MA6003: Mathematical Methods for Power Engineering

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6301: Power Electronic Circuits

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6501: High Voltage Engineering

Pre-requisite: Nil
Total hours: 42 Hrs.

Generation and measurement of high voltage AC, DC and Impulse voltages and currents. Detailed study of solid, liquid and gaseous insulation and its breakdown phenomena. Application of nanofilled material as electrical insulation for high voltage power apparatus.
EE6503  Power System Transients

Pre-requisite: Nil
Total hours: 42 Hrs


EE6591 High Voltage Laboratory

Experiments on measurement of HVAC and HVDC by sphere gap, chubb and fortescue method, voltage divider method and AC breakdown studies on solid and liquid insulation. Simulation of field for different electrode arrangements

EE 6502: Computational Electromagnetics

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6504: Physics of Dielectrics

Pre-requisite: EE 6501 High Voltage Engineering
Total hours: 42 Hrs.

Dielectrics and electrical insulation used in HV Power apparatus, behaviour of insulators under time varying electric field, mechanism of breakdown in solid dielectrics, Ageing theory and accelerated tests for determining the life, polymers as insulation, nanodielectrics, design of insulation systems
EE6506: EHV Power Transmission

Pre-requisite: Nil
Total hours: 42 Hrs.

Introduction to EHV AC Transmission- Calculations of line and ground parameters- Corona- factors affecting corona. Audible noise - radio interference, limits for radio interference fields - Theory of reactive power control- different reactive power compensation methods- HVDC transmission-HVDC link.

EE6201: Computer Methods in Power Systems

Pre-requisite: Nil
Total hours: 42 Hrs.

Power flow analysis- Sparsity Oriented and Optimal Ordering-Fault Analysis-Power System Optimization-Optimal Load flow solution- Optimum reactive power dispatch-Scheduling of hydrothermal systems-AI Techniques applied to power Systems- Power system security-Contingency analysis-state estimation.

EE6222: Power Quality

Pre-requisite: Nil
Total hours: 42 Hrs.

Power quality measures and standards-IEEE guides, standards and recommended practices, Harmonics--important harmonic introducing devices -effect of power system harmonics on power system equipment and loads. - Modeling of networks and components under non-sinusoidal conditions, power quality problems created by drives - Power factor improvement- Passive Compensation - Active Power Factor Correction - Single Phase APFC, Three Phase APFC and Control Techniques, static var compensators-SVC and STATCOM - Active Harmonic Filtering-Dynamic Voltage Restorers for sag, swell and flicker problems. - Grounding and wiring-introduction

EE6308: FACTS and Custom Power

Pre-requisite: Nil
Total hours: 42 Hrs.

EE 6505: High Voltage DC Transmission

Pre-requisite: Nil
Total hours: 42 Hrs.

Evolution of HVDC systems, comparison of HVAC and HVDC transmission systems, components of HVDC transmission system, analysis of HVDC converters, HVDC control, mal-operation and protection of converters, filter design, AC/DC load flow and stability analysis, multi-terminal HVDC, different application of HVDC system, advances in HVDC systems.

EE6426: Distribution Systems Management and Automation

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6122: Biomedical Instrumentation

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6103: Applied Instrumentation

Pre-requisite: Nil
Total hours: 42 Hrs.

Generalized performance characteristics of measuring systems-general static and dynamic characteristics- mathematically models-general concepts of transfer functions related to instrumentation system. Response of general form of instruments to different types of inputs like periodic, transient and random signals, their characteristics etc. Study, analysis etc of modulation and demodulation problems of instrumentation systems. Design considerations of instrumentation systems.
EE6428: SCADA Systems and Applications

Pre-requisite: Nil
Total hours: 42 Hrs.
Introduction to SCADA, Monitoring and supervisory functions, SCADA applications in Utility Automation, SCADA System Components, RTU, IED, PLC, Communication Network, SCADA Server, SCADA/HMI Systems, Various SCADA architectures, single unified standard architecture - IEC 61850, SCADA Communication, open standard communication protocols.

EE6129: Artificial Neural Networks and Fuzzy Systems

Pre-requisite: Nil
Total hours: 42 Hrs.

EE6304: Advanced Digital Signal Processing

Pre-requisite: Nil
Total hours: 42 Hrs.

EE6323: Digital Simulation of Power Electronic Systems

Pre-requisite: Nil
Total hours: 42 Hrs.
EE6422: Engineering Optimization

Pre-requisite: Nil
Total hours: 42 Hrs.


NS 6101: Structure of Nanomaterials


NS 6112: Experimental Techniques in Nanotechnology

Statistical principles for design-of-experiment methods as applied to nanomaterials Elementary ideas of blocking, general principles of linear model analysis. Experimental techniques for temperature measurement – Characterization techniques in nanotechnology - Microscopy - Spectroscopic Methods

NS 6124: Computational Nanotechnology

Need for discrete computations, classical mechanics – Hamilton’s principle and Lagrange’s equations, statistical mechanics – quantum states, ensembles, partition function, equipartition theorem and Maxwell distribution of molecular speeds, Atomistic simulation techniques – Molecular Dynamics and Monte Carlo methods, Mesoscopic methods – Lattice Boltzmann method and Dissipative Particle Dynamics, Introduction to Multiscale methods

EE6121: Data Acquisition & Signal Conditioning

Pre-requisite: Nil
Total hours: 42 Hrs.

Data Acquisition Systems(DAS) - Objectives - General configurations - Transducers - Signal Conditioning - Instrumentation amplifiers - Noise Reduction Techniques in Signal Conditioning - Transmitters - Piezoelectric Couplers - Nyquist’s Sampling Theorem - classification and types of filters - Design of Filters - Butterworth Approximation - Narrow Bandpass and Notch Filters and their application in DAS- Analog-to-Digital Converters(ADC)- Multplexers and demultiplexers - Digital-to-Analog Conversion(DAC) - Data transmission systems - Modulation techniques and systems - Telemetry systems - Study of a representative DAS Board - Interfacing issues with DAS Boards - Software Drivers, Virtual Instruments, Modular Programming Techniques-Bus standard for communication between instruments - Software Design Strategies for DAS.
EE6221: Distributed Generation

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6302: Advanced Power Electronic Circuits

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6508: High Voltage Testing Techniques

Pre-requisite: Nil
Total hours: 42 Hrs.

Objectives of high voltage testing. Determination of probability values - Distribution function of a measured quantity, confidence limits. Testing of insulators, bushings, air break switches, isolators, Dynamic properties of dielectrics-dielectric loss and capacitance measurement, Dimensions of High voltage laboratory, equipment - fencing, earthing and shielding - circuits for high voltage experiments.

EE6507: High Voltage Power Transformers and Circuit Breakers

Pre-requisite: Nil
Total hours: 42 Hrs.

Power Transformer principle and equivalent circuit, Impedance characteristics, short circuit forces, surge phenomenon, Condition monitoring and diagnosis, HV circuit breakers, testing of circuit breakers.
EE6204: Digital Protection of Power Systems

Pre-requisite: Nil
Total hours: 42 Hrs.


EE6509: Electromagnetic Interference and Compatibility

Pre-requisite: Nil
Total hours: 42 Hrs.

Electromagnetic compatibility requirements and principles, non-ideal component behaviour, EMI measurements, EMC standard and regulations conducted and EMI control methods and fixes, EMC design and interconnection techniques.

EE 6510: Pulsed Power Engineering

Pre-requisite: Nil
Total hours: 42 Hrs.

Introduction to pulsed power systems, Insulation and breakdown, Computer simulations, High power switches, Applications, High voltage hazards and accidents.

EE6401: Energy Auditing & Management

Pre-requisite: Nil
Total hours: 42 Hrs.

Energy auditing: Types and objectives-audit instruments, Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors, Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance, case study, Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study, Energy conservation in Lighting Schemes, VFD, Energy conservation measures in Gysers, Transformer, Feeder, Pumps and Fans
MA6003: Mathematical Methods for Power Engineering

Pre-requisite- Nil
Total hours: 42 Hrs.

Module 1: Linear Algebra (10 hours)
Vector spaces, subspaces, Linear dependence, Basis and Dimension, Linear transformations, Kernels and Images, Matrix representation of linear transformation, Change of basis, Eigen values and Eigen vectors of linear operator.

Module 2: Optimisation Methods I (11 hours)
Mathematical formulation of Linear Programming Problems, Simplex Method, Duality in Linear Programming, Dual Simplex method.

Module 3: Optimisation Methods II (10 hours)
Non Linear Programming preliminaries, Unconstrained Problems, Search methods, Fibonacci Search, Golden Section Search, Constrained Problems, Lagrange method, Kuhn-Tucker conditions.

Module 4: Operations on Random Variables (11 hours)

References
8. Simmons D M, Non Linear Programming for Operations Research, PHI, 1975
EE6501: High Voltage Engineering

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (11 hours)
Requirements of HV generation in laboratory, Generation of High voltages, AC voltages: cascade transformers-series resonance circuits; DC voltages: voltage doubler-cascade circuits-electrostatic machines
Generation of Impulse voltages and currents: single stage and multistage circuits-wave shaping-tripping and control of impulse generators Generation of switching surge voltage and impulse currents

Module 2: (11 hours)
Measurement of high voltages and currents-DC, AC and impulse voltages and currents-DSO-electrostatic and peak voltimeters-sphere gaps-factors affecting measurements-potential dividers(capacitive and resistive)-series impedance ammeters-rogowski coils-hall effect generators
Digital techniques in HV measurements, Measurement of electric field.

Module 3: (9 hours)
Insulation materials and -systems: insulation systems in practice, dielectric losses, ageing and life expectancy.

Module 4: (11 hours)

References
EE 6503: Power System Transients

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1 (12 hours)
Fundamental circuit analysis of electrical transients - The Laplace Transform method of solving-
simple Switching transients - Damping circuits - Abnormal switching transients Three-phase circuits
and transients. Computation of power system transients - Principle of digital computation – Matrix
method of solution- Modal analysis- Z transform- Computation using EMTP.

Module 2 (10 hours)
Lightning, switching and temporary overvoltages Lightning: Physical phenomena of lightning –
Interaction between lightning and power system – Influence of tower footing resistance and earth
Resistance- Switching: Short line or kilometric fault – Energizing transients - closing and re-closing
of lines - line dropping, load rejection – over voltages induced by fault – Switching HVDC lines.

Module 3 (10 hours)
Travelling waves on transmission line : Circuits with distributed Parameters – Wave Equation –
Reflection, Refraction, Behaviour of Travelling waves at the line terminations – Lattice Diagrams –
Attenuation and Distortion – Multi-conductor system and Velocity wave.

Module 4 (10 hours)
Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and
Gas Insulated Substation (GIS)- co-ordination between insulation and protection level – statistical
approach- Protective devices- Protection of system against overvoltages– lightning arresters,
substation earthing.

Text Book
EE6301: Power Electronic Circuits

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (11 hours)
D.C.chopper circuits, Type-A, B, C, D and E configurations, Analysis of Type-A chopper with R-L load. -Voltage and current commutated Choppers
Input Line Current Harmonics and power factor.

Module 2: (10 hours)

Module 3: (10 hours)

Module 4: (11 hours)

References
EE6591 High Voltage Lab

1. Measurement of HVAC Voltage using Chubb and Fortescue method
2. Measurement of AC voltage using sphere gap
3. Measurement of HVAC using voltage dividers
4. Study of Impulse generators and generation of standard lightning waveform
5. DC breakdown studies on solid insulators
6. Estimation of AC breakdown strength of paper insulation
7. Estimation of AC breakdown strength of oil
8. Filed plotting using ANSYS and COMSOL
9. Preparation and testing of nanocomposite insulator
Module 1: (11 hours)

Module 2: (11 hours)
Limitations of the conventional design procedure need for the field analysis based design, problem definition and solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

Module 3: (9 hours)

Module 4: (11 hours)

References

5. A Daniel G. Swanson, Wolfgang J. R. Hoefer, “Microwave circuit modeling using electromagnetic field simulation”.

EE6504: Physics of Dielectrics

Pre-requisite: EE6501 High Voltage Engineering
Total hours: 42 Hrs.

Module 1: (11 hours)
Introduction to dielectrics and electrical insulation systems used in high voltage power apparatus: gaseous, vacuum, liquid, solid and composite insulation, behaviour of dielectrics in electric and thermal fields, polarization, relaxation, permittivity and dielectric loss, space charge in dielectrics.

Module 2: (11 hours)
Dielectric Formalism, Equivalent circuits, intrinsic dielectric strength, mechanisms of electrical and thermal breakdown in solids, Phenomenological theory of ageing, mechanisms of ageing under electrical, thermal and combined stresses, Accelerated ageing tests. Statistical models for Insulation failure, Ageing data analysis, Ageing and failure due to partial discharges.

Module 3: (10 hours)
Polymers as dielectrics in various electrical equipments, polymer structure and morphology, classification of polymers, filled polymers for HV applications, introduction to electrical degradation in nanodielectrics– treeing, partial discharge, tracking & erosion.

Module 4: (10 hours)
Design of insulation systems used in various power apparatus (case studies) - transformers, bushings, circuit breakers, cables, capacitors, high voltage rotating machines, gas insulated substations and transmission lines, Computational dielectrics.

References
6. Relevant IS standards and IEC standards
9. Current literature from journals and conference proceedings.
EE6506: EHV Power Transmission

Module 1 (10 hours)
Overview of Electrical power transmission at high voltages. Overhead transmission lines: Bundled conductors, Resistance, Inductance and capacitance calculations of EHV line and multiconductor configurations-seuqence inductance and capacitance-line parameters for modes of propagation-Temperature rise of conductors and current carrying capacity.

Module 2 (12 hours)
Computation of surface voltage gradient on conductors Corona: Power loss due to corona, Radio noise and Audible noise and their measurement as well as computation. Electric Field under transmission lines and its computation Effect of ES fields of humans, Animals and plants.

Module 3 (10 hours)
Theory of reactive power control-Series and Shunt Compensation: Effect of series capacitors, Location of series capacitors. Sub-synchronous resonance in series-capacitor compensated lines and counter measures, Shunt compensation- Static VAR systems: TCR, TCR-FC, TSC-TCR and MSC-TCR schemes

Module 4 (10 hours)
HVDC Transmission: HVDC transmission, kind of dc links, light activated thyristor, series and parallel connection of thyristors. Scheme of converter station, 12 – pulse converter -HVDC Link: Control of HVDC link, Converter control characteristics, firing angle control and extinction angle control. Comparison between AC and DC transmissions Applications of HVDC transmission. Power modulation and power control of HVDC lines.

References

EE6201: Computer Methods in Power Systems

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (11 hours)

Module 2: (10 hours)
Fault Analysis: \( [Z_{BUS}] \) Building Algorithm. Sequence Matrices. Symmetrical And Unsymmetrical Short-Circuit Analysis of Large Power Systems. Phase Shift In Sequence Quantities Due To Transformers.

Module 3: (11 hours)

Module 4: (10 hours)

References
Module 1: (9 hours)

Module 2: (10 hours)
Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.
Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and its impact on drives.

Module 3: (12 hours)

Module 4: (11 hours)
Active Harmonic Filtering-Shunt Injection Filter for single phase, three-phase three-wire and three-phase four-wire systems. d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems.
Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.

References
EE6308: FACTS and Custom Power

Total hours: 42 Hrs

Module 1: (10 hours)
Reactive power compensation – shunt and series compensation principles – reactive compensation at transmission and distribution level – Static versus passive VAr Compensators .

Module 2: (11 hours)
Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control - Comparison between SVC and STATCOM.

Module 3: (10 hours)
Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC- Basic Principle of P and Q control- independent real and reactive power flow control- Applications - Introduction to interline power flow controller.
Modelling and analysis of FACTS Controllers – simulation of FACTS controllers

Module 4: (11 hours)
Power quality problems in distribution systems, harmonics, loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering – shunt , series and hybrid and their control – voltage swells , sags, flicker, unbalance and mitigation of these problems by power line conditioners- IEEE standards on power quality.

References
EE 6505: High Voltage DC Transmission

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (11 hours)
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.

Module 2: (11 hours)

Module 3: (9 hours)
Introduction – Potential applications of MTDC systems – Types of MTDC systems – Control and protection of MTDC systems – Study of MTDC systems.

Module 4: (11 hours)

References

EE6426: Distribution Systems Management and Automation

Prerequisite: Nil
Total hours: 42 Hrs

Module 1: (10 Hours)
Distribution Automation System : Necessity, System Control Hierarchy- Basic Architecture and implementation Strategies for DA- Basic Distribution Management System Functions- Outage management-
Integration of Distributed Generation and Custom Power components in distribution systems-
Distribution system Performance and reliability calculations

Module 2: (10 Hours)
Electrical System Design: Distribution System Design- Electrical Design Aspects of Industrial, Commercials Buildings- Electrical Safety and Earthing Practices at various voltage levels- IS Codes

Module 3: (12 Hours)
Communication Systems for Control and Automation- Wireless and wired Communications- DA Communication Protocols, Architectures and user interface-Case Studies

Module 4: (10 Hours)
Power Quality and Custom Power: Concept- Custom Power Devices - Operation and Applications
Deregulated Systems: Reconfiguring Power systems- Unbundling of Electric Utilities- Competition and Direct access

References
EE6122: Biomedical Instrumentation

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (12 hours)

Module 2: (10 hours)

Module 3: (10 hours)

Module 4: (10 hours)
Measurement of $P_H$, $PCO_2$, $PO_2$ -radiotherapy – Cobalt 60 machine – medical linear accelerator machine – audiometry - electrical safety in hospitals.

References

3. Cromwell Leslie, Biomedical instrumentation and measurements, PHI, 1980
5. John Enderle, Introduction to Biomedical Engineering, Academic Press, 2005
EE6103: Applied Instrumentation

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (10 hours)

Module 2: (10 hours)

Module 3: (10 hours)
Roll for digital computer system in process control. Distributed instrumentation and control system . General purpose digital data acquisition and control hardware.

Module 4: (12 hours)

References
EE6428: SCADA Systems and Applications

Pre-requisite-Nil
Total hours: 42 Hrs

Module 1: (10 hours)
Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries

Module 2: (11 hours)
SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

Module 3: (11 hours)
SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture - IEC 61850. SCADA Communication: various industrial communication technologies - wired and wireless methods and fiber optics. open standard communication protocols.

Module 4: (10 hours)
SCADA Applications: Utility applications- Transmission and Distribution sector - operations, monitoring, analysis and improvement. Industries - oil, gas and water. Case studies, Implementation, Simulation Exercises

References
Pre-requisite: Nil
Total hours: 42 Hrs

Module 1: (10 hours)
Biological foundations, ANN models, Types of activation function, Introduction to Network architectures: Multi Layer Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), Recurring Neural Network (RNN)

Module 2: (10 hours)
Learning process. Supervised and unsupervised learning. Error-correction learning, Hebbian learning, Boltzmen learning, Single layer and multilayer perceptrons, Least mean square algorithm, Back propagation algorithm, Applications in forecasting and pattern recognition and other engineering problems.

Module 3: (10 hours)
Fuzzy sets. Fuzzy set operations. Properties, Membership functions, Fuzzy to crisp conversion. fuzzification and defuzzification methods, applications in engineering problems.

Module 4: (12 hours)
Fuzzy control systems. Introduction, simple fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems. inverter pendulum, image processing. home heating system. Adaptive fuzzy systems, hybrid systems.

References
Module 1: Discrete Time Signals, Systems and Their Representations (12 hours)
Discrete time signals- Linear shift invariant systems- Stability and causality- Sampling of continuous
time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform- Z-
transform- Properties of different transforms- Linear convolution using DFT- Computation of DFT

Module 2: Digital Filter Design and Realization Structures (9 hours)
Design of IIR digital filters from analog filters- Impulse invariance method and Bilinear
transformation method- FIR filter design using window functions- Comparison of IIR and FIR digital
filters- Basic IIR and FIR filter realization structures- Signal flow graph representations

Module 3: Analysis of Finite Word-length Effects (9 hours)
Quantization process and errors- Coefficient quantisation effects in IIR and FIR filters- A/D
conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero
input limit cycles in IIR filters

Module 4: Statistical Signal Processing (12 hours)
Linear Signal Models . All pole, All zero and Pole-zero models .Power spectrum estimation- Spectral
analysis of deterministic signals . Estimation of power spectrum of stationary random signals-
Optimum linear filters-Optimum signal estimation-Mean square error estimation-Optimum FIR and
IIR filters.

References
Processing, Mc Grow Hill international editions .-2000
Pvt. Ltd., New Delhi, 1997
of India Pvt. Ltd, New Delhi, 1997
. Wesley,1993
6. Abraham Peled and Bede Liu, Digital Signal Processing, John Wiley and Sons, 1976
EE6323: Digital Simulation of Power Electronic Systems

Pre-requisite: Nil
Total hours: 42 Hrs

Module 1: (10 hours)

Module 2: (10 hours)

Module 3: (10 hours)

Module 4: (12 hours)
Design Creation and Simulation with SaberDesigner - Placing the Parts - Editing the Symbol - Properties - Wiring the Schematic - Modifying Wire Attributes - Performing a Transient and DC Analysis - Placing Probes in the Design - Performing AC Analysis and Invoking SaberScope - Analysing waveforms with SaberScope - Performing Measurements on a waveform - Varying a Parameter - Displaying the Parameter Sweep Results - Measuring a Multi-Member Waveform - Simulation Examples of Power Electronic Systems.

References
4. Getting Started with SaberDesigner (Release 5.1), Analogy Inc.
5. Guide to Writing MAST Template (Release 5-1), Analogy Inc.
EE6422: Engineering Optimization

Pre-requisite-Nil
Total hours: 42 Hrs

Module 1: (11 hours)
Concepts of optimization: Engineering applications-Statement of optimization problem-Classification
- type and size of the problem.
Classical Optimization Techniques: Single and multi variable problems-Types of Constraints .Semi
definite case-saddle point.
Linear programming: Standard form-Geometry of LP problems-Theorem of LP-Relation to convexity
- formulation of LP problems - simplex method and algorithm -Matrix form- two phase method.
Duality- dual simplex method- LU Decomposition. Sensitivity analysis .Artificial variables and
complementary solutions-QP.
Engineering Applications: Minimum cost flow problem, Network problems-transportation,

Module 2: (11 hours)
Nonlinear programming: Non linearity concepts-convex and concave functions- non-linear
programming - gradient and Hessian.
Unconstrained optimization: First & Second order necessary conditions-Minimisation &
Maximisation-Local & Global convergence-Speed of convergence.
Basic decent methods: Fibonacci & Golden section search - Gradient methods - Newton Method-
Lagrange multiplier method - Kuhn-tucker conditions . Quasi-Newton method- separable convex
programming - Frank and Wolfe method, Engineering Applications.

Module 3: (10 hours)
Nonlinear programming- Constrained optimization: Characteristics of constraints-Direct methods-
SLP,SQP-Indirect methods-Transformation techniques-penalty function-Lagrange multiplier
methods-checking convergence- Engineering applications.

Module 4: (10 hours)
Dynamic programming: Multistage decision process- Concept of sub optimization and principle of
optimality- Computational procedure- Engineering applications.
Genetic algorithms- Simulated Annealing Methods-Optimization programming, tools and Software
packages.

References
1. David G Luenberger, .Linear and Non Linear Programming., 2nd Ed, Addison-Wesley
8 A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering Optimization: Methods And
   Applications, Wiley, 2008
9 Godfrey C. Onwubolu, B. V. Babu, New optimization techniques in engineering, Springer, 2004
    India-1998
NS6101 Structure of Nanomaterials

Pre-requisite: Nil

Module I (12 Hours)
Classification of nanostructures, nanoscale architecture, fundamental structure, chemistry, property relationships in nanomaterials and nanomaterial systems. Top-down processes, bottom-up processes, methods for templating the growth of Nanomaterials Ordering of nanosystems, preparation, safety and storage issues

Module II (10 Hours)
Electronic properties of atoms and solids, the isolated atom, bonding between atoms, giant molecular solids, the free electron model and energy bands, band theory, crystallography, fundamentals of mechanical, electrical and magnetic properties of nanomaterials.

Module III (10 Hours)
Nanocrystalline materials, nanocomposites, quantum well structures, extreme ultraviolet (EUV) optical elements and grain size determination in nanomaterials and nanometer scale systems.

Module IV (10 Hours)
Nanoscale x-ray -electron and neutron diffraction techniques, Application areas, Scanning electron microscopy, Transmission electron microscopy, Atomic force microscopy (AFM), Scanning tunneling microscopy (STM).

References
NS6112 Experimental Techniques in Nanotechnology

Pre-requisite: Nil

Module 1 (10 hours)
Statistical principles for design-of-experiment methods as applied to nanomaterials selfassembly, processing, and associated development of analytical protocols. Elementary ideas of blocking, general principles of linear model analysis. Introduction to replication, covariance, experimental treatment structures, and full- and partial-factorial designs.

Module 2 (8 hours)
Experimental techniques for temperature measurement – thermoreflectance thermometry – measurement of thermal phenomena in nanofluids – thermal conductivity measurement in nanofluids using steady state and transient methods.

Module 3 (12 Hours)

Module 4 (12 Hours)

References
Module 1 (11 hours)

Introduction:
Computational simulation, need for discrete computation.

Classical Mechanics:
Mechanics of Particles, D’Alembert’s principle and Lagrange’s equation, variational principles, Hamilton’s principle, conservation theorems and symmetry properties, central force problems, virial theorem.

Module 2 (11 hours)

Statistical Mechanics:
Review of probability and statistics, quantum states of a system, equations of state, canonical and microcanonical ensemble, partition function, energy levels for molecules, equipartition theorem, minimizing the free energy, partition function for identical particles, Maxwell distribution of molecular speeds.

Module 3 (10 hours)

Atomistic Simulation Techniques:
Molecular Dynamics (MD): Introduction, inter-atomic potential function, Lennard-Jones potential, MD simulation – equilibration and property evaluation, various types of potential functions, computational aspects, introduction to advanced topics.
Monte Carlo (MC) Method: Introduction, Metropolis algorithm, advanced algorithms for Monte Carlo simulations, comparison with Molecular Dynamics.

Module 4 (10 hours)

Mesoscopic Simulation Techniques:
Lattice Boltzmann Method (LBM): Boltzmann equation, derivation of the hydrodynamic equation from Boltzmann equation, Lattice Boltzmann equation and LBM, applications of LBM.
Dissipative Particle Dynamics (DPD): Fundamentals of DPD simulations, timestep size and noise, repulsion parameter, approximate expressions for transport coefficients.

Introduction to Multiscale methods and applications.

References:
4. Ercolessi, F., A Molecular Dynamics Primer, Notes of Spring College in Computational Physics, ICTP, Trieste, June 1997.
Total hours: 42 Hrs.

Module 1: Transducers & Signal Conditioning (11 hours)


Module 2: Filtering and Sampling (10 hours)

Review of Nyquist’s Sampling Theorem-Aliasing. Need for Prefiltering-First and second order filters - classification and types of filters - Low-pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters. Opamp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers

Module 3: Signal Conversion and Transmission (10 hours)


Module 4: Digital Signal Transmission and Interfacing (11 hours)


References

E6221: Distributed Generation

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (10 hours)
Introduction to energy conversion principle of renewable energy systems-technical and social implications; Solar energy. Overview of solar energy conversion methods. Solar radiation components-collector-measurements-estimation; Solar water heating-Calculation-Types-analysis-economics-Applications; Solar thermal power generation

Module 2: (12 hours)
Direct energy conversion (DEC)- DEC devices -Photo voltaic system-Solar cells- Cell efficiency-Limitations-PV modules-Battery back up-System design-Lighting and water pumping applications; Fuel cells. types- losses in fuel cell. applications; MHD generators- application of MHD generation.

Module 3: (10 hours)
Wind energy. characteristics-power extraction- types of wind machines .dynamics matching-performance of wind generators .wind mills -applications- economics of wind power

Module 4: (10 hours)
Biofuels- classification-biomass conversion process-applications; ocean thermal energy conversion systems; Tidal and wave power-applications; Micro and mini hydel power; Hybrid Energy Systems-implementation- case study.

References
5. James Larminie , Andrew Dicks , Fuel Cell Systems, John Weily & Sons Ltd, 2000
EE6302: Advanced Power Electronic Circuits

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (8 hours)
Special Inverter Topologies - Current Source Inverter . Ideal Single Phase CSI operation, analysis and waveforms - Analysis of Single Phase Capacitor Commutated CSI.
Series Inverters . Analysis of Series Inverters . Modified Series Inverter . Three Phase Series Inverter

Module 2: (12 hours)
Switched Mode Rectifier - Operation of Single/Three Phase bilateral Bridges in Rectifier Mode . Control Principles . Control of the DC Side Voltage . Voltage Control Loop . The inner Current Control Loop.Single phase and three phase boost type APFC and control, Three phase utility interphases and control

Module 3: (10 hours)

Module 4: (12 Hours)

References
1. Ned Mohan et.al “Power electronics : converters, applications, and design” John Wiley and Sons, 2006
Pre-requisites-Nil

Module 1: (11 hours)

Objectives of high voltage testing - classification of testing methods- self restoration and non-self restoration systems-standards and specifications - measurement techniques - Diagnostic testing - online measurement.

Module 2: (11 hours)

Determination of probability values - Distribution function of a measured quantity, confidence limits of the mean values of disruptive discharges - ‘Up and Down’ method for determining the 50% disruptive discharge voltage - multi stress ageing - life data analysis.

Module 3: (9 hours)

Testing of insulators, bushings, air break switches, isolators, circuit breakers, power transformers, voltage transformers, current transformers, surge diverters, cable – testing methodology - recording of oscillograms - interpretation of test results.

Module 4: (11 hours)


References

EE6507: High Voltage Power Transformers and Circuit Breakers

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (10 hours)
HV power transformers, principle and equivalent circuit, Magnetic characteristics-Excitation characteristics, over excitation performance, Inrush current. Impedance characteristics, Reactance calculation, Losses in transformers-eddy current loss, hysteresis loss and stray loss in power transformers.

Module 2: (11 hours)
Short circuit forces, failure mode due to radial and axial forces, Short circuit test, Effect of inrush current. Surge phenomenon-initial voltage distribution-ground capacitance calculations-capacitance of winding, inductance calculation-standing and traveling wave theory, Method for analysis of impulse distribution.

Module 3: (10 hours)
Impulse testing, diagnostics and condition monitoring of transformers, Conventional tests, Dissolved Gas Analysis, Partial Discharge Diagnostics, Degree of Polymerisation and Furan Analysis, Time domain and frequency domain dielectric response method.

Module 4: (11 hours)
Introduction to HV switching devices, electric arcs, short circuit currents, TRV, CB types, air, oil and SF6 CB, short circuit testing.

References
EE6204: Digital Protection of Power Systems

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (8 hours)
Protective Relaying - Qualities of relaying - Definitions - Codes- Standards; Characteristic Functions; Classification –analog-digital- numerical; schemes and design-factors affecting performance –zones and degree of protection; faults-types and evaluation; Instrument transformers for protection.

Module 2: (12 hours)
Basic elements of digital protection –signal conditioning- conversion subsystems- relay units-sequence networks-fault sensing data processing units- FFT and Wavelet based algorithms: least square and differential equation based algorithms-travelling wave protection schemes; Relay Schematics and Analysis- Over Current Relay- Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays- Restraining Characteristics; Distance Relays: Types- Characteristics.

Module 3: (14 hours)
Protection of Power System Equipment - Generator, Transformer, Transmission Systems, Busbars, Motors; Pilotwire and Carrier Current Schemes; System grounding –ground faults and protection; Load shedding and frequency relaying; Out of step relaying ; Re-closing and synchronizing

Module 4: (8 hours)
Integrated and multifunction protection schemes -SCADA based protection systems- FTA; Testing of Relays.

References
8. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marcel Dekker, Inc. 1995
EE6509: Electromagnetic Interference and Compatibility

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (11 hours)
BASIC CONCEPTS Definition of EMI and EMC with examples, Classification of EMI/EMC - CE, RE, CS, RS, Units of Parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression

Module 2: (11 hours)
EMI MEASUREMENTS, Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection technique open area site, shielded anechoic chamber, TEM cell.

Module 3: (9 hours)

Module 4: (11 hours)
EMI CONTROL METHODS AND FIXES Shielding, Grounding, Bonding, Filtering, EMI gasket, Isolation transformer, opto isolator.
EMC DESIGN AND INTERCONNECTION TECHNIQUES Cable routing and connection, Component selection and mounting, PCB design- Trace routing, Impedance control, decoupling, Zoning and grounding

References

EE 6510: Pulsed Power Engineering

Pre-requisite: Nil
Total hours: 42 Hrs.

Module 1: (11 hours)
Introduction to pulsed power systems (examples and applications), Energy storage (capacitive, inductive, kinetic, chemical), Voltage multiplier circuits (Marx generators, Blumlein generators, and spiral generators, etc.), Transmission lines and pulse forming networks.

Module 2: (11 hours)
Insulation and breakdown (gas, vacuum, liquid, solid, and surface), Grounding, shielding, safety, Pulsed power materials, High speed diagnostics (voltage, current, plasma, magnetic field, etc.)

Module 3: (9 hours)
Computer simulations, High power switches: spark gaps, low pressure switches, liquid and solid state switches, solid stage switches, magnetic switches, opening switches, Electromagnetic field analysis of pulsed power circuits

Module 4: (11 hours)
Applications: High Power Microwaves, mass drivers, pollution control, particle accelerators, lasers, manufacturing, Nuclear electromagnetic fields, High voltage hazards and accidents.

References
EE6401: Energy Auditing & Management

Pre-requisite: Nil

Total hours: 42 Hrs

Objective: Understanding, analysis and application of electrical energy management-measurement and accounting techniques-consumption patterns-conservation methods-application in industrial cases.

Module 1: (9 hours)
System approach and End use approach to efficient use of Electricity; Electricity tariff types; Energy auditing: Types and objectives-audit instruments-ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models-Case study.

Module 2: (11 hours)
Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors.
Variable speed drives; Pumps and Fans-Efficient Control strategies-Optimal selection and sizing-Optimal operation and Storage; Case study

Module 3: (11 hours)
Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study.
Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study.

Module 4: (11 hours)
Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study;

References


13. NESCAP-Guide Book on Promotion of Sustainable Energy Consumption, 2004

14. IEEE Bronze Book, IEEE STD 739


