Science and Technology of Weft and Warp Knitting
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Module - 1
Lecture - 2
Knitting Glossary

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Welcome back participants. Today we are going to move lecture number 2 and the title for this lecture is Knitting Glossary. Before we move further in this course, it is important for us to know some of the knitting terminologies which I might be using frequently in this course. So, let's move to this particular lecture.

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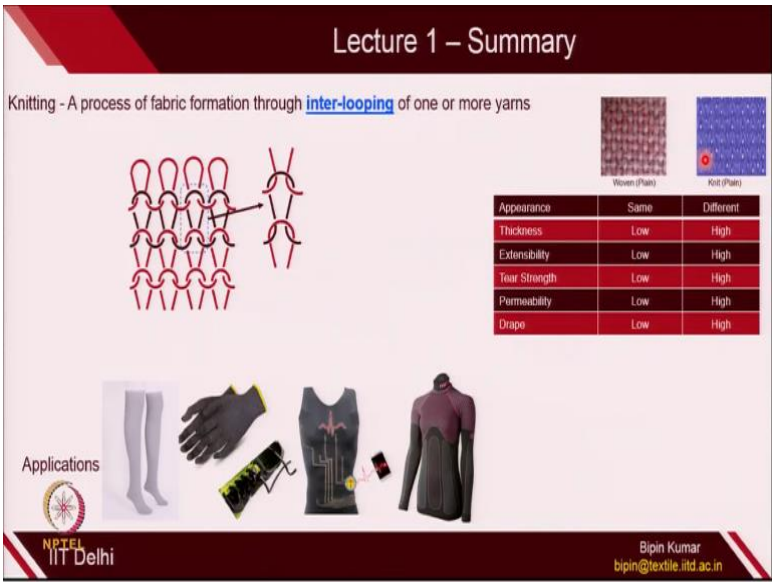

In previous lecture, you might have understood the basic definitions of knitting. So, it talked about knitting process, which is just the inter-looping of one or more yarns. So, you can have the knitted structure here. You can see these loops which are interconnected with the top loop and bottom loop. So, we understood this process well in the last lecture. We also talked about what are the application potential of the knitting fabrics.

It can be used in hosiery clubs, undergarments, in smart textiles, in sports, in shoes and many other technical applications. And at the end of the lecture 1, we tried to differentiate between plain woven fabric and basic knit fabrics. So, we found, there are lots of differences between these 2 structures. This is why these 2 structures are used for different applications. Now, let's move to lecture number 2. So, in today's lecture, what basically we are going to learn is:

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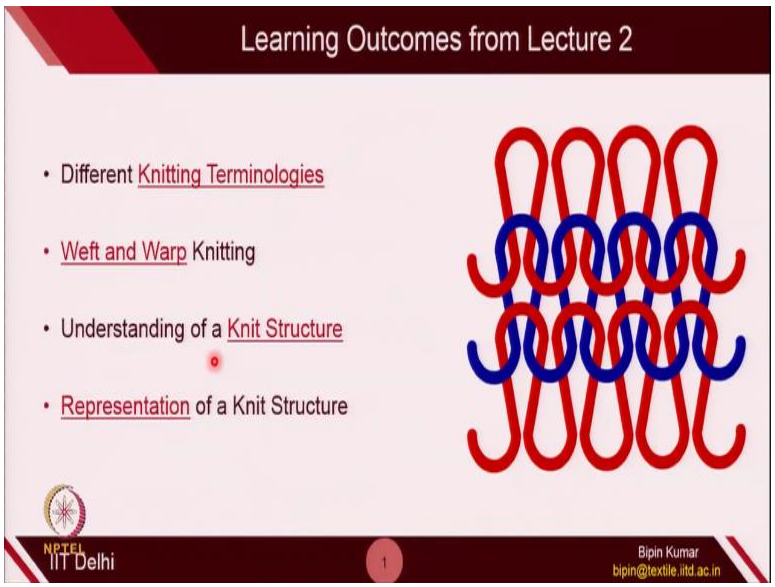

We are going to learn about different knitting technologies which we frequently used to describe a knitted structure. Second thing which we are going to talk about is 2 different types of knitting, which is weft and warp knitting. Apart from that, we are also going to understand very deeply about the loop architecture or loop network inside a knit structure. Okay. And finally, we are also going to learn how we can represent this knit structure by a simple box diagram.

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So, let's move to this course. Some of the basic terms in knitting is quite popular around the world.

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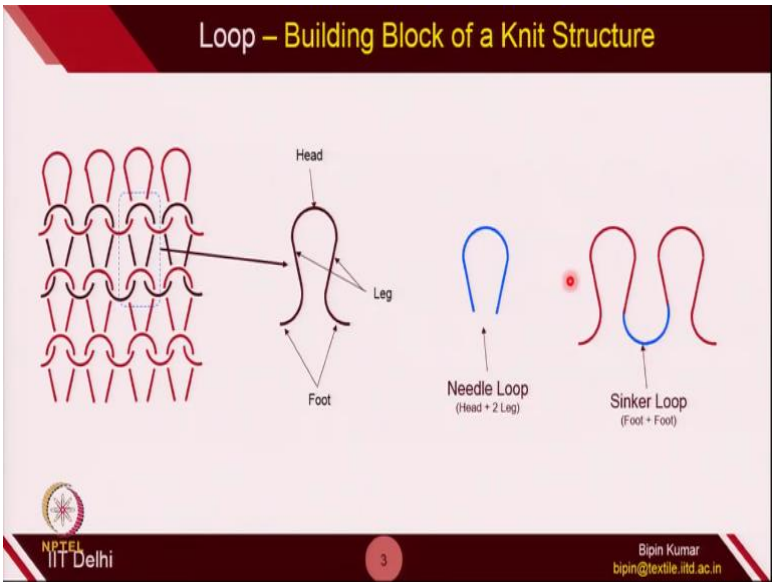

The first one is related to the loop. So, loop is the fundamental building block for any knit structure. So, I have just enlarged one of the loop from the fabric to the side work. Okay. So, you can see the loop here. In this loop, you can easily differentiate some of the components. The first component is the head which is the top circular arc which is called the head. Apart from head, there are 2 straight segments of the loop which is called leg.

And finally, at the bottom part, you have 2 foot segments. So, combining 2 foots, 2 legs and 1 head, we create 1 building block of a knitted structure which is called loop. Okay. Apart from that, we also have one definition called needle loop. So, needle loop is just this name of

particular loop has come from one of the structural elements which is used in the machine. And that element is called needle.

So, this needle usually, during fabric formation, the needle actually helps to create head and 2 legs part. So, that why it is called needle loop, because needle has the major contribution for making this part of the loop. Apart from that, we have other segments in this fabric which is called sinker loop. So, if you see this sinker loop is nothing but you are connecting the foot of 2 consecutive loops along a row.

So, if you connect 2 loops in the same horizontal line, it has to be connected by 2 foots. And that 2 foot is collectively known as sinker loop. Again, the name sinker has come from one of the machine element which predominantly helps to create this sinker part in this knitted structures. So, that's why, needle loop and sinker are 2 of the major elements which helps to create different parts of the loop.

We are going to study about this needle and sinker components later in this course. But for the time being it will be easy if you try to understand what is the importance of needle and sinker. So, if you see the sinker part, sinker is nothing but, it is connecting 2 loops sideways. Okay. And if you see the needle loop; so, needle loop is actually getting intermeshed with top and bottom. So, needle loop actually participates in intermeshing; you can see here. Okay. So, each part of the loop actually helps in creating some intermeshing points inside the fabric structure.

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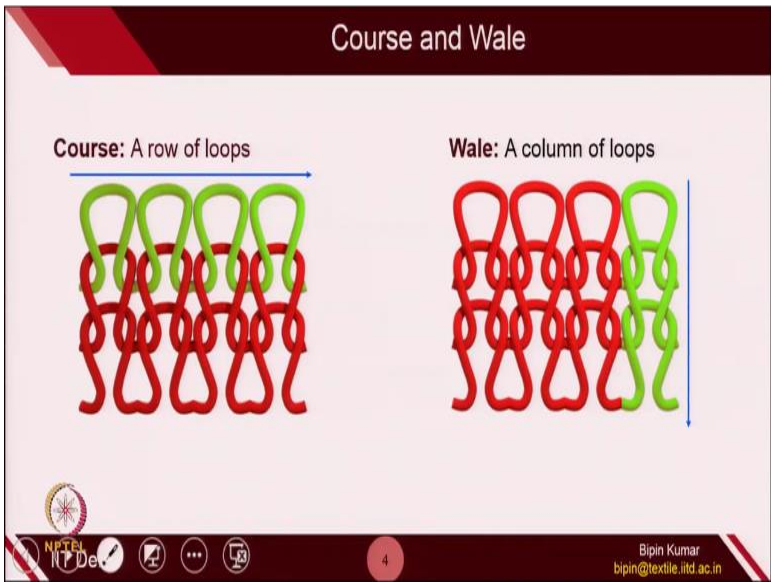

The second 2 terms which is quite common in knitting is course and wale. Course is nothing but a rows of loops. So, you can see here the green segments. If you carefully see this green segments. So, all loops along a row are called a course. Okay. So, right now, you have 4 loops in 1 course. So, it is, we call it just 1 course of loops. Similarly, along the column side, we call it wales.

So, a column of loops is called wales. So, if you see this structure, both the structures; basically, there are 4 columns, it means there are 4 wales. We have 3 rows which is called 3 courses. Okay.

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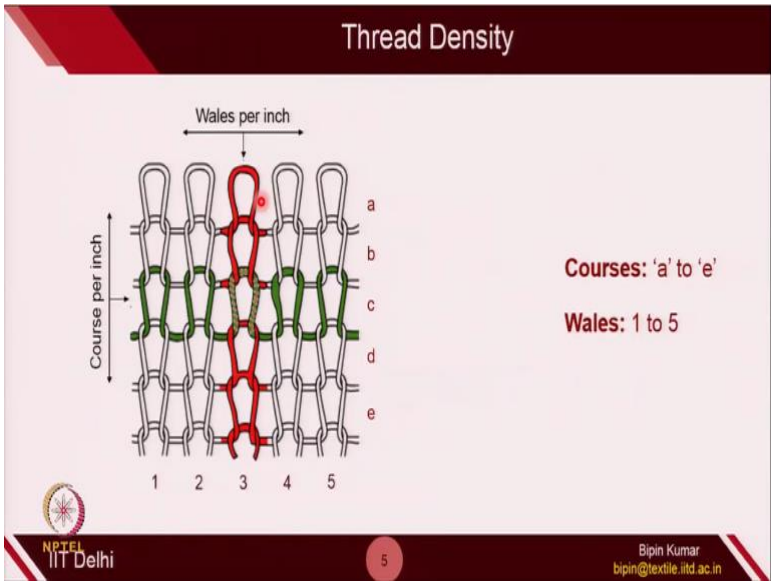

Thread density is also, we frequently use to describe a knitted structure. So, in thread density, we can describe number of rows which are present per unit length. So, if you see, there are 5 rows of loops: 1, 2, 3, 4 and 5; a to e, there are 5 courses. And if you know the length which is required to occupy this 5 courses of loops; so, it is called courses per inch, which is nothing but the total amount of courses which you can measure divided by per unit length.

Apart from course per inch, we have also wales per inch. So, if you see, there are 5 columns. And if you measure the distance, horizontal distance and divide number of loops, number of wales, divided by total length which is occupied by the fabric, when then we can divide. We can get wales per inch for a fabric structure. Okay.

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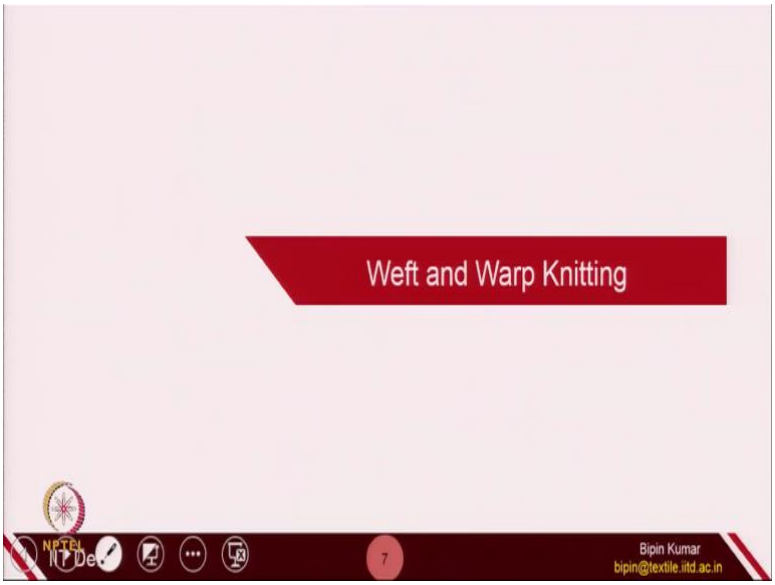

Now, come to the other segment which you might have seen in real life, but it is very difficult to notice or differentiate between these 2 structures. So, let's go and see how, what do you mean by weft and warp knitting.

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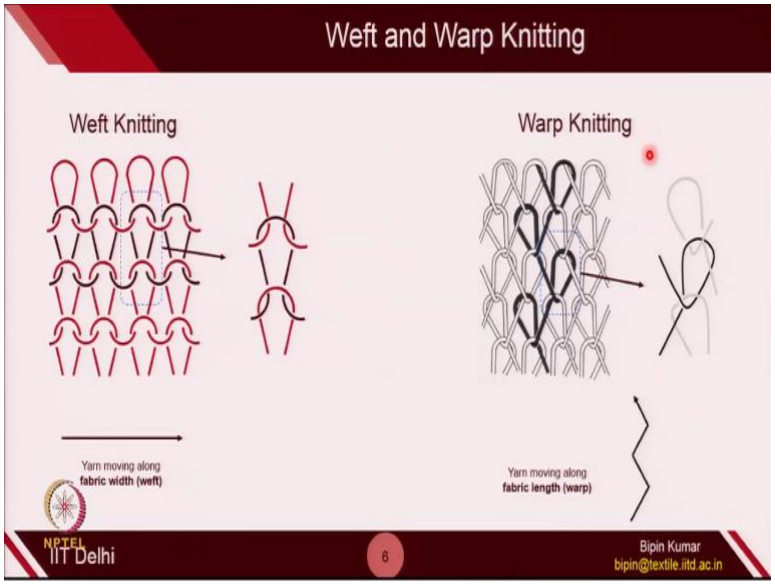

So, weft knitting, if you see this structure which we are following from lecture 1, it is the most simple one, where you can see the 4 wales and 4 courses. But if you pick any particular course and try to follow the path of the yarn; So, for example, I am following the path of black yarn. You can see, once I am leaving from one loop, it is automatically moving to the second loop on the same row.

So, the movement of yarn is actually from left to right or right to left. So, the movement, if you try to differentiate the movement of yarn in the fabric structure is along the width of the fabric.

And in woven fabric, usually weft follows the width direction. So, that's why this kind of knitting in which the yarn follows actually along the horizontal direction or width direction, it is called weft knitting.

Because, it is synonyms to the weft of a woven structure. If you see the loop, the loop is perfectly symmetric, 2 legs are perfectly symmetric. If you try to take the mirror image, you can find out this leg is just the mirror image. Apart from that, if you see the foot also, they looks like a perfect mirror image. So, the overall, the architecture of the loop inside the fabric is perfectly balanced.

Because forces which are acting on this loop are balanced in such a way. Apart from weft knitting the other type of knitting does exist where the network of the loops will not look like this. Let's see this structure. So, here, there is one another structure of fabric, which is also called knitted fabric. But, the direction of loop and movement of yarns are completely different. Let's try to analyze the direction of yarn.

So, if you follow the path of black yarn, you can see, you are moving to second column, which is this one, second column. So, you are first moving to the second column. And then, you are moving to the third column. Then again second column; and then, again third column. So, ideally speaking, the movement of yarn is zigzag. Or you can follow, it is along the fabric length direction.

And in woven fabric, it is the warp yarn which actually follows the fabric length direction. This is why, this type of fabric structure is called warp knitted structure. And the process of making this structure is called warp knitting. Okay. Other interesting thing which you can observe in this fabric is the loop stability. If you carefully enlarge any one of this loop; so, I have enlarged one of the loop, you can see, compared to a weft knitting where the loops looks perfectly balanced, because the forces are distributed in such a way they are cancelling each other.

But here, especially the foot part, if you can see this foot; so, one foot is connecting this loop to the other column on the next course, while the other part of the yarn is connecting on the same column, but on the bottom course. So, the same loop is connected, not on the sideways loops, but on the different columns and in different rows. That's why, the nature of force is imbalanced.

And this is why the loop generally tilt from the vertical position. This structure is called warp knitting. Mostly if you see the nets or maybe agrosheds or maybe you football nets or there are all mesh fabrics are made up of warp knitted structures. I also have one fabric with me through which you can able to see the movement of loops in the fabric structure. Let's see the fabric itself. **(Video Starts: 12:23)**

So, I have the fabric with me; so, here you can see; so, if you can see the fabric structure; so, the loops, basically the yarn, loops are actually bent from one position to other position. So, if you see the entire fabric, it is very difficult to carefully understand what is going on inside, about the yarn in the fabric structure. But, if you take the zoomed version, you would be able to easily differentiate, the loops are actually bent inside the fabric structure. Okay.

So, you can see a loop first goes left side and then on the second column it goes on right side. While if you see a knitted structure, it looks perfectly balanced. Okay. And the reason is because of different types of interlacements inside the fabric structure. **(Video Ends: 13:25)** So, because of the interlacement patterns, these, the loop networking or loop positioning inside the fabric structure is different for weft knitted and warp knitted structure.

In weft knitting, there are tremendous ways through which you can manipulate the structure. And you can also create different types of design. Designs are unlimited.

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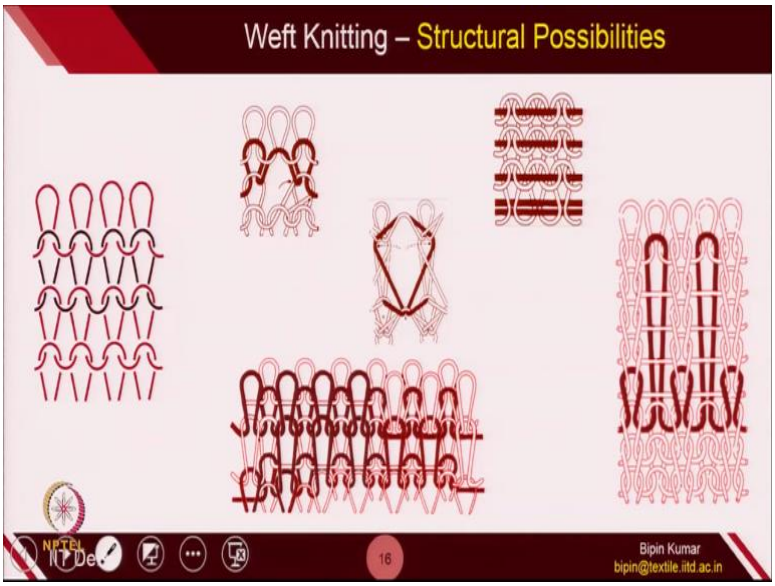

At this moment it is very difficult for you understand these structures. But later in the course, we will be picking one of these structure selectively and we will try to explain how we can actually design this type of a structure.

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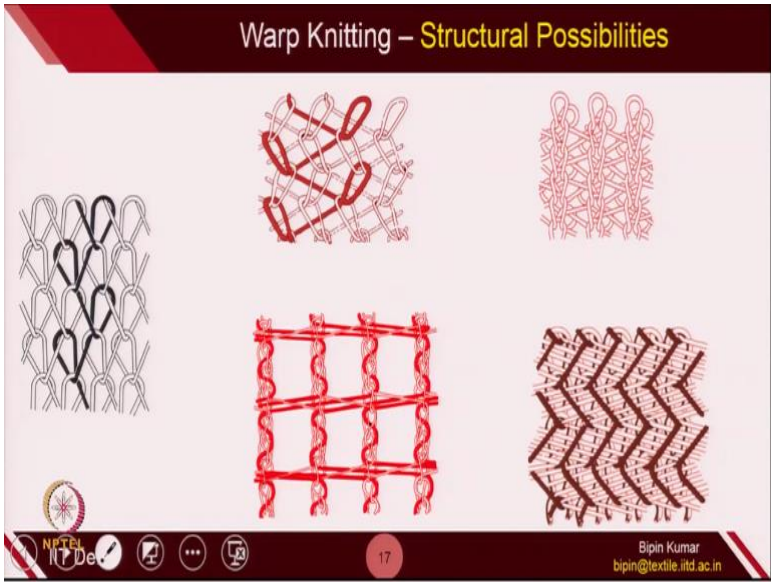

Similarly, warp knitting itself gives lot of design possibilities, where you can design many many complicated structures. This also we are going to cover in the later section of this course.

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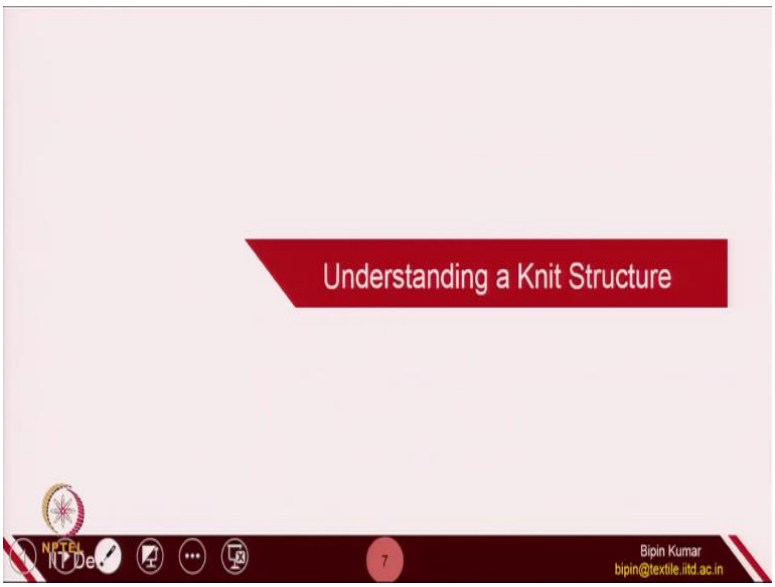

Now, let's try to understand a knit structure, what is actually happening inside a knit structure.

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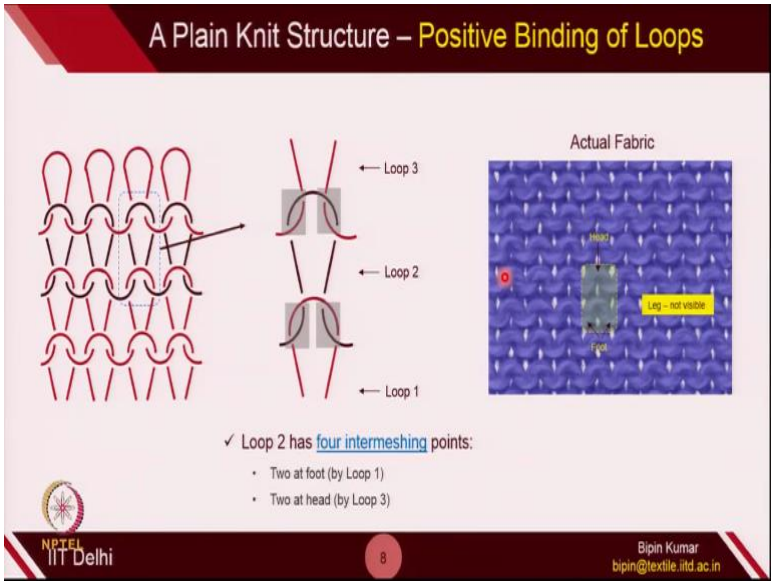

Let's see a say basic weft knitted structure, which is the most simple one. If you try to enlarge it, especially the black one, it is surrounded by 4 types of loops: 1, 2, bottom and top. Okay. If I try to pull this loop from outside, if you try to snatch this loop from the fabric, 2 loops, especially the top one and bottom one will try to protect this loop to go anywhere. Because a loop is positively binded by top loop and bottom loops.

What do you mean by positive binding? Let's try to look at this. So, you have in the same column, you have 3 loops. One is the loop 1 which is at the bottom, the second one is loop 2 which we are going to describe. And again, the next loop which is loop 3. And if you try to further look at the segments of the loop 2, it has 4 intermeshing points. Intermeshing point means, it is interacting with the yarn at 4 different location with these 2 loops.

First, at the foot part. If you see this black yarn, it is basically interacted with the red one. Okay. And on this side, on the right side also, the same yarn is interacted with the head of loop 1. So, loop 2 has 2 intermeshing points at the bottom portion where the foot of the loop 2 is interacted with the head of loop 1. Okay. Now, look at the top side where you have the head part is interacting with the 2 feet of loop 3. Okay.

So, loop 2 in total has 4 interaction, 2 with top loops and 2 with bottom loops. Okay. This is the image of actual fabric, if you try to find out what is happening with the head and the feet portion, I am going to set one segment of the loop which is the exactly the same one. So, I have highlighted here. So, in this segments, you can easily see the head part and the foot parts. So, this is the foot part which is interacted with the bottom loop.

And the head part is interacted with the top loop. Okay. In the entire fabric structure, you would not be able to see the straight segment of the loop. Leg is not visible in this surface of the fabric. Okay.

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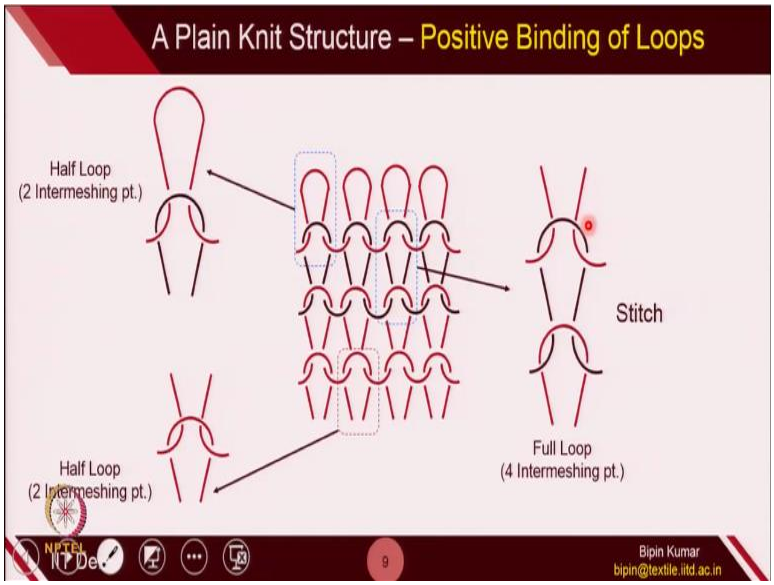

So, if you further try to understand the, intermeshing points, in a, in the entire area of the fabric structure, you can easily differentiate, there will be 3 types of loops which will be existing in this fabric structure. First, let's try to see the loop in the top rows. If you see the loop in the top rows, there are no loops above this particular top row. Okay. What does it indicates? It indicates that this particular red loop have only opportunity to interact twice with the bottom.

There is no intermeshing points on the top sides. So, this loop is highly unstable, because you have only 2 interaction point. So, the bottom loop will try to pull this loop downward. So, this type of loop where there exist only 2 intermeshing points are called half loop. Okay. Now, let's go to the bottom loop, the first row. Here also, if you try to see the network of loop interaction, only the head segment is interacted with the top loop.

The bottom segment is generally free. So, this loop is also unstable, because the force is only interacted on the top side. The bottom side, the loops are highly unstable. This again, this loop, you have only 2 intermeshing points. So, that's why it is also called a half loop. Apart from bottom loop and top loop, if you pick any other loop; for example, let's suppose, if I pick this one which I have enlarged on the right side, you can easily see, there are 2 at the top intermeshing points and 2 at the bottom intermeshing points.

So, this is called full loop. Because this is highly stable as per the networking of the yarn. So, this full loop is in reality, we call this as a stitch loop or a stitch. Because, this is the perfectly stable loop. Because, you have given 2 intermeshing points on the top. Simultaneously, you have also given 2 intermeshing point at the bottom. So, this loop will never able to try to open, either from the bottom or on, from the top side. Okay.

Now, let's see what happen to a loop when you see inside a fabric structure. So, inside a fabric structure, to make the intermeshing, there is only 2 possibility exist for a loop to interact with its previous loop.

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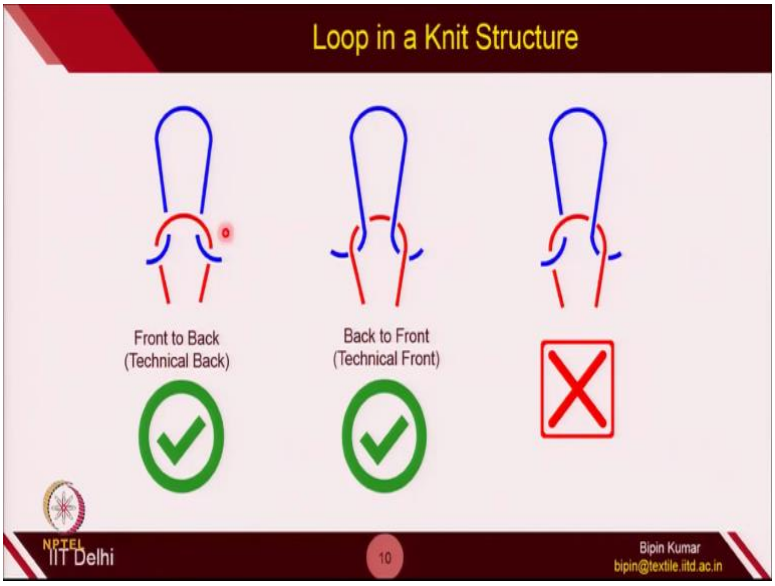

So, for example, here there is a blue one which is interacting with the red one. So, when make the red one; after that, when you have to make the blue one, one possibility is, you take the loop and bring it towards the back side of the red one. So, if you follow the yarn path, you can easily see, this loop is drawn from the front side to the back side of the red loop. So here, the loop, nature of the loop is from front to back.

That's why, this type of loop is called technical back. Okay. The other possibility is, that loop can be projected towards outside. Meaning, here you have the red loop; but if you see the nature of blue one, it is coming towards the viewer. Or maybe you can say, it is coming towards the front side of the bottom loop. Okay. So, the loop has been formed from back side of the bottom loop towards the front side.

So, the loop is been formed from the back side to the front side. We are going to explain this nature of back to front once we actually design the loop. When we have the lecture on designing the loop, you would be able to understand what is front to back and back to front. So, for the time being, when the loop seems or appears towards the back side, we call it technical back; when the loop, new loop seems on the front side, it is called technical front.

There might be other possibilities as well which can be theoretically possible is you have the yarn which moves towards the back side, then make the loop; and then again coming towards the front side; and then, again the yarn can move towards the backside. So, this movement of yarn, where the yarn is going from front to back, then back to front; and then again front to back.

So, there are 3 type of transition a yarn is making. One, you can see here, front to back. Then, after making the loop, it is coming from back to front. And then again from front to back. So, 3 types of transition is happening on the yarn; which is, in reality is not possible when we design any loop inside the fabric structure. So, these 2 are the only possible way where, which you can find the loop exist inside a knit structure.

Because of this appearance of loop inside a knit structure, the surface appearance of the fabric will be completely different. So, let's look one of the surface of the fabric.

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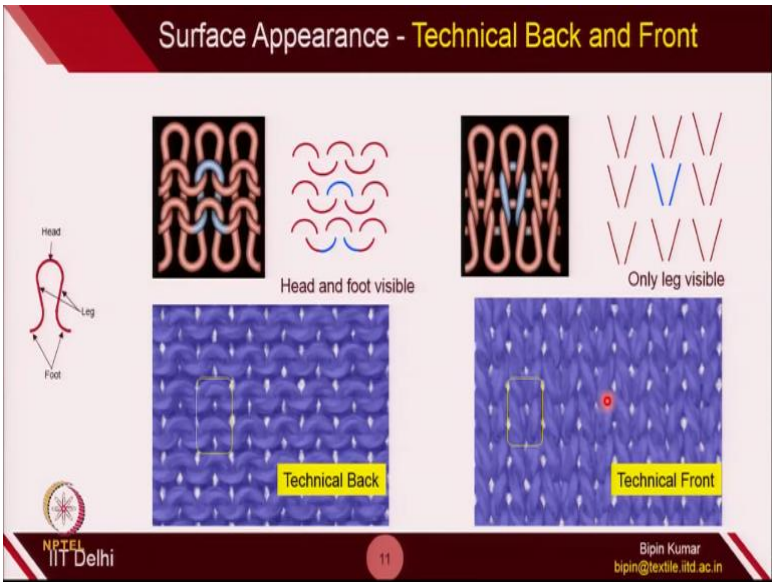

Imagine you make a loop where all the loops are being made towards the back side. Back side meaning; so, if you follow the blue one, if you follow the blue one and if you see the immediately next loop at the bottom side, you can easily find the blue one is being formed

towards the back side of the loop. Okay. This is the actual photo of the fabric where you can only observe the head part and the sinker part of the fabric.

You can easily observe only the head and sinker part of the fabric. So, this side of the surface of the fabric is called technical back. Okay. Because of the nature of loop movement inside the fabric, I have highlighted one of the loop inside the fabric structure. You can only able to see head and foot on the surface. And this is called technical back where you can only see the arc, up right and down right.

So, you have the 2 different types of arc in opposite direction. And the fabric, actual fabric surface looks here. Now, let's see the other side of the fabric. Other side means, if you simply reverse this fabric, if you turn this fabric upside down, you would see a different feature of the loop. In this different feature, if you follow the blue one, so and the bottom loop, you can easily find out, the blue loops is being formed towards the front side. Okay.

So, once the loop is being formed on the front side, only you can able to see the straight segment of yarn which is nothing but the leg. And this surface of the fabric is called technical front side. Okay. So, this fabric where you can only see the legs, we call this as a front side. So, I have highlighted one of the loop area where you can see only the legs are visible. Heads and sinker are visible on the opposite side which is called technical back.

So, like in case of woven fabric, when you turn the both the sides, it almost looks similar. But in case of knitted fabrics, you can easily see the difference. Where one side it will look like arcs and in other side it looks like Vs. So, I have the fabric with me, through which you would be able to easily differentiate or find out which side is technical back and which side is technical front. **(Video Starts: 26:40)**

So, let's see this fabric structure. So, you can see here. So, there is one side which I am pointing out; so, on this surface, when you try to see this surface after zooming, you can only see the head part and sinker part, which one shown in the figure. While if you reverse this fabric on the opposite side and if you try to enlarge it, you can only see the leg portion which is the straight segment of the yarn.

So, this is how both side of the fabric looks different. And they are quite useful in designing. So, we can get different appearance of the fabric just by making the garment from 2 different sides. Okay. **(Video Ends: 27:44)** So, this is a technical back and technical front, extremely important in garmenting, when we design t-shirts or any knit garments.

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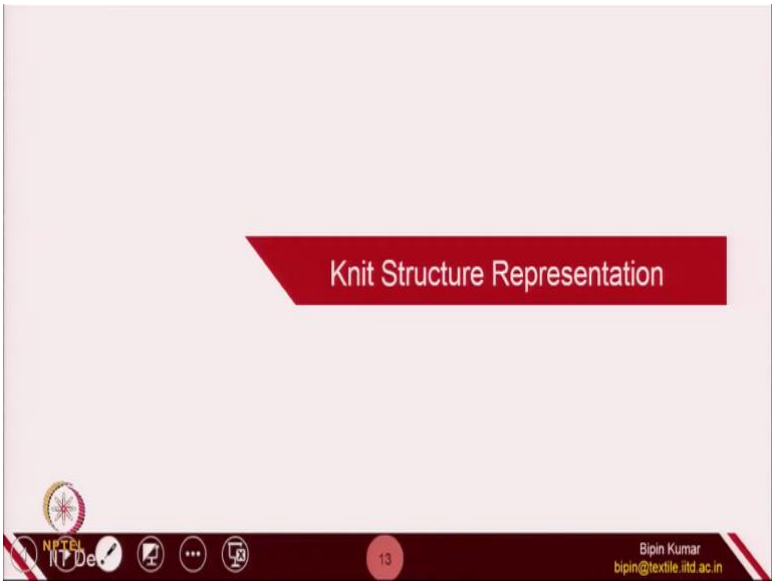

Now, the last segment of this particular lecture is knit structure representation. Just now, we have seen 2 possibilities of loop architecture inside a fabric structure.

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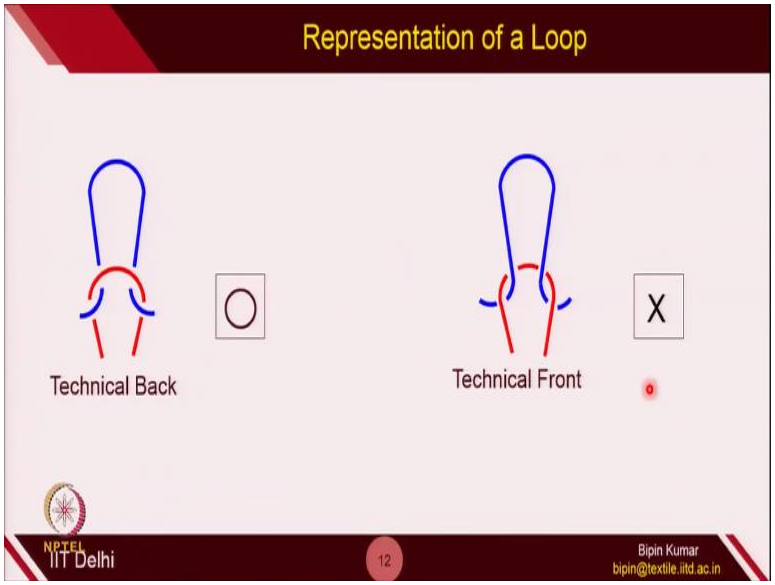

One possibility is technical back where the loops will looks like it is going on the back side. So, we can represent this particular loop which is the blue one, which is being formed on the back side of the bottom loop as circle in a box. Okay. On the right side, we have other option, where the loop looks on coming towards the front side of the bottom loop. We call this loop as

technical front and we represent this loop by cross. So, instead of making the loops, we can simply denote 0 and X.

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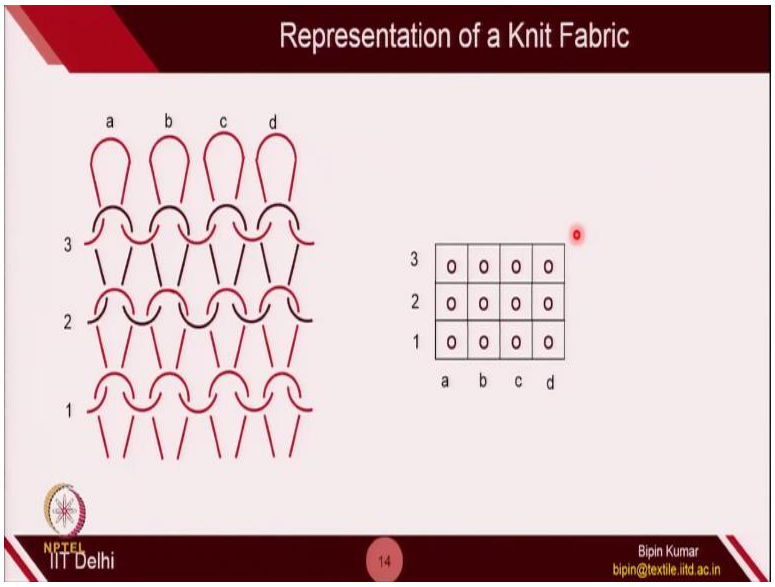

This notation is very very useful when we have to explain any fabric structure. For example, if you try to see this fabric structure, although it looks, the design looks very simple, but once you want to draw this by hand, it is extremely difficult to trace which loop should go up and which loop should go back. Okay. So, to help in representing this fabric, it is always better to follow some representation technique.

For example, we can express this fabric with box 0 and box cross notation. To represent this fabric, you can easily find out the number of loops which you want to represent. For example, here you have 4 columns of loops, a, b, c, d. And if you count the number of rows, there are 1, 2, 3 and 4. But the fourth one, we have no idea whether it is been formed on the front side or at the back side.

So, at the time being, we are just describing only 3 rows which is the 1, 2, and 3. So, I have denoted 1, 2 and 3 right at the end of the yarn movement. Okay. So, in total, we have 1, 2, 3, 4, 4 and 4. There are 12 loops which exist in this fabric structure, that has to be represented by box diagram. So, how we can represent this? So, you have the first course; or in the first row, we follow the yarn movement.

So, if you see this particular loop, the first loop, it means this box. If you follow this loop; this loop, by carefully looking the bottom loop, we can easily see the first loop, that this one is

being formed on the back side. So, that's why we have to place 0 in this box. Similarly, in the row, all loops are being formed on the back side. So, we can simply put zeros in all the box. Now, let's look at the second course which is the black one. Okay.

Following the yarn movement right from one of the end of the yarn, you have again, looking to the loop architecture. We can easily see, this loop is also been formed on the back side of the bottom loop. Okay. So, in the second row also, we have all technical back loops. Again, on the last row which is the top row, all 4 loops are being formed on the back side of the black loops. So, again this is called technical back loops.

So, the entire fabric, you can easily see, we can represent by simple table of rows and columns in the table. And each box of the table, you can identify whether it is a technical front or whether it is a technical back.

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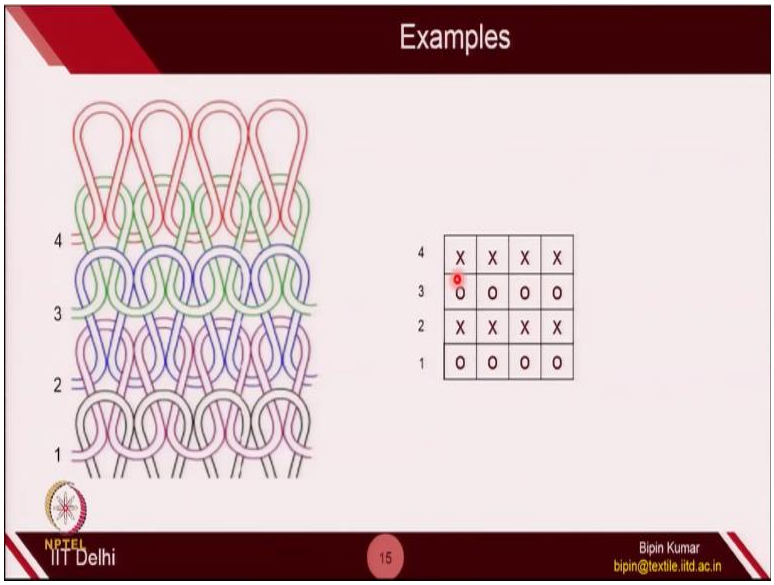

As a different example, we can also look at a different fabrics. Here also, you can see there are 4 rows which is the pink one, blue one, green one and red one. Okay. And there are 4 columns. In the first row, you have 4 loops which is the pink one. If you follow the path of pink one with respect to the black one which is the bottom one, each loop, each pink one is formed on the back side of the black loop.

So, we call that as a technical back. So, we can fill 0 in all the boxes. Now, let's look at the blue loops, second course. So, in blue loops, you can easily see you have 1 blue loop coming out of pink loops. Right? And if you follow the movement of all blue loops, it appears that it

is being formed on the front side of the pink loops. So, that's why this is called technical front. So, second course is all technical front loops.

Again, you see the green one. All green one is being formed on the back side of blue one. So, this is called technical back. And finally, the red one which you can easily observe that it is being formed on the front side of the green loops. So, which is called cross. So, the entire fabric structure can be represented by simple table or box diagram. Okay. This is very useful when we will try to explain or understand complicated structure in the knit.

Because, understanding the movement of loops in a knit structure is the most fundamental aspects. And once we understand that aspects in a knit structure it will be very easy to understand the properties of the fabric or to create any design for the fabric. Okay.

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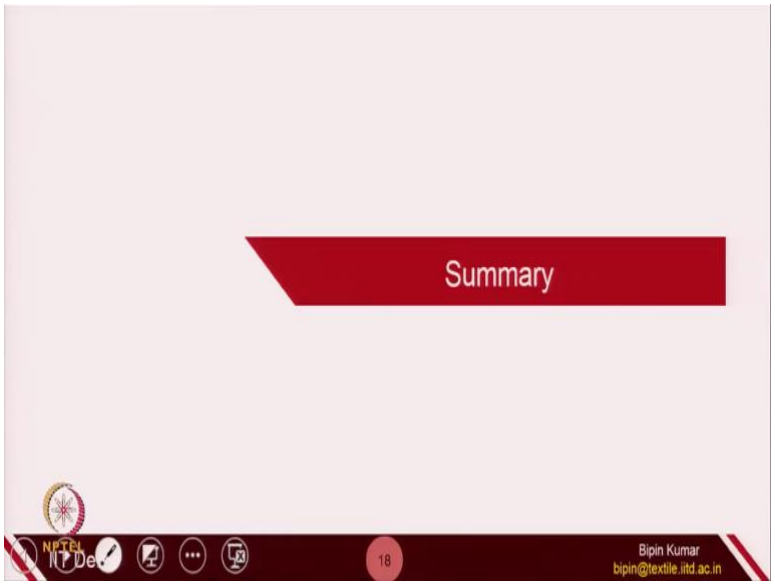

So, now we are going to summarize what we have learned in this particular lecture 2. First thing, we learned lot of terms which is being used in knitting.

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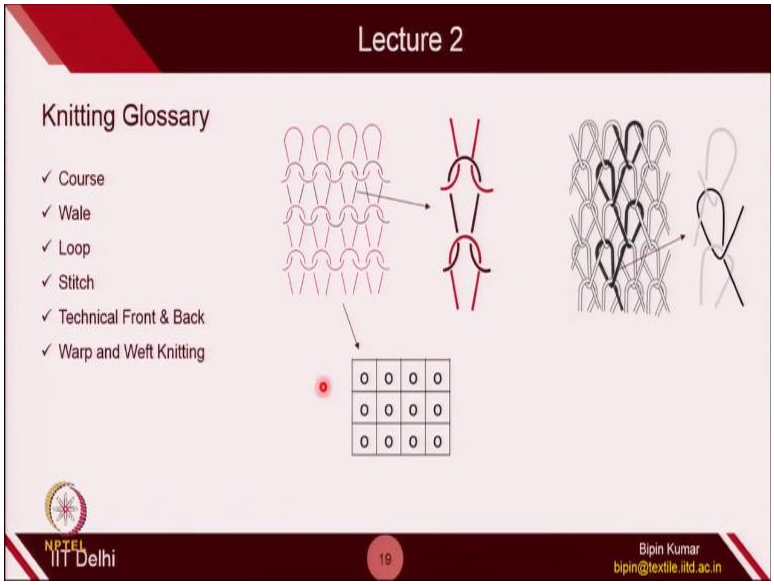

Course; the first one is course, which is nothing but the rows of loops. Wale, which is nothing but the column of loops. Loop itself is the most fundamental block of any knit structure. Stitch is also called loop where all, there are 4 intermeshing points exist. We also define technical back and technical front based on the appearance of the fabric structure. So, right now, if you see this loop, it is been formed on the technical backside.

If you reverse this loop on the other side, it will look like a technical front. We also learned about warp and weft knitting. So, in weft knitting, movement of yarn is from left to right or right to left. Or we call it this as a weft direction. And in warp knitting, the movement of yarn is along the length direction of the fabric, which looks like a warp direction. So, that's why it is called warp knitting.

Fundamentally, the loop network in weft knitting and warp knitting are completely different, because of nature of intermeshing. In weft knitting, loops connected along the rows. But in warp knitting, loop, each loop is connected with the below course and above course. So, that's why they look completely different. Also, we tried to learn how we can explain a fabric structure in terms of technical front and back loops by simple representations.

So, for example, if you see this fabric, we can simply represent this fabric as a zeros in a table. So, we finish lecture 2 now. In the next lecture, we are actually going to learn how we make these loops, especially for the most simple one. Thank you very much. We hope to see you again.