St. PETER'S UNIVERSITY

St. Peter's Institute of Higher Education and Research
(Declared under section 3 of UGC Act 1956)
Avadi, Chennai – 600 054.

M.E. (POWER ELECTRONICS AND DRIVES) PROGRAMME

(I to IV SEMESTERS)

REGULATIONS AND SYLLABI

(REGULATIONS – 2013)

(Effective from the Academic Year 2013-'14)

M.E. (POWER ELECTRONICS AND DRIVES) PROGRAMME

Regulations and Syllabi

(Effective from the Academic Year 2013-'14)

1. **Eligibility:** Candidates who passed B.E. / B.Tech. (EEE / ECE / EIE) of the University or any other equivalent examination thereto are eligible for admission to Two Year M.E. (Power Electronics and Drives) Programme.

2. **Duration:** Two Years Comprising 4 Semesters. Each semester has a minimum 90 working days with a minimum of 5 hours a day.

3. **Medium:** English is the medium of instruction and examination.

4. **Weightage for Internal and End Assessment:** The weightage for Internal Assessment (IA) and End Assessment (EA) be 25:75 unless the ratio is specifically mentioned in the scheme of Examinations.

5. **Credit System:** Credit system be followed with 18 credits for each semester and each credit is equivalent to 25 hours of effective study provided in the Time Table.

6. **Scheme of Examinations (I to IV Semesters)**

I Semester

Code No.	Course Title	Credit	Marks		
Theory			**CA**	**EA**	**Total**
113PEPT01	Applied Mathematics	3	25	75	100
113PEPT02	Analysis of Electrical Machines	3	25	75	100
113PEPT03	Analysis of Power Converters	3	25	75	100
113PEPT04	Analysis and Design of Inverters	3	25	75	100
113PEPT05	Advanced Power Semiconductor Devices	3	25	75	100
113PEPT07	**Elective I:** Microcontroller Based System Design	3	25	75	100
	Total	**18**	**150**	**450**	**600**

II Semester

Code No.	Course Title	Credit	Marks		
Theory			**CA**	**EA**	**Total**
213PEPT01	Solid State DC Drives	2	25	75	100
213PEPT02	Solid State AC Drives	2	25	75	100
213PEPT03	Special Electrical Machines	3	25	75	100
213PEPT04	Power Quality	3	25	75	100
Electives					
213PEPT08	**Elective II :** Flexible AC Transmission Systems	3	25	75	100
213PEPT09	**Elective III:** Energy Management and Auditing	3	25	75	100
Practical					
213PEPP01	Power Electronics and Drives Lab	2	25	75	100
	Total	**18**	**175**	**525**	**700**

III Semester

Code No.	Course Title	Credit	Marks		
Theory			**CA**	**EA**	**Total**
313PEPT01	Power Electronics for Renewable Energy Systems	3	25	75	100
313PEPT04	**Elective IV:** Solar and Energy Storage Systems	3	25	75	100
313PEPT05	**Elective V:** Wind Energy Conversion Systems	3	25	75	100
Practical					
313PEPP01	Project Work – Phase -I	9	25	75	100
	Total	**18**	**100**	**300**	**400**

IV Semester

Code No.	Course Title	Credit	Marks		
Project			**CA**	**EA**	**Total**
413PEPP01	Project Work (Phase-II)	18	25	75	100
	Total	**18**	**25**	**75**	**100**

LIST OF ELECTIVE COURSES

I Semester

Course Code	Course Title	Credit
113PEPT06	System Theory	3
113PEPT07	**Microcontroller Based System Design**	3
113PEPT08	Electromagnetic Field Computation and Modelling	3

II Semester

Course Code	Course Title	Credit
213PEPT05	Soft Computing Techniques	3
213PEPT06	Digital Simulation of Power Electronic Circuits	3
213PEPT07	VLSI Architecture and Design Methodologies	3
213PEPT08	**Flexible AC Transmission Systems**	3
213PEPT09	**Energy Management and Auditing**	3
213PEPT10	SMPS and UPS	3

III Semester

Course Code	Course Title	Credit
313PEPT02	High Voltage Direct Current Transmission	3
313PEPT03	Application of MEMS Technology	3
313PEPT04	**Solar and Energy Storage Systems**	3
313PEPT05	**Wind Energy Conversion Systems**	3
313PEPT06	Non Linear Dynamics for Power Electronics Circuits	3
313PEPT07	Smart Grid	3

7. **Passing Requirements:** The minimum pass mark (raw score) be 50% in End Assessment (EA) and 50% in Continuous Assessment (CA) and End Assessment (EA) put together. No minimum mark (raw score) in Continuous Assessment (CA) be prescribed unless it is specifically mentioned in the Scheme of Examination.

8. **Grading System:** Grading System on a 10 Point Scale be followed with 1 mark = 0.1 Grade point to successful candidates as given below.

CONVERSION TABLE
(1 mark = 0.1 Grade Point on a 10 Point Scale)

Range of Marks	Grade Point	Letter Grade	Classification
90 to 100	9.0 to 10.0	O	First Class
80 to 89	8.0 to 8.9	A	First Class
70 to 79	7.0 to 7.9	B	First Class
60 to 69	6.0 to 6.9	C	First Class
50 to 59	5.0 to 5.9	D	Second Class
0 to 49	0 to 4.9	**F**	**Reappearance**

Procedure for Calculation

Cumulative Grade Point Average (CGPA) = $\frac{\text{Sum of Weighted Grade Points}}{\text{Total Credits}}$

$$= \frac{\sum (CA+EA)\, C}{\sum C}$$

Where Weighted Grade Points in each Course = Grade Points (CA+EA) multiplied by Credits

= (CA+EA)C

Weighted Cumulative Percentage of Marks(WCPM) = CGPAx10

C- Credit, CA-Continuous Assessment, EA- End Assessment

9. Pattern of the Question Paper: The question paper for End Assessment will be set for three hours and for the maximum of 100 marks with following divisions and details.

Part A: 10 questions (with equal distribution to all units in the syllabus). Each question carries 2 marks.

Part B: 5 questions with either or type (with equal distribution to all units in the syllabus). Each question carries 16 marks.
The total marks scored by the candidates will be reduced to the maximum prescribed in the Regulations.

10.Effective Period of Operation for the Arrear Candidates: Two Year grace period is provided for the candidates to complete the arrear examination, if any.

Registrar

11.Syllabus

113PEPT01 - APPLIED MATHEMATICS

OBJECTIVES:

- To develop the ability to apply the concepts of Matrix theory and Liner programming in Electrical Engineering problems.
- To achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems.
- To familiarize the students in calculus of variations and solve problems using Fourier transforms associated with engineering applications.

UNIT I CALCULUS OF VARIATION

Introduction — Euler's equation — several dependent variables Lagrange's equations of Dynamics — Integrals involving derivatives higher that the first — Problems with constraints — Direct methods and eigen value problems.

UNIT II MATRIX THEORY

Eigen values using QR transformations — generalized eigenvectors — canonical forms — singular value decomposition and applications — pseudo inverse — least square approximations.

UNIT III LINEAR PROGRAMMING PROBLEM

Graphical method – simplex method – Big M Technique – Integer programming.

UNIT IV ONE DIMENSIONAL RANDOM VARIABLES

Random variables – probability function – moments – maoent generating function and their properties – Binomial, poisson, Geometric, uniform , Exponential , Gamma and Normal distributions – Function of a Random Variable.

UNIT V FOURIER SERIES

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – even and odd function : cosine and sine series – Non-periodic function: Extension to other intervals – Power signals: exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm – Liouville systems – Generalized Fourier series.

REFERENCES

1. Gupta, A.S, Calculus of variations with Applications, Prentice – Hall of India New Delhi, 1997.
2. Broson, R., Matrix operations, Schaum's outline series, McGraw Hill, New York, 1989.
3. Taha H.A, "Operation Research – An Introduction", Prentice Hall of India, 2001.
4. Ochi, M.K, "Applied Probability and stochastic Processes", John Wiley & Sons (1992).
5. Andres L.C. and Phillips R.L., Mathematical Techniques for Engineers and Scientists, Prentice Hall of India Pvt.Ltd., New Delhi, 2005.

113PEPT02 - ANALYSIS OF ELECTRICAL MACHINES

OBJECTIVES:

To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.

To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.

To provide the knowledge of theory of transformation of three phase variables to two phase variables.

To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.

To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

UNITI PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION

Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf - winding inductances and voltage equations.

UNIT II DC MACHINES

Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt d.c. motors – Time domain block diagrams - solution of dynamic characteristic by Laplace transformation – digital computer simulation of permanent magnet and shunt D.C. machines.

UNIT III REFERENCE FRAME THEORY

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame - variables observed from several frames of reference.

UNIT IV INDUCTION MACHINES

Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations – digital computer simulation.

UNIT V SYNCHRONOUS MACHINES

Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations – digital computer simulation.

REFERENCES

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.
2. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.
3. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

113PEPT03 - ANALYSIS OF POWER CONVERTERS

OBJECTIVES :

To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
To analyze and comprehend the various operating modes of different configurations of power converters.
To design different power converters namely AC to DC, DC to DC and AC to AC converters.

UNIT I SINGLE PHASE AC-DC CONVERTER

Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and free wheeling diodes – continuous and discontinuous modes of operation - inverter operation –Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap-reactive power and power balance in converter circuits.

UNIT II THREE PHASE AC-DC CONVERTER

Semi and fully controlled converter with R, R-L, R-L-E - loads and free wheeling diodes – inverter operation and its limit – performance parameters – effect of source impedance and over lap – 12 pulse converter.

UNIT III DC-DC CONVERTERS

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.

UNIT IV AC VOLTAGE CONTROLLERS

Static Characteristics of TRIAC- Principle of phase control: single phase and three phase controllers – various configurations – analysis with R and R-L loads.

UNIT V CYCLOCONVERTERS

Principle of operation – Single phase and Three-phase Dual converters - Single phase and three phase cyclo-converters – power factor Control – Introduction to matrix converters.

REFERENCES

1. Ned Mohan,T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons.Wiley India edition, 2006.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pierson Prentice Hall India, New Delhi, 2004.
3. Cyril W.Lander, "power electronics", Third Edition McGraw hill-1993
4. P.C Sen.," Modern Power Electronics ", Wheeler publishing Co, First Edition, New Delhi-1998.
5. P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003.
6. Power Electronics by Vedam Subramanyam, New Age International publishers, New Delhi Second Edition, 2006

113PEPT04 - ANALYSIS AND DESIGN OF INVERTERS

OBJECTIVES :

To Provide the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation.

To equip with required skills to derive the criteria for the design of power converters for UPS,Drives etc.,

Ability to analyse and comprehend the various operating modes of different configurations of power converters.

Ability to design different single phase and three phase inverters.

UNIT I SINGLE PHASE INVERTERS

Introduction to self commutated switches : MOSFET and IGBT - 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 – Design of UPS.

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – Application to drive system.

UNIT III CURRENT SOURCE INVERTERS

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 – PWM techniques for current source inverters.

UNIT IV MULTILEVEL & BOOST INVERTERS

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters – PWM techniques for MLI – Single phase & Three phase Impedance source inverters.

UNIT V RESONANT INVERTERS

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

REFERENCES

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, Second Edition, 2002.
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.
4. Ned Mohan,T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons.Wiley India edition, 2006.
5. Philip T. krein, "Elements of Power Electronics" Oxford University Press -1998.
6. P.C. Sen, "Modern Power Electronics", Wheeler Publishing Co, First Edition, New Delhi, 1998.
7. P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003.

113PEPT05 - ADVANCED POWER SEMICONDUCTOR DEVICES

OBJECTIVES :

To improve power semiconductor device structures for adjustable speed motor control applications.
To understand the static and dynamic characteristics of current controlled power semiconductor devices
To understand the static and dynamic characteristics of voltage controlled power semiconductor devices
To enable the students for the selection of devices for different power electronics applications
To understand the control and firing circuit for different devices.

UNIT I INTRODUCTION

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

UNIT II CURRENT CONTROLLED DEVICES

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient 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.

UNIT III VOLTAGE CONTROLLED DEVICES

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.

UNIT IV FIRING AND PROTECTING CIRCUITS

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

UNIT V THERMAL PROTECTION

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

REFERENCES

1. B.W Williams 'Power Electronics Circuit Devices and Applications'.
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
3. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
4. Mohan, Undcland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.

II Semester

213PEPT01 - SOLID STATE DC DRIVES

OBJECTIVES:
To understand steady state operation and transient dynamics of a motor load system
To study and analyze the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively.
To analyze and design the current and speed controllers for a closed loop solid state DC motor drive.
To understand the implementation of control algorithms using microcontrollers and phase locked loop.

UNIT I DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS
DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation - Introduction to high speed drives and modern drives. Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics - stability of drives – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

UNIT II CONVERTER CONTROL
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 free wheeling diode; Implementation of braking schemes; Drive employing dual converter.

UNIT III CHOPPER CONTROL
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.

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

UNIT V DIGITAL CONTROL OF D.C DRIVE
Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant horse power and load disturbed operations; Speed detection and current sensing circuits.

REFERENCES
1. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., New Yersy, 1989.
2. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.
3. Gobal K.Dubey, “Fundamentals of Electrical Drives”, Narosal Publishing House, New Delhi, Second Edition ,2009
4. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.
5. P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 1981

213PEPT02 - SOLID STATE AC DRIVES

OBJECTIVES:

To understand various operating regions of the induction motor drives.
To study and analyze the operation of VSI & CSI fed induction motor control.
To understand the speed control of induction motor drive from the rotor side.
To understand the field oriented control of induction machine.
To understand the control of synchronous motor drives.

UNIT I INTRODUCTION TO INDUCTION MOTORS

Steady state performance equations – Rotating magnetic field – torque production, Equivalent circuit– Variable voltage, constant frequency operation – Variable frequency operation, constant Volt/Hz operation. Drive operating regions, variable stator current operation, different braking methods.

UNIT II VSI AND CSI FED INDUCTION MOTOR CONTROL

AC voltage controller circuit – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed IM variable frequency drives comparison

UNIT III ROTOR CONTROLLED INDUCTION MOTOR DRIVES

Static rotor resistance control - injection of voltage in the rotor circuit – static scherbius drives - power factor considerations – modified Kramer drives

UNIT IV FIELD ORIENTED CONTROL

Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.

UNIT V SYNCHRONOUS MOTOR DRIVES

Wound field cylindrical rotor motor – Equivalent circuits – performance equations of operation from a voltage source – Power factor control and V curves – starting and braking, self control – Load commutated Synchronous motor drives - Brush and Brushless excitation .

REFERENCES

1. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2002.
2. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw Hill, 1994.
3. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Yersy, 1989.
4. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
5. W.Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992.
6. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.

213PEPT03 - SPECIAL ELECTRICAL MACHINES

OBJECTIVES

To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
To develop the control methods and operating principles of switched reluctance motors.
To introduce the concepts of stepper motors and its applications.
To understand the basic concepts of other special machines.

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Characteristics and control.

UNIT II PERMANENT MAGNET SYNCHROUNOUS MOTORS

Principle of operation – EMF and Torque equations - Phasor diagram - Power controllers – Torque speed characteristics – Digital controllers – Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT III SWITCHED RELUCTANCE MOTORS

Constructional features –Principle of operation- Torque prediction–CharacteristicsPower controllers – Control of SRM drive- Sensorless operation of SRM – Applications.

UNIT IV STEPPER MOTORS

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications.

UNIT V OTHER SPECIAL MACHINES

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

REFERENCES:

1. T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Claredon press, London, 1989.
2. R.Krishnan, ' Switched Reluctance motor drives' , CRC press, 2001.
3. T.Kenjo, ' Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000.
4. T.Kenjo and S.Nagamori, 'Permanent magnet and Brushless DC motors', Clarendon press, London, 1988.
5. R.Krishnan, ' Electric motor drives' , Prentice hall of India,2002.
6. D.P.Kothari and I.J.Nagrath, ' Electric machines', Tata Mc Graw hill publishing company, New Delhi, Third Edition, 2004.
7. Irving L.Kosow, "Electric Machinery and Transformers" Pearson Education, Second Edition, 2007.

213PEPT04 - POWER QUALITY

OBJECTIVES :

To understand the various power quality issues.
To understand the concept of power and power factor in single phase and three phase systems supplying non linear loads
To understand the conventional compensation techniques used for power factor correction and load voltage regulation.
To understand the active compensation techniques used for power factor correction.
To understand the active compensation techniques used for load voltage regulation.

UNIT I INTRODUCTION

Introduction – Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM

Single phase linear and non linear loads – single phase sinusoidal, non sinusoidal source – supplying linear and nonlinear load – three phase Balance system – three phase unbalanced system – three phase unbalanced and distorted source supplying non linear loads – convept of pf – three phase three wire – three phase four wire system.

UNIT III CONVENTIONAL LOAD COMPENSATION METHODS

Principle of load compensation and voltage regulation – classical load balancing problem : open loop balancing – closed loop balancing, current balancing – harmonic reduction and voltage sag reduction – analysis of unbalance – instantaneous of real and reactive powers – Extraction of fundamental sequence component from measured.

UNIT IV LOAD COMPENSATION USING DSTATCOM

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the souce is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM

Rectifier supported DVR – Dc Capacitor supported DVR – DVR Structure – voltage Restoration – Series Active Filter – Unified power quality conditioner.

REFERENCES

1. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002
2. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1994(2nd edition)
3. Power Quality - R.C. Duggan
4. Power System Harmonics –A.J. Arrillga
5. Power Electronic Converter Harmonics –Derek A. Paice

213PEPP01 - POWER ELECTRONICS AND DRIVES LAB

Sl. No.	Title	Requirements	Quantity
1.	Speed control of Converter fed DC motor.	Power module for DC converter for separately excited DC machine 0.5HP Speed Sensor, display meters, controller circuit, CRO/DSO	1
2.	Speed control of Chopper fed DC motor.	Power module for DC chopper for separately excited DC machine 0.5HP Speed Sensor, display meters, controller circuit, CRO/DSO	1
3.	V/f control of three-phase induction motor.	IGBT inverter power module , 3 phase induction motor0.5HP,V/f controller display meters CRO/DSO	1
4.	Micro controller based speed control of Stepper motor.	Stepper motor, PIC Micrcontroller, controller circuit , Interface circuit, CRO	1
5.	Speed control of BLDC motor.	Power module, BLDC motor(0.5HP) Controller circuit, sensor circuit, display meter, CRO/DSO	1
6.	DSP based speed control of SRM motor.	SRM motor-0.5 HP, PIC DSP/TMS DSP Processor, speed sensor, Power module, Display meter, DSO	1
7.	Design of switched mode power supplies.	Bread Board, Transformer(Ferrite), Power switches/module, controller circuit, DSO	1
8.	Design of UPS.	Bread board, Transformer, Power switchs/module, PIC controller	1
9.	Simulation of Four quadrant operation of three-phase induction motor.	MATLAB	1
10.	Voltage Regulation of three-phase Synchronous Generator.	Synchronous generator – 0.5HP, Power module(MOSFET/IGBT), Controller circuit, CRO/DSO,Display meters	1
11.	Study of power quality analyser.	Single phase or three phase power quality analyzer	1
12.	Study of driver circuits and generation of PWM signals for three phase inverters.	IGBT,MOSFET,Power modules Microcontroller based pulse generators, interface circuits, CRO/DSO.	1

313PEPT01 - POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

OBJECTIVES :

To Provide knowledge about the stand alone and grid connected renewable energy systems.
To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems : operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS

Solar: Block diagram of solar photo voltaic system : line commutated converters (inversionmode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing.
Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PVMaximum Power Point Tracking (MPPT).

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electricaal Systems”, Oxford University Press, 2009
2. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
3. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
4. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
5. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
6. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

Electives

113PEPT07 - SYSTEM THEORY

OBJECTIVES
To educate on modeling and representing systems in state variable form
To educate on solving linear and non-linear state equations
To illustrate the role of controllability and observability
To educate on stability analysis of systems usig Lyapunov's theory
To educate on modal concepts and design of state and output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION
Introduction-Concept of State-State equation for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model-State Diagrams - Physical System and State Assignment.

UNIT II SOLUTION OF STATE EQUATIONS
Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes- Role of Eigenvalues and Eigenvectors.

UNIT III CONTROLLABILITY AND OBSERVABILITY
Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

UNIT IV STABILTY
Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

UNIT V MODAL CONTROL
Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

REFERENCES:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. K. Ogatta, "Modern Control Engineering", PHI, 2002.
3. John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.
4. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.
5. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.
6. Z. Bubnicki, "Modern Control Theory", Springer, 2005.

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113PEPT07 - MICROCONTROLLER BASED SYSTEM DESIGN

OBJECTIVES

To expose the students to the fundamentals of microcontroller based system design.
To teach I/O and RTOS role on microcontroller.
To impart knowledge on PIC Microcontroller based system design.
To introduce Microchip PIC 8 bit peripheral system Design
To give case study experiences for microcontroller based applications.

UNIT I 8051 ARCHITECTURE

Architecture – memory organization – addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication.

UNIT II 8051 PROGRAMMING

Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming Interrupt Programming – RTOS for 8051 – RTOSLite – FullRTOS – Task creation and run – LCD digital clock/thermometer using FullRTOS.

UNIT III PIC MICROCONTROLLER

Architecture – memory organization – addressing modes – instruction set – PIC progrmming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, MPLAB.

UNIT IV PERIPHERAL OF PIC MICROCONTROLLER

Timers – Interrupts, I/O ports- I2C bus-A/D converter-UART- CCP modules -ADC, DAC and Sensor Interfacing –Flash and EEPROM memories.

UNIT SYSTEM DESIGN – CASE STUDY

Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Stand alone Data Acquisition System.

REFERENCES:

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008
2. John Iovine, ‘PIC Microcontroller Project Book ’, McGraw Hill 2000
3. Myke Predko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001.
4. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2005.
5 .Rajkamal,”.Microcontrollers-Architecture,Programming,Interfacing & System Design”,2ed,Pearson,2012.
6. I Scott Mackenzie and Raphael C.W. Phan, “The Micro controller”, Pearson, Fourth edition 2012

113PEPT08 - ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

OBJECTIVES:

To refresh the fundamentals of Electromagnetic Field Theory.
To provide foundation in formulation and computation of Electromagnetic Fields using analytical and numerical methods.
To impart in-depth knowledge on Finite Element Method in solving Electromagnetic field problems.
To introduce the concept of mathematical modeling and design of electrical apparatus.

UNIT I INTRODUCTION

Review of basic field theory – Maxwell's equations – Constitutive relationships and Continuity equations – Laplace, Poisson and Helmholtz equation – principle of energy conversion – force/torque calculation.

UNIT II BASIC SOLUTION METHODS FOR FIELD EQUATIONS

Limitations of the conventional design procedure, need for the field analysis based design, problem definition, boundary conditions, solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

UNIT III FORMULATION OF FINITE ELEMENT METHOD (FEM)

Variational Formulation – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problems.

UNIT IV COMPUTATION OF BASIC QUANTITIES USING FEM PACKAGES

Basic quantities – Energy stored in Electric Field – Capacitance – Magnetic Field – Linked Flux – Inductance – Force – Torque – Skin effect – Resistance.

UNIT V DESIGN APPLICATIONS

Design of Insulators – Cylindrical magnetic actuators – Transformers – Rotating machines.

REFERENCES

1. Matthew. N.O. Sadiku, "Elements of Electromagnetics", Fourth Edition, Oxford University Press, First Indian Edition 2007.
2. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
3. Nicola Biyanchi , "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer-Verlage, 1992.
5. S.J Salon, "Finite Element Analysis of Electrical Machines" Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai, India.
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 1983.

213PEPT05 - SOFT COMPUTING TECHNIQUES

OBJECTIVES

To expose the concepts of feed forward neural networks.
To provide adequate knowledge about feed back neural networks.
To teach about the concept of fuzziness involved in various systems.
To expose the ideas about genetic algorithm
To provide adequate knowledge about of FLC and NN toolbox

UNIT I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCullochPitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propogation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation trainingapplications.

UNIT II ARTIFICIAL NEURAL NETWORKS

Counter propagation network- architecture- functioning & characteristics of counter- Propagation network-Hopfield/ Recurrent network- configuration- stability constraints-associative memoryand characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory.

UNIT III FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification- inferencingand 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.

UNIT IV GENETIC ALGORITHM

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.

UNIT V APPLICATIONS

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.

REFERENCES

1.. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education,
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.

213PEPT02 - DIGITAL SIMULATION OF POWER ELECTONIC CIRCIUTS

OBJECTIVES:

To provide the requisite knowledge necessary to appreciate the dynamical equations involved in the analysis of different PED configurations.

To analyze, design and simulate different power converters studied in the core courses on power converters, Inverters and dynamics of electrical machines.

1.Simulation of single phase half wave controlled converter fed RLE load
2. Simulation of single phase fully controlled converter fed RLE load.
3. Simulation of three phase half controlled converter fed RL load.
4. Simulation of single phase ac phase controlled fed RL load.
5. Simulation of three phase to single phase cyclo - converter fed RL load
6. Simulation of dynamics of armature plunger / relay contactor arrangement.
7. Simulation of single phase VSI fed RL/RC load.
8. Simulation of i) LC tank circuit resonance,
ii) Basic / modified series inverter
iii)Series loaded series resonant inverter
9. Simulation of single phase current source inverter fed induction heating load.
10. Simulation of multi level inverter topologies.
11. Numerical solution of ordinary differential equations.
12. Numerical solution of partial differential equations.

REFERENCES

1. Ned Mohan,T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design" John Wiley and sons.Wiley India edition, 2006.
2 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hal India, New Delhi, 1995.

213PEPT07 - VLSI ARCHITECTURE AND DESIGN METHODOLOGIES

OBJECTIVES

To give an insight to the students about the significance of CMOS technology and fabrication process.
To teach the importance and architectural features of programmable logic devices.
To introduce the ASIC construction and design algorithms
To teach the basic analog VLSI design techniques.
To study the Logic synthesis and simulation of digital system with Verilog HDL.
McGraw Hill International Editions,1994.

UNIT I CMOS DESIGN

Overview of digital VLSI design Methodologies- Logic design with CMOS-transmission gate circuits-Clocked CMOS-dynamic CMOS circuits, Bi-CMOS circuits- Layout diagram, Stick diagram-IC fabrications – Trends in IC technology.

UNIT II PROGRAMABLE LOGIC DEVICES

Programming Techniques-Anti fuse-SRAM-EPROM and EEPROM technology – Re-Programmable Devices Architecture- Function blocks, I/O blocks,Interconnects, Xilinx-XC9500,Cool Runner - XC-4000,XC5200, SPARTAN, Virtex - Altera MAX 7000-Flex 10KStratix.

UNIT III BASIC CONSTRUCTION, FLOOR PLANNING, PLACEMENT AND ROUTING

System partition – FPGA partitioning – Partitioning methods- floor planning – placementphysical design flow – global routing – detailed routing – special routing- circuit extraction – DRC.

UNIT IV ANALOG VLSI DESIGN

Introduction to analog VLSI- Design of CMOS 2stage-3 stage Op-Amp –High Speed and High frequency op-amps-Super MOS-Analog primitive cells-realization of neural networks.

UNIT V LOGIC SYNTHESIS AND SIMULATION

Overview of digital design with Verilog HDL, hierarchical modelling concepts, modules and port definitions, gate level modelling, data flow modelling, behavioural modelling, task & functions, Verilog and logic synthesis-simulation-Design examples,Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Shift Registers, Multiplexer, Comparator, Test Bench.

REFERENCES:

1. M.J.S Smith, "Application Specific integrated circuits",Addition Wesley Longman Inc.1997.
2.Kamran Eshraghian,Douglas A.pucknell and Sholeh Eshraghian,"Essentials of VLSI circuits and system", Prentice Hall India,2005.
3. Wayne Wolf, " Modern VLSI design " Prentice Hall India,2006.
4. Mohamed Ismail ,Terri Fiez, "Analog VLSI Signal and information Processing",
5. Samir Palnitkar, "Veri Log HDL, A Design guide to Digital and Synthesis" 2nd Ed,Pearson,2005.
6. John P. Uyemera "Chip design for submicron VLSI cmos layout and simulation ", Cengage Learning India Edition", 2011.

213PEPT08 - FLEXIBLE AC TRANSMISSION SYSTEMS

OBJECTIVES

To emphasis the need for FACTS controllers.
To learn the characteristics, applications and modelling of series and shunt FACTS controllers.
To analyze the interaction of different FACTS controller and perform control coordination

UNIT I INTRODUCTION

Review of basics of power transmission networks-control of power flow in AC transmission line-Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

UNIT II STATIC VAR COMPENSATOR (SVC)

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis-Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

UNIT III THYRISTOR AND GTO THYRISTOR CONTROLLED SERIES CAPACITORS (TCSC and GCSC)

Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modelling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS

Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)-Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)- Modelling of UPFC and IPFC for load flow and transient stability studies- Applications.

UNIT V CONTROLLERS AND THEIR COORDINATION

FACTS Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

REFERENCES:

1. A.T.John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.
2. Narain G.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi 2001.
3. V. K.Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", 2004, Kluwer Academic Publishers.
4. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
5. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P) Ltd., Publishers New Delhi, Reprint 2008,

213PEPT09 - ENERGY MANAGEMENT AND AUDITING

OBJECTIVES

To study the concepts behind economic analysis and Load management.
To emphasize the energy management on various electrical equipments and metering.
To illustrate the concept of lighting systems and cogeneration.

UNIT I INTRODUCTION

Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting- energy audit process.

UNIT II ENERGY COST AND LOAD MANAGEMENT

Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures- cost of electricity-Loss evaluation Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification

UNIT III ENERGY MANAGEMENT FOR MOTORS, SYSTEMS, AND ELECTRICAL EQUIPMENT

Systems and equipment- Electric motors-Transformers and reactors-Capacitors and synchronous machines

UNIT IV METERING FOR ENERGY MANAGEMENT

Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs. requirements- Metering techniques and practical examples.

UNIT V LIGHTING SYSTEMS & COGENERATION

Concept of lighting systems - The task and the working space -Light sources - Ballasts - Luminaries - Lighting controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques-Lighting and energy standards
Cogeneration: Forms of cogeneration - feasibility of cogeneration- Electrical interconnection.

REFERENCES

1. Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.
2. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 196.
3. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.
4. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
5. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific & Technical, ISBN-0-582-03184, 1990.

213PEPT10 - SMPS AND UPS

AIM
To study low power SMPS and UPS technologies.

OBJECTIVE
To provide conceptual knowledge in modern power electronic converters and its applications in electric power utility.

UNIT I DC-DC CONVERTERS
Principles of stepdown and stepup converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters.

UNIT II SWITCHING MODE POWER CONVERTERS
Analysis and state space modeling of flyback, Forward, Luo, Half bridge and full bridge converters- control circuits and PWM techniques.

UNIT III RESONANT CONVERTERS
Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS , Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control.

UNIT IV DC-AC CONVERTERS
Single phase and three phase inverters, control using various (sine PWM, SVPWM and advanced modulation) techniques, various harmonic elimination techniques- Multilevel inverters- Concepts - Types: Diode clamped- Flying capacitor- Cascaded types- Applications.

UNIT V POWER CONDITIONERS, UPS & FILTERS
Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – 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 PE applications – Selection of capacitors.

REFERENCES:
1. M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.
2. Kjeld Thorborg, "Power Electronics – In theory and Practice", Overseas Press, First Indian Edition 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- Third Edition- John Wiley and Sons- 2006
5. M.H. Rashid – Power Electronics circuits, devices and applications- third edition Prentice Hall of India New Delhi, 2007.

313PEPT02 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION

OBJECTIVES
To impart knowledge on operation, modelling and control of HVDC link.
To perform steady state analysis of AC/DC system.
To expose various HVDC simulators.

UNIT I DC POWER TRANSMISSION TECHNOLOGY
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 – DC breakers – Cables, VSC based HVDC.

UNIT II ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL
Pulse number, choice of converter configuration **–** Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters. General principles of DC link control **–** Converter control characteristics **–** System control hierarchy - Firing angle control **–** Current and extinction angle control **–** Generation of harmonics and filtering - power control **–** Higher level controllers.

UNIT III MULTITERMINAL DC SYSTEMS
Introduction **–** Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

UNIT IV POWER FLOW ANALYSIS IN AC/DC SYSTEMS
Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow - Solution of AC-DC power flow – Unified, Sequential and Substitution of power injection method.

UNIT V SIMULATION OF HVDC SYSTEMS
Introduction – DC LINK Modelling , Converter Modeling and State Space Analysis , Philosophy and tools **–** HVDC system simulation, Online and OFFline simulators **–**– Dynamic interactions between DC and AC systems.

REFERENCES
1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993
2. K.R.Padiyar, , "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
3. J.Arrillaga, , "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
4. Erich Uhlmann, " Power Transmission by Direct Current", BS Publications, 2004.
5. V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.

313PEPT03 APPLICATION OF MEMS TECHNOLOGY

PRE-REQUISITES:
Basic Instrumentation ,Material Science,Programming

UNIT I MEMS:MICRO-FABRICATION, MATERIALS AND ELECTROMECHANICAL CONEPTS
Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strainflexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION
Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications.

OBJECTIVES
To teach the students properties of materials ,microstructure and fabrication methods.
To teach the design and modeling of Electrostatic sensors and actuators.
To teach the characterizing thermal sensors and actuators through design and modeling
To teach the fundamentals of piezoelectric sensors and actuators
To give exposure to different MEMS and NEMS devices.

UNIT III THERMAL SENSING AND ACTUATION
Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION
Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.

UNIT V CASE STUDIES
Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices.

REFERENCES

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.
3. Boston , "Micromachined Transducers Sourcebook",WCB McGraw Hill, 1998.
4. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.
5. P. RaiChoudry" MEMS and MOEMS Technology and Applications", PHI, 2012.
6. Stephen D. Senturia, " Microsystem Design", Springer International Edition, 2011.

313PEPT04 - SOLAR AND ENERGY STORAGE SYSTEMS

OBJECTIVES
To Study about solar modules and PV system design and their applications
To Deal with grid connected PV systems.
TO Discuss aboyt different energy storage systems.

UNIT I INTRODUCTION
Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection.

UNIT II STAND ALONE PV SYSTEM
Solar modules – storage systems – power conditioning and regulation - protection – stand alone PV systems design – sizing.

UNIT III GRID CONNECTED PV SYSTEMS
PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance - International PV programs.

UNIT IV ENERGY STORAGE SYSTEMS
Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage

UNIT V APPLICATIONS
Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

REFERENCES:
1. Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,1994.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2007,Earthscan, UK.
3. Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
4. Solar & Wind Energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill,1987.

313PEPT05 - WIND ENERGY CONVERSION SYSTEMS

OBJECTIVES

To learn the design and control principles of Wind turbine.
To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
To analyze the grid integration issues.

UNIT I INTRODUCTION

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

UNIT II WIND TURBINES

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 controlstall control-Schemes for maximum power extraction.

UNIT III FIXED SPEED SYSTEMS

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.

UNIT IV VARIABLE SPEED SYSTEMS

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.

UNIT V GRID CONNECTED SYSTEMS

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

REFERENCES

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2. S.N.Bhadra, D.Kastha,S.Banerjee,"Wind Electrical Sytems",Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
4. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
5. N. Jenkins," Wind Energy Technology" John Wiley & Sons,1997
6. S.Heir "Grid Integration of WECS", Wiley 1998.

313PEPT06 - NON LINEAR DYNAMICS FOR POWER ELECTRONIC CIRCUITS

OBJECTIVES:

To understand the non linear behavior of power electronic converters.
To understand the techniques for investigation on non linear behavior of power electronic converters.
To analyse the non linear phenomena in DC to DC converters.
To analyse the non linear phenomena in AC and DC Drives.
To introduce the control techniques for control of non linear behavior in power electronic systems.

UNIT I BASICS OF NONLINEAR DYNAMICS

Basics of Nonlinear Dynamics: System, state and state space model, Vector field- Modeling of Linear, nonlinear and Linearized systems, Attractors , chaos, Poincare map, Dynamics of Discrete time system, Lyapunov Exponent, Bifurcations, Bifurcations of smooth map, Bifurcations in piece wise smooth maps, border crossing and border collision bifurcation.

UNIT II TECHNIQUES FOR INVESTIGATION OF NONLINEAR PHENOMENA

Techniques for experimental investigation, Techniques for numerical investigation, Computation of averages under chaos, Computations of spectral peaks, Computation of the bifurcation and analyzing stability.

UNIT III NONLINEAR PHENOMENA IN DC-DC CONVERTERS

Border collision in the Current Mode controlled Boost Converter, Bifurcation and chaos in the Voltage controlled Buck Converter with latch, Bifurcation and chaos in the Voltage controlled Buck Converter without latch, Bifurcation and chaos in Cuk Converter. Nonlinear phenomenon in the inverter under tolerance band control.

UNIT IV NONLINEAR PHENOMENA IN DRIVES

Nonlinear Phenomenon in Current controlled and voltage controlled DC Drives, Nonlinear Phenomenon in PMSM Drives.

UNIT V CONTROL OF CHAOS

Hysteresis control, Sliding mode and switching surface control, OGY Method, Pyragas method, Time Delay control. Application of the techniques to the Power electronics circuit and drives.

REFERENCES:

1. George C. Vargheese, July 2001 Wiley – IEEE Press S Banerjee, Nonlinear Phenomena in Power Electronics, IEEE Press
2. Steven H Strogatz, Nonlinear Dynamics and Chaos, Westview Press
3. C.K.TSE Complex Behaviour of Switching Power Converters, CRC Press, 2003

313PEPT07 - SMART GRID

COURSE OBJECTIVES

To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
To familiarize the power quality management issues in Smart Grid.
To familiarize the high performance computing for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES

Technology Drivers, Smart energy resources,Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control,Fault Detection, Isolation and service restoration, Outage management,High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits,AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

REFERENCES*:*

1. Vehbi C. Güngör*,* DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella*,* Carlo Cecati*,* and Gerhard P. Hancke*,* Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey" , IEEE Transaction on Smart Grids,
3. Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions",CRC Press 2012.
4. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.

Registrar