Department of Electrical and Electronics Engineering

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

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

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-Doctorallevels 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.

Programme Educational Objectives (PEOs)

PEO1: To acquire in-depth knowledge of complex Electrical Engineering problems especially in Power Electronics 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 electronics 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)

Compulsory PO

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.

Optional PO (Program Specific)

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 electronics 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, 34-66% = 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., 2^{nd} edition. (**T3**)
4. Automatic Control Systems by F. Golnaraghi and B.C.Kuo, Wiley Student Edition, 9^{th} 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: EE507
Course title: Advanced Power Electronics
Pre-requisite(s): Operating Principle of Semiconductor Devices
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.	recognize of different type of modern semiconductor based switching devices and their operating characteristics;
2.	elucidate working principle of power converters and relate them with different area of applications;
3.	analyze closed loop control of electrical drives based on power converters;
4.	differentiate between different control strategy of electrical drives in terms of dynamic parameters of system and overall efficiency;
5.	do performance evaluation, plan and design procedure for a complex power electronics based system.

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

CO1	list different types of high power 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 converters and solve them using proper modifications. Identify potential area for power electronics applications;
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

EE507 Advanced Power Electronics

Module I

Power Electronic Devices: (Diodes, Thyristors), Transistors, MOSFET, IGBT, IGCT, etc. - operating principle, Static & dynamic characteristics, Data sheet ratings; Thermal characteristics of power devices; Sample Gate drive circuits.

(8L)

Module II

Switched Mode Power Supply: Forward and flyback converter circuitsoperation of flyback converter and waveforms analysis, operation of forward converter and waveforms analysis, Double ended forward converter, Push Pull converter, Half Bridge isolated converter, Full bridge isolated converter, Bidirectional power supplies, small signal analysis of DC-DC converters and closed loop control.

(8L)

Module III

PWM Inverter Modulation Strategies & Dual Bridge: Sine wave with third harmonic, space vector modulation and predictive current control techniques; PWM rectifier; Input side bidirectional power flow requirement for regeneration &Dual Bridge.converter.

Multi- level Voltage Source Inverter: Basic topology and waveform, Diode clamped multilevel inverter, Flying capacitor multilevel inverter, cascaded multilevel inverter improvement in harmonics and high voltage application, comparison of different multilevel inverters, application of multilevel inverters;

(8L)

Module IV

Resonant Inverters: Operating principle of series resonant inverter, waveforms analysis, switching trajectory, losses and control, Operating principle of series resonant inverter with bidirectional switches, Frequency response of resonant series loaded, parallel loaded, and series parallel- loaded inverter, Parallel resonant inverter, ZCS resonant converter, ZVS resonant converter.

(8L)

Module V

Introduction to Application Oriented Chips: Industrial PWM driver chips for power supplies such as UC 3843, 3825 or equivalent; Industrial gate driver chips for PWM voltage source inverters with isolation and protection circuits. Intelligent power modules.

(8L)

Books recommended:

Text Book

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 Book

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.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

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

1. Cost Evaluation of Power Electronics based installation based on reliability
2. Application of artificial intelligence in power electronics.
3. Study of impact of power electronics on society and environment

POs met through Gaps in the Syllabus:PO6

Topics beyond syllabus/Advanced topics/Design:

1. Reliability analysis in power electronics topologies
2. Application of adaptive algorithms in power electronics 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: EE511
Course title: Optimization in Engineering Design
Pre-requisite(s):Fundamentals of Engineering Mathematics
Co- requisite(s):

	L	T	P
Credits: 3	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 programs;
5.	formulate optimization criteria for any real time application.

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

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

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: EE521
Course title: Dynamic Behaviour of Electrical Machines
Pre-requisite(s):Electrical Machines
Co- requisite(s): Linear Algebra

Credits: 3	L	T	P
	3	0	0

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

Course Objectives:
This course enables the students to:

1.	understand the basic axis transformation and dynamic behaviour of all electrical machines;
2.	apply mathematical approach to model the machine in different frames;
3.	analyze the dynamic performance of the machine under transient and steady state;
4.	evaluate cost of practical design for controllers of rotating machines;
5.	design of optimal controller for controlling the speed and torque of the machines.

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

CO1	understand principle of energy conversion,, two-pole machines and Kron's primitive machine;
CO2	do the mathematical modeling for analysis of machine in stationary and rotating reference frame ;
CO3	examine the transient behavior of the machine when subjected to sudden load change or during fault ;
CO4	evaluate cost of practical design of such non linear machine for the design of industrial electrical drives;
CO5	design a high performancesensor less drive system with optimal dynamic response.

SYLLABUS

EE523 Intelligent Motor Controllers

Module I

Electromagnetic Energy Conversion and Reference Frame Theory: General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system; Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine, three phase symmetrical induction machine and salient pole synchronous machines in phase variable form.Concept of two pole generalized machine, Rotating & transformer voltage, principle of Kron's primitive machine, transformation of three-phase to two-phase variables and it's vice versa, physical concept of park transformation,

(8L)

Module II

Dynamic Analysisof DC Machines: Voltage and torque equations, modelling of different dc motor under normal motoring and fault condition, steady state analysis, state space and transfer function modelling, regenerative braking, counter current and dynamic braking.

(8L)

Module III

Dynamic Modelling of Induction Machines: Dynamic direct and quadrature axis model in arbitrarily rotating reference frames, voltage and torque equations, derivation of steady state phasor relationship from dynamic model, Dynamic model state space equations, Dynamic modelling of high torque cage motors and single-phase IM.

(8L)

Module IV

Determination of Synchronous Machine Dynamic Equivalent Circuit Parameters: Dynamic d-q axis modelling of wound field SM, Voltage and torque equation with respect to arbitrary reference and rotating reference frame, steady-state analysis, Dynamic performance under load and torque variation, under fault condition.

(8L)

Module V

Special Machines: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines, construction, operating principle and true synchronous characteristics, dynamic modelling and self-controlled operation: construction and operation of BLDC Motor, mathematical model of BLDC motor, commutation torque ripples, Impact of motor inductance on the dynamic performance. Stepper motors operation, classification, features of stepper motor, operation of switched reluctance motor, expressions of torque.

(8L)

Books recommended:

Text Book

1. P.S. Bimbra, Generalised Theory of Electric Machines, Khanna Publications, 7thEdition, Delhi, 2010.
2. D.P. Kothari &I.J.Nagrath, Electric Machines.
3. A.R. Fitzgrald Electric Machinery.
4. Chee- Mun Ong, Dynamic Simulation of Electric Machinery using Matlab/Simulink
5. B.K. Bose, Modern Power Electronics and AC drives.

Reference Book

1. Analysis of Electrical Machinery and drive systems- Paul C. Krause, OlegWasynczuk&Scott D. Sudhoff.
2. B. Adkins & R.G. Harley Generalized Theory of AC Machines.
3. Electric Drive- G.K. Dubey.

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

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

Real times close loop for induction motor drive

POs met through Gaps in the Syllabus:PO5 & PO6

Topics beyond syllabus/Advanced topics/Design:

Assignment: Modelling and simulation of close loop control of zeta converter in MATLAB.

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

Course Outcomes/POs	PO1	PO2	PO3	PO4	PO5	PO6
1.	3	3	2	2	2	1
2.	3	3	3	2	2	1
3.	3	3	3	3	2	1
4.	3	3	3	3	3	2
5.	3	3	3	3	3	3

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CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: EE523
Course title: Intelligent Motor Controllers
Pre-requisite(s):Soft Computing
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.	remember basic principle behind soft computing algorithms;
2.	apply intelligent controllers for speed control of motors;
3.	analyse the performance of adaptive controllers;
4.	evaluate intelligent controller for electrical drives;
5.	develop intelligent controller based large scale plants.

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

CO1	have basic algorithms of intelligent controllers such as Neural Network based controllers, fuzzy Logic Based Controllers etc;
CO2	apply intelligent controllers for adaptive electrical drives;
CO3	analyse the performance of intelligent controller based electrical drive in order to provide cost effective solutions for complex engineering problems which are cost effective;
CO4	predict the potential area of application for intelligent controller for societal benefit;
CO5	design intelligent controller based plant and led a team of technically skilled people for installation of such controllers.

SYLLABUS

EE525 Modelling of Power Electronic Systems

Module I

Introduction: Introduction to non-linearity's of electric machine; Parameter sensitivity in electrical machine; Need of adaptive control in electric machine;

(8L)

Module II

Artificial Neural Network: Block diagram of controller design using ANN ,Morden reference adaptive system (MRAS), Feed forward network, Multilayer perceptron model, Activation function, Supervised learning, Unsupervised learning, Supervised learning, Reinforcement learning, Back Propagation algorithm, Back Propagation neural architecture, K-means learning, Back propagation training, ANN based DC motor control, ANN based V/F control of induction motor, ANN based vector control, d-q model of induction machine , ANN based speed and torque control of induction motor.

(8L)

Module III

Fuzzy based Electric motor drive: Introduction to fuzzy sets, Properties of fuzzy sets, Membership function generation using intuitive method, Membership function generation using probability distribution function method, Membership function generation using Genetic Algorithm, Determination of ruled based for speed control, De-fuzzification method, Min max method, Average method, Centroid method, Fuzzy control of DC motor, Fuzzy control of AC motor, Fuzzy control of BLDC motor.

(8L)

Module IV

ANFIS: Introduction to ANFIS, Application of ANFIS for DC motor, Application of ANFIS for scalar control for IM, Application of ANFIS for vector control for IM, Application of ANFIS for BLDC motor.

(8L)

Module V

Kalman Filter: State estimation technique,Introduction to Kalman Filter, Mathematical analysis, Kalman filter for speed estimation, advantages and limitations.

(8L)

Books recommended:

Text book:

1. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence/Book and Disk, Bart Kosko, Prentice Hall.

2. Modern Power Electronics & Drives, B K Bose.

Reference Books:

1. Fuzzy Logic with Engineering Applications, Timothy J Ross, 3rd Edition, Wiley.
2. Kalman Filtering and Neural Network, Simon Haykin, Wiley Series

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

Gaps in the syllabus (to meet Industry/Profession requirements) :
Hardware based project using intelligent controller

POs met through Gaps in the Syllabus: PO6

Topics beyond syllabus/Advanced topics/Design:
Hardware based project using intelligent controller

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

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	2	2	1
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	3	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: EE525
Course title: Modelling of Power Electronic Systems
Pre-requisite(s): Power electronics and signals and system
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.	model the power electronics converter;
2.	elaborate the working of various power converters and design issues;
3.	analyze of modern converters in island mode and grid mode;
4.	perform evaluation of designed converter for harmonics and ripple;
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	knowledge of the basic operation and modelling feasibility of power electronics system;
CO2	apply the knowledge of mathematics to design and understand the operation of power electronics system;
CO3	analyse the complexity of the system and effective approach to overcome the problem;
CO4	evaluate the system both in terms cost and reliability;
CO5	model and develop the power electronic converter with high performance in terms of stability, reliability and performance.

SYLLABUS

EE525 Modelling of Power Electronic Systems

Module I

Introduction to Modelling of Power Electronics System: Modelling and control introduction for power converters and systems, Introduction to power electronics systems, Review of power converters basics, Basics of converters dynamics, Fundamentals of modelling and control of power converters.

(8L)

Module II

Modelling and Control Oriented to Converter-Level Design: Averaged switch modelling of DC DC converters, Small Signal analysis of various switching modes, Simulation-oriented modelling, Control loop design, Digital control design, Bond graph for modelling of DC DC converter, Lagrange method for modelling of dc dc converter.

(8L)

Module III

Modern Rectifier: Power and Harmonics in Non-sinusoidal Systems, Pulse-Width Modulated Rectifiers: Modelling, analysis, and control of low-harmonic rectifiers Boost, fly back, and other topologies for controlling the input current waveform of an ac-dc rectifier Average-current, peak-current-mode, critical conduction mode, and nonlinear carrier control techniques Determination of rms currents, and comparison of performances of popular topologies System considerations. Modelling losses. Simulation.

(8L)

Module IV

Modelling and Control of Inverters: Inverter concepts and inverter topologies Basic Output Voltage Control: Square wave operation, Fundamentals of PWM modulation, Advanced Modulation Techniques Modelling and control of Single-Phase Voltage Source Inverters. Three- phase inverter with d-q control for renewable energy applications.

(8L)

Module V

Real Cases Design: Buck converter with voltage mode control loop, Boost converter with average current mode control loop, Adapter for battery charge in mobile phone applications, Multiphase converter for high performance.

(8L)

Books recommended:

Text Book

1. Abraham I.Pressman . Switching Power Supply Design. Mc Graw Hill. 1997
2. M.H. Rashid,"Power Electronics: Circuits, Device and Applications",2nd Ed.n, PHI, New

Jersey, 1993
3. Mohan, Underland, Robbins; Power Electronics Converters, Applications and Design, 3rd Edn., 2003, John Wiley & Sons Pte. Ltd.
4. M. D. Singh, K. B. Khanchandani, “Power Electronics”, 2nd Edn., Tata McGraw-Hill, 2007.

Reference Book

1. K. Billings. Switching power supply handbook. Mc Graw Hill . 2011.
2Kislovski, R. Redl, N. O. Sokal. Dynamic Analysis of Switching-Mode DC/DC Converters. Van Nostrand Reinhold. 2013

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

Gaps in the syllabus (to meet Industry/Profession requirements) :
1. Practical implementation of modern converters
2. Design of modern converter in LT spice and MATLAB

POs met through Gaps in the Syllabus:PO5

Topics beyond syllabus/Advanced topics/Design:
Assignments: Hardware design of closed loop Temperature control using AVR microcontroller

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

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	2	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	3	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: EE585
Course title: Hybrid Electric Vehicles
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 of hybrid electric vehicle , energy storage system, planetry gears and 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.	designmotor, generator, energy storage system for HEVof proper size;
5.	validatethe design of a suitable power converter for HEV.

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

CO1	describe fundamental principle of operations 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	develop an HEV for a particular application with help of interdisciplinary team work.

SYLLABUS

EE585 Hybrid Electric Vehicles

Module I

Introduction: Merits of EV, types of electric vehicle, topology of HEVs, series, parallel, series-parallel and complex, classification according to hybridisation-micro, mild and heavy HEV.

(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 Battery and Uitracacitor, their features.

(8L)

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Module V

Design of Hybrid Electric Vehicles: Design of Series Hybrid Electric Vehicle, Design of Parallel Hybrid Electric Vehicle, Design of Electric Vehicle, Controlstrategies, 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

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% = 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: Electromechanical Energy Conversion
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
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", 1stEdn., Prentice Hall,2001.
2. B. K. Bose, "Modern Power Electronics & AC Drives" , 1stEdn., Prentice Hall, 2001
3. L. Umanand, "Power Electronics: Essentials & Applications", 1stEdn. Wiley India Private Limited, 2009.
4. Jeremy Rifkin, "Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World", 1stEdn., St. Martin's, Press, 2011.

Course Evaluation:

Individual assignment, Theory (Quiz and End semester) examinations

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

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

POs met through Gaps in the Syllabus: PO6

Topics beyond syllabus/Advanced topics/Design:

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

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	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
Pre-requisite(s): Power systemcourses, 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 powersystem.

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)

ModuleIII

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): 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: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Electrical Engineering
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:

CO1	to understand the general reliability concept and mathematics;
CO2	to identify events or causes responsible for unreliability of systems through failures;
CO3	to evaluate the associated system risk and thus finding solutions for minimizing therisks to an acceptable level;
CO4	to apply engineering knowledge and design techniques to prevent or to reduce the likelihood or frequency of failures for different systems;
CO5	to apply methods for estimating the reliability of new designs, and for analyzing reliability data.

SYLLABUS

EE597 Reliability Engineering (Open Elective)

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)

Module II

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 modelling 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 5

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)

Books recommended:

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” , 1stEdn., Prentice Hall, 2001.
3. L. Umanand, “Power Electronics: Essentials & Applications”, 1stEdn. 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

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