**Structural Reliability**
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**Lecture –109**
**Representation of Systems (Part -13)**

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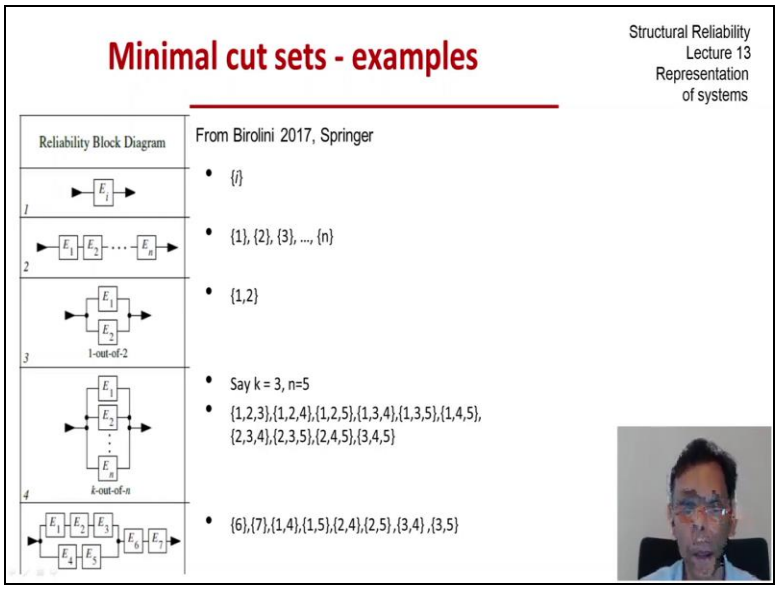


Let us now identify the minimal cut sets from reliability block diagrams for simple problems that I am going to present in this and the next slide. So, the first 1 is a single block. So, obviously it is 1 element and the minimal cut set is that element itself. The next 1 is a series system and so, each of these elements in themselves constitute a minimal cut set and there are n such minimal cut sets. In the third block diagram we it is a 1 out of 2 system or a purely parallel system with 2 elements.

So, again the only way that this system could fail if both of the elements fail and if you take any 1 of them out then that cut set no longer remains a cut set. So, 1, 2 is a minimal cut set of this system. In the 4th example it is known as a k out of n system as we looked at an example a particular case of that which we call 2 out of 3. So, for a k out of n system we have to exhaust all the list all the possibilities.

So, if we do want to go through that trouble let us put some numbers for k and n. So, let us say k

is equal to 3 and n is equal to 5. So, it is a 3 out of 5 system and then let us list out all the minimal cut sets. So, if 1, 2 and 3 fail than 3 items have failed 3 elements have failed 2 are working it is no longer a 3 out of 5 system. So, that would constitute system failure you remove any member from 1, 2, 3 and obviously it no longer remains a cut set.

So, it is a minimal cut set. So, that way we need to identify all the 5 choose 3 possibilities. So, there are 10 all the ten minimal cut sets listed and the on your screen in the last problem on this screen we see that it is mostly a series although there are 2 parallel arms on the left. So, clearly 6 is a minimal cut set if you remove 6 then the system fails. So, 6 are a minimal cut set 7 is also a minimal cut set.

Now what about the 2 arms on the left side of the block diagram, so, in the upper arm 1 or 2 or 3 if any 1 of them fails. So, that arm has failed. So, we do not need to look at more than 2 I am sorry we do not need to look at more than 1 from that upper arm likewise in the lower arm. So, if we have to combine one so element 1 with another one to create a minimal cut set we would look at the lower arm and we will choose 4 or 5 likewise we will do the same with 2 and 3.

So, now we are ready to list out all the minimal cut sets. So, 6 is there 7 is there 1 with 4, 1 with 5, 2 with 4, 2 with 5, 3 with 4 and 3 with 5 so that would give me the entire collection of the minimal cut sets of the system.

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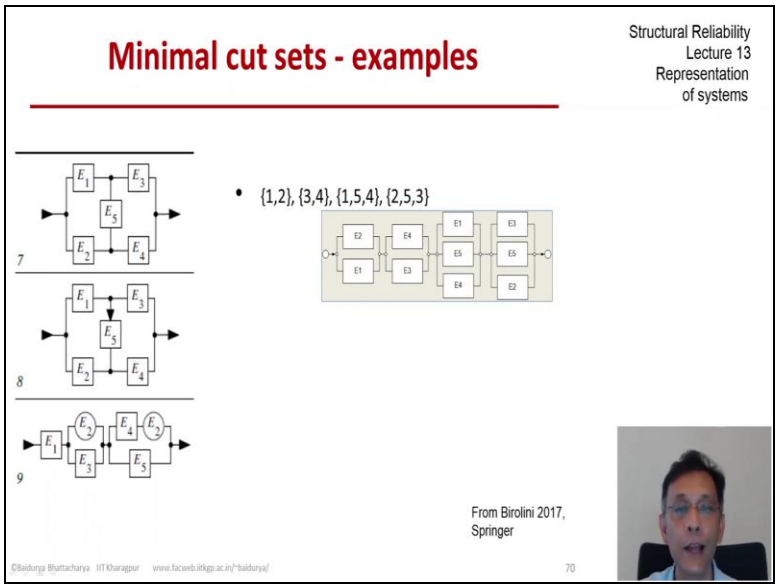


Let us continue this is our close friend our bridge structure that we looked at in detail a few slides ago and. So, what would be the minimal cut sets of this system. So, this clearly and please remember that 5 is bi-directional as opposed to the next problem 8 by 5 is unit direction we did solve that problem as well. So, if we kill both 1 and 2. So, if 1 and 2 fail then the system fails.

So 1, 2 should be a minimal cut set again by symmetry 3, 4 should be a minimal cut set but then if we have to involve 5 then we have to look at the kind of the diagonal arrangement. So, 1, 5 and 4 would constitute a minimal cut set because remove any 1 of those members and it no longer remains a cut set. So, 1, 5, 4 should be a minimal cut set as would 2, 5 and 3. So, this is the answer and so, this also tells us there is a completely equivalent way of expressing the same systems block diagram and that would look like this.

So, we would take advantage of the of the minimal cut sets to create the equivalent block diagram. Let us look at the bridge problem though the bridge problem sorry the bridge problem with the unidirectional key element. The next problem it would have the same minimal cut sets for a few of them. So, 1, 2 will be there 3, 4 will be there but would 1, 5, 4 be there and 2, 5, 3 be there as well that would that is an interesting question.

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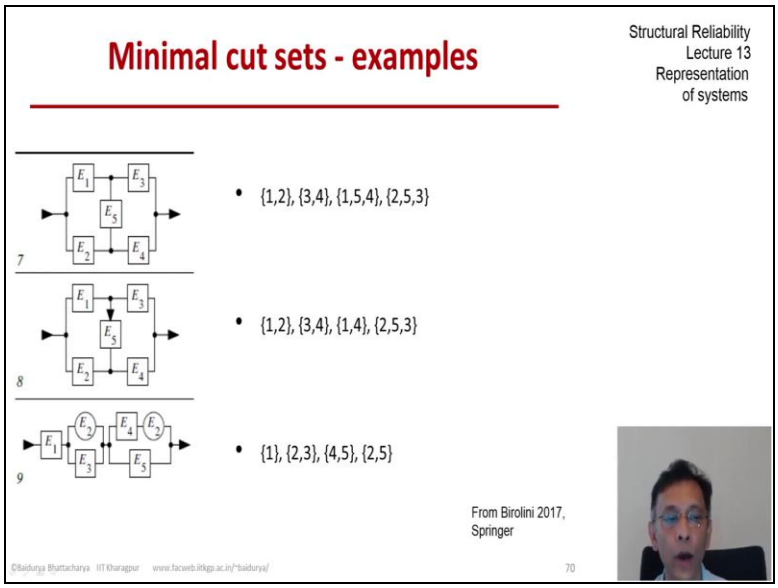


So, let us see. So, 2, 5, 3 is there because you take any 1 of them out we still we do not have a cut set anymore but instead of 1, 5, 4, 1, 4 is sufficient because even if 2 is okay 1 and 4 have failed because the by because of the unidirectional nature of element 5 that 2, 5, 3 path is no longer available. So, because of the unidirectional nature we have a different minimal cut set in this example for 1 of them.

And finally we the last problem on this slide we have looked at this also and let us let us list out its minimal cut sets. So, obviously 1 is a minimal cut set and the next parallel block 2, 3 should be a minimal cut set and what about the block on the right most. So, we 5 should be there and either with 4 or with 2. So, there are 4 minimal cut sets for this example it is 1 and 2, 3 and 4, 5 and finally 2, 5.