Oil Hydraulics and Pneumatics
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Part 1: Pneumatic control system, Representation of a control task in multiple circuit design, 5/2 direction control double pilot valve and its major problem
Lecture - 77
Pneumatic Circuits: Design and Analysis of Multiple Actuators

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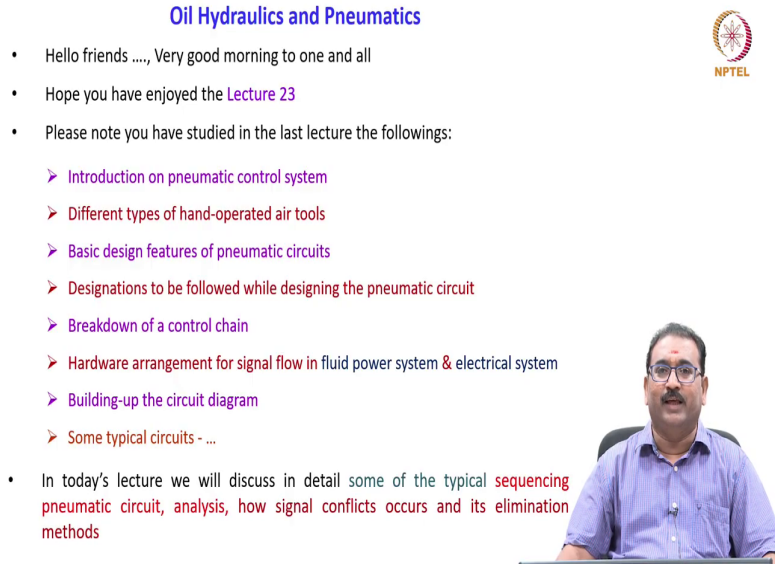

My name is Somashekhar, course faculty for this course. Hello friends, very good morning to one and all. Hope you have enjoyed the last lecture 23rd. Please note you have studied in the last lecture the followings; introduction on pneumatic control system, different types of hand operated air tools, basic design features of pneumatic circuits designations to be followed while designing the pneumatic circuits.

Please note friends, in pneumatics, we are representing the cylinders 1.0, 2.0, 3.0 if multiple actuators are there and all the valves are numbered which we have learned in the last class. Breakdown of a control chain; hardware arrangement for signal flow. Here I am given in the fluid power system and electrical system.

How it is signal flow? From the tank pump control valves, then it will go to actuator; correct? Always it will move from the down to up. Here we have seen how the signal flow will takes place in fluid power, oil hydraulics and pneumatics and it compared with the electrical systems.

Build-up of the circuit diagram, also we have discussed in the last class. Some typical circuits for various applications which are task dependent. Please understand, all the circuit diagram after connecting all the elements, once it is actuated, how they will work, you will understand. Always circuit is drawn in the null position, that is actuators are always in the retracted position.

The operations will start once will give the one push button. Generally, the one valve the DCV, either it is a 2 by 2 way valve or whatever it is, 3 by 2 way valve whatever it is. One they will keep as a main valve, after pressing this, everything will starts moving because that is the main control valve, what we are called controlling the fluid flow from the source to other valves.

In today's lecture, we will discuss in detail some typical sequencing pneumatic circuit. Here, we will discuss in detail analysis and how signal conflicts occur during the operation and how to overcome these signal conflicts and various methods, how to overcome these signal conflicts, which generally occurs when we are operating the multiple circuits in pneumatics.

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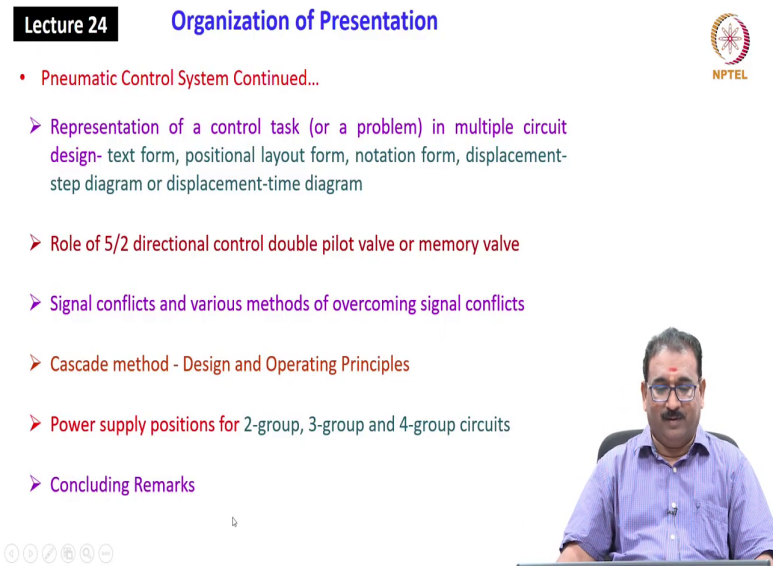

Quickly, we will see the today's organization of presentation. Pneumatic control system is continued. As I have already told the 4 lecture hours for the circuits; 2 for hydraulics and 2 for pneumatics. I am all I am bringing together in 2 class, that is very tough job it is friends.

You will learn other circuits also. In today, we will discuss representation of the control task or a problem restricting to multiple circuit design- how to represent in the text forms, positional layout form, notation form, displacement-step diagram, displacement-time diagram. All the operation, first we have to represent in these forms, for better understanding the task how it is performed.

Last class, we have discussed about the 5 by 2 way valve. Today also, I will give one slide on role of 5 by 2 directional control double pilot valve. It is also known as a memory valve. Signal conflicts and various methods of overcoming the signal conflicts. Next we will move

onto the cascade method - design and operating principles here. Here, we will discuss the power supply positions for 2 group, 3 group and 4 group circuits.

These are very essential, when we are handling the 2 actuator, 3 actuator, 4 actuator in sequencing.

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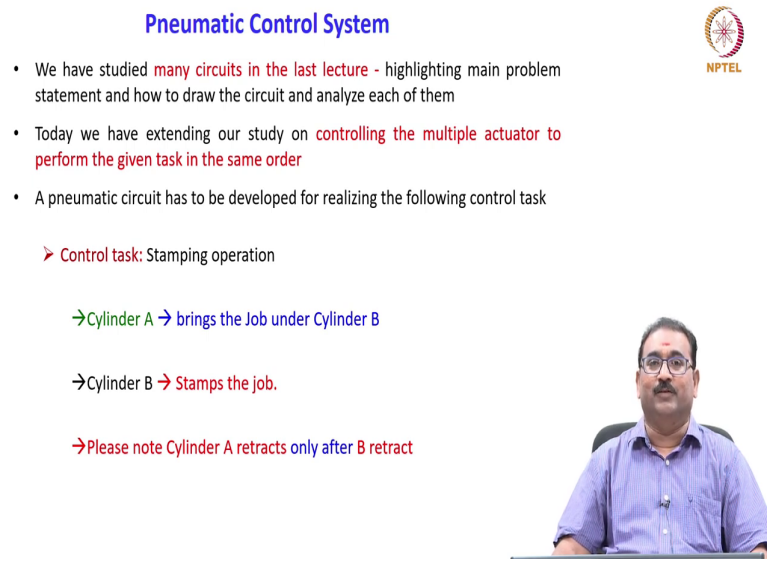

Finally, I will conclude today's talk. We have studied many circuits in the last lecture, highlighting main problem statement and how to draw the circuit and analyze the flow path for each actuations. Today, we have extending our study on controlling the multiple actuator to perform the given task in the same order. A pneumatic circuit has to be developed for realizing the following control task.

The until and I will take this problem and I will analyze in each steps. Control task is stamping operations. Cylinder A brings the job or a workpiece under cylinder B. Cylinder B stamps the job. Please note, cylinder A retracts only after B retract, this is a condition.

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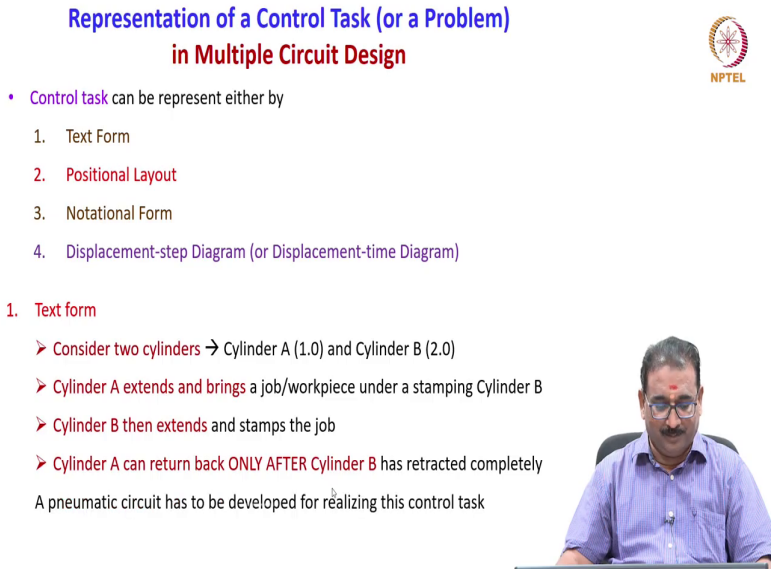

After knowing the control statement, let us we will see the representation of the control problem in multiple circuit like this. Either by the text form, positional layout form, notational form, displacement-step diagram; if you know the timing for each step, you have to represent displacement-time diagram also.

Let us we will see knowing the task in mind for better understanding, after conceiving the problem in the mind. We have to represent this control task using the any one of the method.

First, we will see the text form. Same thing we have to define in the text form. How it is? Now, it is a 2 cylinder stamping operation as I have told you; cylinder A 1.0, cylinder B 2.0. Cylinder A extends and brings the job or a workpiece under the stamping cylinder B. Cylinder B, then extends and stamps the job. Cylinder A can return back only after cylinder B has retracted completely.

A pneumatic circuit has to be developed for realizing this control task. After understanding the problem, you have to form like this. It is an text form representation.

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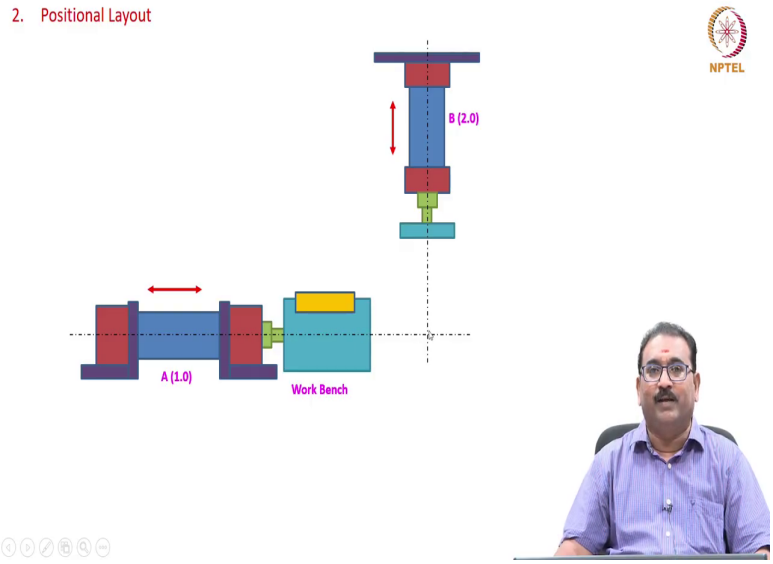

The same thing you have to represent in the positional layout diagram also. How it is? Just I have shown here. 2 cylinders I am taken here for representation; cylinder A 1.0, cylinder B 2.0. What is a duty of A? Cylinder A brings the work bench which has a workpiece under

cylinder B; meaning, it should extend to bring here. After bringing here, cylinder B will extend, stamps the workpiece.

Then, what? It will go back; then, only A will go back. You will see you have to represent the motions like this. This is representing the same task in the positional layout diagram.

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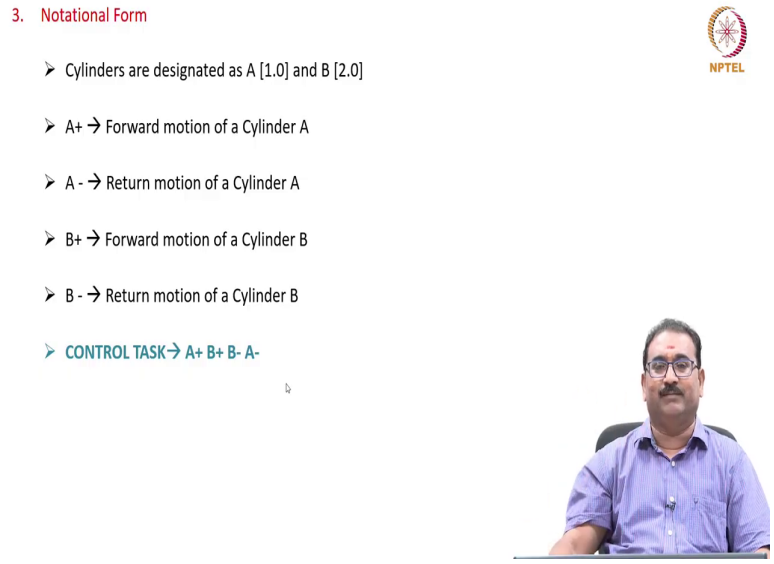

Move on to notational form, how to represent this. Same task. Cylinders are designated as I have told you A 1.0, B 2.0. A plus, forward motion of cylinder A; A minus, return motion of the cylinder A; B plus, forward motion of the cylinder B; B minus, return motion of the cylinder B. Then, how to represent the control task in the notational form?.

First which cylinder will extend A plus, then B plus, then B minus, then A minus; altogether, you represent the control task in a notational form A plus, B plus, B minus, A minus.

Whatever the cylinders are there, you have to represent in notational form like this. A plus means everyone will understand cylinder is extending; A minus means cylinder is retracting. First you have to represent the different task like this.

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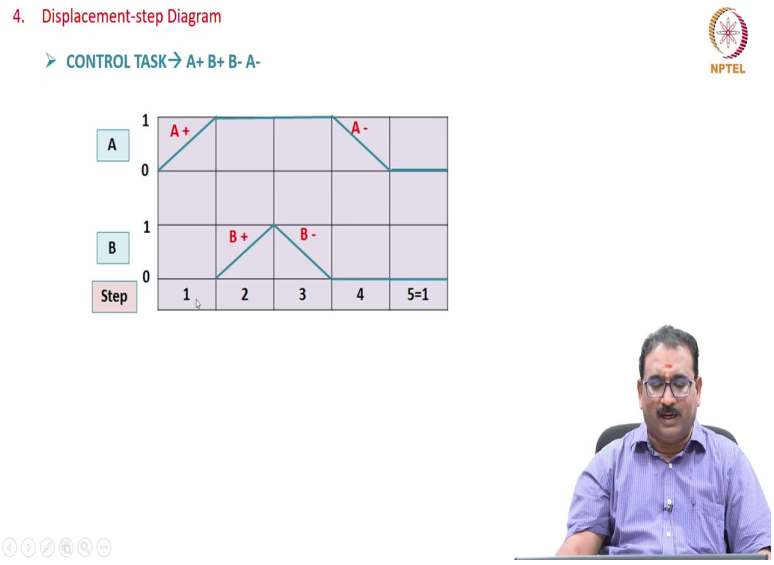

Now, how to represent in the displacement step diagram? Already we know that control task is like this A plus, B plus, B minus, A minus. This is a diagram it is, what I have drawn here, I am taken for cylinder A operation, cylinder B operation; these are the steps. What happens here? You will see here control task from 0 to 1 means the retracted position, extended position, like this it is.

First A will extend A plus, then what happen? That time B will not extend. Here after the A extend, B extends; then, what happen? B retract, then A retract. Please understand this circuit diagram; displacement step diagram. Finally, it both cylinder will be in the retracted

positions, then it will cycle will repeats; A plus, B plus, B minus, correct? A minus it will repeats.

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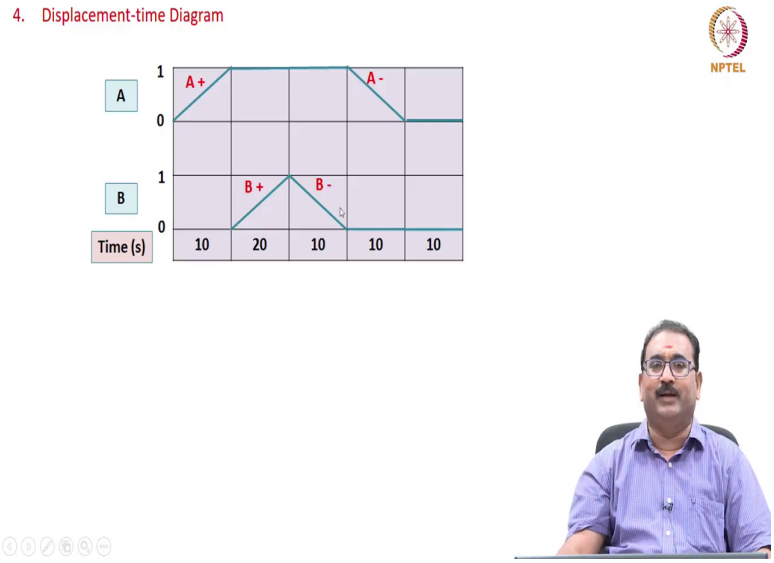

If you know the timings for each step, you have to represent this in the displacement time diagram; same it is friends, see here. Now, I am taking for each step A plus some 10 seconds, B plus 20 seconds, B minus 10 seconds, then A minus again 10 seconds; then, cycle will repeats. If you know the timing, you have to represent like this also. That is why displacement step diagram and displacement time diagram looks same.

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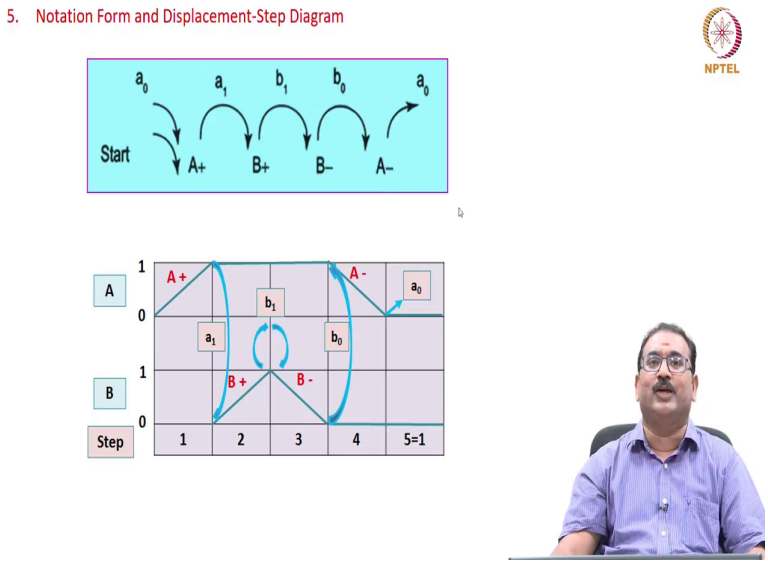

Then, one more is there. Generally, fluid power engineers are used notational form and a displacement step diagram to represent the control task. How it is? We will see now. You will see now friends, where the circuit will start? Always in the retracted position, as I have told you. Cylinder A should retract you have to monitor, B should retract in the retracted position, then we have to monitor the retracted position of the A cylinder and a B cylinder.

If you are sensing this using the sensor, then A will extends, then only B will start extending; meaning, I want to know the extended position of A, similarly the extended position of B; all the retracted position extended positions are sensed using the sensors. Now, I am writing here the sensor positions a 0, a 1, b 1, b 0, a 0. Now, we will see the a 0.

When cylinder is in the null position which will makes the cylinder to extends, once it will extend, where it will go? It will extended position a 1, a 1 will generate, you will see here a 1

will generate. When a 1 will generate, B will starts moving extending. The extended position of the B will generate the b 1 signal which makes the B minus to happen.

When B minus comeback, meaning it will sense b 0; then A minus will takes place. Then, cycle repeats. You will represent like this A plus results in a 0 signal, then B plus will takes place. When B plus will takes place b 1 signal will generate, which makes the B minus to happen. When B minus will takes place, it will generate the b 0; then, A minus will takes place, then cycle repeats.

Please understand this; meaning, I am showing you here the extended and retracted position of the cylinder. These are nothing but we are using the limit switches a 0, a 1, b 0, b 1. We will see further.

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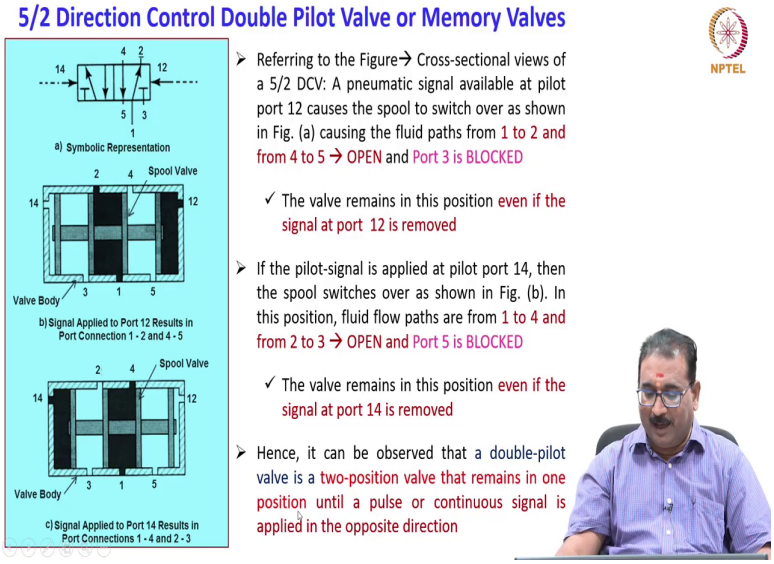

Before that, already you have seen this; correct friends? Quickly, I will tell you this is very important in the today's discussion also. This is a 5 by 2 directional control double pilot valve are also known as a memory valve. See here friends, without this it is your 4 by 2 DCV, two positions; but with this 14 and 12 are the pilot signals, it is a 5 by 2 way valve, already we have seen in the last class also.

Now, I will show you how they will work? Referring to the figure, this is a cross sectional views of the 5 by 2 way valve. This is the valve body which has the ports; 2 and 4 are the actuator ports, c 1 and c 2 what you will call. Then, 1 is a pressure port or a power source; 3 and 5 are the exhaust port, you are seen already in the last class.

Now, we will see here, what happens in the figure b. A pneumatic signal available at pilot port 12 causes the spool to switch over as shown in figure a. What happened here friends, see here, causing the fluid paths 1 to 2, energy is going to 2; then, the cylinder will extends. Whatever the energy is there at the other side, it will pass from 4 to 5 exhaust.

But you will remember, other side port is blocked; correct? The valve remains in this position. Even if the signal at port 12 is removed that is a beauty of this valve. When it will cut off? Whenever the signal is coming from the other side of the pilot port. Now, let us we will see.

If the pilot signal is applied at a pilot port 14, then the spool will switch over like this. In this position what happen now we will see. 1 is connecting to 4 and then, 2 is connecting to 3; now, 5 is blocked. Please remember friends, the valve remains in this position, even if the signal at 14 is removed.

When it will switch over? When opposing signal will come, remember this. Hence, it can be observed that a double pilot valve is a two-position valve that remains in one position until a pulse or a continuous signal is applied in the opposite directions.

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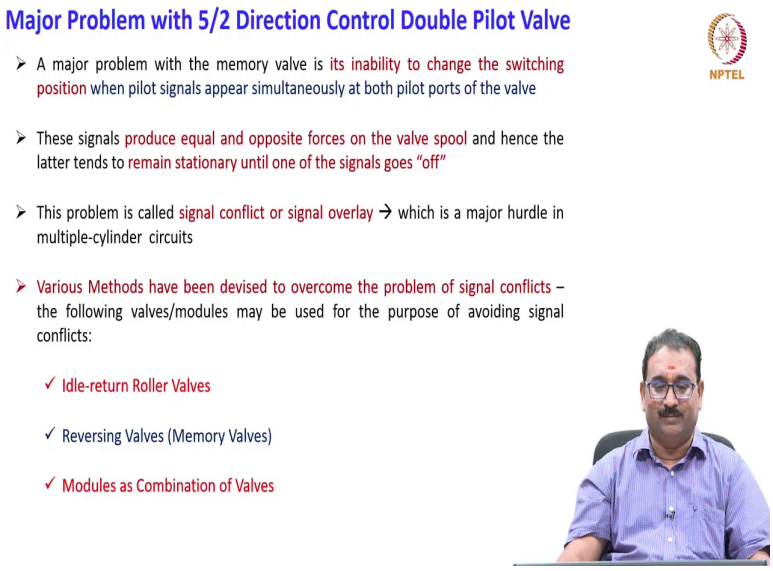

The please remember friends, one major problem is there in the 5 by 2 directional control valve, what is that you will see now. A major problem with the memory valve is its inability to change the switching position, when pilot signals appear simultaneously at both the pilot ports 14 and 12. It will get struck whether I will shift here or I will shift here. These signals produce equivalent opposite forces on the valve spool.

And hence, the latter tends to remain stationary until one of the signal goes off. This is what we can call it as a signal conflicts. This problem is called a signal conflict, also known as signal overlay which is a major hurdle in multiple cylinder circuits. Because we are using the 5 by 2 way valve. 5 by 2 valve biggest problem is when 2 signals pilot signal 14 and pilot signals, both are coming at a time what happens know, it will not understand; but it will remain in the previous stage.

Various methods have been devised to overcome the problem of signal conflicts; the following valves or modules may be used for the purpose of avoiding the signal conflicts. What are those friends? You already seen this 3 by 2 idle-return roller valve; reversing valves or memory valves; modules as a combination of valves.