ABSTRACT

Reliability modeling deals with model building, to obtain solutions to problems in predicting, estimating and optimizing the survival or performance of an unreliable system, the impact of the unreliability and actions to mitigate this impact.

The objective of this dissertation is to analyse certain reliability models. It offers an interdisciplinary presentation on the uses of probability theory and discusses practical applications of stochastic models to diverse areas such as communication networks, software modeling, reliability, and operations research. The analysis helps in finding the performance measures of the systems which in turn, useful for implementing strategies to upgrade the systems. The main objective of the thesis is to present results with potential for solving real-life problems. Another important objective is to present suitable methods for solving these problems by analyzing the relevant data.

System network design problems are becoming increasingly critical and complex as telecommunication networks (and others) are expanded and upgraded in response to consumer satisfaction. The design and operation of a network with high reliability requirements are difficult, yet they are essential tasks. One of the approaches often used to improve the reliability of a network system is to allocate redundant components with similar functionality between the nodes. Chapter II deals with the analysis of a communication network model (linear consecutively connected system). A linear consecutively connected system consists of $N+1$ linear ordered positions. The problem is to allocate M multi state elements(repeaters) in the work stations in order to achieve a highly reliable system. The state of a multi state element indicates the number of work stations upto which the signal can be retransmitted. A genetic model is proposed to

study the reliability optimization in the system by allocating multi state elements. Reliability evaluation for the linear consecutively connected system is based on the universal generating function technique and is very effective in multi state systems. A single objective optimization aimed at maximizing the network reliability is formulated in the proposed problem. The solution procedure characterizes the advantage of using permutation cross over in the case of one to one allocation. It removes the corresponding fitness measure which helps to reduce the computational complexity of the problem to some extent. The results achieved show that when the decision maker is provided with the solution information, different solution alternatives may be considered which allow the identification of a risk-averse network design characterized by a high degree of confidence in the actual network reliability.

In chapter three a comprehensive study of signal transmission in linear multi state consecutively connected system with the effect of noise is considered. Noise is a constant concern in communication systems. Noise is a random signal. The noise can cause the original signal to be distorted in shape, increased or decreased in amplitude, delayed slightly in time, or otherwise corrupted and modified. In wireless communication, the signal level is not steady but increases or decreases due to the nature of the atmosphere and the way in which the signal propagates through the layers of the atmosphere. The practical way to minimize this type of distortion is to ensure that amplifiers and other system components operate in their linear region. Thus, the system is analysed with the multi state elements which receive signals, classify and accordingly amplify it, use it to modulate the carrier and transmit it. Assuming so, depending on the nature of signals received, the multi state element can retransmit the signal with efficiencies 1, 2 and 3 and the amplifying factors in the problem are introduced as multipliers in the course of transmission.

This work pertains to stochastic optimization of system reliability. Considering the effect of noise in signal transmission, the optimization problem is modeled using universal generating function and the optimal allocation is obtained using genetic algorithm.

Software reliability models have received a lot of attention during the last decades, as software systems have become more pervasive and vital to the operation of many important aspects of modern life. So two software models have been analysed in the chapters four and five.

In chapter four Moranda geometric de-eutrophication model is analysed. The reliability function $R_{\tau}(t)$ for a mission time τ of the software, the intensity function $\lambda(t)$ of the process and $P_n(t)$ the probability of removal of n faults from the software in time $(0, t]$ are obtained. Also a recursive scheme is proposed for studying the probability of detecting n bugs in the time interval $(0, t]$. From the results obtained, it is found that the larger the mission time, the larger gets the testing time for meeting a given reliability requirement.

In software testing, Bayesian probabilistic models provide tools for risk estimation and allow decision-makers to combine historical data with subjective expert estimates. Chapter five briefs about how Bayesian probability theory can be used to analyze the software reliability model with multiple types of faults. Suppose a given software system includes faults, to detect those faults a number of sequential independent reviews are to be conducted. In this work, the faults in a software system are grouped as class(1), class(2),…., class(k) and the remaining faults which do not come under these classes as class(k+1) depending upon their severity in detection. In the sequential independent reviews, if the faults are detected in a review, they are to be corrected before starting the next review so that the same fault will not occur in the future reviews. The probability that all faults are detected and corrected after a series of independent software tests and correction cycles is analysed. This has a number of applications like how long to test a software, estimating the cost of testing etc. Probability evaluation is done both prior to and after observing the number of faults detected in each cycle. The conditions under which these two measures, the conditional and unconditional probabilities are the same is also shown. Expressions are derived to evaluate the probability that, after a series of sequential independent reviews have been completed, no class of fault remains in the software system by assuming the prior distribution as Poisson and Binomial.

In chapter six, the transient analysis of repairable $k-out-of-n:G$ shared load system with multiple failures is presented. The same system is also investigated by including preventive maintenance. Assuming constant failure and repair rates for all the components, the system is analysed. To make a non- operational (failed) component operational, service station is considered in the proposed model. When each of the component is dependent on the other and if one component fails, the failure rate of the others increase as a result of the additional load placed on them. There is a multiple repair facility. Each repair has an independent and identically distributed repair time distribution. The system measures such as the reliability function, the failure density function and the availability function are obtained. The steady state solution of the system is obtained independently and is found to be in conformity with the steady state results deduced from the transient result. A memory efficient algorithm is developed to get the characteristic equation of tri diagonal symmetric matrix and is used to find the system reliability.