

Syllabus: Distribution System Design and Safety Training

Total Duration: 40 Hours (7 days)

Total Chapters: 20

Target Audience: Experienced and fresh engineers

Objective: To update knowledge, share expertise, and explore case studies in the Nepalese context.

Host: Nepal Engineers Association (NEA) in collaboration with Nepal Electricity Authority (NEA).

Chapter 1: Introduction to Electrical Distribution System

- **Nomenclature and Voltage Levels:** familiarization with distribution system components and voltage levels.
- **Voltage Standards:** National/international standards and their impact on equipment compatibility and system performance.
- **Three-Phase to Single-Phase transition:** Principles, usage scenarios, and efficiency considerations, and operational implications
- **Conductor and insulators:** AAC, AAAC, ACSR, HTLS, ABC and other conductors
- **System Configurations:** primary and secondary line configurations eg. Radial, loop network etc.
- **Nepalese Distribution System:** Current structure, challenges, and opportunities for modernization.

Chapter 2: Short-Term Load Forecasting & Feature Engineering – Operational Perspectives

- **Real-Time Grid Management:** Utilizing historical load data, weather forecasts, and real-time data for distribution system optimization.
- **Advanced Forecasting Methods:** Implementing regression, neural networks, and ARIMA models with refined feature engineering.
- **Performance Metrics:** Evaluating accuracy using MAPE, RMSE, and pre/post feature engineering comparisons.
- **Nepal-Specific Challenges:** Addressing data limitations, resource constraints, and forecasting gaps in local utilities.
- **Practical Applications:** Case studies from Nepal's power sector demonstrating enhanced forecasting accuracy.

Chapter 3: Long-Term Load Forecasting – Planning Perspectives

- **Role in Infrastructure Planning:** Long-term capacity expansion and investment decisions.
- **Influencing Factors:** Population growth, urbanization, industrialization, and policy impacts.
- **Forecasting Models:** Econometric modeling, scenario-based forecasting, and Delphi method.
- **Uncertainty Management:** Strategies for incorporating variability and risk.
- **Nepal-Specific Examples:** Regional demand growth and its implications.

Chapter 4: Voltage Drop and Loss Calculations

- **Method of Moments:** Step-by-step explanation and applications.
- **Line Flow Calculations:** Shortcut and iterative methods for quick analysis.

- **Analytical Techniques:** Principles of Distribution system load flow methods
- **Advanced Techniques** inclusion of distributed generation in distribution system load flow analysis
- **Voltage Regulation:** Techniques for improving voltage profiles.
- **Hands-On Case Studies:** Real-world examples from Nepal.

Chapter 5: Load Flow in Distribution Systems

- **Load Flow Analysis:** Importance for system planning and operational efficiency.
- **Key Parameters:** Voltage profiles, line currents, and losses.
- **Software Applications:** Use of LF tools like ETAP and others
- **Hands-On Exercises:** Simulation of Nepalese distribution networks.
- **Error Handling:** Addressing convergence issues.

Chapter 6: GIS Systems

- **Concepts:** Role of GIS in utility management.
- **Applications:** Asset mapping, outage management, and route optimization.
- **Implementation Challenges:** Data collection and integration.
- **Case Studies:** Use in Nepal's distribution sector.
- **Future Prospects:** Advancements in GIS technologies.

Chapter 7: Optimal distribution System Design

- **Distribution transformer selection: optimal location and sizing of Distribution transformer.**
- **Substation design principle:** Optimal sitting & sizing based on load centers, environment, and accessibility, Basic design principles.
- **Network Optimization:** HT/LT design with optimal conductor selection for reliability and cost-effectiveness.
- **Cost & Practicality:** Cost-benefit insights with real-world applications in Nepal.

Chapter 8: Losses in Distribution System

- **Introduction to Losses:** Overview of technical and non-technical losses.
- **Breakdown of Losses:** Segregation into primary categories.
- **Non-Technical Loss Issues:** Theft, metering inaccuracies, and billing inefficiencies.
- **Case Studies:** Loss analysis in Nepalese distribution utilities e.g. DLRMP
- **Technological Solutions:** Smart meters, AMI, and automated loss tracking for improved efficiency.
- **Stakeholder Engagement:** Role of utilities, government, and community participation.
- **Lessons Learned:** Key takeaways, replicable strategies, and best practices.

Chapter 9: Case Studies & Practical Insights of Technical Losses

- **Global & Nepal-Specific Success Stories:** Review of major loss reduction initiatives and their impact.
- **Key Loss Contributors:** Conductor losses, transformer inefficiencies, reactive power flow, aging infrastructure, and poor maintenance.

- **Minimization Strategies:** Network reconfiguration, conductor upgrades, and reactive power compensation etc.
- **Open Discussion:** Experience sharing and problem-solving for future loss reduction efforts.

Chapter 10: Distribution System Protection

- **Existing Practices:** Overview of current protection schemes.
- **Conventional Methods:** Fuses, circuit breakers, and relays.
- **Protection Coordination:** Ensuring seamless operation of protective devices.
- **Challenges in Nepal:** Issues in rural and remote areas.
- **Best Practices:** Examples from developed systems.

Chapter 11: Protection Coordination with Renewable Energy

- **Challenges with Integration:** Variability and grid stability.
- **Advanced Protection Systems:** Inverter-based protection, adaptive relays.
- **Practical Examples:** Microgrids and solar integration in Nepal.
- **Reliability Studies:** Ensuring uninterrupted supply.
- **Case Studies:** Lessons from Nepalese renewable projects.

Chapter 12: Urban and Underground Distribution Systems

- **Urban Challenges:** Congestion, reliability, and safety.
- **Underground Systems:** Design considerations and cost implications.
- **Planning and Implementation:** Best practices for urban environments.
- **Economic Analysis:** ROI and lifecycle costs.
- **Case Studies:** Urban projects.

Chapter 13: Nepalese Rural Electrification

- **Historical Progress:** Timeline and milestones.
- **Challenges:** Technical, financial, and social aspects.
- **Community Involvement:** Role of local stakeholders.
- **Lessons Learned:** Successes and failures.
- **Future Prospects:** Expansion and sustainability strategies.

Chapter 14: Distribution System Automation

- **Substation Automation:** SCADA systems and their benefits.
- **Data Center Management:** Centralized monitoring and control.
- **System Integration:** Interoperability and scalability.
- **Challenges and Solutions:** Practical insights.
- **Case Studies:** Nepal's steps toward automation.

Chapter 15: Distribution Network Automation

- **Concepts:** Definition and scope.
- **Implementation Strategies:** Stepwise approach to network automation.

- **Challenges and Solutions:** Overcoming resource and technical barriers.
- **Case Studies:** Successful implementations examples.
- **Future Trends:** Smart grid integration.

Chapter 16: Procurement and Inventory Management

- **Quality Assurance:** Ensuring compliance with standards.
- **Procurement Procedures:** Transparent and efficient processes.
- **Inventory Optimization:** Techniques for minimizing costs.
- **Case Studies:** Examples from Nepalese utilities.
- **Future Directions:** Digital and AI-based tools.

Chapter 17: Demand Side Management

- **Consumer-Side Perspectives:** Role in grid stability.
- **Implementation Techniques:** Load shifting, peak shaving, and efficiency programs.
- **Economic Benefits:** Cost reductions for utilities and consumers.
- **Policy Frameworks:** Supportive regulations.
- **Case Studies:** Implementations examples.

Chapter 18: TOD and Smart Metering

- **Time-of-Use Metering:** Concepts, benefits, and implementation.
- **Smart Metering:** Features, challenges, and opportunities.
- **Net Metering:** Policy and practical aspects.
- **Evolution Story:** Timeline of technological advancements.
- **Case Studies:** Examples.

Chapter 19: Safety Culture and Motivation

- **Safety Principles:** Building a strong safety culture.
- **Motivational Strategies:** Incentives and training programs.
- **Implementation Challenges:** Addressing resistance to safety measures.
- **Case Studies:** Successful examples in Nepal.
- **Discussion:** Open forum for sharing experiences.

Chapter 20: Safety in Distribution Systems

- **Nomenclature and PPE:** Standard terms and equipment.
- **Safety Hazards:** Identification and mitigation strategies.
- **Live Line Maintenance:** Procedures and tools.
- **Global Standards:** Benchmarks and adoption in Nepal.
- **Case Studies:** Practical safety applications.

Note: Each Chapter will include detailed discussions, practical examples, and case studies tailored to the Nepalese context.