RELIABILITY ENGINEERING

**Course objective:**  
To strengthen the knowledge of probability theory by introducing the concept of reliability engineering applicable to the physical systems especially at different level of electric power systems.

1. **Review of probability theory (4 hours)**
   1. Probability concepts, permutation and combination, practical engineering concepts, Venn diagrams
   2. Rules for combining probabilities, independent, mutually exclusive, complimentary, conditional events, application of conditional probability
   3. Probability distributions: random variables, density distribution functions, mathematical expectation, variance and standard deviation.

1. **Binomial distribution and its Applications (4 hours)**
   1. Binomial distribution: concepts, properties, general characteristics, binomial coefficients, expected value and standard deviation
   2. Applications in engineering system evaluation, economic implications, identical and non‐identical units, COPT

1. **Network modeling and analysis of simple systems (4 hours)**
   1. Modeling concepts for reliability evaluations
   2. Series, parallel and series‐parallel systems
   3. Redundancy: standby redundancy, impact of redundancy, perfect and imperfect switching

1. **Modeling and analysis of complex systems (8 hours)**
   1. Modeling and evaluation concepts for complex systems
   2. Conditional probability approach, cut set and tie set methods, connection matrix techniques, event tree and fault tree methods

1. **Probability distribution in reliability evaluation (4 hours)**
   1. Distribution concepts, terminology, general reliability functions, evaluation techniques, shapes
   2. Poisson distribution, relationship with binomial distribution
   3. Normal and exponential distributions, probability density functions, a priori and a posterior probability, normal distribution and probability density function, mean value and mean time to failure.
   4. Other distributions: Weibull, Gamma, Rayleigh and Log Normal distribution and their application in electric power change.

1. **System reliability evaluation using probability distribution (4 hours)**
   1. Series, parallel and partially redundant systems, mean time to failure
   2. Standby systems: perfect and imperfect switching, effect of spare components, failure in standby mode

1. **Discrete Markov chains (4 hours)**
   1. General modeling concept, STPM, time dependent probability evaluation
   2. Limiting state probability, absorbing states, applications of discrete Markov techniques in system reliability evaluation
2. **Continuous Markov processes (4 hours)**
   1. General modeling concepts, transition rates, time dependent and limiting state probabilities, STTP
   2. State space diagram: single, two and three components repairable systems, mission oriented systems
   3. Evaluation of time dependent state probabilities by differential equations method and matrix multiplication methods
   4. Reliability evaluation of repairable systems, MTTF, application in complex system

1. **Frequency and duration techniques for reliability evaluation (8 hours)**
   1. Basic concepts of F&D techniques, application in multi‐state problems, frequency of encountering individual states, mean duration of individual states, frequency of encountering cumulated states, frequency balance approach
   2. Approximate reliability evaluation: series and parallel systems, network reduction techniques, minimum cut set method

**Practical:**

1. Evaluate the reliability of simple and complex systems using various techniques like series/parallel, cut set and tie set methods
2. Application of discrete Markov chain and continuous Markov process, F&D techniques, approximate reliability evaluation for complex engineering system

**References:**

1. Roy Billinton and Ronald Allan, “Reliability Evaluation of Engineering Systems: Concepts and Techniques”, Plenum Publishers, New York, 1992.