



SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)

(Affiliated to JNTUK, Kakinada), (Recognised by AICTE, New Delhi)

Accredited by NAAC with 'A' Grade

Recognised as Scientific and Industrial Research Organisation

CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204

SCHEME OF INSTRUCTION & EXAMINATION

(Regulation R17)

M.TECH (POWER SYSTEM AND AUTOMATION)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(With effect from **2017-2018** Admitted Batch onwards)

Under Choice Based Credit System

I-SEMESTER

Code No.	Name of the Subject	Credits	Lecture Hrs	Tutorial Hrs	Lab Hrs	Contact Hrs/Week	Internal Marks	External Marks	Total Marks
M17 PS 1101	Advanced Power system Operation and control	3	3	1	--	4	30	70	100
M17 PS 1102	HVDC Transmission	3	3	1	--	4	30	70	100
M17 PS 1103	Reactive Power Compensation & Management	3	3	1	--	4	30	70	100
M17 PS 1104	Analysis of Power Electronics Converters	3	3	1	--	4	30	70	100
#ELE-1	Elective-I	3	3	1	--	4	30	70	100
#ELE-2	Elective-II	3	3	1	--	4	30	70	100
M17 PS 1113	Simulation Laboratory	2	--	--	3	3	50	50	100
Total		20	18	6	3	27	230	470	700

	Course Code	Course
#ELE-1	M17 PS1105	Modern Control Theory
	M17 PS1106	Power System Security
	M17 PS1107	Optimization Techniques
	M17 PS1108	Generation and Measurement of High Voltage
#ELE-2	M17 PS1109	Renewable Energy Systems
	M17 PS1110	Advanced Digital Signal Processing
	M17 PS1111	Power System Reliability
	M17 PS1112	Electrical Distribution Systems

ADVANCED POWER SYSTEM OPERATION AND CONTROL

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the effect of generation with limited energy supply.
2. To understand the economics of power system operation with thermal and hydro units.
3. To study the unit commitment problem for economic load dispatch.
4. To study the optimal power flow problem with solution.
5. To study the load frequency control of two area systems with and without control.
6. To study the effectiveness of interchange evaluation in interconnected power systems.

COURSE OUTCOMES:

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

1. Know the effect of generation with limited energy supply.
2. Develop generation dispatching scheme for thermal and hydro units.
3. Determine the unit commitment problem for economic load dispatch.
4. Get the knowledge of load frequency control of single area and two area systems with and without control.
5. Determine the interchange evaluation in interconnected power systems.

SYLLABUS**UNIT-I:**

Generation with limited Energy supply : Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Base point and participation factor method, hard limits and slack variables, Fuel scheduling by linear programming. Hydroelectric plant models –short term hydrothermal scheduling problem – gradient approach.

UNIT-II:

Unit commitment problem: Constraints in UCP,UC solutions. UC Methods-priority list method, Forward Dynamic programming Approach and Lagrange Relaxation method.

UNIT-III:

Optimal power flow: Solution of OPF, gradient method, Newton's method, linear programming method with only real power variables, linear programming with AC power flow variables, security-constrained optimal power flow.

UNIT-IV:

Single area & Two areas Load Frequency Control: concept of single & two area Load frequency control: uncontrolled case and controlled case, tie-line bias control. Optimal two-area LF control-steady state representation, performance Index and optimal parameter adjustment.

UNIT-V:

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

TEXT BOOKS:

1. Power system operation and control PSR Murthy B.S publication.
2. Power Generation, Operation and Control - by A.J.Wood and B.F.Wollenberg, Johnwiley & sons Inc. 1984.

REFERENCE BOOKS:

1. Modern Power System Analysis - by I.J.Nagrath & D.P.Kothari, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
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.

HVDS TRANSMISSION

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

1. Understand the various schemes of HVDC transmission.
2. Understand the basic HVDC transmission equipment.
3. Understand the control of HVDC systems.
4. Understand the interaction between HVAC and HVDC system.
5. Understand the various protection schemes of HVDC engineering.

SYLLABUS**UNIT-I:**

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

UNIT-II:

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

UNIT-III:

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-IV:

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 -V:

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. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.
2. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.

REFERENCE BOOKS:

1. S Kamakshaih and V Kamaraju:HVDC Transmission- MG hill.
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.

REACTIVE POWER COMPENSATION & MANAGEMENT

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To know the basic objectives of reactive power compensation.
2. To know the types of compensation and their behavior.
3. To know the mathematical modeling of reactive power compensating devices.
4. To know the reactive power compensation has to be done at distribution side.
5. To know the role of reactive power compensation at electric traction systems and Arc furnaces.

COURSE OUTCOMES:

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

1. Learn various load compensations.
2. Obtain the mathematical model of reactive power compensating devices.
3. Get application of reactive power compensation in electrical traction & arc furnaces.

SYLLABUS**UNIT-I: Load Compensation**

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

UNIT-II: Reactive power compensation in transmission system:

Steady state -Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples Transient state - Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

UNIT-III: Reactive power coordination:

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

UNIT-IV: Distribution side Reactive power Management:

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

User side reactive power management:

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

UNIT-V: Reactive power management in electric traction systems and arc furnaces:

Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

TEXT BOOK:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982

REFERENCE BOOK:

1. Reactive power Management by D.M.Tagare,Tata McGraw Hill,2004

ANALYSIS OF POWER ELECTRONIC CONVERTERS

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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

SYLLABUS**UNIT-I: AC voltage Controllers**

Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances –synchronous tap changers Application numerical problems Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances– Application numerical problems.

UNIT-II: AC-DC converters

Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems. Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems

UNIT-III: 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-IV: PWM Inverters

Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems. Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 600 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

UNIT-V: 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-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008.
2. Modern power Electronics and AC Drives – B.K.Bose

REFERENCE BOOKS:

1. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley& Sons -2nd Edition.
2. Power Electronics – Lander –Ed.2009.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee Publishing Pvt Ltd.

**MODERN CONTROL THEORY
(ELECTIVE-I)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To facilitate the evolution of state variable approach for the analysis of control systems.
2. To examine the importance of controllability and observability in modern control engineering.
3. To enable students to analyze various types of nonlinearities & construction of trajectories using describing functions and phase plane analysis.
4. To study the analysis of stability and instability of continuous time invariant system

COURSE OUTCOMES:

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

1. Understanding the state variable approach is suitable for higher order.
2. To analyze the concepts of controllability and observability.
3. To analyze the various non-linearities through describing functions and phase plane analysis.
4. Typical issues of stability and instability of continuous time invariant systems.

SYLLABUS

UNIT –I: State Variable Analysis

The concept of state – State Equations for Dynamic systems – State diagram - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and its properties

UNIT –II: State Variable Techniques

General concept of Controllability - General concept of Observability Controllability tests for Continuous & Time Invariant systems - Observability tests for Continuous & Time Invariant systems – Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model – State feedback controller design through pole assignment.

UNIT –III: Non Linear Systems – I

Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions.

UNIT –IV: Non Linear Systems – II

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT –V: Stability Analysis

Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

TEXT BOOKS:

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997

REFERENCE BOOKS:

1. Nonlinear systems, Hassan K. Klalil, Prentice Hall, 1996
2. Modern control systems, Richard C. Dorf and Robert H. Bishop, 11th Edition, Pearson Edu, India, 2009

**POWER SYSTEM SECURITY
(ELECTIVE-I)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the short circuit analysis of balanced and unbalanced power systems.
2. To study the power system security analysis.
3. To study the real time control of power system.
4. To study the principles and applications of SCADA.

COURSE OUTCOMES:

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

1. Analyze the balanced and unbalanced power system under short circuit conditions.
2. Understand how to minimize the short circuit effect on the power System.
3. Design the power system with more security with real time control.
4. Implant SCADA for power system security.

SYLLABUS

UNIT-I:

Short circuit analysis techniques in AC power Systems- Simulation of short circuit and open circuit faults using network theorems- fixed impedance short circuit analysis techniques time domain short circuit analysis in large scale power systems- analysis of time variation of AC and DC short circuit components

UNIT-II:

Fixed impedance Short circuit analysis of large scale power systems-general analysis of balanced, unbalanced and open circuit faults- 3-phase short circuit analysis in large scale power systems, Network equivalents and practical short circuit current assessments in large scale Ac power systems-general studies- uncertainties in short circuit current calculations-probabilistic Short circuit analysis

UNIT-III:

Risk assessment and safety considerations-control and limitation of high short circuit currents-limitation of short circuit currents in power system operation, design and planning, Types of short circuit fault current limiters- earthing resistor or reactor connected to transformer neutral-pyrotechnic fault current limiters- series resonant current limiters- saturable reactor limiters-other types of fault current limiters and their applications.

UNIT-IV:

Power System Security analysis- concept of security- security analysis and monitoring factors affecting power system security- detection of network problems –overview, contingency analysis for generator and line outages by ILPF method – fast decoupled inverse Lemma-based approach, network sensitivity factors –contingency selection –concentric relaxation and bounding.

UNIT-V:

Computer control power systems – need for real time and computer control of power systems- operating states of power system – SCADA- implementation considerations – software requirements for implementing above functions.

TEXT BOOKS:

1. Allen J. Wood and Bruce Woolenber: Power System Generation, Operation and Control ,John Willey and sons,1996

REFERENCE BOOKS:

1. John J. Grainger and William D Stevenson Jr.: Power System analysis, McGraw Hill, ISE, 1994.
2. Nasser D. Tleis : Power System Modelling and fault analysis, Elsevier, 2008.
3. Hand book of Power Systems, GrigsBee., CRC Press ,Newyork.

**OPTIMIZATION TECHNIQUES
(ELECTIVE-I)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To learn essential optimization techniques for applying to day to day problems.
2. To study the optimization techniques for linear programming problems.
3. To understand the optimization techniques for Non-linear programming problems.

COURSE OUTCOMES:

1. After learning the techniques they can apply to engineering and other problems.

SYLLABUS

UNIT-I:

Introduction to Optimization: Introduction, Historical Development, Engineering applications of Optimization, Statement of Optimization Problem.

UNIT-II:

Classical Optimization Techniques: Introduction, Single variable optimization, Multiv-ari-able optimization with no constraints; Multivariable optimization with Equality constraints - Solution by Direct Substitution method, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn-Tucker conditions.

UNIT-III:

Linear Programming: Introduction, Applications of Linear Programming, Standard Form of a Linear Programming, Basic Terminology and Definitions, Exceptional cases, Simplex method, Big-M method, Two-phase method, Revised Simplex method, Duality, Degene-racy Principle.

UNIT-IV:

Non-Linear Programming-I: Unconstrained One Dimensional Minimization Methods- Fibonacci Method, Quadratic Interpolation Method Non- Linear Programming: Un Constrained Optimnization: Univariate Method, Pattern Directions, Powell's Method, Cauchy's Method Or Steepest Descent Method, Powell's Conjugate Direction Method.

UNIT-V:

Non-Linear Programming-II: Constrained Optimization- Characteristics Of A Constrained Problem, Classification- Direct Methods, Indirect Methods- Interior Penalty Function Method, Exterior Penalty Function Method,

TEXT BOOKS:

1. Engineering Optimization: Theory and Applications 'By S.S. Rao, New Age International Publishers, revised Third Edition 2005.
2. Optimization for Engineering Design (Algorithms & Examples)" by Kalyanmoy Deb, PHI Pvt. Ltd, New Delhi.

REFERENCE BOOKS:

1. Optimization Techniques" by Chander Mohan, Kusum Deep, New Age International Publishers, 2009.
2. Optimization Methods, Theory and Applications" by Honglei Xu, Song Wang , Soon-Yi Wu, Springer, 2015.

**GENERATION & MEASUREMENTS OF HIGHVOLTAGES
(ELECTIVE-I)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the numerical methods for analyzing electrostatic field problems.
2. To study the fundamental principles of generation of high voltage for testing.
3. To study the methods for measurement of high AC,DC and transient voltages.
4. To Study the measurement techniques for high AC,DC and impulse currents.

COURSE OUTCOMES:

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

1. Understand numerical computation of electrostatic problems.
2. Understand the techniques of generation of high AC, DC and transient voltages.
3. Measure high AC, DC and transient voltages.
4. Measure high AC, DC and transient currents.

SYLLABUS**UNIT-I: 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-II: Generation of High AC & DC Voltages:

Direct Voltages: AC to DC conversion methods electrostatic generators-Cascaded Voltage Multipliers. Alternating Voltages: Testing transformers-Resonant circuits and their applications, Tesla coil.

UNIT-III: Generation of Impulse Voltages:

Impulse voltage specifications-Impulse generations 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-IV: 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-V: Measurement of Peak Voltages:

Sphere gaps, uniform field gaps, rod gaps. Chubb- Fortesque methods. 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 M.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co., New Delhi, 2nd edition, 1995.
2. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.

REFERENCE BOOKS:

1. High Voltage Technology – LL Alston, Oxford University Press 1968.
2. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge,USA, 1972.

**RENEWABLE ENERGY SYSTEMS
(ELECTIVE-II)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To familiarize students regarding World Energy Scenario and Power Generation.
2. To familiarize students with Features of Conventional and Renewable Generation.
3. To Gain knowledge on Power balance /Frequency control of Renewable energy system.
4. To Study Renewable Energy generation in Power system.
5. To familiarize students with Power System Economics and the Electricity Market.
6. To understand the future towards a Sustainable Electricity supply.

COURSE OUTCOMES:

1. Students will be able to understand the World Energy Generation and consumption Over the past and present;
2. Students will be able to outline the technologies that are used to harness the Energy from Conventional and Non-conventional Sources.
3. Students will be able to understand power governing, dynamic frequency control of large systems, Impact of Renewable generation on Frequency control
4. Students will be able to explain the Issues Regarding Renewable Energy System in Power System
5. Students will be able to outline the Power system economics and Electricity Market
6. Students will have vision towards sustainable supply systems in Future.

SYLLABUS

UNIT-I:

Energy and Electricity: The World Energy Scene, The Environmental Impact of Energy Use, Generating Electricity, The Electrical Power System.

UNIT-II:

Features of Conventional and Renewable Generation: Introduction, Conventional Sources: Coal, Gas and Nuclear, Hydroelectric Power, Wind Power, PV and Solar Thermal Electricity, Tidal Power, Wave Power, Biomass, Summary of Power Generation Characteristics, Combining Sources.

UNIT-III:

Power Balance/Frequency Control: Introduction, Electricity Demand, Power Governing, Dynamic Frequency Control of Large Systems, Impact of Renewable Generation on Frequency Control and Reliability, Frequency Response Services from Renewable, Frequency Control Modelling, Energy Storage.

UNIT-IV:

Renewable Energy Generation in Power Systems: Distributed Generation, Voltage Effects, Thermal Limits, Other Embedded Generation Issues, Islanding, Fault Ride-through, Generator and Converter Characteristics.

UNIT-V:

Power System Economics and the Electricity Market: Introduction, The Costs of Electricity Generation, Economic Optimization in Power Systems., External Costs, Effects of Embedded Generation, Support Mechanisms for Renewable Energy, Electricity Trading.

The Future–Towards a Sustainable Electricity Supply System: Introduction, The Future of Wind Power, The Future of Solar Power, The Future of Bio fuels, The Future of Hydro and Marine Power, Distributed Generation and the Shape of Future Networks.

TEXT BOOKS:

1. Renewable Energy in Power Systems, BY Leon Freris, David Infield, WILEY PUBLISHERS, July 2008
2. Our Energy Future: Resource, Alternatives and the Environment, by Christian Ngo, Joseph Natowitz, Wiley Publishers, Aug 2009.

REFERENCE BOOKS:

1. Renewable Energy Resources“ by John Twidell and Tony Weir, Taylor & Francis, Second edition, 2006.
2. Renewable Energy Systems by Henrik Lund, Elsevier Inc. 2014.

**ADVANCED DIGITAL SIGNAL PROCESSING
(ELECTIVE-II)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To have knowledge on structures of different digital filters.
2. To design digital filters with different techniques.
3. To understand the implementation aspects of digital filters.
4. To analyze the effect of finite word length in signal processing.
5. To understand power spectrum estimation techniques in signal processing.

COURSE OUTCOMES:

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

1. Describe structure of digital filters.
2. Design digital filters with different techniques.
3. Understand the implementation aspects of signal processing algorithms.
4. Know the effect of finite word length in signal processing.
5. Analyze different power spectrum estimation techniques.

SYLLABUS**UNIT-I: Digital Filter Structure**

Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

UNIT-II: Digital filter design

Preliminary considerations-Bilinear transformation method of IIR filter design-design of Low pass high pass-Band pass, and Band stop- IIR digital filters-Spectral transformations of IIR filters, FIR filter design-based on Windowed Fourier series- design of FIR digital filters with least –mean- Square-error-constrained Least-square design of FIR digital filters

UNIT-III: DSP algorithm implementation

Computation of the discrete Fourier transform- Number representation-Arithmetic operations handling of overflow-Tunable digital filters-function approximation.

UNIT-IV: Analysis of finite Word length effects

The Quantization process and errors- Quantization of fixed -point and floating -point Numbers- Analysis of coefficient Quantization effects - Analysis of Arithmetic Round-off errors, Dynamic range scaling-signal- to- noise ratio in Low -order IIR filters-Low-Sensitivity Digital filters- Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters- Round-off errors in FFT Algorithms.

UNIT V: Power Spectrum Estimation

Estimation of spectra from Finite Duration Observations signals – Non-parametric methods for power spectrum Estimation – parametric method for power spectrum Estimation, Estimation of spectral form-Finite duration observation of signals-Non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.

TEXT BOOKS:

1. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996
1st edition-9th reprint.
2. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd
reprint-2001

REFERENCE BOOKS:

1. Digital signal processing-sanjit K. Mitra-TMH second edition.
2. Digital Signal Processing principles, algorithms and Applications – John G.Proakis -PHI –
3rd edition-2002.
3. Theory and Applications of Digital Signal Proceesing-LourensR. Rebinar&Bernold
4. Digital Filter Analysis and Design-Auntonian-TMH

**POWER SYSTEM RELIABILITY
(ELECTIVE-II)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. Will be able to get the basic understanding of network modelling and reliability.
2. Markov chains.
3. Reliability analysis of generation systems.
4. Decomposition techniques.

Course Outcomes:

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

1. Understand reliability analysis applied to power systems.
2. Understand Markov Chains and application to power systems.
3. Perform stability analysis of generation systems.
4. Understand decomposition techniques applied to power system.

SYLLABUS**UNIT-I :**

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-II :

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

UNIT-III :

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 cycletime, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states

UNIT-IV :

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-V :

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

TEXT BOOKS:

1. Reliability Evaluation of Power System – R.Billinton, R.N.Allan, Plenum Press, New York.

REFERENCE BOOKS:

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.

2. An Introduction to Reliability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition

**ELECTRICAL DISTRIBUTION SYSTEMS
(ELECTIVE-II)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To learn the importance of economic distribution of electrical energy.
2. To analyze the distribution networks for V-drops, P_{Loss} calculations and reactive power.
3. To understand the co-ordination of protection devices.
4. To impart knowledge of capacitive compensation/voltage control.
5. To understand the principles of voltage control.

COURSE OUTCOMES:

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

1. Analyze a distribution system.
2. Design equipment for compensation of losses in the distribution system.
3. Design protective systems and co-ordinate the devices.
4. Get understanding of capacitive compensation.
5. Get understanding of voltage control.

SYLLABUS

UNIT-I:Distribution System Basics:

Brief description about electrical power transmission and distribution systems, Different types of distribution sub-transmission systems, Substation bus schemes, Factors effecting the substation location, Factors effecting the primary feeder rating, types of primary feeders, Factors affecting the primary feeder voltage level, Factors affecting the primary feeder loading.

UNIT-II: Distribution System Loads:

Various types of loads, Definitions of various terms related to system loading, Detailed description of distribution transformer loading, feeder loading, Modelling of star and delta connected loads, two-phase and single-phase loads, shunt capacitors.

UNIT-III: Substations and feeders:

Rating of a distribution substation for square and hexagonal shaped distribution substation service area, Derivation of K constant, Radial feeder with uniformly and non-uniformly distributed loading.

UNIT-IV: Distribution System Load Flow:

Exact line segment model, Modified line model, approximate line segment model, Review of the two-winding transformer theory, two-winding auto transformer, Step-Voltage Regulators, Line drop compensator, Forward/Backward sweep distribution load flow algorithm.

UNIT-V: Voltage Drop and Power loss Calculation:

Detailed analysis of non-three phase primary lines, concepts of four-wire multi-grounded common-neutral distribution system, Percent power loss calculation, Distribution feeder cost calculation methods, Capacitor installation types, types of three-phase capacitor-bank connections, Economic justification for capacitors.

Advanced topics in Distribution Systems: Basic reliability indices, Calculation of SAIDI and SAIFI, Distribution automation communication protocols: MODBUS, DNP 3.0, IEC 60870-5-101, UCA 2.0, IEC 61850; Brief description of Smart-grid, Micro-grid, and Nano-grid with simple examples, Concepts of distributed generation.

TEXT BOOKS:

1. Distribution System Modelling and Analysis, William H. Kersting, CRC Press, Newyork, 2002.

REFERENCE BOOKS:

1. Electric Power Distribution System Engineering, Turan Gonen, McGraw-Hill Inc., New Delhi, 1986.
2. Control and Automation of Electrical Power Distribution Systems, James Northcote-Green and Robert Wilson, CRC Taylor & Francis, New York, 2007.

SIMULATION LABORATORY

Lab	: 3 Periods	Int.Marks	: 50
Exam	: 3 Hrs	Ext. Marks	: 50
		Credits	: 2

COURSE OBJECTIVES:

1. To practice the basic theories of Electrical Power system.
2. To provide hands-on experience to the students, so that they are able to apply theoretical concepts in practice.
3. To use computer simulation tools such as MATLAB to carry out design experiments as it is a key analysis tool of engineering design.
4. To give a specific design problem to the students, which after completion they will verify using the simulation software or hardware implementation.
5. To understand the modeling of various aspects of Power System analysis and develop the MATLAB programming.

COURSE OUTCOMES:

1. After the completion of the lab they will verify the theoretical concepts of various aspects of Power System analysis.
2. Graduate will demonstrate the ability to identify, formulate and solve Power System engineering problems.
3. Graduate will demonstrate the ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate the ability to design a electrical systems or process as per needs and specifications.
5. Graduate will demonstrate the skills to use modern engineering tools, software's and equipment to analyze problem.

SYLLABUS**LIST OF EXPERIMENTS:**

1. Formation of Y- Bus by Direct-Inspection Method.
2. Load Flow Solution Using Gauss Siedel Method
3. Load Flow Solution Using Newton Raphson Method
4. Load Flow Solution UsingFast Decoupled Method
5. Formation of Z-Bus by Z-bus building algorithm
6. Symmetrical Fault analysis using Z-bus
7. Unsymmetrical Fault analysis using Z-bus

8. Economic Load Dispatch with & without transmission losses
9. Transient Stability Analysis Using Point By Point Method
10. Load Frequency Control of Single Area Control & Two Area Control system with and without controllers.

REFERENCE BOOKS:

1. Elements of Power System Analysis" by William Stevenson, McGraw Hill Higher Education; 4th Revised edition.
2. Power System Analysis Hadi Saadat, PSA Publishing, 2010.
3. Modern Power System Analysis" by D.P. Kothari and I.J. Nagrath, McGraw-Hill Companies, Incorporated, 2006.
4. Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers" by Rudra Pratap, Oxford University Press, 2010
5. MATLAB: An Introduction with Applications, 5th Edition Amos Gilat, Wiley Global Education, 2014.

SCHEME OF INSTRUCTION & EXAMINATION
(Regulation R17)

M.TECH (POWER SYSTEM AND AUTOMATION)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(With effect from **2017-2018** Admitted Batch onwards)

Under Choice Based Credit System

II-SEMESTER

Code No.	Name of the Subject	Credits	Lecture Hrs	Tutorial Hrs	Lab Hrs	Contact Hrs/Week	Internal Marks	External Marks	Total Marks
M17 PS 1201	Power system Dynamics & stability	3	3	1	--	4	30	70	100
M17 PS 1202	Real Time Control of Power Systems	3	3	1	--	4	30	70	100
M17 PS 1203	Artificial Intelligence Techniques	3	3	1	--	4	30	70	100
M17 PS 1204	Flexible AC Transmission Systems	3	3	1	--	4	30	70	100
#ELE-3	Elective-I	3	3	1	--	4	30	70	100
#ELE-4	Elective-II	3	3	1	--	4	30	70	100
M17 PS 1213	Power system laboratory	2	--	--	3	3	50	50	100
Total		20	18	6	3	27	230	470	700

	Course Code	Course
#ELE-3	M17PS1205	Smart Grid Technologies
	M17PS1206	Power Quality
	M17PS1207	Advanced Power System Protection
	M17PS1208	EHVAC Transmission
#ELE-4	M17PS1209	Power System Deregulation
	M17PS1210	High Voltage Testing Techniques
	M17PS1211	Power System Transients
	M17PS1212	Voltage Stability

POWER SYSTEM DYNAMICS & STABILITY

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the model of synchronous machines.
2. To study the stability studies of synchronous machines.
3. To study the solution method of transient stability.
4. To study the effect of different excitation systems.

COURSE OUTCOMES:

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

1. Able to determine the model of synchronous machines.
2. Able to know the stability studies of synchronous machines.
3. Able to get the knowledge of solution methods of transient stability.
4. Able to know the effect of different excitation systems in power systems.

SYLLABUS**UNIT-I:**

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

UNIT-II:

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-III:

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 – RungeKutta method – Concept of multi machine stability.

UNIT-IV:

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

UNIT-V:

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.
3. Power systems stability and control by PRABHA KUNDUR, TMH.

REFERENCE BOOKS:

1. Computer Applications to Power Systems–Glenn.W.Stagg& Ahmed. H.El.Abiad, TMH.
2. Computer Applications to Power Systems – M.A.Pai, TMH.
3. Power Systems Analysis & Stability – S.S.VadheraKhanna Publishers.

REAL TIME CONTROL OF POWER SYSTEMS

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To understand the importance of state estimation in power systems.
2. To know the importance of security and contingency analysis.
3. To understand SCADA, its objectives and its importance in power systems.
4. To know the significance of voltage stability analysis.
5. To know the applications of AI to power systems problems.

COURSE OUTCOMES:

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

1. Understand state estimation, security and contingency evaluation.
2. Understand about Supervisory control and data acquisition.
3. Real time software application to state estimation.
4. Understand application of AI in power system.

SYLLABUS**UNIT-I:**

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-II:

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-III:

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-IV:

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 and Research Areas.

UNIT-V:

Application of AI and ANN in Power System : Basic concepts and definitions, algorithms for load flow, short term load forecasting, fault diagnosis and state estimation.

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 and control, John Wiley & Sons, 1984.

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, Wiley Eastern 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.

ARTIFICIAL INTELLIGENCE TECHNIQUES

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To have knowledge on concept of neural network.
2. To know different types of neural networks and training algorithms.
3. To understand the concept of genetic algorithm and its application in optimization.
4. To have the knowledge on fuzzy logic and design of fuzzy logic controllers.
5. To know the applications of AI Techniques in electrical engineering.

COURSE OUTCOMES:

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

1. Understand neural networks and analyze different types of neural networks.
2. Design training algorithms for neural networks.
3. Develop algorithms using genetic algorithm for optimization.
4. Analyze and design fuzzy logic systems.
5. Apply AI Techniques in electrical engineering.

SYLLABUS

UNIT-I: Introduction to Neural Networks

Introduction, Humans and Computers, Biological Neural Networks, Historical development of neural network, Terminology and Topology, Biological and artificial neuron models, Basic learning laws.

UNIT-II: Feed Forward Neural Networks

Introduction, Perceptron models: Discrete, continuous and multi-category, Training algorithms: Discrete and Continuous Perceptron Networks, Perceptron convergence theorem, Limitations and applications of the Perceptron model, Generalized delta learning rule, Feed forward recall and error back propagation training-Radial basis function algorithms-Hopfield networks.

UNIT-III: Genetic algorithms & Modelling

Introduction-encoding-fitness function-reproduction operators-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm

UNIT-IV: Classical and Fuzzy Sets

Introduction to classical sets - properties, operations and relations; Fuzzy sets, membership, Uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzy Logic System Components-Fuzzification, Membership value assignment, development of rule base and decision making system, defuzzification to crisp sets, defuzzification methods.

UNIT-V: Application of AI Techniques-load forecasting-load flow studies-economic load dispatch-load frequency control-reactive power control-speed control of dc and ac motors

TEXT BOOKS:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.

REFERENCE BOOKS:

1. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.

FLEXIBLE AC TRANSMISSION SYSTEMS

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the performance improvements of transmission system with FACTS.
2. To study the effect of static shunt compensation.
3. To study the effect of static series compensation.
4. To study the effect of UPFC.

COURSE OUTCOMES:

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

1. Know the performance improvement of transmission system with FACTS.
2. Get the knowledge of effect of static shunt and series compensation.
3. Know the effect of UPFC.
4. Determine an appropriate FACTS device for different types of applications.

SYLLABUS**UNIT-I:**

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

UNIT-II:

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 generators, switching converter type var generators, hybrid var generators.

UNIT-III:

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

UNIT-IV:

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-V:

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.

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.H and John.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

**SMART GRID TECHNOLOGIES
(ELECTIVE-III)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To understand concept of smart grid and developments on smart grid.
2. To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
3. To have knowledge on smart substations, feeder automation and application for monitoring and protection.
4. To have knowledge on micro grids and distributed energy systems.
5. To know power quality aspects in smart grid.

COURSE OUTCOMES:

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

1. Understand smart grids and analyse the smart grid policies and developments in smart grids.
2. Develop concepts of smart grid technologies in hybrid electrical vehicles etc.
3. Understand smart substations, feeder automation, GIS etc.
4. Analyse micro grids and distributed generation systems.
5. Analyse the effect of power quality in smart grid and to understand latest developments in ICT for smart grid.

SYLLABUS

UNIT-I:

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-II:

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Pricing, 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-III:

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-IV:

Microgrids 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, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT-V:

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), Neighborhood 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
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and DemandResponse”,CRC Press
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, Wiley
4. Jean Claude Sabonnadière, NouredineHadjsaïd, “Smart Grids”, Wiley Blackwell 19
5. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010
6. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009
7. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press.

REFERENCE BOOKS:

1. Andres Carvallo, John Cooper, “The Advanced Smart Grid: Edge Power Driving Sustainability: 1”, Artech House Publishers July 2011
2. James Northcote, Green, Robert G. Wilson “Control and Automation of Electric Power Distribution Systems (Power Engineering)”, CRC Press.
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert “Substation Automation (Power Electronics and Power Systems)”, Springer
4. R. C. Dugan, Mark F. McGranahan, Surya Santoso, H. Wayne Beaty, “Electrical Power System Quality”, 2nd Edition, McGraw Hill Publication
5. Yang Xiao, “Communication and Networking in Smart Grids”, CRC Press

**POWER QUALITY
(ELECTIVE-III)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To understand significance of power quality and power quality parameters.
2. To know types of transient over voltages and protection of transient voltages.
3. To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
4. To understand long duration voltage variation and flicker
5. To know power quality aspects in distributed generation.

COURSE OUTCOMES:

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

1. Have the knowledge on causes of power quality, power quality parameters.
2. Understand sources of transient over voltages and providing protection to transient over voltages.
3. Understand effects of harmonics, sources of harmonics and harmonic minimization.
4. Analyze long duration voltage variations and regulation of voltage variations.
5. Describe power quality aspects in distributed generation and develop solutions to wiring and grounding problems.

SYLLABUS

UNIT-I: Introduction

Overview of Power Quality - Concern about the Power Quality - General Classes of Power Quality Problems – Transients -Long-Duration Voltage Variations - Short-Duration Voltage Variations - Voltage Unbalance - Waveform Distortion - Voltage fluctuation - Power Frequency Variations - Power Quality Terms - Voltage Sags and Interruptions - Sources of Sags and Interruptions – Nonlinear loads.

UNIT-II: Transient Over Voltages

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 - Computer Tools for Transient Analysis

UNIT-III: Harmonic Distortion and solutions

Voltage vs. Current Distortion - Harmonics vs. Transients - Power System Quantities under Nonsinusoidal Conditions - Harmonic Indices – Sources of harmonics - Locating Sources of Harmonics – System Response Characteristics - Effects of Harmonic Distortion – Interharmonics - Harmonic Solutions Harmonic Distortion Evaluation - Devices for Controlling Harmonic Distortion - Harmonic Filter Design - Standards on Harmonics

UNIT-IV: Long Duration Voltage Variations

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 Resources – Flicker

UNIT-V: Distributed Generation and Power Quality

Resurgence of Distributed Generation - DG Technologies - Interface to the Utility System Power Quality Issues - Operating Conflicts - DG on Low Voltage Distribution Networks - Interconnection standards - Wiring and Grounding - Typical Wiring and Grounding Problems - Solution to Wiring and grounding Problems

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. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.

REFERENCE BOOKS:

1. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J, First Edition, IEEE Press; 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 Nostrand 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

**ADVANCED POWER SYSTEM PROTECTION
(ELECTIVE-III)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

1. Know the classifications and applications of static relays.
2. Understand the application of comparators.
3. Understand the static version of different types of relays.
4. Understand the numerical protection techniques.

SYLLABUS

UNIT-I:

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-II:

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-III:

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-IV:

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-V:

Microprocessor based relays and Numerical Protection: Introduction – over current relays – impedance relay – directional relay – reactance relay. Numerical Protection: Introduction - numerical relay - numerical relaying algorithms – mannorrison 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.
3. Power System Stability Kimbark Vol-II, Willey.

REFERENCE BOOKS:

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

**EHVAC TRANSMISSION
(ELECTIVE-III)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To calculate the transmission line parameters.
2. To calculate the field effects on EHV and UHV AC lines.
3. To have knowledge of corona, RI and audible noise in EHV and UHV lines.
4. To have knowledge of voltage control and compensation problems in EHV and UHV transmission systems.

COURSE OUTCOMES:

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

1. Calculate the transmission line parameters.
2. Calculate the field effects on EHV and UHV AC lines.
3. Determine the corona, RI and audible noise in EHV and UHV lines.
4. Analyze voltage control and compensation problems in EHV and UHV transmission systems.

SYLLABUS

UNIT-I:

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-II:

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-III:

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-IV:

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-V:

Static reactive 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.

REFERENCE BOOKS:

1. EHV Transmission line reference book – Edison Electric Institute (GEC) 1986.

**POWER SYSTEM DEREGULATION
(ELECTIVE-IV)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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

SYLLABUS

UNIT-I:

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-II:

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-III:

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-IV:

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-V:

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. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
3. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer

REFERENCE BOOKS:

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

**HIGH VOLTAGE TESTING TECHNIQUES
(ELECTIVE-IV)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To understand non destructive testing methods.
2. To understand commercial and technical testing of different HV power applications.

COURSE OUTCOMES:

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

1. Understand different testing procedures on electrical
 - a) Insulating materials
 - b) Insulation Systems.
 - c) Power apparatus.
2. Learn the different testing techniques adopted on electrical power apparatus

SYLLABUS

UNIT-I:

Non Destructive Testing Techniques : Measurement of DC Resistivity – Dielectric loss and dielectric constant of insulating materials – Schering bridge method – Transformer ratio arm bridge for high voltage and high current applications – null detectors.

UNIT-II:

High Voltage Testing of Power Apparatus : Need for testing standards – Standards for porcelain/Glass insulators-Classification of porcelain/glass insulator tests – Tests for cap and pin porcelain/Glass insulators.

UNIT-III:

High voltage AC testing methods-Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables. Artificial Contamination Tests : Contamination flashover phenomena-Contamination Severity-Artificial contamination tests-Laboratory Testing versus in-Service Performance-Case study.

UNIT-IV:

Impulse Testing : Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.

UNIT-V:

Partial Discharge Measurement : PD equivalent model-PD currents-PD measuring circuits-Straight and balanced detectors-Location and estimation of PD in power apparatus-PD measurement by non electrical methods-Calibration of PD detectors. RIV Measurements : Radio Interference – RIV – Measurement of RI and RIV in laboratories and in field. Different test arrangements and their limitations.

TEXT BOOKS:

1. High Voltage Engineering by E.KUFFEL and W.S.ZAENGL, Pergamon press, Oxford 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata McGraw Hill Publishing Company Limited, New Delhi – 2001.

REFERENCE BOOKS:

1. Discharge Detection in H.V. Equipment – by KREUGER, F.H. Haywood London – 1964.
2. Hyltencavallius. N. High voltage laboratory planning EnileHaefely&Co. Ltd. Based Switzerland 1988
3. Ryan H.M. and Whiskand: design and operation perspective of British UHV Lab IEE pre 133 H.V. Testing Techniques Halfly.

**POWER SYSTEM TRANSIENTS
(ELECTIVE-IV)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the effect of over voltages on power system.
2. To study the techniques of travelling wave on transmission lines.
3. To study the effect of lightning and switching transients on power systems.

COURSE OUTCOMES:

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

1. Understand the severity of over voltages due to faults on a given power system.
2. To limit the effects of lightning over voltages in power systems.
3. Understand the various transient over voltages and their effects on power system.

SYLLABUS

UNIT-I:

Basic Concepts and Simple Switching Transients;- Switching an LR,LC,RLC circuits
 Transients Analysis of Three-Phase power Systems: – Symmetrical components in three-phase Systems, Sequence Components for Unbalanced Network Impedances, the Sequence Networks, analysis of Unsymmetrical Three-Phase Faults-single line-to-Ground Fault, Three phase to ground fault.

UNIT-II:

Travelling Waves:- Velocity of Travelling waves and Characteristic Impedance, Energy Contents of Travelling Waves, Attenuation and Distortion of Electromagnetic Waves, telegraph equations-lossless line, distortion less line, Reflection and Refraction of Travelling Waves, Reflection of Travelling Waves against Transformer-and-Generator-windings, the Origin Transient Recovery voltages, bewley-lattice diagram. travelling waves and multi conductor system.

UNIT-III:

Switching Transients:- arc interruption in circuit breaker , transient recovery voltage, arc-circuit interaction, interruption of capacitive currents, interruption of inductive currents, interruption of fault current in transmission line and transformers.

UNIT-IV:

Power System Transient Recovery Voltages:-Characteristics of the Transient Voltage- Short-circuit test duties based on IEC 60056 (1987),ANSI/IEEE Standards, the Harmonization between IEC and ANSI/IEEE Standards with respect to Short-circuit Test duties, transient recovery voltage for Different types of faults.

UNIT-V:

Lightning –Induced Transients:-Mechanism of Lightning, wave shape of the lightning current, Direct lightning Stroke to transmission line towers, direct lightning stroke to a line, lightning protection scheme. Numerical simulation of electrical transients, The Electromagnetic Transient Program, principles of numerical techniques used in transient simulation.

TEXT BOOKS:

1. Electrical Transients in Power System by Allen Greenwood, McGraw Hill 1990
2. Power system grounding & transients by A.P.SakisMeliopolous.
3. Bewley LV “travelling waves on transmission system” Dover publications Inc.,

REFERENCE BOOKS:

1. “Transients in power systems” by Lou Van Sluis
2. Walter Diesendorf, Insulation co-ordination in high-voltage electric power systems, Butterworths, London, (1974),
3. J. G. Anderson: EHV Transmission Line Reference Book (Edison Electric Institute, New York, 1968) p. 126.

**VOLTAGE STABILITY
(ELECTIVE-IV)**

Lecture	: 3 Periods	Int.Marks	: 30
Tutorial	: 1 Period.	Ext. Marks	: 70
Exam	: 3 Hrs.	Credits	: 3

COURSE OBJECTIVES:

1. To study the importance of voltage stability.
2. To study the various load modelling in power system.
3. To study the effect of reactive power compensation and voltage control.
4. To study the modelling of voltage stability static indices.
5. To study the voltage stability margin and its improvement.

COURSE OUTCOMES:

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

1. Know the importance of voltage stability.
2. Determine the load modelling of power systems.
3. Get the knowledge of reactive power compensation and voltage control.
4. Determine the modelling of static voltage stability indices.
5. Know the voltage stability margin and its improvement.

SYLLABUS

UNIT-I:

Reactive Power flow and voltage stability in power systems: Physical relationship indicating dependency of voltage on reactive power flow - reactive power, transient stability; Q V curve; definition of voltage stability, voltage collapse and voltage security. Voltage collapse phenomenon, Factors of voltage collapse, effects of voltage collapse, voltage collapse analysis.

UNIT-II:

Power system loads : Load characteristics that influence voltage stability such as – Discharge lighting, Induction motor, Air conditioning and heat pumps, Electronic power supplies, Over Head lines and cables.

UNIT-III:

Reactive Power compensation : Generation and absorption of reactive power – Reactive power compensators & voltage controllers : - shunt capacitors, synchronous phase modifier – static VAR system – on load tap changing transformer, booster transformers.

UNIT-IV:

Voltage stability static indices : Development of voltage collapse index – power flow studies – singular value decomposition – minimum singular value of voltage collapse – condition number as voltage collapse index.

UNIT-V:

Voltage stability margins & Improvement of voltage stability: Stability margins, voltage stability margin of un compensated and compensated power system . Dynamic voltage stability – voltage security , Methods of improving voltage stability and its practical aspects.

TEXT BOOKS:

1. Performance operation and control of EHV power transmission Systems A. chakrabarti, D.P.Kothari, A.K. Mukhopadhyay, A.H. Wheeler publishing, 1995.

REFERENCE BOOKS:

1. Power system Voltage stability - C.W. Taylor , Mc. Graw Hill, 1994.

POWER SYSTEMS LABORATORY

Lab	: 3 Periods	Int.Marks	: 50
Exam	: 3 Hrs	Ext. Marks	: 50
		Credits	: 2

COURSE OBJECTIVES:

1. To understand the experimental determination of various parameters used in power system area.
2. To analyse the performance of transmission line with and without compensation.

COURSE OUTCOMES:

1. 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.

SYLLABUS**List of Experiments:**

1. Determination of Sequence Impedence 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.

REFERENCE BOOKS:

1. Elements of Power System Analysis“ by by William Stevenson, McGraw Hill Higher Education; 4th Revised edition.
2. Power System Analysis Hadi Saadat, PSA Publishing, 2010.
3. Modern Power System Analysis“ by D.P. Kothari and I.J. Nagrath, McGraw-Hill Companies, Incorporated, 2006.
4. Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers“ by Rudra Pratap, Oxford University Press, 2010
5. MATLAB: An Introduction with Applications, 5th Edition Amos Gilat, Wiley Global Education, 2014.

SCHEME OF INSTRUCTION & EXAMINATION
(Regulation R17)

M.TECH (POWER SYSTEM AND AUTOMATION)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(With effect from **2017-2018** Admitted Batch onwards)
Under Choice Based Credit System

III-SEMESTER

Course Code	Course	Scheme of Examination	C	Int	Ext	Total
M17 PS 2101	Comprehensive Viva-Voce	Viva-Voce	2	50	-	50
M17 PS 2102	Seminar-I	Oral Presentation	2	50	-	50
M17 PS 2103	Project Work Part-I	Review	16	50	-	50
Total			20	150	-	150

1. The Viva-Voce for the Comprehensive Viva-Voce and Seminar-I shall be held with the Project Guide, PG coordinator, and Head of the Department. The marks shall be awarded in the ratio of 20, 10 and 20 Marks by the members respectively.
2. Candidates can do their Project Work Part-I&II work within the department or in any industry/research organization for two semesters (i.e. 3rd and 4th semesters). In case of thesis done in an industry/research organization, one advisor (Guide) should be from the department and one advisor (Co-Guide) should be from the industry/research organization.
3. The Project Work Part-I should be submitted at the end of 3rd Semester and it will be evaluated through Review by a committee consisting of Head of the Department, PG coordinator and Project guide. The marks shall be awarded in the ratio of 20, 10 and 20 Marks by the members respectively.

SCHEME OF INSTRUCTION & EXAMINATION
(Regulation R17)

M.TECH (POWER SYSTEM AND AUTOMATION)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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Under Choice Based Credit System

IV-SEMESTER

Course Code	Course	Scheme of Examination	C	Int	Ext	Total
M17 PS 2201	Seminar-II	Oral presentation	2	50	-	50
M17 PS 2202	Project Work Part-II	Viva-voce	18		100	100
Total			20	50	100	150

1. The viva-voce for Seminar-II shall be held with the Project Guide, PG coordinator, and Head of the Department. The marks shall be awarded in the ratio of 20, 10 and 20 Marks by the members respectively.
2. A publication of a paper on the thesis work in a National/International Journal at the end of 4th semester is mandatory for the submission of thesis work.
3. The Project Work Part-II should be submitted at the end of 4th semester and it will be evaluated through Viva-Voce examination by a committee consisting of External Examiner, Head of the Department, Project guide and PG coordinator. The marks shall be awarded in the ratio of 40, 20, 20 and 20 Marks by the members respectively.