Scheme of

POSTGRADUATE DEGREE COURSE

M.Tech. I to IV Semester

Power System

(Effective from academic session: 2020-21)

Rajasthan Technical University, Kota

Akelgarh, Rawatbhata Road, Kota-324010

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MPS1-01	Modern Power System Analysis	3	0	0	3	30	70	100	3
2	PCC	1MPS1-02	Power System Dynamics	3	0	0	3	30	70	100	3
3	PCC	1MPS1-03	Modern Power System Protection	3	0	0	3	30	70	100	3
4	PEC	1MPS2-11	Electrical Power Distribution System	3	0	0	3	30	70	100	3
		1MPS2-12	Mathematical Methods for Power Engineering								
		1MPS2-13	Pulse Width Modulation for PE Converters								
5	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MPS1-06	Power System Protection Lab	0	0	4		60	40	100	2
7	PCC	1MPS1-07	Power System Dynamics Lab	0	0	4		60	40	100	2
8	SODE-CA	1MPS5-00	Social Outreach Dissertation & Extra Curriculum Activities							100	2
			Total					**270**	**430**	**800**	**20**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA
SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	2MPS1-01	Distributed generation system	3	0	0	3	30	70	100	3
2	PCC	2MPS1-02	Power System Operation and Control	3	0	0	3	30	70	100	3
3	PCC	2MPS1-03	AI Application to Power Systems	3	0	0	3	30	70	100	3
4	PEC	2MPS2-11	Embedded system design	3	0	0	3	30	70	100	3
		2MPS2-12	SCADA System and Applications								
		2MPS2-13	Modern control System and design								
5	MCC	2MCC3-XX	Audit Course-I	2	0	0					
6	PCC	2MPS1-06	Power System Steady State Analysis Lab	0	0	4	4	60	40	100	2
7	PCC	2MPS1-07	Power Electronics Applications to Power Systems Lab	0	0	4	4	60	40	100	2
8	REW	2MPS4-50	Mini Project with Seminar	0	0	3	4	60	40	100	2
9	SODE-CA	2MPS5-00	Social Outreach Dissertation & Extra Curriculum Activities							100	2
			Total					**300**	**400**	**800**	**20**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

2nd Year - III Semester: M.Tech. (Power System)

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	3MPS2-11	Power System Transients	3	0	0	3	30	70	100	3
		3MPS2-12	FACTS and Custom Power Devices								
		3MPS2-13	Industrial Load Modeling 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	3MPS4-60	Dissertation-I / Industrial Project	0	0	20		240	160	400	10
			Total					**300**	**300**	**600**	**16**

2nd Year - IV Semester: M.Tech. (Power System)

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	REW	4MPS4-70	Dissertation-II	0	0	32		360	240	600	16
			Total					**360**	**240**	**600**	**16**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS1-01: Modern Power System Analysis

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.	**Load flow:** Overview of Newton-Raphson, Gauss-Siedel, Fast decoupled methods, convergence properties, sparsity techniques, handling Qmax and Qmin violations in constant matrix, inclusion in frequency effects AVR in load flow, handling of discrete variable in load flow.	08
3.	**Fault Analysis:** Simultaneous faults, open conductors faults, generalized method of fault analysis.	04
4.	**Security Analysis:** Different operating state with state classification Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, single line outages, contingency analysis overload index ranking	08
5.	**Power System Equivalents :** WARD equivalents, Dynamic WARD equivalent , Static Ward-Injection Equivalent, REI equivalents	08
6.	**State Estimation :** Power system state estimation, various methods, formation of Hx, Virtual and Pseudo Measurement, Observability, Tracking state estimation, Weighted least square method, bad data detection, identification and suppression, Application of power system state estimation	04
7.	**Voltage Stability :** Voltage Stability, Reactive power flow andVoltage collapse, Mathematical formulation of voltage stability problem and analysis, Prevention of voltage collapse, future trends and challenges	07

Text/Reference Books

1. J.J. Grainger &W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2003
2. A. R. Bergen & Vijay Vittal , “Power System Analysis” ,Pearson , 2000
3. L.P. Singh , “Advanced Power System Analysis and Dynamics”, New Age International, 2006
4. G.L. Kusic, “Computer aided power system analysis” ,Prentice Hall India, 1986
5. A.J. Wood, “ Power generation, operation and control” , John Wiley, 1994
6. P.M. Anderson, “Faulted power system analysis” , IEEE Press , 1995
7. D.P Kothari,” Modern power system analysis”, Tata McGraw hill, New Delhi

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS1-02: Power System Dynamics

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 system Dynamics and stability:** Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System,Effect of Damper, Detailed study of technique to improve stability. Asynchronous Operation and Resynchronization, Multi-Machine Stability, Dynamic Analysis of Voltage Stability , Voltage Collapse, Frequency Stability	8
3	**Transients:** Per unit system**,** Sub-transient, steady state, transient inductance and Time constants, Simplified models of synchronous machines	4
4	**Dynamics of synchronous machines:**Mathematical description of synchronous machine, fundamental of magnetic circuit, basic equation of synchronous machine, Park's transformation. Equivalent circuit for direct and quadrature axis for the synchronous generator. Steady state analysis with phasor diagram, equation of motion. Synchronous machine representation in stability studies. Rotor angle stability, Power V/s angle relationship and transient stability.	8
5	**Excitation System:** Excitation system requirements in terms of generator consideration, Power system consideration, Elements of excitation system, Types of excitation system, Dynamic performance measure, Indices, Modelling of excitation system components, Philips-Heffron model, PSS	8
6	**Machine Modelling:**Modelling of SMIB(single machine infinite bus) for small signal stability classical model, Multi-machine modelling and Modelling of induction machine.	4

Text/Reference Books

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotia , New Delhi, 1981
2. J Machowski, J Bialek& J. R W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997
3. P.Kundur, "Power System Stability and Control", McGraw Hill Inc., 1994.
4. E.W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS1-03: Modern Power System Protection

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.	**Digital Relays:** Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection	05
3	**Interpolation:** Interpolation formulae, Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method,	10
4	**Digital Protection:** Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a unit consisting of hardware and software	08
5	**Algorithm:** Mathematical background to protection algorithms, Finite difference techniques, Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm.	08
6	**Fourier Algorithm:** Full cycle window algorithm, fractional cycle window algorithm. Walsh function based algorithm. Least Squares based algorithms. Differential equation based algorithms. Traveling Wave based Techniques. Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.	08

Text/Reference Books

1. A.G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press,1999
3. Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing, 2006
4. S.R.Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS2-11: Electrical Power Distribution 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.	1
2	**Power Distribution:** Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Load forecasting, Power System Loading, Technological Forecasting. Advantages of Distribution Management System (D.M.S.)	7
3	**Distribution Automation:** Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints Power Factor Correction, Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation	8
4	**SCADA:** Introduction, Block Diagram, SCADA Applied To Distribution Automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA, DCADA with WAM and SCADA with PMU's	8
5	**Optimal Placement of Various Components:** Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring	8
6	**Maintenance and Difficulties inDistribution Systems:** Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution. Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation	8

Text/Reference Books

1. A.S. Pabla, " Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
4. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS2-12: Mathematical Methods for Power Engineering

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	**Transformation:** Vector spaces, Linear transformations, Matrix representation of linear transformation. Eigen values and Eigen vectors of linear operator	11
4	**Linear Programming:** Linear Programming Problems, Simplex Method, Duality, Non Linear Programming problems	10
5	**Problems:** Unconstrained Problems, Search methods, Constrained Problems, Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions	10
6	**Variables:** Independent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes	8

Text/Reference Books

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004
3. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002
6. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley, 2000
7. Hillier F S and Liebermann G J, "Introduction to Operations Research", 7th Edition, McGraw Hill, 2001
8. Simmons D M, "Non Linear Programming for Operations Research", PHI, 1975

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS2-13: Pulse Width Modulation for PE 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	**PE converters :** Introduction to PE converters Modulation of one inverter phase leg , Modulation of single phase, VSI and 3 phase VSI	8
3	**Modulation**: Zero space vector placement modulation strategies, Losses-Discontinuous modulation, Modulation of CSI Over modulation of converters, programme modulation strategies	10
4	**Isolated single-phase ac-dc flyback converter:** Dc-dc flyback converter, output voltage as a function of duty ratio and transformer turnsratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factoroperation, closed loop control structure.	11
5	**PWM:** Pulse width modulation for multilevel inverters, Implementation of modulation controller, Continuing developments in modulation as random PWM, PWM for voltage unbalance, Effect of minimum pulse width and dead time	10

Text/Reference Books

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. Bin Vew, “High Power Converter”, Wiley Publication
3. Marian K. Kazimicrczuk, “Pulse width modulated dc-dc power converter”, Wiley Publication

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MCC3-21: Research Methodology and IPR

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

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

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS1-06: Power System Protection Lab

Credit: 4 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P

1. Write the code for Modelling of relay for
   a) phase sequence,
   b) phase failure and
   c) voltage asymmetry to a three-phase circuit
2. Develop a microcontroller based model to show zone protection with different time setting.
3. Write the code for using a timer with different time functions to extend the protective relays operation.
4. Write the code for Modellinga differential relay and design a differential relay model using a microcontroller.
5. Study to perform Radial and Parallel feeder protection and also design a simulink model to compare both hardware setup and simulink results.
6. Study to perform Differential protection of a3-Phase Transformerand Design a& simulate a model to compare both hardware setup and simulink results.
7. Write the code to study time v/svoltage characteristics of over voltage induction relay
8. Design and simulate a model to perform the differential protection of generator for internal and external fault.
9. Write the code to obtain generator protection using negative sequence relay.
10. Write the code to perform over voltage and under voltage protection of generator.
11. Model the Impact of Induction Motor Starting on system.
12. Mini Project " Design and simulate a model of power system having protection of all component i.e Generator, transformer, transmission line etc for different types of fault".

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

1MPS1-07: Power System Dynamics Lab

Credit: 4 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P

1. To Study and Write the Program to obtain P-V Curves at different Power factors.
2. Write the Program for Transient and Small Signal Stability Analysis: Single& Multi -Machine Infinite Bus System
3. Write the Program for Transient analysis of single machine infinite bus system with STATCOM
4. To study the PV MPPT testing and see effect of Shading.
5. To study the Current Sharing in DC microgrid and Communication enabled DC micro-grid.
6. Design & simulate a model for Load – Frequency Dynamics of Single- Area and Two-Area Power Systems.
7. Design & simulate a model to test the Capabilities of the Hydrogen Fuel Cells and Capacitors when connected to grid
8. To Study and Design & simulate a model of solar panel observe the effect of Temperature and other different variable on Solar Panel Outputs.
9. To Study and Design & simulate a model of solar panel and observe an Load Effect on Solar Panel Output
10. Design & simulate a model to test the Capabilities of Solar Panels and Wind Turbines, when integrated with common grid.
11. Mini Project " Design & simulate a model of Power Generation System"
    A) Have minimum 3 different Power generating source.
    B) 2 transformer
    C) Minimum 3 Load.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS1-01: Distributed Generation 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.	1
2	**Distributed Generations and Smart Grid:** Grid connection of wind, solar, hydro etc. powerstations. **Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid	07
3	**Geographic Information System(GIS):** Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU)	07
4	**Introduction to Smart Meters& Networks:** Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation . Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN), Local Area Network (LAN), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network,Cyber Security for Smart Grid, IP based protocols	10
5	**Power Quality & EMC in Smart Grid:** Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit	07
6	**Micro-Grid:** Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid., Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines, Captive power plants, Integration of renewable energy sources. DC microgrid: Basic concept of Photovoltaic, Basics of DC/DC converter, DC load detail, AC/DCload detail,DC Microgrid control, PV MPPT testing, Shading, Current Sharing inDC microgrid, Communication enabled DC microgrid	09

Text/Reference Books

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE, 2011
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press , 2009
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and Applications”, Wiley 2012
4. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions “ CRC Press
5. A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS1-02:Power System Operation 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.	1
2	**Optimal Power System Operation:** System constraints, Optimal Operation of generators on a bus bar, algorithm and flow chart, Optimal Unit Commitment, Constraints in unit commitment, spinning reserve, Thermal Unit Constraints, Other constraints, Hydro constraints, Must Run, Fuel constraints.	10
3	**Unit commitment Solution methods:** Priority-List methods, Dynamic Programming solution. Backward DP Approach, Forward DP Approach, Restricted Search Ranges, Strategies.Reliability Considerations, Patton's Security Function, Security constrained Optimal Unit Commitment, Start-up considerations,	10
4	**Optimal Generation Scheduling:** Representation of Transmission Loss by B-coefficients, Derivation of Transmission Loss formula. Representation of Transmission Loss by Power Flow equations, Optimal Load Flow solution. Optimal Scheduling of Hydrothermal System	09
5	**Automatic generation and Load frequency Control:** Introduction Load Frequency Control, Turbine Speed Governing System, Model of Speed governing system. Turbine Model, Generator Load Model, Block diagram representation of Load Frequency Control. Economic Dispatch Control, single area and Two-area load frequency control, Optimal Load Frequency Control (two- area), Voltage Control, Introduction to Digital LF Controllers, Decentralized Control.	11

Text/Reference Books

1. Wood, A.J. and B.F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons, ThirdEdition, 2013.
2. P. Kundur, Power system stability and control, McGraw-Hill, 1994.
3. A. Chakrabati and S. Halder, Power System Analysis Operation and Control, PHI, 2011
4. Jizhong Zhu, Optimization of Power System Operation, John Wiley & Sons, 2009.
5. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, Fourth Edition, TMH, 2011
6. Dhillon, Kothari, Power System Optimization, PHI.
7. O.E. Elgerd: Electric Energy Systems Theory. TMH Publishing Company.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS1-03: AI Application to Power 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.	1
2	**Introduction to AI:** Definition, Applications, Components of an AI program production system. Problem Characteristics. Overview of searching techniques. Knowledge representation: Knowledge representation issues; and overview. Representing knowledge using rules; procedural versus declarative knowledge. Logic programming, forward versus backward reasoning, matching. Control knowledge.	07
3	**Statistical Reasoning:** Probability and Daye's theorem. Certainty factor and rule based systems. Baysian Networks, Dampster Shafer theorem. Semantic nets and frames, Scripts. Examples of knowledge based systems.	07
4	**Pattern Recognition:** Introduction, automatic pattern recognition scheme. Design Concepts, Methodologies, Concepts of Classifier, concept of feature selection. Feature selection based on means and covariances. Statistical classifier design algorithms; increment-correction and LMS algorithms. Applications.	07
5	**Artificial Neural Networks:** Biological Neuron, Neural Net, use of neural 'nets, applications, Perception, idea of single layer and multilayer neural nets, back propagation, Hopfield nets, supervised and unsupervised learning.	07
6.	**Expert Systems:** Introduction. Study of some popular expert systems, Expert System building tools and Shells, Design of Expert Systems.	06

Text/Reference Books

1. ClArtificial Intelligence Techniques in Power Systems (Energy Engineering), by Kevin Warwick (Editor), Arthur Ekwue (Editor), Rag Aggarwal (Editor),1997
2. Artificial Intelligence Techniques in Power Systems Edited by Kevin Warwick, Arthur Ekwue, Rag Aggarwal
3. AI Application Areas in Power Systems, Iraj Dabbaghchi, American Electric Power Richard D. Christie, Gary W. Rosenwald, and Chen-Ching Liu, University of Washington
4. N.P Pandey," Artificial Intelligence and intelligent system" by Oxford.
5. N.K. Bose, " Neural network fundamental with graph algorithm and application" by Tata McGraw hill.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS2-11: 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

SYLLABUS

1st Year - I Semester: M.Tech. (Power System)

2MPS2-12: SCADA System 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	**SCADA System:** Introduction to SCADA, Data acquisition systems, Evolution of SCADA, Communication technologies	7
3	**SCADA Functions :**Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA	6
4	**Industries SCADA:** Industries SCADA System Components, Schemes-Remote Terminal Unit (RTU), Intelligent Electronic Devices(IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems	7
5	**SCADA Architecture:** Various SCADA architectures, advantages and disadvantages of each system, single unified standard architecture -IEC 61850.	7
6	**SCADA Communication:** various industrial communication technologies, wired and wireless methods and fiber optics, Open standard communication protocols	7
7	**SCADA Applications:** Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement, Industries - oil, gas and water , Case studies, Implementation, Simulation Exercises	7

Text/Reference Books

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications,USA,2004
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK,2004
3. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003
5. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS2-13: 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, DigitalController, 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

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS1-06: Power System Steady State Analysis Lab

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

0L+0T+4P

1. Write the program to determine transmission line performance.
2. Write the program to obtain steady state, transient and sub-transient short circuit currents in an alternator also trace their curve.
3. Write the program to obtain formation of Y-bus matrix and perform load flow analysis.
4. Write the program to perform symmetrical fault analysis in a power system
5. Write the program for performing unsymmetrical fault analysis in a power system
6. Write the program for Short circuit analysis of a power system with IEEE 9 bus system.
7. Write the program for Power flow analysis of a slack bus connected to different loads
8. Design & simulate a model for Load flow analysis of 3 motor systems connected to slack bus.
9. To study Swing curve for sustained fault and critical clearing angle & time

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

1st Year - II Semester: M.Tech. (Power System)

2MPS1-07: Power Electronics Applications to Power Systems

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 ofAC-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

SYLLABUS

2nd Year - III Semester: M.Tech. (Power System)

3MPS2-11: Power System Transients

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.	**Power System Transients:** Fundamental circuit analysis of electrical transients, Laplace Transform method of solving simple Switching transients, Damping circuits -Abnormal switching transients, Three-phase circuits and transients, Computation of power system transients	08
3.	**Digital Computation:** Principle of digital computation – Matrix method of solution, Modal analysis- Z transform- Computation using EMTP, Lightning, switching and temporary over voltages, Lightning, Physical phenomena of lightning.	07
4.	**Lightning and Power System:** Interaction between lightning and power system, Influence of tower footing resistance and Earth Resistance, Switching: Short line or kilometric fault, Energizing transients - closing and re-closing of lines, line dropping, load rejection – over voltages induced by faults	08
5.	**HVDC:** Switching HVDC lineTravelling waves on transmission line, Circuits with distributed Parameters Wave Equation, Reflection, Refraction, Behaviour of Travelling waves at the line terminations, Lattice Diagrams – Attenuation and Distortion, Multi-conductor system and Velocity wave	08
6.	**Insulation co-ordination:** Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Coordination between insulation and protection level, Statistical approach	08
7	**System Protection :** Protective devices, Protection of system against over voltages, lightning arresters, substation earthling	

Text/Reference Books

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

2nd Year - III Semester: M.Tech. (Power System)

3MPS2-12: 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.	1
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

SYLLABUS

2nd Year - III Semester: M.Tech. (Power System)

3MPS2-13: Industrial Load Modeling 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.	1
2	**Electric Energy:** Electric Energy Scenario-Demand Side Management-Industrial Load Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers, Classification of Industrial, Loads, Continuous and Batch processes - Load Modeling	07
3	**Electricity pricing** – Dynamic and spot pricing -Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of load, Models, Optimization and control algorithms - Case studies	07
4	**Power Management:** Reactive power management in industries, controls-power quality impacts, application of filters Energy saving in industries	07
5	**OptimalLoading &Control-** Cooling and heating loads, load profiling, Modeling-Cool storage, Types-Control strategies, Optimal operation, Problem formulation-Case studies	06
6	**Energy control strategies:** Captive power units, Operating and control strategies, Power Pooling- Operation models, Energy banking, Industrial Cogeneration	06
7	**Operating Strategies:** Selection of Schemes Optimal Operating Strategies, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries	07

Text/Reference Books

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
4. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995
6. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA