ACE
Engineering College

Ankushapur(V), Ghatkesar(M), R.R.Dist - 501 301

(An Autonomous Institution)

B.TECH. FOURTH YEAR DEGREE COURSE

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE

(R20 Regulation)

IV Year				II Semester			
S.No.	Course type	Course Code	Course Title	Periods per week			Credits
				L	T	P	
1	OEC		Open Elective-III	3	0	0	3
2	PEC		Professional Elective-V	3	0	0	3
3	PEC		Professional Elective-VI	3	0	0	3
4	PROJ	EE801PC	Project Phase-II	0	0	14	7
Total				9	0	14	16

***Open Elective – Students should take Open Electives from List of Open Electives Offered by Other Departments/Branches Only.**

EE811PE: EHVAC TRANSMISSION SYSTEMS

(Professional Elective V)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE811PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power systems – II(EE502PC)

Course Objectives:

1. To understand the basic concepts of EHV AC transmission.
2. To get the Knowledge on EHV AC transmission line inductance and capacitance
3. To understand the voltage gradients of conductor and corona effects on transmission lines
4. To determine electrostatic fields of EHV AC lines.

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

1. Understand the basic concepts of EHV AC transmission.
2. Determine EHV AC transmission line inductance, capacitance and the voltage gradients of conductor
3. Explain about the corona effects on transmission lines
4. Analyze electrostatic fields of EHVAC lines and its effects
5. Distinguish various compensators for voltage control.

UNIT: I **PRELIMINARIES**

Necessity of EHV AC transmission – advantages and problems–power handling capacity and line losses- mechanical considerations – resistance of conductors – properties of bundled conductors – bundle spacingand bundle radius- Examples.

UNIT: II **LINE AND GROUND REACTIVE PARAMETERS AND VOLTAGEGRADIENTS OF CONDUCTORS**

Line inductance and capacitances – sequence inductances and capacitances – modes of propagation –ground return –Examples. Electrostatics – field of sphere gap – field of line changes and properties – charge

– potential relations for multi-conductors – surface voltage gradient on conductors – distribution of voltage

gradient on sub-conductors of bundle – Examples.

UNIT: III **CORONA EFFECTS**

Power loss and audible noise (AN) – corona loss formulae – charge voltage diagram – generation, characteristics - limits and measurements of AN – relation between 1-phase and 3-phase AN level – Examples. Radio interference (RI) - corona pulses generation, properties, limits – frequency spectrum –

modes of propagation – excitation function – measurement of RI, RIV and excitation functions – Examples.

UNIT: IV	ELECTRO STATIC FIELD
Calculation of electrostatic field of EHV/AC lines – effect on humans, animals and plants – electrostatic induction in un energized circuit of double-circuit line – electromagnetic interference-Examples. Traveling Wave Theory: Traveling wave expression and solution- source of excitation terminal conditions- open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed lines- generalized constants-No load voltage conditions and charging current.	
UNIT: V	**LINE COMPENSATION**
Power circle diagram and its use – voltage control using synchronous condensers – cascade connection of shunt and series compensation – sub synchronous resonance in series capacitor – compensated lines – staticVAR compensating system.	

TEXT BOOKS:

1. "R. D. Begamudre", EHVAC Transmission Engineering, New Age International (p) Ltd., 4th Edition2011.
2. "S. Rao", EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 2016

REFERENCE BOOKS:

1. "E. Kuffel, W. S. Zaengl, J. Kuffel", High Voltage Engineering Fundamentals, Elsevier, 3 rd Edition2016.
2. "Mazen Abdel-salam, Hussein Ains, Abdab EI – Mors hedy and Roshdy Radwan", High VoltageEngineering: Theory and Practice, CRC Press, 2nd Edition 2000.
3. "Hugh M. Ryan", High Voltage Engineering and Testing, IEE power and energy series 32, TheInstitution of Engineering and Technology 2nd edition 2001.

WEB REFERENCES:

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee24/
2. https://nptel.ac.in/courses/108/108/108108099/

EE812PE: ARTIFICIAL INTELLIGENT TECHNIQUES FOR ELECTRICAL SYSTEMS
(Professional Elective - V)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE812PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System – I (EE405PC), Power system – II(EE502PC)&Power Systems Operation and Control (EE604PC)

Course Objectives:

1. To understand the concepts of Artificial Intelligence techniques
2. To understand the ANN Models and their training algorithms
3. To understand the concepts of the Fuzzy Logic System and formulation of FLS solutions for Electrical Engineering Applications
4. To understand the concepts of Genetic Algorithm and formulation of its solution to some of Electrical Engineering Applications.

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

1. Apply AI techniques for solving complex problems.
2. Apply the ANN for load forecasting and other mapping related problems in Electrical Engineering
3. Develop Fuzzy Logic Control for applications in electrical engineering
4. Develop Genetic Algorithm for optimum solutions for applications in electrical engineering.
5. Develop the hybrid systems for solving complex problems.

UNIT: I	FUNDAMENTALS OF AI TECHNIQUES AND ARTIFICIAL NEURAL NETWORKS (ANN)

Introduction Artificial Intelligence, Artificial Intelligence Techniques and their potential applications, Fundamentals of Artificial Neural networks (ANN). Biological Neuron Models, Artificial neuron Models, Models of Neural Network-Architectures –Knowledge representation, and Neural networks–Learning Paradigms:-Error correction learning, Hebbian learning –Competitive learning-Boltzman learning, Supervised learning-Unsupervised learning–Reinforcement learning-Learning tasks.

UNIT: II	ANN ARCHITECTURES, TRAINING ALGORITHMS

Single Layer Perceptron, Multi-layer perceptron, Training of Multi-Layer Neural Networks: Back propagation Algorithm (BPA), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT: III	FUZZY LOGIC SYSTEMS (FLS)

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 Logic Systems: Fuzzification, -Fuzzy Rule based system, Fuzzy Inference, Defuzzification methods. Fundamental of Fuzzy Logic Control: Mamdani Architecture and The Sugano-Takagi Architecture.

UNIT: IV	GENETIC ALGORITHMS(GA)

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

ANN Applications in Electrical Engineering: Load forecasting, Turing of control parameters and Speed control of Electrical Motors. FLS Applications in Electrical Engineering: Load frequency Control, Reactive Power Control and Speed control of DC and AC motors. GA Applications in Electrical Engineering: Economic load dispatch, Scheduling of loads, Turing of control parameters

TEXT BOOKS:

1. "S. Rajasekaran"."G.A.V. Pai", Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, June 2013.
2. "Rober J. Schalkoff", Artificial Neural Networks, Tata McGraw Hill Edition, 2011.

REFERENCE BOOKS:

1. John Yen and Reza Langari, Fuzzy Logic: Intelligence, Control, and Information, Pearson Education, 2004
2. P.D.Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York, 1989.
3. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall,1992
4. D.E.Goldberg, Genetic Algorithms, Addison-Wesley 1999.

WEB REFERENCES:

1. https://www.electricalindia.in/artificial-intelligence-an-advanced-approach-in-power-systems/
2. https://nptel.ac.in/courses/108/104/108104112/
3. https://onlinecourses.swayam2.ac.in/arp19_ap60/preview

EE813PE: ADVANCED POWER ELECTRONICS

(Professional Elective V)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE813PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Electronics(EE501PC)

Course Objectives:

1. To understand various advanced power electronics devices.
2. To describe the operation of multi-level inverters with switching strategies for high power applications.
3. To comprehend the design of resonant converters.
4. To understand the operation of switched mode power supplies.

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

1. Develop various converter topologies.
2. Design AC or DC switched mode power supplies.
3. Understand the operation of buck boost converter.
4. Design I / P and O/P characteristics of various DC-DC converters.
5. Design Multilevel Inverters.

UNIT: I	MODERN POWER SEMICONDUCTOR DEVICES

Modern power semiconductor devices. MOS turn off Thyristor (MTO)-Emitter Turn off Thyristor (ETO) – Integrated Gate- Commutated Thyristor (IGCT) – MOS – controlled Thyristors (MCTs) – Static Induction Circuit –. gallium nitride devices, Silicon carbide devices

UNIT: II	ISOLATED DC-DC CONVERTERS

Isolated DC-DC converters forward, fly-back, push-pull, half-bridge and full –bridge converters Relationship between I / P and O/P voltages. Expression for filter inductor and capacitors.

UNIT: III	SOFT SWITCHING AND RESONANT CONVERTERS

Concept of ZVS and ZCS Zero voltage transition converters. Resonant converters- Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero-voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies and applications in lighting

UNIT: IV	MULTI-INVERTERS

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converter' s configurations; Features and relative comparison of these configurations" applications

UNIT: V	MODULATION TECHNIQUES

Single PWM – Multiple PWM – sinusoidal PWM – modified PWM – phase displacement Control – Advanced modulation techniques for improved performance – Trapezoidal, staircase, stepped,

harmonic injection and delta modulation – Advantages – Applications & Problems Introduction to carrier based PWM technique for multi-level converters, techniques for reduction for harmonics, phase shifted

Modular multilevel inverters.

TEXT BOOKS:

1. "M.H.Rashid," Power Electronics – Circuits, Devices & Applications, PHI, 4th edition , July 2013
2. "Ned Mohan, T.M. Undeland, William P.Robbins," Power Electronics: Converters, Applications: John Wiley &Sons,Third edition January 2007

REFERENCE BOOKS:

1. "Taylor Morey, KeithH.Billing,AbrahanL.Pressman", Switching Power supply Design, Mc.Graw Hill International third editionEdition, 2009
2. "Andrzej M. Trzynadlowski", Introduction to Modern Power Electronics, 2nd Edition, illustrated Publisher John Wiley & Sons, 2010

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_ee28/preview
2. https://nptel.ac.in/courses/108/107/108107128/

EE814PE: SMART ELECTRIC GRID

(Professional Elective V)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE814PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Systems –II(EE502PC), Power System Operation and Control(EE604PC), Power System Protection(EE603PC)

Course Objectives:

1. To understand various aspects of the smart grid
2. To discuss about intelligrid and SCADA.
3. To illustrate issues and challenges that remain to be solved.
4. To analyze basics of various aspects in electricity market operations.

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

1. Understand the structure of an electricity market in either regulated or deregulated marketconditions.
2. Discuss the advantages of DC distribution and developing technologies in distribution
3. Determine the trade-off between economics and reliability of an electric power system.
4. Compare various investment options in electricity markets.
5. Analyze the development of smart and intelligent domestic systems

UNIT: I INTRODUCTION TO SMART GRID

Introduction to smart grid- Electricity Network-Local energy networks Electric transportation-Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid. Smart Grid to Evolve a Perfect Power System: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

UNIT: II DC DISTRIBUTION AND SMART GRID

AC vs DC sources-Benefits of and drives of DC power delivery systems-Powering equipment and appliances with DC-Data centers and information technology loads-Future Neighborhood-Potential future work and research. Intelligrid Architecture for the Smart grid: Introduction- Launching intelligrid- Intelligrid today- Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies. SCADA, synchro phasors (WAMS).

UNIT: III CONCEPTS OF DYNAMIC ENERGY SYSTEMS

Smart energy efficient end use devices-Smart distributed energy resources-Advanced whole building control systems- Integrated communications architecture-Energy Management-Role of technology in demand responseCurrent limitations to dynamic energy management-Distributed energy resources- Overview of a dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

UNIT: IV	ENERGY PORT AS PART OF THE SMART GRID

Concept of energy -Port, generic features of the energy port.

Policies and Programs to Encourage End – Use Energy Efficiency: Policies and programs in action -multinational - national-state-city and corporate levels.

Market Implementation: Framework-factors influencing customer acceptance and response - program planning-monitoring and evaluation.

UNIT: V	EFFICIENT ELECTRIC GRID

Use Technology Alternatives: Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating - hyper efficient appliances - Ductless residential heat pumps and air conditioners - Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

TEXT BOOKS:

1. "I S Jha,SubirSen,RajeshKumar,D P Kothari",Smart Grid Fundamentals &Applications,New Age International Publishers; First edition -2019
2. "Stuart Borlase",Smart Grids: Advanced Technologies and Solutions, Second Edition, CRC Press-2018

REFERENCE BOOKS:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis"-Wiley, IEEE Press, 2012.

WEB REFERENCES:

1. https://www.smartgrid.gov/the_smart_grid/smart_grid.html
2. https://www.i-scoop.eu/industry-4-0/smart-grids-electrical-grid/
3. https://nptel.ac.in/courses/108/107/108107113/

EE821PE: UTILIZATION OF ELECTRIC POWER

(Professional Elective VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE821PE	PEC	3	0	0	3	30	70	100

Prerequisite: Electrical Machines-I(EE304PC), Electrical Machines-II (EE402PC)& Basic Electrical Engineering (EE103ES)

Course Objectives:

1. To understand the fundamentals of electric drives.
2. To discuss about the illumination and good lighting practices.
3. To describe the practical applications ofA.C. and D.C. Welding.
4. To understand concepts of electric traction.

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

1. Analyze thecharacteristicsofelectric drives.
2. Determine the concepts and methods of electric heating, welding,
3. Discuss the concepts and methods of illumination
4. Explain the concepts and methods of electric traction
5. Apply the concepts ofelectrical and electronics problems of real world.

UNIT: I	ELECTRIC HEATING & WELDING

Advantages and methods of electric heating, resistance heating induction heating and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT: II	ILLUMINATION

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light.

Various Illumination Methods: Discharge lamps, MV and SV lamps – comparison Between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Typesand design of lighting and flood lighting.

UNIT: III	ELECTRIC TRACTION

System of electric traction and track electrification. Mechanics of train movement-adhesive weight and coefficient of adhesion Speed-time curves for different services – trapezoidal and Quadrilateral speed time curves. Traction motors methods of electric braking-plugging rheostat braking and regenerative braking. Control of traction motors-series-parallel control, Shunt transition, bridge transition,

UNIT: IV	TRACTION LIGHTING SYSTEM

Special requirements of train lighting, methods of obtaining unidirectional polarity constant output- singlebattery system, Double battery parallel block system, coach wiring, lighting by making use of 25KV AC
supply.

UNIT V	TRACTION SUBSTATION

Traction substation, spacing and location of Traction substations, Major equipment at traction substation, selection and sizing of major equipment like transformer and Switchgear, Types of protection provided for Transformer and overhead lines, surge protection, maximum demand and load sharing between substations,
sectionalizing paralleling post and feeder posts,

TEXT BOOKS:

1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press, 2006
2. Partab, H., "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai andSons, New Delhi, 2014.
3. Electrical Railway Transportation Systems by Morris Brenna, Federica Foiadelli and DarioZaninelli, IEEE Press and Wiley, 2018

REFERENCE BOOKS:

1. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives andElectric traction, New Age International (P) Limited, Publishers, 2017.
2. Tripathy, S.C., "Electric Energy Utilisation and Conservation", Tata McGraw HillPublishing Company Ltd. New Delhi, 1991
3. Electric Traction – Motive Power and Energie Supply by Andreas Steimel,OldenbourgIndustrieverlag GmbH, 2008
4. Power Electronics and Electric Drives for Traction Applications Edited by Gonzalo Abad, Wiley, 2017

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105060/
2. https://nptel.ac.in/courses/108/102/108102046/

EE822PE: HYBRID ELECTRIC VEHICLES

(Professional Elective-VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE822PE	PEC	3	0	0	3	30	70	100

Prerequisite: Mathematics-I(MA101BS), Mathematics-II(MA201BS), Applied Physics (PH202BS), Power Semiconductor Drives (EE701PC).

Course Objectives:

1. To understand the fundamental concepts of hybrid and electricvehicles.
2. To discuss various aspects of hybrid and electric drive train.
3. To describe electric traction and electric propulsion.
4. To understand energy storage systems

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

1. Describe hybrid vehicles and their performance.
2. Illustrate the different possible ways of energy storage.
3. Discuss different strategies related to energy storage systems.
4. Estimate electric drives system efficiency.
5. Design of a Hybrid Electric Vehicle (HEV)

UNIT: I **INTRODUCTION TO ELECTRIC VEHICLES**

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

UNIT: II **INTRODUCTION TO HYBRID ELECTRIC VEHICLES**

History of hybrid and electric vehicles, social andenvironmental importance of hybrid and electric vehicles, impact of modern drive-trains on energysupplies.

Basic concept of hybrid traction, introduction to various hybrid drive-traintopologies, 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 electricdrive 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 Motordrives,configuration and control of Permanent Magnet Motor drives, Configuration and control of SwitchReluctance Motor drives, drive system efficiency

UNIT: IV **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

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

REFERENCE BOOKS:

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

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/102/108102121/

EE823PE: CONTROL SYSTEMS DESIGN

(Professional Elective-VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE823PE	PEC	3	0	0	3	30	70	100

Prerequisite: Control Systems (EE404PC)

Course Objectives:

1. To know the time and frequency domain design problem specifications.
2. To understand the effect of addition of zero on system response
3. To understand the design of classical control systems in time-domain
4. To design of various controllers
5. To identify the performance of the systems by design them in state-space

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

1. Understand various design specifications
2. Design control system in time domain
3. Design control system in frequency domain
4. Design controllers to satisfy the desired design specifications using simple controller structures(P, PI, PID, compensators)
5. 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, 2018
2. I. J. Nagrath and M. Gopal, "Control system engineering", New Age International Private Limited, 2021.

REFERENCE BOOKS:

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, June 2016.
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 2020.
3. N. Nise, "Control system Engineering", John Wiley, 2018

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106098/
2. http://nptel.iisc.ac.in/nptel/courses/control-system-design/

EE824PE: RELIABILITY ENGINEERING AND APPLICATION TO POWER SYSTEM

(Professional Elective-VI)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE824PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC), Power System Operation and Control(EE604PC)

Course Objectives:

1. To describe the generation system model and recursive relation for capacitive model building.
2. To explain the equivalent transitional rates, cumulative probability and cumulative frequency.
3. To develop the understanding of risk, system and load point reliability indices.
4. To explain the basic and performance reliability indices.

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

1. Estimate loss of load and energy indices for generation systems model
2. Describe merging generation and load models
3. Apply various indices for distribution systems
4. Evaluate reliability of interconnected systems
5. Analyze the Open and Short circuit failures

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 averagerate 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. "R. Billinton", "R.N. Allan",Reliability Evaluation of Power systems, BS Publications, 2008.
2. "J. Endrenyi",Reliability Modeling in Electric Power Systems, John Wiley and Sons, 1978

REFERENCE BOOKS:

1. "Alessandro Birolini",Reliability Engineering: Theory and Practice, Springer Publications, 2017.
2. "Charles Ebeling",An Introduction to Reliability and Maintainability Engineering by, TMH,2017Publications.
3. "E. Balaguruswamy",Reliability Engineering by, TMH Publications, 2017

WEB REFERENCES:

1. https://nptel.ac.in/courses/105/108/105108128/

EE700OE: ESTIMATION AND COSTING OF ELECTRICAL SYSTEMS
(Open Elective - II)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE700OE	OEC	3	0	0	3	30	70	100

Prerequisite: NIL

Course Objectives:

1. To understand the estimation and costing aspects of all electrical equipment
2. To explain the concept of installation and designs on the cost viability.
3. To design overhead and underground distribution lines.
4. To design substations and illumination.

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

1. Understand the design considerations of electrical installations.
2. Design electrical installation for buildings and small industries.
3. Identify the various types of light sources for different applications.
4. Classify various types of substations.
5. Design of illumination schemes

UNIT: I **DESIGN CONSIDERATIONS OF ELECTRICAL INSTALLATIONS**

Electric Supply System, Three phase four wire distribution system, Protection of Electric Installation against over load, short circuit and Earth fault, Earthing, General requirements of electrical installations, testing of installations, Indian Electricity rules, Neutral and Earth wire, Types of loads, Systems of wiring, Service connections , Service Mains, Sub-Circuits, Location of Outlets, Location of Control Switches, Location of Main Board and Distribution board, Guide lines for Installation of Fittings, Load Assessment, Permissible voltage drops and sizes of wires, estimating and costing of Electric installations.

UNIT: II **ELECTRICAL INSTALLATION FOR DIFFERENT TYPES OF BUILDINGS AND SMALL INDUSTRIES**

Electrical installations for residential buildings – estimating and costing of material, Electrical installations for commercial buildings, Electrical installations for small industries.

UNIT: III **OVERHEAD AND UNDERGROUND TRANSMISSION AND DISTRIBUTION LINES**

Introduction, supports for transmission lines, Distribution lines – Materials used, Underground cables, Mechanical Design of overhead lines, Design of underground cables.

UNIT: IV **SUBSTATIONS**

Introduction, Types of substations, Outdoor substation – Pole mounted type, Indoor substations – Floor mounted type.

UNIT: V **DESIGN OF ILLUMINATION SCHEMES**

Introduction, Terminology in illumination, laws of illumination, various types of light sources, Practical lighting schemes LED, CFL and OCFL differences.

TEXT BOOKS:

1. "K. B. Raina, S. K. Bhattacharya", Electrical Design Estimating and Costing, New Age International Publisher, 2010.
2. "Er. V. K. Jain, Er. Amitabh Bajaj", Design of Electrical Installations, University Science Press. January 2016

REFERENCE BOOKS:

1. Code of practice for Electrical wiring installations(System voltage not exceeding 650 volts), Indian Standard Institution, IS: 732-1983.
2. Guide for Electrical layout in residential buildings, Indian Standard Institution, IS: 4648-1968.
3. Electrical Installation buildings Indian Standard Institution, IS: 2032.
4. Code of Practice for selection, Installation of Maintenance of fuse (voltage not exceeding 650 V), Indian Standard Institution, IS: 3106-1966.
5. Code of Practice for electrical wiring, Installations (system voltage not exceeding 650 Volts), Indian Standard Institution, IS: 2274-1963.
6. "Gupta J. B., Katson, Ludhiana", "Electrical Installation, estimating and costing", S. K. Kataria and sons, 2013.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105104/

EE701OE: ENGINEERING OPTIMIZATION
(Open Elective – II)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE701OE	OEC	3	0	0	3	30	70	100

Prerequisite: Mathematics-I(MA101BS), Mathematics-II(MA201BS)

Course Objectives:

1. To enable the student to understand Multivariable optimization techniques
2. To enable the student to understand Linear and Non – Linear Programming of various optimization techniques
3. To enable the student to understand Geometric Programming of Engineering optimization techniques
4. To enable the student to understand Dynamic Programming of various optimization techniques

Course Outcomes: : After Completion of this course, student will be able to

1. Explain various optimization techniques.
2. Illustrate various problems involving single variable and multi variables under constrained or unconstrained environments.
3. Discuss the impact of various factors affecting the Linear programming problem and solution using sensitivity (Post Optimality) analysis, with the aid of Simplex Method, Revised Simplex Method, Dual Simplex Method etc
4. Apply dynamic programming technique to find optimum solution for inventory, capital budgeting, resource allocation, Production planning and control problems etc.
5. Evaluate quadratic, geometric and non-linear programming problems using different methods.

UNIT: I	OPTIMIZATION TECHNIQUE

Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem.

UNIT: II	LINEAR PROGRAMMING:

Introduction, Revised Simplex Method, Duality in Linear Programming, Decomposition Principle, Sensitivity or Postoptimality Analysis, Transportation Problem, Karmarkar"s Method, Quadratic Programming

UNIT: III	NON-LINEAR PROGRAMMING

Introduction, Unimodal Function, Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval Halving Method, Fibonacci Method, Golden Section Method, Comparison of Elimination Methods, Quadratic Interpolation Method, Cubic Interpolation Method, Direct Root Methods, Rate of convergence, Design variables, Random search methods, Chrivariate methods, Powell"s method, Newton"s method, Marquard Method, Test function.

Unit: IV	GEOMETRIC PROGRAMMING

Introduction, Posynomial, Unconstrained Minimization Problem, Primal-Dual Relationship and Sufficiency Conditions in the Unconstrained Case,Constrained Minimization, Primal and Dual Programs in the Case of Less-Than Inequalities, Geometric Programming with Mixed Inequality Constraints, Complementary Geometric Programming, Applications of Geometric Programming.

Unit: V	DYNAMIC PROGRAMMING

Introduction, Multistage Decision Processes, Concept of Sub optimization and the Principle of Optimality, Computational Procedure in Dynamic Programming, The Calculus Method of Solution, The Tabular Method of Solution, Conversion of a Final Value Problem into an Initial Value Problem, Linear Programming as a Case of Dynamic Programming, Continuous Dynamic Programming, Applications.

TEXT BOOKS:

1. "C B Gupta" , Optimization Techniques in Operations Research, 1st Edition, I K International Publications, New Delhi, 2013.
2. "Singireshel S Rao", Engineering Optimizations, 4th Edition, Elsevier Butterworth, Heineman, USA, 2011.

REFERENCE BOOKS:

1. "Jasibir Arora", Introduction to Optimum Design, 4th Edition, Academic press in an Imprint of Elsevier, USA,2016.
2. "N V S Raju", Optimization Methods for Engineering, 1st edition, PHI Publications, New Delhi, 2014
3. "Edwin K", "P Chang", "Stanislaw H. Zak", An Introduction to Optimization, 3rd Edition, Jhon Wiley, New York, 2013

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/105/111105039/
2. https://www.udemy.com/course/optimization-for-engineering-students

EE800OE: ENERGY STORAGE SYSTEMS
(Open Elective – III)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE800OE	OEC	3	0	0	3	30	70	100

Prerequisite: Engineering Chemistry(CH102BS)

Course Objectives:

1. To understand the need for energy storage, devices and technologies available and their applications
2. To discuss the role of electrical storage technologies
3. To explain various types of energy storage systems and its comparison.
4. To explain various applications both utility use and consumer use

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

1. Analyze the characteristics of energy from various sources and need for storage
2. Classify various types of energy storage and various devices used for the purpose
3. Discuss the features of energy storage systems.
4. Explain different types of energy storage systems and its comparison.
5. Identify various real time applications.

UNIT: I **ELECTRICAL ENERGY STORAGE TECHNOLOGIES**

Electrical Energy Storage Technologies: Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, long distance between generation and consumption, Congestion in power grids, Transmission by cable.

UNIT: II **NEEDS FOR ELECTRICAL ENERGY STORAGE**

Needs for Electrical Energy Storage: Emerging needs for EES, more renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy

UNIT: III **FEATURES OF ENERGY STORAGE SYSTEMS**

Features of Energy Storage Systems: Classification of EES systems, Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG).

UNIT: IV **TYPES OF ELECTRICAL ENERGY STORAGE SYSTEMS**

Types of Electrical Energy Storage systems: Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

UNIT: V **APPLICATIONS**

Applications: Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers), New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems , Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA– aggregation of many dispersed batteries.

TEXT BOOKS:

1. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.
2. The Electrical Energy Storage by IEC Market Strategy Board,2011

REFERENCE BOOKS:

1. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc21_mm34/preview
2. https://nptel.ac.in/courses/113/105/113105102/

EE801OE: ENERGY MANAGEMENT AND AUDIT
(Open Elective - III)

B.TECH. IV YEAR II SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE801OE	OEC	3	0	0	3	30	70	100

Prerequisite: Nil

Course Objectives:

1. To discuss the conventional energy sources and their utilization.
2. To understand the importance of heat recovery and energy conservation methods and energy audit.
3. To explain different basic terms related to Indian Energy Scenario and Energy Conservation Act
4. To describe the building envelope analysis.

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

1. Explain conventional energy sources and their audit.
2. Apply the fundamentals of energy conservation and management.
3. Discuss energy audit report for different energy conservation instances.
4. Describe the energy saving methodologies.
5. Evaluate the energy saving and conservation in different electrical utilities.

UNIT: I	INTRODUCTION TO ENERGY MANGEMENT

Global & Indian Energy Scenario-Classification of Energy Sources-Energy needs of growing economy-Energy sector reform, Energy and Environment: Global Environmental Concerns, Basics of Energy and its various forms.

UNIT: II	ENERGY AUDIT, MATERIAL AND ENERGY BALANCE

Energy Audit: Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, and Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams,

UNIT: III	ENERGY ACTION PLANNING AND FINANCIAL MANAGEMENT

Energy Action Planning, Financial Management: Financial analysis techniques- Risk and sensitivity analysis- Financing options, Energy performance contracts and role of ESCOs
Energy Monitoring and Targeting: Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM).

UNIT: IV	BULIDING ENVELOPE ANALYSIS

Building Envelope – principles of analysis – Envelope performance -Envelope analysis of Existing and new buildings – Building standards for new and Existing constructions. HVAC Systems types – Energy conservation opportunities – cooling equipment – Domestic hot water Estimating HVAC Energy consumption

UNIT: V	ELECTRIC ENERGY MANAGEMENT

Principles of Electric Energy Management, Energy Management control systems – Energy systems maintenance. Energy management in water and waste water treatment – solid waste treatment- air pollution control systems. Energy Management in Boilers and Fired systems – Steam and condensate systems – cogeneration – Waste Heat recovery. Energy Management in Process Industries, Energy Security, Codes, Standards, Electricity Act, Energy Conservation Act.

TEXT BOOKS:

1. "Murphy.W. R", Energy Management Elsevier/bsp Books Pvt. Ltd,2003
2. General Aspects of Energy Management and Audit, National Productivity Council of India, Chennai (Course Material- National Certification Examination for Energy Management)

REFERENCE BOOKS:

1. Energy Management Handbook, W.C. Turner, 5th Edition, Marcel Dekker, Inc, New York, 2005.
2. Guide to Energy Management, B. L. Capehart, W. C. Turner, W. J. Kennedy, CRC Press, New York, 2005.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106022/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-me44/