ON THE RELIABILITY OF REPAIRABLE REDUNDANT SYSTEMS

THESIS

Submitted for the Award of the M. Sc.
Degree in Mathematical Statistics

By

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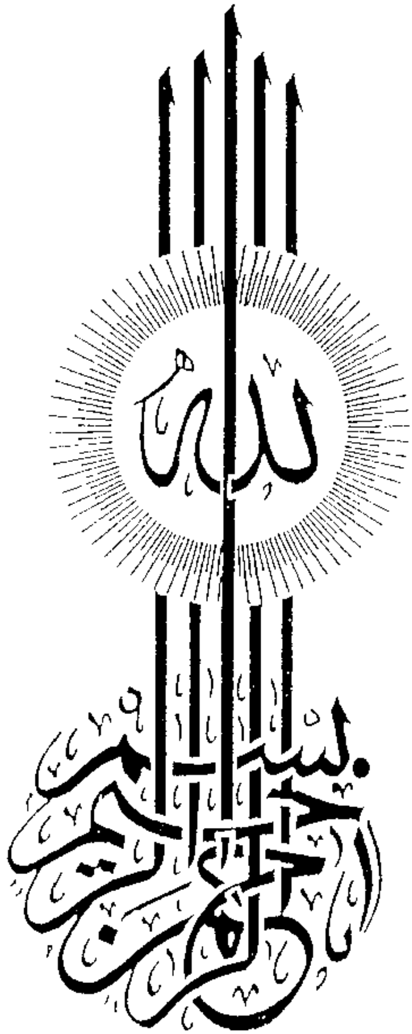
بسم الله الرحمن الرحيم

M. Sc. COURSES

Studied by the Author (1985 - 1986)

1. Stochastic Processes and their applications. — 2 hours per week.

2. Theory of Statistics. — 2 hours per week.

3. Multivariate Analysisis — 2 hours per week.

4. Theory of Reliability — 2 hours per week.

5. Life Test Distribution. — 2 hours per week.

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PREFACE

The interest in Reliability theory currently exhibited by engineers, mathematicians, economists and industrial managers has stimulated the publication of many papers. Problems in reliability theory are extremely varied. Though, it is commonly that papers should appear expounding reliability theory from many points of view. The present thesis deals with analytical methods for studying some problems in reliability theory from many points of view. This thesis consists of three chapters and two appendices for computer programs developed in this thesis.

The first chapter considers two models for two dissimilar unit cold standby redundant system with partial failure and two types of repairs. Each model consists of two dissimilar units. In the first model, the operative unit can either be in normal or partial failure mode, when it fails from the partial failure mode, it undergoes minor repair. After repairing it becomes operative. If this unit fails again, it goes to major repair after which it becomes as good as new. The standby unit has one mode of operation, namely : normal mode, whereas the standby unit fails without passing through the partial failure mode and after repair, it again becomes as good as new. In the second model, each unit has three modes of operation, normal mode, partial failure mode and total failure mode.When a unit is in total failure mode, it goes to either major or minor repair with priori probability. All the random variables concerning failure and repair times are general distributed.

Using the results of regenerative process, explicit expressions for Laplace transform of the reliability function, mean time to first failure, pointwise and steady state availabilities for both models have been obtained. The results in [8,9] have been derived as special cases from the results of this chapter. The material of this chapter has been accepted for publication in "Journal of Microelectronic and Reliability", England (1989).

The second chapter investigates the probabilistic behaviour of two unit warm standby models having one regular and one expert repairman. An expert repairman is called to the system, if the regular repairman is not able to complete the repairs within some tolerable time. In the first model, we assume that the regular repairman can always repair the failed unit from standby state. In the second model, the regular repairman sometimes may not be able to do the repairs of the above nature within some tolerable time and the expert is used for in case of either the standby unit failure or operative unit failure. All random variables concerning failure, repair and tolerable times are aribitrarily general distributed. Using the results of regenerative process, explicit expressions for Laplace transform of the reliability function, mean time to first failure, pointwise and steady state availabilities, busy period analysis for regular repairman and expert repairman, expected number of calls for the expert repairman and cost analysis for both models have been obtained in the steady state. The results in [27]have been derived as special cases from the results of this chapter.

The third chapter investigates the stochastic behaviour of three models for two dissimilar unit cold standby repairable systems. In these models different types of repairmen are employed.

In the first model, the repairman is always with the system. In the second model, the repairman comes immediately at the failure of a unit, but in the third model, he takes some random time in reaching the system. All random variables concerning failure, repair and arrival time are arbitrarily distributed.

Using the results of regenerative process, explicit expressions for Laplace transform of the Reliability function, mean time to first failure, pointwise and steady state availabilities, busy period analysis, expected number of (ordinary and immediate) visits by the repairman, expected number of repairs for (ordinary and immediate) visits of repairman and cost analysis have been obtained in the steady state. The results in[26] have been derived as special cases from the results of this chapter. The material of this chapter has been accepted for publication in "Journal of Microelectronic and Reliability", England (1988).

The first appendix consists of a computer programme, to compute the mean time to first failure for the different models of the three chapters in this thesis. Also we give a graphical representation for each model.

The second appendix consists of a computer programme, to compute the profits for the several models discussed in the second chapter and third chapter. Also we give a graphical representation for each model.

CHAPTER I

TWO MODELS FOR TWO DISSIMILAR UNIT COLD STANDBY REDUNDANT SYSTEM WITH PARTIAL FAILURE AND TWO TYPES OF REPAIRS

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TWO MODELS FOR TWO DISSIMILAR UNIT COLD STANDBY REDUNDANT SYSTEM WITH PARTIAL FAILURE AND TWO TYPES OF REPAIRS

This chapter deals with the availability function and the mean time to the first failure for two models of a cold standby redundant system with two different types of repair. Each model consists of two-dissimilar units. In the first model, the operative unit has two modes of operation, normal mode and partial failure mode. The standby unit has one mode of operation, normal mode. In the second model, each unit has three modes of operation, normal mode, partial failure mode and total failure mode. Both models are analyzed by semi-Markov process technique, assuming that the failure time and repair time distributions are general and arbitrary. Some reliability measures of interest to system desingers as well as operations managers have been obtained. Moreover, we give computer programmes for calculating the MTSF for each model (see appendix I).