LESSON 7: RELIABILITY

Outline

- System with series components
- System with parallel components
- Complex modular systems

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System Reliability

- In this lesson, we discuss an application of probability to predict an overall system's reliability.
- Reliability of a product is defined as the probability that the product will not fail throughout a prescribed operating period.
- Most products are made up of a number of components
- The reliability of each component and the configuration of the system consisting of these components determines the system reliability (i.e., the reliability of the product).

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System Forms

- The components may be in
  - series: system performs satisfactorily if all components are fully functional
    - For example, Christmas lights
  - parallel: system performs if any one component remains operational
    - For example, (i) an airplane with four engines, or (ii) a laptop with a power source and a battery.
  - combination of series and parallel

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Components in Series

- If the components are in series, system performs satisfactorily if all components are fully functional
- If there are n components in series, where the reliability of the i-th component is denoted by r_i , the system reliability is

$$R_s = (r_1)(r_2)\cdots(r_n)$$

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Components in Series

Example 1: A module of a satellite monitoring system has 500 components in series. The reliability of each component is 0.999. Find the reliability of the module. If the number of components is reduced to 200, what is the reliability?

Note: if the components are in series, reliability increases if the number of components decreases.

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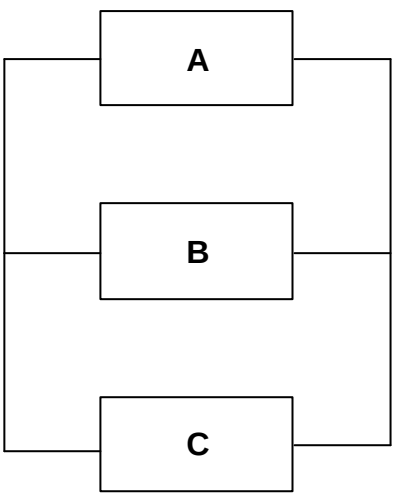
Components in Parallel

- If the components are in parallel, system performs if any one component remains operational
- If there are n components in parallel, where the reliability of the i-th component is denoted by r_i , the system reliability is

$$R_p = 1 - (1 - r_1)(1 - r_2)\cdots(1 - r_n)$$



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Components in Parallel

Example 2: A system has three parallel components, A, B, and C with reliabilities 0.95, 0.92, and 0.90, respectively. Find the reliability of the system.

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Redundant Systems and Backup Components

Example 3: A system has three parallel components, A, B, and C with reliabilities 0.95, 0.92, and 0.90, respectively. Find the reliability of the system if C is out of order.

Note: if the components are in parallel, the reliability decreases if the number of components decreases.

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Combination System

Example 4: Find the reliability of the system shown on the next page.

First, identify the series and parallel sub-systems. There are 4 sub-systems.

$R_1 =$

$R_2 =$

$R_3 =$

$R_4 =$

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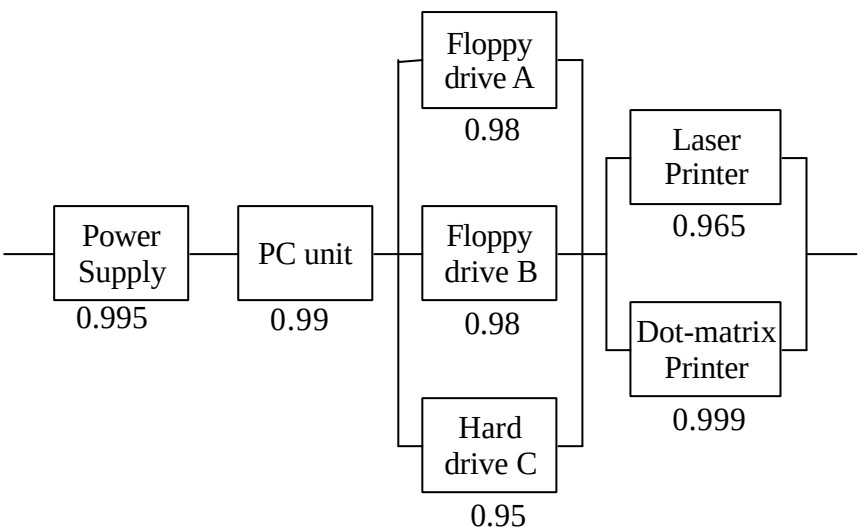

The sub-systems R_1, R_2, R_3 and R_4 are in series.

$R_{system} =$

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READING AND EXERCISES

Lesson 7

Reading:

Sections 6-5, pp. 181-186

Exercises:

6-33, 6-37

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