

TECHNICAL ENGINEERING COURSES

System Reliability

Long Term Dynamics

System Restoration

Voltage Stability

Methods of Reliability Applied to Distribution Systems

Introduction

Most of power system interruptions are due to breakdowns in distribution systems. It is essential for a distribution company to have the proper means to systematically assess the level of network reliability and the frequency and duration of customer interruptions.

The end customers are greatly affected by the level of reliability in the distribution system. Most jurisdictions require reporting on the quality of service in terms of frequency and duration of sustained interruptions with specifications on the reporting of the reliability indices such as the System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI).

What you will learn

The Reliability Tutorial is meant to be a practical course to introduce reliability concepts through a systematic building-block approach. It starts with basic notions of probability theory and progresses towards stochastic models and their application to the distribution networks. This course introduces Markov models, the frequency and distribution method; all supported by relevant industry examples. The tutorial introduces the standard measures for distribution reliability, and fosters discussions around the most contributing factors affecting the reliability indices.

The tutorial captures all the steps required not only to assess Distribution Reliability but also to implement effective actions to reduce the frequency and duration of customer interruptions. It will provide you with essential tools to improve the reliability indices and to determine the best investment strategies.

Audience

The tutorial has been developed for a wide range of practitioners from the power industry. It is particularly useful for:

- Distribution system planning and operation engineers.
- Distribution system economists and risk managers.
- Decision makers of system expansion, refurbishment and rehabilitation.

Course Language:

English

Duration:

2 days

Instructor:

Puica Nitu

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Course Outline

Day 1

- **Regulatory Framework: Reliability and Security**
 - Security criteria
 - Operating strategies
 - Area supply reliability
 - Definitions of factors affecting distribution reliability indices
 - Load distribution company
 - Customer performance
 - Forced outages
 - Maintenance strategy
- **Concepts of Probability Theory**
 - Probability concepts
 - Probability distributions
 - Binomial distribution
 - Poisson distribution, exponential distribution
 - Empirical distributions
 - Estimation
 - Fitting methods
 - Serial/parallel systems
- **Application of Probability Distributions in Reliability Assessments**
 - Concept of reliability
 - Reliability function
 - Common distributions in component reliability
 - Component reliability model selection:
 - Binomial, frequency and duration, minimal cut set
- **Stochastic Processes to Model Generator Behavior**
 - Markov process
 - Stochastic transitional probability matrix
 - The concept of transition rate
 - State space diagram
 - The bathtub hazard function
 - Frequency and duration technique
 - Mean duration of individual states
 - Mean duration of states
 - Cumulative frequency
 - Binomial method
 - Cut set method
- **Probability Distribution of Distribution Networks**
 - Distribution indices
 - Assessment of past performance
 - Sustained interruption indices
 - SAIFI
 - SAIDI
 - CAIDI
 - Load-based indices
 - Application of the indices

Day 2

- **Distribution System Reliability Evaluation**
 - Reliability evaluation
 - Series configurations
 - Series system applications
 - Parallel configurations
 - Parallel systems
- **Decision Tree Methods for Complex Power Systems**
 - Decision tree analysis
 - Bayesian decision trees
 - FMEA
 - FMECA
- **Identification of Major Events in the Distribution Systems**
 - Major event classification
 - Example of calculating SAIDI
- **Methods for Efficient State Selection**
 - Truncation of state space
 - Minimal cut technique
 - Minimal cut set and failure modes approach
 - Ranking contingencies by their impact on the system
- **Ancillary Services: A Market of its Own**
 - Design of ancillary service markets
 - Efficient market structures for ancillary services
 - The effect of loading on reactive market power
 - Spot pricing of electricity and ancillary services in a competitive market

Instructor



Puica Nitu (Senior Member, IEEE)

Received the M.S. degree from the Polytechnic University of Bucharest, Romania with major in Electrical Engineering. She currently holds the position of Senior Advisor in Energy Markets with Ontario Power Generation Inc.

Puica has an extensive experience in the utility industry, from power systems' applications and reliability to aspects of risk management and financial engineering. She co-authored one book on 'Power System Reliability' and published over 25 technical papers on the subject. She chairs the IEEE Task Force on 'Resources Adequacy of Power Systems'.

Puica was invited to develop and deliver seminars to IEEE – PMAPS (Probabilistic Methods Applied to Power Systems), electric power utilities and conferences in Portugal, Japan, Romania, South Africa as well as in the USA and Canada.



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