



VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
BURLA, SAMBALPUR, ODISHA-768018
DEPARTMENT OF ELECTRICAL ENGINEERING

MISSION OF THE DEPARTMENT

To produce Electrical Engineers with dynamic well rounded personalities adaptable to ever increasing demands of emerging technologies involving analytical and practical skills.

VISION OF THE DEPARTMENT

- To develop the department as a renowned academic center of learning in the discipline of Electrical Engineering.
- To establish research and development center of repute so as to encourage active participation with industry by staff and students to take on practical problems of industry and to provide feasible solutions.
- To establish tie-ups with institutions of national and international repute and to foster building up of a wide knowledge base to keep in tune with ever increasing demands of technologies.
- Developing simple, appropriate technologies, which will be instrumental in the upliftment of rural society.



VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
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DEPARTMENT OF ELECTRICAL ENGINEERING

**MASTER OF TECHNOLOGY IN POWER ELECTRONICS CONTROL
& DRIVES**

PROGRAMME EDUCATIONAL OBJECTIVES

1. Excel professionally in Power Electronics and allied domains.
2. Be empowered to undertake research and development that addresses technological requirements of Industry and Institutes of higher learning.
3. Adapt to the changing needs of Industry/Society through lifelong learning.



**VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
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DEPARTMENT OF ELECTRICAL ENGINEERING**

MASTER OF TECHNOLOGY IN POWER ELECTRONICS CONTROL & DRIVES

PROGRAMME OUTCOMES

- a) have an ability to evaluate and analyse problems related to Power Electronic Systems and incorporate the principles in the state of art systems for further improvement
- b) be able to investigate critical Power Electronics problems and to arrive at possible solutions independently, by applying theoretical and practical considerations
- c) be able to solve Power Electronics problems such as switching control, converter design, analysis and control of solid state drives and stability studies
- d) be able to develop appropriate power converters for sustainable energy technologies
- e) be able to identify optimal solutions for improvising power conversion and transfer capability, enhancing power quality and reliability through PE based solutions
- f) be able to evolve new power electronic topologies and control schemes based on literature survey and propose solutions through appropriate research methodologies, techniques and tools, and also by designing and conducting experiments
- g) be able to work on small, well-defined projects with particular goals to provide real time solutions pertaining to power electronics
- h) be able to develop, choose, learn and apply appropriate techniques, various resources including sophisticated digital controllers and IT tools for modern power electronic system simulation, including prediction and modelling with existing constraints
- i) be able to pursue challenging professional endeavours based on acquired competence and knowledge
- j) be a responsible professional with intellectual integrity, code of conduct and ethics of research, being aware of the research outcomes and serve towards the sustainable development of the society
- k) be capable of examining critically the outcomes of research and development independently without any external drive

Master of Technology in Power Electronics Control & Drives (Two Years Regular Course) 2016

First (Autumn) Semester:

Sub No.	Subjects	L	T	P	C
MEE2111	Power Electronics Devices-I	3	1	0	4
MEE2108	Advanced Control Systems	3	1	0	4
MEE2107	Dynamics of Electrical Machines	3	1	0	4
	Elective – I(Any two)	3+3	1+1	0	4+4
MEE2181	Power Electronics & Drives Lab-I	0	0	6	4
MEE2182	Seminar – I	0	0	3	2
MEE2183	Comprehensive Viva Voce-I				2
	Total	15	5	9	28

Second (Spring) Semester:

Sub No.	Subjects	L	T	P	C
	Power Electronics Devices-II	3	1	0	4
	Machines Drives	3	1	0	4
	FACTS Modelling, Control & Applications	3	1	0	4
	Elective-II (Any two)	3+3	1+1	0	4+4
	Power Electronics & Drives Lab-II	0	0	6	4
	Seminar – II	0	0	3	2
	Comprehensive Viva Voce-II				2
	Total	15	5	9	28

Third (Project) Semester:

Sub No.	Subjects	L	T	P	C
	Dissertation interim evaluation	0	0	0	10
	Seminar on Dissertation	0	0	0	3
	Comprehensive Viva Voce-III				2
	Total				15

Fourth (Project) Semester:

Sub No.	Subjects	L	T	P	C
	Dissertation Open Defence	0	0	0	5
	Dissertation Evaluation	0	0	0	20
	Total				25

Elective -I in First Semester

Advanced Digital Signal Processing
 Power Semiconductor Devices & Modelling
 Embedded Systems
 Microprocessor & Microcontroller Based System
 Data acquisition & Signal Conditioning

Elective -II in Second Semester

Digital Simulation of Power Electronic Systems
Advanced Control of Drives
Switch Mode & Resonant Converters
Power Quality
Non Linear System Theory

(1ST SEMESTER)

POWER ELECTRONICS DEVICES-I (3-1-0)

Course Objectives:

1. Students will be able to understand the concept of power electronic converters.
2. Students will be able to relate to the applications of phase controlled rectifiers.
3. Students will be able to comprehend the importance of AC voltage controllers and cyclo- converters for various industrial applications.
4. Students will be able to analyze and design switch mode power electronic converters for various applications including microprocessor power supplies, renewable energy systems, and motor drives.
5. Able to analyze pulse width modulated inverters used for variable speed drives.

MODULE-I (10 HOURS)

Line Frequency Diode Rectifiers. Single-Phase Diode Bridge Rectifiers with Capacitor Filter . Voltage Doubler Rectifiers. Effect of Single Phase Rectifiers on Neutral Currents in a Three Phase Four-Wire System. Three Phase half wave rectifier with resistive load . Three phase full wave rectifier. Double Y type rectifier. Single Phase rectifiers with LC filter . Cascaded LC Filter . LC Filter Design. Three Phase Rectifier Circuits. Design of Power Transformers for Rectifiers . Inrush Currents and Overvoltages at turn on in Rectifier Circuits Input Line Current Harmonics and power factor.

MODULE-II (10HOURS)

Line Frequency Phase-Controlled Rectifiers and Inverters. Single Phase - Half Wave Controlled Rectifier with R, RL, RL with Flywheel diode loads. Full Wave Controlled Rectifier with various kinds of loads. Half Controlled and Full Controlled Bridges with passive and active loads - Input Line Current Harmonics and Power Factor- Inverter Mode of Operation - Three

Phase. Half Wave Controlled rectifier with RL Load. Half Controlled Bridge with RL Load. Fully Controlled Bridge with RL Load. Input Side Current Harmonics and Power Factor - Dual Converters. Circulating Current Mode and Non-Circulating Current Mode.

MODULE-III (8 HOURS)

AC Voltage Regulators and DC choppers-Types of ac voltage regulators -Single phase full wave ac voltage controller - Single phase transformer tap changer - Multistep transformer tap changer. D.C chopper circuits, Type-A, B, C, D and E configurations, Analysis of Type-A chopper with R-L load. -Voltage and current commutated Choppers

MODULE-IV (12 HOURS)

Switch-Mode dc-ac Inverters. Basic Concepts . Single Phase Inverters . Push Pull , Half Bridge and Full Bridge Square Inverters .Blanking Time .Single Pulse Modulation of Single Phase Square Wave Inverters . Multi pulse modulation .- PWM Principles . Sinusoidal Pulse Width Modulation in Single Phase Inverters . Choice of carrier frequency in SPWM .spectral Content of output . Bipolar and Unipolar Switching in SPWM - Maximum Attainable DC Voltage Switch Utilization .Reverse Recovery Problem and Carrier Frequency Selection . Output Side Filter Requirements and Filter Design - Ripple in the Inverter Output - DC Side Current. - Three Phase Inverters -Three Phase Square Wave /Stepped Wave Inverters . Three Phase SPWM Inverters . Choice of Carrier Frequency in Three Phase SPWM Inverters . Output Filters . DC Side Current . Effect of Blanking Time on Inverter Output Voltage.

BOOKS

1. Ned Mohan et.al: "*Power Electronics*", John Wiley and Sons.P.C. Sen : "*Power Electronics*", Tata McGraw Hill
2. G.K.Dubey et.al , "*Thyristorised Power Controllers*", Wiley Eastern Ltd.
3. B. K Bose : "*Modern Power Electronics and AC Drives*", Pearson Education (Asia)

Course Outcomes:

1. Comprehend the basic principles of switch mode power converters.
2. Understand the operating principles and models of different types of power electronic converters AC-AC, AC-DC, DC-AC and DC-DC converter systems.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√		√	√						√
CO2	√	√	√	√	√						√

(1ST SEMESTER)

ADVANCED CONTROL SYSTEM (3-1-0)

Course objectives

1. The purpose of this course is to introduce the key concepts in advanced control systems for SISO as well as MIMO systems.
2. Digital control techniques are to be described
3. The students should be able to characterize and tune different adaptive controllers
4. The purpose is to give up-to-date knowledge for designing controllers for non-linear systems.

SYLLABUS

MODULE-I (10 HOURS)

SISO Control Analysis and Design Analysis of SISO Control Loops, Classical PID Control, Synthesis of SISO Controllers, Fundamental Limitations in SISO Control, Model error Limitations, Structural Limitations, Frequency Domain design limitations, Architectural Issues in SISO Control, Internal Model Principle , Feed forward and Cascade Control, Anti-wind-up scheme, Introduction to Model Predictive Control

MODULE-II (10 HOURS)

Digital Computer Control, Models for sampled Data Systems, Sample Data Design, Internal Model Principle for Digital Control, Models for hybrid Control, Systems, Analysis of Inter sample behaviour

MODULE-III (10 HOURS)

Advanced SISO Control, SISO CONTROLLER Parametrisations, Control Design Based on Optimisation, Synthesis via state space methods, Introduction to Nonlinear Control

MODULE-IV (10 HOURS)

MIMO Control Essentials, Analysis of MIMO Control Loops, Exploiting SISO Techniques in MIMO Control, MIMO Control Design: Design via Optimal control techniques, Model Predictive Control MIMO Controller Parametrisations, Decoupling

TEXT BOOKS:

- [1]. Graham C. Goodwin, Stefan F.Graebe, Mario E.Salgado, “Control System Design”, PHI-2002.
- [2]. M. Athans and P. Falb, “Optimal control”, MGH
- [3]. K. Astrom, and B.wittenmark, “Computer Control Systems: Theory and design”, Prentice Hall

Course Outcomes:

1. At the end of the course students will be able to apply the modeling concepts.
2. The students will learn issues of sensitivity, stability, and loop synthesis as well as feedforward and cascade structures
3. The students will learn designs for digital control and how the constraint of the trade-off web be circumvented by optimization.
4. The students will learn techniques specifically aimed at MIMO Control Problems
5. Students can apply Matlab Real Time programming/ LabVIEW to the model

Mapping of Course Outcomes to Programme Outcomes

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1					√			√			√
CO2					√			√			√
CO3					√			√			√
CO4											√
CO5								√	√		√

(1ST SEMESTER)

DYNAMICS OF ELECTRICAL MACHINES (3-1-0)

Course Objectives:

1. To provide knowledge about the fundamentals of electrical machines by using transformation theory based mathematical modelling.
2. To impart knowledge about principle of operation and performance of DC, Synchronous, Induction machines and transformers.
3. To analyze the steady state and dynamic state operation of DC, Synchronous, Induction machines and transformers.

SYLLABUS

MODULE-I (10 HOURS)

Singly excited circuits, Coupled circuits, Solution of Electro-dynamical Equations by Euler's method and Runge-Kutta method. Linearization of the Dynamic Equations and Small Signal Stability.

Elementary DC Machine, Voltage and torque equations, Basic types of DC machines, Dynamic characteristics of DC motors, time-domain block diagrams and state equations, solution of dynamic characteristics by Laplace transformation.

MODULE-II (10 HOURS)

The basis of General Theory and Generalized Equation of A.C machines, Equation in terms of phases variable park's transformation, Various reference frames, Derivation of two-axis equation, Torque equation, Field and damper windings, Equivalent circuits, Operational

impedances and frequency response loci, Modified equation with more accurate coupling between field and damper windings.

MODULE-III (10 HOURS)

Synchronous Generator short circuit and system faults: Symmetrical short circuit of unloaded generator, Analysis of short circuit oscillograms, short circuit of loaded synchronous generator, Unsymmetrical short of synchronous generator, system fault calculation, Sudden load changes, Equivalent circuit under transient condition, Constant flux linkage theorem, Simplified phasor diagram for transient changes.

MODULE-IV (10 HOURS)

Induction machines: General equation of the induction motor (equation), Application of equation in primary and secondary reference frames and complex form of equation, Short circuit and fault current due to the induction motor, fault calculation.

Transformers: Transient phenomena in transformer, General characteristics of over voltage and current inrush, Transient over voltage characteristics.

BOOKS

- [1].B.Adkins and R.H. Hiiley, *The Generalized Theory of Electrical Machines*, Chapman and Hall,. London, UK
- [2].P.C. Kraus, O. Wasynczuk, S.D. Sudhof, *Analysis of Electrical Machinery and Drives Systems*, IEEE Press, John Wiley and Sons, Piscataway, New Jersey, USA
- [3].P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1994

Course Outcomes:

1. An ability to develop dynamic model of electrical machines.
2. An ability to develop equivalent circuit of machines and perform steady state analysis.
3. Ability to perform fault analysis by using dynamic machine models.
4. Ability to develop and test new control approaches in electrical machines.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1		√							√		
CO2				√	√						
CO3	√						√	√			
CO4					√	√					

(1ST SEMESTER)
ADVANCED DIGITAL SIGNAL PROCESSING (3-1-0)

Course Objective:

1. To introduce the concept and technique associated with the understanding of Digital Signal Processing. To familiarize with techniques suitable for analysing and synthesizing Discrete time systems on the basis of Transforms.
2. To gain an understanding about Digital Filters, design and structure of digital filter.
3. To understand the concept of Finite word length effect process and errors.
4. To introduce the concept of statistical signal processing and their models.

SYLLABUS

MODULE-I (10 HOURS)

Discrete time signals, systems and their representations: Discrete time signals- Linear shift invariant systems- Stability and causality- Discrete Fourier transform- Properties of different transforms- Linear convolution using DFT- Computation of DFT

MODULE-II (10 HOURS)

Digital filter design and realization structures Design of IIR digital filters from analog filters- Impulse invariance method and Bilinear transformation method- FIR filter design using window functions.

Comparison of IIR and FIR digital filters- Basic IIR and FIR filter realization structures-Signal flow graph representations.

MODULE-III (10 HOURS)

Analysis of finite word-length effects Quantization process and errors- Coefficient quantization effects in IIR and FIR filters- A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero input limit cycles in IIR filters

MODULE-IV (10 HOURS)

Statistical signal processing Linear Signal Models All pole, All zero and Pole-zero models. Power spectrum estimation- Spectral analysis of deterministic signals. Estimation of power spectrum of stationary random signals-Optimum linear filters-Optimum signal estimation-Mean square error estimation-Optimum FIR and IIR filters.

BOOKS

- [1]. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing (third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997
- [2]. Alan V . Oppenheim, Ronald W. Schaffer, Discrete-Time Signal Processing, Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
- [3]. A. NagoorKani, Digital Signal Processing(Second edition, Mc Graw Hill
- [4]. Sanjit K Mitra, Digital Signal Processing: A computer-based approach ,Tata Mc Grow-Hill edition .1998

Course Outcomes:

When the students have passed the course, they shall be able

1. To understand the fundamental concept of Digital Signal Processing, Discrete Fourier Transform and its application.
2. Apply several design techniques for IIR type digital filter, apply a design technique for FIR filter. Also understand the filter realisation structures.
3. To understand the errors of word length effect and their correction techniques.
To understand spectral characteristics in form of power spectral estimation.

Mapping of Course Outcomes to Programme Outcomes

Course Outcome	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√					√	√			√
CO2					√						√
CO3					√						√

(1ST SEMESTER)

POWER SEMICONDUCTOR DEVICES & MODELING

(3-1-0)

Course Objectives:

1. Students will learn everything about construction and switching characteristics of different solid state devices like Power MOSFET, IGBT, GTO etc.
2. Students will design the drive circuit, methods of cooling and protection of solid state power devices.
3. Students will understand the operation, effect of blanking time, Harmonic Elimination methods, Bang-bang and space vector modulation techniques of Resonant DC-DC converters.
4. Students will understand the Regulated PWM Voltage Source Inverters.
5. Students will understand Hysteresis Control of Areas of application of Current Regulated VSI.
6. Students will know about Shunt Reactive Power Compensators, Switched Capacitors Static Reactor Compensators based on thyristors for power factor control.
7. Students will have exposure to introductory knowledge of Vector controlled and slip-power controlled Induction motor drives and Application of PC, DSP and microprocessor in machine drives.

SYLLABUS

MODULE-I (10 HOURS)

Solid State Power Devices: Construction and switching characteristics of Gate Turnoff Thyristor (GTO), Power BJTs, Power MOSFETs, Insulated Gate Bipolar Transistors (IGBTs), Design of above devices drive circuits, switching and aid circuits. Methods of cooling and Protection

MODULE-II (10 HOURS)

Resonant DC-DC Converters: Operation, characteristics and design equations, Control techniques and application. Three Phase Square Wave /Stepped Wave Inverters. Three Phase SPWM Inverters. Effect of Blanking Time on Inverter Output Voltage. Selective Harmonic Elimination Method. Current controlled PWM, Bang-bang and space vector modulation

techniques.

MODULE-III (10 HOURS)

Current Regulated Inverter -Current Regulated PWM Voltage Source Inverters. Hysteresis Control - Areas of application of Current Regulated VSI. Switched Mode Rectifier - Operation of Single/Three Phase Bridges in Rectifier Mode. Control Principles. Special Inverter Topologies - Current Source Inverter. Analysis of Single Phase Capacitor Commutated CSI. Resonant DC-link VSI, Its operation characteristics design and control.

MODULE-IV (10 HOURS)

Power Factor Control - Shunt Reactive Power Compensators. Switched Capacitors. Static Reactor Compensators based on thyristors. Static Reactive VAR Generators using PWM Current Regulated VSIs. Active power line conditioners, Active Power Filtering. Harmonic Generation by PE Equipment. Harmonic Pollution Standards. PWM Current Regulated VSI based implementation of a Single Phase Active Power Filter. Vector controlled and slip-power controlled Induction motor drives. Application of PC, DSP and microprocessor in machine drives

BOOKS

- [1]. Ned Mohan , Tore M. Undeland , William P.Robbins , “ *Power Electronics: Converters, Applications & Design* “, John Willey & Sons , INC
- [2]. M H Rashid, “*Power Electronics*, Prentice Hall India,1993
- [3]. B. K Bose, *Modern Power Electronics and AC Drives*”, Pearson Education (Asia), 1992.
- [4]. Robert W. Erickson , D. Makimovic , “ *Fundamentals of Power Electronics* ” , 2nd edition ,
Kluwer Academics Publishers

Course Outcomes:

When the students have passed the course, they shall be able to

CO1: Use of various solid state devices and Design their drive circuit.

CO2:How to control the firing at Zero current and voltage in Resonant DC-DC converter.

CO3: Use of control strategy for power factor control of inverters.

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Department of Electrical Engineering
Master of Technology in Power Electronics Control & Drives (Two Years Regular Course) 2016

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1			√		√						√
CO2	√		√	√				√			√
CO3	√		√								√

(1ST SEMESTER)

EMBEDDED SYSTEM (3-1-0)

Course Objectives:

1. Architecture of Embedded system
2. High level program design UML of Embedded system .
3. Coding using assembly , C , C++ of Embedded system
4. Use of Real Time operating system (RTOS) in Embedded system development.

SYLLABUS

MODULE-I (10 HOURS)

Introduction: An embedded system, Processor in the system, Other hardware units, Software embedded into a systems, exemplary system-in-chip, Devices and Device Drivers : I/O devices, Timer and counting devices, serial communication using the IC, CAN and advance I/O buses between the networked multiple devices. Host system or computer parallel communication between the networked I/O multiple devices using the ISA, PCI, PCI-X and advance buses. Device drivers, Parallel port devices drivers in a system, Serial port device drives in a system, Interrupt servicing (Handling) mechanism.

MODULE-II (10 HOURS)

Software and Programming Concept : Processor selection for an embedded system, memory selection for an embedded system, Embedded programming in C++, Embedded programming in JAVA, Unified modeling language (UML), Multiple processes and application, problem of sharing data by multiple tasks and routines, Inter process communication.

MODULE-III (10 HOURS)

Real time Operating System: Operating system services, I/O subsystem, Network operating system, Real Time and embedded system, Need of well tested and debugged Real Time operating system (RTOS), Introduction to C/OS-II. Case studies of programming with RTOS : Case study of an embedded system for a smart card

MODULE-IV (10 HOURS)

Hardware and Software Co-design : Embedded system project management, Embedded system design and co-design issues in system development process, design cycle in the

development phase for an embedded system, Use of software tools for development of an embedded system, Issues in embedded system design.

BOOKS

- [4]. Embedded System Architecture, Programming and Design, Raj Kamal, TMH
- [5]. Hardware Software Codesign of Embedded System, Ralf Niemann, Kulwer Academic
- [6]. Embedded Real time system Programming, Sriram V. Iyer and Pankaj Gupat, TMH

Course Outcome :

- 1. 100% result showing learning of all objectives
- 2. Assembly , C,C++ , Java , UML are well learnt.
- 3. Knowledge of RTOS is satisfactory.

Mapping of Course Outcomes to Programme Outcomes

Course Outcon	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1											√
CO2								√			√
CO3								√			√

(1ST SEMESTER)

**MICROPROCESSOR AND MICROCONTROLLER BASED
SYSTEMS (3-1-0)**

Course Objectives:

The objective of this course is to provide extensive knowledge of

1. Microprocessor and microcontroller based systems and its interfacing techniques and assembly language programming in 8086, Intel 8051, Intel 8096 and Motorola 68HC11.
2. Architectural model of Intel 8096, Motorola 68HC11, Pentium microprocessors.
3. Data transfer technique in communication media and various Bus standards.
4. Concept of programming logic unit.

SYLLABUS

MODULE-I (10 HOURS)

(Prerequisite: A basic course on 8 bit ups such as 8085), 16-bit microprocessor(one well known processor, say 8086 to 68000 to be taken as case study)-quick overview of the instruction set, Assembly language programming. Interrupt structure, Interfacing memory and IO devices. Memory organizations. Standard peripherals and their interfacing-(sw and hw aspects) color graphic terminals and ASCII keyboards, mouse, floppy and hard disc drive, other storage media (optical disks, Digital Audio Tapes etc.)

MODULE-II (10 HOURS)

Data transfer techniques-Asynchronous and synchronous. Serial and parallel interface standards. Communication media and adapters. Modems and their interfacing. Bus structures and standards-basic concepts. Example of a bus standard (PC-VME bus). Salient features of other processors (80286/386/486 or 68020/68030/68040). Microcontrollers and digital signal processors. IO processors and arithmetic coprocessors. Logic design for microprocessor-based systems-design of state.

MODULE-III (10 HOURS)

Introduction to Microcontrollers - Motorola 68HC11 - Intel 8051 - Intel 8096 - Registers -

Memories - I/O Ports - Serial Communications - Timers - Interrupts.

MODULE-IV (10 HOURS)

Instructions in Microcontrollers - Interfaces - Introduction to Development of a Microcontroller Based System - Concept of a Programmable Logic Controller-Features and parts in a PLC unit.

BOOKS

- [1]. John.F.Wakerly: Microcomputer Architecture and Programming, John Wiley and Sons.
- [2]. Ramesh S.Gaonker: Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India).
- [3]. Yu-Cheng Liu and Glenn A.Gibson: Microcomputer systems: The 8086/8088 Family Architecture, Programming and Design, Prentice Hall of India.
- [4]. Raj Kamal: The Concepts and Features of Microcontrollers, Wheeler Publishing.

Course Outcome:

At the end of this course, students will be able to

CO1:Understand memory organization of 16 bit microprocessor; interrupt structure and interfacing of standard peripheral devices.

CO2:Analyze the various types of data transfer technique in communication media, adapter and modem by using standard interfaces and buses.

CO3:Know the architecture and features of Intel 8096 and Motorola 68HC11 microcontroller.

CO4: Realize the role of microcontroller based system and programmable logic controller.

Mapping of Course Outcomes to Programme Outcomes

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1								√			√
CO2								√	√		√
CO3								√			√
CO4								√	√		√

(1ST SEMESTER)

DATA ACQUISITION AND SIGNAL CONDITIONING (3-1-0)

Course Objectives:

1. To teach the principles of measurement.
2. To teach principles of digital sampling.
3. To teach the principles of signal conditioning/filtration.
4. To expose students to automated data acquisition and data processing.

SYLLABUS

MODULE-I (10 HOURS)

Transducers & Signal Conditioning Data Acquisition Systems(DAS)- Introduction . Objectives of DAS . Block Diagram Description of DAS- General configurations - Single and multichannel DAS-Transducers for the measurement of motion, force, pressure, flow, level, dc and ac voltages and currents (CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors , Optosensors, Rogowski Coil, Ampflex Sensors etc.) - Signal Conditioning: Requirements - Instrumentation amplifiers: Basic characteristics . Chopped and Modulated DC Amplifiers-Isolation amplifiers - Opto couplers - Buffer amplifiers .Noise Reduction Techniques in Signal Conditioning- Transmitters .Optical Fiber Based Signal Transmission-Piezoelectric Couplers-Intelligent transmitters.

MODULE-II (10 HOURS)

Filtering and Sampling Review of Nyquist's Sampling Theorem-Aliasing . Need for Prefiltering-First and second order filters - classification and types of filters - Low -pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters .Opamp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers

MODULE-III (10 HOURS)

Signal Conversion and Transmission Analog-to-Digital Converters(ADC)-Multiplexers and demultiplexers - Digital multiplexer . A/D Conversion . Conversion Processes , Speed, Quantization Errors . Successive Approximation ADC . Dual Slope ADC . Flash ADC . Digital-to-Analog Conversion(DAC) . Techniques, Speed, Conversion Errors, Post Filtering-

Weighted Resistor, R-2R, Weighted Current type of DACs- Multiplying Type DAC-Bipolar DACs- Data transmission systems-Schmitt Trigger-Pulse code formats- Modulation techniques and systems-Telemetry systems.

MODULE-IV (10 HOURS)

Digital Signal Transmission And Interfacing DAS Boards-Introduction . Study of a representative DAS Board-Interfacing Issues with DAS Boards, I/O vs Memory Addressing, Software Drivers, Virtual Instruments, Modular Programming Techniques for Robust Systems, Bus standard for communication between instruments - GPIB (IEEE-488bus) - RS-232C-USB-4-to-20mA current loop serial communication systems. Communication via parallel port . Interrupt-based Data Acquisition. Software Design Strategies-Hardware Vs Software Interrupts-Foreground/ background Programming Techniques- Limitations of Polling . Circular Queues.

BOOKS

- [1]. Ernest O Doebelin., "Measurement Systems: Application and Design", McGraw Hill (Int. edition) 1990, ISBN 0-07-100697-4
- [2]. George C.Barney, "Intelligent Instrumentation", Prentice Hall of India Pvt Ltd., New Delhi, 1988.
- [3]. Ibrahim, K.E., "Instruments and Automatic Test Equipment", Longman Scientific & Technical Group Ltd., UK, 1988.
- [4]. John Uffrenbeck, "The 80x86 Family ,Design, Programming, And Interfacing", Pearson Education , Asia.

Course Outcomes:

After successful completion, students will be able to,

1. Operate instruments and measuring systems.
2. Apply the principles of digital sampling and signal conditioning to measurement instruments.

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1			√		√						√
CO2	√		√	√				√			√

(1ST SEMESTER)
POWER ELCTRONICS & DRIVES LAB-I (0-0-6)

Course Objectives:

In this laboratory students will learn about the following points:

1. To prepare students to succeed in industry, technical profession, and to excel in PhDprogramme.
2. able to use control system and simpower system tool boxes.
3. able to realize different converter circuits.
4. able to visualize input/output voltage/current waveforms.
5. able to learn use of PSPICE software for circuit analysis.
6. able to design and analyze any circuits, before going to design practical circuits.
7. able to solve circuit problem and debugging.

SYLLABUS

LIST OF EXPERIMENTS

1. Pspice simulation of single phase full converter using RL & E loads & single phase AC voltage controller using RL & E loads
2. Pspice simulation of resonant pulse commutation circuit and buck chopper
3. Pspice simulation single phase inverter with PWM control
4. Simulation of Buck/Boost DC-DC converter using PSPICE
5. Simulation of SMPS using Pspice
6. Simulation of 3-phase bridge converter in MATLAB with R-L-E load
7. Simulation of 1-phase bridge converter in MATLAB

Course Outcomes:

After completion of this course

1. Graduate will have the ability to apply knowledge of math, science and engineering.
2. Graduate will have basic skill in methods of design and analysis across a broad range of electrical and computer engineering areas.
3. Graduate will have the ability to make thoughtful, well-informed career choices.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Program Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√	√	√	√		√		√		√
CO2	√	√	√		√	√	√	√		√	
CO3							√	√	√		√

(2ND SEMESTER)

POWER ELECTRONIC DEVICES-II (3-1-0)

Course Objectives:

In this laboratory students will learn about the following points:

1. To prepare students to succeed in industry, technical profession, and to excel in PhD programme.
2. able to use control system and sim power system tool boxes.
3. able to realize different power electronics components and its applications.
4. able to visualize input/output voltage/current waveforms.
5. able to learn use of PSPICE software for circuit analysis.
6. able to design and analyze any circuits, before going to design practical circuits.
7. able to solve circuit problem and debugging and ready to face the challenges.

SYLLABUS

MODULE-I (10HOURS)

Converters for Static Compensation . Standard Modulation Strategies - Programmed Harmonic Elimination . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies -Space Vector Modulation - Minimum ripple current PWM method. Multi-level inverters of Cascade Type. Current Regulated Inverter -Current Regulated PWM Voltage Source Inverters . Methods of Current Control Hysteresis Control . Variable Band Hysteresis Control . Fixed Switching Frequency Current Control Methods . Switching Frequency Vs accuracy of Current Regulation . Areas of application of Current Regulated VSI .

MODULE-II (10 HOURS)

Switched Mode Rectifier - Operation of Single/Three Phase Bridges in Rectifier Mode . Control Principles . Control of the DC Side Voltage, Voltage Control Loop. The inner Current Control Loop. Special Inverter Topologies - Current Source Inverter . Ideal Single Phase CSI operation, analysis and waveforms - Analysis of Single Phase Capacitor Commutated CSI. Series Inverters . Analysis of Series Inverters . Modified Series Inverter . Three Phase Series Inverter

MODULE-III (10 HOURS)

Buck, Boost, Buck-Boost SMPS Topologies . Basic Operation- Waveforms - modes of operation-Output voltage ripple Push-Pull and Forward Converter Topologies - Basic Operation . Waveforms - Voltage Mode Control. Half and Full Bridge Converters . Basic Operation and Waveforms- Fly back Converter .discontinuous mode operation . waveforms . Control -

Continuous Mode Operation . Waveforms

MODULE-IV (10 HOURS)

Introduction to Resonant Converters . Classification of Resonant Converters . Basic Resonant Circuit Concepts . Load Resonant Converter . Resonant Switch Converter . Zero Voltage Switching Clamped Voltage Topologies . Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter

BOOKS

- [1]. Ned Mohan et.al: Power Electronics John Wiley and Sons
- [2]. Rashid: Power Electronics Prentice Hall India
- [3]. G.K.Dubey et.al: Thyristorised Power Controllers, Wiley Eastern Ltd.

Course Outcomes:

After completion of this course

1. Graduate will have the ability to apply knowledge of mathematics, science and Engineering.
2. Graduate will have basic skill in methods of design and analysis across a broad range of electrical and computer engineering areas.
3. Graduate will have the ability to make thoughtful, well-informed career choices and to meet the global challenges of tomorrow's technology.

Mapping of Course Outcomes to Programme Outcomes

Course Outcon	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√		√	√						√
CO2	√	√	√	√	√						√
CO3	√	√		√	√				√		√

(2ND SEMESTER)
MACHINE DRIVES (3-1-0)

Course Objectives:

In this subject students will learn about the following points:

1. To make students familiar about the adjustable speed electric motor Drives through conventional methods and various motor load characteristics.
2. To make understand the students about the application of power electronics converter for adjustable speed drives to save the energy.
3. The students should understand the various power electronics converter used in DC motor drive and application of voltage source and current source converter in induction as well as synchronous motor.
4. To make students familiar with motor armature mmf in space distribution and control of harmonics and its effect on motor.
5. To make understand the control system speed drive system by voltage and frequency control method and soft starting if the induction as well as synchronous motor.
6. To acquire knowledge of vector control used in very precious application of induction motors.

SYLLABUS

MODULE-I (10 HOURS)

Introduction to Motor Drives - Components of Power Electronic Drives - Criteria for selection of Drive components - Match between the motor and the load - Thermal consideration - Match between the motor and the Power Electronics converter - Characteristics of mechanical systems - stability criteria

MODULE-II (10 HOURS)

D.C Motor Drives - System model motor rating - Motor-mechanism dynamics - Drive transfer function - Effect of armature current waveform - Torque pulsations - Adjustable speed dc drives - Chopper fed and 1-phase converter fed drives - Effect of field weakening.

MODULE-III (10 HOURS)

Induction Motor Drives - Basic Principle of operation of 3 phase motor - Equivalent circuit - MMF space harmonics due to fundamental current - Fundamental spatial mmf distributions due to time harmonics - Simultaneous effect of time and space harmonics - Speed control by varying stator frequency and voltage - Impact of nonsinusoidal excitation on induction motors - Variable frequency converter classifications - Variable frequency PWM-VSI drives - Variable frequency square wave VSI drives - Variable frequency CSI drives - Comparison of variable frequency drives - Line frequency variable voltage drives - Soft start of induction motors - Speed control by static slip power recovery. - Vector control of 3 phase squirrel cage motors - Principle of

operation of vector control-

MODULE-IV (10 HOURS)

Synchronous Motor Drives - Introduction - Basic principles of synchronous motor operation methods of control - operation with field weakening - load commutated inverter drives.

BOOKS

- [1]. Ned Mohan, “*Power Electronics*”, et. al Wiley.
- [2]. G.K.Dubey&C.R.Kasaravada, “*Power Electronics & Drives*”, Tata McGraw Hill.
- [3]. W.Shepherd, L N HulleyCambride, “*Power Electronics & Control of Motor*”, University Press.
- [4]. Dubey, “*Power Electronics Drives*”, Wiley Eastern
- [5]. R. Krishnan , “ *Electric Motor Drives : Modeling , Analysis & Control* ” , ‘ Prentice Hall ’ , New Jersey, 2001.
- [6]. M.H.Rashid *Power Electronics*”, (P.H.I.Edition)
- [7]. S.K.Pillai, Jhon Willy & Sons,” *A first Course on Electrical Drives*”

Course Outcomes:

After completion of this course

CO1: Graduate will demonstrate the control techniques during starting, running and breaking periods of the drive systems.

CO2:Graduate will able to know the saving of electric power by power electronics converter techniques.

CO3: Graduate will able to know with the adjustable speed drives of induction and synchronous motor through voltage and frequency control by PWM-VSI and CSI methods.

CO4: Students will demonstrate the adjustable speed drives of DC motors through DC-DC Chopper and control rectifier methods.

Mapping of Course Outcomes to Programme Outcomes

Course Outcome	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1			√								√
CO2	√		√	√				√			√
CO3	√		√	√							√
CO4	√					√		√			√

(2ND SEMESTER)
FACTS MODELING CONTROL & APPLICATION (3-1-0)

Course Objectives:

1. Understand the importance of controllable parameters and benefits of FACTS controllers in power system operation.
2. Know the significance of different types of FACTS controller and their modelling for power system control.
3. Understand the application of various FACTS controller for improvement of power system performance.

SYLLABUS

MODULE-I (10 HOURS)

FACTS concepts and general system considerations: Power flow in AC system, transient stability and dynamic stability, basic description of FACTS controllers, brief review of voltage sourced converter and current sourced converter, modeling philosophy

Static var compensator (SVC and STATCOM): objectives of shunt compensation, methods of controllable Var Generation, regulation slope, transfer function, V-I and V-Q characteristics, transient stability enhancement, var reserve control, conventional power flow models, shunt variable susceptance model, firing angle model, transient stability model, voltage magnitude control using SVC & STATCOM, Application example

MODULE-II (10 HOURS)

Static Series compensators (TCSC and SSSC): objectives of series compensation, improvements of voltage and transient stability, power oscillation damping, subsynchronous damping, transmittable power and transmittable angle characteristics, control range, conventional power flow models, variable series impedance model, firing angle model, transient stability model, active power flow control using TCSC & SSSC, Application example

MODULE-III (10 HOURS)

Static voltage and phase angle regulator (TCVR and TCPAR): objectives of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter based voltage and phase angle regulators

Unified power flow controller: Basic operating principles, transmission control, independent real and reactive power flow control, power flow models, transient stability model, control structure, basic control system for P and Q control, dynamic performance, Application example

MODULE-IV (10 HOURS)

Brief control studies such as Steady state analysis and control, EMTP studies, power oscillation stability analysis and control, transient stability control

BOOKS

- [1]. Y. H. Songs, A. T. Johns, “*Flexible AC Transmission Systems*”, IEE Press, 1999
- [2]. N. G. Hingorani, L. Gyugyi, “*Understanding FACTS*”, IEEE Press, Indian Edition, 2001.
- [3]. E. Acha, “*FACTS: modelling and simulation in power networks*”, John Wiley & Sons, 2004.
- [4]. K. R. Padiyar , “ *FACTS Controllers in Power Transmission & Distribution* ” , New Age International Publishers , 2014
- [5]. Vijay K. Sood , “ HVDC and FACTS Controller: Applications of Static Converters in Power Systems” , Kluwer Power Electronics & Power System Series , 2006

Course Outcomes:

1. An ability to apply knowledge of FACTS Controllers.
2. An ability to design a Compensators within realistic constraints.
3. An ability to identify, model, and solve real network problems with FACTS controllers.
4. The broad education necessary to understand the impact of engineering solutions in a global perspective.
5. A knowledge of recent trend in FACTS controllers and application of FACTS controllers.

Mapping of Course Outcomes to Programme Outcomes

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√	√	√	√	√				√	√
CO2	√	√	√	√		√	√				√
CO3	√	√	√				√	√			
CO4									√	√	
CO5	√				√				√	√	√

(2ND SEMESTER)
DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS
(3-1-0)

Course Objectives :

1. Device modeling
2. State Space modeling
3. PSpice A/D simulation
4. PSpice Schematic simulation

SYLLABUS

MODULE-I (10 HOURS)

Principles of Modeling Power Semiconductor Devices - Macromodels versus Micromodels - Thyristor model - Semiconductor Device modelled as Resistance, Resistance-Inductance and Inductance-Resistance-Capacitance combination - Modelling of Electrical Machines - Modelling of Control Circuits for Power Electronic Switches. Computer Formulation of Equations for Power Electronic Systems - Review of Graph Theory as applied to Electrical Networks - Systematic method of Formulating State Equations - Computer Solution of State Equations - Explicit Integration method - Implicit Integration method.

MODULE-II (10 HOURS)

Circuit Analysis Software MicroSimPSpice A/D - Simulation Overview - Creating and Preparing a Circuit for Simulation - Simulating a Circuit with PSpice A/D - Displaying Simulation Results - PSpice A/D Analyses - Simple Multi-run Analyses - Statistical Analyses - Simulation Examples of Power Electronic systems.

MODULE-III (10 HOURS)

MicroSim PSpice A/D - Preparing a Schematic for Simulation - Creating Symbols - Creating Models - Analog Behavioural Modeling - Setting Up and Running analyses - Viewing Results - Examples of Power Electronic Systems.

MODULE-IV (10 HOURS)

Design Creation and Simulation with Saber Designer - Placing the Parts - Editing the Symbol Properties - Wiring the Schematic - Modifying Wire Attributes - Performing a Transient and DC Analysis - Placing Probes in the Design - Performing AC Analysis and Invoking SaberScope - Analysing waveforms with SaberScope - Performing Measurements on a waveform - Varying a

Parameter - Displaying the Parameter Sweep Results - Measuring a Multi-Member Waveform - Simulation Examples of Power Electronic Systems.

BOOKS

- [1]. V.Rajagopalan, ”Computer Aided Analysis of Power Electronic Systems”, Marcel Dekker, Inc.
- [2]. MicroSimPspice A/D and Basics+: Circuit Analysis Software, User's Guide, MicroSim Corporation.
- [3]. MicroSim Schematics: Schematic Capture Software, User's Guide, MicroSim Corporation.

Course Outcomes :

- 1. 100% result showing learning of all objectives
- 2. One M Tech thesis is produced on PSpice Schematic simulation

Over all students have learnt simulation of power electronics system.

Mapping of Course Outcomes to Programme Outcomes

Course Outcon	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√		√	√		√	√	√			√
CO2	√										√

(2ND SEMESTER)
(ELECTIVE-II)
POWER QUALITY (3-1-0)

Course Objectives:

The objective of this course is to

1. Provide general concept of power quality issues.
1. The main reasons of getting the power quality down.
2. The various bench marks to be followed in maintaining the power quality,
3. The power quality issues with the increase use of power electronics as well as microprocessor based devices in modern power system.
4. To know the practical problems in modern power systems includes the distribution generation.
5. Help the student understand the monitoring of power quality issues.

SYLLABUS

MODULE-I (10 HOURS)

PQ Definitions and Standards General Classification of PQ Phenomena IEEE and IEC PQ Standards, PQ Monitoring and Measuring Available monitoring techniques and their drawbacks Commercial power quality monitors, Power quality monitors sensitivity PQ Problems Identification, PQ Phenomena Classification Identification and localization of PQ problems Different PQ classification techniques and case studies

MODULE-II (10 HOURS)

Harmonic Sources, Effects, Analysis, and Modeling, Harmonic Distortion Mitigation Voltage vs. Current Distortion, Harmonics vs. Transients Harmonic Sources from Commercial and Industrial Loads, Time domain versus frequency domain Different Harmonic filters (passive, active and hybrid); and case studies

MODULE-III (10 HOURS)

Voltage Sag, Swell and Interruptions, Transient Over-voltages, Sources of Sags and Interruptions, Fundamental Principles of Protection, Motor-Starting Sags, Utility System Fault-Clearing. Issues, and Case Studies, Sources of Transient Overvoltages; Principles of Overvoltage Protection and Switching Transient Problems with Loads

MODULE-IV (10 HOURS)

Voltage Flicker, Voltage Unbalance, Voltage Regulation Sources of voltage flicker; Effects and mitigation techniques Sources of voltage unbalance; Effects and mitigation techniques Devices for Voltage Regulation; Utility Voltage Regulator Application and End-User Capacitor Application

BOOKS

- [1]. R. Dugan, M. Mc Granaghan, S. Santoso and H. Beaty, Electrical Power System Quality, Second Edition, McGraw-Hill, 2002, ISBN 0-07-138622-X.
- [2]. J. Arrillaga, B. Smith, N. Watson and A. Wood, Power System Harmonic Analysis, John Wiley, 1997, ISBN 0-471-97548-6.
- [3]. Understanding Power Quality Problems by Math H. Bollen
- [4]. J. Arrillaga, .Power System Quality Assessment., John wiley, 2000
- [5]. R. SastryVedam , M. S. Sarma , “ Power Quality: VAR Compensation in Power System ” CRC Press , Taylor and Francis group , 2008

Course Outcomes:

When the students have passed the course, they shall be able to

- 1. Understand the reasons for increased concern for power quality issues in power systems.
- 2. Follow the benchmarking process in power quality sector.
- 3. To analyses and solve the issues in power quality improvement.
- 4. To apply technology in solving the problems of power quality.
- 5. To solve the problems when there is use of distribution generation.
- 6. Understand the various monitoring methods used in power quality issues.
- 7. Plan of controlling the power quality issues.

Mapping of Course Outcomes to Programme Outcomes

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1			√		√				√		√
CO2									√	√	√
CO3			√		√		√				√
CO4	√	√			√						√
CO5	√	√							√		√
CO6			√								√
CO7			√								√

(2ND SEMESTER)

(ELECTIVE-II)

NON LINEAR SYSTEM THEORY (3-1-0)

Course Objectives:

The objectives of the course is to make the students able

1. To understand the fundamentals of nonlinear systems.
2. To apply mathematical analysis of nonlinear systems.
3. To understand stability of nonlinear system.

SYLLABUS

MODULE-I (10 HOURS)

Non Linear Systems:

Ordinary differential equation (ODE) systems, Differential & algebraic equation (DAE) systems, Equilibrium points, Limit cycles, pointcare maps, monodromy matrices, dynamic manifolds, region of attraction, Lyapunov stability,

MODULE-II (10 HOURS)

Numerical Methods: Newton Raphson, eigen value computation, initial value problems (IVP) and boundary value problems (BVP)

Definitions of local and global bifurcations saddle node bifurcations, transcritical bifurcations, pitchforks and Hopf bifurcations, Limit induced bifurcations, center manifolds

Normal forms: Lyapunov Schmidt reduction

DAE systems: bifurcations transversality conditions and singularity induced bifurcations

MODULE-III (10 HOURS)

Singular bifurcations computations: continuation methods and direct methods, optimization techniques

Hopf bifurcations computations: continuation methods and direct methods Bifurcations of limit cycle: definition and computation

MODULE-IV (10 HOURS)

Chaotic Behavior:

Definition and examples of continuous and discrete (fractal) strange attractors.

Mechanisms that lead to chaos: Torus bifurcations period doubling, intermittency, instant chaos, fractal, dimensions, Lyapunov exponents, power spectra.

BOOKS

- [1]. R Seydel, “*Practical Bifurcation and Stability Analysis*”, Springer Verlag 1994
- [2]. M Vidyasagar, “*Nonlinear Systems Analysis*”, Prentice Hall
- [3]. Hassan K. Khalil , “ *Nonlinear System* ” , Prentice Hall , New Jersey , 2002

Course Outcomes:

At the end of the course, the student will be able to

CO1:Get knowledge on nonlinear systems.

CO2: Able to apply mathematical analysis for control of nonlinear systems.

CO3: Gain knowledge on nonlinear systems stability and apply selectively.

Mapping of Course Outcomes to Programme Outcomes

Course Outcomes	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1			√		√						√
CO2	√		√	√				√			√
CO3	√		√								√

(2ND SEMESTER)

(ELECTIVE-II)

ADVANCED CONTROL OF DRIVES (3-1-0)

Course Objectives:

1. The purpose of this course is to introduce the various modelling concepts in vector and field-oriented control for induction and synchronous drives.
2. Concept of Parameter sensitivity, selection of flux level, field weakening and parameter detuning in steady-state operation is necessary to be learnt.
3. The students should be capable to principles for speed sensor-less control and their application in drives.
4. The purpose is to give up-to-date knowledge for designing the drives.

SYLLABUS

MODULE-I (10 HOURS)

Principles for vector and field-oriented control-Complex-valued dq-model of induction machines. Turns ratio and modified dq-models. Principles for field-oriented vector control of ac machines. Current controllers in stationary and synchronous coordinates. Rotor-flux oriented control of current-regulated induction machine - Dynamic model of IM in rotor-flux coordinates. Indirect rotor-flux oriented control of IM - Direct rotor-flux oriented control of IM.- Methods to estimation of rotor-flux

MODULE-II (10 HOURS)

Generalized flux-vector control using current- and voltage decoupling networks- Generalized flux-vector oriented control. Current and voltage decoupling networks. Air gap-oriented control. Voltage-fed vector control. Stator-flux oriented vector control.

MODULE-III (10 HOURS)

Parameter sensitivity, selection of flux level, and field weakening - Parameter detuning in steady-state operation. Parameter detuning during dynamics. Selection of flux level. Control strategies for used in the over-speed region .

MODULE-IV (10 HOURS)

Principles for speed sensor-less control - Principles for speed sensor-less control. Sensor-less methods for scalar control. Sensor-less methods for vector control .Introduction to observer-based techniques

BOOKS

- [1]. Extract of D. W. Novotny and T. A. Lipo, Vector Control and Dynamics of AC Drives, Oxford University Press, 1996.
- [2]. P. L. Jansen and R. D. Lorenz, A Physically Insightful Approach to the Design and Accuracy Assessment of Flux Observers for Field Oriented Induction Machine Drives, IEEE Trans. on Industry Applications, Vol. 30, No. 1, Jan./Feb. 1994, pp. 101110.
- [3]. Extract of I. Boldea and S. A. Nasar Electric Drives, CRC Press, 1998.
- [4]. J. Holtz, Methods for Speed Sensorless Control of AC Drives, in K. Rajashekara Sensorless Control of AC motors. IEEE Press Book, 1996. Supplementary literature

Course Outcomes:

1. Understanding of the basic principles and importance of various controlling of drives
2. Learning of recent advancement in control of drives
3. The course provides a sound foundation for students to pursue a career in various organizations where drives are applied through a diverse range of theoretical skills and practical experience of real time applications and design experience
4. Modules of this programme train the students to study, design, install, operate, control and maintain complex systems of various drives

Mapping of Course Outcomes to Programme Outcomes

Course outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√		√							√
CO2	√			√		√					√
CO3							√		√	√	
CO4	√	√		√							√

(2ND SEMESTER)

(ELECTIVE-II)

SWITCHED MODE AND RESONANT CONVERTERS (3-1-0)

Course Objectives:

1. Students will learn basic operation, waveform, modes of operation and switching losses of Buck, Boost, and Buck-Boost converter.
2. Students will understand the Voltage control mode and Current control mode of SMPS .
3. Students will understand State Space Averaging and Linearisation and discontinuous mode of operation of SMPS .
4. Students will understand the EMI Filtering at Input and Output and Effect of EMI Filter on SMPS Control Dynamics.
5. Students will understand the introduction and classification of resonant converter.
6. Students will understand Zero Voltage Switching Clamped Voltage Topologies and Resonant DC Link Inverters with Zero Voltage Switching.

SYLLABUS

MODULE-I (10 HOURS)

Buck, Boost, Buck-Boost SMPS Topologies . Basic Operation- Waveforms - modes of operation - switching stresses - switching and conduction losses - optimum switching frequency - practical voltage, current and power limits - design relations - voltage mode control principles. Push-Pull and Forward Converter Topologies - Basic Operation . Waveforms - Flux Imbalance Problem and Solutions - Transformer Design -Output Filter Design -Switching Stresses and Losses - Forward Converter Magnetics --Voltage Mode Control. Half and Full Bridge Converters . Basic Operation and Waveforms-Magnetics . Output Filter . Flux Imbalance . Switching Stresses and Losses . Power Limits . Voltage Mode Control. Flyback Converter .discontinuous mode operation . waveforms .Control . Magnetics- Switching Stresses and Losses . Disadvantages - Continuous Mode Operation .Waveforms .Control . Design Relations.

MODULE-II (10 HOURS)

Voltage Mode Control of SMPS . Loop Gain and Stability Considerations . Shaping the Error Amp frequency Response . Error Amp Transfer Function .Transconductance Error Amps . Study of popular PWM Control Ics (SG 3525, TL 494, MC34060 etc.)Current Mode Control of SMPS . Current Mode Control Advantages . Current Mode Vs Voltage Mode . Current Mode Deficiencies . Slope Compensation . Study of a typical Current Mode PWM Control IC UC3842.

MODULE-III (10 HOURS)

Modeling of SMPS . State Space Averaging and Linearisation. State Space Averaging Approximation for Continuity . Discontinuous Conduction Modes . Small Signal Approximation- General Second Order Linear Equivalent Circuits . The DC Transformer . Voltage Mode SMPS Transfer Function . General Control Law Considerations . Source to State Transfer Function . Source to Output Transfer Function .Stability . Loop Compensation EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS . Techniques to reduce Emissions . Control of Switching Loci . Shielding and Grounding . Power Circuit Layout for minimum EMI . EMI Filtering at Input and Output . Effect of EMI Filter on SMPS Control Dynamics

MODULE-IV (11 HOURS)

Introduction to Resonant Converters . Classification of Resonant Converters . Basic Resonant Circuit Concepts . Load Resonant Converter . Resonant Switch Converter . Zero Voltage Switching Clamped Voltage Topologies . Resonant DC Link Inverters with Zero Voltage Switching . High Frequency Link Integral Half Cycle Converter.

BOOKS

- [1]. Abraham I Pressman : Switching Power Supply Design. McGraw Hill Publishing Company.
- [2]. Daniel M Mitchell : DC-DC Switching Regulator Analysis. McGraw Hill Publishing Company
- [3]. Ned Mohan et.al : Power Electronics.John Wiley and Sons.
- [4]. OtmarKilgenstein: Switched Mode Power Supplies in Practice. John Wiley and Sons.
- [5]. Keith H Billings: Handbook of Switched Mode Power Supplies. McGraw Hill Publishing Company.

Course Outcomes:

When the students have passed the course, they shall be able to

1. To introduce and clasify different forms of resonant dc-dc converter.
2. Use of vector analysis, different topologies and control mechanism of SMPS.
3. To analyse and know the high frequency and zero switching.

Mapping of Course Outcomes to Programme Outcomes

Course Outcom	Programme Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√				√				√		√
CO2	√		√						√		√
CO3	√		√			√					√

(2ND SEMESTER)

POWER ELECTRONICS & DRIVES LAB-II (0-0-6)

Course Objectives:

In this laboratory students will learn about the following points:

1. To prepare students to succeed in industry, technical profession, and to excel in PhD programme.
2. able to use control system and simpower system tool boxes.
3. able to realize different power electronics components and its applications.
4. able to visualize input/output voltage/current waveforms.
5. able to learn use of PSPICE software for circuit analysis.
6. able to design and analyze any circuits, before going to design practical circuits.
7. able to solve circuit problem and debugging and ready to face the challenges.

**SYLLABUS
LIST OF EXPERIMENTS**

1. Analysis of Dual Converter fed DC motor Drive
2. Chopper Fed DC motor Drive
3. Performance study of Stator Voltage controlled Induction Motor Drive
4. Analysis of Vector Controlled Induction Motor Drive
5. IGBT based Three Phase inverter
6. IGBT based single phase PWM Inverter
7. Speed control of DC motor using three phase fully controlled converter
8. Three phase half wave cycloconverter
9. Simulation of power electronics systems using PSPICE
10. Modeling and simulation of electric Drives using MATLAB
11. Operation of Cycloconverter on R-L and Motor Load.
12. Speed control of induction motor by operation of cycloconverter on R-L and motor load.

Course Outcomes:

After completion of this course

1. Graduate will have the ability to apply knowledge of mathematics, science and Engineering.
2. Graduate will have basic skill in methods of design and analysis across a broad range of electrical and computer engineering areas.

3. Graduate will have the ability to make thoughtful, well-informed career choices and to meet the global challenges of tomorrow's technology.

Mapping of Course Objectives and Course Outcomes

Course Outcomes	Program Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
CO1	√	√	√	√	√		√		√		√
CO2	√	√	√		√	√	√			√	
CO3	√	√	√	√	√		√	√			√