Vision of the Institution

To ignite the minds of the students through academic excellence so as to bring about social transformation and prosperity.

Mission of the Institution

- To expand the frontiers of knowledge through Quality Education.
- To provide valued added Research and Development.
- To embody a spirit of excellence in Teaching, Creativity, Scholarship and Outreach.
- To provide a platform for synergy of Academy, Industry and Community.
- To inculcate high standards of Ethical and Professional Behavior.

Vision of EEE Department

"Centre of Excellence in Education and Research in the field of Electrical and Electronics Engineering and to become the foremost academic department through its education and research programs"

Mission of EEE Department

- To develop innovative, efficient and proficient electrical engineers.
- To keep the curriculum industry friendly, with due regard to the University curriculum.
- To participate in large projects of National and International importance.
- To promote ethical and moral values among the students so as to make them emerge as responsible professionals.

Program Educational Objectives (PEOs)

PEO 1. To produce Electrical and Electronics Engineering graduates who have strong foundation in Mathematics, Sciences and Basic Engineering.

PEO 2. To provide intensive training in problem solving, laboratory skills and design skills to use modern engineering tools through higher education and research.

PEO 3. Ability to seek employment in a variety of engineering (or) engineering technology positions to specialize in specific areas of interest and work successfully in their chosen career aspirations.

PEO 4. To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate engineering issues to broader social context through life-long learning.

Program Outcomes(POs) of EEE Department

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs) of EEE Department

PSO 1: The EEE program must demonstrate knowledge and hands-on competence in the application of electrical and electronics circuits in a rigorous mathematical

environment at or above the level of algebra and trigonometry.

PSO2: The EEE program must demonstrate that graduates can apply interdisciplinary project management techniques to electrical and electronics systems.

PSO 3: The EEE program must demonstrate that graduates can analyze, design and develop hardware and software for control systems, measurements, power electronics and power systems

M.Tech. (EPE)
R19 Course Structure

I .M.Tech. I- Semester

S.No	Category	Sub. Code	Course Title	L	T	P	C	I	E	TM
1	PC	EE1T0119	Power System Operation & Control	4	-		3	40	60	100
2	PC	EE1T0219	Analysis of Power Electronics Converters	4	-	-	3	40	60	100
3	PE		**Elective – I**	4	-	-	3	40	60	100
		EE1T0319	i.Electrical DistributionSystems							
		EE1T0419	ii.Power System Deregulation							
		EE1T0519	iii.Renewable EnergySystems							
4	PE		**Elective – II**	4	-	-	3	40	60	100
		EE1T1619	i. Advanced Power System Protection							
		EE1T1719	ii. HVDC Transmission							
		EE1T1819	iii.Power System Reliability							
5		EE1T1919	Research Methodology	2	0	0	2	40	60	100
6		EE1P0119	Electrical Simulation Laboratory	-	-	4	2	40	60	100
7		EE1P0219	Power Systems Laboratory	-	-	4	2	40	60	100
8		EE1T01019	Audit Course-I	2	0	0	0	-	-	-
		Total		**20**	**0**	**8**	**18**	**280**	**420**	**700**

I .M.Tech. II- Semester

S.No	Category	Sub. Code	Course Title	L	T	P	C	I	E	TM
1	PC	EE2T0119	Power System Dynamics and Stability	4	-	-	3	40	60	100
2	PC	EE2T0219	Real Time Control of Power Systems	4	-	-	3	40	60	100
3	PE		**Elective – IIII**	4	-	-	3	40	60	100
		EE2T0319	i.FACTS							
		EE2T0419	ii. Hybrid Electric Vehicles							
		EE2T0519	iii.Modern Control Theory							
4	PE		**Elective – IV**	4	-	-	3	40	60	100
		EE2T0619	i Programmable Logic Controllers and Applications							
		EE2T0719	ii.Generation& Measurement of High Voltage							
		EE2T0819	iii.Smart Grid Technologies							
5		EE2P0119	Power System Simulation Laboratory	-	-	4	2	40	60	100
6		EE2P0219	Power Converters Laboratory	-	-	4	2	40	60	100
7		EE2PJ0119	Mini Project with Seminar			4	2	40	60	100
8		EE2T0919	Audit Course--II	2	0	0	0	-	-	-
		Total		**18**	**0**	**12**	**18**	**280**	**420**	**700**

II. M.Tech. I- Semester

S.No	Category	Sub. Code	Course Title	L	T	P	C	I	E	TM
1	PE		**Elective – V**	4	-	-	3	40	60	100
		EE3T0119	i.Demand side Energy Management							
		EE3T0219	ii.Power Quality and Custom Power Devices							
		EE3T0319	iii.High Voltage Testing Techniques							
2	OE		**Elective – VI**	4	-	-	3	40	60	100
		EE3T0419	i AI Techniques							
		EE3T0519	ii. Reactive Power Compensation&Management							
		EE3T0619	iii.Operations Research							
3		EE3D0119	Dissertation Phase-I	-	-	20	10	40	60	100
		Total		**8**	**0**	**20**	**16**	**120**	**180**	**300**

II. M.Tech. II- Semester

S.No	Sub. Code	Course Title	L	T	P	C	I	E	TM
1	EE4D0119	Dissertation Phase-II	-	-	20	16	40	60	100
	Total		**0**	0	20	**16**	**40**	**60**	**100**

I YEAR I SEMESTER
ELECTRICAL POWER ENGINEERING
R19 SYLLABUS

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0119		L	P	C
COURSE TITLE : POWER SYSTEM OPERATION AND CONTROL		4	0	3

Learning Objectives:

- To study the unit commitment problem for economic load dispatch.
- To study the load frequency control of single area and two area systems with and without control.
- To study the effect of generation with limited energy supply.
- To study the effectiveness of interchange evaluation in interconnected power systems

Unit-1 :
Unit commitment problem and optimal power flow solution : Unit commitment : Constraints in UCP,UC solutions. Methods-priority list method, introduction to Dynamic programming Approach.

Unit-2 :
Single area Load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis. Proportional plus Integral control of single area and its block diagram representation, steady state response, load frequency control and Economic dispatch control.

Unit-3 :
Two area Load Frequency Control : Load frequency control of 2-area system : uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment.

Unit-4 :
Generation with limited Energy supply : Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming.

Unit-5 :
Interchange Evaluation and Power Pools Economy Interchange, Economy interchange Evaluation, Interchange Evaluation with unit commitment.Multiple Interchange contracts. After-the-fact production costing, Transmission Losses in transaction Evaluation, other types of Interchange, power pools.

Course Outcomes:

After completion of this course the students will be able to:

- Determine the unit commitment problem for economic load dispatch.
- Get the knowledge of load frequency control of single area and two area systems with and without control.
- Know the effect of generation with limited energy supply.
- Determine the interchange evaluation in interconnected power systems.

TEXT BOOKS:

1. Modern Power System Analysis - by I.J.Nagrath&D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.
2. Power system operation and control PSR Murthy B.S publication.
3. Power Generation, Operation and Control - by A.J.Wood and B.F.Wollen berg, John wiley & sons Inc. 1984.

REFERENCE BOOKS:

1. Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
2. Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0219		L	P	C
COURSE TITLE: ANALYSIS OF POWER ELECTRONIC CONVERTERS		4	0	3

Learning Objectives:

- To understand the control principle of ac to ac conversion with suitable power semi conductor devices.
- To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
- To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
- To acquire the knowledge on dc-ac converters and to know the different control techniques of dc-ac converters.
- To know multilevel inverter configuration to improve the quality of the inverter output voltage.

Unit-1 : AC voltage Controllers

Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers –Application-numerical problems

Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application-numerical problems.

Unit –2: AC-DC converters

Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems.

Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems.

Unit-3: Power Factor Correction Converters

Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

Unit –4: PWM Inverters

Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

Unit 5: Multi level inverters

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents-DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Course Outcomes:

After completion of this course the students will be able to:

- Have the knowledge on principle of ac voltage controller and their control techniques.
- Convert ac voltage to dc voltage and different control strategies of the converter.
- Control the power factor of single phase and three phase ac to dc converters.
- Understand the conversion of dc to ac and their control strategies.
- Analyze different multilevel inverters to improve the quality of the output voltage of the inverter.

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
2. Daniel W. Hart - McGraw-Hill,2011.

Reference Books:

1. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
2. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE:EE1T0319		L	P	C
COURSE TITLE: ELECTRICAL DISTRIBUTION SYSTEMS (ELECTIVE-1)		4	0	3

Learning Objectives:

- To learn the importance of economic distribution of electrical energy.
- To analyze the distribution networks for V-drops, PLosscalculations and reactive power.
- To understand the co-ordination of protection devices.
- To impart knowledge of capacitive compensation/voltage control.
- To understand the principles of voltage control.

Unit -1: Objectives of electrical distribution system - factors effecting – present & future electrical distribution system in india, voltage lvels – Loss factor - Load factor - relation between loss factor and load factor.Residential, Commercial, Agricultural and Industrial loads and their characteristics.

Unit -2: Distribution Feeders and Substations : Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder-loading. Design practice of the secondary distribution system. Location of Substations : Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations.

Unit -3 : System analysis , Voltage drop and power loss calculations,Derivation for volt-drop and power loss in lines, manual methods of solution for radial networks, three-phase balanced primary lines, non-three-phase primary lines.

Unit -4 : Protective devices and coordination : Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices,general coordination procedure.

Unit -5 : Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched Capacitors).Power factor correction, capacitor location. Economic justification.Procedure to determine the best capacitor location. Voltage control : Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

Course Outcomes:

- After completion of this course the students will be able to:
- Analyze a distribution system.
- Design equipment for compensation of losses in the distribution system.
- Design protective systems and co-ordinate the devices.
- Get understanding of capacitive compensation.
- Get understanding of voltage control.

Text Books:

1. "Electric Power Distribution System Engineering " by Turan Gonen, McGraw-Hill Book Company,1986.

2. Distribution System Analysis and Automation, by Juan M. Gers, The Institution of Engineering and Technology, UK 2014.

Reference Books:

1. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.
2. Electrical Distribution V.Kamaraju-McGraw Hill
3. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0419		L	P	C
SUB.TITLE: POWER SYSTEM DEREGULATION (ELECTIVE – I)		4	0	3

Learning Objectives:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To examine typical issues in electricity markets and how these are handled world –wide in various markets.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

Unit 1

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation.

Unit 2

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Unit 3

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices

Unit 4

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

Unit 5

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Course Outcomes:

Aftercompletion of this course the students will be able to:

- Understand of operation of deregulated electricity market systems
- Typical issues in electricity markets
- To analyze various types of electricity market operational and control issues using new mathematical models.

Text Books:

1. Power System Economics: Designing markets for electricity - S. Stoft, wiley.
2. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer.

Reference Books:

1. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
2. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li,Wiley.
3. Fundamentals of power system economics - S. Kirschen and G. Strbac, Wiley.
4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineeirng.
5. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0519		L	P	C
SUB. TITLE: RENEWABLE ENERGY SYSTEMS (ELECTIVE-I)		4	0	3

Learning Objectives:

- To learn the fundamental and basic principle of renewable energy sources.
- To the adoption of solar and wind energy sources for the electric power generation.
- To study the principle and working of ocean energy, tidal, wave, bio and geo-thermal energy
- To the adoption and inter connection of renewable and alternative energy sources to grid.

Unit 1 - Fundamentals of Solar Energy & Thermal Systems:

Energy conservation principle and world energy scenario-various forms of renewable energy. Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal. Basics of solar concentrators Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

Unit 2 - Solar Photovoltaic systems:

Solar PV cell, module array and construction. Efficiency of solar cell-developing technologies, IV-PV characteristics. Equivalent circuit of solar cell- Series & shunt resistance. Balance of system components - System design - Storage sizing - PV system sizing - Maximum power point techniques - Perturb & Observe technique - Incremental conductance method.

Unit 3 - Wind Energy

Wind energy – Nature of wind – Characteristics – Variation with height and time – Power in wind –Aerodynamics of Wind turbine – Aero foils and their characteristics – Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise Applications of wind energy - Maximum power point techniques – Tip Speed Ratio (TSR)

Unit 4 - Ocean Energy Technologies

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience. Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal power house. Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

Unit 5 - Bio mass & Geo Thermal Systems:

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems. Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas. Geo thermal energy-Classification-Dry rock & hot aquifer - Energy analysis - Power generation techniques - Prime mover.

Course Outcomes:

After completion of this course the students will be able to:

- Identify alternate energy sources.
- Classify and analyze different renewable energy systems.
- Adopt different alternate energy sources for power generation.
- Design of solar photovoltaic systems
- Develop MPPT strategies in solar PV and wind energy systems
- Explain the principle behind ocean energy, biomass and geo-thermal energy sources

Text Books

1. Non-conventional Energy Sources by G.D. Rai, Khanna Publishers, 2011 Edition, ISBN 9788174090737
2. Renewable energy sources, John Twidell and Tony Weir, Taylor and Francis – 2nd Edition, 2013.
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.

Reference Books

1. Renewable energy – Edited by Godfrey Boyle-Oxford University Press, 3rd Edition, 2013.
2. Renewable Energy Resources Basic Principles and Applications, G. N. Tiwari and M. K. Ghosal / Narosa
3. Solar Energy Thermal Processes, Duffie & Beckman.
4. Wind Energy Handbook, Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / Wiley Publications, 2nd Edition, 2011.
5. Renewable Energy From the Ocean: A Guide to OTEC Johns Hopkins University Applied Physics Laboratories Series in Science and Engineering, William H. Avery, Chih Wu, Reprint, Oxford University Press, 1994
6. Biogas Technology - A Practical Hand Book, K. Khendelwal & S.S. Mahdi, McGraw-Hill, Vol. 1, 1989.

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0619		L	P	C
SUB.TITLE: ADVANCED POWER SYSTEM PROTECTION (ELECTIVE-II)		4	0	3

Learning Objectives:

- To learn about classification and operation of static relays.
- To understand the basic principles and application of comparators.
- To learn about static version of different types of relays.
- To understand about numerical protection techniques.

Unit 1 : Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays.

Unit 2 : Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.
Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices.

Unit 3 : Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings,

Unit 4 : PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fibre channels.

Unit 5 : Microprocessor based relays and Numerical Protection: Introduction – over current relays impedance relay – directional relay – reactance relay.Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann- morrison technique - Differential equation technique and discrete fourier transform technique - numerical over current protection - numerical distance protection.

Course Outcomes:

After completion of this course the students will be able to:

- Know the classifications and applications of static relays.
- Understand the application of comparators.
- Understand the static version of different types of relays.
- Understand the numerical protection techniques.

Text Books :

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Protective Relaying Vol-II Warrington, Springer.
3. Art & Science of Protective Relaying - C R Mason, Willey.

Reference Books:

1. Power System Stability KimbarkVol-II, Willey.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.
3. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0719		L	P	C
COURSE TITLE: HVDC TRANSMISSION (ELECTIVE-II)		4	0	3

Learning Objectives:

- To learn various schemes of HVDC transmission.
- To learn about the basic HVDC transmission equipment.
- To learn the control of HVDC systems.
- To be exposed to the interaction between HVAC and HVDC system.
- To be exposed to the various protection schemes of HVDC engineering.

Unit -1: Limitation of EHV AC Transmission, Advantages of HVDC Technical economical reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose.

Unit-2: Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the perform of diametrical connection with 6-pulse bridge circuit

Unit-3 : Control of HVDC Converters and systems : constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current harmonics effect of variation of α and μ. Filters Harmonic elimination.

Unit-4 : Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

Unit -5 : Transient over voltages in HV DC systems : Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters.

Course Outcomes:

After completion of this course the students will be able to:

- Understand the various schemes of HVDC transmission.
- Understand the basic HVDC transmission equipment.
- Understand the control of HVDC systems.
- Understand the interaction between HVAC and HVDC system.

- Understand the various protection schemes of HVDC engineering.

TEXT BOOKS:

1. S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.

REFERENCE BOOKS:

1. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
2. J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
3. Vijay K Sood :HVDC and FACTS controllers:Applications of static converters in power systems by, Kluwer Academic Press

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0819		L	P	C
SUB.TITLE: POWER SYSTEM RELIABILITY (ELECTIVE – II)		4	0	3

Learning Objectives:

- Will be able to get the basic understanding of network modeling and reliability.
- Markov chains.
- Reliability analysis of generation systems.
- Decomposition techniques.

Unit 1 : Basic probability theory – rules for combining probabilities of events – Bernoulli`s trials- probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution.

Unit 2 : Network Modelling and Reliability Analysis of Series, Parallel, Series-Parallel networks-complex networks – decomposition method-Reliability functions F(t), F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponentional distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR, MTBF

Unit 3 : Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabililties using STPM – two component repairable models – Frequency and duration concept.Evaluation of frequency of encountering state, mean cycletime, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

Unit 4 : Generation system reliability analysis-Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices – Examples. Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2-level daily load representation - merging generation and load models – Examples.

Unit 5 : Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices.

Course Outcomes:

After completion of this course the students will be able to:

- Understand reliability analysis applied to power systems.
- Understand Markov Chains and application to power systems.
- Perform stability analysis of generation systems.
- Understand decomposition techniques applied to power system.

Text Books:

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons 1978
3. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMH Publications.
4. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications

Reference Books :

1. C. Singh, P. Jirutitijaroen and J. Mitra,Electric Power Grid ReliabilityEvaluation: Models and Methods. Wiley-IEEE Press, Hoboken, NJ: 2019.ISBN: 9781119486275.
2. Reliability Engineering by E. Balaguruswamy, TMH Publications.
3. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.
4. An Introduction to Reliability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition.

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T0919		L	P	C
COURSE TITLE: RESEARCH METHODOLOGY		4	0	3

Syllabus Contents:

UNIT 1: RESEARCH FOUNDATION: Motivation and objectives – Research methods, Methodology. Types of research, Defining and formulating the research problem, Hypothesis – Qualities of a good Hypothesis, Hypothesis Testing – Logic & Importance

UNIT 2: LITERATURE REVIEW: Pimary and secondary sources, Effective literature studies approaches, analysis, identifying gap areas from literature and research database.

UNIT 3: DATA COLLECTION AND ANALYSIS: Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT 4: RESEARCH ETHICS: Plagiarism, Research ethics, IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, reproducibility and accountability.

UNIT 5: INTERPRETATION AND REPORT WRITING: Significance of Report Writing, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Course Outcomes:

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

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

Text Books:

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
2. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
4. Stuart Melville and Wayne Goddard, 1996. Research methodology: an introduction for science & engineering students, Kenwyn, South Africa : Juta& Co. Ltd.,
5. T. Ramappa, 2008, Intellectual Property Rights Under WTO, S. Chand.

Reference Books:

1. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
6. Ranjit Kumar, 2 nd Edition, "Research Methodology: A Step by Step Guide for beginners"

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1P0119		L	P	C
SUB.TITLE: ELECTRICAL SIMULATION LABORATORY		0	4	2

Learning Objectives:

- To understand the modeling and simulation of various aspects of Power Electronics and control systems in MATLAB/Simulink platform.

List of Experiments

1. Step, ramp and Sinusoidal response of series RLC circuit.
2. 3-phase Bridge Controlled rectifier with R & RL loads.
3. 3-phase Bridge Controlled rectifier with Source inductance.
4. Single phase AC Voltage controller with R & RL-loads.
5. Design a filter for 1-phase Bridge Controlled rectifier with R & RL loads.
6. Design of L & C based on voltage & current ripples of buck and boost converters.
7. FFT Analysis of 1-phase Bridge inverter for R & RL loads & Design a harmonic trap filter.
8. 3-phase PWM Inverter with R & RL Loads
9. Closed loop control of chopper fed DC Drive.
10. VSI fed three-phase Induction Motor.
11. Draw the Bode plot, Nyquist plot and Root locus for the given transfer function.

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1P0219		L	P	C
SUB.TITLE: POWER SYSTEMS LABORATORY		0	4	2

Learning Objectives:

- To apply measurement techniques associated with High voltage power system.
- To determine the sequence impedances of the power system elements and to evaluate the influence of faults on power system.

List of Experiments:

1. Voltage distribution across string insulator.
2. Determination of leakage current of pin insulator.
3. Breakdown characteristics of sphere gap.
4. Sequence impedance of 3ϕ-transformer .
5. Sequence impedance of alternator by fault analysis.
6. Sequence impedance of alternator by direct method.
7. ABCD Parameters of transmission line.
8. Power angle characteristics of alternator .
9. Load flow studies using Gauss-Siedel method.
10. Load frequency control(with and without controllers).

BRANCH : EPE	I YEAR – I SEMESTER	REGULATION: R19		
SUB. CODE: EE1T01019		L	P	C
SUB.TITLE:ENGLISH FOR RESEARCH PAPER WRITING (AUDIT COURSE-I)		2	0	0

Learnings objectives:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title.
- Ensure the good quality of paper at very first-time submission

Syllabus

Unit 1

Planning and Preparation, Word Order, Breaking up long sentences,Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit 2

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.Introduction

Unit 3

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

Unit 5

Skills needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press Model Curriculum of Engineering & Technology PG Courses [Volume-I] [374]
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011