SRI VENKATESWARA COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to Anna University, Chennai)
SRIPERUMBUDUR TK - 602 117
REGULATION – 2018
M.E. POWER ELECTRONICS AND DRIVES
Choice Based Credit System
I-IV Semesters CURRICULUM

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
THEORY										
1.	MA18181	Applied Mathematics for Engineers	FC	5	3	1	0	4	NONE	F
2.	PD18101	Power Semiconductor Devices	PC	4	3	0	0	3	NONE	F
3.	PD18102	Analysis of Electrical Machines	PC	4	3	0	0	3	NONE	F
4.	PD18103	Analysis and Design of Power Converters	PC	4	3	0	0	3	NONE	F
5.		Professional Elective I	PE	4	3	0	0	3		M
PRACTICAL										
6.	PD18111	Power Electronics Circuits Laboratory	PC	4	0	0	4	2	NONE	F
7.	PD18112	Electrical Machines Laboratory	PC	4	0	0	4	2	NONE	F
			TOTAL	**29**	**15**	**1**	**8**	**20**	-	-

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
THEORY										
1.	PD18201	Analysis and Design of Inverters	PC	4	3	0	0	3	NONE	F
2.	PD18202	Solid State Drives	PC	4	3	0	0	3	NONE	F
3.	PD18203	Power Quality	PC	4	3	0	0	3	NONE	F
4.	MC18081	Introduction to Research Methodology and IPR	PC	2	2	0	0	2	NONE	F
5.		Professional Elective II	PE	4	3	0	0	3		M
6.		Professional Elective III	PE	4	3	0	0	3		M
PRACTICAL										
7.	PD18211	Electrical Drives Laboratory	PC	4	0	0	4	2	NONE	F
8.	PD18212	Microcontroller Laboratory	PC	4	0	0	4	2	NONE	F
9.	PD18213	Mini Project	EEC	4	0	0	4	2	NONE	F
		TOTAL		**34**	**17**	**0**	**12**	**23**	-	-

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
THEORY										
1.		Professional Elective IV	PE	4	3	0	0	3		M
2.		Professional Elective V	PE	4	3	0	0	3		M
3.		Professional Elective VI	PE	4	3	0	0	3		M
PRACTICAL										
4.	PD18311	Project Work Phase I	EEC	12	0	0	12	6		F
TOTAL				**24**	**9**	**0**	**12**	**15**	-	-

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
PRACTICAL										
1.	PD18411	Project Work Phase II	EEC	28	0	0	28	14		F
TOTAL				**28**	**0**	**0**	**28**	**14**	-	-

Total Credits: 72

PROFESSIONAL ELECTIVES (PE)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/ Movable
1.	PD18001	Soft Computing Techniques	PE	4	3	0	0	3	NONE	M
2.	PD18002	Electromagnetic Field Computation and Modelling	PE	4	3	0	0	3	NONE	M
3.	PD18003	Control System Design for Power Electronics	PE	4	3	0	0	3	NONE	M
4.	PD18004	Analog and Digital Controllers	PE	4	3	0	0	3	System Theory	M
5.	PD18005	Flexible AC Transmission Systems	PE	4	3	0	0	3	Analysis and Design of Inverters	M
6.	PD18006	Modern Rectifiers and Resonant Converters	PE	4	3	0	0	3	Analysis and Design of Power Converters	M
7.	PD18007	Electromagnetic Interference and Compatibility	PE	4	3	0	0	3	NONE	M
8.	PD18008	MEMS for power Electronics	PE	4	3	0	0	3	NONE	M
9.	PD18009	Distributed Generation and Micro grid	PE	4	3	0	0	3	Analysis and Design of Power Converters, Analysis and Design of Inverters	M
10.	PD18010	High Voltage Direct Current Transmission	PE	4	3	0	0	3	Analysis and Design of Power Converters, Analysis and Design of Inverters	M
11	PD18011	Solar and Energy Storage Systems	PE	4	3	0	0	3	NONE	M
12	PD18012	Wind Energy Conversion Systems	PE	4	3	0	0	3	NONE	M
13	PD18013	Energy Management and Auditing	PE	4	3	0	0	3	NONE	M
14	PD18014	Electric Vehicles and Power Management	PE	4	3	0	0	3	Analysis and Design of Power Converters, Analysis	M

									and Design of Inverters, Special Electrical Machines	
15	PD18015	Non Linear Dynamics for Power Electronics Circuits	PE	4	3	0	0	3	NONE	M
16	PD18016	Smart Grid	PE	4	3	0	0	3	NONE	M
17	PD18017	Power Electronics for Renewable Energy Systems	PE	4	3	0	0	3	NONE	M
18	PD18018	Robotics and Control	PE	4	3	0	0	3	System Theory	M
19	PD18019	Non Linear Control	PE	4	3	0	0	3	System Theory	M
20	PD18020	Special Electrical Machines	PE	4	3	0	0	3	NONE	M
21	PD18021	System Theory	PE	4	3	0	0	3	NONE	M

OPEN ELECTIVES - Nil

Summary

Name of the Programme					
Subject Area	**Credits per Semester**				**Total**
	I	**II**	**III**	**IV**	
Humanities and Social Sciences (HS), including Management					
Foundation Course(FC)	4	-	-	-	**04**
Professional Subjects-Core (PC)	13	15	-	-	**28**
Engineering Sciences (ES)	-	-	-	-	**-**
Professional Subjects – Electives (PE)	3	6	9	-	**18**
Open Subjects - Electives (OE), from other technical and/or emerging subject areas	-	-	-	-	**-**
Project Work, Seminar and/or Internship in Industry or Elsewhere (EEC)	-	2	6	14	**22**
Total Credits	**20**	**23**	**15**	**14**	**72**

MA18181 APPLIED MATHEMATICS FOR ENGINEERS **L T P C**

(Common to PED, Communication systems and Applied Electronics) **3 1 0 4**

OBJECTIVES:

- To develop the ability to use the concepts of Linear algebra and Special functions for solving problems related to Networks.
- To formulate and construct a mathematical model for a linear programming problem in real life situation.
- To expose the students to solve ordinary differential equations by various techniques.

UNIT I LINEAR ALGEBRA **12**

Vector spaces – norms – Inner Products – Eigen values using QR transformations – QR factorization - generalized eigenvectors – Canonical forms – singular value decomposition and applications - pseudo inverse – least square approximations --Toeplitz matrices and some applications.

UNIT II LINEAR PROGRAMMING **12**

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

UNIT III ORDINARY DIFFERENTIAL EQUATIONS **12**

RungeKutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT IV TWO DIMENSIONAL RANDOM VARIABLES **12**

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

UNIT V QUEUEING MODELS **12**

Poisson Process – Markovian queues – Single and Multi-server Models – Little's formula -Machine Interference Model – Steady State analysis – Self Service queue.

TOTAL: 45+15: 60 PERIODS

OUTCOMES:

- To achieve an understanding of the basic concepts of algebraic equations and method of solving them.
- To familiarize the students with special functions and solve problems associated with Engineering applications.

REFERENCES:

1. Richard Bronson, Gabriel B.Costa, "Linear Algebra", Academic Press, Second Edition, 2007.
2. Richard Johnson, Miller & Freund, "Probability and Statistics for Engineers", 7th Edition, Prentice – Hall of India, Private Ltd., New Delhi (2007).
3. Taha H.A., "Operations Research: An introduction", Pearson Education Asia, New Delhi, Ninth Edition, 2012.
4. Donald Gross and Carl M. Harris, "Fundamentals of Queueing Theory", 2nd edition, John Wiley and Sons, New York (1985).
5. Moon, T.K., Sterling, W.C., Mathematical methods and algorithms for signal processing, Pearson Education, 2000.

PD18101 POWER SEMICONDUCTOR DEVICES **L T P C**
3 0 0 3

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 9

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 9

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor- Basics of GTO, MCT, FCT, RCT

UNIT III VOLTAGE CONTROLLED DEVICES 9

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - and IGCT. New semiconductor materials for devices – Intelligent power modules- Integrated gate commutated thyristor (IGCT) - Comparison of all power devices.

UNIT IV FIRING AND PROTECTING CIRCUITS 9

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 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- Determine the suitable power semiconductor device for power electronic application.
- Analyze transient behavior of current controlled semiconductor device.
- Analyze transient behavior of voltage controlled semiconductor device.
- Design control and protection circuits for power semiconductor device.
- Analyze thermal protection and design heat sinks for reliable power electronic system.

REFERENCES

- B.W Williams ‘Power Electronics Circuit Devices and Applications’..
- Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
- MD Singh and K.B Khanchandani, “Power Electronics”, Tata McGraw Hill, 2001.
- Mohan, Undeland and Robins, “Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.
- Joseph Vithayathil, Power Electronics: Principles and Applications, Delhi, Tata McGraw- Hill, 2010.

PD18102 **ANALYSIS OF ELECTRICAL MACHINES** **L T P C**
3 0 0 3

OBJECTIVES:

- To know 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.

UNIT I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9

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 9

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 9

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 9

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 9

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 – Generalized theory of rotating electrical machine and Krons primitive machine.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the basics of magnetic circuits and calculate the energy, force and torque of electrical machine.
- Compute the mathematical equation and analyze the steady state and dynamic equation of DC machine.
- Understand the reference frame theory of transformation of three phase variables to two phase variables.
- Derive the mathematical equations using reference frame theory and analyze the steady state and dynamic operation of three-phase induction machine.
- Derive the mathematical equations using reference frame theory and analyze the steady state and dynamic operation of three-phase synchronous machines.

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
4. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, New Delhi, Prentice Hall of India, 2001

PD18103 ANALYSIS AND DESIGN OF POWER CONVERTERS **L T P C**

3 0 0 3

OBJECTIVES:

- To determine the operation and characteristics of controlled rectifiers.
- To apply switching techniques and basic topologies of DC-DC switching regulators.
- To introduce the design of power converter components.
- To provide an in depth knowledge about resonant converters.
- To comprehend the concepts of AC-AC power converters and their applications.

UNIT I SINGLE PHASE & THREE PHASE CONVERTERS 9

Principle of phase controlled converter operation – single-phase full converter and semiconverter (RL,RLE load)- single phase dual converter – Three phase operation full converter and semi-converter (R,RL,RLE load) – reactive power – power factor improvement techniques –PWM rectifiers.

UNIT II DC-DC CONVERTERS 9

Limitations of linear power supplies, switched mode power conversion, Non-isolated DCDC converters: operation and analysis of Buck, Boost, Buck-Boost, Cuk& SEPIC – under continuous and discontinuous operation – Isolated converters: basic operation of Flyback, Forward and Push-pull topologies.

UNIT III DESIGN OF POWER CONVERTER COMPONENTS 9

Introduction to magnetic materials- hard and soft magnetic materials –types of cores, copper windings – Design of transformer –Inductor design equations –Examples of inductor design for buck/flyback converter-selection of output filter capacitors – selection of ratings for devices – input filter design.

UNIT IV RESONANT DC-DC CONVERTERS 9

Switching loss, hard switching, and basic principles of soft switching- classification of resonant converters-load resonant converters – series and parallel – resonant switch converters – operation and analysis of ZVS, ZCS converters comparison of ZCS/ZVS Introduction to ZVT/ZCT PWM converters.

UNIT V AC-AC CONVERTERS 9

Principle of on-off and phase angle control – single phase ac voltage controller – analysis with R & RL load – Three phase ac voltage controller – principle of operation of cycloconverter – single phase and three phase cycloconverters – Introduction to matrix converters.

TOTAL: 45 PERIODS

OUTCOMES:

- Analyze single-phase and three-phase power converters for different loads.
- Select and design the DC-DC converter topologies for a broad range of power conversion applications.
- Identify and design the reactive components for various converter topologies.
- Design and analyze the operation of resonant converters.
- Develop the suitable AC-AC converter for industrial applications.

TEXT BOOKS:

1. Ned Mohan,T.MUndeland 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 Hall India, Third Edition, New Delhi, 2004.
3. P.C. Sen, "Modern Power Electronics", Wheeler Publishing Co, First Edition, New Delhi, 1998.

4. P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003.
5. SimonAng, Alejandro Oliva, “Power-Switching Converters, Second Edition, CRC Press, Taylor & Francis Group, 2010.
6. V. Ramanarayanan, “Course material on Switched mode power conversion”, 2007
7. Alex Van den Bossche and VencislavCekovValchev, “Inductors and Transformers for Power Electronics”, CRC Press, Taylor & Francis Group, 2005.
8. W. G. Hurley and W. H.Wolfle, “Transformers and Inductors for Power Electronics Theory, Design and Applications”, 2013 John Wiley & Sons Ltd.
9. Marian.K. Kazimierczuk and DariuszCzarkowski, “Resonant Power Converters”, John Wiley & Sons limited, 2011

PD18111 POWER ELECTRONICS CIRCUITS LABORATORY L T P C

0 0 4 2

OBJECTIVES:

- To provide an insight on the switching behaviours of power electronic switches.
- To make the students familiar with the digital tools used in the generation of gate pulses for the power electronic switches.
- 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 and dynamics of electrical machines.
- To make the students acquire knowledge on mathematical modelling of power electronic circuits and implementing the same using simulation tools.

LIST OF EXPERIMENTS

1. Study of switching characteristics of Power electronic switches i.) SCR ii.) MOSFET.
2. Single phase AC to DC Half and Fully Controlled Converter with Firing Circuit.
3. Three Phase AC to DC Half controlled Converter.
4. Three Phase AC to DC Fully Controlled Converter.
5. Study of Driver circuits and generation of PWM signals for 3Φ Inverter.
6. Generation of sine-PWM pulses for a 1Φ Voltage Source Inverter.
7. Simulation of basic power electronic circuits using MATLAB –Simulink.
   a.D.C Source fed R Load & RL Load.
   b.D.C Source fed DC motor Load.
8. Simulation of SCR based 1Φ full converter with different types of load using MATLAB –Simulink.
9. Simulation of SCR based 3Φ full converter with different types of load using MATLAB –Simulink.
10. Simulation of BUCK converterusing MATLAB – Simulink.
11. Simulation of BOOST converter using MATLAB – Simulink.
12. Simulation of 1phase Voltage Source Inverter with R & RL Load using MATLAB- Simulink.

TOTAL: 60 PERIODS

OUTCOMES:

- Analyze the switching behavior of various power electronics devices.
- Design the various power electronic circuits and experimentally analyze its performance.
- Design the pulse generation circuits for single phase and three phase inverter circuits.
- Examine the performance of various power electronic converters for any application using simulation tools.

REFERENCES

1. Ned Mohan T. M.Undelandand 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.

LIST OF EQUIPMENT:

1. Device characteristics (for SCR, MOSFET with built in / discrete power supply and meters) – 1 each
2. Single phase SCR based half controlled converter and fully controlled converter along with built-in firing circuit/module and meter – 1 each
3. IGBT based single phase PWM inverter module/Discrete Component –1
4. IGBT based Driver circuit for 3Φ Inverter –1
5. MOSFET based Driver circuit for 3Φ Inverter -1
6. DSPIC 4011 Microcontroller kit - 1
7. Digital Storage Oscilloscope –5
8. Isolation Transformer – 3
9. Single phase Auto transformer –3
10. Components (Inductance, Capacitance) 3 set for each
11. Multimeter – 5
12. LCR meter – 3
13. Rheostats of various ranges
14. Work tables – 10
15. Desktop PC with MATLAB software - 5
16. Component data sheets to be provided.

PD18112 ELECTRICAL MACHINES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To provide insight knowledge on behavior and efficiency characteristics of DC and AC motors.
- To make students familiar with the speed characteristics of DC shunt motors.
- To provide insight knowledge on calculating the behaviour of induction motor and DC shunt motor by conducting predetermination test.
- To provide requisite knowledge on the experiments on synchronous motor.

LIST OF EXPERIMENTS:

1. Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics.
2. Field Test on dc series machines.
3. Speed control of dc shunt motor by armature and field control.
4. Swinburne's Test on dc motor.
5. Retardation test on dc shunt motor.
6. Regenerative test on dc shunt machines.
7. Load test on three phase induction motor.
8. No load and Blocked rotor test on three phase induction motor to draw (i) equivalent circuit and (ii) circle diagram. Determination of performance parameters at different load conditions from (i) and (ii).
9. Load test on induction generator.
10. Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.
11. Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.
12. Conduct an experiment to draw V and inverted curves of synchronous motor at no load and load conditions.

OUTCOMES:

- Comprehensive understanding on the behaviour of AC and DC motors.
- Predetermine efficiency of induction and DC shunt motor.
- Apply speed control of DC shunt motor.
- Interpret the v and inverted v curves by conducting suitable experiments on synchronous motor.

REFERENCES

1. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall, 2001.
2. “A. E. Fritzgerald, C. Kingsley and S. Umans”, “Electric Machinary”, McGraw Hill Companies, 6th edition, 2003.
3. “Abhijith Chakrabarthi & Subitha Debnath”, “Electrical Machines”, Mc Graw Hill, 2015.

LIST OF EQUIPMENT :

1. DC Shunt Motor Coupled With DC Compound Generator – 1 no
2. DC Shunt Motor Coupled With DC Compound Generator – 1 no
3. DC Shunt Motor with loading Arrangement – 3 nos
4. DC Series Motor with loading Arrangement – 1 no.
5. Three phase induction motor – 2 no.
6. Single phase induction motor – 1 no.
7. Synchronous motor – 1 no.

8. Tachometer -Digital/Analog – 8 nos
9. Single Phase Auto Transformer –5 nos
10. Three Phase Auto Transformer – 1 No.
11. SPST switch – 3 nos
12. Wattmeter :2nos
13. Computer with Labview / Matlab software for simulation: 4 nos
14. Ammeters : 5 nos
15. Voltmeters : 10 nos
16. Rheostats : 15 nos

PD18201 ANALYSIS AND DESIGN OF INVERTERS L T P C

3 0 0 3

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 inverters for UPS, drives etc.,
- To analyse and comprehend the various operating modes of different configuration of inverters.
- To design different single phase and three phase inverters.
- To impart knowledge on multilevel inverters and modulation techniques.

UNIT I SINGLE PHASE INVERTERS 10

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.

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS 9

180˚ 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 9

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 9

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

UNIT V RESONANT INVERTERS 8

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters – power line disturbances – power conditioners – UPS: offline UPS ,online UPS.

TOTAL: 45 PERIODS

OUTCOMES:

- Expertise in the operation of inverters and modulation techniques of Voltage Source Inverters.
- Equip skills to formulate and design the inverters for generic loads and machine loads.
- Derive the PWM techniques for Current Source Inverters.
- Acquire knowledge on multilevel inverters and modulation techniques.
- Analyse resonant inverters and design of UPS.

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. MUndeland 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
   P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003

PD18202 **SOLID STATE DRIVES** **L T P C**
3 0 0 3

OBJECTIVES:

- To study and analyze the operation of the converter / chopper fed DC drives, both qualitatively
- and quantitatively.
- To familiarize the students on the operation of VSI and CSI fed induction motor drives.
- To understand the field oriented control of induction machines.
- To impart knowledge on the control of synchronous motor drives

UNIT I RECTIFIER CONTROL OF DC DRIVES **9**

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

UNIT II CHOPPER CONTROL OF DC DRIVES **9**

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 III CONTROL OF INDUCTION MOTOR DRIVES- STATOR SIDE AND ROTOR SIDE 9

AC voltage controller circuit – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed variable frequency drives – comparison 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 OF INDUCTION MOTOR DRIVES **9**

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 **9**

Wound field cylindrical rotor motor – Equivalent circuits – performance equations for operation from a voltage source – starting and braking - V curves - Self control-margin angle control-torque control-power factor control-Brushless excitation systems

TOTAL:45 PERIODS

OUTCOMES:

- Formulate, design and analyze power supplies for generic loads and machine loads.
- Acquire knowledge on the operation of VSI and CSI fed induction motor drives.
- Expertise in the field oriented control of Induction motor drives.
- Formulate the control schemes for synchronous motor drives.

REFERENCES:

1. P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 1981
2. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersy, 1989
3. Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, Second Edition ,2009
4. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2002.

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PD18203 **POWER QUALITY** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the various power quality issues.
- To understand the harmonic producing loads and its effects
- To understand the modelling of networks and components under non-sinusoidal conditions.
- To understand the passive and active compensation techniques for power quality improvement
- To understand the various custom power devices
- To understand the importance of grounding and wiring

UNIT I INTRODUCTION **9**

Power quality-voltage quality-overview of power quality phenomena- classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and recommended practices.

UNIT II HARMONICS **9**

Harmonics-individual and total harmonic distortion - RMS value of a harmonic waveform-Triplen harmonics-Inter harmonics - important harmonic introducing devices-SMPS-Three phase power converters- arcing devices- saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads- Standards on harmonics.

UNIT III MODELING OF NETWORKS AND COMPONENTS UNDER NON- SINUSOIDAL CONDITIONS **9**

Transmission and distribution systems – resonance-shunt capacitors-transformers-inrush currents-electric machines-ground systems- loads that cause power quality problems – battery chargers-arc furnaces-pulse modulated devices-adjustable speed drives.

UNIT IV POWER QUALITY IMPROVEMENT **9**

Passive compensation –Design of Passive Filter- Active Harmonic Filtering- generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory -uninterruptable power sources- constant voltage transformers - series active power filtering techniques for harmonic cancellation and isolation.

UNIT V CUSTOM POWER DEVICES **9**

Distribution Static Compensator (DSTATCOM)- Dynamic Voltage Restorers (DVR) for sag, swell and flicker problems- Unified power quality conditioner (UPQC)- -reasons for grounding - typical grounding and wiring problems -solutions to grounding and wiring problems.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the power quality terms, standards and application of expert systems to monitor power quality issues
- Analyze the power quality issues arising of DG-Utility System interface and related interconnection requirements
- Design harmonic compensators applying the concepts of instantaneous power theory
- Acquire knowledge on custom power devices for monitoring power quality.
- Identify suitable control for mitigation of power quality problems.

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1. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition)
2. R.C. Dugan, Mark.F. Mc Granaghan, Surya Santoso and H. WayneBeaty, "Electrical Power System Quality", Tata McGraw-Hill, 2004.
3. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002.
4. C. Sankran, "Power quality", CRC Press, 2002.

MC18081 INTRODUCTION TO RESEARCH METHODOLOGY AND IPR **L T P C**
2 0 0 2

OBJECTIVES:

- To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection.

UNIT I RESEARCH METHODOLOGY **6**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics

UNIT II RESULTS AND ANALYSIS **6**

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.

UNIT III TECHNICAL WRITING **6**

Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee

UNIT IV INTELLECTUAL PROPERTY RIGHTS **6**

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.

UNIT V PATENT RIGTS AND NEW DEVELOPMENTS IN IPR **6**

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.

TOTAL: 30 PERIODS

OUTCOMES:

- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, andcreativity.
- Formulate research problem formulation & Analyze research related information and Follow researchethics
- Correlate the results of any research article with other published results. Write a review article in the field ofengineering.
- Appreciate the importance of IPR and protect their intellectual property. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

REFERENCES:

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2. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

4. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International publishers, New Delhi, 2004.
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6. Robert P. Merges, Peter S. Menell and Mark A. Lemley, “Intellectual Property in New Technological Age”, Aspen Publishers, 2016.
7. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007
8. Mayall , “Industrial Design”, McGraw Hill, 1992.
9. Niebel , “Product Design”, McGraw Hill, 1974.
10. Asimov , “Introduction to Design”, Prentice Hall, 1962.

PD18211 **ELECTRICAL DRIVES LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To design and analyze various DC and AC drives.
- To generate the firing pulses for converters and inverters using digital processors
- Design of controllers for linear and nonlinear systems
- Implementation of closed loop system using hardware simulation

LIST OF EXPERIMENTS

1. Study of Thyristor controlled D.C Drive.
2. Study of Chopper Fed DC Motor.
3. Study of A.C single phase motor speed control using TRIAC.
4. PWM inverter fed three phase induction motor control using PSPICE/MATLAB/PSIM software.
5. VSI/CSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM software.
6. Study of V/f control operation of three phase induction motor.
7. Study of permanent magnet synchronous motor drive fed by PWM inverter using software.
8. Regenerative/ Dynamic breaking operation for DC motor study using software.
9. Regenerative/ Dynamic breaking operation for AC motor study using software.
10. PC/PLC based AC/DC motor control operation.
11. Study of power quality analyzer
12. Design of UPS

OUTCOMES:

- Ability to simulate different types of machines, converters in a system.
- Analyze the performance of various electric drive systems.

REFERENCES

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

LIST OF EQUIPMENT:

1. Power module for DC converter for separately excited DC machine 0.5HP Speed Sensor, display meters, controller circuit, CRO/DSO-1
2. Power module for DC chopper for separately excited DC machine 0.5HP Speed Sensor, display meters, controller circuit, CRO/DSO -1
3. IGBT inverter power module,3 phase induction motor0.5HP,V/f controller display meters CRO/DSO- 1
4. Stepper motor, PIC Micrcontroller, controller circuit , Interface circuit, CRO- 1
5. Power module, BLDC motor(0.5HP) Controller circuit, sensor circuit, display meter, CRO/DSO -1
6. SRM motor-0.5 HP, PIC DSP/TMS DSP Processor, speed sensor, Power module, Display meter, DSO- 1
7. Synchronous generator –0.5HP, Power module(MOSFET/IGBT), Controller circuit, CRO/DSO, Display meters- 1
8. Bread board, Transformer, Power switchs/module, PIC controller – each 1 set
9. Desktop PC with MATLAB Simulation software – 1

10. Single phase or three phase power quality analyzer -1
11. Digital Storage Oscilloscope –5
12. Isolation Transformer – 3
13. Single phase Auto transformer –3
14. Work tables – 10
15. Component data sheets to be provided

PD18212 MICROCONTROLLER LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To provide training on programming of microprocessors and microcontrollers and understand the interface requirements.

EXPERIMENTS ON ASSEMBLY PROGRAMMING

1. Write a program to multiplication and division using MUL and DIV instructions.
2. Write a program to transfer a block of data from internal memory to external memory.
3. Write a program to exchange two set of eight-byte data.
4. Write a program to find the sum of two numbers in decimal.
5. Write a program to convert decimal number to hexadecimal.
6. Write a program to add a number n, m number of times.
7. Write program to find the largest from a set of n numbers.
8. Write program for sorting the given set of numbers.

EXPERIMENTS ON 8051 INTERFACING

1. Write an assembly language program for generating a triangular wave.
2. Write a program to find the largest from a set of ten numbers and display it using LED.
3. Write a program to for displaying the decimal numbers in 7 Segment display.
4. Write a program to read the DIP switches for displaying the reading using 7 Segment display.
5. Write a program to rotate the given motor in clockwise direction.
6. Write a program to rotate the given motor in anticlockwise direction.
7. Write a program to generate a square wave.
8. Write a program to display a message in LCD display.

OUTCOMES:

- Apply computing platform and software for engineering problems.
- Design algorithm for microcontroller based engineering system
- Interface 8051 microcontroller with various electronic applications.
- Design controller circuit to understand and analyze, linear and digital electronic circuits.

REFERENCE BOOKS:

1.Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India,New Delhi , 2007.

2. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd. New Delhi, 2013.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.8085 Microprocessor Trainer with Power Supply
2.8051 Micro Controller Trainer Kit with power supply
3.8255 Interface board
4.8251 Interface board
5.8259 Interface board
6.8279 Keyboard / Display Interface board
7.ADC and DAC card

PD18001 **SOFT COMPUTING TECHNIQUES** **L T P C**

3 0 0 3

OBJECTIVES:

• To expose the concepts of feed forward neural networks.
• To provide adequate knowledge about feedback neural networks.
• To teach about the concept of fuzziness involved in various systems.
• To expose the ideas about genetic algorithm

UNIT I INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS 9

Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems – Single objective and multi-objective problems - Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- Mc Culloch Pitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propagation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training-applications.

UNIT II ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY 9

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

UNIT III FUZZY LOGIC SYSTEM 9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and 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.

UNIT IV GENETIC ALGORITHM 9

Evolutionary programs – Genetic algorithms, genetic programming and evolutionary programming - Genetic Algorithm versus Conventional Optimization Techniques – Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators - Optimization problems using GA-discrete and continuous – Single objective and multi-objective problems - Procedures in evolutionary programming.

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine-Evolutionary Programming-Particle Swarm Optimization – Case study – Familiarization of NN, FLC and ANFIS Tool Box.

TOTAL: 45 PERIODS

OUTCOMES:

- Analyze different types of artificial neural network and their modeling and control aspects.
- Apply artificial neural network to electrical engineering problems.
- Acquire knowledge on fuzzy systems control and apply to Electrical Engineering problems.
- Acquire knowledge on Genetic algorithm and apply to Electrical Engineering problems
- Understand and apply new computing techniques for engineering problems.

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, 2008.
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.
6. T. Ross, “Fuzzy Logic with Engineering Applications”, Tata McGraw Hill, New Delhi, 1995.
7. EthemAlpaydin, “Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)”, MIT Press, 2004.
8. Corinna Cortes and V. Vapnik, " Support - Vector Networks, Machine Learning ” 1995.

PD18002 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING **L T P C**

3 0 0 3

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 **9**

Review of basic field theory–Maxwell'sequations–ConstitutiverelationshipsandContinuityequations–Laplace, Poisson and Helmholtz equation– principle of energy conversion–force/torque calculation.

UNIT II BASIC SOLUTION METHODS FOR FIELD EQUATIONS **9**

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) **9**

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

UNIT IV COMPUTATION OF BASIC QUANTITIES USING FEM PACKAGES **9**

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

UNIT V DESIGNAPPLICATIONS **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to understand the concepts of electromagnetic.
- Acquire knowledge to design based on field analysis using boundary condition.
- Develop to formulate the FEM method.
- Learn about the computation of field quantities using FEM packages.
- Apply the concepts in the design of 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.WT row bridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley &Sons, 1993.
3. NicolaBiyanchi,"Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. NathanIda,Joao P.A.Bastos "Electromagnetics and calculation of fields" ,Springer Verlage,1992.
5. S.JSalon,"FiniteElementAnalysisofElectricalMachines"KluwerAcademicPublishers,London,1995, distributed by TBH Publishers & Distributors, Chennai, India
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press,1983.

PD18003 CONTROL SYSTEM DESIGN FOR POWER ELECTRONICS L T P C
3 0 0 3

OBJECTIVES:

- To explore conceptual bridges between the fields of Control Systems and Power Electronics
- To Study Control theories and techniques relevant to the design of feedback controllers in Power Electronics

UNIT I MODELLING OF DC-TO-DC POWER CONVERTERS 9

Modelling of Buck Converter , Boost Converter ,Buck-Boost Converter, Cuk Converter ,Sepic Converter, Zeta Converter, Quadratic Buck Converter ,Double Buck-Boost Converter, Boost- Boost Converter General Mathematical Model for Power Electronics Devices

UNIT II SLIDING MODE CONTROLLER DESIGN 9

Variable Structure Systems. Single Switch Regulated Systems Sliding Surfaces, Accessibility of the Sliding Surface Sliding Mode Control Implementation of Boost Converter ,Buck-Boost Converter, Cuk Converter, Sepic Converter, Zeta Converter, Quadratic Buck Converter, Double Buck-Boost Converter, Boost-Boost Converter

UNIT III APPROXIMATE LINEARIZATION CONTROLLER DESIGN 9

Linear Feedback Control, Pole Placement by Full State Feedback , Pole Placement Based on Observer Design ,Reduced Order Observers , Generalized Proportional Integral Controllers, Passivity Based Control , Sliding Mode Control Implementation of Buck Converter , Boost Converter ,Buck-Boost Converter

UNIT IV NONLINEAR CONTROLLER DESIGN 9

Feedback Linearization Isidori's Canonical Form ,Input-Output Feedback Linearization ,State Feedback Linearization, Passivity Based Control , Full Order Observers , Reduced Order Observers

UNIT V PREDICTIVE CONTROL OF POWER CONVERTERS 9

Basic Concepts, Theory, and Methods, Application of Predictive Control in Power Electronics, AC-DC-AC Converter System, Faults and Diagnosis Systems in Power Converters.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand an overview on modern linear control strategies for power electronics devices.
- Design appropriate controllers for modern power electronics devices.
- Learn the concept and overview on modern nonlinear control strategies for power electronics devices.
- Model modern power electronic converters for industrial applications.

REFERENCES

1. Hebertt Sira-Ramírez PhD, Ramón Silva-Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer 2012
2. Mahesh Patil, PankajRodey, "Control Systems for Power Electronics: A Practical Guide", Springer India, 2015.
3. Blaabjerg José Rodríguez, "Advanced and Intelligent Control in Power Electronics and Drives" , Springer, 2014
4. Enrique Acha, Vassilios Agelidis, Olimpo Anaya, TJE Miller, "Power Electronic Control in Electrical Systems", Newnes, 2002
5. Marija D. Aranya Chakrabortty, Marija , "Control and Optimization Methods for Electric Smart Grids", Springer, 2012.

PD18004 **ANALOG AND DIGITAL CONTROLLERS** **L T P C**
3 0 0 3

OBJECTIVES

- To provide a overview of the control system and converter control methodologies
- To provide an insight to the analog controllers generally used in practice
- To introduce Embedded Processers for Digital Control
- To study on the driving techniques, isolation requirements, signal conditioning and protection methods
- To provide a Case Study by implementing an analog and a digital controller on a
- converter

UNIT I CONTROL SYSTEM – OVERVIEW **9**

Feedback and Feed-forward control, Right Half Plane Zero, Gain margin and Phase Margin, Stability, Analysis and Transfer function of PI and PID controllers and its effects. Voltage mode control, Peak Current mode Control, Average Current mode Control for Converters – Need, advantages and disadvantages.

UNIT II ANALOG CONTROLLERS **9**

Major components of a controller – Op-Amp based PI and PID controller – Proportional, Integral and Differential gains in terms of Resistance and Capacitance, Error Amplifiers, PWM generator using Ramp or Triangular generator and comparator, and Driver, Voltage mode controller design using UC3524, Peak Current mode controller design using UC3842, Average Current mode controller design using UC3854.

UNIT III DIGITAL CONTROLLERS **9**

Micro Controllers and Digital Signal Controllers for Converter Control Application, Interface Modules for Converter Control – A/D, Capture, Compare and PWM, Analog Comparators for instantaneous over current detection, interrupts, Discrete PI and PID equations, Algorithm for PI and PID implementation, Example Code for PWM generation.

UNIT IV SIGNAL CONDITIONING, DRIVER, ISOLATION AND PROTECTION **9**

Voltage feedback sensing circuits, Hall effect sensors and Shunts for current feedback sensing, Low offset Op-Amps for signal conditioning, Single and dual supply op-amps, Totem pole drivers, Need for isolated drivers, Optically isolated drivers, low side drivers, high side drivers with bootstrap power supply, Vce sat sensing, CT based Device current sensing and pulse blocking.

UNIT V CONTROLLER IMPLEMENTATION **9**

Analog and Digital Controller Design for Buck Converter – Power circuit transfer function and bode plot, PI controller bode plot, Combined bode plot with required Gain and Phase margins, Implementation of Analog controller and Digital controller.

TOTAL : 45 PERIODS

OUTCOMES:

- Identify the effect of PID controllers in system stability.
- Design and apply analog controller for applications.
- Design and apply Digital controller for applications.
- Design suitable signal conditioning circuits and drivers for hardware.
- Implement controller design in hardware.

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REFERENCES

1. I.J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International Publishers
2. TI Application notes, Reference Manuals and Data Sheets.
3. Agilent Data Sheets
4. Microchip Application notes, Reference Manuals and Data Sheets.

PD18005 **FLEXIBLE AC TRANSMISSION SYSTEMS** **L T P C**
3 0 0 3

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 **9**

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) **9**

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) **9**

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 **9**

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 **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

- Realize the concept of reactive power compensation and operating principles of various types of FACTS controllers
- Model Static VAR Compensator and apply to the transmission lines
- Model and apply Thyristor Controlled Series Capacitor for power flow control
- Model voltage source converter based facts controllers and apply to the transmission lines
- Analyze the interactions among various FACTS Controllers

REFERENCES

1. A.T.John, “Flexible AC Transmission System”, Institution of Electrical and Electronic Engineers (IEEE), 1999.
2. NarainG.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,

PD18006 MODERN RECTIFIERS AND RESONANT CONVERTERS L T P C
3 0 0 3

OBJECTIVES:

- To gain knowledge about the harmonics standards and operation of rectifiers in CCM & DCM.
- To analyze and design power factor correction rectifiers for UPS applications.
- To know the operation of resonant converters for SMPS applications.
- To carry out dynamic analysis of DC- DC Converters.
- To introduce the source current shaping methods for rectifiers

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS 9

Average power-RMS value of waveform– Effect of Power factor-. current and voltage harmonics – Effect of source and load impedance - AC line current harmonic standardsIEC1000-IEEE 519-CCM and DCM operation of single phase full wave rectifier- Behavior of full wave rectifier for large and small values of capacitance - CCM and DCM operation of three phase full wave rectifier- 12 pulse converters - Harmonic trap filters.

UNIT II PULSE WIDTH MODULATED RECTIFIERS 9

Properties of Ideal single phase rectifiers-Realization of nearly ideal rectifier-. Single-phase converter systems incorporating ideal rectifiers - Losses and efficiency in CCM high quality rectifiers -single-phase PWM rectifier -PWM concepts - device selection for rectifiers – IGBT based PWM rectifier, comparison with SCR based converters with respect to harmonic content -applications of rectifiers.

UNIT III RESONANT CONVERTERS 9

Soft Switching - classification of resonant converters - Quasi resonant converters- basics of ZVS and ZCS-half wave and full wave operation (qualitative treatment) - multi resonant converters - operation and analysis of ZVS and ZCS multi resonant converter - zero voltage transition PWM converters -zero current transition PWM converters

UNIT IV DYNAMIC ANALYSIS OF SWITCHING CONVERTERS 9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter and an ideal Cuk Converter. Pulse Width modulation - Voltage Mode PWM Scheme - Current Mode PWM Scheme - design of PI controller.

UNIT V SOURCE CURRENT SHAPING OF RECTIFIERS 9

Need for current shaping - power factor - functions of current shaper - input current shaping methods - passive shaping methods -input inductor filter - resonant input filter – active methods - boost rectifier employing peak current control - average current control – Hysteresis control- Nonlinear carrier control.

TOTAL: 45 PERIODS

OUTCOMES:

- Apply the concept of various types ofrectifiers.
- Simulate and design the operation of resonant converter and itsimportance.
- Identify the importance of linear system, state space model, PIcontroller.
- Design the DC power supplies using advancedtechniques.
- Understand the standards for supply current harmonics and itssignificance.

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1. Robert W. Erickson and Dragon Maksimovic, “Fundamentals of Power Electronics” ,Second Edition, Springer science and Business media, 2001.
2. William Shepherd and Li zhang, “Power Converters Circuits”, Marceld Ekkerin,C, 2005.
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PD18007 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY L T P C
3 0 0 3

OBJECTIVES:

- To provide fundamental knowledge on electromagnetic interference and electromagnetic compatibility.
- To study the important techniques to control EMI and EMC.
- To expose the knowledge on testing techniques as per Indian and international standards in EMI measurement.

UNIT I INTRODUCTION 9

Definitions of EMI/EMC -Sources of EMI- Inter systems and Intra system- Conducted and radiated interference- Characteristics - Designing for electromagnetic compatibility (EMC)- EMC regulation typical noise path- EMI predictions and modeling, Cross talk - Methods of eliminating interferences.

UNIT II GROUNDING AND CABLING 9

Cabling- types of cables, mechanism of EMI emission / coupling in cables –capacitive coupling inductive coupling- shielding to prevent magnetic radiation- shield transfer impedance, Grounding – safety grounds – signal grounds- single point and multipoint ground systems hybrid grounds- functional ground layout – grounding of cable shields- -guard shields- isolation, neutralizing transformers, shield grounding at high frequencies, digital grounding- Earth measurement Methods

UNIT III BALANCING, FILTERING AND SHIELDING 9

Power supply decoupling- decoupling filters-amplifier filtering –high frequency filtering- EMI filters characteristics of LPF, HPF, BPF, BEF and power line filter design -Choice of capacitors, inductors, transformers and resistors, EMC design components -shielding – near and far fields shielding effectiveness- absorption and reflection loss- magnetic materials as a shield, shield discontinuities, slots and holes, seams and joints, conductive gaskets-windows and coatings - grounding of shields

UNIT IV EMI IN ELEMENTS AND CIRCUITS 9

Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive inter modulation, transients in power supply lines, EMI from power electronic equipment, EMI as combination of radiation and conduction

UNIT V ELECTROSTATIC DISCHARGE, STANDARDS AND TESTING TECHNIQUES 9

Static Generation- human body model- static discharges- ESD versus EMC, ESD protection in equipments- standards – FCC requirements – EMI measurements – Open area test site measurements and precautions- Radiated and conducted interference measurements, Control requirements and testing methods

TOTAL : 45 PERIODS

OUTCOMES:

- Identify the sources of Conducted and radiated EMI in Power Electronic Converters and consumer appliances.
- Analyze and suggest remedial measures to mitigate the problems.
- Assess the insertion loss and design EMI filters to reduce the loss
- Design EMI filters, common-mode chokes and RC-snubber circuits measures to keep the interference within tolerable limits

REFERENCES

1. V.P. Kodali, "Engineering Electromagnetic Compatibility", S. Chand, 1996
2. Henry W.Ott, " Noise reduction techniques in electronic systems", John Wiley & Sons, 1989
3. Bernhard Keiser, "Principles of Electro-magnetic Compatibility", Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987
4. Bridges, J.E Milleta J. and Ricketts.L.W, "EMP Radiation and Protective techniques", John Wiley and sons, USA 1976.
5. William Duff G., & Donald White R. J, "Series on Electromagnetic Interference and Compatibility", Vol.
6. Weston David A., "Electromagnetic Compatibility, Principles and Applications", 1991.

PD18008 **MEMS FOR POWER ELECTRONICS CIRCUITS** **L T P C**
3 0 0 3

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 through exposure to
- different MEMS and NEMS devices

UNIT I MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS **9**

Overview of micro fabrication – Silicon and other material based fabrication processes – Silicon plasma etching for micromachining- Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION **9**

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators – Applications – Inter digitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors.

UNIT III PIEZOELECTRICSENSINGANDACTUATION **9**

Piezoelectric effect - cantilever piezo electric actuator model- properties of piezo electric materials-Applications. Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys – Piezo resistive sensors

UNIT IV MICROMACHINING AND PASSIVE COMPONENTS **9**

Anisotropic Wet etching – Dry and Deep Reactive ion Etching- Isotropic Wet Etching – Surface micromachining- Passive components: Inductor, Capacitor and Switches

UNIT V DC-DC CONVERTERS IN CMOS **9**

Monolithic DC-DC Converters: CMOS technology and the Challenges - Monolithic Converter Components: 3D Air core Inductor, Capacitor and Switches - Measuring DC-DC converters- Case Study Monolithic integrated Buck and Boost Converters

TOTAL: 45 PERIODS

OUTCOMES:

- Utilize the microfabrication technology available in the market.
- Design electrostatic MEMS sensors and actuators.
- Design piezoelectric MEMS sensors and actuators
- Design and analyze micromachining to realize active and passive electrical components
- Realize monolithic DC-DC converter on a chip.

REFERENCES:

1. Chang Liu, ‘Foundations of MEMS’, Pearson Education Inc., 2012.
2. Boston , “Micro machined Transducers Source book”,WCB McGraw Hill, 1998.
3. M.H.Bao “Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 2000.
4. P. RaiChoudry“ MEMS and MOEMS Technology and Applications”, PHI, 2012.
5. Stephen D. Senturia, “Micro system Design”, Springer International Edition, 2011

PD18009 DISTRIBUTED GENERATION AND MICROGRID L T P C
3 0 0 3

OBJECTIVES

- To illustrate the concept of distributed generation
- To analyze the impact of grid integration.
- To study concept of Micro grid and its configuration

UNITI INTRODUCTION 9

Conventional power generation: advantages and disadvantages, Energy crises, Non conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

UNIT II DISTRIBUTED GENERATIONS (DG) 9

Concept of distributed generations, topologies, selection of sources, regulatory standards/framework, Standards for interconnecting Distributed resources to electric power systems: IEEE1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

UNIT III IMPACTOFGRIDINTEGRATION 9

Requirement for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system :reliability, stability and power quality issues.

UNIT IV BASICS OFA MICROGRID 9

Concept and definition of micro grid, micro grid drivers and benefits, review of sources of micro grids, typical structure and configuration of a micro grid, ACandDC micro grids, Power Electronics interfaces in DC and AC micro grids.

UNIT V CONTROLANDOPERATION OFMICROGRID 9

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti islanding schemes: passive, active and communication based techniques ,microgrid communication infrastructure, Power quality issues in micro grids, regulatory standards, Micro grid economics, Introduction to smart micro grids.

TOTAL: 45 PERIODS

OUTCOMES:

- Acquire knowledge on the various schemes of conventional and non conventional power generation.
- Identify the topologies and energy sources of distributed generation.
- Formulate the requirements for grid interconnection and its impact with NCEsources.
- Analyse the concept of Microgrid over conventional grid.
- Select and design suitable control of microgrid.

REFERENCES

1. Amir naser Yezdani, and RezaIravani,“VoltageSourceConvertersinPowerSystems:Modeling,Control and Applications”, IEEEJohnWileyPublications,2010.
2. DorinNeacsu,“PowerSwitchingConverters:MediumandHighPower”,CRCPress,Taylor&Francis, 2006
3. Chetan Singh Solanki, “Solar Photo-Voltaics”, PHI learning Pvt. Ltd., NewDelhi,2009
4. J.F.Manwell, J.G.Mc Gowan “Wind Energy Explained, theory design and applications”, Wiley publication2010.
5. D.D. Halland R. P. Grover,“Biomass Regenerable Energy”, JohnWiley, NewYork,1987.
6. John T widelland TonyWeir, “Renewable Energy Resources” Taylor and Francis Publications, Second edition 2006.

PD18010 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION L T P C
3 0 0 3

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 9

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 THYRISTOR BASED HVDC CONVERTERS AND HVDC SYSTEM CONTROL 9

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-Valve tests

UNIT III MULTITERMINAL DC SYSTEMS 9

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 9

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 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Understands the principle and types of HVDC system.
- Identify and Analyze suitable converters for HVDC system.
- Analyze the methodologies for control of HVDC converters.
- Acquire knowledge on MTDC system and the HVDC system simulation.
- Model HVDC system and run power flow analysis.

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 J.Arrillaga, , “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983
3. Erich Uhlmann, “ Power Transmission by Direct Current”, BS Publications, 2004.
4. V.K.Sood ,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.

PD18011 SOLAR AND ENERGY STORAGE SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To Study about solar modules and PV system design and their applications
- To Deal with grid connected PV systems
- To Discuss about different energy storage systems]

UNIT I INTRODUCTION 9
Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection

UNIT II STAND ALONE PV SYSTEM 9
Solar modules – storage systems – power conditioning and regulation - MPPT- protection – stand alone PV systems design – sizing

UNIT III GRID CONNECTED PV SYSTEMS 9
PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance **-** International PV programs.

UNIT IV ENERGY STORAGE SYSTEMS 9
Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage.

UNIT V APPLICATIONS 9
Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

TOTAL: 45 PERIODS

OUTCOMES:

- Acquire knowledge on behavioral properties solar energy storagesystems
- Design a standalone PVsystem
- Analyse the issues in grid connected PVsystems
- Identify suitable energy storage systems based on performance
- Examine the different applications of solar energy.

REFERENCES

1. Solanki C.S., “Solar Photovoltaics: Fundamentals, Technologies And Applications”, PHI Learning Pvt. Ltd.,2015.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, “Applied Photovoltaics”,2007, Earthscan, UK. Eduardo Lorenzo G. Araujo, “Solar electricity engineering of photovoltaic systems”, Progensa,1994.
3. Frank S. Barnes & Jonah G. Levine, “Large Energy storage Systems Handbook”, CRC Press, 2011.
4. McNeils, Frenkel, Desai, “Solar & Wind Energy Technologies”, Wiley Eastern, 1990 5 S.P. Sukhatme , “Solar Energy”, Tata McGraw Hill,1987.

PD18012 WIND ENERGY CONVERSION SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

UNIT II WIND TURBINES 9

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.

UNIT III FIXED SPEED SYSTEMS 9

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 9

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 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Acquire knowledge on aerodynamics and wind energy power conversion.
- Design wind turbines and its associated control.
- Model the fixed speed wind energy conversion systems.
- Analyse the variable speed wind energy conversion systems.
- Examine Grid integration issues and impact of WECS on power system.

REFERENCE:

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

PD18013 ENERGY MANAGEMENT AND AUDITING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the need for energy auditing.
- To understand of various loads involved based on power consumption for auditing.
- To Know about different audit instruments used in practice.

UNIT I INTRODUCTION 9

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 9

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 9

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

UNIT IV METERING FOR ENERGY MANAGEMENT 9

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 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Acquire the background required for engineers to meet the role of energy managers and to acquire the skills and techniques required to implement energy management.
- Analyze the basic concepts of economic analysis and load management.
- Identify the energy management strategies on various electrical equipments.
- Explore the concepts of metering and metering location and techniques.
- Analyse the concept of lighting systems, light sources and various forms of cogeneration

REFERENCE:

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, “Guide to Energy Management”, Fifth Edition, The Fairmont Press, Inc., 2006
2. Eastop T.D & Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, 1990.
3. Reay D.A, “Industrial Energy Conservation”, 1st edition, Pergamon Press, 1977.
4. “IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities”, IEEE, 1996
5. Amit K. Tyagi, “Handbook on Energy Audits and Management”, TERI, 2003.

PD18014 ELECTRIC VEHICLES AND POWER MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the concept of electrical vehicles and its operations.
- To understand the need for energy storage in hybrid vehicles.
- To provide knowledge about various possible energy storage technologies that can be used in electric vehicles.

UNIT I ELECTRIC VEHICLES AND VEHICLE MECHANICS 9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

UNIT II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS 9

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT III CONTROL OF DC AND AC DRIVES 9

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives.

UNIT IV BATTERY ENERGY STORAGE SYSTEM 9

Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries.

UNIT V ALTERNATIVE ENERGY STORAGE SYSTEMS 9

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors.

TOTAL: 45 PERIODS

OUTCOMES:

- Comprehend the architecture of Electric Vehicles and vehicle mechanics
- Analyze different propulsion technology used for electric vehicle application.
- Design a control methodology for DC/AC Drives used in electric vehicle
- Identify, select and model suitable battery for EV applications
- Select and analyze different energy storage technology used for electric vehicle application.

REFERENCE:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2010.

PD18015 NON LINEAR DYNAMICS FOR POWER ELECTRONIC CIRCUITS **L T P C**
3 0 0 3

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 analyze the non linear phenomena in DC to DC converters.
- To analyze 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 9

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 9

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 9

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 9

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

UNIT V CONTROL OF CHAOS 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Identify & analyze various phenomena of non linear dynamics.
- Investigate various phenomena of non linear dynamics.
- Examine the behavior of non-linearity in DC-DC Converters
- Acquire knowledge on the non-linear phenomena in drives..
- Select and design suitable control for non linear phenomena.

REFERENCES

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

PD18016 **SMART GRID** **L T P C**
3 0 0 3

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 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES 9

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 9

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 9

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.

TOTAL: 45 PERIODS

OUTCOMES:

- Develop more understanding on the concepts of Smart Grid and its presentdevelopments.
- Study about different Smart Gridtechnologies.
- Acquire knowledge about different smart meters and advanced meteringinfrastructure.
- Knowledge on power quality management in SmartGrids
- Develop more understanding on LAN, WAN and Cloud Computing for Smart Gridapplications.

REFERENCES

1 Stuart Borlase “Smart Grid :Infrastructure, Technology and Solutions”, CRC Press 2012.

2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley 2012.

3. Vehbi C. Güngör, DilanSahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: Communication 38 Technologies and Standards” IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.

4. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grids, vol. 14, 2012.

PD18017 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 9

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 9

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

UNIT III POWER ELECTRONICS FOR SOLAR 9

Block diagram of solar photo voltaic system: line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV POWER ELECTRONICS FOR WIND 9

Three phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM cnverters, matrix converters- Stand alone operation of fixed and variable speed wind energy conversion systems- Grid connection Issues -Grid integrated PMSG and SCIG Based WECS.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- Attain knowledge of power generation methods using different renewable energy sources.
- Analyze the operation of electrical machines for wind energy conversion systems
- Design and analyze different power converter circuits applicable to solar and wind systems
- Acquire knowledge on the need for hybridization of renewable energy systems.

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical 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.

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5. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
6. B.H.Khan, "Non-conventional Energy sources", Tata McGraw-hill Publishing Company.
7. P.S.Bimbhra,"Power Electronics",Khanna Publishers, 3rd Edition,2003.
8. Fang Lin Luo Hong Ye, "Renewable Energy systems", Taylor & Francis Group, 2013.

PD18018 **ROBOTICS AND CONTROL** **L T P C**
3 0 0 3

OBJECTIVES:

1. To introduce robot terminologies and robotic sensors.
2. To educate direct and inverse kinematic relations.
3. To educate on formulation of manipulator Jacobians and introduce path planning techniques.
4. To educate on robot dynamics.
5. To introduce robot control techniques.

UNIT I INTRODUCTION AND TERMINOLOGIES 9

Definition-Classification-History- Robots components-Degrees of freedom-Robot joints- coordinates-Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors-proximity and range sensors- vision system-social issues.

UNIT II KINEMATICS 9

Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics solution and programming-degeneracy and dexterity

UNIT III DIFFERENTIAL MOTION AND PATH PLANNING 9

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian- Robot Path planning

UNIT IV DYNAMIC MODELLING 9

Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton- Euler formulation – Inverse dynamics

UNIT V ROBOT CONTROL SYSTEM 9

Linear control schemes- joint actuators- decentralized PID control- computed torque control – force control-hybrid position force control- Impedance/ Torque control.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the components and basic terminology ofRobotics.
- Model the motion of Robots and analyze the workspace and trajectorypanningofrobots.
- Develop application basedRobots.
- Formulate models for the control of mobile robots in various industrialapplications.
-

REFERENCES

1. R.K. Mittal and I J Nagrath, “Robotics and Control”, Tata MacGraw Hill, Fourth edition.
2. Saeed B. Niku, ‘Introduction to Robotics ", Pearson Education, 2002.
3. Fu, Gonzalez and Lee Mcgrahill ,"Robotics ", international edition.
4. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering, An Integrated approach”, Prentice Hall of India, 2003.

PD18019 **NON LINEAR CONTROL** **L T P C**
3 0 0 3

OBJECTIVES:

- To impart knowledge on phase plane analysis of non-linear systems.
- To impart knowledge on Describing function based approach to non-linear systems.
- To educate on stability analysis of systems using Lyapunov's theory.
- To educate on stability analysis of systems using Lyapunov's theory.
- To introduce the concept of sliding mode control.

UNIT I PHASE PLANE ANALYSIS 9

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits- Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems- Existence of Limit Cycles. simulation of phase portraits in Matlab.

UNIT II DESCRIBING FUNCTION 9

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions- Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension- Existence of Limit Cycles- Stability of limit Cycles. simulation of limit cycles in Matlab.

UNIT III LYAPUNOV THEORY 9

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunov's Direct Method-Positive definite Functions and Lyapunov Functions-Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunov's Direct Method- Krasovski's Method-Variable Gradient Method-Physically – Control Design based on Lyapunov's Direct Method.

UNIT IV FEEDBACK LINEARIZATION 9

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation-Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non- Minimum-Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design. Simulation of tracking problems in Matlab.

UNIT V SLIDING MODE CONTROL 9

Sliding Surfaces- Continuous approximations of Switching Control laws- The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in Matlab.

TOTAL : 45 PERIODS

OUTCOMES:

- Identify the properties of non-linear control system and analyzing methods.
- Construct the phase plane and analyzethe stability of non linear system.
- Derive describing function and analyze the stability of non linear system.
- Apply Lyapunov method of stability analysis.
- Acquire knowledge on Feedback linearization and sliding mode control for SISO & MIMO systems.

REFERENCES

1. J A E Slotine and W Li, Applied Nonlinear control, PHI, 1991.
2. K. P. Mohandas, Modern Control Engineering, Sanguine, India, 2006
3. Hasan Khalil, “Nonlinear systems and control”, Prentice Hall.
4. S H Zak, “Systems and control”, Oxford University Press, 2003.
5. Torkel Glad and Lennart Ljung, “Control Theory – Multivariable and Nonlinear Methods”,Taylor&Francis, 2002.
6. G. J. Thaler, “Automatic control systems”, Jaico publishers, 2006.

PD18020 **SPECIAL ELECTRICAL MACHINES** **L T P C**

3 0 0 3

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 **9**

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

UNIT II PERMANENT MAGNET SYNCHROUNOUS MOTORS **9**

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 **9**

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

UNIT IV STEPPER MOTORS **9**

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

UNIT V OTHER SPECIAL MACHINES **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

- Design a stepper motor drive for an application.
- Learn the principle and characteristics of a synchronous reluctance motor drive.
- Configure a switched reluctance motor drive for an application.
- Understand the operation and control of a PMBLDC motor drive.
- Learn the operation and control of a permanent magnet synchronous motor drive

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.T.Kenjo, ‘ Stepping motors and their microprocessor controls’, Oxford University press, New Delhi, 2000
3. T.Kenjo and S.Nagamori, ‘Permanent magnet and Brushless DC motors’, Clarendon press, London, 1988
4. R.Krishnan, ‘ Electric motor drives’ , Prentice hall of India,2002.
5. D.P.Kothari and I.J.Nagrath, ‘ Electric machines’, Tata Mc Graw hill publishing company, New Delhi, Third Edition, 2004.
6. Irving L.Kosow, “Electric Machinery and Transformers” Pearson Education, Second Edition, 2007.

PD18021 **SYSTEM THEORY** **L T P C**
3 0 0 3

OBJECTIVES:

- To educate on representing systems in state variable form
- To educate on solving linear and non-linear state equations
- To exploit the properties of linear systems such as controllability and observability
- To educate on stability analysis of systems using Lyapunov's theory
- To educate on modal concepts and design of state and output feedback controllers and estimators.

UNIT I STATE VARIABLE REPRESENTATION **9**

Introduction-Concept of State-State equations for Dynamic Systems - Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment – free and forced responses- State Diagrams.

UNIT II SOLUTION OF STATE EQUATIONS **9**

Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- System modes- Role of Eigen values and Eigen vectors.

UNIT III STABILITY ANALYSIS OF LINEAR SYSTEMS **9**

Controllability and Observability definitions and Kalman rank conditions -Stabilizability and detectability-Test for Continuous time Systems- Time varying and Time invariant case- Output Controllability-Reducibility- System Realizations.

UNIT IV STATE FEEDBACK CONTROL AND STATE ESTIMATOR **9**

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.

UNIT V LYAPUNOV STABILTY ANALYSIS **9**

Introduction-Equilibrium Points- BIBO Stability-Stability of LTI Systems- Stability in the sense of Lyapunov - 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 – Krasovskil's and Variable-Gradiant Method.

TOTAL : 45 PERIODS

OUTCOMES:

- Represent the time-invariant systems in state variableforms
- Solve non linear and linear state equations
- Analyze whether the system is stabilizable, controllable, observable anddetectable.
- Design state feedback controller and stateobservers
- Analyze the stability of certain class of non-linearsystem.

TEXT BOOKS:

1. M. Gopal, "Modern Control System Theory", New Age International, 2005.
2. K. Ogatta, "Modern Control Engineering", PHI, 2002.
3. D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.
4. John J. D'Azzo, C. H. Houpis and S. N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Taylor Francis, 2003.
5. 5.C.T. Chen, "Linear Systems Theory and Design'' Oxford University Press, 3rd Edition,1999.

REFERENCE BOOKS

1. Z. Bubnicki, ”Modern Control Theory”, Springer, 2005.
2. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999.
3. M. Vidyasagar, “Nonlinear Systems Analysis’, 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey.

PD18213 **MINI PROJECT** **L T P C**
0 0 4 2

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification till the successful solution of the same.
- To train the student in preparing project reports and to face reviews and viva voce examination.

A PROJECT TO BE DEVELOPED BASED ON RESEARCH CARRIED OUT IN THE FIELD OF "POWER ELECTRONICS AND DRIVES".

MODALITIES OF EXECUTION:

1. Students should select a problem which addresses some research related topics on the related his subjects.
2. The Power Electronics and Drives application to different fields.
3. Students should understand and analyze the problem with practically.
4. Both Simulation and Hardware work must be carried out by students individually.
5. A Final review (40 Marks) will be conducted where a report (20 Marks) and circuit with working condition (40 Marks) need to be submitted.
6. Each student has to work on a single mini project.

TOTAL: 60 PERIODS

OUTCOME:

Students will be able to

- Acquire practical knowledge within the chosen area of technology during project development.
- Identify and analyze the technical aspects of the chosen project with a comprehensive and systematic approach.
- Reproduce, improve and refine technical aspects of the projects.
- Work as an individual for technical projects.
- To present and prepare report effectively for the project.

PD18311 **PROJECT WORK PHASE I** **L T P C**
0 0 12 6

OBJECTIVES:

- Encourage student to take up research in power electronics and drives, and provide an optimal solution for the same through simulation and hardware implementation.
- Submission of a detailed report on the research topic.

DESCRIPTION:

The project topic should be selected to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity so that this will reduce the gap between the institution and industry.

The thesis should have the one of the following

- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industrial need
- Problems of national importance
- Research and development in power electronics and drives domain

The student should complete the following:

- Motivation and Research problem
- Literature survey
- Gap identification and Objectives/Problem definition
- Preliminary design / feasibility / modular approaches
- Software simulation and hardware implementation
- Report and presentation

GUIDELINES FOR THESIS

Thesis is a yearlong activity, to be carried out and evaluated in two phases.

- The thesis may be carried out in-house i.e. department's laboratories and centers OR industry.
- After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the particular areas' In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.

OUTCOMES:

- Demonstrate a depth of knowledge in Power Electronics and Drives.
- Demonstrate knowledge of contemporary issues in their chosen field of research.
- Demonstrate an ability to present and defend their research work to a panel of experts.

PD18411	PROJECT WORK PHASE II	L	T	P	C
		0	0	28	14

OBJECTIVES:

- Encourage student to take up research in power electronics and drives, and provide an optimal solution for the same through simulation and hardware implementation.
- Complete an independent research project, resulting in at least a thesis publication, and research outputs in terms of publications in high impact factor journals, conference proceedings, and patents.
- Submission of a detailed report on the research topic.

DESCRIPTION:

The project topic should be selected to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity so that this will reduce the gap between the institution and industry.

The thesis should have the one of the following

- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industrial need
- Problems of national importance
- Research and development in power electronics and drives domain

The student should complete the following:

- Motivation and Research problem
- Literature survey
- Gap identification and Objectives/Problem definition
- Preliminary design / feasibility / modular approaches
- Software simulation and hardware implementation
- Report and presentation

The thesis phase II is based on a report prepared by the students on thesis allotted to them.

The viva-voce examination will be based on the following.

- Modeling and Simulation of Electrical System.
- Hardware implementation.

GUIDELINES FOR THESIS

Thesis is a yearlong activity, to be carried out and evaluated in two phases i.e.

- During phase – II, student is expected to exert on design, simulation and hardware implementation of the proposed work. Accomplished results/contributions/innovations should be published in terms of research papers in reputed peer reviewed journals and conferences or IP/Patents.
- Phase – II deliverables: A thesis report as per the specified format, developed system in the form of hardware and/or software, A record of continuous progress.
- Phase – II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, and viva-voce. In case of unsatisfactory performance, committee may recommend for extension or repeating the work

OUTCOMES:

- Demonstrate a depth of knowledge in Power Electronics and Drives.
- Demonstrate knowledge of contemporary issues in their chosen field of research.
- Demonstrate an ability to present and defend their research work to a panel of experts