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57:022 Principles of Design II - Quiz #6

Spring 2002

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One hundred identical devices are tested, and the test is terminated after 50 days, at which time 42 of them have failed. ***Assumption***: The device has a lifetime with Weibull distribution.

*Indicate "+" for **true**, "o" for **false**.*

___ 1. To estimate the time at which 90% of the devices will have failed, evaluate 1 – F(0.90).

___ 2. The quantity R_t is the fraction of the devices which have survived until time t.

___ 3. To estimate the Weibull parameters u & k for this particular device, we may use the "Method of Moments".

___ 4. The Weibull CDF, i.e., F(t), gives, for each device, the probability that it has failed at time t.

___ 5. The time between the failures in the group of 200 units was assumed to have the Weibull distribution.

___ 6. The *secant method* is a method for solving a nonlinear equation.

___ 7. A value of $k>0$ indicates an increasing failure rate, while $k<0$ indicates a decreasing failure rate.

___ 8. The slope of the straight line fit by linear regression to the data will be the estimate of the shape parameter k.

___ 9. In general, given only the coefficient of variation (i.e., the ratio σ/μ) for the Weibull distribution, the shape parameter *k* can be determined.

___ 10. The method used in homework #6 to estimate the Weibull parameters *u* & *k* requires that the motors be tested until all have failed.

___ 11. The CDF of the failure time of a motor is assumed to be $F(t) = 1 - e^{-\left(t/u\right)^k}$ for some parameters *u* & *k*.

___ 12. The p_i of a motor failing in the time interval $[t_{i-1}, t_i]$ is $F(t_i) - F(t_{i-1})$ where F(t) is the CDF of the failure time distribution.

___ 13. In the chi-square goodness-of-fit test, the number of degrees of freedom is never more than the number of "cells" of the histogram.

___ 14. If the assumption of Weibull distribution were correct, a plot of $N_f(t)$ vs. t should be approximately on a straight line.

___ 15. If the failure rate is decreasing, it may be more appropriate to use the *Gumbel* distribution than the Weibull.

___ 16. In the chi-square goodness-of-fit test, the number of *degrees of freedom* is equal to the number of "cells" of the histogram (in this case, 8).

___ 17. If 10 units of this device are installed in a facility, the number still functioning after 50 days has a Weibull distribution.

Part II: Multiple choice: *Let t_i be the time of the i^{th} failure, $F_i = i/N$, and $R_i = 1 - F_i$.*

When plotting the points to fit a straight line in order to estimate *k* & *u* for the *Weibull* distribution,

___ 18. The vertical axis should represent ...

___ 19. The horizontal axis should represent ...

___ 20. The slope of the line should be approximately ...

___ 21. The vertical intercept (y-intercept) of the line should be approximately…

a. t	b. F	c. $\ln t$	d. $\ln R$	e. $\ln \ln t$	f. $\ln 1/t$
g. $\ln 1/R$	h. $\ln(\ln 1/R)$	i. $\ln u$	j. $\ln k$	k. k	l. u
m. $-k\,u$	n. mean μ	o. standard deviation σ		p. *coefficient of variation*	
q. ku	r. $k \ln u$	s. $-k \ln u$		t. *None of the above*	