MATHEMATICAL ANALYSIS OF MULTI-UNIT SYSTEMS

INTRODUCTION:

In the present times we are fastly moving towards sophisticated systems which are based on modern technology and are complex in a nature. For this we need such a technology which provides answers to demands of society and industry as well in such a way to produce maximum using minimum resources. The attention of researchers and engineers have been attracted all over the world to design and develop highly sophisticated systems with high level of reliability.

The word reliable is commonly used in the same sense as dependable. When a statement is made to the effect that a particular component is reliable, we mean that the component will behave in the manner that is expected of it. If that particular component happens to fail unexpectedly, we accept it as a chance failure. Thus the expected behaviour under certain assumed conditions along with a certain degree of uncertainty form the basis of definition of reliability. Before proceeding further, we introduce first the basic idea of reliability.

RELIABILITY:

L.S.SRINATH in his book titled “RELIABILITY ENGINEERING” defined reliability as under:

“Reliability is the probability of a device performing its purpose adequately for the period intended under the given operating conditions.”

The definition mainly focus on following observations

(i) The reliability of a device is considered as a probability.

(ii) The device is required to perform adequately.

(iii) The performance is a function of time and

(iv) The operating environment or operating conditions are given.
Mathematically, we define reliability as:

If $T$ is the time till the failure of the unit (or device) occurs, then the probability that it will not fail in a given environment before time $t$ is

$$R(t) = P(T > t)$$

Thus reliability is always a function of time. Since it is a probability, its numerical value is always between one and zero. i.e.,

$$R(0) = 1, \ R(\infty) = 0$$

Thus, initially component will perform perfectly and no component will perform infinitely.

Systems are made up of parts and components. The failure of a part may lead to the failure of the whole system, which contributes to the system reliability. This leads to a careful analysis of components and to the study of their failures. Components failure models can be obtained either from the basic failure rates and working stresses using stress models or from part failure data obtained from life-tests. It is almost impossible to establish failure rate of components from working conditions, however it is possible through extrapolation or interpolation to predict reliability under specified conditions from the available data.

We define failure rate, a major measurement of reliability as the conditional probability that the system fails during the time interval $(t, t+\Delta t)$ given that it was operating during $(0, t]$. Let $r(t)\Delta t$ be the probability that the device has life time between $t$ and $t+\Delta t$, given that it has functioned upto time $t$ then

$$r(t)\Delta t = Pr[t < T \leq t + \Delta t \mid T > t]$$

Thus defining $r(t)$ as

$$r(t) = \lim_{\Delta t \to 0} \frac{R(t+\Delta t) - R(t)}{R(t)}$$

To determine the reliability of a component various measures such as Mean Time to System Failure (MTSF), MTBF, Availability of system point wise as well as
steady state are calculated. Before proceeding towards these tools first we have a look on relevant literature.