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# Addressing the problem of increasing the reliability of a mixed system

**Abd Alhasan Hameed Saleh**
Department of Mathematics, College of Education for Pure Sciences, University of Babylon, Iraq
Email: abdalhasanhameed0@gmail.com

**Zahir Abdul Haddi Hassan**
Department of Mathematics, College of Education for Pure Sciences, University of Babylon, Iraq
Email: mathzahir@gmail.com. / zahir.a.h.hassan@uobabylon.edu.iq

***Abstract*---**In this research, we will study the reliability of the mixed system and how to increase its reliability using the repetition technique. We use the unit repetition method, and then find the reliability of the system after using the reduction method without repetition and after iteration to find out the amount of increase in the reliability of the system.

***Keywords*---**reliability, mixed system, increase.

## Introduction

A redundant system contains one or more standby components or subsystems in system configuration. If a redundant unit is fully energized when the system is in use, the redundancy is called active or hot standby If a redundant unit is fully energized only when the primary unit fails, the redundancy is known as passive standby. When the primary unit is successfully operational, the redundant unit may be kept in reserve. Such a unit is said to be in cold standby [4,20-22]. A cold standby system needs a sensing mechanism to detect failure of the primary unit and a switching actuator to activate the redundant unit when a failure occurs. In the following discussion we use the term switching system to include both the sensing mechanism and the switching actuator. On the other hand, if the redundant unit is partially loaded in the waiting period, the redundancy is a warm standby. A warm standby unit usually is subjected to a reduced level of stress and may fail before it is fully activated [6,14,25].


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**Some Concepts and Definitions**

Definition (2.1) System: A set of interconnected components has special reliability to calculate the system's overall reliability [3].
Definition (2.2) Reliability R(t): The reliability of a component (or a system) is the probability that the component will not fail for a time t[2].
Definition (2.3) Redundancy: Is improve the system reliability by the technique of introducing redundancies this involves the deliberate creation of new paths in a system[1].
Definition (2.4) Series system: The systems of the series only work if every components work[3].

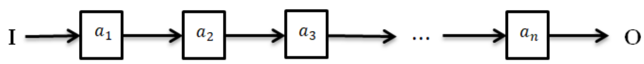



Figure 1. Series system

The reliability of the system is given by:
$R_S = R_{a_1} \times R_{a_2} \times \ldots \times R_{a_n}$
(1)

**Mixed System**

We simply divided this system into series and parallel to measure the reliability of every subsystem and the system's cumulative reliability [3,5,10-13].

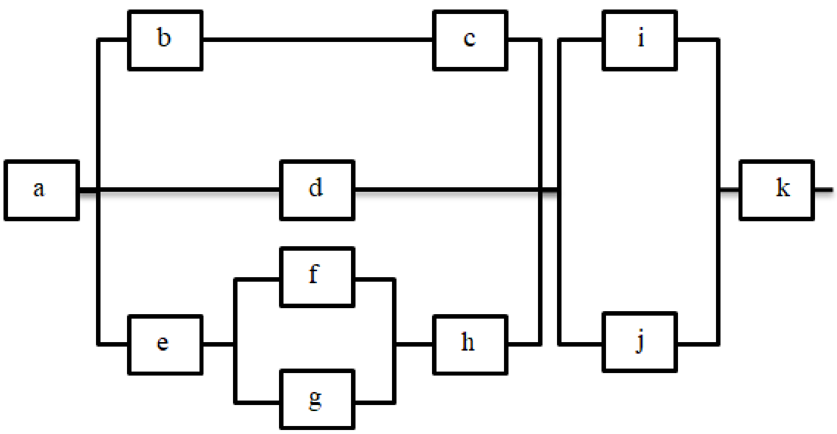



Figure 2. Mixed system

**Redundancy**

If the state of are is such that either it is not possible to produce highly reliable components or the cost of producing such components is very high, we can improve the system reliability by the technique of introducing redundancies, this involves the deliberate creation of new parallel paths in a system [9,15,23]. We have observed that if two elements with probabilities of success P (a) and P (b ) are connected in parallel, the probability P (a or b) is.

$$P(a \text{ or } b) = P(a) + P(b) - P(a \text{ and } b)$$
$$= P(a) + P(b) - P(a)\,P(b)$$

Assuming that the element are independent. Sine both P ( a ) and P ( b ) are individually less than one, their product is always less than P ( a ) or P ( b ). Hence, P (a or b) is always greater than either P (a) or P(b). This illustrates a simple method of improving the reliability of a system when the element reliability cannot be increased. Although either one of the elements is sufficient for the successful operation of the system, we deliberately use both elements so as to increase the probability of success, thus causing the system to become redundant, there are many methods of introducing redundancies in a system a few of these will be considered in this report [7,16-18].

**Unit Redundancy**

Let two elements $a_1$ and $b_1$, with reliabilities $\boldsymbol{R_{a1}}$ and $\boldsymbol{R_{b1}}$, respectively, be connected in series. The reliability of successful operation of the system is.

$$R(s) = R(a_1 \text{ and } b_1)$$

$$= R(a_1 \times b_1)$$

Assuming that the two element are independent [8,19,24]. Next we introduce redundancies if that series – parallel, so that the path with elements $a_1$ and $b_1$ in series in duplicated by another path with elements $a_2$ and $b_2$ in series the successful operation of the system depends on the successful functioning of path $a_1$ $b_1$ paths $a_2$ $b_2$. Hence the reliability of successful operation of the system is given by

$$R(s) = R(a_1 \text{ and } b_1) \text{ or } (a_2 \text{ and } b_2)$$

$$= R(a_1 \text{ and } b_1) + R(a_2 \text{ and } b_2) - R[(a_1 \text{ and } b_1) \text{ and } (a_2 \text{ and } b_2)]$$

$$= R(a_1) \times R(b_1) + R(a_2) \times R(b_2) - R(a_1) \times R(b_1) \times R(a_2) \times R(b_2)$$

**Example:** After using the reduction method in the figure 2 we get, fore element a, p, u and k with reliabilities 0.91 , 0.93 , 0.95 and 0.90 respectively to be connected in series as shown in figure 3 what the resultant system reliabilities.

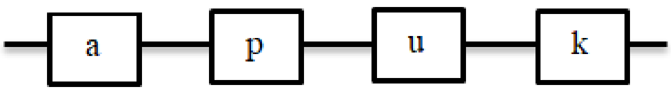



Figure 3

**Solution**

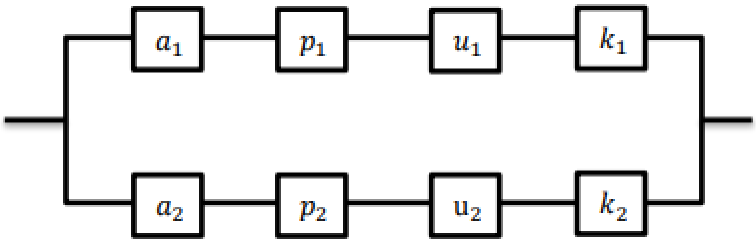
For series configuration with no redundancy

$R(S) = R(a) \times R(p) \times R(u) \times R(k)$

$= 0.91 \times 0.93 \times 0.95 \times 0.90$

$= 0.72$

For unit redundancy




$R(s) = R(a_1) \times R(p_1) \times R(u_1) \times R(k_1) + R(a_2) \times R(p_2) \times R(u_2) \times R(k_2) - R(a_1)$

$\times R(p_1) \times R(u_1) \times R(k_1) \times R(a_2) \times R(p_2) \times R(u_2) \times R(k_2)$

$= 0.91 \times 0.93 \times 0.95 \times 0.90 + 0.91 \times 0.93 \times 0.95 \times 0.90 - (0.91)^2 \times (0.93)^2 \times$

$(0.95)^2 \times (0.90)^2$

$= 0.92$

**Conclusions**

It was found through this research that when using the unit repetition technique, the reliability of the mixed system increased by a good amount.

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