SREE VIDYANIKETHAN ENGINEERING COLLEGE

(AUTONOMOUS)

Sree Sainath Nagar, Tirupati

Department of Electrical and Electronics Engineering

Supporting Document for 1.1.3

Courses having focus on

Employability/ Entrepreneurship/ skill Development

Program: M.Tech.- Power Electronics and Drives

Regulations : SVEC-16

The Courses (with course outcomes) under SVEC-16 Regulations which focus on ***employability/ entrepreneurship/ skill development*** are highlighted with the following colours.

Skill

Employability

Entrepreneurship

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 and non-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*, 42nd edition, 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, 7th edition, 2007.

(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, operation and 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, 4th edition, 2013.
2. Dr. P. S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 5th edition, 2012.

REFERENCE BOOKS:

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

M. Tech. (PED) – I Semester

(16MT18302)ANALYSIS OF INVERTERS

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

PREREQUISITES: Courses on Power Electronics at UG Level.

COURSE DESCRIPTION:
Operation and performance of single phase and three phase voltage source inverters; Voltage control of single phase and three phase inverters; Design of PWM inverter; Current Source Inverters; Multilevel inverters and resonant inverters.

COURSE OUTCOMES: On successful completion of the course, students will be able to
CO1. demonstrate knowledge on
- operation of various configurations of inverters.
- various voltage control methods.
- Pulse Width Modulation techniques.

CO2. analyze& comprehend the operating modes of inverters under different configurations subjected to various loads.
CO3. evaluate the performance of various types of inverters and PWM controllers.
CO4. conduct investigations to provide feasible solutions for the problems in the field of power inverters.
CO5. select appropriate controlling technique for improving the performance of inverters.

DETAILED SYLLABUS:
UNIT-I: SINGLE PHASE VOLTAGE SOURCE INVERTERS (11 periods)
Introduction, classification of inverters, single phase half bridge and full bridge voltage source inverters and performance parameters of inverter. Voltage control of single phase inverters – single PWM, multiple PWM, sinusoidal PWM, modified sinusoidal PWM and phase displacement control. Uninterruptable Power Supply (UPS) – offline and online.

UNIT-II: THREE PHASE VOLTAGE SOURCE INVERTERS (13 periods)
Introduction, 180° conduction mode with R and RL load, 120° conduction mode with R-load, comparison of two conduction modes, voltage control of three phase inverter -Advanced modulation techniques - trapezoidal, staircase, stepped, harmonic injection and delta modulation.

UNIT-III: CURRENT SOURCE INVERTERS (09 periods)
Introduction, Operation of six-step thyristor inverter, commutated Inverters, Auto Sequential Current source Inverter (ASCI), current pulsations, comparison of current source inverter and voltage source inverters, PWM techniques for current source inverters.

UNIT-IV: RESONANT PULSE INVERTERS (08 periods)
Introduction, series resonant inverters with unidirectional and bi-directional switches, frequency response of series resonant inverters-series loaded, parallel loaded, parallel resonant inverters, voltage control of resonant inverters and class E resonant inverters.

UNIT-V: MULTILEVEL INVERTERS (14 periods)
Introduction, multilevel concept, types of multilevel inverter, diode clamped multilevel inverter- principle of operation and features.Flying capacitor multilevel inverter - principle of operation and features.Cascaded multi-level inverter - principle of operation and features. Applications of multilevel inverters, switching device current, DC link capacitor voltage balancing and comparison of multilevel inverters.

Total Periods: 55

TEXT BOOKS:

1. Muhammad H. Rashid,*Power Electronics: Circuits, Devices and Applications*, Pearson Education, 4th edition, 2013.

2. Ned Mohan, T.M.Undeland and W.P.Robbin, *Power Electronics: Converters, Application andDesign*, Wiley, 3rd edition, 2007.

REFERENCE BOOKS:

1. Dr. P. S. Bimbhra, *Power Electronics,* Khanna publishers, New Delhi, 5th edition, 2012.
2. M D Singh & K B Khanchandani, *Power Electronics*, Tata McGraw – Hill Publishers, New Delhi, 2ndedition, 2013.
3. P C Sen, *Modern Power Electronics*, Wheeler publishing Co, New Delhi, 1st edition, 1998.

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. initiateresearch 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, 4th edition, 2013.

2. Ned Mohan, T. M. Undeland, W.P. Robbins, *Power Electronics: Converters, Applications and Design*, Wiley, 3rd edition, 2007.

REFERENCE BOOKS:

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

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: Courses 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, 5th edition, 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 and

disadvantages, 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, 2nd edition, 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, 2nd edition, 2011.
2. Jack Erjavec, *Hybrid, Electric & Fuel-Cell Vehicles*, Delmar Cengage learning, 2nd edition, 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 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, 10th 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. (PED) – I Semester

(16MT10707)MICROCONTROLLERS AND APPLICATIONS

(Common to EPS & PED)

(Professional Elective-1)

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

PREREQUISITES: Digital logic design, Microprocessors and Microcontrollers at UG level.

COURSE DESCRIPTION:
8051 Microcontroller: Architecture, Programming and Interfacing; PIC Microcontrollers: Architecture, features, programming and Interfacing

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

CO1. demonstrate knowledge on
- architecture of 8051 and PIC microcontroller
- salient features of 8051 and PIC

CO2. analyze and develop a suitable interface with an appropriate microcontroller for the control operations.

CO3. develop programs for stand-alone systems.

CO4. do research by identifying a suitable microcontroller for solving complex problems in the domain of Power Electronics and Drives.

CO5. use tools like PROTEUS, MPLAB, SCILAB, PIC 'C' Compiler etc., for the design, analysis and implementation of the system.

DETAILED SYLLABUS:

UNIT–I: 8051 MICROCONTROLLER (12 Periods)
Overview of 8051 microcontrollers. 8051/8052 – architecture and features. Memory – internal / external Program, Data memory and their interfacing. Data memory – Register Bank, Bit addressable space, scratch pad area. Special Function Registers (SFRs). Instruction set – Data transfer, Arithmetic, logical, branch control instructions. Addressing modes. Timers – Mode - 0, 1, 2 and 3 operations, TMOD, TCON. Timer applications – wave generation, Device control operations.

UNIT-II: 8051 INTERFACING (10 Periods)
Basics of serial communication – RS232, MAX232, Baud rate.Serial port programming - SCON, SMOD, SBUF, PCON. Interrupts – IE, TCON, IP. Applications using interrupts of 8051/8052 – wave generation. Device control operations. Interfacing – ADC, DAC, DC motor key board and PWM.

UNNIT-III: PIC MICROCONTROLLERS (11 Periods)
CISC vs RISC.Harvard vs Von Neumann architectures.PIC16F87XA architecture and features.PIC16 Memory organization – program memory, data memory. PIC Register file – General purpose registers and SFRs.
Introduction to PIC Assembly Programming, PIC Data Format and Directives.PIC programming tools. Instruction set – data transfer, arithmetic, logical, bit manipulation, branch Instructions. I/O Port Programming. Addressing modes – Immediate, Direct, Register Indirect Addressing Modes. Macros and Modules.PIC programming using MPLAB and PIC 'C' Compiler.

UNIT–IV:SERIAL, INTERRUPT, I/O PORTS AND TIMER PROGRAMMING (11 Periods)
I/O ports – Port A, TRISA, Port B, TRISB, Port C TRISC. Timer - 0, 1, 2 modules. Compare mode, capture mode. PIC Serial Port programming, PIC Interrupts, Programming Timer Interrupts, Programming the Serial Communication Interrupts, Port-B - Change Interrupt, Interrupt Priority in the PIC.

UNIT–V: PIC INTERFACING (11 Periods)

ADC Characteristics, ADC Programming in the PIC, DAC Interfacing, Sensor Interfacing and Signal Conditioning, Standard and Enhanced CCP Modules, Compare Mode Programming, Capture Mode Programming, PWM Programming, ECCP Programming, Relays and Opto-isolators, Stepper Motor Interfacing, DC Motor Interfacing and PWM, PWM Motor Control with CCP, DC Motor Control with ECCP.

Total Periods: 55

TEXT BOOKS:

1. Muhammad Ali MAzidi, JancieGillispieMazidi, RolinMcKinlay, *The 8051 Microcontroller and Embedded Sytems using Assembly and C*, Pearson Education, 2nd edition, 2007.
2. John B. Peatman, *Design with PIC Microcontrollers*, Pearson Education, 2007.

REFERENCE BOOKS:

1. PIC16F87XA manual.
2. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, *PIC Microcontroller and Embedded Systems using assembly and C for PIC 18,* Pearson Education, 1999.
3. John B. Peatman, *Embedded design with the PIC18F452 Microcontroller*, Printice Hall, 2003

M. Tech. (PED) – I Semester

(16MT10705)REACTIVE POWER COMPENSATION AND MANAGEMENT

(Common to EPS & PED)

(Professional Elective-1)

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

PREREQUISITES: Power Systems at UG level

COURSE DESCRIPTION:
Reactive Power compensation: Ideal compensator; Line and load compensation ; Compensating devices; Reactive power coordination; Quality of power supply; Distribution side management; Reactive power management in domestic and industrial sectors.

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

CO1. demonstrate advanced knowledge on:
- necessity for reactive power compensation
- different methods of reactive power compensation.
- types of load patterns and loss reduction methods in distribution lines.

CO2. analyzedifferent types of compensations

CO3. developskills in designing a compensator for industrial applications.

CO4. do research in reactive power management in commercial and industrial applications

DETAILED SYLLABUS:

UNIT–I: REACTIVE POWER COMPENSATION (10 periods)
Need for Reactive Power compensation – reactive power characteristics. Ideal compensator, practical compensation – power factor correction and voltage regulation. Load compensator as a voltage regulator, phase balancing and power factor correction of unsymmetrical loads–examples.

UNIT–II: REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS (12 periods)
Steady state Reactive power compensation –Uncompensated line.Types of compensation, Passive shunt, series and dynamic shunt compensation–examples.
Transient state Reactive power compensation–Characteristic time periods. Passive shunt compensation. Static compensations–series capacitor compensation, compensation using synchronous condensers -examples

UNIT–III: REACTIVE POWER COORDINATION AND PLANNING (11periods)
Reactive power coordination: Objectives, Mathematical modeling, Operation planning, transmission benefits. Basic concepts of quality of power supply: Disturbances, steady – state variations, effects of under voltages, frequency, Harmonics, radio frequency and electromagnetic interferences, IEEE /IEC standards.
Reactive power planning: Objectives, Economics Planning capacitor placement and retrofitting of capacitor banks.

UNIT–IV: REACTIVE POWER MANAGEMENT (12 periods)
KVAR requirements for domestic appliances: Purpose of using capacitors, selection of capacitors, deciding factors. Types of available capacitors – characteristics and limitations, Control of capacitors.
Demand side management: Load patterns, basic methods load shaping, power tariffs, KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels - System losses, loss reduction methods - examples.

UNIT–V:REACTIVE POWER MANAGEMENT IN INDUSTRIAL SECTORS (10 periods)

Typical layout of traction systems–reactive power control requirements. Distribution transformers, Electric arc furnaces, textile and plastic industries, furnace transformer, filter requirements, remedial measures, and power factor of an arc furnace, role of capacitors in wind mill generator, minimum capacitance required for excitation.

Total Periods: 55

TEXT BOOKS:

1. T.J.E.Miller, *Reactive power control in Electric power systems*, JohnWiley and Sons, 1982.
2. D.M.Tagare, *Reactive power Management*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

REFERENCE BOOKS:

1. Wolfgang Hofmann,Jurgen schiabbach, Wolfgang just, *Reactivepower compensation: A Practical Guide,* Willey, April,2012*.*

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.
- understandingof 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.

COURSEOUTCOMES: 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.

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, 2nd revised edition, 2004.

REFERENCE BOOKS:

1. Ranjit Kumar, *Research Methodology: A step-by-step guide for beginners*, Sage South Asia, 3rd edition, 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;Nonlinearcontrol 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., 2nd edition, 2000.
2. K. Ogata, *Modern Control Engineering*, Prentice Hall of India, 4th edition, 2006.
3. Hasan A. Khalil *Nonlinear Systems,* Prentice Hall of India, 3rd edition, 2002.

REFERENCE BOOKS:

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

M. Tech. (PED) – II Semester

(16MT28302)POWER ELECTRONICS IN RENEWABLE ENERGY SYSTEMS

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

PREREQUISITES: Courses on Analysis of power converters, Analysis of inverters and Modelling of electrical machines.

COURSE DESCRIPTION:
Solar energy conversion system; Types of photovoltaic systems – Stand-alone, hybrid and grid connected systems; Wind Energy Conversion Systems; Types of WECS - stand-alone, hybrid and grid connected systems; Hybrid systems – PV-diesel, PV-wind and wind-diesel hybrid systems.

COURSE OUTCOMES: On successful completion of this course, student will be able to

CO1. demonstrate potential knowledge on
- photo-voltaic panels and wind turbines.
- various possible hybrid systems.
- operation of stand-alone and grid connected renewable energy systems.
- applications of various renewable energy systems.

CO2. analyze the performance of converters used for various conversion systems.

CO3. solve engineering problems pertaining to Renewable Energy Conversion Systems to provide feasible solutions.

CO4. initiate research to design PV system, wind energy system and controller for power converters.

CO5. select and apply appropriate controlling technique and converters for applications of various Renewable energy systems.

CO6. possess knowledge in turbines, gears and generators and contribute positively to collaborative-multidisciplinary scientific research.

CO7. followprofessional code for safe and reliable operation of electrical appliances and power grid.

DETAILED SYLLABUS:

UNIT-I: POWER CONVERTERS FOR SOLAR APPLICATIONS (12 periods)
Solar: Characteristics of sunlight, semiconductors and P-N junctions, behavior of solar cells, cell properties, PV cell interconnection, block diagram of solar photo voltaic system. Principle of operation: line commutated converters (inversion-mode), boost and buck-boost converters. Selection of inverter.Multilevel inverters and its types.Battery sizing and array sizing.

UNIT-II: PHOTO VOLTAIC POWER SYSTEMS (11 periods)
Types of PV Systems: Stand-alone PV system: Charge controllers - series, shunt charge regulators and DC/DC converters, maximum power point tracking, selection of inverters, solar pumping application.
Grid Connected PV Systems: Inverter types – Line, self-commutated inverters and PV inverter with high frequency transformer, grid-compatible inverter characteristics

UNIT-III: ELECTRICAL MACHINES AND POWER CONVERTERS FOR WIND APPLICATIONS (13 periods)
Wind: Basic principle of wind energy conversion, nature of wind, power in the wind, components of Wind Energy Conversion System (WECS), performance of induction generators for WECS, classification of WECS.
Electrical Machines: Principle of operation and analysis of induction generator, permanent magnet synchronous generator, squirrel cage induction generator and doubly fed induction generator. Power converters: Three phase AC voltage controllers, AC/DC/AC converters - uncontrolled rectifiers, PWM inverters, grid interactive inverters and matrix converters.

UNIT-IV: WIND POWER SYSTEMS **(11 periods)**

Types of wind power systems, stand-alone WECS: Elements of a stand-alone WECS, battery charging application with block diagram.

Grid connected WECS: Soft starting technique of induction generator, control of wind turbines-fixed and variable speed wind turbines. Selection of generators for variable speed wind turbines - Synchronous generator, squirrel cage and wound rotor induction generator. Isolated grid supply system with multiple wind turbines.

UNIT-V: HYBRID ENERGY SYSTEMS **(08 periods)**

Need for hybrid energy systems, issues in designing the hybrid energy systems. PV and Diesel hybrid system: Types – Series, parallel and switched hybrid energy systems. Stand-alone PV and wind hybrid energy system.Hybrid wind and diesel energy systems.

Total Periods: 55

TEXT BOOKS:

1. Rashid. M. H, *Power electronics Hand book*, Academic press, 2001.
2. Mukund R Patel, *Wind and Solar Power Systems*, CRC Press, 2004.

REFERENCE BOOKS:

1. J K Kaldellis, *Stand-alone and Hybrid Wind Energy Systems: Technology, Energy Storage and Applications*, Woodhead Publishing, 2010.
2. Rai, G.D., *Non-conventional Energy Sources*, Khanna Publishers, New Delhi, 2002.

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.

M. Tech. (PED) – II Semester

(16MT28304)SOLID STATE DC DRIVES

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

PREREQUISITES: Courses on Analysis of power converters and Modelling of electrical machines.

COURSE DESCRIPTION:
Operation, characteristics, speed control and applications of DC motors;Performance characteristics and parameters of single phase, three phase and twelve pulse converters fed DC motor; Open loop, closed loop and digital control of DC drives.

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

CO1. demonstrate knowledge on
- power circuit configuration.
- steady state operation and transient dynamics of motor load system.
- characteristics of DC motors.

CO2. analyze
- the operation of converter/chopper fed DC drives.
- single phase and three phase converter fed drives.
- the closed loop control and digital control of DC drives.

CO3. design speed controllers for closed loop solid-state DC drives.

CO4. solve engineering problems pertaining to electrical drives to provide feasible solutions.

CO5. select and apply appropriatepower circuit configuration of the phase controlled rectifiers and choppers for the speed control of DC drives.

DETAILED SYLLABUS:

UNIT–I: DC MOTOR FUNDAMENTALS AND MECHANICAL SYSTEMS (10 periods)
DC motor: Types, induced emf, speed-torque relations, electro-mechanical modeling, state space modeling of DC motor. Speed control: Armature and Field control, Ward Leonard Control - constant torque and horse power applications.
Characteristics of mechanical system: Dynamic equations, components of torque, types of load. Electric braking.Requirements of drives characteristics.Multi-quadrant operation.

UNIT–II:CONVERTER FED DC MOTOR DRIVES (14 periods)
Principle of phase control, fundamental relations. Analysis of series and separately excited DC motor with single-phase, three-phase and twelve pulse converters – waveforms, performance parameters and characteristics.

Steady state analysis of three phase controlled converter DC motor drive, average analysis, steady state modeling. Continuous and Discontinuous armature current operations, current ripple and its effect on performance, operation with freewheeling diode.Implementation of braking schemes, drive employing dual converter andapplications. Four quadrant DC motor drive.Converter selection and its characteristics.

UNIT–III:CHOPPER CONTROL (15 periods)
Introduction to time ratio control and frequency modulation, model of chopper, input to the chopper. Class A,B,C,D and E chopper controlled DC motor: performance analysis, multi-quadrant control, chopper based implementation of braking schemes. Steady state analysis of chopper controlled DC motor drive, rating of devices, pulsating torques.Multi-phase chopper andapplications.

UNIT–IV:CLOSED LOOP CONTROL OF DRIVES (09 periods)
Modeling of drive elements, equivalent circuit, transfer function of self, separately excited DC motors. Linear transfer function model of power converters, sensing and feedback

elements,closed loop speed control, current and speed loops. P, PI and PID Controllers – response comparison.

UNIT–V:DIGITAL CONTROL OF DC DRIVES (07 periods)

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

Total Periods: 55

TEXT BOOKS:

1. Gopal K.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. Gopal K.Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2001.
2. Bimal K.Bose, *Modern Power Electronics and AC Drives*, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2002.
3. M.D.Singh, *Power Electronics*, Tata McGraw-Hill publishing company Ltd., New Delhi, 2008.

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 operating conditions.

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

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 and society.

DETAILED SYLLABUS:

UNIT-I:STEPPER MOTOR(09 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 (09 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 (09 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 (09 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 (09 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: 45

TEXT BOOKS:

1. K. Venkata Ratnam, *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

(16MT20701)FLEXIBLE AC TRANSMISSION SYSTEMS

(Common to EPS & PED)

(Professional Elective-2)

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

PRE-REQUISITES: Power Electronics and Power Systems at UG level, Analysis of Power Converters and Analysis of Inverters

COURSE DESCRIPTION:
Need for Flexible AC transmission systems; objectives of shunt and series compensation, phase angle regulators; FACTS controllers: shunt, series and combined; Coordination of various FACTS controllers.

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

CO1. demonstrate knowledge on:
- compensation schemes for real and reactive power control.
- Static Shunt, Series and Shunt-Series compensation.
- FACTS devices and controllers

CO2. analyze and adopt a suitable FACTS device for the appropriate control.

CO3. develop skills in coordination of multiple FACTS controllers in an interconnected power systems.

CO4. develop new FACTS controllers for reliable and flexible control of power system.

CO5. employ modern techniques in coordination of FACTS devices for reliable and efficient operation.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO AC TRANSMISSION SYSTEMS (08 Periods)
Overview of interconnected power system. Power flow in AC systems – Expression for real and reactive power flow between two nodes of a power system, controllable parameters. Power flow in parallel and meshed system.Overview of compensated transmission lines – shunt and series compensation.Conventional controllers for real and reactive power flows – merits and demerits.
FACTS – benefits, types of FACTS controllers.

UNIT-II: STATIC SHUNT COMPENSATION (12 Periods)
Expression for real and reactive power flow with mid-point voltage regulation. Variable impedance type static VAR generators - V-I characteristics and control schemes of TCR, TSR, TSC. Q_D-Q_O characteristic and control scheme of TSC-TCR. Switching converter type VAR generators – V-I characteristics and control schemes of STATCOM. Hybrid VAR generators – V-I characteristics of SVC and STATCOM, regulation of V-I slope. Applications of static shunt compensators – Voltage regulation, improvement in transient stability, prevention of voltage instability, power oscillation damping. Comparison of static shunt compensators.

UNIT-III: STATIC SERIES COMPENSATION (11 Periods)
Expression for real and reactive power flow with series line compensation. Variable impedance type series compensators: V-I characteristics and control schemes of GCSC, TSSC, TCSC- modes of operation. Sub-synchronous resonance. Switching converter type series compensator – V-I characteristics, internal and external control schemes of SSSC. Applications of static series compensators – improvement in transient stability, power oscillation damping. Comparison of static series compensators.

UNIT-IV: STATIC PHASE ANGLE REGULATORS AND COMBINED COMPENSATORS (12 Periods)
Power flow control by phase angle regulators - Concept of voltage and phase angle regulation. Operation and control of TCVR and TCPAR.Switching converter type phase angle

regulators.Objectives of TCPAR - improvement of transient stability, power oscillation damping. UPFC – Principle, expression for real and reactive power between two nodes of UPFC, independent real and reactive power flow control using UPFC, control schemes of UPFC - operating principle and characteristics of IPFC.

UNIT-V: CO-ORDINATION OF FACTS CONTROLLERS (12 Periods)

FACTS controller interactions – interaction between multiple SVC's – interaction between multiple TCSC's – SVC-TCSC interaction – co-ordination of multiple controllers using linear control techniques. Comparative evaluation of different FACTS controllers: performance comparison and cost comparison, Control coordination using Genetic Algorithm, Future direction of FACTS technology.

Total periods: 55

TEXT BOOKS:

1. Narain G. Hingorani, LasziGyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems,* Wiley-IEEE Press, 1999.
2. R. Mohan Mathur and Rajiv k. Varma, *Thyristor based FACTS controllers for Electrical Transmission Systems,* Wiley-IEEE Press, 2002.

REFERENCE BOOKS:

1. Xiao-Ping, Rehtanz, Christian, Pal, Bikash, *Flexible AC Transmission Systems: Modeling and Control*, Springer Power Systems Series, 2006.
2. T.J.E. Miller, *Reactive Power control in electric systems*, Wiley, 1982.

M. Tech. (PED) – II Semester

(16MT20707)HIGH VOLTAGE DC TRANSMISSION

(Common to EPS & PED)

(Professional Elective-2)

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

PRE-REQUISITES: Power Electronics and Power Systems at UG level, Analysis of Power Converters and Analysis of Inverters.

COURSE DESCRIPTION:
HVDC Transmission: Capabilities, Applications and planning; Analysis and control of power converter; Harmonics and Filters; Types of Multi-Terminal DC Systems and control; Faults and Protection.

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

CO1. demonstrate knowledge on:
- HVDC transmission systems.
- operation of static converters and its analysis.
- different types of faults and protection schemes in HVDC systems.

CO2. analyze various static converters operation in HVDC systems, harmonics, filters and MTDC systems.

CO3. evaluate the performance of HVDC systems under various operating conditions.

CO4. develop new control techniques forHVDC converter systems.

CO5. follow professional code of ethics.

DETAILED SYLLABUS:

UNIT–I: INTRODUCTION TO HVDC TRANSMISSION (10 periods)
HVDC Transmission– Comparison of HVAC and HVDC transmission, types of DC Links, power handling capabilities of HVDC lines, applications of HVDC Transmission, planning for HVDC transmission, modern trends in DC Transmission, basic conversion principles.

UNIT–II: STATIC POWER CONVERTOR ANALYSISIS AND CONTROL (12 periods)
Static Power Converters: Static converter configuration- 6 pulse & 12 pulse converters, converter station and terminal equipment. Rectifier and inverter operation,converter bridge characteristics, equivalent circuit for converter.
Control of HVDC converter: Principle of DC link control – constant current, constant extinction angle and constant ignition angle control. Individual phase control and equidistant firing angle control.

UNIT–III: HARMONICS AND FILTERS (11 periods)
Generation of harmonics in HVDC systems, IEEE/IEC standards, methods of harmonics elimination, harmonic instability problems, Causes for instability, remedies for instability problems. Design of AC filters, single frequency tuned filter, Double frequency tuned filter, high pass filter, cost consideration of AC harmonic filter, DC filters.

UNIT–IV: MULTI-TERMINAL DC LINKS AND SYSTEMS (10 periods)
Introduction – Potential applications of MTDC systems – Types of MTDC systems – series, parallel and series-parallel systems, their principle of operation and control - Protection of MTDC systems.

UNIT–V: FAULTS AND PROTECTION: (12 periods)
Over voltages due to disturbance on DC side, over voltages due to DC and AC side line faults – Converter faults, over current protection– Valve group and DC line protection. Over voltage protection of converters – Surge arresters.

Total Periods: 55

TEXT BOOKS:

1. K.R.Padiyar, *High Voltage Direct current Transmission*, New Age International (P) Ltd, Publishers, 2nd edition, 2011.
2. Sunil S. Rao, *EHV-AC, HVDC Transmission & Distribution Engineering*, Khanna Publishers, 3rd edition, 2001.

REFERENCE BOOKS:

1. E.Uhlman, *Power Transmission by Direct Current*, Springer Verlag, Berlin, Heedelberg, 1975.
2. E. W. Kimbark, *Direct current Transmission*, John Wiely& sons, New York.
3. JosArillaga, *HVDCTranmission*, the Institute of Electrical Engineers, 2nd edition, London UK, 1998.

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	4	--	--	4

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 Mc Graw 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.(PED) – II Semester

(16MT20709)SMART GRID TECHNOLOGY

(Common to EPS & PED)

(Professional Elective-2)

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

PREREQUISITES:--

COURSE DESCRIPTION:
Concept of smart grid; various information and communication technologies for Smart Grid; Smart metering; Demand side integration; Energy management systems

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

CO1. demonstrate knowledge in
- Smart grid initiatives and technologies
- Information and communication technologies for the smart grid.
- Sensing, measurement, control and automation.

CO2. apply skills in fault calculation and state estimation.

CO3. apply various information security tools in the smart grid technology.

CO4. extend research activities on implementation of smart grid.

CO5. develop usage of modern techniques to integrate renewable energy sources into the smart grid.

DETAILED SYLLABUS:

UNIT–I: SMART GRID (07 periods)
smart grid introduction, ageing assets and lack of circuit capacity, thermal constraints, operational constraints, security of supply, national initiatives, early smart grid initiatives, active distribution networks, virtual power plant, other initiatives and demonstrations, overview of the technologies required for the smart grid.

UNIT–II: COMMUNICATION TECHNOLOGIES FOR THE SMART GRID (13 periods)
Data Communications: Introduction, Dedicated and Shared Communication Channels, Switching Techniques, Circuit Switching, Message Switching, Packet Switching, Communication Channels, Wired Communication, Optical Fiber, Radio Communication, Cellular Mobile Communication, Layered Architecture and Protocols, the ISO/OSI Model, TCP/IP
Communication Technologies: IEEE 802 Series, Mobile Communications, Multi-Protocol Label Switching, Power line Communication, Standards for Information Exchange, Standards for Smart Metering, Modbus, DNP3, IEC 61850

UNIT–III: INFORMATION SECURITY FOR THE SMART GRID(11 periods)
Introduction, Encryption and Decryption, Symmetric Key Encryption, Public Key Encryption, Authentication, Authentication Based on Shared Secret Key, Authentication Based on Key Distribution Center, Digital Signatures, Secret Key Signature, Public Key Signature, Message Digest, Cyber Security Standards, IEEE 1686: IEEE Standard for Substation Intelligent Electronic Devices(IEDs) Cyber Security Capabilities, IEC 62351: Power Systems Management and Association Information Exchange – Data and Communication Security.

UNIT–IV: SMART METERING AND DEMAND SIDE INTEGRATION (13 periods)
Introduction, smart metering – evolution of electricity metering, key components of smart metering, smart meters: an overview of the hardware used – signal acquisition, signal conditioning, analogue to digital conversion, computation, input/output and communication. Communication infrastructure and protocols for smart metering - Home area network, Neighborhood Area Network, Data Concentrator, meter data management system, Protocols for communication. Demand Side Integration- Services Provided by DSI, Implementation of

DSI, Hardware Support, Flexibility Delivered by Prosumers from the Demand Side, System Support from DSI.

UNIT–V: TRANSMISSION AND DISTRIBUTION MANAGEMENT SYSTEM (11 periods)

Data Sources, Energy Management System, Wide Area Applications, Visualization Techniques, Data Sources and Associated External Systems, SCADA, Customer Information System, Modeling and Analysis Tools, Distribution System Modeling, Topology Analysis, Load Forecasting, Power Flow Analysis, Fault Calculations, State Estimation, Applications, System Monitoring, Operation, Management, Outage Management System, Energy Storage Technologies, Batteries, Flow Battery, Fuel Cell and Hydrogen Electrolyzer, Flywheels, Super conducting Magnetic Energy Storage Systems, Super capacitors, Energy storage for wind power, Agent-based control of electrical vehicle battery charging.

Total Periods: 55

TEXT BOOKS:

1. JanakaEkanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins, *Smart Grid,* Wiley Publications, 2012.
2. James Momoh, *Smart Grid: Fundamentals of Design and Analysis,* Wiley, IEEE Press, 2012.
3. Bharat Modi, Anuprakash, Yogesh Kumar, *Fundamentals of Smart Grid Technology* by S.K Kataria & Sons

REFERENCE BOOKS:

1. Raj Samani, *Applied Cyber Security and the Smart Grid,*Syngress Publishers, 2012.
2. Jean Claude Sabonnadiere, NouredineHadjsaid, *Smart Grids,* Wiley Blackwell.
3. Peter S.FoxPenner, *Smart Power: Climate Changes, the Smart Grid, and the future of electric utilities,* Island Press, 2014.

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.

M. Tech. (PED) – II Semester

(16MT28333)SEMINAR

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

PREREQUISITES: --

COURSE DESCRIPTION:
Identification of seminar topic; literature survey; preparation of technical report and presentation.

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

CO1. demonstrate capacity to identify an advanced topic for seminar in core and allied areas.
CO2. extract information pertinent to the topic through literature survey.
CO3. comprehend the extracted information through analysis and synthesis critically on the topic.
CO4. contribute to multidisciplinary scientific workin the field of Power systems.
CO5. manage time and resources effectively and efficiently.
CO6. plan, organize, prepare and present effective written and oral technical report on the topic.
CO7. engage in lifelong learning for development of technical competence in the field of Power Systems.
CO8. understand ethical responsibility towards environment and society in the field of Electrical engineering.
CO9. adapt to independent and reflective learning for sustainable professional growth in Electrical power systems.

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 Mc Graw Hill Publishing Company Ltd.

M. Tech. (PED) III & IV-Semester

(16MT38301 & 16MT48301)PROJECT WORK

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
200	200	400	--	--	--	28

PREREQUISITES: --

COURSE DESCRIPTION:
Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Writing of thesis and presentation.

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

CO1. demonstrate capacity to identify an advanced topic for project work in core and allied areas.

CO2. analyze the problem and derive an optimal solution pertinent to the chosen topic.

CO3. solve engineering problems and provide a wide range of potential solutions.

CO4. comprehend extracted information through the literature survey for design and development of engineering problems pertinent to the chosen topic.

CO5. use the techniques, skills and modern engineering tools necessary for project work.

CO6. contribute to multidisciplinary scientific workin the field of Electrical power Systems.

CO7. execute the project effectively and efficiently considering economical and financial factors.

CO8. plan, prepare and present effective written and oral technical report on the topic.

CO9. engage in lifelong learning for development of technical competence in the field of Electrical power systems and allied fields.

CO10. understand ethical responsibility towards environment and society in the field of Electrical Engineering.

CO11. adapt to independent and reflective learning for sustainable professional growth.