Reliability properties of k-out-of-n systems with several cold standby units

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Abstract

A k-out-of-n system is a technical structure consisting of n components and functioning as long as at least k out of them are working. Such systems can be found in various engineering compositions, e.g. in airplane systems, industrial manufacturing lines, telecommunication networks and power supply devices. As the reliability of a k-out-of-n system strongly depends on the right tail properties of its components' lifetime distributions, in some situations it is reasonable to immediately replace a failed element by a new standby unit and put the system in operation. In this talk, we consider systems that operate in cycles or are monitored at discrete times, i.e. we assume that system component lifetimes have a discrete joint distribution. For systems equipped with several cold standby units, we show some monotonicity properties and derive formulas for the reliability function and the expected system lifetime. These results are applied for obtaining optimal number of spare units for minimizing the mean acquisition cost rates. Since the calculation of the described quantities requires finding sums of infinite series, we provide a procedure for approximating them with a prefixed desired accuracy. As an illustration, three special cases with geometric, negative binomial and discrete Weibull distributions are studied in more detail.

The talk is based on a joint work with Anna Dembińska (Warsaw University of Technology).