Dr. M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
(Deemed to be University)
Maduravoyal, Chennai - 600 095. Tamilnadu. India.
(An ISO 9001 : 2015 Certified Institution)

M.Tech –Power System (Part Time)

Curriculum and Syllabus
2018 Regulation

I SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18P001	Power System Dynamics and Stability	3	0	0	3
2	MEE18P002	Advanced Power System Protection	3	0	0	3
3	MEE18P005	Introduction to Soft Computing Techniques	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

II SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MMA18016	Random Process and Optimization Techniques	3	1	0	4
2	MEE18P003	Electrical Transients in Power Systems	3	1	0	4
3	MEE18P008	Energy Audit Conservation and Management	3	0	1	4
4	MEE18P004	Distributed Energy Resources and Storage Techniques	3	0	0	3
		TOTAL	**12**	**2**	**1**	**15**

III SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18P006	Smart Grid Design	3	1	0	4
2	MEE18P009	Modern Distribution System Design & Control	3	1	0	4
3	MEE18PEXX	Elective – I	3	0	0	3
4	MEE18PL01	Programming & Simulation Laboratory	0	0	2	2
		TOTAL	**9**	**2**	**2**	**13**

IV SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18P007	Power System Economics	3	0	0	3
2	MEE18P010	Synchrophasor Technology in WAMPAC	3	1	0	4
3	MEE18PEXX	Elective – II	3	0	0	3
4	MEE18PL03	Advanced Design and Implementation Practice	0	0	2	3
		TOTAL	**9**	**1**	**2**	**13**

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V SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18P011	Power Quality and Grid Integration @	3	1	0	4
2	MEE18PEXX	Elective – III	3	0	0	3
3	MEE18PEXX	Elective – IV	3	0	0	3
4	MEE18PL06	Project Phase - 1	0	0	12	3
		TOTAL	**9**	**1**	**12**	**13**

IV SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PL07	Project Phase – II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

Summary of Credits:

1st Semester Credits	**09**
2nd Semester Credits	**15**
3rd Semester Credits	**13**
4th Semester Credits	**13**
5th Semester Credits	**13**
6th Semester Credits	**12**
Total	**75**

The @ indicates that the corresponding course is offered as an internal paper evaluated by the department. The evaluation procedure to be adopted is mentioned in the respective course syllabus.

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ELECTIVE - I						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PE01	Fuzzy System And Application In Modern Electric Power System	3	0	0	3
2	MEE18PE02	Analysis of Electrical Machines	3	0	0	3
3	MEE18PE03	Substation Design and Automation	3	0	0	3
4	MEE18PE04	Solid State Power Converters	3	0	0	3
5	MEE18PE05	MEMS Technology	3	0	0	3

ELECTIVE - II						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PE06	ANN And Application In Modern Electric Power system	3	0	0	3
2	MEE18PE07	Green Building Design	3	0	0	3
3	MEE18PE08	Power Electronics Applications in Power Systems	3	0	0	3
4	MEE18PE09	Computers in Networking and Digital Control	3	0	0	3
5	MEE18PE10	Research Methodology	3	0	0	3

ELECTIVE - III						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PE11	Intelligent Optimization Techniques and Application in Modern Power systems	3	0	0	3
2	MEE18PE12	System Theory	3	0	0	3
3	MEE18PE13	Power Distribution Reliability	3	0	0	3
4	MEE18PE14	HVDC Transmission	3	0	0	3
5	MEE18PE15	Advanced Digital Signal Processing	3	0	0	3

ELECTIVE - IV						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	MEE18PE16	Dynamic modeling and control of wind turbines	3	0	0	3
2	MEE18PE17	Micro Grid in Modern Power Systems	3	0	0	3
3	MEE18PE18	Micro controller based System Design	3	0	0	3
4	MEE18PE19	FACTS Controllers	3	0	0	3
5	MEE18PE20	Sustainable Power Generation & Utilization	3	0	0	3

MEE18P001 **POWER SYSTEM DYNAMICS AND STABILITY** **3 0 0 3**

OBJECTIVES:

- Understands the Power system Structure
- Analyze Small & Large Disturbances
- Ability to model a Power Network

UNIT I: Introduction to Power System **9 Hours**

Stability and control of a Dynamic system- Classification of Dynamics – PV and QF – Stability and Security of PS – Structure of Power System – Generating Units – Substations – T&D Networks – WAMS

UNIT II: Small & Large Disturbances **9 Hours**

Electromagnetic Phenomena – Short Circuit – Synchronization- Fault & Clearing- Swing Equations – Damping Power- Equilibrium points – Steady state stability of Unregulated & Regulated system - Electromechanical Dynamics – Transient stability – Swings in Multi machine system – Direct method for stability – Asynchronous Operation

UNIT III: Voltage & Frequency Stability **9 Hours**

Network Feasibility – Stability Criteria – Critical Load Demand & Voltage collapse – Static, Dynamic Analysis – Prevention- Self Excitation of a Generator Operating on a Capacitive load - AGC – Rotor Swings – Frequency Drop – Primary, Secondary control

UNIT IV: Stability Enhancers **9 Hours**

Power System Stabilizers – Fast Valving – Braking Resistors – Generator Tripping – Shunt FACT Devices- Series Compensators – Unified Power Flow Controller

UNIT V: Power System modeling **9 Hours**

Synchronous Generator – Excitation Systems – Turbines & Governors –Steady state stability of Multi-Machine System – Mathematical Background – Power System Dynamic Simulation

Total no. of Hours: 45

References:

1. Jan Machowski, Janus Bialek, Dr Jim Bumby, Power System Dynamics: Stability & Control, 2nd Edition,(2008) Wiley Publisher, ISBN : 978-0-470-72558-0
2. Prabha Kundur, Power System Stability & Control, McGraw-Hill, Inc, EPRI
3. Leonard L. Grigsby, Power System Stability & Control, third Edition CRC Press

MEEE18P002 ADVANCED POWER SYSTEM PROTECTION 3 0 0 3

Objectives

- To study fundamental principles of power system protection
- To study numerical relaying & DSP fundamentals
- To study advance concepts of numerical relaying algorithms for over current, distance protection, differential protection, Bus bar protection of lines, cables, Transformers & Generators.

Unit I: Protection basics 9 Hours

Digital Relaying - Block diagram of Digital Relay - Anti aliasing filters, Data window - facilities in commercial digital relays - Different relay algorithms - Communication protocol (IEC 61850)

Unit II: Protection of Transmission lines 9 Hours

Advanced Protection of Transmission Line Coordination of over current relays in an interconnected system - LINKNET structure - Concept of Sympathy Trips - Coordination of Distance Relays - Protection of Series Compensated Lines - Problems & Solutions - Teed Line - Carrier Current Protection - Phase Comparison Carrier - Carrier Aided Distance Protection - Blocking Carrier - Carrier Intercropping and Acceleration - Adaptive Relaying

Unit III: Reclosing and Synchronizing 9 Hours

Introduction - Reclosing Precautions and System Considerations - One-Shot vs. Multiple-Shot Reclosing Relays - Synchronism Check - Live-Line/Dead-Bus and Control - Instantaneous-Trip Lockout - Intermediate Lockout - Factors Governing Application of Reclosing - Considerations - Feeders with No- Fault-Power Back-Feed and Minimum Motor Load - Single Ties to Industrial Plants with Local Generation - Reclosing Relays and Operation - Review of Breaker Operation

Unit IV: Protection against Transients and Surges 9Hours

Introduction – Electrostatic and Electromagnetic Induction - Differential and Common- Mode Classifications - Transients Originating in the High Voltage System - Capacitor Switching - Bus De-energization - Transmission Line Switching - Current Transformer Saturation - Grounding of Battery Circuit - Protective Measures – Separation and Suppression at the Source - Suppression by Shielding and Twisting - Radial Routing of Control Cables – Buffers - Optical Isolators - Increased Energy Requirement - Load Shedding and Frequency Relaying

Unit V: Shunt Reactor & Series Reactors 9 Hours

Applications - Rate-of-Rise-of-Pressure Protection - Over current Protection - Differential Protection - Reactors on Delta System - Turn-to-Turn Faults - Capacitor Bank Protection

Total No of Hours: 45

References:

1. Date, Oza , Nair, Power System Protection - Bharti Prakashan, Tata McGraw Hill
2. Walter A Elmore, Protective Relaying Theory & Application, Marcel Dexxer Inc, New York
3. J J Blackburn, Protective Relaying Fundamentals, John Wiley & Sons
4. P M Anderson, Power System Protection, IEEE Press Book

MEE18P005 INTRODUCTION TO SOFT COMPUTING TECHNIQUES 3 0 0 3

OBJECTIVES:

- To familiarize with soft computing concepts, feed forward , feedback neural networks and learning methods.
- To expose to the concepts of Fuzzy Logic, Genetic algorithm and its applications to soft computing.
- To gain knowledge about the hybrid systems

UNIT I: Fundamentals of Neural Networks and Artificial Neural Networks 9 Hours

Introduction to Neural Networks, Fuzzy Logic, Genetic Algorithm, Hybrid Systems and Soft Computing Artificial Neural Network: Introduction, Fundamental Concept, Basic Models, important Terminologies of ANNs, McCulloch-Pitts Neuron, Hebb Network, Supervised Learning Networks: Introduction, Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons. Back-Propagation Network: Architecture, Learning, Applications, Selection of various parameters

UNIT II: Artificial Neural Networks 9 Hours

Associative Memory Networks: Introduction, Training Algorithms for Pattern Association, Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory (BAM),Hopfield Networks .Counter-propagation Networks: Architecture, functioning & characteristics of counter Propagation network, Hopfield/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications. Hopfield v/s Boltzman machine Adaptive Resonance Theory: Architecture, classifications, Implementation and training

UNIT III: Introduction to Fuzzy Logic 9 Hours

Introduction, Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of Membership Functions, Fuzzification, and Defuzzification, Fuzzy Arithmetic and Fuzzy Measures, Fuzzy Rule Base and Approximate Reasoning, Fuzzy Decision Making

UNIT IV: Introduction to Genetic Algorithm and Hybrid Systems 9 Hours

Genetic Algorithm**:** Introduction, Traditional Optimization and Search Techniques, Genetic Algorithm and Search Space, General Genetic Algorithm, Operators in Generic Algorithm, Stopping Condition, Constraints, Advantages and Limitations and Applications of Genetic Algorithm

Hybrid Systems: Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms, GA Based Back Propagation Networks, Fuzzy Associative Memories, and Simplified Fuzzy ARTMAP

UNIT V: Applications of Soft Computing in Electrical Engineering 9 Hours

Introduction, Application of Generalized Neuron Models to Electrical Machine Modeling, Electrical Load Forecasting Problem, Load Frequency Control Problem

Total no. of Hours: 45

References:

1. Timothy J. Ross (2010) Fuzzy Logic with Engineering Applications, 3rd Edition,Wiley India
2. Jacek M. Zurada, (1999) Introduction to Artificial Neural Systems. Jaico Publishing House
3. Wassermann, P.D. (1989) Neural computing: Theory and Practice, Van Nostrand Reinhold Company
4. Rajasekaran,S, Vijayalakshmi Pai,G.A,(2011) Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI Learning Private Ltd
5. Dr. Sivanandam, S. N. ,Dr. Deepa, S. N.(2007) Principles of Soft Computing, Wiley India
6. Chaturvedi, Devendra K(2008), Soft Computing Techniques and its Applications in Electrical Engineering, Springer
7. Padhy, N.P. (2005) Artificial Intelligence and Intelligent Systems, Oxford University Press
8. Zimmermann, H.J. (2001) Fuzzy set Theory and its Application Springer Science Business Media, LLC
9. David E. Gold Berg,(1996) Genetic Algorithms in Search, Optimization and Machine Learning, Addison Wesley Publishing Company

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MMA18016 RANDOM PROCESS AND OPTIMIZATION TECHNIQUES 3 1 0 4

OBJECTIVES:

- Capable to solve the problems arises in Power System, Control System etc
- Understand the concept of interpolation like least square method etc
- The student will be capable of solving Eigen value problems

UNIT I: Random Variables **12 hours**

Random variables – Distribution functions – Moments – Moment generating functions – Two dimensional Random variables – Marginal and conditional distributions

UNIT II: Random Process **12 hours**

Classification of Random Process – Stationary Process – Ergodic Process – Markov Process – Markov Chains – Auto Correlation – Auto Covariance – Cross Correlation – Cross Covariance – Spectral Density

UNIT III: Solution of Equations **12 hours**

Solution of Algebraic and Transcendental equations – Method of false position – Iteration method – Newton-Raphson method – Solution of Linear system of equations – Gauss Elimination method – Gauss-Jordan method Iterative methods – Gauss-Jacobi method – Gauss-Seidel method – Matrix Inversion by Gauss-Jordan method

UNIT IV: Advanced Matrix Theory **12 hours**

Generalized Eigen vectors – Jordan canonical form – Matrix norms – QR algorithm – Pseudo inverse – Singular value decomposition – Least square solutions

UNIT V: Linear Programming **12 hours**

Formulation of LPP – Standard form of LPP – Graphical method – Simplex method – Big M method – Two phase method

Tutorials: 15
Total no. of Hours: 60

References:

1. Richard Johnson, A.(2009) Miller & Freund's Probability and statistics for Engineers 8th Ed. Prentice Hall of India
2. Veerarajan, T.(2008) Probability, Statistics and Random Processes. Tata McGraw Hill Publishing Co
3. Gupta,S.C. Kapoor, V.K. (2007) Fundamentals of Mathematical Statistics, Chand S. & Co
4. Veerarajan, T.(2005) Numerical Methods. Tata McGraw Hill Publishing Co
5. Sastry, S.S.(2003) Introductory Methods of Numerical Analysis. Prentice Hall of India
6. Bronson, R.(1989) Theory and problems of Matrix operations (Schaum's outline series).McGraw Hill
7. Lewis,D.W.(1995) Matrix theory. Allied publishers
8. Hamdy A. Taha, (2010) Operations Research: An Introduction.9th Ed. Pearson
9. Panneerselvam, R.(2011) Operations Research .2nd Ed. Prentice Hall of India

MEE18P003 ELECTRICAL TRANSIENTS IN POWER SYSTEMS 3 1 0 4

OBJECTIVES:

- Understand the basics of transients and transient analysis for three phase systems
- Understand the concepts of travelling waves, switching and lightning induced transients
- Understand the concepts of transients in power system
- Ability to measure and test the transients

UNIT I: Concepts of Switching Transients and Analysis 12Hours

Origin and Classifications, Switching an LR Circuit, Switching an LC Circuit, Switching an RLC Circuit Symmetrical Components in Three-Phase Systems ,Sequence Components for Unbalanced Network Impedances, The Sequence Networks, The Analysis of Unsymmetrical Three-Phase Faults -The Single Line-to-Ground Fault, The Three-Phase-to-Ground Fault.

UNIT II: Travelling Waves 12Hours

Velocity of Travelling Waves and Characteristic Impedance , Energy Contents of Travelling Waves , Attenuation and Distortion of Electromagnetic Waves, The Telegraph Equations - The Lossless Line , The Distortion less Line . Reflection and Refraction of Travelling Waves - Reflection of Travelling Waves against Transformer- and Generator-Windings, the Origin of Transient Recovery Voltages, the Lattice Diagram

UNIT III: Switching and Lightning Induced Transients 12Hours

Normal and abnormal switching transients, current suppression, Interrupting Capacitive Currents , Capacitive Inrush Currents, Interrupting Small Inductive Currents, Transformer Inrush Currents ,.The Mechanism of Lightning, Wave shape of the Lightning Current, Direct Lightning Stroke to Transmission Line Towers, Direct Lightning Stroke to a Line

UNIT IV: Transients in Integrated Power System 12Hours

The Short line and Kilometric fault - Distribution of voltages in a power system - Line dropping and Load rejection - Voltage transients on Closing and Reclosing lines - Over voltage induced by faults - Switching surges on integrated system Qualitative application of EMTP for transient computation

UNIT V: Measuring Techniques and Surge Testing 12Hours

Minimizing problem of interference, Differential measurements, Multi channel sequence timer, Low voltage surge testing, measurements of Random disturbances, and measurements of fast transients, Surge voltage testing, High power testing, and Case studies in transient measurements

Tutorial hours: 15
Total no. of Hours: 60

References:

1. Lou van der Sluis, Transients in Power Systems, John Wiley & Sons, Ltd, 2001
2. Allan Greenwood, Electrical Transients in Power Systems, Wiley Interscience, New York, 2nd edition 1991
3. R.D.Begamudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Limited, 1986
4. M.S.Naidu and V.Kamaraju, High Voltage Engineering, Tata McGraw Hill, 2nd edition, 2000

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MEE18P008 ENERGY AUDIT CONSERVATION AND MANAGEMENT@ 3 0 1 4

OBJECTIVES:

- To impart basic knowledge to the students about current energy scenario, energy management, auditing and conservation
- To inculcate among the students systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management
- To initiate the students to conduct live energy audit and present the recommendations report to the consumers

UNIT I: Introduction 12 Hours

Energy Scenario, Need for energy audit, types of audit, need for energy management, load profiles, energy conservation schemes, energy conservation act, energy policies, procedure of BEE star rating, basic instruments and metering for energy audit, residential house energy audit

UNIT II: Energy Balance and Action Planning 12 Hours

Principles of material and energy balance, material balance, energy balance, energy manager quality and functions, sankey diagram, energy action planning steps, top management commitment and support, energy policy and planning, evaluating energy performance, management tools for effective implementation

UNIT III: Industrial Energy Audit 12 Hours

Procedure for conducting industrial energy audit, motor selection and factors affecting motor efficiency, energy efficient improvement opportunities in motors, pumping, fans, compressed air, lighting and heating systems
Energy saving equipments, Cost benefit analysis of energy efficient opportunities, preparation of energy audit report

UNIT IV: Building Lighting Audit and Management 12 Hours

Basics parameters of lighting systems, types of lamps, optimal lighting audit procedure, luminance calculation methods, general energy saving opportunity, energy efficient lighting controls, experience on lighting design software

UNIT V: Economic Aspects and analysis 12 Hours

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

Tutorial: 15
Total no. of Hours: 60

References:

1. General Aspects of Energy Management and Energy Audit, (2015), Guide book for National Certification for Energy Managers and Energy Auditors, Bureau of Energy Efficiency, India
2. Energy Efficiency in Electrical Utilities, (2015), Guide book for National Certification for Energy Managers
3. and Energy Auditors, Bureau of Energy Efficiency, India
4. Albert Thumann and William J Younger, (2012) Handbook of Energy Audits, Taylor and Francis CRC Press.
5. Tarik Al-Shemmeri, (Oct 3, 2011) Energy Audits: A Workbook for Energy Management in Buildings
6. Abbi.Y.P. and Shashank Jain, (Jan 30, 2009) Handbook on Energy Audit and Environment Management
7. Lal Jayamaha, (Nov 20, 2006) Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance
8. Websites for reference https://beeindia.gov.in/ www.green9.org http://www.energyauditsoftware.com/

Evaluation Process: Each student has to conduct the live energy audit* in application to residential building or commercial building or industry or institution or others and submit the report with optimal recommendations and cost analysis
(* - Case study presentation on residential house energy audit, Case study presentation relevant to the topic, Case study presentation on benchmark industrial energy audit, lighting audit case study presentation – Any one case may be done - 50 marks)
For the other 50 marks written examination will be conducted by the department using OBE

MEE18P004 DISTRIBUTED ENERGY RESOURCES AND STORAGE TECHNIQUES 3 0 0 3

OBJECTIVES:

- Understands the role of Renewable Energy
- Analyze Protection schemes in distribution system related to DERs
- Analyze the Stability analysis & energy storage techniques

UNIT I: Role of Renewable Energy 9 Hours

Introduction- Distributed Generation Resources- Renewable Energy sources – Energy Storage Systems - Smart Grid – Interconnection issues and counter measures – Role of ICT in the integration of distributed energy resources

UNIT II: Distributed Energy Resources 9 Hours

Forecasting PV, Wind Power - Output fluctuation characteristics- forecasting methods – Smoothing effect – Power system operation considering PV, wind power output fluctuations- Energy management – Smart house with PV, wind- Fuel cells-operation & types - micro turbines

UNIT III: Protection in Distribution System 9 Hours

General Protection- IEEE Standards for protection – Smart protection -Power Quality issues – Faults – Consequences of Electric Faults- Application based three Phase fault Analysis- Impact of DER on Protection System- Protection schemes – Lightning Protection principles – Lightning protection for Wind Power Generation Systems, Wind Farms & Photovoltaic Generation Systems

UNIT IV: Power Electronics in PV Power Generation Systems 9 Hours

Power Electronics in Wind Power Generation systems- - PQ problems related to DERs – Control Objectives- Stability problem - DGs connected to a weak Power System, Power Electronics in DGs, Microgrids - Applications for microgrids

UNIT V: Energy Storage in Microgrid 9 Hours

Concept of AC Microgrid – Battery Charge pattern & Cost- Power electronics in Battery Energy Storage Systems- BESS at the interconnection point- Plug-in-Electric Vehicles – V2G & G2V Transactions- Basic Concepts of DC microgrids- Supply & Demand control of Microgrids

Total no. of Hours: 45

References:

1. Toshihisa Funabashi, Integration of Distributed Energy Resources in Power Systems Implementation, Operation and Control(2015,) Elsvier Publisher ISBN:978-0-12-803212-1
2. Rajakaruna, Sumedha, Garcia-Cerrada, A., Ghosh, Arindam, Plug In Vehicles in Smart Grids, Springer Publisher (2014) ISBN 978-981-287-299-9
3. Salvador Acha, Modeling Distributed Energy Resources in Energy Service Networks, IET Publisher (2013) ISBN-13: 978-1849195591

MEE18P006 **SMART GRID DESIGN** **3 1 0 4**

OBJECTIVES:

- Understands the concept of Smart Grid
- Able to design Smart Grid

UNIT I: Smart Grid Architectural Design & Communication **12 Hours**

Introduction-Today's grid Vs smart grid-Computational Intelligence – Power system enhancement-Communication & Standards- Environment & Economy- Stake holder Roles & Function- Performance Measure-Architecture- Functions of Smart grid components– Comparison of Smart Grid & Micro grid

UNIT II : Performance Analysis & Stability Analysis Tools for Smart Grid **12Hours**

Introduction to Load Flow Studies- Challenges - Load Flow State of the Art: Classical- Extended Formulation and Algorithm for GS, NR, FD DLF Methods - Congestion Management Effect- Load Flow for Smart Grid Design (DSOPF)- Application of DSOPF in Smart Grid- Static Security Assessment & Contingencies-Stability Tool – Voltage Stability - Computational Tool – Optimization Techniques

UNIT III: Path way for Designing Smart Grid **12Hours**

Barrier & Solution to Smart Grid Development- Design of Smart Grid using Advanced Optimization and control Techniques - General level Automation- Bulk Power System Automation of Smart Grid- Distribution System Automation Requirement of Power Grid- End User- Appliance level of the Smart Grid- Application for Adaptive Control & Optimization – Renewable Energy Storage

UNIT IV : Renewable Energy, Storage & Interoperability **12Hours**

Renewable Energy resources- Sustainable Energy options for Smart Grid- Penetration & Variability Issues Associated with Sustainable Energy Technology- Demand Response Issues- Electric Vehicle and Plug In Hybrids- PHEV Technology- Environmental Implication- Storage Technology- Tax Credit.- Interoperability, Standards & Cyber Security

UNIT V: Fast Forward to Smart Grid **12Hours**

Smart Grid Emergence- Rationale for an Advanced Smart Grid- Smart Convergence- Smart Grid Enterprise Architecture- Envisioning & Designing the Energy Internet-Today's Smart Grid- Advanced Smart Grid Complexities-Grid Operation- Market Operation- Revolutionary Smart Grid Tools- Smart Grid Architecture Frame (SGAF)- Smart Grid Optimization Engine(SGOE)- From Static to Dynamic Grid Operations – Grid Journey

Tutorials: 15
Total no. of Hours: 60

References:

1. James Momoh SMART GRID-Fundamentals of Design and Analysis.published in John Wiley.IEEE Press.
2. Chowdhury,S.P. Crossley, P. and Chowdhury, S. (Jul 15, 2009) Micro grids and Active Distribution Networks.
3. Shin'ya Obara, (Dec 10, 2010) Fuel Cell Micro-grids (Power Systems)
4. Gloria Phillips-Wren, (Dec 1, 2010) Advances in Intelligent Decision Technologies. Proceedings of the Second KES International Symposium IDT 2010
5. Andres Carallo, and John Cooper, The Advanced Smart Grid –Edge Power Driving Sustainability. ISBN_13:978-1-60802- 127-2
6. Stuart Borlase, (Jan 1, 2012) Smart Grids: Infrastructure, Technology and Solutions (Electric Power and Energy Engineering)
7. Tony Flick, and Justin Morehouse, (Oct 7, 2010) Securing the Smart Grid: Next Generation Power Grid Security

M.Tech –Power System (Part Time)

MEE18P009 MODERN DISTRIBUTION SYSTEM DESIGN AND CONTROL 3 1 0 4

OBJECTIVES:

- Able to design concepts related with the planning of modern power distribution system with the integration of distributed generation
- Aims at preparing students to conduct research or helping them to improve their research skills

UNIT I: Introduction to Distribution System Planning 12Hours

Introduction – Factor Affecting System Planning – Planning Techniques- Future Planning Factors – Role of Computer in Planning – Importance and Impact of Distributed Generation consideration in Planning – Load Characteristics – Load Forecasting – Load Management

UNIT II: Design of Distribution Substation and Automation 12Hours

Introduction – Types – Planning Techniques **-** Substation Cost – Bus Scheme – Location – Rating – Comparison of four and six feeder pattern – Derivation of K Constant **-** Design consideration for Remote Terminal Units **-** Components for Distribution Substation Automation – Power Transformers – Substation Protection Schemes- Substation Earthing and Grounding – Distribution Automation – Substation **-** Feeder level and Customer level Automation – Control Center Architecture

UNIT III: Design of Primary and Secondary Distribution System 12 Hours

Introduction – Types of Primary Feeders **-** Methods – Radial Feeders with Distributed Loads – Application of ABCD Constants – Overhead and Underground Design Consideration – Cost Analysis – Secondary Feeder Voltage level and Design Practice – Secondary Banking – Secondary Networks – Spot Networks – Economic Design of Secondary's **-** Cost Analysis

UNIT IV: Application of Capacitor in Distribution System 12 Hours

Basic Definition – Effect of Series and Shunt Capacitors – Power Factor Correction – Application of Capacitor – Economic Justification for Capacitor – Mathematical Procedure to Determine the Location of Capacitor **-** Practical Procedure to determine the location of Capacitor – Dynamic Behavior of Distribution System – Application of AI Techniques in Optimal Capacitor Location

UNIT V: Future of Distribution System 12Hours

Introduction – Concept of distributed generations, topologies, selection of sources, regulatory standards/Framework, Standards for interconnecting Distributed resources to electric power distribution systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels

Tutorials:15
Total no. of Hours: 60

References:

1. Turan Gonen, (2012) Electrical Power Distribution System Engineering. Taylor & Francis Group. CRC Press
2. MIT Study Report (2012) Future of grid.http://mitei.mit.edu/system/files/Electric_Grid_Full_Report.pdf
3. IEEE Tutorial Distribution Automation

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MEE18PL01 PROGRAMMING AND SIMULATION LABORATORY 0 0 2 2

OBJECTIVES: To encourage the students to learn various programming languages like ETap/MATLAB/PSCAD/LabVIEW and apply it to learn the operation of various test systems and gain extensive knowledge about the operation of various equipments utilized in power systems

- Power flow analysis of standard test systems
- Short-circuit analysis of standard test systems
- Transient stability analysis of standard test systems
- Simulation of Multi-level converters
- Performance analysis of a three-phase synchronous machine in the isolated and grid connected modes of operation
- To analyze the effect of FACTS controllers by performing steady state analysis
- Characteristics and control aspects of various renewable energy systems such as wind energy conversion system, photovoltaic systems, and hybrid systems etc.(Both isolated and grid-connected systems)

Total no. of Hours: 45

MEE18P007 POWER SYSTEM ECONOMICS 3 0 0 3

OBJECTIVES:

- Understand s the Power Market Scenario
- Analyze Locational Pricing
- Ability to design the Power market

UNIT I: Fundamentals of Power Markets 9 Hours

Power Market Fundamentals- Need for Deregulate – Unit commitment- Pricing Power, Energy and Capacity- Power Supply and Demand- Power competition- Marginal Cost in a Power Market- Market Structure- Market Architecture – Designing and testing Market Rules

UNIT II: Reliability, Price Spikes and Investment 9 Hours

Reliability and Investment Policy – Price Spikes Recover Fixed costs- Reliability and Generation – Limiting the Price Spikes – Value of Lost Load Pricing – Operating- Reserve Pricing – Market Dynamics, Profit Function – Requirements for Installed Capacity – Inter-system competition for Reliability

UNIT III: Market Architecture 9 Hours

Introduction- Two Settlement system- Day ahead Market Designs – Ancillary Services- Economic Dispatch – Day Ahead , Real time Market in Theory & Practice- New Unit commitment Problem – Market for Operating Reserves

UNIT IV: Market Power 9 Hours

Market Power- Definition- Price Quantity Outcomes- Monopoly power in a Power Auction- Exercising Market Power – Long Run Reactions –Long Run & Short run – Modeling- Cournot model, Designing-Demand Elasticity & Supplier Concentration, Predicting-Estimating MP, Technical Supplement, Market Monitoring

UNIT V: Locational Pricing 9 Hours

Power Transmission Losses (DC & AC) - Physical Transmission Limits-Thermal, Stability, Reactive Power – Congestion Pricing Fundamentals, Methods – Refunds & Taxes – Pricing Losses on Lines, Nodes – Transmission Rights

Total no. of Hours: 45

References:

1. Steven Stoft, Power System Economics- Designing Markets for Electricity, Wiley Publisher, ISBN978-0-471-15040-4
2. Geoffrey Rothwell, Tomas Gomez, Electricity Economics : Regulation & Deregulation, Wiley –IEEE Press ISBN 978-0-471-23437-1
3. Alexandra Von Meier “ Electric Power System : A conceptual Introduction” Wiley – IEEE Press, ISBN : 978 – 0-471-17859-0

M.Tech –Power System (Part Time)

MEE18P010 SYNCHROPHASOR TECHNOLOGY IN WAMPAC 3 1 0 4

OBJECTIVES:

- Understand the concept of PMU and its techniques
- Capable to estimate frequency during balanced and unbalanced conditions
- Able to develop communication options for PMU

UNIT I: Introduction to Phasor Measurement Techniques 12 Hours

Historical Review- Phasor Representation of Sinusoids- Fourier Series-Fourier Transformation- Sample Data & Aliasing- DFT – Leakage phenomenon – Phasor Estimation of Nominal Frequency input and Off Nominal Frequency input

UNIT II: Frequency Estimation, PMU &PDC 12 Hours

Historic Overview- Frequency Estimation from Balanced and Unbalanced 3ø input- Non Linear Frequency estimation- other techniques

Introduction to PMU – GPS- Hierarchy for Phasor measurement systems- Communication options for PMU- Functional requirement for PMU and PDC's- Transient response of Phasor Measurement units

UNIT III: Phasor Measurement Application 12 Hours

State Estimation-History- Weighted Least Square- Static State Estimation- Bad Data Detection- State Estimation with Phasor Measurements- Linear State Estimation- Calibration- Dynamic Estimation

UNIT IV: Control & Protection with Phasor Input 12 Hours

Introduction to Control- Linear Optimal Control- Linear Optimal Control Applied to Nonlinear Problem- Coordinated Control of Oscillation – Discrete event Control. Introduction to Protection – Differential Protection of Transmission line- Distance Relaying of Multiterminal transmission line- Adaptive Protection- Control of backup Relay Performance- Intelligent Islanding- Supervisory Load Shedding

UNIT V: WAMPAC – Guardian of Power System 12 Hours

Introduction & Scope- WAMPAC Background- Impact on Power System Stability- Interoperability- Experiences of using WAM system worldwide - Real-time monitoring applications-Future protection schemes based on synchronized Phasor measurements - Applications based on synchronized Phasor measurements- Improved state estimation- Phasor Measurement Unit – Testing standards- System Integrity Protection Scheme - Future growth

Tutorials:15

Total no. of Hours: 60

References:

1. Phadke, A. G. and Thorp, J. S. Synchronized Phasor measurement and their applications
2. Kundur,P. Power systems stability and control.
3. Hector J. Altuve Ferrer, and Edmund O. Schweitzer III, (2010) Modern Solutions for Protection, Control and Monitoring of Electric Power Systems
4. Fahd Hashiesh, M. M. Mansour, and Hossam E. Mostafa, (Feb 28, 2011) Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids
5. Zhao yang Dong, Pei Zhang, Jian Ma, and Junhua Zhao, (May 21, 2010) Emerging Techniques in Power System Analysis

M.Tech –Power System (Part Time)

MEE18PL03 ADVANCED DESIGN AND IMPLEMENTATION PRACTICE 0 0 2 3

The Procedure for execution of Advanced Design and Implementation Practice are

- Each student has to select their own topic which is in real time operation
- Develop the mathematical model for the suitable selected topic
- Optimize the finalized process plan with suitable selection of equipments
- Prepare the cost analysis with breakeven chart
- Finalize the implementation model for action
- Simulate the finalized model with suitable simulation package
- Implement the developed design in real or prototype category

The end semester examination will be conducted internally in the department with suitable presentation by the student with design and implementation report

Total no. of Hours: 45

MEE18P011 POWER QUALITY AND GRID INTEGRATION@ 3 1 0 4

OBJECTIVES:

- Understand the importance and causes of transients
- Understand the sources of transient over-voltages and its causes
- Understand the effect of harmonics in industrial and commercial loads

UNIT I: Introduction 12 Hours

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage unbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards

UNIT II: Measurement and Analysis Methods 12 Hours

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform

UNIT III: Analysis and Conventional Mitigation Methods 12 Hours

Analysis of power outages, Analysis of unbalance: Symmetrical components of Phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction

UNIT IV: Power Quality Improvement 12 Hours

Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters –Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method – Custom power park –Status of application of custom power devices

UNIT V: Grid Integration and Power Quality 12 Hours

Stand alone and Grid Connected WECS system- Basics of Grid Connection; Characteristics of Wind Generator; State-of-the-art of power Electronics in Wind Energy - Soft-starter, Capacitor bank, Rectifiers and inverters, Frequency converters. Power Converters for WECS; Power Quality Standards in Wind Farms- Reactive power, flicker coefficient, Maximum number of wind turbine switching operations, flicker step factor, Voltage change factor, Harmonic currents

Total no. of Hours: 60

References:

1. Dranetz--BMI; NJATC (2010) Power Quality Analysis. 2010 Ed. (Dranetz-BMI and NJATC)
2. Luisa Martinez Muneta, Gregorio Romero Rey, and Teodora Smiljanic, (Nov 23, 2011) Power Quality Harmonics Analysis and Real Measurements Data
3. Antonio Moreno-Muñoz, (Dec 10, 2010) Power Quality: Mitigation Technologies in a Distributed Environment (Power Systems)
4. Mohammed Hasan Ali, (Feb 16, 2012) Wind Energy Systems: Solutions for Power Quality and Stabilization

Evaluation Process

- For 50 marks written examination will be conducted by the department using OBE
- The remaining 50 marks to be allocated for Innovative Learning Practice (IPL) like development of prototype, new design development, paper publication and field training. All these mentioned IPL should be accompanied by a 25 pages report in an appropriate format as mentioned in ISO

M.Tech –Power System (Part Time)

MEE18PE01 FUZZY SYSTEM AND APPLICATION IN MODERN ELECTRIC POWER SYSTEM 3 0 0 3

OBJECTIVES:

- Understand the mathematical adaptation of fuzzy systems
- Capable to control Power Network
- Capable to detect and diagnose in rotating machines

UNIT I: Fuzzy Logic and Its Controllers 9 Hours

Fuzzy set - Crisp set – vagueness – uncertainty and imprecision – fuzzy set –fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relations –fuzzy Cartesian product and composition – composition of fuzzy relations- Fuzzy to crisp conversion –structure of fuzzy logic controller – database – rule base – Inference engine

UNIT II: Fuzzy Application to power system Operation 9 Hours

Overview-Load Forecasting-Economic Dispatch-Unit commitment using Fuzzy concepts

UNIT III: Control of Electrical Energy Systems 9 Hours

Automatic Generation Control (AGC) and Reactive Power control using: classical, optimal-Fuzzy control techniques. Energy Storage Devices to Power System Control using Fuzzy concepts

UNIT IV: Power system Stability Control 9 Hours

Introduction-Types-Voltage Stability Control-Angle Stability Control-stability assessment using Fuzzy concepts

UNIT V: Fault Deduction and Diagnosis 9 Hours

Introduction –Transmission line fault Diagnosis-Rotating machines fault-transformer fault-transmission fault-using Fuzzy concept - Application of fuzzy logic to identify different types of Machines Faults

Total no of hours: 45

References:

1. Timothy J. Ross, (1997) Fuzzy Logic with Engineering Applications. McGraw Hill International Edition
2. Hawary, E.L.(1998) Electric Power Applications of Fuzzy Systems. IEEE Press
3. Klir, G. J. and Yuan, B. Fuzzy Sets and Fuzzy Logic
4. Loi Lei Lai, Intelligent System Application in Power Engineering

MEE18PE02 **ANALYSIS OF ELECTRICAL MACHINES** **3 0 0 3**

OBJECTIVES:

- Understands the basics of EM energy conversion
- Able to analyze the different electrical machines
- Capable of designing electrical machines

UNIT I: Principles of Electromagnetic Energy Conversion **9 Hours**

Basic principles of Electric Machine Analysis - Electromagnetic energy conversion – Linear and non linear magnetic System – Winding configuration in rotating machines and air gap configuration - Force and torque equations of Co-energy and energy equations – Winding inductances and voltage equations

UNIT II: DC Machines **9 Hours**

Analysis of steady state operation of DC Machine – Permanent Magnet DC Machine- Voltage and torque equations – dynamic characteristics of DC Machine shunt DC. motors –Analysis of Steady State Performance – Permanent Magnet DC Machines - Analysis of Shunt, Series Excited motors, Laplace transformation – dynamic characteristics -Digital computer simulation of DC Machines

UNIT III: Reference Frame Theory **9 Hours**

General aspects of Reference Frame Theory–Stationary Reference Frame, Synchronously rotating Reference Frame, Arbitrary Reference Frame – Advantages of Reference Frame Transformations - phase transformation and commutator transformation – observation from several frames of reference

UNIT IV: Induction Machines **9 Hours**

Equivalent Circuit of Three phase induction machine, simulink implementation of steady state operation – Controller design – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of Load torque variations – dynamic performance, digital computer simulation

UNIT V: Synchronous Machines **9 Hours**

Analysis of steady state operation of Three phase synchronous machine, Simulink implementation of steady state operation – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of Load torque variations – dynamic performance, digital computer simulation

Total no. of Hours: 45

References:

1. Paul C.Krause, Oleg Wasyczczuk, Scott S, Sudhoff, Analysis of Electric Machinery and Drive Systems, John Wiley, Second Edition, 2010
2. P S Bimbhra, Generalized Theory of Electrical Machines, Khanna Publishers, 2008
3. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, Electric Machinery, Tata McGraw Hill, 5th Edition, 1992

MEE18PE03 **SUBSTATION DESIGN AND AUTOMATION** **3 0 0 3**

OBJECTIVES:

- Understands the basics of Substation
- Analyze different security & Protection Schemes
- Ability to design Substation

UNIT I: Basics of Substation **9 Hours**

Substation- Background- Budgeting-Traditional & Innovative Substation Design- Site Selection- Design, Construction – Types of Substation- GIS and AIS- Construction, Operation , Interlocking, economics, maintenance-

UNIT II: High Voltage Power Electronic Substation **9 Hours**

High Voltage Switching Equipment- Ambient Conditions - Disconnect Switches - Load Break Switches - 5 High-Speed Grounding Switches - Power Fuses - Circuit Switchers- Circuit Breakers- Converter Stations- FACTS Controllers- Control & Protection System – Losses and cooling – Civil works- Reliability and Availability

UNIT III: Substation Automation **9 Hours**

Definitions – Components of a substation Automation system- Measurement- State monitoring- Control functions- Communications - Testing Automation Systems – Open Systems- Architectural functional Data paths - Substation Integration and Automation Technical issues –IEC61850

UNIT IV: Environmental Considerations **9 Hours**

Oil Containment – Community Consideration – Animal Deterrents – Substation Grounding –Accidental Ground Circuit - Design Criteria – Lightning stroke protection – Lighting parameters- Seismic Considerations – Relationship between Earthquakes and substations - Fire protection –Risk Analysis

UNIT V: Security & Protection **9 Hours**

Physical Security of substations – Threat Assessment- System Analysis - Cyber Security of Substation control and Diagnostic systems -Gas Insulated Transmission Line – Corrosion Protection - Substation Asset Management- Station Commissioning and Project Closeout

Total no. of Hours: 45

References:

1. John D. McDonald, Leonard L. Grigsby, Electric Power Substations Engineering CRC Press
2. Evelio Padilla Substation Automation Systems: Design & Implementation(2015) Wiley Publisher, ISBN:978-1-118-98729-2
3. Edward Chikuni Power System & Substation Automation Intech ISBN: 978-953-51-0685-2

MEE18PE04 SOLID STATE POWER CONVERTERS 3 0 0 3

OBJECTIVES:

- Familiarity to Power Electronic Devices and its characteristics
- Capable of designing converters
- Familiarization to Inverters, Choppers and Industrial drives

UNIT I: Power Semiconductor Devices 9 Hours

Characteristics of Diodes - Thyristors – Power transistors, GTO's, IGBTs, TRIAC and Power MOSFETs, its ratings and triggering circuits, Protection against over voltage and over currents, cooling of semiconductor devices

UNIT II: Phase-Controlled Converters 9 Hours

Diode Rectifiers – Single Phase & Three Phase Bridge Rectifier with R, RL load – Distortion Factor (DF), Displacement Power Factor (DPF), Power Factor (PF)- Thyristor Converters – Single Phase Bridge RL and Discontinuous Conduction –Three Phase converter - RL, Half-Wave Converter, Analysis for Line Leakage Converters - Three Phase Dual Converter - 12-Pulse Converter-Converter Controllers - EMI Problems - Line Harmonic Problems

UNIT III: DC Choppers 9 Hours

DC choppers – Step-down and step-up chopper – Time ratio control and current limit control –Various classes of Operation – Buck, boost and buck – boost type choppers – merits and applications – Concept of Resonant switching – SMPS

UNIT IV: Cycloconverters 9 Hours

Phase-Controlled Cycloconverters - Cycloconverter Circuits - Circulating vs Non-Circulating Current Mode - Load and Line Harmonics - Line Displacement Power Factor- Control of Cycloconverter - Matrix Converters - High – Frequency Cycloconverters

UNIT V: Inverters 9 Hours

Voltage – Fed Converters- Single Phase Inverters-Three –Phase Bridge Inverters-Multi-Stepped Inverters-Pulse Width Modulation Techniques-Three Level Inverters-Current-Fed Converters- General Operation of a Six-Step Thyristor Inverter-Load Commutated Inverter-Force-Commutated Inverters-Current – Fed vs Voltage-Fed Converters

Total no. of Hours: 45

References:

1. Bimal K.Bose, Modern Power Electronics and AC Drives, Prentice Hall, 2010
2. Vedam Subrahmanyam, (1996) Power Electronics. New Delhi: New Age International Pvt. Ltd
3. Rashid, M.H. (1995) Power Electronics Circuits, Devices and Applications 2nd Ed. New Delhi: New Age International Pvt. Ltd.
4. Sen, P.C. (1998) Modern Power Electronics, 1st Ed. New Delhi: Wheeler Publishing Co
5. Ned Mohan, Udeland & Robbins, (1995) Power Electronics: Converter, Application & Design. John Wiley & Sons Inc. New York
6. Dubey, G.K. Doradla, S.R. Joshi, A. R. Shinha, M.K. (1996) Thyristorised Power Controllers. New Delhi: New Age International Pvt. Ltd

MEE18PE05 **MEMS TECHNOLOGY** **3 0 0 3**

OBJECTIVES:

- Understands the concept of MEMs Technology
- Knowledge of MEMs structures
- Ability to design a Microsystems

UNIT I: Introduction to MEMS **9 Hours**

Introduction to Micromachining- Material for MEMS- Silicon Compatible Material System- Other materials and substrates – Important material properties and physical effects

UNIT II: MEMS Tools **9 Hours**

Processes for Micromachining- Basic Process Tools – Advanced Process Tools – Non lithographic Microfabrication Technologies – Combining the Tools- Examples of Commercial Process

UNIT III: MEMS Structures **9 Hours**

General Design Methodology- Techniques for sensing and Actuation –Passive Micromachines Mechanical Structures – Sensors and Analysis Systems – Actuators and Actuated Microsystems-Imaging & Displays- Fiber-Optic Communication Devices

UNIT IV: MEMS Application **9 Hours**

Microfluidics for Biological Applications- DNA Analysis- Microelectrode Arrays- Signal Integrity in RF MEMS-Passive Electrical Components – Microelectromechanical Resonators – MEM Switches

UNIT V: Reliability consideration for MEMs **9 Hours**

Key Design & Packaging Considerations- Die Attach Processes- Wiring and Interconnects – Types of Packaging Solutions- Quality Control, Reliability and failure Analysis

Total no. of Hours: 45

References:

1. Nadim Maluf, Kirt Williams , An Introduction to Microelectro mechanical Systems Engineering Second edition, Artech House, Inc British Library Cataloguing ISBN 1-58053-590-9
2. Stephen D. Senturia, Microsystem Design Springer Publisher ISBN 979-0792372462
3. Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology Volume –II, CRC Press ISBN : 978-1420055191

MEE18PE06 ANN AND APPLICATION IN MODERN ELECTRIC POWER SYSTEM 3 0 0 3

OBJECTIVES:

- Capable to forecast Electricity pricing with propagation network
- Ability to apply applications of ANN
- Capable to detect fault and diagnose in rotating machines

UNIT I: Power System Stabilizer **9 Hours**

Introduction-Conventional PSS- Tuning of parameter -back-propagation –Application of ANN with PSS for DFIG

UNIT II: State Estimation **9 Hours**

Introduction-different modules of state estimator ANN models- Observability analysis using back propagation network, counter propagation network models. Application of ANN to WLSE method

UNIT III: Forecasting **9 Hours**

Introduction- Load forecasting-types using ANN. Electricity price forecasting with back propagation-wind speed, direction, power forecasting using multi layer approach. Application of ANN to Electric Load Forecasting

UNIT IV: Fault Deduction and Diagnosis **9 Hours**

Introduction –Rotating machines fault-transformer fault-transmission fault-Relay coordination-speed control of AC and DC machines using ANN. Application of ANN to identify different types of Machines Faults

UNIT V: ANN for security Assessment **9 Hours**

Introduction -static security problems-challenges-characteristics of supervised and unsupervised learning-Architecture-training set selection –Interpretation of the weight - Application of ANN to predetermine the Contingency Status of Power system

Total no. of Hours: 45

References:

1. Kothari, D.P. Dhillon, J. S.(2012), Power System Optimization
2. Rajasekaran, S.and Pai, G.A.V.(2003) Neural Networks, Fuzzy Logic & Genetic Algorithms. New Delhi:
3. PHI
4. Warwick, K. Arthur Ekwue, Raj Aggarwal, (1999) Artificial Intelligence Techniques in Power System. IEEE

MEE18PE07 GREEN BUILDING DESIGN 3 0 0 3

OBJECTIVES:

- Understands the concept of Green Building
- Knowledge on the Design aspect of Green Building
- Familiarity in the reduction of carbon foot print

UNIT I: Introduction to Green Building 9 Hours

Green Movement– Green Basics –-Sustainable Development-Sustainable Design, Ecological Design, and Green Design- Rationale for High-Performance Green Buildings-Green Building Progress and Obstacles - Trends in High-Performance Green Building

UNIT II: Green Building Design 9 Hours

Green Building Foundations-Major environmental & Resource Concerns – Ecological Design- - Green Building Assessment- International Building Assessment- Green Building Design Process-Executing the Green Building Project –Landscape Approaches for Green Building –Heat Island mitigation – Assessment of sustainable sites

UNIT III: Energy & Carbon footprint Reduction 9 Hours

Building Energy Issues- Design Strategy- -Active Mechanical Systems –Innovative Energy Optimization strategies – Renewable Energy systems- Smart Building & Energy Management systems – Reducing the Carbon footprint of the built Environment

UNIT IV: Environmental Aspects 9 Hours

Built Environment Hydrological cycle- Sustainable storm water management-Closing Material loops- Indoor Environmental Quality – Integrated IEQ Design – Construction Operations and commissioning of Green Building – Construction & Demolition Waste management

UNIT V: Economics & Future Trends 9 Hours

Green Building Economics- Quantifying Benefits – Managing first costs – Cost barriers- Passive survivability – Articulating Performance goals for future Green Buildings – Revamping Ecological Design

Total no. of Hours: 45

References:

1. Charles J.Kibert Sustainable Construction: Green Building Design and Delivery, 3rd Edition Wiley Publisher, (2012)ISBN :978-0-470-90445-9
2. Sam Kubba, Handbook of Green Building Design, and Construction, Elsevier Publisher(2012) ISBN: 978-0-12-385128-4
3. Charles J.Kibert, Martha C.Monroe, Anna L.Peterson, Richard R.Plate, Leslie Paul Thiele ,Working Toward Sustainability: Ethical Decision –Making in a Technological World, Wiley Publisher, ISBN : 978-0-470-53972-9
4. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari, (2017), Handbook on Standalone Renewable Energy Systems, 1st Edn, Research India Publication ISBN No 978-93-87374-12-6

MEE18PE08 POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS 3 0 0 3

OBJECTIVES:

- Capable to regulate and control voltage using Thyristors
- Familiarity to converters, UPS and frequency devices
- Capable to improve power factor of converters

UNIT I: Static VAR Control 9 Hours

Principles of load compensation – voltage regulation and power factor correction – unsymmetrical loads – phase balancing and power factor Corrections – static compensation properties – Thyristors controlled Reactor (TCR), Thyristors switched capacitor (TSC), saturable core reactor (control strategies)

UNIT II: Power factor Improvement & Harmonic Control Converters 9 Hours

Poor power factor – forced commutation techniques for power factor improvement – methods of improving the power factor of the line commutated converters – use of high frequency devices

UNIT III: Voltage Control 9 Hours

Static Tap changer for voltage control – Static Tap changing using Thyristors -comparison of different schemes Generator excitation – schemes, comparison

UNIT IV: Uninterrupted Power Supply 9 Hours

Parallel redundant & non-redundant UPS, UPS using frequency devices, resonant converters and switched mode power supplies

UNIT V: Unified Power Flow Control 9 Hours

Implementation of power flow control using conventional Thyristors, implementation of Unified power flow controller

Total no. of Hours: 45

References

1. Miller, T.J.E. (1982), Reactive Power control in Electric Systems, New York: Wiley Interscience
2. Yoshihide Hase, Handbook of Power Systems Engineering with Power Electronics Applications, 2nd Edition, 2012, wiley
3. Gyugyi, L.(July 1994) Unified Power Flow Control Concept for Flexible AC Transmission. Vol. 139. IEEE proceedings

MEE18PE09 COMPUTERS IN NETWORKING AND DIGITAL CONTROL 3 0 0 3

OBJECTIVES:

- Understands the fundamental of Networks
- Ability to simulate & design Signals
- Upgrading to web based control

UNIT I: Network Fundamentals **9 Hours**

Data communication networking – Data transmission concepts – Communication networking - Overview of OSI-TCP/IP layers – IP addressing - DNS – Packet Switching – Routing –Fundamental concepts in SMTP, POP, FTP, Telnet, HTML, HTTP, URL, SNMP,ICMP

UNIT II: Data Communication **9 Hours**

Sensor data acquisition, Sampling, Quantization, Filtering ,Data Storage, Analysis using compression techniques, Data encoding – Data link control – Framing, Flow and Error control, Point to point protocol, Routers, Switches , Bridges – MODEMs, Network layer –Congestion control- Transport layer- Congestion control, Connection establishment

UNIT III: Virtual Instrumentation **9 Hours**

Block diagram and Architecture – Data flow techniques – Graphical programming using GUI – Real time system – Embedded controller – Instrument drivers – Software and hardware simulation of I/O communication blocks – ADC/DAC – Digital I/O – Counter , Timer, Data communication ports

UNIT IV: Measurement and Control through Internet **9 Hours**

Web enabled measurement and control-data acquisition for Monitoring of plant parameters through Internet – Calibration of measuring instruments through Internet, Web based control – Tuning of controllers through Internet

UNIT V: VI Based Measurement and Control **9 Hours**

Simulation of signal analysis & controller logic modules for Virtual Instrument control – Case study of systems using VI for data acquisition - Signal analysis - controller design - Drives control

Total no. of Hours: 45

References:

1. Wayne Tomasi, Introduction to Data communications and Networking, Pearson Education
2. Al Williams, Embedded Internet Design, Second Edition, TMH
3. Douglas E.Comer, Internetworking with TCP/IP, Vol. 1, Third Edition, Prentice Hall
4. Cory L. Clark, LabVIEW Digital Signal Processing and Digital Communication, TMH edition
5. Behrouza A Forouzan,Data Communications and Networking, Fourth edition, TMH
6. Krishna Kant,Computer based Industrial control, PHI
7. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill,Newyork
8. Kevin James, PC Interfacing and Data Acquisition: Techniques for measurement, Instrumentation and control, Newnes
9. Cory L. Clark, LabVIEW Digital Signal processing and Digital Communications, TataMcGRAW-HILL edition

M.Tech –Power System (Part Time)

MEE18PE10 **RESEARCH METHODOLOGY** **3 0 0 3**

OBJECTIVES:

- Understands the fundamentals of Research
- Attains knowledge to collect Data
- Ability to write Reports & Research Papers

UNIT I: Fundamentals of Research **9 Hours**

Basic principles of research- theory building, facts- concepts- constructs and definitions- Valuable and its attributes- Ethics in research - Preparation of proposal-Review of literature- formation and types of hypothesis and testing of the hypothesis- Research designs- sampling designs-methods-techniques and tools of research

UNIT II: Analysis of Existing Empirical Research **9 Hours**

Needs assessment and program evaluation, including formative and summative assessment-Evidence-based practice-Practice-based evidence-Research methods such as qualitative-quantitative-mixed method -single-case design-action research and outcome-based research- Descriptive and inferential statistical analysis-Ethical and cultural issues in research

UNIT III: Data Collection and Processing **9 Hours**

Types of data and sources – Primary and Secondary data sources - Data analysis for specific type of data - Methods of collection of primary data- Experimental Field – Experimental Laboratory

UNIT IV: Quantitative Method **9 Hours**

Use of quantitative method in research- Tabulation and graphical representation - Central tendency-Dispersion-Correlation-Regression-Use of chi square-Steps involved in applying chi—square test-Non parametric or free distribution tests-Testing of hypothesis for non parametric data

UNIT V: Communication and Evaluation of Research **9 Hours**

Report writing and the writing of research papers-Presentation of research proposals-Evaluation of research report-Presentation of research-Oral and Written (abstracts/synopsis)- Word processing-Data processing-Graphical processing-Use of web-2 tools for research-Use of excel-Use of SPSS-Use of graphical software- Use of multimedia tools

Total no. of Hours: 45

References:

1. Kothari C R, Research Methodology : Methods and Techniques , New age international publishers, 3rd edition, 2014
2. Yogesh Kumar Singh(2006), Fundamentals of Research Methodology and Statistics, New age international publishers
3. David Targett(1990), Quantitative Methods, Heriot-Watt University
4. Sinha P.K. (2004), Computer Fundamentals, BPB Publications, 3rd edition, New Delhi

MEE18PE11 INTELLIGENT OPTIMIZATION TECHNIQUES AND APPICATIONS IN MODERN POWER SYSTEMS **3 0 0 3**

OBJECTIVES:

- Familiarity to evolutionary algorithm
- Capable to solve Power System problem using optimization techniques
- Capable to develop programming with suitable software

UNIT I: Evolutionary Algorithm **12 Hours**

Introduction to Computational Intelligence – Genetic Algorithms – Initiation – Selection - Crossover - Mutation – Control Parameters – Genetic Algorithm Variants – Differential Evolution - Basic Differential Evolution – Basics of Cultural Algorithm

UNIT II: Computational Swarm Intelligence **12 Hours**

Particle Swarm Optimization: Basic Particle Swarm Optimization -Global Best PSO-Local Best PSO - Ant colony Algorithms: Ant Colony Optimization -Foraging Behavior of Ants-Simple Ant Colony Optimization

UNIT III: Application to Modern Power System **21 Hours**

Study of Power System Optimization Techniques like Optimal Capacitor Placement, Optimal Meter Placement, Optimal Location of DG, Power System Stabilizers

The students have to develop the suitable code with suitable software to apply the Intelligent Optimization Techniques in Unit I and II to the Application of Power System in Unit III

Total no. of Hours: 45

References

1. Andries P. Engel brecht, Computational intelligence, university of Pretoria-South Africa
2. Singiresu s. Rao, Engineering optimization. West Lafayette Indiana

M.Tech –Power System (Part Time)

MEE18PE12 | **SYSTEM THEORY** | **3 0 0 3**

OBJECTIVES:

- Understands the fundamentals of Control System
- Analyze the system characteristics
- Ability to maintain stability

UNIT I: Introduction **9 Hours**

State space modeling of physical systems –determining of STM – controllability and observability of linear time invariant system

UNIT II: Non-Linearity System **9 Hours**

Different techniques of line arising in non-linear systems – Describing functions for various types of non-linearity's – describing function analysis of non linear control systems

UNIT III: Analysis of Systems **9 Hours**

Method of constructing phase – trajectories- phase plane analysis of linear and non-linear systems – Bang-bang system

UNIT IV: Stability Criteria **9 Hours**

Stability of LTI Systems - Different methods of constructing Lyapunov's functions for linear and non-linear continuous time systems

UNIT V: Pole Placement **9 Hours**

Pole placement technique by state feedback for linear SISO time invariant system – Theory of high-gain feedback-advantages – Pole placement technique along with high-gain feedback control

Total no. of Hours: 45

References

1. M. Gopal, & Madan, Modern Control System Theory, New Age International, 3rd edition, 2014
2. D. Roy Choudhury, Modern Control Engineering, PHI Learning Pvt. Ltd, 2005
3. Ogata, K. (2003) Modern Control Engineering.5th Ed. Prentice Hall of India, 2009
4. Kuo. B.C. Automatic Control Systems. Hoboken, NJ Wiley 2010

M.Tech –Power System (Part Time)

MEE18PE13 POWER DISTRIBUTION RELIABILITY 3 0 0 3

OBJECTIVES:

- Understand the basic of distribution reliability issues
- Capable of addressing reliability issues
- Ability to assess and restructure distribution system

UNIT I: Reliability Metrics and Indices 9 Hours

Introduction – Power Quality, Reliability and Availability – Reliability Indices – Customer cost of Reliability – Reliability Target – History of Reliability Indices – Load Management

UNIT II: Interruption Causes and Component Modeling 9 Hours

Factors Affecting Interruption – Equipment failure, Animal, Weather, Tree, Human factors – Components of Reliability Parameters – Failure rates and Bathtub Curves – Probability Distribution function – Fitting curve to measure data – Component reliability data

UNIT III: System Modeling 9 Hours

System Events – Event Independence - Network modeling – Markov modeling – Analytical simulation for radial systems – Analytical simulation for network systems – Monte carlo simulation – Other methodologies – Economic Analysis – Marginal benefit to cost analysis

UNIT IV: Maintenance and Aging in Reliability 9 Hours

Maintenance and Reliability – Maintenance of distribution system – Reliability centered maintenance – Implementation plan for maintenance – Illustrative examples – Equipment aging – Equipment age profile – Population aging behavior – Aging and increasing failure rates – Inspection repair and replacement – State of the industry

UNIT V: Reliability Assessment 9 Hours

Introduction – Types of evaluation methods -- Case study on distribution system reliability assessment (any two mathematical method and any two artificial intelligence method) - Case study on reliability assessment with distributed generation - reliability assessment of microgrid - Study of Reliability assessment software

Total no. of Hours: 45

References:

1. Turan Gonen, (2012) Electrical Power Distribution System Engineering. Taylor & Francis Group. CRC Press
2. Richard E Brown (2008) , Electrical Power Distribution Reliability, CRC Press, Taylor & Francis Group
3. James M Momoh (2007) Electrical Power Distribution Automation Protection and Control, Taylor & Francis Group. CRC Press

MEE18PE14 **HVDC TRANSMISSION** **3 0 0 3**

OBJECTIVES:

- Comparison of DC & AC system.
- Analyze the HVDC Converters
- Modeling and design of filters

UNIT I: Introduction to HVDC **9 Hours**

Comparison of AC & DC- Application- Description and planning of DC Transmission – Modern trends in HVDC transmission - Recent developments in switching devices

UNIT II: Analysis of HVDC converters **9 Hours**

Pulse number – Choice of Converter Configuration – Simplified analysis of Graetz circuit – Converter bridge characteristics – Characteristics of twelve pulse converters – Detailed analysis of converters

UNIT III: Converter and system control **9 Hours**

Principles of DC link control – Converter control Characteristics - system control hierarchy – Firing angle control – Current and extinction angle control - Starting and stopping of DC Link – Higher level controllers

UNIT IV: Converter faults and protection **9 Hours**

Converter Faults – Protection against over currents – Over voltages in a converter station & Protection - Smoothing Reactor - DC Line – Transient overvoltages in DC line – Protection of DC line – Effect of proximity in AC and DC Transmission line

UNIT V: Harmonics and Filters, MTDC system **9 Hours**

Generation of Harmonics - Design of AC Filters – DC Filters - MTDC Systems – types, control & Protection

Total no. of Hours: 45

References:

1. K.R.Padiyar , HVDC Power Transmission Systems, New Academic Science, 2011
2. Kamakshaiah, HVDC Transmission, TMH Education, 2011
3. Jos Arrilaga , High Voltage Direct Current Transmission, 2nd Edition, IEEE, 1998

MEE18PE15 ADVANCED DIGITAL SIGNAL PROCESSING 3 0 0 3

OBJECTIVES:

- To enable the students to get the fundamentals of parametric and non-parametric analysis
- To enable the students to design adaptive filters using different methodologies

UNIT I: Discrete Random Signal Processing 9 Hours

Discrete Random Process- Expectation- Variance- Co-Variance- Scalar Product-Energy of Discrete Signal-Parseval's Theorem- Wiener Khintchine Relation-Power Spectral Density –Periodogram – Sample Autocorrelation-Sum Decomposition Theorem, Spectral Factorization Theorem – Discrete Random Signal Processing by Linear Systems-Simulation of White Noise – Low Pass Filtering of White Noise

UNIT II: Spectrum Estimation 9 Hours

Non-Parametric Methods-Correlation Method – Co-Variance Estimator – Performance Analysis of Estimators – Unbiased- Consistent Estimators – Periodogram Estimator – Bartlett Spectrum Estimation – Welch Estimation – Model based Approach – AR, MA, and ARMA Signal Modeling – Parameter Estimation using Yule-Walker Method

UNIT III: Linear Estimation and Prediction 9 Hours

Maximum likelihood criterion-efficiency f estimator – Least mean squared error criterion – Wiener filter – Discrete Wiener Hoff equations – Recursive estimators-Kalman filter – Linear prediction, prediction error-whitening filter, inverse filter – Levinson recursion-Lattice realization and Levinson recursion algorithm for solving Teoplitz system of equations

UNIT IV: Adaptive Filters 9 Hours

FIR adaptive filters – Newton's steepest descent method-adaptive filter based on steepest descent method – Widrow Hoff LMS adaptive algorithm – Adaptive channel equalizations – Adaptive echo chancellor – Adaptive noise cancellation – RLS adaptive filters –Exponentially weighted RLS – sliding window RLS – Simplified IIR LMs adaptive filter

UNIT V: Multi Rate Digital Signal Processing 9 Hours

Mathematical description of change of sampling rate – Interpolation and Decimation –continuous time model – Direct digital domain approach **-**Decimation by an integer factor – Interpolation by an integer factor – single and multistage realization **-** Poly phase realization – Application to sub band coding – Wavelet transform and filter bank implementation of wavelet expansion of signals

Total no. of Hours: 45

References:

1. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, Inc., New York, 1996
2. John G. Proakis, Dimitris G. Manolais, Digital Signal Processing Prentice Hall of India, 1995
3. Sopocles J. Orfanidis, Optimum Signal Processing, McGraw Hill, 1990

MEE18PE16 DYNAMIC MODELING AND CONTROL OF WIND TURBINES 3 0 0 3

OBJECTIVES:

- Understand the concepts of Power Electronic Devices for wind turbine
- Capable to design modeling of wind turbines
- Capable to design the mechanical equations for Induction Machines

UNIT I: Generators & Power Electronics for Wind Turbines 9 Hours

Introduction – State of the art technologies – Overview of Wind Turbine Topologies – Power Control Concepts – State of the art Generators – State of the art Power Electronics – Generator Concepts – Power Electronic Concepts – Power Electronic Solutions in Wind Farms

UNIT II: Introduction to the Modeling of Wind Turbines 9 Hours

Introduction - Basic Considerations regarding Modeling and Simulations - Overview of Aerodynamic Modeling - Basic description of the turbine rotor - Different representations of the turbine rotor - Basic Modeling Block - Description of Wind Turbines - Aerodynamic system - Mechanical system - Generator drive concepts - Pitch servo Main control system - Protection systems and relays - Per Unit Systems and Data for the Mechanical System - Different Types of Simulation and Requirements for Accuracy - Simulation work and required modeling accuracy Different types of simulation

UNIT III: Reduced-Order Modeling of Wind Turbines 9 Hours

Introduction - Power System Dynamics Simulation - Current Wind Turbine Types - Modeling Assumptions - Model of a Constant-speed Wind Turbine - Model structure - Wind speed model - Rotor model - Shaft model - Generator model - Model of a Wind Turbine with a Doubly fed Induction Generator - Model structure - Rotor model - Generator model - Converter model - Protection system model - Rotor speed controller model - Pitch angle controller model - Terminal voltage controller model - Model of a Direct drive Wind Turbine - Generator model - Voltage controller model - Model Validation - Measured and simulated model response - Comparison of measurements and simulations

UNIT IV: High Order Models of Doubly-Fed Induction Generators 9 Hours

Introduction - Advantages of Using a Doubly-fed Induction Generator - The Components of a Doubly-fed Induction Generator - Machine Equations - The vector method - Notation of quantities - Voltage equations of the machine - Flux equations of the machine - Mechanical equations of the machine - Mechanical equations of the wind turbine - Voltage Source Converter - Sequencer - Simulation of the Doubly-fed Induction Generator - Reducing the Order of the Doubly-fed Induction Generator

UNIT V: Full Scale Verification of Dynamic Wind Turbine Models 9 Hours

Introduction - Background - Process of validation - Partial Validation - Induction generator model - Shaft system model - Aerodynamic rotor model - Summary of partial validation - Full-scale Validation - Experiment outline - Measured behavior - Modeling case - Model validation - Discrepancies between model and measurements

Total no. of hours: 45

References:

1. Thomas Ackerman ,Wind Power in Power Systems.John Wiley & Sons Ltd
2. Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, and Pill Cartwright, (Aug 31, 2009) Wind Energy Generation: Modeling and Control
3. (Jul 21, 2012) Dynamics Modeling and Loads Analysis of an Offshore Floating Wind Turbine. National Renewable Energy Laboratory (NR)
4. Loi Lei Lai, and Tze Fun Chan, (Nov 28, 2007) Distributed Generation: Induction and Permanent Magnet Generators
5. Thomas Ackermann, (Mar 28, 2005) Wind Power in Power Systems

M.Tech –Power System (Part Time)

MEE18PE17 MICROGRID IN MODERN POWER SYSTEMS 3 0 0 3

OBJECTIVES:

- Development of Micro grid
- Ability to understand the operation of SCADA
- Ability to design protection and control for microgrid

UNIT I: Distributed Generation and Micro grid Concept 9 Hours

Distributed Generation-Active Distribution Network-Concept of Microgrid- Configuration-Interconnection of Microgrid-Technical and economical Advantage of Microgrid-Challenges and disadvantages of Microgrid Development- Management and Operational Issues of a Microgrid- Dynamic Interactions of Microgrid with main grid- Basics of Distributed Energy Resources

UNIT II: Impacts of Micro grid and Active Distribution Management System 9 Hours

Introduction- Impact of Heat Utilization- Impact on process Optimization-Impact on market-Impact on environment-Impact on Distribution System-Impact on communication standards and protocols-Network Management needs of Microgrid-Micro source Controller- Central Controller

UNIT III: Protection Issues on Microgrid and Power Electronic Interface 9 Hours

Introduction-Islanding: Separation from Utility-Major Protection issues of standalone Microgrid-Power Electronic Interface Introduction- Background- Power converter trends- Bricks-Buses-Software (BBS) framework- BBS Issues

UNIT IV: SCADA & Distribution Networks , Impact Of DG Integration on PQ 9 Hours

Introduction- Existing DNO SCADA systems - Control of DNO SCADA systems- SCADA in Microgrid - Human–machine interface (HMI)- Hardware components - Communication trends in SCADA-Distributed control system (DCS)- Sub-station communication standardization-SCADA communication and control architecture - Communication devices- Observations on SCADA and communication - Introduction to Power quality Disturbances

UNIT V: Micro grid Economics and Market Participation 9 Hours

Introduction- Micro grids and traditional power system economics- Joint optimization of heat and electric power supply- Emerging economic issues in Micro grids- Micro generation-Future developments of Microgrid economics. Restructuring models - Independent System Operator (ISO) - Power exchange (PX) - Market clearing price (MCP) - Day-ahead and hour-ahead markets - Elastic and inelastic markets- Market power stranded costs - Transmission pricing - Congestion management

Total no. of Hours: 45

References:

1. S.Chowdhury., S.P.Choudhury., Microgrid & Active Distribution Networks (2009)ISBN 978-1-84919-014-5 The Institution of Engineering & Technology
2. Hector J. Altuve Ferrer, and Edmund O. Schweitzer III, (2010) Modern Solutions for Protection, Control and Monitoring of Electric Power System.
3. Fahd Hashiesh, M. M. Mansour, and Hossam E. Mostafa, (Feb 28, 2011) Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids
4. Zhaoyang Dong, Pei Zhang, Jian Ma, and Junhua Zhao, (May 21, 2010) Emerging Techniques in Power System Analysis
5. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari, (2017), Handbook on Standalone Renewable Energy Systems, 1st Edn, Research India Publication ISBN No 978-93-87374-12-6

MEE18PD006 MICROCONTROLLER BASED SYSTEM DESIGN 3 0 0 3

OBJECTIVES:

- To gain knowledge of the latest microcontrollers like RL78 and PIC16F877A
- To educate on the interrupts, timers, peripheral devices for data communication and transfer
- To gain knowledge to design and build a real-time system performing data-capture, communications, and user interface

UNIT I: Introduction of Rl78 9 Hours

Introduction about RENESAS Family of microcontrollers - RL78 Processor Core basics-Block Diagram, Data flow diagram within core- Instruction set-Addressing Modes-RL78 Pipeline structure-Implementation of C language statements in RL78Assembly language- Programming -Software development tools for RL78

UNIT II: Rl78 Interrupts and Timer Peripherals 9 Hours

RL78 Interrupt mechanism, Interrupt processing activities- both hardware and software with ISR examples,-Interrupt Characteristics- RL78 Interrupt vector table- Concurrent Interrupt, External Interrupt Timers- Timer Array Unit:-Independent Channel Operation Modes-Simultaneous Channel Operation Modes - Using PWM Mode to Control a Servo Motor- Programming

UNIT III: Serial Communication 9 Hours

Basic Concepts-Synchronous, Asynchronous- Protocols- CSI, UART, I2C- Serial Array Unit Concept- CSI Mode, UART Mode- Simplified IIC Mode-Serial Communications Device Driver Code- Programming Examples for serial communication

UNIT IV: PIC Microcontroller 9 Hours

Introduction to PIC Microcontroller- PIC16F877A Architecture- Pin Description- Peripheral Features- Analog Features- Pipelining -Program Memory considerations- Register File Structure- Instruction Set- Addressing modes- Advantages of PIC

UNIT V: Interfacing with PIC Microcontroller 9 Hours

Interfacing- LCD Display- Keypad Interfacing- Generation of Gate signals for converters and Inverters- Motor Control, Controlling AC appliances-Measurement of frequency- Stand alone Data Acquisition System

Total no. of Hours: 45

References:

1. Alexander, G.,Conrad, M (2012),Embedded Systems using Renesas RL78 Microcontroller, Micrium Press
2. Ganssle, J.(2008),The Art of Designing Embedded systems, Newnes
3. RL78 Family User‟ s Manual: RENESAS Electronics, 2011
4. http://microcontrollerslab.com/pic16f877a
5. http://www.microchip.com
6. www.circuitstoday.com

MEE18PE19 **FACTS CONTROLLERS** **3 0 0 3**

OBJECTIVES:

- To understand the need and concept of flexible AC transmission and the associated problems
- To gain knowledge about the characteristics, applications and modeling of series and shunt FACTS controllers
- To study the operation of controllers for enhancing the transmission capability
- To analyze the interaction of different FACTS controllers and perform control coordination

UNIT I: Introduction **9 Hours**

Introduction, Basics of Power Transmission Networks- Control of Power Flow in AC Transmission Line- Transmission problems and needs- emergence of FACTS- Concept of FACTS Controllers- FACTS controllers – Need, types, benefits & applications in Distribution Systems. Analysis of uncompensated AC Transmission line, reactive power control in electrical power transmission lines - Line compensation - Principle, Types, Compensation by FACTS devices

UNIT II: Static VAR Compensators **9 Hours**

Static shunt compensators- SVC and STATCOM, Operation and control of TSC, TCR and STATCOM Methods of Controllable VAR Generation, Static VAR Compensators- SVC and STATCOM, Comparison, Static VAR Systems, Voltage control by SVC, Advantages of slope in dynamic characteristics, Influence of SVC on system voltage, Modeling of SVC for power flow and stability studies, Applications, Harmonics and Filtering, Protection Aspects

UNIT III: Static Series Compensators **9 Hours**

Objectives of Series Compensation- Variable Impedance Type Series Compensators- Switching Converter Type Series Compensator- External (System) Control for Series Reactive Compensators- Modeling of TCSC and GCSC for load flow studies, stability studies - Applications of TCSC and GCSC, SSR mitigation

UNIT IV: Co-Ordination of FACTS Controllers **9 Hours**

Introduction- FACTS Controller interactions - SVC-SVC, SVC-HVDC, TCSC-TCSC, SVC-TCSC, Performance Criteria for Damping - Controller Design, Coordination of Multiple Controllers Using Linear-Control Techniques, Coordination of Multiple Controllers using Nonlinear-Control Techniques-Quantitative treatment of control Co-ordination

UNIT V: Emerging FACTS Controllers **9 Hours**

Introduction-Mechanically Switched Capacitors (MSC/MSCDN), SSSC, UPFC - Principle, modes of operation-applications- modeling- IPFC- GIPFC and HPFC- SMES-Comparative Evaluation of FACTS Controllers, Future Direction of FACTS Technology

Total no. of Hours: 45

References:

1. Hingorani, N.G., Gyugyi, L. (2001), Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press Book, Standard Publishers and Distributors, Delhi
2. Padiyar , K. R. (2007), FACTS Controllers in Power transmission and Distribution, New Age International (P) Limited, Publishers
3. Yong-Hua Song, Allan Johns,(1999), Flexible Ac Transmission Systems (FACTS), IET
4. Mohan Mathur, R., Rajiv K. Varma (2002), Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Wiley-IEEE Press
5. John, A.T.(1999), Flexible AC Transmission System, Institution of Electrical and Electronic Engineers (IEEE)
6. http://www.energy.siemens.com/hq/en/power-transmission/facts/
7. http://spectrum.ieee.org/energy/the-smarter-grid/flexible-ac-transmission-the-facts-machine
8. http://www.electrical4u.com/facts-on-facts-theory-and-applications/

M.Tech –Power System (Part Time)

MEE18PE20 SUSTAINABLE POWER GENERATION AND UTILIZATION 3 0 0 3

OBJECTIVES:

- Understands the concepts of power generation
- Understands the concepts of power utilization

UNIT I: Heat and Power Generation Methods 9 Hours

Principles of different power generation methods- both conventional and renewable- Hydro and Wind power- Steam Cycle- Gas Turbine Cycle- Combined Gas and Steam Turbine Cycle-Nuclear Power Plants

UNIT II: Heat Supply 9 Hours

Combustion, Fuels and Emission Control-Boilers and Furnaces- Nuclear Reactor Physics- Nuclear Reactor Thermal-Hydraulics- Dynamics and Control of Light Water Reactors

UNIT III: Environmental and Economical Sustainability 9 Hours

Energy Economy and Analysis- Environmental Aspects of Nuclear Power Plants- Safety of Nuclear Power Plants

UNIT IV: Energy Utilization – I 9 Hours

Utilization of energy in the present day society - the physics that govern an indoor climate-the changes needed to improve the indoor climate in existing buildings- Perform heating/cooling load calculations for a single family residence - heaters (radiators) and connecting tubing -selection of proper circulation pump

UNIT V: Energy Utilization – II 9 Hours

Design a ventilation system to provide an adequate air flow of a proper temperature and humidity- Understand and explain the basic fundamentals of conventional refrigeration systems- including components like heat exchangers-compressors- expansion valves

Total no of Hours: 45

References:

1. Kenneth C. Weston, Energy Conversion, Web book. www.personal.utulsa.edu/-kenneth-weston/
2. Jamie Bull, Gavin D. J. Harper and Professor Tariq Muneer, Small-Scale Wind Power Generation: A Practical Guide, (Jan 19, 2011)
3. Kasthurirangan Gopalakrishnan, J. (Hans) van Leeuwen and Robert C. Brown (Nov 5, 2011) Sustainable Bioenergy and Bioproducts: Value Added Engineering Applications, (Green Energy and Technology)
4. E. Jeffs, Generating Power at High Efficiency: Combined Cycle Technology for Sustainable Energy Production (May 14, 2008)
5. Naim Hamdia Afgan and Maria Cristina Ramos de Carvalho, New and Renewable Technologies for Sustainable Development (Apr 30, 2013)
6. S.T.Rama, E.Sheeba Percis, A.Nalini, S.Bhuvaneswari, (2017), Handbook on Standalone Renewable Energy Systems, 1st Edn, Research India Publication ISBN No 978-93-87374-12-6