EIGHTH SEMESTER

Flexible AC transmission System (EL20811)

Objectives

- To impart the knowledge, to tackle the problem of regulatory constraints on the expansion of power transmission network by introduction of high power electronic controllers for regulation of power flow and voltages in the AC transmission network.

Syllabus:

UNIT I: **Introduction of semiconductor devices**
Flow of power in AC system, Steady state and dynamic problems in AC systems loading capability, controllable parameters, basic types of FACTS controllers, Flexible AC transmission systems (FACTS) Basic realities and roles.

UNIT II: Voltage Source Converters (VSC)
Basic concepts of VSC, single-phase full wave bridge converter operation, single phase-leg operation, three-phase full wave bridge converter and its operation, transformer connections for 12-pulse, 24-pulse and 48-pulse operation.

UNIT III: Current source converters (CSC)
Basic concepts, three-phase CSCs, three-phase full wave rectifier, comparison of VSC and CSC. Static shunt compensators: basic concepts, method of controllable VAR generation, Static VAR compensator, (SVC), application of SVC in power systems.

UNIT IV: Shunt Compensators
Introduction, mathematical model, working of STATCOM, V-I and V-Q characteristics, transient stability enhancement and exchange of real power using STATCOM, comparison of SVC and STATCOM, Merits of hybrid compensators.

UNIT V: Static Series Compensators
Objectives of series compensation, variable impedance type series compensation, GTO thyristor controlled series capacitors (GCSC), thyristor controlled series capacitor (TCSC), basic concepts of GCSC and TCSC, static synchronous series compensator (SSSC). Introduction to Unified Power Flow Controller (UPFC).

Text Books:
1. *"Understanding FACTS",* Hingorani.
2. *"Thyristor controlled FACTS devices*", Mathur

Reference Books:
1. *"FACTS for Transmission lines"*, Song, Yu.
2. Recent publications on IEEE Journals.
3. "*Power Quality*", G.T. Heydt, Stars in a Circle Publications, Indiana, 1991.
4. "*Static Reactive Power Compensation*" T.J.E. Miller, John Wiley & Sons, New York, 1982.

Course Outcomes:

After the completion of the course the student will be able to:

- Understand the bottle necks in power transmission systems and the methods to overcome them.
- Familiarize with the methods of shunt compensation for active and reactive power compensation.
- Acquainted with the methods of series compensation for active and reactive power compensation.
- Understand the principal of operation and controllability of different FACTS controllers and analyzing their effects.

POs / COs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓					✓		✓	✓
2	✓	✓	✓					✓		✓	✓
3	✓	✓	✓					✓		✓	✓
4	✓	✓	✓					✓		✓	✓

Power Apparatus System(EL20813)

Objectives

- To understand the various apparatus used in electrical power system.
- To understand the basic concepts of earthing and surge protection schemes along with insulation coordination and reliability of transmission and distribution systems.

Syllabus*:*

UNIT I: Overhead Line Design

Types of Insulator, String Efficiency, Improvement of voltage distribution, Improvement of String Efficiency, Line Supports, Types of Steel Towers, Cross Arms, Equivalent span, Conductor configurations, Spacing & Clearance, Sag & Tension calculations, Erection conditions, Factors affecting Sag, Sag Template, Catenary, Vibration of conductors & prevention, Selection of conductor size, Cross arm, No. Of circuits, Selection of ground wire

UNIT II: Electrical Substation and Earthing:
Types of Substation, Layout and Bus Bar schemes, Voltage level, Substation equipments Protection & Control Substation Earthing, Tolerance limits of body currents, Soil resistivity, Earth resistance, Tolerable & Actual Step & Touch Voltages, Design of Earthing Grid, Tower Footing Resistance, Measurement of soil & earth resistivity

UNIT III: Power System Earthing:
Ground versus isolated neutral, Solidly and effectively grounded system Resistance and Impedance Grounding, Resonant Grounding, Reactance Grounding, Voltage Transformer Grounding, Zigzag Transformer Grounding, Grounding practice, Effect of grounding on system over voltages & protection over voltage and over voltage phenomenon in isolated and grounded neutral system.

UNIT IV: Surge Protection and Insulation Co-ordination:
External and Internal over voltages mechanism of lighting discharge, wave shapes of stroke current line design based on direct stroke, over voltage protection, earth wire Rod gap T.F.R., Expulsion tube, surge diverter. General idea, Selection of B.I.L., International recommendation, Selection of arrester rating, Co-ordination of protector devices with apparatus insulation

UNIT V: Reliability of Transmission and Distribution Systems:
Definition, Outage, Bath Tub Curve, Two State Model, Failure & Repair Rate, Probability Density Function, Probabilities of Survival & Failure, Mean Time to Failure, Mean Down Time,Reliability of Series & Parallel Systems, Two-State Fluctuating Environment, Approximate Method, Reliability Planning, Preparation of Reliability Models.

Textbook:
1. *"Power System Analysis and Design"*, B.R. Gupta,S.Chand
2. *"Sub Station Design and Equipment"*, Gupta &Satnam (DhanpatRai& Sons)

Reference books:
1. *"Transmission & Distribution",*Westinghouse
2. *"A Course in Electrical Power",*J.B. Gupta, Kataria

Course Outcomes:

After the completion of the course the student will be able to:

- Explain the practical application of different types of apparatus used in power system.
- Illustrate the concepts of substation, bus-bar scheme, earthing, and protection.
- Apply the knowledge of different types of power system earthing which are useful practically in the field.
- Apply the surge protection schemes and insulation coordination.

- Analyse themechanism of lightning and surges and evaluate the reliability of transmission and distribution systems.

POs / COs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓		✓					✓	✓
2	✓	✓	✓				✓			✓	✓
3	✓	✓	✓				✓			✓	✓
4	✓	✓	✓				✓				✓
5	✓	✓	✓		✓		✓			✓	✓

Modern Control System Engineering (EL20814)

Objectives:

- To understand the various engineering system using modern strategies.
- To understand the basic concepts controller designing and optimisation.

Syllabus:

UNIT I: Non-Linear Control System
Introduction, some common types of nonlinearities, comparison of linear and non-linear systems, properties of non-linear control systems, describing functions, stability analysis using describing functions, limit cycle, lyapunov Stability Analysis of Linear and Non-linear Systems, Second method of Lyapunov with four stability theorems.

UNIT II: State Space Analysis
Basics: State and its non-uniqueness, Eigen values and its invariance, Diagonalization and Jordan canonical form, Caylay- Hamilton theorem, Computation of state transition matrix by **(a)**Inverse Laplace method **(b)**Caylay Hamilton method and **(c)** other methods. Controllability and observability of time invariant systems, State equations in CCF, OCF and Diagonal Canonical form, Decompositions of Transfer Functions, Effect of Pole-Zero cancellation in Transfer Function.

UNIT III: Control System Design by State Space
Pole placement design, Ackermann's Formula for pole placement, Design of full and reduced order state observers, Design of Servo system.

UNIT IV: Discrete System Control

Introduction, Impulse sampling and Data Hold, Reconstructing original signals from sampled signals, Pulse Transfer Function, Mapping between the s-plane and the z-plane, Dominant pole, Characteristic equation, Roots, Stability Analysis using Bilinear transformation Method of Jury's stability test, Solution of discrete time state equations.

UNIT V: Optimal Control Systems

Parametric optimization problem using second method of Lyapunov, Quadratic optimal control problems, Matrix Riccati equation, Alternate approach to determine optimal feedback gain matrix, Solving optimal control problems using Hamiltonian and Pontrygin's Maximum Principle.

Test Books:

1. "*Modern Control Systems Engineering*", Ogata, PHI.
2. *"Digital Control Systems"*, Benjamin. C Kuo; Oxford University Press, Second edition.

Reference Books:

1. *"Modern control engineering"*, Roy Choudhary, PHI.
2. *"Control System Analysis and Design"*,K K Agarwal.
3. *"Control Engineering Theory and Practice",*M N Bandhopadhyay, PHI.
4. *"Introduction to Control Engg. Model, Analysis and Design"*, Ajit K Mandal, New Age International Publishers.
5. I J Nagrath and M Gopal; New Age international Publishers, Forth Edition

Course Outcomes:

After the completion of the course the student will be able to:

- Explain the advantages of modelling engineering systems in time domain by state space analysis.
- Demonstrate basic nonlinearities and analyze stability of nonlinear systems.
- Design the controllers using state space approach.
- Design of optimal controllers for linear systems.
- Illustrate the representation, analysis and controller design in digital domain.

POs / COs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓		✓		✓	✓	✓	✓
2	✓	✓	✓	✓		✓		✓		✓	✓
3	✓	✓	✓	✓	✓	✓				✓	✓
4	✓	✓	✓	✓		✓					✓

5	✓	✓	✓	✓	✓	✓					✓

ELECTRIC DRIVES (EL20812)

Objectives:

- To understand the concept and different components of electrical drives and their role in our society
- To understand structure, operating concept and applications of DC Drive systems
- To understand structure, operating concept and applications of AC Drive systems
- To acquire the knowledge of different methods of speed control and braking of AC and DC drives and its influence on the operation of drives.
- To acquire the knowledge of structure, different features, advantages and practical applications of traction drives.

UNIT I: Electric Drives
Basic concept of electric drives, Requirement of electric drives, fundamental torque equation, speed torque converter and multi quadrant operation, equivalent values of drive parameters, concept of load torque, calculation of time and energy loss in transient operation, steady state stability and load equalization.

UNIT II: Drives Control
Speed control and drive classification, closed loop control of drives, current limit control, closed loop torque control, closed loop speed control, closed loop speed control of multi motor drives, phase locked loop controller (PLL), closed loop position control.

UNIT III: DC Drives
DC motor drives, Controlled rectifier Fed dc drives, DC motor speed control and their performance.

UNIT IV: AC Drives
Induction motor drives, Review of conventional method of Starting, Braking and Speed control, Dynamic model of induction motor, Cyclo-converter fed drives, Static Kramer &Scherbius drives, vector control of induction motor

UNIT V: Traction drives
Nature of traction load, important feature of traction drives, Motors employed in traction, Conventional method for AC and DC traction drives control, Semiconductor converter controlled drives employing DC motors, AC motors for 25kV AC traction drives.

Text Books:
1. *"Fundamentals of electrical drives"*,G K Dubey, 2nd edition, NarosaPb
2. *"Electric Drives"*,VedamSubramanyam, TMH Pbs.
3. *"Utilization of electric energy"*, Taylor, Orient Longman Pbs.

Reference Books:
1. "Electric drives", De and Sen, PHI Pbs.

2. “A first course on Electric drives”, S K Pillai, University press.
3. “Modern Power Electronics and A C Drives” B K Bose, Pearson Education.

Course Outcomes:

After the completion of the course the student will be able to:

- Understand the structure and concept of electrical drives and appreciate its role in our society.
- Describe the structure of DC Drive systems and their role in various applications.
- Describe the structure of DC Drive systems and their role in various applications.
- Infer the different methods of speed control and braking of AC and DC drives and its influence on the operation of Drives.
- Appraise the concepts, advantages and practical applications of traction drives.

POs / COs	a	b	c	d	e	f	g	h	i	j	k
1	✓								✓	✓	✓
2	✓	✓	✓	✓	✓	✓			✓	✓	✓
3	✓	✓	✓	✓	✓	✓			✓	✓	✓
4	✓	✓	✓	✓	✓	✓				✓	✓
5	✓	✓			✓				✓	✓	

Electrical Drives Lab (EL20821)
B.Tech (Electrical Engineering) VIIISemester

List of Experiments

1. To study the operation of bridge type single phase fully controlled converter.
2. To study the operation of mid-point converter.
3. To study the operation of bridge type single phase semi controlled converter.
4. To Measure the following DC Motor Parameters using WARD LEONARD set up.
   (a) Armature Resistance Measurement
   (b) Armature Inductance Measurement
   (c) Field Resistance Measurement
   (d) Field Winding Inductance Measurement
   (d) Back emf constant / torque constant
5. To study the operations of single-phase step down cycloconverter using lamp load and motor load.

6. To investigate the characteristics and performance of separately excited DC motor using virtual instrumentation (machine core system).
7. To investigate the characteristics and performance of DC shunt motor using virtual instrumentation (machine core system).
8. To investigate the characteristics and performance of DC series motor using virtual instrumentation (machine core system).
9. To investigate the characteristics and performance of three phase induction motor using virtual instrumentation (machine core system).

Course Outcomes (COs):

After the completion of the course the student will be able to:

- Utilize measuring instruments (DSO, power supply, virtual instrumentation etc.) for analyzing the performance of various drives.
- Demonstrate and analyze the steps involved in the operation of converter-fed AC and DC drives.
- Infer the effect of variation in controller parameters on the speed profile of AC/DC drives.
- Interpret and distinguish the stages and components of AC and DC drives set-up.
- Interpret the utility of AC and DC Motor drives in industrial settings.

COsPOs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓		✓				✓	
2	✓	✓	✓	✓		✓			✓	✓	✓
3	✓	✓	✓	✓		✓				✓	✓
4		✓	✓	✓		✓				✓	✓
5		✓	✓	✓	✓	✓			✓	✓	✓

Simulation Lab (Subject Code: EL20822)
B.Tech. (Electrical Engineering) VIII Semester

List of Experiments

Perform any Ten from the Following list of following Experiments

1. To study the load flow analysis of multi-machine power system
2. Transient stability analysis of a single-machine infinite bus power system.
3. Analysis of symmetrical and asymmetrical fault on a power system using MATLAB/SIMULINK.

4. To study the load frequency control of a two area power system using MATLAB/SIMULINK.
5. Analysis of a large circuit using malab using nodal/mesh technique.
6. Simulation of following opamp circuits using Simscape toolbox of MATLAB:
   (a) inverting amplifier (b) non-inverting amplifier (c) integrator
7. Simulation of uncontrolled rectifier with R, RL and RLE load.
8. Simulation of full-wave bridge-rectifier with R, RL and RLE load.
9. Simulation of step-up/step-down chopper circuit.
10. Mathematical modeling and simulation of separately excited dc motor using MATLAB/SIMULINK and to find the overall transfer function of the system.
11. Time response analysis of a standard second order control system using MATLAB
12. Design of a PI controller for desired performance specification.
13. Frequency response analysis for a system with given transfer function and to find gain and phase margins using MATLAB functions.
14. State space analysis of a given system and to evaluate the controllability and observability of the system.

Course Outcomes (COs):

After the completion of the course the student will be able to:

- Apply the concepts of Programming and Simulation in analyzing various systems
- Design the simulation model for various systems using important simulation software such as MATLAB, PSCAD, PSim, MiPower etc.
- Analyze different systems in both time and frequency domain by both programming and simulation techniques
- Utilize the simulation tools to evaluate the performance of various systems in different subject domains
- Design controllers for linear systems and access its effects on improving the system response

COs \ POs	a	b	c	d	e	f	g	h	i	j	k
1	✓	✓	✓	✓	✓	✓				✓	✓
2	✓	✓	✓	✓	✓	✓				✓	
3	✓	✓	✓	✓	✓	✓				✓	✓
4	✓	✓	✓	✓	✓	✓				✓	
5	✓	✓	✓	✓	✓	✓				✓	✓