

SQC & OR Unit

Indian statistical Institute, 8th Mile Mysore Road, Bangalore-59

M.S.(Quality Management Science) (2015-2016)

Semester I-July 2015

Paper :Reliability, Maintainability and Safety

Time: 3 Hours

Date: 6 November, 2015

Max. Marks: 100

Answer as many questions as you can

Question (1): (a) Define probability density function (pdf) which is used to describe the Probability distribution of a continuous random variable

(b) A probability density function is defined as $f(x) = a \div x, 1 \leq x \leq 10$, for $f(x)$ to be a valid pdf, what is the value of a ?

(4+8=12)

Question (2): (a) Define a standard normal random variable

(b) A multiple choice quiz has 200 questions, each with four possible answers of which only one is correct. What is the probability that sheer guess work yields from 25 to 30 correct answers for 80 of the 200 problems about which the student has no knowledge?

(4+8=12)

Question (3): The distribution function of a continuous random variable is given by

$$F(x) = \begin{cases} 1 - 1/x & \text{for } x \geq 1 \\ 0 & \text{for } x < 1 \end{cases}$$

Find the corresponding probability density function

(8)

Question (4) (a) If 'T' is a nonnegative continuous random variable that represents Time to Failure of a component or a piece of equipment, then define Reliability Function R(t). What are four key elements in the definition ?

(b) Explain failure density function f(t) and hazard function h(t)

(c) The case in which only hazard function h(t) is given, then find out the expression for the Reliability function R(t) in terms h(t)

(d) Suppose the hazard function increases or decreases sharply, exhibiting exponential behavior, and the model used is

$$h(t) = c \cdot \exp(\alpha t)$$

Then find the expression for the failure density function and the Reliability Function

(4+4+6+8=22)

- Question (5)** (a) Derive the hazard function for three parameter Weibull Distribution
- (b) Explain “Why the shape parameter of Weibull Distribution is called “Weibull Slope ?”
- (c) Interpret the behavior of the Hazard Function of Weibull Distribution with reference to shape parameter and bath tub curve
- (d) A small generator has a random failure rate of 10^{-4} failure/hr. Assume wear out is normally distributed with a mean of 12000 hrs and s.d of 2000 hrs. What is the reliability for an operating period of 100 hrs if its age is 11,900 hrs.

(6+ 4+4+10=24)

- Question (6)** Suppose you work for a company that manufactures Engine Windings for turbine assemblies. Engine windings may decompose at an unacceptable rate at high temperatures. Failure times in months for 12 engine windings out of 50 at 80 degree centigrade and 10 engine windings out of 40 at 100 degree centigrade were collected and given below. The balance windings are unfailed

Serial No.	Temperature 80 ⁰ C	Temperature 100 ⁰ C
1	83	28
2	41	21
3	63	87
4	37	54
5	66	74
6	41	56
7	86	66
8	80	14
9	33	42
10	37	65
11	86	
12	65	

- (a) Draw two probability plots to see if the Weibull distribution provides a good fit for the data
- (b) Assuming Weibull distribution fits, find out 10th percentile of both temperatures and comment
- (c) Find out proportion of windings that survive 70 months at both temperatures and comment.(Assume Weibull Distribution fits)

(8+8+6=22)

- Question (7):** 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 5th percentile of the life of such an electronic control.

(10)