SQC & OR Unit

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

M.S.(Quality Management Science) (2018-2019)
Semester I-July 2018

Paper :Reliability, Maintainability and Safety

Time: 3 Hours Date: 16 November, 2018 Max. Marks: 100

Answer as many questions as you can

Question (1): Ten units are placed on Life Test, and the individual failure times are {7,17,25,32,40,48,50,55,61 and 65 hours}. Plot the empirical density function f(t),hazard function h(t) and reliability function R(t) for the data given (4+4+4=12)

Question (2):

i. Derive the expression of (a) the hazard function (b) scale parameter in terms of B_{50} life for two parameter Weibull Distribution.
ii. Why the shape parameter of Weibull Distribution is called "Weibull Slope."
iii. State whether the following statement is "True" or "False" with justification "Scale Parameter of the Weibull Distribution is the life by which 63.2% of the population have failed." (4+3+4+4=15)

Question (3): For the hazard function of the random variable time "t", h(t) = c.t where 'c' is a positive constant, find out the pdf f(t) and the reliability function R(t).Which portion of the 'bath tub curve' is represented by this hazard function? What is the expected value of the r.v 't' ? (4+2+2+7=15)

Question (4): The consumption of Electric Power in a city can be approximated to having Gamma Distribution with the shape parameter =2 and the scale parameter = 1/3 when expressed in 100 megawatts. What is the probability that power needed would be 1000 megawatts or more?. What is the average power needed? (8+2=10)

Question (5): Three critical components in an electrical control circuit are subject to thermal stresses. The magnitude of the thermal stress 'X' is described by an Exponential Distribution with average stress θ_1 and the ability to withstand thermal stress (i,e Y=Strength) is described by exponential distribution with average strength θ_2. The reliability of each component is the probability that the strength 'Y' is greater than the stress 'X' for all possible values of X. When any one component fails, the circuit fails. Find the circuit reliability. (10+5=15)

Question (6):

a) Prove that the Normal density function, the hazard rate is monotonically increasing.

b) A DC battery has a time to failure that is normally distributed with a mean of 30 hrs and s.d of 4 hrs

(i) What's the 25 hrs reliability?

(ii) When should a battery be replaced to ensure 10% chance of failure prior to replacement ?

(iii) Two batteries are connected in parallel to power a light. Assuming that the light does not fail, what's the 35 hrs reliability for the power source?

(iv) A particular battery has been in continuous use for 30 hrs. What's the probability that this battery will last another 4 hrs

(7+2+3+3+3=18)

Question (7): The following table summarizes data on components in a hydraulic system:

Component	Quantity	Failure rate/hr
Relief valve	1	$200 * 10^{-6}$
Check valve	1	$150 * 10^{-6}$
Filter valve	1	$100 * 10^{-6}$
Cylinder	1	$50 * 10^{-6}$

Assume that all components must operate for system success and that the system is used continuously throughout the 8760 hours in a year with no shutdowns except for failures. Repair time varies with the type of failures but 50% of the repairs require 3 hrs or more. The following average cost estimates apply

Material Cost/failure = $ 100.00
Repair Labor Cost/hr = $ 5.00

Assume that failure time and repair time are exponentially distributed.
Calculate the average cost of repairing failures per year (12)

Question (8): Consider a system which has 'n' independent, identical and parallel subsystems; however at least 'r' subsystems must survive if the system is to continue operating. If all the 'n' subsystems are in useful life, find the expression of the system reliability. (8)

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