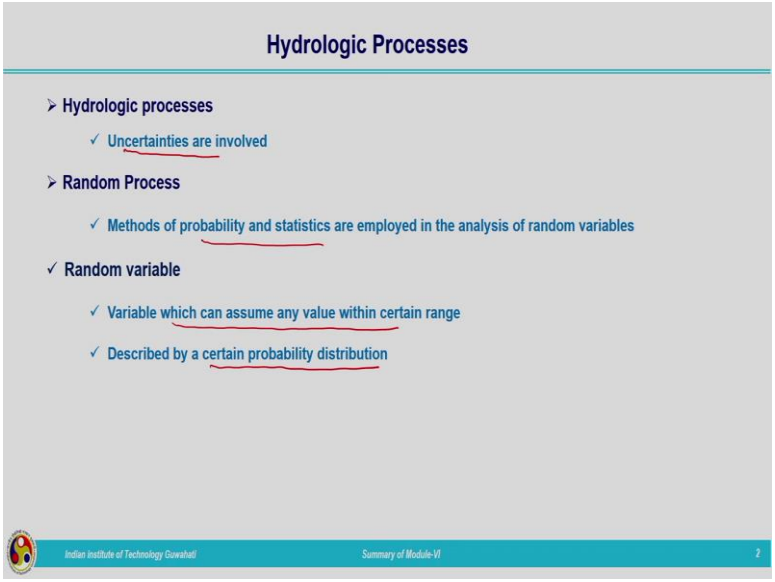
Engineering Hydrology
Dr. Sreeja Pekkat
Department of Civil Engineering
Indian Institute of Technology, Guwahati
Module 6
Lecture 77: Summary of Module-VI

Hello all, welcome back. In the previous lecture, we have completed module 6 on hydrologic statistics. Today, let us see the summary of that module.

(Refer Slide Time: 0:58)



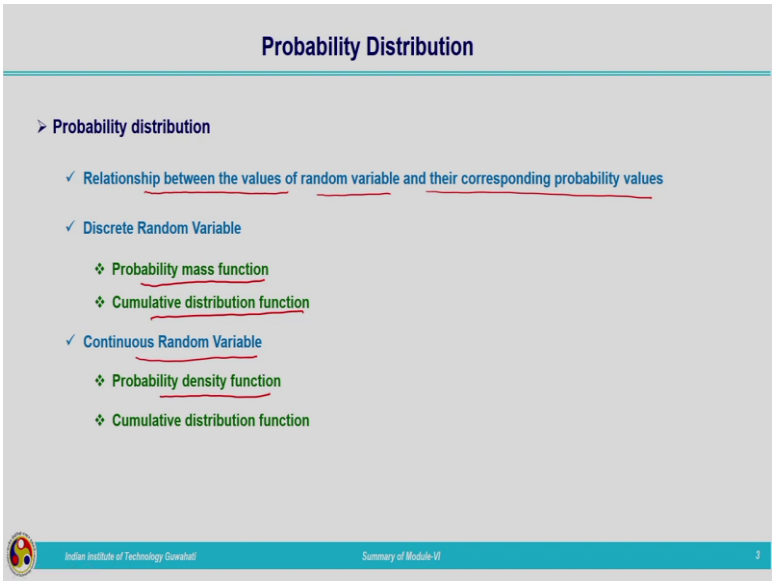
Different hydrologic processes we have looked into, those processes when we observe we can understand that, there are a lot of uncertainties involved with those processes. So, in such cases when uncertainties are involved with the processes, we cannot model those systems which are involving inputs, which are having the uncertainties by making use of deterministic principles. So, we may have to consider those variables and the system by means of random process.

So, random process is involved with different variables which are termed as random variable. Those two types of random variables we have already discussed, continuous random variable and discrete random variable.

And when we are dealing with the analysis of discrete and continuous random variables, we have to make use of probability and statistics for the analysis. Random variables are the variables which can assume any value within certain range. Instead of providing a single value, it will be having a range of values, associated with that we will be having different probabilities. So, that for the systems having randomness, we have to incorporate the

uncertainties involved with the input variables by means of certain probabilities. That is described by certain probability distributions, these things in detail we have covered in the lecture related to probability distribution.

(Refer Slide Time: 2:44)



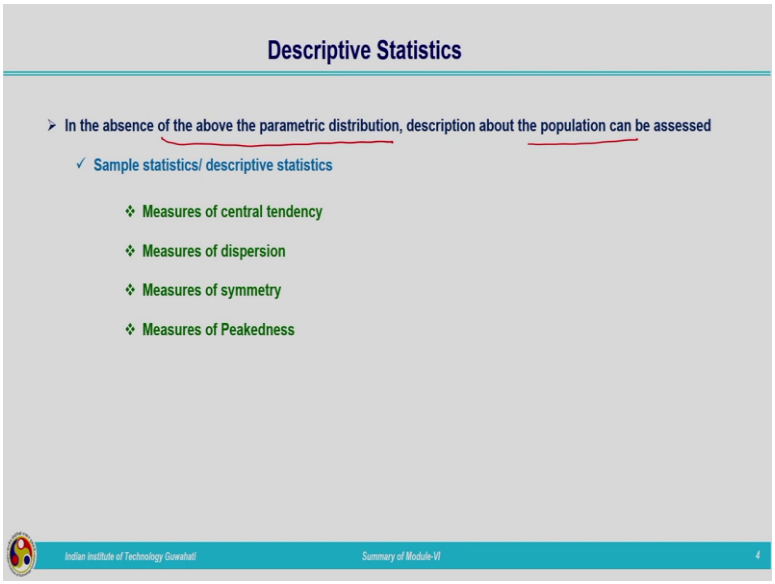
Now, coming to different probability distribution. This distribution means finding out the relationship between the values of random variable and their corresponding probability values. As I told, this particular random variable takes a single value, in that case we will be having a single output, but because of the presence of uncertainties, we cannot assign a single value, we are assigning a range of values corresponding to this random variable. So, corresponding to each and every value related to this random variable, there is a probability associated with that. The relationship with the value corresponding to this random variable and the associated probability is described by means of probability distribution.

Different distributions related to discrete random variable and continuous random variables we have covered. When we were discussing about discrete random variable, we have seen how the probability distribution function can be represented. In the case of discrete random variable, we were making use of the terminology probability mass function, and when it comes to cumulative probability, it is described by cumulative distribution function, that is the cumulative probabilities plotted against the value of the random variable. That way, discrete random variable is represented by means of probability mass function and cumulative distribution function.

And now, coming to continuous random variable. When we are plotting the probability distribution, we will be calling it as probability density function. And again, cumulative

distribution function. These are different terminologies used when we are dealing with the discrete random variable and continuous random variables. And majority of the cases we may not be able to fit a probability distribution in the case of hydrologic variables. In such cases, for understanding the properties of the population data, we can make use of some statistical parameters which are described by descriptive statistics.

(Refer Slide Time: 5:06)

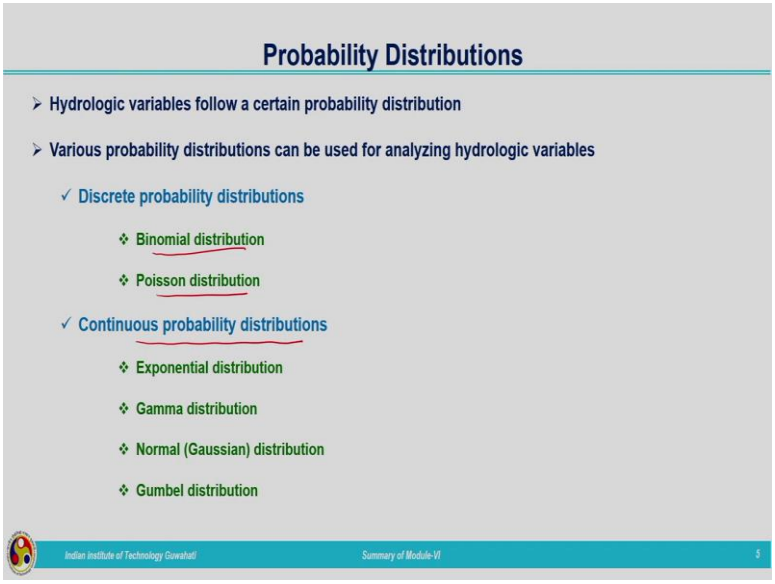


That is, in the absence of probability distribution function explained in the previous slide, we can make use of the details related to population by means of descriptive statistics. That is, we are making use of the sample data and the properties related to the sample data is described by means of descriptive statistics. Different descriptive statistics which we have discussed are, measures of central tendency, measures of dispersion, measures of symmetry, and measures of peakedness.

Four different measures we have discussed under descriptive statistics. All these are representing the moments of the distribution function. Three different terminologies are there which describes the central tendencies, that is mean, mode, median, but, in our lecture, we have considered only mean that is the expected value.

Expected value is described by means of the first moment about the origin, this thing should be very clear that mean is represented by means of the first moment about the origin. But as far as other measures are concerned, that is the variation, symmetry and peakedness, these things are taken about the mean. Second moment, third moment and fourth moments are taken about the mean.

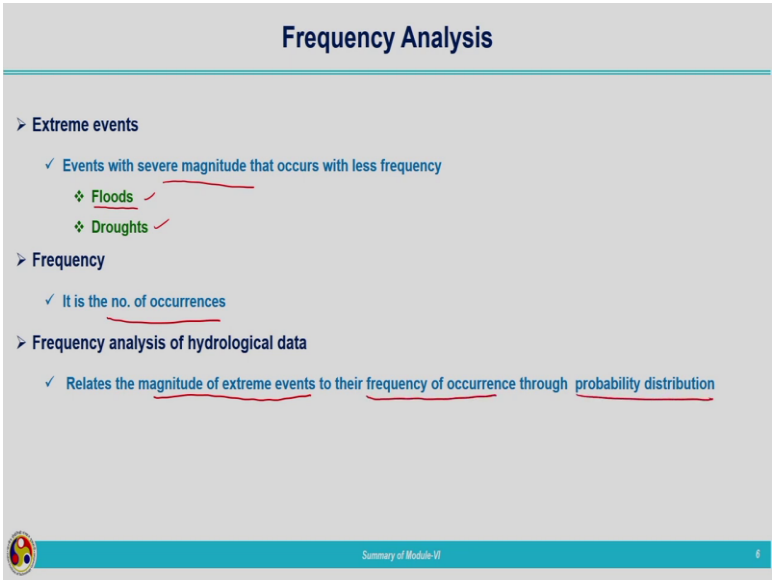
(Refer Slide Time: 6:38)



And after that, we have looked into different probability distributions corresponding to discrete random variable and also continuous random variables. In the case of discrete probability distribution, we have discussed about binomial distribution and poison distribution. While talking about the distributions related to continuous probability distributions, we have completed exponential distribution, gamma distribution, normal distribution and Gumbel distribution.

All these distributions we have discussed in surficial level, we have been gone into the concepts related to these distribution in an in depth way, whichever minimal way we wanted to use in hydrologic perspective, we have covered in the previous lectures. After that we have moved on to the topic related to frequency analysis. Frequency analysis, this is very important, because, by carrying out frequency analysis, we can understand the magnitude of a particular hydrologic event corresponding to particular return period.

(Refer Slide Time: 7:53)



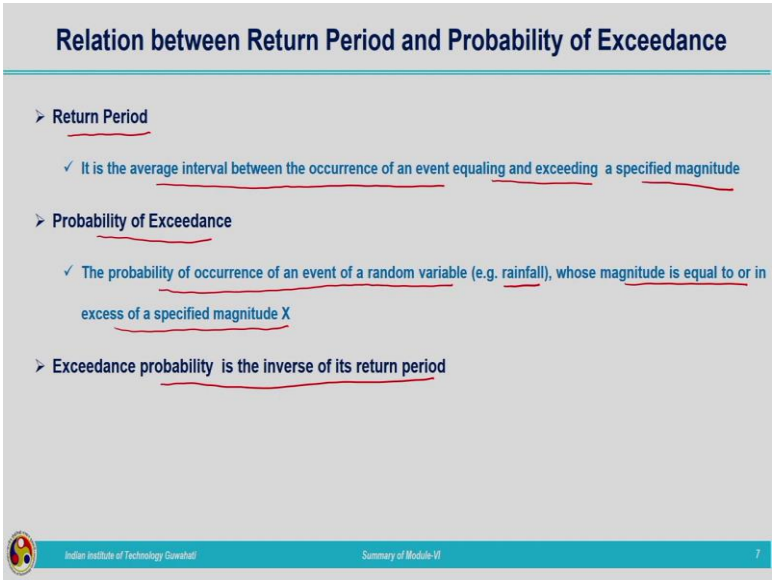
So, in this case, we were mainly looking into extreme events, that is in events with severe magnitude, such as flooding and also droughts. These events which are termed as extreme events will not be occurring very frequently, the frequency of occurrence will be very less in the case of extreme events. Extreme events mainly droughts and floods, but we were carried out the analysis by making use of streamflow data related to flooding.

And frequency term is nothing but the number of occurrence of a particular event. May be considering certain period of years, and in that how many times, what is the frequency of occurrence, that is very important, and the mean interval between the frequency of occurrence of a particular event is termed as the recurrence interval.

And frequency analysis of hydrologic data we have carried out, that is it relates the magnitude of extreme events to their frequency of occurrence through probability distribution. So, here different terminologies are coming into picture, magnitude of the extreme event, then frequency of occurrence, these two are related by means of certain probability distribution.

So, out of different probability distributions which we have covered, we will be choosing which will be the best one for certain analysis. Flood analysis I have explained to you, we will be making use of Gumbel distribution. If you are going for extreme value analysis related to droughts, in that case, we will be making use of extreme value type II distribution. So, that way depending on the type of analysis, which you are intending to carry out, you have to choose the suitable probability distribution.

(Refer Slide Time: 9:50)

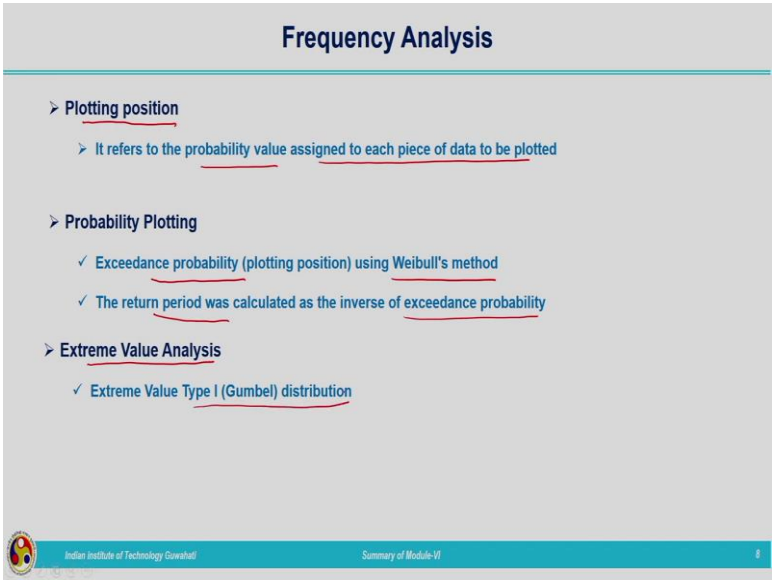


In related to frequency analysis, we have understood the terminology such as return period and exceedance probability. Return period is the average interval between the occurrence of an event equalling and exceeding a specified value. It is mainly the average interval of time of occurrence of a particular event having certain magnitude, which may be equal to that value or exceeded to that specified magnitude.

And corresponding probability is expressed in terms of probability of exceedance, the probability of occurrence of an event of a random variable, we have considered the case of rainfall and streamflow whose magnitude is equal to or in excess of a specified magnitude X, these two are interrelated to each other that is return period and probability of exceedance.

If you are having certain value corresponding to stream flow, which is causing flooding and beyond that, an event is occurring, there are chances of occurrence of that event that will be represented by means of probability of exceedance. This probability of exceedance and return period is related to each other, that is exceedance probability is the inverse of return period. So, if T is the return period, we can find out the exceedance probability by taking the value corresponding to 1 by T.

(Refer Slide Time: 11:32)



Then we have moved on to the topic of frequency analysis by making use of certain example data. First method was plotting position, we have made use of plotting position technique for carrying out frequency analysis. It refers to the probability value assigned to each piece of data to be plotted, since it is a random variable, corresponding to each value of random variable there will be an associated probability. So, the plotting position represents the probability assigned to each piece of data point.

After that, we have done the probability plotting that is exceedance probability calculated by using the Weibull method. Different probability plotting methods we have discussed, but the example which we have carried out was related to Weibull method. So, in that case the data which is having highest value is put rank 1. Data is arranged in the descending order and the ranks are started from 1 to N, if N number of data points are there. And based on Weibull distribution, we can find out the exceedance probability, and once the exceedance probability is calculated, we can calculate the return period by taking the reciprocal of that exceedance probability value.

After calculating return period corresponding to the exceedance probability, we have plotted that, that is the magnitude of event versus the return period is plotted and corresponding to any return period we can find out the value corresponding to the event, magnitude of the event by interpolation or by means of extrapolation.

After that, we have moved on to extreme value analysis. Extreme value analysis we have carried out by making use of Gumbel distribution, three different types of probability distributions we have seen, extreme value type I, extreme value type II, and type III. We have

looked into the extreme value type I distribution in detail, that is the Gumbel's distribution. This is mainly used for the analysis related to maximum value that is, when the rainfall is very high it will be leading to flooding that is it is related to maximum value. When the rainfall is less during certain period it will be leading to drought. So, that is representing the minimum value.

So, if it is related to extremes such as maximum, then we will be making use of extreme value type I, and in the case of drought analysis, which is related to the minimum value, then we will be making use of the type II distribution. So, that much we have carried out in this particular module on hydrologic statistics and some of the numerical examples related to all these concepts we have covered. So, here let me wind up this summary session on module 6 on hydrologic statistics. Thank you.