Assignment 3 Solutions

I. Question 1 - Reliability of r out of n components

We assume that all components are identical and have the reliability $R(t) = e^{-\lambda}t$. 'r' out of 'n' components are required to be operational at the time of the evaluation. Therefore, the probability of success is equivalent of obtaining 'r' or more successes out of the possible 'n' trials with success probability $p = R(t)$. Note that this is the definition of a binomial distribution.

Therefore the total system reliability $\mathcal{R}(t) = \sum_{j=r}^{n} C(n,j)R(t)^j(1 - R(t))^{n-j}$, where $C(n,j)$ is the combination operator of choosing 'j' samples out of a set of size 'n'. Note that this can also be written as $\mathcal{R}(t) = \sum_{j=r}^{n} B(j : n, p)$.

Alternatively, people also write the formula $\mathcal{R}(t) = 1-F(t)$ where $F(t)$ is the probability of only 0 to $r-1$ components surviving. That again can be written using the binomial distribution:

$\mathcal{R}(t) = 1 - \sum_{j=0}^{r-1} B(j : n, p)$ or

$\mathcal{R}(t) = 1 - \sum_{j=0}^{r-1} C(n,j)R(t)^j(1 - R(t))^{n-j}$

As a sanity check $\sum_{j=0}^{r-1} C(n,j)R(t)^j(1 - R(t))^{n-j} + \sum_{j=r}^{n} C(n,j)R(t)^j(1 - R(t))^{n-j} = 1$

You can check easily the value of series and parallel reliability from this.

II. Other Questions

Q.2 Generally, having the input to the top element of a fault tree come from an and gate is considered desirable. Explain why this is the case.

Answer: The key points to capture here is that and implies multiple failures are required simultaneously for the goal to be not met. hence it reduces the likelihood of failures.

Q.3. Suppose you have been hired by the XYZ Corporation to help deal with the least dependable component of a laptop computer, the hard disk drive. In order to improve the dependability of the disk drive systems used in laptops, the goals are to analyze the current designs to see where the likely causes of failure are and to consider ideas like mirrored and solid-state disk designs. What is the most significant hazard associated with the disk that a laptop faces?

Answer - Any reasonable answer is fine. The reasonable answers can be data loss, inability to write.

Q.4 For the hazard identified in Q.3 draw the top three levels of the associated (hypothetical) fault tree.

Answer 4: Check that the fault tree is correct. Please make sure you use the right sign for 'or' and 'and'.

Q.5. List the nodes in the fault tree in Q. 3 that would not be present with a disk-drive replacement based on compact-flash technology.

Answer 5 - fault nodes related to mechanical component

Q.6 Test cases

- There should be atleast three possible values of n. n==0; n <= 100; n> 100
- for all possible values of n, choose a case where c is in the array and another case when c is not in the array.
- so there will be atleast 6 cases.
- Grade this generically. If they have identified partial test cases – then give partial credit and note which test case is missing