JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.TECH. ELECTRICAL AND ELECTRONICS ENGINEERING
IV YEAR COURSE STRUCTURE & SYLLABUS (R16)

Applicable From 2016-17 Admitted Batch

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	EE701PC	Power Semiconductor Drives	4	1	0	4
2	EE702PC	Power System Operation and control	4	1	0	4
3		Professional Elective - II	3	0	0	3
4		Professional Elective - III	3	0	0	3
5		Professional Elective - IV	3	0	0	3
6	EE703PC	Electrical Systems Simulation Lab	0	0	3	2
7	EE704PC	Electrical Workshop	0	0	3	2
8	EE705PC	Industry Oriented Mini Project	0	0	3	2
9	EE706PC	Seminar	0	0	2	1
		Total Credits	**17**	**2**	**11**	**24**

IV YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Open Elective - III	3	0	0	3
2		Professional Elective-V	3	0	0	3
3		Professional Elective-VI	3	0	0	3
4	EE801PC	Major Project	0	0	30	15
		Total Credits	**9**	**0**	**30**	**24**

Professional Elective - I (PE - I):

EM611PE	Computer Organization
EE612PE	Linear Systems Analysis
EE613PE	Linear and Digital IC Applications
EE614PE	Electrical and Electronics Instrumentation

Professional Elective - II (PE - II):

EE721PE	Digital Signal Processing
EE722PE	HVDC Transmission
ET721PE	Switch Mode Power Supplies
EE724PE	Reliability Engineering

Professional Elective - III (PE - III):

EE731PE	Digital Control Systems
EE732PE	Power Quality
EE733PE	Modern Power Electronics
EE734PE	Optimization Techniques

Professional Elective - IV (PE-IV):

EE741PE	Programmable Logic Controllers
EE742PE	EHV AC Transmission Systems
EE743PE	Flexible A.C. Transmission Systems
EE744PE	Special Machines

Professional Elective - V (PE-V):

EE851PE	Artificial Neural Networks and Fuzzy Systems
EE852PE	Electrical Distribution Systems
EE853PE	Wind, Solar and Hybrid Energy Systems
EE854PE	High Voltage Engineering

Professional Elective - VI (PE-VI):

EE861PE	VLSI Design
EE862PE	Smart Electric Grid
EE863PE	Utilization of Electric Power
EE864PE	Electric and Hybrid Vehicles

***Open Elective** subjects' syllabus is provided in a separate document.

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

Ex: - A Student of Mechanical Engineering can take Open Electives from all other departments/branches except Open Electives offered by Mechanical Engineering Dept.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
LIST OF OPEN ELECTIVES OFFERED BY VARIOUS DEPARTMENTS FOR B.TECH. III AND IV YEARS

S. No.	Name of the Department Offering Open Electives	Open Elective – I (Semester – V)	Open Elective – II (Semester – VI)
1	Aeronautical Engg.	AE511OE: Introduction to Space Technology	AE621OE: Introduction to Aerospace Engineering
2	Automobile Engg.	CE511OE: Disaster Management MT512OE: Intellectual Property Rights	MT621OE: Data Structures MT622OE: Artificial Neural Networks
3	Biomedical Engg.	BM511OE: Reliability Engineering	BM621OE: Medical Electronics
4	Civil Engg.	CE511OE: Disaster Management.	CE621OE: Remote Sensing and GIS CE622OE: Geo-Informatics CE623OE: Intellectual Property Rights
5	Civil and Environmental Engg.	CE511OE: Disaster Management	CN621OE: Environmental Impact Assessment CE623OE: Intellectual Property Rights
6	Computer Science and Engg. / Information Technology	CS511OE: Operating Systems CS512OE: Database Management Systems	CS621OE: Java Programming CS622OE: Software Testing Methodologies CS623OE: Cyber Security
7	Electronics and Communication Engg. / Electronics and Telematics Engg.	EC511OE: Principles of Electronic Communications	EC621OE: Principles of Computer Communications and Networks
8	Electronics and Computer Engg.	EM511OE: Scripting Languages	EM621OE: Soft Computing Techniques
9	Electrical and Electronics Engg.	EE511OE: Non-Conventional Power Generation EE512OE: Electrical Engineering Materials EE513OE: Nanotechnology	EE621OE: Design Estimation and Costing of Electrical Systems EE622OE: Energy Storage Systems EE623OE: Introduction to Mechatronics
10	Electronics and Instrumentation Engg.	EI511OE: Electronic Measurements and Instrumentation	EI621OE: Industrial Electronics
11	Mechanical Engg.	ME511OE: Optimization Techniques ME512OE: Computer Graphics ME513OE: Introduction	ME621OE: World Class Manufacturing ME622OE: Fundamentals of Robotics ME623OE: Fabrication

		to Mechatronics ME514OE: Fundamentals of Mechanical Engineering	Processes
12	Mechanical Engg. (Material Science and Nanotechnology)	NT511OE: Fabrication Processes NT512OE: Non destructive Testing Methods NT513OE: Fundamentals of Engineering Materials	NT621OE: Introduction to Material Handling NT622OE: Non-Conventional Energy Sources NT623OE: Robotics
13	Mechanical Engg. (mechatronics)	MT511OE: Analog and Digital I.C. Applications MT512OE: Intellectual Property Rights MT513OE: Computer Organization	MT621OE: Data Structures MT622OE: Artificial Neural Networks MT623OE: Industrial Management
14	Metallurgical and Materials Engg.	MM511OE: Materials Characterization Techniques	MM621OE: Science and Technology of Nano Materials MM622OE: Metallurgy of Non Metallurgists
15	Mining Engg.	MN511OE: Introduction to Mining Technology	MN621OE: Coal Gasification, Coal Bed Methane and Shale Gas
16	Petroleum Engg.	PE511OE: Materials Science and Engineering PE512OE: Renewable Energy Sources PE513OE: Environmental Engineering	PE621OE: Energy Management and Conservation PE622OE: Optimization Techniques PE623OE: Entrepreneurship and Small Business Enterprises

S. No.	**Name of the Department Offering Open Electives**	**Open Elective –III (Semester – VIII)**
1	Aeronautical Engg.	AE831OE: Air Transportation Systems AE832OE: Rockets and Missiles
2	Automobile Engg.	AM831OE: Introduction to Mechatronics AM832OE: Microprocessors and Microcontrollers
3	Biomedical Engg.	BM831OE: Telemetry and Telecontrol BM832OE: Electromagnetic Interference and Compatibility
4	Civil Engg.	CE831OE: Environmental Impact Assessment CE832OE: Optimization Techniques in Engineering CE833OE: Entrepreneurship and Small Business Enterprises
5	Civil and Environmental Engg.	CN831OE: Remote Sensing and GIS CE833OE: Entrepreneurship and Small Business

		Enterprises
6	Computer Science and Engg. / Information Technology	CS831OE: Linux Programming CS832OE: R Programming CS833OE: PHP Programming
7	Electronics and Communication Engg. / Electronics and Telematics Engg.	EC831OE: Electronic Measuring Instruments
8	Electronics and Computer Engg.	EM831OE: Data Analytics
9	Electrical and Electronics Engg.	EE831OE: Entrepreneur Resource Planning EE832OE: Management Information Systems EE833OE: Organizational Behaviour
10	Electronics and Instrumentation Engg.	EI831OE: Sensors and Transducers, EI832OE: PC Based Instrumentation
11	Mechanical Engg.	ME831OE: Total Quality Management ME832OE: Industrial Safety, Health, and Environmental Engineering ME833OE: Basics of Thermodynamics ME834OE: Reliability Engineering
12	Mechanical Engg. (Material Science and Nanotechnology)	NT831OE: Concepts of Nano Science And Technology NT832OE: Synthesis of Nanomaterials NT833OE: Characterization of Nanomaterials
13	Mechanical Engg. (mechatronics)	MT831OE: Renewable Energy Sources MT832OE: Production Planning and Control CE833OE: Entrepreneurship and Small Business Enterprises
14	Metallurgical and Materials Engg.	MM831OE: Design and Selection of Engineering Materials
15	Mining Engg.	MN831OE: Solid Fuel Technology MN832OE: Health & Safety in Mines
16	Petroleum Engg.	PE831OE: Disaster Management PE832OE: Fundamentals of Liquefied Natural Gas PE833OE: Health, Safety and Environment in Petroleum Industry

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

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EE701PC: POWER SEMICONDUCTOR DRIVES

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

Prerequisite: Power Electronics & Electrical Machines – I, II

Course Objectives:

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

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

- Indentify the drawbacks of speed control of motor by conventional methods.
- Differentiate Phase controlled and chopper controlled DC drives speed-torque characteristics merits and demerits
- Understand Ac motor drive speed–torque characteristics using different control strategies its merits and demerits
- Describe Slip power recovery schemes

UNIT – I

Control of DC motors by single phase and three phase converters: Introduction to 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: Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic, and Regenerative Braking operations. Four quadrant operation 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 Motor Through Stator Voltage And Stator Frequency: 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 (Block Diagram Only)

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 (Block Diagram Only), variable frequency control - Cyclo converter, PWM based VSI& CSI.

Text Books:

1. "G K Dubey", Fundamentals of Electric Drives, CRC Press, 2002.
2. "Vedam Subramanyam", Thyristor Control of Electric drives, Tata McGraw Hill Publications, 1987.

Reference Books:

1. "S K Pillai", A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. 1989
2. "P. C. Sen", Thyristor DC Drives, Wiley-Blackwell, 1981
3. "B. K. Bose", Modern Power Electronics, and AC Drives, Pearson 2015.
4. "R. Krishnan", Electric motor drives - modeling, Analysis and control, Prentice Hall PTR, 2001

EE702PC: POWER SYSTEM OPERATION AND CONTROL

B.Tech. IV Year I Sem.

L	T	P	C
4	1	0	4

Prerequisite: Power Systems - I & Power Systems - II

Course Objectives:

- To understand real power control and operation
- To know the importance of frequency control
- To analyze different methods to control reactive power
- To understand unit commitment problem and importance of economic load dispatch
- To understand real time control of power systems

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

- Analyze the optimal scheduling of power plants
- Analyze the steady state behavior of the power system for voltage and frequency fluctuations
- Describe reactive power control of a power system
- Design suitable controller to dampen the frequency and voltage steady state oscillations

UNIT – I

Load –Frequency Control: Basics of speed governing mechanism and modeling - speed-load characteristics – load sharing between two synchronous machines in parallel. Control area concept LFC control of a single-area system. Static and dynamic analysis of uncontrolled and controlled cases. Integration of economic dispatch control with LFC. Two-area system – modeling - static analysis of uncontrolled case - tie line with frequency bias control of two-area system - state variable model.

UNIT – II

Reactive Power – Voltage Control: Basics of reactive power control. Excitation systems – modeling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node - method of voltage control - tap-changing transformer. System level control using generator voltage magnitude setting, tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

UNIT – III

Economic Load Dispatch: Statement of economic dispatch problem – cost of generation – incremental cost curve - co-ordination equations without loss and with loss, solution by direct method and λ-iteration method.

UNIT – IV

Unit Commitment: Statement of Unit Commitment problem – constraints; spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. Solution methods - Priority-list methods - forward dynamic programming approach. Numerical problems on priority-list method using full-load average production cost and Forward DP method.

UNIT – V

Computer Control of Power Systems: Need of computer control of power systems. Concept of energy control centre (or) load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions. Network topology – Importance of Load Forecasting and simple techniques of forecasting.

Text Books:

1. D. P. Kothari and I. J. Nagrath, 'Modern Power System Analysis', Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.
2. Olle. I. Elgerd, 'Electric Energy Systems Theory – An Introduction', Tata McGraw Hill Publishing Company Ltd, New Delhi, 30th reprint, 2007.

Reference Books:

1. Chakrabarti & Haldar, "Power System Analysis: Operation and Control", Prentice Hall of India, 2004 Edition.
2. C. L. Wadhwa , 'Power System Analysis', New Age International-6th Edition, 2010, ISBN : 978-81-224-2839-1
3. Robert Miller, James Malinowski, 'Power System Operation', Tata McGraw Hill Publishing Company Ltd, New Delhi, 3rd Edition 2009.
4. P. Kundur, Neal J. Balu, 'Power System Stability & Control', IEEE, 1998.

EE721PE: DIGITAL SIGNAL PROCESSING
(PROFESSIONAL ELECTIVE – II)

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

Course Objectives: This course is an essential course that provides design techniques for processing all type of signals in various fields. The main objectives are:

- To provide background and fundamental material for the analysis and processing of digital signals.
- To familiarize the relationships between continuous-time and discrete time signals and systems.
- To study fundamentals of time, frequency and Z-plane analysis and to discuss the inter-relationships of these analytic method.
- To study the designs and structures of digital (IIR and FIR) filters from analysis to synthesis for a given specifications.
- The impetus is to introduce a few real-world signal processing applications.
- To acquaint in FFT algorithms, Multi-rate signal processing techniques and finite word length effects.

Course Outcomes: On completion of this subject, the student should be able to:

- Perform time, frequency, and Z -transform analysis on signals and systems.
- Understand the inter-relationship between DFT and various transforms.
- Understand the significance of various filter structures and effects of round off errors.
- Design a digital filter for a given specification.
- Understand the fast computation of DFT and appreciate the FFT processing.
- Understand the tradeoffs between normal and multi rate DSP techniques and finite length word effects.

UNIT - I

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

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

UNIT - II

Discrete Fourier Transforms: Properties of DFT, Linear Convolution of Sequences using DFT, Computation of DFT: Over-Lap Add Method, Over-Lap Save Method, Relation between DTFT, DFS, DFT and Z-Transform.

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

UNIT - III

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

UNIT - IV

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

UNIT - V

Multirate Digital Signal Processing: Introduction, Down Sampling, Decimation, Upsampling, Interpolation, Sampling Rate Conversion, Conversion of Band Pass Signals, Concept of Resampling, Applications of Multi Rate Signal Processing.

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

TEXT BOOKS:

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

REFERENCES:

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

EE722PE: HVDC TRANSMISSION
(PROFESSIONAL ELECTIVE – II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: Power Systems & Power Electronics

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

Course Outcomes: After completion of this course the student is able to
- Compare EHV AC and HVDC system and to describe various types of DC links
- Analyze Graetz circuit for rectifier and inverter mode of operation
- Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems
- Describe various protection methods for HVDC systems and classify Harmonics and design different types of filters

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

UNIT - IV

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

UNIT – V

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

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

TEXT BOOKS:

1. “K. R. Padiyar”, HVDC Power Transmission Systems: Technology and system Interactions, New Age International (P) Limited, and Publishers, 1990.
2. “S K Kamakshaiah, V Kamaraju”, HVDC Transmission, TMH Publishers, 2011
3. “S. Rao”, EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 1999.

REFERENCE BOOKS:

1. “Jos Arrillaga”, HVDC Transmission, The institution of electrical engineers, IEE power & energy series 29, 2nd edition 1998.
2. “E. W. Kimbark”, Direct Current Transmission, John Wiley and Sons, volume 1, 1971.
3. “E. Uhlmann”, Power Transmission by Direct Current, B. S. Publications, 2009

EE723PE: SWITCH MODE POWER SUPPLIES
(PROFESSIONAL ELECTIVE – II)

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

Prerequisite: Power Electronics

Course Objectives:
- The introduction of concept of switched mode power supply with both D.C. and A.C. outputs.
- To elaborately study the working of switched mode topologies including resonant power suppliers.
- To have the knowledge of their importance and applications in various fields.

Course Outcomes: After completion of this course the students are able to understand the concepts and principle of operation of various types of switched mode power supply systems for both D.C. and A.C. outputs.

UNIT - I
Switched Mode Power Conversion: Introduction to Switched Mode Power Supply**,** Linear DC to DC Power converters, Non- Idealities in reactive elements, Design of Inductors, Design of Transformers- Copper loss, Power factor, Non-isolated topologies, Isolated topologies, Quasi-resonant zero-current/zero-voltage switch Operating principle of Non-Isolated DC to DC power Converters (Buck, Boost, Buck-Boost, and Cuk) Equivalent circuit model of the non-isolated DC-DC converters. Isolated converters (forward, Flyback).

UNIT - II
Multiple Output Flyback Switch Mode Power Supplies: Introduction, operating Modes, operating principles, Direct off line Flyback Switch Mode Power Supplies, Flyback converter, snubber network, Problems.

UNIT – III
Using Power Semiconductors in Switched Mode Topologies: Introduction to Switched Mode Power Supply Topologies, The Power Supply Designer’s Guide to High Voltage Transistors, Base Circuit Design for High Voltage Bipolar Transistors in Power Converters, Isolated Power Semiconductors for High Frequency Power Supply Applications

UNIT - IV
Rectification: Explanation, Advantages and disadvantages, SMPS and linear power supply comparison, Theory of operation , Input rectifier stage, Inverter stage, Voltage converter and output rectifier, Regulation, An Introduction to Synchronous Rectifier Circuits using Power MOS Transistors

UNIT – V

Switch mode variable power supplies: Introduction, variable SMPS techniques, operating principles, practical limiting factors, Efficiency and EMI Applications.

Resonant Power Supplies: An Introduction to Resonant Power Supplies, Resonant Power Supply Converters - The Solution for Mains Pollution Problems.

TEXT BOOKS:

1. "Keith H. Billings and Taylor Morey", "Switch Mode Power Supplies", Tata McGraw-Hill Publishing Company, 3rd edition 2010.
2. "Robert W. Erickson", "Switch Mode Power Supplies", Springer, 2nd edition 2001.

REFERENCE BOOKS:

1. "Sanjaya Maniktala", "Switching Power Supplies A-Z", Elsevier, 2nd Edition 2012
2. "Steven M. Sandler", Switch Mode Power Supplies, Tata McGraw Hill, 1st Edition 2006

MT723PE/EE724PE: RELIABILITY ENGINEERING
(PROFESSIONAL ELECTIVE – II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: Mathematics - III

Course Objectives:

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

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

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

UNIT – I

Basic Probability Theory: Elements of probability, probability distributions, Random variables, Density and Distribution functions- 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

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

Network Modeling and Evaluation of Complex systems: Conditional probability method- tie set, Cutset approach- Event tree and reduced event tree methods- Relationships between tie and cutsets- Examples.

UNIT – III

Time Dependent Probability: Basic concepts- Reliability function f(t). F(t), R(t) and h(t) - Relationship between these functions.

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

UNIT – IV

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

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

UNIT – V

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

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

TEXT BOOKS:

1. Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Plenum Press, 1983.
2. E. Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited, 2002.

REFERENCE BOOK:

1. K. K. Agarwal, Reliability Engineering-Kluwer Academic Publishers, 1993**.**

EE731PE/EI733PE: DIGITAL CONTROL SYSTEMS
(PROFESSIONAL ELECTIVE – III)

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

Prerequisite: Control Systems

Course Objectives:

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

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

- Carry map S-plane and Z-plane, do state-space analysis
- Carry stability analysis in S-domain and Z-domains
- Carry stability analysis through bilinear transformation and R-H criteria,
- design of discrete-time control systems, design of lag, lead, lead-lag compensators, design of PID controllers and design of state feedback controllers and observers,
- Apply the above concepts to real-world electrical and electronics problems and applications.

UNIT - I

Introduction To Digital Control Systems And Z-Transforms: Introduction - Merits and Demerits of Digital Control Systems - Practical aspects of the choice of sampling rate and Multirate sampling - Basic discrete time signals - Quantization – Sampling Theorem - Data Conversions and Quantization - Sampling process - Mathematical Modeling - Data Reconstruction and Filtering of sampled signals - Zero - Order Hold (ZOH).

z- Transform and Inverse z-Transform, Relationship between s - plane and z - plane - Difference equation - Solution by recursion and z-Transform - Pulse Transfer Functions of the ZOH and relationship between G(s) and G(z) - Bilinear Transformation.

UNIT- II

Input/output Analysis of Digital Control Systems: Pulse transfer function - z transform analysis of open loop, closed loop systems - Modified z Transform - transfer function - Stability of linear digital control systems - Stability tests – Jury Stability test.

Root loci - Frequency domain analysis - Bode plots - Gain margin and phase margin.

UNIT – III

Design of Controllers For I/O Model Digital Control Systems: Cascade and Feedback Compensation by continuous data controllers - Digital controllers - Design using Bilinear

Transformation - Realization of Digital PID controllers, Design of Digital Control Systems based on Root Locus Technique.

UNIT – IV

State Space Analysis and State Feedback Control Design of Digital Control Systems: State Equations of discrete data systems, solution of discrete state equations, State Transition Matrix: Computation methods for State Transition Matrix: z - transform method - Relation between State Equations and Pulse Transfer Functions.

Concepts on Controllability and Observability - Pole placement design by state feedback.

UNIT - V

Digital State Observer and Stability Analysis: Design of the full order and reduced order state observer, Design of Dead beat Controller - some case studies - Stability analysis of discrete time systems based on Lyapunov approach.

TEXT BOOKS:

1. K. Ogata, Discrete Time Control Systems, PHI/Addison - Wesley Longman Pte. Ltd., India, Delhi, 1995.
2. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

REFERENCE BOOKS:

1. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison - Wesley Longman, Inc., Menlo Park, CA , 1998.
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, India, 1997.
3. C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw Hill, 1985.
4. John S. Baey, Fundamentals of Linear State Space Systems, McGraw Hill, 1st edition 1999
5. Bernard Fried Land, Control System Design, McGraw Hill, 1st edition 1986.
6. Dorsay, Continuous and Discrete Control Systems, McGraw Hill, 2001.

EE732PE: POWER QUALITY
(PROFESSIONAL ELECTIVE – III)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: Power Systems - II

Course Objectives:
- Definition of power quality and different terms of power quality.
- Study of voltage power quality issue – short and long interruption.
- Detail study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- Know the behaviour of power electronics loads; induction motors, synchronous motor etc by the power quality issues.
- Overview of mitigation of power quality issues by the VSI converters.

Course Outcomes: After completion of this course, the student will be able to:
- Know the severity of power quality problems in distribution system
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
- Concept of improving the power quality to sensitive load by various mitigating custom power devices

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

Single and Three Phase 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 Considerations In Industrial Power Systems: Voltage sag – equipment behaviour 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. “Math H J Bollen”, “Understanding Power Quality Problems” , IEEE Press, 2000.
2. “R. Sastry Vedam and Mulukutla S. Sarma”, “Power Quality VAR Compensation in Power Systems”, CRC Press, 2008.

REFERENCE BOOKS:

1. C. Sankaran, Power Quality, CRC Press 2001.
2. Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, Electrical Power Systems Quality, Tata McGraw Hill Education Private Ltd, 3rd Edition 2012.

EE733PE: MODERN POWER ELECTRONICS
(PROFESSIONAL ELECTIVE – III)

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

Prerequisite: Power Electronics

Course Objectives:
- To understand various Power Electronics devices such as SCR, TRIAC, DIAC, IGBT, GTO etc.
- To understand application of aforesaid Power Electronics devices in Choppers, Inverters and Converters etc.
- To understand control of Electrical Motors through DC-DC converters, AC Converters etc.
- To understand the use of Inductors and Capacitors in Choppers, Inverters and Converters.

Course outcomes: Students are able to
- To understand various Power Electronics devices such as SCR, TRIAC, DIAC, IGBT, GTO etc.
- To understand application of aforesaid Power Electronics devices in Choppers, Inverters and Converters etc.
- To understand control of Electrical Motors through DC-DC converters, AC Converters etc.
- To understand the use of Inductors and Capacitors in Choppers, Inverters and Converters.

UNIT - I

High-Power Semiconductor Devices: Introduction, High-Power Switching Devices, Diodes, Silicon-Controlled Rectifier (SCR), Gate Turn-Off (GTO) Thyristor, Gate-Commutated Thyristor (GCT), Insulated Gate Bipolar Transistor (IGBT), Other Switching Devices, Operation of Series-Connected Devices, Main Causes of Voltage Unbalance, Voltage Equalization for GCTs,

UNIT-II

Cascaded H-Bridge Multilevel Inverters: Introduction, Sinusoidal PWM, Modulation Scheme, Harmonic Content, Over modulation, Third Harmonic Injection PWM, Space Vector Modulation, Switching States, Space Vectors, Dwell Time Calculation, Modulation Index, Switching Sequence, Spectrum Analysis, Even-Order Harmonic Elimination, Discontinuous Space Vector Modulation.

Introduction, H-Bridge Inverter, Bipolar Pulse-Width Modulation, Unipolar Pulse-Width Modulation.

UNIT - III

Diode-Clamped Multilevel Inverters: Three-Level Inverter, Converter Configuration, Switching State ,Commutation, Space Vector Modulation, Stationary Space Vectors , Dwell Time Calculation, Relationship Between V_refLocation and Dwell Times, Switching Sequence Design, Inverter Output Waveforms and Harmonic Content , Even-Order Harmonic Elimination, Neutral-Point Voltage Control, Causes of Neutral-Point Voltage Deviation , Effect of Motoring and Regenerative Operation, Feedback Control of Neutral-Point Voltage

UNIT - IV

DC-DC Switch-Mode Converters & Switching DC Power Supplies Control of dc-dc converter, Buck converter, boost converter, buck-boost converter, cuk dc-dc converter, full-bridge dc-dc converter, dc-dc converter comparison. Introduction, linear power supplies, overview of switching power supplies, dc-dc converters with electrical isolation, control of switch mode dc power supplies, power supply protection, and electrical isolation in the feedback loop, designing to meet the power supply specifications.

UNIT - V

Resonant Converters & Power Conditioners And Uninterruptible Power Supplies Classification of resonant converters, basic resonant circuit concepts, load-resonant converters, resonant-switch converters, zero-voltage-switching, resonant-dc-link inverters with zero-voltage switching’s, high frequency-link integral-half cycle converters. Power line disturbances, Introduction to Power Quality, power Conditioners, uninterruptible power supplies, Applications.

TEXT BOOKS:

1. “M. H. Rashid”, Power electronics circuits, Devices and applications, PHI, I edition – 1995.
2. “Ned Mohan, Tore M. Undeland and William P. Robbins, A”, “Power Electronics converters, Applications and Design” John Wiley & Sons, Inc., Publication, 3rd Edition 2003

REFERENCE BOOK:

1. “Bin Wu, A”, “High-Power Converters and Ac Drives” John Wiley & Sons, Inc., Publication (Free down load from rapidshire.com) 2006.

EE734PE/EC741PE: OPTIMIZATION TECHNIQUES
(PROFESSIONAL ELECTIVE – III)

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

Prerequisite: Mathematics – I & Mathematics – II

Course Objectives:

- To introduce various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming
- Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.
- To explain the concept of Dynamic programming and its applications to project implementation.

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

- explain the need of optimization of engineering systems
- understand optimization of electrical and electronics engineering problems
- apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
- apply unconstrained optimization and constrained non-linear programming and dynamic programming
- Formulate optimization problems.

UNIT – I

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.

Solution by method of Lagrange multipliers – Multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT – II

Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.

UNIT – III

Unconstrained Nonlinear Programming: One dimensional minimization methods, Classification, Fibonacci method and Quadratic interpolation method

Unconstrained Optimization Techniques: Univariant method, Powell's method and steepest descent method.

U**NIT – IV**

Constrained Nonlinear Programming: Characteristics of a constrained problem - classification - Basic approach of Penalty Function method - Basic approach of Penalty Function method - Basic approaches of Interior and Exterior penalty function methods - Introduction to convex programming problem.

UNIT – V

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

TEXT BOOKS:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
2. H. S. Kasene & K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd., 2004

REFERENCE BOOKS:

1. George Bernard Dantzig, Mukund Narain Thapa, "Linear programming", Springer series in operations research 3rd edition, 2003.
2. H.A. Taha, "Operations Research: An Introduction", 8th Edition, Pearson/Prentice Hall, 2007.
3. Kalyanmoy Deb, "Optimization for Engineering Design – Algorithms and Examples", PHI Learning Pvt. Ltd, New Delhi, 2005.

EE741PE: PROGRAMMABLE LOGIC CONTROLLERS
(PROFESSIONAL ELECTIVE – IV)

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

Prerequisite: Basic Electrical Course or equivalent.
Course Objectives:

- To provide knowledge levels needed for PLC programming and operating.
- To make the students how devices to which PLC input and output modules are connected
- To train the students to create ladder diagrams from process control descriptions.
- To make the students understand various types of PLC registers
- Apply PLC Timers and Counters for the control of industrial processes
- To make the students understand PLC functions, Data Handling Function

Course Outcomes: After completion of this course, the student

- Understand the purpose, functions, and operations of a PLC
- Identify the basic components of the PLC and how they function
- View a directory of processor files using PLC software
- Ability to gain knowledge on Programmable Logic Controllers
- Will understand different types of Devices to which PLC input and output modules are Connected
- To provide the knowledge about understand various types of PLC registers
- Able to create ladder diagrams from process control descriptions
- Ability to apply PLC timers and counters for the control of industrial processes
- Able to use different types PLC functions, Data Handling Function.

UNIT - I

PLC Basics PLC system, I/O modules and interfacing CPU processor programming equipment programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT - II

PLC Programming input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill-press operation. Digital logic gates programming in the Boolean algebra system, conversion examples Ladder diagrams for process control Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT - III

PLC Registers: Characteristics of Registers module addressing holding registers input registers, output registers. PLC Functions Timer functions and industrial applications counters counter function industrial applications, Architecture functions, Number comparison functions, number conversion functions.

UNIT - IV

Data handling functions: SKIP, Master control Relay Jump Move FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axes and three axis Robots with PLC, Matrix functions.

UNIT - V

Analog PLC operation: Analog modules and systems Analog signal processing multi bit data processing , analog output application examples, PID principles position indicator with PID control, PID modules, PID tuning, PID functions

TEXT BOOKS:

1. "John W Webb and Ronald A Reiss", Programmable Logic Controllers – Principle and Applications, PHI, 5th Edition 2003.
2. "JR Hackworth and F. D Hackworth Jr", Programmable Logic Controllers – Programming Method and Applications by - Pearson, 2004

REFERENCE BOOKS:

1. "W. Bolton", Programmable Logic Controllers, Newnes, 4th Edition 2000.

EE742PE: EHV AC TRANSMISSION SYSTEMS
(PROFESSIONAL ELECTIVE – IV)

B.Tech. IV Year I Sem.

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

Prerequisite: Power systems - II

Course Objectives:

- To understand the basic concepts of EHV AC transmission.
- To get the Knowledge on EHV transmission line inductance and capacitance
- To understand the voltage gradients of conductor
- To identify corona effects on transmission lines
- To calculate electrostatic fields of EHV AC lines and its effects
- To Analyze travelling waves
- To distinguish various compensators for voltage control

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

- Understand the basic concepts of EHV AC transmission.
- Get the Knowledge on EHV transmission line inductance and capacitance
- Understand the voltage gradients of conductor
- Identify corona effects on transmission lines
- Calculate electrostatic fields of EHVAC lines and its effects
- Analyze travelling waves
- 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 spacing and bundle radius- Examples.

UNIT – II

Line and Ground Reactive Parameters: Line inductance and capacitances – sequence inductances and capacitances – modes of propagation – ground return - Examples

Voltage Gradients of Conductors: 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 – I: 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 levels – Examples.

Corona Effects – II: 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: Electrostatic field: calculation of electrostatic field of EHV/AC lines – effect on humans, animals and plants – electrostatic induction in unenergised 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 – static VAR compensating system.

TEXT BOOKS:

1. "R. D. Begamudre", EHVAC Transmission Engineering, New Age International (p) Ltd., 3rd Edition 2006.
2. S. Rao, HVAC and DC Transmission, Khanna Publishers, 3rd Edition 2001.

REFERENCE BOOKS:

1. "E. Kuffel, W. S. Zaengl, J. Kuffel", High Voltage Engineering Fundamentals, Elsevier, 3rd Edition 2016.
2. "Mazen Abdel-salam, Hussein Ains, Abdab EI – Mors hedy and Roshdy Radwan", High Voltage Engineering: Theory and Practice, CRC Press, 2nd Edition 2000.
3. "Hugh M. Ryan", High Voltage Engineering and Testing, IEE power and energy series 32, The Institution of Engineering and Technology 2nd edition 2001.

EE743PE: FLEXIBLE A.C. TRANSMISSION SYSTEMS
(PROFESSIONAL ELECTIVE – IV)

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

Prerequisite: Power Electronics, Power System Analysis & Power System Operation and Control

Course Objectives:

- To understand the fundamentals of FACTS Controllers
- To know the importance of controllable parameters and types of FACTS controllers & their benefits
- To understand the objectives of Shunt and Series compensation
- To Control STATCOM and SVC and their comparison and the regulation of STATCOM, Functioning and control of GCSC, TSSC and TCSC

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

- Choose proper controller for the specific application based on system requirements
- Understand various systems thoroughly and their requirements
- Understand the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping
- Understand the Power and control circuits of Series Controllers GCSC, TSSC and TCSC

UNIT - I

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: SVC: 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 and L. Guygi", Understanding FACTS Devices, IEEE Press Publications 2000.
2. "Yong- Hua Song, Allan Johns", Flexible AC Transmission System, IEE Press 1999.

REFERENCE BOOKS:

1. "Kalyan K. Sen and Meylingsen", Introduction to FACTS Controllers, John wiley& sons, Inc., Mohamed E. EI – Hawary Series editor, 2009.
2. "K. R Padiyar, Motilal", FACTS controllers in power transmission and distribution UK Books of India 2007.

EE744PE: SPECIAL MACHINES
(PROFESSIONAL ELECTIVE – IV)

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

Prerequisite: Electrical Machines - I & Electrical Machines - II

Course objectives:
- To understand the working and construction of special machines
- To know the use of special machines in different feed-back systems
- To understand the use of micro-processors for controlling different machines

Course Outcomes: Upon the completion of this subject, the student will be able
- To select different special machines as part of control system components
- To use special machines as transducers for converting physical signals into electrical signals
- To use micro-processors for controlling different machines
- To understand the operation of different special machines

UNIT – I

Special Types of DC Machines - I: Series Booster-Shunt Booster-Non-reversible boost-Reversible booster

Special Types of DC Machines – II: Armature excited machines—Rosenberg generator-The Amplidyne and metadyne— Rototrol and Regulex-third brush generator-three-wire generator-dynamometer.

UNIT – II

Stepper Motors: Introduction-synchronous inductor (or hybrid stepper motor), Hybrid stepping motor, construction, principles of operation, Energisation with two phase at a time-essential conditions for the satisfactory operation of a 2-phase hybrid step motor- very slow-speed synchronous motor for servo control-different configurations for switching the phase windings-control circuits for stepping motors-an open-loop controller for a 2-phase stepping motor.

UNIT – III

Variable Reluctance Stepping Motors: Variable reluctance (VR) Stepper motors, single-stack VR step motors, Multiple stack VR motors-Open-loop control of 3-phase VR step motor-closed-Loop control of step motor, discriminator (or rotor position sensor) transilator, major loop-characteristics of step motor in open-loop drive – comparison between open-loop position control with step motor and a position control servo using a conventional (dc or ac) servo motor- Suitability and areas of application of stepper motors-5- phase hybrid stepping motor-single phase-stepper motor, the construction, operating principle torque developed in the motor.

Switched Reluctance Motor: Introduction – improvements in the design of conventional reluctance motors- Some distinctive differences between SR and conventional reluctance motors-principle of operation of SRM- Some 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 – IV

Permanent Magnet Materials And Motors: Introduction, Hysteresis loops and recoil line-stator frames (pole and yoke - part) of conventional PM dc Motors, Equivalent circuit of a PM-Development of Electronically commutated dc motor from conventional dc motor.

Brushless DC Motor: Types of construction – principle of operation of BLDM- sensing and switching logic scheme, sensing logic controller, lockout pulses –drive and power circuits, Base drive circuits, power converter circuit-Theoretical analysis and performance prediction, modeling and magnet circuit d-q analysis of BLDM -transient analysis formulation in terms of flux linkages as state variables-Approximate solution for current and torque under steady state –Theory of BLDM as variable speed synchronous motor (assuming sinusoidal flux distribution)- Methods or reducing Torque Pulsations, 180 degrees pole arc and 120 degree current sheet.

UNIT – V

Linear Induction Motor: Development of a double-sided LIM from rotary type IM- A schematic of LIM drive for electric traction development of one-sided LIM with back iron-field analysis of a DSLIM fundamental assumptions.

TEXT BOOKS:

1. K. Venkataratnam, Special electrical machines, university press, 2009.
2. R. K. Rajput - Electrical machines, Laxmi Publications, 5th Edition 2016.
3. V.V. Athani - Stepper motor: Fundamentals, Applications and Design, New age International publishers, 1997.

REFERENCE BOOK:

1. “E. G. Janardanan”, Special electrical machines-PHI 2014.

EE703PC: ELECTRICAL SYSTEMS SIMULATION LAB

B.Tech. IV Year I Sem.

L	T	P	C
0	0	3	2

Prerequisite: Electrical and Electronic circuits, Power System Analysis & Power Electronics

Course Objectives:
- To Simulate and analyse electrical and electronic systems**.**
- To evaluate the performance of transmission lines.
- To Analyze various Faults in power systems
- To Model, simulate and analyze the performance of DC Machines and Induction Motors.
- To Analyze performance of feedback and load frequency control of the systems

Course Outcomes: After going through this lab the student will be able to
- Design and Analyze electrical systems in time and frequency domain
- Analyze various transmission lines and perform fault analysis
- Model Load frequency control of Power Systems
- Design various Power Electronic Converters and Drives.

Any ten of the following experiments are required to be conducted using suitable software
1. Design of first and second order circuits in time and frequency domain
2. Performance evaluation of medium and long transmission lines
3. Symmetrical component analysis
4. Transmission Line Fault Analysis
5. LG, LL and 3-Φ fault analysis of Transformer
6. Short Circuit Analysis of Power system models
7. Speed Control of DC Motor
8. Speed Control of Induction motor
9. Design and analysis of feedback control system
10. Transient analysis of open ended line and short circuited line
11. Load frequency control of single area and two area power system
12. Economic Dispatch of Thermal Units
13. Design of Single Phase and Three Phase Inverters
14. Design of Single Phase and Three Phase Full Converters

Reference Books:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.

3. "I. J. Nagrath & M. Gopal", Control Systems Engineering, New Age International Pub. Co., 5th Edition 2009.
4. A.E. Clayton & C.I. Hancock Performance and Design of DC Machines, CBS Publisher, 1st Edition 2004.

EE704PC: ELECTRICAL WORKSHOP

B.Tech. IV Year I Sem.

L	T	P	C
0	0	3	2

Prerequisite: Basics of Electrical Engineering

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

Course Outcomes: After completion of course, student will be able to
- Get practical knowledge related to electrical
- Fabricate basic electrical circuit elements/networks
- Trouble shoot the electrical circuits
- Design filter circuit for application
- Get hardware skills such as soldering, winding etc.
- Get debugging skills.

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

Group B: This group consists of electronic circuits which must be assembled and tested on general purpose PCB or bread boards.
1. Design and development of 5 V regulated power supply.
2. Design and development of precision rectifier.
3. Design and development of first order/ second order low pass/high pass filters with an application.
4. Microcontroller Interface circuit for temperature/level/speed/current/voltage measurement.
5. Peak detector using op-amplifiers.
6. Zero crossing detector using op-amplifiers.

EE851PE: ARTIFICIAL NEURAL NETWORKS AND FUZZY SYSTEMS (PROFESSIONAL ELECTIVE – V)

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

Course Objectives:

- To introduce the basics of Neural Networks and its architectures.
- To introduce the Fuzzy sets and Fuzzy Logic system components
- To deal with the applications of Neural Networks and Fuzzy systems

Course Outcomes: After completion of this course, the students are able

- To understand artificial neural network models and their training algorithms
- To understand the concept of fuzzy logic system components, fuzzification and defuzzification
- Apply the above concepts to real-world problems and applications.

UNIT – I

Introduction To Neural Networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.

Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

UNIT – II

FeedForward Neural Networks: Single Layer Feed Forward Neural Networks: Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.

Multilayer Feed forward Neural Networks: Credit Assignment Problem, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

UNIT - III

Associative Memories: Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory).

Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem.

Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network.

UNIT – IV

Classical and Fuzzy Sets: Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT – V

Fuzzy Logic System: Fuzzification, Membership value assignment, development of rule base and decision-making system, Defuzzification to crisp sets, Defuzzification methods.

TEXT BOOKS:

1. Rajasekharan and Pai, Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications– PHI Publication, 1st Edition, 1905
2. Satish Kumar, Neural Networks, TMH, 2004.

REFERENCE BOOKS:

1. “James A Freeman and Davis Skapura”, Neural Networks, Pearson Education, 2002.
2. “Simon Hakins”, Neural Networks, Pearson Education, 3rd Edition 2008.
3. C. Eliasmith and Ch. Anderson, Neural Engineering, PHI, 2004.

EE852PE: ELECTRICAL DISTRIBUTION SYSTEMS
(PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Prerequisites: Power Systems – I & Power Systems - II

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

Course Outcomes: After completion of this course, the student able to
- distinguish between transmission, and distribution line and design the feeders
- compute power loss and voltage drop of the feeders
- design protection of distribution systems
- understand the importance of voltage control and power factor improvement

UNIT – I

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

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

UNIT – II

Substations: Location of Substations: Rating of distribution substation, service area with ‘n’ primary feeders. Benefits derived through optimal location of substations. Optimal location of Substations (Perpendicular bisector rule and X, Y co-ordinate method).

System Analysis: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines, analysis of non-three phase systems, method to analyze the distribution feeder cost.

UNIT – III

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

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

UNIT – IV

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

UNIT – V

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

EE853PE: WIND, SOLAR AND HYBRID ENERGY SYSTEMS
(PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Renewable Energy Systems

Course Objectives:
- To study the physics of wind power and energy
- To understand the principle of operation of wind generators
- To know the solar power resources
- To analyze the solar photo-voltaic cells
- To discuss the solar thermal power generation
- To identify the network integration issues

Course Outcomes: At the end of this course, students will demonstrate the ability to
- Understand the energy scenario and the consequent growths of the power generate renewable energy sources.
- Understand the basic physics of wind and solar power generation.
- Understand the power electronic interfaces for wind and solar generation.
- Understand the issues related to the grid-integration of solar and wind energy systems

UNIT - I
PHYSICS OF WIND POWER
History of wind power, Indian and Global statistics, Wind physics, Betz limit ratio, stall and pitch control, Wind speed statistics-probability distributions, and Wind power-cumulative distribution functions.

UNIT - II
WIND GENERATOR TOPOLOGIES
Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator configurations, Converter Control.

UNIT - III
THE SOLAR RESOURCE
Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

SOLAR PHOTOVOLTAIC

Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power point Tracking (MPPT) algorithms. Converter Control.

UNIT - IV

SOLAR THERMAL POWER GENERATION

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis

UNIT - V

NETWORK INTEGRATION ISSUES

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

TEXT BOOKS:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons, 2004.

REFERENCES:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
2. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
4. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

EE854PE: HIGH VOLTAGE ENGINEERING
(PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Prerequisite: Power Systems – I, Electromagnetic Field theory

Course Objectives:
- To deal with the detailed analysis of Breakdown occurring in gaseous, liquids and solid dielectrics
- To inform about generation and measurement of High voltage and current
- To introduce High voltage testing methods

Course Outcomes: After completion of this course, the student will be able to
- Acquire knowledge on, basics of high voltage engineering
- understand break-down phenomenon in different types of dielectrics
- understand generation and measurement of high voltages and currents
- understand the phenomenon of over-voltages, concept of insulation co-ordination
- know testing of various materials and electrical apparatus used in high voltage engineering

UNIT – I
Introduction To High Voltage Technology And Applications: Electric Field Stresses, Gas / Vacuum as Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings.

UNIT – II
Break Down In Gaseous And Liquid Dielectrics: Gases as insulating media, collision process, Ionization process, Townsend’s criteria of breakdown in gases, Paschen’s law - Liquid as insulator, pure and commercial liquids - breakdown in pure and commercial liquids.
Break Down In Solid Dielectrics: Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice.

UNIT – III
Generation of High Voltages And Currents: Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators.
Measurement Of High Voltages And Currents: Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High

Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements.

UNIT – IV

Non-Destructive Testing of Material and Electrical Apparatus: Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements.

High Voltage Testing of Electrical Apparatus: Testing of Insulators and bushings, Testing of Isolators and circuit breakers, testing of cables, Testing of Transformers, Testing of Surge Arresters, and Radio Interference measurements.

UNIT – V

Over Voltage Phenomenon and Insulation Co-Ordination: Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

TEXT BOOKS:

1. M. S. Naidu and V. Kamaraju, High Voltage Engineering by– TMH Publications, 4th Edition 2009.
2. E. Kuffel, W. S. Zaengl, J. Kuffel, High Voltage Engineering: Fundamentals by Elsevier, 2nd Edition 2000.

REFERENCE BOOKS:

1. C. L. Wadhwa, High Voltage Engineering by, New Age Internationals (P) Limited, 1997.
2. Ravindra Arora, Wolfgang Mosch, High Voltage Insulation Engineering by, New Age International (P) Limited, 1995.
3. “Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy and Roshdy Radwan”, High Voltage Engineering, Theory and Practice, CRC Press, 2nd Edition 2000.

EM851PE/EE861PE: VLSI DESIGN
(PROFESSIONAL ELECTIVE – VI)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to:

- Give exposure to different steps involved in the fabrication of ICs using MOS transistor, CMOS/BICMOS transistors, and passive components.
- Explain electrical properties of MOS and BiCMOS devices to analyze the behavior of inverters designed with various loads.
- Give exposure to the design rules to be followed to draw the layout of any logic circuit.
- Provide concept to design different types of logic gates using CMOS inverter and analyze their transfer characteristics.
- Provide design concepts to design building blocks of data path of any system using gates.
- Understand basic programmable logic devices and testing of CMOS circuits.

Course Outcomes: Upon successfully completing the course, the student should be able to:

- Acquire qualitative knowledge about the fabrication process of integrated circuit using MOS transistors.
- Choose an appropriate inverter depending on specifications required for a circuit
- Draw the layout of any logic circuit which helps to understand and estimate parasitic of any logic circuit
- Design different types of logic gates using CMOS inverter and analyze their transfer characteristics
- Provide design concepts required to design building blocks of data path using gates.
- Design simple memories using MOS transistors and can understand design of large memories.
- Design simple logic circuit using PLA, PAL, FPGA and CPLD.
- Understand different types of faults that can occur in a system and learn the concept of testing and adding extra hardware to improve testability of system

UNIT – I

Introduction: Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS

Basic Electrical Properties: Basic Electrical Properties of MOS and BiCMOS Circuits: I_{ds}-V_{ds} relationships, MOS transistor threshold Voltage, g_m, g_{ds}, Figure of merit ωo; Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

UNIT - II

VLSI Circuit Design Processes: VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, 2 µm CMOS Design rules for wires, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits.

UNIT – III

Gate Level Design: Logic Gates and Other complex gates, Switch logic, Alternate gate circuits, Time delays, Driving large capacitive loads, Wiring capacitance, Fan – in, Fan – out, Choice of layers.

UNIT - IV

Data Path Subsystems: Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators, Zero/One Detectors, Counters.
Array Subsystems: SRAM, DRAM, ROM, Serial Access Memories.

UNIT - V

Programmable Logic Devices: PLAs, FPGAs, CPLDs, Standard Cells, Programmable Array Logic, Design Approach, Parameters influencing low power design.
CMOS Testing: CMOS Testing, Need for testing, Test Principles, Design Strategies for test, Chip level Test Techniques.

TEXT BOOKS:

1. Essentials of VLSI circuits and systems – Kamran Eshraghian, Eshraghian Dougles and A. Pucknell, PHI, 2005 Edition
2. CMOS VLSI Design – A Circuits and Systems Perspective, Neil H. E Weste, David Harris, Ayan Banerjee, 3rd Ed, Pearson, 2009.

REFERENCE BOOKS:

1. CMOS logic circuit Design - John. P. Uyemura, Springer, 2007.
2. Modern VLSI Design - Wayne Wolf, Pearson Education, 3rd Edition, 1997.

EE862PE: SMART ELECTRIC GRID
(PROFESSIONAL ELECTIVE – VI)

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

Prerequisite: Power Systems - II & Electrical Distribution Systems

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

Course Outcomes: Upon the completion of the subject, the student will be able to
- Recite the structure of an electricity market in either regulated or deregulated market conditions.
- Understand the advantages of DC distribution and developing technologies in distribution
- Discriminate the trade-off between economics and reliability of an electric power system, differentiate various investment options (e.g. generation capacities, transmission, renewable, demand-side resources, etc) in electricity markets
- Analyze the development of smart and intelligent domestic systems.

UNIT – I
Introduction: 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 Neighbourhood-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

Dynamic Energy Systems Concept: 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 response-Current 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 End – 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. Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2009.
2. Jean Claude Sabonnadiere, Nouredine Hadjsaid, “Smart Grids”, Wiley-ISTE, IEEE Press, May 2012.

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.

EE863PE: UTILIZATION OF ELECTRIC POWER
(PROFESSIONAL ELECTIVE – VI)

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

Prerequisite: Electrical Machines-I & Electrical Machines-II

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

Course Outcomes: After completion of this course, the student will be able to
- Acquire knowledge on, electric drives characteristics and their applicability in industry based on the nature of different types of loads and their characteristics
- understands the concepts and methods of electric heating, welding, illumination and electric traction
- apply the above concepts to real-world electrical and electronics problems and applications.

UNIT – I
Electric Drives: Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

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

UNIT – III
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, Types and design of lighting and flood lighting.

UNIT – IV
Electric Traction – I: System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostat braking and regenerative braking.

Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.

UNIT – V

Electric Traction-II: Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and coefficient of adhesion.

TEXT BOOKS:

1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press, 1961.
2. Partab, H., 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Sons, New Delhi, 1986.

REFERENCE BOOKS:

1. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers, 1996.
2. C. L. Wadhwa, Generation, Distribution and Utilization of electrical Energy, New Age International (P) Limited, Publishers, 1997.
3. Tripathy, S.C., 'Electric Energy Utilisation and Conservation', Tata McGraw Hill Publishing Company Ltd. New Delhi, 1991.

EE864PE: ELECTRIC AND HYBRID VEHICLES
(PROFESSIONAL ELECTIVE – VI)

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

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

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

Course Outcomes: At the end of this course, students will demonstrate the ability to
- Understand the models to describe hybrid vehicles and their performance.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

UNIT - I
INTRODUCTION
Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

UNIT - II
INTRODUCTION TO HYBRID ELECTRIC VEHICLES
History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.
HYBRID ELECTRIC DRIVE-TRAINS: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT - III
ELECTRIC TRAINS
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.
ELECTRIC PROPULSION UNIT: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT - IV

ENERGY STORAGE

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

UNIT-V:

ENERGY MANAGEMENT STRATEGIES

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

CASE STUDIES: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

TEXT BOOKS:

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

REFERENCES:

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