1. A system requires all of its components to be operational 24 hours a day 7 days a week. Failure of one of the components occurs as follows:

   Mon No failure

   Tue 5 PM to 7 PM

   Wed No failure

   Thu 1 AM to 3 AM

   Fri 8 PM to 11 PM

   Sat No failure

   Sun 2 AM to 5 AM

   Calculate availability of the failing component.

2. A system requires all of its components to be operational during business hours 9 AM to 5 PM on workdays (Monday–Friday). Failure of one of the components occurs as follows:

   Mon 8 AM to 11 AM

   Tue No failure

   Wed 4 PM to 7 PM

   Thu 5 PM to 8 PM

   Fri 1 PM to 2 PM

   Calculate availability of the system.

3. A system requires all of its components to be operational 24 hours a day 7 days a week. One of its components has failed 3 times in the last year:

Failure occurred	Failure detected	Back in service
11:00	13:00	22:00
04:00	10:00	17:00
07:00	10:00	16:00

   Calculate availability of the failing component.

4. Consider the case of a car with one spare tire. The car will become impaired if at least two of its tires are lost. Calculate the probability of not completing a trip. Compare the probability of completing a car trip in the cases without spare tire and with 1 spare tire. Consider the probability that a tire will break is $p = 0.01$.

   When we consider a spare tire, We define the following events:

5. In order to fly, an airplane needs half of its engines to be functioning. Suppose that, during any given flight, engines fail independently with some probability p. What are the probabilities that an airplane with $1, 2, 3, 4$ engines will fly?

6. A system consists of a number of components in series, each having reliability of 0.97. What is the reliability of the system with 5 components? 6 components? 7 components?

7. An electronic product contains 100 integrated circuits. The probability that any integrated circuit is defective is 0.01, and the integrated circuits are independent. The product operates only if all the integrated circuits are operational. What is the probability that all 100 circuits are functioning properly?

8. A system consists of 5 components in parallel. If each component has a reliability of 0.97, what is the overall reliability of the system, if it needs at least one operational component to work? What the reliability would be in the case of $2, 3, 4$ components required for the system to work?

9. Consider a system with 5 kinds of components with reliability 0.95 for component of types 1 and 2, 0.70 for type 3, 0.75 for type 4, and 0.90 for type 5.

$$\text{input} \longrightarrow [\text{C1}] \longrightarrow [C2] \longrightarrow \begin{bmatrix} C3 \\ C3 \\ C3 \end{bmatrix} \longrightarrow \begin{bmatrix} C4 \\ C4 \end{bmatrix} \longrightarrow [\text{C5}] \longrightarrow \text{output}$$

   Due to low reliability of the 3rd and 4th components, they are replicated, the system contains 3 components of the 3rd kind, and 2 components of the 4th kind. What is the reliability of the system?

10. The following system operates iff there is a path of functional devices from left to right. Assume devices are all independent. Calculate probability that the system will be functioning properly.

$$\text{input} \longrightarrow \begin{bmatrix} C1 \\ C1 \end{bmatrix} \longrightarrow \begin{bmatrix} C2 \\ C2 \\ C2 \end{bmatrix} \longrightarrow \text{output}$$

The corresponding reliabilities are 90% for C1 and 85% for C2.

11. Consider the system comprised of two subsystems working in parallel.

$$\text{input} \longrightarrow \begin{bmatrix} \overbrace{\text{C1} \longrightarrow \text{C2}}^{\text{Subsystem A}} \\ \underbrace{\text{C1} \longrightarrow \text{C2}}_{\text{Subsystem B}} \end{bmatrix} \longrightarrow \text{output}$$

The system operates if at least one of the subsystems operates. Calculate reliability of the system. What would be the reliability for k subsystems? Assume the reliability of every individual component is p.

12. Imagine a redundant pair of components. Let the reliability of every component be 0.98. What is the reliability of the system?

13. A system has 3 components and requires all 3 components be operational 24 hours a day on workdays (Monday–Friday). Failure of component 1 occurs as follows:

Mon No failure

Tue 5 AM to 7 AM

Wed No failure

Thu 4 PM to 8 PM

Fri 8 AM to 11 AM

Calculate reliability of component 1.

14. A steel rope has 4 wires. Correct functionality of the rope is if at least 2 wires are not broken. Probability that a single wire will break is $p = 0.1$. What is the reliability of the rope?

15. A simple signal processing system consists of an input transducer, two signal processors, and an output transducer. An input transducer receives the signal and converts it to a data stream suitable for further processing, its output is fed into a redundant pair of signal processors. The output from both signal processors is combined and fed into the output transducer, which outputs the signal to the external world.

    Only one signal processor is active at a time. The active signal processor processes input, while the standby signal processor ignores the data from the input transducer and monitors the sanity of the active signal processor. The signal processor cards run a real-time operating system and signal processing applications. Input and output transducers are passive devices with no microprocessor control.

    Table 1 lists information that is provided for the system components. Calulcate reliability of the signal processing system

Table 1: System components

Component	MTBF	MTTR
Input Transducer	100'000 h	2 h
Signal Processor HW	10'000 h	2 h
Signal Processor SW	2190 h	5 min
Output Transducer	100'000 h	2 h