Scheme of

POSTGRADUATE DEGREE COURSE

M.Tech. I to IV Semester

Power Electronics and Electrical Drives

(Effective from academic session: 2020-21)

Rajasthan Technical University, Kota

Akelgarh, Rawatbhata Road, Kota-324010

RAJASTHAN TECHNICAL UNIVERSITY, KOTA
SCHEME & SYLLABUS

M.Tech.: Power Electronics and Electrical Drives

Semester- I

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MPE1-01	Electric Drives System	3	0	0	3	30	70	100	3
2	PCC	1MPE1-02	Modeling and Analysis of Electrical Machines	3	0	0	3	30	70	100	3
3	PCC	1MPE1-03	Power Electronic Converters	3	0	0	3	30	70	100	3
4	PEC	1MPE2-11	Power Quality	3	0	0	3	30	70	100	3
		1MPE2-12	PWM converter and Applications								
		1MPE2-13	Power Semiconductor Devices & Modeling								
5	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MPE1-06	Electrical Drives Laboratory	0	0	4	4	60	40	100	2
7	PCC	1MPE1-07	Power Electronics Laboratory	0	0	4	4	60	40	100	2
8	SODECA	1MPE5-00	Social Outreach Discipline & Extra Curriculum Activities							100	2
			Total					**270**	**430**	**800**	**20**

Semester- II

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exm Hrs	IA	ETE	Total	
1	PCC	2MPE1-01	Intelligent control techniques	3	0	0	3	30	70	100	3
2	PCC	2MPE1-02	Modeling and Control of Power Electronic Converters	3	0	0	3	30	70	100	3
3	PCC	2MPE1-03	Digital Signal Processing	3	0	0	3	30	70	100	3
4	PEC	2MPE2-11	Embedded System Design	3	0	0	3	30	70	100	3
		2MPE2-12	Switched Mode and Resonant Converters								
		2MPE2-13	Modern control System and de-sign								
5	MCC	2MCC3-XX	Audit Course-I	2	0	0	0	0	0	0	
6	PCC	2MPE1-06	Artificial Intelligent Control Lab	0	0	4	4	60	40	100	2
7	PCC	2MPE1-07	Embedded System Lab	0	0	4	4	60	40	100	2
8	REW	2MPE4-50	Mini Project with Seminar	0	0	4	4	60	40	100	2
9	SODE CA	2MPE5-00	Social Outreach Discipline & Extra Curriculum Activities							100	2
			Total					**300**	**400**	**800**	**20**

Semester- III

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	3MPE2-11	Dynamics of Electrical Machines	3	0	0	3	30	70	100	3
		3MPE2-12	FACTS and Custom Power Devices								
		3MPE2-13	Renewable Power Generation and Control								
2	MCC	3MCC3-XX	Open Elective	3	0	0	3	30	70	100	3
3	MCC	3MCC3-XX	Audit Course-II	2	0	0					
4	REW	3MPE4-60	Dissertation-I / Industrial Project	0	0	20		240	160	400	10
			Total					**300**	**300**	**600**	**16**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA
SCHEME & SYLLABUS

Semester- IV

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exm Hrs	IA	ETE	Total	
1	REW	4MPE4-70	Dissertation-II	0	0	32		360	240	600	16
			Total					**360**	**240**	**600**	**16**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronics and Electrical Drives)

1MPE1-01: Electric Drives System

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction:** Objective, scope and outcome of the course.	01
2.	**Dynamics of Electric Drives:** Fundamentals of torque equation. Speed torque convention and multi-quadrant operation, components of load torques.	08
3.	**Load Torque:** Classification of load torques steady state stability. Load equation, Speed control and drive classification. Close loop control of drives.	04
4.	**DC motor Drives-**Modeling of DC machines. Steady state characteristics with armature and speed control. Phase controlled DC motor drives, chopper controlled DC motor drives.	08
5.	**Poly-phase induction machines-** Dynamic modeling of induction machines. Small signal equations, control characteristics of induction machines. Phase-controlled induction machines.Stator voltage control. Slip energy recovery scheme, frequency control and vector control of induction motor drives.	08
6.	**Traction motor:** Starting, Speed-Time characteristics, Braking, Traction motors used in practice.	04
7.	**Industrial Drives-**Digital Control of Electric Drives. Stepper motor.Servo motor and their Applications.	07

Text/Reference Books

1. G.K, Dubey, "Power semiconductor controlled Drives", Prentice Hall international, New Jersey, 1989.
2. R.Krishanam, “Electric motor drives modeling, analysis and control”, PHI-India-2009.
3. G. K. Dubey,“Fundamentals of electric Drives, Narosa Publishing House”, 2nd edition, 2011.
4. W. Leonhard, “Control of Electrical drives”, Springer, 3rd edition, 2001.
5. P.C. Krause –, “Analysis of Electric Machine”, Wiley-IEEE press 3rdedition.
6. K. Bose,“Modern Power Electronics and AC Drives”, Prentice Hall publication, 1st edition, 2001.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA
SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronics and Electrical Drives)
1MPE1-02: Modeling and Analysis of Electrical Machine

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Energy Conversion:** Principles of Electromagnetic Energy Conversion. General expression of stored magnetic energy. Co-energy and force/torque, example using single and doubly excited system.	07
3	**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.	07
4	**Concept of Transformation:** Change of variables & m/c variables and transform variables for arbitrary reference frames. Application to D.C. machine for steady state and transient analysis, and equation of cross field commutator machine, linear transformation from 3-phase to 2-phase transformation from rotating axes to stationary axes - power in-variance - park's transformation for 3-phase synchronous andinduc-tionmachines	
5	**Induction Machine:** 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 syn-chronous machines, Dynamic direct and quadrature axis model in arbi-trarily rotating reference frames	10
6	**Synchronous machine :** Determination of Synchronous machine dy-namic equivalent circuit parameters, Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.	08
7	**Special Machines** - Permanent magnet synchronous machine, Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines, Construction and operating principle, Dy-namic modelling and self-controlled operation. Analysis of Switch Reluctance Motors. Brushless D.C. Motor for space Applications.	08

Text/Reference Books

1. Charles Kingsle,Jr., A.E. Fitzgerald, Stephen D.Umans, "Electric Machinery", Tata Mcgraw Hill
2. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India
3. Miller, T.J.E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press
4. P.C.Krause "Analysis of Electric Machine" Wiley IEEE Press 3rd Edition

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronics and Electrical Drives)

1MPE1-03: Power Electronic Converters

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction :** Objective, scope and outcome of the course.	01
2	**Switching DC Power supplies:** Linear power supplies, overview of switching power supplies, DC-DC converters with Electrical isolation (Flyback, Forward, Push-pull, Half and Full bridge converter), Control of Switch Mode DC Power Supplies.	07
3	**DC-AC converters:** Single phase and three phase bridge inverters, PWM switching scheme, unipolar and bipolar switching scheme, space vector modulation (SVPWM), Reduction of harmonics, Output Voltage Control.	07
4	**AC-AC Direct Converter:** AC Voltage Controller with PWM Control, Single phase and three phase Cyclo-converters, Matrix Converter.	07
5	**Resonant Converters:** Principle of soft switching – concept of zero current switching (ZCS) and zero voltage switching (ZVS). Series and parallel loaded resonant converter.	07
6.	**Multilevel Converter:** Fundamental topologies, neutral point clamped (NPC) flying capacitor converter, cascade multilevel convertor, applications.	06
7	**Application of power electronic converters:**HVDC transmission, induction heating, electric welding, electronic ballast, UPS, static VAR compensators, active filters.	07

Text/Reference Books

1. *Rashid "Power Electronics" Prentice Hall India 2007.*
2. *Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design", John's Wiley and sons. Inc,Newyork.*
3. *G.K.Dubey et.al "Thyristorised Power Controllers" Wiley Eastern Ltd., 2005, 06.*
4. *Dewan&Straughen "Power Semiconductor Circuits" John Wiley &Sons., 1975.*
5. *G.K. Dubey& C.R. Kasaravada "Power Electronics & Drives" Tata McGraw Hill., 1993*
6. *Cyril W Lander "Power Electronics" McGraw Hill., 2005.*
7. *B. K Bose "Modern Power Electronics and AC Drives" Pearson Education (Asia)., 2007*
8. *Abraham I Pressman "Switching Power Supply Design" McGraw Hill Publishing Company., 2001.*

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronics and Electrical Drives)

1MPE2-11: Power Quality

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Power Quality :**What is Power Quality?, Voltage Quality, Why are we concerned about power quality?, The power quality evaluation procedure-Need for a consistent Vocabulary, General classes of power quality problems, Transients, Long-Duration voltage variations, Short-Duration voltage variations, Voltage Imbalance, waveform distortion, voltage fluctuation, Power frequency variations, Power quality terms	8
3	**Voltage Sags and Interruptions:** Sources of sags and interruptions-Estimating Voltage sag performance-Fundamental principles of protection-Solutions at the End-User level-Evaluating the economics of different ride_ through alternatives-Motor_ starting sags-Utility system fault_ clearing issues	8
4	**Fundamentals of Harmonics:** Harmonic Distortion-Voltage versus current distortion Harmonic versus Transients-Power system Quantities under non sinusoidal conditions-Harmonic indices-Harmonic sources from commercial loads-Harmonic sources from industrial loadsLocating harmonic sources-System response characteristics-Effects of harmonic distortion Inter harmonics	8
5	**Applied Harmonics:** Harmonic Distortion Evaluation-Principles of Controlling Harmonics Where to control Harmonics? - Harmonic studies-Devices for controlling Harmonic Design Harmonic filter Design.	8
6	**Power Quality Monitoring:** Monitoring considerations-Historical perspective of power quality measuring instruments-Power quality measurement equipment-Assessment of power quality measurement data-Application of intelligent systems-Power quality monitoring standards	8

Text/Reference Books

1. Electrical power systems quality-Roger C.Dugan- McGraw- Hills
2. Power quality- C.Sankaran, CRC Press
3. Electrical power systems quality-Roger C.Dugan- McGraw- Hills
4. Power quality- C.Sankaran, CRC Pressaul.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronic and Electrical Drives)

1MPE2-12: PWM Converter and Applications

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	1
2	• AC/DC and DC/AC power conversion • Overview of applications of voltage source converters and current source converters.	6
3	• Pulse width modulation techniques for bridge converters • Bus clamping PWM Space vector based PWM. • Advanced PWM techniques	7
4	• Practical devices in converter. • Calculation of switching and conduction power losses.	6
5	• Compensation for dead time and DC voltage regulation. • Dynamic model of PWM converter, Multilevel converters. • Constant V/F induction motor drives.	7
6	• Estimation of current ripple and torque ripple in inverter fed drives. • Line-side converters with power factor compensation.	7
7	• Active power filtering. Reactive power compensation. • Harmonic current compensation. • Selective harmonic elimination PWM technique for high power electric drives	7

Text/Reference Books

1. Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John’s Wiley and Sons.
2. Erickson RW, “Fundamentals of Power Electronics”, Chapman and Hall.
3. Vithyathil. J, “Power Electronics: Principles and Applications”, McGraw Hill

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronic and Electrical Drives)

1MPE2-13: Power Semiconductor Devices & Modeling

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction :** Objective, scope and outcome of the course.	1
2	**Introduction to Power switching devices:** Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.	8
3	**Current Controlled Devices:** BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power darlington – Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor.	9
4	**Voltage Controlled Devices:** Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and GATT.	8
5	**Firing and Protecting Circuits:** Necessity of isolation, pulse transformer, optocopler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers	8
6	**Thermal Protection:** Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types	8

Text/Reference Books

1. Rashid M. H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi.
2. B.W. Williams 'Power Electronics: Devices, Drivers, Applications and Passive Components, Tata McGraw Hill.
3. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill.
4. Mohan, Undeland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore.
5. L. Umanand, Power Electronics, Essentials and Applications, Wiley India Pvt. Ltd.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronics and Electrical Drives)

1MCC3-21: Research Methodology and IPR

Credit: 2 **Max. Marks: 100(IA:30, ETE:70)**

2L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Research Problem:** Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	6
3	**literature studies:** Effective literature studies approaches, analysis Plagiarism, Research ethics,	5
4	**Effective technical writing:** how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	5
5	**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	5
6	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	5

Text/Reference Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1MPE1-06: Electrical Drives Laboratory

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P

1. To Study of Thyristor controlled D.C Drive also Design & simulate a model to compare both hardware setup and simulation results.
2. To Study of Chopper Fed DC Motor also Design & simulate a model to compare both hardware setup and simulation results.
3. To Study of A.C single phase motor speed control using TRIAC also Design & simulate a model to compare both hardware setup and simulation results.
4. Design and Simulate a model of PWM inverter fed three phase induction motor control using PSPICE/MATLAB/PSIM software.
5. Design and Simulate a model of VSI/CSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM software.
6. To Study of V/f control operation of three phase induction motor also Design and Simulate a model of
7. Design and Simulate a model of permanent magnet synchronous motor drive fed by PWM inverter.
8. Design and Simulate a model of Regenerative/ Dynamic breaking operatation for DC motor.
9. Design and Simulate a model of Regenerative/ Dynamic breaking operatation for AC motor.
10. PC/PLC based AC/DC motor control operation.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1MPE1-07: Power Electronics Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P

1. To Study a) Single phase controlled / uncontrolled converter
   b) three phase Semi controlled / uncontrolled converters
   c) Full controlled / uncontrolled converters and obtain results for R & RL loads. and also Design & simulate a model to compare both hardware setup and simulation results.
2. To study an open & close loop for DC-DC Choppers.
   a) Buck Converter
   b) Boost Converter
   c) Buck- Boost Converter and trace the curve of output voltage.
   and also Design & simulate a model to compare both hardware setup and simulation results.
3. To study an open & close loop for a) Single phase Inverter
   b) Three phase inverters using IGBTs, and trace the output curve for different values of input voltage and also Design & simulate a model to compare both hardware setup and simulation results.
4. Design & simulate a model of AC-AC voltage regulators and trace the output curve for different values of input voltage.
5. Design & simulate a model of single phase cyclo-converter and trace the curve of output voltage.
6. Design & simulate a model of CuK converter and trace the curve of output voltage.
7. To Study, Design & simulate a model for grid integration of DFIG and PMSG.
8. Mini project Design and fabricate power electronic switching based converters using Aurdino, microcontroller, DSP.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE1-01: Intelligent control techniques

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction:** Objective, scope and outcome of the course.	01
2.	**Introduction to intelligent control:** Approaches to intelligent control; Architecture for intelligent control; Symbolic reasoning system; rule-based systems; AI approach; Knowledge representation; Expert systems.	06
3	**Fuzzy Logic Control System:** Motivation and basic definitions; Fuzzy arithmetic and Fuzzy relations; Fuzzy logic modeling and control; Fuzzy knowledge and rule bases; Fuzzy modeling and control schemes for nonlinear systems; Self-organizing fuzzy logic control; Fuzzy logic control for nonlinear time-delay system; Stabilization using fuzzy models; Fuzzy estimators; Adaptive fuzzy control	09
4	**ANN based Controllers and Estimators:** Concept of Artificial Neural Networks and its basic mathematical model; McCulloch-Pitts neuron model; simple perceptron; Adaline and Madaline; Feed-forward Multi-layer Perceptron; Learning and Training the neural network; Data Processing: Scaling; Fourier transformation; principal-component analysis and wavelet transformations; Hopfield network; Self-organizing network and Recurrent network; Neural Network based controllers and estimators.	09
5	**Genetic Algorithm:** Basic concept of Genetic algorithm and detail algorithmic steps; Adjustment of free parameters; Solution of typical control problems using genetic algorithm; Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems; Evolutionary Fuzzy logic controllers.	08
6	**Case Studies:** Identification and control of linear and nonlinear dynamic systems using MatlabNeural Network toolbox; Stability analysis of Neural-Network interconnection systems; Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox; Stability analysis of fuzzy control systems.	08

Text/Reference Books

1. Padhy.N.P.; “Artificial Intelligence and Intelligent System”; Oxford UniversityPress.
2. KOSKO;B. "Neural Networks and Fuzzy Systems"; Prentice-Hall of India Pvt. Ltd.
3. Jacek.M.Zurada; "Introduction to Artificial Neural Systems";Jaico PublishingHouse.
4. KLIR G.J. & FOLGER T.A. "Fuzzy sets; uncertainty and Information"; Prentice-Hall of India Pvt. Ltd.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE1-02: Modeling and Control of Power Electronic Converters

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction :** Objective, scope and outcome of the course.	01
2	**Introduction to Power Electronic Converters Modeling:** Scope of Modeling, Model Types, Use of Models, Switched Model: Mathematical Modeling, Modeling Methodology, Case Study: Three-Phase Voltage-Source Converter as Rectifier	08
3	**Classical Averaged Model:** Sliding Average, State Variable Average, Average of a Switch, Complete Power Electronic Circuit Average , Methodology of Averaging, Analysis of Averaging Errors , Small-Signal Averaged Model, Case Study: Buck-Boost Converter	06
4	**Linear Control Approaches for DC-DC Power Converters :** Linearized Averaged Models, Direct Output Control, Indirect Output ControlTwo-Loop Cascaded Control Structure, Converter Control Using Dynamic Compensation by Pole Placement, Digital Control Issues	10
5	**Linear Control Approaches for DC-AC and AC-DC Power Converters:** Control in Rotating dq Frame, Resonant Controllers, Control of Full-Wave Converters, Case Study: dq Control of a PWM Three-Phase Grid-Tie Inverter.	11
6	**Energy-Based Control of Power Electronic Converters :** Stabilizing Control of Power Electronic Converters , Approaches in Passivity-Based Control. Euler-Lagrange General Representation of Dynamical Systems, Passivity-Based Control of Power Electronic Converters, Case Study: Passivity-Based Control of a Buck-Boost DC-DC Converter	06

Text/Reference Books

1. Seddik Bacha, Iulian Munteanu, Antoneta Iuliana Bratcu " Power Electronic Converters Modeling and Control", Springer
2. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John's Wiley and Sons.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE1-03: Digital Signal Processing

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction :** Objective, scope and outcome of the course.	1
2	**Discrete time Signal:** Review of Discrete – Time Signal & System representation in Z – Transform domain – Inverse Z – Transform – Properties – System characterization in Z – domain -- Equivalence between Fourier Transform and the Z-Transform of a Discrete signal.	7
3	**Discrete Fourier Transform:** Sampling in Fourier domain -Discrete Fourier Transform and its properties – Linear filtering using DFT – Resolution of DFT - FFT Algorithm – Radix-2 FFT Algorithm - DIT & DIF Structures - Higher Radix schemes.	6
4	**Filters Analysis:**Classification of filter design -Design of IIR filters – Bilinear transformation technique – Impulse invariance method – Step invariance method. FIR filter design – Fourier series method - Window function technique - Finite Word Length Effects.	7
5	**Multirate systems:** Introduction to Multirate Signal Processing - Decimation - Interpolation - Case Studies on Speech Coding, Transform Coding – DSP based measurement system.	7

Text/Reference Books

1. Ludemann L. C., "Fundamentals of Digital Signal Processing", Harper and Row publications, 1986.
2. Antoniou A., "Digital Filters – Analysis and Design", Tata Mc-Graw Hill, 1980.
3. Oppenheim and Schaffer, 'Discrete time Signal processing', PHI, 1989.
4. P.P. Vaidhyanathan, " Multirate systems and filter banks", PHI, 1993.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE2-11: Embedded System Design

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Computer Organization:** Basic Computer Organization, Accumulator based Processes-Architecture, Memory Organization-I/O Organization	7
3	**Micro-Controllers-**Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication, Timers, Interrupts, Programming	8
4	**Intel 8051 –** Assembly language programming, Addressing-Operations, Stack & Subroutines, Interrupts-DMA	8
5	**PIC 16F877-** Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication **Digital Signal Processor (DSP)**: Architecture – Programming ,Introduction to FPGA	8
6	**Motor Control:** Microcontroller development for motor control applications, Stepper motor control using micro controller	8

Text/Reference Books

1. John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981
2. Ramesh S.Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085",Penram International Publishing (India), 1994
3. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005
4. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004
5. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005
6. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008
7. Microchip datasheets for PIC16F877

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - I Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE2-12: Switched Mode and Resonant Converters

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Reactive Elements in Power Electronic Systems, Design of inductor, Design of transformer, Capacitors for power electronic applications.	8
3	Basic concepts of Switched Mode power converters, DC-DC converters characteristics, constituent elements, operating principles.	8
4	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.	8
5	Classification of resonant converters, Basic resonant circuit concepts, Load resonant converters, Resonant switch converters, Zero voltage switching.	8
6	Design of feedback compensators, unity power factor rectifiers, resistor emulation principle and applications to rectifiers.	8

Text/Reference Books

1. Abraham I Pressman, "Switching Power Supply Design,". McGraw Hill Publishing Company, 2001.
2. Daniel M Mitchell,"DC-DC Switching Regulator Analysis," McGraw Hill Publishing Company-1988.
3. Ned Mohan et.al, "Power Electronics," John Wiley and Sons2006.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE2-13: Modern Control System and Design

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction :** Objective, scope and outcome of the course.	1
2	**State Variable Analysis and Design:** State space models, state space representation of simple electrical and mechanical systems, canonical forms, solution of state equation, state transition matrix, relation between transferfunction and state variable representations; controllability and observability, pole- placementusing state variable feedback; design of full order and reduced order observer, observer basedand state feedback controller, optimal control concept, solution of linear quadratic regulator.	9
3	**Discrete Control** Discrete Time Systems and the Z-Transform Method: Sampled Data Control Systems, Digital Controller, Sample &Hold Operation, Frequency consideration in Sampling and Reconstruction. Z-transformation, Solution of Differential & State Equations by Z Transform Method, TheInverse Z-Transform, Pulse Transfer Function and Stability in Z-plane.	8
4	**Sample Data Control System:** Mathematical preliminaries- difference equations, Z Transform and properties; samplingquantization and reconstruction process, discrete time systems, system response, transferfunction stability, bilinear transformation and the jury stability criterion, implementation ofdigital controllers and digital controllers for deadbeat performance. Root loci - Frequencydomain analysis - Bode plots - Gain margin and phase margin - Design of Digital ControlSystems based on Root Locus Technique, state space analysis of discrete system.	6
5	**Nonlinear Control Systems:** Characteristics of nonlinear systems; linearization techniques; phase plane analysis, singularpoints, limit cycle vs closed trajectory; stability analysis using phase plane analysis- describingfunction (DF) of common nonlinearities, stability analysis using DF; stability in the sense ofLyapunov, Lyapunov's stability theorems for linear and nonlinear systems; effect of nonlinearity in root locus and Nyquistplot. Introduction to Modern Nonlinear control system. Introduction to modern nonlinear control system. Generalized Stability Creterion (d-partitiontechnique), Pole Assignment method, LURE's transformation, POPOV's criterion.	8

Text/Reference Books

1. Modern Control Theory, 3rd Edition by William L Brogan
2. Modern Control System Theory, by Madan Gopal (Author), New Edge publications
3. Modern control theory By U.A.Bakshi, M.V.Bakshi , Technical Publications Pune

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE1-06: Artificial Intelligent Control Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P

1. Design and simulate a model for implementation of state estimator based closed loop control system with estimator gain design and control law design.
2. Familiarization with fuzzy logic controller implementation and Design and simulate a model forfuzzy logic controller.
3. Design and simulate a model for Speed and position control of DC Motor using Fuzzy Rule-Based System.
4. Design and simulate a model for stability analysis of control system with common non-linearities.
5. Design and simulate a model forPerformance analysis of non-linear electrical circuit using phase plane method.
6. Write a code for Generalized Neuron and Its Validation.
7. Design and simulate a model for discrete time control system.
8. Familiarization with robust control system also Design and simulate a model forrobust control system
9. Design and simulate a model to analyse effect of P, PD, PI, PID Controller on a second order systems.

1st Year - II Semester: M.Tech. (Power Electronics and Electrical Drives)

2MPE1-07: Embedded System Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P

1. To perform Energy Management in Centrifugal pumps by Variable Frequency Drive using micro-controller
2. DSP Programming Experiments.

a) Speed control of BLDC motor (2812/2407 kit).
b) Speed control of Induction motor (2812/2407 kit).
c) Speed control of DC motor (2812/2407 kit).

3. To Perform Stepper Motor speed control and step angle control using 8051 Microcontroller.
4. Design and simulate a model of Linear Induction Motor for Measuring Force and thrust of a Linear Induction Motor.
5. To perform Measurement of breaking Torque for Eddy Current Control drive.
6. Design and simulate a model of Pick and Place Robot in robot studio software and implementation in ABB IRB 1200
7. To perform Vector control drive for 3 phase Induction motor using FPGA.
8. Develop a model of 1 HP Switched Reluctance Motor with Eddy Current loading arrangement.
9. To perform Speed control of three phase Induction motor by variable frequency method.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

2nd Year - III Semester: M.Tech. (Power Electronics and Electrical Drives)

3MPE2-11: Dynamics of Electrical Machines

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction:** Objective, scope and outcome of the course.	01
2.	**Basic Machine Theory:** Electromechanical Analogy, Magnetic Saturation, Rotating field theory, Operation of Inductor motor, equivalent circuit, Steady state equations of DC machines, operations of synchronous motor, Power angle characteristics.	08
3.	**Electro-dynamical Equation & Their Solutions:**Spring and Plunger system, Rotational motion, mutually coupled coils, Lagrange's equation, application of Lagrange's equation solution of Electro dynamical equations.	07
4.	**Dynamics of DC Machines:** Separately excited d. c. generator, stead state analysis, transient analysis, Separately excited d. c. motors, stead state analysis, transient analysis, interconnection of machines, Ward Leonard system of speed control.	08
5.	**Induction Machine Dynamics:** Induction machine dynamics during starting and braking, accelerating time, induction machine dynamic during normal operation. Equation for dynamical response of the induction motor.	08
6.	**Synchronous Machine Dynamics:** Electromechanical equation, motor operation generator operation, small oscillations, general equations for small oscillations, representation of the oscillation equations in state variable form.	08

Text/Reference Books

1. Sen Gupta D.P. and J. W "Electrical Machine Dynamics "Macmillan Press Ltd 1980.
2. Bimbhra P.S. "Generalized Theory of Electrical Machines "Khanna Publishers 2002.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

2nd Year - III Semester: M.Tech. (Power Electronics and Electrical Drives)

3MPE2-12: FACTS and Custom Power Devices

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**General system consideration and FACTs concepts:** Reactive power flow control in Power Systems, Control of dynamic power unbalances in Power System, Constraints of maximum transmission line loading, Need of FACTs controller in power system, Transmission line compensation, Uncompensated line -Shunt compensation, Series compensation Phase angle control, Reactive power compensation Shunt and Series compensation principles, Reactive compensation at transmission and distribution level	09
3	**Static Shunt Compensator:** Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM, Operation and control of TSC, TCR and STATCOM -Compensator control, Comparison between SVC and STATCOM	07
4	**Static Series Compensator:** TSSC,TCSC, Sub Synchronous characteristics SSSC -Static voltage and phase angle regulators, TCVR and TCPAR Operationand Control, Applications, Static series compensation, GCSC,TSSC, TCSC their application, operating principle and characteristics Static synchronous series compensators: Operation characteristics and application, comparison of TCSC and SSSC, Voltage & phase angle regulation and stability improvement by TCVR and TCPAR, SSR and its damping.	07
5	**UPFC and IPFC:** SSR and its damping Unified Power Flow Controller, Circuit Arrangement, Operation and control of UPFC, Basic Principle of P and Q control, Independent real and reactive power flow control- Applications.	07
6	**Interline power flow controller:** Introduction to interline power flow controller, Basic operating principle, characteristics and application, Modeling and analysis of FACTS, Controllers, Simulation of FACTS controllers Power quality problems in distribution systems, harmonics, loads that create harmonics, modeling, harmonic propagation, series and parallel resonances mitigation of harmonics, passive filters, active filtering – shunt , series and hybrid and their control	07
7	**Power Quality issues and modelling of FACTs:** Voltage swells , sags, flicker, unbalance and mitigation of these problems by power line conditioners, IEEE standards on power quality. Modelling of TCSC, STATCOM, UPFC	04

Text/Reference Books

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age InternationalPublishers, 2007
2. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control", SpringerVerlag, Berlin, 2006
3. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible ACTransmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K.S.Sureshkumar ,S.Ashok , "FACTS Controllers & Applications", E-book edition, Nalanda DigitalLibrary, NIT Calicut,2003
5. G T Heydt , "Power Quality", McGraw-Hill Professional, 2007
6. T J E Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork, 1982.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SCHEME & SYLLABUS

2nd Year - III Semester: M.Tech. (Power Electronics and Electrical Drives)

3MPE2-13: Renewable Power Generation and Control

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

S.No.	CONTENTS	CONTACT HOURS
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Renewable Energy Systems:** Introduction to Renewable Energy Systems, Wind power, Hydropower, Solar energy-Biomass, Bio-fuel, Geothermal Heat energy, Solar-thermal plants, Applications.	06
3	**PV-Cells:** Introduction to PV-Cells, Array, Solar power extraction using PV-Cells, I-V Characteristics, PV- Inverters without D.C. to D.C. converters, Grid interfacing-with isolation, without isolation, Maximum power point tracking-Methods, PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation.	09
4	**Wind power energy:** Wind energy sources and potentials, Evaluation of wind Intensity, Topography, General classification of Wind turbines,Rotor turbines, Multiple-Blade turbines, Drag turbines, Lifting turbines, System TARP–WARP, Generators and speed control used in wind power energy, Wind power control: Fixed speed with capacitor bank, Rotor resistance control, DFIG, Synchronous generator-external magnetized, Synchronous generator-permanentmagnets.	09
5	**Fuel cells:** Fuel cells, Commercial technologies for generation of electricity, Constructional features of Solid Oxide Fuel Cells, Constructional features of proton exchange Membrane fuel cells, Load curve peak sharing with fuel cells, Advantages and disadvantages of fuel cells, voltage step-up using DC-DC converter with and without battery storage, Voltage controller for fuel cell using DC–DC converter, Inverter interaction with fuel cell for AC loads, AC Voltage build-up and controller for fuel cells using power converters and transformers (isolation).	09
6	**DC Micro grid:** DC load detail, AC/DC load detail, Microgrid fundamental, DC microgrid control, PV MPPT testing, Shading, Current sharing in DC microgrid, Communication enabled DC microgrid.	07

Text/Reference Books

1. Anne Maczulak, “Renewable Energy: Sources and Methods,” Library of Congress,2010.
2. G. N. Tiwari and R. K. Mishra, “Advanced Renewable Energy Sources,” RSCPublication.
3. Shivaji Hariba Pewar and L. A. Ekal, “Advances in Renewable Energy Technology,” Narosa Publishing House,2003.
4. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and Applications”, Wiley 2012.