Internet Technology
Prof. Indranil Sengupta
Department of Computer Science and Engineering
Indian Institute of Technology, Kharagpur
Lecture No #40
Course Summary and Conclusion

In this last lecture today, means, we have ultimately come towards the end of this course on internet technology. Today we shall basically not be talking about anything new. Rather we would like to summarize whatever had been covered so far in this course and that way we will be concluding this particular course on internet technology.

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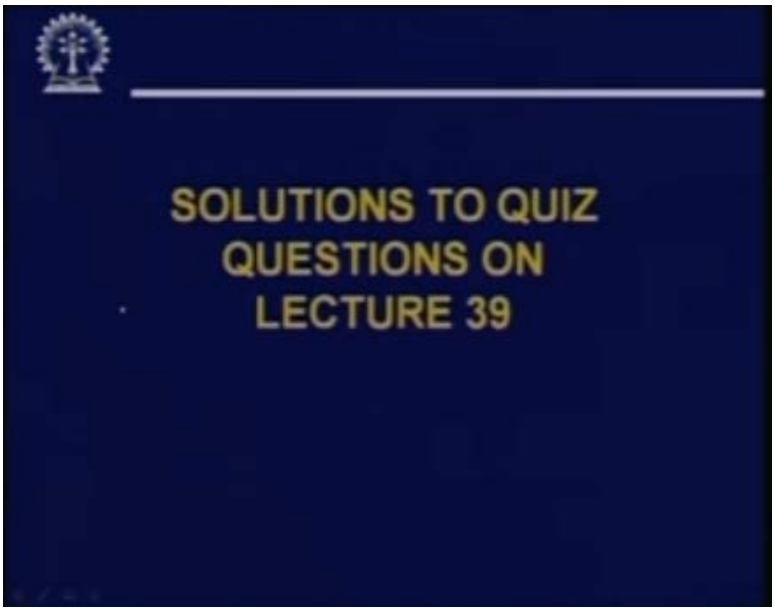

But before that let us first look at the answers to the questions that were post in our last lecture. We start like this.

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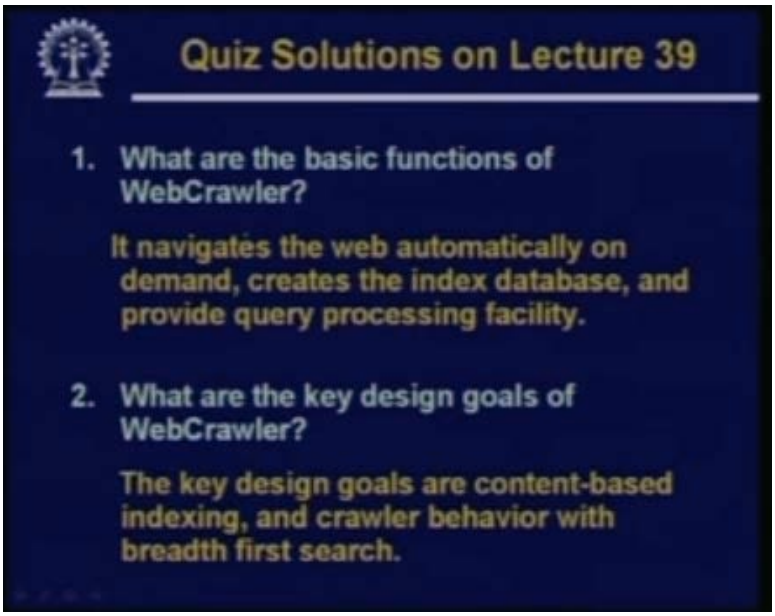

The first question was what are the basic functions of WebCrawler? Well WebCrawler as we have said, it is a software tool which navigates the web automatically on demand. It creates the index data base and provides query processing facilities. These are the main tasks of WebCrawler.

What are the key design goals of WebCrawler?
The key design goals were content based indexing. Indexing based on whatever is there as part of the document in contents, not just the name of the file or the keywords. And crawler behavior we had mentioned it. The WebCrawler uses a modified version of breadth first search to create the index.

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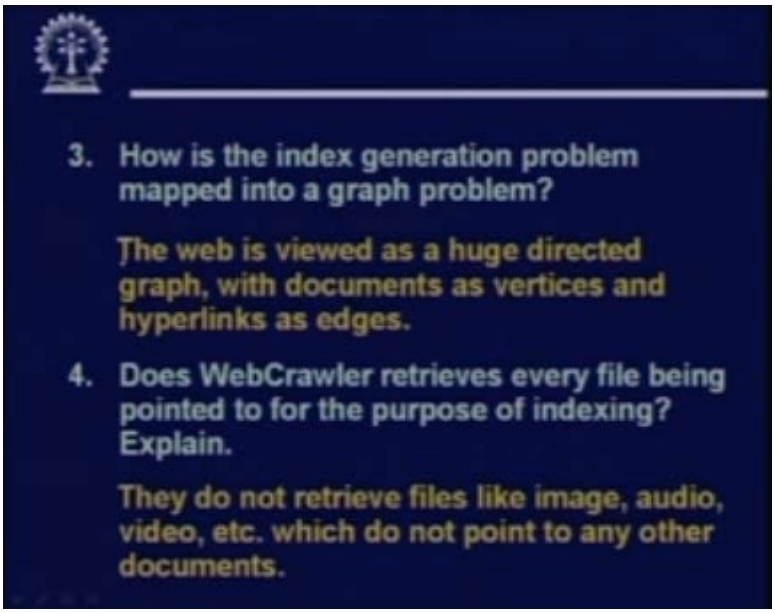

How is the index generation problem mapped into a graph problem?
Well here we have said the whole web is viewed as a graph, a huge directed graph with the documents as the vertices and hyperlinks as edges directions; directed edges.

Does WebCrawler retrieve every file being pointed to for the purpose of indexing?
Well they do not retrieve all files. There is no point in retrieving files like image, audio, video, etcetera which do not point to any other documents or content wise they do not provide any additional useful information. So that is why WebCrawler need not retrieve these kinds of files which may not provide any additional information to it from the point of view of indexing.

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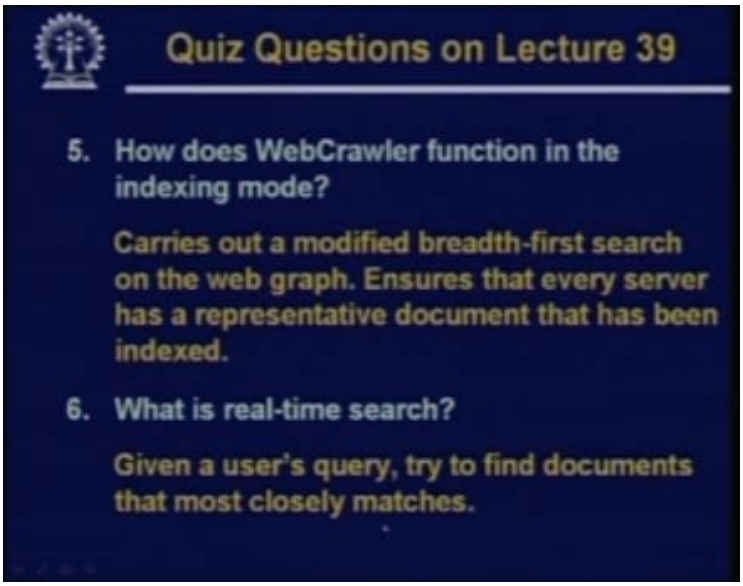

How does WebCrawler function in the indexing mode?
Well in the indexing mode WebCrawler carries out a modified version of breadth first search on the web graph. It also ensures that every sever has a representative document that has been indexed. So at least one document from every server is included in the index.

What is real time search?
Well in real time search given the users query. WebCrawler tries to find the document that most closely matches. Well here this is a combination of data base search and also a modified version of crawling to get information about documents which are not yet been indexed.

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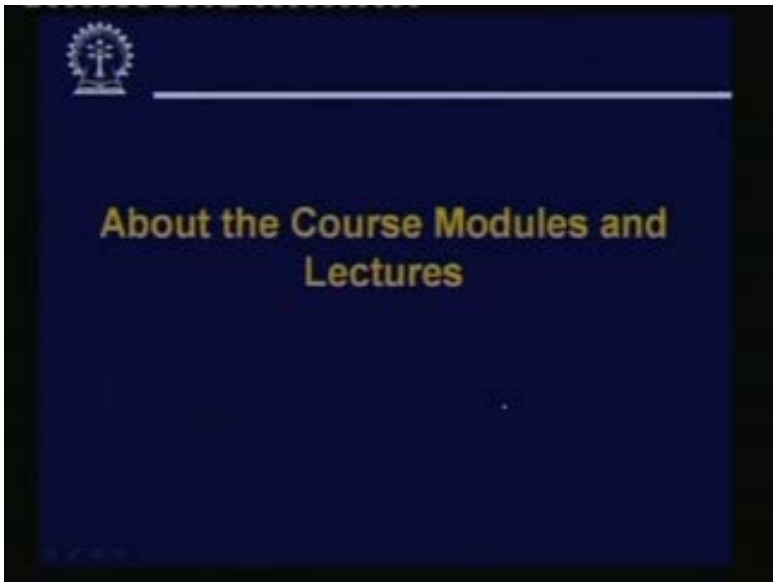

So now let us come to the course modules that we have already covered in the lectures. So here we would try to look at an overview that we had seen so far in the last 39 lectures. So let us go through this journey and try to find out what are the things we had covered.

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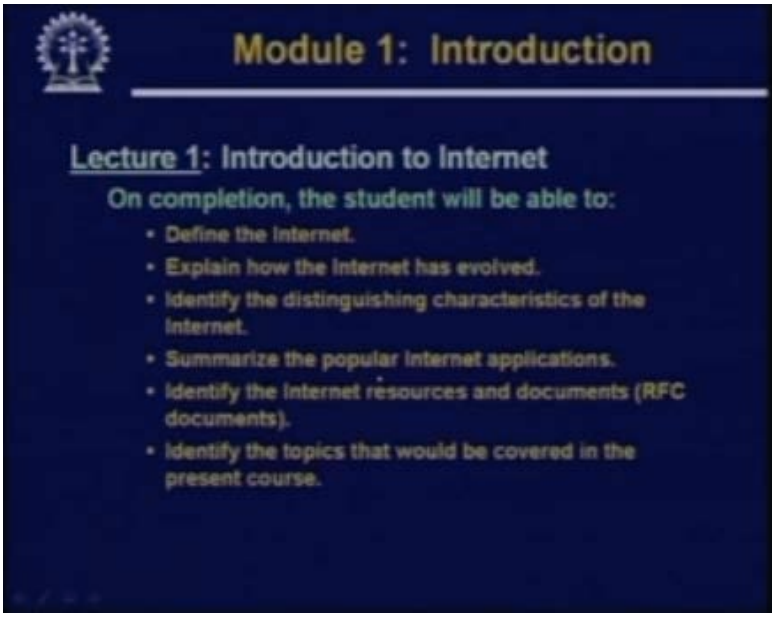

The first module was introduction. In the first lecture which was titled introduction to internet these were the topics that were covered. Define the internet. Explain how the internet has evolved. Identify the distinguishing characteristics of the internet quite is

different from yet another network. Summarize the popular internet applications. Identify the internet resources and other documents RFC documents. So here I repeat this RFC documents carry great wealth of information. So if you want to know more about a particular protocol or technology just search for RFC documents. They are the authentic source of all details that is pertaining to a particular protocol or technology. Finally identify the topics that would be covered in the present course. This was the coverage in the first lecture.

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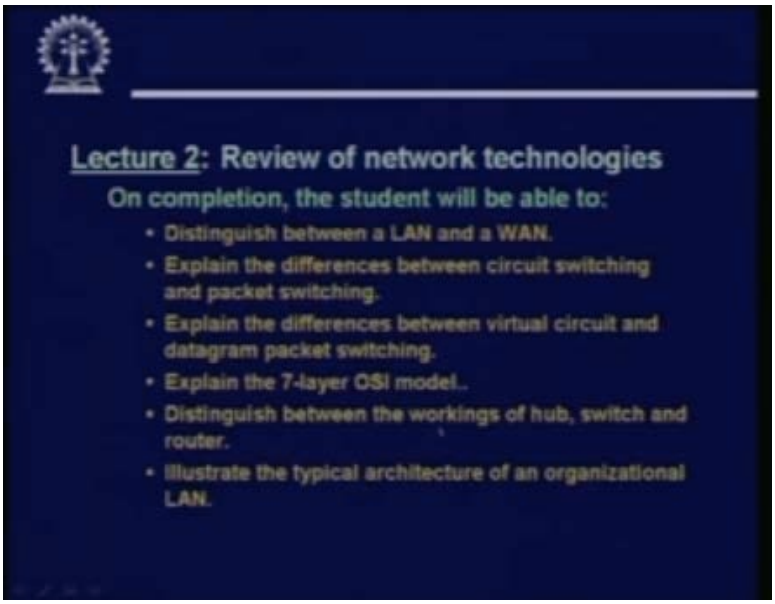

Now in the second lecture we reviewed the network technologies that would be required for remainder of the course. So some basic networking concepts like distinguish between a LAN and a WAN. Explain the differences between circuit switching and packet switching. Differences between virtual circuit and datagram packet switching. The seven layer OSI model. Distinction between the workings of hub, switch and router. And illustration of the typical architecture of an organizational LAN. So this lecture basically was meant to give you an overview of the kind of networking concepts and terminologies that we would be using subsequently. So that even if some one of you do not have a proper background in networking, you can means really pick up your knowledge and understand the lectures that will follow.

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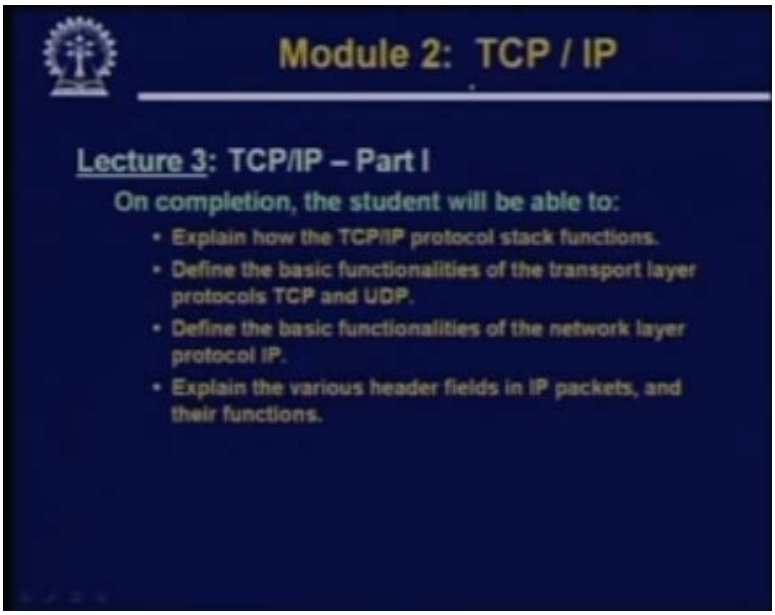

In the second module which was on transmission control protocol and internet protocol TCP/IP. In the third lecture TCP/IP part one. We basically talked about the TCP/IP protocol stack. How the TCP/IP protocol stack functions? We started with the transport layer protocol basic functionalities. The basic functionalities of TCP and UDP. Then the basic functionalities of the network layer protocol IP. And we looked into some detail about the IP packets. In particular we looked at the different header fields in IP packets. And why they have used? What are the different functions?

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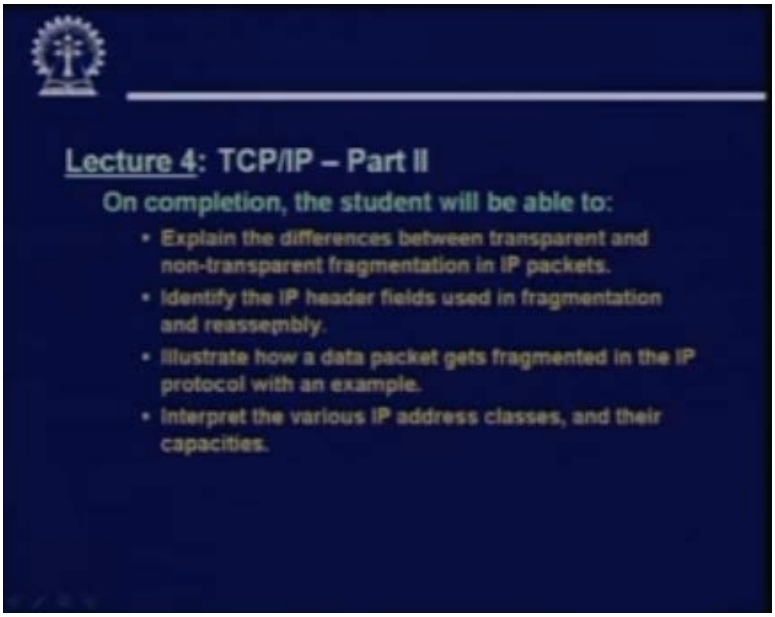

In the fourth lecture TCP/IP part two. Here we proceeded with our discussion on IP packets. We first talked about fragmentation. How IP packets are fragmented and what are the fields in the IP headers that are used in the process of fragmentation? We had mentioned that IP users' non transparent fragmentation in the sense that it is the responsibility of the final destination to put together all these small pieces of fragments together to generate or recreate the original packet. So here we discussed the differences between transparent and non-transparent fragmentation in IP packets. We identified the IP header fields which are used in fragmentation of the packets and subsequent reassembly and we illustrated through an example. How a data packet gets fragmented in the IP protocol? Lastly we looked at the IP address classes and their basic capacities and sizes.

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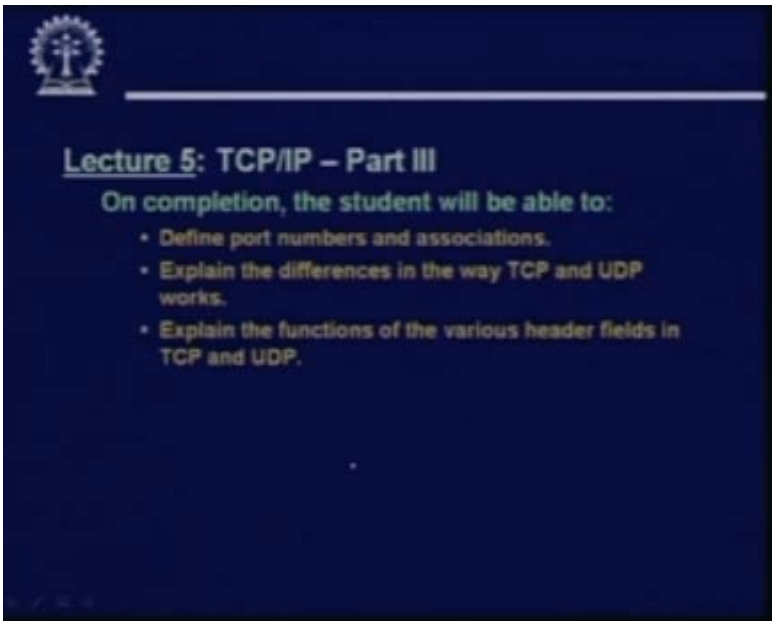

In the next lecture TCP/IP part three. We continued our discussion by looking at the transport layer protocol this time. So we started with the definition of port numbers and associations which are essential to identify the communicating entities at the transport layer level. So we discussed what are the main differences in TCP and UDP in the way they function; in the way they define in terms of the capabilities and we also looked at the headers of TCP and UDP packets. What are the various headers and why are they used?

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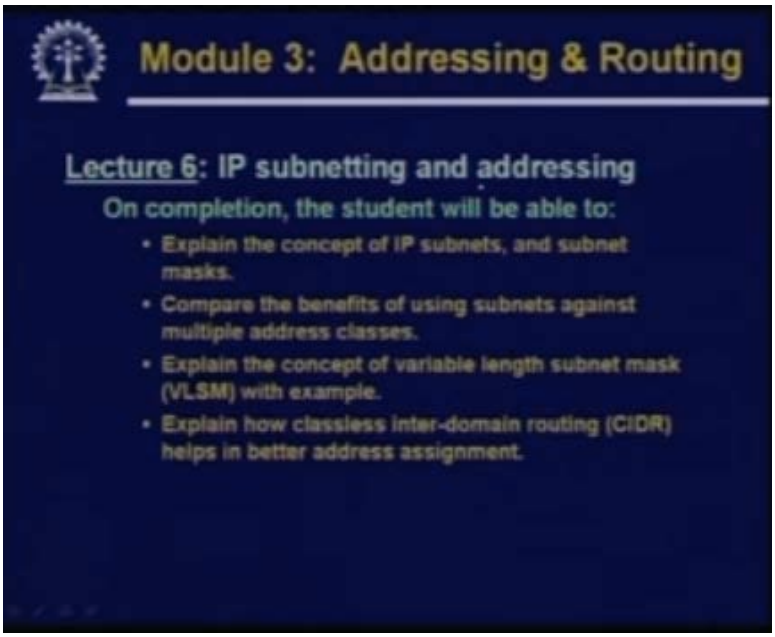

In the third module we used the concepts of TCP UDP addressing whatever we have discussed before to talk about addressing and routing which are very essential in internet. So the first lecture under this module lecture 6 was on IP subnetting and addressing. So here we basically started by talking about the basic concepts of IP subnets and subnet masks. We had also mentioned that as an alternative using subnets we can also use multiple address classes. So what are the relative benefits? Why to use subnets and not multiple address classes? This is what we had discussed. And to provide more flexibility how the concept of variable net subnet mask or VLSM can be used to achieve much better utilization of the available IP address space that was also discussed. Then finally we talked about the present day trend, how the so called class full trend address classes are significant, that is slowly disappearing and we are going towards something called classless internet domain routing or CIDR. This was also discussed.

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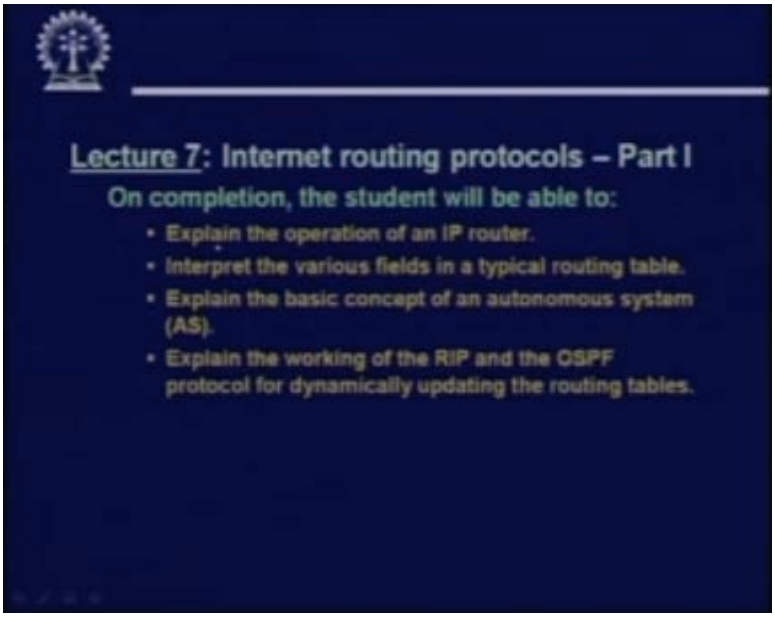

In lecture seven we started our discussion on internet routing protocols part one. So here we started with an explanation how an IP router works. How routing is carried out? We looked at the various fields in a typical routing table and what are the kinds of decisions a router has to take based on the entries in a routing table. Well understanding the concept of autonomous system is essential here. So we talked about an autonomous system what it is and we started our discussion on the internet internal routing protocols. We talked about RIP and OSPF and how they can dynamically update the routing tables of the routers inside a particular autonomous system. Now recall the internet or the internal routing protocols they are usable to routers which are inside an autonomous system. So this RIP and OSPF these are protocols which are used for that purpose.

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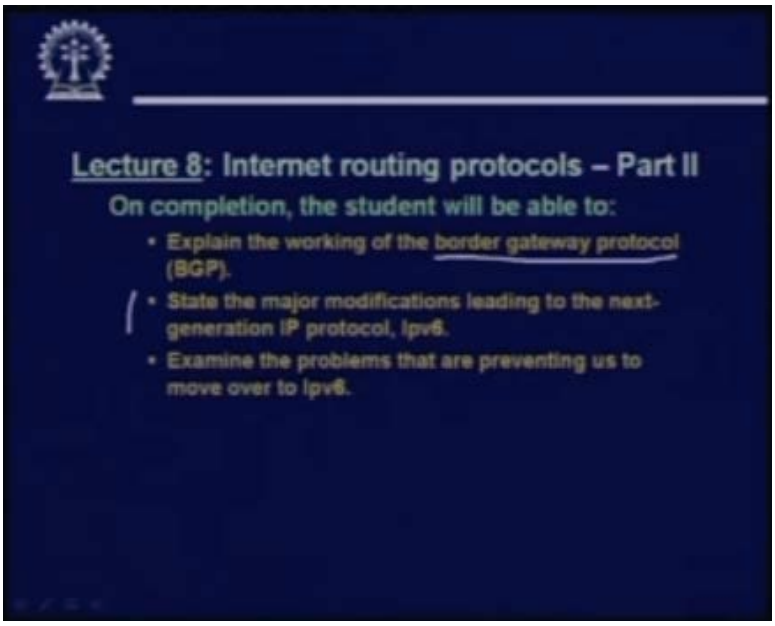

Now in internet routing protocol part two we extended our discussion to the external routing protocols which means routers across more than one autonomous systems. So the routers which are located in different places in different autonomous systems they can exchange messages and keep their routing tables updated. If someone discovers a better route particular destination it can inform the other routers in the autonomous systems to make the necessary updation in the table. So the most common protocol in the category are the border gateway protocol or the BGP. This was discussed here and we also talked about the IP next generation or IP version 6. What are the major modifications and capabilities and we had also mentioned why we have not already moved on to ipv6. What are the problems that are still preventing us to migrate from the so called IP version 4 to IP version 6? Well although some of the isolated companies and organization they have migrated, but that is still on an experimental level. Still it will take some time for us to move on to ipv6 in a very coordinated way.

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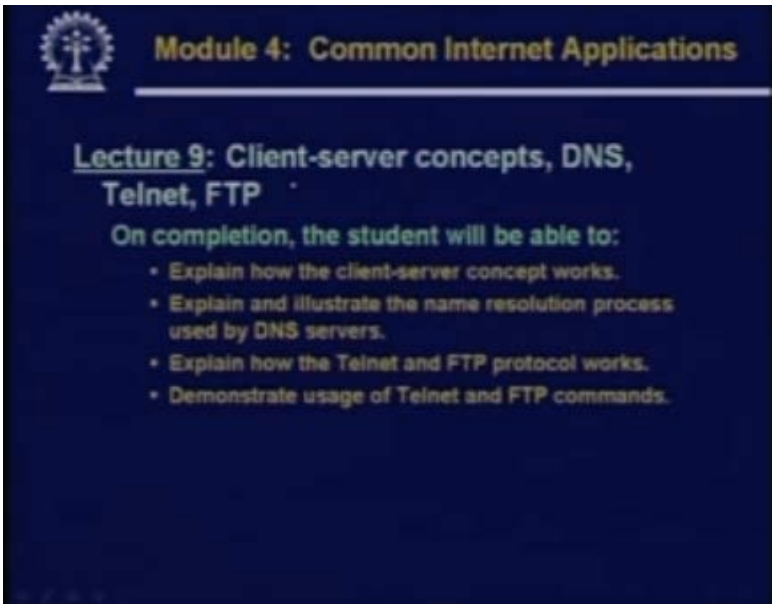

Now in module four we talked about common internet applications we started with a discussion on client-server concepts, domain name system, telnet, FTP. Since all the internet applications that we see are based on client-server concepts. So we started our discussion with basic understanding of how the client server concept works. Then we explained with illustrations how DNS servers work and how they can be used to translate a domain name into an IP address and vice versa. So the name resolution process how DNS servers can do that, this was explained. Then we talked about telnet and FTP protocol with some demonstration usages. So telnet and FTP protocol we had said that these were perhaps the first protocols to be used and they are still very useful.

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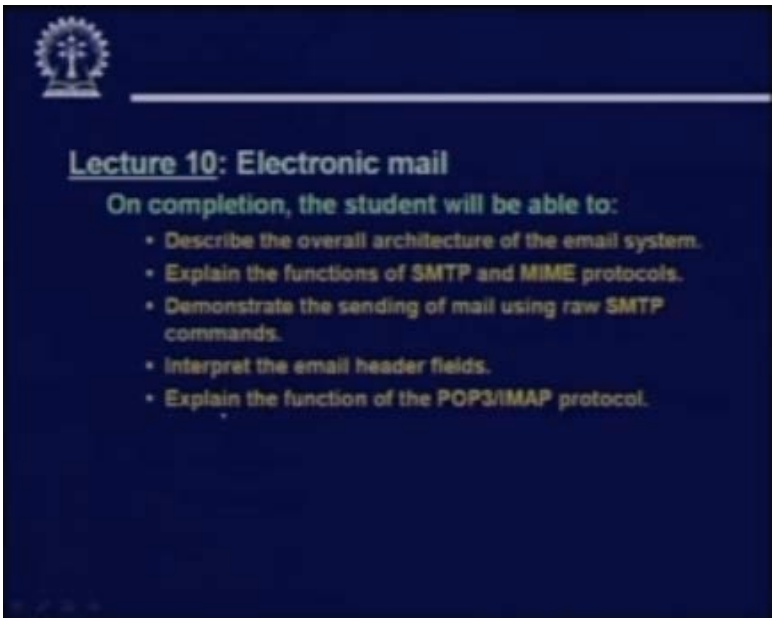

I the next lecture, lecture 10, we talked about the electronic mail. Well here we looked at the overall architecture of the email system. So we saw that what are the different components, how email flow from client to a destination. What are the basic functionalities of the two main protocols that are used in email. Simple Mail Transfer Protocol, SMTP and Multipurpose Internet Mail Extension, MIME. Some sort of an example demonstration that how a mail can be sent using raw SMTP commands. Let us see that just by connecting a mail server over port number 25 and by directly giving the SMTP commands, it is possible to send a mail from any host which has a connection to that SMTP server. And we had some discussion regarding the email header fields and how on the receiver side you can use POP3 or IMAP to extract or read your mails from a mail server.

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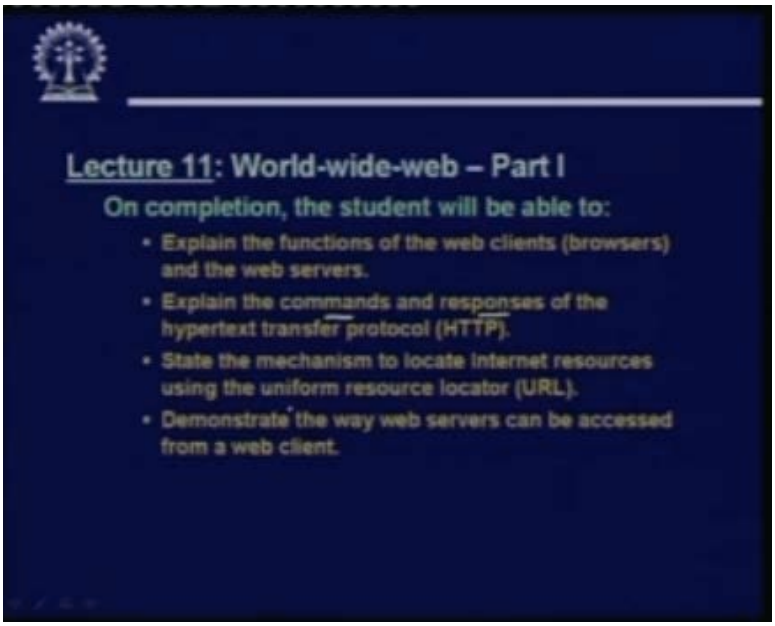

Now in lecture eleven we started our discussion on World Wide Web part one. So here we first explained the basic functionalities of the web clients which are the browsers and the web servers. We talked about the hypertext transfer protocol HTTP, which is the language using which the web clients and servers communicate among themselves. So we talked about the different commands responses that are possible under HTTP. We talked about uniform resource location URL. So what are the different kinds of URLs you can use to locate different kinds of resources. And finally we say that how a web server can be accessed from a web client. That means from the basic get commands, first you have to connect to the server over a specified port number, port number 80 is typical and after that you will have to send a sequence of GET or POST requests and you will be getting back some responses based on whatever you have sent.

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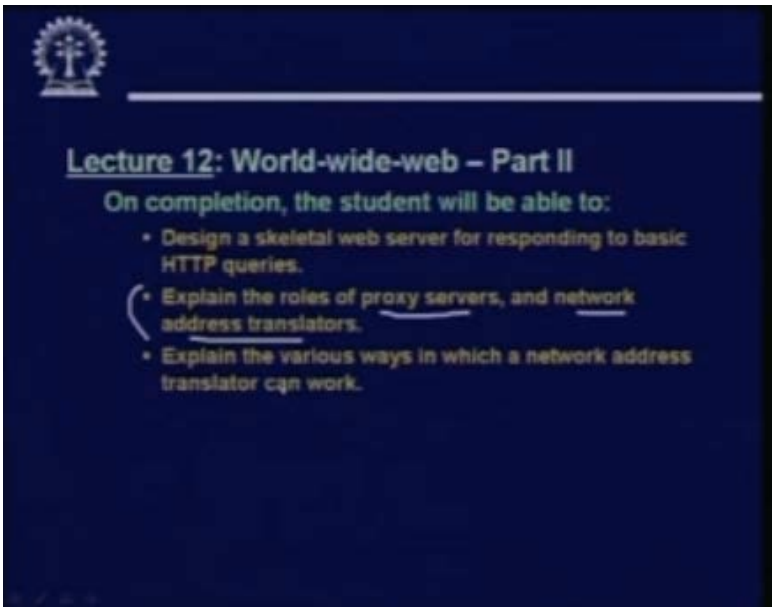

So the next lecture; lecture 12, we continued with World Wide Web. So here we talked about the design of a skeletal web server and how it can be used to respond to basic HTTP queries. We talked about proxy servers, we talked about network address translators. How these two you can say devices has become so very essential in modern day networks. And we had also looked in detail what are the different operational modes of a network address translator. So depending on the requirement of your organization you can configure a NAT or a network address translator in the way it suits you the best.

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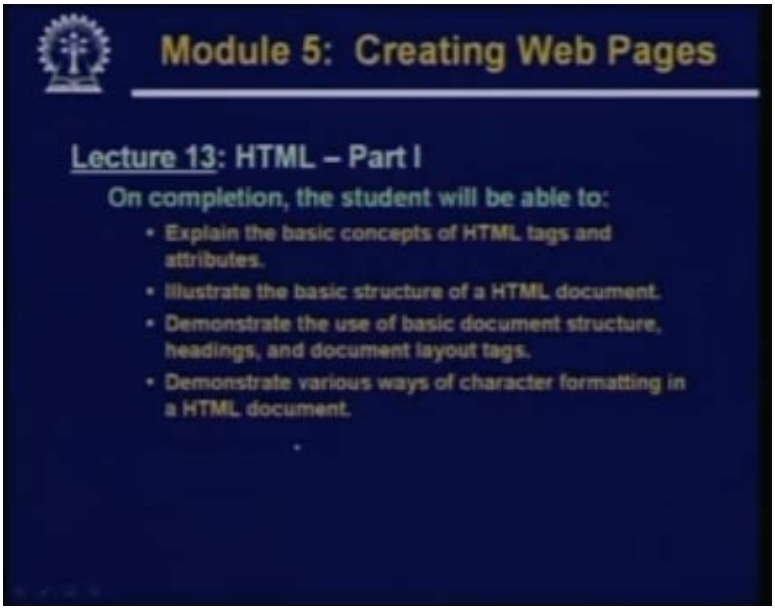

So in the next module; module 5, we talked about the creating or the creation of the web pages. So here we started with our discussion on HTML. HTML part one. So in the first lecture here we talked about the basic concepts of HTML tags and attributes. Here we had said that HTML is markup language where the tags are all predefined. So unlike XML where you can define your own tags, in HTML all the tags are predefined in the language. So you will have to understand what are the tags that are available to you and since they are predefined all tags also have a specific meaning. So you will have to understand what our tag really signifies and suppose you are designing a browser yourself you will have to interpret the tags accordingly and you have to display the text in a suitable form depending on the semantic of the tag. So here we explain the basic concepts of tags and then we saw how an HTML document looks like. What are the different components of an HTML document? We saw various usages of the basic document structure how you can give headings, layout tags and some character formatting tags. These were something which we had discussed in the first lecture here lecture 13.

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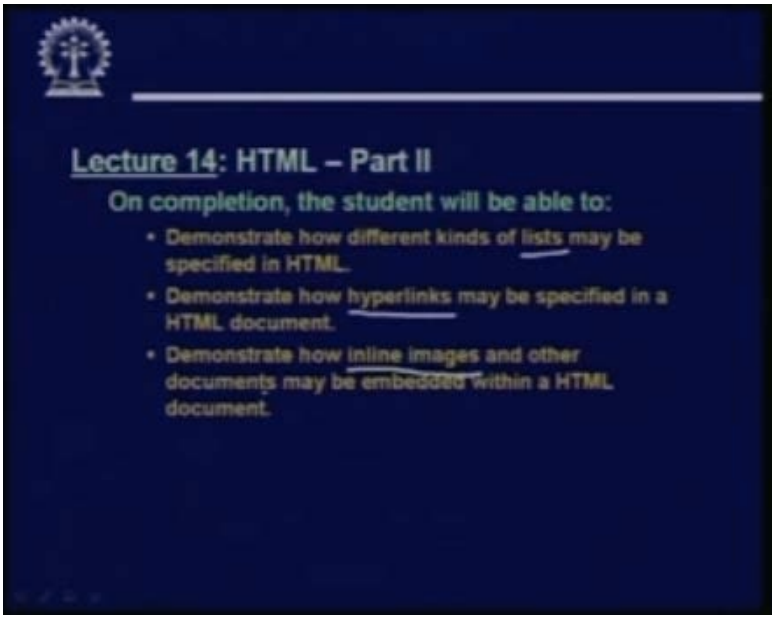

Now in the next lecture; lecture 14, HTML part two. Here started by talking about lists. Now you can recall in HTML you can have various kinds of lists; ordered lists, unordered lists, description you can also nest list one inside the other. So depending on how you want to format your document how you want to document you like, you can use nesting's of the lists in whatever way you can make your document look better and attractive. Then we talked about hyperlinks. How you can add hyperlinks to an HTML page and how you can include images inline images and other documents images, it can be audio video, pdf file, anything. How you can include them within a HTML document.

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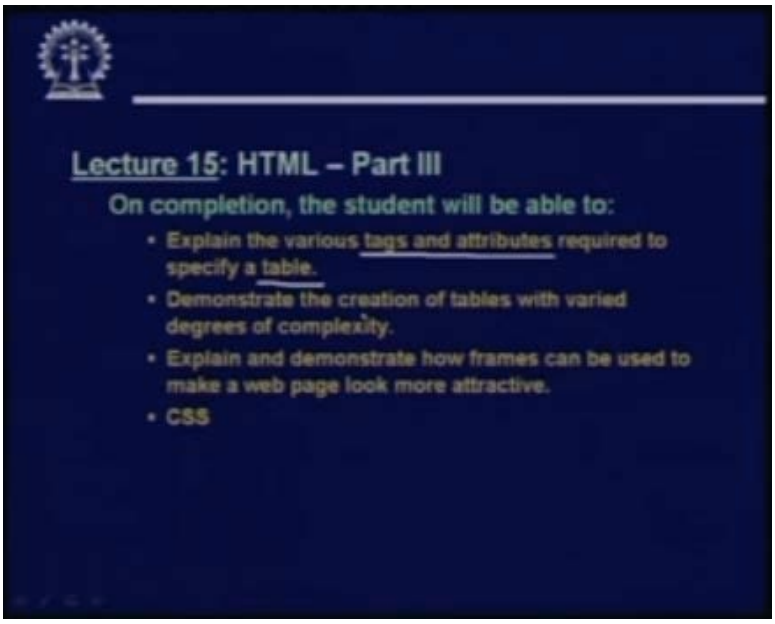

The next lecture, lecture number 15, here again continuing with HTML we first talked about you can specify a table description. So what are the tags and attributes that are available in HTML which can help us in specifying the structure of a table. So we give a number of examples here, where various kinds of tables with varied degree of complexity was shown. How you can write that? You can have multiple columns, you can merge two or more columns; you can merge two and more rows. So you can have whatever you want while you are basically composing the table. So in whatever way you want to look, you can also have center, left justified, right justified. All those things are possible. And we also talked about frames here. So how you can use frames to make a web page more attractive way with several different sections in a page. You can interlink them using hyperlinks and so on. And of course lastly we talked a little bit about cascaded style sheets or CSS.

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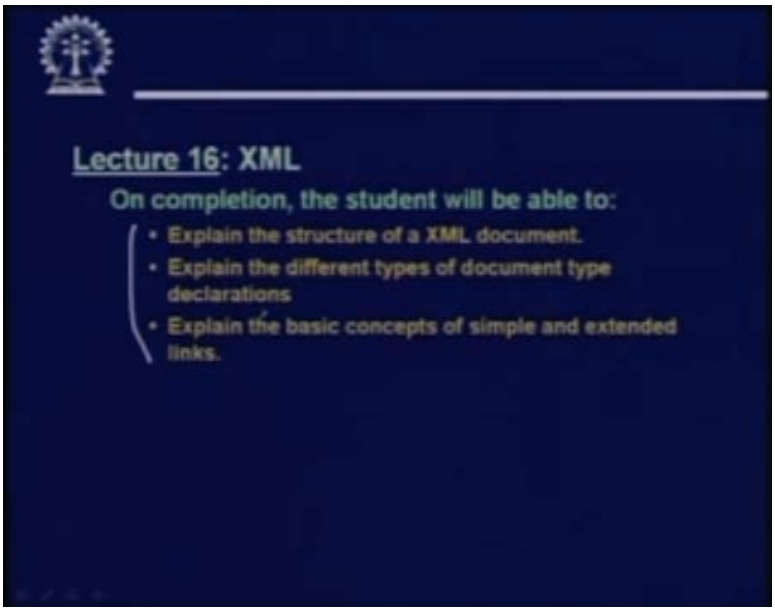

In lecture 16, we tried to give an overview of the extensible markup language XML. Because XML is so very popular today you may be knowing that there are so many various applications which use XML for the specification and also post processing. So here we tried to give you an overview of the basics the HTML language regarding the structure of the of an XML document, the different types of document type declarations and the basic concept of simple and extended links. See here one thing we emphasized that XML language which the user can define. Because in XML nothing is predefined there are no predefined tags. Depending upon the context in which you want to use the language.

See XML need not only be used for the creation of web pages. You can use it to specify some kind of a timing diagram. You can specify you can use it to specify say for example some molecular structures in chemistry. So whatever is the domain, XML is just a vehicular language using which you can provide a specification. But what will you do with the specification? There will be some application you will be running in the back end that will be taking your XML specification as input. And XML parsers are available which can parse the XML file to give the relevant information to your backend application. And the backend application can work on whatever you have specified.

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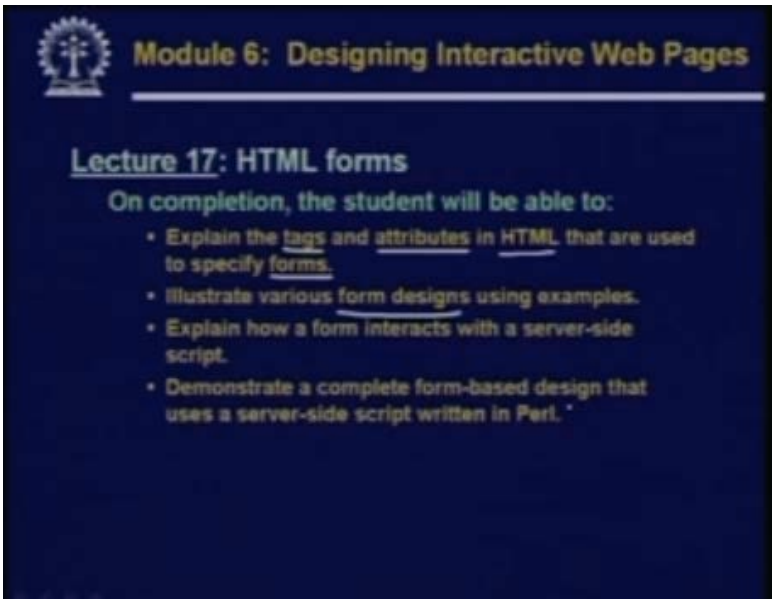

In the next module we started our discussion on interactive web pages. So here we said that web pages need not be deciding statically on a web server. Depending on user's requests some page may be created on the fly and can be sent back to the client. These are called dynamic or the dynamically generated web pages or interactive. So first we talked about HTML forms which are our basic means to provide this interactivity. So firstly we looked at the HTML language. What are the various tags and attributes which are there that allow us to specify a form to design a form. And we had given a number of examples to illustrate the so called form design you can design the forms. Then we illustrated how a form interacts with a server side script. What is the basic mechanism? So the form resides on the client side; a server side program resides on the server side. How do they interact among themselves? This is something which needs to be understood. This was explained here in this lecture and finally a complete form based design shown which uses a server side script which was written in PERL.

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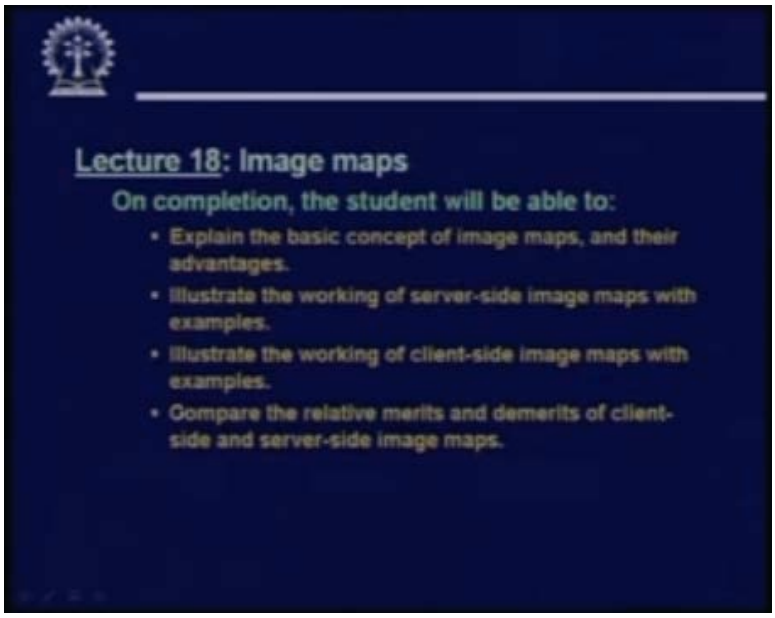

In the next lecture; lecture 18 we talked about image maps. In this image maps just recall it is an image where different portions may point to hyperlinks. You can click on the different portions of an image to go to several different documents or links. So here we started with a basic understanding of the image maps. What are image maps and how are their advantages as compared to other technologies that are provided in HTML? There are two kinds of image maps we have said server side and client side. So firstly we had seen how server side image map works and then how a client side image map works. Then you looked at the relative merits and demerits. That means when to use client side image map; when to use server side image maps. Today most people prefer to use client side image map but we have to understand what are the advantages there, why do you why do you want to use client side image maps.

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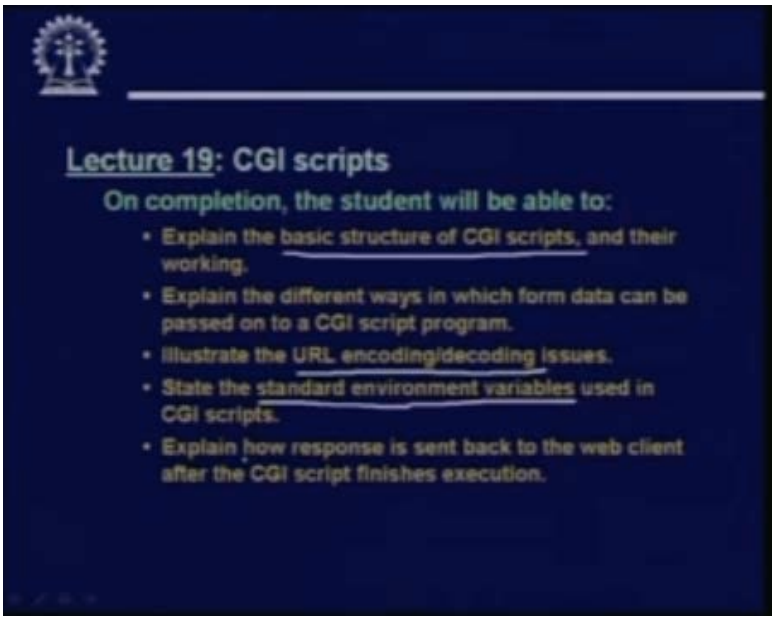

In the next lecture; lecture 19, we talked about common gateway interface or CGI scripts. Now here in the CGI script, we basically talked about the basic technology using which the client side forms and the server side scripts can interact among themselves. The server side script was additionally named as CGI script and this name is still continuing. So here we looked at the basic structure of CGI scripts and how they work. What are the different ways in which form data can be passed to a CGI script? There are two methods GET and POST. So how the URLs are encoded and decoded when they are sent to the CGI script or the server. And how the CGI script can access standard environment variables when they want to? And how the CGI script send back the responses back to the web client after they have finished whatever they are trying to do? Because ultimately the CGI script is trying to do some processing on the server side. After the processing is done, the result of the processing has to be sent back to the client properly formatted typically in the form of an HTML file. So this file is created on the fly depending on the result of the computation.

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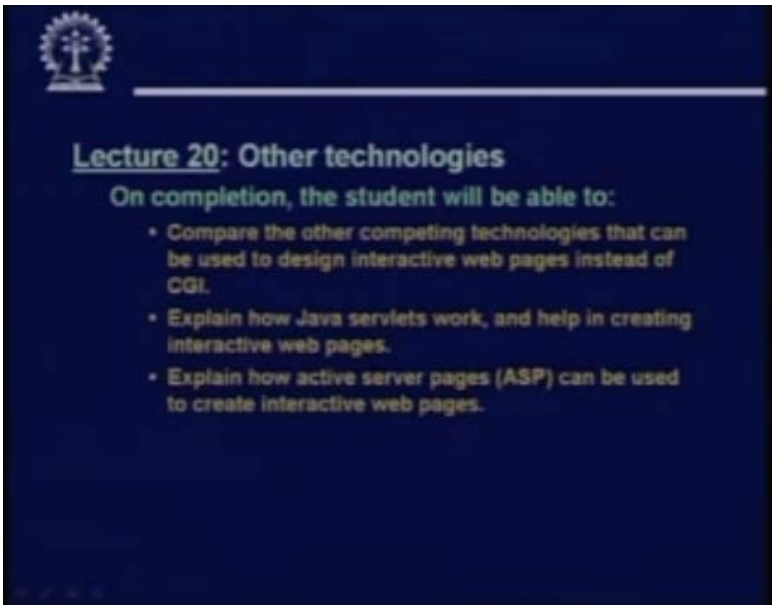

Lecture 20, where some other technologies we have discussed here. So here we try to compare the other competing technologies than can be used to design interactive web pages instead of CGI. Well, there are other competing technologies like asp, php, java, server pages and there are many other such standard environments available. So it is not necessarily for you to learn each and every one whenever you require. And if you know any one of them you can easily pick up the others. They are all quite similar in nature. So here we talked about java servlets, little bit about java servlets an how they can be used to create interactive web pages. And also we talked about active server pages ASP. Both of them can be used for the design of so called interactive or dynamic web pages.

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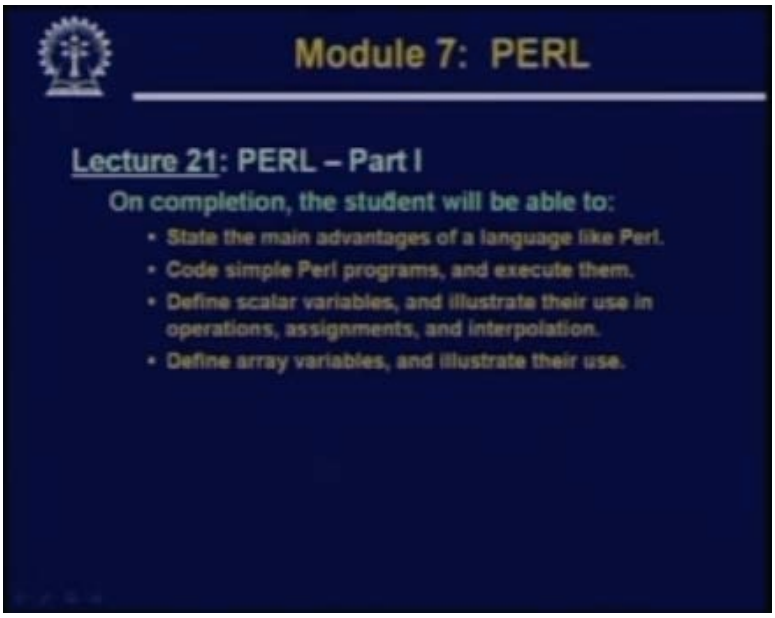

Next we moved on to the module number 7. So here we talked about the language Perl. Now means I have mentioned earlier also I am just also emphasizing now. That Perl is a language which has wide applicability in a number of different areas. One of the areas is of course in the writing of server side scripts. Perl has a number of powerful capabilities like string processing and string matching which are required in a wide variety of applications. It is a very powerful scripting language. You can write automated scripts Perl to do a number of different things starting from very simple to very complex in an automated way. So learning Perl is useful not only for internet applications but for other applications as well. So in the first part of the lecture, lecture 21, Perl part one, here we first stated the main advantages of a language. We looked at simple Perl programs and to run them. Introduced the concept of scalar variables. How you can use them in assignments and the concept of interpolation? Then we talked about array variables and how they can be used in typical programs.

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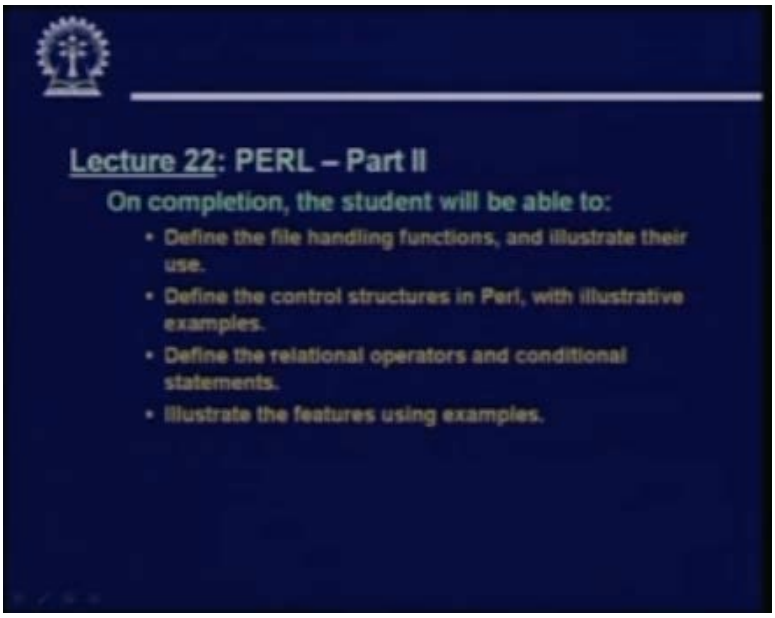

Now in lecture number 22, here we continued with Perl we started by introducing the file handling functions available in Perl. How they can be used? Then the various control structures with examples. The relational operators, conditional statements and all these features were illustrated through examples. This was what was discussed in lecture 22.

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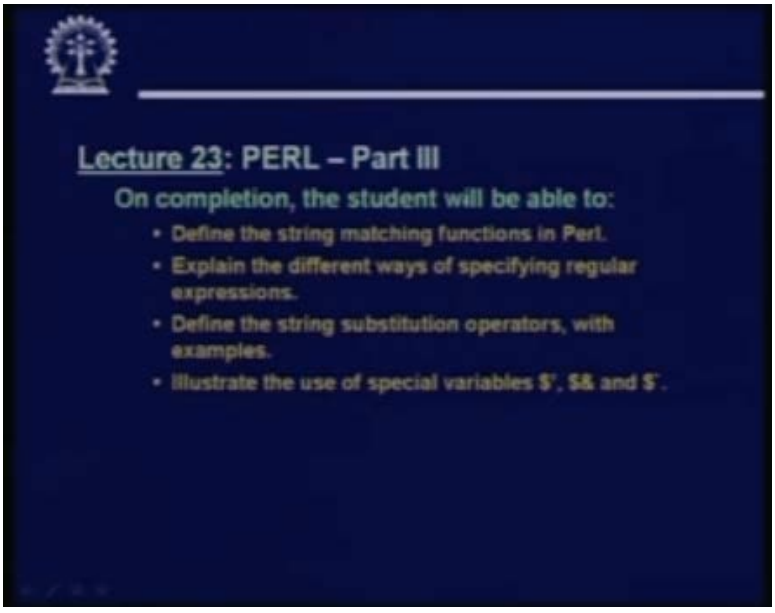

Now in lecture 23, we started by talking about the string matching functions in Perl which are supposed to be very powerful. We introduced the concept of regular expression. This carries most of the power of the string manipulation function in Perl. We

illustrated how string substitution operators work? We illustrated them through examples. And interpretation of the special variables that are used in Perl; dollar and its various post fixes.

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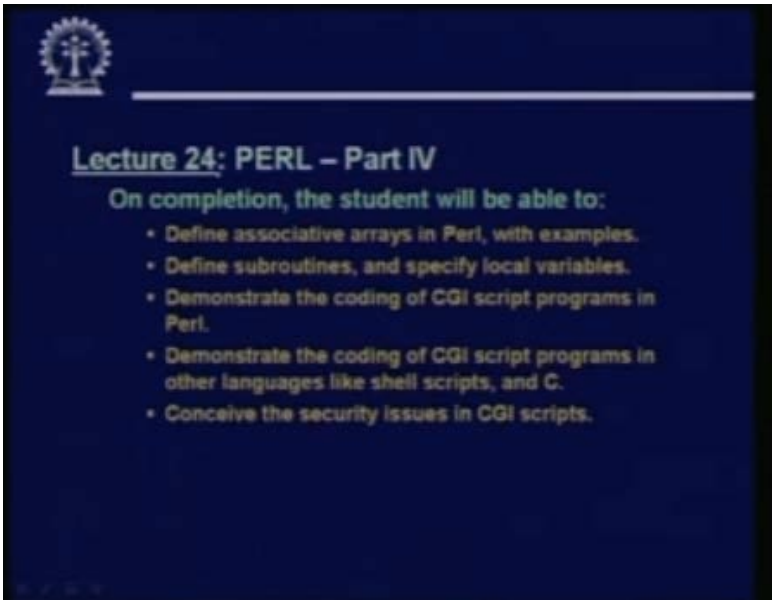

In lecture 24, here we are continuing with Perl. Perl part 4. Here we talked about associative arrays. We talked about subroutines, local variables. And with all this things we explained the coding of complete CGI script programs using Perl. And we also mentioned that other than Perl you can also write CGI scripts in other languages like C or other shell programming languages like shell scripts, bone shell, cone shell. But Perl will give you certain distinct advantages that was mentioned. Because Perl helps you doing certain things much easier as compared to the other languages that have developed. But there are some security issues in CGI scripts which were also discussed. I mean if you are not careful so a CGI script may lead to a security loop hole in your system. So when you are designing a system with a CGI script in it, you should properly check the CGI script the way user is submitting the form data and the way they are processed, there are no loop holes in it.

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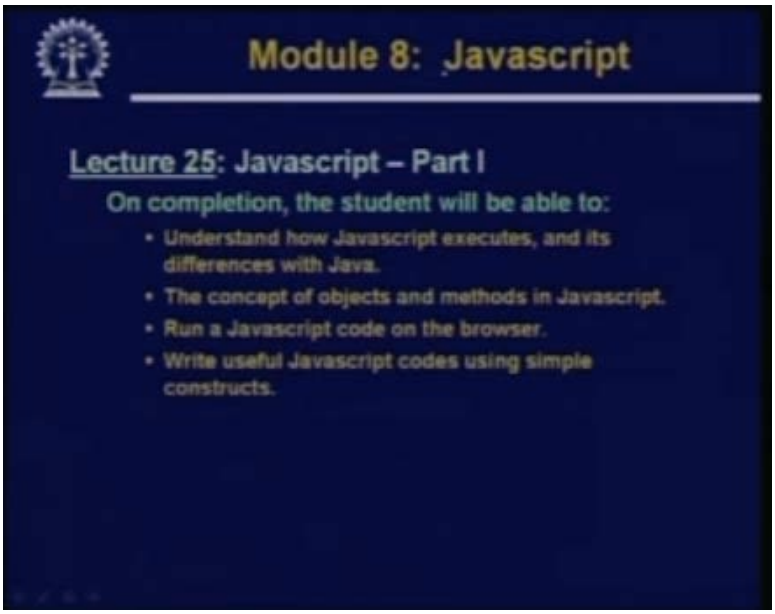

In the next module we talked about a very important tool that is used in internet today java script. Java script essentially is considered to be an extension of html language. Java script is not an independent language. It runs hand in hand with html that embedded inside html and they are interpreted at the side of the client only. Server does not do processing on java script. So the whole html file along with java script downloaded on a client and the browser executes the java script whatever are present there. So in the first lecture, lecture number 25, out here Javascript part one. So we first talked about how Javascript executes while embedded in html and we also mentioned that java and Javascript are not the same. They are different. There are differences in java. Java script is object oriented. So the concept of objects and methods in Javascript were explained and how a Javascript code was run or can be run on the browser was explained and some useful Javascript codes were shown.

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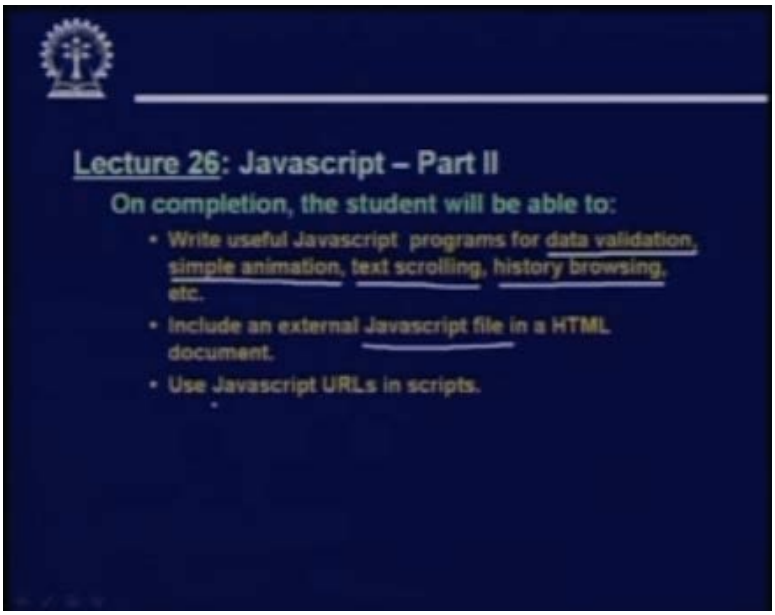

In lecture 26, Javascript part two. Now we continued with illustrating Javascript through examples. We gave some examples for data validation, some simple animation examples, scrolling of texts, how to browse through the history and so on. And we also showed that how you can include an external Javascript file in an html document. So instead of being embedded inside html you can have the Javascript code in a separate file which can be linked. The advantage is that if several html files have the same Javascript functions to be used then it need to be written and stored only once. And also we have seen how we can use Javascript URLs in scripts.

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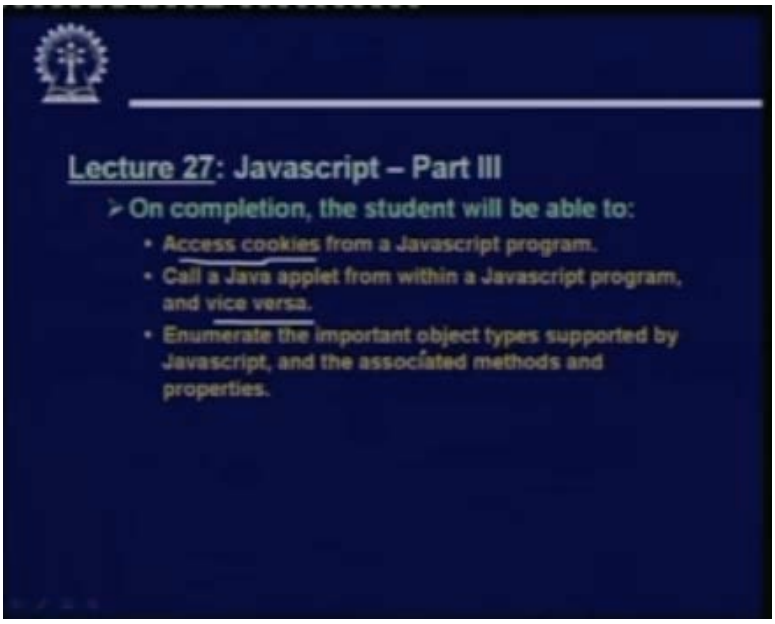

In the next lecture continuing with java script we first talked about cookies. How we can use cookies? And then we talked about interoperability with applets. How a java applet can be called from a Javascript program and vice versa. Then we talked about the various object types which was supported by Javascript and what are the methods and properties. Because understanding of these features is important because only then you will know that what are the facilities that the language Javascript offers you. Well you can change the color of a document, you can replace a document by another document. But you must know that which object you are modifying and which property of the object attribute you are trying to change. So all these things we have discussed.

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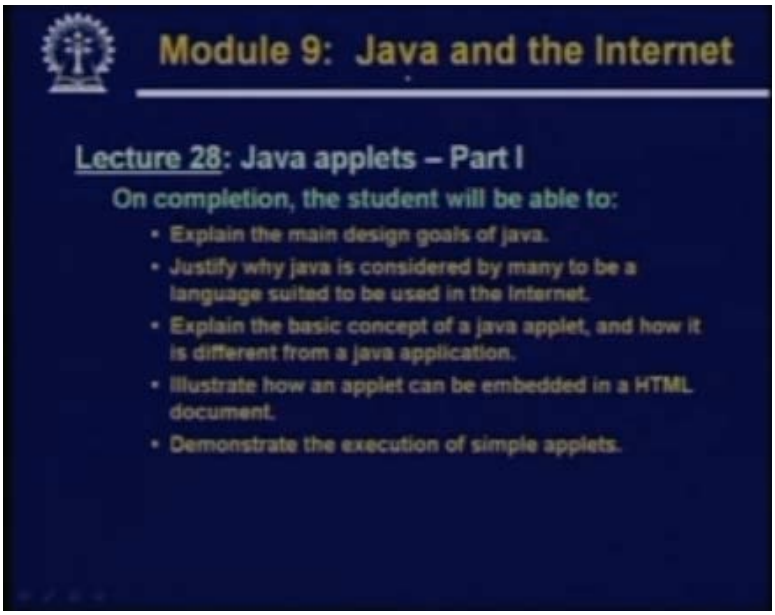

So in the next module we started our discussion on java and the internet. Here we started our discussion on the language java. How are they relevant in the internet scenario. So in lecture number 28, we talked about java applets part one. So here we first explained the main design goals of java. We tried to explain why java is considered to be language suitable for the internet. See today some other competing languages have also come up like c#, the dot net platform which are considered to be platform independent. And also suitable for internet. But java was the language which emerged you can say first in the category which was supposed to be very suitable for applications in the internet. So we talked about the basic concept of a java applet and how it is different from a standalone java application. You will be knowing that this java applet is the program which you can embed in an html document. So you will have to understand the concept of an applet how an applet can be written. So we also showed how an applet can be embedded in an html document and how they can be executed.

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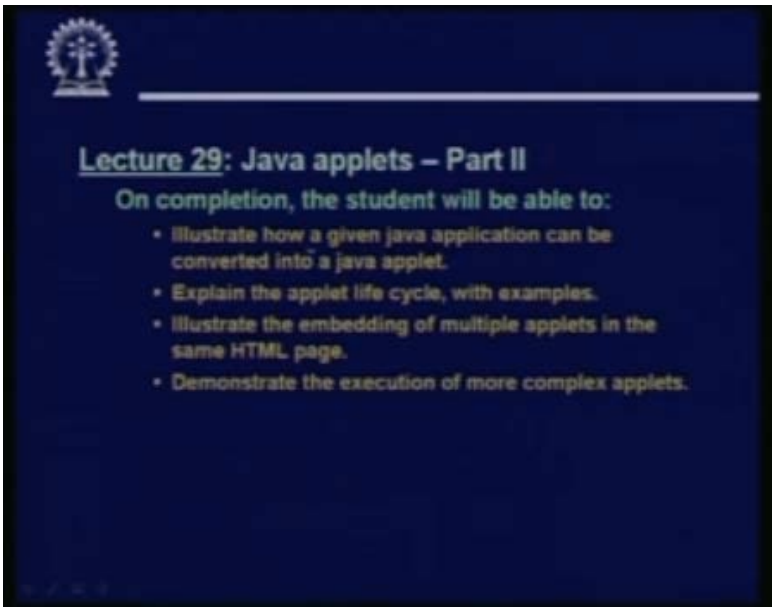

In the next lecture java applet part two, we illustrated first that how a java application can be converted to an applet. Because it is quite possible that whatever you are trying to embed in html, that is already available in the form of a java application. So first you will have to convert it into an applet. So this was illustrated. What are the different steps to be followed? What are the different rules you must use? And the so called applet life cycle, see applet resides within the browser. So what are the different states of an applet and how the states move from say one to the other and when applet terminates. How it terminates and so on. So these things were explained with examples. And then we showed how multiple applets embedded within the same html page and how they can interact among themselves more complex applets.

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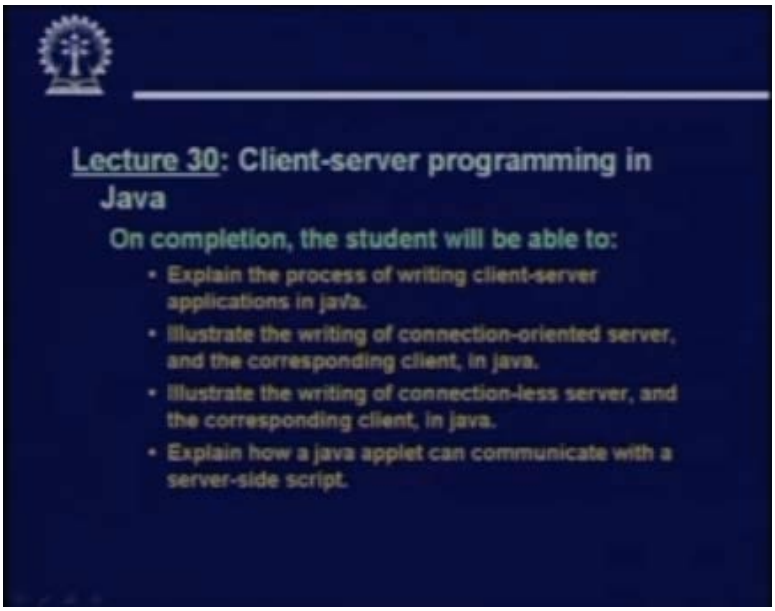

In lecture 30, we had seen some of the client server programming features in java. And we found that it is really very easy to write or develop client server applications in java. So here we explained the process of writing client server application. How we can write the code here. We demonstrated writing of connection oriented servers also connection less servers which uses TCP and UDP respectively. And also the corresponding client in java and how they work. And lastly we also had an example that how a java applet communicate with a server side script.

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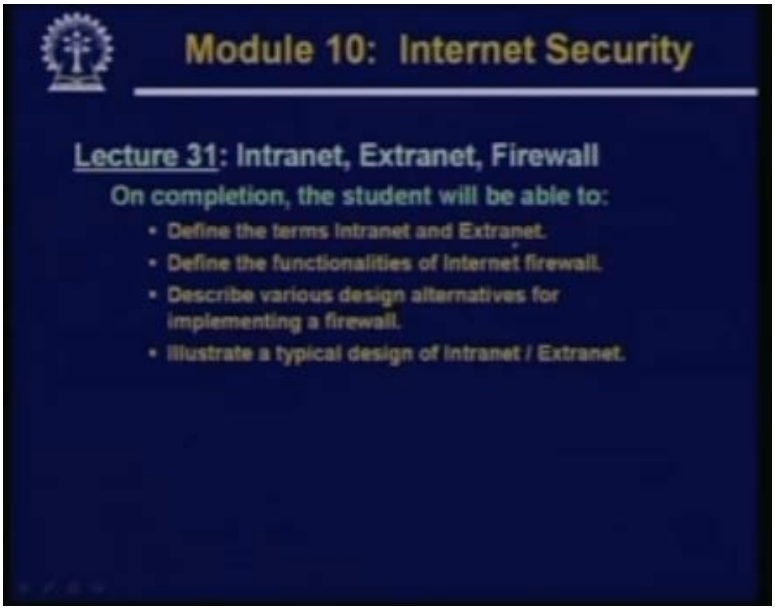

Now in module ten we started our discussion on a very important topic internet security. Now you know today that internet due to its vast size and its openness they are also they have also become a place where unless you are careful, there can be a kind of a harm that can be stored on. You see harm can be defined in two ways. One is related to the information you are trying to hide. Some of the information which was confidential and hidden and stored somewhere, someone else can have access to those unclassified information. And the second thing is that, well nowadays so many different kinds of applications are emerging on the internet. The e-commerce or the e-business are one of the most important and emerging applications. So there you are transacting money on the internet and very naturally that is one of the target of the hackers to try and break into.

So you must be extremely careful about the way you logged into the systems when you are carrying out monitory transaction, be sure to log off from the system when you have finished transaction and close the browser. No trace of the history should be maintained in your system so that subsequently some hacker or some of the malicious scripts can try to dig out the information in your machine. So in the first lecture in this module lecture 31, we talked about intranet extranet and firewall. What are the different kinds of firewall? So we looked at intranets, extranets. What are their differences? What are the functionalities of the firewall? What are the various design alternatives that you may face when you are implementing a firewall? And illustration of a typical design of intranet and extranet.

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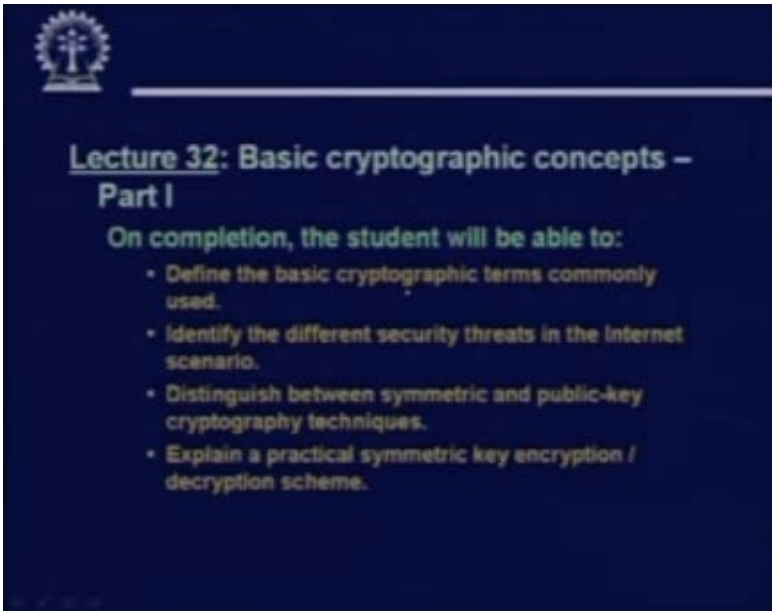

Lecture 32 concerned about the basic cryptographic concepts. First part of it part one. Here we first introduced the basic cryptographic terminologies that are used commonly. Then we identified the different security threats that we faced in the internet. We talked about the so called symmetric or public key, private key and the public key or the

asymmetric cryptography techniques. And in this lecture we talked about also a practical symmetric key encryption decryption scheme. Now we had mentioned under the symmetric key category where both the sender and receiver are sharing the same key for encryption and decryption both. There are many commercially available algorithms. DES is the older version of the algorithm but today advanced encryption standard or AES is considered to be the algorithm which is safe and can be used.

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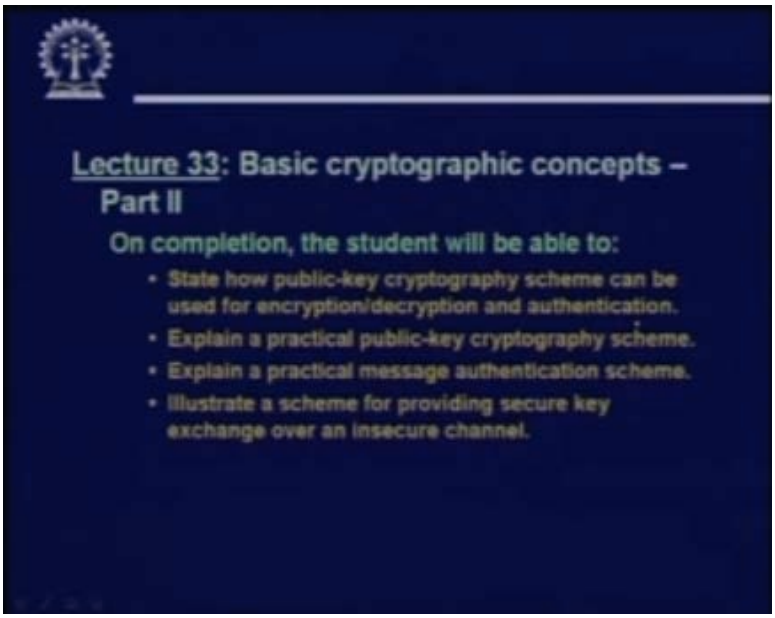

Now in lecture 33, we continued our discussion on cryptographic concepts. We first looked at how public key cryptographic schemes can be used for encryption decryption and also authentication. And we looked at a practical public key cryptography scheme that is the RSA. The RSA algorithm is the most widely used public key cryptographic scheme almost universally used. So we talked about how the RSA system works. We also looked at practical message authentication scheme and we gave an idea we illustrated a scheme where a key can be exchanged by two parties over an insecure channel namely Diffie-hellmen key exchange algorithm that was also discussed.

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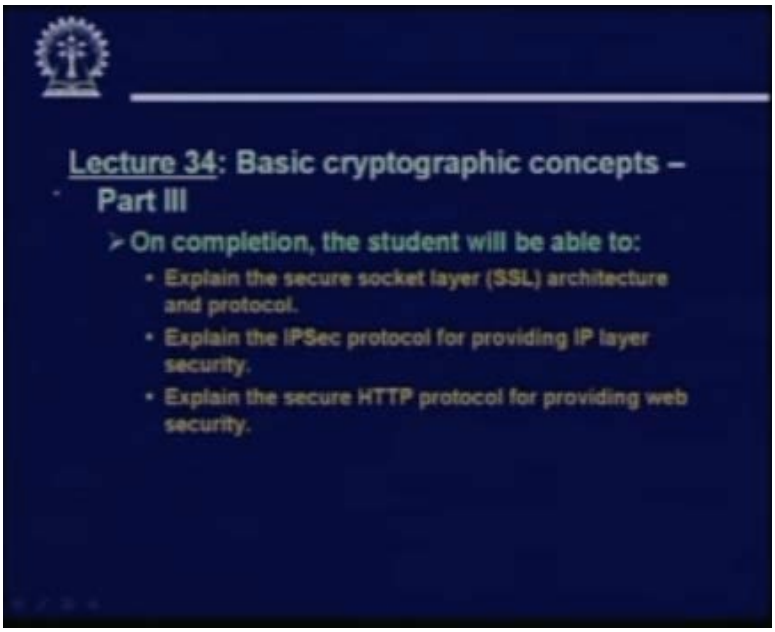

Now in lecture 34, we actually looked at some of the cryptographic applications that are used on the internet. Well, the basic concepts of symmetric key cryptography, public key cryptography, authentication. All of them are combined together to create or formulate internet security applications. So here in this lecture we talked about several security applications. So we first talked about the so called secure socket layer or SSL. This particular architecture and the protocol. Then we talked about the IPSec protocol to provide security at the IP layer level. And secure HTTP protocol which is used quite widely nowadays are providing security at the web server level and the web access level.

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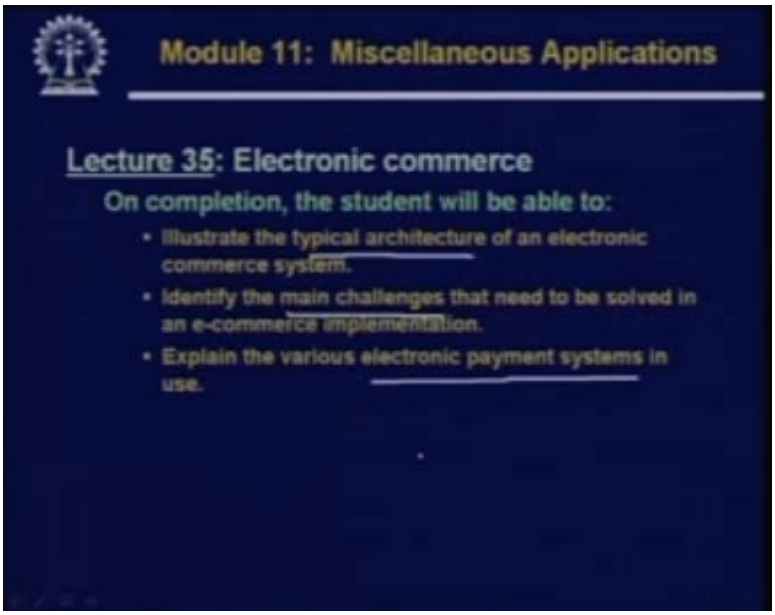

So in module 11 we looked at some miscellaneous applications instead of concentrating any particular topic. So first in lecture 35, we talked about electronic commerce. As you know, electronic commerce is gaining in popularity nowadays. Today sitting anywhere you can carry out any kind of transaction. Well even through your mobile phone if you have GPRS capability or even through SMS also you can carry out a number of such transactions. For example you can book a ticket through a mobile phone even by sending a SMS. So all these things are available today. And these are certainly some utilities which are extreme you can say fit to the users. But along with it comes the threats and the you can say the security worries.

You must be very sure what you are doing how you are doing and what are the different possible attacks that might be taking place while you are carrying out the transaction. So a good electronic commerce system should be able to safeguard against all these possibilities. So we talked about electronic commerce. Some of the issues which are involved in the process. So we looked at the typical architecture of an e-commerce system. So what are the main challenges and some of the electronic payment systems that are in use. So I have mentioned that some of the electronic payment systems are very complex or proprietary. Some of the companies are using them but they do not disclose it to the general public.

So one thing is to be understand whatever is being used, it must be a very safe and secure method which should be well. It should be hacker proof, but hacker proof is a term which is not possible hackers is always one ahead of what you are doing. Hacker is supposed to be the person who knows the ins and outs of a system and their loop holes. So whatever you do today tomorrow you can be sure that hacker will find some loop hole in your existing system and find some new way of attacking. So when you are seeing that time building a secure system it should be a continuous process, building a secure system may

not mean the system will remain secure tomorrow. You will have to update it continuously.

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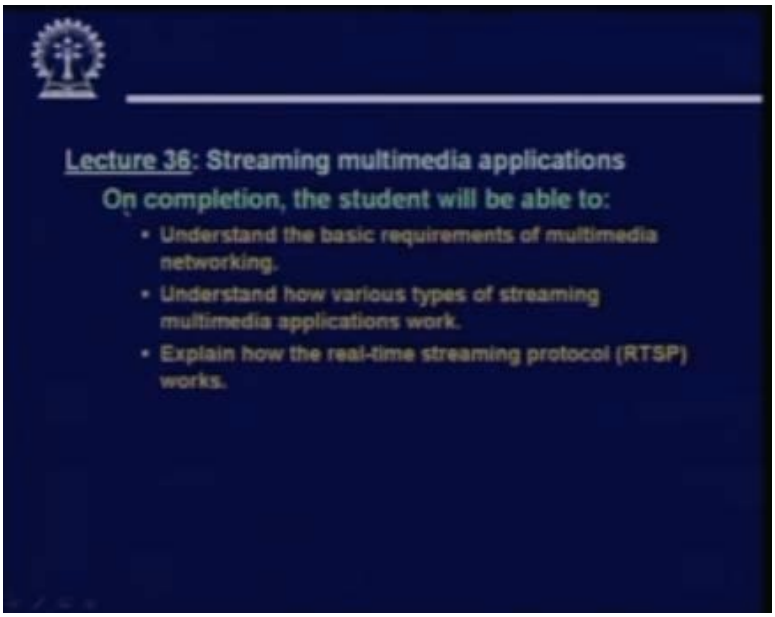

So in lecture 36, we talked about some very interesting or important applications which we see on the internet today, the so called streaming multimedia applications. So here in this lecture we tried to talk about the basic requirements of multimedia networking. To understand how the different types of streaming multimedia applications work and one standard protocol was discussed here the real time streaming protocol RTSP. So here we emphasized that the standard network protocols like TCP/IP, they may not be suitable for delivering real time data to a destination which is playing the real time data continuously as it is receiving. Because TCP/IP has unpredictable delay packets may appear out of order. So all these issues are there. But real time protocol any protocol which wants to handle real time traffic must address these issues. So this is what was discussed there.

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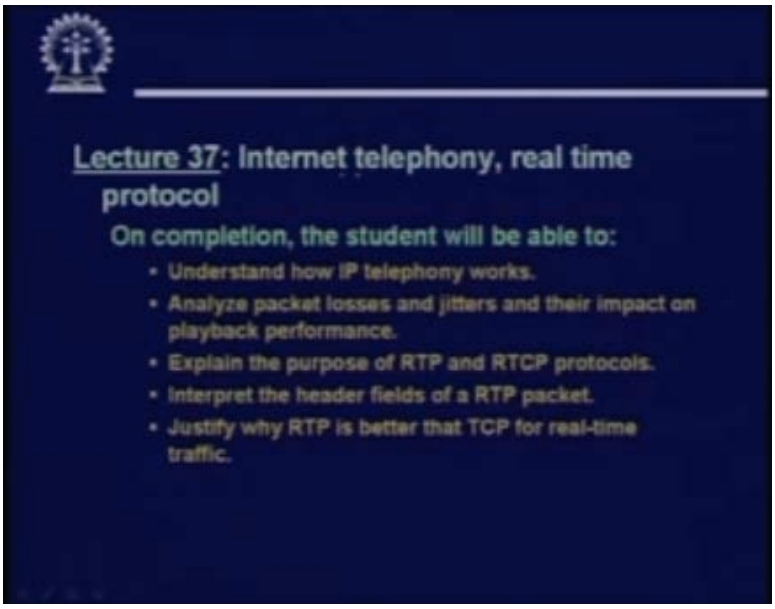

And in lecture 37, we talked about some specific application of real time protocol, the internet telephony and this RTP. So here we talked about IP telephony to start with, then we analyzed the packet losses and jitters. Why this packet losses take place? Why jitters appear and what are their impacts on the playback performances? Then we talked about the standard protocols RTP and their control protocol real time control protocol. How an RTP packets look like and why RTP is considered to be better than TCP for real time traffic. Because RTP takes cares of a few things, RTP will not allow you to play a traffic which is to play a packet which is coming out of order.

RTP also uses buffering to minimize jitters. If there is a variability in the packet delays to minimize that sometimes some buffering and delay is done before the playback is started. So all these things are taken care of by RTP at the application layer level. See may be the internet of tomorrow the low level protocol layers will directly support real time traffic. But unfortunately the internet that we have today at the lower level network layer and the transport layer, there is no support, no direct support of real time traffic. So whatever you can do best do by having something at the application layer level. That is the approach which is mostly followed in these protocols.

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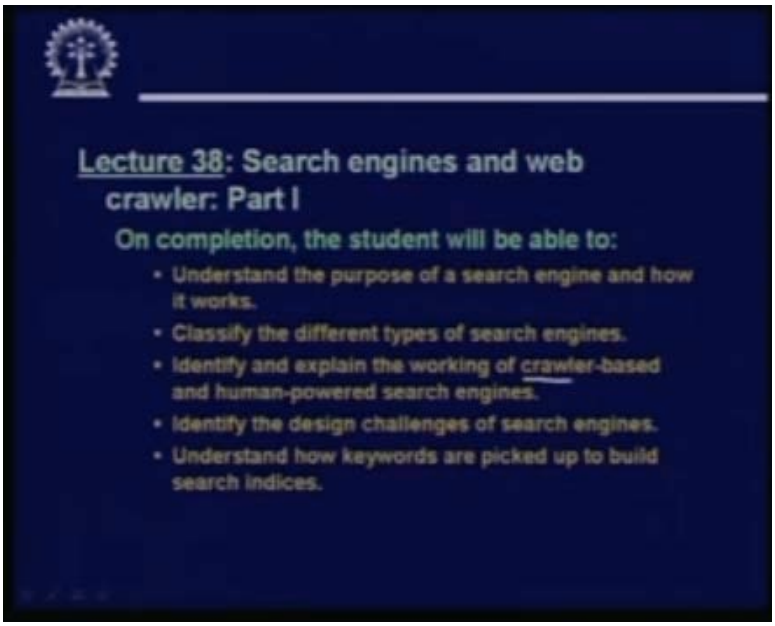

Now in lecture 38, we talked about search engines and web crawler the first part of it. So in lecture 38, we talked about the search engine why it is used. How it works? What are the different types of search engines and we have said that broadly there are two classes of search engines. One is crawler based and other is human powered well both are important. But under what circumstances which one to use and which one not to use. So these are something you need to look at or understand and what are the design challenges of a search engines and how a search engine can automatically find keywords from our document. So all these issues are discussed in these lectures.

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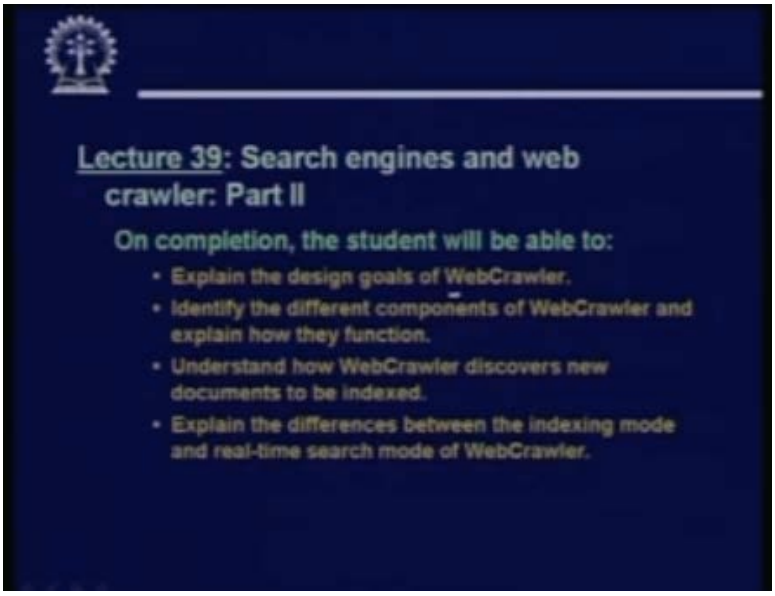

Now in lecture 39, search engines and web crawler the part two, the last topic. Now here we explained the design goals of the WebCrawler which is one of the commercially available tools which came in the 90s, mid 90s. But still considered to be one of the very you can say important ones in term of design principle. And we looked at what are the different design components of the web crawler in terms of its architecture and what are their functions. We also looked at some of the heuristics used by WebCrawler to discover new documents to be indexed. And we have said WebCrawler works in two different modes. First is the indexing mode. When the WebCrawler is actually trying to crawl through the web and get indexes of new documents is discovering and the real time search mode where depending on the keywords the user is supplying, the WebCrawler will of course search its dictionary in addition it can also look for some other pages which it has not indexed so far. So this phase also may need some searching or crawling through the web. This is the basic principle of web crawling.

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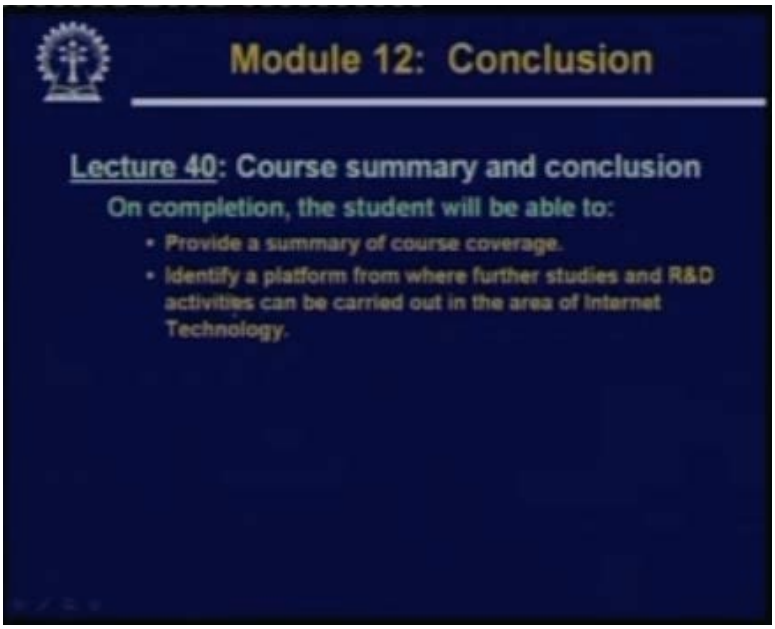

And of course in this last lecture today we are talking about the course summary and conclusion. So we have basically at the end of this course on internet technology. See internet technology there are so many different things to talk about and discuss. So based on my wisdom I had selected certain topics and I had tried to convey some information on these topics to you. But this is not all. There are so many other things to look at and study. Deliberately I am not giving you any particular references to study because what I feel is that, at least in this subject giving you some reference will limit the domain beyond which you will not explore. Rather you use this internet as a resource. You go to the internet search for resources you see what new is going on. You look at the RFCs, you will get a huge wealth of information out there. Of course many books are available many very good books are also available.

So I deliberately would not like to give you any reference of those books. I would like you to find them out yourselves, explore the web, see whatever I have tried to discuss in this course you can treat this as some kind of a platform. So that platform would be useful for you to explore and understand some new materials that you find. I have tried to give you some basic background. Suppose if you know means one language it will be easier for you to pick up and learn a second language. So in a very similar way, so whatever the basic prerequisites I felt, I tried to cover this course and whatever else is left that you can explore depending on your requirement, depending on your interest depending on your needs, you can explore, you can find out and you can get almost everything available on the net. So with this I come to the end of this lecture. All the best wishes to you all. Thank you.