**Probability Foundations for Electrical Engineers**
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**Lecture – 53**
**More on Assigning Probability to Regions of x-y Plain**

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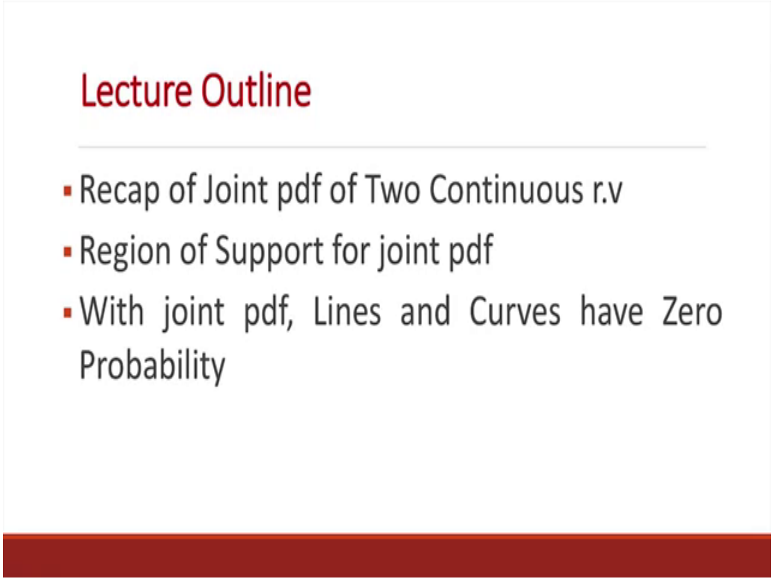


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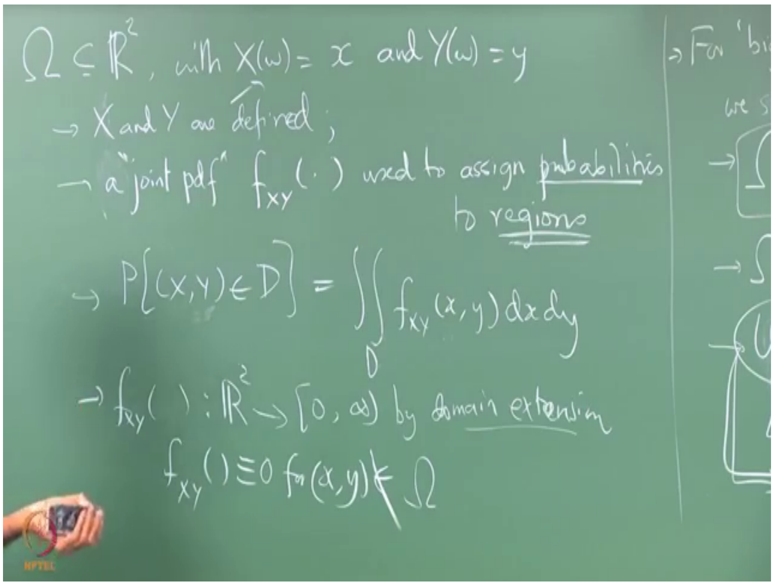

So, last week we consider the case of omega being some subset of R square with this. So, this define X and Y are defined are properly defined using this and a joint ideas probabilities to regions, some region D is what we used last week, does not matter, so you do this double integration like this.

Note that D can be any arbitrary region in R squared actually because we are going to define. So, f xy is defined for all is defined for all R squared by domain extension although it is nonzero it is 0 outside not in omega. So, this a summary of what we solved as Wednesday in last Wednesdays class. We have taken an integrable function two arguments f xy and we defining it was a whole plain by domain extension, I like with its for this one the pdfs one with of one variable, here write we have a region where define region where x and y take values which is write a countable substitute of R square.

Now, this is small notational extension I have to do what if my x and y are obtained from bigger space for example, some R power k for k bigger than 2, in such a case we will have to we can you know you cannot claim that omega itself is a its contained in R squared omega can be bigger, but x and y are two continuous random variables and I mean there just two random variables so they have to take values only in the plain together.

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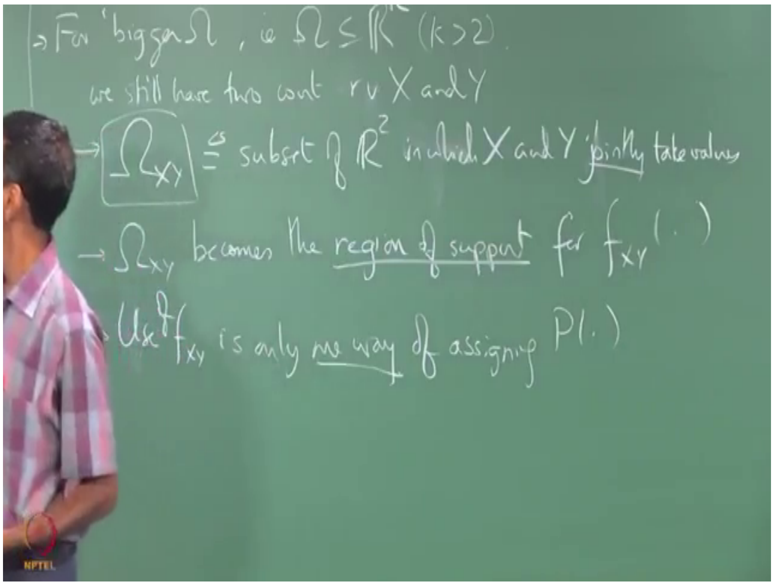


So, for bigger omega, ie in for there is omega let us say it is a subset of some R power k k more than 2, we still have, we can still have two continuous random variables x and y only thing is you will have to qualify they substitute in which they take values. So, we define omega xy as a subset of R squared where x and y take values or in which jointly take values these also important.

Now, this omega xy notation we have already seen in the case of discreet. The same idea except that and countable subset of R squared supposed to a countable subset that we had earlier, is not it. So, I just want to may write from now on where since we are only going to for the time being focus on two random variables x and y we can stick to omega xy rather, you know we should not, we should realize that write it is a unfair to call omega xy as omega, omega can be is much bigger you could have a random vector with components and we can just focus on two of them which case you would need something more specific. So, that is all.

So, this notation omega xy is exactly the same whether we deal with two descript random variable or two continuous random variables which is said in which they take value jointly. But otherwise you still have the joint pdf exactly define the same when. So, this omega xy becomes this region was support for what you what you understand by this region of support what is meaning of this idea for f xy like you have the interval omega in the 1D case you would talk of capital omega x being the interval of supports. So, here you have a region of support that is the only region where this has nonzero values.

So, if you take xy outside this region was support you guaranteed that f xy 0 right. So, we will use this you know this nomenclature quite frequently. So, what is a limitation of? So, this is remember a bottom line is there write f xy, use of f xy is only one way of assigning of consistently assigning probabilities right, but note that we have to assign P to region. So, otherwise we are not write the limit two continuous two random variables.

And it turns out that it is the most analytically the one of the simplest way the easiest way of doing. So, because these double integrals even if you cannot evaluate them analytically you can always value the numerically and so on and so forth and so on and we saw the other day also that the joint CDF is which is defined specifically with a particular a infinite semi infinite rectangular in generally that is very complicated to compute and specific for each xy. So, we will avoid that completely, even though its put in all books as a wholly everything starts off with joint CDF, but we will not take that approach here. Given that very few examples later on will anyway you know nobody use this that joint CDF after stating it, yes it is there and then people come away from that in only look at this.

So, we can avoid it right from the beginning, but just keep it in mind in case if somebody ask you the joint CDF we should know how to answer them.

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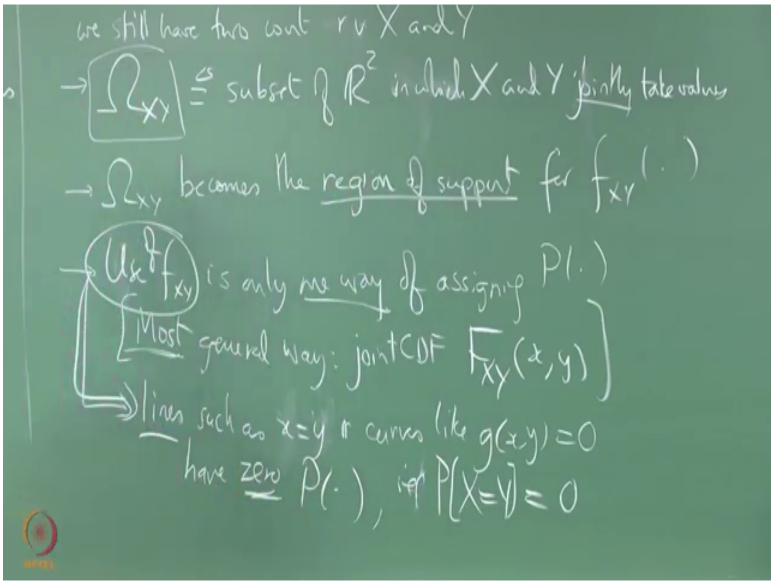


So, most general is joint CDF. This is by virtue being a probability is bounded this being always being 0 and 1, unlike this which can take any real number any positive real number, so anyway.

So, what are the limitations of using this joint pdf f x small f? It turns out that you cannot give positive probability to what types of entities in the plain you cannot give positive probability to points of course, you cannot give positive probability give on points you cannot give probability to lines and curves. So, the user f xy means that lines such as x equals to y or in general curves how do we define a general curve g of x well let me write small x equal to y instead of this is just to g curves like g of x y equal to 0 always have 0 probability in if you say that if you start off with this. This is a very important point.

So, please pay attention this is a question which can come at you. So, we should immediately say every if you start with by integrating joint pdf like f xy every curve has 0 probability. Why does it have 0 probability? Because it has 0 area, any; by virtue having 0 area when you in when you do this double integral over region which has 0 area which is D for region at case of such w into you know that the value has to be 0 is not it, you know if this is the well behaved integrable function if you cannot integrated over, over line in get finite answers.

So, the user f xy means this any line. In particular therefore, what is it mean for the probability that x will be equal to y. That has to be 0 because this line represents the event that capital X equal to Y, capital Y, the event capital X equal to capital Y is captured by the line x equal to y; exactly has in the in the this 3 case, is not it. So, which ie let me say that p of x equal to y is 0 in general sorry ie or eg whatever we want to say.

Whereas our, that is also true for any curve g xy we if you have the case that you know very important special case which we have to look at later for me with using some different tools is the fun the same thing that we did may be within do in such great extendency with discrete random variables, but we have case of y being function of x right.

So, y is a function of x actually we do not need to random variables to describe that situations because x is the say the a single random variables defined on some interval omega x and knowing x if you know why exactly that happens when y equals to f x some function of x I should not use word f let f, but some g of x whatever; why; it turns out the that entire probabilities concentrated where on the curve in which defines a two random variables is not it or they two variables in this case just x, y and x.

So, that we will differ to a later discussion the important special case of y equal to call of g of x we will do different. I think you may have seen such cases in your early in the other course I am not sure, but anyhow, right.

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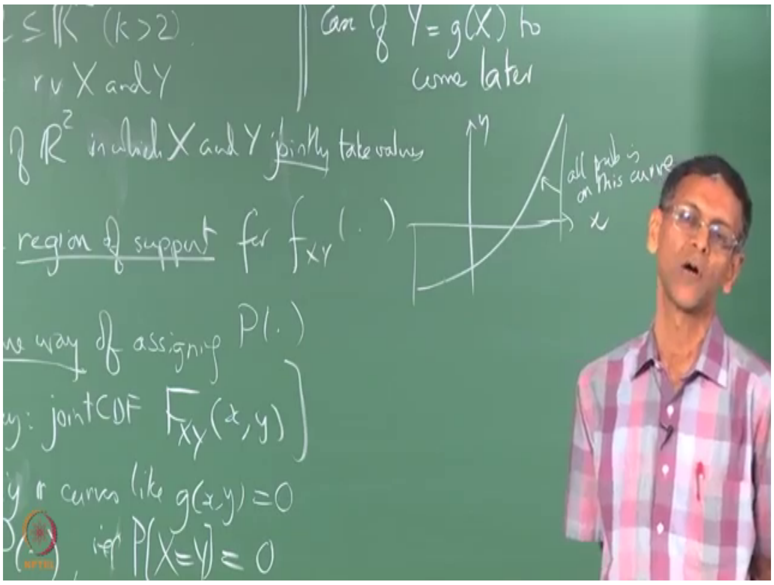


The case of y equal to g of x to be done later. This is two important situation to pass up. But one thing remember for y is g of x; that means, your entire probability is concentrated in this line there is no probability, there is know there is by what happens see a omega x y; automatically 0 0 area. So, all probability is concentrated here, is on this line on this curve shall we say in general. It could be our some interval whatever. So, here you cannot talk in this in that situation you cannot ask or jog meaningfully if you a joint pdf.

So, for now we are sticking to the case of this very important equation here where we are using small the joint pdf, where we have a healthy joint pdf a healthy nonzero region omega xy and you are going to sign probability is based on this very important relationship.