# SONA COLLEGE OF TECHNOLOGY, SALEM-5

**(An Autonomous Institution)**

## M.E-Electrical and Electronics Engineering

## (Power System Engineering)

# CURRICULUM and SYLLABI

**[For students admitted in 2019-2020]**

**M.E / M.Tech Regulation 2019**

**Approved by BOS and Academic Council meetings**

**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME I Semester under Regulations 2019**
**Electrical and Electronics Engineering**
**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Theory** | | | | | | |
| 1 | P19PSE101 | Advanced Power System Analysis | 3 | 0 | 0 | 3 |
| 2 | P19PSE102 | Electric and Hybrid Vehicles | 3 | 0 | 0 | 3 |
| 3 | P19PSE103 | High Voltage and Insulation Systems | 3 | 0 | 0 | 3 |
| 4 | P19PSE501 | **Elective-** Power Quality Engineering | 3 | 0 | 0 | 3 |
| 5 | P19PSE502 | **Elective-** Mathematical Methods for Power Engineering | 2 | 1 | 0 | 3 |
| 6 | P19GE101 | Research Methodology and IPR | 2 | 0 | 0 | 2 |
| 7 | P19GE701 | **Audit Course-**English for Research Paper Writing | 2 | 0 | 0 | 0 |
| **Practical** | | | | | | |
| 8 | P19PSE104 | Advanced Power System Simulation Laboratory-I | 0 | 0 | 4 | 2 |
| | | | | | **Total Credits** | **19** |

**Approved by**

**Chairperson, Electrical and Electronics Engineering BOS**
**Dr.S.Padma**

**Member Secretary, Academic Council**
**Dr.R.Shivakumar**

**Chairperson, Academic Council & Principal**
**Dr.S.R.R.Senthil Kumar**

Copy to:-
HOD/EEE, First Semester ME PSE Students and Staff, COE

**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME II Semester under Regulations 2019**
**Electrical and Electronics Engineering**
**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Theory** | | | | | | |
| 1 | P19PSE201 | Modern Protection of Power Systems | 3 | 0 | 0 | 3 |
| 2 | P19PSE202 | Power System Dynamics and Stability | 3 | 0 | 0 | 3 |
| 3 | P19PSE203 | Restructured Power Systems | 3 | 0 | 0 | 3 |
| 4 | P19PSE506 | **Elective –** Smart Grid | 3 | 0 | 0 | 3 |
| 5 | P19PSE508 | **Elective –** Artificial Intelligence Applicable to Power Systems | 3 | 0 | 0 | 3 |
| 6 | P19GE702 | **Audit Course –** Stress Management by Yoga | 2 | 0 | 0 | 0 |
| **Practical** | | | | | | |
| 7 | P19PSE204 | Power Electronics Applied to Power Systems Laboratory | 0 | 0 | 4 | 2 |
| | | | | | **Total Credits** | **17** |

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**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME III Semester under Regulations 2019**
**Electrical and Electronics Engineering**
**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Theory** | | | | | | |
| 1 | P19PSE511 | **Elective -** FACTS and Custom Power Devices | 3 | 0 | 0 | 3 |
| 2 | P19ISE601 | **Open Elective –** Transport Safety | 3 | 0 | 0 | 3 |
| | P19MIT601 | **Open Elective –** Python Programming | | | | |
| **Practical** | | | | | | |
| 3 | P19PSE301 | Project Work Phase - I | 0 | 0 | 16 | 8 |
| | | | | | **Total Credits** | **14** |

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Copy to:-
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**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME IV Semester under Regulations 2019**
**Electrical and Electronics Engineering**

**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Practical** | | | | | | |
| 1 | P19PSE401 | Project Work Phase – II | 0 | 0 | 28 | 14 |
| | | | | | **Total Credits** | **14** |

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**Dr.R.Shivakumar**

**Chairperson, Academic Council & Principal**
**Dr.S.R.R.Senthil Kumar**

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**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME I Semester under Regulations 2019**
**Electrical and Electronics Engineering**
**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Theory** | | | | | | |
| 1 | P19PSE101 | Advanced Power System Analysis | 3 | 0 | 0 | 3 |
| 2 | P19PSE102 | Electric and Hybrid Vehicles | 3 | 0 | 0 | 3 |
| 3 | P19PSE103 | High Voltage and Insulation Systems | 3 | 0 | 0 | 3 |
| 4 | P19PSE501 | **Elective-** Power Quality Engineering | 3 | 0 | 0 | 3 |
| 5 | P19PSE502 | **Elective-** Mathematical Methods for Power Engineering | 2 | 1 | 0 | 3 |
| 6 | P19GE101 | Research Methodology and IPR | 2 | 0 | 0 | 2 |
| 7 | P19GE701 | **Audit Course-**English for Research Paper Writing | 2 | 0 | 0 | 0 |
| **Practical** | | | | | | |
| 8 | P19PSE104 | Advanced Power System Simulation Laboratory-I | 0 | 0 | 4 | 2 |
| | | | | | **Total Credits** | **19** |

**Approved by**

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**Dr.S.Padma**

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**P19PSE101 ADVANCED POWER SYSTEM ANALYSIS 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Compute solutions for large scale power systems using sparsity and optimal ordering schemes.
2. Analyze the power flow methods to find power flow solutions for various power networks.
3. Calculate the symmetrical and unsymmetrical fault parameters in typical power systems.
4. Carry out security assessment and enhancement procedures for various power networks.
5. Estimate the power system states using various techniques.

**UNIT I SOLUTION TECHNIQUES 9**

Sparsematrix techniques for large scale power systems- Optimally ordered Triangular Factorization- Triangular Decomposition- Gaussian Elimination- Triangular Decomposition of table of factors- Bi-factorization method- Sparsity and Optimal Ordering schemes- Comparative advantages for a sparse matrix.

**UNIT II POWER FLOW SOLUTIONS 9**

Power flow equation for "n" bus system-Overview of Gauss seidel and Newton Raphson method- Fast Decoupled power flow method- Power flow studies in system design and operation-Regulating Transformers.

**UNIT III FAULT ANALYSIS 9**

Types of faults- Transient on power system components- Symmetrical fault analysis using bus impedance matrix – Concepts in symmetrical components of unsymmetrical phasors- Sequence networks for various power system components- Unsymmetrical fault analysis in power systems.

**UNIT IV SECURITY ANALYSIS 9**

Factors affecting power system security - Security state diagram- Security assessment using Linear sensitivity factors- Generation shift and Line-outage distribution factors- Contingency analysis using sensitivity factors- Security enhancement by preventive, emergency and restorative control.

**UNIT V STATE ESTIMATION 9**

Introduction – Maximum Likelihood Weighted Least Squares Estimation-State Estimation of an AC network- State estimation by Orthogonal Decomposition algorithm- Detection and Identification of Bad measurements- Network Observability and Pseudo measurements- Application of power system state estimation.

**Lecture: 45, Tutorial: 0, Total: 45 Hrs**

**REFERENCE BOOKS:**


1. John J. Grainger, William D. Stevenson, "Power System Analysis", Mc- Graw Hill, Reprint Edition, 2017.
2. Prabha Kundur, "Power System Stability and Control", Tata McGraw-Hill, 2014.
3. Allen J Wood, Bruce F Wollenberg, "Power Generation and Control", John Wiley & Sons, New york, reprint edition, 2015.
4. M.A.Pai, "Computer Techniques in Power System Analysis", Tata McGraw- Hill publishing ltd, New Delhi, 2014.
5. P.Venkatesh, B.V.Manikandan, S.Charles raja and A.Srinivasan, "Electrical power systems-Analysis, security and Deregulation", PHI Learning Pvt Ltd, New Delhi, 2016.

**P19PSE102 ELECTRIC AND HYBRID VEHICLES 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Explain the necessity of hybrid electric vehicle and to model vehicles for its performance analysis.
2. Illustrate the basic concepts of hybrid and electric drive train topologies and explain power flow control with fuel efficiency analysis.
3. Explain the configuration and control of various motor drives used in hybrid and electric vehicles and to elaborate on the energy storage requirements for the electric vehicles.
4. Compare the performance of electric motor with IC engine in order to select Electric drive and energy storage technology and to explain various vehicle communication subsystems.
5. Classify and compare different energy management strategies and list the issues pertaining to its implementation.

**UNIT I INTRODUCTION TO HYBRID ELECTRIC VEHICLE 9**

History of hybrid and electric vehicles- social and environmental importance of hybrid and electric vehicles- impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

**UNIT II HYBRID TRAIN ARCHITECTURES AND POWER FLOW MANAGEMENT 9**

Fundamental concept of hybrid traction- introduction to various hybrid drive-train topologies power flow control in hybrid drive-train architectures- fuel efficiency analysis. Basic concepts of electric traction- introduction to various electric drive-train topologies- power flow control in hybrid drive -train topologies- fuel efficiency analysis.

**UNIT III ELECTRIC PROPULSION AND ENERGY STORAGE 9**

Introduction to hybrid and electric vehicles- Configuration and control of DC Motor drives -AC Motor drives- Permanent Magnet Motor drives- Switch Reluctance Motor drives and drive system efficiency.

Energy storage requirements in Electric and Hybrid electric vehicles, Battery types, Properties of Batteries, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery Modeling - Run Time Battery Model, First Principle Model, Battery pack Design.

**UNIT IV PERFORMANCE ANALYSIS AND VEHICLE COMMUNICATION SYSTEMS 9**

Matching the electric machine and the internal combustion engine (ICE)- Sizing the propulsion motor- sizing the power electronics- selecting the energy storage technology. Communications supporting subsystems- Introduction to CAN, LIN, FLEXRAY, MOST, KWP 2000 - Details of CAN, Introduction to V2V, V2I systems.

**UNIT V ENERGY MANAGEMENT STRATEGIES 9**

Introduction to energy management strategies used in hybrid and electric vehicle- classification of different energy management strategies- comparison of different energy management strategies- implementation issues of energy strategies.

**Lecture: 45, Tutorial: 0, Total: 45 Hrs**

**REFERENCES BOOKS:**


1. Iqbal Husain, "Electric and Hybrid vehicles Design Fundamentals", CRC Press, second edition 2013.
2. James Larminie, John Lowry, "Electric vehicle technology Explained" second Edition,Wiley 2012.
3. Ion Boldea and S.A Nasar “Electric drives”, CRC Press, 2005.
4. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Springer, 2013.

**P19PSE103 HIGH VOLTAGE AND INSULATION SYSTEMS 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Describe the various insulating materials used in power system
2. Illustrate breakdown mechanism of solid, liquid and gaseous dielectrics
3. Explain the high voltage generation methods and measurements
4. Evaluate insulation testing of electrical equipments
5. Describe the various Non-destructive testing in high voltage.

**UNIT I INSULATING MATERIALS IN POWER SYSTEM 9**

Review of insulating materials Gases, Vacuum, liquids and solids- characterization of insulation condition – permittivity, capacitance, resistivity and insulation resistance, dielectric dissipation factors- partial discharges sources, forms and effects- ageing effects- electrical breakdown and operating stresses- standards relating to insulating materials.

**UNIT II BREAKDOWN MECHANISMS OF SOLID, LIQUID AND GASEOUS DIELECTRICS 9**

Introduction to insulation systems used in high voltage power apparatus - breakdown mechanisms of solid, liquid, gas and vacuum insulation.

**UNIT III BASIC METHODS OF GENERATION AND MEASUREMENT OF TEST HIGH VOLTAGES 9**

Generation of high alternating voltages: cascaded transformers and series resonant circuit- Generation of high dc voltages: rectifier circuit and voltage multiplier circuit- Generation of impulse voltages: multistage impulse generator circuit- Generation of impulse currents – Measurement of high ac, dc and impulse voltages: voltage divider circuits- Digital Storage Oscilloscope for impulse voltage and current measurements.

**UNIT IV INSULATION TESTING OF ELECTRICAL EQUIPMENTS 9**

Necessity for high voltage testing - testing of distribution and power transformers - voltage transformers - current transformers - bushings – overhead line and substation insulators - surge arresters – high voltage cables - circuit breakers and isolators – IEC and Indian standards.

**UNIT V NON-DESTRUCTIVE TESTING 9**

Insulation resistance measurement- Measurement of tan delta and capacitance of dielectrics - grounded objects like transformers and alternators – Measurement of Partial discharges - location and measurement of discharges in electrical equipment –Dissolved gas in oil measurement.

**Lecture: 45, Tutorial: 0, Total: 45 Hrs**

**REFERENCE BOOKS:**


1. Naidu,M.S. and Kamaraju,V., High Voltage Engineering, Tata McGraw Hill Publishing Company Ltd., New Delhi, 5th edition, 2013.
2. Kuffel,E. and Zaengl, W.S., High Voltage Engineering Fundamentals, Pergamon Press, Oxford,New York 2000.
3. R.E.James and Q.Su, Condition assessment of high voltage insulation in power system equipment, IET Power and Energy Series 53, 2008
4. Adrianus,J. Dekker, Electrical Engineering Materials, Prentice Hall of India Pvt. Ltd., New Delhi, 1979.
5. Gallagher,T.J., and Permain,A., High Voltage Measurement, Testing and Design, John Wiley Sons, New York, 1984.
6. IEC & IS Standards on testing.

**P19PSE104 ADVANCED POWER SYSTEM SIMULATION LABORATORY 0 0 4 2**

**COURSE OUTCOMES:**

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

1. Compute load flow, contingency economic dispatch and unit commitment solutions for various power systems.
2. Analyze different power systems by carrying out various short circuit and state estimation techniques.
3. Model and simulate AGC and AVR systems for given power system.
   (All simulation shall be performed using suitable simulation softwares).

**LIST OF EXPERIMENTS**

1. Load flow analysis by Newton-Raphson method
2. Load flow analysis by Fast decoupled method
3. Contingency analysis: to calculate sensitivity factors.
4. Economic dispatch using lambda-iteration method
5. Unit commitment: Priority-list schemes and dynamic programming.
6. Short circuit analysis in power system.
7. State estimation of power system network
8. Automatic Generation control for power system network
9. Familiarization of Relay Test Kit
10. Modeling and Simulation of AVR.

**Total : 60 Hours**

**P19PSE501 POWER QUALITY ENGINEERING 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Describe the basic power quality issues.
2. Discuss about voltage related problems.
3. Evaluate harmonics in power system due to power electronic devices.
4. Evaluate power quality using measuring equipment.
5. Improve the power quality using different types of filters.

**UNIT I INTRODUCTION 9**

Power quality, Voltage quality – power quality evaluation procedure – overview of power quality phenomena – classification of power quality problems – power quality measures and standards – THD-TIF-DIN-C-message weights – flicker factor – occurrence of power quality problems – power acceptability curves – overview of EMC and IEEE standards.

**UNIT II VOLTAGE SAGS AND INTERRUPTIONS 9**

Long Interruptions: Causes – generation, transmission and distribution reliability – basic concepts of reliability evaluation techniques – costs.

Short Interruptions: Origin – influence on motors and electronic equipment – single phase tripping.

Sags:Introduction – sag magnitude, duration – load influence on voltage sags – sags in adjustable speed AC and DC drives.

**UNIT III HARMONIC DISTORTION 9**

Harmonic distortion – harmonics versus transients – harmonic indices – harmonic sources from commercial and industrial loads – locating harmonic sources – SMPS – Three phase power converters – arcing devices – Harmonic Distortion of fluorescent lamps – effects of harmonic distortion – inter-harmonics – principles for controlling harmonics –devices for controlling harmonic distortion.

**UNIT IV POWER QUALITY MONITORING 9**

Monitoring considerations –power quality measurement equipment – power quality data assessment – basic design of an expert system for monitoring applications – power quality monitoring in internet.

**UNIT V POWER QUALITY IMPROVEMENT 9**

Static compensator – Distribution static compensator – Dynamic voltage restorer – Power factor corrector – Active filters – Shunt active filters – applications – PSCAD / EMTDC – simulation of Active filters.

**Lecture: 45, Tutorial: 0, Total: 45 Hrs**

**REFERENCE BOOKS:**


1. Math H.J. Bollen, "Understanding Power Quality Problems: Voltage sags and interruptions", IEEE press, 2011.
2. Roger C. Dugan, "Electrical power Systems Quality", McGraw Hill Education, Third edition, 2012.
3. Arrillaga J, Watson NR, Chen S, "Power System Quality Assessment", John Wiley & Sons, 2011.
4. Heydt G T, "Electric Power Quality", Stars in a Circle Publications, 1991.

| SEMESTER – I | **MATHEMATICAL METHODS FOR POWER ENGINEERING** | L | T | P | C |
|---|---|---|---|---|---|
| P19PSE502 | | 2 | 1 | 0 | 3 |

**COURSE OUTCOMES**

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

1 find the rank of the matrix and solve linear system of equations by direct and indirect methods.

2. apply the concepts of eigen values and eigen vectors of a real matrix and their properties in diagonalization.

3. find the power spectral density for the wide sense stationary process.

4. apply the suitable methods to solve linear programming problem.

5. apply the appropriate methods to solve nonlinear programming problem.

**UNIT – I LINEAR SYSTEM OF EQUATIONS 9**

Rank of a matrix – Solution of linear system of equations by matrix method, Gauss elimination, Gauss – Jordan, Gauss – Jacobi and Gauss – Seidel methods.

**UNIT – II EIGEN VALUES AND EIGEN VECTORS 9**

Eigen values and eigen vectors – Properties of eigen values and eigen vectors – Cayley-Hamilton theorem – Diagonalization of symmetric matrices.

**UNIT – III RANDOM PROCESSES 9**

Classification of random processes – First order, second order, strictly stationary, wide-sense stationary processes – Auto correlation function and its properties – Power spectral density function and its properties.

**UNIT – IV LINEAR PROGRAMMING 9**

Simplex algorithm – Big–M method – Transportation problem – Assignment problem.

**UNIT – V NONLINEAR PROGRAMMING 9**

Formulation of nonlinear programming problem – Constrained optimization with equality constraints – Constrained optimization with inequality constraints – Kuhn-Tucker conditions with non-negative constraints.

Theory: **30 Hours** Tutorial: **15 Hours** Total**: 45 Hours**

**TEXT BOOKS:**


1. P. K. Gupta and D. S. Hira, "Problems in Operation Research", Sultan Chand and Sons Publishers, 4th Edition, 2015.
2. T. Veerarajan, "Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks", McGraw Hill Publishers, 4th Edition, 7th Reprint, 2018.
3. T. Veerarajan, "Linear Algebra and Calculus", McGraw Hill Publishers, 2019.


**REFERENCE BOOKS:**


1. H. A. Taha, "Operation Research: An Introduction", Pearson Publishers, 9th Edition, 2014.
2. M. K. Venkataraman, "Higher Mathematics for Engineering and Science", National Publishers, 2000.
3. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2018.

**P19GE101 RESEARCH METHODOLOGY AND IPR 2 0 0 2**

## COURSE OUTCOMES

At the end of the course, the student will be able to

1. Review the literature of the research problem
2. Choose appropriate data collection and sampling method according to the research problem.
3. Interpret the results of research and communicate effectively with their peers
4. Explain the Importance of intellectual property rights
5. Evaluate trade mark, develop and register patents

## UNIT 1 INTRODUCTION TO RESEARCH METHODS 6

Definition and Objective of Research, Various steps in Scientific Research, Types of Research, Criteria for Good Research, Defining Research Problem, Research Design , Case Study Collection of Primary and Secondary Data, Collection Methods: Observation, Interview, Questionnaires, Schedules,

## UNIT 2 SAMPLING DESIGN AND HYPOTHESIS TESTING 6

steps in Sampling Design, Types of Sample Designs, Measurements and Scaling Techniques - Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), concerning variance – one tailed Chi-square test.

## UNIT 3 INTERPRETATION AND REPORT WRITING 6

Techniques of Interpretation, Precaution in Interpretation, Layout of Research Report, Types of Reports, Oral Presentation, Mechanics of Writing Research Report

## UNIT 4 INTRODUCTION TO INTELLECTUAL PROPERTY 6

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights, Innovations and Inventions trade related intellectual property rights.

## UNIT 5 TRADE MARKS, COPY RIGHTS AND PATENTS 6

Purpose and function of trade marks, acquisition of trade mark rights, trade mark registration processes, trademark claims –trademark Litigations- International trademark law

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

**THEORY: 30 Hours TUTORIAL: - PRACTICAL: - TOTAL: 30 Hours**

## TEXT BOOKS


1. C.R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques ,4th Edition, New Age International Publishers, 2019.
2. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets”, Delmar Cengage Learning, 4th Edition, 2012.
3. Prabuddha Ganguli, “Intellectual Property Rights: Unleashing the Knowledge Economy”, Tata Mc Graw Hill Education, 1st Edition, 2008.

**REFERENCE BOOKS**


1. Panneerselvam, R., Research Methodology, Second Edition, Prentice-Hall of India, New Delhi, 2013.
2. Ranjith Kumar, Research Methodology – A step by step Guide for Begineers, 4th edition, Sage publisher, 2014.
3. D Llewelyn & T Aplin W Cornish, "Intellectual Property: Patents, Copyright, Trade Marks and Allied Rights", Sweet and Maxwell, 1st Edition, 2016.
4. Ananth Padmanabhan, "Intellectual Property Rights-Infringement and Remedies", Lexis Nexis, 1st Edition, 2012.
5. Ramakrishna B and Anil Kumar H.S, "Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers", Notion Press, 1st Edition, 2017.
6. M.Ashok Kumar and Mohd.Iqbal Ali :"Intellectual Property Rights" Serials Pub

**P19GE701** **English for Research Paper Writing**

**2 0 0 0**

**Course Outcomes:**

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

- Demonstrate research writing skills both for research articles and thesis
- Frame suitable title and captions as sub-headings for articles and thesis
- Write each section in a research paper and thesis coherently
- Use language appropriately and proficiently for effective written communication
- Exhibit professional proof-reading skills to make the writing error free

**Unit – I** **6**

Planning and preparation, word order, breaking up long sentences, organising ideas into paragraphs and sentences, being concise and avoiding redundancy, ambiguity and vagueness

**Unit – II** **6**

Interpreting research findings, understanding and avoiding plagiarism, paraphrasing sections

of a paper/ abstract.

**Unit- III** **6**

Key skills to frame a title, to draft an abstract, to give an introduction

**Unit – IV** **6**

Skills required to organise review of literature, methods, results, discussion and conclusions

**Unit – V** **6**

Usage of appropriate phrases and key terms to make the writing effective - proof-reading to ensure error-free writing.

**Text Books:**

1.Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2.HighmanN , Handbook of Writing for the Mathematical Sciences, SIAM.Highman's book, 1998.
3. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
4.Goldbort R, Writing for Science, Yale University Press, 2006. (available on Google Books)

**Total: 30 hours**

**REFERENCES**

Martin Cutts, Oxford Guide to Plain English, Oxford University Press, Second Edition, 2006

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**Electrical and Electronics Engineering**
**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Theory** | | | | | | |
| 1 | P19PSE201 | Modern Protection of Power Systems | 3 | 0 | 0 | 3 |
| 2 | P19PSE202 | Power System Dynamics and Stability | 3 | 0 | 0 | 3 |
| 3 | P19PSE203 | Restructured Power Systems | 3 | 0 | 0 | 3 |
| 4 | P19PSE506 | **Elective –** Smart Grid | 3 | 0 | 0 | 3 |
| 5 | P19PSE508 | **Elective –** Artificial Intelligence Applicable to Power Systems | 3 | 0 | 0 | 3 |
| 6 | P19GE702 | **Audit Course –** Stress Management by Yoga | 2 | 0 | 0 | 0 |
| **Practical** | | | | | | |
| 7 | P19PSE204 | Power Electronics Applied to Power Systems Laboratory | 0 | 0 | 4 | 2 |
| | | | | | **Total Credits** | **17** |

**Approved by**

**Chairperson, Electrical and Electronics Engineering BOS**
**Dr.S.Padma**

**Member Secretary, Academic Council**
**Dr.R.Shivakumar**

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**Dr.S.R.R.Senthil Kumar**

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**P19PSE201 MODERN POWER SYSTEM PROTECTION 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Describe the protection schemes for power system equipments
2. Evaluate static relays and their characteristics
3. Discuss different digital protection scheme
4. Illustrate modern trends in protective relaying
5. Evaluate various relay testing methods

**UNIT I INTRODUCTION 9**

General philosophy of protection – Characteristic functions of protective relays – Protection schemes for Transmission lines, Transformers, Generators, Motors – Bus bar protection – Back up protection.

**UNIT II STATIC RELAYS AND THEIR CHARACTERISTICS 9**

Static relays – Amplitude comparator, phase comparator – Static Over current relay – Synthesis of Impedance relay, MHO relay, Reactance relay, Quadrilateral relay, and Differential relay – Static frequency relay.

**UNIT III DIGITAL PROTECTION 9**

Numerical relay – Sampling frequency – Digital signal processing – Digital filtering in protective relays – Relays algorithms – Over current relays , Directional relay , Impedance relay , MHO relay , Differential relay - Quadrilateral relay .

**UNIT IV MODERN TRENDS IN PROTECTIVE RELAYING 9**

Carrier current pilot relaying – Phase comparison, carrier Aided distance protection – Travelling wave relays – Amplitude comparison relay , phase comparison relay – Fiber optic based relaying – SCADA architecture – Use of SCADA in interconnected power systems – PLC and DCS control.

**UNIT V TESTING OF PROTECTIVE SYSTEMS AND ADAPTIVE PROTECTION 9**

Testing of protective current and potential transformers – Testing of relays – primary and secondary injection tests – Relay burden – Relay setting – Relay co – ordination – Fault locators – Adaptive protection – Fault analysis – Adaptive techniques – Intelligent Electronics devices.

**Lecture: 45, Tutorial: 0, Total: 45**

**REFERENCE BOOKS:**


1. Y.G .Paithankar, S.R.Bhide, " Fundamentals of Power System Protection" . Prentice – Hall India, 2004
2. Badri Ram and D.N. Vishwakarma , " Power System Protection and Switch Gear" Tata McGraw Hill, New Delhi, 2003
3. RavindraP.Singh , " Digital Power System Protection" , PHI , New Delhi ,2007.
4. T.S.M.Rao , "Digital / Numerical Relays" Tata McGraw Hill ,2005.
5. Sunil S. Rao "Switch Gear and Protection", Khanna Publishers Delhi, 1998.
6. T.S. MadhavaRao , "Power System Protection Static Relays" , second Edition. Tata McGraw Hill, New Delhi.

**P19PSE202 POWER SYSTEM DYNAMICS AND STABILITY 3 0 0 3**

**COURSE OUTCOMES**:

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

1. Analyze the mathematical modeling and inductance calculations in synchronous machine.
2. Develop the transfer function model for excitation, speed governing and turbine systems.
3. Analyze the small signal stability of SMIB power systems.
4. Analyze the small signal stability of SMIB and Multimachine power systems with damping controllers.
5. Describe feedback controllers for small signal stability enhancement in power systems.

**UNIT I SYNCHRONOUS MACHINE MODELLING 9**

Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, electrical power and torque, Physical interpretation of dq0 transformation, Per Unit Representations- Power-invariant form of Park's transformation-Steady state analysis: Voltage, current and flux-linkage relationships- Computation of steady-state values.

**UNIT II MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS 9**

Elements of an Excitation System, Types of Excitation Systems- Modeling of Excitation system components, Modeling of IEEE type ST1A Excitation system model, Turbine and Governing System Modeling- Classical transfer function of a hydraulic turbine (no derivation), Special characteristics of hydraulic turbine, Electrical analog of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation,: Modeling of Single reheat tandem compounded type Steam Turbine.

**UNIT III SMALL SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS 9**

Classification of Stability- State- Space representation- Eigen properties of state matrix: Eigen values and Eigenvectors for stability, Participation factor. Single Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis- Effects of Field Circuit Dynamics- Block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability.

**UNIT IV SMALL SIGNAL STABILITY ANALYSIS WITH CONTROLLERS 9**

Effects of Excitation System: Thyristor Excitation System with AVR, Block diagram representation with Exciter and AVR, Effect of AVR on Synchronizing and Damping torque components, Power System Stabilizer: Block diagram representation with AVR and PSS, System state matrix including PSS- Small Signal Stability of Multi machine systems.

**UNIT V ENHANCEMENT OF SMALL SIGNAL STABILITY 9**

Power System Stabilizer – Stabilizer based on shaft speed signal (delta omega) – Delta P-Omega stabilizer-Frequency-based stabilizers – Digital Stabilizer – Excitation control design – Exciter gain – Phase lead compensation – Stabilizing signal washout and stabilizer gain – Stabilizer limits, Selection of PSS location.

**Lecture: 45, Tutorial: 00, Total: 45 Hours**

**REFERENCE BOOKS**


1. Prabha Kundur, "Power System Stability and Control", Tata McGraw-Hill, 2014.
2. J.Machowski, Bialek, Bumby, " Power System Dynamics and Stability", John wiley and sons, 2011.
3. L.Leonard Grigsby, " Power System Stability and Control", CRC Press, 2017.
4. P.M Anderson and A.A Fouad, "Power System Control and Stability", Iowa State University Press, Ames, Iowa, 2008.
5. Peter W.Sauer&M.A.Pai, "Power System Dynamics & Stability", Pearson Education, 2006.

**P19PSE203 RESTRUCTURED POWER SYSTEMS 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Understand the concepts of restructuring of power industry
2. Explain the basics of congestion management
3. Discuss about locational margin prices and financial 21 transmission rights
4. Explain the significance of ancillary services and pricing of transmission network
5. Elaborate the reforms of power sectors in India

**UNIT I INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY 9**

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity vis – a – vis other commodities, Market architecture, Case study.

**UNIT II TRANSMISSION CONGESTION MANAGEMENT 9**

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion management – Capacity alleviation method.

**UNIT III LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS 9**

Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights – Risk hedging functionality -Simultaneous feasibility test and revenue adequency – FTR issuance process: FTR auction, FTR allocation – Treatment of revenue shortfall – Secondary trading of FTRs – Flow gate rights – FTR and market power - FTR and merchant transmission investment.

**UNIT IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK 9**

Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service - How to obtain ancillary service –Co- optimization of energy and reserve services - Transmission pricing – Principles – Classification – Rolled in transmission pricing methods – Marginal transmission pricing paradigm – Composite pricing paradigm – Merits and demerits of different paradigm.

**UNIT V REFORMS IN INDIAN POWER SECTOR 9**

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future

**Lecture: 45, Tutorial: 00, Total: 45 Hours**

**REFERENCES**


1. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" CRC Press, 2001.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic, 2001.
3. Paranjothi, S.R. , "Modern Power Systems" Paranjothi, S.R. , New Age International, 2017.
4. Sally Hunt," Making competition work in electricity", John Willey and Sons Inc, 2002.
5. Steven Stoft, "Power system economics: designing markets for electricity", John wiley and sons 2002.

**P19PSE506** **SMART GRID** **3 0 0 3**

**COURSE OUTCOMES:**

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

1. Distinguish between smart grid and conventional grid.
2. Apply smart metering concepts to industrial and commercial installations.
3. Apply modern communication technologies for smart grid solutions.
4. Explain about the microgrid renewable energy systems.
5. Formulate solutions for the power quality issues in smart grid.

**UNIT I INTRODUCTION 9**

Introduction to Smart Grid - Evolution of Electric Grid - Concept of Smart Grid, Definitions, Need of Smart Grid- Concept of Robust &Self-Healing Grid - Present development & International policies in Smart Grid.

**UNIT II SENSING, MEASUREMENTS, CONTROL AND AUTOMATION TECHNOLOGIES 9**

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, Smart Substations, Substation Automation, Feeder Automation

**UNIT III COMMUNICATION TECHNOLOGIES 9**

Home Area Network (HAN) - Neighbourhood Area Network (NAN), Wide Area Network (WAN) - Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication - Wireless Mesh Network.Basics of CLOUD Computing &Cyber Security for Smart Grid - Broadband over Power line (BPL). IP based protocols

**UNIT IV RENEWABLE ENERGY SYSTEMS AND MICROGRID 9**

Plastic & Organic solar cells, Thin film solar cells - speed wind generators, fuel-cells, micro-turbines.
Smart storage like Battery, SMES, Pumped Hydro - Compressed Air Energy Storage - Concept of micro-grid, need & applications of micro-grid - Formation of micro-grid, Issues of interconnection - Protection & control of micro-grid

**UNIT V POWER QUALITY IN SMART GRID 9**

Power Quality issues of Grid connected Renewable Energy Sources -Power Quality Conditioners for Smart Grid - Web based Power Quality monitoring, Power Quality Audit.

**Lecture: 45, Tutorial: 00, Total: 45 Hours**

**REFERENCES**


1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2011.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley 2012.
3. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions "CRC Press, 1st edition, 2012.
4. A.G.Phadke , "Synchronized Phasor Measurement and their Applications", Springer, 2nd edition, 2017.

**P19PSE508 ARTIFICIAL INTELLIGENCE APPLICABLE TO POWER SYSTEMS 3 0 0 3**

**COURSE OUTCOMES:**

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

1. Model and design the Fuzzy Logic Controller.
2. Describe in-depth knowledge on basic concepts and different learning methods of Artificial Neural Networks.
3. Model and design inference systems of Neuro fuzzy Controllers.
4. Describe the impart in-depth knowledge on basics and design issues of different genetic algorithms.
5. Apply fuzzy logic, Neural Network and Genetic Algorithm for power system problems.

**UNIT I FUZZY LOGIC 9**

Introduction to Artificial Intelligence, Classic set-Fuzzy set theory–Basic Definition and Terminology-Set Theoretic operations and properties- Membership function-Linguistic variable-Formation of fuzzy IF-THEN rules -Fuzzy inference- Design of fuzzy logic controller-Defuzzification methods.

**UNIT II ARTIFICIAL NEURAL NETWORKS 9**

Introduction Models of Neuron Network – Architectures – Knowledge representation – Artificial Intelligence and Neural networks–Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzman learning –Supervised learning – Unsupervised learning – Reinforcement learning – learning tasks- Multi – layer perceptron using Back propagation Algorithm (BPA) – Self – Organizing Map (SOM)–– Radial Basis Function Network – Functional Link Network (FLN) – Hopfield Network.

**UNIT III NEURO-FUZZY 9**

Neuro Fuzzy Modeling - Adaptive Neuro fuzzy Inference Systems- Neuro fuzzy controllers.

**UNIT IV GENETIC ALGORITHMS 9**

Genetic Algorithms: Introduction–Encoding – Fitness Function–Reproduction operators–Genetic Modeling – Genetic operators–Cross over – Single site cross over – Two point cross over – Multi point cross over – Uniform cross over – Matrix cross over–Cross over Rate –Inversion & Deletion – Mutation operator – Mutation – Mutation Rate–Bit–wise operators –Generational cycle – convergence of Genetic Algorithm-Hybrid Approach-Neuro-Genetic Hybrid and Fuzzy-Genetic Hybrid

**UNIT V APPLICATIONS 9**

Load forecasting Load frequency control -Economic Load Dispatch- Unit Commitment- Power system Stabilizer- Reactive power control – speed control of DC and AC Motors- Stability studies.

**Lecture: 45, Tutorial: 00, Total: 45 Hours**

**REFERENCE BOOKS:**


1. S. Rajasekaran and G. A. VijayalakshmiPai, "Neural Networks, Fuzzy Logic & Genetic Algorithms", Prentice-Hall India, 2003.
2. David. E. Goldberg, "Genetic Algorithms", Pearson Education, 2003.
3. J.S.R.Jang, C.T.Sun, and E. Mizutani, "Neuro-fuzzy and soft computing ", Prentice-Hall of India, pvt .Ltd 1997.
4. Fausett Laurence, "Fundamentals of Neural Networks", Pearson Education, New Delhi, 2004.
5. Dirankov .D, Hellendoorn .H and Reinfrank. M, "An Introduction to Fuzzy Control", Narosa Publishing House, New Delhi, 2001.
6. B.Yegnanarayana, "Artificial Neural Networks", Prentice Hall of India Pvt.Ltd, 2004.
7. Randy L. Haupt, Sue Ellen Haupt, "Practical Genetic Algorithm" ,John Wiley & sons, 2004

**REFERENCE JOURNALS**

1. IEEE Transactions on Fuzzy Systems.
2. IEEE Transactions on Neural Networks.
3. IEEE Transactions on Industrial Applications.
4. IEEE Transactions on Industrial Electronics.
5. IEEE Transactions on Power Systems.
6. IEEE Transactions on Power Delivery.

**P19PSE204 POWER ELECTRONICS APPLIED TO POWER SYSTEMS LABORATORY 0 0 4 2**

**COURSE OUTCOMES:**

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

1. Analyze the small signal stability of single machine and multi machine models.
2. Analyze the effect of FACTS controllers by performing steady state analysis.
3. Analyze the concepts in different wind energy conversion technologies.

**LIST OF EXPERIMENTS**

1. Small-signal stability analysis of single machine-infinite bus system using classical machine model
2. Small-signal stability analysis of multi-machine configuration with classical machine model
3. Load flow analysis of two-bus system with STATCOM
4. Transient analysis of two-bus system with STATCOM
5. Available Transfer Capability calculation using an existing load flow program
6. Modeling and simulation of variable speed wind energy conversion system- DFIG
7. Modeling and simulation of variable speed wind energy conversion system- PMSG
8. Simulation of MOSFET, IGBT based Choppers
9. Simulation of IGBT based Single phase inverters
10. Simulation of single phase AC voltage controller

**Total Hours : 60**

**P19GE702** **Stress Management by Yoga**

**2 0 0 0**

## Course Outcomes:

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

1. Develop physical and mental health thus improving social health
2. Increase immunity power of the body and prevent diseases
3. Acceleratememory power
4. Achieve the set goal with confidence and determination
5. Improve stability of mind, pleasing personality and work with awakened wisdom

**UNIT – I** **6**

Yoga-Introduction - Astanga Yoga- 8 parts-Yam and Niyam etc.- Do`s and Don'ts in life-Benefits of Yoga and Asana- Yoga Exercise- and benefits- Pranayam Yoga- Nadisuthi, Practice and Spinal Sclearance Practice-Regularization of breathing techniques and its effects-Practice and kapalapathy practice.

**UNIT – II** **6**

Neuromuscular breathing exercise and Practice- Magarasa Yoga, 14 points Acupressure techniques and practice- Body relaxation practice and its benefits- Raja Yoga- 1.Agna –explanation and practice- Activation of Pituitary- Raja Yoga-2. Santhi Yoga-Practice-Balancing of physical and mental power.

**UNIT – III** **6**

Raja Yoga-3.Sagasrathara yoga –practice- Activation of dormant brain cells-Kayakalpa-theory- Kayakalpa – practice-Yogic exercise to improve physical and mental health and practice-Asanas –explanation-Practice-benefits

**UNIT –IV** **6**

Sun namaskar- 12 poses-explanation and practice-Yoga –Asana-Padmasana, vajrasana,chakrasana, viruchasanaetc-Stress management with Yoga-Role of women and Yoga
Equality, nonviolence, Humanity,Self- control- Food and yoga Aware of self-destructive habits
Avoid fault thinking (thought analysis-Practice)-Yoga Free from ANGER (Neutralization of anger)& practice

**UNIT – V** **6**

Moralisation of Desire & practice- Punctuality-Love-Kindness-CompassionEradication ofworries-Practice - Personality development, positive thinking-Good characters to lead a moral life
How to clear the polluted mind- Benefits of blessing- Five- fold culture –explanation- Karma Yoga Practice In Geetha- Sense of duty-Devotion, self- reliance, confidence, concentration, truthfulness, cleanliness.

**Total : 30 hours**

**Reference Books**

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

**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME III Semester under Regulations 2019**
**Electrical and Electronics Engineering**
**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Theory** | | | | | | |
| 1 | P19PSE511 | **Elective -** FACTS and Custom Power Devices | 3 | 0 | 0 | 3 |
| 2 | P19ISE601 | **Open Elective –** Transport Safety | 3 | 0 | 0 | 3 |
| | P19MIT601 | **Open Elective –** Python Programming | | | | |
| **Practical** | | | | | | |
| 3 | P19PSE301 | Project Work Phase - I | 0 | 0 | 16 | 8 |
| | | | | | **Total Credits** | **14** |

**Approved by**

**Chairperson, Electrical and Electronics Engineering BOS**
**Dr.S.Padma**

**Member Secretary, Academic Council**
**Dr.R.Shivakumar**

**Chairperson, Academic Council & Principal**
**Dr.S.R.R.Senthil Kumar**

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**P19PSE511 FACTS AND CUSTOM POWER DEVICES 3 0 0 3**

**COURSE OUTCOMES**

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

1. Explain the need of FACTS technology.
2. Illustrate the static shunt compensation techniques.
3. Emphasize the objectives of Shunt compensation, and basic operation of SVC and STATCOM.
4. Design the UPFC and IPFC controllers
5. Explain static series compensators and controller interactions.

**UNIT I INTRODUCTION 9**

Electrical transmission network – Need of transmission interconnections – power flow in AC systems – power flow and dynamic stability considerations – Relative importance of controllable parameters – Basic types of FACTS controllers Brief description & definitions – Benefits from FACTS technology.

**UNIT II STATIC SHUNT COMPENSATION 9**

Objectives of shunt compensation, mid-point 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 9**

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modeling of svc for power flow and transient stability – Applications: Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping – Prevention of voltage instability

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability.

**UNIT IV UPFC AND IPFC 9**

UPFC - Basic Operations Principles – Conventional transmission control capabilities – Independent real and reactive power flow control – Control Structure- IPFC – Basic Operations Principles and Characteristics – Control Structure.

**UNIT V STATIC SERIES COMPENSATORS AND FACTS CONTROLLERS 9**

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

Controller interactions –SVC interaction – Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms.

**Lecture: 45, Tutorial: 00, Total: 45 Hours**

**REFERENCES**


1. R.Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC TransmissionSystems", Standard Publishers Distributors, Delhi- 110 006
3. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P)Limited, Publishers, New Delhi, 2008
4. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash "Flexible AC Transmission Systems: Modeling and Control", Springer, 2012
5. V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.

# EEE

**P19PSE601 SMART GRID TECHNOLOGIES 3 0 0 3**

**COURSE OUTCOME:**

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

- Understand the features of Smart Grid.
- Assess the role of automation in Transmission and Distribution
- Apply Evolutionary Algorithms for the Smart Grid and Distribution Generation.
- Analyze the impact of renewable DG in micro-grid and electric vehicles.
- Understand operation and importance of PMUs, PDCs, WAMS, Voltage and Frequency control in Micro Grids.

**UNIT I INTRODUCTION TO SMART GRID 9**

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

**UNIT II SMART GRID ARCHITECTURE 9**

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

**UNIT III TOOLS AND TECHNIQUES FOR SMART GRID 9**

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

**UNIT IV DISTRIBUTION GENERATION TECHNOLOGIES 9**

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

**UNIT V COMMUNICATION TECHNOLOGIES IN SMART GRID 9**

Introduction to Communication Technology – Synchro - Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS) - Introduction to Internet of things (IOT) - Applications of IOT in Smart Grid

**Lecture: 45 Hours; Tutorial: 00 Hours; Total: 45 Hours**

**REFERENCE BOOKS:**


1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 1e, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2e, 2013.
3. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2e, 2017.
4. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2e, 2012.

**Sona College of Technology, Salem**
**(An Autonomous Institution)**
**Courses of Study for ME IV Semester under Regulations 2019**
**Electrical and Electronics Engineering**

**Branch: M.E. Power Systems Engineering**

| S. No | Course Code | Course Title | Lecture | Tutorial | Practical | Credit |
|---|---|---|---|---|---|---|
| **Practical** | | | | | | |
| 1 | P19PSE401 | Project Work Phase – II | 0 | 0 | 28 | 14 |
| | | | | | **Total Credits** | **14** |

**Approved by**

**Chairperson, Electrical and Electronics Engineering BOS**
**Dr.S.Padma**

**Member Secretary, Academic Council**
**Dr.R.Shivakumar**

**Chairperson, Academic Council & Principal**
**Dr.S.R.R.Senthil Kumar**

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