IE-10001 ANALYTICAL INSTRUMENTATION

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Introduction: Basics of physical methods of chemical analysis, Spectral method of analysis, basic techniques, terminology, units, interaction of emf radiation with matter, emission, absorption and scattering, various light sources, design consideration of analytic laboratory.

Unit II (10 Hours)

Spectrophotometers: Visible, UV and IR type of spectrophotometer, Atomic Absorption, Mass spectrometer, NMR and X-ray and related instrumentation, comparison of various spectral analysis techniques, data processing techniques and various detectors for these instruments.

Unit III (10 Hours)

Chromatography: Basics of Chromatography, various types of chromatography and their related instrumentation, liquid chromatography & HPLC.

Unit IV (10 Hours)

Electron Microscopy: Introduction to electron microscopy- SEM and TEM type of electron microscope, Difference between light microscopy, SEM and TEM.

Data Presentation & Analysis: Analytical data presentation, Error analysis.

RECOMMENDED BOOKS:

1. Handbook of analytical instruments; R.S. Khandpur; Tata McGraw Hill
2. Instrumental methods of analysis; H.H.Willaird, Lynnel Merriktt Jr., John A. Dean, F.A. Settle Jr ;Wadsworth Publishing Company
3. Introduction to instrumental analysis; Robert D. Brawn; McGraw Hill Co
4. Instrumental method of chemical analysis; Galen W. E.wing; McGraw Hill

IE-10009 POWER PLANT INSTRUMENTATION

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Introduction: Resources and development of power in India, various types of power plants, present energy scenarios in India.

Hydro-Power Plant: Hydrology, site selection of site for hydroelectric power plant, essential features/elements of hydroelectric power plant, classification, hydro turbines, governing of hydroelectric turbines.

Unit II (10 Hours)

Steam power plant: Classification, fuel handling, combustion equipments for steam boilers, classification of boilers and their accessories, ash handling, steam turbines, classification, advantages, steam turbine governing and control, feed water treatment for steam power plant.

Unit III (10 Hours)

Nuclear Power Plant: Element and layout of Nuclear power plant, Generation of Nuclear energy by fission, Nuclear reactor, Types and the applications, nuclear waste and its disposal.

Unit IV (10 Hours)

Plant Instrumentation: Significance of measurement and Instrumentation in Electric power plant, Measurement of water purity, Gas Analysis, Oxygen and Carbon dioxide Measurement of Smoke and Dust, Nuclear Measurements.

RECOMMENDED BOOKS:

1. Power Plant Engineering; Varma; Metroplitan Publication
2. Power Plant Engineering; R.K Rajput; Laxmi Publishers
3. Nuclear Power; Loftness D Van Nostrand; McGraw Hill
4. Nuclear power plant System and Equipment; Lish; Industrial press

IE-10005 ENERGY MANAGEMENT

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Introduction: Various Sources of Energy, Conventional and non- Conventional energy, Concept and Classification of Renewable energy, Concept of Energy Conservation and Energy Management, Present Energy Scenario in India (Conventional and non- Conventional energy).

Unit II (10 Hours)

Renewable Energy Sources: Potential and Utilization status of Renewable Energy in India, Solar Energy: Solar Water Heater Systems, Solar Air dryer Systems, Solar Photo-voltaic Systems, Solar Cookers and Solar ponds, Wind Energy: Selection Criteria for Wind farms, Wind Mills, Bio Gas Plants-Construction and Operation, Bio Mass Gasification, Bio Mass Briquetting; Mini and Micro Hydel Power Plants, Geo-Thermal Energy, Ocean Energy.

Unit III (10 Hours)

Energy Conservation and Management: Actual energy requirement assessment techniques of any industry and energy consumption status, possibility of reduction of energy consumption by using various energy conservation techniques or equipments e.g. variable speed drives, constant voltage transformers, electronic chokes, CFLs etc.

Unit IV (10 Hours)

Energy Conservation and Management: Importance of instrumentation and control techniques in the energy conservation and management, SCADA systems, Instruments required to carry out energy audit exercise, optimal mixing of renewable energy sources and load rationalization for reducing load on conventional energy sources.

RECOMMENDED BOOKS:

1. Solar Energy & Energy Conservation; Sawhney & Maheshwari; PHI
2. Energy Technology; S Rao & B. B. Parulkar; Khanna Publishers
3. Solar Energy; S. P. Sukhatme; TMH
4. Hand Book of Industrial Energy Conservation; S David; Van Nostrand Reinhold Publishing Company

IE-10006 OPTIMAL AND ROBUST CONTROL SYSTEM

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Introduction and Parametric Optimization: Introduction to optimal control problems, Classification of optimal control problems, performance indices for optimal control and their selection, Dynamic optimization using.

Calculus of variations: Lagrange multiplier, Euler Lagrange's equation for different conditions, Transversality conditions, Dynamic optimization with equality and inequality constraints.

Unit II (10 Hours)

Pontryegans Max/min Principle: Optimization using Pontryegans maximum (minimum) principles with special emphasis on Bang-Bang type system.

Dynamic Programming in Continuous Time: Developments of Hamilton Jacobi equation, Matrix Riccati equation, optimal control based on quadratic performance indices, Linear regulator and servomechanism problem.

Unit III (10 Hours)

Dynamic programming in Discrete System: Dynamic programming multi stage decision processes in continuous time. Principle of causality, Invariant inbedding & optimality.

Iterative Method of Optimization: Optimization using gradient methods and interactive techniques (steepest descent), Newton Raphson and Fletcher Powell. Introduction to multivariable system and decoupling, Introduction to Optimal Filters (Kalman Filter).

Unit IV (10 Hours)

Robust Control System: Introduction, Robust Control System and System sensitivity, Analysis of Robustness, system with uncertain parameters, the design of robust control system, PID controllers, the design of robust PID controlled systems, design examples.

RECOMMENDED BOOKS:

1. Modern Control System Theory; M Gopal; Wiley Eastern
2. Modern Control Systems 8th Ed; Richard C Drof & R H Bishop; Addision Wesley
3. Optimum Systems Control; Andrew P Sage & C C White-III; PHI
4. Optimum System Control; B D O Anderson & B Moree; PHI

IE-10002 COMPUTATIONAL ELECTROMAGNETICS

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Introduction: Conventional design methodology, Computer aided design aspects – Advantages.

Electromagnetic and Electrostatics: Basic field equations, calculation of field distribution, flux linkage, Voltage induced, inductance, capacitance, and force/torque. Electric and magnetic potentials, boundary conditions, Maxwell's equations, diffusion equation.

Unit II (10 Hours)

CAD packages: Recent developments, processing, modeling, material characteristics, problem formulation, solution, post processing, commercial packages.

Finite Difference Analysis-FDM: Finite Difference Method (FDM): Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method.

Unit III (10 Hours)

Finite Element Analysis-FEM: Finite Element Method (FEM): overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.

Unit IV (10 Hours)

Special Topics: hybrid methods, coupled circuit - field computations, electromagnetic - thermal and electromagnetic - structural coupled computations, solution of equations.

Applications: Applications: low frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, actuators.

RECOMMENDED BOOKS:

1. The Finite Element method in electromagnetics; J. Jin; John Wiley & sons
2. Finite Elements in Electric and Magnetic field Problems; M.V.K. Chari, P.P. Silvester; John Wiley
3. Computer Aided Design in Magnetics Springer; D.A. Lowther & P.P. Silvester; Verlog New York
4. Finite Element for Electrical Engineers; P.P. Silvester & Ferrari; Cambridge University Press

IE-10007 OPTIMIZATION TECHNIQUES

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Optimization Problem: Definition, types, optimality criteria, single-variable optimization, exhaustive search, region elimination, fibonacci search and golden section search, cubic interpolation method, Newton-Raphson bisector and secant method.

Unit II (10 Hours)

Multivariable Optimization Algorithms: Direct search methods-evolutionary simplex, Hooke-Jeeves pattern search, Gradient Based Method- Steepest method, Newton conjugate gradient method.

Unit III (10 Hours)

Constrained Optimization: Kuhn Tucker condition, transformation methods, penalty function, method of multipliers, sensitivity analysis, interior point optimization.

Unit IV (10 Hours)

Non-Traditional Optimization: Genetic Algorithms for constrained optimization, simulated annealing, Multi Objectives Optimization Problems, weighting method, $\in$-constrained method, decision-making, min-max problem.

RECOMMENDED BOOKS:

1. Optimization for Engineering Design Algorithms and Examples; Kalyanmoy Deb; PHI
2. Multi Objective Optimization using Evolutionary Algorithms; Kalyanmoy Deb, Chichester, UK; Wiley
3. Emerging Optimization Techniques in Production Planning & Control; Godfrey G Onubolu; Imperial College Press
4. Modern Optimization Techniques in Power Systems; Yong Hua Song, Kluwer; Academic Publishers

IE-10011 RELIABILITY ENGINEERING

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Reliability Fundamentals: Introduction, Importance of reliability, Reliability functions, Failure and Failure Modes, causes of failure, Instantaneous failure rate, General reliability Function.

Component Reliability and Hazard Model: Component reliability from Test data, failure data (Failure density, failure rate, reliability, probability of failure) mean failure rate MTTF,MTBF. Hazard Models (Time dependent Hazard models, Constant Hazard model, Linear Hazard model, on-linear hazard model.

Unit II (10 Hours)

System Reliability: Reliability evaluation of non-maintained systems, series, parallel, series-parallel, non-series, standby configuration, k out of n configuration, complex system, Markov's Method, Fault tree technique, Event space, path Tracing methods, cut-set and tie set method.

Unit III (10 Hours)

Reliability Improvement: Introduction, Improvement of components, redundancy: standby with perfect and imperfect switching .Comparison of component redundancy to system/unit redundancy, mixed redundancy, stand by redundancy.

Reliability Allocation: Introduction, Redundancy allocation and techniques for reliability allocation.

Unit IV (10 Hours)

Availability and Maintainability: Concepts of reliability ,availability and maintainability, types of availability, objectives of maintenance, classification and factor effecting maintenance, maintenance levels, Inventory control of spare parts, Preventive maintenance of some electrical appliances.

RECOMMENDED BOOKS:

1. Reliability Engineering; L.S. Srinath; Affiliated East –West Press
2. Reliability Engineering; E. Balagurusamy; Tata McGraw Hill
3. Reliability Evaluation of Engg. Systems: Concepts & Techniques; R. Billinton & Ronald N. Allan; Plenum Press
4. Reliability Engineering; K K Aggarwal; Academic Press

IE-10012 **STATISTICAL ANALYSIS**

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit-I (10 Hours)

Data Presentation: Introduction, Bar Chart, Pie Chart, Histogram, Pictogram, Scatter Diagram, Graphs: Linear and Logarithmic Axes, Venn and Euler Diagrams.

Describing Curves and Distributions: Introduction, Mean, mode and Median, Skewness, Standard Deviation and Variance, Coefficient of Variation, Probability Density Function. Normal Distribution Curve: Introduction, Mathematical Formula, Mathematical Tables, Normal Probability Graph Paper, Testing for Normality using the Chi-squared Test, The Lognormal Curve.

Introduction to Sampling, Errors, Accuracy and Precision: Introduction, Sample Distribution and Sampling Distribution of the Sample Mean, Central Limit Theorem, Formulae for Standard Errors, Gross Accidental Errors, Systematic Errors, Errors of Interpretation, Random Errors, Combination of Errors, Root Mean Square Errors, Confidence Limits.

Unit-II (10 Hours)

Sensitivity and Specificity: Definitions, Problems of Defining Normality and Abnormality, Receiver Operating Characteristics (ROC) curve, Example: Prostate Cancer Early Detection, Example: Nuclear Medicine Imaging Inter-laboratory Comparison Studies, Kappa Test.

Probability: Introduction to Probability, Descriptions of Probability, Two Laws of Probability, Bayesian Probability. Binomial Probability: Permutations and Combinations, the Binomial Distribution, the Normal Approximation to the Binomial. Poisson Probabilities: The Poisson distribution, The Poisson Approximation to the Binomial, The Normal Approximation to the Poisson, Radioactive Decay.

Unit-III (10 Hours)

Statistical Hypothesis Testing: Introduction to Statistical Significance of Probability: The Null Hypothesis, Null, Positive and Negative Results of Studies, Probability Levels and Significance, $P<0.05$, Clinical and statistical significance, Type-I and Type-II Errors and Alpha and Beta Risks, A Generalized Schedule for Significance Testing, Degrees of Freedom.

Chi Squared Test: Introduction, Goodness of Fit: Precision of Nuclear Medicine Counting Instruments, Goodness of Fit: A Racing Problem, Goodness of Fit: A Poison Problem, Goodness of Fit: A Lognormal Curve Fitting Problem, The 2*2 Contingency Table, A 2*2 Contingency Table: A Cholera Epidemic Problem, The Generalized r*c Contingency Table, Yates Correction for Small Samples.

Unit-IV (10 Hours)

Regression and Correlation: Introduction, Method of Least Squares for Estimation of the Slope and Intercept of a Straight Line, Regression Lines, Pearson's Correlation Coefficient, Testing for a Significant Correlation: an Application of the t-test, Spearman's Rank Correlation Coefficient, Kendall's T Rank Correlation Coefficient.

RECOMMENDED BOOKS:

1. Introductory Medical Statistics; RF Mould; Overseas Press

IE-10010 POWER SYSTEM OPTIMIZATION

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Load flow studies: Introduction, network model formulation, YBUS formulation, ZBUS formulation, load flow problem, computation of line flows, modeling of regulating transformers, Gauss-Seidel method, Newton-Raphson method, decoupled Newton method, fast decoupled load flow (FDLF).

Unit II (10 Hours)

Economic load dispatch of thermal generating units: Introduction, generator operating cost, economic dispatch problem on a bus bar, optimal generation scheduling, economic dispatch using Newton-Raphson method, economic dispatch using the approximate Newton-Raphson method, loss coefficients using sensitivity factors, transmission loss coefficients, transmission loss formula- functions of generation and loads, economic dispatch using exact loss formula, economic dispatch using loss formula which is a function of real and reactive power, economic dispatch of active and reactive power balance, evaluation of incremental transmission loss, economic dispatch based on penalty factors, optimal power flow based on gradient method.

Unit III (10 Hours)

Optimal hydrothermal scheduling: Introduction, hydro plant performance models, short range fixed head hydrothermal scheduling, Newton-Raphson method for short range fixed head hydrothermal scheduling, short range variable head hydrothermal scheduling problem-classical method, approximate Newton-Raphson method for short range variable-head hydrothermal scheduling problem, hydro plant modeling for long term operation, long range generation scheduling of hydrothermal systems.

Unit IV (10 Hours)

Multi Objective Generation Scheduling: Introduction, multi objective optimization-state of the art, fuzzy set theory in power systems, multi objective thermal power dispatch problem-weighing method, multi objective dispatch for active and reactive power balance, multi objective short range fixed head hydrothermal scheduling- approximate Newton-Raphson method.

RECOMMENDED BOOKS:

1. Power System Optimization; D P Kothari and J S Dhillon; PHI

RM-10000 RESEARCH METHODOLOGY

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Introduction: Research and scholarship; deference between undergraduate and research education; skill habits and attitudes for research; status of research in India; Psychological phases of Ph.D. process, stress point; aims of supervisors; mismatches and problems.

Managing self; empathy; managing relations with your supervisor; colleagues and supporting staff. Listening; assertiveness; teamwork; sense of humor.

Duration and stages of a Ph.D. process; long term and short goals; time tabling and dead lines.

Profession; integrity, objectivity, fairness and consistency; loyality; plagiarism and research ethics; safely.

Problem finding and literature survey.

Unit II (10 Hours)

Survey Based Research: Scope of survey based research, types of surveys- specific, periodic and transition- driven, identification of research problem, analysis of research problem, customer identification, categorization and sampling, planning a survey project- resources, budget and schedule, preparation of questionnaire- elements of questionnaire, sequencing questions, question formats, methods of conducting survey, data collection, analysis and compilation of survey report.

Unit III (10 Hours)

Publishing- Patenting and Communication: Difference between publishing and patenting, relative importance of various form of publications; choice of journal and reviewing process, stages in the realization of paper or a patent and how to handle these.

Importance of communication; stages and dimensions of communications process, oral communication- verbal, non verbal, casual, formal and informal communications, interactive communications, listening form; content and delivery, various context for speaking- conference, seminars etc; visual aids, written communication- form, content and language- layout typography and illustration, contexts for writing –paper, thesis, reports etc.

Prescription for developing communication skills.

IE-10000 RESEARCH METHODOLOGY

Unit IV (10 Hours)

Problem Solving and Creativity:

(a) **Thinking processes problem solving and creativity:** Level and styles of thinking; common sense and scientific thinking; examples, problems solving strategies- reformulation or rephrasing; techniques of representation, logical thinking, division into sub problems, verbalization awareness of scale; importance of graphical representation; examples.

Creativity- some definitions, illustrations from day to day life; gift or skill creative process, requirement of creativity- role of motivation and open vs closed minds; multiple approaches to a problem analytical vs analogical reasoning, puzzle solving; example; prepared mind.

Creative problem solving using Triz.

Prescriptions for developing creativity and problem solving.

(b) **Experimental and Modeling Skills:** Introductions, selection of variables, design matrix, 2-level factorial design, 3-level factorial design, fractional factorial design, analysis of variance, Taguchi methods- orthogonal arrays, signal to noise ration; response surface.

Methodology, latest trends in experimental designs.

RECOMMENDED BOOKS:

1. How to get a Ph.D.- a handbook for Ph.D. students and their supervisors; E M Phillip and D S Pugh; Viva books Pvt Ltd
2. Hand book of Science Communication; Antony Wilson, Jane Gregory, Steve Miller, Shirely Earl; Overseas Press India Pvt Ltd, New Delhi, First Edition 2005
3. Practical Physics; G L Squires; Cambridge University Press
4. Advice to a Young Scientist; Peter b Medewar; Pan Books, London, 1979
5. Design and Analysis of Experiments; D C Montgomery
6. Survey Guidebook; Fred Van Bennekom

IE-10003 COMPUTERS IN BIOMEDICAL ENGINEERING

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Marks)

Computer in Data Collection: Introduction, Basic Building Blocks of Data Acquisition Systems, Use of Computers in Physiological Data Acquisition, Off –Line Data Collection, Data Collection Techniques, Patient Data Base, computerized Medical Records

Unit II (10 Marks)

Hospital Data Management: Hospital Information System, Functional capabilities of Computerized Hospital Information System, Efficiency, Security and Cost Effectiveness of Computer Records, Computerized Patient Data Management

Unit III (10 Marks)

Bio-Signal Analysis: Computerized Electrocardiography, Holter Electro-cardiography, Electromyography, Electroencephalography and Echocardiography, Computer Analysis of Non-Electrical Signals, Computer Aided Medical Decision Making

Medical Imaging: Introduction to Medical Imaging, Computers in Medical Imaging, Computerized Ultrasonography, X-Rays, Computerized Tomography, Computerized Emission Tomography

Unit IV (10 Marks)

Aids for Handicapped: Computer aids for blind and visually handicapped and deaf

Medical Research: Computers in simulation, modeling and analysis of bio-systems, On-line Interactive systems with patients for analysis and research, introduction to expert system

RECOMMENDED BOOKS:

1. Handbook of Biomedical Instrumentation; R S Khandpur; TMH
2. Biomedical Engineering Handbook; Joseph P Bronzino; CRC Press
3. Design Engineering of Biomaterials for Medical Devices; David Hill; Wiley International
4. Biomedical Signal Processing; Metin Akay; Academic Press

IE-10004 CONTROL OF ELECTRIC DRIVES

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hrs)

Basic Concepts Characteristics and operating modes of drive motors, Types of loads, torque and associated controls, four quadrant operation of drives. Applications of solid state controllers such as choppers, rectifiers and inverters in drive systems, and their performance characteristics. Convertor fed operation of various motors, electronically commutated and permanent magnet motors. Computer aided modelling and analysis of drives. Modelling of various machines including special machines, their operation and control.

Unit II (10 Hrs)

Review of power electronic switching devices, i.e., Thyristors, GTO, MOSFETS, BJT, IGBT and MCT. Trigger techniques, optical isolators, protection circuits, isolation transformers. Natural and forced commutation, phase-controlled rectifier configurations, their analysis and design. DC-DC converter circuits, their analysis and design. Reduction of harmonic using multipulse, multiphase and mulilevel control. Analysis of various converter circuits, ZVS and ZCS, power factor correction and their applications to drives.

Unit III (10 Hrs)

Power electronics control of various motors with application to variable speed drives. Variable frequency inverter fed motors for drive applications. Details of PWM inverter fed ac drives with different forms of feedback control and their realisation on computer based systems. Vector control and direct torque control of ac motors; Present day shortcomings of inverter fed induction motor drives, involvement of soft switching inverters and impact on ac drive performance, special motors and their control. Power quality problems and their control, Design of power electronic modules and microprocessor/DSP based controllers.

Unit IV (10 Hrs)

Features of a DSP in comparison to those of ordinary processors, Communication and computational advantages and disadvantages of analog and digital interface circuits; Harmonic analysis in real time using a DSP, specific assembly language features for a DSP. On chip RAM and external RAM I/O interface. PWM and firing pulse generation through a typical DSP, look-up tables and real-time computation. Interfacing and actuation circuits for DSP based controllers. Realization of computationally intensive algorithms for control of drive systems.

RECOMMENDED BOOKS:

1. J. M. D. Murphy and F. G. Turnbull, “Power Electronic Control of AC Motors”, Pergamon Press, Oxford, 1988.
2. G. K. Dubey, “Power Semiconductor Controlled Drives", Prentice Hall, New Jersey, 1989.
3. B. K Bose, Power Electronics and Variable Frequency Drives, Technology and Applications, IEEE Press, 1997.
4. I. Bolden and S. A. Nasar, Electric Drives, CRC Press, New York, 1998.
5. C. M. Ong, Dynamic Simulation of Electric Machinery using MATLAB / SIMULINK, Prentice Hall USA, 1998.

IE-10004 CONTROL OF ELECTRIC DRIVES

6. R. Krishnan, Electric Motor Drives: Modeling, Analysis and Control, Pearson Education, India, 2001
7. A.E. Fitzgerald, C. Kingsley, Jr., S.D. Umans, “Electric Machinery,” Tata McGraw-Hill, New Delhi, 2002.
8. D.W. Novotny and T.A. Lipo, “Vector Control and Dynamics of AC Drives,” Oxford University Press, New York, 1997.
9. I. Boldea and S.A. Nasar, “Vector Control of AC drives,” CRC Press
10. H.A. toliyat and S. Campbell, “ DSP based Electromechanical Motor Control,” CRC press, New York, 2004.
11. N. Mohan, T. Udeland and W. Robbins, Power Electronics: Converters, Applications and Design. Third Edition, New York: John Wiley & Sons, 2002.

IE-10008 POWER QUALITY ANALYSIS AND CONTROL

Total Hours: 40
Maximum Marks: 100
Credits: 4

L T P
3 1 0

Unit I (10 Hours)

Review of power electronic switching devices, i.e., Thyristors, GTO, MOSFETS, BJT, IGBT and MCT. Trigger techniques, optical isolators, protection circuits, isolation transformers. Natural and forced commutation, phase-controlled rectifier configurations, their analysis and design. DC-DC converter circuits, their analysis and design. Inverters: PWM and vector control, multi level inverters; Reduction of harmonic using multipulse, multiphase and multilevel control. Analysis of various converter circuits, ZVS and ZCS, power factor correction and their applications to control of VSI and CSI.

Unit II (10 Hrs)

Review of various generators, their operation and control; Review of power system protection equipments and their control, Concepts of reactive power support and voltage stability. Compensation at a bus and over a line; synchronous condenser, static var compensation, static phase shifter, thyristor controlled switched capacitor, STATCOM's and DVR's, unified power flow controller, interphase power controller. Reactive power balance over a network and its optimization. Comparison of HVAC and HVDC transmission, HVDC transmission schemes, Component description, converter: principles, characteristics, control circuits, HVDC system control, Protection, Harmonics and filters.

Unit III (10 Hours)

Overview and definition of power quality (PQ) Sources of pollution, international power quality standards, and regulations; Power system harmonics: harmonic analysis, harmonic sources- the static converters, transformer magnetization and non-linearities, rotating machines, arc furnaces, fluorescent lighting; Harmonic effects-within the power system, interference with communication; Harmonic measurements; Harmonic elimination-Passive and active filters, Multipulse transformer configurations and their operation.

Unit IV (10 Hours)

Features of a DSP in comparison to those of ordinary processors, Communication and computational advantages and disadvantages of analog and digital interface circuits; Harmonic analysis in real time using a DSP, specific assembly language features for a DSP. On chip RAM and external RAM I/O interface. PWM and firing pulse generation through a typical DSP, look-up tables and real-time computation. Interfacing and actuation circuits for DSP based controllers. Realization of computationally intensive algorithms for control of VSI, CSI for power system.

RECOMMENDED BOOKS:

1. J.Arrillaga, N.R.Watson and S.Chen, Power System Quality Assessment. Wiley, 2000.
2. R. C.Dugan, S.Santoso and M.F. McGranaghan, Electric Power Systems Quality, McGraw Hill, 2nd Edition 2004.
3. E.W. Kimbark, Direct Current Transmission. New York: John Wiley &Sons, 1971.

IE-10008 POWER QUALITY ANALYSIS AND CONTROL

4. D.A. Paice, Power Electronic Converter Harmonics: Multipulse Methods for Clean Power. New York: IEEE Press, 1996.
5. E.Acha, V.G. Agelidis, O. Anaya-Lara and T.J.E. Miller, Power Electronic Control in Electric Systems, Newness Power engineering series, 1st Edition, Oxford, 2002.
6. Math H. J. Bollen and Irene Gu, Signal Processing of Power Quality Disturances, Wiley-IEEE Press, 2006.
7. K.R. Padiyar, FACTS Controllers in Transmission and Distribution Systems, New Age International, New Delhi, 2007.
8. N. Mohan, T. Udeland and W. Robbins, Power Electronics: Converters, Applications and Design. Third Edition, New York: John Wiley & Sons, 2002.