Structural Reliability
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Lecture –105
Representation of Systems (Part -09)

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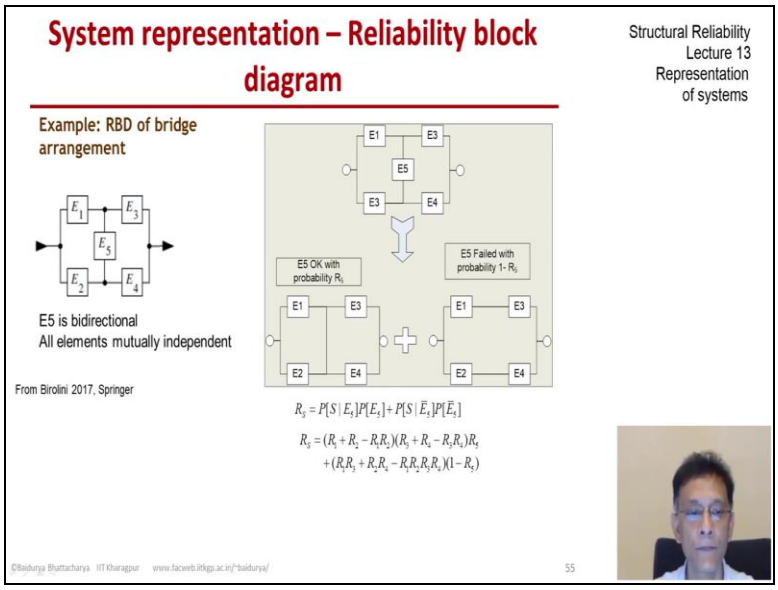

However things become little more complicated and challenging for certain configurations where this sort of reduction in parallel and series arrangements is not possible. So, one classical example is this bridge arrangement. So, we have a key element E5. So, there is no way that this can be reduced to an arrangement as we looked at in the previous slide 5 just to be sure is bi-directional. We are going to next look at an example where 5 are actually unidirectional.

So, how do we solve this? If you want to work through this please pause the video otherwise let me present the solution. Again let us note that all the 5 elements are mutually independent. So, the way to proceed would be to split to split this bridge system into two simpler systems uh. So, one in which the 5th element the key element is working for sure and the other case where the fifth element has failed for sure.

So, this gives us the two simpler systems that you see on your screen on the left where because

E5 is working for sure that has been replaced by just a simple link and on the right E5 has failed for sure. So, that has been eliminated completely. So, now we have on the left we have a simple parallel arrangement in series two parallel subsystems in series and on the right we have two series systems in parallel.

So, we know how to solve this now. So, we use the theorem of total probability the system reliability is the system reliability given that element 5 is okay times the probability of element 5 is okay plus the same system but given element 5 has failed times the probability of its failure. And now we can proceed as we have done in the past uh. So, on the first line you see the left configuration which is multiplied by the reliability of 5.

And on the bottom line you see the right configuration which is multiplied by the failure probability of 5.

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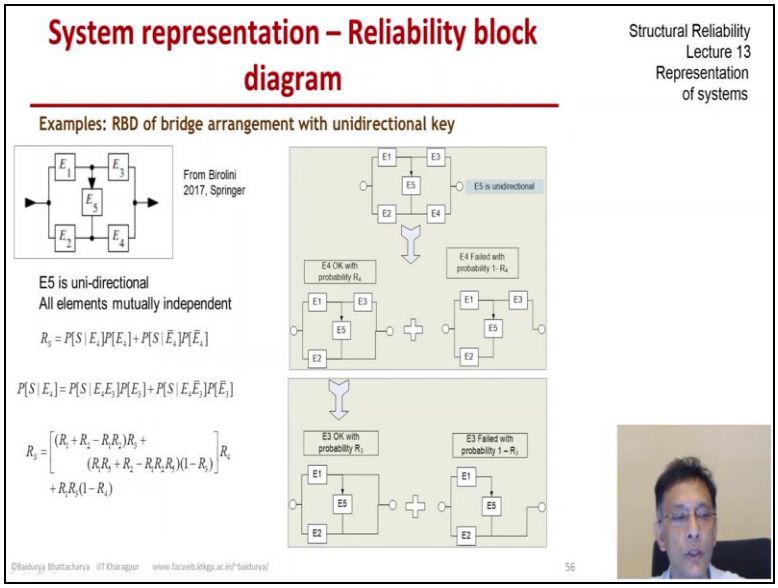

Things become even more interesting if we consider the key element 5 to be unidirectional. So, we have to modify our approach a little bit since the previous solution to account for the fact that 5 is unidirectional. So, we would not condition on 5 anymore but we will take one of the others say let us take 4. So now we take on the left as you see the conditioning event that four is for sure working and on the right 4 has for sure failed.

So, that is our partition and our system reliability can be expressed in terms of the equation that you see on the left. So, if we just inspect the figure on the right when 4 has failed it is a very simple configuration now because whether E2 is working or not it has no contribution because it cannot reach the end terminal. Likewise whether E5 is working or not it makes no difference because it there is no way to reach the end terminal.

So, the in effect it is a series system involving elements one and three. So, we will keep that in mind. The one on the left where four is working when it is conditioned that element 4 is working it still needs a little bit of simplification we would not be able to proceed just with this but we are going to make one more partition and that would be on element three. So, on the left we have element three working and on the right we have element three has failed for sure.

So, in terms of writing the first term on in the first equation system survival given E4 we now condition that further on E3. So, you see the second equation where we have s given E4, E3 and s giving E4 and E3 bar. So, it is now straightforward to solve both of the configurations on the bottom pane and the answer would be for when our 3 is working it is simply an arrangement of E1 and E2 it is a parallel arrangement of E1 and E2 whether E5 works or not it makes no difference.

So, that is the first line on the bottom block. The second line is when E3 has failed and that is actually that takes into account element 5's reliability and that is what you see on the second line and the third line is basically what we looked in the beginning is when element four has failed. So, the combined system reliability is computed in this manner.