Anil Neerukonda Institute of Technology & Sciences (Autonomous)
(Affiliated to AU, Approved by AICTE & Accredited by NBA & NAAC with 'A' Grade)
Sangivalasa-531 162, Bheemunipatnam Mandal, Visakhapatnam District
Phone: 08933-225083/84/87 Fax: 226395
Website: www.anits.edu.in email: principal@anits.edu.in

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

IV/IV B.TECH-EEE SYLLABUS

REGULATION-R19

2022-23

4th Year

Semester - I

Course Code	Title of the course	Category	Periods						Sessional Marks	Semester end Exam marks	Total Marks	Credits
			L	T	P	E	O	Total				
EEE411	**Open Elective-III**	OE	3	0	0	1	2	6	40	60	100	3
EEE412	**Professional Elective –IV**	PE	3	0	0	1	2	6	40	60	100	3
EEE413	**Professional Elective –V**	PE	3	0	0	1	2	6	40	60	100	3
EEE414	Power System Protection	PC	3	0	0	1	5	9	40	60	100	3
EEE415	Design Thinking	SC	2	0	2	0	0	4	0	0	0	0
EEE416	Power Electronics Laboratory	PC	0	0	3	0	1	4	50	50	100	1.5
EEE417	Power Systems Simulation Laboratory	PC	0	0	3	0	1	4	50	50	100	1.5
EEE418	Project -I	PR	0	0	3	0	1	4	60	0	60	2
EEE419	Summer Internship	PR	0	0	0	0	1	1	100	0	100	1
Total			**12**	**0**	**9**	**4**	**15**	**40**	**420**	**340**	**760**	**18**

Open Elective-III	
S. No.	**Infosys Springboard Courses**
1.	Computational Problem Solving
2.	Programming Fundamentals using Python - Part 1
3.	Python - The Practical and Hands-on approach
4.	Data Structures and Algorithms: The Complete Master class
5.	Data Structures and Algorithms using Python - Part 1
6.	Machine Learning, NLP & Python
7.	Data Analysts Toolbox: Excel, Python, Power BI
8.	Advanced Python Concepts
9.	Programming Fundamentals using Python - Science Graduates - Foundation Program
10.	Hands-On Deep Learning on Artificial Neural Networks
11.	Learn Python and Ethical Hacking from Scratch
12.	Data Structures and Algorithms using Java

Professional Elective –IV
1. Energy Management and Control
2. Nonlinear Systems
3. Control & Instrumentation
4. Electrical Engineering Drawing

Professional Elective – V
1. Electric Hybrid Vehicles
2. Electrical Machine Design
3. Power Semiconductor Drives
4. AI Techniques in Electrical Engineering
5. Process Control & Automation

Semester - II												
Course Code	Title of the course	Category	Periods						Sessional Marks	Semester end Exam marks	Total Marks	Credits
			L	T	P	E	O	Total				
EEE421	**Open Elective-IV**	OE	3	0	0	1	2	6	0	0	100	3
EEE422	Engineering Economics and Management	HS	3	0	0	0	1	4	40	60	100	3
EEE423	**Professional Elective –VI**	PE	3	0	0	1	2	6	40	60	100	3
EEE424	Research Methodology	SC	2	0	0	0	0	2	0	0	0	0
EEE425	Comprehensive Viva	PR	0	0	0	0	1	1	0	100	100	2
EEE426	Project - II	PR	0	0	9	0	2	11	60	80	140	6
Total			**9**	**0**	**9**	**2**	**8**	**28**	**140**	**300**	**540**	**17**

Open Elective-IV	
S. No.	**Infosys Springboard Courses**
1.	Computational Problem Solving
2.	Programming Fundamentals using Python - Part 1
3.	Python - The Practical and Hands-on approach
4.	Data Structures and Algorithms: The Complete Master class
5.	Data Structures and Algorithms using Python - Part 1
6.	Machine Learning, NLP & Python
7.	Data Analysts Toolbox: Excel, Python, Power BI
8.	Advanced Python Concepts
9.	Programming Fundamentals using Python - Science Graduates - Foundation Program
10.	Hands-On Deep Learning on Artificial Neural Networks
11.	Learn Python and Ethical Hacking from Scratch
12.	Data Structures and Algorithms using Java

Professional Elective –VI
1. HVDC & FACTS
2. Smart Grid
3. Advanced Power Electronic Converters
4. Sliding Mode Control
5. Electrical Installation, Estimation & Cost

Fourth Year Semester-1

Professional Elective-IV **ENERGY MANAGEMENT AND CONTROL**	
EEE 412	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Apply** Lagrange multiplier method to **Determine** optimal solution through unit commitment and Economic load dispatch including transmission losses.
CO2	BL-4	**Model** the single area and two area load frequency control and **analyze** the steady state and dynamic response of power system.
CO3	BL-4	**Analyze** Automatic Voltage Regulator mechanism and **Classify** various excitation systems
CO4	BL-2	**Identify** different levels of the EMS and State their functions. **Describe** Operating States of Power System.
CO5	BL-3	**Discuss** about energy management system and **Apply** Energy diagnosis procedure for Power Distribution systems, Lighting systems, Compressed Air system, Air Condition and Ventilation system.

CO	Bloom's Level
CO1	Action Verb from Blooms Taxonomy-**Determine**/ Cognitive level- Application (BL-3)
CO2	Action Verb from Blooms Taxonomy-**Analyze**/ Cognitive level- Application (BL-4)
CO3	Action Verb from Blooms Taxonomy- **Analyze** /Cognitive level- Analysis (BL-4)
CO4	Action Verb from Blooms Taxonomy-**Describe**/Cognitive level- Analysis (BL-2)
CO5	Action Verb from Blooms Taxonomy-**Apply** / Cognitive level- Application (BL-3)

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Non-Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	2	-	-	-	-	-	-	1	2	-
CO2	2	3	2	-	2	-	-	-	-	-	-	1	2	-
CO3	2	3	1	-	-	-	-	-	-	-	-	1	2	-
CO4	2	3	-	-	-	-	-	-	-	-	-	1	2	-
CO5	2	3	-	-	-	-	-	-	-		-	1	2	-

UNIT-I **[12 Periods]**

ECONOMIC OPERATION OF POWER SYSTEMS

Various aspects of economic operation, characteristics of steam, cogeneration and hydroelectric units, economic dispatch problem of thermal units with and without considering transmission losses using Lambda–iteration method, derivation of transmission loss formula, coordination equation, penalty factors, unit commitment problem and solution using Lagrange relaxation method, economic dispatch versus unit commitment, hydrothermal coordination problem and solution using Lagrange relaxation method, optimal load flow problem.

UNIT-II **[12 Periods]**

REAL POWER AND FREQUENCY CONTROL

Basic generator control loops, importance of frequency control, load-frequency control model, automatic generation control, automatic generation control in single and two-area systems, automatic generation control with economic dispatch control, speed governor dead-band and its effect on automatic generation control.

UNIT-III **[12 Periods]**

REACTIVE POWER AND VOLTAGE CONTROL

Reactive power flow, methods of voltage control-injection of reactive power by using shunt capacitors, series capacitors, synchronous compensators, tap-changing transformers, booster transformers and phase-shift transformers, types of excitation system, block diagram of automatic voltage regulator, automatic voltage regulator model,

UNIT-IV **[12 Periods]**

EMERGENCY CONTROL

Energy control center – various levels – national, regional and state level – SCADA system– computer configuration – function – monitoring, data acquisition and controls – EMS system, Power system operating states and control actions, power system security, power system state estimation-static and dynamic.

UNIT-V **[12 Periods]**

ENERGY AUDITING

Energy management system model, definition of energy audit, contents of energy audit, energy audit laws and regulations, key reasons for energy audit, energy diagnosis methods, energy diagnosis of power distribution systems, lighting systems, compressed air system, air condition and ventilation system, case study.

Text Books:

1. Hadi Sadat, "Power System Analysis", TMC Publications, 3rd edition, 2010.
2. B. M. Weedy & B. Cory, "Electric Power Systems", Wiley Publications, 4th edition, 2012.
3. O.I. Elgerd "Electric Energy Systems Theory-An Introduction", TMH edition, 2nd edition, 2012.
4. I.G. Nagrath & D.P. Kothari, "Modern Power System Analysis", TMH Publications, 4th edition, 2011.

Reference books:

1. L.P. Singh, "Advanced Power System Analysis and Dynamics", New Academic Science Ltd., 6th edition, 2011.
2. Mahalanabis A. K., Kothari D.P. and Ahson S.I., "Computer Aided Power System Analysis and Control, TMH Publications, 1999.
3. BSR Energy Management Hand Book (e-book).

Professional Elective-IV **NON-LINEAR SYSTEMS**	
EEE 412	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I **[12 Periods]**

INTRODUCTION TO NON-LINEAR SYSTEMS

Classification of non-linearity, types of non-linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non-linear systems and comparison, isoclines, singular point, limit cycle.

UNIT-II **[12 Periods]**

PHASE PLANE ANALYSIS

Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol's equation, stability from phase portrait, time response from trajectories, isoclines method, Pell's method of phase trajectory, and Delta method of phase trajectory construction.

UNIT-III **[12 Periods]**

FREQUENCY DOMAIN ANALYSIS

Absolute stability, Describing function, DF of typical nonlinearities stability analysis using DF method, stability studies using DF method.

UNIT-IV **[12 Periods]**

LIAPUNOV STABILITY

Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Liapunov function, Liapunov Stability: asymptotic stability, global asymptotic stability, instability.

UNIT-V **[12 Periods]**

LINEARIZATION

Linear systems, linearization of nonlinear systems about equilibrium point, feedback linearization and input/output linearization.

TEXT BOOK:

1. M.Vidyasagar, 'Nonlinear systems Analysis', 2nd Edition, 1991, Prentice-Hall Inc.

REFERENCE BOOK:

1. Control Systems Theory and Application: Samarjit Ghosh, Pearson Education
2. Control System Engineering: Nagrath and Gopal, Wiley Eastern
3. Automatic Control System: George J. Thaler Brown, Jaico Publications
4. Nonlinear Systems: Hasan A. Khalil, Prentice Hall of India

Professional Elective-IV **CONTROL AND INSTRUMENTATION**	
EEE 413	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I: Instrumentations: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain. pressure, flow, temperature and vibration.

UNIT-II: Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement. Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

UNIT-III: State Variable Analysis: Concept of state variables & state models, state model for line a continuous time systems, solution of state equation, state transition matrix.

UNIT-IV: Concept stability: System controllability & observability, pole placement by state feedback method, design of state feedback controller

UNIT-V: Introduction to Design: Lag, lead, lag-lead compensating networks and realization of networks. Design of lag, lead and lag-lead compensators by using Root locus technique, design of lag, lead, lag-lead compensators by using Bode plot method.

Text Books:

1. Automatic Control Systems, by Benjamin C. Kuo.
2. Control Systems Engineering by I.J. Nagrath and M.Gopal, New Age International Publications.
3. Control systems components by G.J. Gibson Tuetor

References:

1. Modern Control Engineering by Ogata K., 4th Edition, Prentice Hall
2. System Dynamics by Ogata K. 3rd Edition, Prentice Hall
3. Control Systems Principles and Design by M. Gopal, 2nd Edition, Tata McGraw Hill
4. Control Systems Engineering by Norman S. Nise, 3rd Edition, Wiley
5. Control System Design Guide – A Practical Guide by George Ellis, 3rd Edition, Academic Press

Professional Elective-IV **ELECTRICAL ENGINEERING DRAWING**	
EEE 413	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I **[12 Periods]**

Different views of different types of nuts and bolts including foundation bolts with threads. Different types of welded joints, riveted joints, keys and cotters. Different types of solid and flexible couplings Pulleys flat and V-belt drive and gears used in Electrical Machine Drive. Knifes switches: Single, Double and Triple pole types, Main Switches, Energy meters.

UNIT-II **[12 Periods]**

Pin insulators, Sackless Insulators and Disc type Insulators for L.T. and H.T. Lines. String Insulators and Guard Ring for String Insulators. Cable supports and Holders. Sketches of C.T., P.T. and other Relays with feeders and distributors.

UNIT-III **[12 Periods]**

Development of Machine Winding**:** D.C. pole windings. D.C. Lap winding/Single and Double layer. D.C. wave winding: Single and Double layer. Placing of carbon brushes on the commutator segments showing the direction of current.

UNIT-IV **[14 Periods]**

Free Hand Sketches**:** Different Industrial Electrical symbols. Pole of Machine: Different views. Armature of D.C. Machine: Different views. Commutator of D. C. Machine: Different views. D.C. Machine brush and brush holder. Single-phase Transformer. Three-phase transformer. Cross arms and their arrangement with various Insulators. Different types of poles and Towers with feeders and Distributors and Lightning Arrestors. Stay Arrangement and guard wires arrangement for roads and rail lines crossing. Battery Charging Circuit with Battery.

UNIT-V **[10 Periods]**

Earthing - different types

TEXT BOOKS

1. Electrical Engineering Drawing by G.B. Bharadwajan.
2. Electrical Engineering Drawing by Dargon.
3. Electrical Engineering Drawing by Narang.
4. Electrical Engineering Drawing by Surjit Singh.

Professional Elective-V **ELECTRIC AND HYBRID VEHICLES**	
EEE 413	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Associate** with the history of hybrid vehicles and physics involved in the conventional vehicle movement to **Calculate** the total tractive force required for vehicle motion.
CO2	BL-3	**Classify** various types of hybrid vehicle configurations to **interpret** their compatibility in specific applications.
CO3	BL-4	**Identify** specific configuration of electric vehicle, electric drive machine and power converter as per the requirement to **Analyze** the performance of system design.
CO4	BL-3	**Distinguish** the features and suitability of energy storage devices to **Relate** them as per the requirement.
CO5	BL-4	**Compare** various energy management strategies to **Select** them appropriately in specific EHV/EV controller design.

CO	Bloom's Level
CO1	Action Verb from Blooms Taxonomy-**Calculate**/ Cognitive level- Application (BL-3)
CO2	Action Verb from Blooms Taxonomy-**Interpret**/ Cognitive level- Application (BL-3)
CO3	Action Verb from Blooms Taxonomy-**Analyze**/Cognitive level- Analysis (BL-4)
CO4	Action Verb from Blooms Taxonomy-**Relate**/Cognitive level- Analysis (BL-3)
CO5	Action Verb from Blooms Taxonomy-**Select**/Cognitive level- Analysis (BL-4)

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	-	-	-	-	-	-	-	1	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-	1	-	-
CO3	2	3	2	-	2	-	-	-	-	-	-	1	-	2
CO4	2	3	1	-	2	-	-	-	-	-	-	1	-	1
CO5	2	2	2	-	1	-	-	-	-	-	-	1		1

SYLLABUS

UNIT-I **[12 Periods]**

INTRODUCTION OF VEHICLES

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

Electric Hybrid Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT-II **[10 Periods]**

HYBRID ELECTRIC DRIVE-TRAINS

Basic concept of hybrid traction, various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT-III **[10 Periods]**

ELECTRIC DRIVE-TRAINS

Basic concept of electric traction, various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT-IV **[12 Periods]**

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-V **[12 Periods]**

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.

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.
3. 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.
4. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

Professional Elective-V **ELECTRICAL MACHINE DESIGN**	
EEE 413	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I **[10 Periods]**

RATING AND HEATING OF MOTORS

Heating effects, loading conditions and classes of duty, determination of power ratings of motors for different applications, effect of load inertia, load equalization and fly wheel, calculations, environmental factors.

UNIT-II **[15 Periods]**

D.C.MACHINES

E.M.F generated from full pitch - fractional pitch with and without distributed windings - distribution factor. Design of main dimensions from output equation - Design of Armature windings - Design of field system - Design of inter pole and Commutator.

UNIT-III **[10 Periods]**

TRANSFORMERS

Derivation of output equation - volt per turn importance and calculation of main dimensions for three phase and single phase transformers - window dimensions – Yoke design and coil design - Design of tank with tubes.

UNIT-IV **[13 Periods]**

INDUCTION MOTOR

Derivation of output equation - calculation of main dimensions – Stator design - number of slots - shape and area of slots - Rotor design for squirrel cage and slip ring types.

UNIT-V **[12 Periods]**

SYNCHRONOUS MACHINES

Derivation of output equation - Calculations of Main Dimensions for salient pole and cylindrical rotor alternators - Stator design - number of stator slots and slot dimensions - Pole design for salient pole generators - pole winding calculations. Design of rotor for cylindrical rotor alternator - Design of rotor windings.

TEXT BOOKS

1. A.K. Sawhney, A Course in Electrical machine Design, Dhanpatrai & Sons,
2. M.G. Say,Performance and Design of AC Machines 3rd Edition.
3. A.E. clayton, Performance and Design of AC Machines 2004.

Professional Elective-IV **POWER SEMI CONDUCTOR DRIVES**	
EEE 412	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Discuss** the operation and characteristics of single phase and three phase controlled rectifiers fed to D.C motors to **Calculate** the values of output voltage, speed and torque for a given D.C drive.
CO2	BL-3	**Illustrate** braking techniques and **Explain** the four quadrant operation fed Dual converter. **Calculate** the values of output voltage, speed and torque in motoring and braking modes.
CO3	BL-4	**Demonstrate** the operation and speed –torque characteristics of Choppers fed D.C motors to **Select** a drive based on mechanical characteristics for a particular drive application.
CO4	BL-3	**Classify** induction motor speed control methods connected to A.C Voltage controller, Cycloconverter, VSI and CSI to **Examine** their use in specific applications.
CO5	BL-3	**Describe** the operation and speed –torque characteristics of Separate control & self control of synchronous motors using VSI, CSI and Cycloconverter. **Examine** the possible combinations of converter fed motors.

CO	Bloom's Level
CO1	Action Verb from Blooms Taxonomy-**Calculate**/ Cognitive level- Application (BL-3)
CO2	Action Verb from Blooms Taxonomy- **Illustrate** / Cognitive level- Application (BL-3)
CO3	Action Verb from Blooms Taxonomy- **Select** /Cognitive level- Analysis (BL-4)
CO4	Action Verb from Blooms Taxonomy-**Examine**/Cognitive level- Analysis (BL-3)
CO5	Action Verb from Blooms Taxonomy- **Examine** /Cognitive level- Analysis (BL-3)

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific Pos					Non-Domain Independent Pos								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO2	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO3	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO4	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO5	2	3	-		-	-	-	-	-	-	-	1	-	2

SYLLABUS

UNIT I **[14 Periods]**

CONTROL OF DC MOTOR BY SINGLE-PHASE AND THREE-PHASE CONVERTERS

Introduction to Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to DC 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 **[08 Periods]**

FOUR QUADRANT OPERATIONS 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 dual converters.

UNIT III **[10 Periods]**

CONTROL OF DC MOTORS BY CHOPPERS

Single quadrant, Two –quadrant and four quadrant chopper fed dc separately excited and series excited motors – Continuous current operation – Output voltage and current wave forms – Speed torque expressions – speed torque characteristics– Problems on Chopper fed D.C Motors.

UNIT IV **[16 Periods]**

CONTROL OF INDUCTION MOTOR THROUGH STATOR VOLTAGE

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

UNIT V **[12 Periods]**

CONTROL OF SYNCHRONOUS MOTORS

Separate control & 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.

TEXT BOOKS

1. Fundamentals of Electric Drives – by G K Dubey Narosa Publications
2. Power Electronic Circuits, Devices and applications by M.H.Rashid, PHI.

REFERENCE BOOKS

1. Power Electronics – MD Singh and K B Khanchandani, Tata – McGraw-Hill Publishing company,1998.
2. Modern Power Electronics and AC Drives by B.K.Bose, PHI.
3. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publilcations.
4. A First course on Electrical Drives – S K Pillai New Age International(P) Ltd. 2nd Editon.

Professional Elective-V **PROCESS CONTROL AND AUTOMATION**	
EEE 413	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I **[12 Periods]**

FUNDAMENTALS OF PROCESS CONTROL

Definition of industrial processes and control, Hierarchies in process control systems, block diagram representation of process control system, Current trends in computer control of process plants.

UNIT-II **[12 Periods]**

STRATEGIES FOR COMPUTER-AIDED PROCESS CONTROL

Definition of process, Open loop control, closed loop control, basic principles of Single Controller loop, effects of P, PI and PID controllers, control system response, controllability of process, PID controller tuning techniques, closed loop cycling technique, multi-variable control, feed forward control.

UNIT-III **[12 Periods]**

PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

Introduction, principles of operation, architecture of programmable logic controllers, programming the programmable controllers, programming languages, ladder diagram instruments, software, configurations, applications.

UNIT-IV **[12 Periods]**

DISTRIBUTED CONTROL SYSTEMS

Introduction, functional requirements of distributed control system, system architecture, distributed control systems, Leeds and Northup Max-1 distributed control systems, Control bailey Micro – Z distributed control systems.

UNIT-V **[12 Periods]**

INDUSTRIAL CONTROL APPLICATIONS

Automation strategy of Thermal power plant, distributed system structure of Thermal power plant, man-machine interface, Automation strategy of water treatment plant, distributed digital control, Automation and production planning of steel plant.

TEXT BOOKS

1. Computer based Industrial Control, Krishna Kant, Prentice-Hall India, 2003.
2. Computer Aided Process Control, S.K.Singh, Prentice-Hall India, 2005.

REFERENCE BOOKS

1. Process Dynamics and Control, Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, John Wiley, 2004.
2. Johnson D Curtis, Instrumentation Technology, Prentice-Hall India, (7th Edition), 2002.
3. S.K. Singh, Process control concepts, Prentice-Hall India, 2009.

Professional Elective-V **AI TECHNIQUES IN ELECTRICAL ENGINEERING**	
EEE 413	**Credits: 3**
Instruction: 3 Periods & 1 Tut/Week	**Sessional Marks:40**
End Exam: 3 Hours	**End Exam Marks:60**

SYLLABUS

UNIT-I **[8 Periods]**

ARTIFICIAL NEURAL NETWORK

Introduction, Models of Neuron Network-Architectures –Knowledge representation, Artificial Intelligence and Neural networks–Learning process-Error correction learning, Hebbian learning –Competitive learning-Boltzmann learning, supervised learning-Unsupervised learning–Reinforcement learning-Learning tasks.

UNIT-II **[14 Periods]**

ANN PARADIGMS

Multi-layer perceptron using Back propagation Algorithm (BPA), Self –Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

UNIT-III **[12 Periods]**

FUZZY LOGIC

Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets –Fuzzy Cartesian Product, Operations on Fuzzy relations –Fuzzy logic –Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods

UNIT-IV **[12 Periods]**

GENETIC ALGORITHM

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 **[14 Periods]**

APPLICATIONS OF AI TECHNIQUES

Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Small Signal Stability (Dynamic stability), Reactive power control , Speed control of DC and AC Motors.

TEXT BOOKS:

1. S.Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi, 2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011
3. P.D.Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York, 1989.
4. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall,1992
5. D.E.Goldberg, Genetic Algorithms, Addison-Wesley 1999.

POWER SYTEM PROTECTION	
EEE 414	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Compare** the construction, operation and applications of electromagnetic relays and Over Current protection. **Determine** the settings of PSM and TMS of Over Current relay. **Explain** the construction, operation and applications of Distance and Differential Protection. **Determine** the minimum value of earthing resistance and percentage of winding unprotected for Alternators. **Determine** relay setting and CT ratio of transformer protected by percentage differential protection.
CO2	BL-2	**Explain** operation of Static Over current, Distance, Differential protection and Microprocessor based relay. **Identify** the difference between electromagnetic and static relays.
CO3	BL-3	**Explain** the construction, operation and applications of various types of Lightning arresters. **Determine** reflected, refracted voltages and currents of Travelling waves.
CO4	BL-3	**Explain** the construction, operation and application of various types of Fuses and Circuit Breakers. **Determine** the TRV/RRRV. **Construct** substation layout and bus bar arrangement using single diagram.

CO1: Action Verb (BT)-**Compare, Explain, Determine**/ Cognitive level- Application (BL-3)

CO2: Action Verb (BT)-**Explain, Identify**/Cognitive level- Understanding (BL-2)

CO3: Action Verb (BT)-**Explain**, **Determine**/Cognitive level- Application (BL-3)

CO4: Action Verb (BT)-**Explain, Determine, Construct**/Cognitive level- Application (BL-3)

Program Matrix

	Program Outcomes (POs)												**PSOs**	
COs	**Domain Specific POs**					**Domain Independent POs**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	-	-	-				-	1	3	
CO2	2	2	-	-	-	-	-				-	1	3	
CO3	2	1	-	-	-	-	-				-	1	3	
CO4	2	3	2	-	2	-	-				-	1	3	

SYLLABUS

UNIT-I **[15 Periods]**

PROTECTIVE RELAYING

Faults, causes and effects, Importance of protective relaying, Evolution of protective relays, Protective zones, Primary and backup protection, Desirable qualities of protective relaying, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology, Operating principle and construction of electromagnetic relays.

Over Current and Earth Fault Protection- Applications of over current protection, relays used in over current protection, time current characteristics, directional relays, protection of parallel feeders, and protection of ring mains. Phase fault and earth fault protection, combined earth fault and phase fault protective scheme, Directional earth fault relay.

UNIT-II **[10 Periods]**

Distance and Differential Protection:

Distance Protection - Principle of operation of distance protection, R-X diagram, universal torque equation, impedance, reactance and mho relay. Zones of protection, auto reclosing. Pilot wire protection and carrier current protection.

Differential Protection -Types, protection of generators, protection of transformers and bus-zone protection.

UNIT-III **[10 Periods]**

STATIC AND NUMERICAL RELAYS

Block diagram representation, Merits and demerits of static relays, amplitude and phase comparators, basic block diagrams of static over current, distance and differential protection. Block diagram of microprocessor based relay, advantages.

UNIT-IV **[10 Periods]**

PROTECTION AGAINST OVER VOLTAGES

Causes of over voltages, over voltages due to lightning, Protection against lightning and travelling waves – earth wire, effects of series inductances, shunt capacitance, spark gap, surge arresters, lightning arresters, insulation co-ordination.

UNIT-V **[15 Periods]**

CIRCUIT BREAKERS AND SUBSTATION LAYOUT

Fuses -Types of fuses, high voltage HRC fuses applications, selection and discrimination.

Circuit Breakers-Principle of operation, formation of arc, methods of arc extinction, transient recovery voltage, resistance switching, switching of capacitor banks and un-loaded lines, current chopping, ratings and characteristics of circuit breakers, Classification, constructional features of air circuit breakers, oil circuit breakers, air blast circuit breakers, SF-6 circuit breakers and vacuum circuit breakers, testing of circuit breakers.

Sub-Station Layout & Bus Bars: Classification of substations, substation equipment and their function, bus-bar design and schemes of layout.

TEXT BOOKS:

1. Sunil S. Rao, "Switchgear Protection and Power Systems" Khanna Publishers, 13th, edition, 2013,
2. B. Ram and D.N. Viswakarma, "Power System protection and Switchgear" TMH Publications, 2nd, edition, 2013.

REFERENCE BOOKS:

1. C.L. Wadhwa, "Electrical power Systems", New Age International Publishers, 6th edition, 2010.
2. L. P. Singh, "Protective relaying from Electromechanical to Microprocessors", New Age International Publishers, 2nd edition, 2004.

DESIGN THINKING	
EEE 415	**Credits : 0**
Instruction : Periods /Week	**Sessional Marks : 00**
End Exam : 0 Hours	**End Exam Marks : 00**

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Explain** the design thinking principles & **Identify** an opportunity and scope of the project and **prepare** the problem statement
CO-2	**Apply** the empathy tools to study the user and **summarize** finding related to problem for define phase.
CO-3	**Describe** and **define** the problem specific to the user group and **apply** Ideation tools to **generate** Ideas to **solve** the problem
CO-4	**Develop** prototypes for test phase.
CO-5	**Test** the ideas and **demonstrate** Storytelling ability to present the Ideas.

SYLLABUS

UNIT - I	**Periods: 3L+3P=6**

Introduction To Design Thinking

Design Thinking, Need of design thinking, 7 characteristics that define design thinking, comparison of design thinking to other ways of thinking, tools and resources, 5 actions phases of Design thinking, 5 characteristics of action plan. Problem statement. Design principles.

Activities:

a. Case studies of General, engineering and service applications

b. Identify an opportunity and scope of the project and prepare the problem statement.

UNIT - II	**Periods: 5L+5P=10**

Empathize Phases: Design Thinking Tools

Interview for empathy, Explorative interview, Ask 5x why, 5W+H questions, Stakeholder map, Emotional response cards, Empathy map, Persona/User profile, Customer journey map, AEIOU, Analysis questions builder,

Activities:

a. Study the user using empathy tools and summarize finding related to your problem for define phase.
b. Iterate the process at any stage if required

UNIT - III	**Periods: 5L+5P=10**

Define point of view & Ideate Phase: Design Thinking Tools

Define point of view :"How might we…" question, Storytelling, Context mapping, Define success, Vision cone, Critical items diagram

Ideate: Brainstorming, 2x2 Matrix, Dot voting, 6-3-5 Method, Special brainstorming, Analogies & benchmarking as inspiration

Activities:

a. Apply the define tools to your problem: Finalize the problem statement

b. Apply the ideate tools to your problem: Generate lots of Ideas

c. Iterate the process at any stage if required

UNIT - IV	**Periods: 6L+6P=12**
Prototyping Phase: Methods and Tools	
Frequently used kinds of prototypes, Focused experiments – Critical Experience Prototype (CEP) & Critical Function Prototype (CFP), Crazy experiments – Dark horse prototype, Combined experiments – Funky prototype, Imagining the future – Vision prototype, Prototype with a first function - functional (system) prototype, Solutions in detail - "X is finished", (Hopefully) at the finish – Final prototype, Exploration map, Prototype to test **Activities:** a. Create prototype for best idea to your problem using any prototype method. b. Iterate the process at any stage if required	
UNIT - V	**Periods: 5L+5P=10**
Test Phase: Methods and Tools & Implementation	
Test Phase: Methods and Tools Testing sheet, Feedback capture grid, Powerful questions in experience testing, Solution interview, Structured usability testing, A/B Testing **Implementation:** Road map for implementation, Problem to growth & scale innovation funnel **Activities:** a. Test the developed prototype by test phase tools and finalize the solution to the problem. b. Iterate the process at any stage if required c. Prepare the complete project report.	
TEXT BOOKS:	
1.	Daniel Ling "*Complete Design Thinking Guide for Successful Professionals*", Emerge Creatives Group LLP, Print ISBN: 978-981-09-5564-9.
2.	Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, HarperCollins e-books, 2009.
3.	Jeanne Liedtka, Andrew King, And Kevin Bennett, "*Solving Problems with Design Thinking"* , Columbia University Press Publishers, E-ISBN 978-0-231-53605-9
4.	Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Toolbox,* John Wiley & Sons, 2020.
REFERENCE BOOKS:	
1.	Michael G. Luchs, Scott Swan, Abbie Griffin , *"Design Thinking: New Product Development Essentials from the PDMA"*, ISBN-13 : 978-1118971802
2.	Beverly Rudkin Ingle, *"Design Thinking for Entrepreneurs and Small Businesses"*, Apress, ISBN: 9781430261827
3.	Jose Betancur *"The Art of Design Thinking: Make More of Your Design Thinking Workshops",* ISBN: 9781522095378
4.	Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook, John Wiley & Sons, 2018

WEB RESOURCES:	
1.	https://dschool.stanford.edu/resources/design-thinking-bootleg
2.	https://www.ideo.com/post/design-thinking-for-educators
3.	https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58890239db29d6cc6c3338f7/1485374014340/METHODCARDS-v3-slim.pdf.
4.	https://www.intel.com/content/dam/www/program/education/us/en/documents/K12/design-and-discovery/student-guide-full-curriculum-session1-18.pdf

POWER ELECTRONICS LABORATORY	
EEE 416	**Credits:1.5**
Instruction: 3 Periods	**Sessional Marks:50**
End Exam: 3 Hours	**End Exam Marks:50**

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

COs	BLs	CO Statement
CO1	BL-4	**Analyze** the VI characteristics of SCR and **Illustrate** different turnoff and turn on methods.
CO2	BL-4	**Analyze** the operation of 1-phase & 3-phase rectifier circuits & **Examine** the output waveforms for different firing angles.
CO3	BL-4	**Analyze** the operation of on 1-phase inverter circuits & **Examine** the output waveforms for different frequencies.
CO4	BL-4	**Analyze** the operation of on 1-phase cycloconverter with different frequencies for different loads and **Compare** the output waveforms of 1-phase AC voltage controller circuits for different firing angles for different loads.
CO5	BL-4	**Distinguish** TRC & Frequency control methods on chopper circuits & **Examine** the output waveforms.

CO1: Action Verb (BT)-**Analyze, Illustrate**/ Cognitive level- Analysis (BL-4)

CO2: Action Verb (BT)-**Analyze, Examine**/ Cognitive level- Analysis (BL-4)

CO3: Action Verb (BT)-**Analyze, Examine**/Cognitive level- Analysis (BL-4)

CO4: Action Verb (BT)-**Analyze, Compare**/Cognitive level- Analysis (BL-4)

CO5: Action Verb (BT)-**Distinguish, Examine** /Cognitive level- Analysis (BL-4)

Program Matrix

	Program Outcomes (POs)												**PSOs**	
	Domain Specific POs					**Domain Independent POs**								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	3	3	1			1	1		1	0	2
CO2	2	3	1	3	3	1			1	1		1	0	2
CO3	2	3	1	3	3	1			1	1		1	0	2
CO4	2	3	1	3	2	1			1	1		1	0	2
CO5	2	3	1	3	2	1			1	1		1	0	2

S.No	Name of the Experiment	CO's
1	V-I characteristics of SCR.	CO1
2	SCR firing circuits (R, RC and UJT).	CO1
3	Forced commutation techniques.	CO1
4	Single-phase semi and full converters.	CO2
5	Three-phase semi-converter.	CO2
6	Single-phase AC voltage controller	CO4
7	Single-phase cyclo converter.	CO4
8	Jones Choppers.	CO5
9	Series converter.	CO3
10	Parallel converter.	CO3

POWER SYSTEM SIMULATION LABORATORY	
EEE 417	**Credits: 1.5**
Instruction: 3 Periods	**Sessional Marks:50**
End Exam: 3 Hours	**End Exam Marks:50**

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

COs	BLs	CO Statement
CO1	BL-3	**Obtain** Y-bus and **Determine** String efficiency using MATLAB program.
CO2	BL-4	**Analyze** the performance of transmission lines, transient stability and economic dispatch using MATLAB program.
CO3	BL-4	**Analyze** and **Simulate** symmetrical, unsymmetrical faults and load flow methods for a given power system network using ETAP software.
CO4	BL-4	**Analyze** and **Simulate** single area and two-area load frequency mechanism using MATLAB software.

CO1: Action Verb (BT)-**Determine**/ Cognitive level- Application (BL-3)

CO2: Action Verb (BT)-**Analyze**/ Cognitive level- Analysis (BL-4)

CO3: Action Verb (BT)-**Analyze, Simulate**/Cognitive level- Analysis (BL-4)

CO4: Action Verb (BT)-**Analyze, Simulate**/Cognitive level- Analysis (BL-4)

Program Matrix

	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	3				1	1		1	2	0
CO2	2	3	2	3	3				1	1		1	2	0
CO3	2	3	2	3	3				1	1		1	2	0
CO4	2	3	2	3	3				1	1		1	2	0

S.No	Name of the Experiment	CO's
1	Formation of Y-bus using MATLAB Software	CO1
2	Performance Analysis of Transmission Lines using MATLAB Software	CO2
3	String Efficiency of the Insulator using MATLAB Software	CO1
4	Solution of Swing Equation using MATLAB Software	CO2
5	Optimal Operation of Thermal Units without considering Transmission Losses using MATLAB Software	CO2
6	Optimal Operation of Thermal Units considering Transmission Losses using MATLAB Software	CO2
7	Three Phase Short circuit Analysis using ETAP Software	CO3
8	Load Flow Analysis using ETAP Software	CO3
9	Single Area Load Frequency Control Using MATLAB Software	CO4
10	Two Area Load Frequency Control Using MATLAB Software	CO4

Fourth Year Semester-2

Professional Elective-VI **HVDC AND FACTS**	
EEE 423	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I

HVDC TRANSMISSION

DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems

UNIT-II

ANALYSIS OF HVDC CONVERTERS

Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms

UNIT-III

CONVERTER AND HVDC CONTROL

Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control

UNIT-IV

Harmonics and Filters: Effects of Harmonics, sources of harmonic generation, Types of filters –Design examples

Power Flow Analysis in AC/DC Systems: Modelling of DC links, solutions of AC-DC Power flow

UNIT-V

FLEXIBLE AC TRANSMISSION SYSTEMS

FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters

Static Shunt Compensators:

Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics

Static Series Compensators:

Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

Combined Compensators:

Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

TEXT BOOKS

1. HVDC Power Transmission Systems –Technology and System Interactions" K.R.Padiyar, New Age International Publishers
2. "Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems" Narain G.Honorani, Laszlo Gyugyi

Professional Elective-VI **SMART GRID**	
EEE 423	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I

INTRODUCTION TO SMART GRID

What is Smart Grid? Working definitions of Smart Grid and Associated Concepts –Smart Grid Functions-Traditional Power Grid and Smart Grid –New Technologies for Smart Grid –Advantages –Indian Smart Grid –Key Challenges for Smart Grid.

UNIT-II

SMART GRID ARCHTECTURE

Components and Architecture of Smart Grid Design –Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs –Transmission Automation –Distribution Automation –Renewable Integration

UNIT-III

TOOLS AND TECHNIQUES FOR SMART GRID

Computational Techniques: Static and Dynamic Optimization Techniques –Computational Intelligence Techniques –Evolutionary Algorithms –Artificial Intelligence techniques.

Distribution Generation Technologies: Introduction to Renewable Energy Technologies –Micro grids –Storage Technologies –Electric Vehicles and plug –in hybrids –Environmental impact and Climate Change –Economic Issues.

Communication Technologies and Smart Grid: Introduction to Communication Technology –Synchro Phasor Measurement Units (PMUs) –Wide Area Measurement Systems (WAMS).

UNIT-V

CONTROL OF SMART POWER GRID SYSTEM

Load Frequency Control (LFC) in Micro Grid System –Voltage Control in Micro Grid System –Reactive Power Control in Smart Grid, Case Studies and Test beds for the Smart Grids.

TEXT BOOKS

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.
3. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2010.
4. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2005.

Professional Elective-VI **ADVANCED POWER ELECTRONIC CONVERTERS**	
EEE 423	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I
SWITCHING VOLTAGE REGULATORS
Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converter, Cuk converters and their analysis for continuous and discontinuous mode.

UNIT-II
CONVERTERS
Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, Sepic Converter; SMPS.

UNIT-III
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

UNIT-IV
MULTI-LEVEL CONVERTERS
Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations, applications.

UNIT-V
DC-AC SWITECHED MODE INVERTERS
PWM, SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, applications, merits and demerits.

TEXT BOOKS

1. Power Electronics – Converters, Applications and Design Ned Mohan, Tore M. Undeland and William P. RobbinsJohn Willey & sons
2. Power Electronics - Circuits, Devices and Applications Muhammad H. Rashid Prentice Hall of India
3. High Power Converters and AC Drives Bin WuJohn Willey & sons, Inc.,
4. Power Electronic Converter Harmonics – Multipulse Methods for Clean PowerDerek A. PaiceIEEE Press
5. Power Electronics Handbook Muhammad H. Rashid Elsevier
6. Modern Power Electronics P.C.Sen S. Chand and Co. Ltd.
7. Power Electronics Essentials and Applications L. Umanand Wiley India Pvt Ltd

Professional Elective-VI **SLIDING MODE CONTROL**	
EEE 423	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I: An Introduction to Sliding Mode Control: Introduction, properties of sliding motion, typical controller design, pseudo-sliding with a smooth control action, a state-space approach

UNIT-II: Sliding mode control: Introduction, problem statement, existence of solution and equivalent control properties of the sliding motion, The reachability problem, the unit vector approach, continuous approximations.

UNIT-III: Sliding mode Design approaches: Introduction, A regulator form based approach, a direct Eigen structure assignment approach, Incorporation of a tracking requirement, Design study of Pitch- pointing flight controller.

UNIT-IV: Sliding mode controllers using output information: Introduction, problem formulation, a special case of square plants, a general frame work, dynamic compensation, observer based dynamic compensation, a model reference system using only outputs.

UNIT-V: Sliding mode observers: Introduction, sliding mode observers, synthesis of a discontinuous observer, the Walcott-Zak observer revisited, sliding mode observers for fault detection

TEXT BOOK:

1. Sliding Mode Control: Theory And Applications (Series in Systems and Control) by C Edwards and S Spurgeon, Published by Taylor & Francis,

REFERENCE BOOK

1. Sliding Mode Control In Engineering (Automation and Control Engineering) by Wilfrid Perruquetti , Jean-Pierre Barbot published by Marcel Dekker, Inc, New York

Professional Elective-VI **ELECTRICAL INSTALLATION, ESTIMATING AND COSTING**	
EEE 423	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

SYLLABUS

UNIT-I [12 HOURS]

Installation testing and maintenance - Types of heavy Electrical equipment, unloading accessories precautions for unloading, installation of small and large machines of both static and rotating type. Installation of pole mounted transformer. Instruments used for measuring insulation resistance, reasons for deterioration of insulation resistance, improving insulation resistance, drying of insulation, Measurement of internal temperature of winding, vacuum impregnation / filtering of insulating oil, testing of insulating oil.

UNIT-II [10 HOURS]

Earthing - Reasons of Earthing, Earthing system, earth lead and its size, permissible earth resistance for different installations, improvement of earth resistance, double Earthing, earth resistance measurement, rules for Earthing.

UNIT-III **[10 HOURS]**

Elements of Estimating -Principles of estimating, purchase procedure, cost of materials, various charges like labour, stores, overhead tools, contingency etc.

UNIT-IV [12 HOURS]

Domestic and Industrial Wiring -Various types of wiring systems including P.V.C. pipe, their merits and demerits. Calculation of total load & selection of wire, preparation of estimates for a small residential building, big institution or office building. Estimate for single store yard, multistory building. Estimate for a small workshop and industrial installation, agricultural pump, domestic pump, floor mills etc. Estimation of total cost.

UNIT-V [12 HOURS]

Substations -Various types of sub-stations, pole-mounted in-door and out-door substations. Estimating quantity and cost for a substation of a given specification.

Overhead lines - H.T. & H.T. lines Preparation of estimate and costing of 11KV or 33KV line. Selection of routes. Estimates for distribution lines- Location of poles for a given situation or locality. Providing street lights, necessary hardware, stay arrangements, underground cables, providing services lines using underground cables.

TEXT BOOKS

1. Electrical Installations work by T.G. Ffancist. E.L.B.S (Vth metric edition)
2. Electrical Installations Maintenance & fault location work book by T.T.T.I.(W.R.) Bhopal 3. Preventive maintenance Electrical equipment by Charies J Hurburt.

RESEARCH METHODOLOGY	
EEE 424	**Credits : 0**
Instruction : 2 Periods /Week	**Sessional Marks : 00**
End Exam : 0 Hours	**End Exam Marks : 00**

SYLLABUS

Unit-1: Introduction, Problem Identification & Formulation

Introduction to Research: Foundation, Objectives, Motivation, Concept of Utility theory, empiricism, deductive and inductive theories. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Research Process. Problem Identification & Formulation – Research Questionnaires – Investigation Questionnaires – Measurement Issues – Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

Unit-2: Research Design & Qualitative, Quantitative Approaches

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

Unit-3: Experimental Design & Sampling

Concept of Independent & Dependent variables. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Guidelines for designing experiments, Experiments with single factor: Analysis of Variance, Analysis of the fixed effects model, Model adequacy checking, sample computer output, Regression approach to the Analysis of Variance.

Unit-4: Data Analysis

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

Unit-5: Interpretation and Writing of Paper

Layout of a Research Paper, Journals in Mechanical Engineering, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Data bases for Mechanical Engineering Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

REFERENCE BOOKS:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari