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Design of Optimum Component Test Plans while Considering Expected System Lifetime ⋆

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Abstract

We analyze the component testing problem of devices which consist of series connection of redundant, standby redundant and k-out-of-n subsystems. Although system reliability is a common performance measure, here we extend previous studies by considering expected system lifetime. This case applies when setting mission time for a system is more practical than deciding on system reliability accurately. The problem is formulated as a semi-infinite linear programming problem, and the optimum test times are obtained with a column generation technique incorporating reverse convex programming. The proposed solution technique is also illustrated by numerical examples.

Key words: Component testing, Mean time to failure, Semi-infinite linear programming, Reverse convex programming, Column generation

1 Introduction

Testing the system as a whole might be found economically infeasible or physically impossible in many cases. For example, testing a nuclear device is currently banned by international agreements or testing a space shuttle might be found too risky because of its financial consequences. These are extreme but typical examples where one needs to attain a certain performance level without testing the system. Instead the test is done on various components to meet some desired performance measure for the whole system, while achieving a minimal testing cost. This approach has been known in the literature as the system-based component testing which is first mentioned by Gal [12]. The author proposes to minimize total component testing cost while keeping type I error probability at a desirable level and no component failures during tests as the system acceptance criterion. Mazumdar [14] extends this model by also considering type II error probability and changing the acceptance criterion to sum rule. Furthermore, Mazumdar [15]

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