School of Engineering and Technology

Programme Structure & Syllabus

Electrical Engineering

2022-23

K.K. University

Bihar Sharif, Nalanda – 803115

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Objective of the Program:

1. **Advanced Knowledge and Skills**: Provide in-depth knowledge and technical skills in power system engineering, including generation, transmission, distribution, and utilization of electrical power.
2. **Research and Development**: Foster the ability to conduct independent and collaborative research to address contemporary challenges in power systems, including the integration of renewable energy sources, smart grids, and sustainable energy solutions.
3. **Problem-Solving and Innovation**: Develop problem-solving abilities and innovative thinking to design, analyze, and implement advanced power system technologies and solutions.
4. **Professional Competence**: Enhance professional skills, including project management, communication, and teamwork, to prepare graduates for leadership roles in the power industry, academia, or research organizations.
5. **Ethical and Sustainable Practices**: Promote ethical standards and sustainability principles in engineering practices, ensuring graduates are equipped to contribute to the development of environmentally and socially responsible power systems.
6. **Adaptability and Lifelong Learning**: Instill a mindset of lifelong learning and adaptability to keep pace with the rapid technological advancements and evolving industry trends in power systems.

Program Education Outcomes:

PEO-1: Technical Proficiency: Graduates will exhibit comprehensive knowledge and skills in the design, analysis, operation, and control of power systems, and will be proficient in using modern tools and techniques for solving complex engineering problems.

PEO-2: Research Competence: Graduates will be capable of conducting independent and collaborative research, contributing to the advancement of knowledge in power systems engineering and addressing contemporary challenges such as renewable energy integration, smart grids, and sustainable energy solutions.

PEO-3: Problem-Solving and Innovation: Graduates will demonstrate the ability to apply advanced problem-solving techniques and innovative approaches to develop effective solutions for power system-related issues, thereby contributing to technological advancement in the field.

PEO-4: Leadership and Professionalism: Graduates will possess strong leadership qualities, effective communication skills, and the ability to work in multidisciplinary teams, preparing them for successful careers in industry, academia, or research organizations.

PEO-5: Ethics and Sustainability: Graduates will uphold high ethical standards and be committed to sustainable engineering practices, ensuring their contributions to power system engineering are environmentally responsible and socially beneficial.

PEO-6: Lifelong Learning: Graduates will recognize the importance of lifelong learning and will be equipped to continuously update their knowledge and skills to keep pace with the rapid advancements in power system technologies and industry trends.

Program Outcomes:

PO-1: Engineering Knowledge: Apply advanced knowledge of mathematics, science, and engineering principles to complex power system problems.

PO-2: Problem Analysis: Identify, formulate, and analyze engineering problems in power systems, and derive valid conclusions using principles of mathematics, natural sciences, and engineering sciences.

PO-3: Design/Development of Solutions: Design and develop solutions for complex power system problems, considering public health and safety, cultural, societal, and environmental factors.

PO-4: Investigation of Complex Problems: Conduct investigations of complex problems using research-based knowledge and research methods, including experiment design, data analysis and interpretation, and synthesis of information to provide valid conclusions.

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PO-5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex power system activities, with an understanding of their limitations.

PO-6: The Engineer and Society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate knowledge of and need for sustainable development.

PO-8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO-9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO-10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11: Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO-13: Lifelong Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes:

PSO-1: Advanced Power System Analysis and Design: Graduates will be able to analyze, design, and optimize complex power systems, including generation, transmission, and distribution networks, using advanced techniques and tools.

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PSO-2: Renewable Energy Integration: Graduates will have the capability to integrate renewable energy sources into existing power grids, manage variability and intermittency, and design sustainable energy solutions.

PSO-3: Power Electronics and Drives: Graduates will possess expertise in the application of power electronics in power systems, including the design and control of power converters and drives for various industrial and renewable energy applications.

PSO-4: Smart Grid Technologies: Graduates will be proficient in the concepts and implementation of smart grid technologies, including advanced metering infrastructure, demand response, and grid automation for enhanced reliability and efficiency.

PSO-5: Protection and Control: Graduates will understand and apply principles of protection and control in power systems, ensuring the stability and security of electrical networks through the use of modern protection schemes and control strategies.

PSO-6: Power System Dynamics and Stability: Graduates will be able to analyze the dynamic behavior of power systems, assess stability issues, and implement control measures to maintain system stability under different operating conditions.

PSO-7: Energy Management and Policy: Graduates will have knowledge of energy management principles and policies, enabling them to contribute to the development and implementation of energy-efficient practices and regulatory frameworks.

PSO-8: Simulation and Modeling: Graduates will be skilled in using advanced simulation and modeling tools to conduct research and solve practical problems in power systems engineering.

PSO-9: Technical Innovation and Entrepreneurship: Graduates will be equipped with the knowledge and skills to drive technical innovation and entrepreneurship in the power sector, fostering the development of new technologies and business models.

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PSO-10: Industry-Academia Collaboration: Graduates will be prepared to engage in collaborative projects with industry and academia, contributing to the advancement of knowledge and technology transfer in the field of power systems.

M.tech Electrical Engineering Programme/Course Structure

FIRST SEMESTER

S. No	CODE	TITLE	CREDIT	L	T	P	HOURS PER WEEK	Internal Marks	External Marks
1	EMEE1101	Power System Analysis	4	3	1	0	4	30	70
2	EMEE1102	Power System SCADA	4	3	1	0	4	30	70
3	EMEE1103	Power Electronics & Drives	4	3	1	0	4	30	70
4	EMEE1104	EHV AC/DC Transmission	4	3	1	0	4	30	70
5	EMEE1105	Reliability Engineering	4	3	1	0	4	30	70
6	EMEE1106	Numerical Technique in Power System	3	3	0	0	3	30	70
7	EMEE1103(P)	Power Electronics & Drives Lab	2	0	0	4	4	30	70
8	EMEE1105(P)	Reliability Engineering	2	0	0	4	4	30	70
Total			**27**	**18**	**5**	**8**	**31**	**240**	**560**

SECOND SEMESTER

S. No	CODE	COURSE TITLE	CREDIT	L	T	P	HOURS PER WEEK	INTERNA L MARKS	EXTERNAL MARKS
1	EMEE1201	Transients Study	4	3	1	0	4	30	70

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2	EMEE1202	Protection of Power System	4	3	1	0	4	30	70
3	EMEE1203	Soft Computing Technique	3	3	0	0	3	30	70
4	EMEE1204	Process Control & Industrial Automation	4	3	1	0	4	30	70
5	EMEE1205	Power System Reliability	4	3	1	0	4	30	70
6	EMEE1206	Power System Planning & Layout	4	3	1	0	4	30	70
7	EMEE1202(P)	Protection of Power System Lab	2	0	0	4	4	30	70
8	EMEE1205(P)	Power System Reliability Lab	2	0	0	4	4	30	70
		TOTAL	**27**	**18**	**5**	**8**	**31**	**240**	**560**

THIRD SEMESTER

S.No	CODE	COURSE TITLE	CREDIT	L	T	P	Hours Per Week	Internal Marks	External Marks
1	EMEE2101i	Energy Management & Audit(Elective-I)							
2	EMEE2101ii	Smart Grid Technology & Applications (Elective-I)	4	3	1	0	4	30	70
3	EMEE2101iii	Modern Control System (Elective-I)							
4	EMEE2102i	Power Quality Improvement Techniques (Elective-II)	4	3	1	0	4	30	70
5	EMEE2102ii	An Introduction to Robotics (Elective-II)							
6	EMEE2102iii	Information Security (Elective-II)							
7	EMEE2103	Seminar and Viva Voce-I	2	0	0	4	4	30	70
8	EMEE2104	Mini Project	10	0	0	20	20	30	70
TOTAL			**20**	**6**	2	**24**	**32**	**120**	**280**

FOURTH SEMESTER

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S.No	CODE	COURSE TITLE	CREDIT	L	T	P	Hours Per Week	Internal Marks	External Marks
1	EMEE2201	Major Project/Dissertation	16	0	0	32	32	30	70
2	EMEE2202	Seminar & Vivavoce	5	0	0	10	10	30	70
TOTAL			21	0	0	42	42	60	140

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School of Engineering and Technology

Department of Electrical Engineering

Master of Technology(Power System)

Program Structure	M. Tech (Electrical Engineering))
Subject Code	EMEE 1106
Course Name	Numerical Techniques in Power System
Course Credits	4(T) + 0 (P)= 4
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

1. **Course Overview:**

   This comprehensive course integrates advanced numerical methods with applied statistics, offering students a holistic understanding of mathematical techniques essential for solving intricate problems in engineering, science, and data analysis. Beginning with advanced numerical methods, students explore the solutions of linear simultaneous equations, tridiagonal systems, and iterative approaches to enhance accuracy in ill-conditioned systems.

Moving to numerical methods and applications, they delve into the evaluation of multiple integrals, solution techniques for non-linear simultaneous equations and integral equations, as well as advanced interpolation methods and numerical solutions for ordinary differential equations. The course further encompasses the numerical solution of partial differential equations, programming implementations, and statistical analyses including probability distributions, significance tests, and non-parametric tests. By combining these units, students gain a comprehensive skill set in both numerical analysis and statistical analysis, empowering them to tackle complex challenges across various fields with proficiency and insight.

2. **Prerequisite:**

Prerequisites for this course include a solid foundation in calculus, linear algebra, and probability theory. Students should be familiar with concepts such as differentiation, integration, matrices, vectors, and basic probability distributions. Additionally, proficiency in programming languages such as Python, MATLAB, or similar tools would be beneficial for implementing numerical algorithms and statistical analyses. A basic understanding of differential equations and statistical methods would also be advantageous for grasping more advanced concepts covered in the course.

3. **Objective of the Syllabus:**

The syllabus aims to equip students with advanced numerical methods and applied statistical skills, enabling them to solve complex mathematical problems across engineering, science, and data analysis domains. It focuses on providing a strong theoretical foundation, practical programming experience, and problem-solving abilities necessary for academic and professional success.

4. **Course Outcomes:**

S. No.	Course Outcomes (Cos)
CO1	Proficiency in solving linear simultaneous equations and tridiagonal systems, understanding and addressing ill-conditioned systems through iterative methods.
CO2	Ability to evaluate double and triple integrals, solve non-linear simultaneous equations and integral equations, and proficiency in advanced interpolation and numerical solutions for ODEs.
CO3	Competence in solving initial and boundary value problems, proficiency in numerical solutions for PDEs, and implementation of numerical methods through programming.
CO4	Understanding and application of various probability distributions, conducting tests of significance and goodness-of-fit tests, and analysis under large sample approximation.
CO5	Proficiency in non-parametric tests, time series analysis, applying statistical techniques to reliability and life testing experiments, understanding and applying ANOVA designs.

5. **Syllabus:**

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Unit-I

Advanced Numerical Methods: Review of solution of system of linear simultaneous equation. Solution of tridiagonal system, III conditioned system and iterative method to improve accuracy of an ill-conditioned system.

Unit-II

Evaluation of double and triple integrals by numerical methods and its application, solution of non-linear simultaneous equations, numerical solutions of integral equations, Advanced method of interpolation, spline interpolation, numerical solution of simultaneous first order ordinary differential equations, and higher order O.D.E.

Unit-III

Initial and boundary value problems; Numerical solution of partial differential equations; Laplace and Poisson equation; heat conductive and wave equations; Writing computer program in the above methods.

Unit-IV

Applied Statistics: - Review of binomial, negative binomial, Poisson, normal and log normal distribution. Test of significance of mean, variance, correlation and regression coefficients $\chi 2$ test of goodness of fit; attributes and contingency table; F tests, tests of proportions, tests of significance under large sample approximation.

Unit-V

Non-Parametric Tests: Wald-Wolfowitz runs tests, tests of randomness, median tests, sign tests, Mann-Whitney Wilcoxon U-tests. Time series analysis, introduction to reliability and life

testing experiments in engineering problems. One way and two-way analysis of variance, Completely Randomized Design (CRD), Randomized block Design (RBD), Latin Square Design (LSD).

BOOKS AND REFERENCES

Text Books

1. Peyton Z. Peebles Jr. Probability, Random Variables and random Signal Principles, 4th edition, Tata McGraw Hill, New Delhi, 2010

2. Y.T. Chan Wavelet Basics, Kluwer Publishers, 1993

Reference Books Y.T. Chan Wavelet Basics, Kluwer Publishers, 1993.

Program Structure	M. Tech (Electrical Engineering))
Subject Code	EMEE 1105

Course Name	Reliability Engineering
Course Credits	3 (T) + 2 (P)= 5
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

This course provides a comprehensive exploration of reliability engineering principles and their application in electrical systems, with a specific focus on power systems. Beginning with foundational concepts such as probability theory and random variables, students delve into advanced techniques including system reliability evaluation, Markov processes analysis, and maintenance strategies. Through a combination of theoretical lectures, practical examples, and hands-on exercises, students gain proficiency in evaluating, designing, and optimizing reliable electrical systems. Emphasizing real-world application, the course covers topics ranging from basic reliability definitions to complex power system modeling, outage analysis, and load forecasting. By the end of the course, students develop a deep understanding of reliability engineering principles and acquire the skills necessary to address practical engineering challenges, making meaningful contributions to the reliability and performance of electrical systems.

Prerequisite: Basic understanding of probability theory and engineering principles.

Objective of the Syllabus:

To provide students with a comprehensive understanding of reliability engineering principles and their application in electrical systems, focusing on power systems. Through theoretical instruction, practical examples, and hands-on exercises, the syllabus aims to equip students with the knowledge and skills necessary to analyze, design, and optimize reliable electrical systems, contributing to advancements in the field of reliability engineering.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Understanding of probability theory and its application to reliability analysis.
CO2	Proficiency in evaluating system reliability using various modeling and evaluation techniques.
CO3	Mastery in applying Markov processes to analyze and solve multi-state reliability problems.
CO4	Competence in assessing and optimizing reliability and maintainability parameters in engineering systems.
CO5	Ability to analyze and improve the reliability of power systems through outage analysis and load forecasting techniques.

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Syllabus:

Unit I Theory of Reliability:
Definition of reliability, probability concepts, rules for combining Probability, probability distributions, random variables, density and distribution functions, mathematical expectations, variance, and standard deviation.

Unit II Reliability Evaluation:
General reliability functions, system reliability modeling and evaluation: series, parallel, series-parallel, and complex systems, cut-set method, tie-set method.

Unit III Markov Processes:
Discrete Markov chains, continuous Markov process, frequency and duration approach, application to multi-state problems, examples study.

Unit IV Reliability & Maintainability:
Basic concepts, MTTF, MTTR, MTBF, preventive maintenance, breakdown maintenance, and optimum number of spare parts.

Unit V Power System Reliability - An Introduction:
Generation system models, capacity outage table, loss of load probability, load models, loss of load indices, load forecast uncertainty, and energy index of reliability.

BOOKS AND REFERENCES

Text Books

- Billiton R. And Ronald N. A., "Reliability Evaluation of Power Systems", Pitman Advanced Publishing Program. 1984.
- Billinton R. And Ronald N. A., "Reliability Evaluation of Engineering Systems Concepts and Techniques", Pitman Advanced Publishing Program. 1983

Reference Books

- Endrenyi J., "Reliability Modeling in Electric Power Systems", John Wiley and Sons 1978

RELIABILITY ENGINEERING LAB SUB-CODE: EMEE 1106 CREDIT: 02

Course Objective:
To introduce the concepts of system reliability modeling and evaluation with thrust on generating system reliability evaluation..

Course Outcomes:
Graduates will demonstrate a deep understanding of reliability engineering principles, applying probabilistic models and evaluation techniques to analyze and optimize complex engineering systems, particularly in the realm of electrical power systems, contributing to

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advancements in reliability and performance across industries. They will exhibit proficiency in employing Markov processes, maintenance strategies, and outage analysis to enhance system reliability, ensuring the effective operation of critical infrastructure and fostering innovation in reliability engineering practices.

Syllabus:

Week 1:Determination of Reliability of series and parallel systems.

Week 2: Evaluation of Reliability of a Complex System.

Week 3 : Evaluation of basic probability indices for an electrical power (radial) system.
Week 4:Testing for defective items coming out of manufacturing plants.
Week 5: Determination of power system reliability.
Week 6 : Characteristics of Normal & Log-Normal distributions.
Week 7 : Component & unit redundancy with Exponential distribution.
Week 8 : Optimal redundancy calculation.
Week 9 : Optimum number of spare parts in a repairable/maintainable system.
RAM Analysis of a simple power system

REFERENCE BOOKS:

- Billiton R. And Ronald N. A., “Reliability Evaluation of Power Systems”, Pitman Advanced Publishing Program. 1984.
- Billinton R. And Ronald N. A., “Reliability Evaluation of Engineering Systems Concepts and Techniques”, Pitman Advanced Publishing Program. 1983

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Programme Structure	**M. Tech (Power System)**
Subject Code	**EMEE1104**
Course Name	**EHV AC/DC Transmission**
Course Credits	**3 (L) + + 1 (T) + 0 (P)= 4**
Total Course Credit	**95**

Abbreviations: L- lecture per week T-Theory, P-Practical

Course Overview:

Modern power transmission is utilizing voltages between 345 kV and 1150 kV, A.C. Distances of transmission and bulk powers handled have increased to such an extent that extra high voltages and ultra-high voltages (EHV and UHV) are necessary. The problems encountered with such high voltage transmission lines exposed to nature are electrostatic fields near the lines, audible noise, radio interference, corona losses, carrier and TV interference, high voltage gradients, heavy bundled conductors, control of voltages at power frequency using shunt reactors of the switched type which inject harmonics into the system, switched capacitors, over voltages caused by lightning and switching operations, long air gaps with weak insulating properties for switching surges, ground-return effects, and many more. This course covers all topics that are considered essential for understanding the operation and design of EHV ac overhead lines and underground cables. Theoretical analysis of all problems combined with practical application are dealt in this course.

Prerequisite:

Electric Circuit Analysis, Power system-1 and Power system-2.

Objective of the Syllabus:

Elicit the advantages of EHV AC transmission systems. Mould students to acquire knowledge about HVDC transmission systems. This course gives idea about modern trends in HVDC transmission and its application, Understand about the overvoltage and its effect on power system. Complete analysis of harmonics and basis of protection for HVDC Systems.

Course Outcomes:

S. No.	Course Outcomes (Cos)

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CO1	To Provide In-depth understanding of different aspects of Extra High Voltage AC transmission system design and Analysis.
CO2	To understand the concept of the effect of corona, electrostatic field, voltage control for extra high voltages.
CO3	To develop the empirical formula to determine the Corona loss occurring in EHV AC transmission Line and interference caused by it.
CO4	To analyze the basic concept of reactive power compensation and improvement of system performance due to series and shunt compensation.
CO5	To develop the basic concepts of HVDC, HVDC converters, effect of harmonics and suppression of harmonics by using filters and HVDC control system such as CIA,CC and CEA.

Syllabus:

Unit I- EHVAC Transmission System:
Sequence impedance calculation, calculation of transmission line parameters and sequence impedances for lines with ground returns, lines with bundle conductors and ground returns, sequence networks for various three phase transformer connections.

Unit II- Corona:
Basic phenomenon and calculation of voltage gradient of conductors, power loss, audible noise and radio interference due to corona, electrostatic field of EHV lines.

Unit III- EHV Transmission Line:
Introduction, concepts of design.

Unit IV: Reactive Power Compensation:
Basic concepts of reactive power compensation, principles of series and shunt compensation; Improvement of system performance due to reactive power compensation.

Unit V: HVDC Transmission System:
Brief history of HVDC transmission system, comparison with EHVAC transmission, analysis of converter circuits for HVDC transmission.
HVDC control system: CIA, CC and CEA control analysis of faults in HVDC converters, basic concepts of multi-terminal HVDC system.

BOOKS AND REFERENCES

Text Books

1. Begamudre R.D., Extra High Voltage AC Transmission Engineering, 3 rd Edition, New Age International Private Limited, 2008.

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2. Hingorani N.G. Gyugyi L., Understanding FACTS, IEEE Press, Standard publishers and Distributors, 2001.
3. Miller T.J.E., Reactive Power Control in Electric System, John Wiley and Sons, 1982.

Reference Books

1. Arrilaga J., High Voltage Direct Current Transmission, 2nd Edition, IET Publications.
2. Padiyar K. R., HVDC Power Transmission System, New Age publications, 2008.

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School of Engineering & Technology.

Department of Electrical Engineering

Programme Structure	M. Tech (Power System)
Subject Code	EMEE1103
Course Name	Power Electronics & Drives
Course Credits	3 (L) + + 1 (T) + 2 (P)= 6
Total Course Credit	95

Abbreviations: L- lecture per week, T-Theory, P-Practical

Course Overview:

This course provides a comprehensive understanding of power electronics, motor drives, and control techniques. The students are able to develop technical knowledge, skills and analytical ability to design, develop and test power electronic converters and drives using modern tools and technologies. The course broadly emphasizes on the modelling and control techniques of DC and AC motor drives by the application of power electronics switches. The ultimate goal of the course is to solve the real-world problems in the emerging fields like smart grid, renewable energy interfaces, and electric vehicles and to develop innovative technologies relevant to social, ethical, economic and environmental issues.

Prerequisite:

Electric Circuit Analysis, Analog and Digital electronics, Electrical machines & Power electronics.

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Objective of the Syllabus:

The course is aiming to give a thorough understanding of converter topologies and control principles used in modern electrical motor drives. The course develop basic concepts of load and drive interaction, speed control concepts of ac and dc drives, speed reversal, regenerative braking aspects and design methodology. The significance of applying control techniques in electric drives are further validated through the mathematical modelling in Simulink environment through MATLAB simulation.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	**To** describe the fundamental concepts of electric drives, speed-torque characteristics of different DC and AC motors and their speed control.
CO2	To understand the principle of operation of Converter fed separately excited dc motor drives and explore dual converter-fed DC drives using MATLAB simulation.
CO3	To learn the principle of operation for chopper-fed DC drives and develop its mathematical model to perform stability analysis.
CO4	To analyze the Inverter fed AC Drives using V/f and PWM technique and understand slip power-controlled AC drives.
CO5	Develop mathematical models for induction motor drives to analyze transient response and stability and analyze adjustable frequency operations in synchronous motor drives.

Syllabus:

Unit I- SCADA System:

Basic concepts, design aspects, operational principle, advantages and limitations.

Unit II- Sensor & Controller:

Process sensors – types and roles, A/D & D/A conversion, data communication and storage, parameter set points (references), computer control, controller settings.

Unit III- Signal Conditioning:

Introduction, signal Processing and its Components, Operational Amplifier, Instrumentation Amplifiers, Isolation Amplifiers, Charge Amplifier, Analog Multipliers, Analog Dividers, Function Generator, Timers, Sample and Hold Circuits, Electrical Isolators, Frequency to Voltage Converters, Grounding & Shielding.

Unit IV: Measurement:

Measurement of Voltage, Current, phase angle, frequency, active power and reactive power

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in power plants. Energy meters and multipart tariff meters. Capacitive voltage transformers and their transient behavior, current transformers for measurement and protection, composite errors and transient response.

Unit V: SCADA Examples:
Data acquisition system, Functioning of SCADA, Communication technologies, Monitoring performances, supervisory co-ordination and linkages, SCADA application in Utility Automation, Industrial applications.

BOOKS AND REFERENCES

Text Books

1. Dubey G. K., Fundamentals of Electric Drives, 2 nd Edition, Narosa Publishing House, 2007.
2. Pillai S. K., A first Course in Electric Drives, 2nd Edition, New Age publishers, 2008.
3. Mohan N., Undeland T.M. & Robbins W.P., Power electronics Converters Applications and Design, 3rd Edition, Wiley India, 2008.

Reference Books

3. Dubey G.K., Power Semiconductor Controlled Devices, PHI Editions, 2001.
4. Murphy J.M.D. and Turnbull F.G., Power Electronics Control of AC Motors, Pregamon Press, 1990.

POWER ELECRONICS & DRIVES LAB
SUB-CODE: EMEE1103(P) **CREDIT: 02**

Course Objective:
To introduce basic concepts of load and drive interaction, speed control concepts of ac and dc drives, speed reversal, regenerative braking aspects, design methodology.

Course Outcomes:
At the end of the course the students will be able to:

- Describe the fundamental concepts of electric drives.
- Identify the suitable power converters and fix its rating based on requirement.
- Classify the different types of DC drives and construct its controller.
- Categorize the AC drives and differentiate from DC drives.
- Compare scalar and vector control of AC drives.
- Design and Conduct experiments using MATLAB simulation, as well as analyze and interpret data.

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Syllabus:
Week 1: Study of three phase converters and inverters.
Week 2 Open loop control of DC drive: TF, output responses, etc.
Week 3: Open loop control of AC drive: TF, output responses, etc.
Week 4: SCR / Thyristorized inverters.
Week 5: Study of Jones Chopper: circuit diagrams, operation, etc.
Week 6: Simulation of Electric Drives using MATLAB.

i) Single phase full converter fed separately excited DC Motor.
ii) Chopper control fed separately excited DC Motor.
iii) Three phase converter fed separately excited DC Moto

Week 7: Study of harmonics found in 3-phase Thyristorized induction motor drive.
Week 8: Synchronous Motor control using Thyristor – A Study.

REFERENCE BOOKS:

1. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia, 2012.
2. R. Krishnan, "Electric Motor Drives- Modeling, Analysis and Control", Prentice Hall Inc., 2008.
3. Werner Leonard, "Control of Electric Drives", Springer Verlag, 2012.

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School of Engineering & Technology.

Department of Electrical Engineering.

Programme Structure	**M. Tech (Power System)**
Subject Code	**EMEE1101**
Course Name	**Power System Analysis**
Course Credits	**3 (L) + + 1 (T) + 0 (P)= 4**
Total Course Credit	**95**

Abbreviations: L- lecture per week T-Theory, P-Practical

Course Overview:

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Power system analysis is the core of power engineering, a specialized section of Electrical engineering and its understanding is therefore essential for a career in this field. The course starts with the physical interpretation of bus admittance and impedance matrices in a power system network. After the formation of admittance matrix, load flow analysis is performed using N-R method and Fast decoupled load flow technique in order to analyze the stability of a power system network. This course also broadly deals with power system stability that includes especially transient stability and voltage stability. The various techniques of improving these stability constraints are also discussed briefly.

Prerequisite:

Electric Circuit Analysis, Electrical Machines, Power System - I and Power systems - II.

Objective of the Syllabus:

The course lays the foundation for exploring the ways and means to perform power system stability in normal operation and under symmetrical and unsymmetrical faults. Additionally, principles for the formulation, solution, and application of optimal power flow are established. Computer-aided analysis of the performance of large-scale power systems is one of the central learning objectives.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	**Formation of bus admittance matrix using singular transformation method and their modification for branch addition/deletion in existing power system network.**
CO2	Analytical formulation of complex power flow solution using N-R method and fast decoupled load flow techniques.
CO3	To understand stability constraints of power system network.
CO4	Learn about transient stability of a system by the application of Euler and Runge Kutta method and equal area criterion along with the methods of improving transient stability.
CO5	Assessment of voltage stability, voltage collapse and reactive power control (VAR control) to maintain voltage stability.

Syllabus:

Unit I- Network Matrix:

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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, singular transformation, modification of admittance matrix for branch addition/ deletion.

Unit II- 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 solving power flow problem using N-R method in polar form, fast decoupled load flow method.

Unit III- Power System Stability:
Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study.

Unit IV: 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, solution of swing equation by 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.

Unit V: 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, Reactive power control for voltage stability.

BOOKS AND REFERENCES

Text Books

1. A. Chakrabarti, M.L. Soni, P. V. Gupta, U. S. Bhatnagar "A text book on Power System Engineering", Dhanpat Rai and Co.
2. Hadi Saadat, Power system Analysis, Tata McGraw-Hill Publishing Company Limited.
3. Gross Charles A. Power system Analysis, John Wiley & Sons.
4. Grainger John J. & Stevenson, William D., Power system Analysis, Tata McGraw-Hill Edition.

Reference Books

5. M. A. Pai" Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company, 2nd Edition, 2006.

6. I.J. Nagrath & D.P. Kothari, "Modern Power System Analysis", Tata McGraw-Hill Publishing Company, 3rd Edition, 2010.

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Programme Structure	**M. Tech (Power System)**
Subject Code	**EMEE1102**
Course Name	**Power System SCADA**
Course Credits	**3 (L) + + 1 (T) + 0 (P)= 4**
Total Course Credit	**95**

Abbreviations: L- lecture per week T-Theory, P-Practical

Course Overview:

In today's digital world, we are looking for new opportunities to automate and accelerate our workflows and industrial processes. Since the invention of the computer and the internet, machines begin to integrate computing technologies within the system. This advancement in conventional systems started the new age of the industrial revolution. And like any other system, the power system is no exception. Power systems have evolved according to the needs of investors, consumers, and operators over the past decades. Enterprise resource planning solutions has led power systems to automate. And so, power systems began to incorporate the SCADA system in the late twentieth century. Data acquisition system, Functioning of SCADA, Communication technologies, Monitoring performances, supervisory co-ordination and linkages, SCADA application in Utility Automation are the key topics discussed in this course.

Prerequisite:

Electric Circuit Analysis, Analog and Digital electronics, Measurement and Instrumentation, Power System - I and Power systems - II.

Objective of the Syllabus:

The uninterrupted operation of power system has gained importance in recent years. Also, the advances in interconnected power system and grid operation complexity have led to the automation of plants and machinery for which this course is useful for power engineers.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	**To learn about** basic concepts, design aspects, operational principle, advantages and limitations of SCADA system.
CO2	To analyze different types of sensors and controller used in the field of industrial Automation.
CO3	To analyze signal conditioning and processing by the application of several op-amp based amplifiers and timer circuits.

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CO4	To deal with the measurement of Voltage, Current, energy, phase angle, frequency, active power and reactive power in power plants and analyze the errors associated with them.
CO5	To learn about SCADA applications in Communication technologies, Monitoring performances, supervisory co-ordination and linkages, Utility Automation and Industrial applications.

Syllabus:

Unit I- SCADA System:
Basic concepts, design aspects, operational principle, advantages and limitations.

Unit II- Sensor & Controller:
Process sensors – types and roles, A/D & D/A conversion, data communication and storage, parameter set points (references), computer control, controller settings.

Unit III- Signal Conditioning:
Introduction, signal Processing and its Components, Operational Amplifier, Instrumentation Amplifiers, Isolation Amplifiers, Charge Amplifier, Analog Multipliers, Analog Dividers, Function Generator, Timers, Sample and Hold Circuits, Electrical Isolators, Frequency to Voltage Converters, Grounding & Shielding.

Unit IV: Measurement:
Measurement of Voltage, Current, phase angle, frequency, active power and reactive power in power plants. Energy meters and multipart tariff meters. Capacitive voltage transformers and their transient behavior, current transformers for measurement and protection, composite errors and transient response.

Unit V: SCADA Examples:
Data acquisition system, Functioning of SCADA, Communication technologies, Monitoring performances, supervisory co-ordination and linkages, SCADA application in Utility Automation, Industrial applications.

BOOKS AND REFERENCES

Text Books

1. Doeblin B.D., Measurement systems – Application and Design, McGraw Hill, New York.
2. Bentley John P., Principles of Measurement System, Pearson Education.
3. Ramnath, Power System Instrumentation, Genius publication.

Reference Books

7. Klassen K.B., Electronics Measurement and Instrumentation, Cambridge University.

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8. Stuart A. Boyer, SCADA-Supervisory Control and Data Acquisition, Instrument Society of America Publishers, USA, 2004.

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School of Engineering & Technology.

Department of Electrical Engineering.

Program Structure	M. Tech (Electrical Engineering))
Subject Code	EMEE 1202
Course Name	Protection of power system
Course Credits	3 (T) + 2 (P)= 5
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

This course offers a comprehensive exploration of relay protection systems within electrical power networks. Beginning with the foundational principles in Unit-I, students gain an understanding of fault types, protection zones, relay classifications, and basic elements. Unit-II delves into static relays, examining solid-state devices, comparator functions, and synthesis techniques for various relay types. In Unit-III, digital relay technologies are introduced, covering DSP fundamentals, phasor estimation, and traveling wave-based protection methods. Unit-IV focuses on protecting generators, transformers, and bus zones, addressing stator and rotor protection, differential schemes, and high impedance relay applications. Finally, Unit-V delves into overvoltage phenomena, including lightning protection for transmission lines and substations, alongside discussions on insulation coordination and the integration of AI and SCADA systems. Through this course, students develop the skills to design, implement, and maintain robust relay protection systems critical for ensuring the reliability and safety of electrical power distribution networks.

Prerequisite: The prerequisites for this course typically include a foundational understanding of electrical engineering principles, including circuit theory, electromagnetism, and power systems. Proficiency in mathematics, particularly in calculus and differential equations, is essential for grasping the mathematical concepts involved in relay protection analysis and design. Additionally, familiarity with basic concepts in digital signal processing (DSP) and control systems can be beneficial for comprehending the advanced topics covered in digital relay technologies. Some knowledge of programming languages like MATLAB or Python may

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also be helpful, especially for implementing algorithms and simulations. Overall, a strong background in electrical engineering fundamentals forms the basis for effectively engaging with the material presented in this course.

Objective of the Syllabus:

To understand different protection schemes and applications to transformer, bus bar and generator armature winding protection. To understand the application of DSP fundamentals and application to current and voltage phasor estimation.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Students will be able to identify and classify various types of faults, understand protection zones, and describe the basic elements and terminology of relay protection systems..
CO2	Students will gain proficiency in analyzing and synthesizing static relays, including amplitude and phase comparators, and apply these concepts to design effective protection schemes.
CO3	Students will acquire knowledge of digital relay technologies, including DSP fundamentals, phasor estimation techniques, and traveling wave-based protection principles, enabling them to design and implement advanced protection algorithms.
CO4	Students will develop the skills necessary to design protection schemes for generators, transformers, and bus zones, including differential protection, high impedance relay schemes, and frame leakage protection.
CO5	Students will understand the causes and mitigation strategies for overvoltage phenomena, including lightning strikes, and will be able to design protection systems for transmission lines and substations, incorporating principles of insulation coordination and artificial intelligence.

Syllabus:

Unit-I Basic ideas of relay protection:

Nature and causes of faults, types of faults, zones of protection, classification of protective relays, basic relay elements and relay terminology. Classification of Relays, construction and operation of Electromagnetic relays, current transformer and potential transformer for protection, types of construction, transient behavior.

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Unit-II Static Relays:

Solid state devices used in static protection, amplitude comparator and phase comparator, classification- basic components, static over current relays: non-directional and directional, synthesis of mho relay, reactance relay, impedance relay, and quadrilateral distance relay using static comparators, pilot relaying schemes, carrier current protection.

Unit-III Digital Relay:

Basic components of digital relay, DSP fundamentals like aliasing, sampling theorem. Discrete Fourier transform and application to current and voltage phasor estimation, sinusoidal wave based algorithms, least square based methods. Fundamentals of travelling waves based protection, Bergeran's equation, and discriminant functions.

Unit-IV Protection of Generators:

stator and rotor protection. Transformer protection: differential protection, protection against magnetizing inrush current, earth fault protection. Bus Zone protection: Differential current protections, high impedance relay scheme, frame leakage protection.

Unit-V Causes of over voltages:

lightning phenomena, over voltages due to lightning, protection of transmission lines against direct lightning strokes, protection of sub stations. Insulation coordination, basic impulse level, protection of long and short lines, protection based on artificial intelligence and SCADA. write course overview in brief **.**

BOOKS AND REFERENCES

Text Books

1. Rao T.S.M., Power System Protection Static Relays with Microprocessor Applications, TMH Publication, 1994.
2. Ram Badri and Vishwakarma D.N., Power System Protection and Switchgear, TMH, New Delhi, 2003.
3. Singh L.P. Digital Protection, protective Relaying from Electromechanical to Microprocessor, John Wiley & Sons, 1995.
4. John A.T. and Salman A.K., Digital Protection for Power Systems, IEE Power Series- 15, Peter Peregrines Ltd. UK, 1997.

Reference Books

5. Ram Badri and Vishwakarma D.N., Power System Protection and Switchgear, TMH, New Delhi, 2003.
6. Singh L.P. Digital Protection, protective Relaying from Electromechanical to Microprocessor, John Wiley & Sons, 1995.

PROTECTION OF POWER SYSTEM LAB SUB-CODE: EMEE 1202 CREDIT: 02

Course Objective:

To understand different protection schemes and applications to transformer, bus bar and generator armature winding protection. To understand application of DSP fundamentals and application to current and voltage phasor estimation.

Course Outcomes:
In the lab, students will develop practical skills in testing and calibrating various types of relays, simulating fault conditions in power systems, and analyzing relay response. They will gain hands-on experience in programming digital relays, configuring relay coordination settings, and designing protection schemes for transmission lines, transformers, and substations. Through collaborative projects, students will apply theoretical knowledge to real-world scenarios, fostering teamwork and problem-solving abilities essential for effectively managing and optimizing relay protection systems in electrical power networks.

Syllabus:
Week 1: Determination of sequence impedance of an alternator.

Week 2: Breakdown strength of Transformer Oil

Week 3 Power angle Characteristics of a Salient pole synchronous Machine.
Week 4: Construction and operation of Electromagnetic Relays.
Week 5: Performance Characteristics of an over voltage relay.
Week 6 : Voltage distribution across the string insulator.
Week 7 : Determination of Operating Characteristics of IDMT Relay.
Week 8 : Performance Characteristics of earth fault relay.
Week 9 : Performance of a differential over current relay.
Week 10: Study of DC / AC Circuit Breakers.
Week 11: Study of Buccholz Relay

REFERENCE BOOKS:

- Singh L.P. Digital Protection, protective Relaying from Electromechanical to Microprocessor, John Wiley & Sons, 1995.
- John A.T. and Salman A.K., Digital Protection for Power Systems, IEE Power Series-15, Peter Peregrines Ltd. UK, 1997.

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School of Engineering & Technology.

Department of Electrical Engineering.

Program Structure	M. Tech (Electrical Engineering))
Subject Code	EMEE 1203
Course Name	Soft Computing Technique
Course Credits	3 (T) + 2 (P)= 5
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

This course offers a comprehensive exploration of neural networks and computational intelligence, covering foundational concepts such as biological neuro-systems, mathematical

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models of neurons, and various learning paradigms including supervised, unsupervised, and reinforcement learning. Students delve into neural network architectures, training algorithms like backpropagation, and applications across diverse fields. Additionally, the course delves into fuzzy sets, fuzzy control systems, and their applications in engineering, alongside an introduction to genetic algorithms and hybrid systems. Throughout the course, emphasis is placed on understanding theoretical underpinnings, implementing algorithms, and analyzing real-world case studies to gain practical insights into pattern recognition, control systems, and engineering challenges.

Prerequisite: Prerequisites for this course include a fundamental understanding of mathematics, particularly calculus, linear algebra, and probability theory. Additionally, familiarity with programming languages such as Python or MATLAB is beneficial for implementing algorithms and conducting experiments. Basic knowledge of computer science concepts like data structures and algorithms would also be advantageous. Understanding concepts from introductory courses in artificial intelligence or machine learning would provide a helpful foundation, although it's not strictly required.

Objective of the Syllabus:
To provide concepts of soft computing and design controllers based on ANN and Fuzzy systems. To identify systems using soft computing techniques. To give exposure to optimization using genetic algorithm. To provide knowledge on hybrid systems.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Understand neural network fundamentals and their applications.
CO2	Implement various types of neural networks and activation functions.
CO3	Apply supervised and unsupervised learning algorithms effectively.
CO4	Design and analyze fuzzy logic controllers for engineering systems.
CO5	Implement genetic algorithms and hybrid systems for optimization and control.

Syllabus:

Unit-I Neural Networks:
Overview of biological Neuro-system, Mathematical models of neurons, ANN architecture, Learning rules; Learning paradigms - Supervised, Unsupervised and Reinforcement learning;

ANN training algorithms - perceptions, Training rules, Delta, Back propagation algorithm; Multilayer perceptron model; Applications of artificial neural networks.

Unit-II Biological Foundations:
ANN models, types of activation function, introduction to Network architectures, multi-layer feed forward network, radial basis function network, recurring neural network.

Unit-III Learning Process:
Supervised and unsupervised learning, error correction learning, Hebbian learning, Boltzmen learning, single layer and multi-layer perceptrons, least mean square algorithm, back propagation algorithm, applications in pattern recognition and other engineering problems. Case Study: Identification and control of linear and nonlinear systems.

Unit-IV Fuzzy Sets:
Fuzzy set operations, properties, membership functions, Fuzzy to crisp conversion, fuzzification and defuzzification methods applications in engineering problems. Fuzzy Control Systems: Introduction, simple fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy heating system, Adaptive fuzzy system.

Unit-V Genetic Algorithm:
Introduction, basic concepts of Genetic Algorithm, applications. Hybrid Systems: Adaptive neuro fuzzy interference system, Neuro-genetic, Fuzzy-genetic systems.

BOOKS AND REFERENCES

Text Books/ Reference Books

1. Zurada M., Introduction to Artificial Neural Systems, Jaico Publishers, 1992.
2. Haykins Simon, Neural Networks-A Comprehensive Foundation, Macmillan College, Proc, Con, Inc., New York 1994.
3. Driankov, D., Hellendorn H. & Rein frank M. Fuzzy Control-An Introduction, Narosa Publishing House, New Delhi, 1993.
4. Klir G.J. Boyuan, Fuzzy Sets and Fuzzy Logic, PHI, 1997.

Program Structure	M. Tech (Electrical Engineering))
Subject Code	EMEE 1201
Course Name	Transients Study
Course Credits	4(T) + 0 (P)= 4
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

This comprehensive course on transients and surges in electrical power systems provides a thorough understanding of the fundamental principles, practical strategies, and mitigation techniques essential for ensuring the reliable operation of power grids. Spanning across five units, it covers the origins, characteristics, and control of transients and surges, encompassing topics such as surge parameters, equivalent circuit representations, lightning-induced transients, switching transients, and protective devices. Through a combination of theoretical discussions and real-world examples, students will gain insights into the complexities of transient phenomena and learn how to apply various methods and devices to effectively manage and mitigate their impacts in power system design, operation, and maintenance.

Prerequisite:

This course is designed for students with a background in electrical engineering or a related field. Prior knowledge of fundamental concepts in electric circuits, electromagnetic theory, and power systems is essential. Familiarity with topics such as circuit analysis, transmission lines, transformers, and protective devices will be beneficial for understanding the material covered in this course. Additionally, proficiency in mathematical techniques such as differential equations and complex numbers will be advantageous for solving problems and analyzing transient phenomena effectively.

Objective of the Syllabus:

This syllabus aims to impart a comprehensive understanding of transients and surges in electrical power systems, enabling students to analyze, control, and mitigate transient phenomena effectively. By the end of the course, students should be equipped to understand, evaluate, and address transient-related challenges in power system design, operation, and maintenance.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Students will comprehend the fundamental characteristics and behaviors of transients and surges in electrical power systems, including surge parameters and equivalent circuit representations
CO2	Students will analyze and apply control techniques for transients, including understanding the influence of tower footing resistance and earth resistance on transient behavior.

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CO3	Students will evaluate lightning-induced transients and surges in power systems, including mathematical modeling and prevention techniques, as well as understanding transformer behavior under surge conditions.
CO4	Students will demonstrate proficiency in analyzing switching transients and the operation of protective devices in power systems, including surge diverters, absorbers, and lightning arresters.
CO5	Students will apply the symmetrical component method to analyze and mitigate abnormal switching transients, including addressing issues such as ferro resonance and transformer inrush current.

Syllabus:

Unit-I

Introduction: Origin and nature of transients and surges; Surge parameters of plants; Equivalent circuit representations; Lumped and distributed circuit transients. Line energization, and de- energization transients; Earth and earth wire effects; current chopping in circuit breakers; short Line fault condition and its relation to circuit breaker duty; Trapped charge effects; Effect of source and source representation in short line fault studies.

Unit-II

Control of Transients: Control of transients; Influence of tower footing resistance and earth resistance; travelling waves in distributed parameter multi-conductor lines, parameters as a function of frequency.

Unit-III

Lightning: Transients in electric power systems - internal and external causes of over voltages - lightning strokes – mathematical model to represent lightning - stroke to tower and midspan prevention of lightning over voltages. Transformer model for switching on open circuit, surges in transformer, step voltage, voltage distribution in transformer winding, winding oscillations.

Unit-IV

Switching Transients: The circuit closing transient – the recovery transient initiated by the removal of the short circuit – double frequency transients. Transmission Lines Protective Devices and Systems: Basic idea about protection, surge diverters, surge absorbers, ground fault neutralizers. Protection of lines and stations by shielding, ground wires, counter poises, driven rods, modern lightning arresters.

Unit-V

Abnormal switching transients, Current suppression, capacitance switching, arcing ground, transformer inrush current, Ferro resonance, neutral connections, transients in switching a three phase reactor, three phase capacitor, Symmetrical component method for solving three phase switching transients.

BOOKS AND REFERENCES

Text Books

1. Allen Greenwood, Electrical transients in Power Systems, Wiley Inter science, 1971.

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2. Bewely L. W., Travelling Waves and Transmission Systems, Dover Publications, New York, 1963.
3. Gallagher P.J. and Pear main A.J., High Voltage Measurement, Testing and Design, John

Wiley and Sons, New York, 1982.
4. Klaus Ragallea, Surges and High Voltage Networks, 1980.

Programme Structure	M. Tech (Power System)
Subject Code	EMEE1205
Course Name	Power System Reliability
Course Credits	3 (L) + + 1 (T) + 3 (P)= 6
Total Course Credit	95

Abbreviations: L- lecture per week, T-Theory, P-Practical

Course Overview:

Electric grid is an extremely important piece of infrastructure, a single daylong nationwide power outage can shave off 0.5% of the country's GDP. The cost of improvements is also high, so in practice a balance is sought to reach an "adequate level of reliability" at an acceptable cost. The power system reliability (sometimes grid reliability) is the probability of a normal operation of the electrical grid at a given time. Reliability indices characterize the ability of the electrical system to supply customers with electricity as needed by measuring the frequency, duration, and scale of supply interruptions. This course introduces the concepts of reliability modeling of generation, transmission and distribution systems and their applications in assessing the system adequacy and continuity; and to include service quality based on key reliability indices.

Prerequisite:

Electric Circuit Analysis, Power system-1 and Power system-2.

Objective of the Syllabus:

To introduce the concepts of reliability modeling of generation, transmission and distribution systems and their applications in assessing the system adequacy and continuity; and to include service quality based on key reliability indices.

Course Outcomes:

S. No.	Course Outcomes (Cos)

CO1	Understanding how to model the capacity of power generation units, analyzing load characteristics using load duration curves and calculating reliability indices such as Loss of Load Probability (LOLP) and Expected Energy Not Served (EENS).
CO2	To understand spinning reserve and operating reserve in isolated and interconnected power systems considering customer preferences and reliability levels.
CO3	To analyze the impact of losing one or more transmission lines and assessing transmission line capacities.
CO4	Assessing reliability in two-area interconnected power systems considering tie capacity and reliability indices and to understand extending reliability assessment to larger interconnected systems.
CO5	Analyzing the impact of lateral distributor protection and disconnects considering weather conditions, failure modes and maintenance strategies.

Syllabus:

Unit I- Generation System Reliability:
Generation capacity modeling, load capacity modeling, capacity outage probability tables, unit outage / removal, role of adding one or more units, evaluation of loss of load and energy indices, Frequency and Duration method, generation inadequacy assessment: risk of generating unit coming under breakdown (or repair), static generation reserve margin.

Unit II- Spinning Reserve:
Basic concepts of spinning reserve, operating reserve, spinning reserve study in isolated and interconnected power system, spinning reserve unit commitment, spinning reserve clearing system, customer choice on reliability.

Unit III- Transmission System Reliability:
Transmission system capacity evaluation, loss of one or more transmission lines, transmission lines reliability, inadequacy and risk assessment. Reliability assessment of combined generation and transmission systems.

Unit IV: Interconnected Power System Reliability:
Probability array method in reliability assessment of two area interconnected power systems, effect of tie capacity, reliability indices, reliability evaluation of multi-area interconnected systems.

Unit V: Distribution System Reliability:
Basic technique and application to radial systems, customer– oriented indices, load and energy indices, effect of lateral distributor protection, effect of disconnects, effect of

protection failures, effect of load transfer, failure modes and effects analysis, scheduled and breakdown maintenance, effect of weather conditions.

BOOKS AND REFERENCES

Text Books

Roy Billinton and Ronald N. Allan, Reliability Evaluation of Engineering Systems, Reprinted in India B.S. Publication, 2007.

E. Balagurusamy, Reliability Engineering, TMH, 2003.

Charles E. Ebeling, Reliability and Maintainability Engineering, TMH, 2000.

Reference Books

Power System Reliability Evaluation By Roy Billinton,1970.

Reliability Modeling in Electric Power Systems by J. Endrenyi,1979.

POWER SYSTEM RELIABILITY LAB

SUB-CODE: EMEE1205(P) CREDIT: 02

Course Objective:

To introduce the concepts of reliability modeling of generation, transmission and distribution systems and their applications in assessing the system adequacy and continuity; and to include service quality based on key reliability indices.

Course Outcomes:

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

- **Status of Indian Power Grid Operational Feature** obtained from the Central Electricity Authority (CEA) and the Power System Operation Corporation Limited (POSOCO).
- To analyze reliability indices assessment like LOLP, LOLE, EIR, EFLC and EENS.
- To analyze transmission reliability indices like SAIFI, SAIDI and CAIDI.
- Load forecasting prediction using ANN, ARIMA, regression models and machine learning algorithm.
- **To understand generating System Planning with Load & Reserve Margin.**
- To analyze distribution reliability indices include SAIFI, SAIDI, CAIDI, and Energy Not Supplied (ENS).

Syllabus:

Week 1: Status of Indian Power Grid operational features.

Week 2: Reliability Indices of Generating power systems: LOLP, LOLE, EIR, etc.
Week 3: Reliability Indices of Transmission Line System.
Week 4: Reliability Indices of Combined Generation & Transmission systems.
Week 5: Modeling of electrical load forecasting techniques.
Week 6: Generating System Planning with Load & Reserve Margin.
Week 7: Reliability Indices of Electrical Distribution system.
Week 8: Reliability Indices of Industrial Power System: SAIFI, SAIDI, ASAI, etc.

REFERENCE BOOKS:

4. Roy Billinton and Ronald N. Allan, Reliability Evaluation of Engineering Systems, Reprinted in India B.S. Publication, 2007.
5. Reliability Modeling in Electric Power Systems by J. Endrenyi,1979.
6. E. Balagurusamy, Reliability Engineering, TMH, 2003.

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School of Engineering & Technology.

Department of Electrical Engineering.

Programme Structure	M. Tech (Power System)
Subject Code	EMEE 1206
Course Name	Power System Planning & Layout
Course Credits	3 (T) + 2 (P)= 5
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

Giving students a thorough grasp of power system planning, design, and operation is the aim of this course. The goal of the course is to give students the information and abilities needed to efficiently plan, evaluate, and operate electrical power systems.

Prerequisite:

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Apply knowledge of power system planning and layouts to analyze and design industrial power systems effectively.

Objective of the Syllabus:

a. Apply critical thinking and problem-solving skills to address real-world challenges in power system planning and operation.
b. Demonstrate an understanding of regulatory standards, safety norms, and current developments in the Indian power industry.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Understand the fundamental elements of power system planning and layouts, including the representation of power systems using 1-line diagrams.
CO2	Gain insights into the generation, transmission, and distribution aspects of power systems, including both long-term and short-term planning.
CO3	Analyze and evaluate generation planning, load forecasting techniques, power quality, reliability, and losses in power systems.
CO4	Understand transmission line planning, including line capacity, selection of voltage levels, and the application of FACTS for system reactive power control.
CO5	Explore growth prospects in the power sector, including capacity augmentations, energy conservation, and security and contingency analysis.

Syllabus:

Unit-I Basic Elements Power System Planning & Layouts

Representation of power system using 1- line diagram, layouts of actual industrial power system, various issues relating to power system planning: an overview of the generation, Transmission, and distribution aspects: long-term and short-term planning, growth, and development of the Electrical Power Industry: global and Indian Scenario, India Electricity Rules, safety standards, Indian power industry, and current developments.

Unit-II Generation Planning

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Load forecasting techniques, power quality, and reliability, losses in power system, generation reserve capacity, technical, operational, and economical issues.

Unit-III Transmission Line Planning

Line capacity, selection of voltage levels and type of system (EHV AC or HVDC), applications of FACTS and system reactive power control, Line congestion in deregulated systems and their minimization, Grid issues and regulations, Tie-Line power flow regulation.

Unit-IV Distribution Planning

Selection of Transformer, distribution systems: ring mains and radial systems, power loss minimization, voltage regulation, substation location and planning, loss minimization in feeders by VAR compensation: series and shunt compensation, improved billing strategies, System control using SCADA and computer control.

Unit-V Growth Prospects

Power system capacity augmentations, energy conservation and audits, Security and contingency analysis.

BOOKS AND REFERENCES

Text Books

a. Pabla, A.S., Electrical Power Distribution Systems, TMH, New Delhi, *1992.*
b. National Power Plan (1985-2000AD) Central Electricity Authority, Ministry of Power, Government of India, New Delhi, *1987.*
c. Sullivan W. and Wayne, W., Fundamentals of Forecasting, Reston Publishing Company, Virizinia,*1977.*

Reference Books

a. Johnson C.D., Process Control Instrumentation Technology, 8 th Edition, PHI.
b. Billington, Roy and Allen, R.N., Reliability Evaluation of Power System, Pitman, London (U.K.), 1984. 5. Weedy, B.M., Electrical Power Systems, John Wiley and Sons, Singapore, *1988.*

Programme Structure	M. Tech (Power System)
Subject Code	EMEE 1204
Course Name	Process Control & Industrial Automation
Course Credits	3 (T) + 2 (P)= 5
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

To comprehend issues with physical process control. to provide information about PID controllers' industrial applications. To assess alternative control structures used in process control. to comprehend industrial automation as a field. to comprehend computer-controlled operations and programmable logic controllers.

Prerequisite:

Basic knowledge of electrical circuits and systems, basic understanding of industrial processes and equipment.

Objective of the Syllabus:

c. Learn about controller principles, including different controller modes and their characteristics.

d. To model the transmission lines in terms of mechanical parameter and stresses.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Understand the fundamental concepts of process dynamics, including first and second-order systems, control valves, and heat exchangers.
CO2	Analyze and design control strategies for various processes, such as level control, flow control, and control of chemical reactors.
CO3	Familiarize themselves with advanced control techniques for both linear and non-linear systems.
CO4	Gain knowledge about SCADA systems, PLCs, and distributed control systems and their applications in industrial settings.
CO5	Understand digital controllers, their implementation, and the effects of sampling on control systems

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Syllabus:

Unit-I Introduction to Process Dynamics

Physical Examples of first-order process, first-order systems in series, dynamic behavior of first and second-order systems, Control valves and transmission lines dynamics, and control of heat exchangers. Process Control Dynamics: Level Control, flow control, stability and control of chemical reactors, different control modes, and turning ON/OFF, P, PI, PD, PID. Zeigler Nichols self-tuning methods.

Unit-II Advanced process control techniques

Advanced process control techniques for both linear and non-linear systems: Feedforward control, cascade control, ratio control, adaptive control, override control, control of the nonlinear process with delay, Hierarchical control, and internal mode control. MPC, statistical process control. Digital controllers, the effect of sampling, Implementation of PID-stability and turning, and digital feed-forward control.

Unit-III Introduction to SCADA

SCADA Systems, SCADA Architecture, monolithic, distributed and network, PLC-combinational and sequential logic controllers, system integration with PLCs and computers, application in industry. Distributed control systems- PC-based control.

Unit-IV Programming

Programming ON/OFF inputs to produce ON/OFF outputs, Relation of digital gate logic to contact/coil logic, digital gate logic, PLC ladder logic, Introduction to IEC61511/61508, and the safety cycle.

Unit-V Controller principles

Controller principles: Process Characteristics, Control System parameters, Discontinuous controller modes, Continuous Controller modes, composite controller modes.

BOOKS AND REFERENCES

Text Books

d. Donald R. Coughanowr, Process Systems Analysis and Control MGH, 3rd edition, *1994.*

e. Liptak G. Handbook of process Control, *1996.*

f. Luyben W., Process Modeling, Simulation and Control for Chemical Engineers, MGH, 2 nd edition.,*1999*

Reference Books

c. Johnson C.D., Process Control Instrumentation Technology, 8 th Edition, PHI.

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d. B.M.Weedy, B.J.Cory, N.Jenkins, J.Ekanayake and G.Strbac, "Electric Power Systems", Wiley,*2012*

Programme Structure	M. Tech (Power System)
Subject Code	EMEE2102i
Course Name	Power Quality Improvement Techniques
Course Credits	3 (T) + 2 (P)= 5
Total Course Credit	95

Abbreviations: T-Theory, P-Practical

Course Overview:

The goal of the course is to provide students with a comprehensive grasp of various communication technologies and smart grid power management concerns, as well as to establish a conceptual framework for smart grids.

Prerequisite:

Analyze the architecture and components integral to power quality improvement.

Objective of the Syllabus:

a.These course outcomes aim to provide students with a comprehensive understanding of power quality improvement.

b.Understand the cloud architecture of power quality improvement and its benefits.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Understand and Analyze Power Quality Issues.
CO2	Understand Comprehend Harmonics Fundamentals.
CO3	Understand the Evaluate Harmonic Effects.
CO4	Understand the design Harmonic Mitigation Techniques.
CO5	Understand Active Filter Compensation.

Syllabus:

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Unit-I Concept of Power Quality

Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise. Fundamentals of Harmonics: Representation of harmonics, waveform, and harmonic power, measures of harmonic distortion; Current and voltage limits of harmonic distortions: IEEE, IEC, EN, and NORSOK

Unit-II Causes of Harmonics

2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger. Effect of Harmonics: Parallel and series resonance, effect of harmonics on static power plant – transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipment's and communication systems, power measurement.

Unit-III Elimination/ Suppression of Harmonics

High power factor converter, multi-pulse converters using transformer connections (delta, polygon), Passive Filters: Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design. Introduction to digital filter techniques.

Unit-IV Active Power Filters

Compensation principle, classification of active filters by objective, system configuration, and power circuit and control strategy. PWM Inverter: Voltage sourced active filter, current sourced active filter, constant frequency control, constant tolerance band control, variable tolerance band control.

Unit-V Shunt Active Filter

Single-phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three-phase active filter: Operation, analysis and modeling; Instantaneous reactive power theory. Three-phase Series Active Filter: Principle of operation, analysis and modeling

BOOKS AND REFERENCES

Text Books

1.Derek A. P., "Power Electronic Converter Harmonics", IEEE Press. *1989.*

2.Arrillaga J., Smith B.C., Watson N.R. and Wood A.R. Power SystemHarmonics Analysis, 2nd edition, Wiley India, *2008.*

3.Arthur R. B., "Power System Analysis", 2nd Ed., Pearson Education. *2008.*

Reference Books

4.Sankaran C., "Power Quality", CRC Press. *2001*

5.Arrillaga J., Braedlley D. A. and Bodger P. S., "Power System Harmonics",John Wiley and Sons. *1985.*

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School of Engineering & Technology.

Department of Electrical Engineering.

Programme Structure	M. Tech (Power System)
Subject Code	EMEE2101ii
Course Name	**Smart Grid Technology & Applications**
Course Credits	**3 (T) + 2 (P)= 5**
Total Course Credit	**95**

Abbreviations: T-Theory, P-Practical

Course Overview:

The goal of the course is to provide students with a comprehensive grasp of various communication technologies and smart grid power management concerns, as well as to establish a conceptual framework for smart grids.

Prerequisite:

Analyze the architecture and components integral to Smart Grid design.

Objective of the Syllabus:

These course outcomes aim to provide students with a comprehensive understanding of Smart Grid technologies.

Understand the cloud architecture of Smart Grids and its benefits.

Course Outcomes:

S. No.	Course Outcomes (Cos)
CO1	Understand the evolution of the electric grid and its transition to Smart Grid technologies.

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CO2	Understand Real-Time Pricing models and their impact on consumer behavior.
CO3	Understand the principles of Substation Automation.
CO4	Understand Load Frequency Control (LFC) and its importance in maintaining grid stability.
CO5	Explore the integration of cloud computing in Smart Grids.

Syllabus:

Unit-I Evolution of Electric Grid

Evolution of Electric Grid, Concept, Definitions and need for Smart Grid, Smart grid Drivers, functions, opportunities, challenges and benefits. Present development & International policies in Smart Grid. Indian Smart Grid. Components and architecture of Smart Grid design.

Unit-II Introduction to smart meters

Real-Time Pricing- Models, Smart Appliances, Automatic meter Reading; Plug-in Hybrid electric vehicles, vehicle to grid, Smart Sensors, Home & Building Automation.

Unit-III Smart Substations

Smart Substations, Substation Automation, Introduction to IEC 61850 Feeder Automation, Geographic Information System, Intelligent Electronic Devices & their applications for monitoring and protection, Wide Area measurement system, the Phase measurement unit

Unit-IV Load Frequency Control (LFC)

LFC in Micro Grid System, Voltage Control in Micro Grid system, and reactive power control in Smart Grid.

Unit-V Advanced Metering

AM Infrastructure, Home area Network, Bluetooth, Zig-Bee, GPS, Wi-Fi & Wi-Max based communication, cloud computing in Smart Grid. Cloud architecture of smart grid

BOOKS AND REFERENCES

Text Books

A Stuart Borlase, “Smart Grids, Infrastructure, Technology and Solutions”, CRC Press, *2013.*

Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley.

Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press.

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Reference Books

James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley, IEEE Press, *2012.*

A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, *2010.*