PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018
(AUTONOMOUS)
M.E. POWER SYSTEMS ENGINEERING
REGULATIONS 2015
CURRICULUM

SEMESTER III

Course Code	Course Title	L	T	P	C
PP*15E**	Elective IV	3	0	0	3
PP*15E**	Elective V	3	0	0	3
PP*15E**	Elective VI	3	0	0	3
PPS15301	Project Phase I	0	0	12	6

SEMESTER IV

Course Code	Course Title	L	T	P	C
PPS15401	Project Phase II	0	0	24	12

LIST OF ELECTIVES

ELECTIVE I

Course Code	Course Title	L	T	P	C
PPE15E01	Analysis of Inverters	3	0	0	3
PPS15E01	Power System Reliability	3	0	0	3
PPS15E02	Insulation and Testing Engineering	3	0	0	3

ELECTIVE II

Course Code	Course Title	L	T	P	C
PPS 15E03	Flexible AC Transmission Systems	3	2	0	4
PPS 15E04	Linear and Non-Linear System Theory	3	2	0	4
PPS 15E05	Industrial Power System Analysis and Design	3	2	0	4

ELECTIVE III

Course Code	Course Title	L	T	P	C
PPS 15E06	Power System Economics	3	0	0	3
PPS 15E07	Power Quality Analysis	3	0	0	3
PPS 15E08	Power System Security	3	0	0	3

ELECTIVE IV

Course Code	Course Title	L	T	P	C
PPS15E09	High Voltage Direct Current Transmission	3	0	0	3
PPS15E10	Computer Aided Power Systems Analysis	3	0	0	3
PPS15E11	Industrial Power System Analysis and Design	3	0	0	3

ELECTIVE V

Course Code	Course Title	L	T	P	C
PPS15E12	Advanced Power System Dynamics	3	0	0	3
PPS15E13	Smart Grid Design and Analysis	3	0	0	3
PPS15E14	Distributed Generation and Micro grid	3	0	0	3

ELECTIVE VI

Course Code	Course Title	L	T	P	C
PPS15E15	Applications of MEMS Technology	3	0	0	3
PPE15E11	VLSI Design Techniques	3	0	0	3
PPE15E12	Virtual Instrumentation Systems	3	0	0	3

LIST OF ELECTIVES

PPE15E01 ANALYSIS OF INVERTERS 3 0 0 3

COURSE OBJECTIVES

- To provide the electrical circuit concepts behind the different working modes of single phase inverters.
- To brief the different working modes of three phase inverters and various switching techniques.
- To make the students to gain knowledge on design and development of current source inverters.
- To analyse and comprehend the various operating modes of different configurations of power converters.
- To familiarize the concepts of various resonant inverter techniques and its application.

UNIT I SINGLE PHASE INVERTERS 12

Introduction to self commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated Thyristor inverters.

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques.

UNIT III CURRENT SOURCE INVERTERS 9

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters.

UNIT IV MULTILEVEL INVERTERS 9

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters.

UNIT V RESONANT INVERTERS 6

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters- advancements in inverter technology for industrial applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- understand the various circuit concepts of single phase inverters.
- analyse the working of three phase inverters with modulation techniques.
- design and develop current source inverters.
- derive the design criteria and analyse the various operating modes of different configurations of power converters.
- design inverters for various power applications.

REFERENCES

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, New Delhi, 2011.
2. BimalK.Bose., “Modern Power Electronics and AC Drives”, Pearson Education, 2009.
3. Ned Mohan,Undeland and Robbin, “Power Electronics: converters, Application and design” John Wiley and sons.Inc,Newyork, 2009.
4. P.C. Sen, “Modern Power Electronics”, S. Chand Limited, New Delhi, 2008.
5. P.S.Bimbra, “Power Electronics”, Khanna Publishers, 2005.
6. Dubey. G.K., "Thyristorised power controllers", New age International, New Delhi, 2002.

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PPS15E01 POWER SYSTEM RELIABILITY 3 0 0 3

COURSE OBJECTIVES

- To understand the reliability concepts and planning criteria.
- To analyze the reliability models and its applications.
- To obtain the reliability of power system through various approaches.
- To evaluate the reliability of single machine under various loading conditions.
- To evaluate the reliability of multi machine using various approaches.

UNIT I BASIC RELIABILITY CONCEPT 9

The General reliability function - The exponential distribution – Mean time to failure – series and parallel systems – Markov process – continuous Markov processes – Recursive Techniques.

UNIT II RELIABILITY MODELS AND ITS APPLICATION 9

Equipment Failure Mechanism-Availability of Equipment’s-Oil Circuit Recloser Maintenance Issues - Distribution Pole Maintenance-Procedure for Grounding Testing-Insulator Maintenance- Customer Service outages.

UNIT III RELIABILITY APPROACHES 9

Loss of energy probability method – frequency and duration approach – conclusion spinning capacity evaluation – Load forecast uncertainty – de-rated capacity levels.

UNIT IV SINGLE SYSTEM RELIABILITY EVALUATION 9

Average interruption rate method – The frequency and duration method – stormy and normal weather effects – The Markov process approach – system studies – Service quality criterion – The conditional probability approach – simple system application, Two plant single load system, Two plant – two load system – networked system approach

UNIT V MULTIPLE SYSTEM RELIABILITY EVALUATION 9

The probability array for two systems – The loss of load approach – Load forecast uncertainty – Reliability evaluation in more than two systems – interconnection benefits – The system modes of failure – The loss of load approach – The frequency and duration approach – spare value assessment – Multiple Bridge equivalents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- plan and design a model for reliable power system network .
- analyse the reliability models.
- obtain the reliability of power system through various approaches.
- evaluate single reliable systems under various loading conditions.
- evaluate the reliability of multi machine systems.

REFERENCES

1. Gonen, Turan, “Electric Power Distribution System Engineering”, Crc, 2009.
2. Ali Chowdhury, Don Koval,”Power Distribution system Reliability: Practical Methods and Applications”, 2009.
3. William H. Smith, P.E, “Electric Power System Reliability”, Power smiths International, Inc., 2007.
4. Roy Billinton and R.N. Allan, “Reliability Evaluation of Power Systems”, Pitman, London, 1990 Edition.

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2. www.csun.edu/~bjc20362/Billinton-Allan-Excerpt.pdf
3. www.cargobooks.org/2gmiuk_ebooks-electric-machinery-fundamentals.

PPS15E02 INSULATION AND TESTING ENGINEERING 3 0 0 3

COURSE OBJECTIVES

- To acquire knowledge about the properties of organic and inorganic insulating materials.
- To study the breakdown mechanisms for various dielectric materials.
- To understand the various methods of generation and measurement of high voltage.
- To impart knowledge on electrical equipment testing techniques.
- To gain the knowledge on non destructive testing on electrical apparatus.

UNIT I INSULATING MATERIALS 9

Requirements for insulating materials - electrical properties - molecular properties of dielectrics - dependence of permittivity on temperature, pressure, humidity and voltage - permittivity of mixtures - practical importance of permittivity - behavior of dielectrics under alternating fields - complex dielectric constants - bipolar relaxation and dielectric loss dielectric strength - Natural inorganic insulating materials - synthetic inorganic insulating materials - natural organic insulating materials - synthetic organic insulating materials.

UNIT II BREAKDOWN MECHANISMS IN SOLID, LIQUID AND GASEOUS DIELECTRICS 9

Intrinsic breakdown of solid dielectrics – electromechanical breakdown - Streamer breakdown thermal breakdown - electrochemical breakdown - tracking and treeing. Breakdown due to internal discharges. Liquid dielectrics - capitation breakdown - suspended particle theory. Behavior of gaseous dielectrics - ionization processes - effect of electrodes on gaseous discharge - Townsend's theory - Streamer theory - breakdown in electronegative gases - Townsend's criterion for break down – breakdown in non-uniform fields - breakdown in vacuum insulation.

UNIT III HIGH VOLTAGES GENERATION AND MEASUREMENT 9

Generation and measurement of high direct voltage, alternating voltages, impulse voltages and impulse currents – Tripping and control of Impulse voltage Generator – Digital Storage Oscilloscope for impulse voltage and current measurements.

UNIT IV ELECTRICAL EQUIPMENT TESTING TECHNIQUES 9

Necessity for high voltage testing - classification of testing methods - self restoration systems - standards and specifications - testing of power transformers - voltage transformers - current transformers - bushings - insulators - surge diverters - cables - circuit breakers and isolators – Artificial pollution testing on insulators – IEC and Indian standards.

UNIT V NON-DESTRUCTIVE TESTING 9

Loss in a Dielectric - Measurement of Resistivity - Measurement of Dielectric Constant and Loss Factor - High Voltage Schering Bridge - Measurement of Large Capacitance - Schering Bridge Method for Grounded Test Specimen - Schering Bridge for Measurement of High Loss Factor - Transformer Ratio Arm Bridge - Partial Discharges: equivalent circuit- Bridge Circuit - Recurrent Surge Generator.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- know the electrical properties of insulating materials
- acquire the knowledge on the different breakdown mechanisms of dielectrics.
- understand the various methods of generation and measurement of high voltage.
- acquire the knowledge of various methods of electrical equipments.
- know the use of electric bridges for non-destructive testing.

REFERENCES

1. SK Bhattacharya, "Electrical and Electronic Engineering Materials" 1st edition Khanna Publishers, New Delhi, 2006.
2. A.J. Dekker "Electrical Engineering Materials", PHI, 2006.
3. Naidu,M.S. and Kamaraju,V., "High Voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. C.L.Wadhwa., "High Voltage Engineering", New Age International (P) Ltd, Publishers,2007.
5. Kuffel E., Zaengl W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India Pvt. Ltd, 2005.
6. Ushakov V.Y., "Insulation of High Voltage Equipment", Springer, 2004.

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2. https://www.scribd.com/.../High-Voltage-Engineering-Von-M-S-Naidu.
3. https://ofazesap.files.wordpress.com/.../high-voltage-and-electrical-insulation.

PPS15E03 FLEXIBLE AC TRANSMISSION SYSTEMS 3 2 0 4

COURSE OBJECTIVES

- To emphasis the need of FACTS controllers.
- To learn the characteristics, applications and modelling of SVC controllers.
- To understand the characteristics, applications and modelling of TCSC controllers.
- To know about the emerging trends of FACTS controller.
- To analyze the interaction of different FACTS controllers and perform control coordination.

UNIT I INTRODUCTION 15

Reactive power control in electrical power transmission lines –Uncompensated transmission line - series compensation – Basic concepts of Static Var Compensator (SVC)–Thyristor Switched Series capacitor (TCSC) – Unified power flow controller (UPFC).

UNIT II STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 15

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling 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.

UNIT III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 15

Operation of the TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit – Enhancement of system damping-SSR Mitigation.

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 15

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability. SSSC-operation of SSSC and the control of power flow –Modelling of SSSC in load flow and transient stability studies. Applications: SSR Mitigation-UPFC and IPFC

UNIT V CO-ORDINATION OF FACTS CONTROLLERS 15

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

TOTAL: 75 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- understand the need for FACTS controllers.
- learn the characteristics, applications and modeling of SVC controllers.
- learn the characteristics, applications and modeling of TCSC controllers.
- update knowledge on the merging trends of FACTS controllers.
- analyze the interaction of different FACTS controller and perform control coordination.

REFERENCES

1. R.MohanMathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc., 2002.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi- 110 006, 2000.
3. K.R.Padiyar,"FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008.
4. A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers, IEEE, 1999.
5. Xiao – Ping Zang, Christian Rehtanz and Bikash Pal, "Flexible AC Transmission System: Modelling and Control" Springer, 2012.

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3. www.botonbook.com/doc/understanding-facts.pdf

PPS15E04 LINEAR AND NON-LINEAR SYSTEM THEORY 3 2 0 4

COURSE OBJECTIVES

- To introduce the modeling and representing systems in state variable form.
- To acquire knowledge on solving linear and non-linear state equations.
- To illustrate and analyse the role of controllability and observability.
- To familiarize the nonlinearity of systems by describing function.
- To educate on stability analysis of systems using Lyapunov's theory and other techniques.

UNIT I STATE VARIABLE REPRESENTATION 15

Introduction-Concept of State equation for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model-State Diagrams - Physical System and State Assignment.

UNIT II SOLUTION OF STATE EQUATIONS 15

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential.

UNIT III FEEDBACK CONTROLLERS AND OBSERVERS 15

Controllability and Observability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Controllable and Observable Companion Forms-SISO and MIMO Systems-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

UNIT IV ANALYSIS OF NON LINEAR SYSTEMS 15

Classification of nonlinearity-physical nonlinearities-Linearization of nonlinear systems-phase plane analysis-describing function analysis of nonlinear systems-Application of describing functions

UNIT V STABILTY 15

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

TOTAL: 75 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- apply the mathematical fundamentals for deriving the state model.

- obtain solutions of state equations to derive the system matrix.
- analyse and design the linear and nonlinear systems.
- analyse non-linear system using describing functions.
- determine the complexity and stability of control systems.

REFERENCES

1. M.Gopal, “Modern Control System theory”, New Age International Publishers, 2014.
2. Nagrath I.J., and Gopal, M., “Control Systems Engineering” New Age International Limited, 2013.
3. K. Ogatta, “Modern Control Engineering”, Pearson Education Asia, 2010.

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2. een.iust.ac.ir/.../Linear%20Control%20System/Ogata%20Modern_Control_Engineering.
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PPS15E05 INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN 3 2 0 4

COURSE OBJECTIVES

- To brief about the various motor starting techniques and computer aided analysis.
- To study about power factor correction methods.
- To analyze the harmonic sources and design the harmonic filters.
- To understand the flicker analysis and conduct a case study.
- To know about ground grid analysis.

UNIT I MOTOR STARTING STUDIES 15

Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time-Motor Starting with Limited-Capacity Generators Computer-Aided Analysis-Conclusions.

UNIT II POWER FACTOR CORRECTION STUDIES 15

Introduction-System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis-Voltage Magnification Analysis-Sustained Over voltages-Switching Surge Analysis-Back-to-Back Switching-Summary and Conclusions.

UNIT III HARMONIC ANALYSIS 15

Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis-Acceptance Criteria-Harmonic Filters-Harmonic Evaluation-Case Study- Summary and Conclusions.

UNIT IV FLICKER ANALYSIS 15

Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study- Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT V GROUND GRID ANALYSIS 15

Introduction-Acceptance Criteria-Ground Grid Calculations-Computer-Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

- know about the various motor starting techniques and computer aided analysis.
- demonstrate the power factor correction techniques.
- determine the level of harmonics and its effect.

- analysis the flickers and methods of minimizing its effects.
- perform ground grid calculations and analyze the performance of ground grids.

REFERENCES

1. Ramasamy Natarajan,” Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2002.
2. J. Duncan Glover, MulukutlaS.Sarma, Thomas Overbye, “Power System Analysis and Design”, 2011.
3. Patrick H Garrett,” High performance Instrumentation and Automation”, CRC Press, Taylor & Francis Group, 2005.
4. TuranGonen “Electrical Power Transmission System Engineering: Analysis and Design”, Mcgraw Hill publishers, 2008.
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6. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2008.

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PPS15E06 POWER SYSTEM ECONOMICS 3 0 0 3

COURSE OBJECTIVES

- To brief about the various generation constraints and its load characteristics.
- To understand the methods of solving the economic dispatch problems.
- To analyse the basic electric energy market computational tools.
- To know the methods of plant location and equipment selection.
- To analyze the solutions of optimal power flow.

UNIT I INTRODUCTION 8

Introduction – Characteristics of Stream units, Hydro units, Cogeneration plants – Load curves – Load duration curves – Number and size of generator units – Cost of Electrical energy – Cost of service, Fixed charges, Interest applications, Investment, Taxes, Depreciation charges and Annual operating cost.

UNIT II ECONOMIC DISPATCH 9

Economic Dispatch problem – Thermal system dispatching with Network losses considered – Lambda Iteration method – Gradient Method – Newton's Method – Piecewise linear cost functions – Dynamic programming – Base point and participation factor – Transmission system effects – Power flow problem and its solution – Transmission Losses – Problems.

UNIT III UNIT COMMITMENT 8

Introduction – Constraints in unit commitment – Reserves – Unit commitment solution methods – Priority List method, Dynamic programming solution, FDP method, Lagrange Relaxation solution, Linear programming – Load Forecasting.

UNIT IV POWER ECONOMICS 8

Selection of plant: Plant capacity, Capacity Probability analysis, Plant location, equipment selection, Equipment cost – Station performance and operation characteristics – Specific economic energy problems: Steam plant, Hydraulic plant Interconnections – Energy rates.

UNIT V OPTIMAL POWER FLOW AND SECURITY 12

Introduction – Solution of optimal power flow: Gradient method, Newton's method, Linear Sensitivity analysis, Linear programming methods (with real power variables & AC power flow variables) – Security constrained optimal power flow – Correction of generator dispatch by sensitivity method – Compensation factor – Voltage security assessment – Transient security assessment – Methods and Calculations – Comparisons.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- understand the basic economical factors related to power system.
- solve the economic dispatch problems using Newton's method and Lambda Iteration method.
- gain knowledge about unit commitment solution methods.
- make a choice on the plant location and optimal equipment selection.
- provideoptimal power flow using Gradient method, Newton's method.

REFERENCES

1. Allen J.Wood, Bruce F. Wollenberg, " Power Generation, Operation and Control", John Wiley & Sons, 2012
2. Bernhardt, Skrotzki.G.A., William A. Vopat, "Power Station Engineering and Economy" Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
3. Wadwa.C.L, "Generation, Distribution and Utilization of Electrical Energy", (Revised Edition), New Age International, New Delhi, 2006.
4. George L.Kusic,"Computer Aided Power System Analysis", Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
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PPS15E07 POWER QUALITY ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To understand the power quality issues.
- To learn about the concept of power quality monitoring.
- To familiarize the concept of short interruptions & long interruptions .
- To analyse the various power quality issue and mitigation.
- To understand the active compensation techniques used for power factor correction.

UNIT I INTRODUCTION 9

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

UNIT II POWER QUALITY MONITORING 9

Introduction – Power quality monitoring : Need for power quality monitoring, Evolution of power quality monitoring, Deregulation effect on power quality monitoring – Power factor improvement – Brief introduction to power quality measurement equipments and power conditioning equipments – Planning, Conducting and Analyzing power quality survey – Active Filters for Harmonic Reduction.

UNIT III SHORT INTERRUPTIONS & LONG INTERRUPTIONS 9

Introduction – Origin of short interruptions : Voltage magnitude events due to re-closing, Voltage during the interruption – Monitoring of short interruptions –Influence on induction motors, Synchronous motors, Adjustable speed drives, Electronic equipments – Single phase tripping : Voltage during fault and post fault period, Current during fault period. Definition – Failure, Outage, Interruption – Origin of interruptions – Causes of long interruptions – Principles of regulating the voltage – Voltage regulating devices, Applications: Utility side, End-User side.

UNIT IV ANALYSIS AND CONVENTIONAL MITIGATION METHODS 9

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 V LOAD COMPENSATION USING DSTATCOM 9

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- understand the various power quality issues.
- know the various methods of monitoring the power quality issues.
- distinguish short and long interruptions.
- analyse the various power quality issue and mitigation.
- demonstrate the conventional compensation techniques used for power factor correction.

REFERENCES

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002.
2. Power System Harmonics, Second Edition J. Arrillaga, N.R. Watson. 2003 John Wiley
3. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition).
4. Roger C. Dugan, Mark F. McGranaghan and H.WayneBeaty, "Electrical Power Systems Quality", McGraw-Hill, New York,2012
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PPS15E08 POWER SYSTEM SECURITY 3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on various power system security techniques.
- To know the various power system state estimation methods.
- To learn the security assessment in the different networks.
- To acquire knowledge on the various power system security enhancement methods.
- To update knowledge on the recent power system security techniques.

UNIT I INTRODUCTION 9

Factors affecting power system security, decomposition and multilevel approach, state estimation, system monitoring, security assessment and security enhancement.

UNIT II POWER SYSTEM STATE ESTIMATION 9

Maximum likelihood weighted least-square estimation, state estimation, detection and identification of bad measurements, estimation of quantities not being measure, network observability and pseudo measurements.

UNIT III SECURITY NETWORK 9

Detection of network problems, network equivalent for external system, network sensitivity methods, calculation of network sensitivity factors, fast contingency algorithms, contingency ranking, dynamic security indices.

UNIT IV SECURITY ENHANCEMENT 9

Correcting the generator dispatch by sensitivity methods, compensated factors, security constrained optimization, preventive, emergency and restorative control through NLP and LP methods.

UNIT V RECENT TECHNIQUES 9

Voltage security assessment - Transient Security assessment – methods - Comparison.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the fundamentals of security system.
- know various techniques for power system security.
- estimate and design the security assessment network.
- understand the security enhancement methods.

- update knowledge on the recent power system security techniques.

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1. Wood, Allen J./ Wollenberg, Bruce F./ Sheble, Gerald "Power Generation, Operation, and Control" , published by John Wiley and Sons Inc., 2013.
2. Wood, A.J. and Woolenberg, John Wiley and sons, "Power generation operation for security", 2013.
3. Abdullah Khan, M, "Real time control of power system for security", vol.2, Proceedings of summer school, College of Engineering, Madras.
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3. www.mit.edu/~mitter/publications/C11_hierarchical_system_EPS.pdf

PPS15E09 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION 3 0 0 3

COURSE OBJECTIVES

- To discuss the basic concepts of HVDC with existing HVDC projects.
- To analyze the HVDC Converters and HVDC System Control and harmonics and filtering.
- To infer knowledge on types of Multi terminal DC Systems.
- To understand the concepts of power flow analysis in AC/DC systems.
- To explain the basic concepts of simulation of HVDC systems.

UNIT I DC POWER TRANSMISSION TECHNOLOGY 6

Introduction - Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system - Planning for HVDC transmission – Modern trends in DC transmission – DC breakers – Cables, VSC based HVDC.

UNIT II ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL 12

Pulse number, choice of converter configuration – Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters. General principles of DC link control – Converter control characteristics – System Control hierarchy - Firing angle control – Current and extinction angle control – Generation of harmonics and filtering - power control – Higher level controllers.

UNIT III MULTITERMINAL DC SYSTEMS 9

Introduction – Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

UNIT IV POWER FLOW ANALYSIS IN AC/DC SYSTEMS 9

Per unit system for DC Quantities - Modeling of DC links - Solution of DC load flow - Solution of AC-DC power flow - Case studies.

UNIT V SIMULATION OF HVDC SYSTEMS 9

Introduction – System simulation: Philosophy and tools – HVDC system simulation – Modeling of HVDC systems for digital dynamic simulation – Dynamic in traction between DC and AC systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- describe the basic concept of DC power transmission technology.

- analyze HVDC converters and HVDC system control with converter.
- understand the concepts of multi terminal DC systems with control and protection of MTDC system.
- analyze the solution of AC/DC power flow analysis.
- design the simulation of HVDC systems with Philosophy and tools.

REFERENCES

1. K.R.Padiyar, , “HVDC Power Transmission Systems”, New Age International (P) Ltd., 2010.
2. J.Arrillaga, , “High Voltage Direct Current Transmission”, Peter Pregrinus, London,1983.
3. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2000.
4. ErichUhlmann, “Power Transmission by Direct Current”, BS Publications, 2004.
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PPS15E10 COMPUTER AIDED POWER SYSTEMS ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To know power flow analysis using Matrix method.
- To learn the basic concepts to analyze the faults in power system.
- To design the matrix for port networks and power flow problems.

UNIT I INTRODUCTION TO AC POWER FLOW ANALYSIS 9

Introduction, Review of Fundamentals, Types of power system analysis, Modeling of power system components, Basic Matrix Algebra, Formation of Y_{bus} Matrix, Power Flow Solution Algorithms, Newton Raphson Load Flow Method, AC-DC System Power Flow Analysis- Sequential and Simultaneous Solution Algorithms.

UNIT II FAULT ANALYSIS IN POWER SYSTEM 9

Analysis of Symmetrical and Unsymmetrical Faults, Shunt Faults, Series Faults, Formation of Z_{bus} Matrix Short Circuit Analysis of Large Power Systems using Z_{bus}, Analysis of Open Circuit faults.

UNIT III STABILITY ANALYSIS IN POWER SYSTEM 9

Basic Concepts of Voltage Stability Analysis, Small Signal Stability Analysis using Classical Model, Transient Stability Analysis of Multi-Machine Systems, Eigen Analysis of Dynamical Systems, Application of FACTS in Power system stability.

UNIT IV ANALYSIS OF SIMULTANEOUS FAULTS 9

Simultaneous faults, Simultaneous faults by Two – Port Network Theory (Z, Y and H Type Faults), Simultaneous faults by Matrix Transformation, Analytical Simplifications of Series and Shunt Faults.

UNIT V COMPUTER AIDED POWERFLOW ANALYSIS 9

Computer solution to Power flow problems, Solution using Admittance and Impedance Matrix, Comparison of Admittance and Impedance Matrix Techniques, Power-Flow problem, Power flow studies in System Design and Operation, Decoupled Power Flow Method.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- apply the mathematical fundamentals for deriving the fault analysis.
- analyse and design the port networks and matrix transformation.
- determine a computer based solution for power flow problems.

REFERENCES

1. J.J. Grainger and W.D. Stevenson, " Power System Analysis", McGraw Hill, New York,1994.
2. G.L. Kusic, "Computer Aided Power Systems Analysis", Prentice Hall, 1986.
3. I.J. Nagrath and D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill, 1980.
4. P. Kundur, Power System Stability and Control, McGraw Hill, 1994.
5. J.D. Glover, M. Sarma and T.J. Overbye, Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.

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2. https://www.scribd.com/.../Computer-Aided-Power-Systems-Analysis.
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PPS15E11 INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN 3 0 0 3

COURSE OBJECTIVES

- To study about power factor correction methods and analyze the harmonic sources.
- To design the harmonic filters.
- To understand the flicker analysis and case study.
- To know about ground grid analysis.

UNIT I MOTOR STARTING STUDIES 9

Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time-Motor Starting with Limited-Capacity Generators Computer-Aided Analysis-Conclusions.

UNIT II POWER FACTOR CORRECTION STUDIES 9

Introduction-System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis-Voltage Magnification Analysis-Sustained Overvoltage's-Switching Surge Analysis-Back-to-Back Switching-Summary and Conclusions.

UNIT III HARMONIC ANALYSIS 9

Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis-Acceptance Criteria-Harmonic Filters-Harmonic Evaluation-Case Study- Summary and Conclusions.

UNIT IV FLICKER ANALYSIS 9

Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study- Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT V GROUND GRID ANALYSIS 9

Introduction-Acceptance Criteria-Ground Grid Calculations-Computer-Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Demonstrate the power factor correction techniques.
- Determine the level of harmonics and its effect.
- Analysis the flickers and methods of minimizing its effects.

REFERENCES

1. Ramasamy Natarajan, ”Computer-Aided Power System Analysis”, Marcel DekkerInc., 2002.
2. J. Duncan Glover, MulukutlaS.Sarma, Thomas Overbye, “Power System Analysis and Design”, 2011.
3. Patrick H Garrett,” High performance Instrumentation and Automation”, CRC Press, Taylor & Francis Group, 2005.
4. TuranGonen “Electrical Power Transmission System Engineering: Analysis and Design”, Mcgraw Hill publishers,2008.
5. RamasamyNatarajan, “Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2012.
6. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2008.

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PPS15E12 ADVANCED POWER SYSTEM DYNAMICS 3 0 0 3

COURSE OBJECTIVES

- To apply transient stability analysis using unified algorithm.
- To describe knowledge on sub-synchronous resonance and oscillations.
- To analyze the mathematical model of the synchronous machine to analyze it under stationary and transient conditions.
- To describe the transient stability problems and to protect the system against stability problems.
- To infer knowledge on voltage stability problems by applying transient stability enhancement methods.

UNIT I TRANSIENT STABILITY ANALYSIS 9

Review of numerical integration methods: Euler and Fourth Order Runge-Kutta methods, Numerical stability and implicit methods, Simulation of Power System Dynamic response: Structure of Power system Model, Synchronous machine representation: equations of motion, rotor circuit equations, stator voltage equations, Thevenin's and Norton's equivalent circuits, Excitation system representation, Transmission network and load representation, Overall system equations and their solution.

UNIT II SUBSYNCHRONOUS OSCILLATIONS 9

Introduction – Turbine Generator Torsional Characteristics: Shaft system model – Examples of torsional characteristics – Torsional Interaction with Power System Controls: Interaction with generator excitation controls – Interaction with speed governors – Interaction with nearby DC converters.

UNIT III SUBSYNCHRONOUS RESONANCE (SSR) 9

Sub synchronous Resonance (SSR): Characteristics of series –Compensated transmission systems – Self-excitation due to induction generator effect – Torsional interaction resulting in SSR – Analytical Methods – Numerical examples illustrating instability of sub synchronous oscillations – Impact of Network-Switching Disturbances: Steady-state switching – Successive network-Switching disturbances – time-domain simulation of sub synchronous resonance – EMTP with detailed synchronous machine model.

UNIT IV TRANSMISSION, GENERATION AND LOAD ASPECTS OF VOLTAGESTABILITY ANALYSIS 9

Review of transmission aspects – Generation Aspects: Review of synchronous machine theory – Voltage and frequency controllers – Limiting devices affecting voltage stability – Voltage-reactive power characteristics of synchronous generators – Capability curves – Effect of machine limitation on deliverable power – Load Aspects – Voltage dependence of loads – Load restoration dynamics – Induction motors – Load tap changers – Thermo static load recovery – General aggregate load models.

UNIT V ENHANCEMENT OF TRANSIENT STABILITY AND COUNTER MEASURES FOR SUB SYNCHRONOUS RESONANCE 9

Principle behind transient stability enhancement methods: high-speed fault clearing, reduction of transmission system reactance, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, single-pole switching, fast-valving, high-speed excitation systems; NGH damper scheme.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students will be able to:

- Apply numerical integration methods to analyze transient stability.
- Understand Torsional Interaction with Power System Controls
- Solve Switching Disturbances in Sub synchronous resonance
- Analyze voltage stability in Transmission, generation and load aspects
- Understand and apply various transient stability enhancement methods

REFERENCES

1. P. Kundur, Power System Stability and Control, McGraw-Hill, 1993.
2. Narendra and Annasamy," Stable Adaptive Control Systems, Prentice Hall, 1989.
3. H. W. Dommel, EMTP THEORY BOOK, Microtran Power System Analysis Corporation, Second Edition, 1996.

WEBLINKS

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PPS15E13 SMART GRID DESIGN AND ANALYSIS 3 0 0 3

COURSE OBJECTIVES

The objective of the course is

- To produce a comprehensive understanding on design and analysis of smart grids
- To understand the phasor measurement unit technologies in smart grid.
- To understand the wide area measurement system in smart grid.
- To apply advanced analytic tools in planning and operation of smart grids.
- To discuss the renewable energy resources and storages integrated with smart grid

UNIT I SMART GRID ARCHITECTURAL DESIGNS 9

Introduction – Comparison between existing grid and smart grid– power system enhancement – communication and standards - General View of the Smart Grid Market Drivers - Stakeholder Roles and Function - Measures - Representative Architecture - Functions of Smart Grid Components Wholesale energy market in smart grid

UNIT II PHASOR MEASUREMENT UNIT TECHNOLOGY 8

Architecture, Functions, Optimal Placement of PMUs, Phasor data concentrators and associated communication system. Visualization tools to enhance visibility and control within transmission system, PMU measurements and sampling rates State Estimation &observability by using PMU, phasor data use for real time operation, frequency stability monitoring and trending, power oscillation, voltage monitoring and trending. Alarming and setting system operating limits. Dynamic line rating and congestion management, outage restoration. Application of PMU for wide area monitoring and control.

UNIT III WIDE AREA MEASUREMENT SYSTEM 9

Architecture, Components of WAMS, GUI (Graphical User Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide Area Monitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEEC37.118 (2005), IEEE Standard C37.111-1999 (COMTRADE), IEC61850 GOOSE.

UNIT IV STABILITY ANALYSIS TOOLS FOR SMART GRID 10

Voltage Stability Analysis Tools-Voltage Stability Assessment Techniques-Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid- Pathway for designing smart grid-Approach of smart grid to State Estimation-Energy management in smart grid. Environmental impacts.

UNIT V SUSTAINABLE ENERGY AND GRID INTEGRATION 9

Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, students will be able to

- summarize the understanding on recent development of power grids.
- apply advanced analysis tools in planning and operation of smart grids
- analyze the stability of smart grid.
- demonstrate the renewable energy resources and storages integrated with smart grid.
- integrate the sustainable energy and grid integration.

REFERENCES

1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & sons inc, 2012.
3. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.
4. Clark W.Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009.
5. "Smart Grid Infrastructure & Networking", Krzysztof Iniewski, Tata McGraw-HillEdition. 2012

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PPS15E14 DISTRIBUTED GENERATION AND MICROGRID 3 0 0 3

COURSE OBJECTIVES

The objective of the course is

- To understand Conventional power generation
- To analyze interconnecting distributed resources to electric power systems.
- To point out the impact of grid integration with NCE sources on existing power system.
- To study concept and definitions of Micro grid and its configuration.
- To produce knowledge on various power quality issues in micro grids.

UNIT I INTRODUCTION 9

Conventional power generation: Advantages and disadvantages, Energy crises, Non-Conventional Energy (NCE) resources: Review of Solar PV, Wind Energy systems, Fuel Cells, Micro-turbines, Biomass, and Tidal sources.

UNIT II DISTRIBUTED GENERATIONS (DG) 9

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

UNIT III GRID INTEGRATION IN DG 9

Requirements for grid interconnection, limits on operational parameters: Voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT IV MICROGRIDS 10

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes.

UNIT V POWER QUALITY ISSUES IN MICROGRIDS 8

Power quality issues in micro grids- Modeling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart micro grids.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, students will be able to

- understand the basic concept of distributed generation.
- summarize the interconnecting Distributed resources to electric power systems.
- analyze the impact of grid integration with NCE sources on existing power system.
- study the concepts and definitions of Microgrid and its configuration.
- demonstrate the availability based tariff and framework of Indian power sector.

REFERENCES

1. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi, 2009.
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5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, 1987.
6. John Twidell and Tony Weir, "Renewable Energy Resources" Tyalor and Francis Publications, 2005.

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PPS15E15 APPLICATIONS OF MEMS TECHNOLOGY 3 0 0 3

COURSE OBJECTIVES

- To design the concepts of new fabrication methods and more reliable MEMS technology.
- To understand the differentiate MEMS sensors and actuator based on electrostatic and thermal principles.
- To infer knowledge on the design of new MEMS device based on various principles.
- To study the design of MEMS devices that works based on various principles.
- To discuss the industrial application of MEMS device.

UNIT I MEMS: MICRO-FABRICATION, MATERIALS AND ELECTROMECHANICALLY CONCEPTS 9

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION 9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and comb drive -micro motors-actuators-Applications.

UNIT III THERMAL SENSING AND ACTUATION 9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION 9

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.

UNIT V CASE STUDIES 9

Piezoresistive sensors, Acceleration sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices Note :Discussions/Exercise/Practice on Workbench : on the basics /device model design aspects of thermal/peizo/resistive sensors etc

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Demonstrate the MEMS technology and MEMS materials.

- Explain the different fabrication methods used in MEMS technology and packaging and reliability issues.
- Classify the MEMS sensors and actuators working based on electrostatic principles.
- Discuss the suitable applications of MEMS sensors and actuators working based on thermal principles.
- Design MEMS devices that works based on various principles.

REFERENCES

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.
3. Boston , "Micromachined Transducers Sourcebook",WCB McGraw Hill, 1998.
4. M.H.Bao "Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.
5. Tai-Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill, 2002.
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PPE15E11 VLSI DESIGN TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

- To describe the significance of CMOS technology and fabrication process.
- To understand the importance and architectural features of programmable logic devices.
- To apply the ASIC construction, design algorithms and basic analog VLSI design techniques.
- To explain the concepts of sequential system and floor planning.
- To study the logic synthesis and simulation of digital system using VHDL and Verilog HDL.

UNIT I CMOS DESIGN 9

Overview of digital VLSI design Methodologies- Logic design with CMOS-transmission gate circuits - Pass Transistor - Clocked CMOS-dynamic CMOS circuits, Bi-CMOS circuits- Layout diagram, Stick diagram-IC fabrications – Trends in IC technology.

UNIT II PROGRAMABLE LOGIC DEVICES 12

Programming Techniques-Anti fuse-SRAM-EPROM and EEPROM technology – Re- Programmable Devices Architecture- Function blocks, I/O blocks, Interconnects, Xilinx- XC9500,Cool Runner - XC-4000,XC5200, SPARTAN, Virtex - Altera MAX 7000-Flex 10KStratix.

UNIT III BASIC CONSTRUCTION, PLACEMENT AND ROUTING 6

System partitioning– FPGA partitioning – Partitioning methods – placement physical design flow – global routing – detailed routing – special routing- circuit extraction –DRC.

UNIT IV SEQUENTIAL SYSTEMS AND FLOOR PLANNING 6

Memory cells and Arrays, Clocking disciplines, Design, Power optimization, Design validation and testing.Floorplanning methods, Global Interconnect, Floor Plan Design, Off-chip connections.

UNIT V LOGIC SYNTHESIS AND SIMULATION 12

Overview of digital design with Verilog HDL- hierarchical modeling concepts- modules and port definitions- gate level modeling- data flow modeling- behavioral modeling- task & functions- Verilog and logic synthesis-simulation-Design examples- Ripple carry Adders- Carry Look ahead adders- Multiplier-ALU- Shift Registers, Multiplexer- Comparator- Test Bench.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the basic concepts of CMOS circuits.
- acquire knowledge on architectural features of programmable logic devices.

- understand basic analog VLSI design techniques.
- apply and use the sequential system circuits.
- design and simulate the basic analog and digital circuits using Verilog HDL.

REFERENCES

1. E. Eshranghian, D.A. Pucknell and S. Eshraghian, “Essentials of VLSI circuits and systems”, PHI, 2010.
2. Neil H.E. Weste, David Harris and Ayan Banerjee, “CMOS VLSI Design, A circuits and Systems Perspective”, 2010.
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PPE15E12 VIRTUAL INSTRUMENTATION SYSTEMS 3 0 0 3

COURSE OBJECTIVES

- To infer knowledge on Virtual instrumentation Architecture.
- To analyze the new concepts on Graphical programming.
- To understand the programming structure for various parameters.
- To discuss the data acquisition and instrument control.
- To use the applications of hardware and software specifications.

UNIT I INTRODUCTION 9

General Functional description of a digital instrument - Block diagram and Architecture of a Virtual Instrument - Physical quantities and Analog interfaces - Hardware and Software – User interfaces - Advantages of Virtual instruments over conventional instruments –Data flow techniques - Architecture of a Virtual instrument and its relation to the operating system.

UNIT II INSTRUMENT INTERFACE 9

Interfacing of external instruments to a PC – RS 232, RS 422, RS 485 and USB Standards – IEEE 488 standard – ISO – OSI model for series bus – Introduction to bus protocols – Interface basis: USB, PCMCIA, VXI, SCXI, PXI etc.

UNIT III PROGRAMMING TECHNIQUE 9

FOR loops, WHILE loop, CASE structure, formula node, Sequence structures – Arrays and Clusters - Array operations - Bundle - Bundle/Unbundle by name, graphs and charts - String and file I/O - High level and Low level file I/O's.

UNIT IV DATA ACQUISTION 9

Installing hardware, installing drivers - Configuring the hardware –Introduction to data acquisition on PC, Sampling fundamentals,Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA,Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

UNIT V APPLICATIONS 9

Motion Control: General Applications - Feedback devices, Motor Drives – Machine vision – Instrument Connectivity - GPIB, Serial Communication - General, GPIB Hardware & Software specifications –Real –Time Systems, Embedded controller, OPC, HMI, SCADA software – Development of process database management system.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Discuss the knowledge on Virtual instrumentation Architecture.
- Apply the new concepts in Graphical programming.
- Understand the programming structure for various parameters.
- Summarize the data acquisition and instrument control.
- implement the applications of hardware and software specifications

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1. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement,Instrumentation and Control, Newnes, 2000.
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