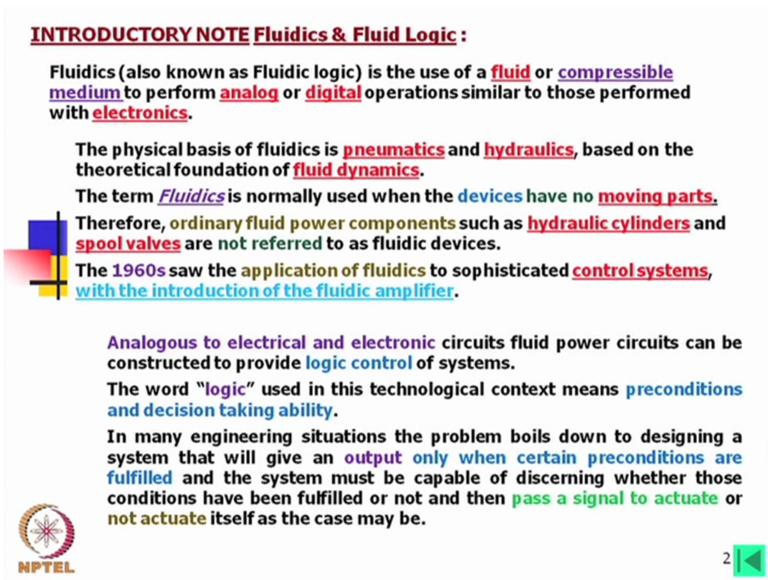
**Fundamentals of Industrial Oil Hydraulics and Pneumatics**
**By Professor R. Maiti**
**Department of Mechanical Engineering**
**Indian Institute of Technology, Kharagpur**
**Lecture no 26**
**Module no 7**
**Introduction to Fluid Logic 2**

Welcome, now we shall enter into completely new topic which is fluidic and fluid Logic and in this lecture; lecture 26 we shall discuss about the fluid Logic, this will be very introductory lecture on fluid Logic. Now you know that fluid in case of automation there are valves which are called fluidic valves which are used for just ON-OFF operations in say automation.

(Refer Slide Time: 1:15)




Now 1st of all if you look into the very fundamentals of fluidics what it is, then the word fluidic also known as fluid Logic is the use of fluid or compressible medium to perform analog or digital operations similar to those performed with electronics, this might be fluid, incompressible fluid or compressible medium that means compressible fluid. The physical basis of fluidics is pneumatics and hydraulics, both are used based on the theoretical foundation of fluid dynamics.

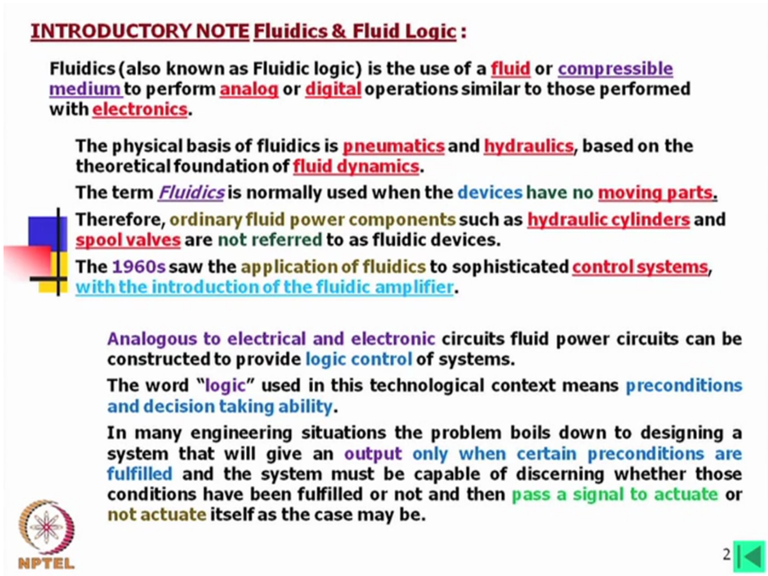
The term fluidics is normally used when the devices have no moving parts, in such valves which is known as fluidic valves you will find that there is no point part, this does not mean that fluid is not flowing, fluid is flowing but no say spool or other things are not there. Therefore, ordinary fluid power components such as hydraulic cylinders, spool valves are not referred as fluidic devices. Now in 1960s, the application of fluidics to sophisticated control systems with the introduction of the fluidic amplifier.

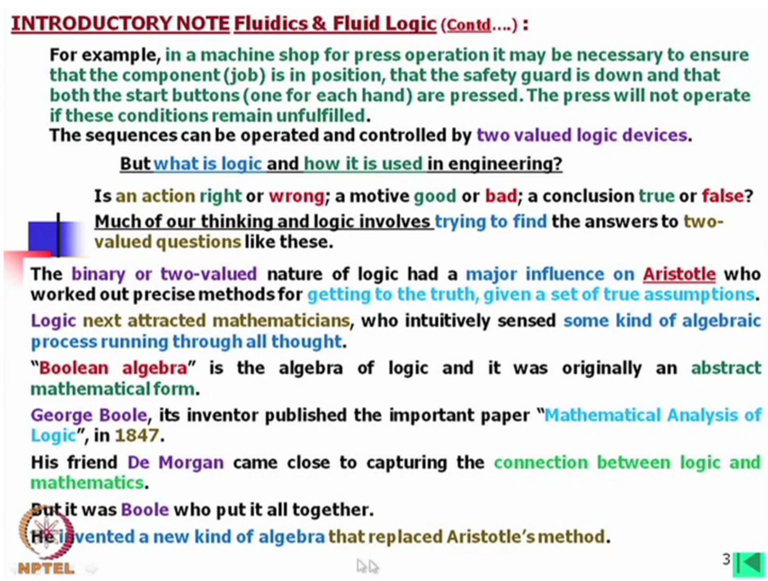
The 1st invention or you can say discovery in the fluid which be named as fluidics device was the fluidic amplifier and that is in 1960s. I must say that time just after the World War, there was the researchers were very much interested to explore the fluid power because they found the lot of applications was there in the machineries, so that there was everywhere at was going on where the engineering was there, the research application, engineering of fluid power. But at that time, the electronic devices were not that much developed, it had started but not that much developed so people were thinking of the analog and digital operation using theses fluidic devices.

Analogous to electrical and electronic circuits, fluid power circuits can be constructed to provide Logic control of the systems, now what is Logic control that will come later? The what “Logic” used in the technological context means predictions and decision taking ability, the prediction and decision takings we call Logic, but it really means we are predicting something and on that basis we are taking some decision, only then we should call it is Logic.

In many engineering situations the problem boils down to designing a system that will give an output only when certain preconditions are fulfilled and the system must be capable of discerning whether those conditions have been fulfilled or not and then pass a signal to actuate or not actuate itself as the case may be, so it is like that it will ask a question single question that to do or not to do and we will do this operation. Many operations we will find that you can (())(5:54) such operations into just ON and OFF ON and OFF ON and OFF. If you go to go through few ON and OFF, you will arrive into the same result.

(Refer Slide Time: 06:12)




For example, in a machine shop for a press operation, it may be necessary to ensure that the component is in position, that the safety guard is down and that both the start buttons one for each hand are pressed, the press will not operate if these conditions remain unfulfilled. That means, let us consider a paper cutting machines shearing machines or sheet metal shearing machines, in that case what normally you will do, you will put the paper in the position but while you are putting the paper in the position, your both hands might be on the paper and it might be just under the cutter.

So if it operates there will be an accident, so for the safety purpose what is done 1st of all you are putting the job in position then there is no operation, then you are putting a safeguard in front of that, there is double safety, you are taking out your hand from there and putting the guard okay. At that condition you can operate the switch, again for the further safety there is not one switch, there are 2 switches and these 2 sides, if you operate one it will not operate, if you operate this separately it will not operate, you have to put the switch on both switches by 2 hands then you are sure that your hands are not under the cutter and surely you are not going to put your leg there.

So these operations can be done easily by electronic devices now, but the early stage fluidic devices was being used for such sequential operations. Again one can do some mechanical say unless you do not put this guard ON that means you do not put the guard, you cannot operate that such, even with one switch you cannot operate but to be in safe side better operate by 2 switches okay. The sequences can be operated and controlled by 2 valued logic devices, this is look at this term “2 valued logic devices”, 2 valued means yes or no.

But what is Logic and how it is used in engineering, let us examine that. Is an action right or wrong, a motive good or bad, a conclusion true or false? Much of our thinking and logic involves trying to find the answers to 2 valued questions like this, yes or no. If you, you can think in this way, you are trying to do something then you first, first step is yes or no then you have forwarded with yes or no answer then another yes or no, in that way you can find the logic. In fact, the those who are strongly believing in these logical sequences, they always say that each and every action, each and everything can be explained by simply no, yes or no yes or no by this.

you can arrive into a decision whatever may be the matter, just simply answering that yes or no, yes or no. Say for example, you have to go to market and it is raining, then 1st answer what is that, is it essential to go to market now? Come yes or no. Say it is yes, then if yes then how to go, it will come the next question, shall I take an umbrella or some raincoat? Say suppose you are thinking of umbrella, okay yes I would take an umbrella, the next question how we will go? I will take the scooter, then you will find the scooter with umbrella this is not a combination so one will be eliminated, you can then think of okay no this path is not possible.

Then next part take a raincoat, in that way gradually we will find that with this answer you take the decision but in normal cases you will find this morning it is raining you have to you may try to not to go to the market, if you have to go then what you will do you will take your raincoat and you will take your car and or whatever it may be, you will go simply maybe car and umbrella, car you will keep here and with umbrella you will go. But that decision you take within a few seconds, but in fact all such logics works and with yes and no answer you arrive there, so that is called 2 valued question.

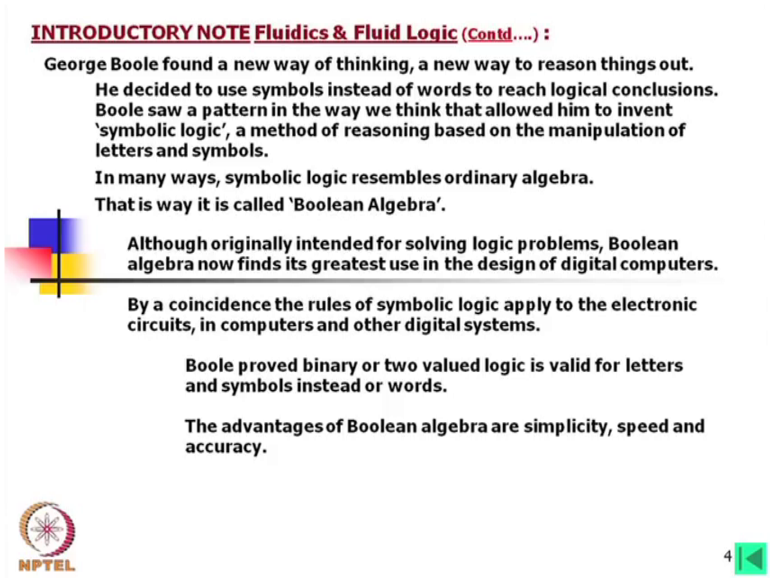
The binary or 2 valued nature of logic had a major influence on had a had a major influence on Aristotle. It is said that Aristotle first talked about this logic who worked out precise methods for getting to the truth given a set of true assumptions. He was a philosopher Aristotle you must know, he was a philosopher, he wanted to always arrive in truth behind anything and then he was thinking of how we can arrive into that truth, he gave the idea of logical thinking.

Logic next attractive mathematicians, then mathematicians who are doing mathematics, they thought that in many cases if they think in this binary way, probably they will arrive into they can do some mathematical operation to arrive to an answer, who intuitively sensed some kind of algebraic processor running through all thought, any thinking process also there must have some algebraic process. Now Boolean algebra is the algebra of logic and it was originally an abstract mathematical form okay, we will come to that Boolean algebra.

Now Boolean after the name of George Boole who invented this algebra, he published paper "Mathematical analysis of logic" in 1847. This means that from now it is more than 160 years 165 precisely, 165 years from now he George Boole 1st showed some mathematical analysis of logic. Now his friend De Morgan who helped him, okay you can make theory in this way and he also helped in connecting between logic and mathematics connection between logic and mathematics, but ultimately Boole he summed up all such things suggested by De Morgan and he developed this algebra that is why it is named after Boolean algebra.

But in that algebra you will find he honoured Morgan and there are a few De Morgan laws, theories De Morgan which are very essential for this mathematical computation. In fact, when Boole invented this logic that time no computer nothing was there. Later computer as you know, we all follow this binary algebra that is based on Boolean algebra. Now that replaced Aristotle's method, Aristotle proposed some method but Boolean algebra found to be much easier than Aristotle method and then onwards the Boolean algebra was being used.

(Refer Slide Time: 16:18)




However, you will find that this Boolean algebra who found a new way of thinking a new way to reason things out was not used for several years, I am coming to that but he decided to use symbols instead of words to reach logical conclusion, so he invented also some symbols for the presentation of logic. Now George Boole saw a pattern in the way we think that allowed him to invent "symbolic logic" method of reasoning based on the manipulation of letters and symbols okay.

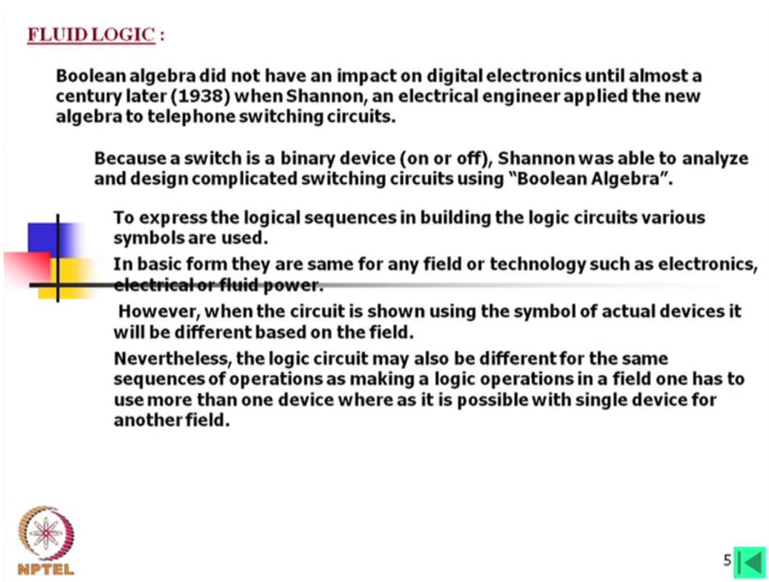
In many ways, symbolic logic resembles ordinary algebra, if you go into these Boolean algebra, you will find at some places it is ordinary algebra, but at other places you will find it is not matching with ordinary algebra. Now although originally intended for solving logic problems, Boolean algebra now finds its greatest use in the design of digital computers which I have mentioned. By a coincidence, the rules of symbolic logic applied to the electronic circuits is in computers and other digital systems. Boole proved binary or 2 valued logic is valid for letters and symbols instead of words.

The advantages of Boolean algebra are simplicity, speed and accuracy, you will find that they are using 0 and 1 0 and 1, with this you will find that in many cases particularly connecting to the electronic devices, it is very easy to arrive to a result rather than solving it mathematically.

However, the Boolean algebra did not have any impact on digital electronics until almost 1938, look at this when he published the paper that was 1837, so 1938 almost hundred years it has no application much application, people are thinking this is not abundant but still they do not found that this algebra can be used in some engineering applications.

But Simon who was an electrical engineer he 1st thought of applying this algebra in telephone switching circuits telephone, by the time 1930 the telephone has come then for switching circuits he was thinking that we can use this Boolean algebra, because which was a binary device on or off, Simon was able to analyse and design complicated switching circuit using Boolean algebra. So he was the 1st engineer who applied this Boolean algebra and better way and then it was followed for computers and many other applications. To express the logical sequence in building the logic circuits various symbols are used. In basic form they are same for any field or technology such as electronic, electrical or fluid power.

(Refer Slide Time: 20:19)

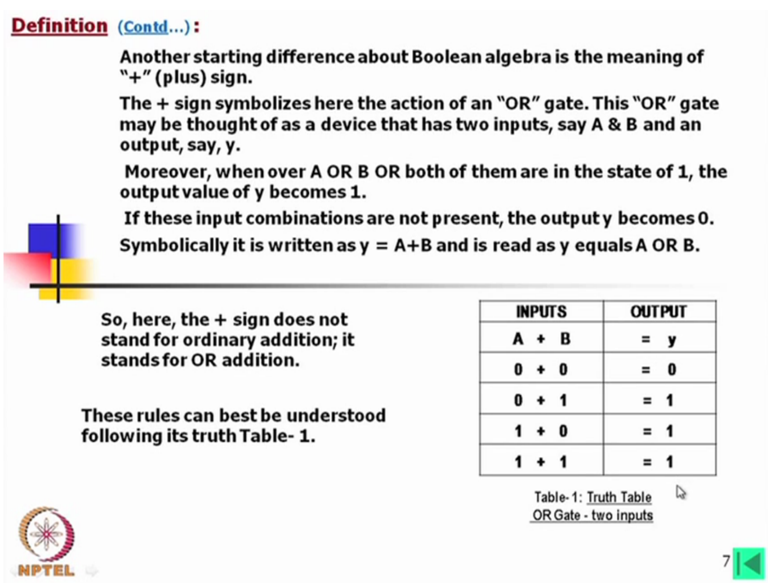



However, when the circuit is shown using the symbol of actual devices it will be different based on the field. Just you have to identify say for example, the similar symbols are used but you will find that for electronics for electrical circuits there are separate sets of symbols than the fluid power symbols, but circuits may look more or less alike. Logic will work in the same way, but while you are thinking of the fluid power device or electronic device symbols will be different. Nevertheless the logic circuit may also be different for the same sequence of operation as making a logic operation in a field, one has to use more than one device, whereas it is possible with single device for another field.

This is again say some of the devices was developed say in electronics that cannot be developed in fluid power, for fluid power the same operation you will find they have used some other devices or maybe 2 in number together to have the same operations which is achieved by a single device in electronics. In case of fluid power it may be common and ordinary devices of fluid power say fluidic devices is not the fluid power component, whereas using 2 fluid powercomponent you can develop a logic element that you should remember, which are used for both drive and control or fluidic devices.

Then we call this is fluidic devices that means you take 2 ordinary valves or ordinary fluid power components and combined together, have a function which is functioning like a fluidic device, then together you can call it is a fluidic device but ordinarily the moving the fluid power have moving components those are not fluidic device. It is proper to start with a few definitions to understand the text that will follow okay to understand this what are these fluid logics.

(Refer Slide Time: 23:02)




Now in definition 1st of all we will learn about the gate, there is a term which is used in logic "Gate". What is gate? Gate is a logic circuit with one output and one or more input. Now remember, gate is not a device, gate basically is a circuit which comprises of one output and one or more inputs. An output signal occurs only for certain combinations of input signals okay. Now another term is used in logic circuit, the truth table, now while you are thinking of some operation you will think of a circuit. Now to make this circuit you have to go through some truth table that means there where it is written if this is 1, this is 0 then what will be the output.

Sometimes called a table of combination as I have told you is a list or a table that shows all input/output possibilities for a logic circuit. The number of horizontal rows in a truth table equals 2 raised to the power n, where n is the number of inputs. Suppose there are n number of inputs, in that case in that table there will be 2 to the power n is the number of rows. Let us consider there are 4 inputs so 2 to the power 4 means 16, you have to at least 16 row truth table you have to make, we will show you that those truth table. For a 2 input gate for example, the truth table has 4 rows, a 3 input gate will have a truth table with 8 rows.

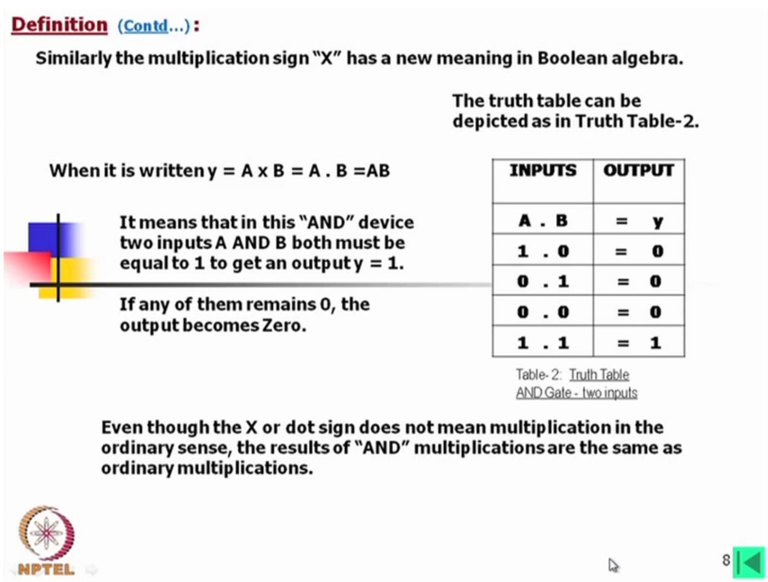
In ordinary algebra when we solve an equation for its roots, we may get a real number positive, negative, fractional and so forth. In other words, the set of numbers in ordinary algebra is in finite, in Boolean algebra when we solve an equation, we get either 0 or 1, it is always no means 0, yes means 1 but always you should remember, you should not be confused with there is no signal, it might be 0 or might be it is not operating, so a care must be taken to find out real 0 or no function it is not functioning.

No other answer is possible because the set of numbers includes only the binary digits 0 and 1. Actually as I have told that whether it is not functioning there are some other signals that it is not functioning. Another starting difference about Boolean algebra is the meaning of "+" sign, in ordinary algebra + means 1 + 1 means we just 2, in case of Boolean algebra 1 + 1 is not 2, we will see that what it is. The '+' sign symbolises here the action of an OR gate, this OR gate may be thought of as a device that has 2 inputs say A and B and output say Y. Now here as I have told that actually answer will come into 0 or 1 but input name we have given A, B and output name we have given Y and then we will put its value.

Moreover, when over A or B or both of them are in the state of 1, the output value of Y becomes 1. If these input combinations are not present, the output Y becomes 0 we will see that in detail. Symbolically it is written as Y is equal to A + B and is read as Y equals A OR B. So here the + sign does not stand for ordinary addition, it stands for OR addition, we call this + sign in Boolean algebra is OR addition. Now these rules can best be understood following its truth table, we have made to understand this equation we have made a truth table. Y is output so we have kept it in right-hand side, A the input on left hand side.

Now let us consider A is equal to 0, B is equal to 0 then it is 0, now this is OR addition, A = 0 and B = 1 then output is 1, this means that in OR addition if one of that is on then this will be ON, output will be some output will be there. This means that this is not quantity this is not quantitative, only thing there is some signal at input so output must have signal. 1 + 0 is also one and 1 + 1 is 1 that means if both are giving signal then there is output, any of them is giving signal there is output, none of them giving signal is not put so this is only this you can think in terms of or okay. But this quantity actual quantity say quantity of flow, quantity of may be in case of that inputs or power anything, the quantity is different, this is only thinking of the possibility of ON and OFF.

(Refer Slide Time: 30:37)

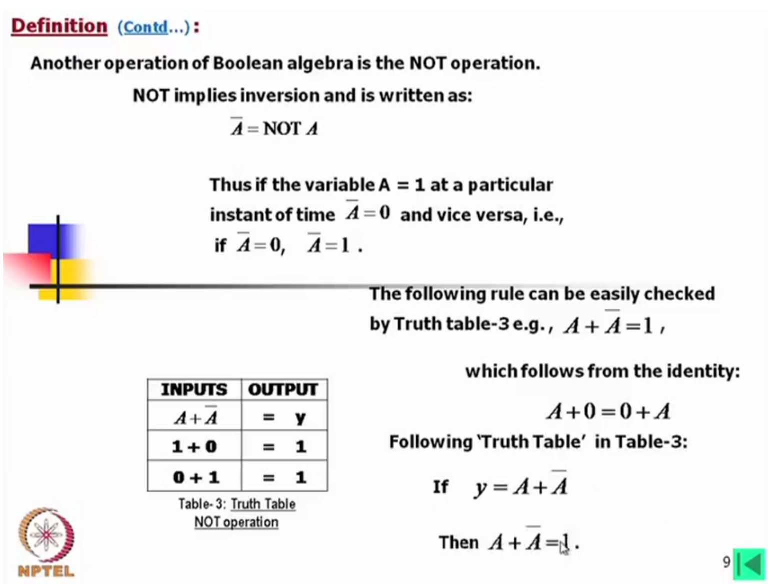



Similarly, the multiplication sign that is cross has a new meaning in Boolean algebra, this is not an ordinary product. When it is written, Y = A into B, sometimes it is written A dot B or even we write AB then it is it means that it is AND device, 2 inputs A and B both must be equal to 1 to get an output Y = 1, if any of them remains 0, the output becomes 0. See this again with a truth table say A dot B = Y, now A is 1 that means signal is there, but B is no signal output, there is no output.

A is no signal, B is a signal, still it is no output, only there will be output if both are giving signals then there will be output signals but none of them are giving signals is 0, where as one of them is giving signal is 0 so these 2 are okay but when these 2 are 0 there is no signal, there is also a dangerous because it might be whole system is not working so there should have some precautionary measure for that. But here as you see these when both are ON in that case this is 1, in case of OR also if both are 1 then this is 1 so you will find that there is some similarity in AND and OR for some operations.

But if you come to say this operation in case of OR the output will be 1 whereas in case of AND this output is 0. This means that depending on the requirement we will think of such device either AND OR we are going to use OR. Even though the cross or dot sign does not mean multiplication in the ordinary sense, the result of 'AND' multiplication are the same as ordinary multiplication, if you look into this, these are like an ordinary multiplication, so there is a similarity with the ordinary algebra.

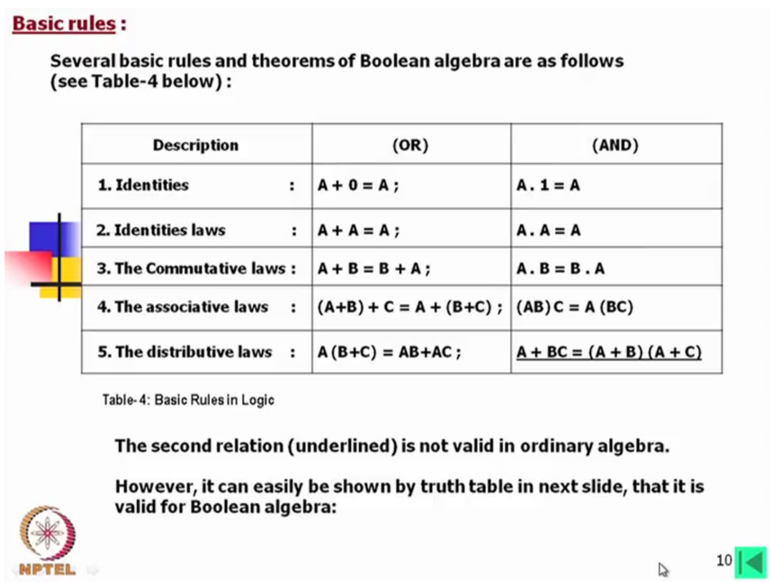
(Refer Slide Time: 33:35)




Another operation of Boolean algebra is the NOT operation NOT. This NOT implies inversion and it is written as A bar is equal to NOT A, this means that this device if we this in this gate if we put a device, so if you put a signal that will after the device that will become no signal. So that operation is required, say 1 signal is coming, we have to put into no signal so that combining with other signal we can arrive into a desired signal, so this NOT A is also a device. Thus if the variable A is equal to 1 of a particular instant of time, A bar = 0 and vice versa, in a particular instant of time A bar = 0 and vice versa that is if A bar = 0 sorry this if A = 0 then A bar will be 1, if A = 0, then A bar = 1 .

The following rule can be easily checked by truth table 3 that is A + A bar = 1 how say which follows from the identity that A + 0 = 0 + A and we can have from this truth table what it is, A + A bar = Y then this + means OR so 1 + 0 = 1, 0 + 1 = 1 that means A + A bar, A OR A bar this combination always will give a positive signal. If y = A + A bar then A + A bar is always 1, several basic rules and theorems of Boolean algebra as follows.

(Refer Slide Time: 36:20)




| Description | (OR) | (AND) |
|---|---|---|
| 1. Identities : | A + 0 = A ; | A . 1 = A |
| 2. Identities laws : | A + A = A ; | A . A = A |
| 3. The Commutative laws : | A + B = B + A ; | A . B = B . A |
| 4. The associative laws : | (A+B) + C = A + (B+C) ; | (AB) C = A (BC) |
| 5. The distributive laws : | A (B+C) = AB+AC ; | A + BC = (A + B) (A + C) |

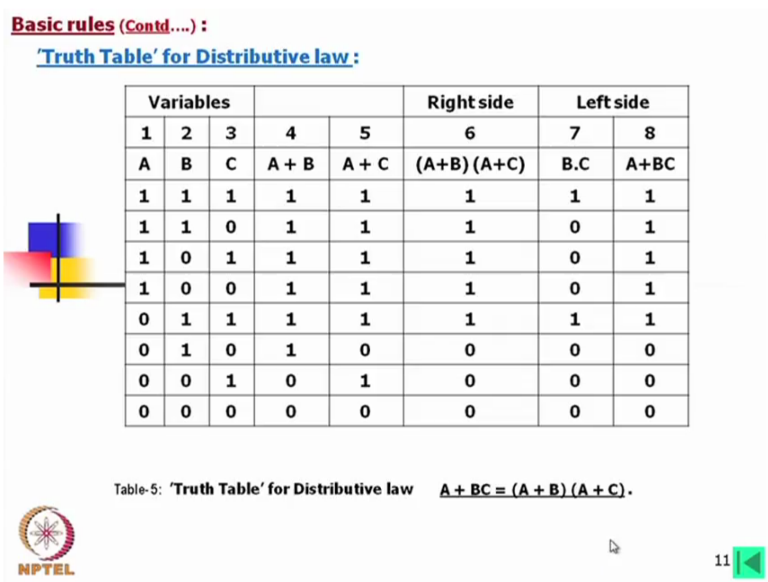


It is presented in the tabular form, so this is description OR and AND. Now there are identities that means if you combine with OR that is OR addition then A + 0 = A and A dot 1 = A, we to arrived into A we can use A + 0 or A dot 1 = A, so these are called identities. Now I would say, it is very difficult to just remember all these things looking into just one time. If you want to be expert in Boolean algebra, you have to remember these things because only with such identities and other combinations which I will show, you can simplify this Boolean algebra we will come to that.

Next the identities laws, this is simply called identities then next comes identities laws; A + A = A and A dot A = A, say this combination is called identities, whereas this combination is called identities laws. Now coming to the 3rd one, the Commutative laws; A + B can also can be achieved by B + A okay and A dot B also can be achieved by B dot A. Fourth one Associative laws, in that case (A + B) + C that that this means this is OR addition of A and B then this is one output, that output is an input and that is further being combined with an OR will give you A and then B + C and in case of AND function AB into C is A into B into C.

Now the distributive laws are A into B + C is equal to AB + AC, we will have same output with such combinations, also you will have the same output with such combination. This is I I do not know, maybe you can remember this thing, apparently it is difficult but if you can remember this while you are simplifying, it will become easy. The 2nd relation underlined is not valid in ordinary algebra, this you will find there following ordinary algebra but this is not following ordinary algebra. However, it can easily be shown by truth table in next slide, that it is valid for Boolean algebra.

(Refer Slide Time: 40:09)




| Variables | | | | | Right side | Left side | |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | B | C | A + B | A + C | (A+B) (A+C) | B.C | A+BC |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

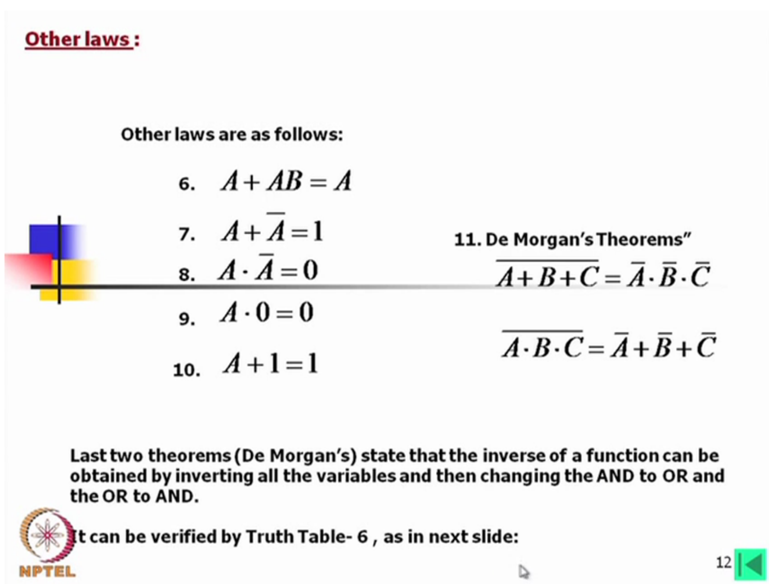
Table-5: 'Truth Table' for Distributive law A + BC = (A + B) (A + C).

Now in this table in this truth table what we have considered, there are 3 variables A, B, C we have taken 3 variables. Then 1st we have made these OR additions and then we have made this combination and then BC and A + BC we are trying to proof this one. Now let us consider that this is we have taken 1, this is 1 and this is also 1 so definitely A + B will be 1, A+ C will be 1, A + B, 1 into 1 = 1, B dot C will be also 1 and this is 1 so hence this you will find this is proved. Now if you take A, B both 1 but C = 0, in that case A + B = 1, A + C = 1, this is 1 but B dot C will be 0 whereas A + BC will be 1 because A = 1 okay, now still you can find this okay.

With A = 1, C = 1, B = 0 so this is 1, this is 1, this is 1, this is 0 and this is 1, now how many rows will be there, again there are 3 so 3 to the power 2 is not it, or 2 to the power 3, so there will be 8 rows let us see how many rows are there. Now then we find 1, 0, 0, this is 1 this is 1 this is 0 this is 1, again it can be proved. 0, 1, 1, this will be 1, this will be 1, this will be 1, these all are 1. And 0, 1, 0 then 1, 0, 0, 0, 0 and 0 0 1 this is 0, 1, 0, 0, 0 and lastly if 3 of them 0, all will become 0 so this will be also proved but this is dangerous one.

So in that way if you consider any such theory or mathematical expression Boolean algebra then you can prove it by using the truth table. Also, this can be you can simplify this but then you have to apply some laws which you should remember, but it might not be difficult because if you put 1 value then if you go for the simplification by Algebraic method also, we will arrive into this but truth table is very easy one, other laws are as follows.

(Refer Slide Time: 43:32)




That A + AB = A so that you can prove also in a truth table, say if this is 1 then say this is 0, then 1, 0 = A, say this is 0 and this is 1 then this is 0 say A = 0, this is 1 that means 0 + 0 must be = A in 0, so in that way you can prove this making the truth table. Now this already we have shown, this is always true A + A bar = 1 and A into A bar A dot A bar is always 0 is not it? Because one of them is 0, other will be 1 so 0 into 1 is always will be 0 so which I have shown in 8. Now, this is again true, something into 0 is always 0, it is like an ordinary algebra.

Then 10, A + 1 = 1 this, A here as you see suddenly we have used all these letter symbols and why this is numerical, this means that 1 positive and another is whatever may be, this is unknown, we have written in the form of a letter that this might be 0 might be 1, whereas when we are indicating 1 or 0 that means 0 means 0, 1 is 1 right, so the equations are written in this form. Now an important theorem that is proposed by Morgan but this algebraic form it is not known who developed this, maybe Boolean or together. As you see this 1st OR operation here and then NOT of this OR operation = NOT of A dot NOT of B and NOT of C or inverse of this, similarly this equation also, now these 2 we will prove by using a table.

Last 2 theorems state that the inverse of a function can be obtained by inverting all the variables and then changing the AND to OR and the OR to AND so this you can see, this combination this is quite interesting if you look into this, this A + B + C then inverse of that, A inverse dot B inverse dot C inverse, now simply we have bought this side then automatically say as if you are bringing this one and then joining these 3 together and bringing this right-hand side and just you making these discreet, this will be true we will verify in the next slide.

(Refer Slide Time: 47:25)

**Other laws (Contd...) :**

**Proof of De Morgan's Theorems -** $\overline{A+B+C}=\bar{A}\cdot\bar{B}\cdot\bar{C}$ **&** $\overline{A\cdot B\cdot C}=\bar{A}+\bar{B}+\bar{C}$ **with The help of 'Truth Table'.**

| L.H.S | | | | | R.H.S | | | | | L.H.S | R.H.S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| $A$ | $B$ | $C$ | $A+B+C$ | $\overline{A+B+C}$ | $\bar{A}$ | $\bar{B}$ | $\bar{C}$ | $\bar{A}\cdot\bar{B}\cdot\bar{C}$ | $A\cdot B\cdot C$ | $\overline{A\cdot B\cdot C}$ | $\bar{A}+\bar{B}+\bar{C}$ |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

Table – 6 : Truth Table to show $\overline{A+B+C}=\bar{A}\cdot\bar{B}\cdot\bar{C}$ & $\overline{A\cdot B\cdot C}=\bar{A}+\bar{B}+\bar{C}$.

**Columns (5) and (9) proves the first theorem and columns (11) and (12) the second one.**

NPTEL

13

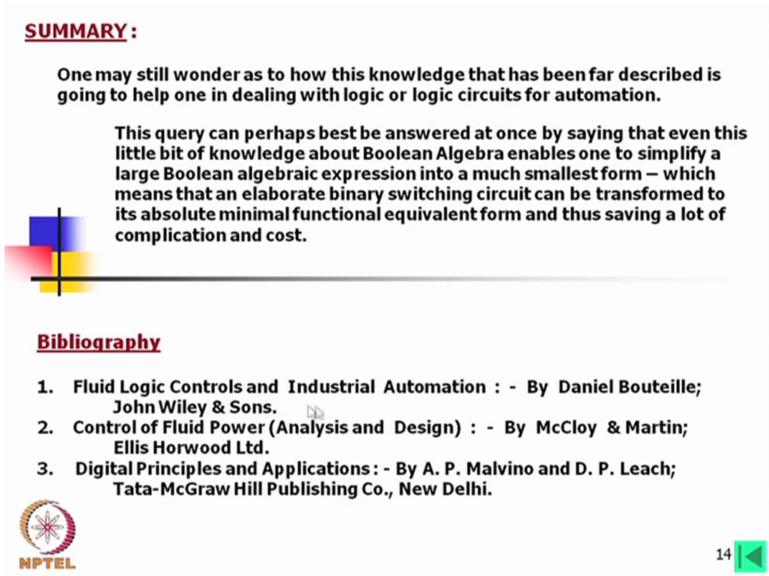
Now again in this truth table we are trying to proof this, so definitely there will be also 8 rows 1, 2, 3, 4, 5, 6, 7, 8 but we have 2 make the columns depending on that for each element then for each combination. So what we have done, we have made A, B, C these 3 columns then one column for A + B + C, one column for inverse of that then one column for A inverse, another B inverse, another C inverse or C NOT you can say, then A bar dot B bar dot C bar dot, etc, etc so all possible that what we would like to get in the form of equation that we will have to make the column, so column number may be anything but rows number will be 2 to the power n.

Now again in 1st column we have taken 1 + sorry A = 1, B = 1 and C = 1 and you just look that for OR combination this will be 1 and inverse of that will be definitely 0, NOT of that will be 0 and as these are 1 each 1, so these will be all 0 0 0 sorry C bar will be 0 also, so there is a mistake. So A dot B dot C any of them will be 0 so even if for this also it is 0 but this will be 0, A dot B dot C will be should be again 1, maybe this is A dot B dot C = 0 this will be 1 and this will be 1, but A dot B dot + C dot maybe this sorry maybe this combination is something wrong.

Let us see this next table 1 1 0, A + B + C is equal to 1 right, this obviously A + B + this is inverse into 0 this = 0 whereas, this will be, I think these tables are just exchanged okay. Then ABC = 1 and this is obviously 0 okay I think these 2 rows are exchanged okay. So we will come to the next one, 1 0 1, so this is 1 and this is 0 right, A bar = 0, this is equal to 1 may be so I I will give you the correct table, possibly that while I were just copying from the actual table to this slide form, these are the mistakes we have made, anyway you develop this table of your own and you will find that this can be proved.

Let us see this one, this is correct, this is correct, A = 0, 1, 0 no, this is not correct again, ABC = 0, so 0 1 1, 1, 0 that is correct this is correct this is correct but this is not correct. Anyway, this table is wrong what I find so but it can be proved using this theorem, maybe this this and these are interchanged somewhere. Although these are written, but these combinations are not correctly repeated. Okay, this is the end of that, column 5 and 9 we will find 5 and 9 and 11 and 12 these are proving these 2 equations, one is this one combination of 5 and 9 and another is 11 and 9. Although here it is correctly written but these are not in proper form okay, I will give you the correct table while I I will send you the notes.

(Refer Slide Time: 53:19)




Now what we have learned so far on the fluidic logics, one may still wonder as to how this knowledge that has been far described is going to help one in dealing with logic or logic circuits for automations. This query can perhaps best be answered at once by saying that even this little bit of knowledge about Boolean algebra enables one to simplify a large Boolean Algebraic expression into a much smallest form, which means that an elaborate binary switching circuit can be transformed to its absolute minimum functional equivalent form and thus saving a lot of complication and cost.

This means that while such combination are shown that what we will find to arrive into solution, we will find that many intermediate steps can be omitted because they are combination of few inputs which is giving the output and that can be achieved by must simpler input. So in many operations in computer you will find that many intermediate steps are eliminated following this Boolean algebra simplification and circuit becomes very simple and operation becomes much much faster. Now we have followed these books you will find there, but that is much elaborate form here I have presented in very concise form okay, thank you.