Scheme of Teaching & Examination
M.Tech in Power Electronics

III - Semester

S.N.	code	Subject	Periods per week			Scheme of marks		Total Credit
			L	T	P	ESE	IM	
1.	Ref Table	ELECTIVE-III	4	-	-	70	30	4
2.	Ref Table	ELECTIVE – IV	4	-	-	70	30	4
3.	MTECE333	Renewable Energy Sources Lab	-	-	3	30	20	2
4.	MTECE334	Project Work (Phase I)	-	-	24	140	60	12
Total			**8**		**27**	**310**	**140**	**22**

Elective – III

S.No	Subject code	Name of Subject
1.	MTECE3310	Static Var Control & Harmonic Filtering
2.	MTECE3311	Flexible AC Transmission Systems
3.	MTECE3312	Digital Controllers in Power Electronics Applications
4.	MTECE3313	Power Quality
5.	MTECE3314	Programmable Logic Controllers And Their Applications

Elective – IV

S.No	Subject code	Name of Subject
1.	MTECE3320	Fuzzy Systems
2.	MTECE3321	Digital Simulation of Power Electronic Systems
3.	MTECE3322	Electrical Energy Conservation and Management
4.	MTECE3323	Renewable Energy Sources
5.	MTECE3324	Machine Modeling And Analysis

P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

L – Lecture, T – Tutorial, ESE – End Semester Examination,

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Static Var Control & Harmonic Filtering
Code : MTECE3310

UNIT I
Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems , Reactive Power Compensation and Dynamic Performance of Transmission Systems . Power Qulity Issues . Sags, Swells, Unbalance, Flicker , Distortion , Current Harmonics.

UNIT II
Static Reactive Power Compensators and their control. Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping,

UNIT III
Converters for Static Compensation . Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM) . GTO Inverters . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) . Multi-level inverters of Cascade Type and their modulation . Current Control of Inverters.

UNIT IV
Passive Harmonic Filtering . Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling . Three-phase four-wire shunt active filters . Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode . Series Active Filtering in Harmonic Isolation Mode.

UNIT V
Sources of Harmonics in Distribution Systems and Its Effects . Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems Dynamic Voltage Restorer and its control . Power Quality Conditioner

Text Books:
1. T.J.E Miller : Reactive Power Control in Electric Systems, John Wiley & Sons
2. N.G. Hingorani & L. Gyugyi :Understanding FACTS: Concepts and Technology of Flexible AC Transmission, Systems. IEEE Press, 2000.

REFERENCE BOOKS:
1. Ned Mohan et.al :Power Electronics. John Wiley and Sons

MATS UNIVERSITY

Semester :	3st M.Tech. Course	Branch	:	Power Electronics
Subject :	Flexible AC Transmission Systems			
		Code :	MTECE3311	

UNIT I
Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS-FACTS control considerations, FACTS controllers.

UNIT II
Principles of shunt compensation – Variable Impedance type & switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

UNIT III
Principles of static series compensation using GCSC, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC).

UNIT IV
Principles of operation-Steady state model and characteristics of a static voltage regulators and phase shifters- power circuit configurations.

UNIT V
UPFC -Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters.

Text Books:

1. Song, Y.H. and Allan T. John, Flexible ac transmission systems (FACTS)‟, Institution of Electrical Engineers Press, London, 1999.
2. Hingorani ,L.Gyugyi, „ Concepts and Technology of flexible ac transmission system‟, IEEE Press New York, 2000 ISBN –078033 4588.
3. IEE Tutorials on „Flexible ac transmission systems‟, published in Power Engineering Journal, IEE Press, 1995.
4. K.R.Padiyar, „FACTS controllers for transmission and Distribution systems‟ New Age international Publishers 1st edition -2007

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Digital Controllers in Power Electronics Applications
Code : MTECE3312

UNIT I
Introduction to the C2xx DSP core and code generation, The components of the C2xx DSP core, Mapping external devices to the C2xx core , peripherals and Peripheral Interface ,System configuration registers , Memory , Types of Physical Memory , memory Addressing Modes , Assembly Programming using C2xx DSP, Instruction Set, Software Tools.

UNIT II
Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts, Interrupt Hierarchy , Interrupt Control Registers , Initializing and Servicing Interrupts in Software .

UNIT III
ADC Overview , Operation of the ADC in the DSP , Overview of the Event manager (EV) , Event Manager Interrupts , General Purpose (GP) Timers , Compare Units, Capture Units And Quadrature Enclosed Pulse (QEP) Circuitry , General Event Manager Information.

UNIT IV
Introduction to Field Programmable Gate Arrays – CPLD Vs FPGA – Types of FPGA , Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) – Programmable Interconnect Point (PIP) – Xilinx 4000 series – HDL programming –overview of Spartan 3E and Virtex II pro FPGA boards- case study.

UNIT V
Controlled Rectifier , Switched Mode Power Converters , PWM Inverters , DC motor control, Induction Motor Control.

TEXT BOOKS:

1. Hamid.A.Toliyat And Steven G.Campbell " DSP Based Electro Mechanical Motion Control " CRC Press New York , 2004.
2. XC 3000 Series Datasheets (Version 3.1). Xilinx,Inc.,USA, 1998.
3. XC 4000 Series Datasheets (Version 1.6). Xilinx,Inc.,USA, 1999.
4. Wayne Wolf," FPGA Based System Design ", Prentice Hall, 2004

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Power Quality
Code : MTECE3313

Unit-I
Electric power quality phenomena: - Impacts of power quality problems on end users, Power quality standards, power quality monitoring.
Power quality disturbances:- transients, short duration voltage variations ,long duration voltage variations, voltage imbalance, wave-form distortions, voltage fluctuations, power frequency variations, power acceptability curves.

Unit-II
Power quality problems: poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage.

Unit-III
Transients: Origin and classification- capacitor switching transient-lighting-load switching-impact on users-protectionmitigation.

Unit-IV
Harmonics: harmonic distortion standards, power system quantities under non sinusoidal conditions-harmonic indices-source of harmonics-system response characteristics-effects of harmonic distortion on power system apparatus –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response- Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.

Unit-V
Power quality conditioners: Shunt and series compensators, Dstatcom-dynamic voltage restorer, unified power quality conditioners.

Book
1. Ghosh Arindam and Ledwich Gerard, 'Power quality enhancement using custom power devices' Springer.
2. Arrillaga J., Watson N. R. and Chen S., 'Power System Quality Assessment' Wiley.
3. Caramia P, Carpinelli G and Verde P, 'Power quality indices in liberalized markets' – Wiley
4. Angelo Baggini 'Handbook of Power Quality' – Wiley.

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Programmable Logic Controllers And Their Applications
Code : MTECE3314

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

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

UNIT III – CURRENT CONTROLLER DESIGN
Hysteresis current control (HCC) – Design of HCC with PWM schemes-Case Studies Predictive current controller (PCC) –Model predictive control (MPC)-PWM predictive control (PPC)

UNIT IV – H-INFINITY CONTROL & ROBUST CONTROL THEORY
Introduction of H-infinity methods in control theory-Elements of robust control theory – Design objectives – Shaping the loop gain –Signal spaces – Computation of H∞ norm- All pass systems--Linear-quadratic-Gaussian control (LQG)- -Case Studies Robust control theory- Robust controller design- Robust decision methods- Analytic tools for robust decision making-Case Studies

UNIT V – CONTROLLER DESIGN
Controller synthesis and tuning, Linear Matrix inequalities, LMI solvers, control system analysis and design with LMIs using MATLAB/Simulink Uncertain system analysis -Statistical and worst-case analysis of stability and performance Analysis
Survey and review of different controllers used in power system and power electronics practices

REFERENCES

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

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Fuzzy Systems
Code : MTECE3320

UNIT I
Different faces of imprecision – inexactness, Ambiguity, Undecidability, Fuzziness and certainty, Probability and fuzzy logic, Intelligent systems.

UNIT II
Fuzzy sets and crisp sets - Intersections of Fuzzy sets, Union of Fuzzy sets, the complement of Fuzzy sets.

UNIT III
Fuzzy reasoning - Linguistic variables, Fuzzy propositions, Fuzzy compositional rules of inference- Methods of decompositions, Defuzzification.

UNIT IV
Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts, Adaptive fuzzy control, Rule base design using dynamic response.

UNIT V
Fuzzy logic applications to engineering, Fuzzy decision making, Neuro-Fuzzy systems, Fuzzy Genetic Algorithms.

TEXT BOOKS:
1. Zimmermann, H.J., „Fuzzy set theory and its applications‟, Allied publishers limited, Madras,1966
2. Klir, G.J., and Folge., T., „Fuzzy sets, uncertainty and information‟, PHI, New Delhi,1991.
3. EarlCox,„‟The Fuzzy Systems Handbook‟, AP professional Cambridge, MA 02139, 1994.

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Digital Simulation of Power Electronic Systems
Code : MTECE3321

UNIT I
Review of numerical methods. Application of numerical methods to solve transients in D.C.Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.

UNIT II
Modeling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply.
Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

UNIT III
State space modeling and simulation of linear systems. Introduction to electrical machine modeling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.

UNIT IV
Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self commutated devices- simulation of power factor correction schemes, Simulation of converter fed dc motor drives ,Simulation of thyristor choppers with voltage, current and load commutation schemes, Simulation of chopper fed dc motor.

UNIT V
Simulation of single and three phase inverters with thyristors and self-commutated devices,
Space vector representation, pulse-width modulation methods for voltage control, waveform control. Simulation of inverter fed induction motor drives.

TEXT BOOKS:
1. Simulink Reference Manua , Math works, USA.
2. Robert Ericson, „Fundamentals of Power Electronics‟, Chapman & Hall, 1997.
3. Issa Batarseh, „Power Electronic Circuits‟, John Wiley, 2004Simulink Reference Manual, Math works, USA

MATS UNIVERSITY

Semester :	3st M.Tech. Course	Branch	:	Power Electronics
Subject :	Electrical Energy Conservation and Management			
		Code :	MTECE3322	

UNIT I

Electrical Energy and safety audit-Overview of Electricity Act – Energy conservation act - Electrical energy audit – tools for electrical energy audit - billing elements - tariff system, energy and demand charge, electrical demand and load factor improvement, power factor correction, power demand control, demand shifting – Electrical Safety Auditing.

UNIT II

Electric motors-Motors efficiency, idle running - motor selection – factors affecting motor performance, efficiency at low load – high efficiency motors - reduce speed/variable drives, load reduction - high-starting torque, rewound motors, motor generator sets, energy efficiency in transformers - Case studies.

UNIT III

Electrical energy conservation in driven equipments-Input electrical energy requirements in pumps – fans and compressors – load factor estimation in the equipments – different types of VFD, energy conservation potential – electrical energy conservation in refrigeration and A/C system, operation and maintenance practices for electrical energy conservation case studies.

UNIT IV

Electrical Energy conservation in industrial lighting-Choice of lighting - energy saving – control of lighting - lighting standards – light meter audit - methods to reduce costs – summary of different lighting technologies – Case Studies.

UNIT V

Energy efficiency and demand management-Basic concepts – Co-generation – importance of demand side management – virtues of DSM –efficiency gains - estimation of energy efficiency potential, cost effectiveness, payback period, barriers for energy efficiency and DSM – Case Studies.

References:

1. Openshaw Taylor E., “Utilisation of Electric Energy”, Orient Longman Ltd, 2003
2. Donald R. Wulfingoff, “Energy Efficiency Manual”, Energy Institute Press, 1999.
3. Tripathy S.C., “Electrical Energy Utilization and Conservation”, TMH, 1991

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Renewable Energy Sources
Code : MTECE3323

UNIT I
Basic characteristics of sunlight – solar energy resource – photovoltaic cell-characteristics – equivalent circuit – photo voltaic for battery charging.

UNIT II
Wind source – wind statistics - energy in the wind – aerodynamics - rotor types – forces developed by blades – aerodynamic models – braking systems – tower - control and monitoring system – power performance.

UNIT III
Wind driven induction generators-power circle diagram-steady state performance –modeling integration issues –impact on central generation- transmission and distribution systems – wind farm electrical design.

UNIT IV
Wind-diesel systems-fuel savings-permanent magnet alternators – modeling – steady state equivalent circuit-self-excited induction generators – integrated wind-solar systems.

UNIT V
Micro-hydel electric systems – power potential – scheme layout – generation efficiency and turbine part flow-isolated and parallel operation of generators – geothermal-tidal and OTEC systems.

TEXT BOOKS:
1. John F.Walker & Jenkins. N , „Wind energy Technology „ , John Wiley and sons, chichester , U.K,1997.
2. Van Overstraeton and Mertens R.P., „Physics, Technology and use of Photovoltaics‟, Adam Hilger, Bristol,1996.
3. Freries LL , „ Wind Energy Conversion Systems‟, Prentice Hall, U.K., 1990

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Machine Modeling And Analysis
Code : MTECE3324

Unit-I
Principles of Electromagnetic Energy Conversion, General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system.

Unit-II
Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.

Unit-III
Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form; Application of reference frame theory to three phase symmetrical induction and synchronous machines, dynamic direct and quadrature axis model in arbitrarily rotating reference frames

Unit-IV
Determination of Synchronous Machine Dynamic Equivalent Circuit Parameters, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.

Unit-V
Special Machines - Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines. Construction and operating principle, dynamic modeling and self-controlled operation; Analysis of Switch Reluctance Motors.

TEXT BOOKS
1. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans, „Electric Machinery‟, Tata Mcgraw Hill,6ht Edition, 2003.
2. R. Krishnan, „Electric Motor & Drives: Modeling, Analysis and Control‟, Prentice Hall of India, 2001.
3. Miller, T.J.E,. „Brushless permanent magnet and reluctance motor drives‟, Clarendon Press, Oxford, 1989

MATS UNIVERSITY

Semester :	3st M.Tech. Course	Branch	:	Power Electronics
Subject :	Renewable Energy Sources Lab			
		Code :	MTECE333	

List of experiments

Solar energy

1) To study P-V and I-V characteristics of Solar module.
2) To study P-V and I-V characteristics of series and parallel combination of solar modules.
3) To study effect of varying irradiation level and temperature on P-V and I-V characteristics of solar panel.
4) To study effect of shading and tilt angle.
5) To study the effect of blocking and bypass diodes on solar panel.
6) To study the power characteristics of solar system using Ac-load, DC-load and AC-DC load.
7) To study the natural convection and forced circulation of water for calculating heat removal factor and loss coefficient.
8) To study the various PV based transformer less inverter topologies.
9) To study and implement perturb and observe method for Maximum power point tracking.

Wind energy

1) To study and simulate the IG , PMSG and DFIG based wind energy system.
2) To study and simulate the interconnected SG and IG based wind energy system.
3) To study and implement the vector control for grid connected PMSG based wind energy conversion system (WECS).
4) To study the effects of FACTS devices with WECS for power quality improvement.

Hydro Power

1) Any relevant case study on installed hydro power plant.

MATS UNIVERSITY

Semester : 3st M.Tech. Course Branch : Power Electronics
Subject : Project Work (Phase I)
Code : MTECE334

- The students are expected to take up a Project under the guidance of a faculty from the Institute.
- The topic of the project should be justified for the degree of M.Tech (Power Electronics)
- The project selected should ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivities.
- The student/group of student shall collect all necessary information from literature on selected topic/project.
- It should include the scope of project, identification of necessary data, source of data, development of design method and identification, methodology, software analysis.
- Students should deliver a seminar on the selected Project/topic.
- The students are expected to submit the report in standard format approved by the University in partial fulfillment of the requirement for the degree of M.Tech (Power Electronics).
- There will be an external viva-voce at the end of the semester and the students are to demonstrate the project at the time of viva-voce.