M.E. POWER ELECTRONICS AND DRIVES

Signature of the Chairman BOS EEE

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

The Vision of the Department is to be a Centre of Excellence in Globalizing Power Engineering and Technology.

MISSION

The mission of the department is to Empower Youth by Imparting Technical Knowledge and Skills to Innovate, Transform and Globalize the Power Sector. It intended to equip the graduates with deftness to overcome challenges culminating in success in diverse competitive careers with societal impacts and values.

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KUMARAGURU COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University Chennai)
COIMBATORE – 641 049

REGULATIONS 2014 (Revised 2015)

ME POWER ELECTRONICS AND DRIVES

CURRICULUM

SEMESTER I

Course Code.	Course Title	L	T	P	C
Theory					
P14MAT105	Applied Mathematics for Electrical Engineers	3	1	0	4
P14PET101	Advanced Control Theory	3	1	0	4
P14PET102	Advanced Power Semiconductor Devices	3	0	0	3
P14PET103	Analysis of Power Converters	3	0	0	3
P14PET104	Analysis of Inverters	3	0	0	3
E1	Elective I	3	0	0	3
Practical					
P14PEP101	Power Electronics Simulation Laboratory I	0	0	2	1

Total Credits: 21

SEMESTER II

Course Code.	Course Title	L	T	P	C
Theory					
P14PET201	Solid State DC Drives	3	0	0	3
P14PET202	Solid State AC Drives	3	0	0	3
P14PET203	Microcontroller and DSP based System Design	3	0	0	3
P14PET204	Special Electrical Machines and their Controllers	3	0	0	3
E2	Elective II	3	0	0	3
E3	Elective III	3	0	0	3
Practical					
P14PEP201	Power Electronics and Drives Laboratory	0	0	2	1

Total Credits: 19

SEMESTER III

Course Code.	Course Title	L	T	P	C
Theory					
E4	Elective IV	3	0	0	3
E5	Elective V	3	0	0	3
E6	Elective VI	3	0	0	3
S1	Self study	0	0	0	3
Practical					
P14PEP301	Advanced Power Electronics and Drives Laboratory	0	0	2	1
P14PEP302	Project (Phase I)	0	0	6	3

Total Credits: 16

SEMESTER IV

Course Code.	Course Title	L	T	P	C
Practical					
P14PEP401	Project (Phase II)	0	0	24	12

Total Credits: 12
Total Credits: 68

ELECTIVES FOR FIRST SEMESTER

Course Code.	Course Title	L	T	P	C
Elective I					
P14PETE01	Industrial Control Electronics	3	0	0	3
P14PETE02	Modeling and Analysis of Electrical Machines	3	0	0	3
P14PETE03	Intelligent Control	3	0	0	3

ELECTIVES FOR SECOND SEMESTER

Course Code.	Course Title	L	T	P	C
Elective II & III					
P14PETE04	Digital Control in Power Electronics	3	0	0	3
P14PETE05	High Voltage Direct Current Transmission	3	0	0	3
P14PETE06	VLSI Design in Power Electronics	3	0	0	3
P14PETE07	Advanced Embedded Systems	3	0	0	3
P14PETE08	Power Quality	3	0	0	3
P14PETE09	Advanced Optimization Techniques	3	0	0	3

ELECTIVES FOR THIRD SEMESTER

Course Code.	Course Title	L	T	P	C
Elective IV, V, VI					
P14PETE10*	Advanced Digital Signal Processing	3	0	0	3
P14PETE11	PWM Converters and Applications	3	0	0	3
P14PETE12	SMPS and UPS	3	0	0	3
P14PETE13	Power Electronics in Wind & Solar Power Conversion	3	0	0	3
P14PETE14	Advanced Electric Drives & Controls	3	0	0	3
P14PETE15	Flexible AC Transmission Systems	3	0	0	3
P14PETE16	Control Design Techniques for Power Electronic Systems	3	0	0	3
P14PETE17	Electric and Hybrid Vehicles	3	0	0	3
P14PETE18	Energy Storage System	3	0	0	3
P14PETE19	Simulation of Power Electronic Systems	3	0	0	3
P14PETE20	Wind Energy Conversion Systems	3	0	0	3
P14PETE21	Emerging Trends in Power Conversion Technology	3	0	0	3

***** Common Elective subject for Power Electronics and Drives & Embedded System Technologies.

****** Self study subjects can be offered from elective I to VI

ONE CREDIT COURSES

S. No.	Course Code	Course Title	Industry that will offer the course
1.	P14PEIN01	Design Consideration for Variable Speed Drives	M/S, Versa Drives, CBE
2.	P14PEIN02	Automotive Control Electronics	Robert Bosch , CBE
3.	P14PEIN03	Development of Regulated Power Supply Circuits	Numeric Power Systems
4.	P14PEIN04	Backup Power Supply System for Aero Applications	MAK Control Corporation

SEMESTER I

P14MAT105 **APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS**

L	T	P	C
3	1	0	4

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Construct the inverse of a rectangular matrix and generalized Eigen vectors of a matrix.

CO2: Determine the maximum and minimum values of functional.

CO3: Apply the concepts of transforms (Discrete Fourier transform, Z-transform and wavelet transforms) to physical problems

CO4: Discuss the soft computing techniques with their operations and functions.

PRE-REQUISITE

1. Engineering Mathematics I
2. Engineering Mathematics II
3. Engineering Mathematics III

ADVANCED MATRIX THEORY 9+3 Hours

Matrix norms – Jordan canonical form – Generalized eigen vectors – Singular value decomposition – Pseudo inverse – Least square approximations.

CALCULUS OF VARIATIONS 9+3 Hours

Euler's equation – Functionals dependent on first and higher order derivatives – Functionals dependent on functions of several dependent variables – Some applications – Direct method: Ritz method.

FOURIER ANALYSIS AND Z –TRANSFORMS 9+3 Hours

Discrete Fourier Transforms and its properties – Fourier series and its properties – Fourier representation of finite duration sequences – Z-transform – Properties of the region of convergence – Inverse Z-transform – Z-transform properties.

WAVELET TRANSFORMS 9+3 Hours

Continuous and discrete time wavelet transform – Definition and examples - Inverse transform of continuous and discrete time wavelet transform- Some applications.

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SOFT COMPUTING METHODS **9+3 Hours**

Fuzzy variables - Fuzzy relations – Neural networks – Genetic algorithms (basic concepts only)

Theory:45 Hrs **Tutorial: 15 Hrs** **Total: 60 Hrs**

REFERENCES

1. Lewis D.W., "Matrix Theory", Allied Publishers, Peebles Jr., P.Z., Chennai 1995.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 40th Edition 2007.
3. Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms introduction to theory and applications, Addition Wesley, 2003.
4. Rajasekaran S., Vijayalakshmi Pai G.A., "Neural Network, Fuzzy Logic and Genetic Algorithm", Synthesis and Applications, Prentice Hall of India – 2008.
5. Bronson R., "Theory and problems of Matrix operations", Schaums outline series, Tata McGraw Hill, New York, 2005.
6. Elsgolts L., "Differential equations and Calculus of variations", University Press of Pacific, 2006.
7. Athanasios Papoulis, "Probability, Random Variables and Stochastic Processes", McGraw Hill International Editions, 4th Edition 2002.
8. Sivanandam S. N., Deepa S.N., "Principles of Soft Computing", Wiley India Pvt. Limited, 2007.

P14PET101 ADVANCED CONTROL THEORY

L	T	P	C
3	1	0	4

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Develop transfer function model for discrete time system, find the stability of the discrete time systems

CO2: Exposed to analyze the system and find the state space model of any given systems

CO3: Analyze the stability of non – linear systems

PRE-REQUISITE

1. Control Systems
2. Engineering Mathematics

INTRODUCTION TO DIGITAL CONTROL SYSTEMS 9+3 Hours

Configuration of the basic digital control scheme-Principles of signal conversion-Basic discrete time signals-Time domain models for discrete time systems-Transfer function models-Stability on the Z-plane and the Jury stability criterion-Sampling as impulse modulation-Sampled spectra and Aliasing-Filtering

STATE VARIABLE REPRESENTATION AN SOLUTION OF STATE EQUATION 9+3 Hours

Introduction-State space formulation-state model of linear system-state diagram-state space representation using physical variable- state space representation using phase variable - state space representation using canonical variable-Solution of state equations-state space representation of discrete time systems.

STATE SPACE ANALYSIS AND DESIGN OF CONTROL SYSTEM 9+3 Hours

Definitions involving matrices-Eigen values and eigen vectors-Similarity transformation-Cayley-Hamilton theorem-Transformation of state model-Concepts of controllability and Observability-controllable phase variable

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form of state model-Control system design via pole place by state feedback –Observable phase variable form of state model-State observers.

NON LINEAR SYSTEMS 9+3 Hours

Introduction to non linear systems-Describing functions-Dead zone, saturation non linearity, Dead zone and saturation non linearity, relay with dead zone and hysteresis, backlash nonlinearity-Describing function analysis of non linear systems.

LYAPUNOV STABILITY ANALYSIS 9+3 Hours

Introduction-Basic concepts-stability definitions-Stability Theorems-Lyapunov functions for linear systems-A model reference adaptive systems-Discrete time system

Theory:45 Hrs Tutorial: 15 Hrs Total: 60 Hrs

REFERENCES

1. M. Gopal, "Modern Control System Theory", 3rd Edition, New Age International, 2014.
2. M. Gopal, "Digital control and state variable methods", 3rd Edition, Tata McGraw Hill, 2006.
3. K. Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall of India, 2002, New Delhi.
4. John S. Bay, "Fundamentals of Linear State Space Systems", 2nd Edition, McGraw Hill, 1999.
5. D. Roy Choudhury, "Modern Control Systems", 2nd Edition, New Age International, 2005.
6. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", 6th Edition, CRC Press, 2013.
7. Z. Bubnicki, "Modern Control Theory", 2nd Edition, Springer, 2007.

P14PET102	ADVANCED POWER SEMICONDUCTOR DEVICES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: To understand the behavior, characteristics of semiconductor devices operated as power switches.

CO2: Compare the capabilities and limitations of power devices, and decide them to suit the specification

CO3: Able to design control circuits, protection circuits and thermal management circuits

PRE-REQUISITE

1. Engineering Physics
2. Electron Devices Circuits
3. Power Electronics

DEVICES AND CHARACTERISTICS 9 Hours

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.

CURRENT CONTROLLED DEVICES 9 Hours

BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington - 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.

VOLTAGE CONTROLLED DEVICES 9 Hours

Power MOSFETs and IGBTs – Principle of voltage controlled devices,

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construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.

FIRING AND PROTECTING CIRCUITS **9 Hours**

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

THERMAL PROTECTION **9 Hours**

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

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. B.W Williams, "Power Electronics: Devices, Drivers, Applications and passive components", 3rd Edition, McGraw Hill, 2006.
2. Rashid M.H., "Power Electronics: Circuits, Devices and Applications", 3rd Edition, Pearson Education, 2014, New Delhi.
3. MD Singh and K.B Khanchandani, "Power Electronics", 2nd Edition, Tata McGraw Hill, 2006.
4. Ned Mohan, Tore M. Undeland and William P.Robins, "Power Electronics – Concepts, applications and Design", 3rd Edition, Wiley India, 2006.

P14PET103	ANALYSIS OF POWER CONVERTERS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Understand the operation and various working modes of power converters.

CO2: Analyze the performance parameters of the power converters.

CO3: Design, develop and test the various power converter circuits.

PRE-REQUISITE

1. Power Electronics
2. Power Semiconductor Devices

SINGLE PHASE AC-DC CONVERTER 9 Hours

Uncontrolled, half controlled and fully controlled converters with RL, RLE loads and freewheeling diodes – continuous and discontinuous modes of operation – inverter operation – Dual converter - Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap.

THREE PHASE AC-DC CONVERTER 9 Hours

Uncontrolled and fully controlled – converter with R, RL, RLE - loads and freewheeling diodes – inverter operation and its limit – Dual converter – performance parameters – effect of source impedance and over lap

DC-DC CONVERTERS 9 Hours

Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters – time ratio and current limit control – Full bridge converter – Resonant and quasi – resonant converters.

AC VOLTAGE CONTROLLERS 9 Hours

Principle of phase control: single phase and three phase controllers – various configurations – analysis with R and RLE loads.

CYCLOCONVERTERS **9 Hours**

Principle of operation – Single phase and three phase cyclo-converters – power circuits and gating signals.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Ned Mohan, Tore M. Undeland and William P.Robins, "Power Electronics – Concepts, applications and Design", 3rd Edition, John Wiley and Sons, 2006.
2. Rashid M.H., "Power Electronics: Circuits, Devices and Applications", 3rd Edition, Prentice Hall India, 2013, New Delhi.
3. P.C.Sen, "Power Electronics", 1st Edition, Tata McGraw Hill, 2007.
4. P. S. Bimbhra, "Power Electronics", Khanna Publishers, 2012.

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L	T	P	C
3	0	0	3

P14PET104 ANALYSIS OF INVERTERS

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: To design inverters for different applications.

CO2: To develop gating circuits for inverters

CO3: To understand the working of multilevel and resonant inverters.

PRE-REQUISITE

1. Power Semiconductor Devices
2. Electron Devices Circuits

SINGLE PHASE INVERTERS 9 Hours

Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated Thyristor inverters.

THREE PHASE VOLTAGE SOURCE INVERTERS 9 Hours

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters.

CURRENT SOURCE INVERTERS 9 Hours

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters

MULTILEVEL INVERTERS 9 Hours

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - comparison of multilevel inverters - application of multilevel inverters

RESONANT INVERTERS 9 Hours

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters.

Theory:45 Hrs Total: 45 Hrs

REFERENCES

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd Edition, Pearson Education, 2014, New Delhi.
2. Jai P. Agrawal, "Power Electronics Systems", 2nd Edition, Pearson Education, 2002.
3. P.C.Sen, "Power Electronics", 1st Edition, Tata McGraw Hill India, 2007.
4. P.S. Bimbra, "Power Electronics", Khanna Publishers, 2012, New Delhi.
5. Bimal K. Bose. "Modern Power Electronics and AC Drives", 2nd Edition, Prentice Hall of India, 2005.

P14PEP101	POWER ELECTRONICS SIMULATION LABORATORY – I	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Design and develop a Matlab model for power converter circuits

CO2: Analyze the operation and performance of power converter circuits

CO3: Choose a power converter circuit for specific application

PRE-REQUISITE

1. Electron Devices and Circuits
2. Power Electronics
3. Analysis of Converters

LIST OF EXPERIMENTS:

1. Simulation of single phase half controlled converter.
2. Simulation of single phase fully controlled converter.
3. Simulation of three phase half controlled converter.
4. Simulation of three phase fully controlled converter.
5. Simulation of DC chopper.
6. Simulation of single phase inverter.
7. Simulation of three phase inverter.
8. Simulation of single phase AC voltage controller.
9. Simulation of three phase AC voltage controller.
10. Simulation of cyclo - converters.

Experiments beyond the syllabus should be conducted

Practical:45 Hrs **Total: 45 Hrs**

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SEMESTER II

L	T	P	C
3	0	0	3

P14PET201 SOLID STATE DC DRIVES

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: The students will acquire knowledge of characteristics of rotating electrical Machines and power electronics modeling of drive system.

CO2: Analyze the steady-state operation of power electronic converters and to understand the basic requirements of industrial power electronics.

CO3: The students will be able to design, development and testing of DC drive system.

PRE-REQUISITE

1. Electrical Machines
2. Analysis of Power Converters

DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS **9 Hours**

DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operations. Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

CONVERTER CONTROL **9 Hours**

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter.

CHOPPER CONTROL **9 Hours**

Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control – Chopper based implementation of braking schemes; Multi-phase chopper; Related problems.

CLOSED LOOP CONTROL **9 Hours**

Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feedback elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed DC drive.

DIGITAL CONTROL OF DC DRIVE **9 Hours**

Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant horse power and load disturbed operations; Speed detection and gate firing.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall, 1989, New Jersey.
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", 1st Edition, Pearson Education, 2001, New Delhi.
3. Gopal K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House, 2015, New Delhi.
4. Vedam Subramanium, "Electric Drives Concepts and Applications", 2nd Edition, Tata McGraw Hill, 2011, New Delhi.
5. P.C.Sen, "Thyristor DC drives", 1st Edition, John Wiley & Sons, 1991, New York.

L	T	P	C
3	0	0	3

P14PET202 SOLID STATE AC DRIVES

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Describe the components of drives for AC motors

CO2: Present the control methodologies of AC drives

CO3: Choose an AC drive and apply the speed control methodology for an application

PRE-REQUISITE

1. Electrical Machines
2. Analysis of Inverters

CONVENTIONAL CONTROL OF INDUCTION MOTORS 9 Hours

Review of Induction Machine operation – Equivalent circuit – Performance of the machine with variable voltage, rotor resistance variation, pole changing and cascaded induction machines, slip power recovery – Static Kramer Drive.

VSI AND CSI FED INDUCTION MOTOR CONTROL 9 Hours

AC voltage controller fed induction machine operation – Energy conservation issues – V/F operation theory – requirement for slip and stator voltage compensation. CSI fed induction machine – Operation and characteristics.

FIELD ORIENTED CONTROL 9 Hours

Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation.

DIRECT TORQUE CONTROL 9 Hours

Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.

SYNCHRONOUS MOTOR CONTROL **9 Hours**

Synchronous motor control - Brush and Brushless excitation – Load commutated inverter fed drive.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Bimal K. Bose. "Modern Power Electronics and AC Drives", 2nd Edition, Prentice Hall of India, 2005.
2. Vedam Subramanium, "Electric Drives Concepts and Applications", 2nd Edition, Tata McGraw Hill, 2011, New Delhi.
3. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", 1st Edition, Pearson Education, 2001, New Delhi.
4. Gopal K Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989, New Jersey.
5. Gopal K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House, 2015.
6. W. Leonhard, "Control of Electrical Drives", 3rd Edition, Narosa Publishing House, 2001.
7. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", 2nd Edition, Pergamon Press, 1988, Oxford.

P14PET203	MICROCONTROLLER AND DSP BASED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: To increase understanding and aid- retention of student to come up with good knowledge to cope up with recent trends and makes a remarkable impact on global economy.

CO2: Contemporary issues could be resolved using knowledge of Digital Signal Processing.

CO3: An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

PRE-REQUISITE

1. Microprocessor and Microcontroller
2. Digital Signal Processing

MICROCONTROLLER AND INTERFACING 9 Hours

8051 Microcontroller - Instruction set – Interrupts - Timers – Memory- I/O ports – Serial Communication - Interfacing –Key board, LED display, External memory, ADC, DAC, LCD, RTC – Typical applications- DC motor speed control, speed measurement, Temperature control, Stepper motor control, PID control.

PIC MICROCONTROLLER 9 Hours

PIC Processors - RISC concepts - PIC processors- overview-16F877 - Architecture – Elementary Assembly Language Programming- Interrupts – Timers – Memory – I/O ports – SPI – I2C bus - A/D converter - USART- PWM – Interfacing.

DSP ARCHITECTURE 9 Hours

DSP Architecture - Introduction to DSP architecture- computational building blocks - Address generation unit- Program control and sequencing- Speed issues- Harvard Architecture, Parallelism, Pipelining. TMS 320F2407- Architecture- Addressing modes- I/O functionality, Interrupts, ADC

DSP PERIPHERALS AND APPLICATIONS 9 Hours

PWM, Event managers- Elementary Assembly Language Programming- Typical applications-buck boost converter, stepper motor control- Software and Hardware Development Tools. Voltage regulation of DC-DC converters- Stepper motor and DC motor control- Clarke's and park's transformation-Space vector PWM- Control of Induction Motors and PMSM

REAL TIME SYSTEMS 9 Hours

Real-time Systems - Introduction to real time systems-interrupt driven systems-context switching- scheduling- roundrobin pre-emptive-rate monotonic-Foreground and Background systems-Intertask communication- Buffering data-Mailboxes-Critical regions-Semaphores-Deadlock-Process stack management- Dynamic allocation-Response time calculation-Interrupt latency.

Theory:45 Hrs Total: 45 Hrs

REFERENCES

1. Mazidi & Mazidi, "Embedded System Design using 8051 Microcontroller", 2nd Edition, Prentice Hall of India, 2005.
2. Ajay V DeshMukh, "Microcontrollers -Theory and Applications", 1st Edition, Tata McGraw Hill, 2005, New Delhi.
3. Phillip A Laplante, "Real Time Systems Design and Analysis", 4th Edition, John Wiley & Sons / IEEE Press, 2012.
4. Daniel W Lewis, "Fundamentals of Embedded Software", 2nd Edition, Pearson Education, 2012.
5. Sen M Kuo, Woon Seng Gan, "Digital Signal Processors-Architecture, Implementation and Applications", 1st Edition, Pearson Education, 2004.
6. H A Toliyat, S Campbell, "DSP Based Electro Mechanical Motion Control", 1st Edition, CRC Press, 2003.
7. Avtar Singh, S Srinivasan, "Digital Signal Processing", 1st Edition, Thomson / Brooks/ Cole, 2004.
8. Phil Lapsley, Bler, Sholam, E A Lee, "DSP Processor Fundamentals", 2nd Edition, IEEE Press, 1997.

P14PET204	SPECIAL ELECTRICAL MACHINES AND THEIR CONTROLLERS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Describe the construction and working of special electrical machines.

CO2: Identify the characteristics of different special electrical machines

CO3: Choose a particular electrical machine for the given requirements.

PRE-REQUISITE

1. AC Machines
2. Power Electronics

SYNCHRONOUS RELUCTANCE MOTORS 9 Hours

Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque – phasor diagram, motor characteristics.

SWITCHED RELUCTANCE MOTORS 9 Hours

Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control Microprocessor based controller

PERMANENT MAGNET SYNCHRONOUS MOTORS 9 Hours

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.

PERMANENT MAGNET BRUSHLESS DC MOTORS 9 Hours

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller.

STEPPING MOTORS 9 Hours

Constructional features, principle of operation, modes of excitation torque production in Variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", 1st Edition, Clarendon Press, 1989, London.
2. T. Kenjo, "Stepping Motors and Their Microprocessor Controls", 2nd Edition, Clarendon Press, Oxford University, 1994, London.
3. T. Kenjo and S. Nagamori, "Permanent Magnet and Brushless DC Motors", 1st Edition, Clarendon Press, Oxford University, 1986, London.
4. Kenjo, T, "Power Electronics for the Microprocessor Age", Oxford University Press, 1994.
5. B.K. Bose, "Modern Power Electronics & AC drives" 1st Edition, Pearson Education, 2003
6. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", 1st Edition, Prentice- Hall of India, 2010, New Delhi.
7. R. Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications", 1ST Edition, CRC Press, 2001.

P14PEP201 **POWER ELECTRONICS AND DRIVES LABORATORY**

L	T	P	C
0	0	4	2

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Design and conduct an experiment for various power converter circuits

CO2: Analyze the operation and performance of power converter circuits

CO3: Apply power converter circuits for electric drives application

PRE-REQUISITE

1. Analysis of Power Converters
2. Analysis of Inverters
3. Solid State Drives (AC & DC)

LIST OF EXPERIMENTS:

1. Single phase half controlled Converter with RL and RLE loads.
2. Single phase fully controlled Converter with RL and RLE loads.
3. Three phase fully controlled Converter fed DC Shunt motor.
4. Four quadrant IGBT based chopper fed DC motor drive
5. Single phase PWM inverter
6. Three phase PWM inverter fed Induction motor Drive.
7. Resonant converters.
8. Series Inverter.
9. AC voltage controller.
10. BLDC motor drive.

Experiments beyond the syllabus should be conducted

Practical :45 Hrs **Total: 45 Hrs**

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SEMSTER III

P14PEP301	ADVANCED POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: To design the closed loop control system for AC and DC drives and power supplies.

CO2: To choose the suitable controller for the specific application.

CO3: To apply the control technique for drives and power supply in simulation and real time environments

PRE-REQUISITE

1. Control Systems
2. Solid State Drives
3. Analysis of Power Converters and Inverters

LIST OF EXPERIMENTS:

1. Simulation of closed loop control of Converter fed DC motor.
2. Simulation of closed loop control of Chopper fed DC motor.
3. Simulation of closed loop control of VSI fed three-phase induction motor.
4. Simulation of closed loop control of Synchronous motors.
5. Simulation of Four quadrant operation of three-phase induction motor.
6. DSP based speed control of PMSM.
7. Realization of control logic for motor drives using FPGA.
8. Design of switched mode power supplies
9. Design of Buck boost converters
10. Harmonic Analysis of power converters

Experiments beyond the syllabus should be conducted

Practical :45 Hrs **Total: 45 Hrs**

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ELECTIVE I

P14PETE01	INDUSTRIAL CONTROL ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Demonstrate proficiency in automation programming/troubleshooting related to programmable logic controllers and digital controllers required for industrial employment.

CO2: Demonstrate problem solving skills used in ladder logic for development of industrial automation.

CO3: Students will be acquainted with knowledge of opto electronic based automated systems for case studies of various industries.

PRE-REQUISITE

1. Electron Devices and Circuits
2. Power Electronics

INTRODUCTION TO INDUSTRIAL INSTRUMENTS 9 Hours

Review of switching regulators and switched mode power supplies, uninterrupted power supplies- off-line and on-line topologies-UPS topologies, solid state circuit breakers, solid-state tap-changing of transformer.

PROGRAMMABLE LOGIC CONTROLLERS 9 Hours

Process Controller- Relay Logic – Programmable Logic Controller- Basic Structure –Ladder Logic- Programming- PLC Internal Operation and Signal Processing- I/O Processing- Communication System for Industrial Automation- Intelligent System for Monitoring, Supervision and Control.

COMPUTER NUMERIC CONTROL & AUTOMATED SYSTEMS 9 Hours

Introduction to CNC Systems- Types –Analogue, Digital, Absolute and Incremental- Open Loop and Closed Loop - CNC Drives and Feedback Devices. Material Transport Systems – Process Monitoring – Conveyor Systems – Cranes and Hoists – Automated Storage and Retrieval Systems

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OPTO ELECTRONIC DEVICES **9 Hours**

Opto-Electronic devices and control , electronic circuits for photo-electric switches-output signals for photo-electric controls; Applications of opto-isolation, interrupter modules and photo sensors; Fibre-optics; Bar code equipment, application of barcode in industry.

INDUSTRIAL APPLICATIONS **9 Hours**

Industrial Control Applications- Cement Plant – Thermal Plant- Water Treatment Plant- Steel Plant- Paper Industry.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Krishna Kant, "Computer-Based Industrial Control", 2nd Edition, Prentice Hall of India, 2010.
2. Gray Dunning, "Introduction to Programmable Logic Controllers", 3rd Edition, Delmar Publishers, 2007.
3. Frank D. Petruzella, "Programmable Logic Controllers", 3rd Edition, McGraw Hill, 2010.
4. Michael Jacob, "Industrial Control Electronics – Applications and Design", Prentice Hall, 1995.
5. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 3rd Edition, Pearson Education, 2008.

P14PETE02	MODELLING AND ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Outline the concept of magnetic circuits in electrical machines and the characteristics and specifications of different electrical machines

CO2: Design the DC machines for the given specifications

CO3: Design the induction, synchronous machines and transformers for the specifications

PRE-REQUISITE

1. Engineering Mathematics
2. Electrical Machines
3. Electric Utilization

PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9 Hours

General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system

BASIC CONCEPTS OF ROTATING MACHINES 9 Hours

Calculation of airgap 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

INTRODUCTION TO REFERENCE FRAME THEORY 11 Hours

Static and rotating reference frames, transformation relationships, examples using static symmetrical three phase R, RL, RLE and RLC circuits, application of reference frame theory to three phase symmetrical induction and synchronous 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, generalized theory of rotating electrical machine and Kron's primitive machine

DETERMINATION OF SYNCHRONOUS MACHIN DYNAMIC EQUIVALENT CIRCUIT PARAMETERS **8 Hours**

Standard and derived machine time constants, frequency response test; Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine

SPECIAL MACHINES **9 Hours**

Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modeling and self controlled operation; Analysis of Switch Reluctance Motors

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Charles Kingsley, Jr., A.E. Fitzgerald, Stephen D. Umans "Electric Machinery", 5th Edition (18th reprint), Tata Mcgraw Hill, 2009.
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", 1st Edition, Prentice- Hall of India, 2010, New Delhi.
3. Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", 1st Edition, Clarendon Press, 1989, London.

L	T	P	C
3	0	0	3

P14PETE03 INTELLIGENT CONTROL

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Explain the Artificial intelligence approach to Engineering problems.

CO2: Interpret intelligent control techniques to Engineering problem.

CO3: Design and Develop Intelligent controller for non linear system.

PRE-REQUISITE

1. Engineering Mathematics
2. Control Systems

SYSTEMS AND APPROACH 9 Hours

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

ARTIFICIAL NEURAL NETWORKS 9 Hours

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch- Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller

GENETIC ALGORITHM 9 Hours

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

FUZZY LOGIC SYSTEM 9 Hours

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and

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approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

FL AND NN APPLICATIONS 9 Hours

GA application to power system optimization problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

Theory:45 Hrs Total: 45 Hrs

REFERENCES

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 2012.
2. Kosko, B. "Neural Networks and Fuzzy Systems", Prentice Hall International, 2007.
3. Klir G.J. & Folger T.A. "Fuzzy sets, uncertainty and Information", Prentice Hall of India, 2003.
4. Zimmermann H.J. "Fuzzy set theory-and its Applications", Kluwer Academic Publishers, 2004.

ELECTIVE II & III

P14PETE04	DIGITAL CONTROL IN POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Design first order second order and zero order could transfer function for the given converters in Z-transform

CO2: Model the given type of AC/DC rectifier and DC/AC inverters in digital control

CO3: Model the given type of DC/DC converters and AC/AC converters in digital control and analyze the response of the system.

PRE-REQUISITE

1. Engineering Mathematics
2. Control Systems
3. Analysis of Power Converters and Inverters

MATHEMATICAL MODELING OF DIGITAL POWER ELECTRONICS — 9 Hours

Introduction – A zero-order hold (ZOH) for AC/DC controlled rectifiers – A first-order transfer function for DC/AC pulse-width-modulation inverters – A second-order transfer function for DC/DC converters – A first-order transfer function for AC/AC (AC/DC/AC) converters – Open-loop Control for Digital Power Electronics – Stability analysis – Unit-step function response – Impulse responses.

DIGITALLY CONTROLLED AC/DC RECTIFIERS — 9 Hours

Introduction – Mathematical modeling for AC/DC rectifiers – Single-phase half-wave controlled AC/DC rectifier - Single-phase full-wave AC/DC rectifier - Three-phase half-wave controlled AC/DC rectifier - Three-phase full-wave controlled AC/DC rectifier – Three-phase double-anti-star with inter phase-transformer controlled AC/DC rectifier – Six-phase half-wave controlled AC/DC rectifier - Six-phase full-wave controlled AC/DC rectifier

DIGITALLY CONTROLLED DC/AC INVERTERS 9 Hours

Introduction – Mathematical modeling for DC/AC PWM inverters – Single-phase half-wave VSI – Single-phase full-bridge PWM VSI - Three-phase full-bridge PWM VSI - Three-phase full-bridge PWM CSI – Multistage PWM inverter – Multilevel PWM inverter.

DIGITALLY CONTROLLED DC/DC CONVERTERS 9 Hours

Introduction – Mathematical modeling for power DC/DC converters – Fundamental DC/DC converter – Developed DC/DC converters – Soft-switching converters – Multi-element resonant power converters.

DIGITALLY CONTROLLED AC/AC CONVERTERS 9 Hours

Introduction – Traditional modeling for AC/AC (AC/DC/AC) converters – Single-phase AC/AC converter – Three-phase AC/AC voltage controllers – SISO cyclo converters – TISO cyclo converters – TITO cyclo converters – AC/DC/AC PWM converters – Matrix converters.

Theory:45 Hrs Total: 45 Hrs

REFERENCES

1. Fang Lin Luo, Hong Ye, Muhammad Rashid, "Digital Power Electronics and Applications", 1st Edition, ELSEVIER Academic Press, 2010.

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P14PETE05	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Compare HVAC and HVDC transmission based on reliability, technical performance and economic aspects.

CO2: Choose the best converter configuration for any pulse number

CO3: Analyze the working of Graetz circuit, with and without overlap. About all the harmonics components of a typical HVDC system. About the various simulation models of HVDC system valves

PRE-REQUISITE

1. Transmission and Distribution
2. Analysis of Power Converters and Inverters

DC POWER TRANSMISSION TECHNOLOGY 9 Hours

Introduction-comparison of AC and DC transmission application of DC transmission – description of DC transmission system planning for HVDC transmission-modern trends in DC transmission.

ANALYSIS OF HVDC CONVERTERS 9 Hours

Pulse number, choice of converter configuration-simplified analysis of Graetz circuit converter bridge characteristics – characteristics of a twelve pulse converter-detailed analysis of converters.

CONVERTER AND HVDC SYSTEM CONTROL 9 Hours

General principles of DC link control-converter control characteristics-system control hierarchy-firing angle control-current and extinction angle control-starting and stopping of DC link-power control-higher level controllers-telecommunication requirements.

HARMONICS AND FILTERS 9 Hours

Introduction-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise.

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SIMULATION OF HVDC SYSTEMS **9 Hours**

Introduction-system simulation: Philosophy and tools-HVDC system simulation modeling of HVDC systems for digital dynamic simulation.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Padiyar, K.R., "HVDC Power Transmission System", 2nd Edition, New Age International, 2011.
2. Rakosh Das Begamudre, "Extra high voltage AC transmission engineering", 4th Edition, New Academic Science, 2011, New Delhi.
3. Arrillaga, J., "High Voltage Direct Current Transmission", 2nd Edition, Peter Peregrinus, 1988, London.
4. S.Kamakshaiah, V. Kamaraju, "HVDC Transmission", 5th Edition, Tata McGraw Hill, 2013.

P14PETE06	VLSI DESIGN IN POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Students able to understand the various steps of fabrication and characteristics of MOS transistor.

CO2: Students able to acquire the knowledge of layout design and CMOS switches

CO3: Students familiarize the VLSI design and simple system design and implementation through HDL.

PRE-REQUISITE

1. Microprocessors and Microcontrollers
2. Power Electronics

VLSI DESIGN METHODOLOGY & MOS TECHNOLOGY — 9 Hours

VLSI Design process - Architectural Design - Logical design - Physical design - Layout styles - Full custom - Semicustom approaches - An overview of wafer fabrication - Wafer processing - Oxidation- Patterning - Diffusion - Ion implantation - Deposition - Silicon gate nMOS process - CMOS processes - nWeIl - pWell - Twintub - Silicon on insulator.

ELECTRICAL PROPERTIES OF MOS AND CMOS CIRUITS — 9 Hours

MOS enhancement transistor - PMOS enhancement transistor - Threshold voltage - Threshold voltage equations - MOS device equations - Basic DC equations - Second order effects - MOS modules - Small signal AC characteristics - nMOS inverter - Steered Input to an nMOS inverter - Depletion mode and enhancement mode pullups - CMOS inverter - DC characteristics - Inverter delay - Pass transistor - Transmission gate.

MOS AND CMOS CIRCUIT DESIGN PROCESSES — 9 Hours

CMOS process enhancements - Interconnect - Circuit elements - Latch up - Latch up prevention techniques - Need for Layout design rules - Mead Conway design rules for the silicon gate nMOS process - CMOS nWell

,pWell design rules - Simple Layout examples - Sheet resistance - Area capacitance - Wiring Capacitance - Drive large capacitive loads.

LOGIC DESIGN **9 Hours**

Switch Logic - Pass Transistor and transmission gate - Gate Logic - Inverter - Two input NAND gate - NOR gate - Other forms of CMOS logic - Dynamic CMOS logic - Clocked CMOS logic - Precharged domino CMOS logic - Structured design - Simple combinational logic design examples - Parity generator - Multiplexers - Clocked sequential circuits - Two phase clocking - Charge storage - Dynamic register element - nMOS and CMOS - Dynamic shift register - Semi static register - JK flip flop circuit.

VHDL PROGRAMMING **9 Hours**

HDL introduction- top down approach - Y chart - VHDL constructs - data-types - array - package-conditional statements - case statement - generate statement - programs in digital circuits - time- PWM pulse generation-case study - design of inverter through VHDL.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Douglas A Pucknell and Kamran Eshrarigian, “Basic VLSI Design”, 3rd Edition, Prentice Hall of India, 2004, New Delhi.
2. Neil H B West and Kamran Eshranghian, “Principles of CMOS VLSI Design: A system perspective Addison-Wesley”, 2nd Edition, India Reprint, 2000.
3. Amar Mukherjee, “Introduction to NMOS and CMOS VLSI system design”, Prentice Hall, 1996, USA.
4. Wayne Wolf, “Modem VLSI Design: Systems on Si1icon”, 2nd Edition, Pearson Education, 2001.
5. Eugene D Fabricous, “Introduction to VLSI design”, McGraw Hill International Edition, 1990.

P14PETE07 ADVANCED EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Distinguish between general purpose system and embedded system, classify various I/O devices and is able to interpret the protocols used in device communication

CO2: Outline RTOS concepts and able to apply the hardware and software knowledge to design and develop simple firmware modules.

CO3: Understand techniques for interfacing I/O devices to the embedded controller, including several specific standard I/O devices and will acquire the knowledge about different peripheral interfacing devices, their working and interfacing them with embedded controller.

PRE-REQUISITE

1. Microprocessors and Microcontrollers
2. Embedded Systems

INTRODUCTION AND REVIEW OF EMBEDDED HARDWARE — 9 Hours

Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Round-Robin – Round Robin with interrupt function – Rescheduling architecture – algorithm.

REAL TIME OPERATING SYSTEM — 9 Hours

Task and Task states – Task and data – Semaphore and shared data operating system services – Message queues timing functions – Events – Memory management – Interrupt routines in an RTOS environment – Basic design using RTOS.

EMBEDDED HARDWARE, SOFTWARE AND PERIPHERALS **9 Hours**

Custom single purpose processors: Hardware – Combination Sequence – Processor design – RT level design – optimizing software: Basic Architecture – Operation – Programmers view – Development Environment – ASIP – Processor Design – Peripherals – Timers, counters and watch dog timers – UART – Pulse width modulator – LCD controllers – Key pad controllers – Stepper motor controllers – A/D converters – Real time clock.

MEMORY AND INTERFACING **9 Hours**

Memory: Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic – Microprocessor interfacing I/O addressing – Interrupts – Direct memory access – Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.

CONCURRENT PROCESS MODELS AND HARDWARE SOFTWARE CO - DESIGN **9 Hours**

Modes of operation – Finite state machines – Models – HCFSL and state charts language – state machine models – Concurrent process model – Concurrent process – Communication among process –Synchronization among process – Implementation – Data Flow model. Design technology; Automation synthesis – Hardware software co-simulation – IP cores – Design Process Model.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. David. E.Simon, “An Embedded Software Primer”, Pearson Education, 2001.
2. Frank Vahid and Tony Gwargie, “Embedded System Design”, John Wiley & sons, 2002.
3. Steve Heath, “Embedded System Design”, 2nd Edition, Elserien, 2004.

L	T	P	C
3	0	0	3

P14PETE08 **POWER QUALITY**

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: To understand the various power quality issues and mitigation techniques.

CO2: To be familiar with the conventional compensation techniques and active compensation techniques used for power factor correction and load voltage regulation.

CO3: To know the working of various power quality meters.

PRE-REQUISITE

1. Power System Analysis
2. Power Electronics

INTRODUCTION TO POWER QUALITY 9 Hours

Terms and definitions: Overloading, under voltage, sustained interruption; sags and swells; waveform distortion, Total Harmonic Distortion (THD), Computer Business Equipment Manufacturers Associations (CBEMA) curve.

VOLTAGE SAGS AND INTERRUPTIONS 9 Hours

Sources of sags and interruptions, estimating voltage sag performance, motor starting sags, estimating the sag severity, mitigation of voltage sags, active series compensators, static transfer switches and fast transfer switches.

OVERVOLTAGES 9 Hours

Sources of over voltages: Capacitor switching, lightning, ferro resonance; mitigation of voltage swells: Surge arresters, low pass filters, power conditioners – Lightning protection, shielding, line arresters, protection of transformers and cables, computer analysis tools for transients, PSCAD and EMTP.

HARMONICS 9 Hours

Harmonic distortion: Voltage and current distortion, harmonic indices, harmonic sources from commercial and industrial loads, locating harmonic sources; power system response characteristics, resonance, harmonic distortion evaluation, devices for controlling harmonic distortion, passive filters, active filters, IEEE and IEC standards.

POWER QUALITY MONITORING 9 Hours

Monitoring considerations: Power line disturbance analyzer, per quality measurement equipment, harmonic / spectrum analyzer, flicker meters, disturbance analyzer, applications of expert system for power quality monitoring.

Theory:45 Hrs Total: 45 Hrs

REFERENCES

1. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, “Electrical Power Systems Quality”, 3rd Edition, McGraw Hill, 2012.
2. Math H J Bollen, “Understanding Power Quality Problem”, IEEE – Wiley, IEEE Press , 1999.
3. C. Sankaran, “ Power Quality”, CRC press, 2002.
4. Alexander Kusko, “Power Quality in Electrical System”, CHIPS Press, 2007, Texas.
5. PSCAD User Manual.
6. Angelo Baggini, “Handbook of Power Quality”, Wiley.

P14PETE09	ADVANCED OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Classify and design the optimization problem

CO2: Discriminate different types of advanced optimization techniques

CO3: Apply the optimization techniques to find the solution of engineering optimization problem

PRE-REQUISITE

1. Engineering Mathematics
2. Operations Research

INTRODUCTION **9 Hours**

Introduction to Optimization- Concept of System and State- Performance Measure- Design Constraints- Condition for Optimality- Formulation of Objective Function-Classification of Optimization Problems.

NONLINEAR OPTIMIZATION TECHNIQUES **9 Hours**

Optimization Techniques- Single Variable and Multi-Variable Optimization Techniques and Unconstrained Minimization- Golden section- Random Pattern and Gradient Search Methods- Interpolation Methods- Optimization with Equality and Inequality Constraints- Direct Methods- Indirect Methods using Penalty Functions- Lagrange Multiplier- Geometric Programming and Stochastic Programming.

GENETIC ALGORITHM **9 Hours**

Introduction to Evolutionary Computing- Genetic Algorithm- Biological Inspiration –Finer Evaluation- Selection methods- Reproduction- Genetic Operators- Cross Over- Mutation- Schema Processing- Fitness Scaling- Advanced Genetic Operators and Techniques in Genetic Search- Constrained Genetic Algorithms- Penalty Functions- Multi Objective Optimization- Applications in Pattern Recognition Computers, Communication and Signal Processing.

IMULATED ANNEALING **9 Hours**

Simulated Annealing- Algorithm- Initial Solution- Assess Solution- Randomly Tweak Solution- Acceptance Criteria- Temperature Schedule- Adjusting Algorithm Parameters-Application

ANT COLONY OPTIMIZATION AND TABU SEARCH **9 Hours**

Ant Colony Optimization – Ant Algorithm- Natural Motivation- Initial Population- Ant Movement- Ant Town- Pheromone Evaporation – Adjusting Algorithm Parameters- Alpha(α)/Beta(β)/ Rho(ρ)- Number of Ants- Applications- Routing- Shortest Term Problem. Tabu Search- Principles- Short Term Memory- Long Term Memory- Tabu Thresholding- Special Dynamic Tabu Tenure Strategies- Hash Function.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Kalyonmoy Deb, "Optimization for Engineering Design", 2nd Edition, Prentice Hall of India, 2012.
2. Pierre. D.A., "Optimization Theory with Applications", John Wiley, 1969.
3. Rao.S.S. "Optimization Theory and Applications", Wiley Eastern Ltd., 1979.
4. David.E.Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", International Student Edition, Addison Wesley Ltd., 1999.
5. Fred Glover, Manuel Laguna, "Tabu Search", Kluwer Academic Publishers, 1997.
6. Tim Jones.M, "Artificial Intelligence Application Programming", Dreamtech Press, 2003, New Delhi.
7. Sin Giresu. S. Rao, "Engineering Optimization", John Wiley and Sons, 2009.

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ELECTIVE IV,
V & VI

P14PETE10	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Acquire the basic concepts of discrete random signal processing

CO2: Estimate the spectrum and use the filters for noise cancellation and echo cancellation

CO4: Apply the basic concepts of multi-rate digital signal processing & wavelet transform

PRE-REQUISITE

1. Digital Signal Processing

DISCRETE RANDOM SIGNAL PROCESSING 9 Hours

Discrete Random Processes – Ensemble averages, stationary processes, Autocorrelation and Auto covariance
matrices – Parseval's theorem – Wiener-Khintchine relation – Power spectral density – Periodogram Spectral Factorization – Filtering random processes – Low pass filtering of white noise – Parameter estimation: Bias and consistency.

SPECTRUM ESTIMATION 11 Hours

Estimation of spectra from finite duration signals – Non- Parametric Methods – Correlation Method – Periodogram Estimator – Performance Analysis of Estimators – Unbiased, Consistent Estimators – Modified periodogram – Bartlett and Welch methods – Blackman – Tukey method - Parametric Methods – AR, MA, and ARMA model based spectral estimation – Parameter Estimation –Yule-Walker equations – Solutions using Durbin's algorithm.

LINEAR ESTIMATION AND PREDICTION 8 Hours

Linear prediction – Forward and backward predictions – Solutions of the Normal equations – Levinson - Durbin algorithms – Least mean squared error criterion – Wiener filter for filtering and prediction – FIR Wiener filter and Wiener IIR filters – Discrete Kalman filter.

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ADAPTIVE FILTERS **8 Hours**

FIR adaptive filters – Adaptive filter based on steepest descent method – Widrow-Hoff LMS adaptive algorithm – Normalized LMS – Adaptive channel equalization – Adaptive echo cancellation – Adaptive noise cancellation – Adaptive recursive filters (IIR) – RLS adaptive filters – Exponentially weighted RLS – Sliding window RLS.

MULTIRATE DIGITAL SIGNAL PROCESSING **9 Hours**

Mathematical description of change of sampling rate – Interpolation and Decimation – Decimation by an integer factor – Interpolation by an integer factor – Sampling rate conversion by a rational factor – Filter implementation for sampling rate conversion – Direct form FIR structures – Polyphase filter structures – Time variant structures – Multistage implementation of multirate system – Application to sub band coding – Wavelet transform and filter bank implementation of wavelet expansion of signals.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", Wiley India, 2008.
2. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall of India, 2006, New Delhi.
3. John G. Proakis, Charles M. Rader, "Algorithms for Statistical Signal Processing", Pearson Education, 2002, New Delhi.

P14PETE11	PWM CONVERTERS AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Model and Analyze the steady-state and transient behavior of power converters with various PWM techniques.

CO2: Design and Analyze the controllers for PWM power converters for an application

CO3: Choose the PWM converter to improve power quality.

PRE-REQUISITE

1. Power Converters

OVERVIEW OF CONVERTERS AND MODULATION 9 Hours

AC/DC and DC/AC power conversion, overview of applications of voltage source converters, pulse modulation techniques for bridge converters.

PWM TECHNIQUES 9 Hours

Bus clamping PWM, space vector based PWM, advanced PWM techniques, practical devices in converter; calculation of switching and conduction losses.

PWM INVERTERS 9 Hours

Compensation for dead time and DC voltage regulation; dynamic model of a PWM converter, multilevel converters; constant V/F induction motor drives.

PWM APPLICATIONS 9 Hours

Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation.

POWER QUALITY IMPROVEMENT 9 Hours

Active power filtering, reactive power compensation; harmonic current compensation.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Ned Mohan, Tore M.Undeland and P.William Robbins, “Power Electronics; Converters, Applications and Design”, John Wiley and Sons, 2006.
2. Marian P. Kazmierkowski, R. Krishnan and Frede Blaabjerg, “Control in Power Electronics”, Academic Press Series, 2002.
3. Erickson R W,D.maksimovic, “Fundamentals of Power Electronics”, springer science & business media, 2001.
4. Joseph Vithyathil J, “Power Electronics: Principles and Applications”, Tata McGraw Hill, 2010.

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P14PETE12 **SMPS AND UPS**

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Select the type of SMPS and UPS needed for specific applications

CO2: Design the Component ratings of SMPS and UPS

CO3: Improve the power quality output of SMPS and UPS using improved filter design.

PRE-REQUISITE

1. Power Converters and Inverters

DC-DC CONVERTERS 9 Hours

Principles of step-down and step-up converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and CUK converters- Introduction to SEPIC and Zeta converters.

ISOLATED SWITCHED MODE DC TO DC CONVERTER 9 Hours

Introduction- single width isolated DC to DC converter- Forward converter, fly back converter, Cuk converter—multi switch isolated DC to DC converter- Push pull converter—full bridge converter—comparison of isolated switched mode DC to DC converter.

SWITCHING MODE POWER CONVERTERS 9 Hours

Analysis and state space modeling of flyback, Forward, Luo, Half bridge and full bridge converters- control circuits and PWM techniques.

UNINTERRUPTABLE POWER SUPPLY 9 Hours

Classification- Stand by UPS—On line UPS system- Line interactive UPS – Universal UPS- Rotary UPS- Hybrid static/ Rotary UPS – Distributed UPS network – Comparison – Control Techniques – Voltage and current control of UPS inverter.

POWER CONDITIONERS & FILTERS 9 Hours

Introduction- Power line disturbances- Power conditioners –Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for Inverter applications – Selection of capacitors.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. M.H. Rashid, "Power Electronics handbook", Elsevier Publication, 2001.
2. Kjeld Thorborg, "Power Electronics – In theory and Practice", 1st Edition, Overseas Press, 2005.
3. Philip T Krein, " Elements of Power Electronics", Oxford University Press
4. Ned Mohan Tore. M. Undeland, William.P.Robbins, "Power Electronics converters, Applications and design", 3rd Edition, John Wiley and Sons, 2006
5. M.H. Rashid, "Power Electronics circuits, devices and applications", 3rd edition Prentice Hall of India, 2013, New Delhi.
6. Andrzej M. Trzynadlowski, "Introduction to Modern Power Electronics", 2nd Edition, Wiley India, 2012, New Delhi.

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P14PETE13	POWER ELCTRONICS IN WIND AND SOLAR POWER CONVERSION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Choose a power converter for the control and conversion of wind and solar energy.

CO2: Use the skills, modern engineering tools necessary for engineering practice.

CO3: Design a system, component or process to meet desired needs.

PRE-REQUISITE

1. Power Electronics
2. Power Generation Systems
3. Renewable Energy Resources

INTRODUCTION — 8 Hours

Trends in energy consumption - World energy scenario - Energy source and their availability – Conventional and renewable source - Need to develop new energy technologies- MNRE Rules and Regulations-TEDA-Wind and solar survey in India and World.

PHOTOVOLTAIC ENERGY CONVERSION — 10 Hours

Solar radiation and measurements - Solar cells – Panels and their characteristics – Influence of insulation and temperature – PV arrays – Maximum power point tracking – Applications – Water pumping – Street lighting – DC-DC converters for solar PV systems**.**

WIND ENERGY SYSTEMS — 8 Hours

Basic principle of Wind Energy Conversion System – Nature of Wind – Components of Wind Energy Conversion System –Generators for WECS-Classifications of WECS – Self excited induction generator - synchronous generator - Power conditioning schemes.

GRID CONNECTED WECS AND SECS — 11 Hours

Grid connectors – Wind farm and its accessories – Grid related problems –

Generator control – Performance improvements - Different schemes – Matrix converters -Line commutated inverters- Multilevel inverters- Power converters for Grid connected WECS-Grid connected solar energy converter systems.

DISTRIBUTED POWER GENERATION SYSTEMS 8 Hours

Solar – PV – Hybrid systems – Selection of power conversion ratio – Optimization of system components – Storage - Reliability evolution – Types of Cogeneration processes – Power converters for distributed power systems.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. S. Rao and B. B. Parulekar, "Energy Technology – Non Conventional, Renewable and Conventional", 3rd Edtion, Khanna Publishers, 1999, New Delhi.
2. Mukund R. Patel, "Wind and Solar Power Systems: Design, Analysis, and Operation", 2nd Edition, CRC Press, 2005, London.
3. Ned Mohan Tore. M. Undeland, William. P. Robbins, "Power Electronics converters, Applications and design", 3rd Edition, John Wiley and Sons, 2006.
4. M.H. Rashid, "Power Electronics Circuits, Devices and Applications", 3rd Edition, Prentice Hall of India, 2004, New Delhi.
5. D. P. Kothari, K.C. Singal and Rakesh Ranjan, "Renewable Energy Sources And Emerging Technologies", 2nd Edition, Prentice Hall of India, 2011, New Delhi.
6. Anbukumar kavitha and Govindarajan Uma, "Experimental Verification of Hopf Bifurcation in DC-DC Luo Converter", Vol.23, No.6, IEEE Transactions on Power Electronics, 2008, pp. 2878-2883.
7. A. Mustafa, Al-Saffar, Esam H. Ismail, Ahmad J. Sabzali and Abbas A. Fardoun, "An Improved Topology of SEPIC Converter with Reduced Output Voltage Ripple", Vol.23, No.5, IEEE Transactions on Power Electronics, September 2008, pp. 2377-2386

P14PETE14	ADVANCED ELECTRIC DRIVES AND CONTROLS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Describe the architecture and instruction set of DSP controller

CO2: Choose the suitable PWM techniques

CO3: Employ intelligent controllers for electric drives

PRE-REQUISITE

1. Digital Signal Processing
2. Electric drives

INTRODUCTION 9 Hours

Need for advanced controls - Principle factor affecting the choice of drive – Parameter identification techniques for electric motors – Electromagnetic compatibility of electric drives – Different options for an adjustable speed electric drive – Simulation of electrical drives – Advanced control strategies for electrical drives – DSP based control of electric drives.

DSP CONTROLLERS AND INSTRUCTION SET 9 Hours

TMS 320 family overview – 320 C24X Series of DSP controllers – Architecture overview – C24X CPU internal bus structure – Memory – Central processing unit – Memory and I/O spaces – Overview of Memory and I/O spaces – Program control –Address modes – System configuration and interrupts – Clocks and low power modes –Digital input / output (I/O). Instruction set: Assembly language instructions – Instruction set summary – Instruction description – Accumulator, arithmetic and logic instructions – Auxiliary register and data page pointer instructions – TREG, PREG, and Multiply instructions – Branch instructions – Control instructions – I/O and memory instructions.

PWM INVETER CONTROL 9 Hours

Inverter – Operation principle – Inverter switching – Unipolar – Bipolar –

Inverter deadtime– Inverter modulation – Different types – Sine triangle – Analysis of Sine triangle modulation – Trapezoidal modulation – Third harmonic Modulation – Analysis of Third Harmonic Modulation – Output filter requirement for different PWM techniques.

SPACE VECTOR MODULATION 9 Hours

Concept of a Space Vector – dq0 Components for Three-phase sine wave source/1evel –dq0 Components for Voltage Source Inverter (VSI) operated in Square Wave Mode –Synchronously rotating reference frame – Space Vector Modulation (SVM) – Principle –SVM compared to regular sampled PWM Phase Lag reference for SVM – Naturally sampled SVM – Analytical solution for SVM – Harmonic losses for SVM – Placement of Zero Space Vector – Discontinuous Modulation – Phase Lag reference for discontinuous PWM.

NEURAL NETWORK AND FUZZY CONTROLLERS 9 Hours

Current and Speed control of Induction Motor – Current control algorithm – Sensorless motion control strategy – Induction Motor Controller using VHDL design. Fuzzy Logic Control of a Synchronous Generator – System representation – VHDL Modeling –FPGA implementation.

Theory:45 Hrs Total: 45 Hrs

REFERENCES

1. Bimal K. Bose, “Power Electronics and Variable Frequency Drives – Technology and Applications”, IEEE Press, 1997.
2. Grafame Holmes. D and Thomas A. Lipo, “Pulse Width Modulation for Power Converters - Principles and Practice”, IEEE Press, 2003.
3. Peter Vas, “Vector Control of AC Machines”, Oxford University Press, 1990.
4. Hamid A. Toliyat and Steven G.Campbell, “DSP based Electromechanical Motion Control”, CRC Press 2003.
5. Ned Mohan, “Advanced Electric Drives: Analysis, Control and Modeling using SIMULINK”, John Wiley & Sons Ltd., 2001.

P14PETE15	FLEXIBLE AC TRANSMISSION SYSTEM

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Understand the operation of shunt and series compensators

CO2: Suggest suitable FACTS controllers for power system stability improvement

CO3: Identify and overcome SSR problems using FACTS devices

PRE-REQUISITE

1. Power System Analysis
2. Power Converters
3. Power Inverters

FACTS INTRODUCTION 9 Hours

Introduction – Power flow control-Stability constraint of maximum transmission line loading-Reactive power constraint of maximum transmission line loading- Uncompensated line- Passive compensation.

SERIES COMPENSATORS 9 Hours

Objectives – Variable Impedance type series compensation – TCSC – TSSC switching converter type series compensators – SSSC

SHUNT COMPENSATORS 9 Hours

Objectives of shunt compensation – Methods of controllable VAR generation – SVC and STATCOM – Saturated reactor – TCR – TSC – FCTCR

EMERGING FACTS CONTROLLERS 9 Hours

UPFC – Basic operating principles – Conventional transmission control capabilities – The Interline Power flow controller (IPFC) – Operating Principles - Control Structure

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SPECIAL PURPOSE FACTS CONTROLLERS **9 Hours**

Sub - Synchronous Resonance – NGH SSR damping scheme – TCBR – Thyristor controlled voltage limiter – Thyristor controlled voltage regulator – Thyristor controlled current limiter

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. N. G. Hingorani, L. Gyugi, "Understanding FACTS - Concept and Technology of FACTS", IEEE press books Standard Publishers distributors, 2001, New Delhi.
2. Mohan Mathur. R., Rajiv K. Varma, "Thyristor – Based FACTS Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc 2002.

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P14PETE16	CONTROL DESIGN TECHNIQUES FOR POWER ELECTRONIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Acquire the basic knowledge of various control design techniques.

CO2: Analyze the state space modeling of various power converters.

CO3: Apply controller design and modeling of converter to special motor drives

PRE-REQUISITE

1. Classical Control
2. Systems Theory
3. Power Converters

OVERVIEW OF CONTROLLERS 9 Hours

Review of basic control theory – Control design techniques such as P, PI, PID and lead lag compensator design. Review of state space control design approach – State feedback controller and observer design

POWER CONVERTERS AND CONTROL 9 Hours

Control of DC-DC converters. State space modelling of Buck, Buck-Boost, Cuk, Sepic, Zeta Converters. Equilibrium analysis and closed loop voltage regulations using state feedback controllers and sliding mode controllers.

MODELING AND DESIGN OF CONTROLLERS 9 Hours

Control of rectifiers. State space modelling of single phase and three phase rectifiers. State feedback controllers and observer design for output voltage regulation for nonlinear loads. Analysis of continuous and discontinuous mode of operation.

MODELING OF SPEED CONTROLLERS 9 Hours

Modelling of Brushless DC motors and its speed regulations – State space model, sensorless speed control of BLDC motor and Sliding mode control

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design for BLDC motor. Modelling and control of switched reluctance motor.

MODELING OF DC-DC CONVERTERS **9 Hours**

Modelling of multi input DC-DC converters and its application to renewable energy. Output voltage regulation of Multi input DC-DC converter using state feedback controllers.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics Devices”, Springer, 2006.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding mode control of switching Power Converters”, CRC Press, 2011.
3. Bimal K. Bose, “Power Electronics and Motor Drives”, Elsevier, 2006.
4. Ion Boldea and S.A Nasar, “Electric Drives”, CRC Press, 2005.

P14PETE17 ELECTRIC AND HYBRID VEHICLES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Understanding the basics of various aspects of hybrid and electric drive train such as their configuration, types of electric machines.

CO2: Analyze the characteristics and performance of hybrid and electric drive train using both dc and ac drives.

CO3: Apply the various energy management strategies to hybrid and electric vehicle.

PRE-REQUISITE

1. Power Conversion Techniques
2. Electrical Machines

OVERVIEW OF HYBRID VEHICLES 9 Hours

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

ELECTRIC TRACTION 9 Hours

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Basic concepts of electric traction, introduction to various electric drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

MOTOR DRIVES 9 Hours

Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC Motor drives, configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor drives, configuration and control of Switch Reluctance Motor drives, drive system efficiency.

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HYBRID METHODS **9 Hours**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems

ENERGY MANAGEMENT **9 Hours**

Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer, 2006.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters", CRC Press, 2011.
3. Bimal K. Bose, "Power Electronics and Motor Drives", Elsevier, 2006.
4. Ion Boldea and S.A Nasar, "Electric Drives", CRC Press, 2005.

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P14PETE18	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Know the energy storage schemes in electrical systems

CO2: Expose their knowledge in batteries, thermoelectric convertors

CO3: Demonstrate the different types and engineering issues in the fuel cells, super capacitors.

PRE-REQUISITE

1. Fundamental Chemistry
2. Material Science

OVERVIEW OF ENERGY SCENARIO — 9 Hours

Prospect for both traditional and renewable energy sources - Detailed analysis of Indian energy market and future need through 2020 - energy, economic growth and the environment, implications of the Kyoto Protocol, and structural change in the electricity supply industry

STORAGE BATTERIES — 9 Hours

Batteries - performance, charging and discharging, storage density, energy density, and safety issues, classical batteries - Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide, and modern batteries -Zinc-Air, Nickel Hydride, Lithium Battery.

THERMO ELECTRIC MATERIALS AND MEASUREMENT — 9 Hours

Thermoelectric - electron conductor and phonon glass, classical thermoelectric materials (i) four-probe resistivity measurement, Seeback coefficient measurement, and thermal conductivity measurement.

SUPER CAPACITORS — 9 Hours

Super capacitors - types of electrodes and some electrolytes, Electrode materials – High surface area activated carbons, metal oxide and conducting polymers, Electrolyte - aqueous or organic, disadvantages and advantages of super capacitors - Compared to battery systems, applications - transport vehicles, private vehicles, and consumer electronics - energy density, power density, price, and market.

FUEL CELLS **9 Hours**

Fuel cells - direct energy conversion - Maximum intrinsic efficiency of an electrochemical converter, physical interpretation - Carnot efficiency factor in electrochemical energy convertors, types of fuel cells - hydrogen oxygen cells, hydrogen air cell, alkaline fuel cell, and phosphoric fuel cell.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Tetsuya Osaka, Madhav Datta, “Energy Storage Systems for Electronics”, Gordon and Breach Science Publishers, 2000.
2. R. M. Dell, D.A.J. Rand, “Understanding Batteries”, RSC Publications, 2001.
3. James Larminie, Andrew Dicks, “Fuel Cell Systems Explained”, John Wiley, 2003.
4. D.M. Rowe, “Thermoelectrics Handbook: Macro to Nano”, CRC Press, 2006.

P14PETE19	SIMULATION OF POWER ELECTRONIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Model the power electronic devices and circuits

CO2: Describe the simulation tools for power electronic systems

CO3: Simulate the power electronic systems using various software

PRE-REQUISITE

1. Power Electronics
2. Control Systems

INTRODUCTION **9 Hours**

Need for simulation - Challenges in simulation - Classification of simulation programs -Overview of Pspice, MATLAB and SIMULINK. Mathematical Modeling of Power Electronic Systems: Static and dynamic models of power electronic switches - Static and dynamic equations and state space representation of Power Electronic systems.

PSPICE **9 Hours**

File formats - Description of circuit elements - Circuit description - Output variables -Dot commands - SPICE models of Diode, Thyristors, Triac, BJT, Power MOSFET, IGBT and Power S-Functions - Converting S-Functions to blocks.

MATLAB AND SIMULINK **9 Hours**

MATLAB – Intro Variables – Matrix representation and operation, Trigonometric functions, Logical relations, Exponential Complex Numbers – m file – Function – For loop – While – If else. Graphics – 2D Plots. SIMULINK: Intro – Basic Block – Sources and Sinks model analysis using SIMULINK - S-functions - converting S-functions to blocks.

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INTRODUCTION TO PSIM **9 Hours**

General Information – Power Circuit Components – Control Circuit & Other Components– Analysis specification – Circuit Schematic Design – Waveform Processing – Error and Warning messages.

SIMULATION USING PSPICE, PSIM, MATLAB AND SIMULINK **9 Hours**

Diode rectifiers - controlled rectifiers - AC voltage controllers - DC choppers – PWM inverters - voltage source and current source inverters - Resonant pulse inverters – Zero current switching and zero voltage switching inverters.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Rashid, M.H., "SPICE for Power Electronics and Electric Power", 3rd Edition, CRC Press, 2012.
2. Ned Mohan, "Power Electronics, Computer Simulation Analysis and Education using Pspice", Minnesota Power Electronics Research and Education, USA, 1992.
3. Chee-Mun-Ong, "Dynamic simulation of Electric Machinery using MATLAB/SIMULINK", Prentice Hall PTR, 2003.
4. "The Pspice User's Guide", Microsim Corporation, California
5. MATLAB simulink – user manual
6. PSIM user manual

P14PETE20	WIND ENERGY CONVERSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Expose their knowledge in wind turbines used in wind energy conversion system.

CO2: Demonstrate their knowledge in different systems used in wind energy conversion.

CO3: To expose the knowledge in grid connected wind energy systems.

PRE-REQUISITE

1. Electrical Machines
2. Renewable Energy Resources

INTRODUCTION 9 Hours

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

WIND TURBINES 9 Hours

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

FIXED SPEED SYSTEMS 9 Hours

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model-Generator model for steady state and transient stability analysis.

VARIABLE SPEED SYSTEMS 9 Hours

Need of variable speed systems-Power-wind speed characteristics-

Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

GRID CONNECTED SYSTEMS **9 Hours**

Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. L.L.Freris, “Wind Energy Conversion Systems”, Prentice Hall, 1990
2. Ion Boldea, “Variable Speed Generators”, Taylor & Francis group, 2006.
3. E.W.Golding, “The Generation of Electricity by Wind Power”, Redwood burn, 1976, Trowbridge.
4. Siegfried Heir, “Grid Integration of Wind Energy Conversion Systems”, 2nd Edition, Wiley, 2006.

P14PETE21	EMERGING TRENDS IN POWER CONVERSION TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Choose the PWM techniques.

CO2: Apply voltage lift techniques in dc-dc converters.

CO3: Analyze the FFT of multilevel inverters

CO4: Apply the harmonic mitigations methods.

PRE-REQUISITE

1. Control Systems
2. Power Electronics

SWITCHING TECHNIQUES 8 Hours

Gating signals – PWM techniques – Types – SPWM, SVPWM and SVM – choice of carrier frequency in SPWM – switch realization – switching losses – Efficiency Vs Switching frequency – applications – EMI and EMC considerations.

DC – DC CONVERTERS 10 Hours

Basic of DC – DC converter – Hard and Soft switching concepts – Digital switching techniques – Luo converter - principle of operation – Voltage lift techniques - MPPT algorithms – Sliding mode control - applications – Photovoltaic systems – Hybrid vehicles.

ADVANCES IN INVERTERS 11 Hours

Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel inverters – Hybrid multi level inverter- FFT analysis- Comparison of multilevel inverters - Applications of multilevel inverter - Principle of operation of impedance source inverter- Shoot thro zero state – Application – UPS – Adjustable speed drives.

MATRIX CONVERTER 8 Hours

Single phase and three phase – Direct indirect – Sparse and very sparse –

Multilevel matrix converter – Z source matrix converter – applications – Wind mills – Adjustable speed drives industrial applications - Hybrid vehicles.

HARMONIC MITIGATIONS **8 Hours**

Effects of harmonics – Harmonics eliminations – Selective harmonic elimination – Selective sine PWM carrier elimination – Power Factor controlling – Active power factor controlling – Hysteresis control – Voltage feedback control - Current feedback control.

Theory:45 Hrs **Total: 45 Hrs**

REFERENCES

1. Ned Mohan, Undeland and Robbin, "Power Electronics: Converters, Application and Design", New York, John Wiley and Sons, 2006.
2. Kolar, J.W. Schafmeister, F. Round, S.D. Ertl, H. ETH Zurich and Zurich, "Novel Three-Phase AC–AC Sparse Matrix Converters", Vol.22, No.5, IEEE Transactions on Power Electronics, Sept. 2007, pp 1649 – 1661.
3. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice Hall of India, 2001, New Delhi.
4. D.M. Bellur, M.K. Kazimierczuk and O.H. Dayton, "DC-DC Converters for Electric Vehicle Applications", Conference on Electrical Insulation and Electrical Manufacturing Expo, 22-24, Oct. 2007, Nashville, USA, pp 286 – 293.
5. S. Masoud Barakati, "Applications of Matrix Converters for Wind Turbine Systems", Germany, VDM Verlag Publishers, 2008.

ONE CREDIT COURSES

P14PEIN01 DESIGN CONSIDERATION FOR VARIABLE SPEED DRIVES

Module I

Choosing the drive architecture – AC drive block diagram – BLDC drive block diagram

Module II

Components in drive systems

Module III

Selection of drive components – Thermal considerations

Theory:15 Hrs **Total: 15 Hrs**

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P14PEIN02 AUTOMOTIVE CONTROL ELECTRONICS

Engine Control Unit (ECU) – Safety and security systems – Actuators and Embedded Control – Electric drives for automobiles – Networking in Automobiles

Theory:15 Hrs **Total: 15 Hrs**

P14PEIN03 DEVELOPMENT OF REGULATED POWER SUPPLY CIRCUITS

Classification and configuration of power supplies – Design and Practical consideration of SMPS – Design and Practical Consideration of UPS

Theory:15 Hrs **Total: 15 Hrs**

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P14PEIN04 BACKUP POWER SUPPLY SYSTEM FOR AERO APPLICATIONS

- Aero Electric power system
- Aircraft ground support system
- Backup Power Supply System

Theory:15 Hrs **Total: 15 Hrs**

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