ERODE SENGUNTHAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University)
PERUNDURAI, ERODE - 638 057

PG Curriculum and Syllabus

(1 to 4 Semesters)

M.E – POWER ELECTRONICS AND DRIVES

Choice Based Credit System (CBCS)

REGULATION 2019

ERODE SENGUNTHAR ENGINEERING COLLEGE, ERODE

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
REGULATION – 2019

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULUM

M.E. POWER ELECTRONICS AND DRIVES
Minimum credits to be earned : 67

FIRST SEMESTER

Code No.	Course	L	T	P	C	Maximum Marks			Category
						CA	ES	Total	
19PE101	Calculus of Variations and Optimization Techniques	3	1	0	4	40	60	100	FC
19PE102	Power Quality Problems and Solutions	3	0	0	3	40	60	100	PC
19PE103	Design and Analysis of Converters	3	0	0	3	40	60	100	PC
19PE104	Design and Analysis of Inverters	3	0	0	3	40	60	100	PC
19PE105	System Theory	3	0	0	3	40	60	100	PC
	Professional Elective I	3	0	0	3	40	60	100	PE
PRACTICALS									
19PE106	Power Electronic Circuits Laboratory	0	0	2	1	60	40	100	PC
19PE107	Technical Seminar-I	0	0	2	0	100	0	100	EEC
	Total	18	1	4	20	400	400	800	-

SECOND SEMESTER

Code No.	Course	L	T	P	C	Maximum Marks			Category
						CA	ES	Total	
19PE201	Research Methodology	3	0	0	3	40	60	100	PC
19PE202	Solid State Drives	3	0	0	3	40	60	100	PC
19PE203	Power Converters for Renewable Energy Systems	3	0	0	3	40	60	100	PC
19PE204	Modeling and Analysis of Electrical Machines	3	0	0	3	40	60	100	PC
	Professional Elective II	3	0	0	3	40	60	100	PE
	Professional Elective III	3	0	0	3	40	60	100	PE
PRACTICALS									

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19PE205	Electrical Drives Laboratory	0	0	2	1	60	40	100	PC
19PE206	Mini Project	0	0	2	1	60	40	100	EEC
19PE207	Technical Seminar-II	0	0	2	0	100	0	100	EEC
	Total	18	0	6	20	460	440	900	-

THIRD SEMESTER									
Code No	Course	L	T	P	C	Maximum Marks			Category
						CA	ES	Total	
	Professional Elective IV	3	0	0	3	40	60	100	PE
	Professional Elective V	3	0	0	3	40	60	100	PE
	Professional Elective VI	3	0	0	3	40	60	100	PE
PRACTICALS									
19PE301	Project Work - Phase I	0	0	12	6	60	40	100	EEC
	Total	0	0	12	15	180	220	400	-

FOURTH SEMESTER									
Code No	Course	L	T	P	C	Maximum Marks			Category
						CA	ES	Total	
19PE401	Project Work-Phase II	0	0	24	12	60	40	100	EEC
		0	0	24	12	60	40	100	-

PROFESSIONAL ELECTIVES					
Code No	Course	L	T	P	C
PROFESSIONAL ELECTIVES I					
19PEX01	Embedded Control of Electric Drives	3	0	0	3
19PEX02	Virtual Instrumentation Systems	3	0	0	3
19PEX03	Digital Signal Processors for Modern Industrial Drives	3	0	0	3
19PEX04	Advanced Control of Electric Drives	3	0	0	3
PROFESSIONAL ELECTIVES II					
19PEX05	FACTS Controllers	3	0	0	3
19PEX06	Smart Grid	3	0	0	3

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19PEX07	Harmonics Filter Design	3	0	0	3
19PEX08	Special Machines and their Controllers	3	0	0	3
PROFESSIONAL ELECTIVES III					
19PEX09	Modern Industrial Drives	3	0	0	3
19PEX10	Advanced Digital Signal Processing	3	0	0	3
19PEX11	FPGA Controller for Power Electronic Systems	3	0	0	3
PROFESSIONAL ELECTIVES IV					
19PEX12	Switched Mode and Resonant Converters	3	0	0	3
19PEX13	Modeling and Control of Power Electronic Systems	3	0	0	3
19PEX14	Power Electronics Applications to Power System	3	0	0	3
PROFESSIONAL ELECTIVES V					
19PEX15	Finite Element Analysis of Electrical Machines	3	0	0	3
19PEX16	Sensors and Instrumentation systems	3	0	0	3
19PEX17	Automotive Electronics	3	0	0	3
PROFESSIONAL ELECTIVES VI					
19PEX18	HVDC Systems	3	0	0	3
19PEX19	Optimization Techniques	3	0	0	3
19PEX20	Hybrid Electric Vehicles	3	0	0	3

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	FC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE101	CALCULUS OF VARIATIONS AND OPTIMIZATION TECHNIQUES	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is to

- Study about the matrix theory used in electrical engineering.
- Study about the variations and its applications.
- Study the various optimization techniques.
- Study the Fourier series analyses and Fourier Transform.
- Obtain the simultaneous linear and non-linear equations.

Course Outcomes: At the end of this course, learners will be able to:

- Integrate undergraduate fundamentals with advanced knowledge to solve complex power electronics problems.
- Get the idea of optimization and the applications.
- Use Fourier series analyses and Fourier Transform to formulate and solve problems applied to engineering.
- Apply the optimization ideas to solve the functional in real time.
- Solve mathematical problems using numerical methods.

Unit I — CALCULUS OF VARIATIONS — 12

Variation and its properties–Euler's equation–Functional dependent on first and higher order derivatives– Functional dependent on functions of several independent variables–Some applications–Direct methods: Ritz and Kantorovich methods..

Unit II — CONSTRAINED OPTIMIZATION TECHNIQUES — 12

Optimization algorithms: Classifications – optimality criteria – single variable optimization- Golden section search method- multivariable optimization: Newton's method – constrained optimization : method of multipliers

Unit III — LINEAR PROGRAMMING PROBLEMS — 12

Graphical Method – Simplex Method –Two phase Method-Revised Simplex Method

Unit IV — DYNAMIC PROGRAMMING — 12

Dynamic Programming – Recursive nature of computation-Forward and Backward Recursion-work force size model- Problem of dimensionality

Unit V — DECISION ANALYSIS and GAME THEORY — 12

Decision models – Decision making under risk – Decision trees – Decision making under uncertainty(AHP)- Game theory – Two person zero sum games – Graphical solution- Algebraic solution–.

REFERENCE(S):

1. Lev Elsgolts, Differential equations and Calculus of Variations, University Press of the Pacific, 2003.
2. Sankar Rao, Numerical methods for scientists and Engineers, Third edition, Prentice Hall of India learning Pvt. Ltd, New Delhi, 2009
3. Eleanor Chu, Discrete and continuous Fourier transforms. Analysis, Applications and Fast Algorithms, Taylor & Francis Group, 2008
4. Hamdy.Taha, Operations Research, Tenth Edition, Pearson

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE102	POWER QUALITY PROBLEMS AND SOLUTIONS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Obtain the characteristic of different types of power quality issues.
- Determine the causes and effects of power quality problems in electrical systems.
- Understand various power quality problems, their mitigation and measuring techniques.
- Analyze the supply system with linear and non-linear load and source.
- Determine the effects of harmonics on various equipment.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the various Power quality problems and their effects.
- Classify power quality events according to IEEE, ITIC (CEBNA) and public utility standards
- Mitigate power quality parameter like harmonics, voltage sag, transients etc...
- Recognize symptoms of power quality problems including sags, swells, under or overvoltage, harmonics, transients, electrical noise (EMI/RFI/EMF), interruptions, wiring and grounding issues.
- Understand power quality monitoring and classification techniques.

Unit I	INTRODUCTION	9

IEC and IEEE definitions -Power quality issues: Short duration voltage variations, Long duration voltage variations, Transients, Waveform distortion, Voltage imbalance, Voltage fluctuation, power frequency variations - power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

Unit II	ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM	9

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

Unit III	CONVENTIONAL LOAD COMPENSATION METHODS	9

Principle of Load compensation and Voltage regulation – Classical load balancing problem : Open loop balancing – Closed loop balancing, Current balancing – Harmonic reduction and voltage sag reduction – Analysis of unbalance – instantaneous real and reactive powers – Extraction of fundamental sequence component.

Unit IV	LOAD COMPENSATION USING DSTATCOM	9

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

Unit V	SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM	9

Rectifier supported Dynamic Voltage Restorer – DC Capacitor supported DVR – DVR Structure – voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TEXT BOOK(S):

1.	ArindamGhosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2.	R.C. Duggan, Mark.F.McGranaghan,SuryaSantoas and H.WayneBeaty, "Electrical Power System Quality", McGraw-Hill, 2004.
3.	G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994.
4.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad , "Power Quality: Problems and Mitigation

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	Techniques", John Wiley & Sons,2015.
REFERENCE(S):	
1.	Jos Arrillaga and Neville R. Watson ," Power system harmonics",Wiley,2003.
2.	Derek A. Paice , "Power Electronics Converter Harmonics :Multipulse Methods for Clean Power",Wiley,1999.
3.	Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Systems and Electrical Machines,Elseveir academic press publications,2011.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE103	DESIGN AND ANALYSIS OF CONVERTERS	3	0	0	3	60	100	

Course Objective (s): The purpose of learning this course is to

- Obtain the switching characteristic of Power diodes and Thyristors.
- Determine the operation, characteristics and performance parameters of AC-DC converters.
- Apply switching techniques and basic topologies of DC-DC switching regulators.
- Determine the operation, characteristics and performance parameters of AC-AC converters.
- Determine the operation, characteristics and performance parameters of Matrix converter.

Course Outcomes: At the end of this course, learners will be able to:

- Analyze the characteristics of Power electronics devices.
- Determine the various parameters of single phase and three phase rectifier.
- Demonstrate the response of chopper for a DC load
- Design a PWM converter and an AC voltage regulator.
- Analyze the performance of Matrix converter.

Unit I | POWER DIODES AND THYRISTORS | 12

Construction, operation, types, switching and steady state characteristics of Power Diodes, SCRs, TRIACs and GTOs - Gate circuit requirements – Protection – Series and parallel operation – Driver circuit – Design of snubber circuits – Commutation.

Unit II | AC-DC CONVERTER | 12

Single phase and Three phase half controlled and fully controlled converters – Dual converters - Effect of source impedance and overlap- Performance parameters: harmonics, ripple, distortion, power factor - Design of converter circuits – power factor correction rectifiers – Fourier series Analysis.

Unit III | DC-DC CONVERTERS | 12

Principles of step-down and step-up converters – Control strategies –Analysis and design of Buck- Boost, CUK, LUO and SEPIC converters - High frequency isolated DC - DC converters- resonant choppers.

Unit IV | AC – AC CONVERTERS | 12

Principle of phase control and ON-OFF control – Single phase and three phase AC voltage controllers – Various configurations – PWM schemes – Single phase and three phase Cyclo converters - SMPS – types and design.

Unit V | MATRIX CONVERTER | 12

Single phase and three phase Matrix Converters – types – Analysis of performance parameters: Output Voltage, input current, input and output power factors – PWM schemes for matrix converter - Applications.

TEXT BOOK(S):

1. M.H. Rashid, Power Electronics: Circuits, Devices and Application, New Delhi, Prentice Hall of India, 2010
2. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design,New Jersey, John Wiley and Sons, 2007.

REFERENCE(S):

1. Hua Bai, Chris Mi, Transients of Modern Power Electronics, John Wiley & Sons, 2011
2. M.H. Rashid, Hand Book of Power Electronics: Circuits, Devices and Application, New Delhi,Prentice Hall of India, 2007.
3. Marty Brown, Power sources and supplies Newnes, Elsevier,Second edition,2010.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE104	DESIGN AND ANALYSIS OF INVERTERS	3	0	0	3	60	100	

Course Objective (s): The purpose of learning this course is to

- To provide the electrical circuit concepts behind the different working modes of inverters so as to enable deep understanding of their operation.
- To equip with required skills to derive the criteria for the design of power converters for UPS,Drives etc.,
- Ability to analyze and comprehend the various operating modes of different configurations of power converters.
- Ability to design different single phase and three phase inverters.
- Study the working of advanced types of inverters such as multilevel inverters and resonant inverters.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the characteristics of power diodes and power handling capability of switching devices
- Understand the static and dynamic characteristics of current controlled power semiconductor devices
- Understand the static and dynamic characteristics of voltage controlled power semiconductor devices
- Enable the students for the selection of firing and protection circuit for different power semiconductor switches
- Understand the methods of thermal protection for different semiconductor devices.

Unit I	POWER DEVICES AND PROTECTION CIRCUITS FOR INVERTERS	12

Construction, Operation, Circuit model and switching characteristics of- MOSFET, IGBT and IGCT- Opto coupler and driver circuits- Design of heat sinks.

Unit II	VOLTAGE SOURCE INVERTERS	12

Series inverter and parallel inverter. Single phase and Three phase Voltage Source - Performance parameters – PWM techniques with Fourier series analysis – Various harmonic elimination techniques.

Unit III	CURRENT SOURCE AND Z-SOURCE INVERTERS	12

Load commutated current source inverter- Single phase and three phase auto sequential current source inverter (ASCI) – Principle of operation of Z- source inverter- Shoot thro zero state- Equivalent circuit-PWM methods for Z-Source inverters – Comparison of current source inverter, Voltage source inverters and impedance source inverter.

Unit IV	MULTILEVEL INVERTERS	12

Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel inverters – Hybrid multi level inverter- FFT analysis- Comparison of multilevel inverters - Applications of multilevel inverters.

Unit V	RESONANT INVERTERS	12

Concept of Zero Voltage Switching and Zero Current Switching - Series and parallel resonant inverters - Voltage control of resonant inverters – Class E resonant inverter – Resonant DC Link inverters.

TEXT BOOK(S):

1. M.H. Rashid, "Hand Book of Power Electronics: Circuits, Devices and Application", New Delhi, Prentice Hall of India, 2007.
2. Ned Mohan, Tore M.Undeland and William P.Robbins, "Power Electronics: Converters, Applications and Design", 3rd Edition, John Wiley and Sons, 2007.

REFERENCE(S):

1. Vinu V. Das, "Proceedings of the Third International Conference on Trends in Information, Telecommunication and Computing Engineering", Springer Science & Business Media, 2012.
2. Bimal K. Bose, "Modern Power Electronics and Motor Drive- Advances and Trends", 2nd Edition, Pearson Education, 2006.
3. Marty Brown, Power sources and supplies Newnes, Elsevier,Second edition,2010.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19PE105	SYSTEM THEORY	3	0	0	3	60	100

Course Objective (s):

The purpose of learning this course is

- To understand the basic concepts of state variable representation.
- To understand the concepts of state equation.
- To acquire the knowledge about controllability and observability.
- To analyze the stability of non linear systems.
- To understand the concepts of stability analysis.

Course Outcomes: At the end of this course, learners will be able to:

- Students understood the basic concepts of state variable representation.
- Students understood the concepts of state equation.
- Students acquired the knowledge in controllability and observability.
- Students able to analyze the stability of non linear systems.
- Students understood the concepts of stability analysis.

Unit I	STATE VARIABLE REPRESENTATION	12

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

Unit II	SOLUTION OF STATE EQUATION	12

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

Unit III	CONTROLLABILITY AND OBSERVABILITY	12

General concept of Controllability - General concept of Observability & Controllability tests for Continuous – Time Invariant systems - Observability tests for Continuous - Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model.

State Feedback Controllers and Observers: State Feedback Controller design through Pole Assignment – State observers: Full order and reduced order.

Unit IV	NON-LINEAR SYSTEMS	12

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of non linear systems, Properties of Non-Linear systems – Phase Plane analysis - Describing function– describing function analysis of nonlinear systems.

Unit V	STABILITY ANALYSIS	12

Stability Concepts-Equilibrium Points-Stability in the sense of Lyapunov-Lyapunov's stability and Lyapunov's instability theorems-Stability Analysis of the Linear Continuous time invariant systems by Lyapunov's second method-Generation of Lyapunov's functions-Krasovskii and Variable-Gradiant Method.

TEXT BOOK(S):

1. Digital Cont & State Var Met, Tata McGraw-Hill Education, 2012
2. K. Ogatta, "Modern Control Engineering, New Delhi", Prentice Hall of India, 2009.

REFERENCE(S):

1. M. Gopal, "Digital Control and State Variable Methods: Conventional and Neural-fuzzy Control Systems", Tata McGraw-Hill Education, 2003

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2.	Seyed Kamaleddin Yadavar Nikravesh,"Nonlinear Systems Stability Analysis: Lyapunov- Based Approach", CRC Press, 2013.
3	Richard L. Dorf and Robert H. Bishop, "Modern control Systems", New Delhi, Prentice Hall of India,2010.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE106	POWER ELECTRONIC CIRCUITS LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is

- To make the students capable of implementing analog interfacing as well as control circuits used in a closed-loop control for power electronic system
- To make the students acquire knowledge on mathematical modeling of power electronic circuits and implementing the same using simulation tools
- To facilitate the students to design and fabricate a power converter circuits at appreciable voltage / power levels
- To develop skills on PCB design and fabrication among the students

Course Outcomes: At the end of this course, learners will be able to:

- Understand on the switching behaviour of Power Electronic Switches
- Understanding on mathematical modeling of power electronic system and ability to implement the same using simulation tools
- Use microcontroller and its associated IDE for power electronic applications
- Design and implement analog circuits for Power electronic control applications
- Design and fabricate a power converter circuit at an reasonable power level

LIST OF EXPERIMENTS

1. Study of switching characteristics of Power electronic switches with and without Snubber (i) IGBT (ii) MOSFET
2. Modeling and system simulation of basic electric circuits using MATLAB- SIMULINK/SCILAB
3. AC Source with Single Diode fed Resistive and Resistive-Inductive Load
4. AC source with Single SCR fed Resistive and Resistive-Inductive Load
5. Full Converter Fed R, RL and DC Motor Load at Different Firing Angles
6. Single Phase PWM Inverter
7. Three Phase PWM Inverter
8. Modeling and System Simulation of SCR based full converter with different types of load using MATLAB
9. Circuit Simulation of Voltage Source Inverter using MATLAB
10. Circuit Simulation of basic electric circuits using MATLAB
11. Circuit Simulation of basic power electronics circuits using MATLAB
12. Measurement of Efficiency at different duty cycle with R and RL Load
13. Interface the Hall effect current sensor and display the current waveform
14. Interface the Hall effect voltage sensor and display the current waveform
15. Design of Driver circuit using IR 2110

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	EEC
Course Code	**Course Name**	**Hours / Week**			**Credit**	**Total Hours**	**Maximum Marks**	
19PE107	**TECHNICAL SEMINAR - I**	**0**	**0**	**2**	-	**30**	**100**	

Course Objective: In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

TECHNICAL SEMINAR	**30**

The work involves the following steps:

- Selecting a subject, narrowing the subject into a topic
- Stating an objective.
- Collecting the relevant bibliography (atleast 15 journal papers)
- Preparing a working outline.
- Studying the papers and understanding the authors contributions and critically analyzing each paper.
- Preparing a working outline
- Linking the papers and preparing a draft of the paper.
- Preparing conclusions based on the reading of all the papers.
- Writing the Final Paper and giving final Presentation

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE201	RESEARCH METHODOLOGY	3	0	0	3	45	100	

Course Objective (s):

The purpose of learning this course is

- To understand the basics of Research formulation and Design
- To analyze data
- To learn Soft Computing Algorithms
- To understand Ethics and IPR
- To prepare reports

Course Outcomes:

At the end of this course, learners will be able to:

- Understand basics of research formulation and design
- Collect and analyze data
- Implement soft computing algorithm
- Understand ethics and IPR
- Prepare reports

Unit I	RESEARCH FORMULATION AND DESIGN	9

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review.

Unit II	DATA COLLECTION AND ANALYSIS	9

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

Unit III	SOFT COMPUTING	9

Computer and its role in research, Use of statistical software SPSS, GRETL etc., in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems

Unit IV	RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING	9

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability

Unit V	INTERPRETATION AND REPORT WRITING	9

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusion

TEXT BOOK(S):

1.	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers
2.	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International

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REFERENCE(S):	
1.	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes
2.	Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	SemesterII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE202	SOLID STATE DRIVES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To learn converter and choppercontrol of DC drives.
- To learn the concept of closed loop control of AC drive.
- To study the control & estimation of induction motor drives.
- To understand the control of synchronous motor drives
- To learn about the digital control of drives.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the converter and choppercontrol of DC drives.
- Know about the control of induction motor drives.
- Able to understand the speed control of induction motor drive.
- Understand the control of synchronous motor drives.
- Study about the digital control drive.

Unit I CONVERTER AND CHOPPER CONTROL OF DC DRIVES 9

Analysis of series and separately excited dc motor with single phase and three phase converters – modes of operation, power factor improvement – analysis of series and separately excited dc motor fed from choppers – chopper based implementation of braking schemes

Unit II CONTROL OF INDUCTION MOTOR AND WOUND ROTOR INDUCTION MOTOR DRIVE 9

Steady state analysis – speed control techniques of induction motor – variable frequency operation of three phase induction motors – constant flux operation – dynamic and regenerative braking of CSI and VSI fed drives – Torque slip characteristics of wound rotor induction motor – rotor resistance control – static Kramer drive – sub synchronous and super synchronous operation.

Unit III CONTROL AND ESTIMATION OF INDUCTION MOTOR DRIVE 9

Field oriented control of induction machines – DC drive analogy - Direct and Indirect methods – Flux vector estimation - Direct Torque control strategy of induction machines – Torque expression with stator and rotor flux

Unit IV SYNCHRONOUS MOTOR DRIVES 9

Synchronous motor types, open loop VSI fed drive and its characteristics – self control model – torque angle and margin angle control – power factor control – brushless excitation systems – closed loop control of load commutated inverter fed synchronous motor drive.

Unit V DIGITAL CONTROL OF DRIVE 9

P, PI and PID controller characteristics - simulation of converter and chopper fed dc drive – Phase locked loop and micro computer control of dc drives - selection of drives and drive considerations for textile mills, lifts and cranes and hoist drives.

TEXT BOOK(S):

1. Bimal K. Bose, Power Electronics And Motor Drives: Advances and Trends, Academic Press, 2006
2. Sundareswaran, K., "Elementary Concepts of Power Electronic drives", CRC Press, 2009, 1st Edition.
3. Vedam Subramanyam, Electric Drives: Concepts & Appl, 2/E, New Delhi, Tata McGraw- Hill Education, 2011

REFERENCE(S):

1. G.K. Dubey, Power Semiconductor Controlled Drives, New Jersy, Prentice Hall International, 1989
2. J.M.D. Murphy and Turnbull, Thyristor Control of AC Motors, Pergamon Press, Oxford, 1973.
3. P.C. Sen, Thyristor DC Drives, New York, John Wiely and Sons, 1981
4. Gopal K. Dubey, Fundamentals of Electrical Drives, New Delhi, 2nd Edition, Narosa Publishing House, 2001

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Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES				R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19PE203	POWER CONVERTERS FOR RENEWABLE ENERGY SYSTEMS	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is

- To expose the students to the applications of power electronics in renewable energy systems
- To understand & design the PV systems
- To understand & design the wind energy systems
- To understand the concepts of grid connected systems
- To study about the distributed power systems.

Course Outcomes: At the end of this course, learners will be able to:

- Deal with energy sources and energy development agencies.
- Understand the photovoltaic energy conversion.
- Understand the wind energy conversion systems.
- Illustrate the grid connected system.
- Illustrate the distributed power systems.

Unit I | INTRODUCTION | 9

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

Unit II | PHOTOVOLTAIC ENERGY CONVERSION | 9

Solar radiation and measurements – Solar Panels and its classifications – PV arrays and their characteristics – Influence of insulation, temperature-Importance of bypass and blocking diodes- Parasitic capacitance and shadowing effect–Maximum power point tracking Algorithms– Power conditioning schemes -DC-DC converters – Inverters - Design of Solar PV systems.

Unit III | WIND ENERGY SYSTEMS | 9

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

Unit IV | GRID CONNECTED WECS AND SECS | 9

Grid connected systems — Grid related problems – Grid Codes -Grid Integrated solar PV systems – Grid integrated WECS -Matrix converters -Line commutated inverters - Multilevel inverters- Power converters for Grid connected WECS - Concept of mini/micro grids and smart grids.

Unit V | DISTRIBUTED POWER SYSTEMS | 9

Need for Distributed Systems - Types of Distributed systems - Hybrid Systems – Selection of power conversion ratio – Optimization of System components – Storage systems - Reliability evaluation.

TEXT BOOK(S):

1. Mukund R Patel, “Wind and Solar Power Systems”, CRC Press, 2, illustrated, revised 2005
2. Ahmed F. Zobaa, Ramesh C. Bansal, “Handbook of Renewable Energy Technology”, World Scientific,2011.

REFERENCE(S):

1. Rakosh Das Begamudre, “Energy Conversion Systems”, New Age International, 2007
2. Chetan Singh Solanki, “Solar Photovoltaic Technology and Systems”,PHI Learning Private Ltd, 2013.
3. Roger A. Messenger, Jerry Ventre,”Photovoltaic System Engineering” CRC Press, 2004
4. Chinnaraj Kamalakannan, Padma Suresh, Subhransu Sekhar Dash, Bijaya Ketan Panigrahi “Power Electronics and Renewable Energy Systems: Proceedings of ICPERES 2014”Springer, 2014

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE204	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- To understand the concepts of rotating machines.
- To apply reference frame theory on Induction machines
- To apply reference frame theory on Synchronous machines.
- To analyze about the equivalent circuit and its parameters of electrical machines.
- To study about the construction and operating principle of special machines.

Course Outcomes: At the end of this course, learners will be able to:

- Know about the concepts of rotating machines.
- Understand the concept of Reference frame theory.
- Analyze about Synchronous machines with dynamic performance.
- Analyze about the equivalent circuit and its parameters of electrical machines.
- Study about the construction and operating principle of special machines.

Unit I	CONCEPTS OF ROTATING MACHINES	9

Calculation of air gap mmf of a single turn full pitch distributed armature windings - Per phase full pitched and short pitched armature coils (AC machines) - Calculation of air gap mmf of a DC machine - Introduction to direct axis and quadrature axis theory in salient pole machines - Calculation of air gap inductances of a synchronous machine.

Unit II	INDUCTION MACHINE MODELING	9

Static and rotating Reference(s): frames, transformation relationships - Stationary circuit variables transformed to the arbitrary Reference frame treating R, L, C elements separately - Application of Reference frame theory to three phase symmetrical induction machine - Direct and quadrature axis model in arbitrarily rotating Reference frame - Voltage and torque equations

Unit III	SYNCHRONOUS MACHINE MODELING	9

Application of reference frame theory to three phase synchronous machine-dynamic model analysis-Park's equation - Voltage and torque equations - Deviation of steady state phasor relationship from dynamic model - Generalized theory of rotating electrical machine and Kron's primitive machine

Unit IV	ELECTRICAL MACHINE EQUIVALENT CIRCUIT PARAMETERS	9

Synchronous machine dynamic equivalent circuit parameters - Standard and derived machine time constants - Frequency response test, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.

Unit V	SPECIAL MACHINES	9

Permanent magnet synchronous machine, Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines - Construction and operating principle - Dynamic modeling and self controlled operation – Dynamic analysis of Switched Reluctance Motors.

TEXT BOOK(S):

1.	Harles Kingsley Jr., A.E. Fitzgerald and Stephen D.Umans, "Electric Machinery", New York, McGraw-Hill Higher Education, 2010.
2.	Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", New Jersey, Wiley Student Edition, 2013

REFERENCE(S):

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

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Dept. of EEE - ESEC

2.	J. R. Hendershot, James R. Hendershot, Timothy John Eastham Miller, "Design of Brushless Permanent-magnet Machines" , Motor Design Books, 2010.
3.	K.T Chau, ,"Electric Vehicle Machines and Drives: Design, Analysis and Application", John Wiley & Sons, 2015.

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Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE205	ELECTRICAL DRIVES LABORATORY	0	0	2	1	30	100	

Course Objective (s): To impart the theoretical and practical knowledge on

- Design and analyse the various DC and AC drives.
- Generating 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

Course Outcomes: At the end of this course, learners will be able :

- To simulate different types of machines, converters in a system.
- To analyze the performance of various electric drive systems.
- To perform both hardware and software simulation.

LIST OF EXPERIMENTS

1. Speed control of Converter fed DC motor
2. Speed control of Chopper fed DC motor
3. V/f control of three-phase induction motor
4. Microcontroller based speed control of stepper motor
5. Speed control of BLDC motor
6. DSP based speed control of SRM motor
7. Voltage regulation of three phase synchronous generator
8. Cyclo convertor fed Induction motor drive
9. Single phase Multi Level Inverter based induction motor drive
10. Study of power quality analyzer

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE206	MINI PROJECT	0	0	2	1	30	100	

Course Objective (s): To impart the theoretical and practical knowledge

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

Course Outcomes: At the end of this course, learners will be able to:

- Acquire practical knowledge within the chosen area of technology for project development
- Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
- Contribute as an individual or in a team in development of technical projects
- Develop effective communication skills for presentation of project related activities

PROCEDURE

A project to be developed based on one or more of the following concepts.

Rectifiers, DC-DC Converters, Inverters, Cyclo Converters, DC drives, AC drives, Special Electrical Machines, Renewable Energy Systems, Linear and non-linear control systems, Power supply design for industrial and other applications, AC-DC power factor circuits, micro grid, smart grid and robotics.

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Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE207	TECHNICAL SEMINAR - II	0	0	2	0	30	100	

Course Objective: In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

TECHNICAL SEMINAR **30**

The work involves the following steps:

- Selecting a subject, narrowing the subject into a topic
- Stating an objective.
- Collecting the relevant bibliography (atleast 15 journal papers)
- Preparing a working outline.
- Studying the papers and understanding the authors contributions and critically analyzing each paper.
- Preparing a working outline
- Linking the papers and preparing a draft of the paper.
- Preparing conclusions based on the reading of all the papers.
- Writing the Final Paper and giving final Presentation

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Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester III	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PE301	PROJECT WORK - PHASE I	0	0	12	6	180	100	

Course Objective: 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

Methodology 180

The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of construction engineering and management. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

Chairman - BoS
Dept. of EEE - ESEC

<table>
<tr><td>Programme</td><td colspan="5">ME - POWER ELECTRONICS AND DRIVES</td><td>R 2019</td><td>Semester IV</td><td>EEC</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td rowspan="2">Total Hours</td><td colspan="2" rowspan="2">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>19PE401</td><td>PROJECT WORK - PHASE II</td><td>0</td><td>0</td><td>24</td><td>12</td><td>360</td><td colspan="2">100</td></tr>
<tr><td colspan="9">Course Objective: 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.</td></tr>
<tr><td colspan="8">Methodology</td><td>360</td></tr>
<tr><td colspan="9">• The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of construction engineering and management. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.</td></tr>
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Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX01	EMBEDDED CONTROL OF ELECTRIC DRIVES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To design and analyze the various electric drives within an embedded system.
- To interface between processors & peripheral devices related to embedded processing.
- To design and formulate efficient programs on any dedicated processor.
- To apply the basic concepts of systems programming like operating system, assembler compliers Etc., and the management task needed for developing embedded system.
- To study about the applications of embedded control of electric drives.

Course Outcomes: At the end of this course, learners will be able to:

- Ability to gain knowledge about hardware units of Embedded System into a System
- Ability to apply microcontroller and PIC controller in electric drives
- Ability to gain knowledge about architecture units of DSP processor.
- Ability to know about the peripherals interfacing among various devices
- Ability to design Embedded System Design Using PIC Controllers

Unit I	**8051 ARCHITECTURE**	9

Basic organization - 8051 CPU structure - Memory Organization – Addressing modes - Instruction set – Programming – Timing diagram – Memory expansion.

Unit II	**PERIPHERALS AND VERSIONS OF 8051**	9

Parallel Ports – Timers and Counters – Interrupts – Serial Communication – Simple Programs ADC, DAC and Analog Comparator – PWM and Watch dog timer options in PIC 16F877A.

Unit III	**ARCHITECTURE OF DSPIC**	9

DSPIC30F4011-Architecture – Timer- I/O ports-PWM module-ADC-Case study.

Unit IV	**PERIPHERALS INTERFACING OF DSPIC**	9

I/O Ports – Timers / Counters – Capture / Compare / PWM modules – Master Synchronous Serial Port (MSSP) module – USART – A / D Converter module – Comparator module.

Unit V	**APPLICATIONS USING 8051 AND PIC16F87XA**	9

Real Time Clock – DC motor speed control – Generation of gating signals for Converters and Inverters – Frequency measurement – Temperature control – Speed control of induction motors – Implementation of PID controller.

TEXT BOOK(S):

1. Muhammad Ali Mazidi, JaniceGillispie Mazidi, Rolin D. McKinlay, " The 8051Microcontroller and Embedded Systems- Using Assembly and C", Prentice Hall of India, New Delhi, 2008.
2. Muhammad Ali Mazidi, JaniceGillispie Mazidi, Rolin D. McKinlay, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Prentice Hall of India, New Delhi, 2007.

REFERENCE(S):

1. Dogan Ibrahim, Designing Embedded Systems with 32-Bit PIC Microcontrollers and MikroC Newnes, 2013
2. Kenneth Ayls, "The 8051 Microcontroller",Cengage Learning 3rd Edition,2007. David Calcutt, Fred Cowan, Hassan Parchizadeh, "8051 Microcontrollers - An Application Based Introduction", Elsevier, 2006.
3. Subrata Ghoshal,"Embedded Systems & Robots: Projects Using The 8051 Microcontroller", Cengage Learning, 2nd Edition, 2009..

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19PEX02	VIRTUAL INSTRUMENTATION SYSTEMS	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is

- To provide an overview of Virtual instruments
- To bring out the overview of the software (LabVIEW).
- To know about the programming structure of the software.
- To know about the hardware structure configuration.
- To familiarize the student with the Applications.

Course Outcomes: At the end of this course, learners will be able to:

- Ability to understand the concept of virtual instrumentation systems
- Ability to understand the programs with LABVIEW.
- Ability to understand the programming structure of the software.
- Ability to understand the hardware structure configuration.
- Ability to understand the machine vision techniques.

Unit I INTRODUCTION 9

General functional description of a digital instrument - Block diagram of a Virtual Instrument – Physical quantities and analog interface- Hardware and software- User interfaces - Advantages of virtual instruments over conventional instruments – Architecture of a virtual instrument and its relation to the operating system.

Unit II SOFTWARE OVERVIEW 9

Lab View – Graphical user interfaces- Controls and inductors – "G" programming – Data flow programming- Editing – Debugging and running a virtual instrument – Graphical programming pallets - Fronts panel objects - Controls, indicators, object properties and their configuration – Typical examples.

Unit III PROGRAMMING STRUCTURES 9

FOR loops - WHILE loops - CASE structure - Formula node - Sequence structures - Arrays and clusters - Array operations – Bundle - Bundle/unbundled by name - Graphs and charts - String and file I/O – High level and low file I/Os - Attribute modes local and global variables.

Unit IV HARDWARE ASPECTS 9

Installing hardware - Installing drives - Configuring the hardware - Addressing the hardware in Lab VIEW - Digital and analog I/O function – Data acquisition – Buffered I/O – Real time data acquisition.

Unit V LAB VIEW APPLICATIONS 9

Motion control - General applications - Feedback devices - Motor drives - Machines vision - Lab VIEW IMAQ vision - Machine vision techniques – Configuration of IMAQ DAQ card – Instrument connectivity - GPIB, serial communication – General, GPIB hardware and software specifications – PX1/PC1 Controller and Chassis configuration and installation.

TEXT BOOK(S):

1. Garry M Johnson, "Lab view Graphical Programming", Tata McGraw Hill book Co, New Delhi, 2006
2. Link "LabVIEW : Basics I & II Manual ", National Instruments, Bangalore, 2011

REFERENCE(S):

1. Jovitha Jerome, "VIRTUAL INSTRUMENTATION USING LABVIEW", PHI Learning Pvt. Ltd., 2010
2. Jeffrey Travis and Jim Kring ," LabVIEW for Everyone: Graphical Programming made Easy and Fun",Tata McGraw Hill book Co, New Delhi, 2006.
3. National Instruments Technical Staff," Lab VIEW: Basics I & II Manual", National Instruments, 2006

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX03	DIGITAL SIGNAL PROCESSORS FOR MODERN INDUSTRIAL DRIVES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To study the programmable digital signal processor architecture and programming techniques.
- To know the application of modern DSP controllers for modern drive applications.
- To apply DSP for engineering application programmable digital signal processor.
- To acquire knowledge on DSP based electric drives.
- To obtain knowledge on DSP based electric system.

Course Outcomes: At the end of this course, learners will be able to:

- Understand and remember the concept DSP Controllers
- Ability to understand the filter concept as well as to design the filters fordigital implementation
- Ability to determine the harmonics and its elimination methods
- Ability to design DSP based controller for industrial drives
- Ability to design DSP based controller for electrical systems

Unit I FUNDAMENTALS OF PROGRAMMABLE DSPs 9

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in P-DSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs– On chip Peripherals.

Unit II TMS320C24XX PROCESSOR 9

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals

Unit III ADSP 2812 PROCESSOR 9

Architecture – Data formats - Addressing modes – Groups of addressing modes- Instruction sets - Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals – Generating and finding the sum of series, Convolution of two sequences, Filter design.

Unit IV DSP BASED ELECTRIC DRIVES 9

Speed control of D.C.motors – Speed control of Induction Motors – PWM and SPWM implementations – Closed loop control – Implementation of Space Vector PWM for speed control of induction motors – Special Electrical machines – Sensor based and sensor less control of PMDC, BLDC and SRM

Unit V DSP BASED ELECTRICAL SYSTEMS 9

Online and Off line UPS systems - Use of DSP for UPS applications – Inverter stage – Converter stage – Battery Charger stage – Harmonic detection – Harmonic Elimination methods – Performance comparison with general purpose microcontrollers

TEXT BOOK(S):

1. B. Venkataramani and M. Bhaskar, "Digital Signal Processors – Architecture, Programming and Applications second edition", New Delhi, Tata McGraw Hill Publishing Company Limited. 2012
2. Ronald. E. Crochiere and Lawrence. R. Rabiner. Multirate "Digital Signal Processing", Published on 2012.

REFERENCE(S):

1. Dimitris G Manolakis , John G. Proakis, "Digital Signal Processing : Principles, Algorithms, and Applications 4th Edition" published on 2007.
2. Manolakis D G, "Applied Digital Signal Processing: Theory and Practice" published by Cambridge university press-new delhi on 2012.
3. K. Padmanabhan, S. Ananthi and R. Vijayarajeswaran, "A Practical approach to Digital Signal Processing", New Delhi, New Age Publications, 2014.

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester I	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX04	ADVANCED CONTROL OF ELECTRIC DRIVES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To study the industrial advanced control methods of AC and DC drives
- To understand the control techniques of Induction Motor.
- To understand the theory and control techniques of PMSM Drives
- To design the model techniques of BLDC and reluctance Drives
- To analyze the operation of advanced Artificial-Intelligence Based Drives.

Course Outcomes: At the end of this course, learners will be able to:

- Ability to understand the principle of direct and indirect vector control of drives.
- Ability to analyze the vector control of Induction drives.
- Ability to model the control techniques of PMSM drives.
- Ability to model the PMSM and synchronous reluctance drives.
- Ability to apply artificial intelligence to electrical machines and drives.

Unit I | INTRODUCTION TO ADVANCED CONTROL | 9

Need for advanced controls, advanced control strategies for electrical drives -Scalar control open loop and closed loop control. Vector control, direct and indirect vector control. Direct torque control, Power Converter Control using State-Space Averaged Models - Sliding-Mode Control of Power Converters.

Unit II | INDUCTION MOTOR DRIVES | 9

Scalar control - Principle of vector or field oriented control - Direct and Indirect vector control- Derivation of indirect vector control scheme-Direct torque control of Induction motor - Multilevel converter fed induction motor drive - Sensor less control and flux observers.

Unit III | PERMANENT MAGNET SYNCHRONOUS MOTOR DRIVES | 9

Types of permanent magnet synchronous machines – Vector control of PM synchronous machine – model of PMSM – Vector control – control strategies – constant torque-angle control, unity power factor control, constant mutual flux-linkages control, optimum torque per ampere control, sensor less PMSM drive.

Unit IV | BRUSHLESS DC AND SYNCHRONOUS RELUCTANCE DRIVES | 9

PM brushless DC motor – Modeling – Drive scheme- Synchronous Reluctance Drives-Current vector control of Synchronous Reluctance Drives- Switched Reluctance Drives.

Unit V | ARTIFICIAL-INTELLIGENCE BASED DRIVES | 9

AI-Based Techniques - Applications in Electrical Machines and Drives - Neural-Network-Based Drives - commercial AI based Drives. The Fuzzy Logic Concept- Applications of Fuzzy Logic to Electric Drives - Fuzzy Logic Control of Power Converters- Hardware System Description.

TEXT BOOK(S):

1. Rik De Doncker , Duco W.J. Pulle , André Veltman , "Advanced Electrical Drives: Analysis, Modeling, Control", Published on 2011.
2. Ned Mohan, "Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink", Wiley Publications, 2014

REFERENCE(S):

1. Malcolm Barnes, "Practical Variable Speed Drives and Power Electronics ", Newness, 2003
2. Grafame Holmes D and Thomas A Lipo, "Pulse Width Modulation for Power Converters-Principles and Practice"- IEEE Press, 2003
3 N.P.Quang and J.A. Dittrich, "Vector Control of Three-Phase AC Machines", published on 2008.
4 Tze-Fun Chan, Keli Shi, "Applied Intelligent Control of Induction Motor Drives", John Wiley & Sons, 2011.

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX05	FACTS CONTROLLERS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To understand the need for FACTS
- To learn shunt and series compensation techniques
- To learn about the different types of series compensation
- To learn about controlled voltage and phase angle regulator
- To learn the concept of unified power flow controller

Course Outcomes: At the end of this course, learners will be able to:

- Ability to gain the knowledge of necessity of FACTS in power system.
- Ability to understand the operation of the compensator and its applications.
- Ability to understand the operation of different types of series compensator.
- Ability to understand the operation of static voltage and phase angle regulator.
- Ability to understand the various emerging Facts controllers.

Unit I	INTRODUCTION TO FACTS	9

Electrical Transmission Network - Necessity - Power Flow in AC System - relative importance of controllable parameter - opportunities for FACTS - possible benefits for FACTS.

Unit II	STATIC VAR COMPENSATION	9

Need for compensation - introduction to shunt & series compensation - objectives of shunt & series compensation - configuration & operating characteristics - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitor (TSC) -Comparison of TCR & TSC.

Unit III	SERIES COMPENSATION	9

Variable Impedance Type Series Compensation: Thyristor Switched Series Capacitor (TSSC)- Thyristor Controlled Series Capacitor (TCSC) - Basic operating control schemes for TSSC & TCSC.

Unit IV	STATIC VOLTAGE PHASE ANGLE REGULATOR	9

Objectives of voltage & phase angle regulators - approaches to Thyristor - Controlled Voltage & Phase Angle Regulator.

Unit V	EMERGING FACTS CONTROLLER	9

STATCOM - Introduction to Unified Power Flow Controller (UPFC) & Interline Power Flow Controller (IPFC) - basic operating principles UPFC - introduction to sub synchronous resonance.

TEXT BOOK(S):

1.	Xiao-Ping Zhang, Christian Rehtanz and, Bikash Pal, "Flexible AC Transmission Systems: Modelling and Control", published on 2012.
2.	K.R. Padiyar, "Facts Controllers In Power Transmission and Distribution", new age international publishers ltd.-new delhi, 2007.

REFERENCE(S):

1.	R. Mohan Mathur and Rajiv K.Varma, " Thyristor Based FACTS Controller forElectrical Transmission Systems," Wiley Interscience Publications, 2002.
2.	V Sridhar, Holalu Seenappa Sheshadri, M C Padma, "Emerging Research in Electronics, Computer Science and Technology", Springer Science & Business Media, 2013
3	T. J. E. Miller, "Reactive Power Control in Electric System", John Wiley & Sons, 2012.

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX06	SMART GRID	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

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

Course Outcomes: At the end of this course, learners will be able to:

- Learners will develop more understanding on the concepts of Smart Grid and its present developments.
- Learners will study about different Smart Grid technologies
- Learners will acquire knowledge about different smart meters and advanced metering infrastructure.
- Learners will have knowledge on power quality management in Smart Grids
- Learners will develop more understanding on LAN, WAN and Cloud 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.

TEXT BOOK(S):

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.

REFERENCE(S):

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: Communication Technologies and Standards” IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grids, vol. 14, 2012.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	SemesterII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX07	HARMONICS FILTER DESIGN	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To learn source and effects of harmonics.
- To understand the concept of harmonic measurement.
- To design & analyze the passive filter.
- To design & analyze the active filter.
- To know about the harmonic elimination techniques.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the source of harmonics.
- Analyse of various methods of harmonics measurement.
- Design & analyze active filter for particular applications.
- Design & analyze passive filter for particular applications.
- Understand about the the various harmonic elimination techniques.

Unit I SOURCE AND EFFECTS OF HARMONICS 9

Introduction to harmonics-linear and non linear loads-power quality indices-Source of harmonics: transformers, rotating machine, power converters- -harmonics standards. Effects of Harmonics: Thermal effects on electrical machines -Transformer-Rotating machines- Effects on communication system- Pulsating Torque in AC Drive-harmonics related losses.

Unit II HARMONIC MEASUREMENT AND ANALYSIS 9

Methods of harmonics measurement- Harmonic source representation- Harmonic Propagation facts- flux of harmonic currents- Interrelation between AC system and Load - Analysis methods- examples of harmonics analysis.

Unit III DESIGN OF PASSIVE FILTER 9

Harmonics Elimination Techniques: Selective harmonic elimination- Modulation based harmonics elimination technique- optimal PWM technique - Types of Passive filters-Design and Analysis of single tuned and Band Pass Filter- Tuned harmonic filter.

Unit IV DESIGN OF ACTIVE FILTER 9

Types of active power filter- Suppression of harmonics using active power filters – topologies and their control methods- Single Phase Shunt Current Injection type filter and its control-Three phase three-wire and four-wire shunt active filtering and their control using p-q theory and d-q modeling Introduction to Hybrid Filter- Case studies.

Unit V CONVERTERS AND REACTIVE ELEMENTS 9

Harmonic Cancellation through use of Multi pulse Converters-Series Reactors as Harmonic Attenuator Elements-Phase Balancing- Harmonic Losses in Equipment-Resistive Elements- Transformers- K Factor-Rotating Machines.

TEXT BOOK(S):

1. Francisco C. De La Rosa Taylor& Francis group" Harmonics and Power systems ",CRC Press.
2. Deare A Paice" Power Electronics Converter Harmonics", IEEE Press.

REFERENCE(S):

1. J. Arrillaga, N.R. Watson, "Power System Harmonics",Second Edition John Wiley & Sons, Ltd
2. S.A. Pactitis, "Active Filters: Theory and Design", CRC Press, 2007.
3. Enriques Acha, Manuel Madrigal, "Power System Harmonics: Computer Modeling & Analysis",John Wiley and Sons Ltd.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX08	SPECIAL MACHINES AND THEIR CONTROLLERS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To study the speed torque characteristics of Synchronous Reluctance Motor.
- To study the construction and operating principle of Switched Reluctance Motor.
- To study the construction and operating principle of Permanent Magnet Synchronous Motor.
- To study the construction and operating principle of Permanent Magnet Brushless DC Motor.
- To study the construction and operating principle of Stepping Motor.

Course Outcomes: At the end of this course, learners will be able to:

- Illustrate the construction and operating principle of Synchronous Reluctance Motor.
- Obtain the construction and operating principle of Switched Reluctance Motor.
- Illustrate the construction and operating principle of Permanent Magnet Synchronous Motor.
- Understand the construction and operating principle of Permanent Magnet Brushless DC Motor.
- Study the construction and operating principle of Stepping Motor.

Unit I **SYNCHRONOUS RELUCTANCE MOTORS** 9

Constructional features: axial and radial air gap Motors - Operating principle - Reluctance torque – Phasor diagram - Motor characteristics.

Unit II **SWITCHED RELUCTANCE MOTORS** 9

Constructional features - Principle of operation - Torque equation - Power controllers - Characteristics and col - Microprocessor based controller.

Unit III **PERMANENT MAGNET SYNCHRONOUS MOTORS** 9

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

Unit IV **PERMANENT MAGNET BRUSHLESS DC MOTORS** 9

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

Unit V **STEPPING MOTORS** 9

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

TEXT BOOK(S):

1. T.J.E.Miller and JRHendershot Jr.,"Design of Brushless Permanent Magnet Motors, USA, Oxford UniversityPress,2010.
2. T.J.E.Miller",Reluctance Motor and their Controls",USA,Oxford University Press, 2001.

REFERENCE(S):

1. Paul Acarnley, Stepping Motors,UK, IET, 2002
2. Chang-liang Xia, "Permanent Magnet and Brush less DC motors", John Wiley & Sons, 2012
3. N.K. Sinha, "Microprocessor-Based Control Systems", Springer Science & Business Media, 2012

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX09	MODERN INDUSTRIAL DRIVES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To provide an overview of PLC based control of drives.
- To provide an overview of DCS based control of drives.
- To know about the FPGA based controls.
- To familiarize the student with the ARM based control of electrical Machines.
- To familiarize the student with the DSP based control of electrical Machines.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the SCADA and PLC based motor controls.
- Study the overview of DCS based drives.
- Learn the principle of FPGA based control of drives.
- Understand ARM processor based machine control.
- Understand DSP processor based machine control.

Unit I PLC BASED INDUSTRIAL CONTROL 9

PLC architecture, Ladder logic Programming, Programming based on Timer And Counter, PLC Interface, Introduction to SCADA Software, PLC based Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller and Variable speed AC motor drive.

Unit II DISTRIBUTED CONTROL AND COMPUTER NUMERICAL SYSTEM 9

Basics DCS introduction, DCS components/block diagram, DCS specification, latest trend and developments, Computer Numerically Controlled (CNC) Machines, Basic CNC Principle, servo control, types of servo control for motion axes, CNC based Lathe and drilling machine control.

Unit III FPGA BASED CONTROLS 9

FPGA-architectures-Types of FPGA ,Xilinx XC3000 series ,Configurable logic Blocks (CLB), Input/ Output Block (IOB) , overview of Spartan 3E and Virtex III pro FPGA boards-Introduction to VHDL programming-simple programs-Control of DC motor-Induction motor speed control- Synchronous motor drive.

Unit IV POWER CONVERTERS FOR ELECTRIC DRIVES 9

Introduction of ARM Processors -ARM7 Architecture -Instruction Set –Programming-RTOS support-Control of DC motor-Induction motor speed control-Synchronous motor drive.

Unit V DSP PROCESSOR BASED MACHINE CONTROL 9

Introduction to the DSP core -The components of the DSP core, Mapping external devices to the core, Peripherals and Peripheral Interface, Assembly Programming using DSP, Instruction Set, Software Tools. DSP Based control of Stepper Motors, Permanent Magnet Brushless DC.

TEXT BOOK(S):

1. William Bolton, "Programmable Logic Controllers", Elsevier, 2011.
2. Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control", CRC Press, 2011.

REFERENCE(S):

1. Wayne Wolf, "FPGAbased system design",Prenticehall, 2004.
2. J.R.Gibson, "ARM Assembly language An Introduction", CENGAGE Learning, 2011.

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19PEX10	ADVANCED DIGITAL SIGNAL PROCESSING	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is

- To study about the discrete random process techniques.
- To study about the spectral estimation techniques.
- To understand the algorithm used in linear estimation and prediction.
- To study about the various types of adaptive filters.
- To study about the multi rate signal processing.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the basics of discrete random signal processing.
- Estimate the spectrum estimation techniques.
- Understand the algorithm used in linear estimation and prediction.
- Analyze the filters for noise cancellation and echo cancellation.
- Understand the wavelet transforms.

Unit I	DISCRETE RANDOM SIGNAL PROCESSING	9

Discrete Random Processes – Ensemble averages, stationary processes, Auto correlation and Auto covariance matrices – Parseval's Theorem – Wiener-Khintchine Relation – Power Spectral Density – Periodogram Spectral Factorization – Filtering random processes – Low Pass Filtering of White Noise – Parameter estimation: Bias and consistency.

Unit II	SPECTRUM ESTIMATION	9

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

Unit III	LINEAR ESTIMATION AND PREDICTION	9

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

Unit IV	ADAPTIVE FILTERS	9

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

Unit V	MULTIRATE DIGITAL SIGNAL PROCESSING	9

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

TEXT BOOK(S):

1. S MonsonH.Hayes,"StatisticalDigitalSignalProcessingandModeling",NewJersey,JohnWile y and Sons,2009
2. John G. Proakisand Dimitris. G. Manolakis, "Digital Signal Processing", New Delhi, PearsonEducation,2011

REFERENCE(S):

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1.	Steven M. Kay, "Fundamentals of Statistical Signal Processing": Practical algorithm development Prentice-Hall PTR, 2013
2.	J.S.Chitode, "Digital Signal Processing, Technical Publications", 2008

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester II PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19PEX11	FPGA CONTROLLER FOR POWER ELECTRONIC SYSTEMS	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is

- To understand the concept of a Field Programmable Gate array and be able to use itin real world applications.
- To understand the programme of VHDL in the FPGA.
- To understand the basics of simulation and implementation of state machine model.
- To understand the concept of Spartan 3E & FPGA boards.
- To understand how a hardware description language can simplify design of very large and complex applications in electronics.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the basic architecture and features of FPGA. ike Spartan3E and Virtex III pro .
- Understand the programming of FPGA.
- Implementation of FPGA in simulation.
- Understand the basic architecture of FPGA like Spartan3E and Virtex III pro .
- Recognize the applications of FPGA in power electronics based applications.

Unit I — INTRODUCTION — 9

Definition and construction of FPGA. Architecting an FPGA. Performance, density and capacity of an FPGA. Programmability issues. A study of the XC4000 configurable logic block. Introduction to major FPGA families, Xilinx, Altera and Cypress.

Unit II — PROGRAMMING OF FPGA — 9

Introduction to VHDL hardware description language. Programming elements, constructs and syntax. Entities and architecture, Creating combinational and synchronous logic. Details of function and procedures. Topics on identifiers, data objects, data types and attributes. Synthesis and fitting of designs.

Unit III — SIMULATION AND VERIFICATION OF THE PROGRAMS. — 9

Considerations of area, speed and device resource utilization in FPGA technology. Creating test benches. Systematic study of implementing state machines using VHDL.

Unit IV — OVER VIEW OF SPARTAN 3E AND VIRTEX III PRO FPGA BOARDS — 9

Block diagram representation & features of Spartan 3E and Virtex III pro FPGA boards- Pipe lining and resource sharing concepts of Virtex III pro and FPGA boards. Future advances in FPGA technology.

Unit V — APPLICATIONS OF FPGA BOARDS IN POWER ELECTRONICS — 9

Applications-Controlled Rectifier, Switched Mode Power Converters, PWM Inverters, DC motor control, Induction Motor Control using Virtex III pro FPGA board.

TEXT BOOK(S):

1. Clive Maxfield,"FPGA'S Instant Access", Newness, 2011
2. Rahul Dubey.,"Introduction to Embedded System Design Using Field Programmable Gate Arrays", Springer Science & Business Media, 2008

REFERENCE(S):

1. Peter Ashenden,"Design guide to VHDL" ,Morgan Kaufmann, 2010
2. Clive Maxfield, "The Design Warriors Guide to FPGAs", Elsevier, 2004
3. Kevin Skahill, "VHDL for Programmable logic". Pearson Education,1st edition 2006

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Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX12	SWITCHED MODE AND RESONANT CONVERTERS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To understand the basic topologies of switched mode converters.
- To understand the different types of modulation schemes.
- To understand the current control techniques of the converters.
- To understand the concepts of various closed loop control techniques.
- To estimate the switching and conduction losses taking place in switched mode converters.

Course Outcomes: At the end of this course, learners will be able to:

- Construct Buck, Boost, Buck-Boost converter.
- Construct Half Bridge and Full Bridge Inverters.
- Design the current control converters.
- Determine the various control techniques.
- Diagnose the cause of switching and conduction losses and switching stresses.

Unit I CONVERTER TOPOLOGIES 9

Buck, Boost, Buck – Boost SMPS Topologies. Basic Operation – Waveforms – modes of operation – switching stresses – switching and conduction losses – optimum switching frequency – practical voltage, current and power limits – design relations – voltage mode control principles.

Unit II CARRIER MODULATION. 9

Switch-Mode dc-ac Inverters - Basic Concepts - Single Phase Inverters - Push Pull - Half Bridge and Full Bridge Square Inverters - Blanking Time - Single Pulse Modulation of Single Phase Square Wave Inverters - Multi pulse modulation - PWM Principles - Sinusoidal Pulse Width Modulation in Single Phase Inverters - Choice of carrier frequency in SPWM - Bipolar and Unipolar Switching in SPWM.

Unit III CURRENT CONTROL SCHEMES. 9

Current Regulated Inverter - Current Regulated PWM Voltage Source Inverters - Methods of Current Control - Hysteresis Control - Variable Band Hysteresis Control - Fixed Switching Frequency Current Control Methods - Switching Frequency Vs accuracy of Current Regulation - Areas of application of Current Regulated VSI.

Unit IV CLOSED LOOP CONTROL 9

Switched Mode Rectifier - Operation of Single/Three Phase Bridges in Rectifier Mode - Control Principles- Control of the DC Side Voltage - Voltage Control Loop - The inner Current Control Loop.

Unit V POWER FACTOR CONTROL 9

Shunt Reactive Power Compensators - Switched Capacitors - Static Reactor Compensators based on thyristor- Static Reactive VAR Generators using PWM Current Regulated VSIs - Principles - Control Strategies -Series Compensation by PWM-VSI based Voltage Injection Scheme - Principles - Control Strategies.

TEXT BOOK(S):

1. AbrahamI. Pressman ,Keith Billingsand Taylor Morey, "Switching Power Supply Design", New York, McGraw-Hill,2009.
2. Simon Ang, Alejandro Oliva,"Power-Switching Converters", Second Edition CRC Press, 2005

REFERENCE(S):

1. NedMohan, Tore M. Undeland and WilliamP .Robbins," Power Electronics: Converters, Applications and Design", NewJersey, JohnWileyandSons,2007.
2. Luca Corradini, Dragan Maksimović, Paolo Mattavelli, Regan Zane, "Digital Control of High-Frequency Switched-Mode Power Converters", John Wiley & Sons, 2015
3 Teuvo Suntio,"Dynamic Profile of Switched-Mode Converter: Modeling, Analysis and Control",John Wiley & Sons, 2009

Chairman - BoS
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<table>
<tr><td>Programme</td><td colspan="5">ME - POWER ELECTRONICS AND DRIVES</td><td>R 2019</td><td>Semester III PE</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td rowspan="2">Total Hours</td><td rowspan="2">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>19PEX13</td><td>MODELING AND CONTROL OF POWER ELECTRONIC SYSTEMS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>45</td><td>100</td></tr>
</table>

Course Objective (s): The purpose of learning this course is

- To understand the steady state analysis of converters.
- To understand the dynamics control of Power Electronic Circuits.
- To model and analyze the transfer function of different converters.
- To design the various controller for power electronic circuits.
- To design and model the AC & DC equivalent circuit.

Course Outcomes: At the end of this course, learners will be able to:

- Design a controller for steady state analysis of converters
- Design a dynamic control for power converters.
- Derive the transfer functions of power electronic converters.
- Design a controller for power switching circuits.
- Determine the equivalent circuit modeling of discontinuous conduction mode.

Unit I CONVERTERS IN EQUILIBRIUM 9

Principles of steady state converter analysis – Steady-state equivalent circuit modeling, Losses, and Efficiency – Switch realization – The discontinuous conduction mode.

Unit II CONVERTER DYNAMICS AND CONTROL 9

AC equivalent circuit modeling – The basic AC modeling approach, State-Space averaging, circuit averaging and averaged switch modeling, the canonical circuit model, Modeling the pulse- width modulator.

Unit III CONVERTER TRANSFER FUNCTIONS 9

Review of Bode Plots – Pole zero response, frequency inversion, quadratic pole response: resonance, the low-Q approximation, approximate roots of an arbitrary-degree polynomial. Analysis of converter transfer function, Graphical construction of impedance and transfer functions – series impedance, series resonant, parallel impedance, parallel resonant, voltage divider transfer functions. Graphical construction of converter transfer functions.

Unit IV CONTROLLER DESIGN 9

Effect of negative feedback on the network transfer functions – construction of important quantities 1/(1+T) and T/(1+T) and the closed-loop transfer functions – stability – regulator design – measurement of loop gains.

Unit V AC AND DC EQUIVALENT CIRCUIT MODELING 9

AC and DC Equivalent Circuit Modeling of the Discontinuous Conduction Mode DCM averaged switch model – Small-Signal AC modeling of the DCM switch network – High Frequency dynamics of converters in DCM.

TEXT BOOK(S):

1. Ericson , "Fundamentals of Power Electronics", Springer Science & Business Media, 2013.
2. " Power electronics", WILEY edition, 2009.G.K.. Dubey, "Fundamental of electric drives", Second edition, Alpha Science

REFERENCE(S):

1. SeddikBACHA,"Power Electronic Converters Modeling and Control"., Springer Science & Business Media, 2013
2. S.K..Bhattacharya , "Fundamental of power electronics", UBS Publishers, Second edition 2009.

Chairman - BoS
Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX14	POWER ELECTRONICS APPLICATIONS TO POWER SYSTEM	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To impart knowledge on HVDC system.
- To analyze the different types of converter configurations.
- To study the different types of compensator for load balancing.
- To design and analyze the different types of reactive power compensation schemes for converters.
- To impart the knowledge of series and shunt compensation.

Course Outcomes: At the end of this course, learners will be able to:

- Illustrate the characteristics of different types of HVDC converter configurations.
- Determine the different control functions required for HVDC link with converters.
- Understand the load balancing in AC and DC system.
- Analyses the reactive power compensation methods.
- Analyze the engineering problems and identify suitable shunt or Series Compensation devices for given applications.

Unit I — HVDC SYSTEM — 9

HVDC configurations, components of HVDC system: Converter, transformer, smoothing reactor, harmonic filter. Reactive power support, operation of 6-pulse controlled rectifier in inverting mode of operation. Operation of 12- pulse converter. Control of HVDC system, Rectifier and inverter characteristics, mode stabilization, current control, voltage dependent current order limit, combined rectifier-inverter characteristics, valve blocking and by - passing, limitations HVDC system using line commutated converters, modern HVDC system - HVDC light.

Unit II — ANALYSIS OF CONVERTERS AND THEIR CONTROL — 9

Pulse number-analysis of Graetz circuit-characteristics of twelve pulse converter – Dc link control –converter Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system; Starting and stopping of DC link; Power Control.

Unit III — LOAD BALANCING — 9

Limitations of load balancing using passive elements, Use of VSI as a Var generator, Indirect current controlled synchronous link converter Var Compensator (SLCVC). Bi-directional power flow in VSI, Use of VSI as active filter cum Var generator, Current controlled SLCVC, Strategy-1: Sensing the compensator current, Strategy-2: Sensing the source current, Use of two VSIs, one as Var generator and another as active filter.

Unit IV — REACTIVE POWER COMPENSATION — 9

Instantaneous reactive power theory, expression for active and reactive powers in terms of d-q components. Reactive power compensator using instantaneous reactive power theory, stationary to rotating frame transformation. Reference wave generation (hardware method), harmonic oscillator, Phase locked loop (PLL) Introduction on one cycle control, discussion on one cycle controlled Var generator and active filter.

Unit V — SHUNT AND SERIES COMPENSATION — 9

Introduction, methods of Var generation, analysis of uncompensated AC line, Passive reactive power compensation, Compensation by a series capacitor connected at the mid point of the line, Effect on Power Transfer capacity, Compensation by STATCOM and SSSC, Fixed capacitor- Thyristor controlled reactor (FC-TCR), Thyristor-switched capacitor- Thyristor controlled reactor (TSC-TCR), static var compensators.

TEXT BOOK(S):

1. K.R. Padiyar, "HVDC Power Transmission System – Technology and System Interaction", New Delhi, New

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	Age International, 2002.
2.	Jos Arrillaga, Y. H. Liu, Neville R. Watson," Flexible Power Transmission: The HVDC Option's, John Wiley &Sons, 2007
REFERENCE(S):	
1.	Ewald Fuchs, Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines", Academic Press, 2011.
2.	Ned Mohan, Power Electronics Converters Applications and Design, New York, John Wiley Sons, 2002.
3	R. Mohan Mathur, Rajiv K. Varma, "Thyristor-Based FACTS Controllers for Electrical Transmission Systems", John Wiley & Sons, 2002

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Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester III PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19PEX15	FINITE ELEMENT ANALYSIS OF ELECTRICAL MACHINES	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is

- To design electrical apparatus using finite element method.
- To design and analyze the eddy current method.
- To analyze the manipulation of machines.
- To analyze the steady state condition of IM.
- To apply the finite element method to study the behavior of Synchronous Machines.

Course Outcomes: At the end of this course, learners will be able to:

- Analyze and design the electrical machines by integrating mathematical equations
- Determine the various electrical quantities required for machine design
- Solve the non linear problems of machines.
- Determine the model of steady state Induction Machine.
- Determine the model of steady state Synchronous Machine.

Unit I	INTRODUCTION TO FINITE ELEMENTS	9

Introduction- Galerkin Finite element method-Boundary conditions-non linear problems- Permanent Magnet modeling

Unit II	EDDY CURRENT ANALYSIS	9

Eddy current and skin effect- Elliptical description of flux density - eddy currents in non linear materials-Non linear permeability models-coupling finite elements to external circuits-modeling considerations

Unit III	COMPUTATION OF PARAMETERS	9

Computation of eddy current loss, losses in a series winding-resistance, inductance- calculation of force and torque- ampere's force law, Maxwell stress method, using machine models to find torque-errors in force computation.

Unit IV	INDUCTION MOTOR IN STEADY STATE	9

Steady state parameters- frequency response- reactance calculation- time domain modeling of induction machine- Galerkin formulation-global system of equations.

Unit V	SYNCHRONOUS MACHINES IN STEADY STATE	9

Basic configuration of synchronous machine-steady state operation-Modeling considerations- excitation calculation-computation of steady state reactance-Poynting Vector method

TEXT BOOK(S):

1. Sheppard Salon, "Finite Element Analysis of Electrical Machines", Springer Science & Business Media, 2012
2. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudh off, "Analysis of Electric Machinery and Drive Systems" New Jersey, Wiley Student Edition, 2013

REFERENCE(S):

1. Craig DiLouie , "Advanced Lighting Controls: Energy Saving Productivity", Technology & Applications, Fairmont Press, Inc., 2006
2. Zhangxin Chen, "Finite element methods and their applications", Springer, 2013.
3 Sheppard J.Salon, "Finite element analysis of electrical machine", Springer, 2007.

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Dept. of EEE - ESEC

Programme	ME - POWER ELECTRONICS AND DRIVES					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19PEX16	SENSORS AND INSTRUMENTATION SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To understand the concept of sensors.
- To understand about mechanical and electromechanical sensors.
- To bring out the overview of thermal and magnetic sensors.
- To study the concept of smart sensors and their technologies.
- To design signal conditioning circuits for sensors.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the principle and characteristics of sensors.
- Analyze the mechanical and electromechanical types of sensors.
- Analyze the thermal and magnetic types of sensors.
- Understand the concept of smart sensors Technology
- Design interfacing and signal conditioning circuits for sensors.

Unit I	INTRODUCTION TO SENSORS	9

Introduction, Aim of measurement, Roll of sensors in engineering-Sensors-principles- classification-parameters: static & dynamic characteristics-Environmental parameters. Electrical, mechanical, thermal characteristics-selection of sensors.

Unit II	MECHANICAL AND ELECTROMECHANICAL SENSORS	9

Resistive potentiometers, strain gauge, LVDT, Inductive and Capacitive sensors, Force &stress sensors, ultrasonic sensors.–Electrostatic transducers-RVDT, DC tachometer, AC tachometer, optical tachometer, Rotary encoder, eddy current, drag cup type tachometer, magnetic, stroboscope, gyroscope.

Unit III	THERMAL & MAGNETIC SENSORS	9

Introduction-gas thermometric sensors-thermal expansion type-Acoustic temperature sensors- dielectric constant and refractive index sensors-nuclear thermometer –thermal EMF and radiation sensors-principle of magnetic sensors-yoke coil & coaxial type sensors-magneto resistive sensors- magnetic thermometers.

Unit IV	SMART SENSORS	9

Introduction, primary sensors, converters, compensation. Recent trends in sensor technology film sensors, semiconductor IC technology, MEMS, Nano-sensors.

Unit V	DESIGN OF SIGNAL CONDITIONING CIRCUITS FOR SENSORS	9

Interfacing of Sensors and Signal conditioning-wireless sensor Network: Wireless sensor based on microcontroller and communicating device-Zigbee and communication device-Power supply to sensors: from mains, battery, solar and wind energy.

TEXT BOOK(S):

1.	"Transducers and Instrumentation", by D.V.S. Murthy (PHI).2008,2nd edition.
2.	Ezzat G. Bakhoum, "Micro- and Nano-Scale Sensors and Transducers", CRC Press, 2015

REFERENCE(S):

1.	S Ruocco, "Robot sensors and transducers", Springer Science & Business Media, 2013
2.	John G. Webster, HalitEren.," Measurement, Instrumentation, and Sensors", CRC Press, 2014
3	"Sensor and actuator :control system instrumentation" By Clarence W. de Silva,crc press,2007

Chairman - BoS
Dept. of EEE - ESEC

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19PEX17	AUTOMOTIVE ELECTRONICS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To study the concept of automobiles in electronics
- T Know the internal structure and the switching characteristics of the basic systems
- To understand the working concept of sensors and actuators
- To study the concept of engine Control Systems.
- To study the advanced power devices and its working principle.

Course Outcomes: At the end of this course, learners will be able to:

- Determine the suitable devicefor the application.
- Design of Ignition & injection systems and its parameters.
- Design of Sensors and actuator of switching system
- Understand the engine control systems.
- Determine the reliabilityof the system.

Unit I INTRODUCTION 9

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards, Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits

Unit II IGNITION AND INJECTION SYSTEMS 9

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition– Distribution less ignition -Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions –Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

Unit III SENSOR AND ACTUATORS 9

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall Effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator.

Unit IV ENGINE CONTROL SYSTEMS 9

Control modes for fuel control- engine control subsystems – ignition control methodologies different ECU"s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

Unit V CHASSIS AND SAFETY SYSTEMS 9

Traction control system – Cruise control system – electronic control of automatic transmission antilock braking system –electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system –climate control of cars.

TEXT BOOK(S):

1. Tom Denton. "Automobile electrical and electronic system", Edward Arnold publishers, 4thEdition , 2012
2. WilliamB. Ribbens, "Understanding Automotive Electronics", Newness 7th Edition2012.

REFERENCE(S):

1. Al Santini,"Automotive Electricity & Electronics" Cengage Learning, 2012
2. Muhammad Rashid,"Power Electronics Hand booke, Elsevier, 2011
3 William B.Ribbens, Understanding automotive electronics, an engineering perspective, Elsevier 2014

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19PEX18	HVDC SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To understand about the importance of HVDC transmission
- To analysis the HVDC converters.
- To understand the control of converters.
- To study the faults in converters and its protection
- To deal with harmonics and filters of the system.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the concept, planning of DC power transmission and comparison with AC power transmission.
- Analyze HVDC Converters.
- Understand the control of converters.
- Analyze the faults in converters.
- Investigate harmonics and filters.

Unit I INTRODUCTION 9

Introduction of DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Structure of HVDC transmission system – Reactive power demand-Economic considerations – Modern trends in DC transmission.

Unit II ANALYSIS OF HVDC CONVERTERS 9

Pulse number converters – Choice of converter configuration – Properties of Thyristor converter circuits – Three phase converters - Simplified analysis of Graetz circuit with and without overlaps Characteristics of a twelve pulse converter – Transformer connections.

Unit III CONTROL OF CONVERTERS 9

Principal of DC Link Control – Basic means of control – Gate Control - Power reversal - Constant current versus constant voltage- Converters Control Characteristics – Firing angle control – Current and extinction angle control- Frequency control – Effect of source inductance on the system- Starting and stopping of DC link-Power Control.

Unit IV FAULTS IN CONVERTERS AND ITS PROTECTION 9

Converter disturbance – By pass action in bridge – Short circuit on a rectifier – Commutation failure- Basics of protection - DC reactors - Voltage and current oscillations - Clearing line faults and re-energizing - Circuit breakers - Overvoltage protection.

Unit V HARMONICS AND FILTERS 9

Introduction – Generation of harmonics –Effects of harmonics and its mitigation-Design of AC filters and DC filters – Corona loss in HVDC lines - Radio interference due to corona- Grounding –advantages and problems.

TEXT BOOK(S):

1. Padiyar K.R., “HVDC Power Transmission System /direct current”, New Academic Science, 2011.
2. Vijay K Sood “HVDC and FACT Controllers: Application of Static Converter in Power Systems” Kluwer Academic Publication, 2006

REFERENCE(S):

1. DraganJovcic, Khaled Ahmed” High Voltage Direct Current Transmission“ .,John Wiley & Sons,2015
2. Colin Adamson and Hingorani N G, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, 1960.
3. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International (P) Ltd,New Delhi,2011.

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19PEX19	OPTIMIZATION TECHNIQUES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To Study the concept of Optimization
- To learn about linear programming
- To learn about nonlinear programming
- To learn geometric and integer programming.
- To learn the dynamic programming

Course Outcomes: At the end of this course, learners will be able to:

- Learn the optimization techniques
- Learn the different types of linear programming
- Learn the non-linear programming
- Know about the geometric and integer programming
- Understand their dynamic programming and their application

Unit I	INTRODUCTION TO OPTIMIZATION	9

Engineering Applications - Classification of optimization problems - Classical optimization techniques - Single and multivariable optimization – multivariable optimization with and without constraints - Lagrange model - Kuhn - tucker conditions.

Unit II	LINEAR PROGRAMMING	9

Applications - Standard form of LPP - definitions and Theorem - Solution of a system of Linear simultaneous equations - Pivoted reduction - Simplex algorithm - Identifying an optimal point Revised simplex methods - Gauss Jordan Elimination process - Duality in linear programming Decomposition principle – Transportation problem - Northwest corner rule - Least cost method

Unit III	NON LINEAR PROGRAMMING	9

Nonlinear programming - one dimensional minimization methods - unrestricted search Exhaustive search - Interpolation and Quadratic interpolation method - Cubic method unconstrained optimization techniques -Direct search methods - simplex method - Descent methods - Gradient of a function – Steepest Descent method - Constrained optimization techniques - Transformation techniques - sequential unconstrained minimization techniques Interior and exterior penalty function method

Unit IV	GEOMETRIC PROGRAMMING AND INTEGER PROGRAMMING	9

Geometric programming - Polynomial - Unconstrained minimization problem – Constrained minimization problem - Primal and Dual programmes – Geometric programming with mixed in equality constraints – Complementary geometric programming. Integer linear programming Mixed integer programming – Integer non linear programming – Sequential linear discrete programming.

Unit V	DYNAMIC PROGRAMMING	9

Dynamic programming: Multistage decision processes – Concept of sub-optimization – Principle of optimality – Conversion of a final value problem into an initial value problem – Linear programming as a case of dynamic programming – Continuous dynamic programming Applications

TEXT BOOK(S):

1. Rao, S.S., "Optimization Theory and Applications", Wiley Eastern Ltd., Second Edition,2009
2. Rao, S.S., "Engineering Optimization Theory and Practice - Third Edition", New Age International, 2009.

REFERENCE(S):

1. Donald A. Pierre.,"Optimization Theory with Applications", Courier Corporation, 2012
2. David G. Luenberger, Yinyu Ye.,"Linear and Nonlinear Programming",Springer Science & Business Media, 2008
3. Hamdy A. Taha.,"Integer Programming: Theory, Applications, and Computations",Academic Press, 2014

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Dept. of EEE - ESEC

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19PEX20	HYBRID ELECTRIC VEHICLES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is

- To understand the basics of electric and hybrid vehicles.
- To understand the configuration of energy storage.
- To understand the working configuration of electric propulsion
- To analyze various electric drives used in hybrid and electric vehicles
- To learn about IC Engine Components

Course Outcomes: At the end of this course, learners will be able to:

- Determine the mathematical model for electric vehicle.
- Identify suitable electric storage devices for a particular application.
- Analyze the different types of electric propulsion
- Analyze various power converters for electric vehicles
- Learn the different types of IC engine and their controls.

Unit I INTRODUCTION 9

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Basics of vehicle propulsion and mechanics, hybrid traction, electric vehicle architecture, Power train components, Mathematical models to describe vehicle performance

Unit II ENERGY STORAGE 9

Introduction to Energy Storage Requirements, Battery Fundamentals, Parameters and Modeling, Types, Battery based energy storage and its analysis: Types, Parameters and Modeling, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Unit III ELECTRIC PROPULSION 9

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

Unit IV POWER CONVERTERS FOR ELECTRIC DRIVES 9

Introduction to power electronics switches, DC/DC Converters, Cell balancing converters, Buck Converter, Boost Converter, Buck-Boost Converter, Fourth Order DC/DC Converters, Power train boost Converters, Cell Balancing Converters.

Unit V IC ENGINES COMPONENTS, CONTROL & COMMUNICATION 9

Internal Combustion Engines-Economy and Emission control, Power train Components, Cooling System, Vehicle Control strategy, Vehicle communication

TEXT BOOK(S):

1. Iqbal Hussain, "Electric & Hybrid Vehicles –Design Fundamentals", Second Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

REFERENCE(S):

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000

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