16.881 – Robust System Design

Homework #9
Robust Design and Reliabilty

Due Date: Thursday, 9 July, 1:05, 4-149

Objectives:

- Understand basic concepts of reliability engineering
- Understand the relationship of robust design to reliability

Assignment

1) Given that for small time intervals Δt

$$\lambda(t)\Delta t = \Pr(\text{The system will fail within the period } t \text{ to } t+\Delta t \mid \text{The product survives to time } t)$$

$$R(t) = \Pr(\text{The product survives to time } t)$$

$$dF(t) = \Pr(\text{The system will fail within the period } t \text{ to } t+dt)$$

$$R(t) + F(t) = 1$$

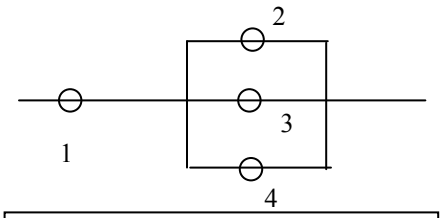
Prove that

$$R(t) = e^{-\int_0^t \lambda(\xi)d\xi}$$

2) What form will the reliability curve $R(t)$ take if the early failure region is removed through "burn-in" and the wear-out region is avoided by retiring the product before the wear-out period? How is this form of $R(t)$ related to a Weibull distribution?

3) If the drift in voltage of a power supply over time is approximated by a Weiner process with increments of one second and a variance of $0.1V^2$. If the voltage of the power supply varies from nominal by more than 3V, it will cause the entire system to fail. What is the expected value of time to failure of the system? If the variance is cut to 0.03V per increment, what is the expected value of time to failure of the system? You may demonstrate your anwers using closed form mathematics or simulations.

4) The unreliability $F(t)_i$ of each element of the system below was reduced by a factor of two (through robust design of course). What was the approximate effect on system reliability R(t)?



This system will fail if subsystem 1 fails *or* if subsystems 2,3, *and* 4 fail.