Symbolic Logic
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Lecture - 06
History of Symbolic Logic

Hello, we have finished the introduction of the elementary, things that we need to learn Symbolic Logic. This module 6 is going to be, sort of a historical introduction to what we call Symbolic Logic.

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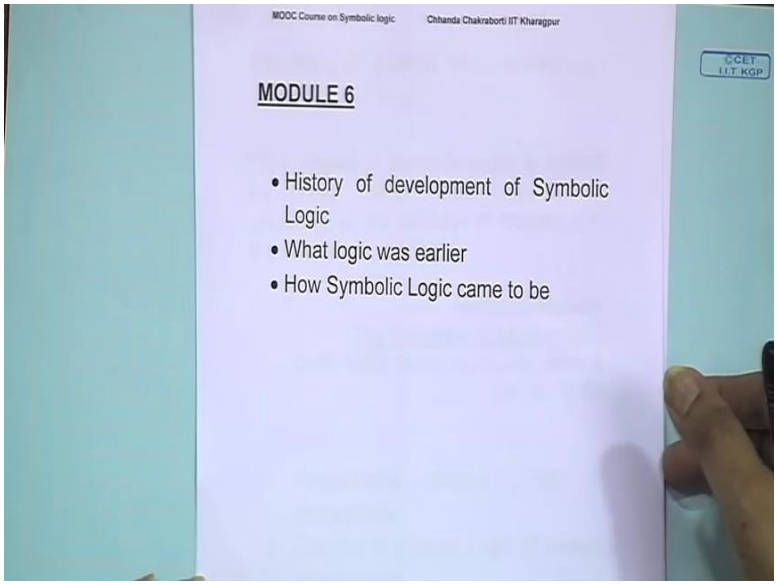

You see, it is better to understand what you are learning in a context; and every discovery or every invention that you know has a, sort of a, social and historical context. So, that's what I am trying to initiate you to is that not just the symbols of the Symbolic Logic, but how the Symbolic Logic came to be. That's what we are going to learn in this module. What logic was earlier, and what is the specialty of Symbolic Logic, and why Symbolic Logic developed in the way it has. So, this kind of answers you are going to get in this module.

So I will start you with this, sort of historical, this historical note, but not before I tell you that Symbolic Logic you can find it also under the name mathematical logic.

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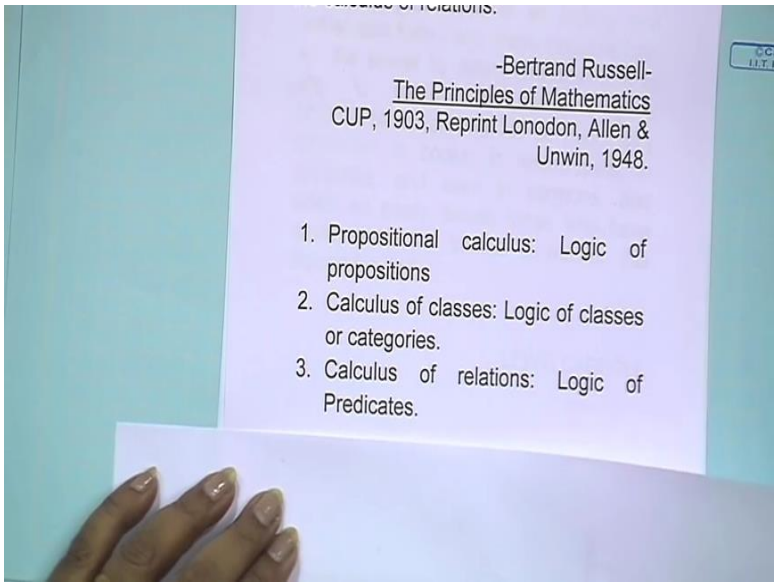

Now, today it may not sound like anything strange. But there was, used to be a time, and that is what I am going to tell you, when logic was not mathematical. Logic was speculative, just like, you know, there used to be a time when physics was not as mathematical as it is today. So, the new physics that you have is a different kind of a understanding on physics, which requires mathematics, and without mathematics one cannot even think about. But the earlier physics used to be more theoretical and speculative and on. So, what you are learning is that this is one kind of logic, which has clear mathematical character. Now, the description of what is the subject of the Symbolic Logic, I have taken this from the very founder of Symbolic Logic; namely; Bertrand Russell. Many of you may have heard this name, also please look him up in the internet and you will find that he is a prolific writer, thinker, and he not only writes about logic, but also on many social issues of his time. So, Bertrand Russell writes in *Principles of Mathematics*, that the subject of Symbolic Logic is formed by three parts. One is the calculus of propositions. Please watch the term *calculus*. That's a clear reference to the mathematical character of the kind of logic that is doing with propositions; and then calculus of classes and the calculus of relations.

So from this we have gained the name *propositional calculus*, which we are going to soon going to learn, but this tells us that there is going to be three components in this logic. One is, as I said, *propositional calculus* or the *logic of propositions*. One is *calculus of classes*. Classes we will try to tell you what they are. These are not exactly

sets, but sort of a rough understanding of collections. So, these are classes, and this logic is known as categorical logic or logic of classes. We will look into that. And then *calculus of relations*. This is not a relation between human beings, but this is more about predicates, n-place predicates. So this is logic of predicates. So, we are going to have some idea about each of these components as we go along.

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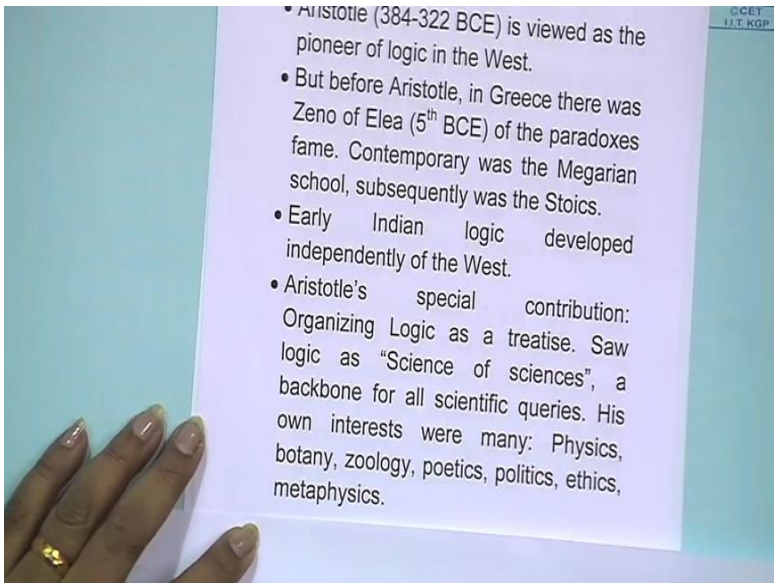

Now, the question is: This kind of a mathematical logic, how did it suddenly come to be? What makes it come through? What was logic like earlier, and so on? So, I have named this part of the lecture the 'Evolution of Symbolic Logic'. Because, you know, as thing grows slowly, so that's what it is all about. So, first to note is that it is a rather recent development. It's a 20th century development and what sets it apart from earlier kind of logics is that it has, as I said, it has a definite mathematical character in it. It is a calculus; it's a sort of an algebra, and so on.

Many of you know, or may be all of you know, that if we talk about western logic, then the person that we look up to, as saying that he started it, he is the pioneer, he is: Aristotle. And look at his time. We are talking about 3rd BCE. Now, this is usually the popular notion, but let me bust that myth, and say that historically we find that even before Aristotle logic existed in Greek world. For example, Zeno belonged to 5th BCE. So at least 2 centuries before Aristotle, there was in Greece a logician calls Zeno. Zeno's paradoxes, by the way, are world famous and they still continue to amaze us. So please

look up Zeno’s paradoxes, when you are doing next internet search, look this up and you will be pleased to find that they are interesting and stimulating. And apart from Zeno, we also find some logic schools. For example, the Megarian school, for example the Stoics school. They had separate logic system. So, in a way, the Greek world had logic earlier. But Aristotle has certain contributions; and we will talk about that separately.

I will take this opportunity to remind you that, early Indian logic developed independently of the west, around this time. I had shown you earlier that the ancient logical treatise, Indian treatise can be found from 6th BCE onwards. Now, why do we still look into Aristotle in western logic, if there were other logicians too and the contributions are actually amazing? What he did was to organize logic as a treatise. So systematizing logic, teaching it as a subject, bringing principles. That’s what Aristotle brought into logic.

In fact, what he saw logic as, is the *science of the sciences*. Remember, he was one of those persons who dabbled in practically all branches of science and other arts. For example, he, Aristotle's physics is well known, also he had interest in botany, zoology and then he also has theories in poetics, politics, ethics, metaphysics. So, he had all-rounded interest and he was a scholarly person. But in logic he saw the backbone concept. So all the discussions in varied subjects, such as these, what would guarantee that the argument is going in the proper direction, in that he thought logic can help us guide into that.

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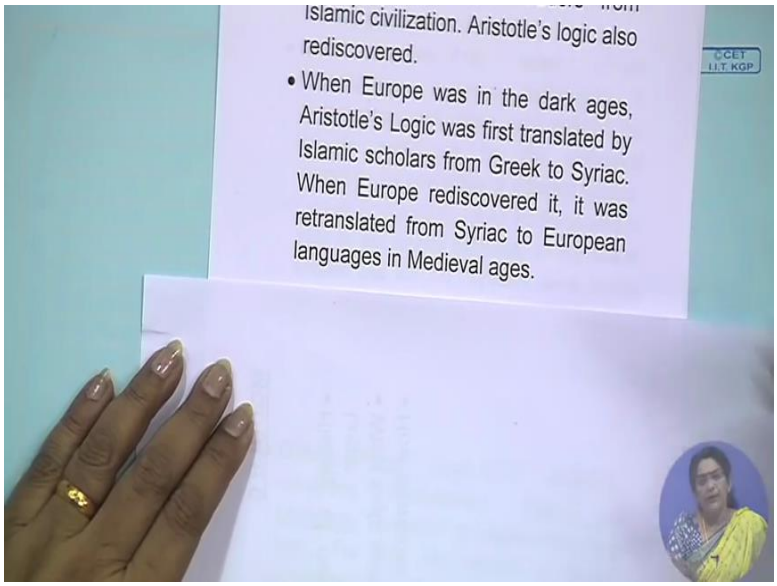

So that was his contribution basically to see the logic as a foundational subject that would provide a structure and the spine, the backbone in this all this discussions. Moreover, what Aristotle did is to bring in what we call the idea of Forms. See, today we talk about Formal logic. In Formal logic, there is a Form, and the contribution of these Forms, the thought that there may be logical forms underlying our discussions, that is an Aristotlean concept. So that is what you brought in also into logic.

Why we could not stop with Aristotle's logic? If he has done so much, then what is the point of going into modern Symbolic Logic? And this is where the history is going to help you to understand that.

See , there was a time when all of these, this whole Greek civilization and what it brought in, for example, Aristotle theories and Sophocles's (Refer Time: 08:37) drama, anything that you can think about the Greek civilization was lost, was lost. Because you know that Europe went through a crisis period, intellectual crisis period, what we call the Dark ages. So, once the Greek civilization went, there came Roman Civilization, there came Vandals and so on and so forth, and slowly there was a delink between what was the European glorious past. and what was the time that they were going through. And this is what is known as the dark ages in Europe.

So, for centuries Europe did not even know that they had this wonderful legacy. They did not know anything about the Greeks, what the Greeks have done and the work, the

intellectual contributions that they have made. Medieval ages, which is from 5th CE to 15th CE, this is when, slowly, eventually the Greek texts started to come back to Europe. You have to understand that in the medieval period, or in the dark ages, when Europe was in an intellectual void, Islamic civilization on the other hand was gaining its peak. So, the intellectual contributions of the Greeks somehow was taken, or they found its way to the libraries in the Islamic world. For example, Baghdad, the house of wisdom, and that's where this texts, sort of, found their ways to. So Aristotle's logic also, the texts, sort of, went there; and eventually, as time is the wonderful thing, it was brought back to Europe through the Arab traders. You know the Moor Civilization, the introduction with Europe and the Islamic world. So one of the fall out of that was the rediscovery of this ancient text, and Aristotle's logic was again rediscovered at this time.

When it was lost from Europe, Aristotle's logic was translated by Islamic scholars into from Greek to Syriac, and it was kept in the library and they knew about the Aristotle's logic. Now when it came back to Europe, and Europe sort of rediscovered and they were amazed by this discovery, it was again retranslated from Syriac to European languages, and this is what happened in the medieval ages.

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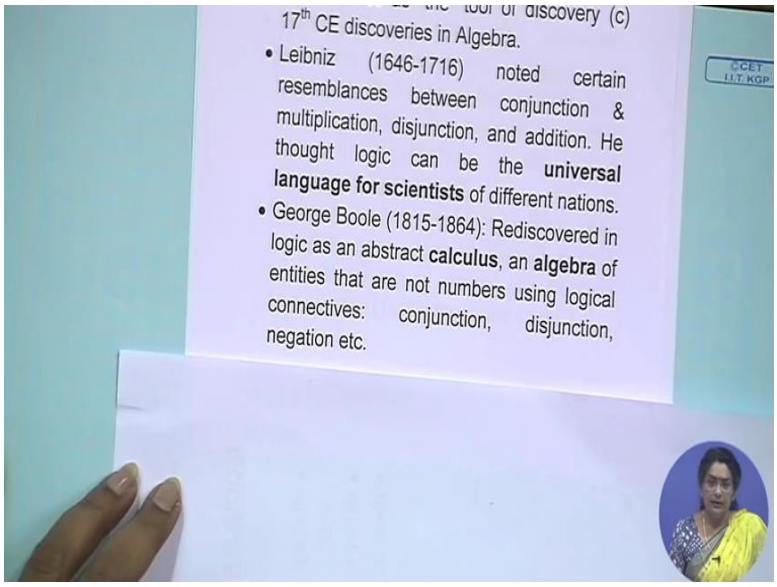

So the medieval age is some sort of a European rediscovery of its past, and when that happened, you know, what usually is the case that when we do not know what we have and then we suddenly gain it, you are enthralled by it. You are completely taken by it and

you are so impressed that you start to think that it is perfect, and that is exactly what happened with Aristotle's logic. Among many other things, Aristotle's logic came back to Europe, when that happened, the medieval scholars started to work on it, to study it, and for thousands of years, Europe continued to thought that this logic is ultimate. That it cannot be perfected anymore, and this is where logic should stop. When that happens you know, usually a field dies. When you start thinking the there cannot be any further progress, usually it starts to decline.

Along with, something else happened, you know, you probably know that, after the medieval ages came the time of Renaissance. Renaissance, those of you have heard this term, you know it is a time of awakening or re-awakening. So whatever slumber, whatever sleepy state Europe was in, it was coming out of that slumberous state and it was awakening. And it brought, this Renaissance brought a radical change in the European mindset, and they were critical of the past. Everything that was in the past, they started to question it, and through that kind of questioning, they gained new knowledge and new sciences.

So during this time, this Renaissance is the time when you see that the modern science sort of came about, through the critical inquiry of the past. Regarding Aristotle's logic, we find that, during Renaissance time, there were at least three kinds of critiques of this. For example, the humanists said that, you know, we do not find any literary value in Aristotle's logic; it is not good enough. And then Galileo brought in the new physics of a rotating globe with telescope and all. So there was new interest. So why would we look into Aristotle's physics anymore? Because it's clearly a new physics is on the rise. Similarly, therefore, Aristotle's logic is also of no use. Then there was also the discovery of the algebra. You know that the contribution of algebra is from "al-jibr" from the Islamic scholars. So there was interest in the algebra. For all these reasons, Aristotle's logic slowly found in the back burner.

So people where becoming disinterested in logic. When this is happening and when the new algebra is coming in, there is a new way to think about mathematics. This is about the time in 17th century, people started to see similarities between mathematics and logic. For example, Leibniz, I am sure you have heard the name as one of the founders' of calculus, he started to see some similarities between the way conjunction works and multiplication works. The way disjunctions works and addition works. And in fact, he

thought that logic can be the universal language for all the scientists, because, you know, not every scientist speak the same language. In those times people did not use English as the lingua…, the link language, but he thought logic could be that universal language.

And then came Boole, George Boole. Many of you have heard this name. If you have done any Boolean algebra, I am sure you know this name by now. Look at his time and Boole thought that this is a calculus. In fact, that is how the Boolean algebra came to be. Please note that this algebra is not with numbers; rather with logical entities and he used this connectives, conjunction, disjunction, negation etc. to have algebra-like formula in logic. So in a way a new vista was opening for logic, where there was lot of closeness with the way mathematics is done, with the way algebra is done, with the way calculus was being done.

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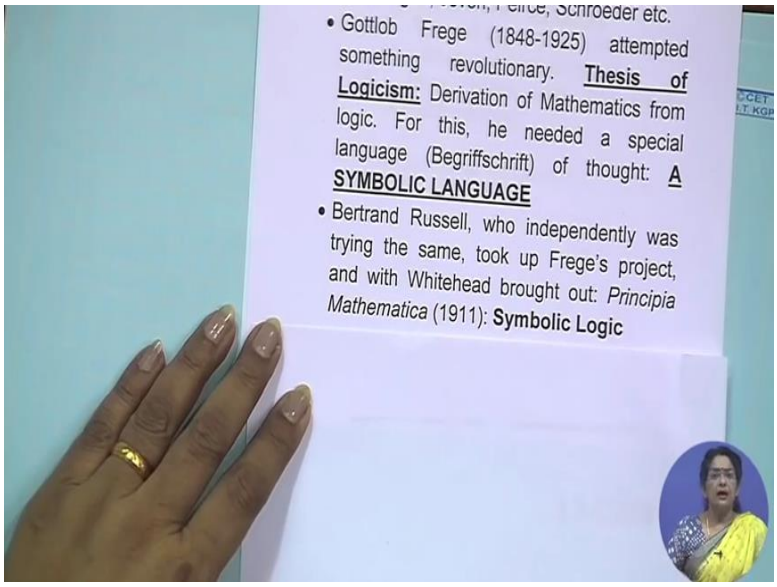

After Boolean algebra was done, then lot of people thought that this is a direction that can be taken. So we soon found that many of the mathematicians and logicians they sort of joined hands, to develop a mathematically inclined logic. And this is where we get to see that logic started to slowly depart from the Aristotlean paradigm and started to go towards mathematics. Then who are the people who join hands? One of them is J. Venn. Yeah, of the Venn diagrams. So, he was an ardent admirer, I mean, he was the fan, sort of, of Boole. He proposed the diagrams of overlapping regions to actually depict the relations between classes. We will try to show you that. But this Venn diagrams was one

of important contribution towards this mathematization of logic Similarly, there was Lewis Carroll. Again whether you have read his works, Lewis Carroll's, I do not know, but “Alice in the Wonderland” he is the author of that, but he was also an excellent mathematician. And he also joined hands to come through to contribute towards this goal to mathematicize logic. Then there were many others; for example, De Morgan, you till date you learn about De Morgan's theorem, so De Morgan, Jevons, Peirce, Schroeder all of them sort of came in. So it was a movement that sort of caught on. (Refer Time: 17:07) But the radical thing was by this logician called Gottlob Frege. Gottlob Frege. He was trying something very very radical, what he was trying is known as the thesis of Logicism. What was he trying? See, the others were trying to bring logic closer to mathematics. They were finding resemblance between logic and mathematics. But what Frege was trying is to derive mathematics out of some logical axioms. Extremely ambitious project, but he thought he can do it. But for this he needed a separate language, he decided that you cannot work with the ordinary language, the writing language of the scholars. So he needed a symbolic language. And this is where we need to pause and note because the symbolic language will soon become the part of this mathematical logic. You will soon see when we start doing the syntax of Symbolic Logic, that its a completely symbol best language.

So this artificial language concept, that today you use in computer programming and so on, actually is from this kind of ideas that we need a special language to express special thoughts. Gottlob Frege, as I said, was trying this logicism idea. So was Bertand Russell, but independently. For a long time they did not know about each other's work, but then Russell discovered. Because Frege was writing in German, and it was rather difficult writing, so lot of people, he did not have a lot of wide audience. But Russell found it out and Russell read it, and soon he took up Frege’s project. There is a story in here, which I do not have time to recount, but you can look it up, but Russell took up Frege’s project.

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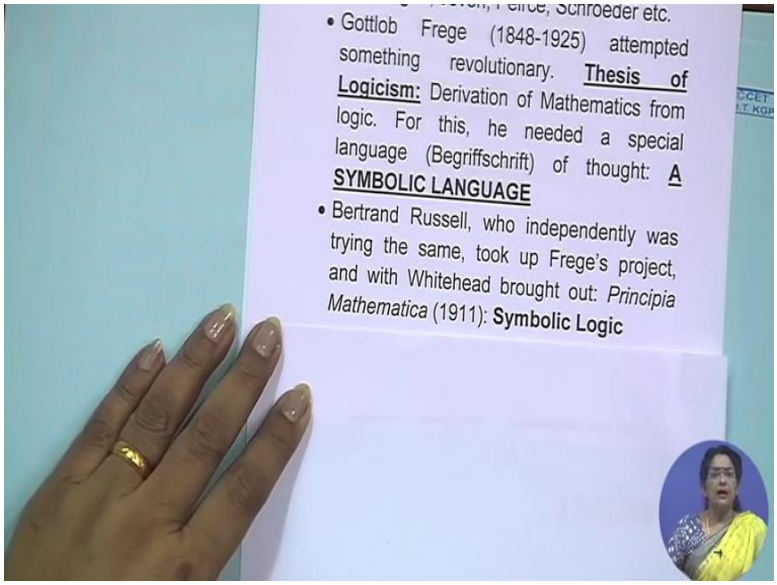

And then finally, with his mathematician friend Whitehead, brought out the *Principia Mathematica*, which is where we find today's Symbolic Logic. So you see this is how we have this mathematical logic, which is basically a system developed by Russell and Whitehead. So, we call it the Russell-Whitehead system, and then it is, as I told you, its logic but with mathematical inclination. It contains three kinds of calculi. Calculi is the plural of calculus. So, it has distinctly three calculi: Propositional calculus, Class calculus and Predicate calculus. And then, as I also pointed it ou,t that it requires an artificial, a specially created language, to express the tautologies of the system. So there is the very symbolic nature of this logic and there is also claim that is sort of a language.

The idea is to avoid the imprecision that exists, the vagueness that exists in ordinary language. That is why this use of this special language. But it also keeps on using English words as you will see, but then assigns it a technical meaning. So in a way what we have learnt today is about this Russell-Whitehead system, how it came to be, in what way is it different from the earlier Aristotelian logic and what were the reasons why people found that it has to be a mathematical kind of a logi,c and I have through this history I have tried to introduce you to Symbolic Logic.

And from next module we are going to actually start learning the Symbolic Logic. This is all for this module.

Thank you.