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NPTEL
National Programme
on
Technology Enhanced Learning

Probability Methods in Civil Engineering

Prof. Rajib Maity

Department of Civil Engineering
IIT Kharagpur

Lecture – 02

Topic

Random Events and Probability Concept

Welcome to the second lecture for the course probability methods in civil engineering.

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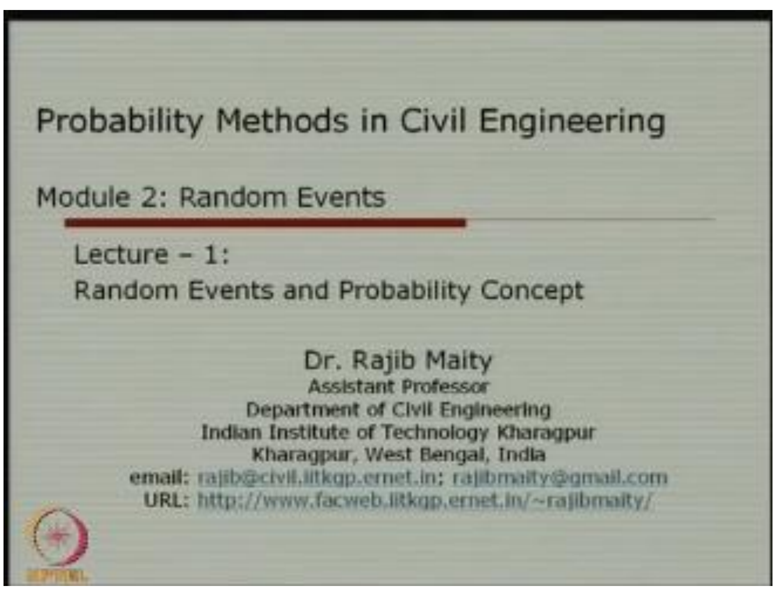

This is basically the starting of module 2, in this module 2 I will cover the concept of random events which is very useful in the probability methods. In this module there are couple of lectures for 5 lectures will be there in the very first lecture I will cover the random events and probability concept.

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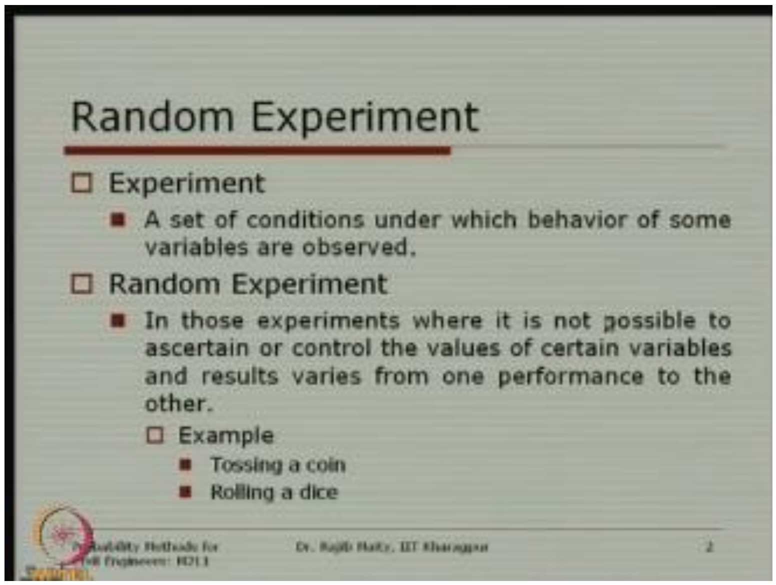

Basically we have to know the concept or random experiment first, and before that what is an experiment? It says a set of conditions under which behavior of some variables are observed and when you say that a particular experiment is random that is random experiment in those type of experiment, where it is not possible to as certain or control the values of certain variables and results varies from one performance to the other performance.

For example, if I say that if I threw a coin and I want to see what is the outcome of the throwing of a coin, I cannot say with full certainty that first to be outcome whether it will be the head or it will be a tail. So this kind of example that is tossing of a coin, and similarly a rolling of a dice where I cannot say the particular outcome from that particular experiment, then the outcome of that experiment becomes random.

And this kind of experiments is known as random experiment. There are when we take this random experiment there are different types of sampling techniques one is with replacement and another one is without replacement. In the case of with replacement each item in the sample space is replaced before the next draw. Say for example, if I say in a box there are few balls, and the balls are of different colors and I want to take out one ball in random, and I want to observe that what is its color.

Now, if I take out one ball and place it back to the box again, and do the next trial after replacing the ball that is known as the with replacement. If I do not go for this example, and if I give the example of the tossing of a coin this is also can be treated as with replacement it is sampling technique, because if in the first trial I get one head, and I am going for the next trial that means all the options that is of all the possible outcome head and tail both are with me.

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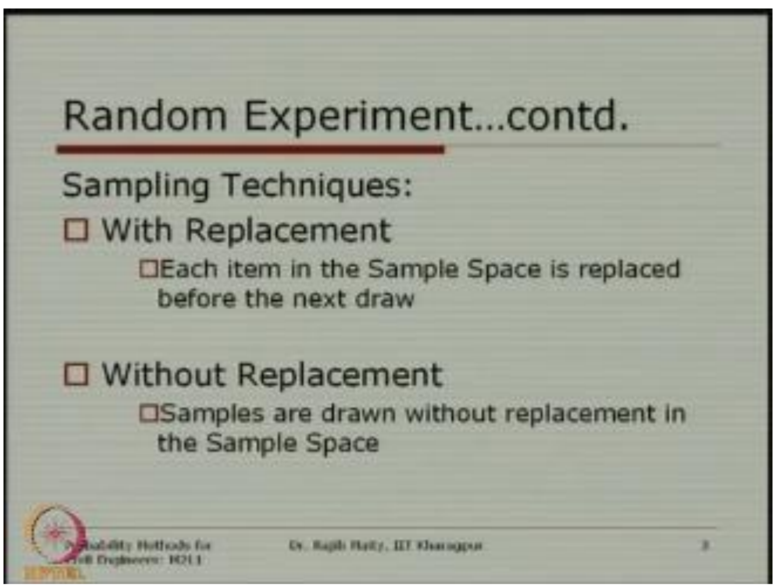

So this kind of experiment is known as the with replacement experiment; there are, there is also possible that we can do the experiment without replacement also in the example of drawing walls from a box, we can just kick out one after another a particular color of ball and keep it outside. So that we will know later gradually in this course that this two kind of sampling technique is different when we are going for the definition of or the computation of probability for that particular experiment.

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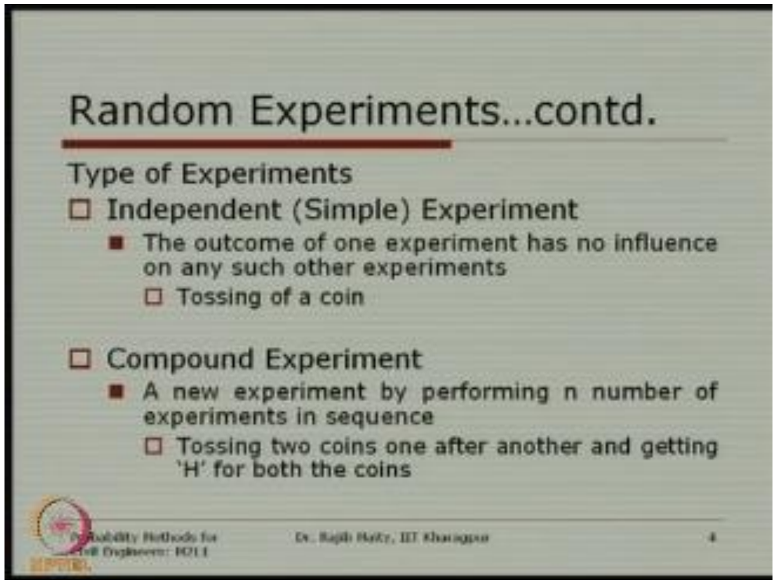

There are different types of this kind of experiment, one is that independent or simple experiment, and second one is compound experiment. In this independent and the simple experiment it says that the outcome of one experiment has no influence on any such other experiments, or also it is also not dependent on whatever the outcome it just replace trail. Say for example, if I say again the tossing of a coin, then if the outcome for a particular trail, if the outcome is head it does not influence it.

It does not have any influence on the outcome for the immediate next trail. So, this kind of experiment is known as independent experiment. Second one is the compound experiment, it says a new experiment by performing n numbers of experiments in sequence; for example, tossing two coins one after another, and getting head for both the coins. So I just want to show experiment here is that I will throw two coins, and I want to see the outcome for both the 4 coins it comes head.

If I give the example of rolling a dice where the possible outcome is 6, that means the number 1 to 6, I can say that what is the possibility that the summation of the outcome of both the dies will be greater than or less than a particular. So this kind of experiment it says that it depends on the outcome of one particular experiment is depends on the total performance or the success rate of the experiment depends on the mutual performance of both the, all the trails that is that we are performing. So this kind of experiment is known as compound experiment.

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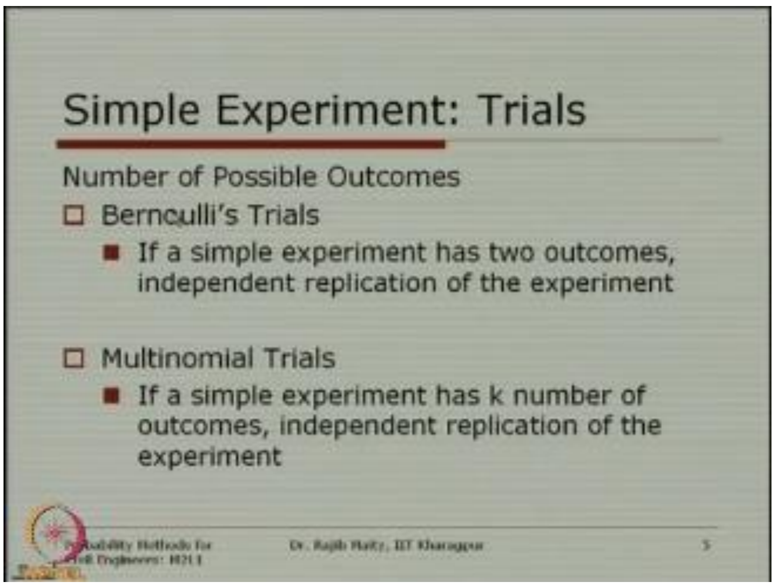

There are different possibilities of the outcome for a particular experiment and based on the number of possible outcome it can be divided into two different parts. The first one is the Bernoulli's trails it is a if a simple experiment has only two outcomes for example, as I said that in case of tossing a coin there are already two possible outcome head and tail and independent replication of the some experiment, then this kind of trials as known as Bernoulli's trials.

On the other hand, if a simple experiment has k numbers of outcome, and independent replication of this experiment this kind of trials is known as multinomial trials. So these things are important to know the basics of these random events which will be useful when we are going to give the concept of probability, so if we know that basics of this experiment and based on this experiment if we know what are the all possible outcome then we will, this will be helpful to understand and to and interrupt the results of the probability and an analysis.

And if we assign some particular probability it will help us to inform from the results in hand. So gradually I will show in this how this kind of concept, this kind of interpretation of the probability is based on this kind of random experiment.

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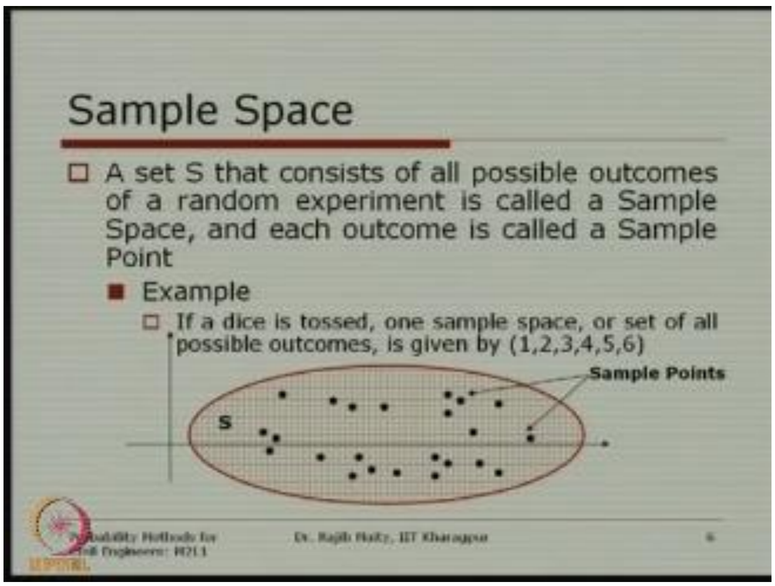

So first one important terminology that we should understand clearly is sample space. A set of S set it is generally a designated as a capital S, A set S that consists of all possible outcomes of a random experiment is called a sample space and each outcome is called a sample point. Example, if a dice is tossed one sample space or set of all possible outcome is given by the numbers from 1 to 6.

So this scan be treated as a pictorial representation of the of the sample space and this black dots are the sample points. So, collection of all these sample points collection of all this possible outcome for a particular experiment is known as the sample space.

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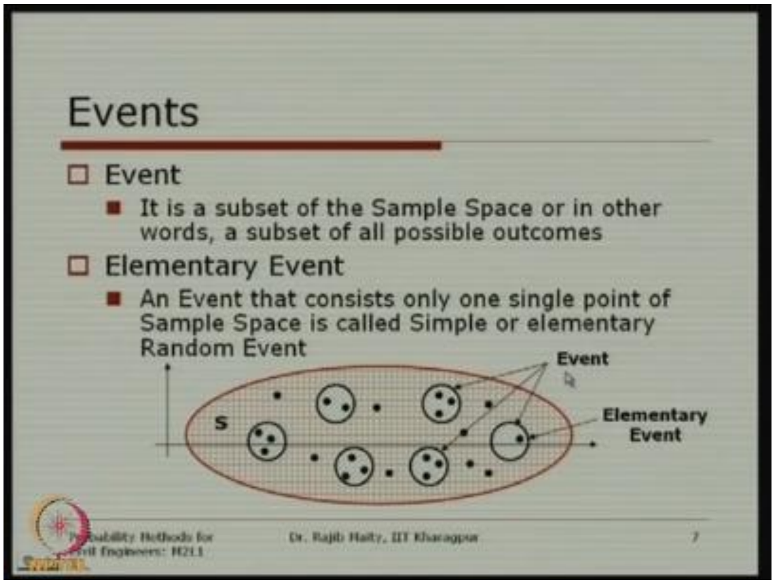

Second thing just occurred we know what is sample space it comes as an event and an event is a subset of the sample space or in other words a subset of all possible outcomes. So, I know what is my sample space, if I want to show it here the black circle that the black or the or the red area. Here is your sample space and in this sample space, if I select any combination of the sample points then each combination or each feasible set is feasible subset of this of this sample points is one in one event there are other terminology like elementary event. It is very simple, and the sense that if a particular sample consists of only one possible outcome then that is known as simple event or the elementary event.

If I give the example again of this throwing a dice here, so here the sample space as I told just in the previous slide that the sample space is any integer number starting from 1 to 6 it is event can be anything if I say that 1, 2, 3 so this is one event I can say that okay the number is less than 4, so this is one event I can say the number is exactly equal to 4 then that is also one event, so number is exactly equal to 4 that means it is only one possible outcome, and if I say the outcome is one even not number then there are 3 possibilities 2, 4 and 6.Similarly, if I say the outcome is less than 5, so these are all event and one particular event may have one or more than one possible sample points.

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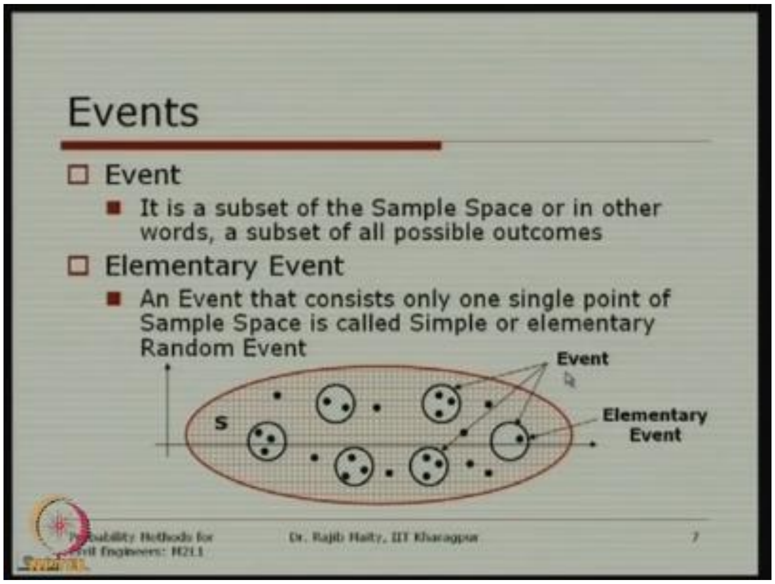

So concept of this sample space and event is very important that we will that will help us to understand the concept or probabilities.

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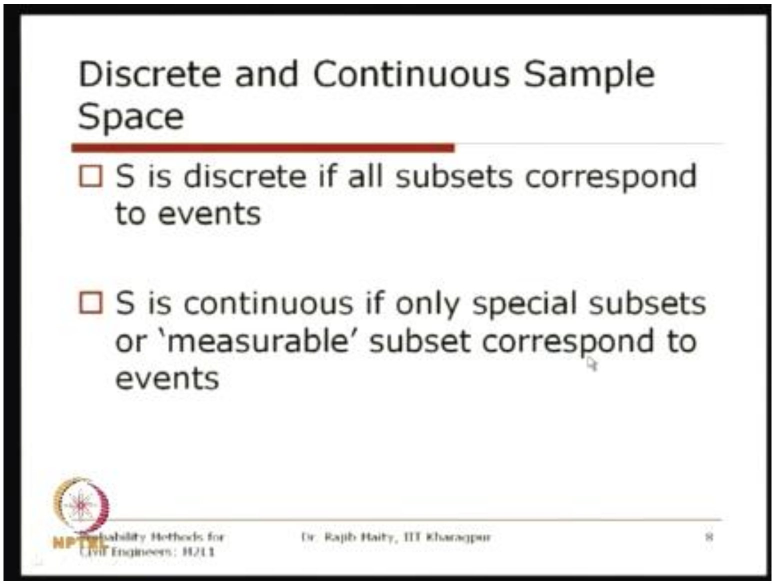

Another thing another important thing to know here is the discrete and continuous sample space, so discrete and continuous sample space can be expressed as follows S, which is which denotes the space that S is discrete if all subsets corresponds to events on the other hand S is continuous, if only special subsets or measurable subset corresponds to events.

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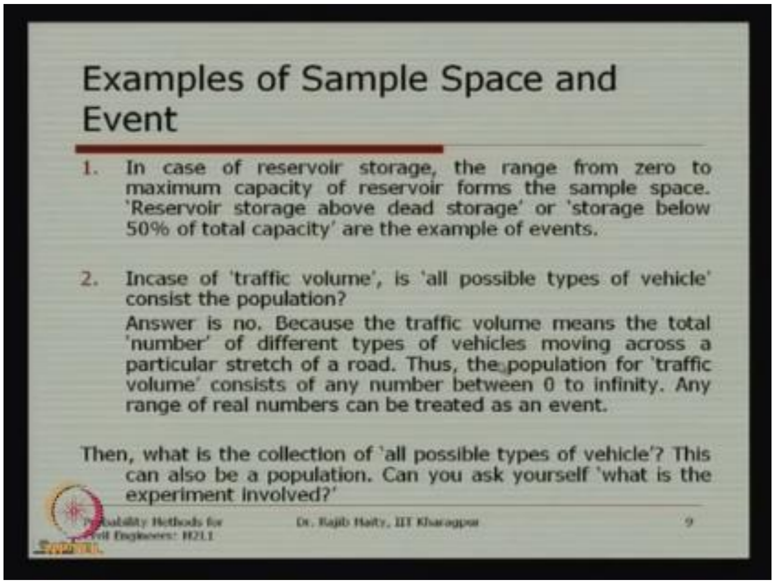

Coming to the civil engineering here, so the concept of the sample space event and the probability of that particular thing, this since should be clear first to understand the probability associated with particular event if I give one example say in case of reservoir storage the range from 0 to maximum capacity of the reservoir forms the sample space, and this is obviously to any value can be taken from this 0 to this maximum capacity say some maximum capacity if I say it is C so 0 to C any value is possible, and this full range is our sample space.

Now, reservoir storage above the dead storage or reservoir storage below the 50% of the total capacity are the example of events, so these are for example, the reservoir storage above the dead storage is a particular subset of the total feasible total possible sample space. So, these particular thing is one event, so if I know this is a event generally the probability are given to this particular event. So, I can ask what is the probability that the reservoir storage is above dead storage or I can ask what is the probability the storage is below the 50% of the total capacity of the reservoir.

Similarly, suppose if you take the example of another random variable random experiment that is the traffic volume in this transporters and engineering this is mostly used, so in case of traffic volume if I ask that is all possible types of vehicle consist the population that answer is no, because the traffic volume means the total number of different types of vehicle moving across a particular stretch of the road. So, this is the number that I want stretch here, so that number consists of by definition that number is your traffic volume.

So, here the population or here the total sample space for the traffic volume consist of any number between 0 to infinity and any range of this real numbers. So, again here this thing is one example of the discrete sample space, because these numbers cannot be any real number this should be an integer number, so these sample space is a discrete sample space, and any range of real numbers can be treated as an event. So, I can say what is the probability of the traffic volume less than 10 or what is the probability that the traffic volume is greater than 100,this kind of thing.

So any subset of this 0 to infinity and it must be a real number and that consist of the sample space for this experiment coming back to this particular thing or before that if, so I hope you understood that in this experiments the reservoir storage least sample space is a continuous, sample space. So the first example is the example of one continuous sample space, and second one is one example of discrete sample space coming to again this particular question that so far in case of this traffic volume all possible types of vehicle are not, that is not the population of this one.

Now, if I ask you that what is the then, what is this since what is the collection of all possible types of vehicle is this not can this not be an population. The answer is yes, this can also be a population, so you can ask yourself what is the experiment involved for this if this is the population. We will come back to this particular question again and this is very interesting and this is very important concept at the starting of the understanding of random variable, and which we will cover may be in the successive after some lectures that this random variable the concept of random variable comes, that it does not mean that random variable is a variable which is which is random.

This is a completely wrong definition of this random variable and when we discuss about this definition of random variable we will come back to this particular question once again, and we will say that what is that particular what should be the exact definition of this random variable.

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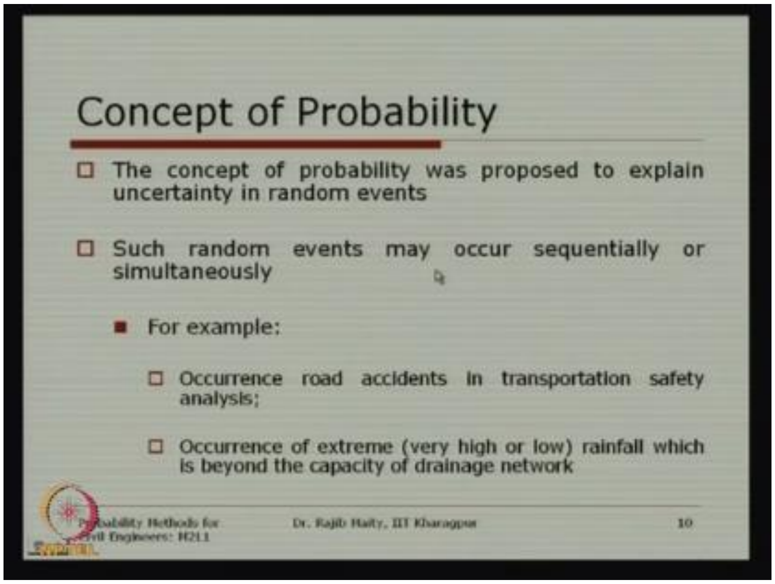

Now, we will try whatever we have understood so far about it about the sample space and it is event we will try to tell them, we will try to understand the concept of the probability here. The concept of probability was proposed to explain the uncertainty in the random events as I told that the outcome of a random experiment is not cannot be a curtained. So, I have to give some numbers some belief, and I have to assess that particular belief I have to assess that particular number, and this concept of probability is generally develop to give to give some explanation to that uncertainty in the random events.

Such random events may occur sequentially or simultaneously as we told in just previous few previous lectures few previous slide that this any random event, which is this can be either consist of the sequentially or this can be in a in a simultaneous fashion.

Now, in the sequentially we will a later part of this course, we will also understand this sequence can be either of in the temporary direction or in the in the special direction, that is known as the special temporary thing so any particular random variable, we can observe it in the time sequence or in the special sequence and there are a different types of analysis that we can prove and we will take you through all this all this things.

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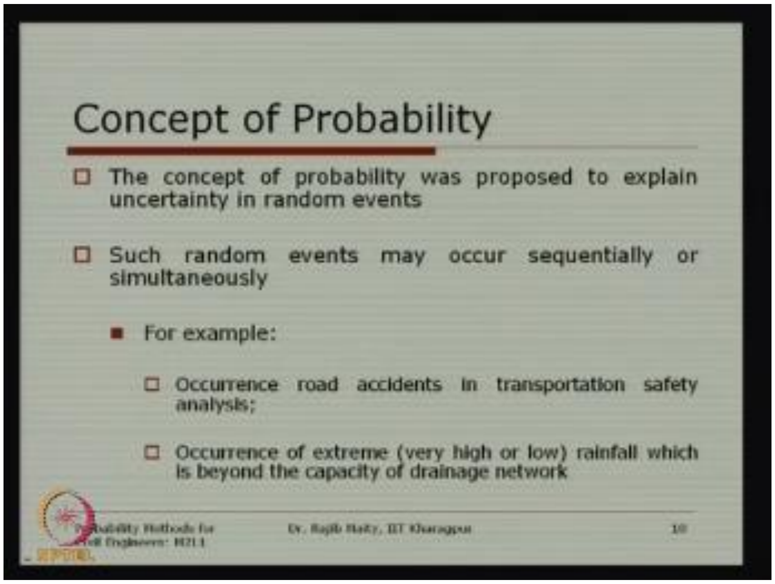

So, for the time being we should understand that this random events can happen either sequentially or simultaneously for example, here the simple example that I can say now is occurrence of road accident in transport and safety analysis or occurrence of extreme that is very high or very low rainfall which is in case of very high of course, it is that which is beyond the capacity of the drainage network or occurrence of the very low rainfall which may affect the agricultural production also.

So, this kind of occurrence this kind of random events is very important for our civil engineering purpose and we will know that what are the way that we can we can assess the probability and what are the way different methods of the probability can be applied to this particular to this concept of the probability can be used in that kind of analysis.

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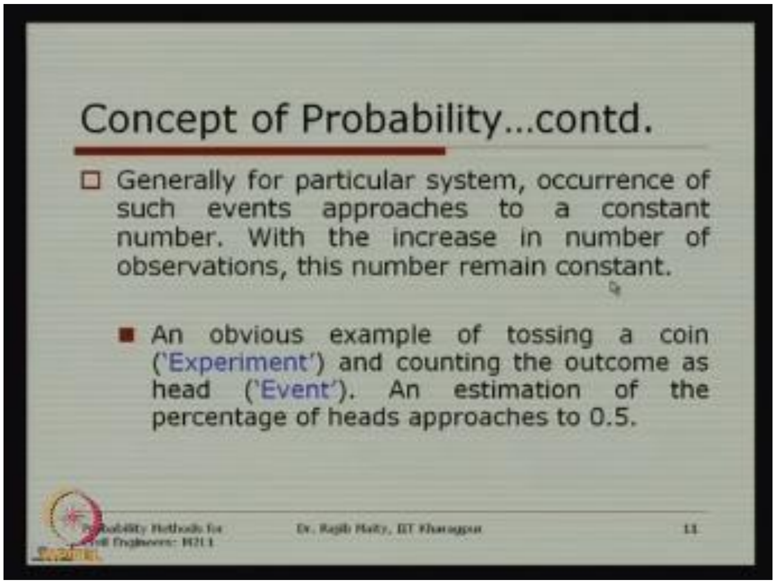

In this concept of probability again generally for a particular system occurrence of such event approaches to a constant number with the increase in the number of observation this number remain constant, so for example if I take a particular experiment in hand and I want I just see for a very long record very long historical record, and if I see that what is the chance or what is the frequency of occurring that particular event.

We can say that it is a generally, we will classify into that success and failure, and we see that what is the chance of what is the frequency of the success or particular thing in the historical record and this historical record is very important here this should be sufficiently long to assess some probability of this, before coming to this real life civil engineering problem I can say you once again a simple example to this.

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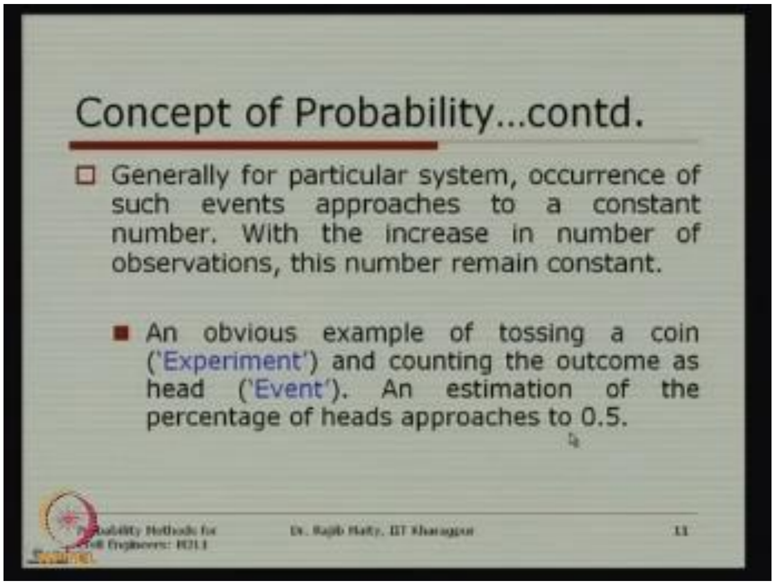

Example of tossing a coin again so here the tossing a coin and observing its outcome is your experiment and counting the outcome as head say for a particular outcome head or it can be tail, so this is a particular event so if I say that the or tossing a coin can observing the head in this experiment if the head comes then it is a success and if head does not come that is failure, so that is one event.

And if I do if I follow this approach that is for what is the occurrence of a such particular event approach to a constant number and by our get to the experiment I can say we can say that this number for this particular experiment will approaches will approach to 0.5, so these 0.5 generally we assign this particular number generally we say this is the probability of getting head of one experiment having a point.

We will come to this real life problem of this cyclone event or this thing a little bit later so that it will be clear in the in the area of civil engineering problem also.

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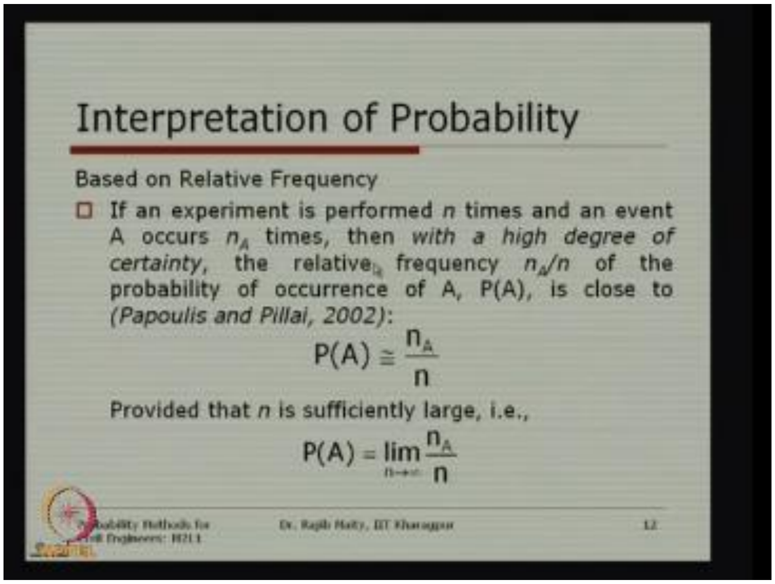

Before that we should we should know the classification we should know the definition the classical definition of probability as I told that we have we should have a very long record have known with us or if we are conducting the particular experiment we should conduct the experiment for a very long time, so that the number will approach to a particular constant value.

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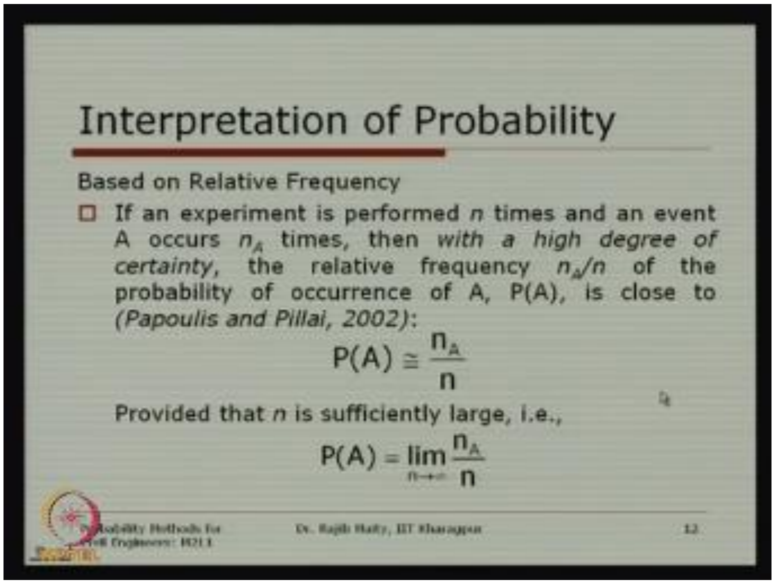

Here based on the relative frequency if an experiment is performed n times and an event A occurs n_A times then with a high degree of certainty this all this chances are very important, so with a high degree of certainty the relative frequency n_A / n of the probability of occurrence of A which is designated as P in bracket A is close to n_A/n. So the probability of occurrence A is the ratio of n_A/ n.

Here you can see that this n_A is nothing but the success the number of success and this is the total number of time, so as I told in that this should be sufficiently long this should be a this should be basically this should be the infinite number of series or sequence should be tested to approach to that particular number. So, this definition so if I want to know exactly what is this probability with the based on this relative frequency concept.

Then this n should be sufficiently large and that is why we write the probability of A is equals to limit n $\rightarrow$ ∞ nA/ n, so this is this definition is generally based on this relative frequency concept there are other definitions of the probability are also there we will probably will see it shortly.

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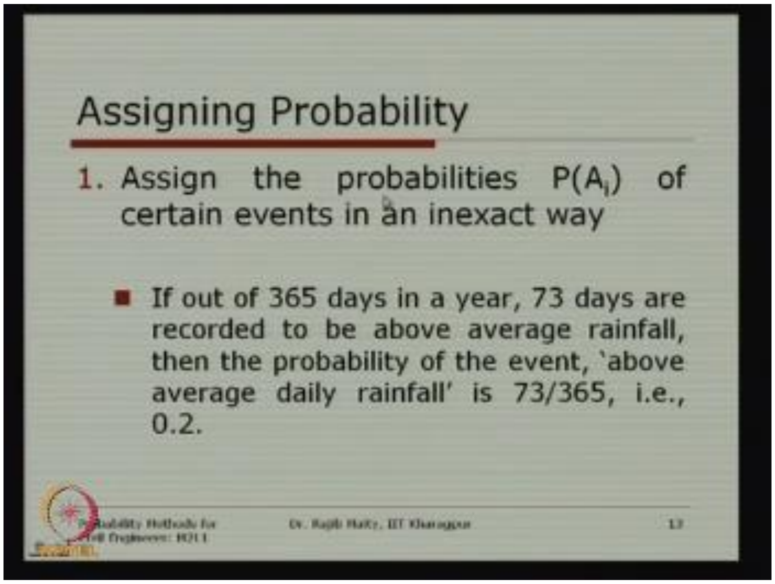

Before that to assign the probability of a particular event there are there are 3 different ways that we can assign the a particular probability for a particular event say for example, one of the event is Ai to assign the probability P(A) of a certain event in a in exact way, suppose this way of this one this way of assigning the probability I have to see the historical record of a particular experiment.

And based on the historical properties based on the historical success rate of that particular experiment I have to assess some number so as this historical record is never infinite series that is why we say it as the in exact way.

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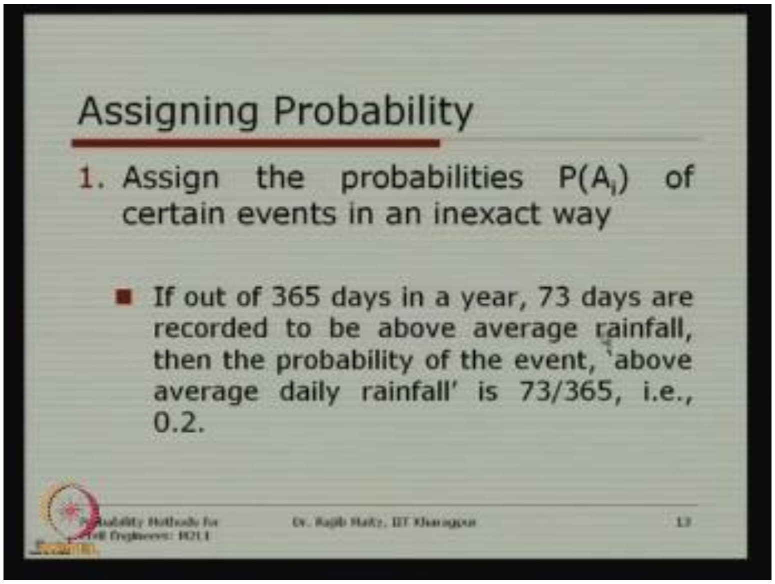

Here one example is that if out of 365 days in a year, there are 73 days are recoded to have to be above average rainfall, then we say the probability of the event above average daily rainfall is 73/ 365. So, this 73 for this experiment is the success and the total number of trial, total number of days, total number of experiment is your 365. So this is an inexact way of assigning the probability to a particular event A.

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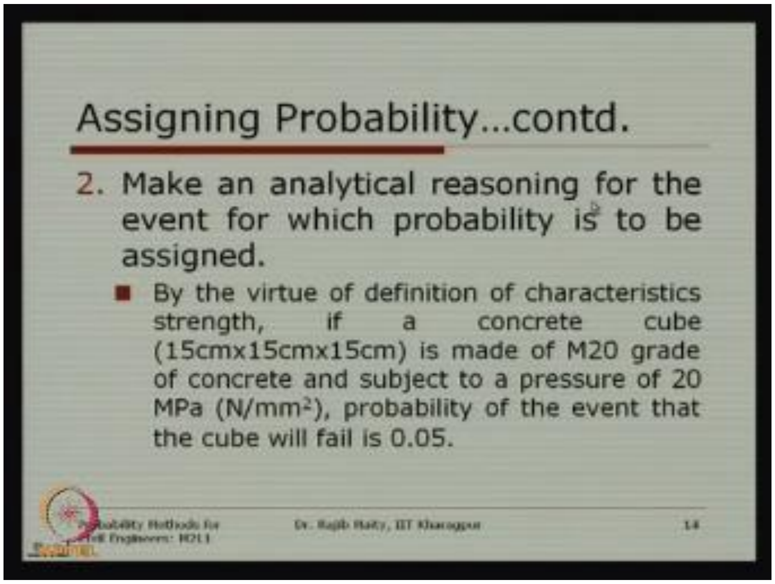

The second way that is to make an analytical reasoning for a for the event which is for which probability is to be assigned. So this analytical reasoning again is one of the most important thing to understand a with respect to the different already established you already established concept that is I generally follow some norms and to develop some particular say particular material in civil engineering.

Or say I have some particular belief in me so in this way if I know that the way the definition is given for a particular for a particular attribute as you say and If I know what was the background to give that give that particular event then I can assess that probability given related to that particular event, here one example is given here that.

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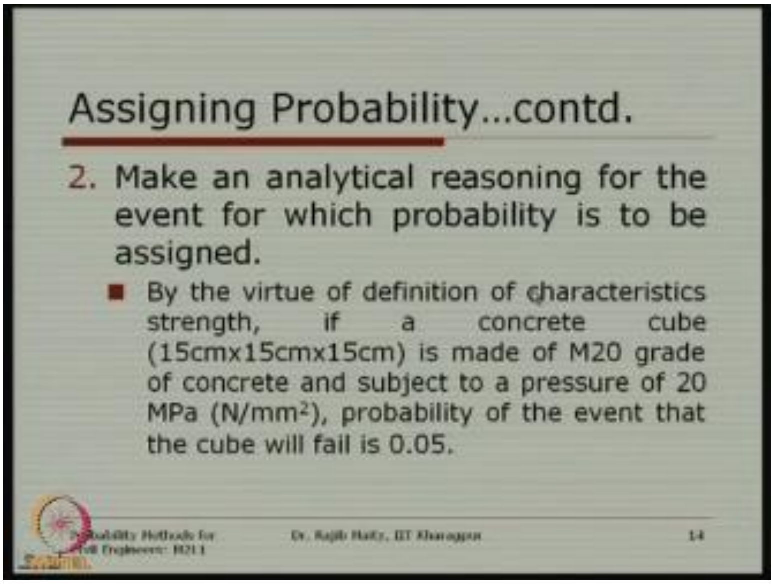

If you already know the basics of the civil engineering ,then I hope you know that m 20 grades of concrete if you do not know this is a particular grade there are different grades of the concretes are available say m 15 M 20 m 25 and 25 m0 35 40 it can have so different grades of the concrete is there the by definition of these particular grade of concrete, it says that this is a characteristics strength and it is defined as if a concrete cube and that concrete cube dimension is 15cm x15 cm x 15 cm, and if we say that this is made of M 20 grade of concrete.

And this cube is subject to a pressure of 20MPa(N/mm^2) then the probability of the event that a cube will fail is 0.05, now where from we get this 0.05 is that is line in the definition of the characteristics strength so this characteristics strength of the definition characteristics strength says that what is the specimen? What is the strength at which I can assure that at least the failure that failure of that particular concrete cube will not exceed 5 percent, so that is why so if I take a m 20 grade concrete.

And the and the pressure is 20 MPa so that the probability that the event the cube will fail is point naught 5 so this is one analytical reasoning and example of this analytical reasoning of assigning probability to this particular event.

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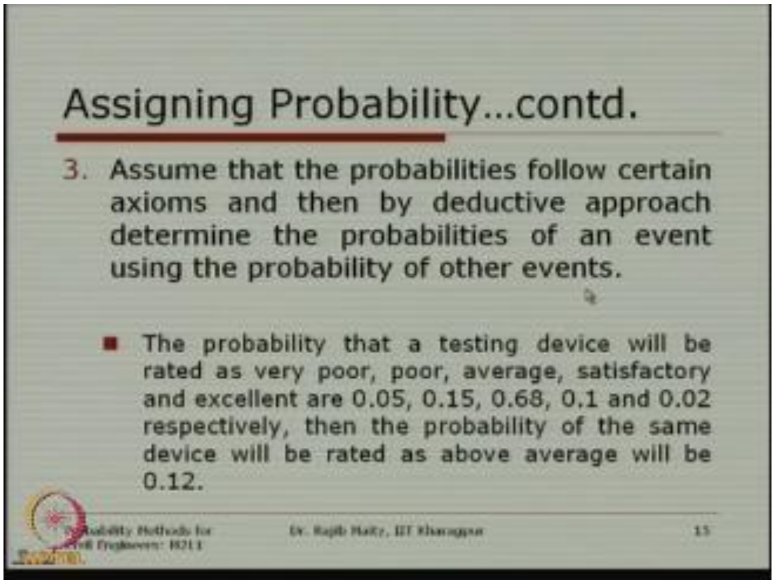

Then the third one is that a kind of deductive approach assume that the probability follows certain axioms will come to this one the axioms of probability, and then by deductive approach determine the probability of an event using the probability of other event so there are different kinds of events is available and somehow say you assume for the time being that somehow I know the probability of a particular event, now using this information that I know the probability of this particular event is this.

Then read the questions come at what is the probability or some other particular event then I should be able to assess I should be able to compute the probability of this particular event using the information of the probability of the available information of the probability or some other events so this is a deductive approach.

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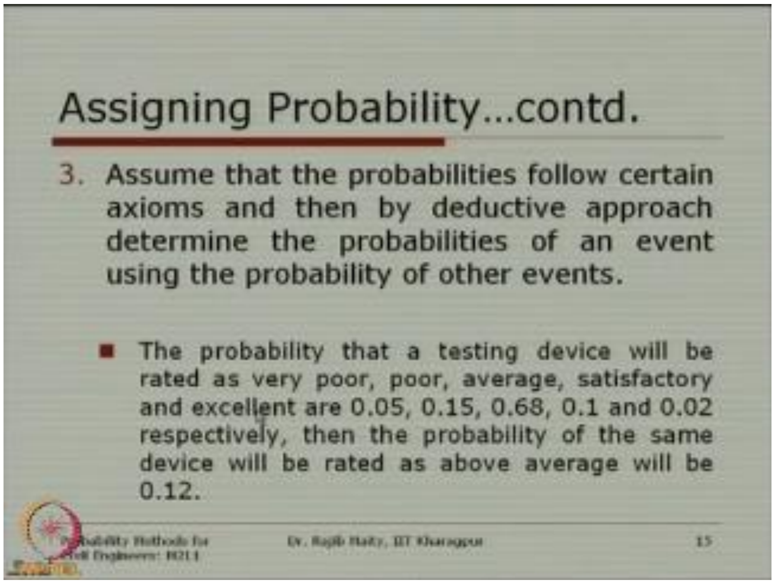

Suppose that here because this will be more clear when we cover this axioms of probability, but before I cover this one this is a very easy example that must be it should be able to understand is the probability that a testing device there are very there are different types of testing device available in civil engineering suppose that testing device is a company has given it to the market, and based on the customer satisfaction that customer will categorize that particular testing device as very poor average satisfactory and excellent.

So based on somehow from the market stud some other way the company knows that a particular testing device to be categorized as very poor the probability of this to be categorized as very poor is 0.05 to be categorized as 4 is 0.15average 0.68 satisfactory 0.1, and excellent point 02 then that if that question is that, what is the probability that the same device will be rated as above average so if I say it is above average that means it should be either satisfactory or excellent now there are some of assumption background to this that a particular customer cannot categorize is at both satisfactory.

And excellent if we categorize the satisfactory so he is having only one choice, so these two particularly these two events of categorizing as satisfactory or excellent is mutually exclusive again the definition of mutually exclusive is says that the occurrence of a particular event ensures that non occurrence of the another event so for example, that tossing of a coin if I say that outcome is head then it is automatically implies that the tail has not occur, so in other words the head and tail both the outcome cannot happen simultaneously this kind of events are known as mutually exclusive okay.

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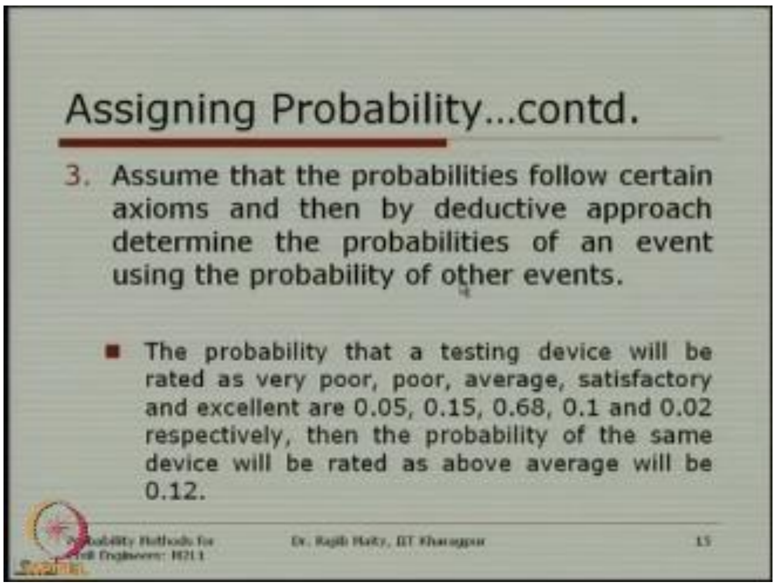

And if again if say that this two things are independent so if one customer as categorizes is as respecter, and other one categorized as excellent and these categorization by different customers is independent to each other then I can if I want to know what is the probability that the particular device is rated as above average this will be simply summation of the probability however for the satisfactory this above average satisfactory, and excellent that is .1 + .2 so here in this way of assigning the probability of a particular event.

Here the event is above average this kept this rated as above average this is particular event is based on not based on any particular experiment this is rather based on the information that is available on the probability of some other even so this is the thing this is a deductive approach that is why this is deductive approach, and it is determined by the probabilities of the other events for base authorities known so these are the three different ways that we can assign.

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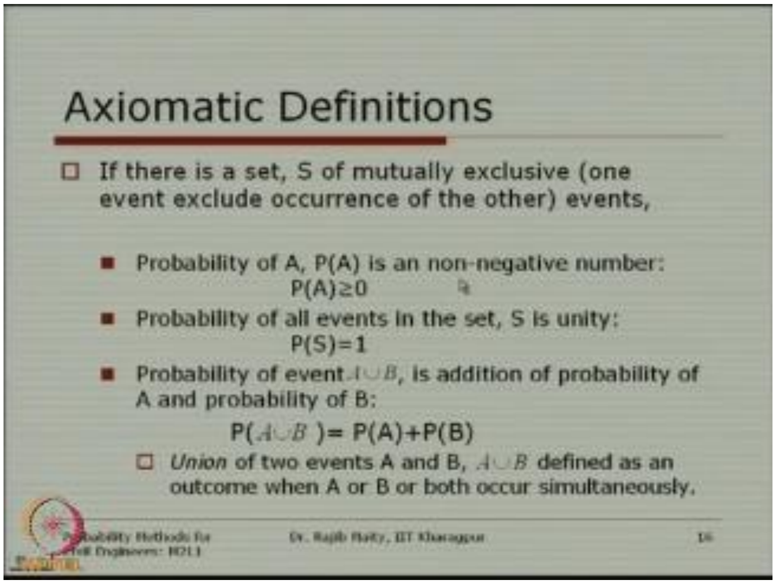

Probability to a particular event, so as I have just in the previous slide we discuss about the axioms of probability so different type of different type of concept of this probability can also have the different way just now we have seen that what is the relative frequency the concept based on the relative frequency, there are other concepts are for example, here the axiomatic.

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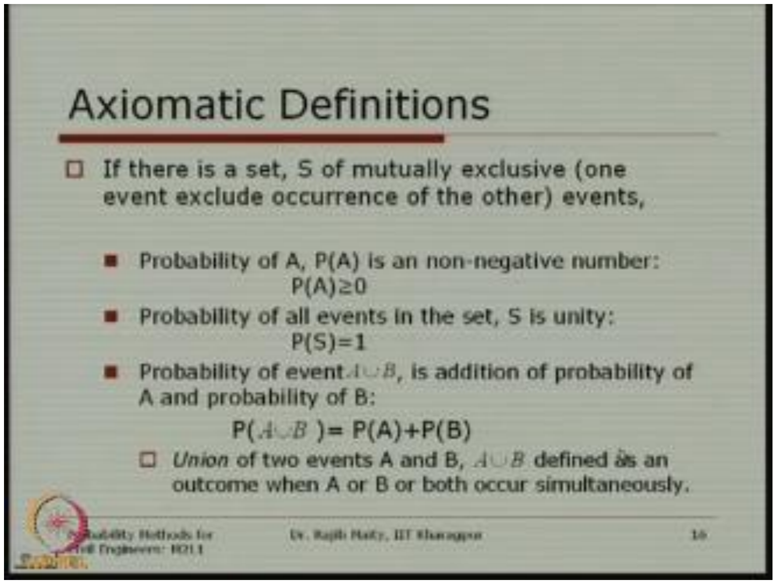

Definition so there are few axioms that is there for a particular probability events there are basically 3 axioms are there they are probability of A P (A) is an non negative number, so this P A is always greater than equivalent to 0, this is the first axiom. Second is the probability of all events in the set S unity, so the probability of all possible outcome of a particular event is equals to one, and the third one is the probability of event A union B is the addition of the probability of A and probability of B that is probability A union B equals to probability A + probability B.

Here this symbol that is A union B is the union of two events - A and B is defined as an outcome when A or B or both as occurred simultaneously in the concept of the Venn diagram you know that if this is your.

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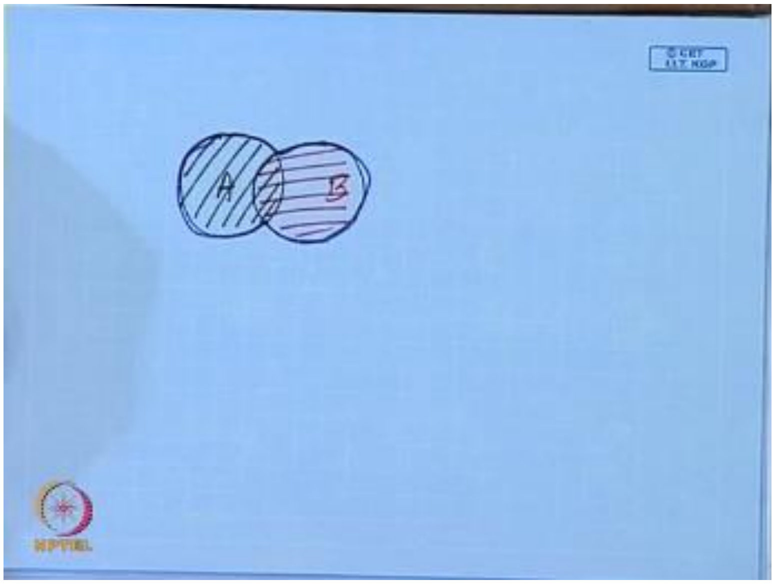

Probability A, and if this is your probability B, so the first circle what I am showing as a black dotted If this is your and if the red dot that have given if that is the red settled area if this your B then A union B is the summation of the both so this total area is your A union B, so this is the two different events.

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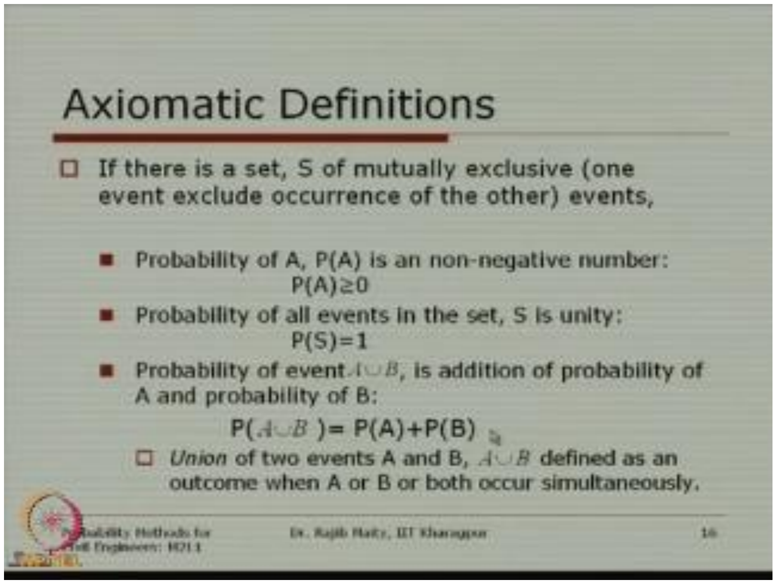

And so if they are unions of the probability of this total event is nothing but probability of A + B, but there is a condition here, that this two events are mutually exclusive why, because here if you again see this one. That if I say that this area.

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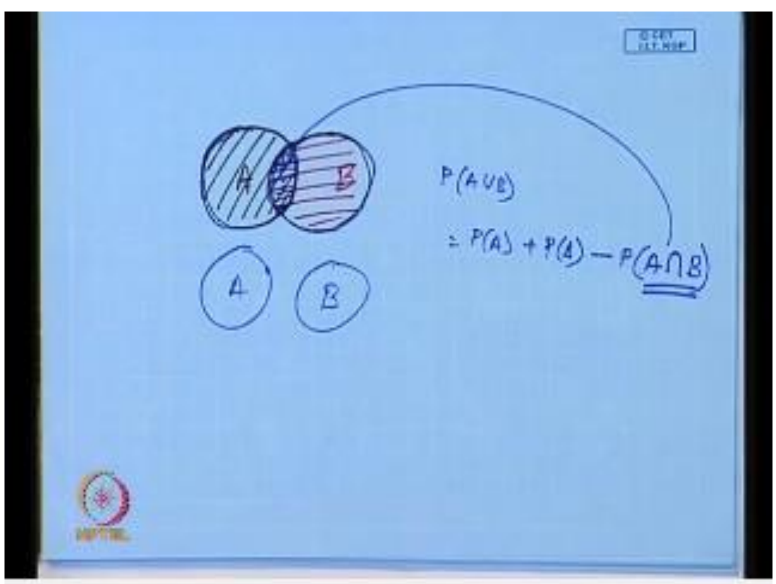

Is your probability A and this area is your probability B, then if I just simply add this one then this area obviously which is common in A and B will be added twice that is why when it is mutually exclusive then I can say suppose, that this is your A and this is your B, then probability union B is nothing but probability of A plus probability of B. Now, based on this 3 axioms that we have discuss with different numbers. We can reduce different numbers of equations where we can use it for the detection of the probability of the others for example, in case of this when two events are overlapping each other then what should be the probability of probability of A union B that you can easily say that probability of A plus probability of B. In this process we have taken this area twice,

So this should be minus this area should given as A minus, and that is probability of A. Another new way and tell it is the intersection of B, so probability this symbol this probability intersection B is nothing but this particular area, where it says that this is A common in both the events. So as we are added in this process, we are added this area twice, so this should be detected here.

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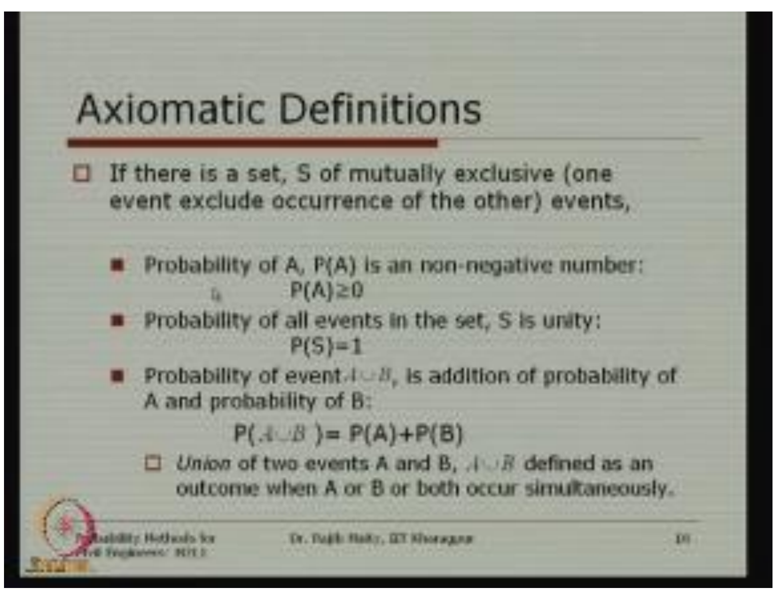

So, this is this second one is yours is a these are the 3 axiomatic definition, where we can follow the detective approach you can get the probability of the other events if the probability of the particular events of some other events is known to us.

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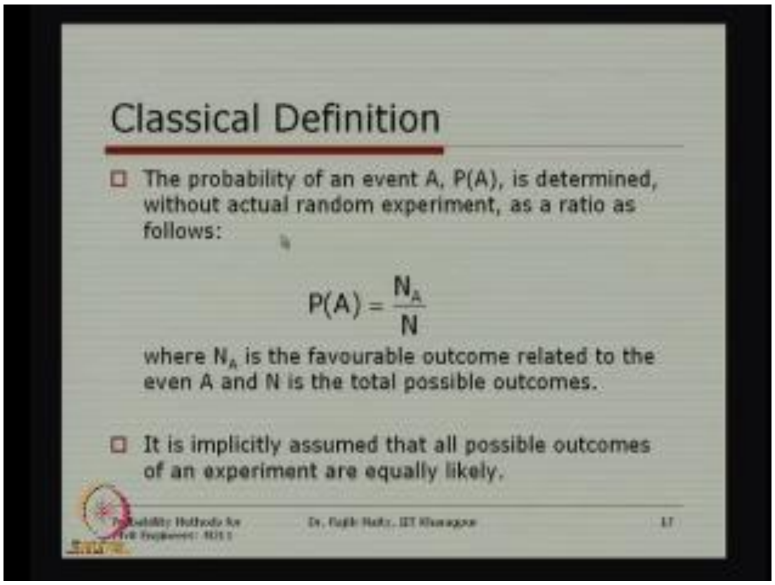

The third one is the classical definition, the classical definition the probability of an event a probability A is determined without the actual random experiment as a ratio as follows probability A equals to probability NA by N, where N A is the favorable outcome related to the events, sorry; this there is one t to the event A and N is the total possible outcome.

That means, we are not exactly following any particular random experiment whatever the observation is available to us based on this whatever the receiver of this success out of the total number of trail, we are assembling this particular number which is the classical definition of this probability. It is implicitly assumed in this event that all possible outcomes of particular experiments are equally likely. Coming to the throwing of a roll dice example that all possible outcome that is any integer number from 1 to 6 the outcome should be all this outcomes should be equally likely.

So that probability of getting one should be equals to probability of getting two equals to all this numbers should be equals to 1by 6. So, however day to experience, we generally assign this probability, and these when we say that yes all these probabilities are equal and equal to 1 by 6, then all this events are equally likely basically this is a point where this basic concept of probability is quotient and sometimes.

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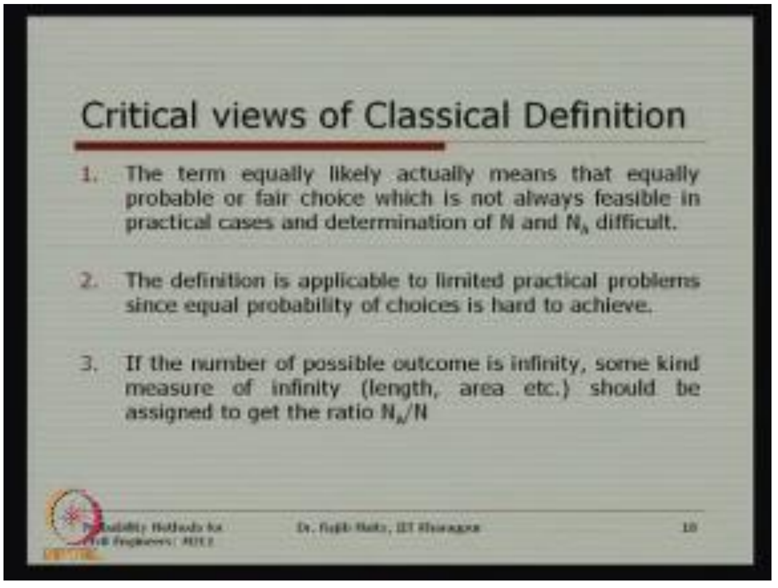

This kind of critical view is throne to this basic concept of this probability. The first the term equally likely actually means that equally probable or fair choice, which is not always feasible in the practical cases. It is not possible for that for the practical cases we basically having a fair dice of fair, one is impossible even though you go for a very large number of trails, and will how large is large to get that particular probability of a head say 0.5 or for a dice for a particular number is 1/ 6 is that that whether they are any equally likely that cannot be ensured always. So, this is one this is the first thing that generally face the problem of this classical definition.

Second thing is that the definition is applicable to the limited practical problems, since the equally probably probability of the choices hard to achieve, so even though there are some experiments that by choice or by the by the experience to say that this entire possible outcome are equally likely. So far those kind of experiments this definition can be applied, but what about there are many other examples where this kind of equally likely events cannot be assumed.

So in such cases the applicability of this classical definition generally throws the question here. And the third thing is that the number of possible outcome is infinity, now if a particular for a particular experiment, if I say the number of possible outcome is infinity, then some kind of measure to the infinity should be assigned to get the ratio of the N .Say for example, if I if that example is given like this.

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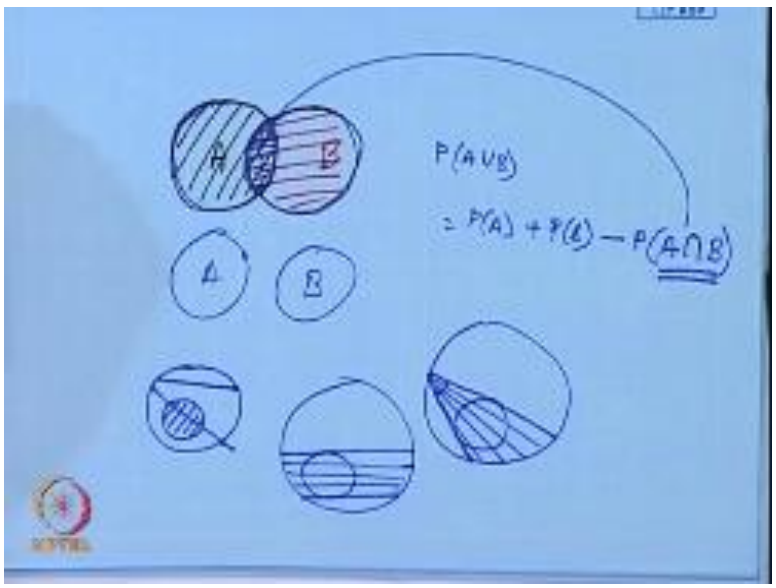

That in a circle is there and there is another circle inside this and one random event is that there is a chord here, what is the probability? That this chord some part of this chord will be inside, this in a circle as well. So, there are two chords, I can just draw now one is that this is passing completely outside, this in a circular another is passing inside this one. Now, if I want to assess the probability of this kind of experiment, then some kind of what is the total possible outcome should be there, so experimenting I can draw any line here and say that there are these many these many chords are possible.

So, I had this some kind of some kind of assessment of this area - this area if it goes this is outside, and if it goes in this area this is outside. So, this can be achieved in different ways, the first thing is that if I know the origin of this two circle; one-way is that we can just start for any point, and say that this is one and there is another chord like this. And I should say that this is the angle, which is my favorable case so all chords in these areas will pass through this circle and all others are this one.

So that this area divided by the total area can give the probability. Second way of looking the same problem is that there is one outer circle, and there is another inner circle as well here. And I can join two particular chord here like this, and say that all possible chords that is in this area are my favorable case, and all other except all other which are falling outside that is the non favorable case. So this area divided by total area we need this, we need the probability.

There is a classical example is known that these two probability. Some time may not may not match to each other, so this is also one particular drawback of this classical theory, and when we are going to give that favorable and non favorable to non favorable ratio when we are computing the ratio of this favorable case and non favorable case. So the definition of this how this experiment is performed whether with respect to the experiment this particular thing is more feasible or this one is more feasible since to be justified first and then the probability should be calculated.

And this is particularly in case of when the possible outcome is infinite that kind of problem may arise.

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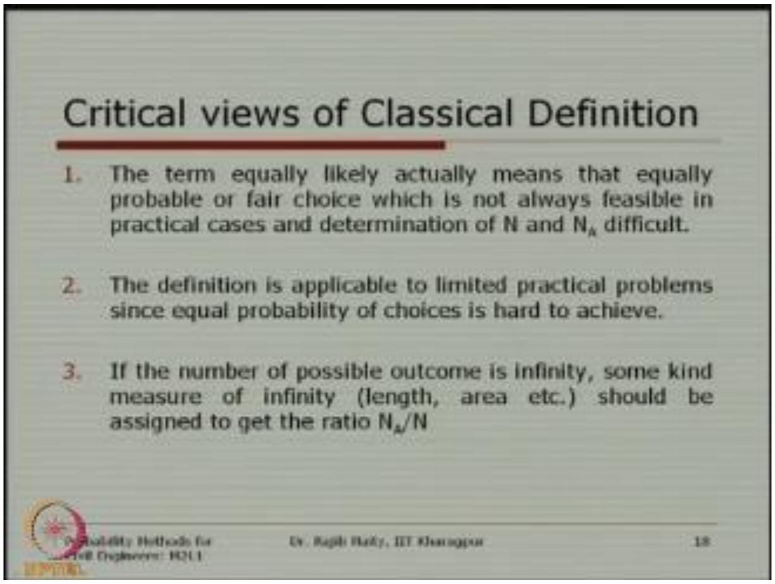

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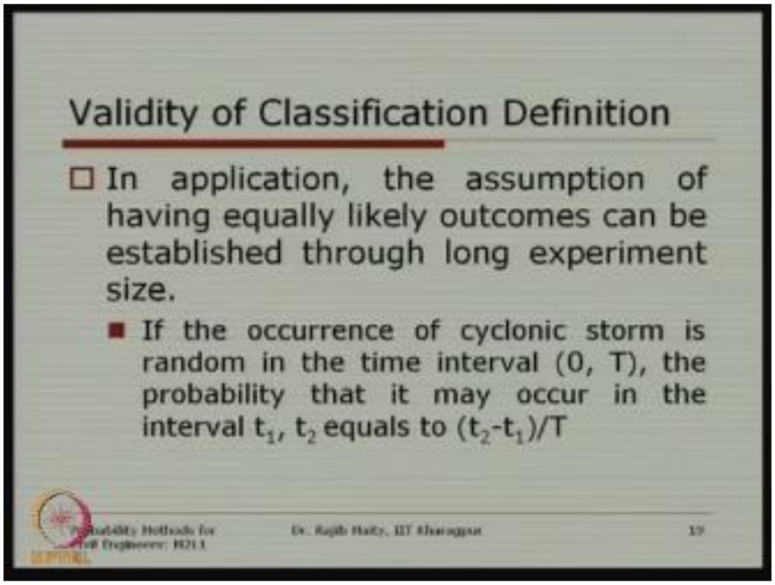

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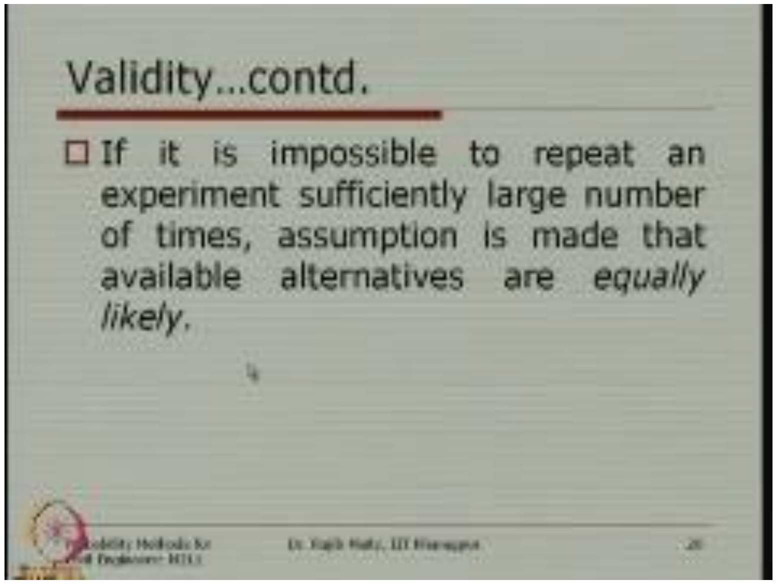

So validity of the classification definition in application the assumption of having equally likely outcomes can be established through an long experiment, so an long experiment size; say for example, that if I take an example or occurrence of cyclonic storm is random in the time interval of 0 to t, then the probability that it may occur in the interval t1 to t2 is equals to t2 by t2 minus t 1 divided by t, so 0 to t some time interval.

I am taking and I am saying that the occurrence of this cyclonic storm is random, and I am implicitly assuming that this occurrence is equally likely over any time in this time interval. Then what is the probability that it will obviously this t1 is greater than 0, and t2 is less than t then in this area of course, is that means that t1 and t2 are lying in the range of 0 to T, then the probability of this cyclonic storm occurring in this time interval is equals to basically this is t2 minus t1 divided by total T minus 0.

So this is the so, in this kind of analysis when we are assigning this probability we are implicitly assuming that the outcomes are equally likely.

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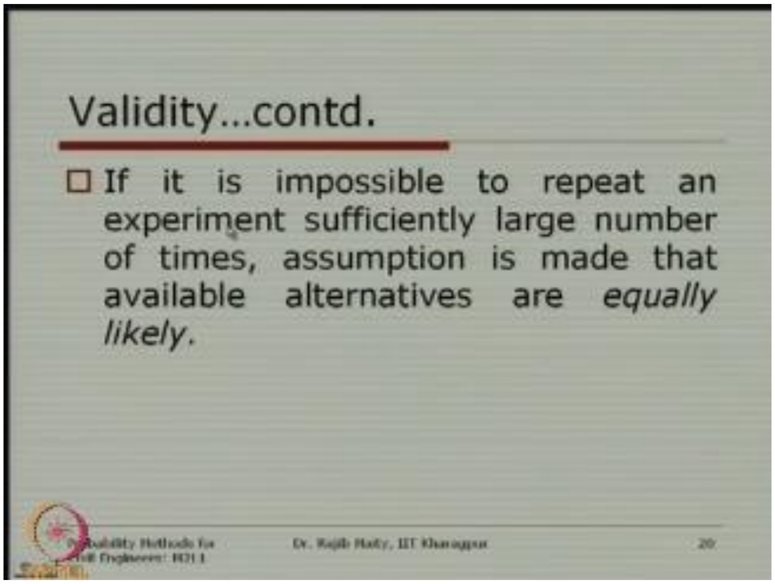

If it is impossible to repeat an experiment sufficiently large number of times assumption of assumption is made that the available alternatives are equally likely, this is the basically the start point of the probability theory. When this kind of experiments cannot be ran in a large number this is implicitly, assume that all possible outcomes are equally likely.

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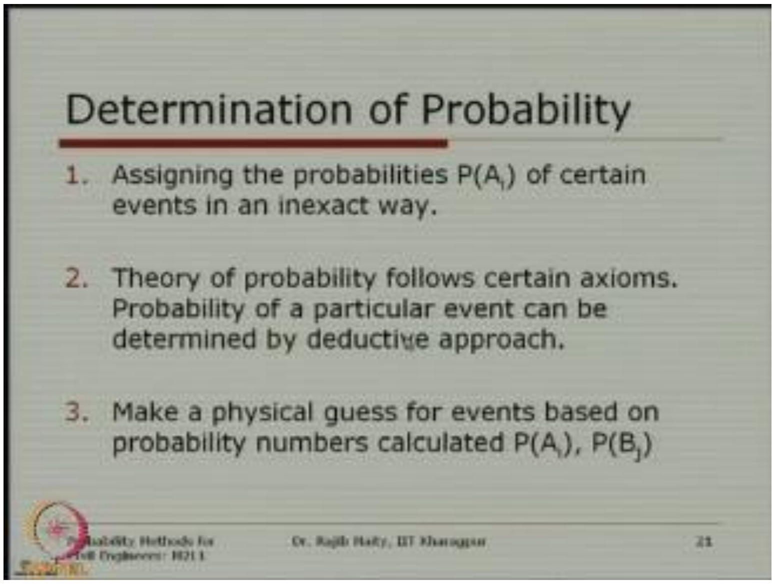

Now, the determination of probability the assigning the probabilities P (Ai) of a certain event in an exact way, second this is we have discuss just whatever the available record that is available with us and in that what is the number of success, and what is the total number that is available that ratio gives you that that probability for the particular event.

Second theory of probability follows certain axioms. So, just now we have seen what are the axioms that that probability follows. So probability of particular event can be determined by the deductive approach, and third one what we have seen that make a physical guess of the event based on the probability numbers and probability numbers calculated Ip I n jv.

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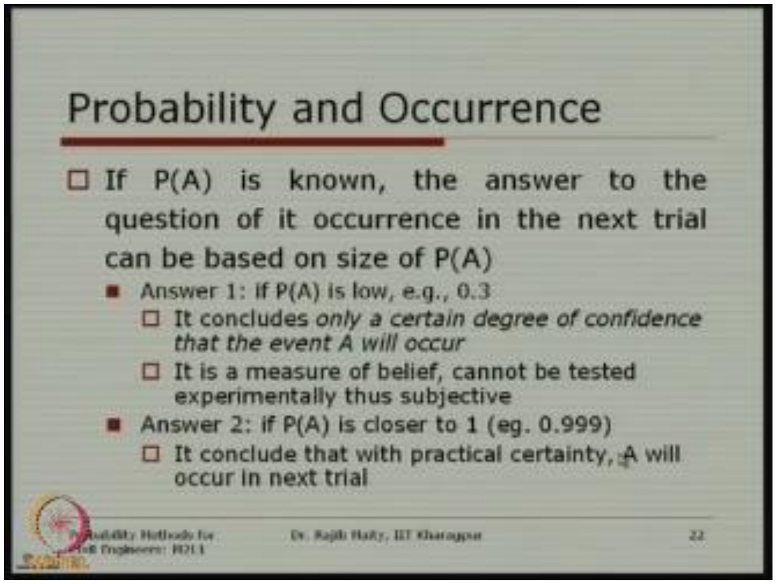

This probability and occurrence, I think this is a needed at the starting of this course to know that what is this probability, and what is this, what is the actual occurrence in the real field, suppose that I say a particular experiment say that the rainfall event say that the rainfall event occurs more than what is my what is the capacity of my drainage in network. So, this is a particular event that rainfall amount greater than the which should be our drainage system can take care. And I say that this probability is say 0.0405.

Now the thing is that if I say that this probability is 0.05 now the question is that in the next event of the rainfall what is the chance what is the occurrence that particular rainfall will really exceed. So, what does this 0.05 what does this number actually give you to inform this is the top icon this particular slide. So the if the P A is known the PA means that probability of particular event is known the occurrence to the question is if it is occurrence to the next trial can be based on the size PA.

So the now this size of P A matters nothing here the P A is low say for example, 0.3 it is given, then it concludes that always certain degree of confidence the event A will occur, it does not mean that exactly you perform ten trials. And exactly 3 trials will be your success that is not the case. So in a long terms that is with certain degree of confidence, so this is very important the certain degree of confidence that is the thing that we can infer from here.

So it a measure of belief that I am this in generally cannot be experimentally tested. So this is subjected thing of the measure of this belief that lead this degree of certain confidence that this a particular event a will occur. Second thing if that if the probability of a probability is living close to one let us say for example, 0.999 it conclude that with the practical certainty a will occur in the next trial.

So if very high probability, then we generally say that with the practical certainty this will definitely occur when the probability is very high. So the probability when it is very low, it is very unlikely to occur, and when it is very high. Generally we say that it is likely to occur, but it can it never say that exactly if you consider some n numbers of trial, and it will happen exactly in the probability number multiplied by this total number of a trial, it may not occur in that exact number way. So the probability and occurrence and occurrence particularly and should be and this should be in this particular way.

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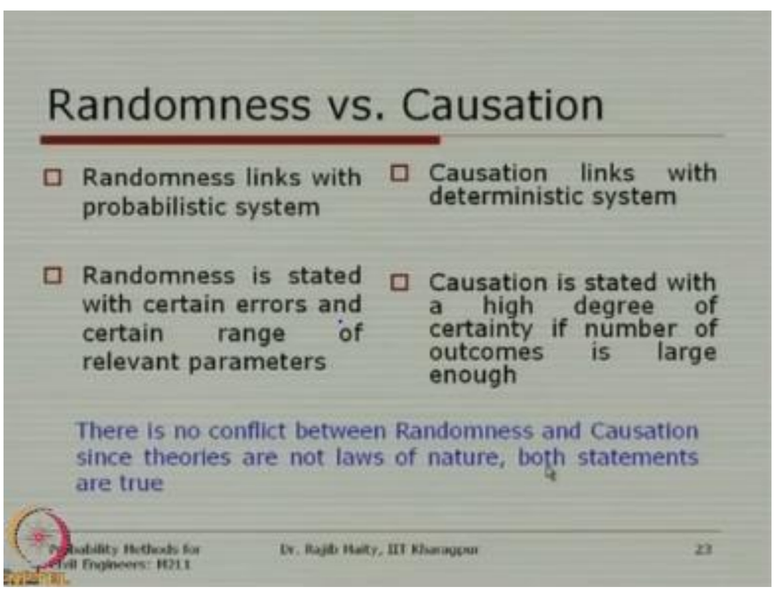

And the last thing, but this is also important the randomness and causation. So this randomness links with the probabilistic say system, and the causation links with the deterministic system. The randomness is stated with certain errors and certain range of this relevant parameters. And causation is stated with high degree of certainty if the number of the outcomes is large enough. But again basically there is no conflict between the randomness and causation because the when you say that there are some laws of this nature, these theories since that it says, this since the theories are not the laws of nature both statements are true .

So even though I say that a particular system is deterministic, that deterministic system may we for our simplicity sake we have just say that this is a deterministic system, but it will really see whether that particular system is exactly determinist on a there is a little bit of randomness maybe there as well.

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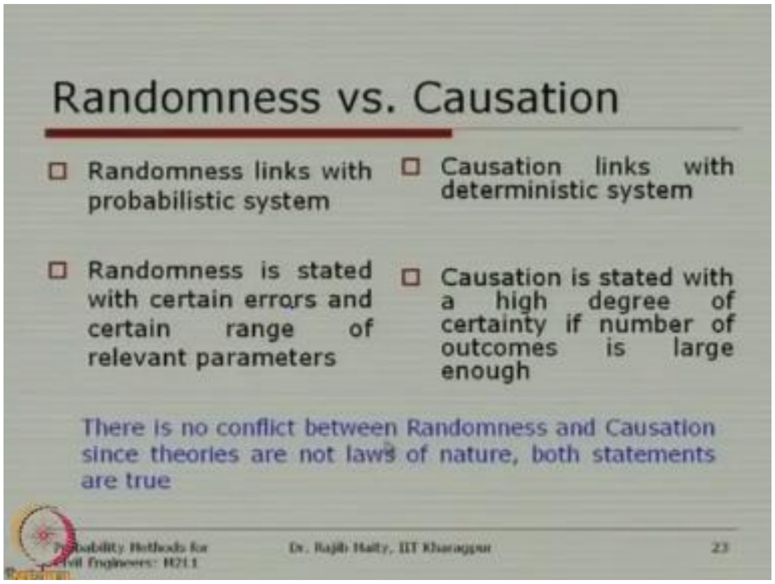

So, basically that is why we say the basically the conflict between the randomness, and causation are not there. These are just basically some concepts, and if it is clear then it is generally very useful to that.

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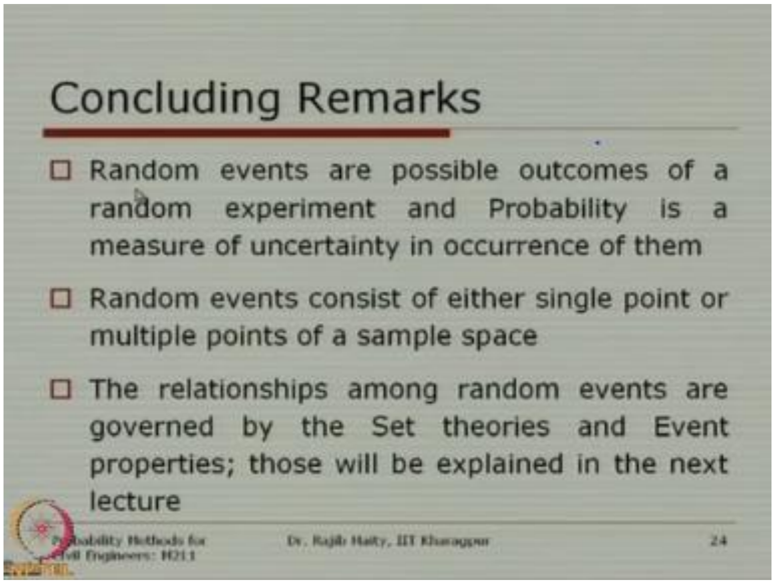

The final concluding remarks is this that in this lecture we have seen that random events are possible outcomes of the random experiment, and probability is a measure of the uncertainty in the occurrence of them. Random events consists of either single point or multiple points on a same sample space, the relationships among the random events are governed by these theory, and the event properties. And this set theory and this event properties will be will be explained in the next lecture of this course. Thank you very much.

Probability Methods in Civil Engineering

End of Lecture 02

Next: "Set Theory and Set Operations"
In Lec 03

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