SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING::TIRUPATI

DEPARTMENT OF ELECTRICALAND ELECTRONICS ENGINEERING

M.TECH WITH SPECIALIZATION – POWER SYSTEMS

SCHEME OF INSTRUCTIONS AND SYLLABUS

R23 – REGULATIONS

(w.e.f. ACY 2023-24)

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTIONS

(R23 REGULATIONS)

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING: TIRUPATI – 517 502

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Scheme of Instruction- (CBCS) Effective from the Academic Year 2023-24

(effective from the batch of students admitted from the academic year 2023-24)

M.Tech (Power Systems) - I Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
			Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
PCC	PSPC 01	Computer Methods in Power Systems.	4	0	0	4	4	40	60	100
PCC	PSPC 02	Interconnected Power System Operation and Control.	4	0	0	4	4	40	60	100
PCC	PSPC03	AI Applications to Power Systems.	4	0	0	4	4	40	60	100
PEC	PSPE 01	Program Elective I.	3	1	0	4	3	40	60	100
PEC	PSPE 02	Program Elective II.	3	1	0	4	3	40	60	100
PCL	PSCP 01	Computer Methods in Power Systems Lab.	0	0	3	3	1.5	40	60	100
PCL	PSCP 02	AI Applications to Power Systems Lab.	0	0	3	3	1.5	40	60	100
MC	PGMC01	Research Methodology and IPR.	3	0	0	3	3	40	60	100
Total			**18**	**03**	**06**	**27**	**24**	**320**	**480**	**800**

Course Code	List of Program Elective Course – I (PSPE 01)	Course Code	List of Program Elective Course – II (PSPE 02)
PSPE 01.1	Reactive Power Control and Management.	PSPE 02.1	Dynamics of System Theory.
PSPE 01.2	Energy Auditing and Management.	PSPE 02.2	Pulse Width Modulation for PE Converters.
PSPE 01.3	Smart Grids Technologies.	PSPE 02.3	High Power Converters.
PSPE 01.4	FACTS and Custom Power Devices.	PSPE 02.4	Advanced Micro- Controller Based Systems .

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING: TIRUPATI – 517 502

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Scheme of Instruction- (CBCS) Effective from the Academic Year 2023-24

M.Tech (Power Systems) - II Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
			Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
PCC	PSPC 04	Advanced Power System Protection.	4	0	0	4	4	40	60	100
PCC	PSPC 05	Electrical Power Distribution Systems.	4	0	0	4	4	40	60	100
PCC	PSPC 06	Wind and Solar Energy Systems.	3	1	0	4	3	40	60	100
PEC	PSPE 03	Program Elective III.	3	1	0	4	3	40	60	100
PEC	PSPE 04	Program Elective IV.	3	1	0	4	3	40	60	100
PCL	PSCP 03	Power System Protection Lab.	0	0	3	3	1.5	40	60	100
PCL	PSCP 04	Wind and Solar Energy Systems Lab.	0	0	3	3	1.5	40	60	100
VAC	PSVAC01	Electrical Safety and Management.	3	1	0	4	3	40	60	100
MINI	PSMPS00	Mini Project with Seminar.	1	0	2	3	2	40	60	100
Total			**21**	**04**	**08**	**33**	**25**	**360**	**540**	**900**

Course Code	List of Program Elective Course – III (PSPE 03)	Course Code	List of Program Elective Course – IV (PSPE 04)
PSPE 03.1	Power Quality Issues and Mitigation	PSPE 04.1	Electric and Hybrid Vehicles.
PSPE 03.2	Restructured Power Systems.	PSPE 04.2	Industrial Power Electronics.
PSPE 03.3	Power Apparatus and Design.	PSPE 04.3	SCADA System and Applications.
PSPE 03.4	Advanced Digital Signal Processing.	PSPE 04.4	Embedded Systems.

Instruction: The students can undergo Open Elective Course work (12 week's duration) from the day of commencement of Second semester class work through online (MOOCS)/ NPTEL and can select the subjects that are not covered in the Curriculum. However, the obtained pass certificate should be submitted on or before the last working day of the III - Semester Course work without fail and result will be reflected in III - Semester Marks MEMO. Otherwise, your results will be reflected in supplementary mode if certificate is submitted after last working day of III - Semester.

M.Tech (Power Systems) - III Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation	
			Lecture	Tutorial	Practical	Total		Semester End Examination Marks	Total
OEC	PGOE01	Open Elective Course (MOOCS).	3	0	0	3	3	100	100
PCC	PSPD01	Dissertation Project Work Phase - I	0	0	24	24	12	100	100
Total			**3**	**0**	**24**	**27**	**15**	**200**	**200**

Instruction:

1. The Students can undergo Open Elective Course work (12 week's duration) from the day of commencement of Second semester class work through online (MOOCS)/ NPTEL and can select the subjects that are not covered in the Curriculum. However, the obtained pass certificate should be submitted on or before the last working day of the III - Semester Course work without fail and result will be reflected in III - Semester Marks MEMO. Otherwise, your results will be reflected in supplementary mode if certificate is submitted after last working day of III-Semester.
2. Evaluation of Dissertation Phase – I work: Review after 6 – 8 weeks (20 marks), Continuous Guide Evaluation (40 marks) and End Semester Evaluation (40 marks). – Total Marls: 100 marks.

M.Tech (Power Systems) - IV Semester

Category	Course Code	Course Title	Scheme of Instruction (Hours/Week)				No. of Credits	Scheme of Evaluation		
			Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
PCC	PSPD02	Dissertation Project Work Phase – II and Viva-Voce	0	0	32	32	16	60	40	100
Total			**0**	**0**	**32**	**32**	**16**	**60**	**40**	**100**

Instruction:

1. Evaluation of Dissertation Project work Phase – II : Review after 8-10 weeks (20 marks) and Continuous Guide Evaluation (40 marks) and End Semester Examination (40 marks).
2. Student must submit their project work on or before the last working day/Instruction day of the IV Semester of the Program. Otherwise Rs. 1,000/- penalty for late submission will be levied to extend submission up to three months. In case of failure of the said condition the penalty amount will be doubled up to the completion of the course.

CHAIRMAN
B.O.S. (P.G.)
Dept. of E.E.E.
Dr. Ch. CHENGAIAH, M.E., Ph.D.
Professor & Dean (SCDC)
Dept. of Electrical & Electronics Engg.
S.V. University College of Engineering
TIRUPATI - 517 502

M.TECH – I SEMESTER

SYLLABUS

(R23 REGULATIONS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS
M.TECH: POWER SYSTEMS - FIRST SEMESTER - SYLLABUS

PSPC 01: COMPUTER METHODS IN POWER SYSTEMS

Instruction Hours/week: 4(L) **Credits: 4**
Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Power System Network Matrices: Graphs, Incidence matrices, Primitive network, formation of Bus admittance matrix by singular transformation
ns, direct inspection method for determination of Y_{BUS}, Formation of Bus impedance matrix - Addition of a branch and Addition of a link. Simple problems.

UNIT-II

Load Flow Studies: Load flow problem, Gauss-Seidel method, Newton Raphson method, Decoupled and Fast decoupled load flow methods, Comparison of load flow methods.

UNIT-III

Fault Analysis: Short circuit (Symmetrical - 3-phase fault, Unsymmetrical - SLG, LL, LLG faults) calculations using Bus impedance matrix, Fault Impedance Matrix, Fault Currents and Fault Voltages.

UNIT-IV

Power System Security Analysis: Factors affecting Power system security, Security state diagram, contingency analysis - Sensitivity factors - Generator Outage Shift factor (GOSF) and Line Outage Shift Factor (LOSF).

UNIT-V

Voltage Stability: Voltage collapse and prevention of voltage collapse, Voltage stability analysis - P-V curve method, V-Q curve method and Modal analysis.

Text Books:

1. Computer methods in Power System Analysis by Stagg and El Abiad, Mc.Graw Hill Book Company.
2. L.P. Singh , "Advanced Power System Analysis and Dynamics", New Age International, 2006
3. A.J. Wood, "Power generation, operation and control", John Wiley, 1994.

References:

1. J.J. Grainger &W.D. Stevenson, "Power system analysis ", McGraw Hill ,2003
2. Arthur. R. Bergen & Vijay Vittal , "Power System Analysis" ,Pearson , 2000
3. P.M. Anderson, "Faulted power system analysis" , IEEE Press , 1995

Course outcomes-

Students will be able to:

1. Find the bus admittance and bus impedance matrices of the given power system network.
2. Perform power flow studies using various load flow methods.
3. Calculate fault currents and voltages during fault conditions.
4. Assess the power system security using GOSF and LOSF methods.
5. Analyze voltage stability using PV, QV and Modal Analysis.

PSPC 02- INTERCONNECTED POWER SYSTEM OPERATION AND

Instruction Hours/week: 4(L) **Credits: 4**

Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Unit Commitment: Introduction, constraints in unit commitment, thermal unit constraints, unit commitment solution methods, priority-list methods, Dynamic-Programming solution, forward DP Approach, Lagrange relaxation solution.

State Estimation: Power System State Estimation, Weighted Least Square Estimation, State Estimation of an AC Network.

UNIT-II

Load Frequency Control: Necessity of keeping frequency constant, definition of control area, single area control, block diagram representation of an isolated power system, steady state analysis, dynamic response, uncontrolled case, load frequency control of 2-area system, uncontrolled case and controlled case, tie-line bias control

UNIT-III

Generation with Limited Energy Supply: Introduction, take-or-pay fuel supply contract, composite generation production cost function, solution by gradient search techniques, hard limits and slack variables, fuel scheduling by linear programming

UNIT-IV

Hydro thermal Coordination: Introduction, long range hydro scheduling, short-range hydro-scheduling, hydroelectric plant models, scheduling problems, types of scheduling problems, scheduling energy, the short term hydro-thermal scheduling problem, short term hydro scheduling, gradient approach, pumped storage hydro plants, dynamic programming solution to the hydrothermal scheduling problem.

UNIT-V

Interchange of Power and Energy: Introduction, economy interchange between interconnected utilities, inter-utility economy energy evaluation, interchange evaluation with unit commitment, multiple-utility interchange transactions, types of interchange, capacity interchange, diversity interchange, emergency power interchange, inadvertent power exchange, power pools, transmission effects and issues, problems

Text Books:

1. Power Generation Operation and Control, Allen J. Wood, Bruce F.Wollenberg, 2nd ed. John Wiley & Sons Inc. 2006.
2. Electrical Energy Systems Theory, O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3. Modern Power System Analysis, I.J. Nagrath & D.P. Kothari, TMH,3rd edition, 9th reprint, 2007

Course outcomes-

Students will be able to:

1. Acquire knowledge on unit commitment, load frequency control, optimum operation, scheduling and coordination of hydrothermal plants, economic generation and power and energy interchange.
2. Solve unit commitment, load frequency control, hydrothermal and fuel scheduling and economy interchange problems using various solution methods.
3. Select and apply appropriate methods to operate inter connected power systems most economically and at constant frequency by optimum utilization of fuels at different loads.

PSPC 03: AI APPLICATIONS TO POWER SYSTEMS

Instruction Hours/week: 4(L) **Credits: 4**
Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

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.

UNIT-II

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.

UNIT-III

Introduction to classical sets – properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.
Fuzzy logic system components: Fuzzification, Inference engine, Defuzzification to crisp sets – Defuzzification methods.

UNIT-IV

Genetic Algorithms – Genetic Algorithm versus Conventional Optimization Techniques, Genetic representations and Selection Mechanisms; Genetic Operators – Different types of crossover and mutation operators.
Particle Swarm Optimization - Particle Swarm Optimization Bird flocking and fish Schooling, anatomy of a particle, equations based on velocity and positions, PSO topologies, control parameters.

UNIT-V

Applications of AI Techniques: ANN – Load flow, Economic load Dispatch, Load forecasting. Fuzzy Logic – Single area and two area load frequency control, Speed control of DC Motor. GA and PSO – GA and PSO algorithms for solving ELD problems.

Text Books:

1. Artificial Intelligence Techniques in Power Systems (Energy Engineering), by Kelvin Warwick, Arthur Ekwue, Rag Aggarwal, 1997.
2. AI Application Areas n Power Systems, Iraj Dabbaghchi, American Electric Power Richard D. Christie, Gary W. Rosenwald and Chen – Ching Liu, University of Washington.
3. J M Zurada , “An Introduction to ANN”, Jaico Publishing House
4. Timothy Ross, “Fuzzy Logic with Engg. Applications”, McGraw. Hill
5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com
6. Rajasekharan and Pai, “Neural Networks, Fuzzy logic – Genetic Algorithms –Synthesis and Applications” PHI Publications.
7. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.

Course outcomes-

Students will be able to:

1. Learn the concepts of artificial neural networks and Fuzzy Logic.
2. Acquire the knowledge of GA and PSO.
3. Use the Soft Computing Techniques for Power System problems.
4. Apply GA and PSO to Power System optimization problems.

PROGRAM ELECTIVE- I

PSPE 01.1: REACTIVE POWER CONTROL AND MANAGEMENT

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

The Steady State Reactive Power Control in Electrical Transmission Systems: Basics of Reactive Power Control, uncompensated transmission lines, compensated transmission lines, passive shunt compensation, series compensation

UNIT-II

Reactive Power Compensation and The Dynamic Performance of Transmission System: Introduction, passive shunt compensation, Static compensators, Synchronous condenser, characteristics, comparison of compensations.

UNIT-III

Principles of Static Compensators: Introduction, Compensator applications, properties and types of static compensators, Thyristor Controlled Reactor (TCR) and types of compensation, Thyristor Switched Capacitor (TSC), SVC Schemes/Configurations, Fixed Capacitance (FC).

UNIT-IV

Demand Side Management: Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.
Distribution side Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives –Economics Planning capacitor placement – retrofitting of capacitor banks.

UNIT-V

User Side Reactive Power Management: KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations.

Reactive power management in electric traction systems and arc furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements –remedial measures –power factor of an arc furnace.

Text Books:

1. Reactive Power Control in Electrical Power Systems by T. J. E. Miller
2. Reactive power Management by D.M. Tagare, Tata McGraw Hill,2004. (Units IV to V)

Course outcomes-

Students will be able to:

1. Understand the significance of reactive power control in power system and principles of various controllers.
2. To know about the importance of reactive power management and various management techniques employed in power system networks

PSPE 01.2: ENERGY AUDITING AND MANAGEMENT

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination:**
60 UNIT-I

System approach and End use approach to efficient use of Electricity, Electricity tariff types.
Energy auditing: Types and objectives - audit instruments, ECO assessment and Economic methods, Specific energy analysis-Minimum energy paths-consumption models- Case study

UNIT-II

Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient /high efficient Motors-Case study, Load Matching and selection of motors Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing-Optimal operation and Storage-Case study, Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation- case study

UNIT-III

Reactive Power Management-Capacitor Sizing-Degree of Compensation-Capacitor Losses-Location-Placement-Maintenance -Case study, Peak Demand controls- Methodologies-Types of Industrial Loads-Optimal Load scheduling-case study, Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes, Electronic ballast-Power quality issues-Luminaries, case study

UNIT-IV

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study, Electric loads of Air conditioning & Refrigeration, Energy conservation measures- Cool storage Types-Optimal operation case study

UNIT-V

Electric water heating-Geysers-Solar Water Heaters, Power Consumption in Compressors, Energy conservation measures, Electrolytic Process, Computer Controls- software-EMS

Text Books:

1. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998)
2. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2ndedition (1994)
3. Giovanni Petrecca, .Industrial Energy Management: Principles and Applications., The Kluwerinternational series -207,1999

Course outcomes-

Students will be able to:

1. Acquire the background required for engineers to meet the role of energy managers and to acquire the skills and techniques required to implement energy management
2. Identify and quantify the energy intensive business activities in an organization
3. Able to perform Basic Energy Audit in an Organization

PSPE 01.3: SMART GRID TECHNOLOGIES

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities and barriers of smart grid, difference between conventional and smart grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid, Case study of Smart Grid.

UNIT-II

Smart Grid Technologies: Introduction to Smart Meters, 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, Geographic Information System (GIS), Phase Measurement Unit (PMU).

UNIT-III

Microgrids and Distributed energy Resources: Concepts of Microgrid, need and applications of Microgrid, formation of Microgrid, Issues of interconnection, protection & control of micro-grid, plastic and organic solar cells, Thin film solar cells, Variable speed wind generation, fuel cells, micro-turbines, Captive power plants, Integration of renewable energy sources.

UNIT-IV

Power Quality Management in Smart Grid: 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.

UNIT-V

Information and Communication technology for smart grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area, Network (NAN), Wide Area Network (WAN), Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid, Broadband over Power line (BPL), IP based protocols

Text 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. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, “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.
6. S. Chowdary, S.P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks”, Institution of Engineering and Technology.
7. A. Keyhani, M.N. Marwali, M. Dal, “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley.

Course Outcomes-

Students will be able to:

1. Appreciate the difference between smart grid & conventional grid.
2. Apply smart metering concepts to industrial and commercial installations.
3. Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.
4. Come up with smart grid solutions using modern communication technologies.

PSPE 01.4: FACTS AND CUSTOM POWER DEVICES

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Transmission line connections, Power flow in parallel lines, Mesh systems, Stability considerations, Relative importance of controllable parameters, Basic types of FACTS controllers, Shunt controllers, Series controllers, Combined shunt and series controllers, Benefits of FACTS.

UNIT-II

Static versus passive VAR compensator, Static shunt compensators: Static VAR Compensation (SVC) and Static Synchronous Compensation (STATCOM), Operation of Thyristor- Switched Capacitor (TSC), Thyristor Controlled Reactor (TCR) and Static Synchronous Compensation (STATCOM), Comparison between SVC and STATCOM.

UNIT-III

Static series compensation: Thyristor Switched Series Capacitor (TSSC), Static Synchronous Series Compensator (SSSC) – Thyristor Controlled Voltage Reactor (TCVR) and Thyristor Controlled Phase Angle Reactor (TCPAR) principle of Operation, Gate-Controlled Series Capacitor (GCSC), Thyristor Switched Series Capacitor (TSSC) and Static Synchronous series compensators operation (SSSC).

UNIT-IV

Sub Synchronous Resonance (SSR) and its damping, Unified Power Flow Controller Circuit, Arrangement Operation of Unified Power Flow Controller (UPFC), Introduction to interline power flow controller (IPFC).

UNIT-V

Power quality problems in distribution systems, passive filters, active filtering – shunt , series and hybrid, Voltage swells , sags, flicker, unbalance and mitigation of these problems by power line conditioners, IEEE standards on power quality.

Text Books:

1. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible
2. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007
3. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modeling and Control", Springer Verlag, Berlin, 2006
4. AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
5. K.S. Suresh kumar, S. Ashok, "FACTS Controllers & Applications", E-book edition, Nalanda Digital Library, NIT Calicut,2003

Course outcomes-

Students will be able to:

1. Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
2. Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled Reactive Power Systems, PWM_Inverter based Reactive Power Systems and their controls.
3. To develop analytical modeling skills needed for modeling and analysis of such Static VAR Systems.

PROGRAM ELECTIVE- II

PSPE 02.1: DYNAMICS OF SYSTEM THEORY

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Controllers: Introduction to controllers – Need for controllers – Types of Controllers – Proportional, Integral and Derivative Controllers – Transfer function of controllers - PI, PD, PID Controllers – Design of controllers using frequency domain analysis – Controllers applications in Systems.

UNIT-II

State Space Analysis: Mathematical Modeling of Physical systems, solutions of state equations – Homogeneous and Non-homogeneous – state transmission matrix (STM) – Computation of STM, Controllability and observability time invariant linear systems.

UNIT-III

Nonlinear Systems - Different techniques of linearizing non-linear systems – behaviour of nonlinear systems - Common physical non linearities - Describing functions for various types of non-linearities – describing function analysis of nonlinear control systems – singular points of non-linear systems.

UNIT-IV

Pole placement technique: Pole placement technique by state feedback for linear SISO time, invariant system – Theory of high-gain feedback-advantages – Pole placement technique along with high-gain feedback control – state observers – Full order and reduced order observer.

UNIT-V

Stability Analysis: Concept of Stability, Definitions in the sense of Lyapunov, Lyapunov stability theorem - Different methods of constructing Liapunov functions for linear and non-linear continuous systems.

Text Books:

1. Gopal, M., „Modern Control Systems Theory‟, Wiley Eastern Ltd., 1993.
2. Ogata, K., „Modern Control Engineering‟, Prentice Hall of India, 4th edition , 2003.
3. Kuo, B.C., „Automatic Control Systems‟, Prentice Hall of India, 1999. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.

Course outcomes-

Students will be able to:

1. To learn linear system modeling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective
2. Design observers and controllers for linear systems
3. Acquire Knowledge of continuous time linear systems modeling, analysis and design.
4. Know the stability analysis using Lyapunov methods

PSPE 02.2: PULSE WIDTH MODULATION FOR PE CONVERTERS

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Fundamental Concepts of PWM: Fundamental Concepts of PWM, Evaluation of PWM Schemes, Double Fourier Integral Analysis of a Two-Level Pulse Width- Modulated Waveform, Naturally Sampled Pulse Width Modulation Sine-Sawtooth Modulation, Sine-Triangle Modulation, PWM Analysis by Duty Cycle Variation, Sine-Sawtooth Modulation, Sine-Triangle Modulation

UNIT-II

Regular Sampled Pulse Width Modulation: Fundamental Concepts of PWM, Evaluation of PWM Schemes, Sawtooth Carrier Regular Sampled PWM, Symmetrical Regular Sampled PWM, Asymmetrical Regular Sampled PWM, direct Modulation

UNIT-III

Modulation of One Inverter Phase Leg: Double Fourier Integral Analysis of a Two-Level Pulse Width- Modulated Waveform, Naturally Sampled Pulse Width Modulation, PWM Analysis by Duty Cycle Variation, Regular Sampled Pulse Width Modulation, Integer versus Non-Integer Frequency Ratios

UNIT-IV

Modulation of Single-Phase Voltage Source Inverters: Topology of a Single-Phase Inverter Three-Level Modulation of a Single-Phase Inverter Analytical Calculation of Harmonic Side band Modulation, Switched Pulse Position, Continuous Modulation, Discontinuous Modulation Losses, Switched Pulse Sequence, Discontinuous PWM

UNIT-V

Zero Space Vector Placement Modulation Strategies: Space Vector Modulation, Principles of Space Vector Modulation, SVM Compared to Regular Sampled PWM, Phase Leg References for Space Vector Modulation Naturally Sampled SVM, Analytical Solution for SVM, Harmonic Losses for SVM, Placement of the Zero Space Vector, Discontinuous Modulation, 1200 Discontinuous Modulation, 600 and 300 Discontinuous Modulation

Text Books:

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. J Ned Mohan, Undeland, Robbins, “Power electronics: converters, applications, and design” (John wiley and Sons 2003)

Course outcomes-

Students will be able to:

1. Learn different types of PWM schemes and their applications
2. Asses the THD for different types of PWM schemes
3. Choose suitable PWM scheme for different topologies of power electronic circuits

PSPE 02.3: HIGH POWER CONVERTERS

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

High-Power Switching Devices: Gate Turn-Off (GTO) Thyristor, Gate-Commutated Thyristor (GCT), Insulated Gate Bipolar Transistor (IGBT), Other Switching Devices, Operation of Series-Connected Devices Main Causes of Voltage Unbalance, Voltage Equalization for GCTs, Voltage Equalization for IGBTs

UNIT-II

Two-Level Voltage Source Inverters: Introduction, Sinusoidal PWM, Modulation Schemes, Harmonic Content Over-modulation, Third Harmonic Injection PWM, Space Vector Modulation Switching States, Space Vectors, Dwell Time Calculation, Modulation Index Switching Sequence, Spectrum Analysis, Even-Order Harmonic Elimination, Discontinuous Space Vector Modulation

UNIT-III

Cascaded H-Bridge Multilevel Inverters: Introduction, H-Bridge Inverter Bipolar Pulse-Width Modulation, Unipolar Pulse-Width Modulation, Multilevel Inverter Topologies, CHB Inverter with Equal dc Voltage, H-Bridges with Unequal dc Voltages, Carrier Based PWM Schemes, PWM Schemes, Staircase Modulation

UNIT-IV

A **Diode-Clamped Multilevel Inverters:** Three-Level Inverter, Converter Configuration, Switching State, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted Commutation, Space Vector Modulation, Inverter Output Waveforms and Harmonic Content, Even-Order Harmonic Elimination, Neutral-Point Voltage Control, Causes of Neutral-Point Voltage Deviation, Effect of Motoring and Regenerative Operation.

UNIT-V

Other Space Vector Modulation Algorithms: Discontinuous Space Vector Modulation, SVM Based on Two-Level Algorithm, High-Level Diode-Clamped Inverters, Four- and Five-Level Diode-Clamped Inverters, Carrier-Based PWM, NPC/H-Bridge Inverter: Inverter Topology, Modulation Scheme, Waveforms and Harmonic Content

Text Books:

1. Bin Wu," High Power Converters and AC Drives (IEEE Press 2008)
2. By Dorian O Neacsu, "Power Switching Converters: Medium and High Power"
3. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI,2006
4. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009

Course outcomes-

Students will be able to:

1. Learn the characteristics of GTOs, IGBTs and use them in practical systems
2. Knowledge of working of multi-level VSIs, DC-DC switched mode converters, cyclo-converters and PWM techniques and the ability to use them properly
3. Acquire knowledge of power conditioners and their applications
4. Ability to design power circuit and protection circuit of PSDs and converters.

PSPE 02.4: Advanced Micro- Controller Based Systems

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

Overview of Architecture & Microcontroller Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – 8051 microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication - Interrupts.

UNIT-II

8051- Microcontrollers Instruction Set: Basic assembly language programming – Data transfer instructions – Data and Bit manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt control flow.

UNIT-III

Real Time Control Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051. TIMERS: Programmable Timers in the MCU's – Free running counter and real time control – Interrupt interval and density constraints.

UNIT-IV

Systems Design Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to High Power Devices – Analog input interfacing

UNIT-V

Real Time Operating System for Microcontrollers: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers. 16-BIT MICROCONTROLLERS: Hardware – Memory map in Intel 80196 family MCU system – IO ports – Programmable Timers and High-speed outputs and input captures – Interrupts – instructions. ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

Text Books:

1. Raj Kamal, "Microcontrollers Architecture, Programming, Interfacing and System Design" – Pearson Education, 2005.
2. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems" – PHI, 2000.
3. Microprocessors and Microcontrollers, Architecture, Programming and System Design, Krishna Kant, PHI Learning PVT. Ltd.
4. Steve Furber "Arm system-on-chip Architechture",2nd edition, Pearson publication.

References:

1. A.V. Deshmuk, "Microcontrollers (Theory & Applications)" – WTMH, 2005.
2. John B. Peatman, "Design with PIC Microcontrollers" – Pearson Education, 2005.
3. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
4. The 8051 Microcontroller, Ayala, Cengage Learning.
5. Microprocessors, Nilesh B. Bahadure, PHI Learning PVT. Ltd.

Course outcomes-

Students will be able to:

1. Distinguish types of computers & microcontrollers,
2. Use 8-Bit, 16- Bit & 32-Bit advanced Microcontrollers.
3. Develop Real time Applications of Microcontrollers & Demonstrate RTOS for Microcontrollers.
4. Translate Hardware applications using Microcontrollers.

PSCP 01: COMPUTER METHODS IN POWER SYSTEMS LAB

Instruction Hours/week: 3(P) **Credits: 1.5**
Sessional Marks: 40 **Semester-End Examination: 60**

S.No	EXPERIMENTS
1	Formation of Incidence Matrices.
2	Formation of Ybus by using Singular Transformation method.
3	Formation of Ybus by using Direct Inspection method.
4	Formation of Bus Impedance Matrix.
5	Load Flow Analysis by using Gauss-Siedel Method.
6	Load Flow Analysis by using Newton-Raphson Method.
7	Fault analysis for Single line to Ground fault.
8	Fault analysis for Three phase to Ground fault.
9	Generation outage Sensitivity Factor.
10	Line Outage Sensitivity Factor.
11	PV Curve.
12	QV Curve.
13	Load Flow Analysis by using Decoupled Methods.

Note: Any **Ten** Experiments are to be conducted.

PSCP 02: AI APPLICATIONS TO POWER SYSTEMS LAB

Instruction Hours/week: 3(P) **Credits: 1.5**
Sessional Marks: 40 **Semester-End Examination: 60**

S.No	EXPERIMENTS
1	Program to Generate XOR Function using Mc-culloch pits Neuron Model
2	Program to Generate Different Activation Function of Neuron Model
3	Load flow analysis using Neural Network
4	State Estimation Using Neural Network
5	Contingency Analysis Using Neural Network
6	Speed Control of DC Motor Using Fuzzy Logic.
7	Single Area Load Frequency Control using Fuzzy Logic Controller.
8	Two Area Load Frequency Control using Fuzzy Logic Controller.
9	Maximization of SinX function using Genetic Algorithm.
10	Economic Load Dispatch solution without system losses using Genetic Algorithm
11	Economic Load Dispatch solution considering system losses using Genetic Algorithm
12	Economic Load Dispatch Solution using PSO

Note: Any **Ten** Experiments are to be conducted.

PGMC 01: RESEARCH METHODOLOGY AND IPR

Instruction Hours/week: 3(L) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

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.

UNIT-II

Effective literature studies approaches, analysis, Plagiarism, Research ethics.

UNIT-III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-IV

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. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

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.

References:

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

Course outcomes-

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

M.TECH – II SEMESTER

SYLLABUS

(R23 REGULATIONS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
M.TECH: POWER SYSTEMS - SECOND SEMESTER - SYLLABUS

PSPC 04: ADVANCED POWER SYSTEM PROTECTION

Instruction Hours/week: 4(L) **Credits: 4**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

General philosophy of protection - Classification and Characteristic function of various protective relays, basic relay elements and relay terminology - Development of relaying scheme

Numerical Protection: Introduction - Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave - Least Error Squared (LES) technique

UNIT-II

Static Relays: Fundamentals of static relays, Basic Block diagram and principle, Advantages of Static Relays, Types of static relays, Static Over-current relays, Differential relays, Percentage Differential relays, distance relays, characteristics of static relays.

UNIT-III

Amplitude Comparators: Circulating current type and opposed voltage type, rectifier bridge comparators, Instantaneous comparators.

Phase Comparators: Coincidence circuit type, block spike phase comparator, techniques to measure the period of coincidence, Integrating type, Rectifier Phase comparators.

UNIT-IV

Digital Protection of power system apparatus – protection of generators – Transformer protection – magnetizing inrush current – Application and connection of transformer differential relays – transformer over current protection Bus bar protection - line protection - distance protection–long EHV line protection - Power line carrier protection.

UNIT-V

Microprocessor Based Protective Relays: Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flowchart approach).

Basic elements of Digital Protection: Historical Developments in digital protection, performance and operational characteristics of digital protection, basic structure of digital relays, components of digital relay, signal conditioning subsystem, conversion subsystem, digital relay subsystem

Text 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
5. Electrical Power Systems – C.L. Wadwa
6. Lewis Blackburn, J., 'Protective Relaying – Principles and Applications', Marcel Dekkar, INC, New York, 2006.
7. Power System Protection with Static Relays – by TSM Rao, TMH.
8. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Course outcomes-

Students will be able to:

1. Learn the importance of static Relays
2. Apply appropriate comparator
3. Learn about digital Protection

PSPC 05: ELECTRICAL POWER DISTRIBUTION SYSTEMS

Instruction Hours/week: 4(L) **Credits: 4**

Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

Distribution of Power, Management, Power Loads, Power System Loading, Short-term & Long-term Load Forecasting, Technological Forecasting. Urban/Rural Distribution, Energy Management and tariffs – Revenue improvement – issues in multi-year tariff and availability based tariff.

UNIT-II

Power Factor Correction, Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman's Optimality Principle.

UNIT-III

Distribution Management System (D.M.S.)-Need, advantages, functions, Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network-Different Methods and Constraints. Interconnection of Distribution, Control & Communication Systems, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring

UNIT-IV

SCADA: Introduction, Block Diagram, SCADA Applied To Distribution Automation. Common Functions of SCADA, RTU and Data Communication, Communication media and protocols for Distribution systems- IEC 61850 and IEEE 802.3 standards, Advantages of Distribution Automation through SCADA

UNIT-V

Remote Metering-Automatic Meter Reading and its implementation, Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution Automation in Actual Practice. AI techniques applied to Distribution Automation.

Text Books:

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

Course outcomes-

Students will be able to:

1. Knowledge of power distribution system
2. Study of Distribution automation and its application in practice
3. To learn SCADA system

PSPC 06: WIND AND SOLAR ENERGY SYSTEMS

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

Renewable Energy System: Introduction to Renewable Energy System**,** Sources of Renewable Energy System**,** Solar and Wind Power in Power System**:** History and current status, characteristics of solar and wind power generation, Network Integration issues.

UNIT-II

Generators and power electronics for wind turbines: Power in wind, availability, Types of wind turbines, Construction features of wind turbines, rotor design considerations, power extraction by turbine, Integration of wind energy converters to electrical networks, applications of wind energy.

UNIT-III

Solar Radiation and its measurements: Introduction, Solar radiation and its measurements, Estimation of average solar radiation.
Solar Energy Collectors: Introduction, Types Characteristics and principles of different types of collectors and their efficiencies, Advantages and Disadvantages

UNIT-IV

Solar Energy Storage: Introduction, Methods of Energy Storage Systems, Solar Ponds. Pumped Energy Storage, Compressed Energy Storage, Storage Batteries.
Applications of Solar Energy: Introduction, Solar Photo-Voltaic cells, PV array and PV module, Maximum power point tracking system.

UNIT-V

Renewable energy integrated with Grid: Introduction, Integration of Wind Energy and solar energy with Power Systems Grid, Impact on Power Quality, Power Electronics and solutions System modeling, Technologies.

Text Books:

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Willy and sons ltd.2005
2. G.D.Rai "Non-Conventional Energy sources", Khanna Publishers, Newdelhi,1999
3. Patel M.R "Wind and solar Power Systems, Design, Analysis and Operation", CRC Press, New York, Second Edition, 2005.
4. Siegfried Heier, "Grid integration of wind energy conversion systems", John Willy and sons ltd., 2006.
5. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata MacGraw Hill, Second Edition, 1996.

Course outcomes-

Students will be able to:

1. Acquire the knowledge on the principles of wind energy generation and solar energy generation.
2. Realize wind energy and solar energy impact on power and voltage quality.
3. Solve the problems related to issues associated with wind and solar energy.

<u>**PROGRAM ELECTIVE- III**</u>

PSPE 03.1: POWER QUALITY ISSUES AND MITIGATION

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination: 60**

UNIT –I

Electric power quality phenomena- Introduction to Power Quality, IEC and IEEE definitions - power quality disturbances-voltage fluctuations – sags - swells – transients – unbalance - waveform distortion - power frequency variations.

UNIT–II

Transients – origin of transients - classifications of transients – capacitor switching transient – lightning transients - load switching transients – impact on users – protection against transients – mitigation of transients.

UNIT–III

Voltage Variations – Voltage Sags – Magnitude & Duration – types – Sources of Sags – Estimation of Voltage sag performance: Transmission and Utility distribution system, Effect of Sag on AC Motor Drives, Single – Phase Domestic and Office loads, mitigation of Voltage Sag. Origin of Long and Short interruption – influence on various equipments –Mitigation of interruption.

UNIT –IV

Harmonics – Introduction to harmonics - sources of harmonics – definitions & standards – impacts - calculation and simulation –harmonic power flow - mitigation and control techniques – filtering – passive and active.

UNIT–V

Power Quality Mitigation Techniques: Harmonics filters: passive, Active and hybrid filters – Customer power device: Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC: Status of application of customer power devices.

Text Books:

1. G.T. Heydt, " Electric Power Quality", Stars in a Circle Publishers.
2. M.H. Bollen, " Understanding Power Quality Problems", Wiley – IEEE Press.
3. J. Arrillaga, B.C. Smith, N.R. Waston & AR Wood, " Power System Harmonic Analysis", John Wiley.
4. Bollen, M.H.J., 'Understanding Power Quality Problems: Voltage sags and interruptions', IEEE Press, New York, 1999.
5. Arrillaga, J, Watson, N.R., Chen, S., 'Power System Quality Assessment', Wiley, New York, 1999.
6. Heydt, G.T., 'Electric Power Quality', Stars in a Circle Publications, Indiana, 1991.
7. RC Dugan, 'Electrical Power Systems Quality', Mc-Graw Hill.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1. Understand the basic concepts of power quality.
2. Understand the basic concepts of voltage variations and transients
3. Understand different harmonics in power systems
4. Understand the working of Power quality conditioners.

PSPE 03.2: RESTRUCTURED POWER SYSTEMS

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

Introduction to restructuring of power industry: Deregulation of power industry, unbundling of electric utilities, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Market Mechanism.

UNIT-II

Power System Operation in Competitive Environment: Role of the independent system operator, Operational planning activities of ISO: ISO in Pool markets, ISO in Bilateral markets, Operational planning activities of a GENCO: GENCOs in Pool and Bilateral markets, market participation issues, competitive bidding.

UNIT-III

Transmission congestion management: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management –Classification of congestion management methods –Calculation of ATC -Non –market methods –Market methods –Nodal pricing –Inter zonal and Intra zonal congestion management –Price area congestion management –Capacity alleviation method.

UNIT-IV

Ancillary service management and pricing of transmission network: Introduction of ancillary services –Types of Ancillary services –Classification of Ancillary services –Load generation balancing related services –Voltage control and reactive power support devices –Black start capability service -ancillary service –Co-optimization of energy and reserve services -International comparison Transmission pricing –Principles –Classification –Role in transmission pricing methods –Marginal transmission pricing paradigm –Composite pricing paradigm –Merits and demerits of different paradigm.

UNIT-V

Power market development in India: Institutional structure in Indian Power sector, generation, transmission and distribution utilities. SO, & LDCs. PFC, REC, ERCs, traders, Power Exchanges and their roles. Availability based tariff, Open access, Industry structure and regulatory framework, market development, RE policies, RPO, Tariff policies. Policy changes, regulatory changes, Critical issues / challenges before the Indian power sector.

Text Books:

1. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 1st edition, 2002.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Springer, 1st edition, 2001.
3. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", CRC Press; 1st edition, 2017.
4. Loi Lei Lai: Power System Restructuring and Deregulation: Trading, Performance and Information Technology, John Wiley & Sons, Pvt. Ltd., 1st edition, 2001.

Course outcomes-

Students will be able to:

1. Understand the basic reasons and motivations for restructuring worldwide.
2. Understand the roles and responsibilities of different entities in electricity market.
3. Explore issues like congestion management, Transmission pricing, Ancillary Services.
4. Understand the power market scenarios in India.

PSPE 03.3: POWER APPARATUS AND DESIGN

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines

Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes

UNIT-II

Separation of main dimension for DC machines, Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating

UNIT-III

General considerations, output equation for induction machines, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor, Elimination of harmonic torques

UNIT-IV

Design of stator and rotor winding, slot leakage flux, Leakage reactance, equivalent resistance of Magnetizing current, efficiency from design data

UNIT-V

Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions, Introduction to Computer Aided Electrical Machine Design Energy efficient machines.

Text Books:

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman
3. Sawhney A.K, "A course in Electrical Machine Design", DhanpatRai & Sons, 5th Edition

Course outcomes-

Students will be able to:

1. To give a systematic approach for design and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used.
2. Ability to design all types of transformers and special machines.

PSPE 03.4: ADVANCED DIGITAL SIGNAL PROCESSING

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

Discrete time signals, Linear shift invariant systems-Stability and causality. Sampling of continuous time signals-Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform, Z Transform-Properties of different transforms

UNIT-II

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method

UNIT-III

FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantization effects in IIR and FIR filters

UNIT-IV

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zero Input limit cycles in IIR filters, Linear Signal Models

UNIT-V

All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals

Text Books:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ", Tata Mc Grow-Hill Edition1998
2. Dimitris G. Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions. -2000

Course outcomes-

Students will be able to:

1. Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
2. Study the design techniques for IIR and FIR filters and their realization structures.
3. Acquire knowledge about the finite word length effects in implementation of digital filters.
4. Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
5. Design of optimum FIR and IIR filters

PSPE 04.1: ELECTRIC AND HYBRID VEHICLES

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance

UNIT-II

Vehicle mechanics, roadway fundamentals, laws of motion, vehicle kinetics, dynamics of vehicle motion, propulsion power, velocity and acceleration, propulsion system design Basic concept of hybrid Electric drive Tains, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies.

UNIT-III

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives configuration and control of Permanent Magnet Motor Drives Configuration and control of Switch Reluctance, Motor drives, drive system efficiency

UNIT-IV

Matching the electric machine and the internal combustion engine (ICE) Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems

UNIT-V

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

Text Books:

1. Iqbal Husain, "Electric and Hybrid Vehicles Design Fundamentals", CRC Press.
2. Mehrdad Ehsani, Yimin Gao, Sebastien, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press

Course outcomes-

Students will be able to:

1. Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
2. To learn electric drive-in vehicles and traction

PSPE 04.2: INDUSTRIAL POWER ELECTRONICS

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**
Sessional Marks: 40 **Semester-End Examination: 60**

UNIT – I

Basic power electronic drive system, components. Different types of loads, shaft-load coupling systems. Stability of power electronic drive,
Introduction to overvoltage conditions and protection, practical overvoltage protection in naturally and forced commutated circuits, overcurrent fault conditions, over current protection, gate protection, heat sinks.

UNIT – II

Modeling of DC machine, Conventional methods of D.C. motor speed control, single phase and three phase converter fed D.C motor drive. Power factor improvement techniques, four quadrant operation. steady-state analysis of the three-phase converter-controlled DC motor drive.

UNIT – III

Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers, multiphase choppers, steady-state analysis of chopper-controlled DC motor drive, closed-loop operation, dynamic simulation of the speed-controlled DC motor drive.

UNIT – IV

Conventional methods of induction motor speed control. Solid state controllers for Stator voltage control, soft starting of induction motors, Rotor side speed control of wound rotor induction motors. Voltage source and Current source inverter fed induction motor drives – d-q axis modeling and vector control.

UNIT – V

Speed control of synchronous motors, field-oriented control, load commutated inverter drives, switched reluctance motors and permanent magnet motor drives. Introduction to design aspects of machines.

Text Books:

1. P.C Sen, 'Thyristor DC Drives', John Wiley and Sons, New York, 1991.
2. R. Krishnan, 'Electric Motor Drives – Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
3. Bimal K. Bose, 'Modern Power Electronics and AC Drives', Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
4. M D Singh, K B Khanchandani, "Power Electronics", Tata Mcgraw-Hill Publishing company limited, New Delhi,2008.

Course Outcomes:

Upon completion of the course, the students will be able to

1. Understand and analyze dc and ac motors supplied from different power converters.
2. Simulate and study motor characteristics with different converter configurations
3. Design and implement a prototype drive system.

PSPE 04.3: SCADA SYSTEM AND

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

SCADA: Introduction to SCADA, Line diagram of SCADA system, Data acquisition systems, Evolution of SCADA, Monitoring and supervisory functions, Communication technologies,

UNIT-II

SCADA COMPONENTS: Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems

UNIT-III

SCADA ARCHITECTURE: SCADA architectures, Various types of technique and applications, advantages and disadvantages of each system, single unified standard architecture -IEC 61850

UNIT-IV

SCADA COMMUNICATION: Schematic diagram of SCADA Communication system, various industrial communication technologies, wired and wireless methods and fiber optics, Open standard communication protocols

UNIT-V

SCADA APPLICATIONS: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement, Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises

Text 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.

Course outcomes-

Students will be able to:

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications
2. Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3. Knowledge about single unified standard architecture IEC 61850
4. To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server

PSPE 04.4: EMBEDDED SYSTEMS

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination: 60**

UNIT-I

Introduction: Processor embedded into system, Embedded Hardware Units, Embedded Software in a system, Embedded system-on-Chip (SOC), Design process, Classification of embedded systems

UNIT-II

8051 and Advanced Processor architecture, Memory Organization and Real- World Interfacing: 8051 architecture, Real world interfacing, Introduction to advanced architecture, Processor and memory organization, Instruction-level-parallelism, Performance matrices, Processor selection, Memory selection

UNIT-III

Devices and Communication buses for Devices and network: I/O types and examples, serial communication devices, Parallel device ports, Wireless devices, Timer and Counting devices, Watch dog timer, real time clock

UNIT-IV

Device Drivers and Interrupts service Mechanism. Programmed I/O Busy- Approach with interrupt service mechanism, ISR concept, Interrupt sources, Interrupt handling mechanism, multiple interrupts, DMA, Device driver programming

UNIT-V

Real-Time- Operating systems: OS Services, Process management, Timer functions, Event functions, Memory management, Real- time Operating systems, Basic design using an RTOS. Introduction to Real time Operating Systems: Windows CE, OSEK, Linux 2.6.X and RT Linux

Text Books:

1. Raj Kamal, "Embedded Systems" (T M H), 2008.
2. Peter Marwedel, "Embedded System Design" – Springer Verlog, 2006.
3. Jane W. S. Liu, "Real time Systems", -Pearson Education, 2000

Course outcomes-

Students will be able to:

1. Program embedded system with 8051 as processor.
2. Understand different types of communication through, parallel ports, wireless
3. Understand significance of device drivers and interrupt mechanism
4. Understand features of different types of real time OS.

PSCP 03: POWER SYSTEM PROTECTION LAB

Instruction Hours/week: 3(P) **Credits: 1.5**
Sessional Marks: 40 **Semester-End Examination: 60**

S.No	EXPERIMENTS
1	Fault Analysis by using the Symmetrical and Unsymmetrical fault MATLAB Simulink model.
2	Transmission fault detection by using Wavelet applications MATLAB Simulink model.
3	Working with Transformer Differential relay model JND, 040
4	Pickup test for Differential Relay.
5	Transformer protection using the Differential Relay for Zone trip fault.
6	Transformer Out Zone (or) Non- Trip faults.
7	Operation of Electromechanical type Earth Fault Relay.
8	Operation of Electromechanical type Over Voltage Relay.
9	Percentage Differential Relay.
10	Micro Controller Based Over Current Relay.
11	Micro Controller Based Over / Under Voltage Relay.

Note: Any **Ten** Experiments are to be conducted.

PSCP 04: WIND AND SOLAR ENERGY SYSTEMS LAB.

Instruction Hours/week: 3(P) **Credits: 1.5**
Sessional Marks: 40 **Semester-End Examination: 60**

S. No	EXPERIMENTS
1	IV & PV characteristics of series and parallel combination of PV module.
2	IV & PV characteristics of PV module with varying the radiation and temperature level.
3	Effect of shading on output power of module.
4	Effect of variation in tilt angle on PV module power.
5	Simulation of IV – PV Curves.
6	Modeling & Simulation of wind turbine generator in MATLAB Simulink.
7	Power Equation simulation for wind turbine.
8	Evaluation of Tip Speed ratio at different wind speed.
9	Evaluation of the efficiency of charge controller.
10	Evaluation of co-efficient of performance of wind turbine.

Note: All the **Ten** Experiments are to be conducted.

PSVAC01: ELECTRICAL SAFETY AND MANAGEMENT

Instruction Hours/week: 3(L) & 1(T) **Credits: 3**

Sessional Marks: 40 **Semester-End Examination:**

60 UNIT-I

INTRODUCTION TO ELECTRICAL SAFETY, SHOCKS AND THEIR PREVENTION: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, principles of electrical safety, Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, approaches to prevent Accidents.

UNIT-II

ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances

UNIT-III

ELECTRICAL SAFETY IN HAZARDOUS AREAS: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements –Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

UNIT- IV

ELECTRICAL SAFETY DEVICES: Fire Extinguishers: Fundamentals of fire-initiation of fires, types; extinguishing techniques, prevention of fire, types of fire extinguishers, fire detection and alarm system; CO2 and Halogen gas schemes; foam schemes.

UNIT-V

SAFETY DURING INSTALLATION OF PLANT: Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel.

SAFETY MANAGEMENT OF ELECTRICAL SYSTEMS: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

Text Books:

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Pradeep Chaturvedi, "Energy Management Policy, Planning and Utilization", Concept Publishing Company, 1997.

Reference Books:

1. Cooper.W.F, "Electrical safety Engineering", Newnes-Butterworth Company, 1978.
2. John Codick, "Electrical safety hand book", McGraw Hill Inc., New Delhi, 2000.
3. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
4. Wadhwa, C.L., "Electric Power Systems", New Age International, 2004.

Course outcomes:

At the end of the course, students will be able to

1. Understand the necessity of electrical safety
2. Know about Hazardous zones
3. Apply different safety measures to various machines and equipment
4. Understand the electrical management principles

PSMPS00: MINI-PROJECT WITH SEMINAR

Instruction Hours/week: 1(L) & 2(P) **Credits: 2**
Sessional Marks: 40 **Semester-End Examination: 60**

Mini-Project with Seminar course is a project-based learning methodology in Power System Analysis

Course outcomes: Students will be able to**:**

1. Know the meaning of research problem, Sources of research problem Approaches of investigation of solutions for research problem.
2. Understand effective literature studies approaches, analysis Effective technical writing.
3. Learn how to write an assessment report and preparation of documentation and presentation.
4. Know the criteria characteristics of good research problem.
5. Acquire the knowledge of comprehensive analysis in Electrical Power Network.

M.TECH – III SEMESTER

COURSE INSTRUCTIONS

(R23 REGULATIONS)

PGOE01: OPEN ELECTIVE COURSE (MOOCS)

Instruction Hours/week: 3(L)-MOOCS (12 weeks) **Credits: 3**

Sessional Marks: 00 **Semester-End Examination: 100**

Instructions of the course: The Students can undergo Open Elective Course work (12 week's duration) from the day of commencement of Second semester class work through online (MOOCS)/ NPTEL and can select the subjects that are not covered in the Curriculum. However, the obtained pass certificate should be submitted on or before the last working day of the III - Semester Course work without fail and result will be reflected in III - Semester Marks MEMO. Otherwise, the results will be reflected in supplementary mode.

PSPD01: DISSERTATION PROJECT WORK PHASE-I

Instruction Hours/week: 24(P) **Credits: 12**

Sessional Marks: 20+40 **Semester-End Examination: 40**

Instructions of the course: The Students will acquire knowledge about research problem, sources of research problem Approaches of investigation of solutions for research problem and understand effective literature studies approaches and analysis.

Scheme of Evaluation of Dissertation project work Phase – I: Review after 6 – 8 weeks (20 marks), Continuous Guide Evaluation (40 marks) and End Semester Evaluation (40 marks). – Total Marls: 100 marks.

M.TECH – IV SEMESTER

COURSE INSTRUCTIONS

(R23 REGULATIONS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
M.TECH: POWER SYSTEMS - FOURTH SEMESTER - SYLLABUS

PSPD02: DISSERTATION PROJECT WORK PHASE – II AND VIVA-VOCE

Instruction Hours/week: 32(P) **Credits: 16**

Sessional Marks: 20+40 **Semester-End Examination: 40**

Instructions of the course: The Student will be able to analyze and solve the problem with programmable code/Simulink to obtain appropriate solution, how to write a assessment report and preparation of project work/documentation and presentation of results.
The student must publish the work in a reputed reviewed UGC approved journal.

Scheme of Evaluation of Dissertation project work Phase – II:

1. Review after 8-10 weeks (20 marks) and Continuous Guide Evaluation (40 marks) and End Semester Examination (40 marks).
2. Student must submit their project work on or before the last working day/Instruction Day of the IV Semester of the Program. Otherwise Rs. 1,000/- penalty for late submission will be levied to extend submission up to three months. In case of failure of the said condition the penalty amount will be doubled up to the completion of the course work.