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

Semestral Exam   Duration: 3 Hrs   Date: November 17, 2017   Max Marks: 100

Answer as many Questions as you can. The maximum marks you can score is 100.

Question (1): Tick the most appropriate answer for the following questions with justification. Justification is not required for the questions with * mark

a) Assuming an exponential failure distribution, the probability of surviving an operating time equal to twice the MTBF is (3)
(i) practically zero (ii) about 14% (iii) about 36% (iv) none of the above

*b) The lifetime of a product that degrades overtime is often modeled by (2)
(i) a exponential variable (ii) a normal variable (iii) a lognormal variable (iv) a gamma variable

c) A device has a failure rate characteristics which can be described by a Weibull failure model with a scale parameter of 2.0X10^8 and a shape parameter of 2.The percentage of items expected to fail in 1000 hours (4)
(i) 5 percent of the items (ii) 3 percent of the items (iii) 0.5 percent of the items (iv) None of the above

d) If the b_{10} life for an equipment having a constant failure rate is 2000 hours, then the average failure rate over 2000 hours is (5)
(i) 42.5 X 10 ^ -6 failures per hour (ii) 52.5 X 10 ^ -6 failures per hour (iii) 63.8 X 10 ^ -6 failures per hour (iv) None of the above

e) An analysis of historic data indicates that the repair time for a particular product can be modeled by the Lognormal Distribution with μ=1.7 hrs and σ =0.65 hrs. The estimate for MTTR (Mean Time to Repair) is (3)
(i) 5.5 hours (ii) 6.8 hours (iii) 7.4 hours (iv) 8.1 hours

*f) The flat portion of the bathtub curve is a region of chance failures; therefore the reliability equation R= exp(-tλ) (2)
(i) does not apply to this region (ii) only applies to this region (iii) applies to the wear out region as well as the flat region (iv) applies to the entire bathtub curve

g) If a system reliability of 0.998 is required , what reliability of two components in series is required? (3)
(i) 0.99 (ii) 0.999 (iii) 0.98 (iv) 0.9999 (v) 0.998

h) The hazard function for a Normal distribution is a monotonically increasing function of time (t).
(i) True (ii) False (3)
(i)Larger the Weibull slope "β", more uniform is the product life(i)True (ii) False (5)

Question (2): A warranty reporting system reports field failures. For the rear brake drums on a particular pickup truck the following data was obtained:

KILOMETER INTERVAL	NUMBER OF FAILURES
M< 2,000	707
2,000≤M<4,000	532
4,000≤M<6,000	368
6,000≤M<8,000	233
8,000≤M<10,000	231
10,000≤M<12,000	136
12,000≤M<14,000	141
14,000≤M<16,000	78
16,000≤M<18,000	101
18,000≤M<20,000	46
20,000≤M<22,000	51
22,000≤M<24,000	56

For the above data calculate Failure Function, Reliability Function and Hazard Rate. Assume that the population size is 2,680 and the above data represents all of the failures (10)

Question (3): For a two parameter Weibull Distribution , derive the expression of Average Failure Rate (AFR) over an interval (0,T) (10)

Question (4): In a quality control application, the dimension of pieces are assumed to be normally distributed with variance 0.09. If the tolerances are 0.20 inch apart, find the probability of '3' defectives in '5' pieces selected at random [assume mean of the process midway between limits] (10)

Question (5): The time to failure of a component has a gamma distribution with the shape parameter '2' and scale parameter '1/3'. Determine the reliability of the component and the hazard rate at '10' time units .What's the mean life?

(6+4+2=12)

Question (5):(i)Derive an expression of the Reliability function for a standby system that has two " subsystems"

(ii)Suppose each subsystem has a constant failure rate λ_1 and λ_2,then find out the expression of the reliability function for the standby system.

(iii) An equipment consists of 3 subsystems A,B,C in series with failure rates $\lambda_A = 0.95x10^{-5}$, $\lambda_B = 0.06x10^{-5}$, $\lambda_C = 0.05x10^{-5}$

Determine the system failure rate and reliability for an operating time of 1000 hours. Would this equipment is suitable for application that requires 1,00,000 hours (6+6+8=20)

Question (6): If the number of occurrences of some event in the interval (0,t] has a poisson distribution with parameter λ, then show that the distribution of the interval between occurrences is Exponential with parameter λ (10)

Question (7): Determine the" b_{50}" and " b_{90}" lives of an electric generator having constant failure rate. From previous test it is known that under highly overloaded conditions 20 percent of these generators will fail at the end of 50 hours of operation (8)