GOVT. COLLEGE OF ENGINEERING, AMRAVATI

CURRICULUM

M.Tech. (ELECTRICAL POWER SYSTEMS)

FULL TIME

Department of Electrical Engineering
2010-11
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<td>SHP103</td>
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Duration of ESE for all courses is 2 Hrs. 30 Min.
TA :Techer Assesment   CT: Class Tests   ESE: End Sem.Examination
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<td>E) POWER SYSTEM TRANSIENTS</td>
<td>E) POWER SYSTEM RELIABILITY</td>
<td>E) ENERGY MANAGEMENT AND ENERGY AUDIT</td>
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Large disturbance Stability: System of one machine connected against infinite bus, classical model, and equal area criteria technique and its applications, precalculated swing curve, Evaluation and simulation

Small disturbance Stability: Two-machine system with and without losses, techniques for S.S.S.limit, effect of inertia, saliency, saturation, governor action and SCR on SS power limit.

Excitation System: Effect of excitation system on generator power limit, transformation model of excitation system, dynamic stability, Routh’s criteria for dynamic stability, self excited electro-mechanical oscillations in Power System, power system stabilizer


Prime mover controllers: Control of Voltage, frequency, SCADA for stability, tie line power flow, emergency control techniques for stability. Application of energy functions for direct stability evaluation

Text Books

References
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
EEP102 ADVANCED POWER SYSTEM PROTECTION

Teaching Scheme: 03 L + 01 T   Total 04   Credit: 05
Marking Scheme: 15 CT1 + 15 CT2 +10 TA + 60 ESE   Total Marks: 100
Duration of ESE : 2 Hrs.30 min.

Introduction: Review of principles of power system equipments protection, basic relay elements and relay terminology, basic construction of static relays protection, Characteristic function of protective relays.

Protection of Power Equipments: Protection of generators and power Transformers for various types of fault, problems in differential protection and various remedies.

Transmission line and Bus-bar Protection: Bus protection, typical bus arrangements, various protective scheme for T.L. and bus systems, distance protection for phase faults, Fault resistance and relaying Backup remote local and Breaker failure.

Protection Of Reactors, Boosters & Capacitors: Placement of reactors in power system, Types of reactors, reactor rating application and protection, booster in the power system, transformer tap changing, protection of boosters, capacitors in an interconnected power system, series, shunt, series-shunt connections, protection of capacitors.

Digital Protection: Performance and operational characteristics of Digital protection, performance of digital relay, Digital filtering in protection relays, digital data transmission, Numeric relay hardware and software considerations, relay algorithms, distance relays, direction comparison relays, differential relays, numeric relay testing, concepts of modern coordinated control system.

Over voltage Protection: Types of over voltages and various causes, criteria for protective techniques against over voltage and protective scheme design considerations.

Text Books:

Reference Books:
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
Signals and Signal Processing: Characterization and classification of signals, Typical signal processing operations, Typical signal processing applications, Advantages of digital signal processing.

Time Domain Representations of Signals and Systems: Discrete time signals Operations on sequences, Discrete time systems Linear time invariant discrete time systems, Characterization of LTI systems.


Structures for discrete time systems: Block diagram and signal flow representation of constant coefficient, linear difference equation, Basic structures for IIR systems, Basic structures for FIR systems, Lattice structures, Effects of coefficient quantization, Effect of round off noise in digital filters, Zero-input limit cycles.

Filter Design Techniques: Design of discrete time IIR filters from continuous time filters, Design of FIR filters by windowing, Optimum approximation of FIR filters, Linear phase filters.

Sampling of continuous time signals: Periodic sampling, Frequency domain representation of sampling, Reconstruction of bandlimited signal from its samples, Discrete time processing of continuous time signals, Continuous time processing of discrete time signals, Changing the sampling rate using discrete time processing.

Text Book:

References
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu

Review of Determinants And Matrix Algebra: Inverse of matrix, characterization of invertible matrices, portioned matrices, matrix factorization, iterative solution of linear systems, determinants, properties of determinants, Cramer’s rule

Vector Spaces: Vector spaces and subspaces, null spaces, column spaces and linear transformations, linearly independent sets; bases, coordinate systems, The dimensions of vector space. Change of bases, application to difference equations.

Eigenvalues and Eigenvectors: Eigenvalues and eigenvectors, the characteristics equation, diagonalization, eigenvectors and linear transformation, complex eigenvalues, discrete dynamical systems, applications to differential equations.

Orthogonality and Least-Squares: Inner product, length and orthogonality, orthogonal sets, orthogonal projections, Gram-Schmidt process, least square problems, inner product spaces, applications of inner product spaces.

Symmetric Matrices And Quadratic Forms: Diagonalization of symmetric matrices, quadratic forms, singular value decomposition, applications

Text books
1. Linear algebra and its application; D.C.Lay, 3/e; Addison Wesley; 2004

References
1. Linear Algebra with applications; Nicholson, McGraw Hill; 2004
2. http://www.nptel.iitm.ac.in/
3. www.ocw.mit.edu
EEP104 ELECTIVE-I
A) NEURAL NETWORK AND FUZZY LOGIC

Teaching Scheme: 03 L + 01 T Total 04 Credit: 05
Marking Scheme: 15 CT1 + 15 CT2 +10 TA + 60 ESE Total Marks: 100
Duration of ESE: 2 Hrs.30 min.

Introduction: Basic Concepts of Neural Network, brain as a NN, properties of neuron, supervised and unsupervised models, layers in a network, single layer and multilayer feed forward network, recurrent networks, learning and training, learning rules (unsupervised and supervised learning laws).

Hopfield Model: basic model, cellular neural networks, perceptron, introduction to adaptive resonance theory, network for ART-1 and ART-2, Kohoran map, training law.

Training: Training of multilayer feed-forward network by backpropagation, training aspects and variations of backpropagation method, backpropagation as stochastic approximation, counter propagation network, radial basis function networks.

Fuzzy Set Theory: fuzzy versus crisps, crisps sets, fuzzy sets – membership function, basic fuzzy set operations, properties of fuzzy sets, crisps relations, fuzzy relations.

Fuzzy Systems: crisps logic, laws and inference in propositional logic, predicate logic, interpretation of predicate logic formula, inference in predicate logic, fuzzy logic, fuzzy quantifiers, fuzzy inference, fuzzy rule based system, defuzzification method.


Text Books

References
3. A course in Fuzzy Systems and Control, Li-Xin Wang Prentice Hall-2004
5. http://www.nptel.iitm.ac.in/
6. www.ocw.mit.edu

Basic Types of FACTS Controllers: Brief Description and Definitions of FACTS Controllers, Benefits from FACTS Technology, HVDC vs. FACTS Static Shunt Compensators

SVC and STATCOM: Objectives of Shunt Compensation, Methods of Controllable Var Generation, Static Var Compensators: SVC and STATCOM, Comparison Between STATCOM and SVC, Static Var Systems.

Static Series Compensators (GCSC, TSSC, TCSC and SSSC): Objectives of Series Compensation, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators, External (System) Control for Series Reactive Compensators, Summary of Characteristics and Features.

Static Voltage and Phase Angle Regulators: (TCVR and TCPAR): Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs), Switching Converter-Based Voltage and Phase Angle Regulators, Hybrid Phase Angle Regulators.


Text Books

2. Flexible AC transmission systems (FACTS), Yong Hua Song IEE Press, 1999

References

2. http://www.nptel.iitm.ac.in/
3. www.ocw.mit.edu
EEP104 ELECTIVE-I
C) COMPUTER METHODS IN POWER SYSTEM ANALYSIS

Teaching Scheme : 03 L + 01 T    Total  04          Credit : 05
Marking Scheme: 15 CT1 + 15 CT2 +10 TA+ 60 ESE          Total Marks :100
Duration of ESE     : 2 Hrs.30 min.

Introduction: Graph of a power system, incidence matrices, primitive network, formation of network matrices by singular and non singular transformation, Representation of power system for computerized analysis, mathematical model of synchronous generator for steady state and transient analysis, transformer with tap changer, transmission line, phase shifter and loads. Algorithm for formation of bus impedance matrix, modification for changes in the network. Incidence and network matrices for three phase network, transformation matrices, algorithm for formation of bus impedance matrix for three phase networks.

Short Circuit Studies: Symmetrical component, Thevenin’s theorem and short circuit analysis of multi node power systems using bus impedance matrix. Short circuit calculations for balanced and unbalanced faults.

Load Flow Analysis: Types of buses, load flow equations, power flow solution through GS and NR methods, decoupled and fast decoupled methods, sparsity.

Transient stability Analysis: including synchronous machines, system network and loads, solution of swing equation by Euler’s, Euler’s modified and RK methods.

Economic Load Scheduling : unit commitment, transmission loss, load scheduling considering transmission losses, unit commitment by dynamic programming method, start up consideration, reliability analysis, hydrothermal scheduling.

Text Books

References
2. Power System Analysis , Hadi Saadat TMH-2004
4. http://www.nptel.iitm.ac.in/
5. www.ocw.mit.edu
Review of Electric Drives: Classification, Comparison of AC and DC drives, Basic elements, Torque equation, Multi-quadrant operation, Equivalent values of drive parameters, components of load torque, Stability consideration, closed loop control of drives, Thermal model of motor for Heating and Cooling, Classes of Duty.

DC Drives: Half controlled, full controlled and dual converter based separately excited dc motor drives and their analysis. Effect of source and load inductance. DC-DC converter (Chopper) fed dc series motor drives and its steady state analysis.


Special Topics: Measures of energy conservation in electrical drives, Introduction to the fundamental principles of torque controlled drives: Vector controlled, Direct torque controlled and Sensorless drives.

Text Books:
11. http://www.nptel.iitm.ac.in/
12. www.ocw.mit.edu
Introduction: Basic concept and simple switching transient, Transients in electric power systems switching of RL, LC, RLC circuits, Transient analysis for 3 phase Power System-Sequence network, Sequence component for unbalanced network impedance, Analysis of unsymmetrical 3 phase faults

Traveling waves: Internal and external causes of over voltages, Lightning strokes, Mathematical model to represent lightning, Lightening stroke to tower and midspan, Traveling waves in transmission lines, Circuits with distributed constants, Wave equations, Reflection and refraction of traveling waves, Traveling waves at different line terminations, Effect of short length of cables, Shape and attenuation and distortion of traveling waves, Selection of typical wave to represent over voltages, Lattice diagram


Surges In Transformers, Motors And Generators: Step voltage, Voltage distribution in transformer winding, Winding oscillations, Traveling wave solutions, Transformer core under surge conditions, Voltage surges, Transformers, Generators and motors, Transient parameter values for transformers.

Switching Arc, Protective devices and system: The switching arc and its modeling, arc circuit interruption, origin of transient recovery voltage, transient recovery voltage for different types of faults, Basic ideas about protection, Surge diverters, Surge absorbers, Ground fault neutralizers, Protection of lines and stations by shielding, Ground wires, Counter poises, Driven rods, Modern lighting arrestors, Insulation coordination

Generation and Measurement of High Voltages And Current: Generation of high AC and DC voltage, Impulse voltage, Impulse current, Measurement using Sphere gaps peak Voltmeters, Potential dividers, measurement set-up for transient voltage and current.

Text Books
1. A statistical approach to power system transients, Dr.C.S.Indulkar, PHI-2006

Reference
2. Power System Grounding and transients: An Introduction, A.P.Sakis Meliopoulos, Marcel Dekker-2005
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
EEP105 LAB-I
Teaching Scheme: 08 P + 00 Total 08 Credit: 04
Marking Scheme: 50 Internal + 50 External Total Marks: 10

**Introduction to MATLAB:** variables and arrays, sub arrays, special values, scalar and array operations, graphics, rational and logical operators, branching if and switch cases, loops, while loop, for loop, script files, function functions, sub function and private functions.

**Linear algebra with MATLAB:** solution of linear differential equations, difference equations, eigenvalues and eigenvectors, Fourier analysis, Laplace and z transforms with symbolic math toolbox, partial fraction expansion

**Introduction to Simulink:** Symbolic math, control and signal processing toolboxes
It should consist of various Practical/Simulation assignments related to all Core subjects and Electives

**Representative List of Experiments:**
1. To obtain swing equation for a synchronous machine connected to infinite bus.
2. To obtain power angle curve for one machine system before fault, during fault and after clearance of fault using Equal Area Criteria.
3. Study of Unit Commitment and Load Scheduling.
4. Transient Stability Analysis using
   1) Euler’s Method
   2) Euler’s Modified Method
5. Transient stability analysis using RK2 and RK4 Method.
6. Conversion of phase quantities to symmetrical quantities and symmetrical quantities to phase quantities.
7. To generate scaling function and wavelet from the ‘h’ filter.
8. Illustration of simple interpolation and decimation operations.
EEP106 SEMINAR I

Teaching Scheme: 02 P + 00 Total 02
Marking Scheme: 25 Internal

Credit: 01
Total Marks: 25

Seminar on any technical subject other than above syllabus
Steady state and dynamics problems in AC systems, Flexible AC transmission systems (FACTS), principles of series shunt compensation, description of static var compensation (SVC), thyristor controlled series compensation (TCSC), static phase shifter (SPS), static condenser (STATCON), static synchronous series compensator (SSSC) and unified power flow controller (UPSC), modeling and analysis of FACTS controllers, control strategies to improve system stability.

Power quality problems in distribution systems, Harmonics, Harmonics creating loads, modeling, Harmonics propagation, series and parallel resonance, harmonic power flow, mitigation of harmonics, filters, active filters, shunt and series hybrid filters, voltage sag and swells, voltage flicker, mitigation of power quality problems using power electronics conditioners, IEEE standards.

Text Books


Reference Books:

1. Power Electronics, Ned Mohan John Wiley and Sons -2003
2. http://www.nptel.iitm.ac.in/
3. www.ocw.mit.edu
Introduction To Optimization And Classical Optimization Techniques: Single variable optimization, multivariable optimization without constraints, multivariable optimization with equality constraints, multivariable optimization with inequality constraints.


Dynamic Programming: Multistage decision process, concept of suboptimization and principle of optimality, conversion of final value problem into an initial value problem, LP as a case of dynamic programming.

Genetic Algorithm: introduction to genetic algorithm, working principle, coding of variables, fitness function, GA operators, similarities and differences between GA and traditional methods, unconstrained and constrained optimization using GA.

Applications To Power System: economic load dispatch in thermal and hydro thermal system using GA, unit commitment problem, reactive power optimization, LPP and NLP techniques to optimal flow problems.

Text Books:
3. Power System Optimization,  Kothari and Dhillon PHI -2004

References
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu

Over Voltages in EHV System: origin & causes, over voltage caused by switching operations, over voltage caused by interruption of low inductive current, over voltage caused by interruption of capacitive currents, ferro-resonance overvoltage Power frequency voltage control, shunt & series compensation.

Lightning: Lightning strokes, Mathematical model to represent lightning, Lightning stroke to tower and mid span, Insulation coordination based on lightning.

Traveling waves in transmission lines: Circuits with distributed constants, Wave equations, Reflection and refraction of traveling waves, Traveling waves at different line terminations, Effect of short length of cables, Shape and attenuation and distortion of traveling waves. Selection of typical wave to represent over voltages, Lattice diagram.


Analysis of HVDC Converters: 3-pulse, 6-pulse, 12-pulse converters, converters station and terminal equipment, commutation process, rectifier & inverter operation, equivalent circuit for converters, simplified analysis of Graetz circuit Control of Converters.

HVDC System Control: Firing angle control, Current and extinction angle control, starting and stopping of DC link, power control, higher level Controllers, Converter faults and protection: Introduction, Converter faults, protection against over current, over voltage in a converter station, surge arrestors. Smoothing reactor, Harmonics and filters.

Multi Terminal DC Systems: Potential applications of MTDC systems, types of system, operation & control and protection of MTDC systems. Parallel operation of HVDC and HVAC.

Text Books

1. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, New Age International(P) Ltd. 2003
2. EHV Transmission Line Reference Book – Edison Electric Institute

References

2. HVDC Transmission, K.R.Padiyar, Wiely Eastern Ltd; New Delhi,1999
Introduction to embedded systems, Background and History of Embedded Systems, definition and Classification, Programming languages for embedded systems: desirable characteristics of programming languages for embedded systems, low-level versus high level languages, main language implementation issues: control, typing, exception handling, modularity and multi-threading. Major programming languages for embedded systems. Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits.

Processor and Memory Organization: Structural units in processor, Processor selection for an embedded system, Memory devices, Memory selection, Allocation for memory to program segments and blocks and memory map of a system, DMA, Interfacing processor, I/O Devices - Device I/O Types and Examples – Synchronous - Iso-synchronous and Asynchronous Communications from Serial Devices - Examples of Internal Serial-Communication Devices - UART and HDLC – Parallel Port Devices - Sophisticated interfacing features in Devices/Ports- Timer and Counting Device

Device Drivers and Interrupts Servicing Mechanism: Device driver, parallel port device driver in a system, serial port device driver in a system, device driver for internal programmable timing devices. Interrupt servicing (handling) Mechanism, Context and the period for context switching. Deadline and interrupt latency.

Real Time Operating Systems: RTOS Task scheduling models - Handling of task scheduling and latency and deadlines as performance metrics – Co-operative Round Robin Scheduling – Cyclic Scheduling with Time Slicing (Rate Monotonics Co-operative Scheduling) – Preemptive Scheduling Model strategy by a Scheduler – Critical Section Service by a Preemptive Scheduler – Fixed (Static)

Software Engineering Practice in the Embedded Systems: Software analysis design, implementation, testing, validation and debugging of embedded systems.

Text Books:
2. Embedded Software primer by David Simon Pearson Education-2005

References
2. http://www.nptel.iitm.ac.in/
3. www.ocw.mit.edu
EEP204 ELECTIVE-II

B) AI TECHNIQUES IN POWER SYSTEMS

Teaching Scheme : 03 L + 01 T    Total  04
Marking Scheme: 15 CT1 + 15 CT2 +10 TA+ 60 ESE    Total Marks :100
Duration of ESE : 2 Hrs.30 min.


Application of ANN to Short-term Load Forecasting: An ANN approach to the Diagnosis of Transformer Faults, Real-Time Frequency and Harmonic Evaluation using ANN.


Text Books

1. Intelligent System Applications in Power Engineering by Loi Lei Lai John Wiley Publication-2004

References

2. Introduction to Neural Systems by Jacek Zurada, Jaico Publishing House -2004
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
EEP204 ELECTIVE-II
C) DIGITAL IMAGE PROCESSING

Teaching Scheme : 03 L + 01 T  Total 04
Marking Scheme: 15 CT1 + 15 CT2 +10 TA+ 60 ESE  Total Marks :100
Duration of ESE : 2 Hrs.30 min.

Digital Image Representation: digitizing images, discrete curves, connected component, space frequency representation, multi resolution representation.

Basics Tools In Image Processing: point operations (LUT), neighborhood processing (linear filtering, rank filtering, basic morphological filtering).

Image Enhancement Techniques And Image Restoration: ad'hoc and optimal techniques; Extraction and characterization of visual cues in images: edge detection techniques (first and second derivative operations, matched filtering, optimal edge detectors), texture characterization (co–occurrence matrices, RLC, curvilinear integration, ARMA modeling). Image segmentation; fixed and adaptive histogram thresholding, boundary detection and extraction (edge thinning, edge following & edge closing), Region growing techniques, Split & Merge techniques, statistical image segmentation by markovian techniques; Statistical Pattern recognition techniques in images: methods, applications. Image analysis and scene description.

Text Books:


References

4. http://www.nptel.iitm.ac.in/
5. www.ocw.mit.edu
Probability: Definition of set, set operations, probability introduction using sets and relative frequency, joint and conditional probability, total probability, Bayes Theorem, independent events, combined experiments, Bernoulli trials.

The Random Variable: The random variable concept, the definition of random variable, conditions for a function to be a random variable, discrete and continuous random variable, mixed random variable, distribution function, density function, properties of density function, the Gaussian random variable, other distribution and density examples, binomial, Poission, exponential, Rayleigh, conditional distribution and density functions.

Multiple Random Variables: vector random variables, joint distributions and its properties, joint density and its properties, conditional distributions and density, statistical independence, central limit theorem.

Operations On Random Variables: Expectations, moments, functions that give moments, transformation of random variables, computer generation of one random variable, expected value of function of a random variable, jointly Gaussian random variable, sampling and some limit theorems.

Random Processes: Concept of random process, stationarity and independence, correlation functions, measurement of correlation functions, Gaussian random process, Poisson random process, power spectral density, relation between power spectral density and autocorrelation function.

Linear Systems With Random Inputs: Linear system response to random signals, system evaluation using random noise, spectral characteristics of system response, noise bandwidth, bandpass band limited and narrow/band processes, sampling of processes, discrete time systems, modeling of noise sources, incremental modeling of noisy networks, systems that maximize signal to noise ratio, systems that minimize mean squared error, some practical applications.

Optimum Linear Systems: Systems that maximize signal-noise ratio, systems that minimize mean squared error, Weiner filters, optimization by parameter selection

Text book:
1. Probability, Random variables and random signal principles 4/e, Peyton Z Peebles TMH, 2001

References
2. http://www.nptel.iitm.ac.in/
3. www.ocw.mit.edu
Probability and Reliability: Review of probability concepts, probability distributions, applications of binomial distribution to engineering problems, probability distribution in reliability evaluation, reliability indices, network modeling and evaluation of simple and complex networks, system reliability evaluation using probability distributions, frequency and load duration techniques, key indices of power system reliability and their calculations.

Generation System Reliability Evaluation: Concept of loss of load probability (LOLP), Energy demand, E(DNS), Evaluation of these indices for isolated systems, generation system, reliability analysis using the frequency and duration techniques.

Transmission System Reliability Evaluation: Evaluation of LOLP and E(DNS), indices for an isolated transmission system, interconnected system reliability, bulk power system reliability.

Distribution System Reliability Evaluation: Reliability analysis of radial systems with perfect and imperfect switching.

Text Books

1. Power System Reliability Calculatio, Billinton R TMH,2001

References

1. Power System Reliability Evaluation, Endreyi, PHI 2004
2. http://www.nptel.iitm.ac.in/
3. www.ocw.mit.edu
EEP205 ELECTIVE-III

A) HIGH VOLTAGE ENGINEERING

Teaching Scheme : 03 L + 01 T    Total 04
Marking Scheme: 15 CT1 + 15 CT2 +10 TA+ 60 ESE    Total Marks :100
Duration of ESE    : 2 Hrs.30 min.

Credit : 04

Mechanism Of Breakdown In Gases: Classification of insulating materials. Gases as insulating media, Ionization & decay process, breakdown in gases. Townsend’s law. The streamer mechanism of spark Paschen’s law, corona discharge, electronegative gases.

Breakdown In Liquid And Solid Dielectrics: Breakdown in pure and commercial liquids, Solid Dielectrics and composite dielectrics, High Voltage bushings, Guarding, Shielding, Field Plotting.

Lightning And Switching Over Voltages And Protection: Lightning strokes to lines and towers, mechanism & characteristics. Protection of transmission lines from lightning, Lightning Arrestors. Insulation co-ordination of HV and EHV transmission line, Power system and substation.


High Voltage And Current Measurement: Peak voltage, Impulse voltage and High Direct current Measurement methods, Non-destructive measurement and testing, High Voltage dielectrics Loss and capacitance measurement, Radio Frequency and partial discharge measurement.


Text Books
3. EHV AC Transmission Engineering, Rokosh Das Begamudre Wiley Eastern Ltd. New Delhi.2005

References
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
EEP205 ELECTIVE-III
B) OPTIMAL CONTROL

Teaching Scheme: 03 L + 01 T Total 04 Credit: 04
Marking Scheme: 15 CT1 + 15 CT2 +10 TA + 60 ESE Total Marks: 100
Duration of ESE: 2 Hrs.30 min.

Introduction: Static and dynamic optimization. Parameter optimization.


Pontryagin’s Maximum Principle: theory; application to minimum time, energy and control effort problems, and terminal control problem.

Dynamic Programming: Belaman’s principle of optimality, multistage decision processes. application to optimal control.

Linear Regulator Problem: matrix Riccati equation and its solution, tracking problem.

Computational Methods in Optimal Control: application of mathematical programming. singular perturbations, practical examples.

Text Books


References

3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
Fundamentals of Restructured System: History of power system restructuring, concept of power system deregulation, regulation vs. deregulation, entities in deregulated system, market architecture, ancillary services.

Models of Restructuring: PoolCo and bilateral contractual models, ISO based markets models, reactive power balancing market, day ahead and hour ahead markets.

Transmission Pricing: Cost components in transmission pricing, embedded cost based transmission-pricing methods, Postage Stamp, MW-Mile, incremental cost based or location marginal pricing (LMP), Tracing of power.

Transmission Open Access Issues: Available Transfer Capability (ATC)- definition and methods of determination, transmission network congestion, congestion management techniques.

Power Sector Restructuring in India: Electricity Act 2003, Evaluation of integrated, monopoly, state owned electricity boards, introduction to various institutions in Indian power sector & their role. Challenges before the Indian power sector, Planning commission CEA,NT,PFC, ministry of power, SEBS.

Text Books

1. Electric Utility Planning and regulation – Edward Kahn , University of California- 2005

References

2. Electrical Energy Utilization And Conservation :- S.C. Tripathi(TMH Pub.)-2003
3. http://www.nptel.iitm.ac.in/
4. www.ocw.mit.edu
**EEP205 ELECTIVE-III**

**D) ROBOTICS AND AUTOMATION**

Teaching Scheme : 03 L + 01 T  
Total 04  
Credit : 04  
Marking Scheme: 15 CT1 + 15 CT2 +10 TA+ 60 ESE 
Total Marks :100  
Duration of ESE : 2 Hrs.30 min.

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**Manipulator Kinematics and Mechanics of Robot Motion:** Link coordinate frames, Denavit-Hartenberg convention, Joint and end-effectors, Cartesian space, Forward kinematics transformations of position, Inverse kinematics of position, Translational and rotational velocities, Velocity Transformations, Manipulator Jacobian. Forward and inverse kinematics of velocity, Singularities of robot motion, Static Forces, Transformations of velocities and static forces, Joint and End Effectors force/torque transformations.

**Manipulator Dynamics:** Trajectory Planning, Control. Lagrangiant formulation, Model properties, Newton-Euler equations of motion, Joint-based motion planning, Cartesian-based path planning. Independent joint control, Feed-forward control, Inverse dynamics control, Robot controller architectures, Implementation problems.

**Automated Manufacturing Systems:** Introduction, Manufacturing systems, Performance measure, Computer controlled machines, Material handling systems, Plant layout. Flexible manufacturing system, Computer control system.

**Texts Books**


**References**

2. [http://www.nptel.iitm.ac.in/](http://www.nptel.iitm.ac.in/)
3. [www.ocw.mit.edu](http://www.ocw.mit.edu)
E) ENERGY MANAGEMENT AND ENERGY AUDIT

Teaching Scheme : 03 L + 01 T    Total 04
Marking Scheme: 15 CT1 + 15 CT2 +10 TA + 60 ESE    Total Marks :100
Duration of ESE : 2 Hrs.30 min.

Energy Scenario: Primary energy resources, Commercial and Non-commercial energy, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment.

Energy management: Definition, significance and objectives of energy management, principle of energy management, sectors of supply side management, Energy and economy, electricity tariff, load management and maximum demand control, power factor improvement, selection and location of capacitors, optimizing the input energy requirements, fuel and energy substitution.

Energy strategies and energy planning: Energy Action Planning: Key elements, force field analysis, Energy policy purpose, Energy planning flow for supply side, essential data for supply side energy planning, roles and responsibilities of energy manager.

Energy Audit: Definition, need of energy audit, types of energy audit, intermediate and comprehensive energy audit, end use of energy consumption profile, procedure of energy auditing, site testing and measurement. Energy security, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, energy audit instruments, Energy Conservation Act-2001.

Energy Conservation and Recycling: Energy conservation and its importance, Listing of energy conservation opportunities (ECOs), Electrical ECOs, ECOs in process industry, small industries building and shopping complexes, waste management, Recycling of discarded materials and energy recycling.

Energy Monitoring and Targeting: Defining monitoring and targeting, elements of monitoring and targeting, data and information-analysis, On line energy monitoring: Various aspects and techniques of on line energy monitoring, Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams. Financial analysis techniques-simple pay back period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis, financing options, energy performance contracts.

Text Books:
2. Introduction to energy technologies – V.A.Venikov ,E.V.Putiatin , Mir, Moskow -2006

References
EEP206 LAB-II
Teaching Scheme: 08 P + 00 Total 08 Credit: 04
Marking Scheme: 50 Internal + 50 External Total Marks: 100

It should consist of various Practical/Simulation assignments related to all Core subjects and Electives

Representative List of Experiments:
1. Program introduces the symbolic math tool box
2. Program illustrates the factoring expressions and solving equation
3. Program explains DEFINING, EVALUATING and PLOTTING FUNCTION
4. Program of illustration of DIFFERENTIAL CALCULUS
5. Program illustrates DERIVATIVES
6. Program illustrates multivariable calculus

EEP207 SEMINAR II
Teaching Scheme: 02 P + 00 Total 02 Credit: 01
Marking Scheme: 25 Internal Total Marks: 100

Seminar on any technical subject other than above syllabus
SEMESTER III

EEP301 DISSERTATION PHASE I

<table>
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<td>Evaluation Scheme</td>
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Dissertation topic selection and introductory seminar on the same
Student has to submit the report and deliver the seminar based on 25% or more work on Dissertation topic. It is to be evaluated internally by three member’s panel of examiners headed by HOD wherein guide should be one of the members of the panel. Last date of submission of report shall be two weeks before the end of semester.

SEMESTER IV

EEP401 DISSERTATION PHASE II

<table>
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<th>08 P + 00</th>
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<td>Evaluation Scheme</td>
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</table>

Final dissertation and final seminar on complete work

Dissertation (Phase-II): Internal assessment of dissertation (complete work) is to be carried out by the guide for 100 Marks. External assessment of Dissertation (complete work) is to be carried out by panel of examiner consisting of internal (guide) and external examiner for 200 marks. Candidate shall present the entire work on Dissertation, followed by viva-voce. Last date of submission of dissertation will be the end of the semester. Please see Appendix-C of Rules & Regulation for Further information.