**Structural Reliability**
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**Lecture –89**
**Reliability Problem Formulation (Part - 01)**

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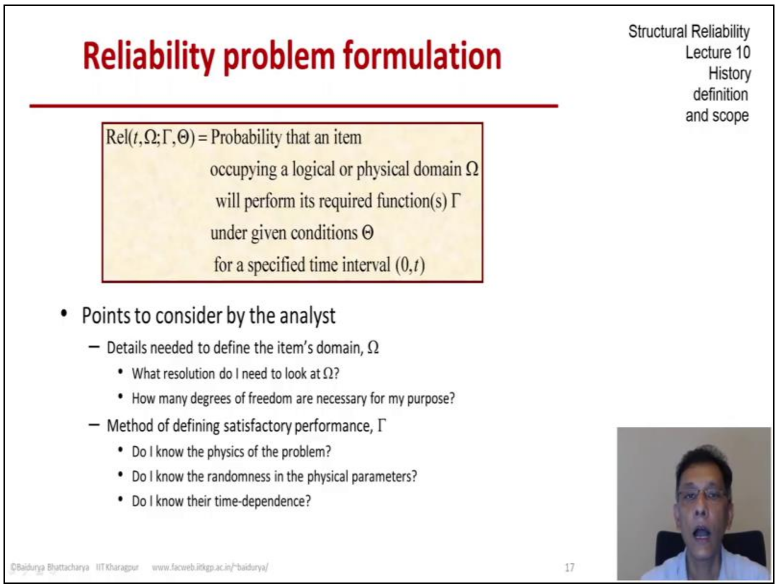


In the previous lecture we discussed how the subject of reliability came to be how it evolved and defined its scope and some terms related to the discipline. Today we are going to look at how to set up our problem in reliability. This was our definition that we discussed yesterday that reliability is the probability that your item of interest would do its job over the service life. The points to note are the domain omega that your item occupies that helps define it the performance objectives the functions that it must satisfy gamma and the service conditions theta under which it must operate.

So, as an analyst I need to consider several things and let us go through one by one. First is what is the level of details I need to define the domain omega what is the resolution how many degrees of freedom do I need to look at? For example let us say I want to find the strength of a cable. Do I treat the cable as just one member with single yield strength or fracture strength or do I go deeper and look at the cable as made up of many strands.

And look and take into account the individual strengths of those strands and how they interact and how they come together in forming the cable system. It depends on what is my purpose. So, as the user as the analyst I get to decide what level of detail I need to look at in order to completely define my system. The next is what do I know how much do I know about the performance that my item is supposed to satisfy.

So I know the physics of the problem do I know the underlying mechanisms or do I simply have a set of identical items that I can test and see how they are behaving. Do I know the randomness in the physical parameters that define my item that define its performance? Do they vary with time and space and do they do so, randomly. If I start asking these questions I get to have the following answers. The first is whether I have a system or an element reliability problem at hand.

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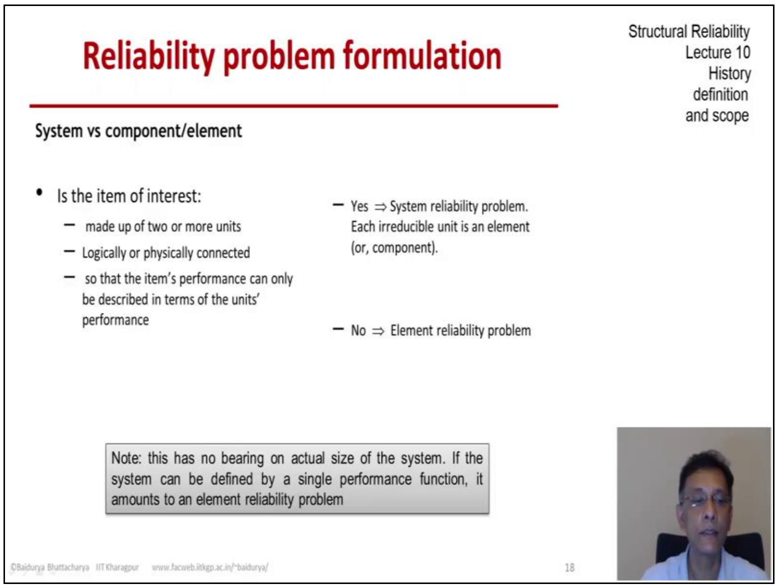


So what would give me that answer how do I arrive at that decision? So, I would ask these questions that is the item of interest is it made up of two or more units now what do I mean by that? These units are to be logically or physically connected so that and this is very important. So, that the item's performance can only be described in terms of the unit's performance if I can ignore that then obviously I do not need to look at the units for what they are.

But is my system is my item defined only in terms of those units two or more. Now if the answer is yes then I have a system reliability problem at hand and each such irreducible unit. So, I cannot define one unit in terms of other further units if that is. So, it is an irreducible unit and that unit we term as an element or component. So, we will use this term element and component interchangeably in this course.

If the answer is no then we have an element reliability problem. Now it should be obvious that this differentiation between an element reliability or system reliability problem it has no bearing on the actual size of the system. Whatever the; size it can be a very small item or a very large item. If I can define this is the item in terms of one single performance function which we will see later through several examples today.

Then we have an element reliability problem however large in real terms that item may be but if I need to have two or more performance functions two or more logically or physically connected units then I have a system reliability problem.

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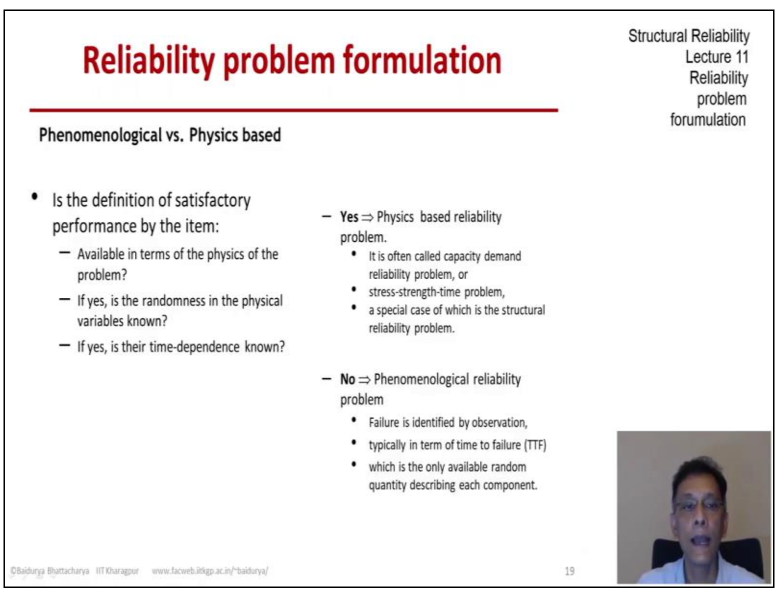


The next question is whether I have a phenomenological or a physics based problem in hand. So, let us approach this step by step. So, is the definition of satisfactory performance the functional objective of the item is it available in terms of the underlying physics or the mechanics of the problem if. So, is the randomness in those variables known do I have an idea about all the random variables or random processes that would define the physics of the problem.

And if it is relevant do I know their time and or their space dependence. If the answer is yes then I have a physics-based reliability problem and that is what actually we are going to see in structure reliability. So, a physic-based problem is often termed as a capacity demand reliability problem or a stress strength time. If time is a factor if things change with time randomly then a stress strength time problem.

And as I said a special case of that is the structural reliability problem. If I do not have a physics-based definition of the satisfactory performance what the item is supposed to do if I do not have that if I can only observe it by testing phenomenologically then I have a phenomenological reliability problem at hand. Failure as I said is identified by observations and typically described in terms of the time to failure which is the only random variable that defines my problem. So, the entire focus is on defining the random properties of the time to failure.