**M.Tech. (POWER SYSTEMS AND AUTOMATION)**

**SCHEME OF INSTRUCTION AND EXAMINATION (2015 Admitted batch onwards)**

Under Choice Based Credit System

### I-Year

#### Semester – I:

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<th>Subject Title</th>
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**Common with M.Tech(CSE)**

##### Semester – II:

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II-Year

Semester III

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Semester IV

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SEMESTER III and IV: THESIS WORK

Work load: 6 Periods/Week/Student

Credits per Semester: 12

Total Credits: 24

The valuation of the thesis credits should be allotted but for the calculation of CGPA these credits will not be taken into consideration.

Candidates can do their work in the department or in any industry/research organization for two semesters (i.e. 3rd and 4th semesters). In case of thesis work to be done in an industry/research organization, the advisor/advisors should be from the industry/research organization.

It is mandatory that two seminars at least one per semester related to thesis work/ general topic in III and IV semesters and publication of a paper in conference proceeding/communicated to Journal for the submission of the Thesis at the end of 4th Semester.

At the end of 4th semester, four bound copies of the thesis are to be submitted to the department, out of which 2 to be retained by the department for evaluation purpose. The thesis is to be evaluated by an examiner external to the University with minimum M.E./M.Tech qualification with relevant specialization and must have minimum 5 years of experience in service.

A Viva-voce examination is to be conducted by a Committee consisting of Head of the department of respective college, Chairman, Board of Studies, the External Examiner who evaluates the thesis and the Advisor of the thesis, after receiving the evaluation report from the External Examiner.

In case the advisor happens to be HOD or Chairman, Board of Studies or from industry/research organization one more member from the department with relevant specialization is to be recommended as examiner by Chairman, Board of Studies for Viva-voce examination.

The Board will submit a report stating whether the thesis is approved or not approved with marks out of 100.
I-Year

Semester – I:

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** Common with M.Tech(PSA)
### II-Year

#### Semester III

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**Credits per Semester:** 12

**Total Credits:** 24

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SYLLABUS FOR M.TECH.(POWER SYSTEMS & AUTOMATION)

SEMESTER – I

EPS 1.1: ADVANCED POWER SYSTEM OPERATION AND CONTROL

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Economic operation: Economic dispatch problem of thermal units without and with losses– Gradient method- Newton’s method –Base point and participation factor method.


Optimal Power Flow: Solution of OPF, gradient method, Newton’s method, linear programming method with only real power variables, linear programming with AC power flow variables, security-constrained optimal power flow.


The control problem: The two-area system, Tie-line Bias control; steady state Instabilities: Torsional Oscillatory Modes-Damper windings and negative damping, effect of AVR loop: AGC Design using kalman method-state variable form of the dynamic model, Optimum control Index, state Trajectories, the RICCATTI equations, preventive and emergency control, computer control.

TEXT BOOKS


REFERENCES

EPC 1.2: OPTIMIZATION TECHNIQUES

(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


Classical Optimization Techniques: Introduction, Single variable optimization, Multivariable optimization with no constraints; Multivariable optimization with Equality constraints – Solution by Direct Substitution method, Method of constrained variation, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn-Tucker conditions.


TEXT BOOK:
EPC 1.3 ADVANCED DRIVES & CONTROL

(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

DC drives: System model, motor rating, motor mechanism dynamics, drive transfer function, effect of armature current waveform, torque pulsations, adjustable speed drives, chopper fed and single-phase converter fed drives, effect of field weakening.

Induction Motor drives: Basic Principle of operation of 3 Phase motor, equivalent circuit, MMF space harmonics due to fundamental current, fundamental spatial MMF distributions due to time harmonics simulation, effect of time and space harmonics, speed control by varying stator frequency and voltage, impact of nonsinusoidal excitation on induction motors, variable square wave VSI drives, variable frequency CSI drives, line frequency variable voltage drives.

Induction Motor drives: Review of induction motor equivalent circuit, effect of voltage, frequency and stator current on performance of the machine, effect of harmonics, dynamic d.q model, small signal model, voltage and current fed scalar control, direct and indirect vector control, sensor less vector control, direct torque and flux control.

Synchronous motor drives: Review of synchronous motor fundamental, equivalent circuit, dynamic d-q model, synchronous reluctance, sinusoidal and trapezoidal back emf permanent magnet motors, sinusoidal SPM machine drives, trapezoidal SPM machines drives, wound field machine drives, switched reluctance motor drives.

Closed loop control: Motor transfer function-P, PI and PID controllers, current control-Design procedure, phase locked loop (PLL) control-microcomputer control.

Text Books:

Reference Books:
1. V. Subrahmanyam, “Electric Drives-Concepts and Applications”, TMH
EPC 1.4: ADVANCED CONTROL SYSTEM DESIGN

(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Design of Linear Control Systems: Review of compensation techniques to obtain desired performance, Reshaping of Bode & Root locus plots to obtain desired response, Initial condition and forced response, a simple lag – lead design.

Integral-square error compensation: parameter optimization using Integral-square error criterion with and without constraints, principles of State variable Feedback compensation of continuous - time and discrete-time systems, simple problems to understand the concept.

MIMO Control design: Principles of Linear Quadratic Optimal Regulators, Discrete Time Optimal Regulators, Observer Design, Linear Optimal Filters, State Estimate Feedback, Transfer Function Interpretation, simple problems to understand the concept.


Text Books:

Reference Books:
EPS 1.5 (a) RENEWABLE ENERGY SYSTEMS
(ELECTIVE- I)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


Text Books:

### EPS 1.5(b) POWER SYSTEM MODELING
(ELECTIVE- I)

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**Modeling of Power System Components:** The need for modeling of power system, Simplified models of non-electrical components like boiler, steam & hydro-turbine & governor system. Transformer modeling such as auto-transformer, tap-changing & phase-shifting transformer.


**Transmission line, SVC and load modeling:** Transmission line, d-q transformation using μ-b variables, static VAR compensators, load modeling.


**Text Book:**

**Reference Books:**
EPS 1.5 (c): POWER SYSTEM PLANNING
(ELECTIVE- I)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Introduction: The electric utility industry, generation systems and transmission systems.

Load forecasting: Classification and characteristics of loads, approaches to load forecasting, load forecasting methodology, energy forecasting, peak demand forecasting, non-weather sensitive forecast (NWSF), weather sensitive forecast, total forecast.

Generation system reliability analysis: Probabilistic generating unit models, probabilistic load models, effective load, reliability analysis of an isolated system and interconnected systems.

Generation system cost analysis: Cost analysis, corporate models, production analysis, production costing, fuel inventories, energy transactions and off-peak loading, environmental cost.

Transmission system reliability analysis: Deterministic contingency analysis, probabilistic transmission system, reliability analysis, capacity state classification by subsets, subset decomposition for system LOLP and (DNS) calculations, single area and multi area reliability analysis.

Automated transmission system expansion planning: Basic concepts, automated network design, automated transmission planning, a DC method, automated transmission planning by interactive graphics.

TEXT BOOK:

SYLLABUS FOR M.E. (CONTROL SYSTEMS ENGINEERING)

SEMESTER – I

ECS 1.1: ADVANCED CONTROL SYSTEMS

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


Controllability and Observability: Controllability and Observability-Tests for Continuous time Systems- Time varying and Time invariant case-Output Controllability-observability- System Realizations.


Modal control: Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems- The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TEXT BOOKS:


REFERENCES:

EPC 1.2: OPTIMIZATION TECHNIQUES
(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


Classical Optimization Techniques: Introduction, Single variable optimization, Multivariable optimization with no constraints; Multivariable optimization with Equality constraints – Solution by Direct Substitution method, Method of constrained variation, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn-Tucker conditions.


TEXT BOOK:
EPC 1.3 ADVANCED DRIVES & CONTROL

(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

DC drives: System model, motor rating, motor mechanism dynamics, drive transfer function, effect of armature current waveform, torque pulsations, adjustable speed drives, chopper fed and single-phase converter fed drives, effect of field weakening.

Induction Motor drives: Basic Principle of operation of 3 Phase motor, equivalent circuit, MMF space harmonics due to fundamental current, fundamental spatial MMF distributions due to time harmonics simulation, effect of time and space harmonics, speed control by varying stator frequency and voltage, impact of nonsinusoidal excitation on induction motors, variable square wave VSI drives, variable frequency CSI drives, line frequency variable voltage drives.

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Closed loop control: Motor transfer function-P, PI and PID controllers, current control-Design procedure, phase locked loop (PLL) control-microcomputer control.

Text Books:

Reference Books:
1. V. Subrahmanyam, “Electric Drives-Concepts and Applications”, TMH
EPC 1.4: ADVANCED CONTROL SYSTEM DESIGN

(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Design of Linear Control Systems: Review of compensation techniques to obtain desired performance, Reshaping of Bode & Root locus plots to obtain desired response, Initial condition and forced response, a simple lag – lead design.

Integral-square error compensation: parameter optimization using Integral-square error criterion with and without constraints, principles of State variable Feedback compensation of continuous - time and discrete-time systems, simple problems to understand the concept.

MIMO Control design: Principles of Linear Quadratic Optimal Regulators, Discrete Time Optimal Regulators, Observer Design, Linear Optimal Filters, State Estimate Feedback, Transfer Function Interpretation, simple problems to understand the concept.


Text Books:

Reference Books:
ECS 1.5 (a): LARGE SCALE SYSTEMS
(ELECTIVE-I)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

L.S.S. Modelling : Time Domain: Introduction, Aggregation methods, exact and model aggregation by continued fraction, chained aggregation descriptive variables approach, descriptive variable systems, solvability and conditionality, time invariance, shuffle algorithm.


Time Scales and Singular Perturbations: Introduction, problem statement and preliminaries, numerical algorithm, basic properties, relation to model aggregation, feedback control design, singularly perturbed linear systems, fast and slow sub systems, eigenvalue distribution, approximation to time scale approach, system properties, design of optimal controllers, fast and slow controllers, lower order controls.

TEXT BOOKS:

ECS 1.5 (b): DIGITAL CONTROL SYSTEMS
(ELECTIVE- I)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


**State Space Representation:** Discrete-Time State Space Equations, Solution of Discrete-Time State Space Equations, Z-Transfer from State Space Equations, Similarity Transformation, Stability of State Space Realizations, Controllability and Stabilizability, Observability and Detectability.

**State Feedback Control:** On State and Output Feedback, Pole Placement, Servo Problem, Principles of Observer, State Feedback and Pole Assignment Using Transfer Functions.

**Text Books:**

1. Digital control systems by B.C.Kuo, Oxford University Press

**References:**

2. Digital control systems by K.Ogata
ECS 1.5 (c): ROBUST AND ADAPTIVE CONTROL
(ELECTIVE- I)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Part I  Robust Control

**Introduction:** Why Robust and Adaptive Control? Control-Oriented Models for Linear-Time-Invariant Systems, Norms of Vectors and Matrices in Euclidean Spaces.


**Output Feedback Control:** Output Feedback Using Projective Controls, Linear Quadratic Gaussian with Loop Transfer Recovery, Summary, Loop Transfer Recovery Using the Lavretsky Method.

Part II  Robust Adaptive Control


**Model Reference Adaptive Control with Integral Feedback Connections:** Introduction, Control Design, MRAC Augmentation of an Optimal Baseline Controller.

**Robust Adaptive Control:** MRAC Design in the Presence of Bounded Disturbances, MRAC Design Modifications for Robustness.

**Text Books:**
1. Robust and Adaptive Control: With Aerospace Applications, Advanced textbooks in control and signal processing, by Eugene Lavretsky, Kevin A. Wise, publisher Springer 2012
SYLLABUS FOR M.TECH.(POWER SYSTEMS & AUTOMATION)

SEMESTER – II

EPS 2.1 POWER SYSTEM DYNAMICS AND STABILITY

Credits: 4
Lectures per week: 4
Theory, Univ. Exam. Marks: 70
Sessional Marks: 30
Total Marks: 100


Dynamics of a Synchronous generator connected to infinite bus: System model, synchronous machine model, Application model(1.1), Calculation of initial conditions, System simulation, Consideration of other machine models, Inclusion of SVC model.

Small Signal Stability Analysis: Analysis of single machine system, small signal analysis with block diagram representation, Characteristic equation and application of Routh-Hurwitz criterion, synchronizing and damping torque analysis, small signal model state equations

Application of Power System Stabilizers: Introduction, Basic concepts in applying PSS, Control signals, structure and tuning of PSS.

Analysis of Multi-machine system: A simplified system model, detailed models, Case I and II, Inclusion of load and SVC dynamics, modal analysis of large power systems.

TEXT BOOK

1. Power System Dynamics, stability and control by K.R.Padiyar, Interline Publishing private limited, Bangalore, India

REFERENCES

2. Power system control and stability by P.M. Anderson and A. A. Fouad, Ezalgotia publications
EPS 2.2 AUTOMATION IN POWER SYSTEMS

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Introduction: Purpose of automatic power control systems, elements of automatic power control systems, automatic power control and controllers relays and relaying devices

Operation and control: Operations environment of distribution networks, evolution of distribution management systems, basic distribution management system functions, basis of a real-time control system (SCADA), data acquisition, monitoring and event processing, control functions, data storage, archiving, and analysis, hardware system configurations, SCADA system principles

Distribution automation: Problems with existing distribution system, need for distribution automation, characteristics of distribution system, distribution automation, feeder automation

Substation automation: Definition, functions of substation automation state and trends of substation automation, intelligent affordable substation monitoring and control

Feeder automation: Losses in distribution systems, system losses and loss reduction, network reconfiguration, improvement in voltage profile, capacitor placement for reactive power compensation, algorithm for location of capacitor

TEXT BOOKS:

1. Automation in Electrical power systems by, P.I.Zabolotny, MIR Publishers, Moscow
3. A Textbook of Electric Power Distribution Automation By Dr. M.K. Khedkar, Dr. G.M. Dhole, university science presss, new delhi2010

REFERENCE BOOKS:

1. Sunil S. Rao, Switchgear and Protections, Khanna Publication
2. Stuart A Boyer: SCADA supervisory control and data acquisition
3. Gordan Clark, Deem Reynders, Practical Modern SCADA Protocols
EPC 2.3: INTELLIGENT SYSTEMS AND CONTROL
(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


ANN based control: Introduction: Representation and identification, modeling the plant, control structures – supervised control, Model reference control, Internal model control, Predictive control, Case study-application to electrical engineering.

Fuzzy Logic: Overview of classical logic, Fuzzy sets vs Crisp set, Membership function, Methods of Membership function, Value Assignment, Defuzzification – Methods of defuzzification, fuzzy rule based and Approximation, Aggregation of Fuzzy rules, Fuzzy inference system – Mamadani and Sugeno methods.


TEXT BOOKS:

1. Bose and Liang, Artificial Neural Networks, Tata Mcgraw Hill, 1996.

REFERENCES:

8. Fuzzy sets, Fuzzy logic, fuzzy systems by – loft Asker Zadeh
9. Timothy J Ross – Fuzzy Logic with Emergency Applications
EPC 2.4: OPTIMAL CONTROL THEORY
(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


The variational approach to optimal control problems: Necessary conditions for optimal control - Linear regulator problem-Pontryagin's minimum principle and state inequality constraints.

Iterative numerical techniques for finding optimal controls: Two-point boundary-value problems-The method of steepest descent-Features of the steepest descent algorithm.

TEXT BOOK:

EPS 2.5 (a): HIGH VOLTAGE AC/DC TRANSMISSION  
(ELECTIVE- II)

Credits : 4  
Lectures per week : 4  
Theory, Univ. Exam. Marks : 70  
Sessional Marks : 30  
Total Marks : 100

EHV AC Transmission: Principles, configuration, special features of high voltage AC lines, power transfer ability, reactive power compensation, audible noise, corona, electric field, right of way, clearances in a tower, phase to phase, phase to ground, phase to tower, factors to be considered, location of ground wire.

Lightning, Travelling waves and switching Transients: Mathematical model to represent lightning- Travelling wave in transmission lines-Circuits with distributed constants- Wave equations- Reflection and Refraction of travelling waves- Travelling waves at different line terminations-effect of short length of cables- Shape and attenuation and distortion of travelling waves- Switching transients- the circuit closing transient-the recovery transient initiated by the removal of the short circuit.

Protective device in HVAC transmission: 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 lightning arrestors.


Modeling and analysis of AC and DC systems interaction: System models, application of switching functions, torsional interactions with HVDC systems, harmonic interaction, control interaction.

TEXT BOOKS:

1. Allen Greenwood, `Electrical Transients in power system', Wiley Interscience,1971  
2. EHV AC Transmission by Rakosh Das Begamudre, New Age Publishers  

REFERENCES:

2. Diesendorf,W., `Overvoltage on High voltage system'Rensselaer Book store ,Troy, New York,1971  
6. HVDC Transmission- Adamson C. Hingorani N.G.
7. Power Transmission by DC Uhimann E.
8. HVAC and HVDC Transmission, Engineering and practice : S. Rao, Khanna Publisher, Delhi.

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**EPS 2.5 (b): POWER QUALITY**  
**(ELECTIVE- II)**

<table>
<thead>
<tr>
<th>Credits</th>
<th>4</th>
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<tr>
<td>Lectures per week</td>
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<tr>
<td>Theory, Univ. Exam. Marks</td>
<td>70</td>
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<td>Sessional Marks</td>
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<tr>
<td>Total Marks</td>
<td>100</td>
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**Introduction**: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring


**Short Interruptions**: Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

**Voltage sag – characterization – Single phase/ Three-phase**: Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non radial systems, meshed systems, voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags

**Power Quality and EMC Standards**: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

**TEXT BOOK:**

EPS 2.5 (C) - POWER ELECTRONIC APPLICATIONS IN POWER SYSTEMS (ELECTIVE-II)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

**Introduction:** Basics of Power Transmission Networks - Control of Power Flow in AC Transmission Line - Flexible AC Transmission System Controllers, Basic types of FACTS Controllers, Brief Descriptions 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 SVC and STATCOM, Static VAR systems.

**Static Synchronous Compensator (STATCOM):** Introduction - Principle of Operation of STATCOM - A Simplified Analysis of a Three Phase Six Pulse STATCOM - Analysis of a Six Pulse VSC Using Switching Functions - Multi-pulse Converters Control of Type 2 Converters - Control of Type 1 Converters - Multilevel Voltage Source Converters - Harmonic Transfer and Resonance in VSC Applications of STATCOM

**Static Phase Shifting Transformer:** General - Basic Principle of a PST - Configurations of SPST Improvement of Transient Stability Using SPST - Damping of Low Frequency Power Oscillations - Applications of SPST

**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, Summery of Characteristics and Features.

**TEXT BOOKS:**


**REFERENCES:**

SYLLABUS FOR M.E. (CONTROL SYSTEMS ENGINEERING)

SEMESTER – II

ECS 2.1: NON-LINEAR CONTROL SYSTEMS

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

Introduction to Non-Linear System: Classification of non-linearity, types of non-linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non-linear systems and comparison, isoclines, singular point, limit cycle.

Phase Plane Analysis: Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol’s equation, stability from phase portrait, time response from trajectories, isoclines method, Pell’s method of phase trajectory, and Delta method of phase trajectory construction.

Frequency Domain Analysis: Absolute stability, Describing function, DF of typical nonlinearities stability analysis using DF method, stability studies using DF method.


Linearization: Linear systems, linearization of nonlinear systems about equilibrium point, feedback linearization and input/output linearization.

TEXT BOOK:


REFERENCE BOOK:

2. Control System Engineering: Nagrath and Gopal, Wiley Eastern
4. Nonlinear Systems: Hasan A. Khalil, Printece Hall of India
ECS 2.2: CONTROL SYSTEM COMPONENTS:

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


Tachometers and Synchros: Construction details, e.m.f equation of tachometers, types of tachometers, characteristics of tachometers, tachometer applications. Constructional details and working of Synchros, Principles of Resolvers and Decoders,


Magnetic Amplifiers and Servo Amplifiers: construction, types of magnetic amplifiers – series, parallel and self saturated magnetic amplifiers, Characteristics of magnetic amplifiers, features of servo amplifiers, DC and AC servo amplifiers.

MEMS and Accelerometers: Introduction to MEMS, definitions, classification and applications. Introduction to the Accelerometer and types of accelerometers.

TEXT BOOK:


REFERENCE BOOKS:

EPC 2.3: INTELLIGENT SYSTEMS AND CONTROL
(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100


ANN based control: Introduction: Representation and identification, modeling the plant, control structures – supervised control, Model reference control, Internal model control, Predictive control, Case study-application to electrical engineering.

Fuzzy Logic: Overview of classical logic, Fuzzy sets vs Crisp set, Membership function, Methods of Membership function, Value Assignment, Defuzzification – Methods of defuzzification, fuzzy rule based and Approximation, Aggregation of Fuzzy rules, Fuzzy inference system –Mamadani and Sugeno methods.


TEXT BOOKS:

1. Bose and Liang, Artificial Neural Networks, Tata Mcgraw Hill, 1996.

REFERENCES:

8. Fuzzy sets, Fuzzy logic, fuzzy systems by – loft Asker Zadeh
9. Timothy J Ross – Fuzzy Logic with Emergency Applications
EPC 2.4 : OPTIMAL CONTROL THEORY
(COMMON FOR POWER SYSTEMS AND AUTOMATION & CONTROL SYSTEM ENGINEERING)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

**Introduction:** Problem formulation- State variable representation of systems – Performance measures for optimal control problems – selecting a performance measure.

**Dynamic programming:** The optimal control law - principle of optimality and its application - optimal control system - interpolation - recurrence relation of dynamic programming-computational procedure for solving optimal control problems –characteristics of dynamic programming solution-analytical results-discrete linear regulator problems- Hamilton- Jacobi-Bellman equation-continuous linear regulator problems.

**The Calculus of variations:** Fundamental concepts- linearity of functional-closeness of functions-the increment of a functional-The variation of a functional- maxima and minima of functional- the fundamental theorem of the calculus of variations - Functional of a single function- the simplest variational problem

**The variational approach to optimal control problems:** Necessary conditions for optimal control - Linear regulator problem-Pontryagin's minimum principle and state inequality constraints.

**Iterative numerical techniques for finding optimal controls:** Two-point boundary-value problems-The method of steepest descent-Features of the steepest descent algorithm.

**TEXT BOOK:**

ECS 2.5 (a): SLIDING MODE CONTROL
(ELECTIVE - II)

Credits : 4
Lectures per week : 4
Theory, Univ. Exam. Marks : 70
Sessional Marks : 30
Total Marks : 100

An Introduction to Sliding Mode Control: Introduction, properties of sliding motion, typical controller design, pseudo-sliding with a smooth control action, a state-space approach

Sliding mode control: Introduction, problem statement, existence of solution and equivalent control properties of the sliding motion, The reachability problem, the unit vector approach, continuous approximations.

Sliding mode Design approaches: Introduction, A regulator form based approach, a direct eigenstructure assignment approach, Incorporation of a tracking requirement, Design study of Pitch-pointing flight controller.

Sliding mode controllers using output information: Introduction, problem formulation, a special case of square plants, a general frame work, dynamic compensation, observer based dynamic compensation, a model reference system using only outputs.

Sliding mode observers: Introduction, sliding mode observers, synthesis of a discontinuous observer, the Walcott-Zak observer revisited, sliding mode observers for fault detection

TEXT BOOK:

1. Sliding Mode Control: Theory And Applications (Series in Systems and Control) by C Edwards and S Spurgeon, Published by Taylor & Francis,

REFERENCE:

2. Sliding Mode Control In Engineering (Automation and Control Engineering) by Wilfrid Perruqueti, Jean-Pierre Barbot published by Marcel Dekker, Inc, New York
Hierarchical Control of Large Scale Systems: Introduction- Coordination of Hierarchical Structures - open Loop and closed loop Hierarchical control of control of continuous - time systems-Hierarchical control of Discrete time approach - Costal prediction approach.

Decentralized control of Large Scale Systems: Introduction - problem formulation of decentralized stabilization - fixed polynomials and fixed modes - stabilization via dynamic compensation -stabilization Via local state feedback - stabilization Via Multilevel control.


TEXT BOOK:

1. Large scale systems modelling and control, Mobamma Jamshidi, 1983, North-Hochand (Chapters 4, 5 and 6).
ECS 2.5 (c): ROBOTICS 
(ELECTIVE- II) 

Credits : 4 
Lectures per week : 4 
Theory, Univ. Exam. Marks : 70 
Sessional Marks : 30 
Total Marks : 100 


Robot classification: according to 1) Co-ordinate system: Cartesian, cylindrical, spherical, SCARA, Articulated 2) Control Method: Servo controlled and non-servo controlled, their comparative study 3) Form of motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study 4) Motion conversion: Rotary to rotary, rotary to linear and vice versa. 

Robot arm dynamics: Newton Euler Equations, Kinetic and potential energy, Lagrangian analysis for a single prismatic joint working against gravity and single revolute joint. Joint vector, homogeneous co-ordinates. Matrix operators for translation and rotation 

Robot Control: Open loop and closed loop control, Linear control Schemes, PD and PID control, Torque and Force control of robotic manipulators, Adaptive control, Hybrid control, Impedance control. Manipulator Jacobian, Jacobian for prismatic and revolute joint. Jacobian Inverse, Singularities, Control of Robot manipulator: joint position controls (JPC), resolved motion position controls (RMPC) and resolved motion rate control (RMRC) 

Industrial Applications: Industrial Applications of Robots: Welding, Spray-painting, Grinding, Handling of rotary tools, Parts handling/transfer, Assembly operations, parts sorting, parts inspection, Potential applications in Nuclear and fossil fuel power plant etc. 

TEXT BOOKS: 


REFERENCE BOOKS: 

1. Arthur J. Critchlow, "Introduction to Robotics" 