit 3: States, Searching, Features and Control Problem Solving as Search, State Spaces, Graph Searching, A Generic Searching Algorithm, Uninformed Search Strategies, Heuristic Search, More Sophisticated Search. Features and Constraints: Possible Worlds, Variables, and Constraints, Generate-and-Test	[8]

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Algorithms, Consistency Algorithms	
Unit 4: Introduction to Machine Learning Well Posed Learning Problem, Design of Learning System, Perspectives and Issues in Machine Learning	[6]
Unit 5: Concept Learning and General to Specific Ordering Concept Learning Task: Inductive Learning Hypothesis, General to Specific Ordering of Hypotheses, List-Then-Eliminate, Candidate-Elimination Algorithm, Inductive Bias: Biased Hypothesis Space, Unbiased Learning, Futility of Bias-free Learning.	[6]
Unit 6: Decision Tree Learning Decision Tree Representation, Basic Decision Tree Learning Algorithm, Inductive Bias in Decision Tree Learning, Issues in Decision Tree Learning, Handling Attributes with Different Costs.	[8]

Text Books:

1. "Machine Learning" by Tom M. Mitchell, McGraw-Hill Science/Engineering/Math; (March 1, 1997).
2. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth, Cambridge University Press.

Reference Books:

1. "Introduction to Artificial Intelligence" by Wolfgang Ertel, Springer 2011.

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C. Optimization in Power Systems

EE704C	PEC	Optimization in Power Systems	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week Tutorial: 1hr/week	CA-I: 10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Mathematics-I & II

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

CO1	Remember different load flow methods
CO2	Understand Economic Load Dispatch of thermal Generating Units
CO3	Explain the concept of hydrothermal scheduling problems solution.
CO4	Solve Multi-Objective Generation Scheduling
CO5	Apply Stochastic Methods for Multi Objective Generation Scheduling
CO6	Formulate Evolutionary Programming for Generation Scheduling

Course Contents:

Unit 1: Load Flow Studies: Network model formulation; Y-bus formulation; Node elimination in Y-bus; Z-bus formulation; Load flow problem; Computation of line flow; modeling of regulating transformer; Gauss-Seidel method; Newton Raphson method; Decoupled Newton method; Fast Decoupled method; DC Load flow; AC-DC Load flow.	[6]
Unit 2: Economic Load Dispatch of thermal Generating Units: Introduction, Generator operating cost, Economic Dispatch problem on a bus bar, Optimal generation scheduling, Economic dispatch using Newton-Raphson method, Economic dispatch using the approximate Newton-Raphson method, Economic dispatch using efficient method, Function of generation & loads.	[6]

Unit 3: Optimal Hydro thermal Scheduling Introduction, Hydro plant performance Models, ShortRange Fixed-Head Hydro thermal Scheduling, Newton-Raphson for short-range fixed –head hydro thermal scheduling, Approximate Newton-Raphson method for short –range fixed-head hydro thermal Scheduling, Short-Range variable-head hydro thermal scheduling-Classical Method, Approximate Newton-Raphson method for short -range variable-head hydro thermal scheduling, Hydro plant modeling for long term operation, Long-Range generation scheduling of hydro thermal systems.	[6]
Unit 4: Multi-Objective Generation Scheduling Introduction, Multi objective optimization- State of the art, Fuzzy set theory in power system, the surrogate worth trade of approach for multi objective thermal power dispatch problem, multi objective thermal power dispatch- weighing method, multi objective dispatch for active & reactive power balance...	[6]
Unit 5: Stochastic Multi Objective Generation Scheduling Introduction, multi-objective stochastic optimal thermal power dispatch- ∈ -constant method, multi-objective stochastic optimal thermal power dispatch- The surrogate worth trade-off method, multi-objective stochastic optimal thermal power dispatch- weighing method, stochastic economic-emission load dispatch, multiobjective optimal thermal dispatch- risk/dispersion method, stochastic multi-objective short term hydro thermal scheduling, stochastic multi -objective long-term hydro thermal scheduling.	[6]
Unit 6: Evolutionary Programming for Generation Scheduling Introduction; Fitness function; Genetic Algorithm Operators; Economic dispatch problem; Genetic Algorithm based on Real Power Search; Economic Dispatch with valve point loading; Economic Dispatch with Ramp Rate limit and prohibited operating zones; Evolutionary search method for economic dispatch; Particle Swarm Optimization for Economic Dispatch.	[6]
Text Books: 3. D.P. Kothari and J.S. Dhillon, Power System Optimzation, , Prentice Hall of India 2. J. A. Momoh, Electric Power system Applications of Optimization, CRC Press.	
Reference Books: 1. J. Zhu, Optimization of power system operation, John Wiley & Sons.	

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D.Grid Integrated Renewable Energy Sources

EE704D	PEC	**Grid Integrated Renewable Energy Sources**	3-0-0	3 Credits

Teaching Scheme	**Examination Scheme**
Lecture: 3 hrs/week	CA-I:10 Marks CA-II: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Power System

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

CO1	Understand various techniques of utilizing power from renewable energy sources.
CO2	Explain Interconnection of alternative energy sources with the grid
CO3	Explain Power quality and management
CO4	Explain principles of Grid stabilization
CO5	Explain Integration of alternate sources of energy
CO6	Assess renewable energy applications and projects in the context of integration

Course Contents:

Unit 1:Introduction Various techniques of utilizing power from renewable energy sources, concept of nano/micro/mini grid. Need of integrating large renewable energy sources, issues related to integration of large renewable energy sources, rooftop plants. Concept of VPP.	[6]
Unit 2: Interconnection of alternative energy sources with the grid Interconnection Technologies-:Synchronous Interconnection, Induction Interconnection, Inverter Interconnection, Interconnection Considerations: Voltage Regulation, Integration with Area EPS Grounding Synchronization, Isolation, Response to Voltage Disturbance, Response to Frequency Disturbance, Disconnection for Faults, Loss of Synchronism, Feeder Reclosing Coordination, Feeder Reclosing Coordination	[6]

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Unit 3: Power quality and management THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, system protection, grid codes	[6]
Unit 4: Grid stabilization Scheduling and dispatch, Forecasting, reactive power and voltage control, frequency control, operating reserve, storage systems, electric vehicles Ancillary services in Indian Electricity Market (regulatory aspect), CERC and CEA orders (technical and safety standards)	[6]
Unit 5: Integration of alternate sources of energy Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection	[6]
Unit 6: Case studies Based on synchronous/induction generator for peak demand reduction, grid connected PV system	[6]

Text Books:

4. Integration of Alternative sources of Energy, Felix A. Farret and M. Godoy Simoes, IEEE Press –Wiley-Interscience publication, 2006.
5. Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, CRC Press (Taylor & Francis group), 2017
6. Renewable Energy Grid Integration, Marco H. Balderas, Nova Science Publishers, New York,2009.
7. Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans,N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, IET Power and Energy Series 50 (IET digital library), 2007

Reference Books :

1. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, John Wiley & Sons, New York, 2013 (3rd edition)
2. Power Electronics: Circuits, Devices, and Applications. M.H.Rashid, Pearson Education India,2013
3. Advanced power system analysis and dynamics, L.P.Singh, New age international publishers,2017

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Electrical System Design Laboratory

EE705	PCC	Electrical System Design Laboratory	0-0-2	1 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I:25 Marks CA-II: 25 Marks

Pre-Requisites: Basic Electrical Engineering

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

CO1	Design electrical circuits for various applications, considering voltage, current, power factor, and efficiency to meet specified objectives.
CO2	Design electrical Lighting system.
CO3	Select Cable Size for single Phase and Three Phase electrical systems.
CO4	Design Internal electrical system.
CO5	Design earthing system.
CO6	Evaluate estimation cost of electrical system.

Course Contents:

List of Experiments

1. Any Two Problem based on Electrical System planning.
2. Any Two Problem based on Lighting Design.
3. Any Two Problem based on Cable Sizing and Selection of single Phase and Three Phase
4. Any Two Problem based on Internal Electrification design.
5. Any Two Problem based on Earthing Design.
6. Any Two Problem based on Cost estimating of industrial power systems.

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High Voltage Engineering Laboratory

EE706	PCC	High Voltage Engineering Laboratory	0-0-2	1 Credit

Teaching Scheme	Examination Scheme
Laboratory : 2 hrs/week	CA-I:15 Marks CA-II: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Basic Electrical Engineering, Electrical Engineering Materials, Power System

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

CO1	To determine dielectric high voltages withstand capability of gaseous medium.
CO2	To determine dielectric high voltages withstand capability of liquid medium.
CO3	To determine dielectric high voltages withstand capability of solid medium.

List of Experiments

Any 8 from below mentioned experiment list

01. To demonstrate Horn Gap arrangement as surge diverter for corona arc discharge.
02. To measure audible sound in db and visible temperature using Thermal Imaging Camera in Faraday's cage arrangement.
03. To determine the effect of gap length on breakdown strength of liquid insulting Material (Transformer Oil).
04. To measure High Voltage Withstand capability of cables at DC Voltages (Max up to 10KV).
05. To determine Breakdown Voltage for Solid Composite Insulating Materials (30KV, 30mA test setup with jig).
06. To measure High Voltage withstand capability of cables at Power Frequency AC Voltages (Max up to 30KV).
07. To demonstrate development of Tracks and Trees of polymeric insulation.

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08. To determine the effect of change in gap length over breakdown voltage in the air medium using sphere gap assembly.
09. To study Impulse voltage generator using Virtual Laboratory.
10. Visit to High Voltage Laboratory and to generate report over Layout and Components of
High Voltage Laboratory.

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Mega Project Phase-II

PRJ06	PROJ	Mega Project Phase-II	0-0-8	4 Credit

Teaching Scheme	Examination Scheme
Laboratory : 8 hrs/week	CA-I:25 Marks CA-II: 25 Marks End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Build an engineering project.
CO2	Discuss with engineers and the community at large in written an oral forms.
CO3	Demonstrate the knowledge, skills and attitudes of a professional engineer.

Since Mega Project Phase-II is in continuation to Mega Project Phase-I, the students are expected to complete the total project by the end of semester VII. After completion of project work, they are expected to submit the project report including the work done in Phase-I and Phase-II.

The report shall be comprehensive and presented typed on A4 size sheets and **hard bound**. The number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners (Guide and Project Evaluation Members) for both, term work and oral examinations.

The project work should be published in any one of the national/international quality conference or reputed journal.

Report shall summarize the literature survey; spell out the scope of work, methodology and results. Viva-voce Examination shall be based on work carried out by the student.

Seminar

PRJ07	PROJ	Seminar	0-0-2	1 Credit

Teaching Scheme	Examination Scheme
Laboratory : 2 hrs/week	CA-I: - CA-II: - End Semester Exam: 50 Marks

Pre-Requisites:

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

CO1	Demonstrate the sound technical knowledge of the selected technical topic.
CO2	Demonstrate technical presentation skill.
CO3	Compose the progress report.

Student shall choose a topic of his/her interest in consultation with faculty in the Electrical department. The topic for seminar may be related to Recent Developments in Electrical Engineering area and/or interdisciplinary area. Student shall attempt to collect necessary information and present a summary indicating comprehension of the topic and acquired depth of knowledge. A brief report on topic of seminar shall be submitted. Evaluation shall be based on report and power point presentation.

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Human Values & Ethics

HMS09	HSMC	Human Values & Ethics	2-0-0	Audit

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	CA-I:25 Marks CA-II: 25 Marks

Pre-Requisites: Nil

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

CO1	Relate the Ethics & Human interface.
CO2	Improve Attitude, Morals, Aptitude, and Integrity towards Society.
CO3	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
CO4	Explain the significance of value inputs in a classroom and start applying them in their life and profession.
CO5	Develop Publication ethics.
CO6	Develop Business ethics in professional careers.

Course Contents:

Unit 1 Ethics and Human Interface : Ethics and Human Interface, Essence, determinants and consequences of Ethics in human actions; Dimensions of ethics; ethics in private and public relationships Human Values – lessons from the lives and teachings of great leaders, reformers and administrators, Role of family, society in inculcating values, role of educational institutions in inculcating values	[4]
Unit 2: Attitude, Morals, Aptitude, Integrity towards Society Attitude: content, structure, function, Attitude and its influence and relation with thought and behavior, Aptitude and foundational values towards society , integrity, impartiality and non-partisanship, objectivity, dedication towards society, empathy, tolerance and compassion intelligence-concepts, and their utilities and application	[4]

Unit 3:Understanding Harmony in the Human Being - Harmony in Myself Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body', Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya, Understanding harmony in the Family	[4]
Unit 4: Value Education: Need, Guidelines, content and process for Value Education, Self-Exploration–; Natural Acceptance and Experiential Validation, Continuous Happiness and Prosperity, Right understanding, Relationship and Physical Facilities, Understanding Happiness and Prosperity correctly, Method to fulfill the above human aspirations: understanding and living in harmony at various levels	[4]
Unit 5: Publication Ethics Publication Ethics: Introduction, Scope & importance, Best practices/standards initiatives & Guidelines: COPE, WAME,etc., Conflict of Interest, Publication Misconduct: definition, concept, problems that lead to unethical behavior & Vice versa, Violation of Publication Ethics, Authorship &Contributor ship, Identification of Publication misconduct, complaints & appeals, Predatory publishers & Journals	[4]
Unit 6: Business Ethics Ethics - Meaning, Importance, & Types of Ethics, Nature and Relevance to Business ethics, Values and Attitudes of Professional Engineers, Seven Principles of Public Life, Ethics in Business: Features, Principles, Need & Importance, Issues in Business ethics, Improving ethical behavior in Business	[4]

Text Books

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.
2. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
3. Neeraj Kumar, "Lexicon for Ethics, Integrity & Aptitude", Chronicle Publication, 2016.
4. Santosh Ajmera, Nand Kishor Reddi, "Ethics - Integrity and Aptitude", Tata Mc Graw Hill Publication, 2014.
5. M. Karthikeyan"Ethics, Integrity and Aptitude", Tata Mc Graw Hill Publication, 2015.

Reference Books:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers , Oxford University Press.
4. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
5. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.

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