Engineering Hydrology
Professor Sreeja Pekkat
Department of Civil Engineering
Indian Institute of Technology, Guwahati
Module: 1
Lecture: 1
Course Contents

Hello all, welcome to the first lecture of NPTEL MOOC on Engineering Hydrology. This lecture is related to the course contents. First of all, let me thank you all the participants for enrolling in this course. And myself Sreeja Pekkat, you can reach me at sreeja@iitg dot ac dot in for clarifying any doubts related to this particular course. You can text me email in this email ID. So, coming to the overview.

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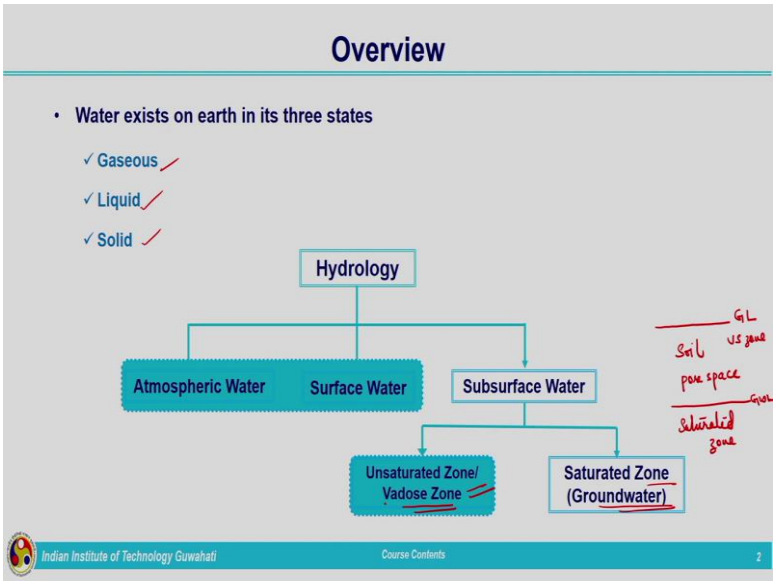

We all know water is existing on earth in three states that is Gaseous state, Liquid state and Solid state. So, water in different phases is present in the earth's surface, beneath the ground surface and also above the ground surface. Based on this and entire course is divided into different modules.

So, hydrology basically, when we talk about hydrology, what is meant by hydrology? Hydrology is the science that deals with the study of occurrence, distribution and circulation of water which is present in the earth. So, the water which is present on the earth can be divided into three, atmospheric water, surface water and subsurface water that is water in three phases, Gaseous phase, liquid phase and solid phase.

So, it is divided into three types atmospheric, surface and subsurface water. And when we talk about subsurface water, it is again divided into two parts that is, beneath the ground level, if you are considering, we are having soil present. This soil is consisting of pore space, pore space is consisting of water and air.

So, if all the pores which are present within the soil is completely filled with water, then we will be calling it as saturated zone and if the pores are filled with water and air, then that zone is termed as unsaturated zone. So, that way if we talk about, we are having the groundwater table present at a certain depth, below that we will be having the saturated zone and above that we will be having unsaturated zone.

So, that way depending on the water which is present in the saturated zone and unsaturated zone, it can be divided into two, that is water which is present in the unsaturated zone and in the saturated zone. So, the water which is present in the saturated zone is termed as the groundwater.

In this course, I will be discussing about water which is present in the unsaturated zone or it is also termed as Vadose zone. We will not be looking into water which is present in the saturated zone or groundwater. This course will be covering atmospheric water, surface water and water which is present in the unsaturated zone that is considered as the subsurface water. So, based on this and the different processes related to the water which is present in the surface, subsurface and atmosphere, the entire course is divided into different modules. Let us see one by one.

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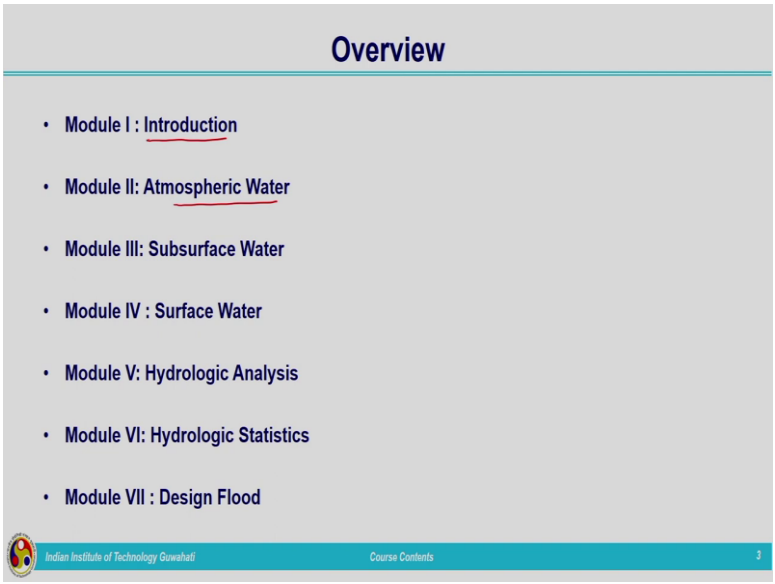

Module 1 is giving you a preliminary idea about the subject that is the introductory module. Second module is related to atmospheric water. Third module, subsurface water and Fourth module covers surface water and the fifth module is related to hydrologic analysis and module six is dealing with hydrologic statistics and module seven is related to design flood. So, total seven modules have been designed for completing this entire course on engineering hydrology. Let us see each module one by one, first module is the introductory module.

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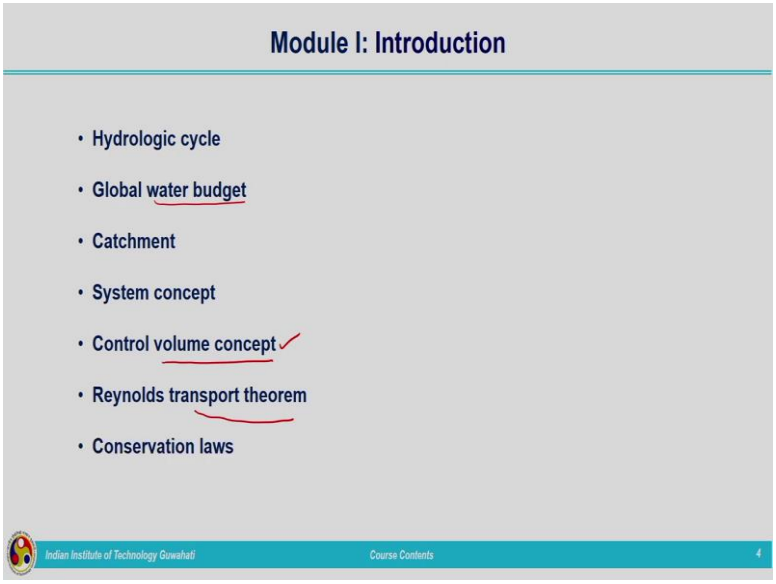

So, we will be starting with the hydrologic cycle. So, we know water is present in the atmosphere in the vapour form on the water bodies and on the surface of the ground in the form

of liquid form. So, water is continuously changing its phase, water is converted to vapour due to evaporation process, coming back to the ground surface in terms of rainfall in the liquid form.

So, this transformation from one phase to another phase is taking place continuously. So, different processes related to water will be explained with the help of hydrologic cycle. Then we will move on to the quantification of water which is present on the earth by means of Global Water Budget, total how much is the quantity of water present on the earth.

It may be in different phases, groundwater, in the form of vapour, and also in the form of liquid. So, how much is the total quantity of water that can be found out under the topic of global water budget. Then we will move on to the specific topic of catchment. Catchment is nothing but an area, it is representing an area over which water is flowing and finally drain out to a particular outlet point. We need to have an area for the quantification of the water which is falling on that particular area. So, that area we will be terming by means of different names. So, it will be coming under the topic of catchment. Then the water which is flowing has to be analyzed or different processes related to hydrology needs to be analyzed. For that in this, the movement of water in different phases are involved.

So, for that we will be making use of different approaches, those approaches are system concept and control volume concept. In hydrology, basically we are going to make use of control volume concept for the analysis of water flow related problems. So, for that we will be making use of a well-known theorem known as Reynolds transport theorem.

So, this Reynolds transport theorem is based on the control volume concept and system concept already you might have studied in fluid mechanics. So, this hydrology course is mainly dealing with the control volume concept and based on the Reynolds transport theorem, we will be deriving different conservation laws. We know different conservation laws are the conservation of mass, momentum and energy. These principles you have already studied. So, these equations or the mathematical representation of these conservation laws will be derived by making use of Reynolds transport theorem in this first module.

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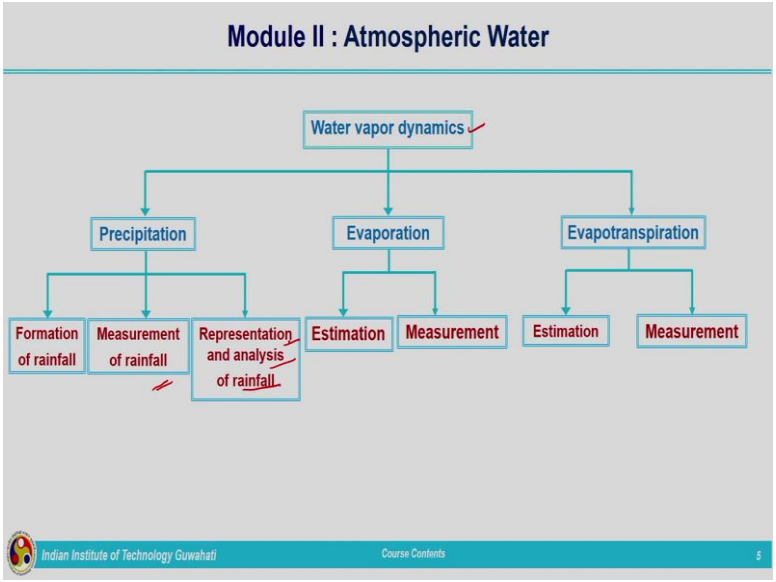

Then we will move on to second module related to atmospheric water. So, from the title itself it is clear it is related to the water which is present in the atmosphere. So, for that, first we need to have understanding about water vapour dynamics. So, it is not simply as we talk about water, liquid water, we need to have fundamental knowledge about the water vapour dynamics and different properties of vapour and different representations in the atmosphere.

Once we get a fair good idea about water vapour dynamics, we will move on to different processes such as Precipitation, Evaporation and Evapotranspiration. So, under precipitation, different types of precipitation we will see after that our main concentration will be on rainfall.

So, how rainfall is occurring, how the raindrops are formed, all those mechanism we will be studying under that and then we will be moving on to the measurement of rainfall. Different measurement techniques which are utilized for getting an idea about for quantification of rainfall we will be seeing under this topic.

And then the representation and analysis of rainfall, once it is measured, how can it be represented, we need to do some analysis before making use of those values for any analysis related to hydrologic processes. So, representation and analysis of rainfall is very important. So, once that topic is over, related to precipitation, we will move on to evaporation. Under evaporation also we will study estimation and measurement methods.

The next is the topic Evapotranspiration, it is a combination of evaporation and transpiration. Evaporation is the water loss from the water body and transpiration is the water lost to the

atmosphere through the plants. So, the combination is studied under Evapotranspiration and we will study the different estimation and measurement methods.

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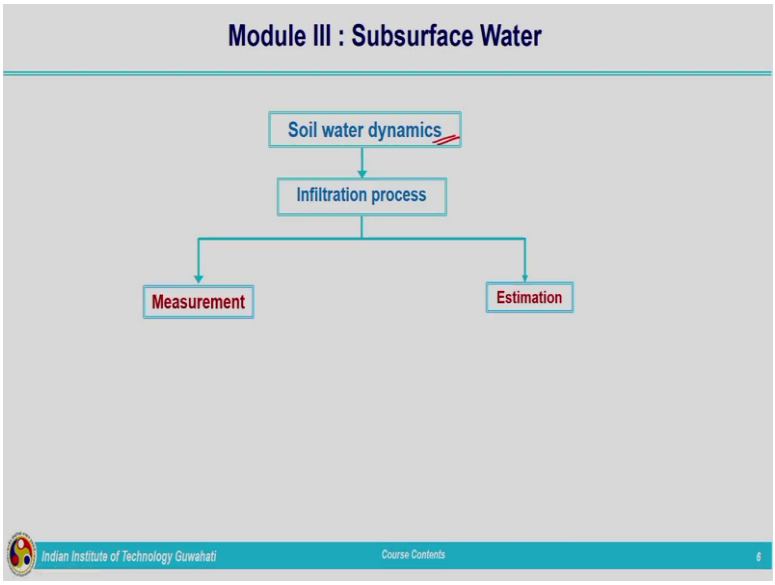

So, here ends the second module. Then we will be moving on to subsurface water. Subsurface water is the study of water related to water which is present in the Vadose zone or the unsaturated zone. So, for that we need to have the idea about soil water dynamics. As I already told you soil is having pore space present in it within that pore space water and air will be present.

So, depending on the presence of water and air, how the soil water will be, soil moisture will be behaving, related to that we need to have the understanding that we will study under soil water dynamics. Then we will move on to infiltration process. We will have idea about the representation of flow taking place within the unsaturated zone.

After that we will move on to the hydrologic process which is taking place beneath the ground surface that is water entry from the ground surface into the soil is taking place that is related to infiltration process. So, we will have detailed understanding related to infiltration process, and will go for measurement and estimation methodologies related to infiltration.

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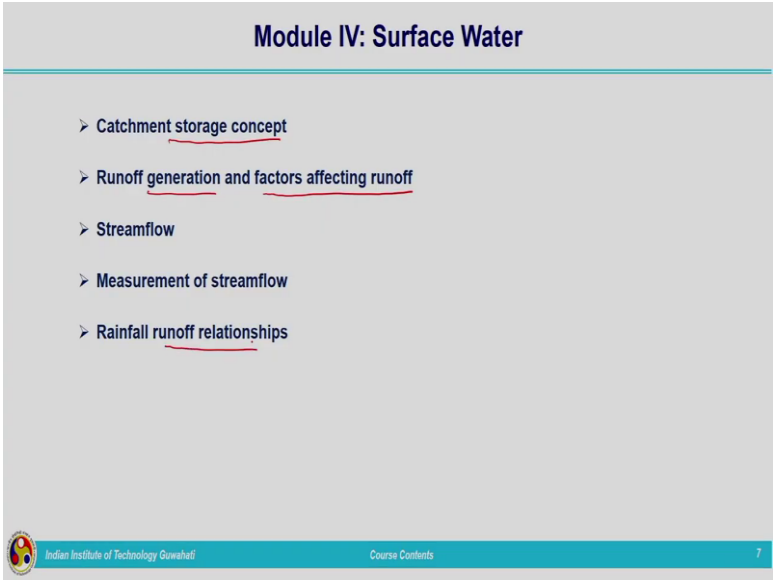

Then we will be moving on to Module four related to surface water. Under the surface water we will start with the catchment storage concept. So, whenever we are experiencing rainfall, some of the water will be utilized for satisfying different storage components. For example, if you are having a pond or a depression present on the ground surface.

First that will be filled then the flow will be taking place right. In the similar way different types of storage are there, storage components are there, soil moisture storage, groundwater storage and different ways of expressing storage components that we will see under this topic of catchment storage concepts.

Once these storage components are satisfied, we will be experiencing the flow taking place on the surface of the ground. That is runoff generation will be starting and we need to understand different factors affecting runoff. After that we will move on to the topic of stream flow.

Stream flow is representing the quantity of water that is the water which is coming as runoff will be from the overland flow and also through the channel will be collected at a particular point, outlet point or at a particular location at the river. So, the quantity which is reaching there is considered as the stream flow and we need to have understanding about different measurement techniques of stream flow. And after that, how we are getting this flow, runoff or stream flow that is based on the rainfall.

So, there is certain relationship between the rainfall and runoff. Depending on the soil characteristics and depending on the landscape, how much is the runoff obtaining. So, we can

find out certain relationship between rainfall and runoff that we will study under rainfall runoff relationships.

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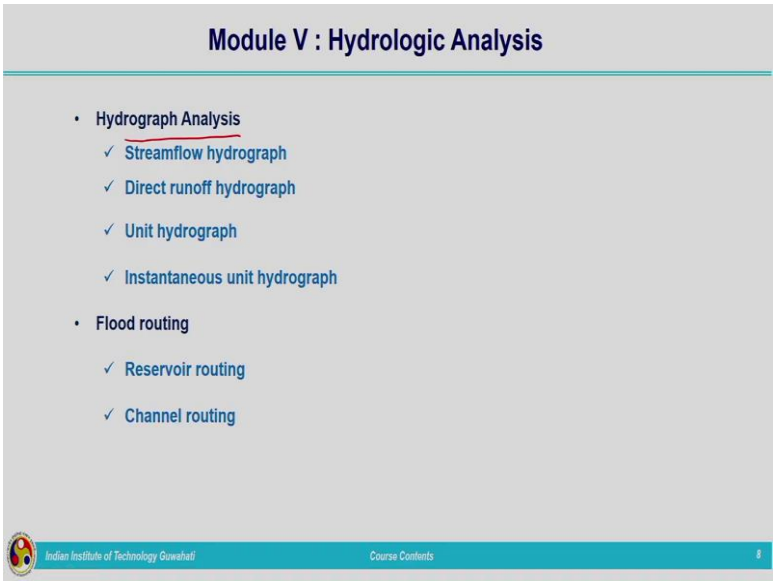

After understanding rainfall runoff relationship, we will move on to hydrologic analysis. So, by the time we complete module four, we will be having the complete knowledge about different hydrologic processes, that is related to atmospheric water, related to surface water, and related to subsurface water.

So, different hydrologic process we will have understanding. After that we will move on to hydrologic analysis that will be explained under module five. So, within this hydrologic analysis, mainly we are dealing with hydrograph analysis. So, first you need to understand what is meant by hydrograph.

Hydrograph is a graphical representation of flow. I have already told you about runoff, stream flow, different terminologies related to surface water. So, that flow when it is plotted against time, that is termed as a hydrograph. Different types of hydrographs are available such as stream flow hydrograph, direct runoff hydrograph, unit hydrograph and instantaneous unit hydrograph.

Four different types of hydrographs we will understand and after understanding the mathematical concepts behind this, we will move on to the application of these things, application of the hydrograph principle and also, we need to have understanding if one type of hydrograph is available to us, how other kinds of hydrographs can be derived from the

particular one which is known to us. So, that also will be studying under hydrograph analysis. After that we will move on to the application part which is coming under the topic of flood routing.

Flood routing means that is the flow is taking place from the river from upper zone to the downward direction. So, when the flow is getting travelled from the upstream to downstream of a river, so much of change is taking place. Exactly what is the flow occurring at the upper side will not be there at the downside.

So, for quantification of these or how what are the changes taking place, as far as the flow is concerned, when it is moving from the upstream to the downstream side, that can be studied under flood routing. So much of losses will be taking place, sometimes some extra channels will be joining the river at a particular point and some water extra water will be withdrawn from one particular location and even after taking place all these what will be the flow coming at the extreme downstream point. So, all this understanding can be done by making use of the known value of flow at the upstream end. So, that we will be studying under flood routing. Different types are there, one is reservoir routing and the second one is channel routing. Reservoir or dams are present, so what will happen to the flow when it is entering to the reservoir and after that what is the flow which is expected at the downstream of the reservoir, that we can study under reservoir routing. Then channel routing, this is something related to the river or channel. The flow which is taking place within the channel or river, there will not be any reservoir present. That much about module five hydrologic analysis. Then we will move on to hydrologic statistics. That is module six is dealing with the hydrologic statistics.

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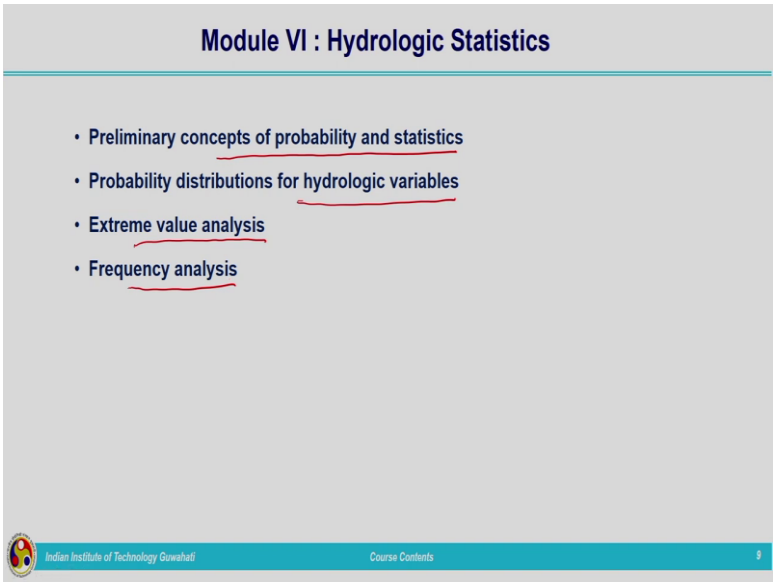

As the name indicates hydrologic statistics, we will start this module with the preliminary concepts of probability and statistics. Basic fundamental knowledge about the probability and statistics will be covering initially and after that, we will be moving on to different probability distributions and what are the different types of distribution which can be utilized for hydrologic variables.

That understanding is required that we will study. Then we will be moving on to extreme value analysis. What is meant by extreme value analysis? If you are having excess rainfall, you might be experiencing flooding and this is a very common phenomena which during every monsoon we are facing and when we are having lack of rainfall, scarcity of rainfall, that time the drought phenomena we are experiencing. That is excess rainfall and also scarcity of rainfall is not desirable actually.

So, we need to have understanding about these extreme events and how can we quantify this extreme events. These are very important whenever we are talking about hydrologic analysis. So, that we will study under extreme value analysis. Then we will move on to frequency analysis. Frequency analysis is dealing with the frequency of occurrence of an event.

That is, what is the likely occurrence of a particular event, that is what we are going to understand from this we will not be exactly able to tell on this particular day a particular time this particular event or this much of flood will be occurring. But we can approximately tell the

likely occurrence of the event can be explained that is frequency of occurrence of a particular event can be explained by means of frequency analysis.

That is very important when we talk about design of hydraulic structures. Whenever we are going to design a hydraulic structure, we need to have idea about frequency of occurrence of an extreme event, what will be the extreme event which will be causing within that frequency. So, that we will study technically under the topic of frequency analysis.

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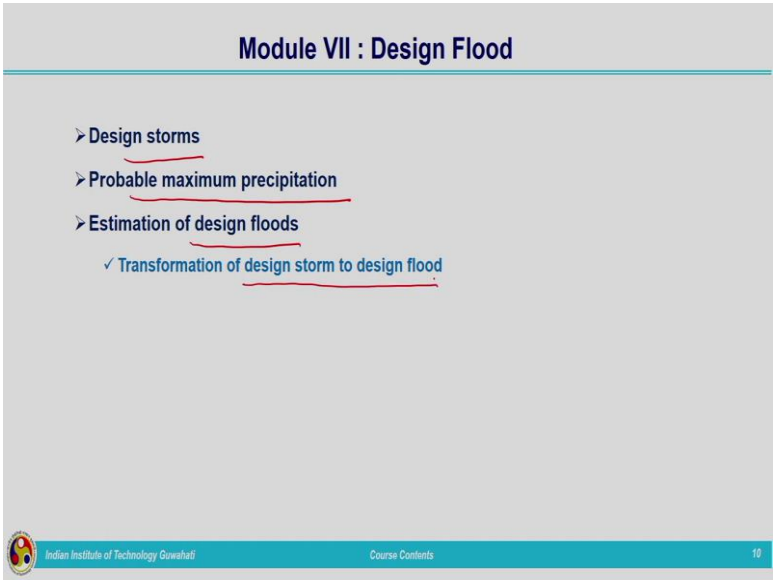

Then we will be moving on to the last module that is module seven related to design flood. Whenever we are designing a hydraulic structure, we need to have what will be the higher value or the extreme value corresponding to that particular hydrologic event.

So, that can be studied under this and always the same value of extreme event will not be used for the design of all the types of hydraulic structures. Depending on the importance of the structure for example, if it is a dam and also reservoir or sometimes, we will be having other hydraulic structures such as culverts, urban drainage system, so, for all these when we design, we will not be taking the same value of design flood. Because more safety is required in the case of design of hydraulic structures such as dams, so we will be considering the extreme event which may occur for, which may be likely occurring, which may occur in a period of 100 years, 150 years it will be a very high value.

But that much high value is not required to be considered when we are designing small structures such as culverts and drainage networks. Some sort of inconvenience will be there due to flooding all those things, but still by considering the economic consideration, we will not be going for 100-year, 150-year consideration or even 50 years consideration while designing small structures like culverts and drainage system.

So, depending on the importance of the structure, we need to find out, what is the value corresponding to design flood? So, for that we need to have understanding about design storms and we will be finding out the values corresponding to probable maximum precipitation and based on that we will be estimating design floods.

Estimation of design floods also different methods are available. One is by transformation of design storm to design flood, what is the design storm which we are expecting that transformed into design storm and by means of flood frequency analysis, how much can be the maximum flood which can occur likely chances of occurrence of a particular flood event or drought event.

So, that thing we can study under extreme value analysis or flood frequency analysis will be carried out under this topic. All these seven modules are designed in such a way that basic knowledge related to that is, fundamental knowledge related to all these topics will be covered. And this course is developed by making use of different textbooks as reference material.

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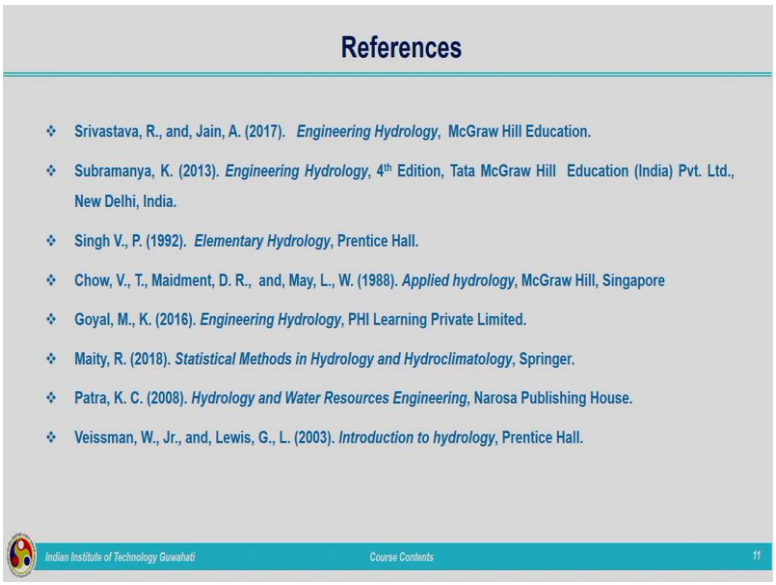

Those reference list is given over here. All these textbooks are being used for the development of the course structure of this engineering hydrology course. So, you can go through these textbooks, or even one or two textbooks if it is available to you. Please read through that textbook for getting more understanding of the subject.

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Now, coming to the course teaching assistants, Miss Aparimita Priyadarshini Naik, Miss Amrutha Suresh and Mister Abdul Rahman. All three of them are my research students, they have helped me a lot in developing this course. So, you can contact my teaching assistants related to this course, their email id is given over here for clarifying any doubts related to this particular course.

Last but not the least I would like to thank Centre for Educational Technology IIT Guwahati for facilitating me in developing this particular course on Engineering Hydrology. So, I wish you all a very happy learning. Thank you. Thank you very much.