Ph.D (Electrical and Electronics Engineering)

Course Work: Curriculum and Syllabi

2023 - 2024

Department of Electrical and Electronics Engineering

Faculty of Engineering

Enable | Enlighten | Enrich

KARPAGAM

ACADEMY OF HIGHER EDUCATION

(Deemed to be University)

(Established Under Section 3 of UGC Act, 1956)

KARPAGAM ACADEMYOFHIGHER EDUCATION

Faculty of Engineering

Department of Electrical and Electronics Engineering

(Deemed University Established Under Section 3of UGCAct1956)

Pollachi Main Road, EachanariPost, Coimbatore- 641021,India.

PhD Course Work Subjects
(Effective from the academic year 2023-2024 onwards)

Paper No.	Subject Code	Subject	Credit	ESE	total
Paper 1	23REEE101	Research Methodology and Pedagogy	4	100	100
Paper II	23REEE201	Research and Publication Ethics	4	100	100
Paper III	23REEE301	Renewable Energy Sources	4	100	100
	23REEE302	Advances in Power Electronics	4	100	100
	23REEE303	Advances in Power Systems	4	100	100
	23REEE304	Distributed Generation	4	100	100
	23REEE305	Smart Grids	4	100	100
	23REEE306	Advanced Control Systems	4	100	100
	23REEE307	Analysis of Inverter Circuits	4	100	100
	23REEE308	Analysis of Converter Circuits	4	100	100
	23REEE309	Power Quality Assessment &Mitigation	4	100	100
	23REEE310	Computer Aided Design of Electrical Apparatus	4	100	100
	23REEE311	Energy Auditing, Energy Efficiency and Energy Conversion	4	100	100
	23REEE312	Power Electronics Applications to Power Systems	4	100	100
	23REEE313	Special Electrical Machines	4	100	100
	23REEE314	Advanced Bio-Medical Digital Signal Processing	4	100	100
	23REEE315	Power Sector Economics, Management and Restructuring	4	100	100
	23REEE316	Wind Energy Conversion Systems	4	100	100
	23REEE317	Theory and Design of Neuro-Fuzzy Controllers	4	100	100
	23REEE318	Soft Computing Techniques	4	100	100
	23REEE319	Flexible AC Transmission Systems	4	100	100
	23REEE320	HVDC Systems	4	100	100
	23REEE321	Digital Power System Protection	4	100	100
	23REEE323	Optimization Techniques	4	100	100
	23REEE323	Embedded Systems	4	100	100
	23REEE324	Artificial Intelligence Applications to Power Systems	4	100	100

Part I - Ph.D - Syllabus
Paper I: 23REEE101 RESEARCH METHODOLOGY AND PEDAGOGY
(Effective from the academic year 2023-2024 onwards)

UNIT I INTRODUCTION TO RESEARCH METHODOLOGY

Research – Definition – Importance and Meaning of research – Characteristics of research – Types of Research – Steps in research – Identification, Selection and formulation of research problem – Research questions – Research design – Formulation of Hypothesis – Review of Literature.

UNIT II SAMPLING TECHNIQUES

Sampling theory – types of sampling – Steps in sampling – Sampling and Non-sampling error – Sample size – Advantages and limitations of sampling. Collection of Data: Primary Data – Meaning – Data Collection methods – Secondary data – Meaning – Relevance, limitations and cautions.

UNIT III HYPOTHESES TESTS

Statistics in Research – Measure of Central tendency – Dispersion – Skewness and Kurtosis in research. Hypothesis – Fundamentals of Hypothesis testing – Standard Error – Point and Interval estimates – Important Non-Parametric tests : Sign, Run, Kruskal – Wallis tests and Mann-Whitney test.

UNIT IV PARAMETRIC TESTS AND REPORT WRITING

Para metric tests : Testing of significance – mean, Proportion, Variance and Correlation – testing for Significance of difference between means, proportions, variances and correlation co-efficient. Chi-square tests – ANOVA – One-way and Two-way. Research Report : Types of reports – contents – styles of reporting – Steps in drafting reports – Editing the final draft – Evaluating the final draft.

UNIT VPEDAGOGICAL METHODS IN HIGHER LEARNING

Objectives and roll of higher education – Important characteristics of an effective Lecture – Quality teaching and learning – Lecture preparation – Characteristics of instructional design – Methods of teaching and learning : Large group – Technique – Lecture, Seminar, Symposium, Team Teaching, Project, Small group Technique – Simulation, role playing Demonstration, Brain storing, case discussion, and assignment, Methods of evaluation – Self-evaluation, student evaluation, Diagnostic testing and remedial teaching – Question banking – Electronic media in education: - ‘e’ learning researches – web based learning

TEXT BOOKS:

- Rajasekar.S (2005) Computer Education and educational computing. Hyderabad: Neel kamal Publications.
- Kumar K.L. (1997) Educational Technologies, New Delhi: New age International.
- Vedanayagam, E.G (1989) Teaching Technology for college teachers. New Delhi: Sterling Publishers (P) Ltd.,

REFERENCES:

- Kothari C.R. Research Methodology Methods and Techniques, New Age Publications, Second edition,2009
- Panneer selvam R., Research Methodology, Prentice-Hall of India, New Delhi,2004

Paper II: 23REEE201 RESEARCH AND PUBLICTION ETHICS
(Effective from the academic year 2023-2024 onwards)

UNIT I PHILOSOPHY AND ETHICS (3 HRS)

Introduction to philosophy: definition, nature and scope, concept, branches - Ethics: definition, moral philosophy, nature of moral judgments and relations.

Unit II SCIENTIFIC CONDUCT (5 HRS)

Ethics with respect to science and research - Intellectual honest and research integrity - Scientific misconducts: falsification, fabrication, and plagiarism - Redundant publications: duplicate and overlapping publications, salami slicing - Selective reporting and misrepresentation of data.

UNIT III PUBLICATION ETHICS (7 HRS)

Publication ethics: definition, introduction and importance - Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. - Conflicts of interest - Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types - Violation of publication ethics, authorship and contributor ship - Identification of publication misconduct, complaints and appeals - Predatory publishers and journals

UNIT – III OPEN ACCESS PUBLISHING (4 HRS)

Open access publications and initiatives - SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

UNIT IV PUBLICATION MISCONDUCT (4 HRS)

Group Discussions: Subject specific ethical issues, FFP, authorship - Conflicts of interest - Complaints and appeals: examples and fraud from India and abroad Software tools - Use of plagiarism software like Turnitin, Urkund and other open source software tools.

UNIT V - DATABASES AND RESEARCH METRICS (7 HRS)

Databases: Indexing databases - Citation databases: Web of Science, Scopus, etc.

Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score - Metrics: h-index, g index, i10 index, altmetrics

UNIT VI Development of e-content & IPR

Integrated Library Management System (ILMS): e-journals – e-books – e-sjodhsindu – shodhganga – Database – e-content development – Learning Management System (LMS) – e-PG-Pathshala – CEC (UG) SWAYAM – MOOCs – NPTEL – NMEICT.

IPR: Patent – copyrights – Trademark – Geographical Indication.

PRACTICE

Open access publications and initiatives - SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies - Software tool to identify predatory publications developed by SPPU - Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Paper III: 23REEE301 RENEWABLE ENERGY SOURCES
(Effective from the academic year 2023-2024 onwards)

UNIT – I SOLAR ENERGY

Introduction to solar energy: solar radiation, availability, measurement and estimation– Solar thermal conversion devices and storage – solar cells and photovoltaic conversion – PV systems – MPPT. Applications of PV Systems – solar energy collectors and storages.

UNIT – II WIND ENERGY

Introduction – Basic principles of wind energy conversion – wind data and energy estimation – site selection consideration – basic components of wind energy conversion system –Types of wind machines – basic components of wind electric conversion systems. Schemes for electric generations – generator control, load control, energy storage – applications of wind energy – Inter connected systems.

UNIT – III CHEMICAL ENERGY SOURCES

Introduction – fuel cells – design and principles of operation of a fuel cell –
Classification of fuel cells. Types of fuel cells – conversion efficiency of fuel cells. Types of electrodes, work output and emf of fuel cell, Applications of fuel cells. Hydrogen energy: Introduction – hydrogen production – electrolysis, thermo chemical methods, Westing House Electro-chemical thermal sulphur cycle. Fossil fuel methods. Hydrogen storage, Utilization of hydrogen gas.

UNIT – IV ENERGY FROM OCEANS

Introduction, ocean thermal electric conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, closed OTEC cycle. Energy from tides: Basic principles of tidal power, component of tidal power plants, operation methods of utilization of tidal energy, site requirements, storage, advantages and limitations of tidal power generation. Ocean waves, energy and power from the waves, wave energy conversion devices.

UNIT – V GEOTHERMAL ENERGY

Introduction, estimation of geothermal power, nature of geothermal fields, Geothermal sources, inter connection of geothermal fossil systems, prime movers for geo thermal energy conversion. Application of geothermal energy. Energy from biomass: Introduction, Biomass conversion technologies, photosynthesis, classification of biogas plants. Biomass Energy conversion, Energy from waste.

TEXT BOOKS:

- Goswami, D.Y., Kreith, F., and Kreider, J.F., 2000, Principles of Solar Engineering, Taylor and Francis, Philadelphia.
- Duffie, J.A., and Beckman, W.A., 1991, Solar Engineering of Thermal Processes, 2nd Edition, John Wiley, New York.

REFERENCES

- Rai, G.D., Non-Conventional Energy Sources. Khanna publishers, Fourth edition,2010
- Twidell, J., and Weir, T., 2006, Renewable Energy Resources, E&FN Spon Ltd., London.
- Sukatme, S.P., 1991, Solar Energy – Principles of thermal collection and storage, 2nd Edition, Tata Mc Graw Hill, New Delhi.

Paper III: 23REEE302ADVANCES IN POWER ELECTRONICS
(Effective from the academic year 2023-2024 onwards)

UNIT-I RESONANT CONVERTERS

Zero voltage and zero current switching-Classification of resonant converters-Basic resonant circuit concepts-Load resonant converters-Resonant switch converters-Zero voltage switching, clamped voltage topologies-Resonant DC link inverters and zero voltage switching- High frequency link integral half cycle converters – Applications in SMPS and lighting.

UNIT-II IMPROVED UTILITY INTERFACE

Generation of current harmonics – Current harmonics and power factor-Harmonic standards and recommended practices-Need for improved utility interface-Improved single phase utility interface- Improved three phase utility interface – Electromagnetic interference

UNIT-III FACTS

Introduction – Principles of reactive power control in load and transmission line compensation-Series and shunt reactive power compensation – Concepts of flexible AC Transmission system(FACTS) –Static var compensators(SVC)-Thyristor controlled reactor-Thyristor switched capacitor –Solid state power control-Static condensers-Controllable series compensation-Thyristor controlled phase angle regulator and unified power flow control.

UNIT-IV MODELING AND ANALYSIS

Modeling and methods of analysis of SVC and FACTS controllers – System control and protection –Harmonics and Filters –Simulation and study of SVC and FACTS under dynamic conditions.

UNIT-V EMERGING DEVICES AND CIRCUITS

Power Junction Field Effect Transistors-Field Controlled Thyristors-JFET based devices Vs other power devices-MOS controlled thyristors-Power integrated circuits-New semiconductor materials for power devices.

TEXT BOOKS:

- Bimal k Bose, “Modern Power Electronics-Evolution, Technology and application”, Jaico Publishing House, Mumbai, 2006
- Ned Mohan., Undeland and Robbins, ”Power Electronics: Convertors, Applications and Design”, John Wiley and Sons(Asia) Pte Ltd, Singapore, 2003.

REFERENCES

- Rashid, M.H., “Power Electronics-Circuits, Devices and Applications”, Pearson Education(Singapore)Pte. Ltd, New Delhi, 2004./Prentice Hall of India, New Delhi.
- Mohan Mathur P, Rajiv K Varma, “Thyristor- Based Facts Controllers for Electrical Transmission Systems”, John Wiley and Sons Inc., IEEE Press, UAS, 2002.
- Roger C Durgan, Maric F Mcgranaghan, “Electrical Power System Quality”, Mc-Graw Hill Inc, New York ,1996.
- Joseph Vithayathil., “Power Electronics”, Mc-Graw Hill series in Electrical and Computer Engineering, USA, 1995.

Paper III: 23REEE303ADVANCES IN POWER SYSTEMS
(Effective from the academic year 2023-2024 onwards)

UNIT-I ECONOMIC DISPATCH

Planning and operational problems of power systems - review of economic dispatch and calculation using B matrix loss formula - Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ-iteration method-Base point and participation factors in on line economic dispatch. Economic dispatch controller added to LFC control.

UNIT-II REAL POWER AND REACTIVE POWER

Fundamentals of speed governing mechanism and modeling- Speed-load characteristics – Load sharing between two synchronous machines in parallel - Plant and system level control problem - ALFC of single area system - modelling-static and transient response - ALFC of multi area system-modelling - static and transient response of two area system - development of state variable model -Two area system- AGC system design Kalmans method. Modeling of AVR loop -components - dynamic and static analysis - stability compensation - system level voltage control using OLTC, capacitor and generator voltages -expert system application for system voltage control.

UNIT-III VOLTAGE STABILITY ANALYSIS-I

Transmission and generation and load aspects. Instability mechanisms and analysis methods: mathematical background -differential equations, bifurcations, multiple time scales.

UNIT-IV VOLTAGE STABILITY ANALYSIS-II

Modeling for voltage stability analysis: time scale decomposition Equilibrium equations for voltage stability analysis. Loadability, sensitivity and bifurcation analysis-eigenvector and singular vector properties-loadability or bifurcation surface-case studies short term and long term voltage instability and counter measures.

UNIT-V SOLUTIONS METHODS AND MODELS FOR ANALYSIS OFELECTROMAGNETIC TRANSIENTS

Steady state and time step solutions in EMTP and their uses-models of synchronous, and induction machines EMTP; Selected case studies.

TEXT BOOKS:

- Allen J Wood and Bruce F Wollenberg, 2013, Power generation and control, John Wiley and sons, New York.
- Kundur, P., 2008 , Power system stability and control, EPRI publications, California.

REFERENCES

- Cutsem,T.V., Vournas, C., 1998,Voltage stability of power systems, Kluwer Academic Publishers.
- Dommel, H.W., August 1986, Electromagnetic Transients Program, Reference Mannual prepared for Bonnerville Power Administration, U.S.A..

Paper III: 23REEE304DISTRIBUTED GENERATION
(Effective from the academic year 2023-2024 onwards)

UNIT I INTRODUCTION TO DISTRIBUTED GENERATION

Introduction to the concept of distributed generation - Distributed generation advantages and needs - Radial distribution system protection: Fuse, circuit breakers, reclosers- Per-unit analysis, fault analysis, sequence component analysis, sequence models of distribution system components. Implications of DG on distribution system protection coordination.

UNIT II DISTRIBUTION SYSTEM LOADING

Introduction – Distribution system loading, line drop model, series voltage regulators and on line tap changers- Power quality requirements and source switching using SCR based static switches- Loop and secondary network distribution grids and impact of DG operation.

UNIT III RELAYING AND PROTECTION

Relaying and protection, distributed generation interconnection relaying, sensing using CTs and PTs- Intentional and unintentional islanding of distribution systems. Passive and active detection of unintentional islands, non detection zones - EMI considerations in DG applications.

UNIT IV DISTRIBUTED GENERATION PLANNING

DG planning and forecasting techniques - Load characteristics: Definitions - tariffs and metering of energy, cost implications of power quality, cost of energy and net present value calculations and implications on power converter design- Distribution Transformers: Types. Distribution sub-stations and primary systems: Voltage drop and power loss calculations: Distribution feeder costs.

UNIT V DG INVERTERS CONTROL

Control of DG inverters, phase locked loops, current control and DC voltage control for stand alone and grid parallel operations. Protection of the converter.

TEXT BOOKS

- A Textbook of Electric Power Distribution Automation by Dr. M.K. Khedkar, Dr. G.M. Dhole Laxmi Publications, Ltd 2010.

REFERENCES

- Power Electronics: Converters, Applications, and Design by Ned Mohan, Tore M. Undeland, William P. Robbins Wiley,2002
- Electric Power Distribution Systems by TuranGonen, CRC Press, 2006
- Electric Power Distribution by Pabla, A. S 6th Edition, Tata McGraw-Hill Education 2011

Paper III: 23REEE305 SMART GRIDS
(Effective from the academic year 2023-2024 onwards)

UNIT I INTRODUCTION : SMART GRID AND EMERGING TECHNOLOGIES

Defining a smart grid – Characteristics of smart grid - Values of a smart grid – The economic Case – The environmental Case – Benefits to utilities – Benefits to consumers – Power system components – Power system protection: Traditional Vs Smart – Case study – Generation fundamentals – Traditional Generations – Distributed Generations – micro grid generation – Generator Protection – Challenges and Opportunities – Cost of smart grid – Government Regulations – Emerging Technologies - FACTS – optimizing integration systems – Multi generation buildings – Case study.

UNIT II SMART GRID: MODELS AND OPERATING PRINCIPLES

Solar Photovoltaic models and grid Integration – Design of a 2 MVA PV station – DG system as part of utility power system – The smart grid PV - UPS DG system – Split DC Bus UPS – PV DG system – Island mode of operation – Parallel operation of Inverters – Power Quality. Wind turbine model and grid Integration – Micro turbine model & Grid Integration. Electric Vehicle model and Grid Integration.

UNIT III SMART GRID: DISTRIBUTED GENERATION SYSTEMS

Power Converter System – Control System Development – Current limit and Saturation Control, Simulation using simulate and MATLAB. Inverter Parallel operation – Load sharing control Algorithm – Distributed Generation System and Newton Raphson method in power flow – Plant modeling and 3 phase 4 wire DG unit topology – Single distributed generation System –MIMO Linear system Stability robustness – PWM rectifier control – 3 Phase AC – DC – AC topology.

UNIT IV ENERGY STORAGE AND COMMUNICATION

State–of–the art storage devices – Battery types – Ultra capacitors based Energy Storage System – Flywheel – Wide Area Network – Substation Information System – Wireless Networks – Distribution Automation – AMI Networks – Utility monitoring and Control – Inter-system Coordination – Industrial systems – Consumer Residential Systems – Network Protection – Channel model Fundamental – Low, medium, High voltage, main Topologies – Residential and Business Indoor wiring Topologies – The Power line Channel model – Digital Transmission Techniques - Threats – IEC61850 Considerations.

UNIT V SMART GRID: RELIABILITY, STABILITY AND COMPONENT INTEGRATION

Smart Grid Programming – Virtual Power Producer – Intelligent reconfiguration using SCADA – Problems in distributed grids – Solutions. Integration of Mini – Micro generation in distribution Grids – Power supply Quality generic standards – Renewable Energies specific standards – Smart Grid stability analysis schemes – Supply guarantee and Power quality – Integration in power systems – Distributed Generation advantages and needs.

REFERENCES

- Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities by Fox-Penner Island Press, Washington DC 2010
- Smart Grid: Modernizing Electric Power Transmission and Distribution; Energy Independence, Storage and Security; Energy Independence and Security Act and Resiliency by StanMark Kaplan, Fred SissineThe Capitol.Net, Washington DC,2009
- Integration of Green and Renewable Energy in Electric Power Systems by Ali Keyhani Mohammad N. Marwali , Min Dai Wiley, USA ,2009
- Power Electronics in Smart Electrical Energy Networks by Ryszard Michal Strzelecki , Grzegorz Pawel Benysek Springer, USA 2008

Paper III: 23REEE306 ADVANCED CONTROL SYSTEMS
(Effective from the academic year 2023-2024 onwards)
ADVANCED CONTROL SYSTEMS

UNIT 1 STATE VARIABLE ANALYSIS

Concept of state – State Variable and State Model – State models for linear and continuous time systems – Solution of state and output equation – controllability and observability - Pole Placement –State observer Design of Control Systems with observers

UNIT II PHASE PLANE AND DESCRIBING FUNCTION ANALYSIS

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearising non-linear systems - Construction of phase portraits – Singular points – Limit cycles Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – Conditions for stability – Stability of oscillations.

UNIT III Z-TRANSFORM AND DIGITAL CONTROL SYSTEM

Z transfer function – Block diagram – Signal flow graph – Discrete root locus – Bode plot.

UNIT 1V STATE-SPACE DESIGN OF DIGITAL CONTROL SYSTEM

State equation – Solutions – Realization – Controllability – Observability – Stability – Jury's test.

UNIT V OPTIMAL CONTROL

Introduction -Decoupling - Time varying optimal control – LQR steady state optimal control Optimal estimation – Multivariable control design.

TEXT BOOKS

- Control Systems Engineering By I.J. Nagrath and M. Gopal New Age International Publishers – 4th edition 2006
- Modern control Design with Matlab and Simulink by Ashish Tewari John Wiley, New Delhi 2002
- Digital Control Systems by Benjamin C. Kuo Oxford University Press – 2nd edition,2012.

REFERENCES

- Modern control system theory by M.Gopal New Age International Publishers,2002
- Feedback Control of Dynamic Systems by Gene F. Franklin, J. David Powell and Abbasemami-NaeiniPrentice Hall, 7th edition,2014
- Design of feedback Control systems by Raymond T. Stefani & Co Oxford University Press,2002

Special Paper III: 23REEE307 ANALYSIS OF INVERTER CIRCUITS
(Effective from the academic year 2023-2024 onwards)

UNIT- I SINGLE PHASE INVERTERS

Principle of operation of half and full bridge inverters – Performance parameters – Voltage and wave form control of single phase inverters using various PWM techniques – SVM Technique.

UNIT- II THREE PHASE VOLTAGE SOURCE INVERTERS

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage and wave form control of three phase inverters –SVM Technique.

UNIT- III CURRENT SOURCE INVERTERS

Operation of six-step thyristors inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters.

UNIT- IV MULTILEVEL INVERTERS

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - comparison of multilevel inverters - application of multilevel inverters.

UNIT- V RESONANT INVERTERS

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters.

TEXT BOOKS

- Rashid, M.H., 2004, Power Electronics Circuits, Devices and Applications, 3rd Edition, Prentice Hall of India, New Delhi.
- Jai P Agrawal, 2002, Power Electronics Systems, Pearson Education, 2nd Edition.
- Ned Mohan, Undeland and Robins, 1995, Power Electronics: converters, Application and design, John Wiley and sons Inc, Newyork.

REFERENCES

- Sen, P.C. 1998, Modern Power Electronics, 1st Edition, Wheeler Publishing Co, New Delhi.
- Bimbra, P.S., 2003, Power Electronics, 11th Edition, Khanna Publishers.
- Bimal K Bose, 2003, Modern Power Electronics and AC Drives, 2nd Edition, Pearson Education.
- Singh, M.D., Khanchandan, K.B., 2002, Power Electronics, Tata McGraw Hill Publishing Limited, New Delhi.

Special Paper III: 23REEE308 ANALYSIS OF CONVERTER CIRCUITS
(Effective from the academic year 2023-2024 onwards)

UNIT- I SINGLE PHASE AC-DC CONVERTER

Uncontrolled, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation – Dual converter - Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap.

UNIT -II THREE PHASE AC-DC CONVERTER

Uncontrolled and fully controlled – converter with R, R-L, R-L-E - loads and freewheeling diodes – inverter operation and its limit – dual Converter – performance parameters – effect of source impedance and overlap.

UNIT- III DC-DC CONVERTERS

Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters – time ratio and current limit control – Full bridge converter – Resonant and quasi – resonant converters.

UNIT- IV AC VOLTAGE CONTROLLERS

Principle of phase control: single phase and three phase controllers – various configurations – analysis with R and R-L loads.

UNIT- V CYCLOCONVERTERS

Principle of operation – Single phase and three phase cycloconverters – power circuits – Output Voltage control – Control Schemes.

TEXT BOOKS

- Ned Mohan, Undeland and RoMEPEin, 2007, Power Electronics: converters, Application and design, John Wiley and sons.Inc, Newyork.

- Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall of India, New Delhi, 1995.

REFERENCES

- Bimbra, P.S., 2003, Power Electronics, 11th Edition, Khanna Publishers.

- Dubey, G.K.,Doradla, S R., Joshi, A., Sinha, R.M K., 2004, Thyristorised Power Controllers, 1st Edition, New Age International Private Ltd.

Special Paper IIII: 23REEE309 POWER QUALITY ASSESSMENT AND MITIGATION
(Effective from the academic year 2023-2024 onwards)

UNIT- I INTRODUCTION

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding.

UNIT- II FLICKERS AND TRANSIENT VOLTAGES

RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Various means to reduce flickers. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

UNIT- III VOLTAGE SAG, SWELLS AND INTERRUPTIONS

Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag *limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions.

UNIT- IV WAVEFORM DISTORTION

Definition of harmonics, inter-harmonics, sub-harmonics. Causes and effect of harmonics. Voltage versus current distortion. Overview of Fourier analysis. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Harmonic filtering, passive and active filters. Modifying the system frequency response. IEEE Harmonic standard 519-1992.

UNIT -V POWER QUALITY MONITORING, ASSESSMENT AND MITIGATION

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors,
data collection and analysis. Selection of transducers. Harmonic monitoring, transient monitoring, event recording and flicker monitoring.
Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion, voltage and current unbalances. Power assessment under waveform distortion conditions. Power quality state estimation, State variable model, observability analysis, capabilities of harmonic state estimation. Test systems. Mitigation techniques at different environments.

TEXT BOOKS

- M. H. J. Bollen IEEE press, 2000, Understanding power quality problems, voltage sag and interruptions - series on power engineering.
- Roger C. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty 2002 ,Electrical power system quality ,second edition, McGraw Hill Pub.

Special Paper III23REEE310 COMPUTER AIDED DESIGN OF ELECTRICAL APPARATUS

(Effective from the academic year 2023-2024 onwards)

UNIT- I INTRODUCTION

Conventional design procedures – Limitations – Need for field analysis based design.

UNIT- II MATHEMATICAL FORMULATION OF FIELD PROBLEMS

Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in field problems – Inductance- Development of torque/force- Lap lace and Poisson's Equations – Energy functional - Principle of energy conversion.

UNIT - III PHILOSOPHY OF FEM

Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variational method- 2D field problems – Discretisation – Shape functions – Stiffness matrix – Solution techniques.

UNIT - IV CAD PACKAGES

Elements of a CAD System –Pre-processing – Modelling – Meshing – Material properties- Boundary Conditions – Setting up solution – Post processing.

UNIT- V DESIGN APPLICATIONS

Design of Solenoid Actuator – Induction Motor – Insulators – Power transformer.

TEXT BOOKS

- Salon, S.J., 1995, Finite Element Analysis of Electrical Machines, Kluwer Academic Publishers, London.

- Hoole, S.R.H., 1989, Computer – Aided, Analysis and Design of Electromagnetic Devices, Elsevier, New York, Amsterdam, London.

REFERENCES

- Silvester and Ferrari, P.P., 1983, Finite Elements for Electrical Engineers, CambridgeUniversity press.

- Lowther, D.A., and Silvester, P.P., 1986, Computer Aided Design in Magnetics, Springer verlag, New York.

Special Paper III: 23REEE311 ENERGY AUDITING, ENERGY EFFICIENCY AND ENERGY CONVERSION

(Effective from the academic year 2023-2024 onwards)

UNIT-I INTRODUCTION

Scope of energy management, necessary steps in energy management programme, general principles of energy management, qualities of energy manager, functions of energy manager, language of energy manager.

UNIT-II ENERGY AUDIT AND ENERGY CONSERVATION

Energy surveying and auditing, objectives, uses of energy, energy conservation schemes, energy index, cost index, pie charts, Sankey diagrams, load profiles (histrograms), types of energy audits preliminary energy audit-detailed energy audit, questionnaire, energy audit instruments, energy audit report writing.

Indian energy conservation act-2001, second law of thermodynamics, rules for efficient energy conservation of energy and materials, technologies for energy conservation(reducing demand using alternative supplies, load factor, balancing and energy storage), supply side options, demand side options, maximum demand controller, transmission and distribution side options.

UNIT-III ENERGY EFFICIENT MOTORS AND BOILERS

Constructional details, factors affecting efficiency, losses distribution, soft starters, variable speed drives.

Power Factor: Causes and disadvantages of low power factor, methods to improve power factor.

Energy Efficient lighting: Terminology, cosine law of luminance, types of lamps, characteristics, design of illumination systems, good lighting practice, lighting control, steps for lighting energy conservation.

Boilers: Fuels and combustion, type of boilers, performance evaluation, factors affecting boiler performance, data collection format for boiler performance assessment, case studies.

Steam Distribution System: Steam pipe sizing, proper selection of steam traps, optimum insulation, steam utilization, steam balance-energy saving opportunities.

Furnaces: Types and classification of furnaces, performance evaluation of a typical furnace, general fuel economy measures in furnaces, case studies.

UNIT-IV HEAT RECOVERY SYSTEMS AND COMPRESSED AIR NETWORK

Sources of waste heat, guidelines to identify waste heat, grading of waste heat, feasibility study of waste heat recovery, gas to gas heat recovery, rotary generators, heat pipes, gas to liquid heat recovery, waste heat boilers

Cogeneration: Definition and need, basics of thermodynamic cycles, classification of cogeneration systems, steam turbine, typical heat to power ratio in various industries, operating strategies for cogeneration plant, typical cogeneration performance parameters relative merits of cogeneration systems.

Compressed Air Network: Types of compressors, compressor selection, monitoring performance, specific power consumption, FAD test, capacity control and power consumption, compressed air distribution system, moisture separation.

UNIT-V HVAC (HEATING VENTILATION AND AIR CONDITIONING)

Vapour compression system, vapour absorption system, measurements/field testing, performance evaluation, heat pump, energy efficiency ratios, energy conservation opportunities, case studies.

Cooling Towers: Classification of pumps, centrifugal pump, system characteristics, pump operating point, factors affecting pump performance, pump efficiency, effect of over-sizing the pump, effect of speed variation/impeller diameter change, energy performance and evaluation of pumping system at sites, flow control strategies, meeting the fixed flow reduction, meeting the variable flow reduction.

Fans and Blowers: Types of fans and blowers, fan performance evaluation and efficient system operation, fan performance curves, fan selection, variable loads, flow control methods, energy.

TEXT BOOKS

- LC Witte, PS Schmidt and DR Brown: Industrial Energy Management and Utilization (Hemisphere Publishing corporation, Wasington, 1998).

- W Trinks, MH Mawhinney, RA Shannon, RJ Reed, JR Garvey: Industrial Furnaces, Sixth Edition, (John Wiley &Sons, 2003).

REFERENCES

- JL Threlkeld: Thermal Environmental Engineering, Second Edition (Prentice Hall, 1970).

- YP Abbi and Shashank Jain: Handbook on energy Audit and Environment Management, (TERI Press, 2006).

- WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007).

- George Polimeros:Enrgy Cogeneration Handbook,(Industrial Press, Inc, New York,1981)

Special Paper III: 23REEE312 POWER ELECTRONICS APPLICATIONS TO POWER SYSTEMS

(Effective from the academic year 2023-2024 onwards)

UNIT-1 INTRODUCTION

High power devices for power system controllers-Characteristics-Converters Configurations for large power control.

UNIT-II SINGLE AND THREE PHASE CONVERTERS

Properties-Current and Voltage harmonics-Effects of source and load impedance-Choice of best circuit for power systems.

UNIT III CONVERTER CONTROL

Gate control-Basic means of control-Control characteristics- Stability of Control –Reactive power control.

UNIT IV HVDC SYSTEMS AND FACTS

Application of converters in HVDC systems-Static VAR control-Sources of reactive power-Harmonics and Filters-Concept of Flexible AC Transmission system-Static VAR compensators-Thyristors controlled reactor – Thyristors switched capacitor- Static condenser-Controllable series compensation-UPFC-Static Voltage and Phase angle Regulators-Transient Stability Analysis.

UNIT-V ENERGY CONVERSION SYSTEM

Basic components-Generator control-Harmonics –Power factor improvement-PV Conversion Systems: Different schemes-DC and AC power conditioners- Synchronised operation with grid supply –Harmonic problems.

TEXT BOOKS

- Arrillaga and Watson, “Computer Modelling of Electrical Power Systems,: John Wiley, London, 2001.
- NarainG.Hingorani, “Understanding FACTS,” IEEE Press, New York, 2000.

REFERENCES

- E.Acha and VG Agilidis, “Power Electronic Control in Electrical Systems”, Elsevier,2002
- Mukund R. Ptel., Wind and Solar Power Systems, CRC Press, London, 1999.
- Rai, G.D., “Solar Energy Utilization”, Khanna Publishers, New Delhi, 1991.

Special Paper III: 23REEE313 SPECIAL ELECTRICAL MACHINES
(Effective from the academic year 2023-2024 onwards)

UNIT- I SYNCHRONOUS RELUCTANCE MOTORS

Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque – phasor diagram, motor characteristics.

UNIT- II SWITCHED RELUCTANCE MOTORS

Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control Microprocessor based controller.

UNIT- III PERMANENT MAGNET SYNCHRONOUS MOTORS

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.

UNIT- IV PERMANENT MAGNET BRUSHLESS DC MOTORS

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller.

UNIT- V STEPPING MOTORS

Constructional features, principle of operation, modes of excitation torque production in Variable Reluctance (VR) stepping motor, dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

TEXT BOOKS

- Miller, T.J.E., 1989, Brushless permanent magnet and reluctance motor drives, Clarendon Press, Oxford.

- Kenjo, T., 1989, Stepping motors and their microprocessor control, Clarendon Press, Oxford.

REFERENCES

- Kenjo, T and Naganori, S., 1989, Permanent Magnet and brushless DC motors, Clarendon Press, Oxford.

- Kenjo, T., 1989, Power Electronics for the microprocessor Age.

- Bose, B.K., 1997, Modern Power Electronics & AC drives, Prentice Hall, New Jersey.

Special Paper III: 23REEE314 ADVANCED BIO-MEDICAL DIGITAL SIGNAL PROCESSING
(Effective from the academic year 2023-2024 onwards)

UNIT- I: INTRODUCTION TO WAVELET TRANSFORMS
Basics of FT,FFT, DTFT, OFT, DIT-FFT, DIF-FFT algorithms, Introduction to wavelet transforms, Advantages, Applications, Limitations, Different types of wavelet transforms & their characteristics, The Discrete Wavelet Series, The Discrete Wavelet Transform, Multi Resolution Analysis

UNIT- II: NEUROLOGICAL SIGNAL PROCESSING
The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis, Linear prediction theory, The autoregressive (AR)· method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, Transient detection and elimination

UNIT- III: CARDIOLOGICAL SIGNAL PROCESSING
Basic electrocardiography, ECG data acquisition, ECG lead system, ECG parameters and their estimation, the use of multistate analysis for parameters estimation of ECG waveforms, Arrhythmia analysis monitoring, Long-term continuous ECG is recording.

UNIT- IV: ADAPTIVE FILTERS &ECG DATA REDUCTION TECHNIQUES
Principal noise canceller model, 60- Hz adaptive canceling using a sine wave model, applications of adaptive filtering, Direct data compression techniques, Direct ECG data compression techniques, Transformation compression technique,

UNIT- V: VLSI IN DSP:
Digital signal processors. High performance VLSI signal processing, VLSI applications in medicine, VLSI sensors for biomedical signals, VLSI tools, choice of custom, ASIC, or off-the- shelf components

TEXT BOOKS

- Biomedical Signal Processing: Principles and Techniques ,Tata McGraw-Hill Education, 2005 - Biomedical engineering.

- James D. Broesch, Dag Stranneby and William Walker. Digital Signal Processing: Instant access. Butterworth-Heinemann, 2004

REFERENCES

- VLSI digital signal processing systems Keshab K. Parhi, 1999

- Digital signal processing in VLSI Richard J. Higgins Prentice Hall, 1990.

Special Paper III: 23REEE315POWER SECTOR ECONOMICS, MANAGEMENT AND RESTRUCTURING
(Effective from the academic year 2023-2024 onwards)

UNIT-I POWER SECTOR IN INDIA, ECONOMICS AND REGULATION

Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act. Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost , annual rate of return , methods of calculations of Internal Rate of Return(IRR) and Net Present Value(NPV) of project, Short term and long term marginal costs, Different financing options for the power sector . Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India.

UNIT-II POWER TARIFF

Different tariff principles (marginal cost, cost to serve, average cost), Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, different tariff based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns. Government policies in force from time to time. Effect of renewable energy and captive power generation on tariff. Determination of tariff for renewable energy.

UNIT-III POWER SECTOR RESTRUCTURING AND MARKET REFORM

Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power.

UNIT-IV ELECTRICITY MARKETS PRICING AND NON-PRICE ISSUES

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices. Non price issues in electricity restructuring (quality of supply and service, standards of performance by utility, environmental and social considerations) Global experience with electricity reforms in different countries.

UNIT -V TRANSMISSION PLANNING AND PRICING

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right. Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction. Power purchase agreements.

TEXT BOOKS

- Sally Hunt, Making Competition Work in Electricity, 2002, John Wiley Inc.

- Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy. 1988

REFERENCES

- Regulation in infrastructure Services: Progress and the way forward - TERI, 2001.

- Maharashtra Electricity Regulatory Commission Regulations and Orders - Various publications, reports and presentations by Prayas, Energy Group, Pune ,2011

- Central Electricity Regulatory Commission, Regulations and Orders - Electricity Act 2003 and National Policies – Market Operations in Electric Power Systems Forecasting, Scheduling and Risk

Special Paper III: 23REEE316 WIND ENERGY CONVERSION SYSTEMS
(Effective from the academic year 2023-2024 onwards)

UNIT I INTRODUCTION

Wind machine types, classification, parameters. Wind, its structure, statistics, measurements, data presentation, power in the wind.

UNIT II AERODYNAMICS THEORY AND WIND TURBINE TYPES

Wind turbine aerodynamics, momentum theories, basic aerodynamics, airfoils and their characteristics, Horizontal Axis Wind Turbine (HA WT) - Blade Element Theory, wake analysis, Vertical Axis Wind Turbine (VA WT) aerodynamics.

UNIT III HORIZONTAL AXIS WIND TURBINE

HAWT rotor design considerations, number of blades, blade profile, 2/3 blades and teetering, coning, power regulation, yaw system, tower.

UNIT IV MODERN WIND TURBINE CONTROL

Wind turbine loads, aerodynamic loads in steady operation, wind turbulence, static - dynamic - fatigue analysis, yawed operation and tower shadow, WECS control system, requirements and strategies.

UNIT V WIND ENERGY CONVERSION SYSTEM

Wind Energy Conversion System (WECS) siting, rotor selection, Annual Energy Output (AEO). Synchronous and asynchronous generators and loads, integration of wind energy converters to electrical networks, inverters. Testing of WECS- Noise- Miscellaneous topics.

TEXT BOOKS:

- Kaldellis., Stand-alone and hybrid wind energy systems,CRS Press,2010
- John D Sorensen and Jens N Sorensen,Wind energy systems,Woodhead publishi8ng Ltd,2011

REFERENCES

- Mario Garcia Sanz,Wind Energy Systems,CRC Press,2012
- Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.

Special Paper III: 23REEE317 THEORY AND DESIGN OF NEURO-FUZZY CONTROLLERS
(Effective from the academic year 2023-2024 onwards)

UNIT-I NEURAL NETWORK

Introduction-biological neurons and their artificial models-learning, adaptation and neural network's learning rules types of neural networks-single layer, multilayer-feed forward, feedback networks; back propagation learning and training-Hop field network.

UNIT-II NEURAL NETWORKS IN CONTROL

Neural network for non-linear systems-schemes of neuro control-system identification forward model and inverse model-indirect learning neural network control applications-case studies.

UNIT-III FUZZY LOGIC

Fuzzy sets-fuzzy operation-fuzzy arithmetic-fuzzy relations-fuzzy relational equations-fuzzy measure-fuzzy functions-approximate reasoning-fuzzy propositions-fuzzy quantifiers-if-then rules.

UNIT-IV FUZZY LOGIC IN CONTROL

Structure of fuzzy logic controller-fuzzification models-data base-rule base-inference engine defuzzification module.

UNIT-V NON-LINEAR FUZZY CONTROL

Introduction of Non-linear fuzzy control-PID like FLC-Sliding mode FLC - Sugeno FLC-adaptive fuzzy control-fuzzy control applications-case studies.

TEXT BOOKS

- Farin Wah, S.S., Filev, D., Langari, R., 2000, Fuzzy control synthesis and analysis, John Wiley and Sons.
- Jacek M Zurada, 1999, Introduction to Artificial Neural Systems, Jaico Publishing House.

REFERENCES

- Kosko, B., 1994, Neural Networks And Fuzzy Sstems, Prentice-Hall of India Pvt.Ltd.
- Klir, G.J. and Folger, T.A., 1993, Fuzzy sets, uncertainty and Information, Prentice-Hall of India Private Ltd.
- Zimmerman, H.J., 1994, Fuzzy set theory-and its Applications, Kluwer Academic Publishers.

Special Paper III: 23REEE318 SOFT COMPUTING TECHNIQUES

(Effective from the academic year 2023-2024 onwards)

UNIT I INTRODUCTION

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

UNIT II ARTIFICIAL NEURAL NETWORKS

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller.

UNIT III FUZZY LOGIC SYSTEM:

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

UNIT IV GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and and-colony search techniques for solving optimization problems.

UNIT-VAPPLICATIONS

GA application to power system optimization problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab- Neural Network toolbox. Stability analysis of Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

REFERENCES

- Oscar Castillo, PatriciaMelin, Soft Computing For Hybrid Intelligent Systems,Wiltold Pedrycz,2008
- Madan M. Gupta, Naresh K Sinha, " Soft computing and intelligent systems: Theory and applications,2000.
- 3. J. Jacek. M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 199

Special Paper III: 23REEE319 FLEXIBLE AC TRANSMISSION SYSTEMS
(Effective from the academic year 2023-2024 onwards)

UNIT-I INTRODUCTION

FACTS-a toolkit, Basic concepts of Static VAR compensator, Resonance damper, Thyristor controlled series capacitor, Static condenser, Phase angle regulator, and other controllers.

UNIT-II SERIES COMPENSATION SCHEMES

Sub-Synchronous resonance, Torsional interaction, torsional torque, Compensation of conventional, ASC, NGH damping schemes, Modelling and control of thyristor controlled series compensators.

UNIT-III UNIFIED POWER FLOW CONTROL

Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller.

UNIT-IV DESIGN OF FACTS CONTROLLERS

Approximate multi-model decomposition, Variable structure FACTS controllers for Power system transient stability, Non-linear variable-structure control, variable structure series capacitor control, and variable structure resistor control.

UNIT-V STATIC VAR COMPENSATION

Basic concepts, Thyristor controlled reactor (TCR), Thyristors switched reactor (TSR), Thyristor switched capacitor (TSC), saturated reactor (SR), Fixed Capacitor (FC).

TEXT BOOKS

- Mohan Mathur. R., Rajiv.K.Varma, Thyristor–Based Facts Controllers for Electrical Transmission Systems , IEEE press and John Wiley & Sons, Inc, New York ,2002.

- Narin G Hingorani, Understanding FACTS : Concepts and Technology of Flexible AC Transmission Systems , Standards publishers, New Delhi ,2001Flexible AC Transmission, IEEE Spectrum, pp 40-45.

REFERENCES

- Narin G Hingorani, High Power Electronics and Flexible AC Transmission Systems, IEEE High Power Engineering Review volume 8: issue 7,2002

- Einar V Larsen, Juan J Sanchez-Gasca, Joe H Chow, May 1995, Concepts for design of FACTS Controllers to damp power swings, IEEE Trans On Power Systems, Vol.10, No.2.

- Gyugyi.L, July 1992, Unified power flow control concept for flexible AC transmission, IEEE Proc-C Vol.139, No.4.

Special Paper III: 23REEE320 HVDC SYSTEMS
(Effective from the academic year 2023-2024 onwards)

UNIT-I INTRODUCTION

Comparison of AC - DC transmission - Description and application of HVDC transmission - DC system components and their functions.

UNIT-II ANALYSIS OF HVDC CONVERTERS

Pulse number - converter configuration, analysis greatz circuit - bridge characteristics - 12-pulse converter.

UNIT-III HVDC SYSTEM CONTROL

Principles of DC link control - converter control characteristics - system control, firing angle control – current and excitation angle control, DC link power control - higher level controllers - reactive power control and VAR sources - Multi terminal DC system - types - control and protection.

UNIT-IV TRANSIENT STABILITY ANALYSIS

Modelling of converter - DC network - AC network and synchronous generator -solution methodology - transient stability improvement using DC link control.

UNIT-V DYNAMIC STABILITY AND POWER MODULATION

Power modulation controls, reactive power modulation, voltage stability in AC -DC systems control.

TEXT BOOKS:

- Naidu, M. S. and Kamaraju, V ,High Voltage Engineering, Tata McGraw Hill, New Delhi ,2004
- Padiyar K.R., " HVDC power transmission system ", Wiley Eastern Pvt. Ltd., 1990.

REFERENCES

- Arrillaga J. and Arnald C.P., & Parker B.J., " Computer modeling of Electric power systems ", John wiley& sons, 2001.

- Arrillaga J., " High voltage direct current transmission ", Peter Peregrinus, London, 1983.

Special Paper III: 23REEE321DIGITAL POWER SYSTEM PROTECTION
(Effective from the academic year 2023-2024 onwards)

UNIT- I NUMERICAL PROTECTION

Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference wave, least error squared (LES) technique, digital filtering, numerical over- current protection.

UNIT- II DIGITAL PROTECTION OF TRANSMISSION LINE

Introduction, Protection scheme of transmission line, distance relays, traveling wave relays, digital protection scheme based upon fundamental signal, hardware design, software design, digital protection of EHV/UHV transmission line based upon traveling wave phenomenon, new relaying scheme using amplitude comparison.

UNIT- III DIGITAL PROTECTION OF SYNCHRONOUS GENERATOR

Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator.

UNIT- IV DIGITAL PROTECTION OF POWER TRANSFORMER

Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer

UNIT-V DISTANCE AND OVERCURRENT RELAY SETTING AND CO-ORDINATION PC APPLICATIONS IN SHORT CIRCUIT STUDIES FOR DESIGNING RELAYING SCHEME

Directional instantaneous IDMT over current relay, directional multi zone distance realy, distance relay setting, co-ordination of distance relays, co-ordination of over current relays, computer graphics display, man-machine interface subsystem, integrated operation of national power system, application of computer graphics.

Types of faults, assumptions, development of algorithm for S.C. studies, PC based integrated software for S.C. studies, transformation to component quantities, S.C. studies of multiphase systems. Ultra high speed protective relays for high voltage long transmission line.

TEXT BOOKS

- L. P. Singh , Digital Protection, New Age International Private Ltd. Publishers, New Delhi, 2nd Edition,1997
- Paithankar, Marcel and Dekker, Transmission Network Protection, New York,1997

REFERENCE

- Paithankar&Bhide ,Fundamentals of Power System Protection ,Prentice Hall of India Pvt Ltd., New Delhi,2010
- Stanley Horowitz, Protective Relaying for Power System II IEEE press , New York,1992

Special Paper III:23REEE323 OPTIMIZATION TECHNIQUES
(Effective from the academic year 2023-2024 onwards)

UNIT I INTRODUCTION:
Historical Development, Engineering application of Optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems.

UNIT II LINEAR PROGRAMMING:
Graphical method, Simplex method, Revised simplex method, Duality in linear programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transportation, assignment
and other applications.

UNIT III NON LINEAR PROGRAMMING:
Unconstrained optimization techniques, Direct search methods, Descent methods, Constrained optimization, Direct and indirect methods, Optimization with calculus, Khun-Tucker conditions.

UNIT IV DYNAMIC PROGRAMMING:
Introduction, Sequential optimization, computational procedure, curse of dimensionality.

UNIT V ADVANCED TECHNIQUES OF OPTIMIZATION:
Introduction, Genetic algorithms for optimization and search.

TEXT BOOKS:

- S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International (P) Ltd., New Delhi, 2000.

- K. Deb, "Optimization for Engineering Design - Algorithms and Examples", Prentice-Hall oflndia Pvt. Ltd., New Delhi, 1995.

REFERENCE :

- H.A. Taha, "Operations Research: An Introduction", 5th Edition, Macmillan, New York, 1992.

- G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.

Special Paper III 23REEE323EMBEDDED SYSTEMS
(Effective from the academic year 2023-2024 onwards)

UNIT-I INTRODUCTION TO EMBEDDED SYSTEM (09)

An embedded system, functional building block of embedded system, Characteristics of embedded system, applications, Challenges in embedded system design, embedded system design processes.

UNIT-II ARCHITECTURE OF EMBEDDED SYSTEM (09)

Computer architecture taxonomy, CPUs–programming input and output, Supervisor mode, exceptions and traps, Co-processors, memory system mechanisms-CPU bus-memory devices - I/O devices – component interfacing - Assembly and linking-basic compilation techniques.

UNIT-III OSFOR EMBEDDED SYSTEMS (09)

Introduction to RTOS, multiple tasks and multiple processes, context switching, operating system,schedulingpolicies,interprocesscommunicationmechanisms.Introductionto μC/OSII

UNIT-IV PERFORMANCE ISSUSESOFEMBEDDED SYSTEMS (09)

CPU Performance, CPU Power consumption, Analysis and optimization of execution time, program size, energy and power, Evaluating operating system performance, power optimization strategies for processes, Hardware accelerators.

UNIT-V DESIGN ANDIMPLEMENTATION (09)

Development and debugging, manufacturing, Testing, Program validation and testing, Need of Distributed embedded architecture, I^2C Bus, CAN Bus, Design examples: GPS Moving map, Personal Digital Assistant, Elevator controller.

REFERENCES

- Wayne Wolf, ,Computers as Components: Principles of Embedded Computer Systems Design, The Morgan Kaufmann Series in Computer Architecture and Design Harcourt Asia Pvt.Ltd., Dehiwella, Srilanka 2000
- Rajkamal, Embedded Systems Tata McGraw-Hill Publishing company Ltd., New Delhi, 2003
- David E, Simon, An Embedded software primer Pearson education India, New Delhi 2004
- Sriram V Iyer, Pankaj Gupta, , EmbeddedReal-time Systems Programming Tata McGraw-Hill Publishing 2004

WEBSITES

1. www.ece.cmu.edu
2. www.cs.rice.edu

Special Paper III 23REEE324 Artificial Intelligence Applications to Power Systems
(Effective from the academic year 2023-2024 onwards)

UNIT-I INTRODUCTION TO EXPERT SYSTEMS

Basics of AI systems - introduction to expert systems - definitions - architecture - differences from conventional programming.

UNIT-II EXPERT SYSTEMS

Knowledge components-levelsofrepresentation-representationschemes-formaland non-formalrepresentationschemes-Expert Systembuilding task-development-knowledgeacquisition-typical buildingprocess

UNIT-III INTRODUCTION TO NEURAL NETWORKS

Neurobiologicalmodelsof neurons-basicsof ANN- perceptron- backpropagation network– memorymodels-bi-directional associativememory -Hopfield network.

UNIT-IV ARTIFICIAL NEURAL NETWORKS

Theory,architecture andapplicationsof computer propagationnetwork- Boltzmann's network– adaptive resonance theory-introduction to cognitron and neocognitron.

UNIT-V APPLICATION OFAITO POWER SYSTEMS

Application of expert systems and neural networks in load forecasting, contingency analysis, VAr control and other power system problems.

REFERENCES

- Rolston, D.W Principles of AI and EIdevelopment McGrawHill,New York 1988
- Wassermann P.D, Van Reinhold Neural Computing Springer,New York 1988
- DejanJ. SobajicIEEEtutorialon application of Neural Network topower systems
- LawrenceErlabumassociates, Inc., USA 1996.

WEBSITES

1. www.slideshare.net
2. www.globalspec.com