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				I Semester			
S. No.	Course type	Course Code	Course Title	Periods per week			Credits
				L	T	P	
01	PCC	EE701PC	Power Semiconductor Drives	2	0	0	2
02	HSMC	SM702MS	Fundamentals of Management for Engineers	3	0	0	3
03	PEC		Professional Elective-III	3	0	0	3
04	PEC		Professional Elective-IV	3	0	0	3
05	OEC		Open Elective-II	3	0	0	3
06	PCC	EE703PC	Electrical and Electronics Design Lab	0	0	2	1
07	PROJ	EE704PC	Project Phase-I	0	0	6	3
08	PROJ	EE705PC	Industry Oriented Mini Project	0	0	0	2
09	PROJ	EE706PC	Technical Seminar	0	0	2	1
10	MC	MC707EC	Introduction to ARDUINO	0	0	2	0
Total				**14**	**0**	**12**	**21**

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

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.**

PROFESSIONAL ELECTIVE-I

EE511PE	Computer Architecture
EE512PE	High Voltage Engineering
EE513PE	Special Electrical Machines
EE514PE	Linear Systems Analysis

PROFESSIONAL ELECTIVE-II

EE611PE	Optimization Techniques
EE612PE	Wind and Solar Energy Systems
EE613PE	Digital Control Systems
EE614PE	VLSI Design

PROFESSIONAL ELECTIVE-III

EE711PE	Flexible AC Transmission Systems
EE712PE	Power System De-Regulation
EE713PE	Computer Methods in power system
EE714PE	Power System Automation

PROFESSIONAL ELECTIVE-IV

EE721PE	HVDC Transmission
EE722PE	Power Quality
EE723PE	Advanced Control System
EE724PE	Electrical Machine Design

PROFESSIONAL ELECTIVE-V

EE811PE	EHV AC Transmission Systems
EE812PE	Artificial Intelligent Techniques for Electrical Systems
EE813PE	Advanced Power Electronics
EE814PE	Smart Electric Grid

PROFESSIONAL ELECTIVE-VI

EE821PE	Utilization of Electric Power
EE822PE	Hybrid Electric Vehicles
EE823PE	Control Systems Design
EE824PE	Reliability Engineering and Applications to Power systems

***Open Elective – Students should take Open Electives from List of Open Electives Offered by Other Departments/Branches Only. These are the list of open electives offered by our branch to other branches**

Open Elective-I

EE600OE	Renewable Energy Sources
EE601OE	Reliability Engineering

Open Elective-II

EE700OE	Estimation and Costing of Electrical systems
EE701OE	Engineering Optimization

Open Elective-III

EE800OE	Energy Storage System
EE801OE	Energy Management and Audit

EE701PC: POWER SEMICONDUCTOR DRIVES

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE701PC	PCC	2	0	0	2	30	70	100

Prerequisite: Power Electronics(EE501PC),Electrical Machines–I(EE304PC), Electrical Machines -II(EE402PC)

Course Objectives:

1. To introduce the drive system and operating modes of drive and its characteristics
2. To understand Speed – Torque characteristics of different motor drives by various power converter topologies
3. To appreciate the motoring and braking operations of drive
4. To differentiate DC and AC drives

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

1. Identify the drawbacks of speed control of motor by conventional methods.
2. Differentiate Phase controlled and chopper-controlled DC drives speed-torque characteristics merits and demerits
3. Understand 3-phase Induction motor drive speed–torque characteristics using different control strategies its merits and demerits
4. Apply Slip power recovery scheme
5. Understand speed control of 3-phase synchronous motor drive

UNIT: I CONTROL OF DC MOTORS BY SINGLE PHASE AND THREE PHASE CONVERTERS

Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – continuous current operation – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque Characteristics Problems on Converter fed d.c motors. Three phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque characteristics – Problems.

UNIT: II FOUR QUADRANT OPERATION OF DC DRIVES & CONTROL OF DC MOTORS BY CHOPPERS

Four quadrant operation of DC drives: Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic, and Regenerative Braking operations. Four quadrant operations of D.C motors by single phase and three phase dual converters – Closed loop operation of DC motor (Block Diagram Only) Control of DC Motors by Choppers: Single quadrant, two quadrant and four quadrant chopper fed dc separately excited and series motors – Continuous current operation – Output voltage and current wave forms – Speed and torque expressions – speed-torque characteristics – Problems on Chopper fed D.C Motors – Closed Loop operation (Block Diagram Only)

UNIT: III CONTROL OF INDUCTION MOTORS

Variable voltage characteristics-Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque characteristics. Variable frequency characteristics-Variable frequency control of induction motor by Voltage source and current source inverter and cyclo converters-

PWM control – Comparison of VSI and CSI operations – Speed torque characteristics – numerical problems on induction motor drives – Closed loop operation of induction motor drives

UNIT: IV	ROTOR SIDE CONTROL OF INDUCTION MOTOR

Static rotor resistance control – Slip power recovery – Static Scherbius drive – Static Kramer Drive – their performance and speed torque characteristics – advantages, applications, problems.

UNIT: V	CONTROL OF SYNCHRONOUS MOTORS

Separate control and self-control of synchronous motors – Operation of self-controlled synchronous motors by VSI, CSI and cyclo converters. Load commutated CSI fed Synchronous Motor – Operation – Waveforms – speed torque characteristics – Applications – Advantages and Numerical Problems – Closed Loop control operation of synchronous motor drives ,variable frequency control - Cyclo converter, PWM based VSI& CSI.

TEXT BOOKS:

1. "G K Dubey", Fundamentals of Electric Drives, CRC Press, 2020
2. "Vedam Subramanyam", Thyristor Control of Electric drives, Tata McGraw Hill Publications, 2004.

REFERENCE BOOKS:

1. "S K Pillai", A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. January 2012.
2. "P. C. Sen", Thyristor DC Drives, Wiley-Blackwell, 1981
3. "B. K. Bose", Modern Power Electronics, and AC Drives, Pearson 2015.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104140/

SM702MS: FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS

B.Tech. IV Year I Sem. L T P C

3 0 0 3

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:

1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009.

REFERENCE BOOKS:

1. Essentials of Management, Koontz Kleihrich, Tata Mc - Graw Hill.

2. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.

3. Industrial Engineering and Management: Including Production Management, T.R. Banga, S.C. Sharma, Khanna Publishers.

EE711PE- FLEXIBLE A.C. TRANSMISSION SYSTEMS
(Professional Elective - III)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE711PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power Electronics(EE501PC), Power System-I(EE405PC), Power System-II(EE502PC)

Course Objectives:

1. To understand the fundamentals of FACTS Controllers.
2. To know the importance of controllable parameters and types of FACTS controllers & their benefits.
3. To study the objectives of Shunt and Series compensation.
4. To Control STATCOM and SVC and their comparison

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

1. Choose proper controller for the specific application based on system requirements.
2. Analyze various systems thoroughly and their requirements.
3. Apply SVC & STATCOM for power quality improvement
4. Analyze the Power and control circuits of Series Controllers GCSC, TSSC and TCSC.
5. Design the thyristor switched series capacitor (TSSC)

UNIT: I	FACTS CONCEPTS

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, and benefits from FACTS controllers.

UNIT: II	VOLTAGE SOURCE CONVERTERS

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

UNIT: III	STATIC SHUNT COMPENSATION

Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable var generation, variable impedance type static var generators, switching converter type var generators and hybrid var generators.

UNIT: IV	SVC AND STATCOM

FC-TCR and TSC-TCR. STATCOM. The regulation and slope. Comparison between SVC and STATCOM

UNIT: V	STATIC SERIES COMPENSATORS

Objectives of Series compensation, concept of series capacitive compensation, GTO thyristor-controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor-controlled series capacitor (TCSC) control schemes for GSC TSSC and TCSC.

TEXT BOOKS:

1. "N.G. Hingorani","L. Guygi", Understanding Facts: Concepts and Technology of Flexible AC Transmission Systems, Wiley India Pvt Ltd, 2011
2. "Yong- Hua Song, Allan Johns", Flexible AC Transmission System, Laxmi Publications, 2009

REFERENCE BOOKS:

1. "Kalyan K. Sen","Meylingsen", Introduction to FACTS Controllers, John wiley& sons, Inc., Mohamed E.EI – Hawary Series editor, 2016.
2. "K. R Padiyar", "Motilal", FACTS controllers in power transmission and distribution, New Age International Pvt Ltd; Second edition, 2016

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/107/108107114/

EE712PE: POWER SYSTEM DE-REGULATION
(PROFESSIONAL ELECTIVE III)

B. Tech. IV Year I Semester								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
EE712PE	**PEC**	L	T	P	C	CIA	SEE	Total
		3	0	0	3	30	70	100

Prerequisite: Power System Operation and Control(EE604PC)

Course Objectives:
1. To understand restructuring of electricity market.
2. To understand the need of deregulation in electricity market.
3. To apply the concept of deregulation and ATC
4. To understand money, power & information flow in a deregulated power system.

Course Outcomes:
1. Understand the Developments of restructuring worldwide.
2. Identify the roles and responsibilities of different entities in power market.
3. Explore issues like Congestion management, Transmission pricing, Ancillary Services Management.
4. Understand operational planning activities of ISO
5. Apply Synchronous Generators as Ancillary service.

UNIT – I	**OVER VIEW OF KEY ISSUES IN ELECTRIC UTILITIES**

Introduction- restructuring models- Independent system operator (ISO)-power Exchange-Market operations-Market power -standard cost -Transmission Pricing-Congestion Pricing -Management of Inter Zonal/Intra Zonal Congestion.

UNIT – II	**OASIS (OPEN ACCESS SAME-TIME INFORMATION SYSTEM)**

Structure of OASIS-posting of Information-Transfer capability on OASIS-Definitions Transfer capabilities -ATC-TTC-TRM-CBM calculations-Methodologies to calculate ATC.

UNIT – III	**ELECTRICITY PRICING**

Introduction -Electricity price volatility-Electricity price Indexes-Challenges to electricity pricing-Construction of forward price curves-short time price forecasting.

UNIT – IV	**POWER SYSTEM OPERATION IN A COMPETITIVE ENVIRONMENT**

Introduction -operational planning activities of ISO-The ISO in Pool Markets-The ISO in Bilateral Markets -Operational Planning Activities of GENCO.

UNIT – V	**ANCILLARY SERVICES**

Introduction- Reactive power as an Ancillary service-a review based on present research-Synchronous Generators as Ancillary service Providers.

Text Books:

1. "Dr.P.V.Ramakrishna","G.Srinivas",Dr.S.V.Padmavathi", Power System Deregulation(Unit Commitment Problem),Namya Press Publication,1st edition -2020.
2. "Pawan Chandrakant Tapre", Generation Rescheduling In Deregulated Power System ,Wizard Publisher; 1st edition -2019

Reference Books:

1. "Krishna P.V. Rama", POWER SYSTEM DEREGULATION (Unit Commitment Problem) ,Namya Press-2020
2. "S.K.Gupta", Power System Operation Control & Restructuring, I K International PublishingHouse Pvt. Ltd – 2015

Web Reference:

1. https://nptel.ac.in/courses/108/101/108101005/
2. https://shodhganga.inflibnet.ac.in/bitstream/10603/17295/13/13_chapter3.pdf
3. https://onlinelibrary.wiley.com/doi/pdf/10.1002/0470846119.fmatter_indsub
4. https://ieeexplore.ieee.org/iel5/2224/21343/00990185.pdf

EE713PE: COMPUTER METHODS IN POWER SYSTEM
(Professional Elective - III)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE713PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System–I(EE405PC), Power system–II(EE502PC**)** & Electrical Circuits (EE302PC)

Course Objectives:

1. To understand formation of Z bus of a transmission line.
2. To discuss power flow studies by various methods.
3. To determine short circuit analysis.
4. To analyze the power system for steady state and transient stability

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

1. Analyze power system network matrices through graph theory.
2. Discuss about the power flow studies (load-flow) through various computer methods.
3. Analyze the short-circuit analysis & per unit representation.
4. Compare symmetrical and unsymmetrical fault analysis.
5. Analyze steady-state and transient state stability in power system.

UNIT: I **POWER SYSTEM NETWORK MATRICES**

Graph Theory: Definitions, Bus Incidence Matrix, Y bus formation by Direct and Singular Transformation Methods, Numerical Problems.

Formation of Z Bus: Partial network, Algorithm for the Modification of Z Bus Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old busses (Derivations and Numerical Problems). - Modification of ZBus for the changes in network (Problems).

UNIT: II **POWER FLOW STUDIES**

Load Flows:

Necessity of Power Flow Studies – Data for Power Flow Studies – Derivation of Static load flow equations. **Load flow solutions using Gauss Seidel Method**:

Acceleration Factor, Load flow solution with and without P-V buses, Algorithm and Flowchart. Numerical Load flow Solution for Simple Power Systems (Max. 3-Buses): Determination of Bus Voltages, Injected Active and Reactive Powers (Sample One Iteration only) and finding Line Flows/Losses for the given Bus Voltages.

Newton-Raphson Method in Rectangular and Polar Co-Ordinates Form:

Load Flow Solution with or without PV Busses- Derivation of Jacobian Elements, Algorithm and Flowchart.

Decoupled and Fast Decoupled Methods:
Comparison of Different Methods – DC load Flow.

UNIT: III	SHORT CIRCUIT ANALYSIS

Per-Unit System of Representation:
Per-Unit equivalent reactance network of a three phase Power System, Numerical Problems.

Symmetrical fault Analysis:
Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors, Numerical Problems.

Symmetrical Component Theory:
Symmetrical Component Transformation, Positive, Negative and Zero sequence components: Voltages, Currents and Impedances. Sequence Networks: Positive, Negative and Zero sequence Networks, Numerical Problems.

Unsymmetrical Fault Analysis:
LG, LL, LLG faults with and without fault impedance, Numerical Problems.

UNIT: IV	STEADY STATE STABILITY ANALYSIS

Elementary concepts of Steady State, Dynamic and Transient Stabilities. Description of: Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability and Methods to improve steady state stability.

UNIT: V	TRANSIENT STABILITY ANALYSIS

Derivation of Swing Equation. Determination of Transient Stability by Equal Area Criterion. Application of Equal Area Criterion, Critical Clearing Angle Calculation. - Solution of Swing Equation: Point-by-Point Method. Methods to improve Stability - Application of Auto Reclosing and Fast Operating Circuit Breakers.

TEXT BOOKS:

1. "M.A.Pai", Computer Techniques in Power System Analysis, TMH Publications 3rd Edition July 2017.
2. "K.Umarao", Computer techniques and models in power systems, , I.K.International 1st edition, September 2014.

REFERENCE BOOKS:

1. "PSR Murty", Power System Analysis, BS Publications, January 2018
2. "HadiSaadat", Power System Analysis, , TMH, 3rd edition, 2018
3. "TuranGonen",Modern Power System Analysis, CRC Press, 2nd edition February 2013

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/107/108107127/
2. https://nptel.ac.in/courses/108/105/108105067/

EE714PE: POWER SYSTEM AUTOMATION
(Professional Elective - III)

B.TECH. IV YEAR I SEMESTER								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
EE714PE	**PEC**	3	0	0	3	30	70	100

Prerequisite: Power System – I (EE405PC), Power System – II(EE502PC)

Course Objectives:

1. To explain the basics of MIMO systems and calculation of system norms
2. To design the hardware and programming of programmable logic controllers
3. To understand the real time systems and inter task communication.
4. To discuss the fundamentals of PLC and its architecture.
5. To develop the PLC programming fundamentals, process logic and human machine interface.

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

1. Understand the need of structure and operation of power system automation.
2. Discuss the Energy Management System and its role in programmable logic controller.
3. Explain the fundamentals of SCADA.
4. Illustrate the substation automation structure and its applications.
5. Describethe various control schemes of distribution automation and its technical benefits.

UNIT: I	**INTRODUCTION**

Evolution of automation system – Benefits of power system automation, Structure of power system automation, Electrical Protection, Control, Measurement, Monitoring- Architecture for power system automation – Classification of power system automation – Substation automation and Distribution automation – Problems with Data acquisition - implementation of power system automation and protection using SCADA.

UNIT: II	**ENERGY MANAGEMENT SYSTEMS & PLC**

Introduction- EMS in Power Systems, Objectives of EMS, Evolution of EMS, Functions and Benefits of EMS, EMS Architecture, Working of EMS, Evolution of EMS.
Introduction – Basic Operation – PLC architecture and components – Programming Languages – PLC"s Applications to Power System Automation.

UNIT: III	**SCADA FUNDAMENTALS**

Introduction – Building Blocks of SCADA - SCADA in power systems – Its application functions in Generation, Transmission and Distribution – Advantages of SCADA - SCADA Communication systems - RTUs – Components of RTUs –Communication Protocols – Advanced RTU functionalities, IEDs, Data concentrators and merging units, Human Machine Interface, Classification of SCADA systems Single master–single remote, Single master–multiple RTU, Multiple master–multiple RTUs, Single master, multiple submaster, multiple remote.

UNIT: IV	SUBSTATION AUTOMATION
Need for Substation automation, Role of IEDs in SA, Conventional substations: Islands of automation, Substation automation issues, SA architectures, application functions, Enterprise-level application functions, Benefits of data analysis to utilities	
UNIT: V	**DISTRIBUTION AUTOMATION**
Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software, Distribution Automation Functions-Information management, system reliability management, system efficiency management, voltage management, Load management, Communication systems used in DA - DA communication requirements, Communication reliability, Cost effectiveness, Data rate Requirements, Two way capability, Technical Benefits of DA.	

TEXT BOOKS:

1. "Mini S Thomas", "John D McDonald",Power system SCADA and smart grids, CRC Press, 2015.
2. "James. Northcote", "Green Robert Wilson", Control and Automation of Electrical Distribution Systems, , CRC Press 1st edition 2007

REFERENCE BOOKS:

1. "Rajesh Mehra", "Vikrant Vij", PLCs and SCADA- Theory and Practice, LaxmiPublications, First edition, 2016.
2. "Dr. M. K. Khedkar", "Dr. G.M.Dhole", Electric Power Distribution Automation, University Science press,2010

WEB REFERENCES:

1. https://www.electricalindia.in/power-system-automation/
2. https://nptel.ac.in/courses/108/105/108105063/

EE721PE: HVDC TRANSMISSION

(Professional Elective-IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE721PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power System-I(EE405PC), Power System-II(EE502PC), Power System Protection(EE603PC), Power System Operation and Control(EE604PC), Power Electronics(EE501PC)

Course Objectives:

1. To compare EHV AC and HVDC systems
2. To analyze Graetz circuit and also explain 6 and 12 pulse converters
3. To control HVDC systems with various methods and to perform power flow analysis inAC/DC systems.
4. To describe various protection methods for HVDC systems and Harmonics

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

1. Compare EHV AC and HVDC system and to describe various types of DC links
2. Analyze Graetz circuit for rectifier and inverter mode of operation
3. Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems
4. Discuss various protection methods for HVDC systems
5. Analyze the classification of Harmonics and design different types of filters.

UNIT: I CONVERTERS FOR HVDC TRANSMISSION

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 CONTROL OF HVDC SYSTEM

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 HVDC 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	PROTECTION OF CONVERTERS

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	HARMONIC ANALYSIS

Characteristics of harmonics, calculation of AC Harmonics, Non harmonics Characteristics, 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, New Age International Publishers, 2017
2. "S K Kamakshaiah, V Kamaraju", HVDC Transmission, Mc Graw Hill Publishers, 2020

REFERENCE BOOKS:

1. "S. Rao", EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 2016.
2. "Jos Arrillaga", HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2nd edition 2008.
3. "E. W. Kimbark", Direct Current Transmission, John Wiley and Sons, volume 1, 1971.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104013/
2. https://nptel.ac.in/courses/108/106/108106160/

EE722PE: POWER QUALITY

(Professional Elective IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE722PE	PEC	3	0	0	3	30	70	100

Prerequisite: Power systems – II(EE502PC)

Course Objectives:

1. To understand the power quality and different terms of power quality.
2. To compare short and long interruption.
3. To study about voltage sag and its effects.
4. To know the behavior of power electronics loads.

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

1. Discuss the severity of power quality problems in distribution system.
2. Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
3. Explain the concept of improving the power quality.
4. Discuss various methods of mitigation in DC drives.
5. Analyze power quality issues by the VSI converters.

UNIT: I	INTRODUCTION

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

UNIT: II	LONG & SHORT INTERRUPTIONS

Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality comparison of observations and reliability evaluation.

Short interruptions: definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

UNIT: III	VOLTAGE SAG CHARACTERIZATION

Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

UNIT: IV	POWER QUALITY ISSUES IN INDUSTRIES

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

UNIT: V	MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller. Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

TEXT BOOKS:

1. "Roger C. Dugan" , "Mark F. Mcgranaghan", "Surya Santoso" , "H. Wayne Beaty",ElectricalPower Systems Quality, McGraw Hill Education; 3rd edition -2017
2. "Math H J Bollen", Understanding Power Quality Problems by Bollen, Wiley India-2011

REFERENCE BOOKS:

1. "P. Sanjeevikumar", "C. Sharmeela", "Jens Bo Holm-Nielsen", "P. Sivaraman", Power Quality in Modern Power Systems, Academic Press-2020
2. "Bhim Singh","AmbrishChandra","Kamal", "Al-Haddad",Power Quality: Problems and Mitigation Techniques, John Wiley & Sons, Inc.- 2015

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/102/108102179/
2. https://nptel.ac.in/courses/108/107/108107157/

EE723PE: ADVANCED CONTROL SYSTEMS
(Professional Elective IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE723PE	PEC	3	0	0	3	30	70	100

Prerequisite: Control Systems(EE404PC)

Course Objectives:

1. To discuss about stability analysis
2. To understand about phase plane analysis
3. To explain describing function analysis
4. To understand observability and controllability

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

1. Understand the basics of advanced control systems.
2. Analyze stability analysis of control systems in frequency domain through polar &nyquist plots
3. Design of lag, lead, lag-lead compensators in frequency domain,
4. Analyze the stability of continuous systems.
5. Apply concept of controllability and observabilty.

UNIT: I	FREQUENCY BASED STABILITY ANALYSIS AND CONTROLLERS DESIGN

Frequency Domain: Polar Plots-Nyquist Plots-Stability Analysis. Lag, Lead, Lead-Lag Controllers design in frequency Domain.

UNIT: II	STABILITY ANALYSIS THROUGH LYAPUNOV METHODS

Stability in the sense of Lyapunov. Lyapunov"s stability and Lypanov"s instability theorems. Direct method of Lypanov for the Linear and Nonlinear continuous time autonomous systems.

UNIT: III	PHASE-PLANE ANALYSIS

Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points,phase-plane analysis of nonlinear control systems

UNIT: IV	DESCRIBING FUNCTION ANALYSIS

Introduction to nonlinear systems, Types of nonlinearities, describing functions, describing function analysis of nonlinear control systems.

UNIT: V	STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS

Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it"s Properties – Concepts of Controllability and Observability.

TEXT BOOKS:

1. "B. N. Sarkar", Advanced Control Systems, PHI Learning Private Limited, 2013
2. "Somanath Majhi", Advanced Control Theory, Cengage Learning, 2nd Edition June 2009

REFERENCE BOOKS:

1. "S.Palani", Control Systems Engineering, Tata-McGraw-Hill, 2nd Edition 2010
2. "I. J. Nagrath and M. Gopal" Control Systems Engineering, , New Age International (P) Limited, Publishers,6th Edition,2017
3. "K. Ogata", Modern Control Engineering,Prentice Hall of India, 5th Edition,2015.
4. M. Gopal, Modern Control System Theory, New Age International Publishers,4th Edition, 2014

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/103/108103007/
2. https://nptel.ac.in/courses/108/107/108107115/

EE724PE: ELECTRICAL MACHINE DESIGN
(Professional Elective - IV)

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE724PE	PEC	3	0	0	3	30	70	100

Prerequisite: Electrical Machines-I(EE304PC), Electrical Machines-II(EE402PC)

Course Objectives:

1. To know the major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings.
2. To analyze the thermal considerations, heat flow, temperature rise, rating of machines.
3. To understand the design of transformers.
4. To study the design of induction motors.
5. To know the design of synchronous machines.
6. To understand the CAD design concepts.

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

1. Design the construction and performance characteristics of electrical machines.
2. Analyze the various factors which influence the design of electrical, magnetic and thermal loading of electrical machines.
3. Apply the principles of electrical machine design and carry out a basic design of an ac machine.
4. Use software tools to do design calculations.
5. Analyze the design considerations of induction motors.

UNIT: I **INTRODUCTION**

Major considerations in electrical machine design, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines. Introduction to design aspects of modern machines PMDC,PMAC,PMSMs, BLDCs, and claw-pole machines.

UNIT: II **SWITCHED RELUCTANCE MOTORS**

Design aspects of stator and rotor pole arcs, design of stator and rotor and pole arcs in SR motor-determination of L(θ)--- θ profile – power converter for SR motor-A numerical example –Rotor sensing mechanism and logic control, drive and power circuits, position sensing of rotor with Hall problems—derivation of torque expression, general linear case.

UNIT: III **INDUCTION MOTORS**

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

UNIT: IV	SYNCHRONOUS MACHINES

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of airgap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

UNIT: V	COMPUTER AIDED DESIGN (CAD)

Limitations (assumptions) of traditional designs need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design.

TEXT BOOKS:

1. "A. K. Sawhney", A Course in Electrical Machine Design, Dhanpat Rai and Sons, 2016.
2. "M.G. Say", Theory & Performance & Design of A.C. Machines, ELBS London.

REFERENCE BOOKS:

1. "S. K. Sen", Principles of Electrical Machine Design with computer programmes, Oxford and IBH Publishing, 2006.
2. "K. L. Narang", A Text Book of Electrical Engineering Drawings, Satya Prakashan, 1969.
3. "A. Shanmugasundaram", "G. Gangadharan"," R. Palani", Electrical Machine Design Data Book, New Age International, 1979.
4. "M. V. Murthy",Computer Aided Design of Electrical Machines, B.S. Publications, 2008.
5. "Electrical machines and equipment design exercise examples using Ansoft"s Maxwell 2D machine design package.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/106/108106023/
2. https://nptel.ac.in/courses/108/105/108105131/

EE703PC: ELECTRICAL AND ELECTRONICS DESIGN LAB

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
EE703PC	PCC	0	0	2	1	30	70	100

Prerequisite: Basic Electrical Engineering(EE103ES)

Course Objectives:

1. To enhance practical knowledge related to different subjects
2. To develop hardware skills such as soldering, winding etc.
3. To develop debugging skills.
4. To increase ability for analysis and testing of circuits.
5. To fabricate basic electrical circuit elements/networks

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

1. Get practical knowledge related to electrical
2. Trouble shoot the electrical circuits
3. Design filter circuit for application
4. Get hardware skills such as soldering, winding etc.
5. Get debugging skills.

List of Experiments:

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.

WEB REFERENCES:

1. http://vlabs.iitkgp.ernet.in/be/index.html#
2. https://vem-iitg.vlabs.ac.in/Star%20Delta%20Starting(intro).html

MC707: INTRODUCTION TO ARDUINO

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a readymade software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board. Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

This course is intended for enthusiastic students or hobbyists. With Arduino, one can get to know the basics of micro-controllers and sensors very quickly and can start building prototype with very little investment. This course is intended to make you comfortable in getting started with Arduino.

B.TECH. IV YEAR I SEMESTER

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
MC707	Mandatory course					30	70	100

Prerequisite: Basics of C and C++. Knowledge in other programming language. A basic understanding of digital electronics , microcontrollers and electronic components is also expected.

Course Objectives:

5. Understand the basics of an embedded system.
6. Understand the typical components of an embedded system.
7. To understand different communication interfaces used in Arduino.
8. To learn the design process of Arduino based embedded system applications.

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

1. Learn the basics of electronics, including reading schematics (electronics diagrams)
2. Learn how to prototype circuits with a breadboard and Arduino programming language and IDE
3. Program basic Arduino examples and Prototype circuits and connect them to the Arduino
4. Program the Arduino microcontroller to make the circuits work
5. Connect the Arduino microcontroller to a serial terminal to understand communication and stand-alone use
6. Explore the provided example code and online resources for extending knowledge about the capabilities of the Arduino microcontroller.

Unit: I	Introduction	

Introduction to Embedded system, Understanding Embedded System, Overview of basic electronics and digital electronics, Representation of data in hexadecimal number system, advantages and applications of hexadecimal number system, Microcontroller vs. Microprocessor, Common features of Microcontroller. Different types of microcontrollers. Pin diagram of 8051,AT 89C52, PIC microcontrollers.

Unit: II	Getting Started with Arduino&Embedded C	

Introduction to Arduino, Pin configuration and architecture, Device and platform features, Concept of digital and analog ports, familiarizing with Arduino Interfacing Board. Types of Arduino boards.
Introduction to Embedded C and Arduino platform, Review of Basic Concepts, data types ,Variables and constants, Operators , Control Statements , Arrays Functions.

Unit: III	**Arduino Sensors& Relays**	

Sensors: Purpose of sensor, **Types**: Humidity Sensor, Temperature Sensor, Water Detector / Sensor, PIR Sensor, Ultrasonic Sensor, LDR. Obstacle sensors, Accelerometer and gyro. Fingerprint sensor. Photoelectric Sensors, Motion Sensors, Gas and Chemical Sensors. Electrical sensor and its types (Voltage and Current sensors).
Relays: Controlling Electrical appliances with electromagnetic relays, Types of Relay.

Unit: IV	**Arduino Communications**	

Wired and Wireless Communication (Bluetooth, WiFi, Zigbee), Communication Protocols, Interfacing Communication Modules with Arduino, (Serial Communication Modules) , Types of Serial Communications Arduino UART , GSM/GPRS Arduino Interfacing.

Unit: V	**Making it a reality (Arduino Projects)**	

This will involve designing, developing, coding and implement Arduino project. Projects will include but not limited to :

- Intelligent home locking system.
- Intelligent water level management system
- Measuring Room Temperature
- Intelligent Automatic Irrigation System
- How To Control a DC Motor with an Arduino
- IoT based Smart Grid System using Arduino

TEXT BOOKS:

1. Arduino for beginners : Essential Skills Every Maker Needs, John Baichtal, Person Education, Inc., 1st edition.
2. Intro to Embedded Systems by ShibuKv
3. Sensors and Transducers Second edition by D. Patranabis

REFERENCE BOOKS:

1. Arduino Cookbook by Michael Margolis, O'Reilly Media, Inc., 1st edition
2. Digital design by Marris Mano
3. A.K.Ray, K.M.Bhurchandi,"Advanced Microprocessors and Peripherals",

WEB REFERENCES:

1. Beginning C for Arduino by Jack Purdum (ebook)
2. https://www.electronicshub.org/different-types-sensors/
3. https://learn.sparkfun.com/tutorials/what-is-an-arduino/all
4. https://create.arduino.cc/projecthub
5. https://www.instructables.com/Arduino-Projects/
6. https://www.allaboutcircuits.com/projects/control-a-motor-with-an-arduino/

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/