I SEMESTER

21ED01 MATHEMATICS OF SYSTEMS ENGINEERING
Vide Applied Electronics 21EA01

21ED02 POWER SEMICONDUCTOR DEVICES

3 0 0 3


(11)


(11)


(11)


(12)

REFERENCES:

Total L: 45

21ED03 MODELING AND ANALYSIS OF ELECTRICAL MACHINES

3 0 0 3


(11)


(12)

SYNCHRONOUS MACHINES: Generalized representation - Steady state analysis- Phasor diagram - Regulation – Power angle characteristics - Short circuit ratio - Transient analysis (Qualitative approach)

(11)


(11)

Total L: 45

REFERENCES:

108
21ED04 POWER CONVERTERS AND ANALYSIS

AC TO DC CONVERTERS: Design and analysis of Single phase and three phase bridge rectifiers, Fully controlled converters with RL, RLE loads, Freewheeling diode, Dual Converter, PWM rectifiers, Input harmonics and output ripple, smoothing inductance, power factor, effect of source inductance and overlap, Design of converter circuits – Snubber circuit design - Control circuit strategies. (12+4)

DC TO DC CONVERTERS: DC choppers: Step down dc chopper with R, RL and RLE loads - Control strategies- Continuous and discontinuous current operations - Two quadrant and four quadrant DC chopper - Multiphase DC chopper - Switching mode regulators: Buck, Boost, Buck-Boost and CUK regulators - Chopper circuit design – Control circuit strategies. (11+3)

AC TO AC CONVERTERS: Principle of phase control, single-phase bi-directional controllers with R, L and R-L loads, 3-phase bi-directional Controllers, different Configurations, Analysis with pure R and L loads. Principle of operation, - single phase and three phase cyclo rectifiers - Control circuit strategies. (11+4)

DC TO AC CONVERTERS: Single phase and Three phase bridge inverters - Evaluation of performance parameters –Voltage control and Waveform improvement Techniques – Current source inverters - Inverter circuit design - SVPWM – Introduction to multilevel inverter. (11+4)

REFERENCES:

21ED05 MODELING AND SIMULATION OF POWER ELECTRONIC CONVERTERS


LINEAR CONTROL APPROACHES FOR DC-AC AND AC-DC POWER CONVERTERS - Issues - Control in Rotating dq Frame - Resonant Controllers: Necessity of Resonant Control - Proportional Resonant Control - Design Methods - Implementation Aspects - Control of Full Wave Converters - Case Studies. (11+3)


REFERENCES:

109
21ED51 POWER CONVERTERS LABORATORY

LIST OF EXPERIMENTS:
2. Performance analysis of AC to DC converter with RL and RLE Load
3. Performance analysis of AC to AC converter with RL and RLE Load
4. Performance analysis of DC to DC converter with RL and RLE Load
5. Performance analysis of DC to AC converter under voltage and v/f control mode.
6. Mini project

Total P: 60

21ED52 / 21EA51 / 21EE52 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

Object Computing (Using C++):
Implementation of the following problems:
1. Implementation of classes and object for simple arithmetic operations.
2. Implementation of array of objects and dynamic objects.
3. Implementation of Static members.
5. Implementation of friend functions, inline functions and default arguments.
6. Implementation of constructors and destructors.
7. Implementation of inheritance and its types

Data Structures (Using C or C++):
1. Program using arrays.
2. Representation of Sparse & dense Matrix using arrays.
3. Implementation of Stacks using array.
4. Application of Stack: Conversion of infix to postfix expression
5. Implementation of queue using array.
7. Implementation of various sorting algorithms.

Total P: 60

REFERENCES:

II SEMESTER

21ED07 ELECTRIC DRIVES AND CONTROL


Induction Motor Drives: Stator Control: control by AC voltage controllers - Variable frequency square wave VSI drives - PWM Drives - CSI drives - closed loop control. Rotor Control: Static rotor resistance control - Slip power recovery : Static Kramer drive - Static Scherbius drive. (11+4)
VECTOR CONTROL OF INDUCTION MOTORS: Principle of vector control - Rotor flux - Oriented control, Stator Flux-oriented control, Magnetizing flux-oriented control of Induction machines. Sensorless Vector and Direct Torque Controlled Drives. (12+4)


REFERENCES:

21ED08 SWITCHED MODE POWER CONVERTERS

DC-DC CONVERTER DYNAMICS: Reactive Elements in Power Electronic Systems, Types of inductor, Types of transformer, Types of Capacitors for power electronic applications - Exact and Approximate Analysis of DC-DC converters, Design and analysis, steady state and dynamic model of Non-isolated DC to DC Power Converter- Buck, Boost, Buck-Boost, Cuk Converters, Isolated DC to DC Power Converter - Forward, Flyback, Half/Full Bridge Converters - Case Study - EMI-EMC Complaints. (12+3)

RESONANT CONVERTERS: Classification of resonant converters-resonant load converters- principal of operation- SMPS using resonant circuit- steady state modeling. Resonant switch converters- Buck converter with ZCS and ZVS-operation and analysis. (11+4)

CLOSED LOOP CONTROL OF POWER CONVERTERS: Closed Loop Control of Switching Converters- Steady State Error, Control Bandwidth, and Compensator Design- Closed Loop Dynamic Performance Functions- Design of feed- back compensators. (11+4)


REFERENCES:

21ED82 AUDIT COURSE II
vide Automotive Engineering 21AE82

21ED61 DRIVES AND CONTROLS LABORATORY

LIST OF EXPERIMENTS:
1. Performance analysis of three phase induction motor using variable frequency drive
2. Performance analysis of Synchronous Reluctance and PMSM motor using variable frequency drive
3. Performance analysis of SRM/BLDC motor using variable frequency drive
4. Harmonic analysis of variable frequency drives using scalar and vector control
5. Hardware-in-loop simulation of Electric Drives using Opal-RT and dSPACE.
6. Mini project

Total P: 60
LIST OF EXPERIMENTS:
1. Design, development and analysis of DC to DC converters using IGBTs, and Power MOSFETs.
2. Design and development of DC to AC converters using IGBTs, and Power MOSFETs.
3. Design, development and analysis of AC to AC converters of various configurations using SCRs, TRIAC, and IGBTs.
4. Design, development and analysis of AC to DC converters using SCR and Diodes.
5. Hardware-in-loop simulation of Power Converters using Opal-RT and dSPACE.
6. Mini project

Total P: 60

21ED63 INDUSTRIAL VISIT AND TECHNICAL SEMINAR
vide Automotive Engineering 21AE63

SEMESTER – III

21ED71 PROJECT WORK – I
vide Automotive Engineering 21AE71

SEMESTER – IV

21ED81 PROJECT WORK – II
Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21ED21 POWER ELECTRONICS IN RENEWABLE ENERGY SYSTEMS

SOLAR PV AND WIND POWER:

SOLAR PHOTOVOLTAIC ENERGY CONVERSION:

WIND ENERGY CONVERSION SYSTEMS:

HYBRID POWER SYSTEMS:
- Wind / Solar PV integrated systems - Other alternate Systems - Requirements - Optimization of system components Power conditioning schemes for Hybrid Power Systems (HPS) - Design of HPS using software - Storage types and selection methods - Applications of HPS (11)

Total L : 45

REFERENCES:


Battery - Types - Charging Circuit - Health monitoring - Sizing Techniques


Product Quality - Regulatory Compliance and Safety - ESD&EMI/EMC - Environmental Regulations - Audible Noise - Reliability - Fault Detection & Isolation - Quality management Workflow


REFERENCES:


TEXT BOOKS:


PERMANENT MAGNET BRUSHLESS DC MACHINES: Commutation in DC motor, Electronic commutation, Hal sensors, Optical sensors, Magnetic circuit model, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics,Control by Back-EMF detection circuits, Controllers- Microprocessor based controller, Field Weakening control.


REFERENCES:
21ED26 / 21EE43 / 21EM26 DIGITAL CONTROLLER FOR POWER ELECTRONICS

TMS C2XX DSP: Introduction to the C2xx DSP core and code generation. The components of the C2xx DSP core, Peripherals and Peripheral Interface, System configuration registers, Memory, Types of Physical Memory, memory Addressing Modes, Code Composer Studio for C2xx DSP. (12)

I/O AND INTERRUPTS: Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers, Programming I/O. Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initialising and Servicing Interrupts in Software, Programming Interrupts (11)

ADC AND EVENT MANAGERS: ADC Overview, Operation of the ADC in the DSP, Overview of the Event manager (EV), Event Manager Interrupts, General Purpose (GP) Timers, Compare Units, Capture Units And Quadrature Encoded Pulse (QEP) Circuitry, General Event Manager Information, Programming of ADC and Event Managers (11)

DESIGN OF CONTROLLER IN POWER ELECTRONICS: Typical applications: DSP-based implementation of DC-DC buck-boost converter- DSP-based control of permanent magnet brushless DC machines- DSP-based Implementation of clarkes’s and park’s transformations- DSP-Based implementation of SPWM, SVPWM inverter pulse generation. (11)

REFERENCES:
2. TMS320C28x CPU and Instruction Set Reference Guide -SPRU430
3. TMS320x28xxx, 28xxx Peripheral Reference Guide -SPRU566
4. TMS320x2833xx System Control and Interrupts Reference Guide -SPRUFB0
5. TMS320x2833x Analog-to-Digital Converter (ADC) Reference Guide -SPRU812

21ED27 / 21EM27 ADVANCED CONTROL OF ELECTRIC DRIVES


DSP CONTROLLED DRIVES: Types of Torque-Controlled Drive Schemes - Vector Drives, Direct-Torque-Controlled Drives - DSP Controlled AC Drive, Synchronous motor Drive, and BLDC Motor drive. (12)

FUZZY CONTROLLED DRIVES: Induction Motor Drives, Synchronous Motor Drives, Reluctance motor Drives, Servo Motor Drives: Speed control using Fuzzy logic based digital controllers (11)

ARTIFICIAL-INTELLIGENCE BASED DRIVES: AI-Based Techniques - Applications in Electrical Machines and Drives –Neural Networks based control of AC Drive, SynRM Drive, and BLDC Motor drive (11)

REFERENCES:

21ED28 / 21EM28 SOFT COMPUTING TECHNIQUES FOR RENEWABLE ENERGY SYSTEMS


OPTIMISATION TECHNIQUES FOR PHOTOVOLTAIC ENERGY CONVERSION: Passive filter design using Genetic Algorithm, harmonic elimination in inverters, Tuning of controllers, GA, PSO, DE, optimized fuzzy logic for the Maximum Power Point Tracking. (11)

OPTIMISATION TECHNIQUES FOR WIND ENERGY CONVERSION SYSTEMS: Simulation model of Wind turbine and Wind Turbine Generators. Prediction of Wind Turbine Power Factor, Pitch Angle Control, MPPT Algorithms, Economic Dispatch For

REFERENCES:

21ED29 FLEXIBLE AC TRANSMISSION SYSTEM


COORDINATION AND APPLICATION OF FACTS DEVICES: Modelling of FACTS devices, optimization of FACTS - Control strategies to improve system stability - Co-ordination of FACTS controllers. Application of FACTS Controllers: Sub-synchronous resonance, Damping oscillations, Transient stability and voltage stability.

REFERENCES:

21ED30 / 21EM33 POWER QUALITY MANAGEMENT


POWER QUALITY SOLUTIONS: Power quality monitoring considerations - Choosing monitoring locations - monitoring and diagnostic techniques for various power quality problems - modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - power line disturbance analyzer - quality measurement equipment - harmonic / spectrum analyzer - flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring. (11)

POWER QUALITY CONDITIONERS: Shunt and series compensators - DSTATCOM - dynamic voltage restorer - unified power quality conditioners - Custom power devices and their applications in power system - Operating principles - Detailed modeling and analysis of DSTATCOM and DVR - Compensators to mitigate power quality related problems - Realization of DVR and DSTATCOM by using VSC. (11)

REFERENCES:

21ED31 / 21EM22 ADVANCED TOPICS IN POWER ELECTRONICS

INTRODUCTION TO SWITCHES: Advanced Silicon devices - Silicon HV thyristors, MCT, BRT & EST - Sic devices - diodes, thyristors, JFETs & IGBTs - Gallium nitrate devices - Diodes, MoSFETs (11)

ADVANCE CONVERTER TOPOLOGIES: Interleaved converters, Z-Source converters, Multi-level converters (cascaded H-bridge, diodeclamped, NPC, flying capacitor) Multi pulse PWM current source converters, Advanced drive control schemes. (12)

ADVANCES IN REACTIVE ELEMENTS: Advanced magnetic material, technology and design (powder ferrite, amorphous, planar designs) Advance capacitive designs (multilayer chip capacitors, double layers for storage, aluminum electrolytic) (11)

THERMAL SOLUTIONS AND EMI/EMC TECHNIQUES: Advanced thermal solutions (fan cooled, liquid cooled, heat pipes, hybrid techniques) EMC techniques (conducted, radiated emissions & susceptibility), System design for EMC. PCB design with EMI/EMC validations - case studies. (11)

REFERENCES:

21ED32 HVDC TRANSMISSION

BASICS OF HVDC TRANSMISSION: Introduction to HVDC transmission, Comparison between HVAC and HVDC systems - Economic, technical and reliability, limitations, Types of HVDC links - monopolar, bipolar and homopolar links, Components of HVDC transmission system.

ANALYSIS OF HVDC CONVERTERS: Analysis of HVDC Converters, Rectifier and Inverter operation of Graetz circuit without and with overlap. Output voltage waveforms and DC voltage in both rectifier and inverter operation, Equivalent circuit of HVDC link. (12)

CONTROL OF HVDC SYSTEMS: Basic means of HVDC system control, desired features, power reversal, Basic controllers - constant ignition angle, constant current and constant extinction/ advance angle control, power control, high level controllers. Converter malfunctioning - misfire, arc through, commutation failure. (11)

HARMONICS IN HVDC SYSTEM: Harmonics in HVDC system - Characteristic and uncharacteristic harmonics - Troubles due to harmonics – Harmonic filters - Active and passive filters - Reactive power control of converters, Protection issues in HVDC, over voltage and over current protection Voltage and current oscillations, DC reactor design, DC Circuit breakers. (11)

RECENT TRENDS IN HVDC TRANSMISSION: CSC based HVDC system, VSC based HVDC system – Multi-terminal HVDC systems and HVDC system applications in wind power generation, Interaction between AC and DC systems (11)
REFERENCES:

21ED33 DESIGN OF SOLAR PHOTOVOLTAIC SYSTEMS

FUNDAMENTALS OF SOLAR PHOTOVOLTAIC TECHNOLOGY: Historical review- Basic approaches and objectives - Phenomena of light and energy- Energy from the sun - Photovoltaic(PV) cell characteristics - Model of PV cell - Datasheet study.


REFERENCES:  

21ED34 / 21EA32 / 21EE42 / 21EM32 OPTIMIZATION TECHNIQUES


DYNAMIC PROGRAMMING: Multistage decision process, Suboptimization and Principle of Optimality, Computational procedure, Final value problem to initial value problem, Linear Programming as a Case of Dynamic Programming, Continuous dynamic programming

Total L: 45
REFERENCES:

21ED35 PULSE WIDTH MODULATED POWER ELECTRONIC CONVERTERS

PURPOSE OF PWM: Review of Fourier series, fundamental and harmonic voltages; machine model for harmonic voltages; undesirable effects of harmonic voltages – line current distortion, increased losses, pulsating torque in motor drives; control of fundamental voltage; mitigation of harmonics and their adverse effects

PWM TECHNIQUES: Square wave operation of voltage source inverter, PWM with a few switching angles per quarter cycle, equal voltage contours, selective harmonic elimination, THD optimized PWM, off-line PWM, Triangle-comparison based PWM - Average pole voltages, sinusoidal modulation, third harmonic injection, continuous PWM, bus-clamping or discontinuous PWM, Space vector based PWM - bus-clamping PWM.

ANALYSIS OF PWM CONVERTERS: Analysis of line current ripple, Analysis of dc link current - Analysis of torque ripple, Inverter loss, Effect of inverter dead-time effect.

OVERMODULATION & PWM FOR MULTILEVEL INVERTER: Per-phase and space vector approaches to over modulation, average voltages in a synchronously revolving d-q reference frame, low-frequency harmonic distortion. Extensions of sine-triangle PWM to multilevel inverters, voltage space vectors, space vector based PWM, analysis of line current ripple and torque ripple.

REFERENCES:

21ED36 / 21EE44 / 21EM36 SMART GRID TECHNOLOGIES

SMART GRID ARCHITECTURE AND COMPONENTS: Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Concept of Robust & Self-Healing Grid, Smart Grid Architecture - Models - Standards, and Road map for Smart Grid in India. WIDE AREA MONITORING SYSTEM: Fundamentals of Synchronphasor Technology, Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC), Operational experience and Blackout analysis using PMU - Case study on Blackout on Indian Grid.


REFERENCES:

21ED37 / 21EM37 DISTRIBUTED GENERATION AND MICROGRIDS


CONTROL AND OPERATION OF MICRO GRID: Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in micro grids, regulatory standards, Microgrid economics, Introduction to smart micro grids. (12)

Total L : 45

REFERENCES:

21ED38 / 21EM38 ELECTRIC VEHICLES

VEHICLE FUNDAMENTALS: Vehicle movement, Vehicle resistance, Dynamic equation, Power train tractive effort and vehicle speed, Vehicle power plant and transmission characteristics, Vehicle performance, Operating fuel economy, Braking performance. (11)

ELECTRIC AND HYBRID ELECTRIC VEHICLES: History, Environmental impact, Configurations of electric vehicles, Performance of electric vehicles, Tractive effort in normal driving, Energy consumption, Concept and architecture of hybrid electric drive trains. (11)

ELECTRIC COMPONENTS IN HYBRID AND ELECTRIC VEHICLES: Electric Drives in HEV/EVs, Classification and Characteristics, configuration and Control of DC Motor drives: Brushed and Brushless, Induction Motor drives, Switched Reluctance Motor drives for HEV/EVs applications, Drive System efficiency, Performance matching of Electric Machine and the Internal Combustion Engine (ICE), Sizing the propulsion motor, sizing of power electronic devices and Energy Storage systems. (12)

ENERGY MANAGEMENT STRATEGIES: Electrochemical batteries: Overview of Batteries-Battery Parameters-Lead acid batteries-Lithium ion batteries-Metal air batteries-Battery Charging, Ultracapacitors, Ultrahigh-speed flywheels, Hybrid sources, Fuel Cell Technologies. (11)

Total L: 45

REFERENCES:

Total L: 120
VEHICLE ELECTRIFICATION: Introduction and definition, energy management in electric vehicles. Comparison of battery SOC profile for various EV modes of control, intelligent energy management of EVs with environment; EVs charging options and infrastructure; Energy, Economic, and Environmental Considerations; Impacts of EV Charging on the Power Grid – general considerations, effects of EV charging on battery lifetime, generation and load profile, distribution networks; The Role of Smart Charging Technologies and Applications (11)

POWER CONVERTERS FOR EV CHARGING: Bidirectional converter topologies for plug in vehicles, dual active converters for vehicle to grid, Converters for regenerative braking, Converters for ultra capacitor applications, converters for multiphase integrated onboard charger (11)

EV BATTERIES: Types of Battery, Vehicle requirements: energy and power requirements, battery design: cell selection, battery components, reliability and safety, battery control and management: battery management system, state functions (11)

EV CHARGING TECHNOLOGIES: Charging and charge completion of a single battery, temperature compensation during charging, charging technologies; Fast charging – fast charging process and strategies, fast charger configurations; Inductive charging; Battery discharging – discharge capacity behaviour, discharge characteristics of a single battery, discharge of an EV battery pack, cold-weather impact on battery discharge (12)

REFERENCES:

INTEGRATED CIRCUITS AND DEVICES FOR POWER ELECTRONICS

INTEGRATED CIRCUITS: Introduction to Op-Amp, Linear and Non-Linear applications. Pulse width modulation for power converters- Trailing edge, leading edge, and double edge carrier wave generation -Practical design problems.

MIXED-SIGNAL DESIGN: Introduction to SystemVerilog - Inverters, Gates, Buffer Design - Switched Mode RF Power Amplifiers, PWM pulse generation for RF power amplifiers (12)

PLL AND SENSOR INTERFACES FOR POWER CONVERTER: Phase locked loop (PLL) and synchronization Methods for Grid interfaced converters - Practical circuit using PLL IC. 555 Timer based application circuits- Design of Signal Gain for AC/DC Voltage and current sensors (11)

DC-DC CONVERTER TOPOLOGIES: Switched-inductor, switched-capacitor, and hybrid converters- Integrated passives and design: integrated inductors and integrated capacitors High voltage Isolation Interfaces for power converters-Opto-isolator – biasing circuits with 1:N isolation transformer. (11)

POWER MANAGEMENT ICS: PMIC Design procedure-Current Sense Circuits- Level Shifter Circuits- ESD - Protection and Timing Consideration (11)

REFERENCES:

CONFIGURATIONS OF DIFFERENT I/O CONTROL: Digital Input and output – Analog Input and output Control-word access – Motion control - Sequential Logic Control (SLC) - Parameterization for different communication protocol: RS 485 – MODBUS PROFIBUS.

CONFIGURATION FOR DIFFERENT APPLICATIONS: AQUA – HVAC – Automation – Master/ Slave control.

CONTROL OF DRIVES: Performance characterization of PMSM and SynRM - Conveyor control – Cascaded Pump Control Synchronization of Drives with Master Slave Control.

REFERENCES:
5. Monograph prepared by PSG-Danfoss CoE for Climate and Energy

OPEN ELECTIVES

21ED91 BUSINESS ANALYTICS
21EA91 vide Applied Electronics

21ED92 ELECTRONIC WASTE MANAGEMENT
21EA92 vide Applied Electronics

21ED93 INDUSTRIAL SAFETY AND STANDARDS
21EA93 vide Applied Electronics

21ED94 INNOVATION AND PRODUCT DEVELOPMENT
21EA94 vide Applied Electronics