

Indian Statistical Institute, Bangalore
M.S. (QMS) First Year
First Semester - Reliability, Maintainability and Safety I

Final Exam

Duration: 3 Hrs

Date: 9 November, 2016

Max. Marks: 100

Answer as many questions as you can

1. If the sales income in excess of Rs. 4 lacs of a large number of firms can be treated as a random variable having an exponential distribution with mean equal to 2 lacs. What's the probability that 3 out of 4 firms selected have sales income in excess of Rs 5 lacs? [12]

2. (a) If the number of occurrences of an event has a Poisson Distribution with parameter λ , then find out the distribution of time of the intervals between occurrences of the events.
(b) Find the expression of Conditional Reliability of a system in terms of Hazard Rate given that the system has operated a warranty period of T_0 . What condition must be satisfied for the reliability of the system (expressed as a function of T_0) to improve ?
(c) Prove that in case of constant failure rate for a component, reliability function depends only on the observed operating time not on its current age. What is this property called?
[5+10+5=20]

3. Fifteen units of a certain automotive component are placed on a life test. The life is measured in Kilocycles. The failures occur at : 90, 150, 240, 340, 410, 450, 510, 550, 600, 670, 710, 770, 790, 830, 880
(a) Plot the Failure density, Unreliability, and Hazard Function based on the above data
(b) Can you suggest a Reliability Model from the Hazard Plot? [4+4+4+3=15]

4. Considering the following two Reliability Functions :
(i) $R_1(t) = \exp(-0.002 t)$, $t \geq 0$ and (ii) $R_2(t) = (1000 - t) / 1000$, $0 \leq t \leq 1000$
(a) Justify the correctness of the statement "MTTF alone will not uniquely characterize failure distribution".
(b) If there is a choice, which of the above Reliability Function should be chosen? Justify the answer.
[8+9=17]

5. The life in thousands of kilometer, of a certain type of electronic control for locomotives has an approximately lognormal distribution with $\mu = 5.149$ and $\sigma = 0.737$. Find the " b_{10} " life of such an electronic control. [8]

6. Suppose the hazard function increases or decreases sharply, exhibiting exponential behavior, and the model used is $h(t) = c \cdot \exp(\alpha \cdot t)$ where c and α are positive constants. Then find the expression for the (a) Failure Density Function
(b) Reliability Function. (7+7=14)

7. Assume that four wheel bolts are adequate from a design point standpoint. However, the wheel attachment under consideration has five bolts. If the chances of losing a wheel bolt are 0.00001, what is the reliability of this "Bolt System". (10)

8. Prove that for useful life the MTTF of a two unit standby system (both the units have same failure rate) as a whole is
(a) double that for a single unit.
(b) greater than the MTTF of a system with two units in parallel.
(6+6=12)