

Educational Tools for Reliability Modeling and Evaluation of the Emerging Smart Grid

Chanan Singh, Texas A&M University



Objectives

- Educate current and future energy professionals in a systematic way of thinking, modeling, analyzing and predicting reliability.
- Educate energy industry professional in modeling uncertainty through probabilistic modeling.
- Provide hands on experience on the use of these tools through assignments and projects.
- Stimulate more research and development in this field through educating the young minds about the emerging reliability problems.

Workforce need for this education

- A highly complex system is emerging with heavy penetration of renewables, central and distributed energy storage, and massive deployment of distributed communication and computational technologies.
- Complexity and uncertainty increase the potential for serious failure events.
- Grid reliability and economy will be a big challenge
- Reliability needs to be engineered into the grid and its subsystems in a systematic and deliberate manner.
- Diverse target audience: university students, working engineers and energy professionals
- This audience needs to be educated about modeling, analyzing and predicting reliability.

Deliverables

- A set of power points for semester long course
- A set of power point s for short course
- A set of example projects

Syllabus

Semester Long Course

1. Motivation and overview of power system reliability analysis.
2. Probability concepts and stochastic processes.
3. Frequency balance approach for reliability analysis.
4. Formal methods for quantitative reliability analysis: analytical as well as Monte Carlo .
5. Power system reliability overview.
6. Generation adequacy – planning.
7. Operational reliability.
8. Multi-area reliability - interconnected systems: analytical & Monte Carlo methods.
9. Composite system reliability.
10. Integration of variable energy sources like wind and solar.
11. Integration of cyber and current carrying part.
12. Modeling relationship between maintenance and reliability.

Short course

1. Motivation for quantitative reliability methods.
2. Basic probability concepts with examples.
3. Monte Carlo simulation technique.
4. Introduction to power system reliability methods.
5. Generation adequacy – single area.
6. Multi area and composite system reliability. evaluation using Monte Carlo.
7. Integration of renewables.

Learning Objectives

1. Promote use of reliability models and analysis in overall optimization of power system performance.
2. Impart sufficient knowledge in the use of probability and stochastic processes for modeling and prediction of reliability.

3. Give knowledge of available models for generation, transmission and composite system.
4. Analysis of reliability issues and quantification for integrating renewable energy sources into the power grid
5. How to integrate cyber components into the reliability models
6. How to model maintenance and its optimization
7. Resource allocation considering reliability and cost.

Method of Delivery

- Material for both courses is being developed in the form of power points with notes for explanation.
- These power points will be available at the website of the PI and also PSERC website if possible.

Assessment of Effectiveness

- Mechanism will be provided on the website for to provide feedback for its further improvement
- The feed back from the class being taught will be used for improvements.

Potential uses

- Give a semester long graduate class in a university.
- Give a short course to industry
- Self learning the subject