DEPARTMENT OF ELECTRICAL ENGINEERING
College of Technology and Engineering, Udaipur-313001
POST GRADUATE PROGRAMME, 2011-12

Details of P.G. Programme Courses offered for the award **M.Tech (Power Electronics)** in Electrical Engineering

S. No.	Title	Course No.	Cr. Hr.	Semester			
				I	II	III	IV-VI
Core Courses *Masters Degree: Total 12 credits, two courses in first semester (6 credits) and one course in second and third semester (3 credits each) to be evaluated externally.*							
1	Advanced Semiconductor devices	EPE 511	3 (3+0)	3	-	-	-
2	Analysis of Power Electronic Converters	EPE 512	3 (3+0)	3	-	-	-
3	Analysis & control of Electrical drive systems	EPE 521	3 (3+0)	-	3	-	-
4	Switched Mode Power Conversion	EPE 531	3 (3+0)	-	-	3	-
Major Courses Masters Degree: Total 15 credits, Three courses in first and second semester each (6 credits in each semester) and one course in third semester (3 credits).							
1	Intelligent Techniques in Electric Drives	EPE 513	3 (3+0)	3	-	-	-
2	System Simulation Lab-1	EPE 514	1(0+1)	1	-	-	-
3	Power Electronics Hardware Lab-1	EPE 515	2(0+2)	2	-	-	-
4	Utility Application of Power Electronics	EPE 522	3 (3+0)	-	3	-	-
5	System Simulation Lab-1I	EPE 523	1(0+1)	-	1	-	-
6	Power Electronics Hardware Lab-1I	EPE 524	2(0+2)	-	2	-	-
7	Power electronics application for renewable energy	EPE 532	3 (3+0)	-	-	3	-
Minor/Supporting Courses *Masters Degree: Total 9 credits, one course in first, second and third semester each (3 credits in each semester).*							
1	System Theory	EPE 516	3 (3+0)	3	-	-	-
2	Modeling & Analysis of Electrical machine	EPE 517	3 (3+0)	3	-	-	-
3	CAD/ CAM	MED 518	3 (3+0)	3	-	-	-
4	Advance Programming with C++	CSE 511	3 (2+1)	3	-	-	-
5	Energy Audit and Management	RES 515	3 (2+1)	3	-	-	-
6	Advanced Power Converters	EPE 525	3 (3+0)	-	3	-	-
7	Methods of Numerical Analysis	BS 521	3 (3+0)	-	3	-	-
8	Alternate Fuels and Applications	RES 524	3 (3+0)	-	3	-	-
9	Design and Analysis of Renewable Energy Conversion Systems	RES 522	3 (3+0)	-	3	-	-
10	High Voltage dc Transmission system	EPE 533	3 (3+0)	-	-	3	-
Others							
	Compulsory Courses	-	Non Credit	3	-	-	3
	Seminar	EPE 534	1 (0+1)	-	-	1	-
	Thesis*	EPE 541	20 (0+20)	-	-	-	20
	Total Credit Hours M.E. (57)			15	12	10	20

*Masters Degree: The minimum duration of thesis will be 2 semesters *i.e* the topic for the thesis (EPE 541) will be allotted in the III semester but assessed in both the semesters. The total credits will however be counted in the IV semester

Course Summary

Masters Programme

Courses	No. of Courses					Credit Hours
	Semester					
	I	II	III	IV	Total	
Core	2	1	1	-	4	12
Major	3	3	1	-	7	15
Minor/Supporting	1	1	1	-	3	9
Seminar	-	-	1	-	1	1
Research Project	-	-	-	1	1	20
Compulsory Courses	1	-	-	-	1	Non Credit
Total	**7**	**5**	**4**	**1**	**17**	**57**

POST GRADUATE PROGRAM 2011-12

SYLLABUS

(Specialization in Power Electronics)

EPE 511 Advanced Semiconductor devices

	L	T	P
Credit	3	0	0
Hours	3	0	0

Structure and Construction, Working and operations, Switching and Static Characteristics , Ratings, Triggering Circuits, Protection Circuits, Commutation Circuits, PSPICE Models, Testing, Gate Drive Requirements and Applications of various Power Switching Devices, *i.e.* SCR, GTO, MOSFETS, BJT, IGBT, MCTs, and Static Induction Devices .

Trigger Techniques, Optical Isolators, Protection Circuits, Isolation Transformers, Future Trends in Power Devices, Comparison Testing of Switches, General Power Semiconductor Switch Requirements.

Text and Reference books:

1. Power electronics – N. Mohan ,John Wiley student edition, Singapore
2. Power electronics and A C Drives – B. K. Bose, Pearson, India
3. Power electronics : circuits, drives and applications – H Rashid, , Pearson, India
4. Power electronics Devices – P. C. Sen, TMH, India

EPE 512 Analysis of Power Electronic Converters

	L	T	P
Credit	3	0	0
Hours	3	0	0

Phase Controlled Converters: Performance measures of single and three-phase converters with discontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three phase converters

Chopper: Review of choppers configurations, Steady state analysis of type A Chopper-Minimum and Maximum Currents, Ripple and average load current. Commutation in Chopper Circuits

Inverters: Performance parameters, Principle of Operation, Single-phase bridge inverters, Three phase bridge Inverters: 180 and 120 degree of conduction, Current source inverters , voltage control of three phase inverters-Sinusoidal PWM, Third Harmonic PWM, 60 degree PWM and Space Vector Modulation. Harmonic reductions

AC Voltage Controllers: Principle of On-Off Control, Principle of Phase control, Single Phase Bi-directional Controllers with Resistive Loads, Single Phase Controllers with Inductive Loads, Three Phase full wave AC controllers, AC Voltage Controller with PWM Control.

Cyclo-converters: Single phase and three phase Cyclo-converters. Reduction in Output Harmonics, Matrix Converter

Text and Reference books:

1 Advanced Power electronics – Vinod Kumar, R. R. Joshi, R C Bansal, Agarwal and Sharma, Vardhan Publication and distributors, Jaipur, India
2 Power electronics – N. Mohan ,John Wiley student edition, Singapore
3 Power electronics : circuits, drives and applications – H Rashid, , Pearson, India

EPE 513 Intelligent Techniques in Electric Drives

	L	T	P
Credit	3	0	0
Hours	3	0	0

Artificial neural systems: Preliminaries, fundamental concepts & models of artificial system, neural networks learning rules, Hebbian, perceptron, delta Widrow-Hoff learning rules; Single layer percepton classification: Classification model, features & decision regions training & classification using discrete perception, algorithm & examples, single layer continuous perceptron networks for linear separable classification; Multilayer feedback work networks: Generalized delta learning rule, feedforword recall & error back propagation training, learning factors. Single layer feedback networks : basic concepts of dynamical systems mathematical modeling of discrete time & gradient type Hopfield networks, transient response of continuous time network solution optimization problems.

Mathematical of fuzzy control: fuzzy sets, fuzzy set theory, properties of fuzzy sets, Operations of fuzzy sets, fuzzy relations .Non linear fuzzy control: The control problem, FKBC as non linear transfer element PID & sliding mode type FKBC, some typical application of fuzzy based control systems. Adaptive Fuzzy control: Introduction, design & performance evaluation, performance monitor, main approaches to design. Stability of fuzzy control system: state space approach, stability and robustness indices, input-output stability. FKBC design parameters: Structure of FKBC fuzzification and defuzzification module, rule based choice of variable and contents of rules, derivation of rule data based, choice of membership function and scaling factors,

Text Books/References:

1. Introduction of artificial neural systems - J.M.ZURADA, Jaico publication House 1997
2. Neural networks: comprehensive foundation - S.IIAYKIN McMillian College Publishing company inc. 1994
3. Neuro control and its application - S.OMATU, M.KHALID, R.YUSOF. Spring Verlag London Ltd. 1996.
4. An introduction to fuzzy control - D.DRIANKOV, H. HELLENDOORN and M REINFRANK Narosa Publication House, 2nd reprint 1997.
5. Neural Network Design, - Hagan, Demuth Deak Thomson Learning
6. Neuro-fuzzy and soft computing, PHI publication
7. Fuzzy logic : Intelligence control and Information, - John Yen Pearson publication.

EPE 514 System Simulation Lab-1

	L	T	P
Credit	0	0	1
Hours	0	0	2

Introduction to PSCAD/EMTDC: Features and libraries of PSCAD/EMTDC. Uncontrolled AC-DC converters. Single phase, and three phase diode bridge converters. Controlled AC-DC converters. Single phase and three phase thyristor converters. Inductance based DC-DC converters. Buck, boost, buck-boost, and flyback converters.
Capacitance based DC-DC converters. Cuk converter. Quasi-square inverters. Single and three phase inverter control by pulse width modulation. Triangular carrier inverters. Single and three phase inverter control by triangular carrier modulation, Single phase cycloconverters, Various chopper circuits
Introduction to MATLAB/SIMULINK: Features and libraries of MATLAB/SIMULINK. Uncontrolled AC-DC converters. Single phase, and three phase diode bridge converters. Controlled AC-DC converters. Single phase and three phase thyristor converters. Inductance based DC-DC converters. Buck, boost, buck-boost, and flyback converters. Capacitance based DC-DC converters. Cuk converter. Quasi-square inverters. Single and three phase inverter control by pulse width modulation. Triangular carrier inverters. Single and three phase inverter control by triangular carrier modulation, Single phase cycloconverters, various chopper circuits

Text Books/References:

1. *Laboratory Manual for Power Electronic System Simulation on PSCAD/EMTDC by* Vinod Kumar, R. R. Joshi
2. Advanced Power electronics – Vinod Kumar, R. R. Joshi, R C Bansal, Agarwal and Sharma, Vardhan Publication and distributors, Jaipur, India
2 P. T. Krein, *Elements of Power Electronics*. Oxford University Press, 1998.

EPE 515Power Electronics Hardware Lab-1

	L	T	P
Credit	0	0	2
Hours	0	0	4

Development of various configurations of power modules using SCRs, IGBTs, power transistors and power MOSFETs. Practical converter design considerations- Snubber design, gate and base drive circuits.
DC to DC converters of various configurations using SCRs, IGBTs, power transistors and power MOSFETs. DC to AC converters of various configurations using SCRs, IGBTs, power transistors and power MOSFETs.
AC to AC converters of various configurations using SCRs, IGBTs, power transistors and power MOSFETs.

Text Books/References:

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wileyand sons.Inc, Newyork, 1995
2. M.H. Rashid, 'Power Electronics Handbook', Elseiver Press, 2003.
3. John D. Lenk ,'Simplified Design of Switching Power Supplies', Butterworth- Heinemann,1995.

EPE 516 System Theory

	L	T	P
Credit	3	0	0
Hours	3	0	0

Linear Equations: Fields, System of Linear equations, Matrices and Elementary row operations, Row-reduced echelon matrices, Matrix multiplication, Invertible matrices. *Vector Spaces:* Vector spaces, Subspaces, Bases and dimension, Coordinates. *Linear Transformations:* Linear transformations, The algebra of linear transformations, Isomorphism, Representation of transformations by matrices, Linear functionals, The double dual, The transpose of a linear transformation. *Determinants:* Commutative rings, Determinant functions, Permutations and the uniqueness of determinants, Additional properties of determinants, Modules, Multilinear functions, The Grassman ring. *Inner Product Spaces:* Inner products, Inner product spaces, Linear functionals and adjoints, Unitary operators, Normal operators. *Vector Norms and Matrix Norms:* Vector norms, Matrix norms, Induced matrix norms, Equivalent norms, Matrix sequence and matrix series, Generalized inverse of a matrix. *Eigenvalues, Eigenvectors:* Eigenvalues, Eigenvectors and the Characteristics Equation of a matrix, Properties of Eigenvectors associated with distinct eigenvalues, Matrix polynomial and lambda matrix, Characteristic polynomial, annihilating polynomial and minimum polynomial, Computation of characteristic polynomial and adjoint of $(\lambda I - A)$, Multiplicities of Eigenvalues, Eigenvalue problem for Hermitian matrices, Congruent matrices. *Practical applications in power electronic systems.*

Text and Reference Books :

1. Linear Algebra – Sharma & Vasishtha, PHI
2. Mathematics for scientists and engineering: Harold Cohen, TMH
3. Partial Differential Equations : Sennedon, TMH
4. Higher Engineering mathematics : Gaur & Kaul, Pearson India

EPE 517 Modeling & Analysis of Electrical machine

	L	T	P
Hours	3	0	0
Credit	3	0	0

Energy state functions. Modelling of electromechanical systems. Matrix methods and use of generalized circuit theory of machines. Different methods of transformation d.c. phase variable, instantaneous symmetrical component techniques. Reference frames. Development of basic performance equations and analysis of different rotating machine such as d.c. synchronous and induction machines. Dynamics and transients in electric machines. Switching transients and surges. Transient and short circuit studies on alternators. Run-up reswitching and other transient in induction machines. Relevant computer techniques for machine analysis. Modelling of special electrical machines.

Text and Reference books:

1. Computer Aided analysis of machine elements – R. V. Dukkipati, PHI
2. Electrical Machine Design – M G Say, TMH
3. Electric Motor Drive : Modeling, Analysis and Control by Krishnan, PHI

EPE 521 Analysis & control of Electrical drive systems

	L	T	P
Credit	3	0	0
Hours	3	0	0

DYNAMICS OF ELECTRIC DRIVES: Mechanical system, fundamental torque equations, components of load torque's, nature and classification of load torques, speed-torque conventions and multi-quadrant operation, equivalent values of drive parameters, Dynamic conditions of a drive system, Energy loss in transient operations, steady state stability, load equalization, close loop configurations of drives.
DC DRIVES: Basics of DC machines, Speed torque curves, torque and power limitation in armature voltage and field control, Starting, Braking-Regenerative Braking, dynamic braking and plugging, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Speed Control-Controlled Rectifier fed DC drives, Dual-converter control of DC drive, Chopper Controlled DC drives
INDUCTION MOTOR DRIVES: Basics of Induction Machines, Starting, Braking-Regenerative braking, plugging and dynamic braking, Transient analysis, Calculation of energy losses, Speed Control-Stator voltage control, variable frequency control from voltage source, Voltage Source Inverter (VSI) Control, Variable frequency control from current source, Current Source Inverter (CSI) Control, Cyclo-converter Control, Static rotor resistance control, Slip Power Recovery- Stator Scherbius drive, Static Kramer drive.
SYNCHRONOUS MOTOR DRIVE: Control of Synchronous Motor-Separately Controlled and VSI fed Self-Controlled Synchronous Motor Drives. Dynamic and Regenerative Braking of Synchronous Motor with VSI, Control of Synchronous Motor Using Current Source Inverter (CSI), Speed control – variable frequency control, Cycloconverters control

Text and Reference books:

1. Power electronics and A C Drives – B K Bose, Pearson, India
2. Power electronics: circuits, drives and applications – H Rashid, Pearson ,India
3. A C Drives – J M D Murphy, John Wiley student edition

EPE 522 Utility Applications of Power Electronics

	L	T	P
Credit	3	0	0
Hours	3	0	0

Power Converters in Static Excitation Systems, HVDC Power Transmission: Converters, technology, Voltage sourced converters, Single phase converters, Three phase converters, Transformer connections, 24 and 48 pulse operation, Three level converter and converter ratings, Self and line commutated CSC
Utility interface: Current harmonics, and p.f., standards, Single phase interface, Three phase interface, EMI.
Static shunt compensators: Objectives, Methods of controllable VAR generation, Static VAR compensators SVC, and STATCOM, Comparison between SVC , TATCOM and static VAR systems

Static series compensators: Objectives, Variable impedance type, Switching converter type, System control and comparison, Combined compensators: PFC , IPFC , Generalized and multi functional FACTS controllers
Active power filters: Types, shunt active filters, Series active filters

Text and Reference books:

1. Padiyar.K.R., HVDC TRANSMISSION SYSTEMS, New Age International, 2006.
2. Mohan.N, Undeland.T.M., Robbins.W.P., POWER ELECTRONICS, John Wiley & Sons (Asia) Pte. Ltd, 3rd ed., 2003.
3.Rashid.M.H(Ed)., POWER ELECTRONICS HANDBOOK, Elsivier, 2001.
4. Padiyar.K.R., FACTS CONTROLLERS IN POWER TRANSMISSION AND DISTRIBUTION, New Age International, 2007.

EPE 523 System Simulation Lab-1I

	L	T	P
Credit	0	0	1
Hours	0	0	2

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.
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.
Modeling and simulation using PSCAD/ EMTDC :DC motor drive. Operation of DC motor with armature fed by single and three phase AC-DC converters. Three phase induction motor drive. Operation of three phase induction motor fed by three phase frequency controlled inverters, three phase synchronous motor drive, Modeling of HVDC system in PDCAD
Modeling and simulation using MATLAB/SIMULINK: DC motor drive. Operation of DC motor with armature fed by single and three phase AC-DC converters. Three phase induction motor drive. Operation of three phase induction motor fed by three phase frequency controlled inverters. Three phase synchronous motor drive

Text and Reference books:

1. *Laboratory Manual for Power Electronic System Simulation on PSCAD/EMTDC by* Vinod Kumar, R. R. Joshi
2. Advanced Power electronics – Vinod Kumar, R. R. Joshi, R C Bansal, Agarwal and Sharma, Vardhan Publication and distributors, Jaipur, India
2 P. T. Krein, *Elements of Power Electronics*. Oxford University Press, 1998.

EPE 524 Power Electronics Hardware Lab-1I

	L	T	P
Credit	0	0	2
Hours	0	0	4

Practical implementation of control techniques for voltage control, speed control and harmonic minimization. Experiments and analysis on various DC and AC drives for different input and output conditions, Experiments using matrix converters

Text Books/References:

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wileyand sons.Inc, Newyork, 1995
2. M.H. Rashid, 'Power Electronics Handbook', Elseiver Press, 2003.
3. John D. Lenk ,'Simplified Design of Switching Power Supplies', Butterworth- Heinemann,1995.

EPE 531 Switched Mode Power Conversion

	L	T	P
Credit	3	0	0
Hours	3	0	0

Reactive Elements in Power Electronic Systems, Design of inductor, Design of transformer, Capacitors for power electronic applications.
Basic concepts of Switched Mode power converters, DC-DC converters Characteristics, constituent elements, operating principles.
Steady state analysis, stress and sizing of elements, control methods, duty ratio, current programmed, frequency programmed and sliding mode control, Dynamic analysis and frequency domain models.
Classification of resonant converters, Basic resonant circuit concepts, Load resonant converters, Resonant switch converters, Zero voltage switching.
Design of feed back compensators, unity power factor rectifiers, resistor emulation principle and applications to rectifiers.

Text Books/References:

1. Switched Mode Power Conversion, Course Notes, CCE, IISc, 2004.
2. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004.
3. Philip T Krein,' Elements of Power Electronics ',Oxford Press.

EPE 532 Power electronics application for renewable energy

	L	T	P
Credit	3	0	0
Hours	3	0	0

Modern power electronics technology for the integration of renewable energy sources, various topologies of power electronics converters (PECs), grid interconnection requirements for wind farms, integration issues, operational issues, grid integration issues in India, challenges for grid integration, wind power integration standards, supergrid strategy, IEC standadrds for wind turbines, power electronics in wind power plants, power electronics converters (PEC) classifications, Applications of PEC in wind power plants, Modern PEC in wind power plants. Power electronics in PV system

Text Books/References:

1. Wind power plants and projects developments, Joshua Earnest and T Wizelius, PHI, New Delhi, 2011.
2. Handbook of renewable energy technology, World Scientific, Siongapore, 2011.

EPE 533 High Voltage dc Transmission system

	L	T	P
Credit	3	0	0
Hours	3	0	0

HVDC Transmission: Basic scheme and equipment of converter station, 12 – pulse converter, converter unit, converter operation, fitters, reactive power source, ground return and ground electrode, Comparison between AC and DC transmissions, Application of HVDC transmission. Converter Circuits: Rectification and inversion, effect of reactance, six pulse and twelve pulse converter circuits.

DC Link Control: Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Extinction angle control, starting, stopping and power flow reversal of DC link, Power control, Parallel operation of DC link with AC transmission line; Converter faults, commutation failure, valve blocking and bypassing; Protection against over currents, over voltages; DC circuit breaker; Reactive Power Control: Reactive power requirement in steady state, Sources of reactive power and reactive power control; Power modulation and power control of HVDC lines

Harmonic and Filters: Generation of harmonics, AC and DC side harmonics, characteristics and non-characteristics harmonics. Types of AC filters – single tuned and double tuned filters, high pass filter, DC Smoothing reactor and filters; Scheme of a HVDC converter station and components of HVDC transmission system.

Multi Terminal DC (MTDC) Systems: Types of MTDC systems, Comparison of series and parallel MTDC systems, Control and protection of MTDC systems, Application of MTDC systems.

Compulsory Courses
EPE 534 Seminar
EPE 541Thesis