

**ABSTRACT**

Reliability Importance and the Invariant Optimal Allocation.

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Relationships between the invariant optimal allocation and reliability importance for general multi-component systems are explored. The invariant optimal allocation is an allocation related only to the relative ordering rather than the magnitude of the component reliabilities. If there exists an invariant optimal allocation for a system, the optimal allocation is to assign component reliabilities according to the B-importance ordering for any given set of component reliabilities.

The reliability importance is a partial derivative of the system reliability with respect to a component reliability. When all components are *i.i.d.*, the reliability importance is called B-importance.

A recursive equation for the system reliability in terms of reliability importance is derived. For small systems, the recursive equation is a useful tool to prove whether a system has an invariant optimal allocation or not. A heuristic method, according to the recursive equation, is developed to search for the optimal allocation. The allocation generated by the heuristic is the optimal allocation if the given system has an invariant optimal allocation.

The B-importance ordering is studied for consecutive- $k$ -out-of- $n$  systems that fail when  $k$  consecutive components fail. In such a system, the components  $k$  and  $n-k+1$  have the highest B-importance while the components 1 and  $n$  have the lowest B-importance. Because the Fibonacci sequence with order  $k$  is related to consecutive- $k$ -out-of- $n$  systems, ordering ratios of successive items of the Fibonacci sequence with order  $k$  can help derive the B-importance ordering of consecutive- $k$ -out-of- $n$  systems.

Furthermore, the B-importance ordering is summarized and proven for systems, including the consecutive- $k^*$ -out-of- $n$  system, the bridge system, the series-parallel system, the parallel-series system.