Solutions

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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**.*

_o_ 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.

_o_ 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.

_o_ 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.

_o_ 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.

_o_ 10. The method used in homework #6 to estimate the Weibull parameters *u & k* requires that the motors be tested until <u>all</u> 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.

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

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

_o_ 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).

_o_ 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 ith 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,

h. $ln(ln\ 1/R)$ 18. The vertical axis should represent ...

c. $ln\ t$ 19. The horizontal axis should represent ...

k. *k*   20. The slope of the line should be approximately ...

s. $-k\ ln\ u$ 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*		