SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

M.Tech. (Full Time) - Power Electronics and Drives
Curriculum & Syllabus
2013 – 2014

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
FACULTY OF ENGINEERING AND TECHNOLOGY
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203

Sl. No	Category	Credits				
		I Semester	**II Semester**	**III Semester**	**IV Semester**	**Category Total**
1	Core courses	12 (3 courses)	12 (3 courses)	---	---	**24**
2	Program Elective courses	18 (in I to III semesters)			---	**18**
3	Interdisciplinary elective courses– mandatory	3 (in I or II or III semester)				**3**
4	Supportive courses – mandatory	3 (in I or II or III semester)			---	**3**
5	Seminar	1	---	---	---	**1**
7	Industrial Training (during summer vacation between II and III semesters)	---	---	1	---	**1**
8	Project work	---	---	06	16	**22**
					Total	**72**

Total credits to be earned for the award of M.Tech degree – 72

PROGRAM CORE COURSES

Course Code	Name of the course	L	T	P	C
PE2001	Analysis of Power Converters	3	0	2	4
PE2002	Analysis of Inverters	3	0	2	4
PE2003	Solid State DC Drives	3	0	2	4
PE2004	Solid State AC Drives	3	0	2	4
PE2005	Advanced Electrical Drives	3	0	2	4
PE2006	Power Electronics in Renewable Energy Systems	3	0	2	4
PE2046	Seminar	0	0	1	1
PE2048	Industrial Training	0	0	1	1
PE2049	Project Work Phase I	0	0	12	6
PE2050	Project Work Phase II	0	0	32	16

PROGRAM ELECTIVES COURSES

Course Code	Name of the course	L	T	P	C
PE2101	Modeling of Electrical Machines	3	0	0	3
PE2102	Digital Controllers for Power Electronic Applications	3	0	0	3
PE2103	Flexible AC Transmission Systems	3	0	0	3
PE2104	Intelligent Controllers	3	0	0	3
PE2105	High Voltage Direct Current Transmission	3	0	0	3
PE2106	Power Quality	3	0	0	3
PE2107	Digital Signal Processing	3	0	0	3
PE2108	Design of Controllers in Power Applications	3	0	0	3
PE2109	Distributed Control System	3	0	0	3
PE2110	MEMS	3	0	0	3
PE2111	Advanced Power Semiconductor Devices	3	0	0	3
PE2112	Special Machines and their Controllers	3	0	0	3
PE2113	Optimization Techniques in Power Electronics	3	0	0	3

PE2114	Software Tool for Power Electronic Applications	3	0	0	3
PE2115	SMART GRID Design and Analysis	3	0	0	3

PROGRAM SUPPORTIVE COURSES

Course Code	Name of the course	L	T	P	C
MA2008	Applied Mathematics for Electrical Engineers	3	0	0	3
PS2201/PE2201	Object Oriented Programming Applications	3	0	0	3
PS2202/PE2202	Computer Networks	3	0	0	3

CONTACT HOUR/CREDIT:

L: Lecture Hours per weekT: Tutorial Hours per week

P: Practical Hours per week C: Credit

PROGRAM CORE COURSES

		L	T	P	C
PE2001	**ANALYSIS OF POWER CONVERTERS**	**3**	**0**	**2**	**4**
	Total Contact Hours – 75				

PURPOSE	
To motivate the students to develop the knowledge about various configurations of rectifiers, DC choppers, AC voltage converters and frequency converters	
INSTRUCTIONAL OBJECTIVES	
1.	To know the operation and steady state analysis of single phase, three phase controlled rectifiers with R, RL and RLE Load..
2.	To develop the knowledge on commutation circuits, ringing circuits, step up and step down choppers.
3.	To know the operation of ac voltage converters and cycloconverters.

UNIT I - SINGLE PHASE AC-DC CONVERTERS (15 hours)
Analysis of switched circuits- Half wave and Full wave controlled rectifier with RL, RLE load – Continuous and discontinuous operation modes of operation – Dual converter-Performance analysis, Harmonics, ripple, distortion, power factor-Effect of source inductance-Simulation on Single phase, half wave, semi converter and full converters-Hardware implementation of single phase controlled rectifiers.

UNIT II - THREE PHASE AC-DC CONVERTERS (15 hours)
Fully controlled converter with R, RL, RLE loads,dual converter–performance parameters – effect of source impedance and over lap – 12 pulse converters-software simulation.

UNIT III - DC-DC CONVERTER (15 hours)
Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters –- Resonant and quasi – resonant converters-sepic converters – super lift converters-zeta converters-Applications-Software Simulation.

UNIT IV - AC VOLTAGE CONTROLLERS **(15 hours)**
Principle of on-off , phase control **-** Analysis of single phase and three phase controllers R and RL loads. Performance parameters- Software Simulation.

UNIT V - FREQUENCY CONVERTERS **(15 hours)**
Principle of operation – Single phase and three phase cycloconverters – power factor control-Forced commutated cycloconverters-matrix converters - Software simulation.

REFERENCES

1. Rashid M.H., "*Power Electronics Circuits, Devices and Applications*", Prentice Hall India, Third Edition, New Delhi, 2011.
2. P.C. Sen, "*Modern Power Electronics*", Wheeler Publishing Co, Third edition, New Delhi, 2008.
3. Ned Mohan, Undeland and Robbin, "*Power Electronics: converters, Application and design*", John Wiley and sons.Inc, Newyork,Reprint - 2009.
4. Cyril W.Lander, "*Power electronics*", Third Edition, McGraw hill- 1993.

		L	T	P	C
PE2002	**ANALYSIS OF INVERTERS**	**3**	**0**	**2**	**4**
	Total Contact Hours – 75				

PURPOSE	
The purpose of this course is to provide an understanding of steady state analysis and operating principle of DC-AC Converters. In addition, the course is expected to develop design and analyze the various inverter's with hardware model.	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the distinct operations of various inverter circuits
2.	To design the various types of inverter circuits and apply these circuits to practical applications
3.	To develop the various inverters in simulation and hardware.

UNIT I - VOLTAGE SOURCE INVERTERS (9 hours)

Single phase and 3-phase voltage source inverters. Analysis of single phase VSI - Operation of single phase and 3-phase McMurray and McMurray Bedford inverters.

UNIT II - CURRENT SOURCE INVERTERS (9 hours)

Operation of single phase and three phase CSI with ideal switches - Operation of single phase capacitor commutated CSI Operation and analysis of Auto sequential commutated inverter.

UNIT III - MULTILEVEL INVERTERS (9 hours)

Operation Analysis of Basic Series Inverter -Basic parallel inverter, Multilevel concept - Types- comparison and application of multilevel inverters

UNIT IV - HARMONIC ELIMINATION AND PWM TECHNIQUES (9 hours)

Output voltage control and Harmonic Neutralization - Analysis of single pulse, multiple pulse, Sinusoidal PWM techniques. Harmonic Reduction using multiple commutation, stepped wave inverters, operation of LC harmonic filter, Resonant arm harmonic filter.

UNIT V RESONANT INVERTERS (9 hours)

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

UNIT VI - SIMULATION AND HARDWARE ANALYSIS (30 hours)

Analysis of series and parallel inverter, VSI, CSI, Multi- level inverter using simulation techniques and its implementation using hardware.

REFERENCES

1. Rashid M.H., "*Power Electronics Circuits, Devices and Applications*", Prentice Hall India, Third Edition, New Delhi, 2011.
2. Bimal K Bose, "*Modern Power Electronics and AC Drives*", Pearson Education, second Edition, 2003.
3. Dubey. G.K., "*Thyristorised power controllers*", New age International, New Delhi, 2002.
4. Bhimbhra P.S., "*Power Electronics*", Khanna Publishers, New Delhi, 2005.

5. P.C. Sen, "*Modern Power Electronics*", Wheeler Publishing Co, Third edition, New Delhi, 2008.
6. Ned Mohan, Undeland and Robbin, "*Power Electronics: converters, Application and design*", John Wiley and sons.Inc, Newyork, Reprint 2009.
7. Jai P.Agrawal, "*Power Electronics Systems*", Pearson Education, Second Edition, 2002.

		L	T	P	C
PE2003	**SOLID STATE DC DRIVES**	**3**	**0**	**2**	**4**
	Total Contact Hours - 75				
PURPOSE					
The purpose of this course is to enable the students to have a fair knowledge about the solid state control of DC drives.					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the concepts of converter, chopper fed DC Motor drives				
3.	To acquire knowledge about closed loop control of DC Drives				
4.	To get ideas about digital control of DC drives				
5.	To gain experimental knowledge about hardware implementation				

UNIT I – DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS (9 hours)

DC motor-Types, induced emf, speed-torque relations; Speed Control – Armature and Field speed control; Ward Leonard Control – Constant torque and horse power applications

Characteristics of mechanical system – dynamic equations, components of torque, types of load; requirements of drives characteristics – multi-quadrant operation; drive elements, types of motor duty and selection of motor rating.

UNIT II – CONVERTER FED DC MOTOR DRIVES (9 hours)

Principle of phase control – Fundamental relations; analysis of series and separately excited DC motor with single-phase, three-phase and Twelve Pulse Converters – waveforms, performance parameters, performance characteristics.

Continuous and discontinuous armature current operations; current ripple and its effect on performance; operation with freewheeling diode; implementation of braking schemes; drive employing dual converter; Applications.

UNIT III – CHOPPER FED DC MOTOR DRIVES (9 hours)

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

UNIT IV– CLOSED LOOP CONTROLLED DC MOTOR DRIVES (9 hours)

Modeling of drive elements – Equivalent circuit, transfer function of self, separately DC motors; Linear transfer function model of power converters; sensing and feedback elements – closed loop speed control – current and speed loops, P, PI and PID Controllers – response comparison. Simulation of converter and chopper fed dc drive.

UNIT V– DIGITAL CONTROL OF DC DRIVES (9 hours)

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

LABORATORY EXPERIMENTS (30 hours)

1. DC Shunt Motor Speed control using Single Phase Full Wave Converter
2. DC Shunt Motor Speed control using Single Phase Half Wave Converter
3. DC Shunt Motor Speed control using Three Phase Full Wave Converter
4. DC Shunt Motor Speed control using Three Phase Half Wave Converter
5. DC Shunt Motor Speed control using Single Quadrant Chopper
6. DC Shunt Motor Speed control Motor using Four Quadrant Chopper

REFERENCES

1. Gopal Dubey, "*Power semiconductor controlled Drives*", Prentice Hall Inc., New Jersey, 1989.
2. R.Krishnan, "*Electric Motor Drives- Modeling, Analysis and Control*", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
3. Werner Leonhard, "*Control of Electrical Drives*", 3rd Edition, Springer, Sept., 2001.

PE2004	**SOLID STATE AC DRIVES**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**
	Total Contact Hours - 75				

PURPOSE	
The purpose of this course is to enable the students to have a fair knowledge about the Solid state control of AC drives.	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the concepts of stator side speed controlled induction motor drives
2.	To acquire knowledge about the concepts of rotor side speed controlled induction motor drives
3.	To get an idea about the concepts of Field oriented controlled Induction Motor Drives
4.	To learn and understand the concepts of Synchronous motor drives
5.	To gain experimental knowledge about hardware implementation

UNIT I – STATOR VOLTAGE CONTROL (8 hours)

Torque Slip Characteristics - operation with different types of loads – performance - Comparison of different ac power controllers – Speed reversal - Closed loop control – Simple problems.

UNIT II – STATOR FREQUENCY CONTROL (9 hours)

Operation of induction motor with non-sinusoidal supply waveforms – variable frequency operation of three phase induction motors, constant flux operation – current fed operation – dynamic and regenerative braking of CSI and VSI fed drives – Simple problems.

UNIT III – ROTOR RESISTANCE CONTROL (10 hours)

Torque slip characteristics - speed control through slip - rotor resistance control-chopper controlled resistance - equivalent resistance - TRC strategy - characteristic relation between slip and chopper duty ratio - combined stator voltage control and rotor resistance control - design solutions - closed loop control scheme - Slip power recovery - torque slip characteristics - power factor considerations – sub and super synchronous operation - design solutions - closed loop control scheme.

UNIT IV – FIELD ORIENTED CONTROL (9 hours)

Dynamic Modeling of Induction Machines – Introduction to Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation using voltage model and current model equations – merits and demerits.

UNIT V– SPEED CONTROL OF SYNCHRONOUS MOTOR DRIVES (9 hours)

Need for leading PF operation - open loop VSI fed drive - group drive applications. Self control - margin angle control - torque angle control - power factor control - simple design examples - Closed loop speed control scheme with various power controllers - starting methods - brush less excitation systems.

LABORATORY EXPERIMENTS (30 hours)

1. Speed Control of Three Phase Induction Motor using AC Voltage Controller
2. Speed Control of Three Phase Induction Motor using Cycloconverter
3. Speed Control of Three Phase Induction Motor using Three Phase Inverter
4. Speed Control of Single Phase Induction Motor using Inverter
5. Speed Control of Slip Ring Induction Motor using Chopper

REFERENCES

1. Gopal Dubey, "*Power semiconductor controlled drives*", Prentice Hall Inc., New Jersey, 1989.
2. R.Krishnan, "*Electric motor drives- modeling, analysis and control*", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
3. Bimal K.Bose, "*Modern power electronics and AC drives"*, Pearson Education (Singapore) Ltd., New Delhi, 2005.
4. Murphy J.M.D, Turnbull, F.G, "*Thyristor control of AC motor*", Pergamon press, Oxford, 1988

		L	T	P	C
PE2005	**ADVANCED ELECTRICAL DRIVES**	**3**	**0**	**2**	**4**
	Total Contact Hours – 75				

PURPOSE	
To create awareness among the students regarding the recent trends in electrical drives	
INSTRUCTIONAL OBJECTIVES	
1.	To get idea about functional considerations regarding switching converters and their applications to variable frequency drive

2.	To acquire knowledge of fuzzy logic and neural network concepts in various drives

UNIT I - INTRODUCTION TO POWER CONVERTERS FOR ELECTRIC DRIVES (15 hours)

Switching converters and their applications to variable frequency drives - Power electronic converters for control of amplitude-AC variable frequency drives - Mathematical representation of switching functions- reduction of switching losses in practical switches. MATLAB simulation -study on 'D0Q' transformation in various frames of reference. Free acceleration characteristics of Induction motor from 'D0Q' model viewed from various reference frames

UNIT II - FIELD ORIENTATED CONTROL & VECTOR CONTROL (15 hours)

Field oriented control of induction machines - Theory – DC drive analogy – Vector control concept- Direct or Feedback vector control - Indirect or Feed forward vector control – Flux vector estimation - Space vector modulation control-PWM current control- MATLAB simulation direct & indirect vector control induction motor- closed loop speed control of VVVF PMAC motor drive & FPGA based closed loop control of BLDC motor drive.

UNIT III – SENSORLESS CONTROL OF AC DRIVES (15 hours)

Introduction to sensorless control of AC drives – Advantages – speed estimation methods-State synthesis method – model reference adaptive system – observer based techniques -MATLAB simulation model reference adaptive system for speed estimation

UNIT IV- DIRECT TORQUE CONTROL (15 hours)

Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy – optimum switching vector selection – reduction of torque ripple methods- adaptive control. MATLAB simulation-open loop control-DTC of induction motor drive-adaptive control

UNIT V-SRM DRIVE & ITS CONTROLLER (15 hours)

SRM configuration and its controller design - converter topologies - control strategies- Sensorless control. Principles of fuzzy logic control and neural network - Design methodology and block diagram implementation of DC drive and vector controlled induction motor. Recent trends in fuzzy control of electrical drives. MATLAB simulation - Fuzzy logic speed control of three phase induction motor drive - Adaptive speed control for induction motor drives using neural network.

REFERENCES

1. Bimal.K. Bose, "*Power Electronics and Variable frequency drives*", Standard Publishers Distributors, New Delhi, 2000.
2. Dubey G.K., "*Power Semiconductor controlled drives*", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey, 1989.
3. Murphy J.M.D, Turnbull, F.G, "*Thyristor control of AC motor*", Pergamon press, Oxford, 1988.
4. Sheperal, Wand Hully, L.N. "*Power Electronic and Motor control*" Cambridge University Press Cambridge, 1987.
5. Dewan, S. Slemon B., Straughen, A. G.R., "*Power Semiconductor drives*", John Wiley and Sons, NewYork, 1984.

		L	T	P	C
PE2006	**POWER ELECTRONICS IN RENEWABLE ENERGY SYSTEMS**	**3**	**0**	**2**	**4**
	Total Contact Hours - 75				
PURPOSE					
To create awareness among the students about the role of power electronic controllers in renewable energy systems.					
INSTRUCTIONAL OBJECTIVES					
1.	To educate scientifically the new developments in non conventional and renewable energy studies .				
2.	To emphasize the significance of power electronic converters in renewable energy systems.				

UNIT I- INTRODUCTION (15 hours)

Recent trends in energy consumption - World energy scenario - Energy sources and their availability - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems - need to develop new energy technologies.

Modeling of renewable energy sources-PV array, Wind Electric generators , Fuel cells etc in MATLAB/PSCAD Simulink environment

UNIT II- SOLAR ENERGY CONVERSION (15 hours)

Photovoltaic Energy Conversion: Working principle – Energy conversion – Maximum power tracker – Photovoltaic system components – Factor influencing output – System design – Power electronics for photovoltaic power systems - DC Power conditioning converters - AC power conditioners - Line commutated inverters - synchronized operation with grid supply - Harmonic problem –Applications.

Modeling and simulation various power converters for PV fed applications. Experimental verifications PV characteristic curves.

UNIT III- WIND ENERGY CONVERSION (15 hours)

Wind Energy Conversion Systems: Basic principle of wind energy conversion - nature of wind - Wind survey in India - Power in the wind - Components of a wind energy conversion system - Performance of Induction Generators for WECS –IG-SCIG-PMSG - Classification of WECS – Power electronics converter for variable speed wind turbines –Matrix - Multilevel converters for very high power wind turbines – Future trends

Modeling of power generators like IG –SCIG-PMSG for Wind Energy Conversion System(WECS) Modeling and simulation of power converters – multilevel – matrix and other contemporary topologies

UNIT IV- FUEL CELL POWER ELECTRONICS FOR DISTRIBUTED GENERATION (DG) (15 hours)

Fuel Cell - Working Principle – Distributed generation – Fuel cell based energy system for DG – Power electronic topologies for residential stationary fuel cell energy systems –Issues in fuel cell power conditioning system – Energy management system issues –Auxiliary storage

Modeling of Fuel cell, power extraction for fuel cell, Stand alone fuel cell system with consumer/load

UNIT V- HYBRID RENEWABLE ENERGY SYSTEMS (15 hours)

Need for Hybrid Systems- Types of Hybrid system-optimization of system components in hybrid power system -Various power quality issues hybrid renewable power system . Modeling and simulation of hybrid renewable power system in MATLAB/PSCAD .Simulation and study of various power quality problems in hybrid /renewable energy power system

REFERENCES

1. Rashid .M. H, "*Power Electronics Hand book*", Academic press, Second edition, 2006.
2. Rai. G.D, "*Solar energy utilization*", Khanna publishes, 1993.
3. Gray, L. Johnson, "*Wind energy system*", prentice hall linc, 1995.
4. Rai,G.D., "*Non- conventional resources of energy*", Khanna publishers, Fourth edition, 2010.
5. Rao. S. & Parulekar, "*Energy Technology*", Khanna publishers, Fourth edition, 2005.
6. Pai, B. R. and Ram Prasad, "*Power Generation through Renewable Sources of Energy*", Tata McGraw Hill, New Delhi, 1991.
7. Bansal, Kleeman and Meliss, "*Renewable Energy Sources and Conversion Techniques*", Tata Mc Graw Hill, 1990.
8. Godfrey Boyl, "*Renewable Energy: Power sustainable future*", Oxford University Press, Third edition, 2012.
9. B.H.Khan, "*Non-Conventional Energy Resources*", The McGraw Hills, Second edition, 2009.
10. John W Twidell and Anthony D Weir, "*Renewable Energy Resources*", Taylor and Francis, 2006.
11. L.L. Freris, "*Wind Energy Conversion systems*", Prentice Hall, UK, 1990.

PE2046	**SEMINAR**	**L**	**T**	**P**	**C**
		0	**0**	**1**	**1**
	Total Contact Hours – 15				
PURPOSE					
To expose the communication of the students by conducting seminar					
INSTRUCTIONAL OBJECTIVES					
1.	To motivate the students to attain the confidence and competence.				

- The students are asked to give a seminar on the recent trends in the field of electrical engineering on an individual basis and evaluation will be done by a panel of faculty members. So this course has no credits and no end semester examination. It is only a pass/fail course. However this course is mandatory and the student has to pass the course to become eligible for the award of degree.

PE2048	INDUSTRIAL TRAINING (Training to be undergone during II semester vacation)	L	T	P	C
		0	0	1	1

PURPOSE	
To provide hands-on experience at industry or a company where Power Electronics Engineering projects are carried out.	
INSTRUCTIONAL OBJECTIVES	
1.	Students have to undergo one week practical training in Power Electronics Engineering related project at industry or a company so that they become aware of the practical application of theoretical concepts studied in the class rooms.

- Students have to undergo one week practical training in Power Electronics Engineering related project at industry or a company of their choice but with the approval of the department. At the end of the training student will submit a report as per the prescribed format to the department.

Assessment process

This is pass (P) / Fail (U) course and no grade point will be awarded. However this course is mandatory and the student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made and award either a P or U. The student with 'U' grade will redo the training.

PE2049	PROJECT WORK PHASE I	L	T	P	C
		0	0	12	6

INSTRUCTIONAL OBJECTIVES	
1.	To impart the practical knowledge to the students and also to make them to carry out the technical procedures in their project work. To provide an exposure to the students to refer, read and review the research articles, journals and conference proceedings relevant to their project work and placing this as their beginning stage for their final presentation.

- Every student has to identify the project supervisor (guide) based on their thrust area of research. He/She has to give the objectives of the project work and the detailed work plan. The project topic will be approved by the project evaluation committee. The committee will assess/review the work done by them by conducting periodical reviews. He/She has to submit a project report at the end of the semester. The grades will be awarded based on their performance in the internal reviews and the viva voce exam conducted at the end of the semester. The topic should be in the recent trends in the field of Power Electronics engineering.

PE2050	PROJECT WORK PHASE II	L	T	P	C
		0	0	32	16
INSTRUCTIONAL OBJECTIVES					
1.	This enables and strengthens the students to carry out the project on their own and to implement their innovative ideas to forefront the risk issues and to retrieve the hazards by adopting suitable assessment methodologies and stating it to global.				

- Usually the student has to continue the work carried out in Phase I. The student's performance will be evaluated by conducting periodical reviews by the committee members nominated by the head of the department.
- The end semester examination/ viva voce will be conducted by the External/Internal Examiner nominated by the controller of examinations. Due weight age & considerations will be given in the internal marks for the project work presented in conferences/ Journals.

PROGRAM ELECTIVE COURSES

PE2101	MODELING OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3
	Total Contact Hours - 45				

PURPOSE	
To enable the students acquire a comprehensive idea on various aspects of electrical machines modeling.	
INSTRUCTIONAL OBJECTIVES	
1.	To acquire the knowledge about linear transformations on generalized machine theory and steady state analysis of various electrical machines
2.	To get an idea about Park's transformation, Transformed impedance matrix and restrictions on generalized machine theory

UNITI– REFERENCE FRAME THEORY (9 hours)

Theory of transformation – Phase transformation and commutator transformation – Invariance of Power - Static and rotating reference frames – balanced steady-state voltage and torque equations using transformation theory.

UNIT II– MODELLING OF DC MACHINES (9 hours)

Separately excited DC machines- DC series, shunt and compound machines-speed-torque characteristics - Steady state and transient analysis - Computer simulation

UNIT III – MODELLING OF POLY PHASE INDUCTION MACHINES (9 hours)

Induction machines – Equivalent circuit – Complete speed-torque characteristics - Voltage and torque equations in static and rotating reference frames – Analysis of steady state and dynamic operations – Induction machine dynamics during starting and braking, accelerating time, under normal conditions - Computer simulation

UNIT IV – MODELLING OF SYNCHRONOUS MACHINES (9 hours)

Synchronous machines – Voltage and torque equations in static and rotating reference frames - Equivalent circuit – Phasor equations - Phasor diagrams - Power angle characteristics - Machine reactance and time constants - – Analysis of steady state and dynamic operations – Synchronous machine dynamics under unbalanced/fault conditions - Computer simulation.

UNIT V – SINGLE PHASE INDUCTION MACHINES AND AC COMMUTATOR MACHINES (9 hours)

Single phase induction motors – Resolving field theory-Equivalent circuit – Cross field theory- Starting methods-Maximum starting torque condition

AC commutator machines: modeling of AC series motor **–** Analysis of repulsion motor, Schrage motor using generalized theory.

REFERENCES

1. Paul C.Krause, OlegWasyzczuk, Scott D.Sudhoff "*Analysis of Electric Machinery and Drive Systems*" IEEE Press, Second Edition, 2002.
2. Krishnan. R., " *Electric Motor Drives, Modeling, Analysis and Control*", Prentice Hall of India, 2002.
3. Samuel Seely, "*Electromechanical Energy Conversion*", Tata McGraw Hill Publishing Company, 2000.
4. Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D.Umans, "*Electric Machinery*", Tata McGraw Hill, 5th Edition, 1992.
5. Bimbhra P.S., "*Generalized theory of Electrical Machines*", Khanna Publishers, 1995.
6. Ned Mohan, "*Advanced Electric Drives, Analysis, Control and Modelling using Simulink*", MNPERE, 2001.

PE2102	**DIGITAL CONTROLLERS FOR POWER ELECTRONIC APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Total Contact Hours -45				
PURPOSE					
To learn the concept of digital principles, digital instrumentation setup to control various power electronics based drives and the recent trends in digital instrumentation.					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the operation and applications of FPGA , DSP, Virtual instrumentation				

UNIT I –DIGITAL SIGNAL PROCESSORS (9 hours)

Introduction to the DSP core and code generation, The components of the DSPcore, Mapping external devices to the core , peripherals and Peripheral Interface ,System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using DSP, Instruction Set, Software Tools. Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General-purpose I/O Control

Registers .Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.
Review of power electronic converters for drive control, VSI fed IM Drive, Drive configuration, Commutation at different speed, control structure. DSP Based Scalar control of Induction motor drive

UNIT II- FIELD PROGRAMMABLE GATE ARRAYS (9 hours)

RTL Design – simulation and synthesis - Combinational logic – Types – Operators –Packages – Sequential circuit – Sub-programs – Test benches. (Examples: adders, counters, flipflops, FSM, Multiplexers / Demultiplexers).
Overview of Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA ,Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) , overview of Spartan 3E and Virtex III pro FPGA boards- case study
Controlled Rectifier, Switched Mode Power Converters, PWM Inverters, DC motor control, Induction Motor Control using Virtex III pro FPGA boards

UNIT III – VIRTUAL INSTRUMENTATION (9 hours)

Introduction of LabView,Virtual instrumentation – Definition, flexibility – Block diagram and architecture of virtual instruments – Virtual instruments versus traditional instruments – Review of software in virtual instrumentation - VI programming techniques – VI , sub VI, loops and charts ,arrays, clusters and graphs, case and sequence structures, formula nodes, string and file input /output

UNIT IV - DATA ACQUISITION SYSTEM (9 hours)

Basic structures, the GUI, Controls and Indicators, Debugging, XY Graphs Using Pre-written VIs Software as Virtual Instrument (VI) object, Front Panel Controls, Indicators,Block Diagram arithmetic and logic functions, Data Acquisition System - Elements of data acquisition systems, Block diagram and details of computerized data acquisition systems.
Control of Electric drive using LabView – 4 Quadrant operation of DC Motor, Design of Current controller and Speed controller for VSI fed Induction motor Drive

UNIT V – SIGNAL CONDITIONING (9 hours)

Signal Conditioning - Necessity, Instrumentation amplifiers, and chopper stabilized amplifiers, Impedance converters, Noise problems, shielding and grounding. Concept of filters, Dynamic compensation, Linearization, Concept of A/D and D/A Converters (voltage to frequency and frequency to voltage converter) sample/hold amplifiers, Microprocessor applications in signal conditioning.

REFERENCES

1. Hamid.A.Toliyat and Steven G.Campbell, *"DSP Based Electro Mechanical Motion Control"*, CRC Press New York, 2004.
2. Wayne Wolf, *"FPGA based system design"*, Prentice hall, 2004.
3. Bhasker J., VHDL Primer, Prentice Hall.
4. Robert H. Bishop, "*University of Texas at Austin*", Learning with Lab VIEW 7 Express.
5. ISBN-10: 0131176056, ISBN-13: 9780131176058, Publisher: Prentice Hall.
6. TMS320C240, *"User's Guide – Preliminary"*, Texas Instruments, 1996.
7. Farzad Nekoogar, Genemoriarty, *"Digital control using DSP"*, Prentice Hall Pvt.Ltd, 1999.
8. Hamid.A.Toliyat and Steven G.Campbell, *"DSP Based Electro Mechanical Motion Control"*, CRC Press New York, 2004.
9. Douglas Perry, *"VHDL Programming by example"*, Tata McGraw Hill.
10. Eugene D.Fabricius, *"Introduction to VLSI Design"*, Tata McGraw Hill.
11. Texas Instruments, *"Digital Signal Processing Solution for AC Induction Motor"*, Application Note BPRA043.
12. Rick Bitter, TaqiMohiuddin and Matt Nawrocki, *"Labview Advanced Programming Techniques"*, CRC Press, Second Edition, 2007.

<table>
<tr><td rowspan="3">PE2103</td><td colspan="2" rowspan="2">FLEXIBLE AC TRANSMISSION SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="2">Total Contact Hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">PURPOSE</td></tr>
<tr><td colspan="7">To enable the students gain a fair knowledge on the concepts and technology of flexible AC transmission systems.</td></tr>
<tr><td colspan="7">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="6">To understand the need for FACTS</td></tr>
<tr><td>2.</td><td colspan="6">To learn shunt and series compensation techniques</td></tr>
<tr><td>3.</td><td colspan="6">To learn about controlled voltage and Phase angle regulator</td></tr>
<tr><td>4.</td><td colspan="6">To learn the concept of unified power flow controller</td></tr>
</table>

UNIT I – INTRODUCTION (9 hours)

Electrical transmission network – Need of transmission interconnections – power flow in AC systems – power flow and dynamic stability considerations – Relative importance of controllable parameters – Basic types of FACTS controllers Brief description & & definitions – Benefits from FACTS technology.

UNIT II – STATIC VAR COMPENSATOR (SVC) (9 hours)

Introduction to shunt compensation – Objectives of Shunt compensation – Voltage control by SVC – VI characteristics – advantages of slope in dynamic characteristics – Influence of SVC on system voltage, SVC applications: Steady state power transfer capacity – enhancement of transient stability – Prevention of voltage instability – Augmentation of power system damping.

UNIT III – THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) (9 hours)

Introduction to series compensation – Objectives of series compensation – Operation of TCSC: Different modes of operation – Modeling of TCSC: variable reactance model, Transient stability model – TCSC applications: Improvement of system stability limit – enhancement of system damping: Sub Synchronous Resonance (SSR) mitigation – voltage collapse prevention – NGH scheme.

UNIT IV – EMERGING FACTS CONTROLLERS (9 hours)

Basic concept of voltage source converters and current source converter - SSSC – principle of operation – Applications , STATCOM – principle of operation – VI characteristics – Applications – UPFC: - Modes of operation – Applications – Introduction to IPFC – Operating principles.Comparison of SVC and STATCOM.

UNIT V – STATIC VOLTAGE AND PHASE ANGLE REGULATOR (9 hours)

Objectives of voltage and phase angle regulators – Power flow control by PAR – Real and Reactive loop power flow control – Improvement of transient stability – PHR – power oscillation damping with PAR – Approaches to thyristor controlled voltage and phase angle regulators – Continuously controllable thyristor tap changer – Thyristor top changer with direct control – FACT controller interactions.

REFERENCES

1. Narain G.Hingorani and Laszl Gyugyi, "*Understanding FACTS – Concept & technology of flexible AC transmission systems*", standard publishers distributors, IEEE press, 2001.
2. R.Mohan Mathur & Rajiv K. Varma, "*Thyristor – Based FACTS controllers Electrical transmission systems*", Wiley inter science publications, 2002.
3. Enrique Acha, Claudio R.Fuerte – Esquivel, Hygo Ambriz – Perez & Cesar Angeles – Camacho, "*FACTS – modeling and simulators in power networks*", John wiley & sons, 2004.
4. A.T. John, "*Flexible AC transmission systems*", institution of electrical and electronics engineers, IEEE Press, 1999.

<table>
<tr><td rowspan="3">PE2104</td><td rowspan="2">INTELLIGENT CONTROLLERS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Total Contact Hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">To enable the students to apply the neural networks, Genetic algorithms & fuzzy logic concepts in power Systems and electronics systems.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To learn the basic knowledge regarding activation function, learning rules and various neural networks.</td></tr>
<tr><td>2.</td><td colspan="5">To understand the knowledge of crisp set, fuzzy set and Fuzzy logic controllers.</td></tr>
<tr><td>3.</td><td colspan="5">To apply the Genetic algorithms in the tuning of controllers</td></tr>
<tr><td>4.</td><td colspan="5">To design controllers using Simulation Software fuzzy logic toolbox & NN tool box.</td></tr>
</table>

UNIT I - NEURAL NETWORKS (9 hours)

Neural Networks – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised & Unsupervised learning – perceptron network- linear separability – back propagation networks algorithms-Radial basis function networks.

UNIT II - ASSOCIATIVE MODELS AND CONTROL SCHEMES IN NN (9 hours)

Auto & hetero associative memory – bi-directional associative memory – Self organizing feature maps-Hopfield networks-Neural Networks for non – linear system – Schemes of Neuro control – System identification – forward model and – Inverse model – Case studies.

UNIT III - FUZZY LOGIC AND ITS CONTROLLERS (9 hours)

Fuzzy set - Crisp set – vagueness – uncertainty and imprecision – fuzzy set – fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relations – fuzzy Cartesian product and composition – composition of fuzzy relations-Fuzzy to crisp conversion –structure of fuzzy logic controller – database – rule base – Inference engine.

UNIT IV - GENETIC ALGORITHMS (9 hours)

Genetic Algorithms: Working principles – terminology – Importance of mutation – comparison with traditional methods – constraints and penalty function – GA operators – Real coded GAs.

UNIT V - APPLICATIONS (9 hours)

Applications of Neural network, Fuzzy system & Genetic algorithms for power systems and power electronics systems-Designing of controllers using Simulation Software, NN tool box & Fuzzy Logic Toolbox.

REFERENCES

1. Lawrence Fausatt, "*Fundamentals of neural networks*", Prentice Hall of India, New Delhi, 1994.
2. Timothy J. Ross, "*Fuzzy Logic with Engineering Applications*", McGraw Hill International Edition, USA, 1997.
3. Bart kosko, " *Neural Networks and Fuzzy Systems*", Prentice Hall of India, New Delhi, 1994.
4. Jack M.Zurada, "*Introduction to Artificial Neural Systems*", Jaico publishing house 2006.
5. Zimmerman H.J. "*Fuzzy set theory – and its applications*", Kluwer Academic Publishers 1994.
6. Simon Haykin, "*Neural Networks – A comprehensive foundation*", Pearson Education Asia, 2002.
7. Kalyanmoy Deb, "*optimization for engineering design*", prentice hall of India first edition,1988.
8. David E.Goldberg, "*Genetic Algorithms in search,optimization and machine learning*", pearson edition 1989 first edition and 2009 fourth reprint.

<table>
<tr><td rowspan="2">PE2105</td><td rowspan="2">HIGH VOLTAGE DIRECT CURRENT TRANSMISSION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>Total Contact hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td>PURPOSE</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">To enable the students gain a fair knowledge on the concepts High voltage DC transmission systems.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To impart knowledge on operation, modelling and control of HVDC link.</td></tr>
<tr><td>2.</td><td colspan="5">To perform steady state analysis of AC/DC system.</td></tr>
<tr><td>3.</td><td colspan="5">To expose various HVDC simulators.</td></tr>
</table>

UNIT I - DC POWER TRANSMISSION TECHNOLOGY (9 hours)

Introduction - Comparison of AC and DC transmission – Application of DC transmission –Classifications of DC transmission system - Planning for HVDC transmission – Modern trends in DC transmission – DC breakers – Cables, VSC based HVDC. Comparison of Line Commutated Converter (LCC) link and Voltage Source Converter (VSC) link

UNIT II-ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL (9hours)

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

UNIT III - MULTITERMINAL DC SYSTEMS AND HARMONICS (9 hours)

Introduction – Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems- parallel operation of AC and DC transmission. Harmonics on AC and DC sides – Filters.

UNIT IV - POWER FLOW ANALYSIS IN AC/DC SYSTEMS (9 hours)

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow - Solution of AC-DC power flow - Case studies.

UNIT V - STABILITY ANALYSIS OF HVDC SYSTEMS (9 hours)

Introduction – System simulation tools – Modelling of HVDC systems for digital dynamic simulation – Dynamic interaction between DC and AC systems– inclusion of HVDC model in Small Signal Stability (SSS) algorithm – inclusion of HVDC model in transient stability algorithm and voltage stability analysis.

REFERENCES

1. K.R.Padiyar, "*HVDC Power Transmission Systems*", New Age International (P) Ltd., New Delhi, 2002.
2. J.Arrillaga, "*High Voltage Direct Current Transmission*", Peter Pregrinus, London, 1983.
3. P. Kundur, "*Power System Stability and Control*", McGraw-Hill, 1993.
4. Erich Uhlmann, " *Power Transmission by Direct Current*", BS Publications, 2004.
5. V.K.Sood, "*HVDC and FACTS controllers – Applications of Static Converters in Power System*", Kluwer Academic Publishers, April 2004.
6. Jos Arrillaga, Liu Y.H. and Neville R.Watson, "*Flexible Power Transmission: The HVDC Options*", Wiley Publishers, 2007.

		L	T	P	C
PE2106	**POWER QUALITY**	**3**	**0**	**0**	**3**
	Total Contact Hours - 45				
PURPOSE					
To study the various issues affecting Power Quality, monitoring, analysis and mitigation methods To know the various power quality enhancement methodologies					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the various power quality characterizations, sources of issues, their mitigation and monitoring.				
2.	To understand the effects of various power quality phenomena in various equipments.				

UNIT I - INTRODUCTION (9 hours)

Power Quality definition, PQ characterization: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation–Power acceptability curves:

CBEMA, ITIC – Sources for Electric Power Quality problem in power system: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards and Guidelines.

UNIT II - SHORT-DURATION & LONG DURATION VOLTAGE VARIATIONS (9 hours)

Voltage Sags - Magnitude & duration-Types- Sources of sags - Estimation of Voltage sag performance: Transmission system and Utility distribution system, Effect of sag on AC Motor Drives, Single-Phase Domestic and Office Loads, Monitoring and mitigation of voltage sag. Origin of Long & Short interruption -influence on various equipments-Basic reliability indices related interruption-monitoring and mitigation of interruption.

UNIT III - PQ ANALYSIS METHODS AND HARMONICS (9 hours)

Measurements of Voltage, Current, Power, Energy, power factor- Time domain methods and Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform.

Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads.

UNIT IV - POWER QUALITY MONITORING AND ANALYSIS (9 hours)

Monitoring considerations: Power line disturbance analyzer, power quality measurement
equipment, harmonic / spectrum analyzer, flicker meters, disturbance analyzer.

Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples

UNIT V - ENHANCEMENT OF POWER QUALITY (9 hours)

Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters –Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method – Custom power park –Status of application of custom power devices.

REFERENCES

1. Math H.J.Bollen, "*Understanding Power Quality Problems-Voltage sag & Interruptions*", IEEE Press, 2000.
2. Arindam Ghosh, "*Power Quality Enhancement Using Custom Power Devices*", Kluwer Academic Publishers, 2002.
3. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, "*Electrical Power Systems Quality*", McGraw Hill, 2003.
4. G.T.Heydt, "*Electric Power Quality*", Stars in a Circle Publications, (2nd edition), 1994.
5. Jos Arrillaga, Neville R. Watson, "*Power System Harmonics*" - John Wiley & Sons.

PE2107	**DIGITAL SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Total Contact Hours- 45				

PURPOSE	
To familiarize the students with the most important application oriented concept of digital signal processing.	
INSTRUCTIONAL OBJECTIVES	
1.	To understand basic concepts of Digital Signal Processing
2.	To gain knowledge on the related mathematical tools
3.	To design and analyze digital filters
4.	To have better knowledge about DSP controllers

UNIT I - SIGNALS AND SYSTEMS **(9 hours)**
Characteristics and classification of signals – Representation and classification of Discrete time systems – Advantages of Digital Signal processing – transfer function – Z-transform, inverse Z-transform and its applications – convolution.

UNIT II – FOURIER TRANSFORM **(9 hours)**
Introduction to analysis of analog and discrete signals – Fourier series, Fourier transform – Discrete Fourier Transform (DFT) properties of DFT – Computation of discrete Fourier transforms – Radix - 2 FFT algorithms.

UNIT III – REALIZATION OF FILTERS **(9 hours)**
Realization of FIR and IIR Filters – Impulse invariance and Bilinear transform methods of IIR filter design – Design of FIR filter using windows – Comparison of IIR and FIR Digital filters. Effects of coefficient on

Quantization – Finite register length effects in realizations of Digital filters and discrete Fourier transform computation.

UNIT IV – DSP CONTROLLERS (9 hours)
Introduction to TMS DSP controllers – C2xx DSP CPU and instruction set – Mapping external devices to the C2xx core and the peripheral interface – General purpose Input/Output functionality – Interrupts – ADC – Event Managers.

UNIT V – DSP BASED APPLICATIONS (9 hours)
DSP based – Implementation of DC-DC Boost converters – Control of stepper motors – Permanent magnet Brushless DC machines – Vector control of Induction motors.

REFERENCES

1. Oppenheim, Alan V., Schafer, Ronald W. "*Digital Signal Processing*", Prentice Hall of India Pvt. Ltd., 2nd ed. 2002.
2. John G. Proakis, Dimitris G. Manoiaias, "*Digital Signal Processing*", Prentice Hall of India Pvt. Ltd., 3rd ed. 2000.
3. Hamid A. Toliyat, Steven G. Campell, "*DSP-Based Electromechanical Motion Control (Power Electronics and Applications Series)*", CRC press, 2004.
4. Sanjit K. Mitra, "*Digital Signal Processing*", Tata McGraw Hill, 4th ed. 2007.
5. Dougles F.Elliott, Hand book of "*Digital Signal proceedings: Engineering applications*", Academic Press, 1987.
6. Texas and Analog Devices - Reference Manual

PE2108	**DESIGN OF CONTROLLERS IN POWER APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Total Contact Hours -45				
PURPOSE					
To provide knowledge on the various types of controllers in power applications.					
INSTRUCTIONAL OBJECTIVES					
1.	To introduce the mathematical representation of controller components and				
2.	solution techniques.				

3.	To impart in-depth knowledge on different methods of modern controllers.
4.	To get insight of contingency analysis problem and the solution methods. To gain knowledge on transient stability analysis and the associated solution techniques

UNIT I – CLASSICAL CONTROLLER DESIGN (9 hours)

Introduction of controller design – Proportional (P)-Integral (I)-Derivative (D)-PI-PD - PID controllers-Characteristics-Design of controller- Tuning-Ziegler-Nichol's method, Cohen coon method and damped oscillation method

UNIT II– SLIDING MODE CONTROL & VARIABLE STRUCTURE CONTROLLER (9 hours)

Dynamics in the sliding mode – linear system, non-linear system, chattering phenomenon – sliding mode control design – reachability condition, robustness properties –application Sliding surfaces- Continuous approximations of Switching control laws- Modeling / Performance trade-Variable structure controller-Adaptive variable structure controller bang-bang control theory-trajectory planning-Case Studies

UNIT III – CURRENT CONTROLLER DESIGN (9 hours)

Hysteresis current control (HCC) – Design of HCC with PWM schemes-Case Studies

Predictive current controller (PCC) –Model predictive control (MPC)-PWM predictive control (PPC)

UNIT IV – H-INFINITY CONTROL & ROBUST CONTROL THEORY (9 hours)

Introduction of H-infinity methods in control theory-Elements of robust control theory – Design objectives – Shaping the loop gain –Signal spaces – Computation of H∞ norm- All pass systems-- Linear-quadratic-Gaussian control (LQG)- -Case Studies

Robust control theory- Robust controller design- Robust decision methods-Analytic tools for robust decision making-Case Studies

UNIT V – CONTROLLER DESIGN (9 hours)

Controller synthesis and tuning, Linear Matrix inequalities, LMI solvers, control system analysis and design with LMIs using MATLAB/Simulink

Uncertain system analysis -Statistical and worst-case analysis of stability and performance Analysis

Survey and review of different controllers used in power system and power electronics practices

REFERENCES

1. Jean Pierre Barbot., "*Sliding Mode Control in Engineering*" Marcel Bekker, 2002.
2. Green M. and Limebeer /D.J.N., "*Linear Robust Control*", Englewood cliffs, NJ: Prentice Hall, 1995.
3. P.C.Chandrasekharan., "*Robust Control of Linear Dynamical Systems*", AcademicPress Limited, San Diego.1996.
4. Zinober, Alan S.I., ed. *"Variable Structure and Lyapunov Control"* , London: Springer-Verlag. doi:10.1007/BFb0033675. ISBN 978-3-540-19869-7, 1994.
5. Bryson, A.E and Ho, Y., "*Applied Optimal Control: Optimization, Estimation and Control* (Revised Printing)", John Wiley and Sons, New York, 1975.
6. SomanathMajhi., *"Advanced Control Theory A relay Feedback Approach"*, Cengage Learning, 2009.
7. www.Mathworks,com/Matlab-2012b,2013a/Simulnik.

		L	T	P	C
PE2109	**DISTRIBUTED CONTROL SYSTEMS**	**3**	**0**	**0**	**3**
	Total Contact Hours - 45				
PURPOSE					
To provide knowledge in distributed Control systems					
INSTRUCTIONAL OBJECTIVES					
1.	To give basic knowledge in the architecture and local control unit of distributed control system.				
2.	To give adequate information in the interfaces used in DCS.				
3.	To give basic knowledge about HART (Highway Addressable Remote Transducer) and field bus technology.				
4.	To introduce polynomial equations approach to control system design.				
5.	To inculcate the Model of digital control devices and systems				

Unit I – INTRODUCTION (9 hours)

Evolution – Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities.

Unit II - INTERFACES IN DCS (8 hours)

Operator interfaces - Low level and high level operator interfaces – Operator display -Engineering interfaces – Low level and high level engineering interfaces – General purpose computers in DCS

Unit III - HART AND FIELD BUS (10 hours)

Evolution of signal standards – HART communication protocol – Communication modes – HART networks – Control system interface – HART and OSI model – Filed bus introduction – General field bus architecture – Basic requirements of field bus standard – Field bus topology – Inter operability.

Unit IV - POLYNOMIAL EQUATIONS APPROACH TO CONTROL SYSTEM DESIGN (9 hours)

Diophantine Equations – Polynomial Equations Approach to Regulator system– Polynomial Equations Approach to Control system Design – Design of Model Matching Control Systems

Unit V - MODELS OF DIGITAL CONTROL DEVICES AND SYSTEMS (9 hours)

Introduction - Z domain description of sampled continuous time plants - Z domain description of systems with dead time- Implementation of digital controllers - Tunable PID controllers - Digital temperature control systems - Digital position control system.

REFERENCES

1. Ogata, *“Discrete – Time Control Systems”*, Pearson Education, Sigapore, 2002.
2. Ky M. Vu, Optimal Discrete Control Theory The Rational Function Structure Model, Library and archives Canada cataloguing in publication, Canada, 2007.

<table>
<tr><td rowspan="3">PE2110</td><td rowspan="2">MEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Total Contact Hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">To learn to develop micro size sensors.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To learn fundamental concept of design and manufacturing of Micro electronics system.</td></tr>
</table>

UNIT I– MEMS AND MICRO SYSTEM (9 hours)
Overview– Typical MEMS and microsystems products – Evolution of micro fabrication - Microsystems and microelectronics – Multidisciplinary nature of microsystems design and manufacturing– Application of Microsystems industries

UNIT II – FUNDAMENTALS OF MICROSYSTEMS (9 hours)
Working principles of microsystems: Introduction – Microsensors – Microactuation – MEMS with microactuators – Microactuators with mechanical Inertia - Microfluidics. Engineering Science for Microsystems design and fabrication : Introduction – Atomic structure of matter – Ions and Ionization – Molecular theory of matter and intermolecular forces – Doping of Semiconductors – Diffusion process – Plasma physics – Electrochemistry

UNIT III – MICROSYSTEMS DESIGN (9 hours)
Introduction – Static bending of thin plates – Thermo fluid engineering and microsystems design: Introduction – Overview of basics of fluid mechanics at macro and mesoscales – Basic equation in Continuum fluid dynamics – Laminar fluid flow in circular conduits – Computational fluid dynamics – Incomressible fluid flow in microconduits – overview of heat conduction in solids – Heat conduction in multilayered thin films – Heat conduction in solids at sub-micrometer

UNIT IV – MICROSYSTEMS FABRICATION (9 hours)
Introduction – Photolithography – Ion implantation – Diffusion – Oxidation – Chemical vapor deposition - Physical vapor deposition: Sputtering – Deposition by expitaxy – Etching – Summary of micro fabrication

UNIT V– MICRO MANUFACTURING **(9 hours)**
Introduction – Bulk micro manufacturing – Surface micromachining – LIGA process – Summary of micro manufacturing.
Microsystems Design: Introduction – Design considerations – Process design – Mechanical design - Mechanical design using finite element method – Design of silicon die of a micro pressure sensor – Design of micro fluid network systems – Computer aided design.

REFERENCES

1. Tai-Ran Hsu, "*MEMS and MICROSYSTEMS*", John Wiley & Sons, New Jersey, 2008.
2. Chang Liu, "*Foundations of MEMS*", Pearson International Edition, 2006.
3. Marc Madou , "*Fundamentals of microfabrication*", CRC Press, 1997.
4. Sergey Edward Lyshevski, "*Nano and Micro electro mechanical Systems*" CRC Press, 2001.
5. Julian W. Gardner Vijay, K.Varadan, Osama , Awadelkarim "*Microsensors, MEMS and Smart Devices*", John Wiley & Sons, Ltd, 2001.

PE2111	**ADVANCED POWER SEMICONDUCTOR DEVICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Total Contact Hours- 45				
PURPOSE					
To enable the students to gain a fair knowledge on characteristics and protection of advanced power semiconductor devices.					
INSTRUCTIONAL OBJECTIVES					
1.	To learn the overview of the power electronic devices and the operation of the power diode.				
2.	To understand the construction and characteristics of current controlled devices.				
3.	To understand the construction and characteristics of voltage controlled devices.				
4.	To understand the operation of firing and protection circuits.				
5.	To learn about the thermal protection of the power electronic devices.				

UNIT I - INTRODUCTION (9 hours)

Power switching devices overview – Attributes of an ideal switch, application
requirements; 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 hours)

BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Thyristors– concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor.

UNIT III - VOLTAGE CONTROLLED DEVICES (9 hours)

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

UNIT IV - FIRING AND PROTECTING CIRCUITS (9 hours)

Necessity of isolation, pulse transformer, optocoupler – Gate drive 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 hours)

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

REFERENCES

1. Rashid M.H., "Power *Electronics Circuits, Devices and Applications* ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. MD Singh and K.B Khanchandani, "*Power Electronics*", Tata McGraw Hill, 2001.
3. Mohan, Undcland and Robins, "*Power Electronics – Concepts, applications and Design*", John Wiley and Sons, Singapore, 2000.
4. P. S. Bhimbra, "*Power Electronics*", Khanna publishers, Fifth edition, 2012.

<table>
<tr><td rowspan="3">PE2112</td><td rowspan="2">SPECIAL MACHINES AND THEIR CONTROLLERS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Total Contact Hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">To have a fair knowledge on various aspects of special machines and their controllers.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To know about the constructional features, principle of operation and mode of excitation of various special machines.</td></tr>
</table>

UNIT I–SYNCHRONOUS RELUCTANCE MOTORS (9 hours)

Constructional features – Types – Axial and radial air gap motors – Operating principle – Reluctance – Phasor diagram – Characteristics – Vernier motor.

UNIT II – STEPPING MOTORS (9 hours)

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Theory of torque predictions – Linear and non-linear analysis – Dynamic Characteristics – Drive systems and circuit for open loop control &Closed loop control of stepping motor.

UNIT III – SWITCHED RELUCTANCE MOTORS (9 hours)

Constructional features – Principle of operation – Torque prediction – Power controllers, Non-linear analysis, Microprocessor based control – speed – torque Characteristics – Computer control.

UNIT IV–PERMANENT MAGNET BRUSHLESS D.C. MOTOR (9 hours)

Difference between mechanical and electronic Commutators, Hall sensors, Optical sensors, Square - Wave permanent magnet brushless motor drives, torque and EMF equation, torque - speed characteristics of Permanent Magnet Brush less DC Motors - controllers PM DC Motor, applications.

UNIT V – PERMANENT MAGNET SYNCHRONOUS MOTORS (9 hours)

Principle of operation – EMF and torque equations – Reactance – Phasor diagram – Power controllers – Converter – Volt-ampere requirements –

Torque speed characteristics, self control ,Microprocessor based control ,applications.

REFERENCES

1. Miller. T. J. E., "*Brushless Permanent Magnet and Reluctance Motor Drives*", Clarendon Press, Oxford, 1989.
2. Kenjo. T and Nagamori. S, "*Permanent Magnet and Brushless DC Motors*", Clarendon Press, Oxford, 1989.
3. Kenjo. T, "*Stepping Motors and their Microprocessor Control*", Clarendon Press, Oxford, 1989.
4. Krishnan R, "*Switched Reluctance Motor Drives*", Modelling, Simulation, Analysis, Design and applications, CRC press.
5. P.P. Aearnley, '*Stepping Motors – A Guide to Motor Theory and Practice'*, Peter Perengrinus, London, 1982.

PE2113	**OPTIMIZATION TECHNIQUES IN POWER ELECTRONICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Total Contact Hours - 45				
PURPOSE					
To impart knowledge on various Optimization Techniques Applied to Power Electronics engineering.					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the concept of various Optimization Techniques				
2.	To acquire an in-depth knowledge on application of Optimization Techniques to Power Electronics				
3.	To get detailed understanding of Optimization Techniques Applied to extract maximum power from photo voltaic systems and Wind Electric conversion System.				

UNIT I - INTRODUCTION (9 hours)

Introduction to fitness evaluation, Definition-classification of optimization problems, unconstrained and constrained optimization, optimality conditions, classical optimization techniques (Linear and non linear programming, Quadratic programming, Mixed integer programming)-. Encoding and decoding functions, Introduction to constraint-handling techniques.

UNIT II - EVOLUTIONARY COMPUTATION TECHNIQUES (9 hours)

Fundamentals of evolutionary algorithms-principle of simple Genetic Algorithm- Evolutionary Strategy and Evolutionary Programming- Direction-based Search-Genetic operators-selection, crossover and mutation- issues in GA implementation.

UNIT III - ADVANCED OPTIMIZATION METHODS (9 hours)

Fundamental principle, velocity updating, advanced operators, hybrid approaches implementation issues (Hybrid of GA and PSO, Hybrid of EP and PSO); Simplifying Particle Swarm Optimization, Optimizer Simplification & Meta-Optimization. Fundamental principle, Classification of Differential evolution techniques, Bacterial foraging, Bees colony algorithm, Concept of MPPT

UNIT IV - MULTI OBJECTIVE OPTIMIZATION (9 hours)

Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-NSGA-II, -Multiobjective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO)

UNIT V -OPTIMISATION TECHNIQUE APPLIED TO POWER ELECTRONICS APPLICATIONS (9 hours)

Passive filter design using genetic algorithm, harmonics elimination in inverters, Tuning of controllers, PV systems-Wind Electric conversion System - GA, PSO, DE, Optimized fuzzy logic control for the Maximum Power Point Tracking (MPPT).

REFERENCES

1. Singiresu S.Rao, "*Engineering Optimization – Theory and Practice*" by John Wiley & Sons, Inc., New Jersey, 2009.
2. Kothari D.P. and Dillon J.S., "*Power system optimization*", PHI, 2004.
3. Thomas Back, David B Fogel and Zbigniew Michalewicz, "*Evolutionary Computation 2 Advanced Algorithms and Operators*" Institute of Physics Publishing, UK, 2000.
4. Kalyanmoy Deb, "*Muti-objective Optimization using Evolutionary Algorithms*", John Wiley & Sons 2001.
5. Kennedy J, Swarm Intelligence, Morgan Kaufmann Publishers, Eberhart R 2001.

6. Kaddah, S.S, "*Genetic algorithm based optimal operation for photovoltaic systems under different fault criteria*", Proceedings of IEEE Power Systems Conference, 2006.
7. F.Jafari, A.Dastfan, "*Optimization of Single-phase PWM Rectifier Performance by Using the Genetic Algorithm*", International Conference on Renewable Energies and Power Quality (ICREPQ'10) Granada (Spain), 23rd to 25th March, 2010.

PE2114	**SOFTWARE TOOL FOR POWER ELECTRONIC APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
	Total Contact Hours - 45				
PURPOSE					
To create awareness among the students about the role of design in drives.					
INSTRUCTIONAL OBJECTIVES					
1.	To educate scientifically the new developments in software for designing the machines				
2.	To emphasize the significance of Power Electronic Controller in Drive Applications				

UNIT I – INTRODUCTION (9 hours)

CAD, Design procedure and limitation, Development of torque and force-Magnetic vector/scalar potential-Electrical vector/scalar potential-stored energy infield problems-Energy functional and principle of energy conversion.

Design of C-core and cylinder shield using CAD software

UNIT II – MATHEMATICAL MODEL AND ELEMENTS OF CAD SYSTEM (9 hours)

Differential / Integral equation - Finite difference method – Finite element method – Energy method – Variational method – Discretisation – shape function, elements of cad system: Preprocessing-modelling – meshing – material properties – postprocessing.

Modeling and mesh analysis of various drive conventional design in simulation using cad software.

UNIT III – MAGNET (9 hours)

Introduction to MagNet – model building – modeling flowchart – geometric modeling – drawing edges – creating surface – creating components – selecting edges surfaces and components – positioning the construction slice – material, boundary condition and finite element mesh – solving the model.

Modeling and simulation of SRM motor with 6:4 slots using MagNet software.

UNIT IV - MOTORSOLVE **(9 hours)**

Introduction to Motorsolve – design parameter and geometric modeling – various design in Motor solve – modification and optimization - result and analysis- cogging torque, output power and efficiency

Design of BLDC motor and Induction motor using Motorsolve

UNIT V - PSIM **(9 hours)**

Introduction to PSIM – elements of psim - power circuit and control circuit component – circuit schematic design using simcad - simcoupler – Magnet plugins – waveform process using simview - voltage and current control in bldc motor -

Simulation of BLDC with various controllers for speed, torque ripple and current control using PSIM

REFERENCES

1. Silvester and Ferrari, "*Finite Elements for Electrical Engineers*" Cambridge University press, 1983.
2. S.R.H. Hoole, *"Computer - Aided, Analysis and Design of Electromagnetic Devices"*, Elsevier, New York, Amsterdam, London, 1989.
3. D.A.Lowther and P.P.Silvester, *"Computer Aided design in Magnetics"*, Springer Verlag, New York, 1956.
4. S.J.Salon, "*Finite Element Analysis of Electrical Machines*", Kluwer Academic Publishers, London, 1995.
5. C.W.Trowbridge, "*An Introduction to Computer Aided Electromagnetic Analysis*", Vector field ltd.,
6. Infolytica corporation, " *MAGNET version 6.11.1 Getting Started guide*"

PE2115	SMART GRID DESIGN AND ANALYSIS	L	T	P	C
		3	0	0	3
	Total Contact Hours- 45				

PURPOSE

To enable the students acquire knowledge on smart grid, different options of architectural design and communication technology for various aspects of smart grid , System analysis and stability analysis in smart grid, renewable energy sources and storage integration with smart grid.

INSTRUCTIONAL OBJECTIVES

1.	To understand the concepts and design of Smart grid
2.	To understand the various communication and measurement technologies in smart grid
3.	To understand the analysis and stability of smart grid.

UNIT I - SMART GRID ARCHITECTURAL DESIGNS (9 hours)

Introduction – Comparison of Power grid with Smart grid – power system enhancement – communication and standards - General View of the Smart Grid Market Drivers - Stakeholder Roles and Function - Measures - Representative Architecture - Functions of Smart Grid Components-Wholesale energy market in smart grid-smart vehicles in smart grid.

UNIT II - SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY (8 hours)

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS)- Advanced metering infrastructure- GIS and Google Mapping Tools.

UNIT III - PERFORMANCE ANALYSIS TOOLS FOR SMART GRID DESIGN (9 hours)

Introduction to Load Flow Studies - Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods - Load Flow State of the Art: Classical, Extended Formulations, and Algorithms –Load flow for smart grid design-Contingencies studies for smart grid.

UNIT IV- STABILITY ANALYSIS TOOLS FOR SMART GRID (10 hours)

Voltage Stability Analysis Tools-Voltage Stability Assessment Techniques-Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid-Angle stability assessement in smart grid-Approach of smart grid to State Estimation-Energy management in smart grid.

UNIT V- RENEWABLE ENERGY AND STORAGE (9 hours)

Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids-PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

REFERENCES

1. James Momoh, "*Smart Grid: Fundamentals of design and analysis*", John Wiley & sons Inc, IEEE press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "*Smart Grid: Technology and Applications*", John Wiley & sons inc, 2012.
3. Fereidoon P. Sioshansi, "*Smart Grid: Integrating Renewable, Distributed & Efficient Energy*", Academic Press, 2012.
4. Clark W.Gellings, "*The smart grid: Enabling energy efficiency and demand response*", Fairmont Press Inc,2009.

SUPPORTIVE COURSES

MA2008	APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS	L	T	P	C
		3	0	0	3
	Total Contact Hours -45				
PURPOSE					
To develop analytical capability and to impart knowledge in Advanced Matrix theory, Linear and Non linear programming, Calculus of variations and Random Processes and their applications in Engineering and Technology and to apply these concepts in Engineering problems they would come across.					
INSTRUCTIONAL OBJECTIVES					
1.	Understand mathematical and statistical techniques				
2.	Logically explain the concepts				

UNIT-I MATRICES (9 hours)

Computation of the greatest and the least eigen values of a matrix by power method - Modal matrix - Spectral - Sylvester's theorem - Power series of matrices - Application of matrices to solution of Differential equations.

UNIT–II LINEAR PROGRAMMING (9hours)

Linear programming - Graphical Method - Simplex method - Duality Theorems - Dual Simplex method - Integer programming.

UNIT–III BOUNDARY VALUE PROBLEMS (9hours)

Solution of Initial and boundary value problems - Characteristics - D'Alembert's Solution - Significance of Characteristic curves - Laplace transform solutions for displacement in a long string - a long string under its weight - a bar with prescribed force on one end - free vibration of a string.

UNIT–IV CALCULUS OF VARIATIONS (9hours)

Calculus of variations - Concepts of functionals - Euler's equation - Brachistochrone problem - Variational problems involving several unknown functions - Functionals involving two or more independent variables - Variational problems with moving boundaries - Isoperimetric problems.

UNIT–V PROBABILITY (9hours)

Probability - Baye's Theorem for conditional probability - Random variables - Distribution function - Density function - Variance and covariance - Stochastic process - Auto correlation - Auto covariance - Cross correlation and cross covariance - Stationary process - Auto correlation and cross correlation functions - Power spectrum.

REFERENCES

1. Dass H.K., "*Engineering Maths*", S.Chand and Co., 2003.
2. Grewal B.S., "*Higher Engineering Mathematics*", Khanna Publishers.36th Edition.
3. Kanti Swarup, Gupta P.K., Manmohan, "*Operations Research*", Sultan Chand, 11th Edition - 2003.
4. Venkataraman M.K., "*Higher Engineering Mathematics*", National Publishing Co., 4th Edition, July 1992. (Unit IV - Chapter 9 section 1,2,3,5,8,9,11-15, 17)
5. Veerajan T., "*Probability, Satistics and Random Processes*", Tata Mc Graw Hill, 2004.

<table>
<tr><td rowspan="3">PS2201/PE2201</td><td rowspan="2">OBJECT ORIENTED PROGRAMMING APPLICATIONS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Total Contact Hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">This course gives a fundamental understanding of the Object Oriented concepts with the help of the programming language C ++.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To understand the basic concepts of Object Oriented programming.</td></tr>
<tr><td>2.</td><td colspan="5">To learn the C and C ++ language concepts and programming.</td></tr>
<tr><td>3.</td><td colspan="5">To study the detailed understanding of OOPS concepts like Inheritance and Polymorphism.</td></tr>
<tr><td>4.</td><td colspan="5">To learn advanced concepts like Templates and file I/O</td></tr>
</table>

UNIT I - OBJECT ORIENTED CONCEPTS (9 hours)

Traditional Programming Approach – Structured Methodology – Object Oriented Concepts – Objects and Classes – Instance – Messages – Methods – Encapsulation – Inheritance – polymorphism – Dynamic binding – Benefits of Object Oriented Programming – C++ Pointers – Runtime binding - Dynamic Objects – Self referential classes.

UNIT II - C++ CLASSES AND METHODS (9 hours)

C++ Classes and Methods – Members – Message Parsing – Creation and Initialization – Constructor and Destructor functions - Reference variables – Inline functions – Friend functions – Default arguments.

UNIT III - INHERITANCE (9 hours)

Inheritance - Benefits – Cost of inheritance – Execution speed - Program size – Message passing overhead - Program complexity – Derived Classes – Abstract classes – Multiple inheritance – Access Control.

UNIT IV - POLYMORPHISM (9 hours)

Polymorphism – Overloading – Operator overloading – Function overloading – Overriding – Deferred methods – Virtual functions.

UNIT V - TEMPLATES AND STREAMS (9 hours)

Templates – List Templates – Function templates – Template arguments. Streams – Input –Output – Formatting – Files and Streams – Exception handling.

REFERENCES

1. Bjarne Stroustrup , "*The C++ Programming Language*", 2nd edition , Wesley, 1997.
2. Robert Lafore, "*Mastering Turbo C++*", BPB Publications, 2000.
3. Yashavant Khanitkar, "*Programming in C++*", 4th edition, BPB Publications, 1999.
4. Venugopal K, Rajkumar R, Ravishankar T. , "*Mastering C ++*" , Tata McGraw Hill Publication Company Ltd, 1997.

<table>
<tr><td rowspan="2">PS2202/PE2202</td><td rowspan="2">COMPUTER NETWORKS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>Total Contact Hours - 45</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">The purpose of this course is to make the students acquire fairly good knowledge on networking computers for reliable and secured operation and also to provide a wide-ranging introduction to modern computer networks and their applications.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To learn the functions of different layers.</td></tr>
<tr><td>2.</td><td colspan="5">To appreciate and understand state-of-the-art in network protocols,</td></tr>
<tr><td>3.</td><td colspan="5">Topologies and applications.</td></tr>
<tr><td>4.</td><td colspan="5">To learn the principles of routing and the semantics and syntax of IP</td></tr>
<tr><td>5.</td><td colspan="5">To study about internetworking, transport and application layer protocol.</td></tr>
<tr><td>6.</td><td colspan="5">To learn network security aspects.</td></tr>
</table>

UNIT I - INTRODUCTION AND PHYSICAL LAYER (8 hours)
Evolution of data networks, Network architecture, ISO Reference model examples of networks, Application of networks, Physical layer, and communication medium characteristics.

UNIT II - DATA LINK LAYERS (10 hours)
Local area networks, conventional channel allocation methods, pure-ALOHA, S-ALOHA, Collision free protocols, Limited contention protocols – IEEE 802 for LAN's - Data link layer design issues – Service primitives – Stop and wait Sliding window protocols – Comparison of stop and wait and sliding window protocols.

UNIT III - NETWORK LAYERS **(9 hours)**

Network layer design issues -Routing– Types of Routing algorithm-Congestion control algorithms –internetworking- IP protocol .

UNIT IV - TRANSPORT LAYER **(8 hours)**

Transport layer design issues – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) –TCP connection management – Quality of services (QOS) – Integrated Services.

UNIT V - APPLICATION LAYER **(10 hours)**

Abstract syntax notation – Data compression techniques – Remote procedure call - Design Issues – DNS – Electronic mail – Multimedia – introduction to digital audio compression, streaming audio, internet radio, voice over IP.
Network Security: Cryptography – Symmetric key – Public key algorithms – Authentication protocols – Digital signatures – Email security – Social issues.

REFERENCES

1. Andrew .S. Tanenbaum, "*Computer Networks"*, Prentice Hall of India publications, 5th edition, 2010.
2. Behrouz A.Forouzan, "Data Communication and Networking", fourth Edition, Tata McGraw Hill, 2009.
3. Stallings, "*Data and Computer Communications"*, Pearson education, 8th edition, 2007.
4. Bertsekas D. and Gallager R., "*Data networks*", 2nd Edition, Prentice Hall of India, 2003.
5. Achyut S Godbole, "*Data Communications and Networking*", Tata McGraw Hill, 2005.