Reliability of Technical Systems
Tutorial #3
Solution

1. Consider the probability density function.

$$f(t) = \begin{cases} 0.002e^{-0.002t} & t \geq 0 \\ 0 & otherwise \end{cases} \quad \text{for t is in hours}$$

Calculate reliability function, failure function , and design life if the reliability of 0.95 is desired.

Solution:

1) Reliability Function R(t)=$\int_t^{\infty} f(t)dt$ (f(t) is the probability density function)

therefore, R(t)= $\int_t^{\infty} 0.002e^{-0.002t}dt$=0.002*$\frac{1}{0.002} * e^{-0.002t} \begin{cases} t \\ \infty \end{cases} = e^{-0.002t}$

2) Failure function F(t)= $\int_0^t f(t)dt$=1-$e^{-0.002t}$

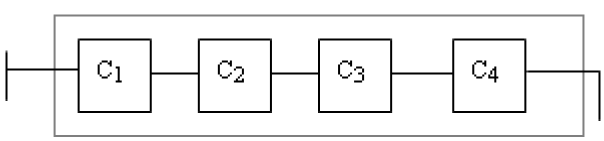
3) R(t)=0.95 $e^{-0.002t}$=0.95

t=25.6 (hours)

2. Consider a system with four-component in series which the components are independent and identically distributed with CFR. If the reliability of the system during 100 hours is 0.95. What is the MTTF of each individual component ?

Solution:

For a system with four-component in series, assume all the components are independent and identical..



Rs (100) = 0.95

Rs = $\prod_{m=1}^{4} R_{cm}$=R_{c1}×.....×R_{c4} (R_{cm} *is the* reliability of the mth component)

Therefore, Rs=$e^{-4\lambda_c t}$ (λ_c *is the failure rate of each component*)

Since t=100 (hrs) and Rs (100) = 0.95

Solve the equation above and $\lambda c=1.28\times10^{-4}$ (1/hour), which means that the every hour there is about 1.28×10^{-4} failures occurring in the component

For CFR distribution, MTTFc=1/λc=1/1.28×10^{-4}= 7812.5 hours

MTTFs= MTTFc/4=1953.125 hours

3. A space vehicle requires three out four of its main engines to operate in order to achieve orbit. If each engine has a reliability of 0.9, determine the reliability of achieving orbit.

Solution:

Total Engines = 4

Required for service = 3, 4 out of 3 should work

$$\sum_{x=k}^{n} \binom{n}{x} R^x (1-R)^{n-x} \quad x = 3,4$$

$$= \sum_{x=3}^{4} \binom{4}{x} R^x (1-R)^{4-x}$$

$R = 4 * (0.9)^3(0.1) + 0.9^4 = 0.9477$

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