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 2017

Program: M.Tech.- Power Electronic Drives

Regulations : SVEC-16

This document details the following:

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

Note: *Program started in the year 2017.*

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.	16MT1BS01	Applied Mathematics	100	3
2.	16MT18301	Advanced Power Semiconductor Devices	30	5
3.	16MT18303	Analysis of Power Converters	40	8
4.	16MT18304	Modelling of Electrical Machines	100	12
5.	16MT18305	Electric and Hybrid-Electric Vehicles	100	14
6.	16MT18306	Intelligent Controllers	100	16
7.	16MT18331	Power Electronics Design Lab	100	18
8.	16MT18332	Power Electronics Simulation Lab	60	19
9.	16MT13808	Research Methodology	100	21
10.	16MT28301	Linear and Nonlinear Control Systems	100	23
11.	16MT28303	Solid State AC Drives	60	25
12.	16MT28305	Special Electrical Machines	100	28
13.	16MT28331	Electric Drives Lab	100	30
14.	16MT28332	Electric Drives Simulation Lab	40	31
15.	16MT23810	Intellectual Property	100	33
		Average %**(A)**	82	-
		Total No. of Courses in the Program **(T)**	28	
		No. of Courses where syllabus (more than 20% content) has been changed **(N)**	15	
		Percentage of syllabus content change in the courses **(C)=(A x N)/100**	12.3	
		Percentage of Syllabus Content changed in the Program (P)= C/T	**43.93**	

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

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

M. Tech. (PED) – I Semester
(16MT1BS01) APPLIED MATHEMATICS

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

PREREQUISITES: Course on Engineering Mathematics at UG Level.

COURSE DESCRIPTION: Matrix theory, Calculus of variations, One dimensional random variables, Linear programming and Fourier series.

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

CO1. demonstrate knowledge on
- matrix theory and eigen vectors
- functions of several variables
- probability theory and distributions
- optimization processes
- fourier series

CO2. analyze and solve problems involving
- matrix factorizations
- variations in moving boundaries
- probability distributions
- optimization methods
- power signals

CO3. design mathematical models for power signals, power electronic circuits and drives.

CO4. develop advanced skills in analyzing the complex problems involving periodic andnon-periodic functions in power signals, power electronic circuits and allied areas.

DETAILED SYLLABUS:

UNIT-I: MATRIX THEORY (11 periods)
The Cholesky decomposition - Generalized Eigen vectors, Canonical basis – QR factorization – Least squares method - Singular value decomposition.

UNIT–II: CALCULUS OF VARIATIONS (11 periods)
Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT–III: ONE DIMENSIONAL RANDOM VARIABLES (11 periods)
Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT-IV: LINEAR PROGRAMMING (11 periods)
Formulation – Graphical solution – Simplex method – Two phase method Transportation and Assignment Models.

UNIT-V: FOURIER SERIES (11 periods)
Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals –

Power signals: Exponential Fourier series – Parseval’s theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm-Liouville systems – Generalized Fourier series.

Total Periods: 55

TEXT BOOKS:

1. Richard Bronson, *Matrix Operation*, *Schaum’s outline series*, 2nd edition, McGraw Hill, 2011.
2. Gupta, A.S., *Calculus of Variations with Applications*, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Oliver C. Ibe, *Fundamentals of Applied Probability and Random Processes*, Academic Press, (An imprint of Elsevier), 2010.
4. Taha, H.A., *Operations Research, An Introduction*, 10th edition, Pearson education, New Delhi, 2010.
5. Andrews L.C. and Phillips R.L., *Mathematical Techniques for Engineers and Scientists*, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.

REFERENCE BOOKS:

1. Elsgolts, L., *Differential Equations and the Calculus of Variations*, MIR Publishers, Moscow, 1973.
2. Grewal, B.S., *Higher Engineering Mathematics*, 42ndedition, Khanna Publishers, 2012.
3. O'Neil, P.V., *Advanced Engineering Mathematics*, Thomson Asia Pvt. Ltd., Singapore, 2003.
4. Johnson R. A. and Gupta C. B., *Miller & Freund’s Probability and Statistics for Engineers*, Pearson Education, Asia, 7thedition, 2007.

M. Tech. (PED) – I Semester
(16MT18301) ADVANCED POWER SEMICONDUCTOR DEVICES

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

PREREQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION: Construction, types, switching, operating characteristics and applications of power semiconductor devices; Design of firing, protective circuits and heat sinks for various power semiconductor devices.

COURSE OUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate knowledge on
- construction, operationand characteristics of various power semiconductor devices.
- applications of power semiconductor devices.
- operation of firing and protection circuits.
- thermal protection of power semiconductor devices.

CO2. analyze various characteristics of power semiconductor devices.
CO3. design firing and protective circuits for power converters.
CO4. initiate research ideas in selecting the appropriate power semiconductor devices for desired applications.
CO5. select and apply the appropriate controlling and firing circuits for different power converters.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO POWER SWITCHING DEVICES (08 periods)
Power semiconductor devices: Introduction, classifications of various power switching devices– circuit symbols and ratings. Characteristics of an ideal switch, characteristics of practical devices, switch specifications, device selection strategy and Electro Magnetic Interference (EMI).
Power diodes: Construction, steady state characteristics, switching characteristics, electrical rating, Types – schottky diodes, fast recovery diodes, silicon carbide diodes, series and parallel connected diodes.

UNIT-II: THYRISTOR (10 periods)
Construction, steady state characteristics and switching characteristics.Thyristor protection – di/dt protection, dv/dt protection, design of snubber circuits, over voltage protection, over current protection and gate protection.Heat sink – Thermal resistance and specifications.Improvements of thyristor ratings and thyristor mounting techniques.

UNIT-III: POWER TRANSISTORS (14 periods)
Power Bipolar Junction Transistor: Construction, steady state characteristics, switching characteristics and Safe Operating Area (SOA).
Power MOSFETs: Types - Depletion & Enhancement, construction, steady state characteristics and switching characteristics.
IGBTs: Construction, steady state characteristics, switching characteristics, series & parallel operation, comparison of BJT, MOSFET & IGBT and design of snubber circuit.

UNIT-IV: SPECIAL POWER DEVICES (11 periods)
Thyristors: GTOs – Construction, operation, steady state characteristics and switching

characteristics. Construction and operation: BCTs, TRIAC, FET – CTHs, ETOs, IGCTs, MCTs, SITHs, ASCR, RCT, SCS and light activated thyristor. Comparisons of various thyristors.Transistors: Construction and operation – COOLMOS and SITs.

UNIT-V: GATE DRIVE CIRCUITS **(12 periods)**

MOSFET and BJT gate drive circuits. Isolation of gate and base drives – Pulse transformer andopto-couplers. Thyristor firing circuits – R, RC firing circuits, photo – SCR isolator, pulse transformer isolation, 1:6 isolation transformer for inverter gate bias circuits, thyristor converter gating circuits and UJT firing circuits. Gate drive ICs – MOSFETs and IGBTs. Drive ICs for converters – MOS Gated Driver.

Total Periods: 55

TEXT BOOKS:

1. Muhammad H. Rashid,*Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4thedition, 2013.
2. Dr. P. S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 5thedition, 2012.

REFERENCE BOOKS:

1. M. D. Singh & K. B. Kanchandhani, *Power Electronics*, Tata McGraw – Hill Publishing Company, 18thedition, 2013.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *PowerElectronics*: *Converters, Applications and Design*, Wiley, 3rdedition, 2007.

15D23101 ADVANCED POWER SEMICONDUCTOR DEVICES

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

UNIT-II: Current Controlled Devices: BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power darlington – Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor.

UNIT-III: Voltage Controlled Devices: Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT(Mos Controlled Thyristor), FCT(Field Controlled Thyristor), RCT(Reverse Conducting Thyristor) .

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

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

Text books:

1. Rashid M. H., "Power Electronics Circuits, Devices and Applications", Prentice HallIndia, Third Edition, NewDelhi.
2. B.W. Williams 'Power Electronics: Devices, Drivers, Applications and PassiveComponents, Tata McGrawHill.

Reference books:

1. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGrawHill.
2. Mohan, Undeland and Robins, "Power Electronics – Concepts, applications andDesign, John Wiley and Sons,Singapore.
3. Power electronics by p.s. Bimbhra, Khannapublications.
4. Advanced power electronics converters by Euzeli dos santos, Edison R. dasilva.

M. Tech. (PED) – I Semester
(16MT18303)ANALYSIS OF POWER CONVERTERS

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

PREREQUISITES: Courses on Engineering Mathematics, Electrical circuits and Power Electronics at UG Level.

COURSE DESCRIPTION:
Single phase and three phase converters - Types, operation of controlled and uncontrolled converters; Analysis of isolated and non-isolated converters; AC voltage controllers; Choppers.
COURSE OUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate knowledge on

- operation of various types of AC–DC and DC-DC converters, AC voltage controllers.
- Total Harmonic Distortion.
- forced commutation circuits.

CO2. analyze& comprehend the operating modesof converters with different configurations subjected to various loads.
CO3. develop skills in evaluating the performance of various power converters.
CO4. initiate research ideas to provide feasible solutions for AC-DC and DC-DC converters.
CO5. select appropriate controlling techniques for improving the performance of Chopper.

DETAILED SYLLABUS:

UNIT-I: SINGLE PHASE RECTIFIERS (12 periods)
Introduction, classification of converters, analysis of semi controlled and fully controlled converters with R, R-L, R-L-E loads, freewheeling diodes, continuous & discontinuous modes of operation and evaluation of various performance parameters. Total Harmonic Distortion (THD), power factor, effect of source impedance, extinction angle control, symmetrical angle control and SPWM control.

UNIT-II: MULTI PULSE CONVERTERS (12 periods)
Introduction, analysis of semi converter and fully controlled converters with R, R-L loads, freewheeling diodes, continuous and discontinuous modes of operation.Total Harmonic Distortion (THD), power factor improvements and effect of source impedance.

UNIT-III: NON-ISOLATED DC-DC CONVERTERS (14 periods)
Introduction, Choppers: Types – Class A, B, C, D & E operation and characteristics.Concept of duty ratio and current limit control.Performance analysis of buck, boost, buck-boost, cuk, sepic and quadratic converters.

UNIT-IV: ISOLATED DC-DC CONVERTERS (11 periods)
Introduction, Performance analysis of forward, fly-back, push-pull, half-bridge and full-bridge converters.Resonant Converters-Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS) converters.Relationship between input and output voltages, expression for filter inductor and capacitors.

UNIT-V: AC VOLTAGE CONTROLLERS AND DUAL CONVERTERS (06 periods)
Principle of phase control: Single phase and three phase controllers - Analysis with R and R-L loads. Single phase dual converters: Non-circulating and circulating modes of operation.

Total Periods: 55

TEXT BOOKS:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4thedition, 2013.
2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rdedition, 2007.

REFERENCE BOOKS:

1. P C Sen, *Modern Power Electronics*, Wheeler publishing Co, 1stedition, New Delhi, 1998.
2. Bimal K Bose, *Modern Power Electronics and Drives*, Pearson Education, 2ndedition, 2003.
3. M D Singh & K B Khanchandani, *Power Electronics*, Tata McGraw – Hill Publishers, New Delhi,2ndedition,2013.

15D23202 SWITCHED MODE POWER CONVERTERS

UNIT –I DC-DC Converters: Buck Converter, Boost Converter, Buck-boost converter, Cuk converter – Steady-State Analysis, Duty Ratio, Volt-Sec Balance and Voltage Gain, Average Voltage and Current Expressions, Ripple Current and Voltage Expressions, Finding Performance Parameters, Numerical problems, Comparison of Converters, Multi Output Boost Converters, Diode Rectifier fed Boost Converter, Chopper CircuitDesign.

UNIT – II Dynamic Analysis of Dc-Dc Converters: Formulation of averaged Circuit Models of Buck, Boost and buck-boost Converters, Small Signal Analysis and Linearization– Need for Small Signal Models, Obtaining Models, Generalizing the Process.
Introduction to Control Design and Control Design based on Linearization - Transfer Functions, Compensation and Filtering, Numerical problems. Voltage Mode, Current Mode and Hysteresis Controls for DC – DC Converters.

UNIT – III Single-Switch Isolated Converters: Requirement for Isolation in the Switch-Mode Converters, Transformer Connection, Forward and Fly Back Converters, Power Circuit and Steady-State Analysis – Finding Performance Parameters - Numerical Problems
Push-Pull Converters: Power Circuit and Steady-State Analysis, Utilization of Magnetic Circuits in Single Switch and Push-Pull Topologies - Finding Performance Parameters - Numerical Problems.

UNIT – IV Isolated Bridge Converters: Half Bridge and Full-Bridge Converters, Power Circuit and Steady-State Analysis, Utilization of Magnetic Circuits and Comparison with Previous Topologies, Numerical Problems.
Configurations of Resonant DC Power Supplies – Bidirectional Power Supplies – Switch Mode AC Power Supplies – Resonant Ac Power Supplies – Bidirectional AC Power Supplies - Finding Performance Parameters – Numerical Problems.

UNIT – V Resonant Converters & Quasi-Resonant Converters:
Classification of Resonant Converters-Basic Resonant Circuits - Series Resonant Circuit - Parallel Resonant Circuits - Resonant Switches, Numerical Problems.
Concept of Zero Voltage Switching, Concept of Zero Current Switching – Principle Of Operation, Analysis of M-Type And L-Type Buck or Boost Converters, Numerical Problems.

TEXT BOOKS:

1. Robert Erickson and Dragon Maksivimovic, Fundamentals of Power Electronics, SpringerPublications.
2. IssaBatarseh, Fundamentals of Power Electronics, John Wiley Publications,2009.
3. M. H. Rashid, Power Electronics Circuits, Devices and Applications, Prentice Hall, 2003

REFERENCE BOOKS:

1. Philip T.Krein Elements of Power Electronics - Oxford University Press,1997.
2. L. Umanand Power Electronics, Tata Mc-Graw Hill,2004.
3. Robert Erickson and Dragon Maksivimovic, Fundamentals of PowerElectronics, SpringerPublications.

15D23201 ADVANCED POWER CONVERTERS

UNIT-I: PWM Inverters: Principle of Operation – Performance Parameters – Single Phase Bridge Inverter – Output Voltage and Current With R, R-L & R-L-C Loads – Voltage Control of Single Phase Inverters – Advanced Modulation Techniques for Improved Performance –Numerical Problems.
Three Phase Inverters –180 Degree Condition –120 Degree Conduction – Analysis – Output Voltage and Current With R, R-L & R-L-C Loads – Voltage Control of Three Phase Inverters – Comparison ofPWMTechniques–HarmonicReductions–CurrentSourceInverter–VariableDCLinkInverter – Buck and Boost Inverter – Inverter Circuit Design – Applications – Numerical Problems.

UNIT-II: Resonant Pulse Inverters: Series Resonant Inverters – Analysis with Unidirectional Switches & Bidirectional Switches – Evaluation of Currents and Voltages – Frequency Response of Series Resonant Inverters – Series Loaded Inverter –Parallel Loaded Inverter –Series and Parallel Loaded Inverters – Parallel Resonant Inverters – Voltage Control of Resonant Inverters – Class E Resonant Inverter & Class E Resonant Rectifier – Numerical Problems.
Resonant Converters – Zero Current Switching Resonant Converters – L Type– M Type – Zero Voltage Switching Resonant Converters – Comparison Between ZCS And ZVS – Resonant Converters – Two Quadrant ZVS Resonant Converters – Resonant DC-Link Inverters – Numerical Problems.

UNIT-III: Multilevel Inverters
Multilevel Concept – Types of Multilevel Inverters – Diode Clamped Multilevel Inverter – Improved Diode Clamped Inverter – Flying Capacitors Multilevel Inverter – Cascaded Multilevel Inverter– Principle Of Operation – Main Features– Applications – Reactive Power Compensation, Back to Back Intertie System, Adjustable Drives– Switching Device Currents – DC Link Capacitor Voltage Balancing – Features of Multilevel Inverters –Comparisons of Multilevel Converters – Numerical Problems.

UNIT-IV: DC Power Supplies :DC Power Supplies – Types – Switched Mode DC Power Supplies – Fly Back Converter –Forward Converter – Push-Pull Converter – Half Bridge Converter – Full Bridge Converter –Resonant DC Power Supplies – Bidirectional Power Supplies – Applications – Numerical Problems.

UNIT-V: AC Power Supplies: AC Power Supplies – Types – Switched Mode AC Power Supplies – Resonant AC Power Supplies – Bidirectional Ac Power Supplies – Multistage Conversions – Control Circuits – Power Line Disturbances – Power Conditioners – Uninterruptible Power Supplies – Applications – Numerical Problems.

TEXT BOOKS:

1. Power Electronics – Mohammed H. Rashid – Pearson Education – ThirdEdition.
2. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons – Second Edition

M. Tech. (PED) – I Semester

(16MT18304) MODELLING OF ELECTRICAL MACHINES

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

PREREQUISITES: Course on DC Machines, Transformers and Induction Machines,Synchronous Machines.

COURSE DESCRIPTION: Modelling and analysis of DC,induction andsynchronous machines in stationary and rotating reference frames

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

CO1. demonstrate potential knowledge on modelling of DC, induction and synchronous machines.
CO2. analyze the performance of DC, induction and synchronous machines.
CO3. design DC, induction and synchronous machines meeting the needs of industry.
CO4. apply appropriate transformation technique to obtain reference frame variables.

DETAILED SYLLABUS:

UNIT-I: BASIC PRINCIPLES OF ELECTRICAL MACHINE ANALYSIS (14 periods)

Magnetically coupled circuits: Review of basic concepts, magnetizing inductance, modeling linear and nonlinear magnetic circuits.

Electromechanical energy conversion: Principles of energy flow, concept of field energy and co-energy. Derivation of torque expression for various machines using the principles of energy flow and the principle of co-energy. Inductance matrices of induction and synchronous machines.

UNIT-II: THEORY OF DC MACHINES (09 periods)

Review of the DC machine. State-space model of a DC machine, reduced order model andTransfer functions of the DC machine. Numerical problems.

UNIT-III: REFERENCE FRAME THEORY (11 periods)

Concept of space vector, types of transformation, condition for power invariance, zero-sequence component, expression for power with various types of transformation. Transformations between reference frames: Clarke and Park's Transformations, variables observed from various frames.

UNIT-IV: THEORY OF SYMMETRICAL INDUCTION MACHINES (11 periods)

Voltage and torque in machine variables, derivation of dq0 model for a symmetrical induction machine, voltage and torque equation in arbitrary reference frame variables, analysis of steady state operation. State-space model of induction machine in 'd-q' variables. Numerical problems.

UNIT-V: THEORY OF SYNCHRONOUS MACHINES (10 periods)

Equations in arbitrary reference frame. Park's transformation, derivation of dq0 model for a salient pole synchronous machine with damper windings, torque expression of a salient pole synchronous machine with damper windings and identification of various components.Numerical problems.

Total Periods: 55

TEXT BOOKS:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, *Analysis of Electric Machinery &Drive systems*, IEEE Press, 2002.
2. R. Krishnan, *Electric motor drives,Modeling,Analysis and Control*,Prentice Hall, 2001.

REFERENCE BOOKS:

1. Rik De Doncker, Duco W. J. Pulle, André Veltman, *Advanced Electrical Drives: Analysis, Modeling, Control*, Springer, 2011.
2. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, *Electric Machinery*, TMH, 5thedition, 2003.

M. Tech. (PED) – I Semester

(16MT18305) ELECTRIC AND HYBRID-ELECTRIC VEHICLES

(Professional Elective-1)

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

PREREQUISITES: Courses on Power Electronics, Special Electrical Machines and Power Semiconductor Drives at UG Level

COURSE DESCRIPTION: Transportation vehicles and their impact in society; Concept and configurations of Electric Vehicles (EV); Principle, Types and operation of Hybrid-Electric Vehicles (HEVs); Power Electronic converters in HEVs; Different motor drives & energy storage technologies in EVs and HEVs.

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

CO1. demonstrate knowledge on
- fundamental concepts of Electric Vehicles (EVs) and Hybrid-Electric Vehicles (HEVs).
- utilization of power converters in electric mobility.
- deployment of various electrical drives used in EVs and HEVs.
- battery energy storage technologies used in EVs and HEVs.
- different applications of EVs and HEVs such as aircraft, ships and locomotives.

CO2. analyze
- the practical aspects of power converters in EVs/HEVs.
- suitability of a motor drive in a vehicle application.

CO3. develop skills in evaluating the basic schemes of series & parallel HEVs and energy storage technologies in EVs/HEVs.

CO4. undertake research by implementing
- special electrical machines such as Switched Reluctance Motor and Permanent Magnet Brushless DC Motor for EVs/HEVs.
- DC-DC boost converter for HEVs.

CO5. select and apply the appropriate power converter & energy storage techniques for designing EVs and HEVs in the applications of aircraft, ships and locomotives.

CO6.demonstrate
- the effects of modern transportation on society and environment.
- the need to develop sustainable technologies in place of conventional vehicles.

DETAILED SYLLABUS:

UNIT-I: ELECTRIC AND HYBRID ELECTRIC VEHICLES (09 periods)

Environmental impact and history of modern transportation, history of transportation electrification.Electric Vehicles (EVs) - Introduction, configurations and traction motor characteristics. Hybrid-Electric Vehicles (HEVs) - Concept and architectures; Series HEV - Configuration, operation, advantages and disadvantages; HEVs - Interdisciplinary nature, challenges and key technologies.

UNIT-II: POWER ELECTRONICS IN HEVS (13 periods)

Introduction, principle of power electronics, rectifiers used in HEVs, Buck converter used in HEVs. Non-isolated bidirectional DC-DC Converter - operating principle, torque and power capability, current ripple and regenerative braking. Isolated bidirectional DC - DC converter - principle, steady state operations, output voltage and output power. Battery chargers - forward, fly back and bridge converters.

UNIT-III: ELECTRIC PROPULSION SYSTEMS (13 periods)

Introduction, typical functional block diagram and classification of electric motor drive, DC motor drives - Control methods, class A and B choppers, two and four quadrant chopper control. Induction Motor drives - Operating principle, steady - state performance, v/f control and power electronic control. PM BLDC Motor drives - Construction, advantages anddisadvantages, performance analysis and control. Switched Reluctance Motor drives - SRM basic magnetic structure, torque production, converter topologies.

UNIT-IV: ENERGY STORAGE TECHNOLOGIES (12 periods)

Battery - basic theory andcharacterization, battery technologies, types – lead acid batteries, nickel-based batteries and lithium-based batteries. Ultra-capacitors - Features, basic principles, performance, battery modeling based on electric equivalent circuit, Modeling of ultra - capacitors, battery charging control and flywheel energy storage system.Fuel Cells - modeling and block diagrams of hybrid fuel cell energy storage systems.

UNIT-V: APPLICATIONS OF HYBRID ELECTRIC VEHICLES (08 periods)

Introduction, Hydraulic Hybrid Vehicles (HHV) - Principle and operation of regenerative braking.Hybrid off road vehicular system, electric or hybrid ships and locomotives.Military applications - Electromagnetic launchers and hybrid-powered ships.

Total Periods: 55

TEXT BOOKS:

1. MehrdadEhsani, YiminGao and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles*, CRC Press, 2ndedition, 2015.
2. Chris Mi, M. AbulMasrur, David WenzhongGao, *Hybrid Electric Vehicles Principles and Applications with Practical Perspectives*, Wiley, 2011.

REFERENCE BOOKS:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, CRC Press, 2ndedition, 2011.
2. Jack Erjavec, *Hybrid, Electric & Fuel-Cell Vehicles*, Delmar Cengage learning, 2ndedition, 2013.

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 powerconverters and allied areas.
CO5. select and apply suitable intelligent techniques for appropriate power converterfed 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'sSOM.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, *ArtificialIntelligence*, 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. (PED) – I Semester
(16MT18331)POWER ELECTRONICS DESIGN LAB

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

PREREQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION: Design and development of various power converters.

COURSEOUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate practical knowledge on:
- design and development of power converters.
- Understanding of gate firing circuits.

CO2. analyze and relate physical observations and measurements of various power converters with theoretical principles.
CO3. solve engineering problems related to power converters and firing circuits to provide feasible solutions.
CO4. initiateresearch ideas to provide solutions for design of power converters.
CO5. select and apply
- suitable commutation circuit for various power converters.
- PWM technique for multilevel inverters.

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.

LIST OF EXPERIMENTS:

Conduct any Two Experiments from the following:

1. Design, develop and analyzeDC to DC converter using IGBTs.
2. Design, develop and analyze DC to DC converter using Power MOSFETs.
3. Design, develop and analyzeDC to AC converter using IGBTs.
4. Design, develop and analyzeDC to AC converter using Power MOSFETs.
5. Design, develop and analyzeAC to AC converters using SCRs.
6. Design, develop and analyzeAC to AC converters using TRIACs/SCRs.
7. Design, develop and analyzeAC to DC converters using SCRs.
8. Design, develop and analyze AC to DC converters using SCRs and Diodes.
9. Analysis of Three Level Neutral Point Clamped Multilevel Inverter.

M. Tech. (PED) – I Semester
(16MT18332)POWER ELECTRONICS SIMULATION LAB

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

PREREQUISITES: Courses on Electronic Devices and Power Electronics at UG Level.

COURSE DESCRIPTION: Design and analysis of various converters and inverters.

COURSE OUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate knowledge on various power converters.
CO2. analyze the performance of various power converters.
CO3. evaluate the output characteristics of different types of Power converters.
CO4. initiate research ideas to provide solutions for design of power converters.
CO5. select and apply appropriate control techniques for power converters.
CO6. function effectively as an individual and as a member in the team to solve various problems.
CO7. prepare laboratory reports that clearly communicate experimental information.
CO8. practice professional code of ethics.

LIST OF EXPERIMENTS:

Conduct any TEN Experiments from the following using MATLAB

1. Simulationof single phase semi converter.
2. Simulation of single phase fully controlled converter.
3. Simulation of three phase semi converter.
4. Simulation of three phase fully controlled converter.
5. Simulation of single phase full bridge inverter.
6. Simulation of three phase full bridge inverter.
7. Simulation of sinusoidal PWM inverter.
8. Simulation of single phase and three phase AC voltage controllers.
9. Simulation of DC–DC Buck–Boost Converter.
10. Simulation of Three level Neutral Point Clamped multilevel inverter.
11. Simulation of Five level H-Bridge cascaded multilevel inverter.

15D23204 POWER ELECTRONICS AND DRIVES SIMULATION LAB

List of Experiments

1. Simulation of 1-phase/ 3-phase IGBT based bridge inverter circuits with R, R-L loads.
2. Simulation of 3-phase bridge inverter.
3. Simulation of 1-phase/3-phase thyristorized converters (semi, full converter)
4. Simulation of 3-phase converters.
5. Simulation of speed control of separately excited DC motor.
6. Simulation of Closed loop speed control of BLDC motor.
7. Simulation of DC-DC converters (Buck, boost and Buck-boost converters).
8. Simulation of two-level and three-level inverter with sinusoidal PWM.
9. Simulation of VSI fed Induction motor (square wave and PWM inverters).
10. Simulation of induction motor with open loop constant V/F control.
11. Simulation of induction motor with indirect vector control.
12. Simulation of PMSM.

(Simulation software tools: Matlab/Simulink/PSPICE/PSIM)

M. Tech. (PED) – I Semester
(16MT13808)RESEARCH METHODOLOGY
(Common to all M. Tech. Programs)
(Audit Course)

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

PREREQUISITES:--

COURSE DESCRIPTION: Overview of Research, research problem and design, various research designs, data collection methods, statistical methods for research, importance of research reports and its types

COURSE OUTCOMES: On successful completion of the course, student will be able to
CO1. demonstrate knowledge on
- research design and conducting good research,
- various data collection methods,
- statistical methods in research,
- report writing techniques.

CO2. analyze various research design issues for conducting research in core or allied areas
CO3. formulate solutions for engineering problems by conducting research effectively in the core or allied areas
CO4. carryout literature survey and apply good research methodologies for the development of scientific/technological knowledge in one or more domains of engineering.
CO5. select and apply appropriate techniques and tools to complex engineering activities in their respective fields.
CO6. write effective research reports.
CO7. develop attitude for lifelong learning to do research
CO8. develop professional code of conduct and ethics of research.

DETAILED SYLLABUS:

UNIT - I: INTRODUCTION TO RESEARCH METHODOLOGY (05 Periods)
Objectives and Motivation of Research, Types of Research, Research Approaches, Research Process, Criteria of good Research, Defining and Formulating the Research Problem, Problem Selection, Necessity of Defining the Problem, Techniques involved in Defining a Problem.

UNIT - II: RESEARCH PROBLEM DESIGN AND DATA COLLECTION METHODS (07 Periods)
Features of Good Design, Research Design Concepts, Different Research Designs, Different Methods of Data Collection, Data preparation: Processing Operations, Types of Analysis.

UNIT - III: STATISTICS IN RESEARCH (06 Periods)
Review of Statistical Techniques - Mean, Median, Mode, Geometric and Harmonic Mean, Standard Deviation, Measure of Asymmetry, ANOVA, Regression analysis.

UNIT - IV: HYPOTHESIS TESTING (07 Periods)
Normal Distribution, Properties of Normal Distribution, Basic Concepts of Testing of Hypothesis, Hypothesis Testing Procedure, Hypothesis Testing: t-Distribution, Chi-Square Test as a Test of Goodness of Fit.

UNIT - V: INTERPRETATION AND REPORT WRITING (03 Periods)
Interpretation – Techniques and Precautions, Report Writing – Significance, Stages, Layout, Types of reports, Precautions in Writing Reports.

Total Periods: 28

TEXT BOOK:

1. C.R. Kothari, *Research Methodology: Methods and Techniques*, New Age International Publishers, New Delhi, 2ndrevised edition, 2004.

REFERENCE BOOKS:

1. Ranjit Kumar, *Research Methodology: A step-by-step guide for beginners*, Sage South Asia, 3rdedition, 2011.
2. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.

M. Tech. (PED) – II Semester
(16MT28301) LINEAR AND NONLINEAR CONTROL SYSTEMS

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

PREREQUISITES: Course on Control systems in UG Level.

COURSE DESCRIPTION: Design of compensators and controllers; describing function, phase plane analysis, Lyapunov's stability analysis; Full order observer and reduced order observer; Nonlinear control design.

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

CO1. demonstrate knowledge on
- various compensators and controllers.
- stability in the sense of Lyapunov.
- nonlinear control design.

CO2. analyze the stability of nonlinear system using
- describing function approach.
- phase plane analysis.
- Lyapunov's method.

CO3. design suitable compensator and controllers using root locus and Bode plot.

CO4. solve stability problems using Lyopunov method.

CO5. select appropriate techniques for analyzing stability of the system.

DETAILED SYLLABUS:

UNIT–I: LINEAR CONTROL SYSTEM DESIGN (12 periods)
Introduction to control system design, types of compensators, design of compensators using root locus technique. Types of controllers, design of PI, PD and PID controllers using Bode plot and root locus technique.

UNIT–II: DESIGN OF CONTROL SYSTEMS IN STATE SPACE (11 periods)
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-III: LYAPUNOV STABILITY (11 periods)
Introduction, stability in the sense of Lyapunov, basic definitions, Lyapunov's second method, Lyapunov's functions for nonlinear systems - variable gradient method, Krasooviski's method.

UNIT–IV: INTRODUCTION TO NON LINEAR SYSTEM (15 periods)
Introduction to non-linear systems, different types of physical non-linearities, describing functions, derivation of describing functions for dead zone, saturation, backlash, relay and hysteresis. Stability analysis of non-linear systems through describing functions, phase-plane analysis, singular points, methods for constructing trajectories - Isoclines' method, delta method.

UNIT–V: NON-LINEAR CONTROL DESIGN (06 periods)
Feedback linearization, Input/output linearization, sliding mode control.

Total Periods: 55

TEXT BOOKS:

1. M. Gopal, *Modern Control System Theory*, New Age International (P) Ltd., 2^{nd} edition, 2000.
2. K. Ogata, *Modern Control Engineering*, Prentice Hall of India, 4^{th} edition, 2006.
3. Hasan A. Khalil,*Nonlinear Systems*, Prentice Hall of India, 3^{rd} edition, 2002.

REFERENCE BOOKS:

1. A. Nagoorkani, *Advanced control theory*, RBA publications, 2^{nd} edition, 1999.
2. I.J. Nagrath and M.Gopal, *Control Systems Engineering*, New Age International (P) Ltd., 2007.

M. Tech. (PED) – II Semester
(16MT28303)SOLID STATE AC DRIVES

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

PREREQUISITES: Courses on Analysis of inverters and modelling of electrical machines.

COURSE DESCRIPTION: Open loop and closed loop speed control of induction motor; Synchronous motor drive; Induction motor drive, torque control, field oriented control, flux vector estimation, synchronous motor control.

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

CO1. demonstrate knowledge on

- operating regions of various AC drives.
- speed control of induction motor drives.
- control of synchronous motor drives.
- field oriented control of induction machines.

CO2. analyze the operation and performance of power converter fed AC motors.

CO3. solve engineering problems pertaining to AC drives to provide feasible solutions.

CO4. initiate research to design open loop and closed loop controllers for controlling of AC motors.

CO5. select and apply appropriatepower circuit configuration for the speed control of AC motor drives.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO INDUCTION MOTORS (09 periods)

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

UNIT-II: STATOR FREQUENCY CONTROL (12 periods)

Operation of induction motor with non-sinusoidal supply waveforms, variable frequency operation of PWM inverter fed three phase induction motors, constant flux operation & current fed operation, dynamic and regenerative braking of Current Source Inverter(CSI) and Voltage Source Inverter(VSI) fed drives.

UNIT-III: ROTOR RESISTANCE CONTROL (11 periods)

Torque-Slip characteristics, sub- and super- synchronous operation, slip control, rotor resistance control, chopper controlled resistance, equivalent resistance, TRC strategy. Characteristic relation between slip and chopper duty ratio, combined stator voltage control and rotor resistance control. Design solutions: Closed loop control scheme, slip power recovery schemes and power factor considerations.

UNIT-IV: FIELD ORIENTED CONTROL (12 periods)

Dynamic modeling of induction machines. Introduction to field oriented control of induction machines: Theory, DC drive analogy. Direct and Indirect methods. Flux vector estimation using voltage model and current model equations, merits and demerits. Direct Torque Control (DTC) of induction machines, torque expression with stator and rotor fluxes, DTC control strategy. Closed loop speed control.

UNIT-V: SPEED CONTROL OF SYNCHRONOUS MOTORS **(11 periods)**

Wound field cylindrical rotor motor, equivalent circuits, performance equations of operation from a voltage source. V-curves. Starting and braking. Open loop VSI and CSI fed synchronous motor. Self-control and Load commutated synchronous motor drives: Margin angle control, torque angle control, power factor control. Brush and Brushless excitation. Closed loop speed control scheme with various power controllers.

Total Periods: 55

TEXT BOOKS:

1. GopalK.Dubey, *Power semiconductor controlled Drives*, Prentice Hall Inc., New Jersey, 1989.
2. R.Krishnan, *Electric Motor Drives- Modeling, Analysis and Control*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.

REFERENCE BOOKS:

1. GopalK.Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2001.
2. BimalK.Bose, *Modern Power Electronics and AC Drives*, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2002.
3. W.Shepherd, L.N.Hulley, D.T.W.Liang, *Power electronics and motor control*, Cambridge university press, 1996.
4. M.D.Singh, *Power Electronics*, Tata McGraw-Hill publishing company Ltd., New Delhi, 2008.

15D23203 SOLID STATE AC DRIVES

UNIT-I: Induction Motor- An Overview
Review of Steady-State Operation of Induction Motor, Equivalent Circuit Analysis, Torque-Speed Characteristics.

Phase Controlled Induction Motor Drive
Stator Voltage Control of Induction Motor, Phase-Controlled Converter Fed Induction Motor, Power Circuit and Gating, Reversible Phase-Controlled Induction Motor Drive, Torque-Speed Characteristics.

UNIT-II: Voltage Source Inverter Fed Induction Motor Drive
Stator Voltage and Frequency Control of Induction Motor, Torque-Speed Characteristic Static Frequency Changers, PWM Inverter Fed Induction Motor Drive, Variable-Voltage Variable- Frequency Operation of Induction Motor, Constant E/f And V/f Control Schemes, Slip Regulation.

Current Source Inverter Fed Induction Motor Drive
Stator Current and Frequency Control of Induction Motor, Auto Sequentially Commutated Inverter (ASCI), Power Circuit, Commutation, Phase Sequence Reversal, Regeneration, Steady-State Performance.

UNIT-III: Rotor Side Control of Slip-Ring Induction Motor
Slip-Power Recovery Schemes, Steady-State Analysis- Range of Slip, Equivalent Circuit, Performance Characteristics; Rating of Converters.

Vector Control of Induction Motor
Principles of Vector Control, Direct Vector Control, Derivation of Indirect Vector Control, Implementation – Block Diagram, Estimation of Flux, Flux Weakening Operation.

UNIT-IV: Control of Synchronous Motor Drives
Synchronous Motor and Its Characteristics- Control Strategies-Constant Torque Angle Control- Power Factor Control, Constant Flux Control, Flux Weakening Operation, Load Commutated Inverter Fed Synchronous Motor Drive, Motoring and Regeneration, Phasor Diagrams.

Unit-V: PMSM and BLDC Drives
Characteristics of Permanent Magnet, Synchronous Machines With Permanent Magnet, Vector Control of PMSM- Motor Model and Control Scheme, Constant Torque Angle Control, Constant Mutual Flux Linkages, Unity PF Control. Modeling of PM Brushless Dc Motor, Drive Scheme, Commutation Torque Ripple, Phase Advancing.

TEXT BOOK:

1. R. Krishnan, Electric Motor Drives Modeling, Analysis & control, Pearson Education, 2001.

REFERENCE BOOKS:

1. B. K. Bose Modern Power Electronics and AC Drives, PearsonPublications-2001.
2. MD Murphy & FG Turn Bull, Pergaman press, Power Electronics control of ACmotors
3. 1st edition-1998.
4. G.K. Dubey Fundamentals of Electrical Drives Narosa Publications-1995.

M. Tech. (PED) – II Semester
(16MT28305)SPECIAL ELECTRICAL MACHINES

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

PREREQUISITES: Courses on Electrical Machines, Control Systems and power electronics at UG level and Modelling of electrical machines at PG level

COURSE DESCRIPTION: Construction, operation, types, characteristics and applications of Stepper Motors, Switched Reluctance Motor, PM Brushless DC Motor, Synchronous Reluctance, Linear Induction and synchronous Motors.

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

CO1. demonstrate knowledge on
- construction and operation of various types of special electrical machines.
- characteristics of special electrical machines.
- open loop and closed loop operation of special electrical machines.

CO2. analyze the operation and performance of special electrical machines for various operatingconditions.

CO3. design suitable accessories / controllers for desired operation and control of special electricalmachines.

CO4. solve engineering problems pertaining to special electrical machines to provide feasible solutions.

CO5. select and apply appropriate technique and tools for control and operation of special electrical machines in domestic and industrial applications.

CO6. apply the conceptual knowledge of special electrical machines in relevance to industry andsociety.

DETAILED SYLLABUS:

UNIT-I: STEPPER MOTOR (10 periods)

Types of construction and working principle of stepping motor. Various configurations for switching the phase windings, torque equation and characteristics. Open loop and closed loop control of stepper motor, applications.

UNIT-II: SWITCHED RELUCTANCE MOTOR (11 periods)

Construction details, Principle of operation – Design of stator and rotor pole arcs – torque equation and characteristics, power converter for switched reluctance motor, control of switched reluctance motor, rotor sensing mechanism.

UNIT-III: SYCHRONOUS RELUCTANCE MOTOR (10 periods)

Constructional features, Types – Axial and Radial flux motors. Principle of operation, torque-speed characteristics, Phasor diagram, Characteristics, control of SyRM, advantages and applications.

UNIT-IV: PERMANENT MAGNET BRUSHLESS DC MOTOR (12 periods)

Permanent magnet materials–hysteresis loop, analysis of magnetic circuits. Constructional details, principle of operation, BLDC square wave motor, types of BLDC motor, sensing and switching logic schemes, sensorless and sensor based control of BLDC motors.

UNIT-V: LINEAR MOTORS (12 periods)

Linear Induction Motor (LIM): Construction, principle of operation – single sided and double-sided LIM, thrust equations and performance equations based on current sheet concept, equivalent circuit of LIM, applications.
Linear Synchronous Motor (LSM): Construction, types, principle of operation, thrust equation, control and applications.

Total Periods: 55

TEXT BOOKS:

1. K. VenkataRatnam, *Special Electrical Machines*, University press, New Delhi, 2009.
2. E.G. Janardhanan, *Special Electrical Machines*, PHI learning private limited, 2014.

REFERENCE BOOKS:

1. Takashi Kenjo, *Stepping Motors and their Microprocessor controls*, clarenden press, Oxford, 1984.
2. T. Kenjo and S. Nagamori, *Permanent-Magnet and Brushless DC Motors*, clarenden press, Oxford, 1984.
3. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, clarenden press, Oxford 1989.
4. R. Krishnan, *Switched Reluctance Motor Drives – Modeling, Simulation, analysis, Design and Applications*, CRC press, Special Indian Edition, 2015.

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. (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 any TEN Experiments from the following 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.

15D23204 POWER ELECTRONICS AND DRIVES SIMULATION LAB

List of Experiments

1. Simulation of 1-phase/ 3-phase IGBT based bridge inverter circuits with R, R-L loads.
2. Simulation of 3-phase bridge inverter.
3. Simulation of 1-phase/3-phase thyristorized converters (semi, full converter)
4. Simulation of 3-phase converters.
5. Simulation of speed control of separately excited DC motor.
6. Simulation of Closed loop speed control of BLDC motor.
7. Simulation of DC-DC converters (Buck, boost and Buck-boost converters).
8. Simulation of two-level and three-level inverter with sinusoidal PWM.
9. Simulation of VSI fed Induction motor (square wave and PWM inverters).
10. Simulation of induction motor with open loop constant V/F control.
11. Simulation of induction motor with indirect vector control.
12. Simulation of PMSM.

(Simulation software tools: Matlab/Simulink/PSPICE/PSIM)

M. Tech. (PED) – II Semester
(16MT23810) INTELLECTUAL PROPERTY RIGHTS
(Common to all M. Tech. Programs)
(Audit Course)

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

PREREQUISITES: -

COURSE DESCRIPTION: Introduction to Intellectual Property; Trade Marks; Law of Copy Rights; Law of Patents; Trade Secrets; Unfair Competition; New Development of Intellectual Property.

COURSE OUTCOMES: On successful completion of the course, student will be able to
CO1. demonstrate knowledge on
- Intellectual Property,
- Trade Marks & Secrets,
- Law of Copy Rights, Patents,
- New development of Intellectual Property.

CO2. analyze the different forms of infringement of intellectual property rights.
CO3. solve problems pertaining to Intellectual Property Rights.
CO4. stimulate research zeal for patenting of an idea or product.
CO5. write effective reports required for filing patents.
CO6. develop life-long learning capabilities.
CO7. develop awareness of the relevance and impact of IP Law on their academic and professional lives.
CO8. develop attitude for reflective learning.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO INTELLECTUAL PROPERTY (05 Periods)
Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT-II: TRADE MARKS (05 Periods)
Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

UNIT-III: LAW OF COPY RIGHTS (06 Periods)
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

UNIT-IV: TRADE SECRETS (06 Periods)
Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.
Unfair competition: Misappropriation right of publicity, false advertising.

UNIT-V: NEW DEVELOPMENT OF INTELLECTUAL PROPERTY (06 Periods)

New developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international - trade mark law, copy right law, international patent law, international development in trade secrets law.

Total Periods: 28

TEXT BOOKS:

1. Deborah, E. Bouchoux, *Intellectual property right*, cengage learning.
2. PrabuddhaGanguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd.