SREE VAHINI INSTITUTE OF SCIENCE AND TECHNOLOGY
(AUTONOMOUS)
TIRUVURU, N T R Dist, Andhra Pradesh

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
V23-COURSE STRUCTURE & SYLLABUS
For
POWER SYSTEMS

I M.Tech I Sem: Power Systems

S. No.	Category	Subject Name	Subject Code	L	T	P	Credits
1	Programme Core	Power Generation operation & Control	V232115631	3	0	0	3
2	Programme Core	Analysis of Power Electronics Converters	V232115632	3	0	0	3
3	Programme Elective-I	Electrical Distribution Automation	V2321156D1	3	0	0	3
	Programme Elective-I	Renewable Energy Technologies	V2321156D2	3	0	0	3
	Programme Elective-I	Power System Deregulation	V2321156D3	3	0	0	3
4	Programme Elective-II	HVDC Transmission	V2321156E1	3	0	0	3
	Programme Elective-II	Advanced Power Systems Protection	V2321156E2	3	0	0	3
	Programme Elective-II	Power System Reliability	V2321156E3	3	0	0	3
5		Research Methodology and IPR	V23211CC11	2	0	0	2
6		Power System Simulation Laboratory-I	V232115661	0	0	4	2
7		Power System Laboratory	V232115662	0	0	4	2
8	MC	Audit Course-I: Constitution of India	V23211C3C1	2	0	0	0

I M.Tech I Sem: Power Systems

S. No.	Category	Subject Name	Subject Code	L	T	P	Credits
1	Programme Core	Power System Dynamics and Stability	V232125631	3	0	0	3
2	Programme Core	Real Time Control of Power Systems	V232125632	3	0	0	3
3	Programme Elective-III	EHVAC Transmission	V2321256F1	3	0	0	3
	Programme Elective-III	Flexible AC Transmission Systems	V2321256F2	3	0	0	3
	Programme Elective-III	Hybrid Electric Vehicles	V2321256F3	3	0	0	3
4	Programme Elective-IV	Generation & Measurement of High Voltages	V2321256G1	3	0	0	3
	Programme Elective-IV	Evolutionary Algorithms and Applications	V2321256G2	3	0	0	3
	Programme Elective-IV	Programmable Logic Controllers & Applications	V2321256G3	3	0	0	3
5		Power System Simulation Laboratory-II	V232125661	2	0	0	2

6		Power Converters Lab	V232125662	0	0	4	2
7		Mini Project with Seminar	V23212CC91	0	0	4	2
8	MC	Audit Course-II: Disaster Management	V23212C3C1	2	0	0	0

II M.Tech I Sem: Power Systems

S. No.	Category	Subject Name	Subject Code	L	T	P	Credits
1	Programme Elective	Energy Audit Conservation & Management	V2322156H1	3	0	0	3
	Programme Elective	Smart Grid Technologies	V2322156H2	3	0	0	3
	Programme Elective	Power Quality and Custom Power devices	V2322156H3	3	0	0	3
2	Open Elective	Industrial Safety	V232215651	3	0	0	3
	Open Elective	Artificial Intelligent Techniques	V232215652	3	0	0	3
	Open Elective	Operations Research	V232215653	3	0	0	3
3	Dissertation	Dissertation Phase – I	V23221CCA1	0	0	20	10

II M.Tech II Sem: Power Systems

S. No.	Category	Subject Name	Subject Code	L	T	P	Credits
1	Dissertation	Dissertation Phase – II	V23222CCA1	0	0	32	16

Audit course 1 & 2

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

The EEE department offers courses for other specializations as OPEN ELECTIVES (Expect power systems).

S. No.	Category	Subject Name	Subject Code	L	T	P	Credits
1	Open Elective	Renewable Energy Driven power systems	V232215654	3	0	0	3
	Open Elective	Advanced Power Electronics Converters	V232215655	3	0	0	3
	Open Elective	SCADA System and Applications	V232215656	3	0	0	3

I-Semester	POWER GENERATION OPERATION & CONTROL	Subject Code V232115631	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Knowledge on Power Generation Engineering, Power Transmission Engineering.

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

CO1: Determine the unit commitment problem for economic load dispatch.
CO2: Understand the knowledge of load frequency control of single area system with and without control.
CO3: Understand load frequency control of two area system with and without control.
CO4: Describe the effect of generation with limited energy supply.
CO5: Determine the interchange evaluation in interconnected power systems.

UNIT – 1

Unit commitment problem and optimal power flow solution: Unit commitment: Constraints in UCP,UC solution methods. Priority list method, introduction to Dynamic programming Approach.
Optimal power flow: OPF without inequality constraints, inequality constraints on control variables and dependent variables.

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, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response.

UNIT – 3

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

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 transactions, Other types of Interchange, power pools, transmission effects and issues.

Text Books:

1. Power Generation, Operation and Control - by A.J.Wood and F.Wollenberg,Johnwiley& sonsInc. 1984.
2. Modern Power System Analysis - by I.J.Nagrath & D.P.Kothari, Tata McGraw-HillPublishing Company ltd, 2nd edition.

Reference Books:

1 Power system operation and control PSR Murthy B.S publication.
2 Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3 Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

I-Semester	ANALYSIS OF POWER ELECTRONIC CONVERTERS	Subject Code V232115632	L-T-P 3-0-0	CREDITS 3

Pre-Requisite: Power Electronics.
Course Outcomes: At the end of the course, student will be able to

CO1: Study the operation & characteristics of switching devices
CO2: Describe and analyze the operation of AC-DC converters.
CO3: Analyze the operation of power factor correction converters.
CO4: Analyze the operation of three phase inverters with PWM control.
CO5: Study the principles of operation of multi- level inverters and their applications.

UNIT– 1
Overview of Switching Devices:
Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.

UNIT– 2
AC-DC converters: Single phase 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 control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.

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. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques- Three phase current source inverters-Variable dc link inverter.

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.

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.

I-Semester	ELECTRICAL DISTRIBUTION AUTOMATION (ELECTIVE–I)	Subject Code V2321156D1	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Knowledge on basics of distribution systems, Compensation in electrical distribution systems, Circuit Analysis, concept of load modeling.

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

CO1: Analyse a distribution system.
CO2: Study the equipment for distribution system and sub-stations.
CO3: Analyse protective systems and co-ordinate the devices.
CO4: Understand of capacitive compensation.
CO5: Understand of distribution automation.

UNIT – 1

General : Introduction to Distribution systems, an overview of the role of computers in distribution system planning-Load modelling and characteristics - definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

UNIT – 2

Distribution Feeders and Substations: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and 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

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; types of coordination.

UNIT – 4

Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), 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.

UNIT – 5

Distribution automation functions: Electrical system automation, EMS functional scope, DMS functional scope functionality of DMS- Steady state and dynamic performance improvement; Geographic information systems-AM/FM functions and Database management; communication options, supervisory control and data acquisition: SCADA functions and system architecture;Synchrophasors and its application in power systems.

Text Books:

1. "Electric Power Distribution System Engineerin" 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

I-Semester	RENEWABLE ENERGY TECHNOLOGIES (ELECTIVE–I)	Subject Code V2321156D2	L-T-P 3 -0-0	CREDITS 3

Pre requisite: UG power Electronics.

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

CO1: Understand various general aspects of renewable energy systems.
CO2: Analyze and study an induction generator for power generation from wind.
CO3: Design MPPT controller for solar power utilization.
CO4: Analyse Photovoltaic Power Plants
CO5: Utilize fuel cell systems for power generation.

UNIT– 1
Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics - Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy based power Systems

UNIT– 2
Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated - Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation - Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation - Speed and Voltage Control.

UNIT– 3
Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation- General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines - Generators and Speed Control Used in Wind Power Energy; Analysis of Small wind energy conversion system.

UNIT– 4
Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O,INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy

UNIT– 5
Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyser Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage

Text Books:

1. Felix A. Farret, M. Godoy Simo` es, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

I-Semester	POWER SYSTEM DEREGULATION (ELECTIVE–I)	Subject Code V2321156D3	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Knowledge on power systems.

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

CO1: Understand of operation of deregulated electricity market systems
CO2: Typical issues in electricity markets
CO3: Analyse various types of electricity market operational and control issues using newmathematical models.
CO4: Understand LMP's wheeling transactions and congestion management.
CO5: Analyse impact of ancillary services.

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.

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 Marketsof the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineeirng.
5. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth

I-Semester	HVDC TRANSMISSION (ELECTIVE–II)	Subject Code V2321156E1	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Knowledge on Power Electronics, Power Systems and High Voltage Engineering.

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

CO1: Understand the various schemes of HVDC transmission.
CO2: Define the basic HVDC transmission equipment and the control of HVDC systems.
CO3: Discuss the interaction between HVAC and HVDC system.
CO4: List the various protection schemes of HVDC engineering.
CO5: Understand the various schemes of HVDC transmission.

UNIT – 1

Limitation of EHV AC Transmission, Advantages of HVDC: Technical economical and 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 performance 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.

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.

I-Semester	ADVANCED POWER SYSTEMS PROTECTION (ELECTIVE–II)	Subject Code V2321156E2	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Concepts of Power Electronics, Electronic circuits, STLD and basics of Relays and protection.

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

CO1: Discuss the classification and operation of static relays.
CO2: Discuss the basic principles and application of comparators.
CO3: Understand the static version of different types of relays.
CO4: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.

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability KimbarkVol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –BhaveshBhalaja, R.PMaheshwari, NileshG.Chothani-Oxford publisher

I-Semester	POWER SYSTEM RELIABILITY (ELECTIVE–II)	Subject Code V2321156E3	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Probability theory, power systems.

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

CO1: Understand reliability analysis applied to power systems.

CO2: Describe the Network Modelling and Reliability Analysis of networks.

CO3: Understand Markov Chains and application to power systems.

CO4: Perform stability analysis of generation systems.

CO5: Understand decomposition techniques applied to power system.

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), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponential 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 probabilities using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

UNIT – 4

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model – evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE.

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.

Reference Books:

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Modeling in Electric Power Systems - J. Endrenyi, John Wiley, 1978, Neewyork.
3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition.

I-Semester	RESEARCH METHODOLGY AND IPR	Subject Code V23211CC11	L-T-P 2-0-0	CREDITS 2

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

I-Semester	POWER SYSTEM SIMULATION LABORATORY – I	Subject Code V232115661	L-T-P 0-0-4	CREDITS 2

Pre-requisite: Electrical Power Systems

Course Outcomes: The student shall be able to

CO1: Analyse the performance of the various transmission lines at different loading conditions
CO2: Perform the load flow study on distribution systems
CO3: Calculate the different line parameters of 3-phase symmetrical and unsymmetricaltransmission lines
CO4: Compute the reflection and refraction coefficients of voltages and currents in thetransmissions
CO5: Form the Z- and Y-bus matrices for the given power transmission system

List of Experiments:

1. Performance analysis of short and medium transmission lines.
2. Performance analysis of long transmission lines.
3. Computation of sag of transmission lines for equal and unequal heights of towers.
4. Distribution load flow analysis.
5. Computation of B- co-efficient in economic load dispatch problem.
6. Computation of line parameters (R, L, C) for different configuration of 3-ϕ symmetrical transmission lines.
7. Computation of line parameters (R, L, C) for different configuration of 3-ϕ unsymmetrical transmission lines with and without transportation.
8. Computation reflection and refraction co-efficient of voltages and currents of transmission line form different conditions.
9. Formation of Y-bus by direct inspection method.
10. Formations of Z-bus by building algorithm.

11. Load Flow Analysis using Mi-Power i) Gauss seidel Method

I-Semester	POWER SYSTEMS LABORATORY	Subject Code V232115662	L-T-P 0 -0-4	CREDITS 2

Course Outcomes:
After the Completion of lab they will understand procedure for determination of various parameters used in power system as well as performance of transmission line.

List of Experiments:

1. Determination of Sequence Impendence of an Alternator by direct method.

2. Determination of Sequence impedance of an Alternator by fault Analysis.

3. Measurement of sequence impedance of a three phase transformer

    (a). by application of sequence voltage. (b). using fault analysis.

4. Power angle characteristics of a salient pole Synchronous Machine.

5. Poly-phase connection on three single phase transformers and measurement of phase displacement.

6.Determination of equivalent circuit of 3-winding Transformer.

7. Measurement of ABCD parameters on transmission line model.

8. Performance of long transmission line without compensation.

9. Study of Ferranti effect in long transmission line.

10. Performance of long transmission line with shunt compensation.

11. Characteristics of Static Negative sequence relay.

12. Characteristics of over voltage relay using Electromagnetic type.

II-Semester	POWER SYSTEM DYNAMICS AND STABILITY	Subject Code V232125631	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Knowledge of synchronous machine, Power System Analysis

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

CO1: Identify the model of synchronous machines.
CO2: Understand the stability studies of synchronous machines.
CO3: Describe the knowledge of solution methods of transient stability.
CO4:Discuss the Effect of governor action and excite on power system stability
CO5: Discuss the effect of different excitation systems in power systems.

UNIT – 1

System Dynamics: Synchronous machine model in state space from computer representation for excitation and governor system –modelling of loads and induction machines.

UNIT – 2

Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by eigen value approach.

UNIT – 3

Digital Simulation of Transient Stability: Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method – Runge Kutta method – Concept of multi machine stability.

UNIT – 4

Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.

UNIT – 5

Excitation Systems : Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.

Text Books:

1. Power System Stability by Kimbark Vol. I&II, III, Willey.
2. Power System control and stability by Anderson and Fund, IEEE Press.

Reference Books:

1. Power systems stability and control by PRABHA KUNDUR, TMH.
2. Computer Applications to Power Systems–Glenn.W.Stagg& Ahmed. H.El.Abiad, TMH.
3. Computer Applications to Power Systems – M.A.Pai, TMH.
4. Power Systems Analysis & Stability – S.S.VadheraKhanna Publishers

II-Semester	REAL TIME CONTROL OF POWER SYSTEMS	Subject Code V232125632	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Power system operation and control.

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

CO1: Understand the importance of state estimation in power systems.

CO2: Describe the importance of security and contingency analysis.

CO3: Understand SCADA, its objectives and its importance in power systems.

CO4: Identify the significance of voltage stability analysis.

CO5: Understand the applications of AI to power systems problems.

UNIT – 1:

State Estimation: Different types of State Estimations, Theory of WLS state estimation, sequential and non-sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination.

UNIT – 2:

Security and Contingency Evaluation : Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.

UNIT – 3:

Computer Control of Power Systems: Need for real time and computer control of power systems, operating states of a power system, SCADA - Supervisory control and Data Acquisition systems implementation considerations, energy control centres, software requirements for implementing the above functions.

UNIT – 4:

Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V' curves and `Q-V' curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices.

UNIT – 5:

Synchrophasor Measurement units: Introduction, Phasor representation of sinusoids, a generic PMU, GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.

Text Books:

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg : Power Generation operation andcontrol, John Wiley & Sons, 1984.
3. A.G.Phadka and J.S. Thorp, "Synchronized Phasor Measurements and Their Applications", Springer, 2008

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics, WileyEastern Ltd. 1986
3. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
4. P.D.Wasserman : `Neural Computing : Theory and Practice' Van Nostrand -Feinhold, New York.

II-Semester	EHVAC TRANSMISSION (ELECTIVE–III)	Subject Code V2321256F1	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Transmission line parameters and properties, Corona etc.

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

CO1: Discuss the transmission line parameters.
CO2: Discribe the field effects on EHV and UHV AC lines.
CO3: Determine the corona, RI and audible noise in EHV and UHV lines.
CO4: Analyse voltage control and compensation problems in EHV and UHV transmissionsystems.
CO5: Understand reactive power compensation using SVC and TCR

UNIT – 1

E.H.V. A.C. Transmission, line trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation. Capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.

UNIT – 2

Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.

UNIT – 3

Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.

UNIT – 4

Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines

UNIT – 5

Reactive power compensating systems: Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system.

Text Books :

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

II-Semester	FLEXIBLE AC TRANSMISSION SYSTEMS (ELECTIVE–III)	Subject Code V2321256F2	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Concepts on Power Electronics and Power Systems

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

CO1: Describe the performance improvement of transmission system with FACTS.
CO2: Understand the effect of static shunt and series compensation.
CO3: Discuss an appropriate FACTS device for different types of applications
CO4: Know the principle of operation and various controls of UPFC

UNIT – 1

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

UNIT – 2

Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.

Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable VAr generation, variable impedance type static VAr generation, switching converter type VAr generation, hybrid VAr generation.

UNIT – 3

SVC and STATCOM: The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.

UNIT – 4

Static series compensators: Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

UNIT – 5

Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators. Introduction to Inter line Power Flow Controller (IPFC)

Text Books:

1. "Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications

Reference Books:

1. Sang.Y.HandJohn.A.T, "Flexible AC Transmission systems" IEEE Press (2006).
2. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers

II-Semester	HYBRID ELECTRIC VEHICLES (ELECTIVE–III)	Subject Code V2321256F3	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Knowledge of Power Electronics and Electric Drives

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

CO1:Understand the details of HEV
CO2: Describe the concept of electric vehicles and hybrid electric vehicles.
CO3: Familiar with different motors used for hybrid electric vehicles.
CO4: Understand the power converters used in hybrid electric vehicles
CO5: Understand different batteries and other energy storage systems.

UNIT– 1
Introduction:
History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs.
UNIT– 2
Hybridization of Automobile:
Fundamentals of vehicle, components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.
UNIT– 3
Plug-in Hybrid Electric Vehicle:
PHEVs and EREVs blended PHEVs, PHEV Architectures, equivalent electric range of blended PHEVs; Fuel economy of PHEVs, power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.
UNIT– 4
Power Electronics in HEVs:
Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.
UNIT– 5
Battery and Storage Systems
Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource

Text Books

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co, 2007.
4. Pistooa G., “Power Sources , Models, Sustanability, Infrstructure and the market”, Elsevier 2008
5. Mi Chris, Masrur A., and Gao D.W., “ Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives” 1995.

II-Semester	GENERATION AND MEASUREMENT OF HIGH VOLTAGES (ELECTIVE–II)	Subject Code V2321256G1	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Basics of Electrical circuits, Electronics and measurements for testing purpose.

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

CO1: Understand the numerical methods for analyzing electrostatic field problems.

CO2: Understand the techniques of generation of high AC, DC and transient voltages.

CO3: To study the methods for measurement of high AC ,DC and transient voltages.

CO4: To Study the measurement techniques for high AC ,DC and impulse currents.

CO5: Understand the measurement of Peak Voltages

UNIT – 1

Electrostatic fields and field stress control : Electric fields in homogeneous Isotropic materials and in multi dielectric media-Simple configurations-field stress control. Methods of computing electrostatic fields-conductive analogues-Impedance networks Numerical techniques-finite difference method-finite element method and charge simulation method.

UNIT – 2

Generation of High AC & DC Voltages:

Direct Voltages: AC to DC conversion methods, electrostatic generators, Cascaded Voltage Multipliers.

Alternating Voltages: Cascading transformers-Resonant circuits and their applications, Tesla coil.

UNIT – 3

Generation of Impulse Voltages :

Impulse voltage specifications-Impulse generation circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses.

Impulse Currents: Generation of high impulse currents and high current pulses.

UNIT – 4

Measurement of High AC & DC Voltages :

Measurement of High D.C. Voltages: Series resistance meters, voltage dividers and generating voltmeters.

Measurement of High A.C. Voltages : Series impedance meters electrostatic voltmeters potential transformers and CVTS-voltage dividers and their applications.

UNIT – 5

Measurement of Peak Voltages:

Sphere gaps, uniform field gaps, rod gaps. Chubb-Fortesque method, passive and active rectifier circuits for voltage dividers.

Measurement of Impulse Voltages: Voltage dividers and impulse measuring systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers-compensated dividers.

Measurement of Impulse Currents: Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes.

Text Books:

1. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.

Reference Books:

1. High Voltage Technology – LL Alston, Oxford University Press 1968.
2. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge,USA, 1972.
3. Relevant I.S. and IEC Specifications.

II-Semester	Evolutionary Algorithms and Applications (ELECTIVE-III)	Subject Code V2321256G2	L-T-P 3 -0-0	CREDITS 3

Pre-Requisite: i) Optimization Techniques ii) Power System Operation

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

CO1. To distinguish between conventional optimization algorithms and evolutionary optimization algorithms.

CO2. To apply genetic algorithm and particle swarm optimization algorithm to power systemoptimization problems.

CO3. To analyse and apply Ant colony optimization algorithm and artificial Bee colony algorithm tooptimize the control parameters./power system optimization problems.

CO4. To apply shuffled frog leaping algorithm and bat optimization algorithm to power systemoptimization problem.

CO5. To apply multi-objective optimization algorithm to power system multi-objective problems.

UNIT– 1

Fundamentals of Soft Computing Techniques

Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

UNIT– 2

Genetic Algorithm and Particle Swarm Optimization

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters – GA and PSO algorithms for solving ELD problem without loss, Selective Harmonic Elimination in inverters and PI controller tuning.

UNIT– 3

Ant Colony Optimization and Artificial Bee Colony Algorithms

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of Elitist Ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms – ACO and ABC algorithms for solving Economic Dispatch without loss and PI controller tuning.

UNIT– 4

Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm

Bat Algorithm- Echolocation of bats- Behaviour of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogscomparison of memes and genes -memeplex formation- memeplexupdation- BA and SFLA algorithms for solving ELD without loss and PI controller tuning.

UNIT– 5

Multi Objective Optimization

Multi-Objective optimization Introduction- Concept of Pareto optimality - Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to general two objective optimization problem.

Text Books

1. Xin-She Yang, „Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb „Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, „Swarm Intelligence", The Morgan Kaufmann Series in Evolutionary Computation, 2001.

Reference Books:

1. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, „Swarm Intelligence-From natural to Artificial Systems", Oxford university Press, 1999.
2. David Goldberg, „Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2007.
3. Konstantinos E. Parsopoulos and Michael N. Vrahatis, „Particle Swarm Optimization and Intelligence: Advances and Applications", InformatIonscIence reference, IGI Global, , 2010.
4. N P Padhy, „Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

Reference Papers:

1. "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization" by Muzaffareusuff, Kevin lansey and Fayzul pasha, Engineering Optimization, Taylor & Francis, Vol. 38, No. pp.129–154, March 2006.
2. "A New Metaheuristic Bat-Inspired Algorithm" by Xin-She Yang, Nature Inspired Cooperative Strategies for Optimization (NISCO 2010) (Eds. J. R. Gonzalez et al.), Studies in Computational Intelligence, Springer Berlin, 284, Springer, 65-74 (2010).
3. "Firefly Algorithms for Multimodal Optimization" Xin-She Yang, O. Watanabe and T. Zeugmann (Eds.), Springer-Verlag Berlin Heidelberg, pp. 169–178, 2009.

II-Semester	PROGRAMMABLE LOGIC CONTROLLERS & APPLICATIONS (ELECTIVE–IV)	Subject Code V2321256G3	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Knowledge on relay logic and digital electronics

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

CO1: Understand the PLCs and their I/O modules.
CO2: Develop control algorithms to PLC using ladder logic etc.
CO3: Identify the PLC registers for effective utilization in different applications.
CO4:Understand Handle data functions and control of two axis and their axis robots with PLC.
CO5: Design PID controller with PLC.

UNIT– 1
PLC Basics:
PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.
UNIT– 2
PLC Programming:
Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.
UNIT– 3
PLC Registers:
Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.
UNIT– 4
Data Handling functions:
SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR and Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions.
UNIT– 5
Analog PLC operation:
Analog modules and systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Text Books:

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

Reference Books:

1. Introduction to Programmable Logic Controllers- Gary Dunning-Cengage Learning.
2. Programmable Logic Controllers –W.Bolton-Elsevier publisher.

II-Semester	POWER SYSTEM SIMULATION LABORATORY-II	Subject Code V232125661	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Power systems

The student should understand the modelling of various aspects of Power System analysis and develop the MATLAB programming.

Course Outcomes:

CO1: The student should analyze load flow solution obtained using GS and NR methods,
CO2: Understand the symmetrical and unsymmetrical faults,
CO3: Discuss the Transient stability analysis using different methods
CO4: Analysis the load frequency deviation in single and two areasystems

List of Experiments

1	Load Flow Solution Using Gauss Siedel Method
2	Load Flow Solution Using Newton Raphson Method
3	Load Flow Solution Using Decoupled Method
4	Symmetrical Fault analysis using Z-bus
5	Unsymmetrical Fault analysis using Z-bus
6	Economic Load Dispatch with & without transmission losses
7	Transient Stability Analysis using modified Euler's method.
8	Transient Stability Analysis using modified R-K method.
9	Transient Stability Analysis Using Point By Point Method
10	Load Frequency Control of Single Area Control & Two Area Control system with and wi
11	Formation of Z-bus by Z-bus building algorithm

II-Semester	POWER CONVERTERS LABORATORY	Subject Code V232125662	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Fundamentals of Power Electronics

Course Educational Objectives: To study and understand the different converters and inverters for single and three phase loads.

Any 10 of the following experiments are to be conducted.

List of experiments

1. Study of DC-DC non-isolated converters such as Buck & Boost converter.
2. Study of DC-DC Buck-Boost and Cuk converters.
3. Study of 1-ϕ dual converter.
4. Determination of input p.f. and harmonic factor for 1-ϕ semi- converter and 1-ϕ full-converter (Inductive load)
5. Study of p.f. improvement in 1-ϕ full-converter with symmetric and extinction angle control.
6. Study of 1-ϕ square wave and sinusoidal PWM inverter.
7. Study of 3-ϕ inverter with 120^{o} and 180^{o} mode of operation.
8. Study of 3-ϕ sinusoidal PWM inverter.
9. Study of 3-level NPC inverter.
10. Study of 5-level cascaded H-bridge inverter.
11. Determination of input p.f. and harmonic factor for 3-ϕ full converter (Inductive load).
12. Determination of input p.f. and harmonic factor for 3-ϕ semi converter (Inductive load).
13. Study the characteristics of IGBT, MOSFET & GTO's.
14. Design of gate drive circuits for IGBT & MOSFET's.

Course Outcomes: Students are able to implement the converter and inverters in real time applications.

II-Semester	MINI PROJECT WITH SEMINAR	Subject Code V23212CC91	L-T-P 0-0-4	CREDITS 2

Note:
It is recommended that a Supervisor/advisor should be allotted to each student at the end of the semester-I or allot at the start of the semester-II

Syllabus content:

A Student has to select one paper published in any of the IEEE Transactions and simulate the same. The student has to present the progress of the work at the middle of the semester. At the end of the semester, the student has to present the results by explaining the idea of the topic, methodology, finding of the simulations. A Student should also submit a report of the entire work carried out under this course. The end semester presentation must be video recorded and preserved.

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Course Outcomes:
Students will be able to:
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

Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
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,	4
5	skills are 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	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

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
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

AUDIT 1 and 2: DISASTER MANAGEMENT

Course Outcomes: -Students will be able to:

learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus

Units	CONTENTS	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man- made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	4

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Outcomes:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested reading

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood

Being a logical language will help to develop logic in

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested reading

4. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
5. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
6. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

AUDIT 1 and 2: VALUE EDUCATION

Course Outcomes:

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Syllabus

Unit	Content	Hours
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgements	4
2	• Importance of cultivation of values. • Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. • Honesty, Humanity. Power of faith, National Unity. • Patriotism.Love for nature ,Discipline	6
3	• Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labour. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	6
4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Nonviolence ,Humility, Role of Women. • All religions and same message. • Mind your Mind, Self-control. • Honesty, Studying effectively	6

Suggested reading

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Course outcomes

Students will be able to 1.Knowledge of self-development

2.Learn the importance of Human values 3.Developing the overall personality

AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Outcomes:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Units	Content	Hours
1	• **History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)	4
2	• **Philosophy of the Indian Constitution:** Preamble Salient Features	4
3	**Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality Right to Freedom Right against Exploitation Right to Freedom of Religion Cultural and Educational Rights Right to Constitutional Remedies Directive Principles of State Policy Fundamental Duties.	4
4	**Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions • Executive President Governor Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions	4

5	**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CE of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	O 4
6	**Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	4

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

AUDIT 1 and 2: PEDAGOGY STUDIES

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classroomsin developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in whatconditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum andguidance materials best support effective pedagogy?
4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers.
5. Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.	4
2	• Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2
3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? • Theory of change. • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	• Professional development: alignment with classroom practices and follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4

5	**Research gaps and future directions** Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.	2

Suggested reading

2. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
3. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
4. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
5. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
6. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
7. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
8. www.pratham.org/images/resource%20working%20paper%202.pdf.

AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also

2. Improve efficiency

Syllabus

Unit	Content	Hours
1	• Definitions of Eight parts of yog. (Ashtanga)	8
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam 1. Various yog poses and their benefits for mind & body 2. Regularization of breathing techniques and its effects-Types of pranayam	8

Suggested reading

2. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami YogabhyasiMandal, Nagpur
3. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity

Study of Neetishatakam will help in developing versatile personality of students

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dont's) • Verses- 71,73,75,78 (do's)	8
2	• Approach to day to day work and duties. • Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, • Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, • Chapter 18-Verses 45, 46, 48.	8
3	• Statements of basic knowledge. • Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8

Suggested reading

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

III-Semester	Energy Audit Conservation& Management (Program Elective-V)	Subject Code V2322156H1	L-T-P 3-0-0	CREDITS 3

Pre-requisite: Electrical power systems and measurements.

Course Educational Objectives:

- To learn the basics of energy audit and energy conservation schemes.
- To comprehend the principles of energy management and understand the need of energy efficient motors and lighting design practices.
- To learn about power factor improvement techniques and energy instruments.
- To learn about the economic aspects o\f energy equipment.

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

CO1: Understand the principle of energy audit and their economic aspects.

CO2: Understand the Concept energy management

CO2: Recommend energy efficient motors and design good lighting system.

CO3: Understand advantages to improve the power factor.

CO4: Evaluate the depreciation of equipment.

UNIT– 1

Basic Principles of Energy Audit

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT– 2

Energy Management

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manager, qualities and functions, language, Questionnaire – check list for top management

UNIT– 3

Energy Efficient Motors and Lighting

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed , variable duty cycle systems, RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. Lighting system design and practice, lighting control, lighting energy audit

UNIT– 4

Power Factor Improvement and energy instruments

Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f, p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's

UNIT– 5

Economic Aspects and their computation

Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.

Text Books:

1. Energy management by W.R.Murphy&G.Mckay Butter worth, Heinemann publications, 1982.
2. Energy management hand book by W.CTurner 7th Edition, 2009.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

III-Semester	SMART GRID TECHNOLOGIES (ELECTIVE–V)	Subject Code V2322156H2	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

Course Educational Objectives:

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have knowledge on smart substations, feeder automation and application for monitoring and protection.

Course Outcomes:

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

CO1: Understand smart grids and analyze the smart grid policies and developments in smartgrids.
CO2: Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
CO3: Understand smart substations, feeder automation, GIS etc.
CO4: Analyze micro grids and distributed generation systems.
CO5: Analyze the effect of power quality in smart grid and to understand latest developmentsin ICT for smart grid.

UNIT – 1:
Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.

UNIT – 2
Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

UNIT – 3
Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

UNIT – 4
Micro grids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT – 5

Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN).

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley, 2009
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, 2020

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, "Smart Grid: Technology and Applications", Wiley, 2010
2. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley Blackwell 19
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011

III-Semester	POWER QUALITY AND CUSTOM POWER DEVICES (ELECTIVE–V)	Subject Code V2322156H3	L-T-P 3 -0-0	CREDITS 3

Pre requisite: Knowledge on electric circuit analysis, power systems and power electronics and concept of reactive power compensation techniques.

Course Educational Objectives:

- To understand significance of power quality and power quality parameters.
- To know types of transient over voltages and protection of transient voltages.
- To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
- To understand the importance of power devices and their applications.
- To understand different compensation techniques to minimize power quality disturbances.

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

CO1: Identify the issues related to power quality in power systems.

CO2: Estimate the problems of transient and long duration voltage variations in power systems.

CO3: Analyze the effects of harmonics and study of different mitigation techniques.

CO4: Identify the importance of custom power devices and their applications.

CO5: Understand the knowledge on different compensation techniques to minimize power qualitydisturbances.

UNIT– 1

Introduction to power quality: Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads.

UNIT– 2

Transient and Long Duration Voltage Variations: Source of Transient Over Voltages - Principles of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor Switching Transients, Utility Lightning Protection, Load Switching Transient Problems.

Principles of Regulating the Voltage, Device for Voltage Regulation, Utility Voltage Regulator Application, Capacitor for Voltage Regulation, End-user Capacitor Application, Regulating Utility Voltage with Distributed generation

UNIT– 3

Harmonic Distortion and solutions: Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics

UNIT– 4

Custom Power Devices: Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations.

UNIT– 5

Application of custom power devices in power systems: Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC); Generalized power quality conditioner

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw-Hill, 2002.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 2000.
3. Guidebook on Custom Power Devices, Technical Report, Published by EPRI, Nov 2000
4. Power Quality Enhancement Using Custom Power Devices – Power Electronics and Power Systems, Gerard Ledwich, ArindamGhosh, Kluwer Academic Publishers, 2002.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley & Sons, 2003.
3. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, Van Nostrad Reinhold, New York.
4. Power Quality c.shankaran, CRC Press, 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa-CRC Press (Taylor & Francis).
6. Power Quality in Power systems and Electrical Machines-EwaldF.fuchs, Mohammad A.S. Masoum-Elsevier
7. Power Quality, C. Shankaran, CRC Press, 2001
8. Instantaneous Power Theory and Application to Power Conditioning, H. Akagiet.al., IEEE Press, 2007.
9. Custom Power Devices - An Introduction, ArindamGhosh and Gerard Ledwich, Springer, 2002

III-Semester	INDUSTRIAL SAETY (OPEN ELECTIVE)	Subject Code V232215651	L-T-P 3 -0-0	CREDITS 3

Pre-requisite: Engineering Fundamentals

Course Educational Objectives:

- To learn safety aspects of any industrial area
- To learn fundamentals and types of maintenance engineering
- To learn causes and effects of wear and Corrosion and their prevention
- To learn identification of faults and their repair
- To learn preventive maintenance- periodic an preventive-maintenance of industrial systems

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

CO1: Understand the general industrial requirements like lighting, cleanliness prevention from Hazardsand accidents.

CO2: Analyze maintenance requirements of the industry and cost associated.

CO3: Analyze wear and corrosion aspects of the industry and their prevention.

CO4: Identify the faults prone areas and their repair and periodic maintenance.

Unit-I: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment and methods.

Unit-II: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit-IV: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit-V: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

III-Semester	ARTIFICIAL INTELLIGENT TECHNIQUES (OPEN ELECTIVE)	Subject Code V232215652	L-T-P 3 -0-0	CREDITS 3

Pre–requisite: Fundamentals of Neural networks and Fuzzy Logic.

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

CO1: Understand the fundamental concepts artificial neuron and its activation functions

CO2: Analyse the Artificial Neural Network paradigms.

CO3: Understand the fundamental concepts of Classical and Fuzzy sets.

CO4: Understand concept of fuzzy logic controllers.

CO5: Apply appropriate AI framework for solving power system problems

UNIT– 1

Introduction

Artificial Neural Networks (ANN) – definition and fundamental concepts – Biological neural networks – Artificial neuron – activation functions – setting of weights – typical architectures – biases and thresholds – learning/training laws and algorithms. Perceptron – architectures, ADALINE and MADLINE – linear separability- XOR function.

UNIT– 2

ANN Paradigms

ADALINE – feed forward networks – Back Propagation algorithm- number of hidden layers – gradient decent algorithm – Radial Basis Function (RBF) network. Kohonen's self organizing map (SOM), Learning Vector Quantization (LVQ) and its types – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.

UNIT– 3

Classical and Fuzzy Sets

Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.

UNIT– 4

FUZZY LOGIC CONTROLLER (FLC)

Fuzzy logic system components: Fuzzification, Inference engine (development of rule base and decision making system), Defuzzification to crisp sets- Defuzzification methods.

UNIT– 5

Application of AI Techniques

Speed control of DC motors using fuzzy logic –load flow studies using back propagation algorithm, single area and two area load frequency control using fuzzy logic.

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – McGraw Hill Inc, 1997.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.
2. Modern power Electronics and AC Drives – B.K.Bose -Prentice Hall, 2002
3. Genetic Algorithms- David E Goldberg. Pearson publications.
5. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam,SSumathi,S N Deepa TMGH
6. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam,SSumathi,S N Deepa Springer, 2007.

III Semester	OPERATIONS RESEARCH (OPEN ELECTIVE)	Subject Code V232215653	L-T-P 3 -0-0	CREDITS 3

Pre –requisite: Engineering Mathematics

Course Outcomes:

CO1: Understand the mathematical modelling of physical systems and its solving techniques withand without constraints.
CO2: Analyse the LPP problem using graphical and simplex method.
CO3: Understand the Solving of non-linear programming problem.
CO4: Estimate the scheduling and sequencing problem of different models with Geometric programming.
CO5: Understand the Solving of LPP using dynamic programming and graph theory.

Unit 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques,Sensitivity Analysis, Inventory Control Models

Unit 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Unit 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit 4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Unit 5

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

III Semester	(OPEN ELECTIVE) **Renewable Energy Driven Power Systems**	Subject Code V232215654	L-T-P 3 -0-0	CREDITS 3

COURSE OBJECTIVES:

1. Aware of various forms of renewable energy.
2. Understand in detail different types of energy conversion systems.
3. Design different power converters for renewable energy conversion and integration

COURSE OUTCOMES:

Upon completion of the course, the student will be able to:

1. Appraise the need and possibility of extracting solar energy and converting into electrical energy using PV cell and solar concentrators.
2. Describe the dynamics of wind turbine and electrical generator.
3. Explain the methods of conversion of bio-mass, Geothermal, Wave and tidal energy into electrical energy.
4. Design renewable energy systems that meet specific energy demands.

Unit-I

Solar Energy Conversion Systems-Solar Photovoltaic Power System: The PV cell, Module and Array, Equivalent Electrical circuit, Open Circuit Voltage and Short Circuit Current, I-V and P-V Curves, Array Design, Peak Power Point operation, Components of Standalone and Grid connected PV systems.

Solar Thermal systems: Energy Collection, Solar Central receiver systems, Solar Pond, Distributed Systems

Unit-II

Wind Energy Conversion Systems-Wind Power System: Wind Energy Conversion Systems and their classification, Wind Power System components, rating, Electrical Load Matching, Variable-speed Operation, System Design features, Maximum Power operation, System Control Requirements, Rate Control and Environmental aspects. Components of Standalone and Grid connected Wind Power Systems, Self-Exited Induction Generator for Isolated Power Generators.

Unit-III

Power Conditioning for Solar and Wind Energy Conversion Systems

Switching Devices for Energy Conversion, DC Power Conditioning Converters, Introduction to Maximum Power Pint Algorithms, AC Power Conditioners, Line Commutated Inverters, Synchronized operation with Grid, Harmonic Reduction and Power Factor Improvement.

Unit-IV

Wave Energy: Theory-Devices for Energy Extraction. Tidal Energy: Tidal Current Energy, Tidal Barrage method, Tidal Turbine Method for Energy Extraction

Ocean Thermal Energy Conversion: Closed Cycle, Open Cycle & Hybrid OTEC Systems, by products of OTEC Systems.

Unit-V

Bio-energy: Types of Biomass, Electric Power Generation using biomass, Bio-methane, Bio fuels Biodiesel Production.

Geothermal Energy: Resource Identification, Geothermal System, Geothermal Resources for Electricity Generation.

Text Books:

1. Mukund R. Patel “Wind and Solar Power Systems” CRC Press, 1999.
2. Tushar K. Ghosh, Mark A. Prelas “Energy Resources and Systems Volume 2: Renewable Resources” Springer, 2011.

Reference Books:

1. Rai G.D., “Non – Conventional Energy Sources”, Khanna Publishers, 1993.
2. Nicola Femia, Giovanni Petrone “Power Electronics and Control Techniques for Maximum energy Harvesting in Photovoltaic Systems” CRC Press, 2013.

III Semester	(OPEN ELECTIVE) Advanced Power Electronic Converters	Subject Code V232215655	L-T-P 3 -0-0	CREDITS 3

Course objectives:

1. To describe the operation of advanced power electronic converters
2. To comprehend the modulation techniques of converters and multi-level inverters

Course Outcomes:

Upon the completion of the subject, the student will be able to:

1. Illustrate and analyse the operation of various line commutated converters.
2. Understand the concepts of analyse the operation of various isolated DC-DC converters.
3. Illustrate and analyse the operation of various AC-AC converters.
4. Understand the operation of various inverters and apply various PWM techniques.
5. Analyse the importance of multilevel inverters.

UNIT-I

LINE COMMUTATED CONVERTERS: Single phase fully controlled converters with RL load analysis & wave forms, Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current-analysis & wave forms, Evaluation of input power factor and harmonic factor-Twelve pulse converter.

UNIT-II

DC-DC CONVERTERS: principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge Converters with continuous and discontinuous operation.

UNIT-III

AC VOLTAGE CONTROLLERS: Single phase AC voltage controllers- with R & RL loads Analysis & waveforms- three phase AC voltage controllers- analysis& wave forms – AC synchronous tap changers – Matrix converters:- Principle of operation only. CYCLO CONVERTER: Single phase – bridge type- R & RL loads- 3 phase bridge type principle of operation.

UNIT-IV

NVERTERS: Bridge type- Single phase Inverters. MC Murray- Bedford inverter- and their analysis & waveforms – Bridge type three phase Inverters –analysis of 180 degree & 120 degree conduction modes. Current Source Inverter- some applications- comparison of VSI & CSI. VOLTAGE CONTROL OF THREE PHASE INVERTERS: Sinusoidal PWM – Third Harmonic PWM – 60 degree PWM – Space Vector Modulation.

UNIT-V

MULTILEVEL INVERTERS: Multilevel concept – Classification of multilevel inverters – Diode clamped multilevel inverter - Flying capacitors multilevel inverter - Cascaded multilevel inverter Up to three levels only. Multilevel inverter applications.

TEXT BOOKS:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – Third Edition – First Indian reprint 2004.
2. Power electronics – V R Moorthy – Oxford Publications.

REFERENCE BOOKS:

1. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley & Sons – Second Edition.

III Semester	(OPEN ELECTIVE) SCADA System and Applications	Subject Code V232215656	L-T-P 3 -0-0	CREDITS 3

COURSE OBJECTIVES:

1. To understand about the SCADA system components and SCADA communication protocols.
2. To provide knowledge about SCADA applications in power system.

COURSE OUTCOMES:

Upon the completion of the subject, the student will be able to

1. Understand the importance of SCADA systems.
2. Describe various SCADA system components.
3. Identify various SCADA system architectures.
4. Analyse SCADA communication protocols.
5. Enumerate SCADA applications in power systems.

UNIT I: SCADA: Data acquisition system, evaluation of SCADA, communication technologies, monitoring and supervisory functions.

UNIT II: SCADA system components: Schemes, Remote Terminal Unit, Intelligent Electronic Devices, Communication Network, SCADA server.

UNIT III: SCADA Architecture - Various SCADA Architectures, advantages and disadvantages of each system, single unified standard architecture IEC 61850 SCADA / HMI Systems. UNIT IV: SCADA Communication - Various industrial communication technologies- wired and wireless methods and fiber optics, open standard communication protocols.

UNIT V: Operation and Control Of Interconnected Power System-Automatic substation control, SCADA configuration, Energy management system, system operating states, system security, state estimation, SCADA applications Utility applications, transmission and distribution sector operation, monitoring analysis and improvement. Industries oil gas and water. Case studies, implementation, simulation exercises.

TEXT BOOKS:

1. Ronald L. Krutz, “Securing SCADA System”, Wiley Publications.
2. Stuart A Boyer, “SCADA supervisory control and data acquisition”, ISA, 4th Revised
3. Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols”, ELSEVIER.

REFERENCES:

1. William T. Shaw, Cybersecurity for SCADA systems, PennWell Books, 2006.
2. David Bailey, Edwin Wright, Practical SCADA for industry, Newnes, 2003.
3. Michael Wiebe, A guide to utility automation: AMR, SCADA, and IT systems for electric Power, PennWell 1999.
4. S. K. Singh, “Computer Aided Process Control”, PHI
5. S. Gupta, JP Gupta, “PC interface For Data Acquiring & Process Control”, 2nd Ed., Instrument Society of America.
6. John W. Web, Ronald A. Reis, “Programmable Logic Controllers” 5th Edition, PHI
7. Liptak, B. G. (E.d.), “Instrument Engineers Handbook”, vol. I to III, Chilton Book Co.

8. Bhatkar, Marshal, “Distributed Computer control & Industrial Automation”, Dekker Publication
9. Frank D. Petruzella, “Programmable Logic Controllers”, 3rd Edition, McGraw Hill
10. Edition Sunil S. Rao, “Switchgear and Protections”, Khanna Publications.

III SEMESTER	DISSERTATION PHASE-I	Subject Code V23221CCA1	L-T-P 0-0-20	CREDIT 10

IV SEMESTER	DISSERTATION PHASE-II	Subject Code V23221CCA1	L-T-P 0-0-32	CREDIT 16