Department of Electrical and Electronics Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

Course Information Sheet
for
M.Tech in Electrical Engineering (Power System)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programs and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become an internationally recognized centre of excellence in academics, research and technological services in the area of ***Electrical and Electronics Engineering*** and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently.
- Developing engineers with managerial attributes capable of applying appropriate technology with responsibility.
- Creation of congenial atmosphere and ample research facilities for undertaking quality research to achieve national and international recognition by faculty and students.
- To strive for internationally recognized publication of research papers, books and to obtain patent and copyrights.
- To provide excellent technological services to industry for the benefit of society.

Program Educational Objectives (PEO)

PEO 1: To acquire in-depth knowledge of complex Electrical Engineering problems especially in Power Systems to impart ability to discriminate, evaluate, analyze critically and synthesize knowledge pertaining to state of art and innovative research.

PEO 2: To solve complex power system problems with commensurate research methodologies as well as modern tools to evaluate a broad spectrum of feasible optimal solutions keeping in view socio- cultural and environmental factors.

PEO 3: To posses wisdom regarding group dynamics to efficaciously utilize opportunities for positive contribution to collaborative multidisciplinary engineering research and rational analysis to manage projects economically.

PEO 4: To communicate with engineering community and society at large adhering to relevant safety regulations as well as quality standards.

PEO 5: To inculcate the ability for life-long learning to acquire professional and intellectual integrity, ethics of scholarship and to reflect on individual action for corrective measures to prepare for leading edge position in industry, academia and research institutes.

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: Anability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Recognise the need for continuous learning and will prepare oneself to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex power system problems.

PO5: Demonstrate knowledge of engineering and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.

PO6: Possess knowledge and understanding to recognize opportunities and contribute to collaborative-multidisciplinary research, demonstrate a capacity for teamwork, decision-making based on open-mindedness and rational analysis in order to achieve common goals.

COURSE INFORMATION SHEET

Course code: EE501
Course title: Advanced Digital Signal Processing
Pre-requisite(s): Basics of signals and systems, transform methods, Filter theory.
Credits: 3 L T P
3 0 0
Class schedule per week: 3 Lectures
Class: M.Tech
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	enumeratethe basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner by employingdifferent mathematical operations like folding, shifting, scaling, convolutions, Z-transform etc;
2.	determine transfer function, impulse response and comment on various properties like linearity, causality, stability of a system;
3.	predict time and frequency response of discrete-time systems using various techniques like Z-transform**,** Hilbert transform**,** DFT, FFT;
4.	designdigital IIR and FIR filters using filter approximation theory, frequency transformation techniques, window techniques and finally construct different realisation structures;
5.	apply DSP processor in processing of 1D and 2D signals.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	state sampling theorem and reproduce a discrete-time signal from an analog signal; acquire knowledge of multi rate digital signal processing, STFT and wavelets;
CO2	classify systems based on linearity, causality, shift-variance, stability criteria and represent transfer function of the selected system;
CO3	evaluate system response of a system using Z-transform, convolution methods, frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques;
CO4	designFIR and IIR filters used as electronic filter, digital filter, mechanical filter, distributed element filter, waveguide filter, crystal filter, optical filter, acoustic filter, etc.;
CO5	construct (structure) and recommend environment-friendly filter for real- time applications.

SYLLABUS

EE501 Advanced Digital Signal Processing

Module I

Introduction: Overview of discrete time signal and systems, Types of discrete time systems, Analysis of discrete-time linear time invariant systems, Multirate signal processing: Decimation by factor D, I sampling rate conversion by a rational factor I/D. Z-transform, Properties of Z-transform, Inverse of Z-transform, Chrip Z-ransform, Zury's test for stability, Digital filter structures: Direct form I & II, Cascade, Parallel and Ladder realizations.

(8L)

Module II

Frequency domain analysis: Discrete Fourier transform (DFT), Inverse DFT, Inter relationship with z-transform and Hilbert-transforms, Discrete Hilbert transform, FFT algorithms- Decimation in time and decimation in frequency. Spectral analysis using DFT, Short term DFT.

(8L)

Module III

Filter function approximation, transforms and IIR filter design: Review of approximation of ideal analog filter response. Butterworth, Chebyshev type I & II, IIR filter designs based on impulse invariant and Bilinear transformation.

(8L)

Module IV

Design of FIR Filters: Characteristic of FIR filters with linear phase, Symmetric and antisymmetric FIR filters, design of linear phase FIR filters using windows and frequency sampling methods, comparison of FIR and IIR filters.

(8L)

Module V

DSP Processor and applications: Introduction to DSP processor, Types of architectures, DSP support tools, code composer studio, compiler, assembler and linker, Introduction TMS320 C6x architecture, functional units, fetch and execute packets, pipe lining, registers, Linear and circular addressing modes. DSP applications in the area of biomedical signal, speech, and image.

(8L)

Books Recommended:

Text Book

1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications.
2. Alan V. Oppenheim Ronald W. Schafer, Digital Signal Processing, PHI, India.

Reference Book

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. S. Salivahanan C Gnanapriya, Digital Signal Processing, Tata McGraw Hill Education Private Limited.
3. A. NagoorKani, Digital Signal Processing, McGraw Hill Education Private Limited.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

1. Visualize different signal processing techniques in real time.
2. Application of real time implementation of digital filter.

POs met through Gaps in the Syllabus:PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

Adaptive signal processing, Image processing.

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	-	-
CO2	3	2	1	2	-	1
CO3	3	1	2	3	-	1
CO4	2	2	2	3	2	2
CO5	2	2	3	1	3	3

$< 34\% = 1$, $34\text{-}66\% = 2$, $> 66\% = 3$

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE503
Course title: Modern Control Theory
Pre-requisite(s): B.E./B.Tech. in ECE/EEE with basic courses on Control Theory
Co- requisite(s): Linear Algebra

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	state basic concepts of state variables, state diagrams, controllability, observability;
2.	extend comprehensive knowledge of mathematical modelling of physical system;
3.	illustrate basics of transformations and decompositions for controllability and observability tests;
4.	enhance skills with application of different control strategy for designing a control problem;
5.	design controller for any type of linear plants.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	demonstrate an understanding of the building blocks of basic and modern control systems by creating mathematical models of physical systems in input-output or transfer function form;
CO2	organize state representations to satisfy design requirements using transformations and decompositions;
CO3	examine state space equations for time domain analysis;
CO4	assess a system for its stability, controllability, and observability properties leading to design of controller and observer in a feedback control system;
CO5	aspire for pursuing a carrier in control, recognize the need to learn, to engage and to adapt in a world of constantly changing technology and play role of team leader or supporter of team.

SYLLABUS

EE503 Modern Control Theory

Module I

Background and Preview, Modelling, Highlights of Classical Control Theory; Block diagram, Transfer functions, State Variables and State Space description of dynamic systems, State diagrams, Differential equations to state diagrams, State diagrams to Transfer function, State diagrams to state and output equations, State equations from system's linear graph.

(8L)

Module II

Fundamentals of Matrix Algebra, Vectors and Linear Spaces, Simultaneous Linear Equations, Eigenvalues and Eigenvectors, Functions of Square Matrices, Similarity Transformations, CCF, OCF, DCF and JCF forms, Decomposition of Transfer Functions, The Caley-Hamilton Theorem and it's applications.

(8L)

Module III

Analysis of Continuous and Discrete-Time Linear State Equations, Local linearization of non-linear models, State Transition Matrix, Significance, Properties and Evaluation of STM, Stability analysis using direct method of Lyapunov.

(8L)

Module IV

Controllability and Observability concept for linear Systems, Relationship among Controllability, Observability and Transfer Functions, Invariant theorems on Controllability and Observability.

(8L)

Module V

Design of Linear Feedback Control Systems, pole placement design through state feedback, Design of servo systems, State observers, Design of Regulator Systems with observers, Design of control systems with Observers, Quadratic Optimal Regulator Systems.

(8L)

Books Recommended:

Text Book

1. Modern Control Theory by Brogan, Pearson, 3rd edition. (**T1)**
2. Systems and Control by Zak, 1st edition, Oxford University Press. **(T2)**
3. Modern Control System Theory by M. Gopal, New Age International(P) Ltd., 2nd edition. (**T3**)
4. Automatic Control Systems by F. Golnaraghi and B.C.Kuo, Wiley Student Edition, 9th edition. (**T4**)

5. Modern Control Engineering by K. Ogata, Pearson, 5th edition (**T5**)

Reference Book

1. Digital Control & State Variable Methods – M. Gopal, Tata McGraw Hill Education. (**R1**)
2. Linear Systems by Thomas Kailath, Prentice-Hall Inc.,1980. (**R2**)

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations.

Gaps in the syllabus (to meet Industry/Profession requirements):

1. Design of real-time industrial projects.

POs met through Gaps in the Syllabus: PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

1. Design optimization for industrial projects, Fractional order controller.

POs met through Topics beyond syllabus/Advanced topics/Design:PO5 & PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	3	-	1	3	-	1
CO3	3	1	2	3	-	1
CO4	3	2	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE531
Course title: Advanced Power System Analysis (Program Core)
Pre-requisite(s): B.E./B.Tech. in ECE/EEE
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students:

1.	to define single-phase modeling of power system components;
2.	to describe steady state operation of large-scale power systems and to solve the power flow problems using efficient numerical methods suitable for computer simulation like N-R,FDLF, Continuation Load Flow, Series Load Flow;
3.	to analyze power systems under abnormal conditions (short circuit) utilizing bus impedance matrix for short circuit analysis;
4.	to analyze power system security in different outage events by contingency analysis and assess the state estimation;
5.	to extend the knowledge for solving harmonic load flow analysis stating the causes for harmonic content and modeling component in harmonic domain.

Course Outcomes:
After completion of the course, the learners will be able to:

CO1	draw the impedance and reactance diagram and can explain different components modeling for load flow, short circuit, contingency analysis and harmonic analysis of power system;
CO2	solve load flow problems by different methods;
CO3	Identify and analyze the different abnormal (fault) conditions in power system utilizing efficient computer algorithm;
CO4	explain different factors affecting the power system security for single and multiple contingencies;
CO5	explain different numerical methods for state estimation of power system.

SYLLABUS

EE531 Advanced Power System Analysis (Program Core)

Module I

Introduction: Modeling of power system component, Basic single-phase modelling, Generation, Transmission line, Transformers, Shunt elements.

(8L)

Module II

Load Flow Analysis: Introduction, Nature of load flow equations, Newton Raphson method: Formulation for load buses and voltage controlled buses in rectangular and polar co-ordinates, Computational steps and flow chart, Computational Aspects of Large Scale System - Introduction, Sparsity oriented technique for reducing storage requirements, Factorization.

(8L)

Module III

Decoupled Load Flow: Formulation, Fast decoupled load flow method, Continuation load flow technique, Series load flow technique. Harmonic Analysis - Power Quality, Sources, Effects of Harmonics, Harmonic load flowanalysis, Suppression of Harmonics.

(8L)

Module IV

Short Circuit Analysis: Introduction, Bus impedance matrix and its building algorithm through modifications, Fault calculation uses Zbus and its computational steps. Symmetrical and Unsymmetrical faults.

(8L)

Module V

Contingency Analysis: Introduction to power system security, Factors affecting power system security, Analysis of single contingencies, Linear sensitivity factors, Analysis of multiple contingencies, Contingency ranking. State Estimation: Introduction, weighted least square technique, Statistics, Errors and estimates.

(8L)

Text Books:

1. Power System Analysis - John J. Grainger, William D. Stevenson, Jr.
2. Power System Analysis - L. P. Singh

Reference Books:

1. Electric Energy Systems Theory - An Introduction, O.L. Elgerd.
2. Computer Modelling of Electrical Power Systems - J. Arrillaga, N.R. Watson
3. Power System harmonic Analysis, J. Arrillage, B.C. Smith, et al.

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Industrial visits/in-plant training
CD5	Self- learning such as use of NPTEL materials and internets
CD6	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	2	2
CO3	3	3	3	2	3	2
CO4	3	3	3	2	2	3
CO5	3	3	2	2	2	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcome	Course Delivery Method
CO1	CD1, CD2, CD3,CD5
CO2	CD1, CD2, CD3,CD5
CO3	CD1, CD2, CD3,CD5
CO4	CD1, CD2, CD3,CD5
CO5	CD1, CD2, CD3,CD5

COURSE INFORMATION SHEET

Course code: EE511
Course title: Optimization in Engineering Design (Program Elective-I)
Pre-requisite(s): B.E./B.Tech. in ECE/EEE
Co- requisite(s):
Credits: 3 L T P
3 0 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	conceptualize the optimizations in engineering design and model the problem mathematically;
2.	understand various optimization methods and algorithms for solving optimization problems;
3.	develop substantial interest in research, for applying optimization techniques in problems of engineering and technology;
4.	analyze and apply mathematical results and numerical techniques for optimization of engineering problems, while being able to demonstrate solutions through computer
5.	formulate the optimization criteria for real time applications.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	have a basic understanding of traditional and non-traditional optimization algorithms;
CO2	formulate engineering design problems as mathematical optimization problems;
CO3	use mathematical software for the solution of engineering problems;
CO4	differentiate the various optimization concepts and equivalently apply them to engineering problems;
CO5	evaluate pros and cons for different optimization techniques.

SYLLABUS

EE511 Optimization in Engineering Design (Program Elective-I)

Module I

One-dimensional search and multivariable optimization algorithm: Optimality Criteria, Bracketing methods: Exhaustive search methods, Region – Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method. Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method

(8L)

Module II

Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's (Steepest descent) method and Newton's method.

(8L)

Module III

Linear Programming: Graphical method, Simplex Method, revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications.

(8L)

Module IV

Constrained Optimization Algorithm: Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.

(8L)

Module V

Advanced Optimization Techniques: Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, advanced GAs, Differences between GAs and traditional methods. Simulated annealing method, working principles. Particle swarm optimization method, working principles.

(8L)

Books recommended:

Reference Book:

1. Optimization for Engineering Design - Kalyanmoy Deb.
2. Optimization Theory and Applications - S.S. Rao.
3. Analytical Decision Making in Engineering Design – Siddal.
4.Linear Programming – G. Had

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :
Validation of optimization based design for industrial projects.
POs met through Gaps in the Syllabus:PO6

Topics beyond syllabus/Advanced topics/Design:
Genetic Algorithm based machine design.
POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	3	-	1	3	-	1
CO3	3	1	2	3	-	1
CO4	3	2	2	3	2	2
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 581
Course title: EHV AC Power Transmission(Program Elective-I)
Pre-requisite(s): Knowledge of basic power system and control system courses.
Co- requisite(s): B.E./B.Tech. in ECE/EEE with basic courses on Power System
Credits: 3 L T P
3 0 0
Class schedule per week: 3 Classes per week
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1.	provide the concept of calculation of line resistance, inductance, capacitance and ground return parameters for N-conductor bundle;
2.	make the students understand the field of point charge ,line charge and then surface voltage gradient for bundle conductor;
3.	expose the students about the calculation process of electrostatic and electromagnetic field for bundle conductor and their effects;
4.	provide the core concept of HVDC system and the working principles of converters, harmonic generation and filtration.

Course Outcomes
After the completion of this course, students will be able to:

CO1	understand the mathematical equations and process of calculation involved to determine the basic parameters for EHV and HVDC line;
CO2	understand the core concept involving with the different alternative designing procedurals to mitigate the different problems for EHV and HVDC line;
CO3	analyze the performance of a conventional EHV A.C. transmission system and evaluate the need of for improvement;
CO4	formulate the mathematical equations for different factors that causes the operational limitations for EHV and HVDC line;
CO5	comprehend the importance of the course and the need for more learning considering the vastness of the subjects and advancements in the particular field.

SYLLABUS

EE581 EHV AC Power Transmission (Program Elective-I)

Module I

Maxwell's coefficients, Sequence inductance and capacitance, Charge Matrix, Effect of Ground wire.

(8L)

Module II

Surface Voltage-gradient on bundled conductors, Mangoldt's formula, Gradient factors & their use, Ground level electrostatic field of EHV lines.

(8L)

Module III

Power frequency over-voltage control, Series and shunt compensation, Generalised Constants of Compensated line, Static Var Compensators (SVC/SVS). Switching over-voltages in EHV Systems.

(8L)

ModuleIV

Six-pulse Bridge Circuit: waveforms and relevant equations, Twelve-pulse converter, Advantages of higher pulse number, Bipolar to monopolar operation, Converter performance with phase control, Commutation and effect of reactance.

(8L)

ModuleV

Introduction to HVDC Transmission system, Economical advantages, Technical advantages, Critical distance, Submarine transmission.Inverter, Equivalent circuit of HVDC system, Schematic diagram, Reactive power consideration in HVDC system, Harmonics, Filters in HVDC system.

(8L)

Text Books:

1. Extra High Voltage AC Transmission Engineering (2nd Ed.) by R.D. Begamudre, Wiley Eastern Ltd.
2. HVDC Power Transmission Systems by K. Padiyar, Wiley Eastern Ltd.

Reference Books:

1. EHV AC and HVDC Transmission

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:**PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects,Fractional order controller
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

Course Delivery Methods

CD	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes And Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between Course Outcomes And Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 533
Course title: Modern Power System Planning (Program Elective-I)
Pre-requisite(s): Knowledge of basic power system and control system courses.
Co- requisite(s): B.E./B.Tech. in ECE/EEE with basic courses on Power System
Credits: 3 L T P
3 0 0
Class schedule per week: 3 Classes per week
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1.	understand the need of power system planning;
2.	describe load forecasting models for short-term and long-term power system planning;
3.	describe the methodologies to solve power system generation system and network expansion planning;
4.	understand the maintenance scheduling processes for obtaining quality power;
5.	understand the research trend towards smart grid planning and integration of distributed generation planning.

Course Outcomes
After the completion of this course, students will be able to:

CO1	acquire the knowledge of basic planning aspects;
CO2	understand the load forecasting models and apply for long and short term load forecasting;
CO3	analyse the techniques for generation system and network expansion planning;
CO4	analyse the maintenancescheduling processes;
CO5	formulate concepts for smart grid planning , micro grid planning, integration of distributed generation.

SYLLABUS

EE533 Modern Power System Planning (Program Elective-I)

Module I

Introduction: Hierarchy of modern power system planning, Brief description about short term and long term planning.Load Forecasting: Classification and characteristics of loads, Forecasting methodology (extrapolation and correlation), Energy forecasting, Peak demand forecasting, Non-weather sensitive forecast (NWSF), Weather-sensitive forecast (WSF), Total forecast, Annual and monthly peak demand forecast.

(8L)

Module II

Power System Probabilistic Production Simulation: Fundamentals of production simulation, Cumulant method in probabilistic production simulation, Equivalent energy function method, Simulation of hydroelectric generating units and pump-storage units.

(8L)

Module III

Maintenance Scheduling of Generating Units in a Power System: Introduction, Levelized reserve method, Levelized risk method, Maintenance scheduling using soft computing techniques.

(8L)

Module IV

Generation Expansion Planning: Fundamental economic analysis, Generation planning optimized according to generating unit categories (WASP), Generation planning optimized according to power plants (JASP), Network Planning: Introduction, Heuristic methods of network planning, Network planning by mathematical optimization, Fast static security contingency analysis, Probabilistic load flow calculation.

(8L)

Module V
Planning of Smart Grid: Introduction, optimal placement of PMUs, planning of microgrid, planning of distributed generation

(8L)

Books Recommended:

1. Modern Power System Planning, X, Wang and J.R. McDonald, McGraw-Hill Book Company.
2. Power System Planning, R.L. Sullivan, McGraw-Hill International Book Company

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:**PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects, Fractional order controller
POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

Course Delivery Methods

CD	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 535
Course title: HVDC and FACTS (Program Elective-I)
Pre-requisite(s):
Co- requisite(s): B.E./B.Tech. in ECE/EEE with basic courses on Power System
Credits: 3 L T P
3 0 0
Class schedule per week: 3 Classes per week
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1.	identify the significance of HVDC System and its components;
2.	understanding the AC/DC conversion, interpretation of harmonics in HVDC system;
3.	judge the efficacy of different controllers and protective mechanism in HVDC system;
4.	judge the significance of reactive power compensation and requirement of FACTS;
5.	analyze different types of FACTS and their need in emerging power system and investigate their performance when installed in a given transmission system.

Course Outcomes
After the completion of this course, students will be able to:

CO1	state the significance of HVDC systems over EHVAC systems and identify appropriate HVDC link and converter;
CO2	explain different converters for AC to DC & DC to AC conversion and to interpret the effect of harmonics in HVDC system and filtering;
CO3	evaluate the function and efficacy of different controllers and analyze the different faults in HVDC systems with required protective mechanism;
CO4	analyze the performance of a conventional A.C. transmission system and evaluate the need of for improvement;
CO5	investigate different series, shunt FACTS controllers and compute the performance when installed in a given transmission system.

SYLLABUS

EE535 HVDC and FACTS (Program Elective-I)

Module I

Introduction to HVDC Transmission: Comparison with EHV AC power transmission, HVDC system configuration and classification: Monopolar links, Bipolar links, Homopolar links, Back-to-back connection, Multi-terminal HVDC System, HVDC systems elements: Converter transformers, D.C. smoothing reactors, Thyristor valves, Earth electrodes & Earth return, etc. HVDC-AC interactions: SCR, Problems with low ESCR system, Solutions to problems associated with weak system.

(8L)

Module II

Principles of AC/DC Conversion with Harmonic Analysis and Filtering: Steady state characteristics of converters, Combined characteristics of rectifier and inverter, Converter connections, Reactive power requirements, Characteristic and non-characteristic harmonics, Harmful effects of harmonics, Harmonic filters and detuning, Cost considerations of filters.

(8L)

Module III

Protection and System Control in HVDC:Response to D.C. and A.C. system faults, D.C. line fault, A.C. system fault, Converter fault, Protection issues in HVDC, D.C. Circuit Breakers, Basic mechanism of HVDC system control, Power reversal, Power control, Constant ignition angle, constant current, constant extinction angle control, High level controllers. Converter mal-operations - misfire, arc through, commutation failure, Frequency Control of A.C. system, Stabilisation & damping of A.C. networks.

(8L)

Module IV

FACTS Concept: Fundamentals of A.C. power transmission, Introduction to FACTS: Need for FACTS in emerging power systems, Definitions, Types of FACTS, Co-ordination of FACTS with HVDC, Static VAr Compensator (SVC) – Functional description and structures , Control components and Models , Concepts of voltage control, Controls and Applications, MATLAB Implementation.

(8L)

Module V

Static Shunt and Series Compensation – Principles of shunt compensation : Variable Impedance type & switching converter type , Static synchronous compensator (STATCOM) configuration, Characteristics, Principles of static series compensation using GCSC, TCSC and TSSC – applications, Static Synchronous Series Compensator (SSSC).

(8L)

Books recommended:

TEXT BOOK

6. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
7. Kimbark, E.W., 'Direct Current Transmission-vol.1', Wiley Inter science, New York, 1971.
8. Hingorani,L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.
9. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.

REFERENCE BOOK

1. Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
2. Vijay K. Sood, 'HVDC and FACTS Controllers', Kluwer Academic Publishers, New York, 2004.
3. Arrilaga, J., 'High Voltage Direct Current Transmission', 2nd Edition, Institution of Engineering and Technology, London, 1998.
4. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.
5. Mohan Mathur R. and Rajiv K.Varma , 'Thyristor - based FACTS controllers for Electrical transmission systems', IEEE press, Wiley Inter science , 2002.
6. Kamakshaiah, S and Kamaraju, V, 'HVDC Transmission', 1st Edition, Tata McGraw Hill Education (India), Newdelhi 2011.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

Design of real-time industrial projects.

POs met through Gaps in the Syllabus:**PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:

Design optimization for industrial projects,Fractional order controller

POs met through Topics beyond syllabus/Advanced topics/Design: **PO5 & PO6**

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE587
Course title: Substation Design and Automation (Program Elective -I)
Pre-requisite(s):
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 3
Class: M.Tech.
Semester / Level: I/05
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	understand the overall idea of Sub-station design and automation;
2.	outline the development of Sub-Station and work on its protection issues;
3.	understand the importance and effectiveness of grounding system;
4.	outline the testing and maintenance mechanism of various sub-stations.

Course Outcomes

After the completion of this course, students will be able to:

CO1	outline the significance of Sub-station design and automation;
CO2	apply the basic knowledge of sub-station development in practical scenario;
CO3	develop the protection aspects in various sub-stations;
CO4	outline the significance of grounding system in various sub-stations;
CO5	assess different types of testing and maintenance in sub-stations.

SYLLABUS

EE587 Substation Design and Automation (Program Elective -I)

Module I

Introduction to Sub-Station Design: Principle of Sub-station design, Types of Sub-station, Bus bar systems and layout, Selection of Sub-station site, Benefits of Substation Automation system, Substation Automation with IEC 61850 Standard.

(8L)

ModuleII

Sub-Station Design Development: Design of Sub-station grounding system, Design of Bus bars, Insulators, Sub-station equipment, Insulation Coordination and surge Arresters, Power Cables, Auxiliary supplies and battery systems.

(8L)

Module III

Automation and Protection in Sub-station: Protection schemes, Electromagnetic pulse (EMP) protection in sub-station, Control and automation in Sub-station, Power line carrier Communication and Tele-control of Sub-stations.

(8L)

Module IV

Earthing Design and Calculation of Sub-station: Factors influencing the choice of earthed and unearthed systems, system earthing & equipment earthing connections to earth, selection of an earthing conductor and connection of an electrode, voltage gradient around earth electrodes, connections to earth electrodes — earthing and protective Conductors, Earthing Arrangement for Protective Purposes, Earthing Arrangement for Functional Purposes, Equipotential Bonding Conductors, Typical Schematic of Earthing And Protective Conductors, Earthing In Power Stations and Substations, Earthing Associated with Overhead Power Lines, Calculation of Earth Fault Currents, Measurement of Earth Resistivity, Measurement of Earth Electrode Resistance, Measurement of Earth Loop Impedance.

(8L)

Module V

SF6 Gas Insulated Sub-station: SF6 Gas Insulated Sub-station (GIS) and Gas insulated cables, Reactive power management, Testing and maintenance of Sub-station equipment.

(8L)

Text Books:

1. Substation Structure Design Guide by Leon Kempner Jr., American Society of Civil Engineers, Technology & Engineering.
2. Electric Power Substations Engineering by John D. McDonald, CRC Press.

Reference Books:

3. Electrical Transmission and Substation Structures by Marlon W. Vogt, American Society of Civil Engineers, Technology & Engineering.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects, Fractional order controller
POs met through Topics beyond syllabus/Advanced topics/Design:
Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 589
Course title: Power System Dynamics (Program Elective-I)
Pre-requisite(s): Knowledge of basic power system and control system courses.
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 3 Classes per week
Class: M. Tech.
Semester / Level: I/05
Branch: EE
Name of Teacher:

Course Objectives
This course enables the students to:

1.	know the basic classification of power system stability;
2.	understand the concept of dynamic model of synchronous machine excitation system;
3.	investigate the concept of excitation system and load modelling;
4.	examine the concept of small signal stability and transient stability.

Course Outcomes
At the end of the course, a student should be able to:

CO1	differentiate between different states and stability;
CO2	describe the dynamic model of single and multi-synchronous machine system;
CO3	describe the modelling of excitation system of a synchronous machine;
CO4	explain the static and dynamic load modelling;
CO5	examine the small signal stability of single and multi-machine system and evaluate the transient stability of an electrical system.

SYLLABUS

EE589Power System Dynamics (Program Elective-I)

Module I

Introduction to Power System Stability problem: Stability classification - Small signal & Transient stability, Rotor angle & Voltage stability, Hierachy of controls in a Power System.

(8L)

Module II

Synchronous Machine Modelling: Basic equations, dqo transformation, equations of motion.

(8L)

Module III

Excitation System: Requirements of excitation system, Elements of excitation system, Types of excitation system, Modelling of excitation system.

(8L)

Module IV

Power System Loads: Static load models, Dynamic load models.

(8L)

Module V

Small Signal (Steady State) Stability: Linearization, State matrix, modal analysis technique. Transient Stability Studies: Network performance equations, Methods of enhancement of transient stability, MATLAB Implementation.

(8L)

Text Books:

1.Power System Stability and Control, P. Kundur.

Reference Books:

2. Electric Energy System Theory – O.I. Elgerd
3. Power System Dynamics – K.R.Padiyar

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

<u>Gaps in the syllabus (to meet Industry/Profession requirements)</u>:
Design of real-time industrial projects.
POs met through Gaps in the Syllabus:

<u>Topics beyond syllabus/Advanced topics/Design:</u>
Design optimization for industrial projects,Fractional order controller
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE585
Course title: Hybrid Electric Vehicles (Open Elective)
Pre-requisite(s): Electrical Machines, Power Electronics and Electrical Drives
Co- requisite(s): Induction Motor, BLDC Motor, Battery, Power Converters

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: EEE
Name of Teacher:

Course Objectives

This course enables the students to:

1.	understand basic working principle of power converter controlled traction drive;
2.	apply power converters in order to provide proper power modulation;
3.	analyze transient performance of power converters for meeting traction load requirement;
4.	evaluate cost of design of HEV;
5.	design a suitable power converter for HEV.

Course Outcomes

At the end of the course, a student should be able to:

CO1	describe fundamental working principle of power converter controlled traction drive;
CO2	apply power converters in conjunction with IC engine for obtaining dynamic requirement of traction drive;
CO3	analyze mutual effect of power converter and IC engine for obtaining optimal performance of HEV;
CO4	evaluate cost effectiveness and optimize performance parameters;
CO5	design an HEV for a particular application with help of interdisciplinary team work.

SYLLABUS

EE585 Hybrid Electric Vehicles (Open Elective)

Module I

Introduction: Hybrid and Electric Vehicles (HEV): History Overview and Modern Applications, Ground vehicles with mechanical powertrain and reasons for HEV development, HEV configurations and ground vehicle applications, Advantages and challenges in HEV design

(8L)

Module II

Power Flow and Power Management Strategies in HEV: Mechanical power: generation, storage and transmission to the wheels, Vehicle motion and the dynamic equations for the vehicle., Vehicle power plant and transmission characteristics and vehicle performance including braking performance., Fuel economy characteristics of internal combustion engine, Basic architecture of hybrid drive train and analysis series drive train., Analysis of parallel, series parallel and complex drive trains and power flow in each case., Drive cycle implications and fuel efficiency estimations.

(8L)

Module III

Hybrid Electric Vehicle: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains, Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains.

(8L)

Module IV

Electric Vehicles: Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Tractive Effort in Normal Driving, Energy Consumption.

(8L)

.

Module V

Design of Hybrid Electric Vehicles: Design of Series Hybrid Electric Vehicle, Design of Parallelk Hybrid Electric Vehicle, Design of Electric Vehicle, Impact on Environment.

. (8L)

Books recommended:

Text Book

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles. Mehrdad Ehsani, CRC Press
2. Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau, Oxford University Press

Reference Book

1. R.Krishnan, ‘Electric motor drives’ , Prentice hall of India,2002
2. T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’,

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design

Assignments: Regenerative Braking, Self Driven HEV

POs met through Topics beyond syllabus/Advanced topics/Design: PO5

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	3	3	3	2	2	1
CO3	3	3	3	3	2	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	2	3

< 34% = L, 34-66% = M, > 66% = H

Mapping Between Course Outcomes And Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE587
Course title: Electromechanical Energy Conversion (Open Elective)
Pre-requisite(s):
Credits: 3 L T P
3 0 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	to explore the basic principles of transformer, dc and ac machines and analysecomprehensively their steady –state behaviours;
2.	to examine characteristic of static and dynamic dc and ac machines;
3.	a technique to draw armature winding of dc machine;
4.	magnetic circuit of transformer in order to evaluate their performance;
5.	to design and recommend low cost and high-performance machines which finds applications in modern industries, homes and offices.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	state and explain working principle, constructions as well as steady- state behaviour of an ac static and dc machines;
CO2	interpret the different transformer and dc machines;
CO3	identify, formulate and solve problems related to power transformer and dc machines;
CO4	specify, interpret data, design an electrical machine and make a judgment about the best design in all respect;
CO5	students able to test, validate and design electrical machine.

SYLLABUS

EE587 Electromechanical Energy Conversion

Module I

Basic Concepts of Electromechanical Energy Conversion: Electromagnetic induction, Classification and description of electrical machines, Rotor, Stator and field excitation. Generator and motor action, EMF and torque equations, Classification and description of electrical machines, Leakage flux, Losses and efficiency, Rating, Electrical and mechanical degrees.

(8L)

Module II

Transformers: Construction**,** Principle of operation, Ideal and physical transformer, emf equation, transformation ratio, Phasor diagram. Equivalent circuit, Losses and efficiency, Autotransformer, 3-phase transformer, Three-phase transformer connections.

(8L)

Module III

Introduction to D.C. Machines: Principle of operation, Armature winding- Lap and wave, Simplex and duplex, Method of excitation, emf and torque equations, commutation.
DC Generators: Magnetization characteristics, Critical resistance and critical speed, Process of building up of voltage.
D.C. Motors: Basic equation for voltage, Power, Torque and speed, Operating characteristics- Torque-current, and Speed-current and Torque-speed characteristics. Starters, Speed control methods.

(8L)

Module IV

Synchronous Machines: Principle of operation, Excitation system, Effect of winding factor on EMF, Circuit model, Phasor diagram, O.C. and S.C. tests, Short-circuit ratio, Determination of voltage regulation by synchronous impedance, MMF and zero power factor methods. Two reaction theory, Power-angle characteristic of synchronous generators, synchronizing power and torque, Synchronizing methods.

(8L)

Module V

3-phase Induction Motor: Principle of operation, Slip and rotor frequency, Comparison with transformer, Equivalent circuit model, Torque and power output, Losses and efficiency, Torque-slip characteristics, Effect of rotor resistance, starting torque and maximum torque, Starting and speed control methods.
1-phase Induction Motor: Introduction, Double revolving field theory, Equivalent circuit model Capacitor Motor, Torque-speed characteristic.

(8L)

Books recommended:

Text Book

1. I. J. Nagrath, D.P. Kothari, Electric Machines, 4th Edition, TMH, New Delhi, 2014.
2. P. S. Bimbhra, Electrical Machines, Khanna Publishers, New Delhi, 7th Edition 2014.

Reference Books:

1. A.E. Fitzgerald, Charles Kinsley, Stephen D. Umansd; Electric Machinery, McGraw Hill Education (India) Pvt. Ltd, Noida, Indian 6th Edition 2003.
2. E.H. Langsdorf; Theory of Alternating Current Machinery, McGraw-Hill,New York 1955.
3. M.G. Say, "Alternating Current Machines", Pitman Publishing Ltd. 1976.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):

1. Cost Evaluation of Electrical drive in electrical machines based on reliability.
2. Application of artificial intelligence in Electrical Machines.
3. Study of impact of Electrical Machine on society and environment

POs met through Gaps in the Syllabus: PO6

Topics beyond syllabus/Advanced topics/Design:

1. Reliability analysis in Electrical Machine topologies
2. Application of adaptive algorithms in Electrical Machine based systems.

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	3	3	3	3	2	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE589
Course title: Power Semiconductor Devices (Open Elective)
Pre-requisite(s):Basic Electronics

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: B.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	identify different type of modern semiconductor based switching devices and their operating characteristics;
2.	explain working principle of semiconductor devices such as Thyristors and PMOSFET;
3.	analyze protection circuit and firing circuit;
4.	evaluate performance parameters of a semiconductor device;
5.	plan and Design complex power electronics based systems.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	list different types of semiconductor devices and remember their operating characteristics. Explain working principle of different semiconductor devices;
CO2	classify different types of power converters. Show suitability of a power converter for a particular application. Solve power management related problems with application of power electronics based topologies;
CO3	outline shortcomings of each class of power devices and solve them using proper circuits such as firing circuit and protection circuit;
CO4	estimate the cost and long term impact of power electronics technology on a large scale project of socio-economic importance;
CO5	modify existing power electronics based installations. Design new power converter topologies and Plan to develop a power processing unit for a particular requirement in industrial plants as well as domestic applications. Lead or support a team of skilled professionals.

SYLLABUS

EE589 Power Semiconductor Devices

Module I

Introduction: Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching – Power diodes – Types, forward and reverse characteristics, switching characteristics – rating.

(8L)

Module II

Current Controlled Devices: BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; – Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor- Basics of GTO, MCT, FCT, RCT.

(8L)

Module III

Voltage Controlled Devices: Power MOSFETs and IGBTs – Principle of voltage-controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs – and IGCT. New semiconductor materials for devices – Intelligent power modules- Integrated gate commutated thyristor (IGCT) – Comparison of all power devices.

(8L)

Module IV

Firing and Protection Circuits: Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. – Over voltage, over current and gate protections; Design of snubbers.

(8L)

Module V

Thermal Protection: Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device.

(8L)

Books Recommended:

Text Books:

1. M.H. Rashid,"Power Electronics: Circuits, Device and Applications",2nd Edn, PHI, New Jersey, 1993.
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", 2nd Edn., Tata McGraw-Hill, 2007.

Reference Books:

1. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", 1^{st}Edn., Prentice Hall,2001.
2. B. K. Bose, "Modern Power Electronics & AC Drives" , 1^{st}Edn., Prentice Hall, 2001
3. L. Umanand, "Power Electronics: Essentials & Applications", 1^{st}Edn. Wiley India Private Limited, 2009.
4. Jeremy Rifkin, "Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World", 1^{st}Edn., St. Martin's, Press, 2011.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

<u>Gaps in the syllabus (to meet Industry/Profession requirements)</u> :

1. Cost Evaluation of Power Electronics based installation based on reliability
2. Study of impact of power electronics on society and environment

<u>POs met through Gaps in the Syllabus:</u> PO6

<u>Topics beyond syllabus/Advanced topics/Design:</u>

1. Reliability analysis in power electronics topologies
2. Application of power electronics in the field of Renewable Energy.

<u>POs met through Topics beyond syllabus/Advanced topics/Design</u>: PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	3	3	2	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	3	2	1
CO5	3	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE595
Course title: Smart Grid (Open Elective)
Pre-requisite(s): Power system courses, power electronics
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: EEE
Name of Teacher:

Course Objectives:
The course objectives are:

1.	introduction to grid operation, necessity of making grid more smart, and basic components of today's grid;
2.	to extend knowledge on different design challenges with grid interfacing systems for Renewable Energy Sources;
3.	to illustrate the basics of the working principle of PMU and its application;
4.	to educate the students about communication protocol and its application in smart grid;
5.	to make the students understood about different demand response programmes.

Course Outcomes:
After the completion of this course, students will be able to:

CO1	demonstrate steps about building blocks of the smart grid;
CO2	organise the steps involved in working principles of PMU and WAMS through PMUs;
CO3	analysis the challenges involved with grid interactive converters connected with RES;
CO4	understand the design concept involved with demand response Programmes, communication standards, cyber security etc;
CO5	aspire and confident for taking up challenge to adopt new technology needed for monitoring, control and operation of power system.

SYLLABUS

EE595 Smart Grid

Module I

Introduction: Basics about Power Grid operation, Concept of Smart Grid, necessity for pushing smart grid concept, operation and control architecture, Basic components.

(8L)

Module II

Smart Grid and Generation: Renewable energy generation, Solar, Wind, Hydroelectric, Biomass, fuel cell, challenges with RE generation, uncertainty and risk estimation, concept of Converter design for grid tied RE sources.

(8L)

Module III

Smart Grid and transmission system: Introduction, Wide area monitoring system, Phasor measurement units (PMUs) smart meters, multi-agent system technology, phasor measurement techniques: introduction, phasor estimation of nominal frequency signals, phasor updation using non-recursive and recursive updates, phasor estimation at off-nominal frequency input, hierarchy of phasor measurement systems, communication options for PMUs, functional requirements of PMUs and phasor data concentrators (PDCs).

(8L)

Module IV

Smart Grid and Communication system: Introduction, communication requirement, list of the standards, architecture of the communication system, wired and wireless communication, security and safety.

(8L)

Module V

Smart Grid and Demand Response: Introduction, demand response, Types of demand Response Programmes, Aggregator concept, Advanced metering infrastructure, Smart home and building automation standards. Basic concept of Big data analysis.

(8L)

Books recommended:

Text Book:

1.Smart Grid Standards : Specifications, Requirements, and Technologies by by Takuro Sato, Daniel M. Kammen, , Bin Duan, , Martin Macuha, , Zhenyu Zhou, , Jun Wu, , Muhammad Tariq, , and Solomon A. Asfaw **PUBLISHER** John Wiley & Sons, Incorporated.

2.A.G. Phadke J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, springer 2008.

3.James Momoh**, “**SMART GRID: Fundamentals of Design and Analysis”, IEEE (Power engineering series) – Wiley- Blackwell, April 2012.

4.Janaka Ekanayake, KithsiriLiyanage, JianzhongWu, Akihiko Yokoyama, Nick Jenkins "Smart Grid Technology and Applications", Wiley, New- Delhi, August 2015.

Course Evaluation:
Individual assignments, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
1. Design of real-time industrial projects.
2. POs met through Gaps in the Syllabus:**PO5 & PO6**

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects,Fractional order controller

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	3	3	2	2
CO2	3	3	3	2	1	2
CO3	2	3	2	3	2	3
CO4	3	2	3	3	3	3
CO5	3	2	3	2	2	1

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	**Course Delivery Method**
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 597
Course title: Reliability Engineering (Open Elective)
Pre-requisite(s): Engineering Mathematics, Probability Theory
Co- requisite(s):

Credits: 3	L	T	P
	3	0	0

Class schedule per week: 3
Class: M.Tech.
Semester / Level: I/05
Branch:
Name of Teacher:

Course Objectives

This course enables the students to:

1.	define probability theory and relate the concept of reliability of systems;
2.	understand general reliability mathematics applicable to all systems;
3.	understand Markov chains, and application of Markov models in reliability analysis of systems;
4.	evaluate reliability of systems using Markov models and available reliability parameters of systems;
5.	use frequency and duration technique for various reliability analysis problems.

Course Outcomes

After the completion of this course, students will be able to:

1.	understand the general reliability concept and mathematics;
2.	identify events or causes responsible for unreliability of systems through failures;
3.	evaluate the associated system risk and thus finding solutions for minimizing the risks to an acceptable level;
4.	apply engineering knowledge and design techniques to prevent or to reduce the likelihood or frequency of failures for different systems;
5.	apply methods for estimating the reliability of new designs, and for analyzing reliability data.

SYLLABUS

EE597 Reliability Engineering

Module I

Introduction: Types of systems, Qualitative and quantitative assessment, Reliability definitions and concepts, Reliability indices and criteria, Reliability evaluation techniques, Reliability improvements, Reliability economics, Reliability monitoring and growth, Basic probability theory**,** Probability concepts, Permutations and combinations, Application in probability evaluation, Practical engineering concepts, Venn diagrams, Rules for combining probabilities, Probability distributions.

(8L)

Reliability Mathematics: The general reliability function, The exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

(8L)

Module III

Network Modeling and Evaluation of Simple and Complex Systems: Service quality criterion, Conditional probability approach, Two-plant single load and two load systems. The probability array for two interconnected systems, Loss of load approach, Interconnection benefits.

(8L)

Module IV

Discrete Markov Chains and Continuous Markov Processes: Introduction toDiscrete Markov chain, Stochastic transitional probability matrix by Discrete Markov chain, Time dependent probability evaluation by Discrete Markov chain**,** Limiting state probability evaluation**,** Absorbing states, Application of discrete Markov techniques, Introduction to Continuous Markov process**,** General modeling concepts, State space diagrams, Stochastic transitional probability matrix by Continuous Markov process , Evaluating limiting state probabilities by Continuous Markov process, Reliability evaluation in repairable systems, Application of techniques to complex systems.

(8L)

Module V

Frequency and Duration Techniques: Frequency and duration concepts, Application to multi-state problems: Two component repairable system, State probabilities, Frequency of encountering individual states**,** Mean duration of individual states, Cycle time between individual states , Frequency of encountering cumulated states**,** Recursive evaluation of cumulative frequency**,** Mean duration of cumulated states, Frequency balance approach, Two stage repair and installation process :One component system-no spare available**,** one spare available**,** two spares available**,** one spare available**,** Limiting number of spares, Application of the techniques.

(8L)

Text Books:

1. Roy Billinton, Ronald N. Allan, “Reliability Evaluation of Engineering Systems Concepts and Techniques”, 2nd Edition, Springer Science + Business Media New York 1992.

2. Hoang Pham, “Handbook of Reliability Engineering”, Springer 2003.

3. Alessandro Birolini, “Reliability Engineering: Theory and Practice”, Springer 1999.

Reference Books:

1. Donald W. Benbow, “The Certified Reliability Engineer Handbook”, 2009.

Course Evaluation:
Individual assignment, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements):
POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping Between Course Outcomes And Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between Course Outcomes And Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE502
Course title: Advanced Digital Signal Processing Laboratory
Pre-requisite(s): Basics of signals and systems, transform methods, Filter theory.

Credits: 2	L	T	P
	0	0	4

Class schedule per week: 4
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	enumerate the basic concepts of signals and systems and their interconnections in a simple and easy-to-understand manner through different mathematical operations like folding, shifting, scaling, convolutions, etc. using MATLAB; also gain Knowledge of TMS kit, digital image filter;
2.	construct different realization structures;
3.	determine transfer function and predict frequency response of discrete-time systems by applying various techniques like Z-transform, DFT and FFT using MATLAB;
4.	evaluate cost of filters in terms of memory space complexity, algorithm complexity and economic values;
5.	design and compose digital IIR and FIR filters using filter approximation theory, for optimal cost.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	convert analog signal into digital signals and vice-versa, generation of different signals and basic knowledge of TMS kit;
CO2	compute frequency response of the systems using frequency transformation technique, DFT, DIF-FFT or DIT-FFT algorithm, window techniques and visualization using MATLAB;
CO3	design FIR and IIR filters;
CO4	evaluate performance of filter with time variant signals;
CO5	recommend environment-friendly filter for different real- time applications such as optical filter design, acoustic filter design etc.

LIST OF EXPERIMENTS

EE502 Advanced Digital Signal Processing Laboratory

1. **Name: Introduction to MATLAB.**
   Aim: An introduction to MATLAB.

2. **Name: Generation and representation of different types of signal.**
   Aim: To perform generation of different signals in MATLAB.

3. **Name: The Z-Transform and Inverse Z-Transform.**
   Aim: To write a program to find z-transform of given signal.

4. **Name: The Cross-correlation, Auto-correlation between two sequences. Also, Circular convolution between two periodic sequence.**
   Aim: To perform cross-correlation, auto-correlation and circular convolution of two sequence.

5. **Name:- Discrete Fourier transform and Inverse- Discrete Fourier transform**
   Aim: To write an MATLAB program to find discrete Fourier transform and Inverse-discrete Fourier transform.

6. **Name: DFT by DIT-FFT and DIF-FFT method.**
   Aim: To perform DFT by DIT-FFT and DIF-FFT methods in MATLAB.

7. **Name: The low pass, high-pass, band-pass and band-stop filter using Butterworth approximation.**
   Aim: To write a MATLAB program for low pass, high pass and band pass filter using Butterworth approximation.

8. **Name: Familiarization with TMS-320C6713 DSP starter Kit.**
   Aim: To perform a descriptive and practical study for hardware of TMS- 320C6713 DSP starter Kit.

9. **Name: Correlation of two discrete time signal**
   Aim: To write a MATLAB program to perform correlation of two discrete time signal.

10. **Name: Linear convolution of two sequence using circular matrix method.**
    Aim: To write a MATLAB program to perform Linear convolution of two sequence using circular matrix method.

11. **Name: The Radix-2 DIT FFT algorithm.**
    Aim: To perform Radix-2 DIT FFT algorithm of 8-point sequence in MATLAB.

12. **Name: Image Processing.**
    Aim: 1.To write a program to remove Salt & paper type noise from a given image
    2. To change the colour of specific part of given image
    3. Write a program to remove Gaussian noise from given image

Books Recommended:

1. Digital signal processing and applications with C6713 and C6416 DSK by RulphChassaing, wiley publication.
2. Real-Time digital signal processing based on the TMS320C6000 by Nasser Kehtarnavaz, ELSEVIER publication
3. DSP applications using C and the TMS320c6x DSK by RulphChassaing, Wiley Publication.

Reference Books:

1. Antonious,Digital Filter Design,Mc-Graw-Hill International Editions.
2. WavelateTransform,S.Rao.
3. WavelateAnalysis:"The scalable structure of Information"Springer2008–Howard L.Resinkoff,RaymondO.Wells

Course Evaluation:

Group project evaluation, Progressive and End semester evaluations

Gaps in the syllabus (to meet Industry/Profession requirements) :

1. Visualize different signal processing techniques in real time.
2. Application of real time implementation of digital filter.

POs met through Gaps in the Syllabus:PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

Adaptive signal processing, Image processing.

POs met through Topics beyond syllabus/Advanced topics/Design: PO5 & PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	-	-	-
CO2	3	2	1	2	-	1
CO3	3	1	2	3	-	1
CO4	2	2	2	3	2	2
CO5	2	2	3	1	3	3

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE506
Course title: Advanced Power Electronics Laboratory
Pre-requisite(s): Basics of signals and systems, transform methods, Filter theory.
Credits: 2 L T P
0 0 4
Class schedule per week: 4 Lab session
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1.	identify semiconductor switches and carryout experimentation to reproduce the I-V characteristics;
2.	explain the operation of triggering circuits, commutation circuits for the semiconductor switches and different energy conversion topologies through experimentation;
3.	choose a suitable and proper switching device for a required power electronics based design;
4.	calculate the performance parameters of energy conversion topologies through experimental and analytical approach;
5.	design simple and efficient power converters under laboratory conditions. Support a team as team member or play the role of team leader to implement projects in group.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	identify different types of semiconductor based switching devices available in market;
CO2	observe different characteristics of semiconductor based switching devices;
CO3	demonstrate and draw the waveforms of the circuit variables through and across the switches and load in different energy conversion topologies, though experimentation;
CO4	experiment with conventional power converters;
CO5	design assigned circuit topology for given specification and fabricate the circuitry of any of the power converter. Evaluate the performance of the power electronics circuitry available in the laboratory and the fabricated one.

LIST OF EXPERIMENTS
EE506 Advanced Power Electronics Laboratory

1. Name: Develop a mathematical model of IGBT and do an experiment in order to obtain its Transfer and Output characteristics.

Aim:

(i) To develop mathematical model.
(ii) To simulate the mathematical model.
(iii) To obtain saturation, cut off and active region of a IGBT.
(iv) To measure minimum gate voltage required for turning on IGBT

2. Name: Develop a mathematical model of Power MOSFET based step up chopper with R and RL load and perform an experiment on the chopper for drawing curve between boost factor and efficiency.

Aim :

(i) To develop mathematical model.
(ii) To simulate the mathematical model.
(iii) To find relative error between calculated and observed output load voltage of Step up Chopper with change in duty cycle.
(iv) To draw curve between boost factor and efficiency for different switching frequency

3. Name: Develop a mathematical model of impulse commutated chopper and do test on its power circuit to study method of commutation and draw corresponding waveforms.

Aim :

(i) To develop mathematical model.
(ii) To simulate the mathematical model.
(iii) To validate the condition for impulse commutation.
(iv) To draw waveform across capacitor and load voltage.
(v) To obtain relation between duty cycle and output average load voltage.

4. Name: Develop a mathematical model of resonant pulse thyristor chopper circuit and execute an experiment on the chopper to study the method of commutation and draw corresponding waveforms.

Aim :

(i) To develop mathematical model.
(ii) To simulate the mathematical model.
(iii) To validate the condition for resonant commutation.
(iv) To draw waveform across capacitor and load voltage.
(v) To obtain relation between duty cycle and output average load voltage.

5. Name: Develop mathematical equations of commutating current in different methods of commutation (Class A, B, C) and perform an experiment to observe the device voltage and load current.

Aim:

(i) To develop mathematical model.
(ii) To simulate the mathematical model.
(iii) To observe load voltage waveform under natural commutation.
(iv) To observe load voltage waveform under forced commutation.

6. Name: Study of single phase rectifier inverter module with multiple PWM.

Aim :

(i) To obtain mathematical expression of Fourier analysis of load voltage waveform

(ii) To simulate a single phase inverter for R and RL load.

(iii) To obtain relation between modulation index and output RMS voltage.

(iv) To develop algorithm for frequency control of line voltage of inverter output.

7. Name: Develop a mathematical model of single phase modified series inverter and do an experiment to find the performance of the inverter.

Aim :

(i) To develop a mathematical model.

(ii) To simulate the mathematical model.

(iii) To differentiate between basic series inverter and modified series inverter.

(iv) To obtain load voltage waveform for line frequencies below resonance and above resonance.

8. Name: Develop a simulation model on PSIM software for three phase VSI based motor speed controller

Aim :

(i) Introduction to simulation using PSIM

(ii) To calculate of RMS output voltage and THD using PSIM

(iii) To obtain speed and torque characteristics of three phase VSI controlled induction motor

9. Name: Minor Project: Mathematical modeling and simulation of a converter

Aim:

(i) Mathematical modeling of a power converter

(ii) Simulation of a power converter

10. Name: Minor Project: Hardware based project in group.

Aim :

(i) Design of a power converter based on basic knowledge of power electronics

(ii) Development of skills to function effectively as individual as well as a team member or as leader of team.

(iii) Application of interdisciplinary skills.

(iv) To think innovative ideas for possible engineering based solution for various social problems.

Text Books:

1. M.H. Rashid,"Power Electronics: Circuits, Device and Applications",2nd Ed.n, PHI, New Jersey, 1993.
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", 2nd Edn., Tata McGraw-Hill, 2007.

Reference Books:

1. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control ", 1st Edn., Prentice Hall,2001.

2. B. K. Bose, “Modern Power Electronics & AC Drives” , 1st Edn., Prentice Hall, 2001.
3. L. Umanand, “Power Electronics: Essentials & Applications”, 1st Edn. Wiley India Private Limited, 2009. 4. Jeremy Rifkin, “Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World”, 1st Edn., St. Martin’s, Press, 2011.
4. Sabyasachi Sengupta and et. all, "NPTEL Power Electronics Notes", [Online]. Available at www.nptel.iitm.ac.in

Course Evaluation:

Group project evaluation, Progressive and End semester evaluations

Gaps in the syllabus (to meet Industry/Profession requirements) :

1. Electrical drives based design
2. Adaptive controller design for power converter.

POs met through Gaps in the Syllabus:PO6

Topics beyond syllabus/Advanced topics/Design:
Fuzzy controller based simulation of DC motor.

POs met through Topics beyond syllabus/Advanced topics/Design: PO6

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	1	1
CO2	3	2	2	2	1	1
CO3	3	3	3	3	2	1
CO4	3	3	3	3	2	2
CO5	3	3	3	3	3	2

< 34% = 1, 34-66% = 2, > 66% = 3

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE 508
Course title: Control and Power Electronics Lab
Pre-requisite(s): B.E./B.Tech. in ECE/EEE
Co- requisite(s):

Credits: 2	L	T	P
	0	0	4

Class schedule per week: 4 Lab Sessions
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
Name of Teacher:

Course objectives:

This course enables the students to:

1.	impart basic concept of various control system components of converter and inverter operation;
2.	provide skills for application of appropriate tools in order to solve various technical problems;
3.	encourage students to undertake technical projects of multi disciplinary nature;
4.	evaluate perfromance parameters of closed loop converters for otimal design;
5.	provide knowledge current state of art in the field of power electronics and control system in order to motivate students to take up research activities.

Course Outcomes:

At the end of the course, a student should be able to:

CO1	explain basic operating principle of various control system components, converters and inverters;
CO2	analyze the performance parameter of various controllers, converters in the application of control of electric drives;
CO3	select appropriate tools for design and up gradation work to solve complex engineering problem;
CO4	undertake design projects involving inter disciplinary nature in the domain of control system and power electronics;
CO5	provide capability to work in a team consisting of members from different areas of expertise and pursue research in order to find new innovative solution for various social and economic problems using technical rationale.

LIST OF EXPERIMENTS
EE508 Control and Power Electronics Lab

Control System Experiments

1. To study and implementation of ON-OFF temperature controller.
2. To obtain the step response of first and second order RLC series circuit and determine the value of R and L for a given value of C through time response specification.
3. To study the characteristics of synchros, potentiometers and servomotors.
4. Determine the characteristics of LOW PASS and HIGH PASS filters by experimental sine sweep and Lissajous figures draw on CRO.
5. Controller design for stabilization of inverted pendulum.

Power Electronics Experiments

1. Perform an experiment on a single phase fully controlled SCR rectifier and find its voltage ripple.
2. Conduct an experiment on a synchronous motor in order to draw it V-Curve.
3. Do a suitable test on a given IGBT to draw its output and transfer characteristics.
4. Execute test on a resonant pulse SCR chopper in order to study its performance.
5. Execute an experiment on a two identical DC machine to find out itsover all efficiency.

Text Books:

1. M.H. Rashid,"Power Electronics: Circuits, Device and Applications",2nd Ed.n, PHI, New Jersey, 1993.
2. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
3. M. D. Singh, K. B. Khanchandani, "Power Electronics", 2ndEdn., Tata McGraw-Hill, 2007.
4. M. Gopal, "Control Systems Principles & Design", 2nd Edition, TMH. (T2)

Reference Books:

1. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", 1st Edn., Prentice Hall,2001.
2. B. K. Bose, "Modern Power Electronics & AC Drives" , 1st Edn., Prentice Hall, 2001.
3. L. Umanand, "Power Electronics: Essentials & Applications", 1stEdn. Wiley India Private Limited, 2009.
4. M. Gopal, "Digital Control & State Variable Method", TMH, 2015.
5. P.S. Bimbra,Modern Power Elctronics , Khanna Publications New Delho,2015

Course Evaluation:

<u>Gaps in the syllabus (to meet Industry/Profession requirements)</u>:
POs met through Gaps in the Syllabus:

<u>Topics beyond syllabus/Advanced topics/Design:</u>
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods

CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	-	3	2	3

< 34% = 1, 34-66% = 2, > 66% = 3