Semester

I

Syllabus

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: I
Course Name: Modern Power System Analysis	**Course Code**: EEPL101	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
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.	8
3	**Fault Analysis:** Simultaneous faults, open conductors faults, generalized method of fault analysis.	4
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	8
5	**Power System Equivalents :** WARD equivalents, Dynamic WARD equivalent , Static Ward-Injection Equivalent, REI equivalents	8
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	4
7	**Voltage Stability :** Voltage Stability, Reactive power flow and Voltage collapse, Mathematical formulation of voltage stability problem and analysis, Prevention of voltage collapse, future trends and challenges	7
	Total	**40**

Text 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

Reference Books:

1. G.L. Kusic, “Computer aided power system analysis”,Prentice Hall India, 1986
2. A.J. Wood, “Power generation, operation and control”, John Wiley, 1994
3. P.M. Anderson, “Faulted power system analysis”, IEEE Press, 1995 7. D.P Kothari,” Modern power system analysis”, Tata McGraw hill, New Delhi

Prerequisite:

1. Power System Analysis
2. Power System Engineering

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year:** I	**Semester:** I
Course Name: Power System Dynamics	**Course Code:** EEPL102	**Credit:** 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Prerequisites and Outcome of the Course	1
2	**Basic Concepts and Review of Classical Methods of Analyzing Power System Stability** Background of Stability Problems faced by Power Systems; Introduction to Power System Stability; States of Operation and System Security- A Review; System Model; Some Mathematical Preliminaries; Analysis of Steady State Stability; Analysis of Transient Stability; Simplified Representation of Excitation Control; Power System Operation and Control; Impact on Power System Operation and Control. System Dynamic Problems- Current Status and Recent Trends. **Analysis of Dynamical Systems** Concept of Equilibria, Small and Large Disturbance Stability; Example: Single Machine Infinite Bus System; Modal Analysis of Linear Systems; Analysis using Numerical Integration Techniques; Issues in Modeling: Slow and Fast Transients, Stiff Systems. Simulation example of SMIB, machine-load systems.	12
3	**Modelling of Synchronous Machine** Introduction; Synchronous Machine Physical Characteristics; Rotor Position Dependent model; Park's Transformation: Analysis of Steady State Performance of synchronous machine; Per Unit Quantities; Equivalent Circuits of Synchronous Machine; Determination of Parameters of Equivalent Circuits; Measurements for Obtaining Data; Short circuit Transient Analysis of a Synchronous Machine; Model with Standard Parameters. Dynamics of a Synchronous Machine Connected to Infinite Bus; System Model; Synchronous Machine Model; Application of Model; Calculation of Initial Conditions; Consideration of other Machine Models. Synchronous machine model design in MATLAB.	10
4	**Modeling of Excitation and Prime Mover Systems** Physical Characteristics of Control system components; Models of Excitation System; Excitation Systems- Standard Block Diagram; System Representation by State Equations; Excitation System Controllers; Prime-Mover Control System.	6
5	**Modeling of Transmission Lines and Loads** Transmission Line Physical Characteristics; Transmission Line Modeling; Load Models-induction machine model; Other Subsystems - HVDC, protection systems. Simulink model of excitation and prime mover system.	5

6	**Stability Issues in Interconnected Power Systems** Single Machine Infinite Bus System; Multi-machine Systems; Stability of Relative Motion; Frequency Stability: Centre of Inertia Motion; Concept of Load Sharing: Governors; Single Machine Load Bus System: Voltage Stability; Torsional Oscillations. **Enhancing System Stability** Planning Measures; Stabilizing Controllers (Power System Stabilizers); Operational Measures- Preventive Control; Emergency Control. International practice scenario for stability improvement measures.	6
	Total	40

Text Books:

1. K.R.Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.
2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.
3. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

Reference Books:

1. M.A.Pai and W.Sauer, “Power System Dynamics and Stability”, Pearson Education Asia, India, 2002.
2. Machowski J, Bialek J W, and Bumby J R, Power System Dynamics and Stability, John Wiley and Sons, 1997.
3. P.M. Anderson and A.A.Fouad, “Power System Control and Stability”, Galgotia Publications, New Delhi, 2003 or P.M. Anderson and A. A. Fouad, “Power system control and stability”, IEEE Press.
4. R. Ramanujam, “Power Systems Dynamics”- PHI Publications.
5. E.W. Kimbark, “Power system stability”, Vol. I & III, John Wiley & Sons, New York 2002.
6. I.J. Nagrath, D.P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
7. Mukund R. Patel, “Wind and Solar Power Systems: Design, Analysis, and Operation”, Second Edition, CRC Taylor & Francis, 2006.
8. NPTEL: Electrical Engineering/ http://nptel.iitm.ac.in

Prerequisite:

1. Electrical Machines
2. Power System Analysis
3. Control Systems

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year:** I	**Semester:** I
Course Name: Modern Power System Protection	**Course Code:** EEPL111	**Credit:** 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction of digital relays** Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection. Fundamentals of digital relays - Basic elements of a digital relay and their functions, signal conditioning subsystem, conversion subsystem, digital relay subsystem, digital relay as a unit, concept of sampling and aliasing for digital relays; Sliding window concept of digital relays	7
3	**Estimation Algorithms:** Estimation of phasors using Full-cycle Discrete Fourier Transform (DFT); Estimation of phasors using Half-cycle DFT and introduction of Discrete Cosine Transform; Estimation of phasors using Walsh function technique and Least Error Square technique; Estimation of frequency in digital relays and practical considerations for selection of various algorithms; Digital Differential Protection of Generator, Induction motors and Busbar	8
4	**Digital Overcurrent Protection:** Digital Directional/Non-directional Overcurrent and Earth fault relays, Overcurrent relay coordination in an interconnected power system network: structure and determination of primary/backup relay pairs, Overcurrent relay coordination in an interconnected power system network.	8
5	**Digital Protection of Components:** Digital Protection of Transformers, Generators, Induction motors **Digital Distance relaying for Transmission Line:** Computation of direction and impedance for digital distance relays; Power swing detection and blocking technique in digital distance Relays; Protection of double-circuit transmission line using digital distance relays; Protection of multi-terminal transmission line using digital distance relays; Problems faced by digital distance relays.	8
6	**System Protection:** Introduction to Phasor Measurement Unit (PMU), Wide area monitoring, control and protection using PMU, Protection of High voltage dc transmission network; Protection of dc microgrid: Review and challenges; AC microgrid protection: Problems and solutions; Various cyber-attacks at substation/transmission level for Indian power grid network; Basic concept and application of control switching, Application of artificial intelligence (AI) in digital relaying	8
	Total	**40**

Text Books:

1. P.M Anderson, P.M., Power System Protection, IEEE Press, New York, 1999.
2. Blackburn, J.L., Applied Protective Relaying, Westinghouse Electric Corporation, New York, 1982.
3. B. A. Oza, N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 2010.
4. A.G. Phadke, and J.S. Thorp, Computer Relaying for Power Systems, Research Study Press Ltd, John Wiley & Sons, Taunton, UK, 1988.
5. Bhavesh Bhalja and Vijay H. Makwana, "Transmission Line Protection Using Digital Technology," Springer Science Business Media Singapore Pvt. Ltd; Singapore, January 2016.

Reference Books:

1. P.M Anderson, P.M., Power System Protection, IEEE Press, New York, 1999.
2. B.A. Oza, N.C. Nair, R.P. Mehta, et al., “Power System Protection & Switchgear,” Tata McGraw Hill, New Delhi, 2010.
3. B. Ravindranath and M. Chander, Power system Protection and Switchgear, Wiley Eastern Ltd.
4. B. Ram and D.N Vishwakarma, “Power System Protection and Switchgear”, McGraw Hill Education.

Prerequisite:

1. Analog Electronics
2. Electrical Measurement & Instrumentation
3. Power System
4. Signal & system

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year:** I	**Semester:** I
Course Name: Power Quality	**Course Code:** EEPL112	**Credit:** 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Electric power quality phenomena:** - Impacts of power quality problems on end users, Power quality standards, power quality monitoring.	5
3	**Power quality disturbances:-** Transients, short duration voltage variations ,long duration voltage variations, voltage imbalance, wave-form distortions, voltage fluctuations, power frequency variations, power acceptability curves.	8
4	**Power quality problems:** Poor load power factor, loads containing harmonics, notching in load voltage, dc offset in loads, unbalanced loads, disturbances in supply voltage. **Transients:** Origin and classification- capacitor switching transient-lighting-load switching-impact on users-protection mitigation.	8
5	**Harmonics:** Harmonic distortion standards, power system quantities under non sinusoidal conditions-harmonic indices-source of harmonics-system response characteristics-effects of harmonic distortion on power system apparatus –principles for controlling harmonics, reducing harmonic currents in loads, filtering, modifying the system frequency response- Devices for controlling harmonic distortion, inline reactors or chokes, zigzag transformers, passive filters, active filters.	10
6	**Power quality conditioners:** Shunt and series compensators, Dstatcom-dynamic voltage restorer, unified power quality conditioners.	8
	Total	40

Text Books:

1. Arrillaga J., Watson N. R. and Chen S., 'Power System Quality Assessment' Wiley

2 Caramia P, Carpinelli G and Verde P, 'Power quality indices in liberalized markets' – Wiley

Reference Books:

1. Angelo Baggini 'Handbook of Power Quality' – Wiley

2. Ghosh Arindam and Ledwich Gerard, 'Power quality enhancement using custom power devices' Springer

Prerequisite:

1. Basic Electrical Engineering
2. Power quality FACTS & devices

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M. Tech. in Power Systems	**Year**: I	**Semester**: I
Course Name: Soft Computing Techniques	**Course Code**: EEPL113	**Credit**:3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction of soft computing**: soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms and Applications of soft computing.	6
3	**Fuzzy Logic:** Fuzzy sets, logic operations, and relations; Fuzzy decision-making; fuzzy inference systems; design steps in fuzzy logic controller; Introduction of Adaptive Neuro-Fuzzy Inference Systems Architecture; application of fuzzy logic controller in Electrical engineering.	9
4	**Neural Networks:** Basic of neural networks- Neural Network Structure and function of a single neuron, definition of ANN, Taxonomy of the neural network, characteristics of ANN, supervised and unsupervised learning, Single-layer perceptron, Multi-layer perceptron, Back Propagation Neural network, Application of neural network modelling in Electrical engineering.	9
5	**Genetic Algorithm:** Biological Background, Traditional optimization and search techniques, Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.	9
6	**Evolutionary Computing:** Genetic programming (GP), Ant colony optimization (ACO), Particle swarm optimization (PSO)	6
	Total	40

Text Books:

1. George J.Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic, Second Edition, PHI, 2006.
2. J.M.Zurada, Introduction to artificial neural systems, Jaico Publishing House, 2006.
3. D.E. Goldberg, Genetic algorithms in search, optimization, and machine learning, Addison-Wesley.
4. Tripathy, Anuradha, "Soft Computing: Advances And Applications", Cengage

Reference Books:

1. Kumar Satish, "Neural Networks", Tata Mc Graw Hill
2. S. Rajsekaran & GA Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India.
3. NP Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.
4. D. K. Chaturvedi, "Soft Computing Techniques and its Applications in Electrical Engineering", Springer Berlin, Heidelberg.

Prerequisite:

1. Basic concepts of Artificial Intelligence.
2. Knowledge of Algorithms.

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech .in Power Systems	**Year**: I	**Semester**: I
Course Name: Electrical Power Distribution System	**CourseCode**:EEPL114	**Credit**:3
Max Marks:100	**CIE:**40	**SEE:**60
End Term Exam Time:3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to Electrical Power Distribution Systems**: Overview of power distribution networks, Components and configurations of distribution systems, Importance and role of EPDS in the power grid **Distribution System Components**: Transformers: Types, operation, and applications, Distribution lines: Overhead vs. underground, conductor types, Switchgear and protection devices	7
3	**Distribution System Planning and Design:** Load estimation and forecasting**,** Feeder design and layout**,** Voltage regulation techniques **Distribution System Operation:** Load balancing strategies, Fault analysis and protection schemes, Control and monitoring of distribution networks **Distribution System Reliability and Performance**: Reliability indices and assessment methods, Factors affecting reliability: Aging infrastructure, environmental conditions, Performance metrics and optimization techniques	10
4	**Smart Grid Technologies**: Overview of smart grids and their components, Advanced metering infrastructure (AMI), Distribution automation and control systems **Renewable Energy Integration**: Distributed generation technologies, Grid integration Challenges and solutions, Impact of renewable on distribution system operation and planning	8
5	**Microgrid Concepts and Applications:** Introduction to microgrids**,** Microgrid components and configurations**,** Operation and control of microgrids **Energy Storage Systems in Distribution:** Types of energy storage technologies**,** Applications in distribution systems**,** Role in enhancing reliability and stability	8
6	**Emerging Trends and Future Directions**: Internet of Things (IoT) in EPDS, Artificial intelligence (AI) applications, Block chain technology for energy transactions	6
	Total	**40**

Text Books:

1. Electric Power Distribution System Engineering "byT uran Gönen
2. Distribution System Modeling and Analysis" by William H.Kersting
3. Smart Grid: Fundamentals of Design and Analysis" by James Momoh
4. Renewable and Efficient Electric Power Systems "by Gilbert M.Masters

Reference Books:

1. Electric Power Distribution Handbook"by Thomas Allen Short
2. Power System Analysis and Design"by J.Duncan Glover,Mulukutla S.Sarma, and Thomas J. Overbye
3. Grid Integration and Dynamic Impact of Wind Energy"edited by GevorgB. Gharehpetian and Reza Ghazi

Prerequisite:

1. Basics of Electrical Engineering
2. Basics of Power System
3. Basics knowledge of Mathematics

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech .in Power Systems	**Year**:I	**Semester**:I
Course Name: System Planning and Reliability	**CourseCode**:EEPL115	**Credit**:3
MaxMarks:100	**CIE:40**	**SEE:**60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Power System:** Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organisation, Regulation, Scenario Planning. **Electricity Forecasting:** Load Requirement, System Load, Electricity Forecasting, ForecastingTechniques,Forecasting Modelling,Spatial–LoadForecasting,Peak Load-Forecast, Reactive–Load Forecast, Unloading of a System.	8
3	**Basic Reliability Concepts:** General reliability function, Markov Chains and processes and their applications, simple series and parallel system models.	7
4	**Static Generating Capacity Reliability Evaluation:** Outage definitions, loss of load probability methods, loss of energy probability method. Frequency and duration methods, load forecasting uncertainty. **Spinning Generating Capacity Reliability Evaluation:** Spinning capacity evaluation, load forecast uncertainty.	8
5	**Transmission System Reliability Evaluation:** Average interruption rate method. The Frequency and duration method. Stormy and normal weather effects.	8
6	**Inter-connected Systems Generating Capacity Reliability Evaluation:** Introduction, The loss of toad approach. Reliability evaluation in two and more than two Interconnected systems. Interconnection benefits.	8
	Total	**40**

Text Books:

1. Electric Power System Planning: Issues, Algorithms, and Solutions" by Hossein Seifiand Mohammad Sadegh Sepasian

2. "Power System Planning" byA.S.Pabla

3. Power System Economics: Designing Markets for Electricity" by Steven Stoft

Reference Books:

1. Electric Power System Planning: Issues, Processes, and Long-Term Solutions" edited by Harry G. Kwatny and Thaddeus P. Neureuther

2. Power System Analysis and Design"by J.Duncan Glover, Mulukutla S.Sarma,and Thomas J. Overbye

3. Power System Planning Technologies and Applications:Concepts,Solutions,and Management"e dited by TakaoTerano,HiroshiKita,andKeikiTakadama

Prerequisite:

1. Basics of Electrical Engineering
2. Basics of Power System
3. Basic knowledge of Mathematics

Name of the Programme: M.Tech .in Power Systems	**Year**: I	**Semester**: I
Course Name: Power System Operation and Control	**Course Code**: EEPL116	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Prerequisites 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.	12
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,	11
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	8
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.	8
	Total	40

Text Books:

1. Wood, A.J. and B.F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons, Third Edition, 2013.
2. P. Kundur, Power system stability and control, McGraw-Hill, 1994.

Reference Books:

1. A. Chakrabati and S. Halder, Power System Analysis Operation and Control, PHI, 2011
2. Jizhong Zhu, Optimization of Power System Operation, John Wiley & Sons, 2009.
3. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, Fourth Edition, TMH, 2011
4. Dhillon, Kothari, Power System Optimization, PHI.
5. O.E. Elgerd: Electric Energy Systems Theory. TMH Publishing Company.

Prerequisite:

1. Power System Analysis
2. Power System Engineering

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech.in Power Systems	**Year**: I	**Semester**: I
Course Name: Optimization Techniques	**Course Code**: NP40.01	**Credit**: 3
Max Marks:100	**CIE:**40	**SEE:**60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI (45) + TW& SL (45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Introduction to optimization:** Engineering applications of optimization, Mathematical Modeling and simulation, Formulation of structural optimization problems as programming problems. Graphical method.	6
3	**Linear Programming:** Theory of Simplex Method, Standard form of LPP, feasible solution and basic feasible solution, Improving BFS, Optimality condition, Unbounded solution, Alternative optimal solution, Simplex method, Big M Method, Two phase method.	8
4	**Metaheuristics in Optimization:** Genetic algorithms, Tabu search, particle swarm intelligence and their applications in Engineering	7
5	**PERT & CPM:** Objective of CPM & PERT, elements of network, network rules, constraints, error in network, Critical Path Analysis, Activity time and floats, optimization through CPM techniques, PERT and three estimates, critical path analysis of a PERT network, probability of completion of project, controlling and monitoring.	8
6	**Non-linear Programming:** Local and global minima of one and two variables, constraints optimization, Lagrange's Method, K-T conditions, Steepest descent method, Conjugate gradient method.	10
	Total	**40**

Text Books:

1. S. S. Rao, Engineering Optimization: Theory and Practice , Wiley, 2008.
2. K. Deb, Optimization for Engineering design algorithms and Examples , Prentice Hall, 2 nd edition 2012.

Reference Books:

1. Operations Research, Hira & Gupta,
2. C.J. Ray, Optimum Design of Mechanical Elements , Wiley, 2007.
3. R. Saravanan, Manufacturing Optimization through Intelligent Techniques , Taylor & Francis Publications, 2006.
4. D. E. Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning , Addison-Wesley Longman Publishing, 1989.

Prerequisite:

1. Basic knowledge of calculus.

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: I
Course Name: Power System Simulation Lab -I	**Course Code**: **EEPP130**	**Credit**: 3
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs	Teaching Scheme: LI(60) = 60 hrs per semester	

Module No.	Contents	Hours
1	Write the program (MATLAB) to form of Y-bus matrix and perform load flow analysis of 3 bus power system network using NR method and and Fast decoupled iterative methods.	6
2	Simulate 3 bus power systems network (Using MATLB/ PWS/PSCAD/ETAP) with 1 generator bus and 2 load buses and determine power flows and losses in line.	6
3	Simulate 3 bus power systems network (Using MATLB/ PWS/PSCAD/ETAP) with 2 generator buses and 1 load bus and determine power flows and losses in lines.	8
4	Simulate symmetrical and unsymmetrical Fault on power systems network (min 3 bus) and verify the results using any simulation software for the cases: (i) LG Fault (ii) LLG Fault (iii) LL Fault and (iv) 3-Phase Fault.	8
5	Solve economic load dispatch problem for 3 bus power system network using simulation software.	8
6	Perform transient stability analysis for 3 bus power system network	4
	Total	**40**

Text Books:

1.MATLAB and Simulink for Engineers, by Agam Kumar Tyagi, Oxford University Press
2. MATLAB and SIMULINK (A Basic Understanding for Engineers) by Pooja Mohindru and Pankaj Mohindru, Cambridge Scholar Publishing

Reference Books:

1. MATLAB and Simulink in Action, by Dingyü Xue , Feng Pan, Springer Publication
2. Modeling and Simulation in Scilab, by Stephen Campbell, Springer Publication

Prerequisite:

1. Load flow studies
2. Fault analysis
3. Transient stability analysis,

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: I
Course Name: Power System Dynamics Lab	**Course Code**: EEPP131	**Credit**: 3
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs	Teaching Scheme: LI(60) = 60 hrs per semester	

Module No.	Contents	Hours
1	Examine the state space model of Swing equation.	3
2	Perform Transient analysis of single machine infinite bus system with STATCOM for midpoint voltage regulation on a 500-kV transmission line.	5
3	Simulate the MATLAB Code subsequent to developing the algorithm for Small Signal Stability Analysis of Single Machine Infinite Bus System.	4
4	Simulate the MATLAB Code subsequent to developing the algorithm for Transient Stability Analysis of Single Machine Infinite Bus System.	3
5	Analyze performance of solar cell from its I-V characteristic curves determined by cell's parameters by plotting the same in MATLAB.	3
6	Illustrate the inferences drawn from P-V characteristic curve of solar cell model simulated in MATLAB based on Shockley diode equation.	3
7	Analyze PV array performance under partial shading condition.	3
8	Demonstrate grid-connected PV array.	2
9	Analyze the step response of uncompensated system to investigate Load Frequency control using pole-placement design.	3
10	Simulate step response of an isolated power station to find the steady state frequency deviation. Also compute time domain specifications using below mentioned control techniques in MATLAB Code/Simulink environment and compare their performances in terms of steady state frequency deviation and settling time: a. Uncompensated System b. Automatic Generation Control c. Pole Placement Design d. Optimal Control Design	4
11	Design model in MATLAB Simulink environment : i. Grid connected EV battery charger. ii. Solar PV based charging of EV battery.	3
12	Simulate Vehicle-to-Grid System used to regulate the frequency of a microgrid.	2
13	Model PEM fuel cells with MATLAB Simulink and Simscape	2
	Total	**40**

Text Books:

1. R. Ramanujam, Power System Dynamics : Analysis And Simulation, PHI
2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.
3. K.R.Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.
4. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

Reference Books:

1. M.A.Pai and W.Sauer, "Power System Dynamics and Stability", Pearson Education Asia, India, 2002.
2. Machowski J, Bialek J W, and Bumby J R, Power System Dynamics and Stability, John Wiley and Sons, 1997.
3. P.M. Anderson and A.A.Fouad, "Power System Control and Stability", Galgotia Publications, New Delhi, 2003 or P.M. Anderson and A. A. Fouad, "Power system control and stability", IEEE Press.
5. E.W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002.
6. I.J. Nagrath, D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
7. Mukund R. Patel, "Wind and Solar Power Systems: Design, Analysis, and Operation", Second Edition, CRC Taylor & Francis, 2006.

Prerequisite:

1. Load flow studies
2. Fault analysis
3. Transient stability analysis,

Semester

II

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: II
Course Name: Advanced Power Electronics	**Course Code**: EEPL201	**Credit**: -3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**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.	7
3	**Choppers:** Review of choppers configurations, Steady state analysis of type A Chopper-Minimum and Maximum Currents, Ripple and average load current. Commutation in Chopper Circuits.	8
4	**Inverters:** Performance parameters, voltage control of three phase inverters-Sinusoidal PWM, Third Harmonic PWM, 60-degree PWM and Space Vector Modulation. Harmonic reductions	8
5	**AC Voltage Controllers:** Performance parameters of Single and Three Phase AC Controllers. AC Voltage Controller with PWM Control.	8
6	**Cyclo-converters:** Single phase and three phase Cyclo-converters. Reduction in Output Harmonics. Matrix Converter	8
	Total	**40**

Text Books:

1. P. S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi.
2. M.D. Singh, K B Khanchandani, 'Power Electronics', second edition, TATA McGraw Hill.
3. Ned Mohan, Tore M. Undeland, 'Power electronics: converters, applications, and design', John Wiley &Sons
4. Ashfaq Ahmed 'Power Electronics for Technology', Pearson education.

Reference Books:

1. Muhammad H. Rashid, "Power Electronics - circuits, devices and applications", Prentice Hall of India
2. Power Electronics – Devices, Converters and Applications", by Vedam Subramanyam, New Age Publications.
3. Thyristorised controller by Dubey, Joshi & Doradla, New age Publication.
4. B. K. Bose, 'Modern Power Electronics & AC Drives', Prentice Hall India.
5. L. Umanand, "Power Electronics essentials and Applications", John Wiley &Sons.
6. R. Krishnan: Electric Motor Drives- Modeling, Analysis and Control, Pearson education.

Prerequisite:

1. Power Electronics

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: II
Course Name: Advanced Power System Optimization	**Course Code**: EEPL202	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Optimal Power System Operation:** Optimal Operation of generators on a bus bar, Economic dispatch problem of thermal units – Gradient method- Newton's method – Base point and participation factor method.	4
3	**Optimal Unit Commitment:** Constraints in unit commitment, spinning reserve, Thermal Unit Constraints, Other constraints, Hydro constraints, Must Run, Fuel constraints, Unit commitment Solution methods: Priority-List methods, Dynamic Programming solution. Backward DP Approach, Forward DP Approach, Restricted Search Ranges, Strategies.	4
4	**Hydro-thermal co-ordination**-Hydroelectric plant models –short term hydrothermal scheduling problem - gradient approach – Hydro units in series - pumped storage hydro plants-hydroscheduling using Dynamic programming and linear programming.	8
5	**Reliability Considerations:** Patton's Security Function, Security constrained Optimal Unit Commitment, Start-up considerations, 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. Inequality constraints, Optimal Scheduling of Hydrothermal System.	8
6	**Optimal Automatic generational 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 and an Isolated System, Steady State Analysis, Dynamic Response, Control Area, Load frequency control and Economic Dispatch Control, Two-area load frequency control, Optimal Load Frequency Control (two- area), three modes of control viz. Flat frequency – tie-line and tie-line bias control, Automatic Voltage Control, Introduction to Digital LF Controllers, Decentralized Control.	8
7	**Introduction to Power System Security:** System State Classification, Security Analysis, Contingency analysis, modelling for contingency Analysis. Linear sensitivity factors, AC power flow methods, contingency selection, concentric relaxation, bounding, security constrained optimal power flow.	7
	Total	40

Text Books:

1. D.P. Kothari and J.S. Dhillon, Power System Optimization, , Prentice Hall of India
2. J. A. Momoh, Electric Power system Applications of Optimization, CRC Press
3. J. Zhu, Optimization of power system operation, John Wiley & Sons

Reference Books:

1. P. Kundur, Power system stability and control, McGraw-Hill, 1994.
2. O.E. Elgerd: Electric Energy Systems Theory. TMH Publishing Company.
3. Wood, A.J. and B.F. Wollenberg, Power Generation Operation and Control, John Wiley & Sons, ThirdEdition, 2013.

Prerequisite:

1. Power System stability
2. Power System Engineering

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech.in Power Systems	**Year**: I	**Semester**: II
Course Name: AI Application to Power Systems	**Course Code**: EEPL211	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Overview of Artificial Intelligence (AI)** Introduction; What is Al? The Importance of Al ; Philosophy of AI, Definitions; Early Work in Al; Al and Related Fields; 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. Knowledge Organization; Knowledge Manipulation; Acquisition of Knowledge. Logic programming, forward versus backward reasoning, matching. Control knowledge.	6
3	**Statistical Reasoning** Introduction: Probability and Daye's theorem. Certainty factor and rule based systems; Bayesian Networks; Bayesian Networks Learning, Bayesian Probabilistic Inference; Possible World Representations; Dempster-Shafer Theorem; Semantic nets and frames, Scripts. Examples of knowledge based systems. Ad-Hoc Methods; Heuristic Reasoning Methods. **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 LMSE algorithms. Applications.	7
4	**Search and Control Strategies** Introduction; Preliminary Concepts; Examples of Search Problems; Modeling a Problem as Search Problem, Uniformed or Blind Search; Informed Search; Searching And-Or Graphs. Heuristic Search, Domain Relaxations. Local Search, Genetic Algorithms. Adversarial Search. **Matching Techniques** Introduction; Structures Used in Matching; Measures for Matching; Matching Like Patterns; Partial Matching; Fuzzy Matching Algorithms; The RETE Matching Algorithm.	9
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. **Dealing with inconsistencies and uncertainties** Introduction; Truth Maintenance Systems; Default Reasoning and the Closed World Assumption; Predicate Completion and Circumscription; Modal and Temporal logics; Fuzzy Logic and Natural Language Computations, Natural Language Processing.	8
6	**Perception, Communication, and Expert Systems** Introduction, Constraint Satisfaction; Propositional Logic & Satisfiability; Decision Theory: Markov Decision Processes; Reinforcement Learning; Introduction to Deep	9

	Learning & Deep RL; Pattern Recognition; Visual Image Understanding; Study of some popular expert systems, Expert System building tools and Shells, Design of Expert Systems Architectures; Knowledge Acquisition; Principles of machine learning.	
	Total	**40**

Text Books:

1. Artificial Intelligence Techniques in Power Systems (Energy Engineering), by Kevin Warwick, Arthur Ekwue, Rag Aggarwal,1997.
2. Patterson, D. W. (1998). *Artificial neural networks: theory and applications*. Prentice Hall PTR.
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.

Reference Books:

1. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.
2. Sergios Theodoridis, Konstantinos Koutroumbas "Pattern Recognition", Elsevier, 2003.
3. Nanda, N. R. (2024). *Fundamental Principles of Machine Learning and AI*. Perfect Writer.
4. https://archive.nptel.ac.in/content/syllabus_pdf/106102220.pdf

Prerequisite:

1. Data Structures, Probability.
2. Basics of power system operation and control

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: II
Course Name: Modern Control System and Design	**Course Code**: EEPL212	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	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 transfer function and state variable representations; controllability and observability, pole-placement using state variable feedback; design of full order and reduced order observer, observer based and 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, The Inverse Z Transform, Pulse Transfer Function and Stability in Z-plane.	11
4	**Sample Data Control System**: Mathematical preliminaries- difference equations, Z Transform and properties; sampling quantization and reconstruction process, discrete time systems, system response, transfer function stability, bilinear transformation and the jury stability criterion, implementation of digital controllers and digital controllers for deadbeat performance. Root loci – Frequency domain analysis - Bode plots - Gain margin and phase margin - Design of Digital Control Systems based on Root Locus Technique, state space analysis of discrete system	11
5	**Nonlinear Control Systems:** Characteristics of nonlinear systems; linearization techniques; phase plane analysis, singular points, limit cycle vs closed trajectory; stability analysis using phase plane analysis- describing function (DF) of common nonlinearities, stability analysis using DF; stability in the sense of Lyapunov, Lyapunov's stability theorems for linear and nonlinear systems; effect of nonlinearity in root locus and Nyquist plot. Introduction to Modern Nonlinear control system. Introduction to modern nonlinear control system. Generalized Stability Criterion (d-partition technique), Pole Assignment method, LURE's transformation, POPOV's criterion.	8
	Total	40

Text 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

Reference Books:

1. Advanced Modern Control System Theory and Design, by Shinners Stanley M., AtlanticPublishers
2. Modern Control Systems, by Richard Dorf ,Robert Bishop, Pearson Publication

Prerequisite:

1. Z Transform
2. Control Systems

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**:II
Course Name: Power System Transients	**Course Code**: EEPL213	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Network Matrix:** Physical interpretation of bus admittance and impedance matrices, introduction to admittance matrix formulation, formation of admittance matrix due to inclusion of regulating transformer, development of admittance matrix using singular transformation, modification of admittance matrix for branch addition/ deletion. Formation of ZBUS: Algorithm for building up of ZBUS, Modification of ZBUS Matrix for addition element - Modification of ZBUS for the changes in network.	6
3	**Complex Power Flow:** Analytical formulation of complex power flow solution, Gauss-Seidal method of power flow, Newton Raphson method of power flow, algorithm for solving power flow problem using N-R method in rectangular form, algorithm for solving power flow problem using N-R method in polar form, fast decoupled load flow method, Distribution System Load Flow.	7
4	**Power System Stability:** Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study. Transient stability: Assumptions for transient stability, derivation of swing equation, swing equation for synchronous machine connected to infinite bus, swing equation for a two machine system.	7
5	**Solutions of Swing Equation** Euler and Runge-Kutta method, equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine. Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing, electric braking, voltage regulators, fast governor action, high speed excitation system.	9
6	**Voltage Stability:** Definition and classification of voltage stability, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, expression for critical receiving end voltage and critical power angle at voltage stability limit for a two bus power system, PV and QV curves, L index for the assessment of voltage stability.	10
	Total	**40**

Text Books:

1. J.J. Grainger & W.D. Stevenson, “Power System Analysis”, Mc. Graw Hill.
2. A.R. Bergen & Vijay Vittal, “Power System Analysis”, Pearson.
3. L.P Singh, “Advanced Power System Analysis and Dynamics”, New Age International.
4. G.L. Kausic, “Computer Aided Power System Analysis”, Prentice Hall India.

Reference Books:

1. A.J. Wood, “Power generation. Operation and control”, John Wiley & Sons.
2. P.M Anderson, “Faulted Power System analysis”, IEEE Press.
3. C. A. Gross, “Power system Analysis”, John Wiley & Sons.

Prerequisite:

1. Basic Electrical Engineering
2. Basic of Electrical Power System
3. Matrix Operations

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: II
Course Name: SCADA System and Applications	**Course Code**: EEPL214	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**SCADA System:** Overview of SCADA systems, Evolution of SCADA technology, Data acquisition systems, Communication technologies in SCADA	7
3	**SCADA Functions:** Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA	7
4	**Industries SCADA:** Components of Industries SCADA systems, Remote Terminal Unit (RTU), Intelligent Electronic Devices(IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems	8
5	**SCADA Architecture:** Various SCADA architectures, advantages and disadvantages of each architecture, single unified standard architecture -IEC 61850	8
6	**SCADA Communication and Applications:** Industrial communication technologies, Wired, wireless, and fiber optics communication methods, Open standard communication protocols, Utility applications, Transmission and Distribution sector operations, Case studies, implementation, and simulation exercises in industries such as oil, gas, and water.	9
Total		**40**

Text Books:

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004
2. Gordon Clarke, and Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004

Reference Books:

1. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006
2. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003
3. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999

Prerequisite:

1. Basic Knowledge of Computer Systems
2. Fundamentals of Control Systems
3. Programming Skills
4. Understanding of Industrial Processes
5. Electrical Engineering Basics
6. Networking Basics
7. Cyber security Basics

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: I	**Semester**: II
Course Name: Renewable Energy Systems	**Course Code**: EEPL215	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Energy Scenario: -** Classification of Energy Sources., Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. World-wide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts. Global environmental concern, Kyoto Protocol, Concept of Clean Development Mechanism (COM) and Prototype Carbon Funds (PCF). Factors favoring and against renewable	7
3	**Solar Energy:** Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications. Photo voltaic (PV) technology: Present status, - solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components, sizing and economics. Peak power operation. Standalone and grid interactive systems.	8
4	**Wind Energy:** wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, suitability of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connectivity, environmental impacts of wind farms.	8
5	**Energy storage and hybrid system configurations:** Energy storage: Battery' - types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Fly wheel- energy relations, components, benefits over battery. Other energy storage systems. Stand alone systems, Hybrid systems - hybrid with diesel, with fuel cell, solar-wind, wind - hydro systems, mode controller, load sharing, system sizing. Hybrid system economics.	8
6	**Grid Integration:** Grid connected system and their electrical performance: Interface requirements, synchronization with grid, inrush, stable operation, load transient, safety. Operating limits of voltage, frequency, stability margin, energy storage, and IQad scheduling. Quality of power- harmonic distortion, voltage transients and sags, voltage flickers. Dynamic reactive power support. Systems stiffness, Effect of Utility restructuring.	8
	Total	**40**

Text Books:

1. Renewable energy technologies - R. Ramesh, Narosa Publication

2 Solar & Wind energy Technologies - McNeils, Frenkel, Desai, Wiley Eastern.

3 Non-conventional Energy Systems - Mittal, Wheelers Publication

Reference Books:

1. Solar Photovoltaics for terrestrials, Tapan Bhattacharya.
2. Wind and solar systems by Mukund Patel, CRC Press.
3. Wind Energy Technology - Njenkins, John Wiley & Sons,
4. Solar Energy - S.P. Sukhatme, Tata McGraw Hill
5. Energy Technology - S. Rao, 'Parulkar
6. Solar Energy - S. Bandopadhay, Universal Publishing

Prerequisite:

1. Basic Electrical Engineering
2. Generation of Electrical Power

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M. Tech. in Power Systems	**Year**: I	**Semester**: II
Course Name: High Voltage DC Transmission	**Course Code**: EEPL216	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Prerequisites and Outcome of the Course	1
2	**DC Transmission Technology:** Comparison of AC and DC transmission (economics, technical performance, and reliability), components of HVDC system, types of HVDC links, application of DC transmission, Line Commutated Converter and Voltage Source Converter based HVDC systems. HVDC commissioned projects in India, Latest Innovations and projects undertaken by leading HVDC firms-Hitachi, Mitsubishi etc.	5
3	**Analysis of Line Commutated and Voltage Source Converters:** **Line Commutated Converters (LCCs):** Six pulse converter- expressions for average DC voltage, AC current and reactive power absorbed by the converters. Analysis neglecting commutation overlap, analysis with commutation overlap, effect of commutation overlap. Twelve pulse converter. Effect of commutation failure, Misfire and current extinction in LCC links. **Voltage Source Converters (VSCs):** Analysis of a six-pulse converter, Two and three level VSCs. PWM schemes- selective harmonic elimination, sinusoidal pulse width modulation. Equations in the rotating frame as per SRF theory and IRP theory. Real and reactive power control using VSC. Latest technology based projects- Tenne T Agreement, NEOM, British National Grid Tender, TWE, Grain Belt Express, SOO Green, CHPE	10
4	**Control of HVDC Converters:** Principles of link control in a LCC HVDC system, control hierarchy, firing angle controls- phase locked loop, current and extinction angle control. Starting and stopping of a link. Higher level controllers, frequency control, stability controllers, reactive power control. Principles of link control in VSC HVDC system- power flow and DC voltage control, reactive power control, AC voltage regulation. **Components of HVDC systems:** HVDC links, Smoothing reactors, reactive power sources and filters in LCC HVDC systems, insulators, DC breakers, ground electrodes. Corona effects, transient over-voltages, DC line faults in LCC systems, DC line faults in VSC systems, monopolar operation.	10
5	**Stability Enhancement using HVDC Control:** Power system angular, voltage and frequency stability, power modulation, synchronous and asynchronous links, voltage stability problem in HVDC systems. NIA funded project -PMU based monitoring in HVDC, Other innovation projects by 'The National HVDC Centre'-TOTEM, INCENTIVE, INSIGHT, BLADE, WISE	7
6	**MTDC System:** MTDC links, Multi-terminal and multi in-feed Systems, series and parallel MTDC systems using LCCs, MTDC systems using VSCs, Modular Multi-level Converters (MMC).	7

	Multi terminal Multi vendor Projects- Scottish Caithness Moray Shetland, Aquila run by SSE & National Grid, Ready4DC, Inter OPERA	
		Total 40

Text Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and system Interactions", 1st edition, New Age International (P) Ltd, 2005
2. S. Rao, "EHV AC and HVDC Transmission and Distribution Engineering", Khanna Publishers, 3rd edition

Reference Books:

1. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd.,1983.
2. E. W. Kimbark, "Direct Current Transmission", 2nd Edition, Wiley, 2006
3. S. Kamakshaiah, V Kamaraju, "HVDC Transmission", Tata McGrawHill, 2011
4. Chan-Ki Kim, Vijay K. Soodet. al,"HVDC Transmission: Power conversion Applications in Power Systems", John Wiley & Sons, IEEE Press, 2009
5. Edited by Hugh M. Ryan, "High Voltage Engineering & Testing", IET Power & Energy Series 66, third edition, IET London UK, 2013
6. AmirnaserYazdanai, Reza Irawani, "Voltage Sourced Converters in Power Systems", John Wiley & Sons, IEEE Press, 2010
7. K. R. Padiyar (2009), FACTS Controllers in power Transmission and Distribution, 1st edition, New Age International (P), Ltd, New Delhi
8. N. G. Hingorani, L. Guygi (2001), Understanding FACTS, 1st edition, IEEE Press, USA.

Prerequisite:

1. Power electronic devices
2. Electric Power Systems

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: MTech in Power Systems	**Year**: I	**Semester**: II
Course Name: Power System Simulation Lab -II	**Course Code**: EEPP230	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: LI(60) = 60 hrs per semester	

S.No.	Contents	Hours
1	Simulate Harmonic in any phase using any available simulation software.	4
2	Analysis of Transmission Line Protection Scheme Using any available simulation Software	4
3	Simulate a Short Circuit Test on the Synchronous Machine Model.	6
4	Simulate IEEE 9 Bus system (Using PWS/PSCAD/ETAP) and verify its results of bus voltages and power loss.	4
5	Simulate IEEE 9 Bus system (Using PWS/PSCAD/ETAP) with 50% increased load and improve its voltage profile by using shunt capacitors banks.	6
6	Simulate IEEE standard 9 bus systems under various short circuit faults.	6
7	Design IEEE 6-BUS power system network on simulation software and analyze transient stability of this network.	4
8	Design a model of HVDC transmission line	6
	Total	**40**

Text Books:

1.MATLAB and Simulink for Engineers, by Agam Kumar Tyagi, Oxford University Press

2. MATLAB and SIMULINK (A Basic Understanding for Engineers) by Pooja Mohindru and Pankaj Mohindru, Cambridge Scholar Publishing

Reference Books:

1. MATLAB and Simulink in Action, by Dingyü Xue , Feng Pan, Springer Publication

2. Modeling and Simulation in Scilab, by Stephen Campbell, Springer Publication

Prerequisite:

1. Load flow studies
2. Fault analysis
3. Transient stability analysis

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M Tech in Power Systems	**Year**: I	**Semester**: II
Course Name: Power Electronics Applications to Power System Lab	**Course Code**: EEPP231	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: LI(60) = 60 hrs per semester	

S.No.	Contents	Hours
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.	6
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.	4
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
4	Design & simulate a model of AC-AC voltage regulators and trace the output curve for different values of input voltage.	4
5	Design & simulate a model of single phase cyclo-converter and trace the curve of output voltage.	6
6	Design & simulate a model of CuK converter and trace the curve of output voltage.	4
7	To Study, Design & simulate a model for grid integration of DFIG and PMSG.	6
8	Mini project Design and fabricate power electronic switching based converters using Aurdino, microcontroller, DSP.	6
	Total	**40**

Text Books:

1. Power Electronics Design Testing and Simulation Laboratory Manual (PB) By Varmah K R,CBS Publications
2. Power Electronics Laboratory : Theory, Practice & Organization,by O. P. Arora Narosa Pubications

Reference Books:

1. Simulation of Power Electronics Circuits with MATLAB/Simulink: Design, Analyze, and Prototype, Farzin Asadi, Maltepe University, **Apress**, 2022

2. Power Ellectronics With MATLAB, by L. Ashok Kumar, A. kalaiarasi, Y. Uma Maheswari, Cambridge Press

Prerequisite:

1. Power Systems Design
2. Power Electronics Drives

Semester

III

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M Tech in Power Systems	**Year**: II	**Semester**: III
Course Name: Power Sector Economics, regulation & Restructuring	**Course Code**: EEPL311	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Fundamentals of Economics, Accounting and Finance:** Behavior of individuals and firms; demand and supply of goods and services and determination of prices; costs in the short and long term and market structures. Overview of economics and data analysis fundamentals, financial statements and financial accounting challenges such as measuring and reporting issues related to assets and liabilities. **Power Sector Reform and Regulation in Practice:** Electricity Act 2003: Policies and rules; Introduction to the Power Sector Reforms; Economic Principles and Evolution; Renewable Energy Policy, Legal Aspects, Regulation and Market; Economic rationale for regulation, Developments in Policy Framework for the Indian Power System illustrating the regulatory and policy changes in the Indian power sector; Emerging Regulatory Challenges.	8
3	**Power Sector Technological & Operational aspects:** Economic Fundamentals of Power Sector; Market Failure and Natural Monopoly; Pricing and Regulation of Natural Monopoly; Theories of Regulation; Economics of Regulation; Regulatory Framework and its evolution; Tariff Framework and Regulatory Perspective; Legal and Commercial Aspects of Tariff; Tariff Tariff Determination for Generators; Evolution of Transmission Pricing and POC Charge; MYT Framework for ARR and Tariff Determination for DISCOMs; ARR and Tariff Determination for DISCOMs - A Case Study; Cost of Service Regulation, Performance Based Regulation and Beyond; Legal and Commercial Aspects of Tariff; Electricity Consumer Grievance Redressal: Institutional Approach and Practices; Performance-based Tariff Regulations for the distribution network - Experience in US; A Look into Future Regulation and Performance of DCPRs; Evolution of DNO Regulation, Future of Networks and Consumer Behaviour	8
4	**Smart Grid Technologies and Implementation**: New and practical solutions to solve the coordination problem between transmission system operators (TSO) and distribution system operators (DSO) due to the increasing integration of	8

	renewable energy sources into existing electricity transmission networks; Implementation and technologies involved to integrate and optimize distributed energy resources; Efficiency and Reliability enhancement; discussions on related concepts; Principles and Practice of Power Procurement in the Power Sector; Regulatory Framework for Long-term Demand Forecasting and Power Procurement Planning	
5	Competition and Power Market Development: Overview of the status of the development of the Power Market in India, case discussions on related concepts; Existing Regulatory framework in Electricity Retail Tariff and Designing Retail Electricity Tariff: Emerging Issues and International Perspectives: International experience from power sector deregulation/reform; Global power sector, regulatory policies and reforms.	8
6	Power System Operation and Ancillary Services: Role and importance of ancillary services in power systems, their classification, procurement methods, and evolving trends. Role of grid operators, service delivery instructions, monitoring, reporting, and penalties for non-delivery. Cost drivers for ancillary services, regulation, and reserve products. Frequency-based services- Inertia, Primary Frequency control, (High- and low-frequency) Power smoothing. Non-frequency Ancillary Services: Voltage regulation (including unbalance mitigation), Congestion management. Emerging services- harmonic mitigation and fault contribution, Integration of renewable energy, cybersecurity, digital twins, market mechanisms for reactive power and efficiency with a focus on BRIC countries (Brazil, Russia, India, and China), impact of the ancillary services market on DSM charges, market-based ancillary services procurement.	7
	Total	**40**

Text Books:

1. Pandey, I. M. (1995). Finance: A management guide. PHI Learning Pvt. Ltd.
2. Power System Restructuring and Deregulation Edited by Loi Lei Lai Copyright © 2001 John Wiley & Sons Ltd ISBNs: 0-471-49500-X (Hardback); 0-470-84611-9 (Electronic)
3. Refaat, S. S., Ellabban, O., Bayhan, S., Abu-Rub, H., Blaabjerg, F., & Begovic, M. M. (2021). Smart Grid and Enabling Technologies. John Wiley & Sons.
4. Mohammad Shahidehpour and MuwaffaqAlomoush, "Restructured Electrical Power Systems: Operation, Trading, and Volatility, Marcel Dekker, Inc., CRC Press, 2001.
5. Devika Jay, K. Shanti Swarup, Market Operation for Reactive Power Ancillary ServiceDesign and Analysis with GAMS Code, Springer, 2024.
6. G Migliavacca, TSO-DSO Interactions and Ancillary Services in Electricity Transmission and Distribution Networks, Modeling, Analysis and Case-Studies, Springer Nature Switzerland AG, 2020.
7. Shahidehpour, M., Yamin, H., & Li, Z. (2002). Market operations in electric power systems: forecasting, scheduling, and risk management. John Wiley & Sons.

Reference Books:

1. Tanaka, M., Conejo, A. J., & Siddiqui, A. S. (2022). Economics of power systems. Springer.
2. Xu Andy Sun, Antonio J. Conejo, Robust Optimization in Electric Energy Systems, 2022

3. Antonio Gómez-Expósito, Antonio J. Conejo, Claudio A. Cañizares (Editors), Electric Energy Systems: Analysis and Operation, 2nd Edition, 2018.
4. Antonio J. Conejo, Luis Baringo, Power System Operations, 2018.
5. Antonio J. Conejo, Luis Baringo Morales, S. Jalal Kazempour, Afzal S. Siddiqui, Investment in Electricity Generation and Transmission, 2016.
6. Juan M. Morales, Antonio J. Conejo, Henrik Madsen, Pierre Pinson, Marco Zugno, Integrating Renewables in Electricity Markets, 2014.
7. Steven A. Gabriel, Antonio J. Conejo, J. David Fuller, Benjamin F. Hobbs, Carlos Ruiz, Complementarity Modeling in Energy Markets, 2013.
8. Antonio J. Conejo, Miguel Carrión, Juan M. Morales, Decision Making Under Uncertainty in Electricity Markets, 2010.
9. Antonio Gómez-Expósito, Antonio J. Conejo, Claudio Cañizares (Editors), Electric Energy Systems: Analysis and Operation, 2008.
10. https://cer.iitk.ac.in/ Power Sector Regulation: Theory and Practice
11. Prasanth Regy, Rakesh Sarwal, Clay Stranger, Garrett Fitzgerald, Jagabanta Ningthoujam, Arjun Gupta, Nuvodita Singh. 2021. Turning Around the Power Distribution Sector: Learnings and Best Practices from Reforms. NITI Aayog, RMI, and RMI India.
12. Sioshansi, F. (Ed.). (2011). Smart grid: integrating renewable, distributed and efficient energy. Academic Press.
13. Sioshansi, F. (2014). Distributed generation and its implications for the utility industry. Academic Press.
14. Sioshansi, F. (Ed.). (2023). The Future of Decentralized Electricity Distribution Networks. Elsevier.
15. Sioshansi, R. (2013). Handbook of renewable energy technology.
16. Sioshansi, F. P., Zamani, R., & Moghaddam, M. P. (2022). Energy transformation and decentralization in future power systems. In Decentralized Frameworks for Future Power Systems (pp. 1-18). Academic Press.
17. Sioshansi, F. (Ed.). (2016). Future of utilities-utilities of the future: how technological innovations in distributed energy resources will reshape the electric power sector. Academic Press.
18. Konstantinos Oureilidis, Charis S. Demoulias, Kyriaki-Nefeli Malamaki, Georgios C. Kryonidis, Eleftherios O. Kontis, Spyros I. Gkavanoudis, Ancillary Service in Active Distribution Systems from Renewable Energy Sources: Control Methodologies and Trends, Elsevier, 2025.

Prerequisite:

1. Restructured Power System
2. Economic Operation of Power System
3. Power System Planning
4. Electricity Tariff framework

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Course Name: FACTS and Custom Power Devices	**Course Code**: EEPL312	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	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.	8
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.	7
4	**Static Series Compensator:** Concept of series compensation, voltage stability, variable impedance type series compensators, GCSC, TSSC, TCSC and SSSC operating principle and characteristics and their application, **Static voltage and phase angle regulators:** TCVR and TCPAR Operation and Control, Applications, Stability improvement by TCVR and TCPAR, SSR and its damping.	8
5	**UPFC and IPFC:** Introduction to 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. Introduction to interline power flow controller, Basic operating principle, characteristics and application	8
6	**Power Quality issues and modelling of FACTs:** Power quality problems in distribution systems, harmonics, voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners, IEEE standards on power quality. Modelling of TCSC, STATCOM, UPFC	8
	Total	**40**

TEXT BOOKS:

1. K.R. Padiyar, "FACTS controllers in power transmission and distribution" New Age international (P) Ltd., Publishers, 2007, ISBN (13) : 978-81-224-2541-3
2. Narain G. Hingorani, Laszlo Gyugyi, "Understanding FACTS: Concepts and technology of Flexible AC Transmission System," IEEE Power Engineering Society, IEEE Press, ISBN: 0-7803-3455-8

REFERENCE BOOKS:

1. Timothy J.E. Miller, “Reactive Power control in electric systems,” John Wiley & Sons, 1982, ISBN 0-471-86933-3
2. R.C. Dugan, “Electric Power Systems,” McGraw Hill, 2012
3. R. Mohan Mathur, Rajiv K. Verma, “Thyristor based FACTS controllers for Electrical
4. Transmission Systems,” IEEE Press, Wiley Interscience, 2002, ISBN 0-471-20643-1
5. Bhim Singh, “Power Quality Problems and Mitigation Techniques,” Wiley, 2015, ISBN:9781118922057
6. K.S.Sureshkumar ,S.Ashok , “FACTS Controllers & Applications”, E-book edition, Nalanda DigitalLibrary, NIT Calicut,2003.
7. G T Heydt , “Power Quality”, McGraw-Hill Professional, 2007 6. T J E Miller, “Static Reactive Power Compensation”, John Wiley and Sons, Newyork, 1982
8. X P Zhang, C Rehtanz, B Pal, “Flexible AC Transmission Systems- Modelling and Control”, SpringerVerlag, Berlin, 2006

Prerequisite:

1. Passive and Active elements in power system. Passive components used for the compensation of reactive power.
2. Reactive power, power factor, compensation of reactive power.
3. Load Compensation
4. Harmonics and their Fourier analysis
5. Basic theory of electrical machines
6. Power electronic devices used in power system, types, characteristics, their use as a switch

Name of the Programme: M.Tech. in Power Systems	**Year**: II	**Semester**: III
Course Name: Energy Management & Audit	**Course Code**: EEPL313	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Energy Management:** Objective of Energy Management, General principles of energy management and its planning. ECBC code (basic aspects), Building Management System (BMS). **Energy Audit:** Energy Audit Definition as per EC act-2001, Objective, Need of Energy Audit, Types and methodologies, Roll of Bureau of Energy Efficiency (BEE), Energy Auditors and managers. Case-studies/ Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.	8
3	**Energy Management in Electricity Utilization:** Electricity transmission and distribution system. Opportunities in Lighting: Modern energy efficient light sources, life and efficacy comparison with older light sources, energy conservation in lighting, use of sensors and lighting automation. Opportunities in Motors: Development of energy efficient motors and the present status, techniques for improving energy efficiency, necessity for load matching and selection of motors for constant and variable loads. Opportunities in Transformers: Present maximum efficiency standards for power and distribution transformers, design measures for increasing efficiency in electrical system components.	9
4	**Demand side Management (DSM):** Introduction, benefits of DSM, different techniques of DSM– time of day pricing, multi-utility power exchange model, time of day models for planning. DSM and Environment. Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. Power factor improvement.	8
5	**Energy Economics:** Economic analysis methods, cash flow model, time value of money, evaluation of proposals, pay-back period, average rate of return method, internal rate of return method, present value method, life cycle costing approach. Computer-aided Energy Management Systems (EMS).	7
6	**Energy Efficiency Performance Analysis:** Different Case Study of Energy audit and management of commercial and industrial sites/projects (Boilers, Steam System, Furnaces, Refrigeration and Air conditioning, Waste Heat recovery etc.).	7
	Total	**40**

Textbooks:

1. S.S. Thipse, Energy Conservation and Management, Narosa Publishing House, 2014.
2. Steve Doty and Wayne C. Turner, Energy management Handbook, The Fairmount Press, Inc., 2012.
3. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons Inc., 1996.
4. Albert Thumann, William J. Younger, Handbook of Energy Audits, River Publishers, 2012.

Reference Books:

1. Energy Conservation Act- 2001 and Related Rules and Standards, Ministry of Power, India.
2. Energy efficiency in electrical utilities, Guidebook, Bureau of Energy Efficiency (BEE), India.
3. General Aspects of Energy Management & Energy Audit, Guidebook, BEE, India.
4. Energy efficiency in thermal utilities, Guidebook, BEE, India.
5. Energy performance assessment for equipment and utility systems, Guidebook, BEE, India.
6. Susmita Mishra, Engineering Economics & Costing, PHI Publication.
7. D. Yogi Goswami and Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2016.
8. Amlan Chakrabarti, Energy Engineering and management, PHI Publication, 2019.

Prerequisite:

1. Basic Electrical Engineering
2. Generation of Electrical Power
3. Electrical Machine
4. Power system

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: M.Tech. in Power Systems	**Year**: II	**Semester**: III
Course Name: Research Methodology & IPR	**Course Code**: NP40.02	**Credit**: : 03
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 03 hours	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Research Methodology**: Basic Statistics, Inferential statistics, Central tendency of data, Standard deviation, frequency distribution, level of measurement, Probability distribution, Normal distribution, Correlation, Numerical problems, Introduction to research, Need of research, 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	8
3	**Research Approaches:** Approaches of investigation of solutions for research problems, Sample design, data collection, Regression and Z-test, t-test, ANOVA, analysis, interpretation, Necessary instrumentations, Effective literature studies approaches, analysis. Plagiarism, Research ethics, examples	7
4	**Effective Technical Writing**: Development of Research Proposal, citation of references, Report writing, Precautions for writing research reports	8
5	**Nature of Intellectual Property**: Patents, Designs, Trademarks, and Copyright, Geographical Indications. Process of Patenting and Development, International Scenario, International Cooperation on Intellectual Property	8
6	**Patent Rights:** Scope of Patent Rights, Licensing and transfer of technology, patent Infringement and Enforcement. New developments in IPR: IPR of Biological Systems, Computer Software, etc. Case Studies on Intellectual Properties	8
	Total	**40**

Text Books:

1. Research Methodology by C. R. Kothari, New Age Publication, 2nd Revised Edition
2. Research Methodology-Concept and Cases 2020 - Deepak Chawla, 2nd Edition, Vikas Publications
3. Intellectual Property A Primer for Academia by Dr. RupinderTewari and Ms. Mamta Bhardwaj, Honorary Director Publication Bureau, Panjab University Chandigarh

Reference Books:

1. Research Methodology and Quantitative Methods- Rao G Nageswara, B S Publications
2. Intellectual Property rights - 2020 by GanguliPrabuddha, McGraw Hill Education

Prerequisite:

1. Knowledge of Basic Statistics

Name of the Programme: M.Tech. in Power Systems	**Year**: II	**Semester**: III

Course Name: Fundamental of Power Systems	**Course Code**: EEPL340.01	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Basic Concepts**: Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.	9
3	**Over-voltages and Insulation Requirements:** Generation of Over-voltages: Lightning and Switching Surges. Protection against Overvoltages, Insulation Coordination. Propagation of Surges. Voltages produced by traveling surges.	5
4	**Conventional Energy Generation:** **Thermal Power plants:** selection of site, elements of the plant, Plant layout. **Gas Power Plants:** elements of the plant, Plant layout, open cycle, and closed cycle gas turbine plants, combined gas & steam plants-basic schemes. **Hydro Power Plants:** Selection of site, elements of the plant, Classification of hydroelectric plants. Layout of hydroelectric and pumped storage plants. **Nuclear Power Plants:** selection of site, nuclear reaction – fission and fusion process and chain reaction, plant layout, nuclear reactor – working, and control (boiling water reactor, heavy water reactor, and fast breeder reactor)	9
5	**Power Factor Improvement** Causes and effects of low power factor and advantages of power factor improvement. Power factor improvement using shunt capacitors and synchronous condensers.	8
6	**Tariff** Objectives of tariffs. General tariff form. Flat demand rate, straight meter rate, block meter rate. Two part tariff, power factor dependent tariffs, three part tariff. Spot (time differentiated) pricing.	8
	Total	**40**

Text Books:

1. B.R. Gupta, "Generation of Electrical Energy", S. Chand Limited, 2009
2. G.D. Rai, Non Conventional Energy Sources, Khanna Publication
3. Leonard L. Grigsby –Electric Power Generation, Transmission, and Distribution, CRC Press
4. S.N. Singh, "Electrical Power Generation, Transmission & Distribution", PHI Pvt. Ltd

Reference Books:

1. Wadhwa, C.L., "Generation Distribution and Utilization of Electrical Energy", New Age International publishers, 3rd edition, 2010.
2. Deshpande M.V, "Elements of Electrical Power Systems Design", Pitman, New Delhi, PHI Learning Private Limited, 1st edition, 2009.

Prerequisite:

1. Basic Electrical Engineering

Name of the Programme: M.Tech. in Power Systems	**Year**: II	**Semester**: III
Course Name: Renewable Energy Technology	**Course Code**: EEPL340.02	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	Teaching Scheme: CI(45) + TW& SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Types of Renewable Energy** –Solar, Wind, Fuel Cell, Biomass, Hydro-Electric, Geothermal; Powering DG systems Operation requirements for Distributed Energy Resources (DERs) integration into power systems (Voltage and frequency function, Power system restoration, Confirming reliability, Virtual inertia)	6
3	**Hybrid Renewable Energy System:** Chronological Evolution of Energy Industry, Criteria for Sustainable Source of Energy, Hybrid Energy System, Hybrid Renewable Energy System (HRES), Hybrid Energy Storage, Hybrid Grid Transport, Hybrid Smart Grid, Role of HRES in Grid-connected Buildings and Vehicles, Management and Control Issues of HRES in the Grid	8
4	**Grid Energy Storage Technologies :** Pumped Hydro, Compressed Air, Flywheel, Superconducting Magnet Storage System, Battery Energy Storage System (BESS), Capacitors and Super Capacitors, Fuel Cell, Thermal Storage System. BESS- Battery Chemistry Types (PbA, Ni-Cd, Ni-MH, Li-ion, NaS, RFB); Components of BESS, Grid Connection, Ownership Models (Third-Party, Outright Purchase/Full Ownership, Electric Cooperative Approach to Energy Storage Procurement); Cost–Benefit Analysis; Battery Recycling and Reuse; Policy Recommendations-Frequency Regulation, Peak Shaving, Load Leveling, Distribution & Transmission Grids, Microgrids. Hybrid Energy Storage System(HESS)- hybridization architectures, control and optimization, Applications (EV, Microgrid, Off grid applications)	11
5	**EVs integration with RESs** Integration of electric vehicles with renewables into power grids, EVs integration with RESs, EVs for ancillary services, V2G concept and challenges; Hybrid Vehicles (HV), Types of Hybrid Renewable Solar Vehicles, Battery Electric Vehicles, Power Electronics of Hybrid Vehicles, Types of Electrical Machines for HV, Economics and Market for Hybrid Cars	7
6	**Green energy solutions for climate action:** Role of innovation and intellectual property rights for clean energy technologies; Green energy solutions for rural households and communities, for agriculture on-farm, for agriculture post-harvest; Smart energy in urban households, Green solutions for public spaces and infrastructure, energy efficiency for water utilities, Energy-efficient supermarkets, Energy smart data centers. Natural Gas to Drive Green and Sustainable Developments in India, Scope for Small Hydro Projects in India, Hydrogen and Fuel Cells, Energy Sustainability Through Nuclear Energy	7
	Total	**40**

Text Books:

1. Kathiresh, M., Subahani, A. M., & Kanagachidambaresan, G. R. (Eds.). (2021). Integration of renewable energy sources with smart grid. John Wiley & Sons.
2. Shah, Y. T. (2021). Hybrid power: generation, storage, and grids. CRC Press.
3. Sharma, A., & Kar, S. K. (Eds.). (2015). Energy sustainability through green energy. Springer.
4. Abdelhay A. Sallam and Om P. Malik, "Power Grids with Renewable Energy Storage, integration and digitalization," IET ENERGY ENGINEERING SERIES 67, Pub. By The Institution of Engineering and Technology, 2021. ISBN 978-1-83953-027-2.
5. "Renewable Energy - Resources, Challenges and Applications," Edited by Mansour Al Qubeissi, Ahmad El-kharouf and Hakan Serhad Soyhan. IntechOpen, Lonmdon, United Kingdom, 2020. Print ISBN 978-1-78984-283-8. http://dx.doi.org/10.5772/intechopen.81765
6. World Intellectual Property Organization (WIPO) (2024). Green Technology Book: Energy Solutions for Climate Change. Geneva: WIPO. DOI 10.34667/tind.50132, ISBN: 978-92-805-3688-1 (print)
7. Asian Development Bank, Hanbook on Battery Energy Storage system, 2018, DOI: http://dx.doi.org/10.22617/TCS189791-2, ISBN 978-92-9261-470-6 (print),

Reference Books:

1. Bansal, R. (2017). Handbook of distributed generation. Electric Power Technologies, Economics and Environmental Impacts, 11, 6330.
2. Ardakanian, O., Keshav, S., & Rosenberg, C. (2019). Integration of Renewable Generation and Elastic Loads into Distribution Grids.
3. IRENA, COP28, COP29, GRA, MoEA and Government of Brazil (2024), Delivering on the UAE Consensus: Tracking progress toward tripling renewable energy capacity and doubling energy efficiency by 2030, International Renewable Energy Agency, COP28 Presidency, COP29 Presidency, Ministry of Energy of the Republic of Azerbaijan, and Government of Brazil, Abu Dhabi.
4. Bollen, M. H., & Hassan, F. (2011). Integration of distributed generation in the power system. John wiley & sons.
5. Singh, S. N. (2015). Non Conventional Energy Resources. Pearson Education India.

Prerequisite:

1. Renewable Energy Systems
2. Generation of Electrical Power/ Power Generation Sources
3. Economic Operation of Power System
4. Power System Planning