SREE VIDYANIKETHAN ENGINEERING COLLEGE

(AUTONOMOUS)

Sree Sainath Nagar, Tirupati

Department of Electrical and Electronics Engineering

Supporting Document for 1.1.2

Syllabus Revision carried out in 2019

Program: M.Tech.- Power Electronic Drives

Regulations : SVEC-19

This document details the following:

1. Courses where syllabus has been changed 20% and more.
2. Course-wise revised syllabus with changes highlighted.

Note: *For SVEC-19 revised syllabus, SVEC-16 (previous syllabus) is the reference.*

List of Courses where syllabus content has been changed (20% and more)

S. No.	Course Code	Name of the course	Percentage of content changed	Page Number in which Details are Highlighted
1.	19MT18304	Control System Design	100	3
2.	19MT18305	Intelligent Controllers	25	5
3.	19MT10705	Digital Signal Processing	100	9
4.	19MT10706	Power Quality	20	11
5.	19MT18307	Electromagnetic Field Computation and Modeling	100	15
6.	19MT10708	Research Methodology and IPR	100	17
7.	19MT1AC01	Technical Report Writing	100	19
8.	19MT28301	Digital Control of Power Electronics and Drive Systems	100	21
9.	19MT28303	Advanced Power Electronic Circuits	100	23
10.	19MT28304	Multilevel Inverters	100	25
11.	19MT28305	Solar Energy Conversion Systems	100	27
12.	19MT28308	Switched Mode Power Supplies and UPS	100	29
13.	19MT28309	Wind Energy Conversion Systems	100	31
14.	19MT28331	Electrical Drives Lab	40	33
15.	19MT28332	Electrical Drives Simulation Lab	25	35
16.	19MT2AC01	Statistics with R	100	37
		Average %**(A)**	81.88	-
		Total No. of Courses in the Program **(T)**	28	
		No. of Courses where syllabus (more than 20% content) has been changed **(N)**	16	
		Percentage of syllabus content change in the courses **(C)=(A x N)/100**	13.1	
		Percentage of Syllabus Content changed in the Program (P)= C/T	**46.79**	

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SREE VIDYANIKETHAN ENGINEERING COLLEGE
Sree Sainath Nagar, A. RANGAMPET
CHITTOOR (DT.)-517 102, A.P.

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(AUTONOMOUS)
Sree Sainath Nagar, A. RANGAMPET
Chittoor (Dist.) - 517 102, A.P., INDIA.

M.Tech. - I Semester

(19MT18304) CONTROL SYSTEM DESIGN

(Program Elective - 1)
(Common to EPS and PED)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Course on Control systems in UG Level.

COURSE DESCRIPTION: Design of compensators and controllers; Controllability and obser vability of a system; Control systems design using state space; Nonlinear systems.

COURSEOUTCOMES: On successful completion of the course, students will be able to

CO1. Apply the knowledge of Lag, Lead and Lead-Lag compensators to analyze and design the systems in frequency and time domains for the given specifications.

CO2. Demonstrate the knowledge of PD, PI &PID Controllers to develop a suitable controller based on the required time and frequency domain specifications and analyze their performance.

CO3. Apply appropriate methods to solve linear and non-linear systems using state space approach.

CO4. Identify the attributes for analyzing the given non-linear systems.

DETAILED SYLLABUS:

Unit - I:Introductionto Design (09hours)

The Design Problem, Preliminary considerations of classical design, Realization of Basic Compensators, Design of Lead, Lag and Lag-Lead compensators using root locus technique. Lead, Lag and Lag-Lead compensators design using Bode plot.

Unit - II:ControllersDesign (09hours)

Introduction to controllers, Types of controllers, Effect of P, PI and PID controllers. Design of PI, PD and PID controllers using bode plot and root locus technique.

Unit - III: Controllability and Observability (09hours)

Review of state variable techniques – Concept of controllability and observability for Continuous Time Systems. Principles of Duality. Controllability and Observability of state models in Jordan canonical form and other canonical forms – effect of state feedback on controllability and observability.

Unit - IV: Design of Control Systems in State Space (09hours)

Necessity of pole placement, design by pole placement, necessary and sufficient conditions for arbitrary pole placement. Determination of feedback gain matrix using direct substitution method and Ackermann's formula. Full order observer and reduced order observer.

Unit-V:IntroductiontoNonLinearSystem (09hours)

Introduction to non-linear systems, behavior of non linear systems, common physical nonlinearities, describing function method, concept derivation of describing function method, phase plane method, singular points, stability of non linear system, construction of phase trajectories by isocline method.

Total hours: 45

TEXT BOOKS:

1. M. Gopal, *Modern Control System Theory*, 2nd edition, New Age International (P) Ltd., NewDelhi, 2005.
2. K. Ogata, *Modern Control Engineering,*4th edition, Prentice Hall of India,2006.
3. Hasan A. Khalil,*Nonlinear Systems*,3rd edition, Prentice Hall of India, 2002.

REFERENCE BOOKS:

1. Nagoorkani, *Advanced control theory*,2nd edition, RBA publications, Chennai,2009.
2. I.J. Nagrath and M.Gopal, *Control Systems Engineering*, New Age International (P) Ltd., New Delhi,2007.

M. Tech. – I Semester

(19MT18305) INTELLIGENT CONTROLLERS

(Program Elective – 1)
(Common to EPS andPED)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Engineering Mathematics, Electrical Machines, Power Systems at UGlevel.

COURSE DESCRIPTION: Neural Networks; Fuzzy Logic Systems; Genetic Algorithms; Differential Evaluation; Hybrid Intelligent Systems; Swarm intelligence; Applications.

COURSEOUTCOMES: Onsuccessfulcompletionofthecourse,studentwill be able to

CO1.Apply the conceptual knowledge of neural networks and fuzzy logic controllers, evolutionary algorithms in hybrid intelligent controllers to analyze and develop the suitable controller for solving engineering problems.

CO2.Analyze the conceptual knowledge of neural networks and fuzzy logic controllers and various evolutionary algorithms to provide optimal solutions.

DETAILED SYLLABUS:

Unit -I:NeuralNetworks (10hours)

Neural network architectures, perceptron model, learning strategies: supervised learning, radial basis function network, back propagation network. Unsupervised learning: Kohonen's SOM, reinforced learning, load forecasting using neural networks.

Unit - II: FuzzyLogicSystems (9hours)

Fuzzy sets: relations & operations, membership functions, Fuzzification, rule base, Inference mechanism, defuzzification and design of fuzzycontrol system,speedcontrolofseparatelyexcitedDCmotorusingfuzzylogic.

Unit - III: Genetic Algorithms andDifferential Evaluation (10 hours)

Genetic algorithms: Introduction to evolutionary computation, Genetic algorithms (GA): biological background, traditional optimization andsearch techniques, basic terminologies, simple GA, Flow chart, operators in GA, encoding, selection, crossover, mutation, constraints in GA, fitness function, advantages and limitations of GA, optimal allocation of DG using GA. Differential Evaluation: Overview, initialization, base vector selection, Differentialmutation,recombination,selectionandTerminationcriteria.

Unit - IV:SwarmIntelligence **(9hours)**

Introduction to swarm intelligence, Swarm intelligence algorithms-Ant colony optimization: Biological and artificial ant colony systems, applications of ant colony intelligence: Static & dynamic combinatorial optimization problems, Algorithm of Ant colony system, Particle swarm optimization: The basic PSO method, characteristic features of PSO, PSO algorithm, Optimum parameter setting for the best performance of PSO, Comparison with other Evolutionary computing techniques, MPPT of PV system by using PSO and Ant-colony.

Unit - V: Hybrid Intelligent Systems **(7 hours)**

Introduction to hybrid intelligent systems: Adaptive neuro-fuzzy Inference Systems, Architecture and learning. Fuzzy GA systems: rules generation. ANN Learning Using GA: Optimization of weights, Load forecastingproblem using Neuro-fuzzyapproach.

Total hours: 45

TEXT BOOKS:

1. S. N. Sivanandam, S.N. Deepa, *Principles of Soft Computing*, Wiley– India Edition,2008.
2. N.P. Padhy, *Artificial Intelligence and Intelligent Systems*, Oxford University press, 10th reprint,2011.

REFERENCE BOOKS:

1. SarojKaushik, *Artificial Intelligence, Cengage Learning India Private Limited*, Fifth Indianreprint, 2013.
2. 2. J.S.R. Jang, C.T. Sun, E. Mizutani, *Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence*, Pearson EducationLimited,2004.
3. Fakhreddine O. karray, Clarence De Silva, *Soft computing and Intelligent systems Design, Theory, tools and applications*, Pearson Education Limited,2009.
4. Kenneth V. Price · Rainer M. StornJouni A. Lampinen, *Differential Evolution, A Practical Approach to Global Optimization*, Springer, 2005.

M. Tech. (PED) – I Semester
(16MT18306)INTELLIGENT CONTROLLERS
(Professional Elective-1)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	4	-	-	4

PREREQUISITES: Engineering Mathematics, Power Electronics, Electrical machines and Control Systems at UG level.

COURSE DESCRIPTION: Neural Networks; Fuzzy Logic Systems; Genetic Algorithms; Hybrid Intelligent Systems; Swarm Intelligence; Applications.

COURSE OUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate knowledge of soft computing techniques to build intelligent systems.
CO2. analyze complex engineering problems with intelligent techniques.
CO3. design and develop intelligent systems for power electronic controllers.
CO4. initiate research related to applications of soft computing in the fields of power converters and allied areas.
CO5. select and apply suitable intelligent techniques for appropriate power converter fed drives

DETAILED SYLLABUS:

UNIT–I: NEURAL NETWORKS (11 periods)
Neural network architectures, perceptron model, Learning strategies – Supervised Learning – radial basis function network, back propagation network. Unsupervised learning – Kohonen's SOM.Reinforced learning.PWM generation using neural networks.

UNIT–II: FUZZY LOGIC SYSTEMS (11 periods)
Fuzzy sets– relations & operations, membership functions, fuzzification, rule base, inference mechanism, defuzzification and design of fuzzy control system, speed control of DC motor using fuzzy logic.

UNIT–III: GENETIC ALGORITHMS (10 periods)
Introduction to evolutionary computation, Genetic Algorithms (GA) – Biological background, traditional optimization and search techniques-Basic terminologies-Simple GA-flow chart – Operators in GA-encoding, selection, crossover, mutation, constraints in GA, fitness function, advantages and limitations of GA, PWM generation using GA.

UNIT–IV: HYBRID INTELLIGENT SYSTEMS (11 periods)
Introduction to hybrid intelligent systems– Adaptive neuro-fuzzy inference systems – architecture and learning.Fuzzy GA systems – rules generation.ANN learning using GA – Optimization of weights, speed control of brushless DC drive using neuro-fuzzy approach.

UNIT–V: SWARM INTELLIGENCE (12 periods)
Introduction to swarm intelligence, swam intelligence algorithms-Ant colony optimization: biological and artificial ant colony systems, applications of ant colony intelligence: Static & dynamic combinatorial optimization problems, algorithm of ant colony system, particle swarm optimization: The basic PSO method, characteristic features of PSO, PSO algorithm, optimum parameter setting for the best performance of PSO, comparison with other evolutionary computing techniques, application of PSO intelligence in renewable energy systems.

Total Periods: 55

TEXT BOOKS:

1. S.N. Sivanandam, S.N. Deepa, *Principles of soft computing*, Wiley–India Edition, 2008.
2. N.P. Padhy, *Artificial Intelligence and intelligent systems*, Oxford university press, 10^{th}Impression, 2011.

REFERENCE BOOKS:

1. SarojKaushik, *Artificial Intelligence*, Cengage Learning, Fifth Indian reprint, 2013.
2. J.S.R. Jang, C.T. Sun, E. Mizutani, *Neuro-Fuzzy & Soft computing*, Pearson Education Limited, 2004.
3. Fakhreddine O. Karray, Clarence De Silva, *Soft computing &Intelligent systems design, Theory, tools and applications*, Pearson Education Limited, 2009.

M. Tech. - I Semester

(19MT10705) DIGITAL SIGNAL PROCESSING

(Program Elective – 2)
(Common to EPS andPED)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Laplace transforms, Z-transforms, FourierTransforms, Signal andSystems.

COURSE DESCRIPTION: Discrete-time signals and systems; Discrete Fourier series, Discrete Fourier Transforms (DFT) and Fast Fourier Transform (FFT) algorithms for the analysis of discrete time sequences; design and realization of Digital IIR and FIR filters; implementation of Park’s and Clark’s transformation using LF240X processor; DSP based implementation of DC-DC buck-boost converters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrate knowledge of digital signals and systems to analyze DFT and FFT techniques.
CO2. Apply the knowledge of analog and digital filters to design and realize IIR and FIR filters using different techniques.
CO3. Apply DSP controllers for buck-boost converter, control of motors and further extend to real time application.

DETAILED SYLLABUS:

Unit-I:DiscreteTimeSignalsandSystems (8hours)

Review of discrete time signals and systems; Review of Z-transforms, Solutions for difference equation of discrete time systems; frequency response of discrete time signals; A/D and D/A conversion; Introduction to DSP system with block diagram.

Unit - II:FrequencyTransformations (9hours)

Introduction to DFT – Properties of DFT, relation between DFT and Z- transforms, linear convolution, Circular Convolution. FFT Algorithms – DecimationintimeAlgorithms,DecimationinfrequencyAlgorithms,inverse DFT.

Unit - III:IIRFilterDesign (10hours)

Digital Vs Analog filters, Analog low pass filter design: Butterworth and chebyshev low pass filters. Design of IIR filter from analog filters using Impulse Invariance and Bilinear transformation techniques. Frequency transformationindigitaldomain.RealizationofDigitalfilters-Directform–I and Direct form–IIstructures.

Unit - IV:FIRFilterDesign (8hours)

Linear phase FIR filters and its frequency response; location of zeros in linear phase FIR filters; Fourier series method of design of FIR filters. Design of FIR filters using windows - Rectangular, Triangular, Hamming, Hanning and Blackmann windows.

Unit - V:DSPApplications (10hours)

Introduction to peripherals-types of physical memory-software used (Preliminary approach). DSP based implementation of DC-DC buck boost converters – introduction, converter structure, continuous and discontinuous conduction modes, connecting DSP to buck-boost converter, controlling the buck-boost converter. Field Oriented Control (FOC) transformations, implementing Clarke's and Park's Transformations on the LF240X

Total hours: 45

TEXT BOOKS:

1. Anandkumar, *Digital signal processing*, PHI Learning Privatelimited, New Delhi,2013.
2. Hamid A. Toliyat, Steven G. Campbell, *DSP based electromechanical motion control*, CRC Press Special Indian edition,2012.

REFERENCE BOOKS:

1. Nagoorkani, *Digital signal processing*, 2nd Edition, TMH Education Pvt., Ltd.,2012.
2. Alan.V. Oppenheim, Ronald.W. Schafer, John R Buck, *Discrete Time Signal Processing, Prentice Hall*, 2nd edition,2006.

M.Tech. – I Semester

(19MT10706) POWERQUALITY

(Program Elective – 2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Powerelectronics,ElectricMachines,ElectronicDevices and Circuits at UG level and high power converters at PGlevel.

COURSE DESCRIPTION: Power Quality concepts; harmonics and power quality standards and monitoring; power quality enhancement using custom power devices; power quality issues in distributedgeneration.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Apply the conceptual knowledge of power quality and it's standards toanalyze,monitorandmitigatevariouspowerqualityissues.

CO2. Applytheknowledgeoffilterstomitigateharmonicdistortiondueto industrial and commercialloads.

CO3. Apply the conceptual knowledge of various custom power devicesto enhance power quality for specificapplications.

CO4. Demonstrate the conceptual knowledge of distributed generation to analyze the power quality issues in powersystems.

DETAILED SYLLABUS:

Unit-I:Fundamentals0fPowerQuality (10hours)

Definition of Power Quality, Classification of Power Quality Issues, Power Quality Standards, Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients, Interruption, Sag, Swell, Sustained Interruption, Under Voltage, Over Voltage, Outage. Sources and causes of different Power Quality Disturbances.

Unit-II:Harmonics&AppliedHarmonics (10hours)

Harmonic Distortion, Voltage Vs Current Distortion, Harmonics Vs Transients, Power System Qualities under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads. Applied Harmonics: Effects of Harmonics, Harmonic Distortion Evaluations, Principles of controlling harmonics, devices for Controlling Harmonic Distortion.

Unit - III: PowerQualityMonitoring (08hours)

Power quality benchmarking, monitoring considerations, choosing monitoring locations, permanent power quality monitoring equipment, historical perspective of power quality measuring instruments, powerquality measurement equipment-types of instruments, assessment of power quality measurement data, power quality monitoring standards.

Unit - IV: Power Quality Enhancement Using Custom Power Devices (09 hours)

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL) -Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS). Compensating Type: Dynamic Voltage Restorer, Distribution STATCOM and Unified Power Quality Conditioner – operation, realizationandcontrolofDVR,DSTATCOMandUPQC–loadcompensation.

Unit - V: Power Quality Issues in Distributed Generation (08 hours)

DG Technologies, Perspectives on DG benefits- Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault-clearing, Reclosing, Interference with relaying, Voltage regulation issues, Islanding - siting DG.

Total hours: 45

TEXT BOOKS:

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. Wayne Beaty*, Electrical Power Systems Quality*, 2ndedition, TATA McGraw Hill,2010.
2. ArindamGhosh, Gerard Ledwich, *Power Quality Enhancement Using Custom Power Devices*, Springer,2002.

REFERENCE BOOKS:

1. Math H J Bollen, *Understanding Power Quality Problems*, IEEE Press, 1998.
2. C. Sankaran,*Power quality*, CRC Press,2002.

M. Tech. (PED) – II Semester

(16MT20708)POWER QUALITY

(Common to EPS & PED)

(Professional Elective-2)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PREREQUISITES: --

COURSE DESCRIPTION: Power Quality concepts; harmonics and voltage regulation using conventional methods; power quality enhancement using custom power devices; power quality issues in distributed generation.

COURSE OUTCOMES: On successful completion of the course the students will be able to

CO1. demonstrate knowledge on:
- various power quality issues and mitigation.
- operating conflicts in distributed generation.

CO2. analyze
- harmonic distortion due to commercial and industrial loads.
- the suitability of various custom power devices.

CO3. evaluate various power quality indices.

CO4. initiate research to develop/design new schemes and techniques for power quality enhancement.

CO5. apply the appropriate principles and techniques for integration of distributed generation and utilities.

DETAILED SYLLABUS:

UNIT-I: FUNDAMENTALS OF POWER QUALITY (12 Periods)

Definition of Power Quality, Classification of Power Quality Issues, Power Quality Standards, Categories and Characteristics of Electromagnetic Phenomena in Power Systems: Impulsive and Oscillatory Transients, Interruption, Sag, Swell, Sustained Interruption, Under Voltage, Over Voltage, Outage. Sources and causes of different Power Quality Disturbances.

UNIT-II: HARMONICS & APPLIED HARMONICS (12 Periods)

Harmonic Distortion, Voltage Vs Current Distortion, Harmonics Vs Transients, Power System Qualities under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads.

Applied Harmonics: Effects Of Harmonics, Harmonic Distortion Evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion.

UNIT-III: VOLTAGE REGULATION USING CONVENTIONAL METHODS (08 Periods)

Principles of Regulating the Voltage, Devices for Voltage Regulation: Utility step-voltage regulators, Ferro-resonant transformers, Magnetic synthesizers, On-line UPS systems, Motor-generator sets, Static VAR compensators, shunt capacitors, series capacitors.

UNIT-IV: POWER QUALITY ENHANCEMENT USING CUSTOM POWER DEVICES (13 Periods)

Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL) -Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS).

Compensating Type: Dynamic Voltage Restorer, Distribution STATCOM and Unified Power Quality Conditioner –operation, realization and control of DVR, DSTATCOM and UPQC –load compensation. Power quality monitoring-Power quality monitoring standards.

UNIT V: POWER QUALITY ISSUES IN DISTRIBUTED GENERATION (10 Periods)

DG Technologies, Perspectives on DG benefits- Interface to the Utility System - power quality issues affected by DG - Operating Conflicts: Utility fault-clearing, Reclosing, Interference with relaying, Voltage regulation issues, Islanding - siting DG.

Total periods: 55

TEXT BOOKS:

1. Roger C. Dugan, Mark E. Mc. Granaghan, Surya Santosoh and H. Wayne Beaty, *Electrical Power Systems Quality*, 2nd edition, TATA McGraw Hill, 2010.
2. ArindamGhosh, Gerard Ledwich, *Power Quality Enhancement Using Custom Power Devices*,Springer, 2002.

REFERENCE BOOKS:

1. Math H J Bollen, *Understanding Power Quality Problems*, IEEE Press, 1998.
2. C. Sankaran, *Power Quality*, CRC press, 2000.

M. Tech. –I Semester

(19MT18307) ELECTROMAGNETIC FIELD COMPUTATION AND MODELING

(Program Elective-2)
(Common to EPS andPED)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Electromagnetic fields, Electrical Machines at UG level.

COURSE DESCRIPTION: Review of basic field theory; Basic solution methods for field equations; Formulation of finite element method; Computation of basic quantities using FEM packages; Design applications.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Apply the knowledge of Electromagnetic fields to analyze various electrical field problems using analytical and numerical methods.

CO2. Demonstrate the knowledge in Computation of electrical parameters using Finite Element Method.

CO3. Provide solutions to design electrical equipment.

DETAILED SYLLABUS:

Unit -I:Introduction (9 hours)

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

Unit - II: Basic Solution Methods for FieldEquations (9 hours)

Limitationsoftheconventionaldesignprocedure,needforthefieldanalysis based design, problem definition, boundary conditions, solution by analytical methods-direct integration method – variable separablemethod
– method of images, solution by numerical methods-Finite Difference Method.

Unit-III:FormulationofFiniteElementMethod (9hours)

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

Unit - IV: Computation of Basic Quantities Using FEM Packages (6 hours)

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

Unit - V:DesignApplications (12hours)

ElectromagneticfieldanalysisofMagneticactuators,transformers,switched reluctance motors, three phase inductionmotors.

TEXT BOOKS:

1. Matthew. N.O. Sadiku, *Elements of Electromagnetics*, FourthEdition, Oxford University Press, First Indian Edition2007.
2. Nicola Biyanchi, *Electrical Machine analysis using Finite Elements*, Taylor and Francis Group, CRC Publishers,2005.

REFERENCE BOOKS:

1. Nathan Ida, Joao P.A.Bastos, *Electromagnetics and calculation of fields*, SpringerVerlage,1992.
2. S.J Salon, *Finite Element Analysis of Electrical Machines*, Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai,India.
3. User manuals of MAGNET, MAXWELL & ANSYSsoftware.

M. Tech.-I Semester

(19MT10708) RESEARCH METHODOLOGYand IPR

(Common to all M. Tech. Programs)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	2	-	-	2

PRE REQUISITES: Engineering Mathematics at UG level.

COURSE DESCRIPTION: Overview of research; research problem and design; various research designs; Data collection methods; Statistical methods for research; Interpretation& drafting reports and Intellectual property rights.

COURSEOUTCOMES: Onsuccessfulcompletionofthecourse,studentwill be able to:

CO1. Apply the conceptual knowledge of research methodology to formulate the hypothesis, data collection and processing, analyzing the data using statistical methods, interpret the observations and communicating the novel findings through a research report.

CO2. Practice ethics and have responsibility towards society throughout theresearchprocessandindulgeincontinuouslearningprocess.

CO3. Apply the conceptual knowledge of intellectual property rights for filing patents and trade mark registration process.

DETAILED SYLLABUS:

Unit - I: Introduction to Research Methodology (07 hours)

Objectives and Motivation of Research, Types of Research, Defining and Formulating the Research Problem; Features of research design, Different Research Designs; Different Methods of Data Collection, Data preparation and Processing.

Unit-II:DataAnalysisandHypothesisTesting (09hours)

ANOVA; Principles of least squares-Regression and correlation; Normal Distribution- Properties of Normal Distribution; Testing of Hypothesis – Hypothesis Testing Procedure, Types of errors, t-Distribution, Chi-Square Test as a Test of Goodness of Fit.

Unit-III:InterpretationandReportWriting (04hours)

Interpretation – Need, Techniques and Precautions; Report Writing – Significance, Different Steps, Layout, Types of reports,Mechanics of Writing a Research Report, Precautions in Writing Reports; Researchethics.

Unit-IV:IntroductiontoIntellectualPropertyandTradeMarks (07hours)

Importance of intellectual property rights; types of intellectual property, internationalorganizations; Purpose and function of trademarks, acquisitionof trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Unit - V: LawofCopyrights (08Hours)

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer
New Developments in IPR: Administration of Patent System.

Total hours: 35

TEXT BOOKS:

1. C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd revisededition,NewAgeInternationalPublishers,NewDelhi,2004.
2. Deborah,E.Bouchoux,*Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, 5th edition, Cengage learning, 2017.

REFERENCE BOOKS:

1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. PrabuddhaGanguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd, 2001.

M. Tech. - I Semester

(19MT1AC01) TECHNICAL REPORT WRITING

(Audit Course)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	2	-	-	-

PRE-REQUISITES: -

COURSEDESCRIPTION: Introduction;Processofwriting;Styleofwriting; Referencing;Presentation.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrate knowledge of Technical Report Writing by examining kinds of reports and structure with scientific attitude.

CO2. Apply the techniques in preparing effective reports by examining Techniques of Description, Describing Machines and Mechanisms and Describing Processes.

CO3. Communicate effectively through writing technical reports by demonstrating the knowledge of Industry Reports, Survey Reports, Interpretive Report and Letter Report.

DETAILED SYLLABUS:

Unit - I:Introduction (6 hours)

Introduction to Technical Report - Types of Reports - Planning Technical Report Writing - Components of a Technical Report - Report Writing in Science and Technology - Selecting and Preparing a 'Title' - Language Use in Report Writing.

Unit - II:ProcessofWriting (5hours)

Writingthe'Introduction'-Writingthe'MaterialsandMethods'-Writingthe Findings/Results'-Writingthe'Discussion'-Preparingandusing'Tables'.

Unit - III:StyleofWriting (6hours)

Preparing and using Effective 'Graphs' - Citing and Arranging References—ICitingandArrangingReferences—II-WritingforPublicationina ScientificJournal.

Unit - IV:Referencing (9 hours)

Literature citations - Introductory remarks on literature citations - Reasons for literature citations – Bibliographical data according to ISO - Citations in the text - Copyright and copyright laws - The text of the Technical ReportUsing word processing and desktop publishing (DTP) systems - Document or page layout and hints on editing - Typographic details - Cross-references.

Unit - V:Presentation (4 hours)

Giving the presentation - Appropriate pointing - Dealing with intermediate questions - Review and analysis of the presentation - Rhetoric tips from A to Z.

Total hours: 30

TEXT BOOKS:

1. R C Sharma – Krishna Mohan, *Business Correspondence and Report Writing*, Tata McGraw-Hill Publishing Company Limited, New Delhi, Third Edition, 2005(reprint).
2. Patrick Forsyth, *How to Write Reports and Proposals,THE SUNDAY TIMES (Kogan Page)*,NewDelhi,RevisedSecondEdition,2010.

REFERENCE BOOKS:

1. John Seely, *The Oxford Writing & Speaking*, Oxford University Press, IndianEdition.
2. Anne Eisenberg, *A Beginner's Guide to Technical Communication*, McGrawHillEducation(India)PrivateLimited,NewDelhi,2013.

M. Tech. – II Semester

(19MT28301)DIGITALCONTROLOFPOWERELECTRONICSANDDRIVE SYSTEMS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: CoursesonPowerElectronics,PowerSemiconductor Drives at UGLevel.

COURSE DESCREPTION: Peripherals; Memory addressing modes; DSP basedcontrolofdc-dcconverters;DSPbasedcontrolofmatrixconverters; DSP based control of PMBLDC and SRMdrives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Apply the knowledge of various addressing modes of LF2407 processor and its instruction set to develop simple and complex programs to control power electronic circuits.

CO2. Apply the knowledge of Space vector modulation technique to control inverter fed AC drives and to implement them in real time using LF2407.

CO3. Design and develop controller for PMBLDC and SRM drives using LF2407.

DETAILED SYLLABUS:

Unit - I: Motor Control Signal Processors (09 hours)

Introduction- Brief Introduction to Peripherals -Types of Physical Memory - The Components of the C2xx DSP Core -System configuration registers- Memory Addressing modes - Instruction set – Programming techniques – simple programs.

Unit- II: Peripherals of SignalProcessors (09 hours)

General purpose Input/output (GPIO) Functionality- Interrupts - A/D converter-Event Managers (EVA, EVB)- PWM signal generation.

Unit-III:DSP-BasedControlofDC-DCConverters (09 hours)

Introduction- Converter Structure-Continuous Conduction Mode, Discontinuous Conduction Mode- Connecting the DSP to the Buck-Boost Converter- Controlling the Buck-Boost Converter- Main Assembly Section Code Description Interrupt Service Routine. The regulation Code Sequences.

Unit - IV: DSP-Based Control of MatrixConverters (09 hours)

SpaceVectorPulseWidthModulation-PrincipleofConstantV/HzControlfor Induction Motors- Space Vector PWM Technique- DSP Implementation- Introduction to matrix converter-Topology and Characteristics- Control Algorithms- Bidirectional Switch-Current Commutation - Overall Structure ofThree-PhaseMatrixConverter-ImplementationoftheVenturiniAlgorithm using theLF2407.

Unit - V: DSP-Based Control of PMBLDC and SRM Drives (09 hours)

ControlofPMBLDCmotordrives:Introduction-PrinciplesoftheBLDCMotor- Torque Generation -BLDC Motor Control System Implementation of the BLDC Motor Control System Using LF2407.Control of SRM drives: Introduction-Fundamentals of Operation-Fundamentals of Control in SRM Drives-OpenLoopControlStrategyforTorque-ClosedLoopTorqueControl of the SRMDrive.

Total hours: 45

TEXT BOOKS:

1. Hamid A.Toliyat, Steven Campbell, *DSP based electromechanical motion control*, CRC Press, Special IndianEdition.

REFERENCE BOOKS:

2. R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*,Prentice-Hall of India Pvt. Ltd., New Delhi, 2010
3. T.Kenjo and S.Nagamori, *Permanent magnet and Brushless DC motors*, Clarendon press, London,1988.

M. Tech. – II Semester
(19MT28303) ADVANCED POWER ELECTRONIC CIRCUITS
(Program Elective – 3)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: CoursesonPowerElectronicConverters,Power SemiconductorDevices.

COURSE DESCRIPTION: Improved DC-DC Converters – Types and operation; Voltage-Lift DC-DC Converters;Super-Lift Converters; Ultra-Lift DC-DC Converter; Multilevel and Soft-Switching DC-AC Inverters – Types, operation and applications; Improved AC-AC Converters Inverters.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Apply the knowledge of various types of improved AC-DC Converters and use appropriate control technique to model and analyze with different configurations subjected to various loads.

CO2. Describe the operation of voltage-lift, super-lift & ultra-lift DC-DC converter and analyze their performance factors with the effects of various control techniques.

CO3. Demonstrate the knowledge of various types of multilevel and soft- switching DC-AC inverter topology and analyze the performance parameters with various control techniques.

CO4. Understand the knowledge of different types of improved AC-AC converters and use appropriate control techniques to model and analyze with different configurations.

DETAILED SYLLABUS:

Unit - I:ImprovedAC-DCConverters (09hours)

DC/DC Converterized Rectifiers, PWM Boost-Type Rectifiers - DC-SidePWM Boost-Type Rectifier - Constant-Frequency Control, Constant-Tolerance- Band (Hysteresis) Control and Source-Side PWM Boost-Type Rectifiers. Tapped-Transformer Converters, Single-Stage PFC AC/DC Converters - Operating Principles, Mathematical Model Derivation - Averaged Modelover One Switching Period T_s and Averaged Model over One Half Line Period T_L. VIENNA Rectifiers - Circuit Analysis and Principle of Operation, Proposed Control Arithmetic, Block Diagram of the Proposed Controller for the VIENNA Rectifier and Converter Design and WaveformAnalysis.

Unit - II:Voltage-LiftDC-DCConverters (09hours)

Self-Lift Cuk-Converter – Continuous and Discontinuous mode operation. P/O Luo-Converters - Relift Circuit, Triple-Lift Circuit and Quadruple-Lift Circuit. N/O Luo-Converters - Relift Circuit, N/O Triple- Lift Circuit and N/O Quadruple-Lift Circuit. Voltage Lift SEPICs - Self-Lift SEPIC, Relift SEPIC and Multiple-LiftSEPICs.

Unit-III:Super-LiftConvertersandUltra-LiftDC-DCConverter (09hours)

P/O SL Luo-Converters: Elementary Circuit, Relift Circuit, Triple-Lift Circuit and Higher Order Lift Circuit. N/O Cascaded Boost Converters: Main series - N/O Elementary Boost Circuit, N/O Two-Stage Boost Circuit, N/O Three-Stage Boost Circuit and N/O Higher Stage Boost Circuit. UL Luo-Converter – Operation of Continuous and Discontinues Conduction Mode.

Unit - IV: Multilevel and Soft-Switching DC-AC Inverters (09 hours)

MultilevelInverters:Types-Diode-ClampedMultilevelInverters,Capacitor- Clamped Multilevel Inverters and Multilevel Inverters using H-Bridge Converters. Soft-Switching Multilevel Inverters: Notched DC-Link Inverters for Brushless DC Motor Drive - Resonant Circuit, Design Consideration, Control Scheme and waveform analysis. Resonant Pole Inverter:Operating Principle, Topology of the Resonant Pole Inverter, Design Considerations waveformanalysis.

Unit - V:ImprovedAC-ACConverters (09hours)

DC-Modulated Single-Phase Single-Stage AC/AC Converters: Bidirectional Exclusive Switches S_M–S_s, Mathematical Modeling of DC/DC Converters, DC-Modulated Single-Stage Buck-Type AC/AC Converter, DC-Modulated Single-Stage Boost-Type AC/AC Converter, DC-Modulated Single-Stage Buck–Boost-TypeAC/ACConverter.DC-ModulatedP/OLuo-Converter-Type AC/AC Converter and DC-Modulated Two-Stage Boost-Type AC/AC Converter. DC-Modulated Multiphase AC/AC Converters: Types - DC- Modulated Three-Phase Buck-Type AC/AC Converter, Boost-Type AC/AC Converter and Buck–Boost-Type AC/AC Converter. Matrix Converter – Principle ofoperation.

Total hours: 45

TEXT BOOKS:

1. Fang Lin Luo and Hong Ye, *Power Electronics Advanced Conversion Technologies*, 2nd Edition, CRC Press,2018.
2. Sergio Alberto Gonzalez, Santiago Andres Verne & Maria Ines Valla, *Multilevel Converters for Industrial Applications*, 1st Edition, CRC Press,2014.

REFERENCE BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education,2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *PowerElectronics: Converters, Applications and Design*, 3rd Edition, Wiley,2007.

M. Tech. – II Semester

(19MT28304) MULTILEVEL INVERTERS

(Program Elective – 3)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Power Electronic Converters and Power Semiconductor Devices & Modeling.

COURSE DESCRIPTION: Symmetric and Asymmetric multilevel inverter; Diode Clamped Multilevel Converter – Types and operation; Flying CapacitorMultilevelConverter:Typesandoperation;CascadedAsymmetric Multilevel Converter: Types and operation;Application of MultilevelInverter fedDrive.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrate the knowledge of multilevel and control techniques to design a three level inverter.

CO2. Demonstrate the knowledge of various topologies of multilevel inverter and use appropriate control technique to model andevaluate their performanceparameters.

CO3. Select appropriate multilevel inverter and control techniques to provide feasible solutions.

DETAILED SYLLABUS:

Unit-I:Introduction (08hours)

Generalized topology with a Common DC Bus - Basic cell, Generalized topology, Characteristics and Three-level generalized Topology. Filtering circuit - Inductor as a low pass filter and capacitor as a low pass filter.Sine Triangle Pulse Width Modulation (PWM) and power switches requirements. H-bridge multilevel inverters - operation, topology, waveforms and advantages.

Unit - II:Diode Clamped Multilevel Converter (10 hours)

Diode Clamped Topology - Neutral Point Clamped (NPC) Converter topology, Four level diode clamped topology, Five level diode clamped topology and n-Level Diode Clamped Multilevel Converter (DCMC) topologies. Converter structure and functional description - Voltage clamping and switching logic. Modulation of Multilevel Converters - Multilevel Space Vector Modulation - Hexagonal co-ordinate System, Nearest three vectors identification, Duty cycle calculation, Voltagebalance control - Capacitor voltage calculation, Voltage balance optimization and Flow diagram.

Unit-III:FlyingCapacitorMultilevelConverter (10hours)

Voltage on the flying capacitor, Four level flying capacitor topology, Five level flying capacitor multilevel inverter and charge balance on the flying capacitors. Modulation scheme for the Flying Capacitor MultilevelConverter (FCMC) - Phase Shifted Carrier Pulse Width Modulation (PSPWM) - Charge balance using PSPWM. Dynamic voltage balance of the FCMC - Dynamic model and Tuned balancing network - Root locusanalysis.

Unit - IV: Cascaded Asymmetric Multilevel Converter (08 hours)

SymmetrictopologieswithoutaCommonDCLink-FivelevelCascadedCell Multilevel Converter (CCMC), Asymmetric topologies: Hybrid Asymmetric topologies - Hybrid Asymmetric Topologies and CCMC with DifferentValues of Voltage Sources, Combining Different Topologies and Cascade

Asymmetric Multilevel Converter. General Characteristics of the Cascaded Asymmetric Multilevel Converter (CAMC) - Modulation Strategy and Averaged Voltage. Comparison of the Five-Level Topologies - DCMC,FCMC, CCMC andCAMC.

Unit - V:Application ofMultilevelInverter (09 hours)

Medium-Voltage Motor Drive Built with Diode Clamped Multilevel Converter (DCMC):Back-to-BackDCMCConverter,UnifiedPredictiveControllerofthe Back-to-Back DCMC in an IM Drive Application - Control of the Back-to- Back DCMC Converter, Load converter - Predictive torque control, Line converter - Predictive power control, Current and Power calculations, DynamicactivepowerreferencedesignandSwitchingtransitionconstraint, Performance evaluation - Mechanical load variation, Voltage sag, Energy recovery and Effectiveness of the DC Bus balancingalgorithm.

Total hours: 45

TEXT BOOKS:

1. Sergio Alberto Gonzalez, Santiago Andres Verne & Maria Ines Valla, *Multilevel Converters for Industrial Applications*, 1st Edition, CRC Press,2014.
2. Krishna Kumar Gupta &PallaveeBhatnagar, *Multilevel Inverters Conventional and Emerging Topologies and their Control*, 1st Edition, Academic Press, 2018.

REFERENCE BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 4th Edition, Pearson Education,2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *PowerElectronics: Converters, Applications and Design*, 3rd Edition, Wiley,2007.

M. Tech. – II Semester

(19MT28305) SOLAR ENERGY CONVERSION SYSTEMS

(Program Elective-3)

(Common to EPS andPED)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Power Electronic Converters.

COURSE DESCRIPTION: Solar energy conversion system; Types of photovoltaic systems – Stand-alone, hybrid and grid connected systems; Energy storage systems; Applications.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrateknowledgeonsolarcellandanalyzethebehaviorofsolar cells for differentirradiations.

CO2. Apply the knowledge of solar modules, energy storage system and MPTT to design the stand-alone and grid connected PV systems for various real time applications.

DETAILED SYLLABUS:

Unit - I:PhotovoltaicBasics (09hours)

Structure and working of Solar Cells - Types, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays – open circuit (Voc) and short circuit characteristics of a PV array- Basics of Load Estimation.

Unit - II: Stand AlonePVSystem (09 hours)

Solar modules – storage systems – power conditioning and regulation - MPPT- protection – stand alone PV systems design – sizing.

Unit - III: Grid ConnectedPVSystems (09hours)

Schematics, Components, solar converters –state of charge characteristics (SOC) - Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings- Micro Grid structure.

Unit - IV:Design ofPVSystems (09 hours)

Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies.

UNIT -V:Applications (09hours)

Water pumping, Battery chargers, Solar car, Direct-drive applications, Space and Telecommunications.

Total hours: 45

TEXT BOOKS:

1. SolankiC.S.,*Solar Photovoltaics: Fundamentals, Technologies and Applications*,PHI Learning Pvt.Ltd.,2015.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, *Applied Photovoltaics*, Earthscan,2007.
3. Earthscan,UK.Eduardo Lorenzo G.Araujo, *Solar electricityengineering of photovoltaic systems*, Progensa,1994.

REFERENCE BOOKS:

1. Frank S. Barnes & Jonah G. Levine, *Large Energy storage Systems Handbook*, CRCPress,2011.
2. McNeils, Frenkel, *Desai, Solar & Wind Energy Technologies*, Wiley Eastern,1990.
3. S.P. Sukhatme, *Solar Energy*, Tata McGraw Hill,1987.
4. Nikos Hatziargyriou,*Microgrids- Architectures and control*, Wiley, IEEE press,2013.

M. Tech. – II Semester
(19MT28308) SWITCHED MODE POWER SUPPLIES AND UPS
(Program Elective - 4)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courseson PowerElectronicConverters,Power Semiconductor Devices &Modeling.

COURSE DESCRIPTION:DC-DC Converters and Switching Mode Power Converters; Resonant Converters – Types and operating waveforms; ZCS and ZVS Resonant converters; Power conditioners, UPS and Filters – ON and OFF line operation.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1.Demonstrate the knowledge of various switch mode DC–DC Converters and useappropriate control technique to design and analyze with different modes of operation.

CO2. Understand the knowledge of resonant converter and useappropriate control technique to model and evaluate their performance parameters.

CO3. Demonstrate the knowledge of power conditioners, UPS and filters to design and analyze for different operating conditions.

DETAILED SYLLABUS:

Unit -I:DC-DCConverters (09 hours)

Performance analysis of buck, boost, buck-boost, cuk, sepic and quadratic converters – Modes of operation, Equivalent circuits and steady state waveforms.

Unit - II:Switching ModePowerConverters (09hours)

Performanceanalysisofforward,fly-back,push-pull,Luo,half-bridgeand full-bridgeConverters– Modesofoperation,Equivalentcircuitsandsteady state waveforms.

Unit - III:ResonantConverters (09hours)

Series Resonant Inverters: Series Resonant Inverter with unidirectional switches – Modes of operations, Waveforms, Types – Based on coupled inductors, Half-Bridge and Full-Bridge resonant inverters. Series Resonant Inverter with bidirectional switches – Types – Half-Bridge and Full-Bridge resonant inverters.

Parallel Resonant inverters, Voltage control of resonant inverters, Class E resonant inverter and rectifiers.

Unit-IV:ZCSandZVSResonantConverters (09 hours)

Zero-Current-Switching Resonant Converter: Types – L-Type and M-Type ZCS, Equivalent circuit, Modes of operation and Waveforms. Zero-Voltage- Switching Resonant Converters: Equivalent circuit, Modes of operation, Waveforms and Two quadrant ZVS resonant converters. Resonant DC-link inverters – Basic concept, Waveforms, Three phase DC-link inverter – Operation and Waveforms. Active clamp dc-link resonant inverter – Operation and Waveforms. Comparison of ZVS and ZCS.

Unit-V:PowerConditioners,UPS&Filters (09hours)

Powerlinedisturbances-Powerconditioners–UPS:offlineUPS,OnlineUPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

Total hours: 45

TEXT BOOKS:

1. Muhammad H. Rashid*, Power Electronics: Circuits, Devices and Applications, Pearson Education*, 4thEdition,2014.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design, Wiley*, 3rdEdition,2007.

REFERENCE BOOKS:

1. M.D.Singh&K. B. Kanchandhani,*Power Electronics, Tata McGraw – Hill Publishing Company*, New Delhi, 3rdEdition,2008.
2. Dr. P. S. Bimbhra, *PowerElectronics*, Khanna Publishers, New Delhi, 4thEdition,2012.

M. Tech. – II Semester
(19MT28309) WIND ENERGY CONVERSION SYSTEMS
(Program Elective-4)
(Common to EPS andPED)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PREREQUISITES: Courses on Power Electronics, control systems in UG level.

COURSE DESCRIPTION: Fundamentals of wind energy and its measurement; wind turbine design and basic aerodynamics principles; need of usage of wind generators; wind turbine control, monitor and implementation in the wind farm and site selection; power quality issues and mitigation methods of wind power integration in the powersystem.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Demonstrate knowledge on various components, types, characteristics and measurements of wind turbines.
CO2. Apply the knowledge of aerodynamics forces to analyze wind turbine blade rotation.
CO3. Use the knowledge of various design procedures and converters for designing modern wind turbines and to integrate.
CO4. Demonstrate knowledge on various types of control and monitoring techniques used in WECS.
CO5. Demonstrate knowledge on power quality problems in WECS and apply suitable mitigation techniques/ custom power devices to improve the power quality.

DETAILED SYLLABUS:

Unit - I:Wind Energy Fundamentals and Measurements (08 hours)

wind power scenario in India; basics of wind characteristics: extractable limits of wind power; estimation of wind power potential; gust/extreme wind speeds; wind turbulence wind measurement and instrumentation; horizontal/verticalaxiswindturbines;windturbinecomponents,braking, yaw system,tower.

Unit - II:Design and Aerodynamics of Wind Turbine (10 hours)

Analysis of semi Review on basic aerodynamics, Airfoils and General Concepts of Aerodynamics, types and characteristics of wind turbine, Blade Design for Modern Wind Turbines, blade element theory, Betz limit, Generalized Rotor Design Procedure, turbine design: Design procedure, topologies , Wind Turbine Standards, Technical Specifications, and Certification, Wind Turbine Design Loads, power curve prediction.

Unit - III:Wind Turbine Generators (09 hours)

Fixed speed and variable speed systems, Electrical machines for wind energy systems, synchronous and asynchronous generators and its performance, Integration of wind energy systems to electrical networks, converters, inverters, directly connected, wind energy storage solutions.

Unit - IV:Wind Turbine Control, Testing and Applications (12 hours)

Types of Control Systems in Wind Turbines, Overview of Wind Turbine Control Systems, Typical Grid-connected Turbine Operation, and Typical Constant-speed and variable

speed Operating Schemes, Supervisory Control Overview Implementation, overview of testing methods.
Applications: hybrid power systems, special purpose applications,overview of energy storage, site selection and environmentalimpacts.

Unit-V:PowerQualityIssuesinIntegrationofWECS (06 hours)

Stand alone and Grid connected wind systems, Power Quality issues, Impact of power quality problems on WECS, Harmonic reduction andPower factor improvement, Mitigation of power quality problems, and role of custom power devices in DistributedGeneration.

Total hours: 45

TEXT BOOKS:

1. J. F. Manwell, J. G. McGowan and A. L. Rogers, *Wind Energy Explained – Theory, Design and Application*, Wiley,2009.
2. G.D. Rai, *Non - Conventional Energy Resources*, Khanna Publishers, 2002.

REFERENCE BOOKS:

1. V. Daniel Hunt, *Wind power: a handbook on wind energy conversion systems*, 4thEdition, Van Nostrand Reinhold Co., 1981, Khanna Publishers, New Delhi,2012.
2. Arindam Ghosh, Gerard Ledwich, *Power Quality Enhancement Using Custom power devices Power Devices*, Springer,2002.
3. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and H. Wayne Beaty, *Electrical Power Systems Quality*, 2ndedition, TATA McGraw Hill,2008.

M. Tech. – II Semester

(19MT28331)ELECTRICAL DRIVES LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Power converters.

COURSEDESCRIPTION: DesignanddevelopmentofvariousACandDC drives.

COURSEOUTCOMES: On successful completion of the course, students will be able to

CO1. Identify appropriate devices, domain specific tools and techniques to develop and control power electronic converters fed drive.

CO2. Analyze and evaluate the performance of Power converters fed drive by practicing professional code of ethics.

CO3. Prepare laboratory reports that clearly communicate experimental information.

CO4. Function effectively as an individual to solve various problems.

PRACTICAL EXERCISES/LIST OF EXPERIMENTS: Conduct any **TwoExperiments** from the following:

1. Single phase half controlled rectifier fed DC motor usingIGBT.
2. Single phase half controlled rectifier fed DC motor usingMOSFET.
3. Single phase fully controlled rectifier fed DC motor usingIGBT.
4. Single phase fully controlled rectifier fed DC motor usingMOSFET.
5. DC-DC converter fed DC Motor usingIGBT.
6. DC-DC converter fed DC Motor usingMOSFET.
7. Single phase inverter fed induction motor usingIGBT.
8. Threephasethreelevelinverter(MLI)fedinductionmotordrive.
9. Fivelevelcascaded multilevelinverterfedinductionmotordrive.

M. Tech. (PED) – II Semester
(16MT28331) ELECTRIC DRIVES LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PREREQUISITES: Courses on Analysis of inverters and converters.

COURSE DESCRIPTION: Design and development of various AC and DC drives.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. demonstrate practical knowledge on design and development of power converter fed drives.
CO2. analyze and relate physical observations and measurements of various power converter fed drives with theoretical principles.
CO3. solve engineering problems related to power converter fed drives to provide feasible solutions.
CO4. initiate research ideas to provide solutions for design of power converter fed drives.
CO5. select and apply suitable controlling techniques for various power converter fed drives.
CO6. prepare laboratory reports that clearly communicate experimental information.
CO7. practice professional code of ethics.
CO8. function effectively as an individual and as a member in the team to solve various problems.

DETAILED SYLLABUS:

Conduct any Two Experiments from the following:
Design of
1. Single phase half-wave converter fed DC motor.
2. Single phase Semi converter fed DC drive.
3. Single phase full controlled fed DC drive.
4. Single phase inverter fed induction motor drive.
5. Speed control of stepper motor.
6. Speed control of universal motor using AC voltage controller.
7. Step up chopper fed DC drive.
8. Step down chopper fed DC drive.
9. Speed control of single phase induction motor using AC voltage controller.
10. AC/DC/AC converter fed induction motor.

M. Tech. – II Semester

(19MT28332)ELECTRICALDRIVESSIMULATIONLAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Power converters.

COURSEDESCRIPTION: DesignandsimulationofvariousACandDC drives.

COURSEOUTCOMES: On successful completion of the course, students will be able to

CO1. Identify appropriate devices, domain specific tools and techniques to develop and control power electronic converters fed drive.
CO2. Analyze and evaluate the performance of Power converters fed drive by practicing professional code of ethics.
CO3. Prepare laboratory reports that clearly communicate experimental information.
CO4. Function effectively as an individual to solve various problems.

LISTOFEXPERIMENTS: Conductany**TENExperiments**fromthe following usingMATLAB

1. Single phase half-wave converter fed DC motor.
2. Single phase Semi converter fed DC drive.
3. Single phase full controlled fed DC drive.
4. Single phase inverter fed induction motor fed drive.
5. Speed control of stepper motor fed drive.
6. Speed control of universal motor using AC voltage controller.
7. Speed Control of Induction motor using cyclo converter.
8. Step up chopper fed DC drive.
9. Step down chopper fed DC drive.
10. Speed control of single phase induction motor using AC voltage controller.
11. Speed control of Permanent Magnet Synchronous motor fed drive.
12. Speed Control Brushless DC Motor fed drive.
13. Speed control of Switched Reluctance Motor fed drive.

M. Tech. (PED) – II Semester
(16MT28332)ELECTRIC DRIVES SIMULATION LAB

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PREREQUISITES: Courses on Analysis of inverters and Analysis of converters.

COURSE DESCRIPTION: Design and analysis of various converter fed drives.

COURSEOUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate knowledge on various power converter fed drives.
CO2. analyze the operating characteristics of various power converter fed drives.
CO3. provide feasible solutions pertaining to electric drives.
CO4. initiate research related to applications of electric drives.
CO5. select and apply appropriate speed control techniques for power converter fed drives.
CO6. prepare laboratory reports that clearly communicate experimental information.
CO7. practice professional code of ethics.
CO8. function effectively as an individual and as a member in the team to solve various problems.

DETAILED SYLLABUS:

Conduct the following Experiments using MATLAB

Simulation of
1. Single phase half-wave converter fed DC motor.
2. Single phase Semi converter fed DC drive.
3. Single phase full controlled fed DC drive.
4. Single phase inverter fed induction motor drive.
5. Speed control of stepper motor using microcontroller.
6. Speed control of universal motor using AC voltage controller.
7. Step up chopper fed DC drive.
8. Step down chopper fed DC drive.
9. Speed control of single phase induction motor using AC voltage controller.
10. AC/DC/AC converter fed induction motor.

M. Tech. – II Semester

(19MT2AC01)STATISTICSWITH R

(Audit Course)

(Common to All M. Tech. Programs)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
-	-	-	2	-	-	-

PRE-REQUISITES: A course on Statistics.

COURSEDESCRIPTION: ConceptsofRprogrammingbasics,Bivariateand multivariate data, Confidence intervals, Goodness of fit, Analysis of variance.

COURSE OUTCOMES: On successful completion of the course, students will be able to

CO1. Import, manage, manipulate, and structure data files using R programming.

CO2. Implement models for statistical analysis of a given dataset and visualize the results to identify trends, patterns and outliers in data.

DETAILED SYLLABUS:

Unit-I:Introduction (5hours)

Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

Unit - II:Bivariate andMultivariateData (7hours)

Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariatedata - Data frames, Applying a function over a collection,Using external data, Lattice graphics, Grouping, Statisticaltransformations.

Unit-III:Populations (6hours)

Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

Unit -IV:ConfidenceIntervals (6hours)

Confidence intervals for a population proportion, *p* - population mean, Other confidence intervals, Confidence intervals for differences,Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for themedian.

Unit - V:GoodnessofFIT (6hours)

The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's χ^2-statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using *lm* for ANOVA.

Total hours: 30

TEXT BOOKS:

1. John Verzani, *Using R for Introductory Statistics*, CRC Press, 2ndEdition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, *Statistics Using R*, Narosa Publishing house, 2ndEdition,2015.

REFERENCE BOOKS:

1. FranciscoJuretig,*R Statistics Cookbook*,PacktPublishing,1stEdition, 2019.
2. PrabhanjanN.Tattar,SureshRamaiah,B.G.Manjunath,*A Course in Statistics with R*, Wiley,2018.