Chapter-0

INTRODUCTION AND SUMMARY

Literally, the term "reliability" means "trustworthiness", that is, something on which one can rely upon. In daily life we commanly use statements like, "this man is reliable for that work", "this machine is reliable", etc. In advertisement we see a words like "a reliable T.V.", "a reliable motor cycle", etc.

The meaning of reliable in above situations is different depending upon task and/or the cost that we need to pay. Also one uses the statement like "a man is reliable for a perticular work" to mean that he can do that work more efficiently with lesser efforts/investment. Again a reliable T.V. or equipment means that it functions satisfactorily for resonabaly longer period, without failure. There are devices which are designed to achive a certain task; if the task is achived by the device the whole purpose of the device is served. Some devices may change the degree of performance and (may by maintainance/repairs) they can be set right for the desired degree of performance.

Thus depending upon situations, meanings of reliability are different. To quantify reliability various measures have been introduced and depending upon that perticular set-up one has to choose an appropriate measure. In chapter-1 we discuss scope and meaning of reliability. It also gives different measures of reliability and some basic elements.

In a sence the technique/art of quantifying reliability can be viewed as a basis for the mathematical theory of reliability. Mathematical theory of reliability includes certain ideas, mathematical models and methods directed towards the solution of problems in predicting, estimating or optimizing the probability of survival, mean life, or more generally, life distribution of components or systems. Other problems considered in reliability theory are those involving the probability of proper functioning of the system at either a specified or an arbitrary time, or the proportion of time the system is functioning properly. From the point of view of designing the system one can look for maximizing i) probability of proper functioning and/or ii) proportion of time system is functioning properly.

There are some practical situations, where failure rate of certain components/systems goes on decreasing and hence reliability goes on increasing. For example, under perfect debugging, failure rate of software goes on decreasing. The same is true in some cases of newly installed complex systems. One may apply mixed exponential life time distribution in such situations, for which hazard rate goes on decreasing. Now naturally problem arises how much duration of time one has to put such system or unit on test in a laboratory so as to bring down its hazard rate and hence increase its reliability, provided it has not failed during that period. For testing one has to take the account of i) cost involved in testing and ii) risk-components. For example, suppose it is possible to attain a desired quality, say q_0, by burning the product in a laboratory, for some time, (this time is called burn-in period), for products of decreasing failure rate characteristics. Producer has to spend certain amount for testing and he is exposed to the risk of such a desired quality level product being introduced in the market from some other producer/s. Also one may be interested in estimating parameters of such life time distributions, generally based on less number of failures. Less number of failures are due to i> decreasing failure rate nature of the system and/or ii> time or cost constraint imposed and/or iii> missing of observations.

Related work based on the life time distribution with decreasing failure rate is studied by Saunder and Mayere (1983) which we are presenting in chapter-2. Also we are discussing how to estimate parameters based on progressively censored data in section 3 of chapter 2. Progressively censored data is obtained from progressively censored experiment, which means that unit is suppose to fail or leave from the experiment and it has no ristriction of time to do so. Now since failure rate goes on decreasing, different optimization criteria for reliability, mean residual life time, etc. are discussed in section 4 of chapter-2. Also we have developed various optimization criteria depending upon different desired qualities. Further, optimum burn-in period is obtained, which depends upon parameters of the model, in section 5 of the same chapter. Optimum burn-in period can be estimated by using m.l.e.'s of parameters. Method and programming to simulation from such type of distribution, estimation of m.l.e.'s and hence to obtain optimum butn-in period under different criteria is provided in appendix.

Chapter-3 is very much different from chapter-2. Chapter-3 is theoretic one and deals with inference in Bayesian set-up and mostly it discusses advantage of Bayesian approach over classical estimation theory. We discuss fundamentals of Bayesian inferancein section 3.1 . Bayesian inferance verses classical inferance is described in section 3.2 . Section 3.3 describes Bayesian inferance in reliability. Nature of Bayesian inferance is described in section section 3.4 which also contais how prior is convinient for engineers in there task to quantify information with them. How to perform Bayesian reliability analysis is described in brief in section 3.5 . Section 6, 7 and 8 of the same chapter briefly describes Bayesian decision theory, point estimation and interval estimation.

In chapter-4 we are discussing how to apply Bayesian methods to reliability estimation for different models. Bayesian estimates for stress-strength model, k-out-of-p system, series system and parallel system are derived by Basu and Ebrahimi(1989) which we discuss in this chapter, assuming exponential population as life time distribution and gamma (inverted gamma) as a prior distribution. Parametric empirical Bayes method is described in section 4 of the same chapter for N independant Poisson processes with parameters λ_i's, where λ_i's are following gamma prior distribution with its unknown parameters, (hyper parameters). Also it contains how to estimate parameter of interest under asymmetric loss function, since asymmetric loss functions are essentially required at appropriate situations, especially from consumers and producers point of view.

Throughout this dissertation we denote equation numbers by the notation (x,y), which means that y^{th} equation of x^{th} chapter.