Automation in Manufacturing
Dr. Shrikrishna N. Joshi
Department of Mechanical Engineering
Indian Institute of Technology, Guwahati

Week – 07
Mechanisms
Lecture – 03
Application of Cams in Automation

Hello everyone, I welcome you all to the lecture 3 of week 7. The title of the lecture is Application of Cams in Automation.

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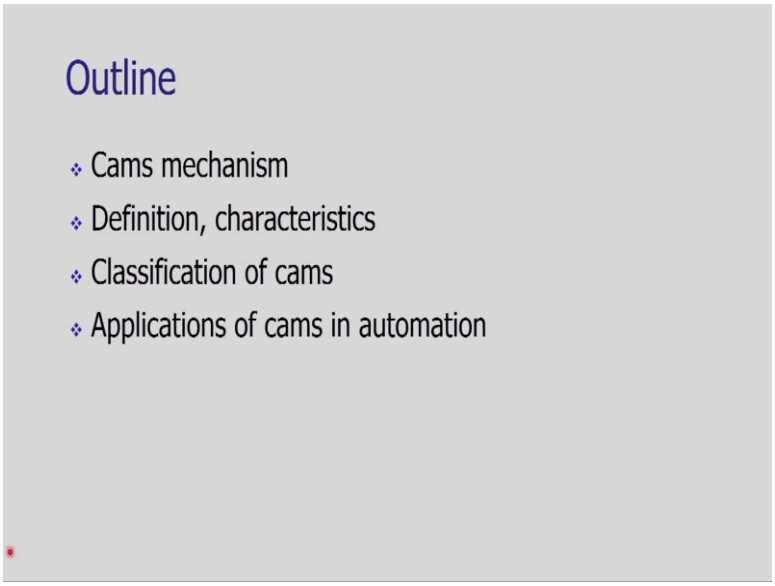

Cam mechanism is very important mechanism. We will be studying its definition, characteristics, how we are generating complex motions. How the cams are useful to automate the processes, that we will be studied. We will have a discussion on the classification of cams; we will look at the various types of cams. At the end of the lecture, we will see various applications of cams in the automation.

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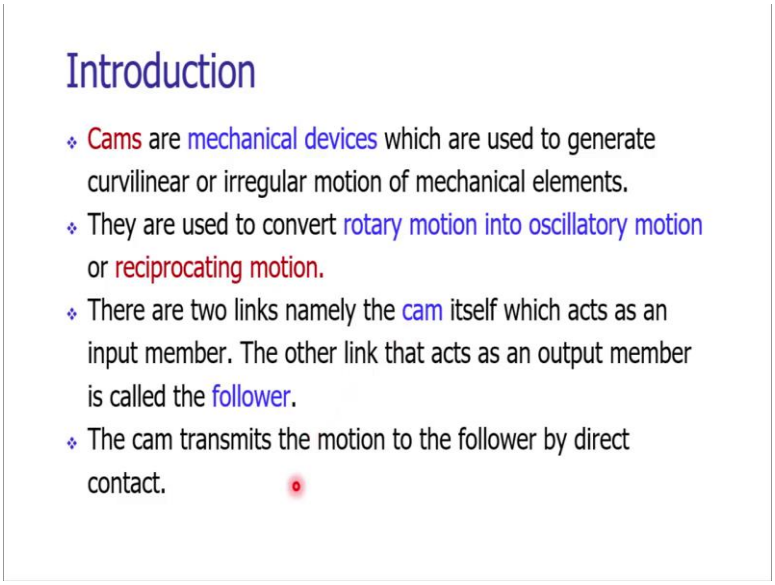

Cams is very useful mechanical device. And the cams based mechanical systems are used to generate curvilinear or irregular motion of mechanical elements. When we want to convert the rotary motion into oscillatory motion or reciprocating motion, we are using the cams. Cams are used in copying the motion from one profile to the other profile.

In the cam based mechanical systems we are using a cam and follower. The cam itself is acting as an input member. Through the cam itself, we are applying the input motion which will be rotating motion. And that rotary motion will be converted into either oscillatory motion or reciprocating motion through a rigid body that we call follower. There is a direct contact between the cam element and the follower element.

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If we want to copy or transfer the complicated movements, we can easily transfer by using the cams. The cam follower mechanisms are widely used in IC engines, particularly to operate the inlet and outlet valves, machine tools, printing control mechanisms, textile weaving industry where we need to transfer the patterns from the master pattern to the products, and various automated machines.

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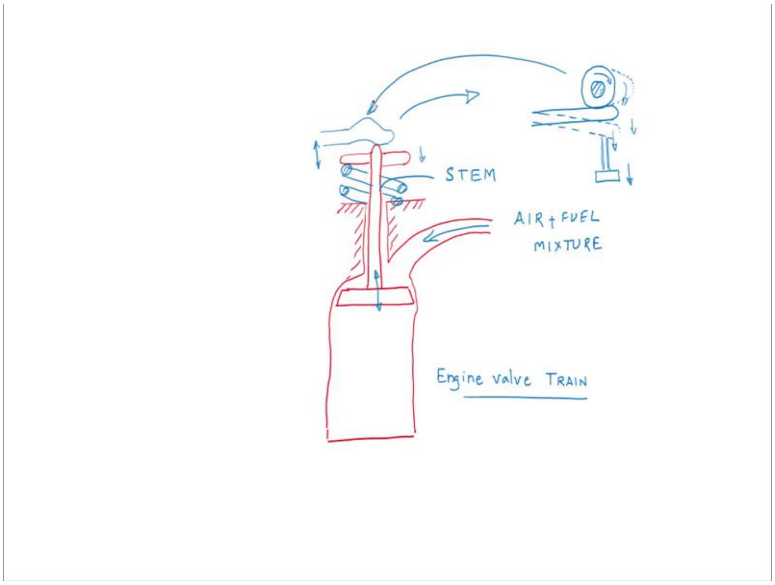

Let us see how exactly the cams are helping us by taking example of an engine valve train. In engine valve train, we have to operate the passage of fuel and air mixture inside

the combustion chamber. On our screen, you can see an engine valve train; the requirement is to have the reciprocatory motion of the valve stem. This is a valve stem, and we need to have reciprocatory motion of this valve this is stem of the valve. Through this passage, the air and fuel mixture will enter. We need to have the downward motion to open the valve, so that air and fuel mixture will come inside, and then there has to be the upward motion as well.

To ensure the upward motion, we are using springs. Due to the stiffness of the spring, the stem would been upward movement always and the valve will be in the closed position. To push the valve in a downward direction, we need to have certain arrangement. And for that arrangement, we are using a mechanism. This to be pushed in downward direction, to push it in to the downward direction, we are using this mechanism. This can be achieved by using the cams.

Suppose, we are having this horizontal plate here, and now we want to just push it in downward direction. Consider there is a disc which is in contact with this. The disc is mounted on a shaft. And as we are rotating the disc, there would be the friction between the disc and this plate.

Now, this disc is circular. If I change its shape, we may have displacement of this disc in downward direction. When this portion will come in a downward direction due to this movement, the disc will be the end of the disc will be displaced. Whatever the elements there in connection with the end that will be moved in downward direction. The same principle will be applied here as well.

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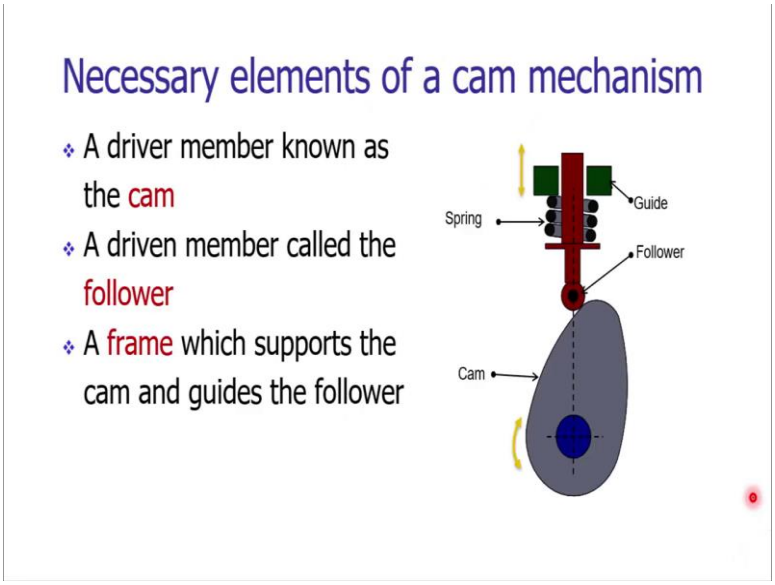

On our screen, you can see a cam as I mentioned right now. We are having a disc. Disc is not in circular shape. It is mounted on a shaft, and that shaft is connected to the electrical drive. There is a follower. That follower is in direct contact with the cam. As the cam is rotating about its axis, it is driving the follower in upward direction.

As it is moving in upward direction, there would be compression of this spring. And when there is a release of the cam when the when the lower diameter portion will come in contact with the follower due to stiffness of the spring, the follower will move in a downward direction. In this way, we can have the conversion of rotary motion in to the reciprocating motion.

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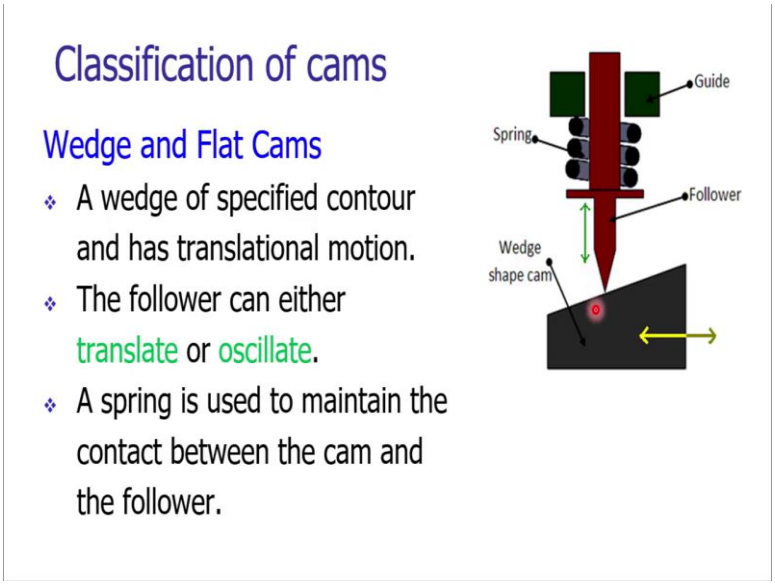

There are various types of cams being used. And we can have the classification such as wedge and the flat cams. In this type of arrangement, we are using a wedge shape cam and the follower is a pointed follower. The shape of the cam is straight; it is not curvilinear. It is a linear cam basically.

As we are giving linear motion to the cam instead of providing the circular or rotary motion that we have seen in the previous slide, in wedge and flat cams we are converting the linear motion in to the reciprocating motion which is at the orthogonal direction to the cam motion. Here we can see the cam motion is linear; and the follower motion is also linear, but both of them are orthogonal to each other.

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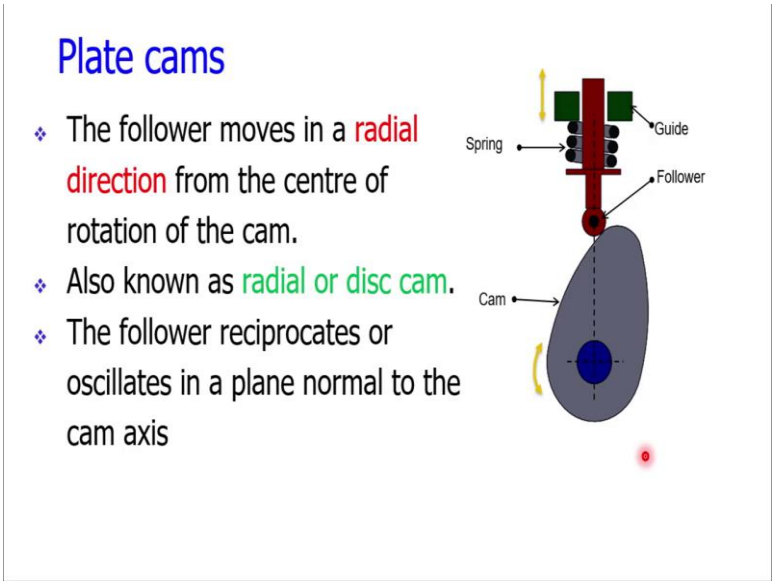

In plate cams, the follower is moving in radial direction. Schematic can be seen on our screen. There is a plate cam which is rotating about its axis. We are having a follower. The translatory motion of the follower is in the radial direction of the cam. The other arrangement is very similar to the previous one. We do have a spring and the guide. This type of plate cams is also called as the disc cam or the radial cam.

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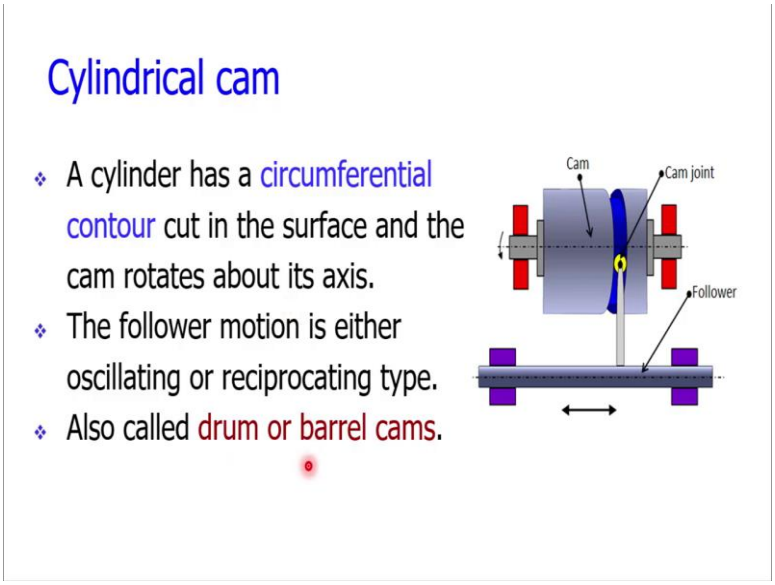

The next variant is cylindrical cam. In cylindrical cam, the cam is in the shape of a cylinder. And we are machining a groove on the circumference of the cylinder. The

follower is engaged inside the groove, and the other end of the follower is attached to a rod which is supported into two supports. The rotary motion is given to the cylinder as the cylinder is rotating about it its axis.

As the cylinder is rotating about its own axis, the cam joint will move inside the groove provided on the outer surface of the cylinder. The cam joint is connected to the follower. The follower is supported into two supports. The rotary motion of the cylinder will be converted in to the translatory motion of the follower through the cam joint. These types of cams are also called as drum or barrel cams.

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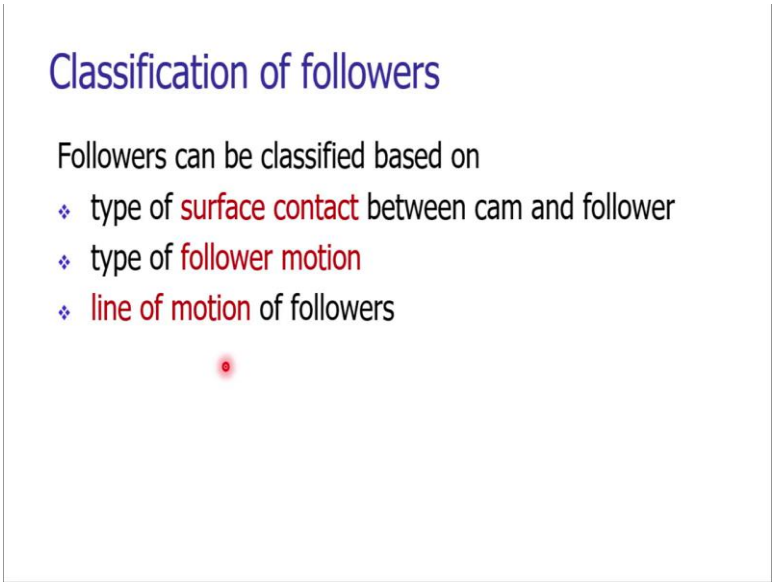

The followers can be classified based on the surface of contact between the cam and the follower, or they can even classified based on the follower motion itself. Third classification is on the line of motion of the followers.

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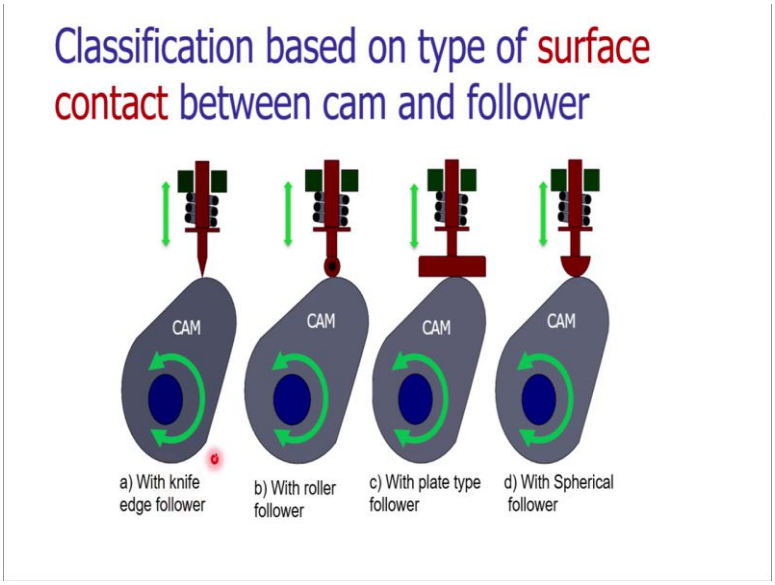

The first classification is based upon the surface contact. In the first variation, the follower is in terms of a knife edge, but due to repetitive contact of the follower with the cam there may be wear and tear of this knife edge contact, it may get worn out and we may lose the accuracy. For this purpose, we are using rolling friction between the follower and the cam. These cams are very efficient with roller follower. We can even have a plate type of follower. To have the efficient contact with the follower, even we can provide the spherical nature to the end of the follower.

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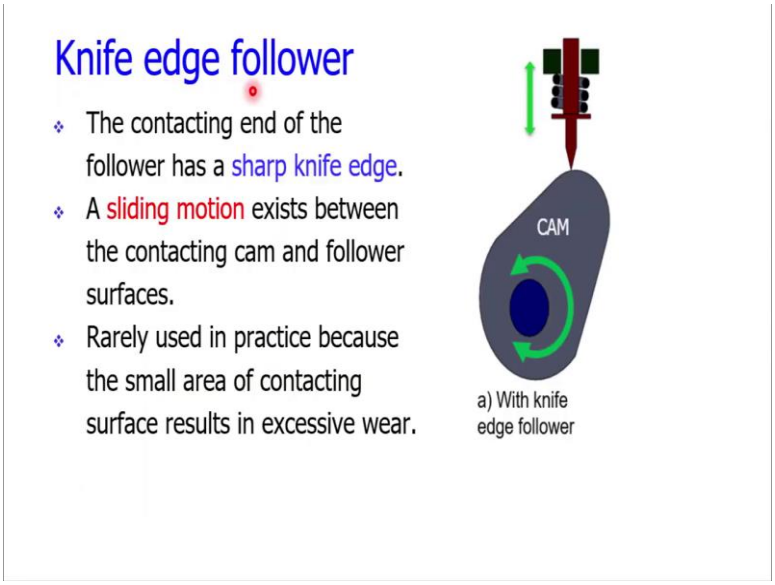

The knife edge follower provides sharp knife edge. Due to that, there will be excessive wear of the knife edge and that will lead to decrease in the accuracy. That is why knife edge based followers are rarely used in the practice.

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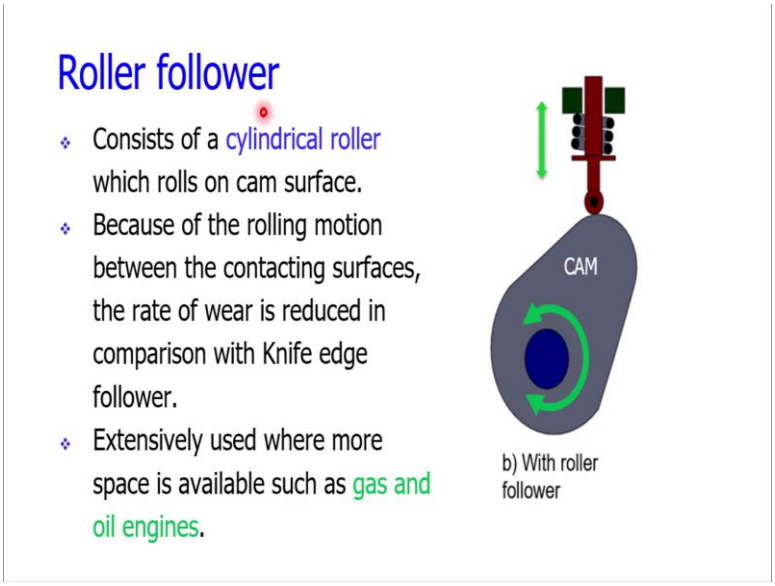

In roller followers, there is rolling friction, rolling motion which is reducing the wear and tear. That is why this roller follower based cams are widely used in gas and oil engines.

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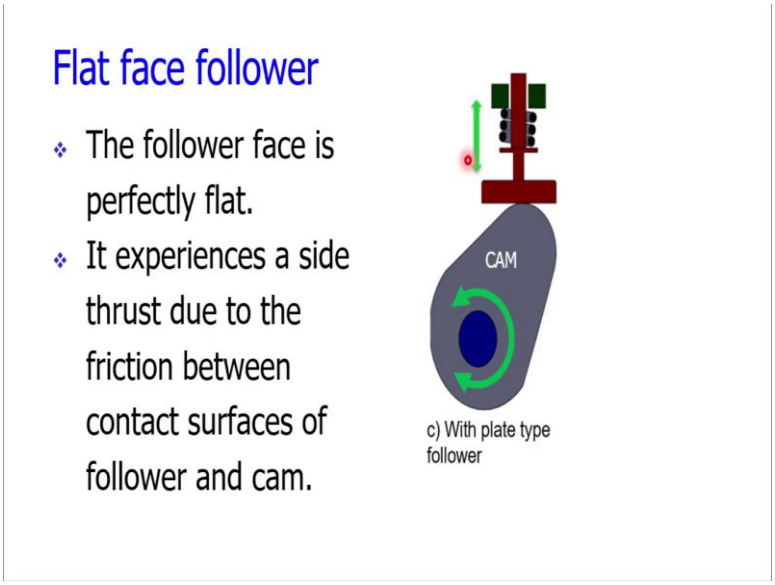

In flat face follower, there may be chances of having the side thrust. As the cams are connecting at these points of the follower, there may be application of the side thrust on the stem of the follower that may lead to the side thrust. It may destabilise the system.

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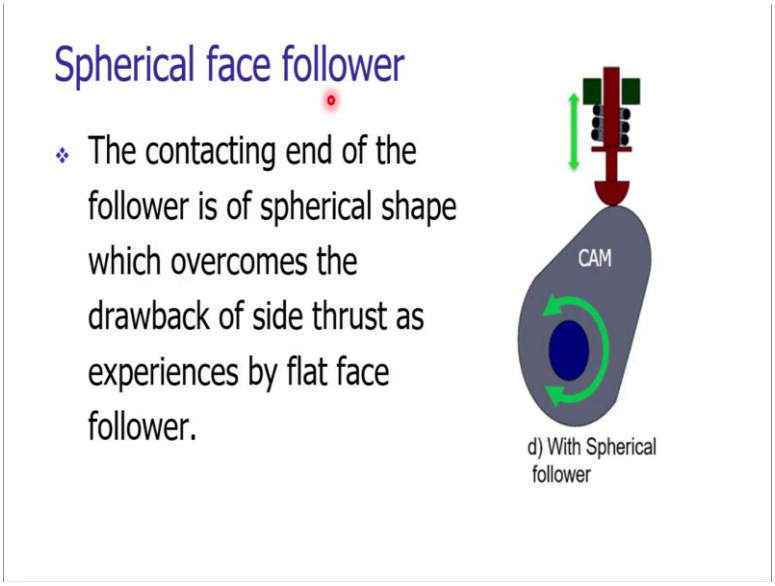

This problem is solved by using a spherical end of the follower. Here will have the gradual engagement of the cam with the follower.

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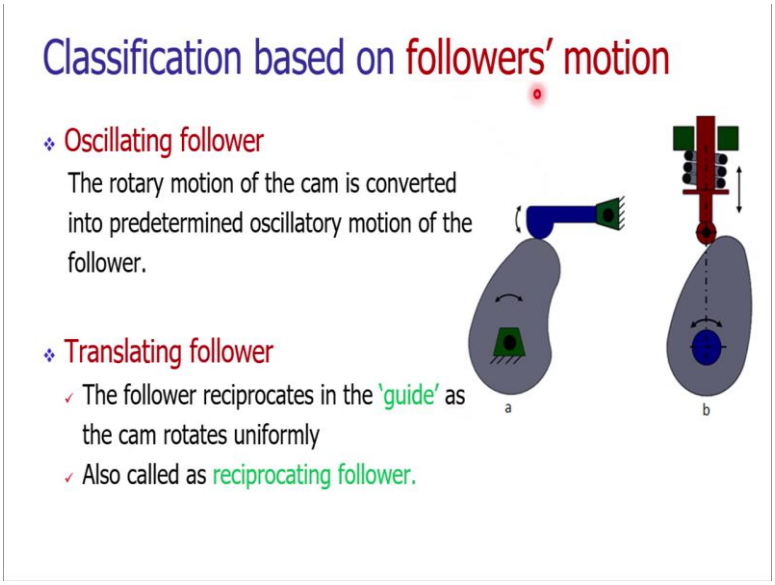

The side thrust will be reduced in spherical face based follower. Followers are also classified based upon the motion. We can have either the oscillating motion of the

follower, or we can have the translating motion of the follower. Here we notice that the cam is rotating about its axis and it is generating the oscillatory motion of the follower or the typical cam which is generating the translatory motion of the follower.

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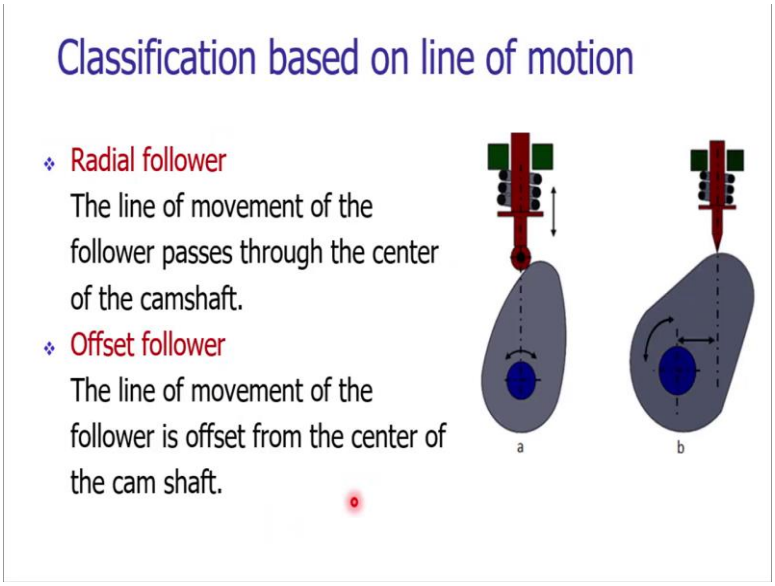

Based on the line of motion as well we can classify. Either we can have the radial followers. The axis of the follower is along the radial direction of the cam itself. The line of movement of the follower passes through the center of the cam shaft. The line of motion is offset with the center of the cam shaft, then we can have the offset follower mechanism.

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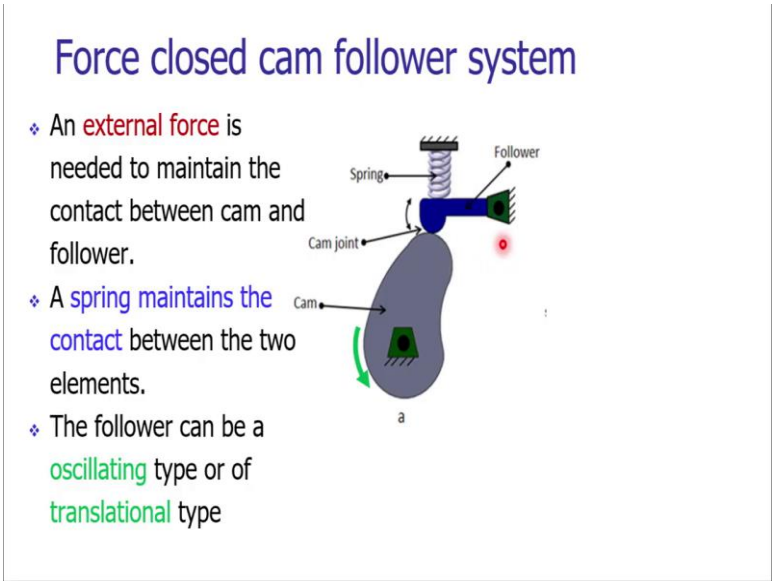

To have an efficient operation of cam follower, we need to ensue the continuous contact or uninterrupted contact of the follower with the cam. For that purpose, we are using external force which will maintain the contact of the follower with the cam. For this purpose, we are using springs in the oscillating motion as well as the translation motion. On our screen, we can see a typical arrangement when where the oscillating follower is in contact with the cam due to the application of spring force.

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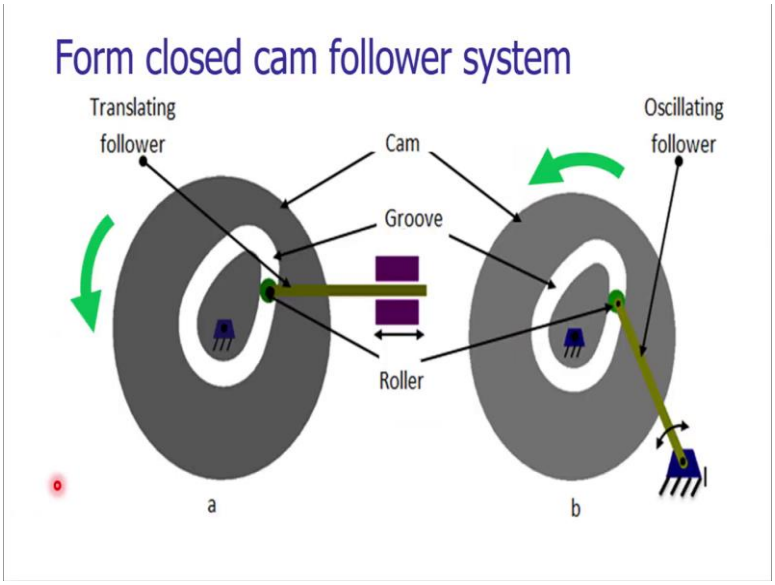

In certain arrangements, we are not applying the external force. We are using the form of the cam itself as a restriction, as an arrangement that will be utilised to ensure the contact of the follower with the cam. For this purpose, we can generate various grooves inside the cam plate itself. And in that grooves, the cam joints are engaged to the cam itself. This groove is ensuring that there is a continuous contact of the follower with the cam itself.

Here we notice the cam is being rotating in a circular direction. As the cam is rotated in circular direction, we can have the translatory motion of the follower. If you oscillate the follower, we can even generate the circulatory motion that can be seen on our screen. This is the follower. As we oscillate the follower, we can generate the circular motion of the cam.

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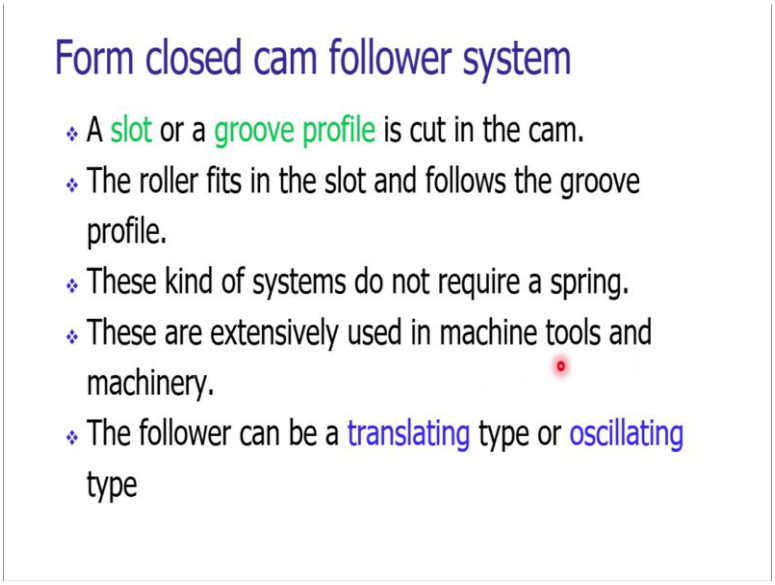

In form closed cam follower system, slot or a groove is cut in the cam. And the roller is fitting inside the slots and follows the groove profile. As mentioned, it does not require any the spring. They are widely used in machine tools and machinery.

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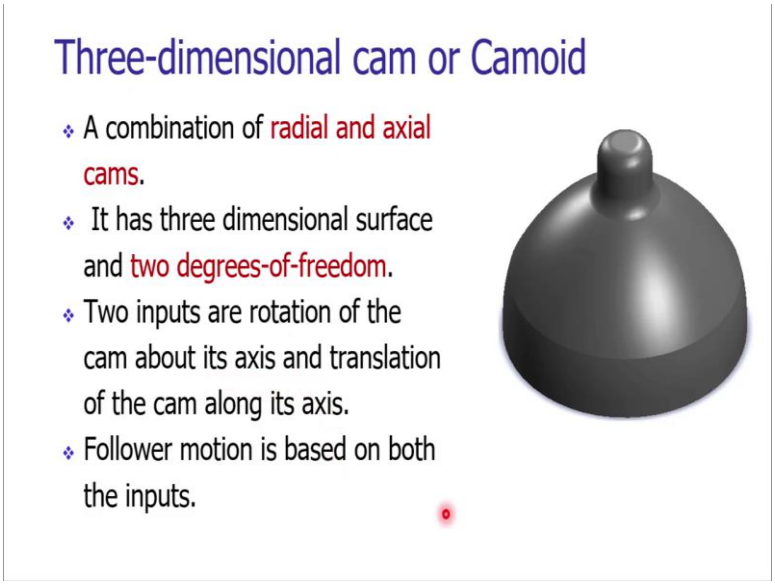

In addition to this two-dimensional cams, we can even have a three-dimensional cam that is called as camoid. It is combination of radial as well as axial cams. It has three-dimensional surface, and it is having two degrees-of-freedom. The cam can be moved along this direction along the radial direction, and it is also moved along this direction as well along the axial direction.

The radial movement and the axial movement are generating the three-dimensional movements. Two inputs are to be given to the cam that is the rotation about its axis and translation of the cam along its axis. Based upon the input that is given in rotation and translation the required follower motion is generated in the cam and camoids.

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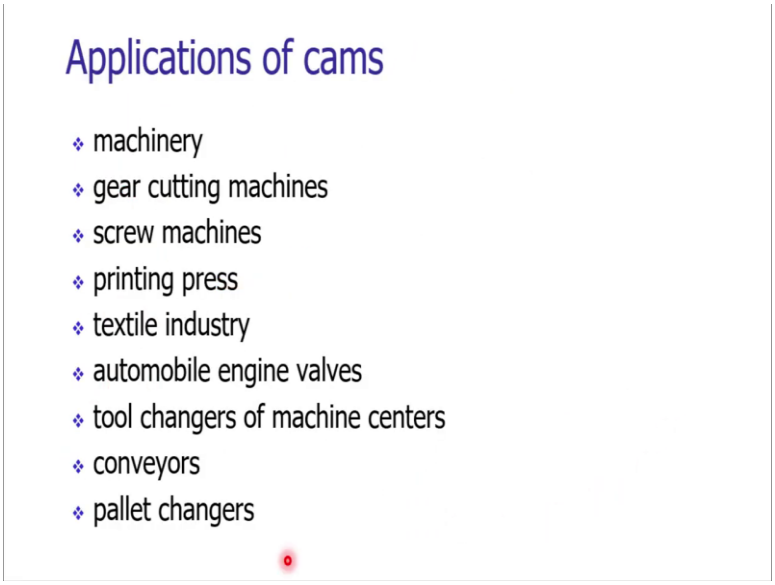

The cams are having enormous applications. They are used in machinery, gear cutting applications, screw machines, printing presses, textile industry, automobile engine valves, tool changing operations, conveyors and pallet changing operations.

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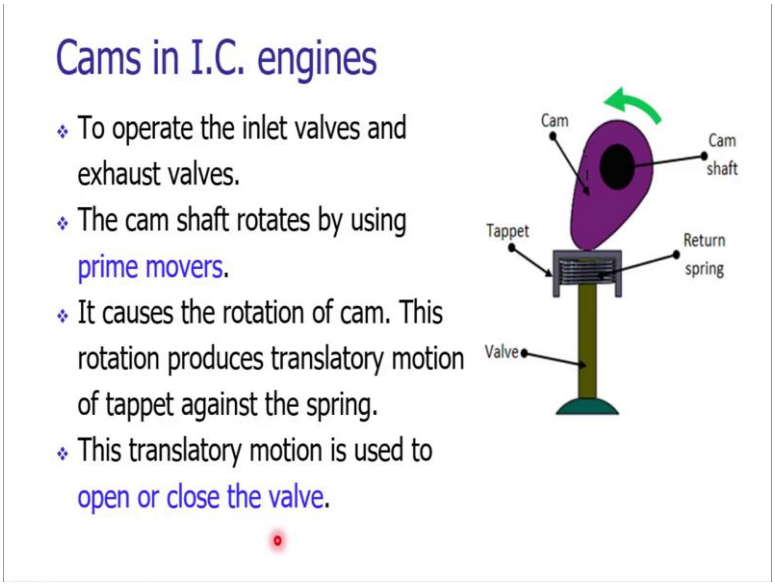

One typical application which we have already seen that, cams in IC engines to operate the inlet and exhaust valve, that cam shaft rotates by using the prime mover it may be a motor or it may be the energy that is getting transferred from the cam shaft itself to the operation of the cam shafts. The prime movers are rotating the cam and that is producing

the translatory motion of the tappet. The tappets are utilised to open or close the valves as we have already seen.

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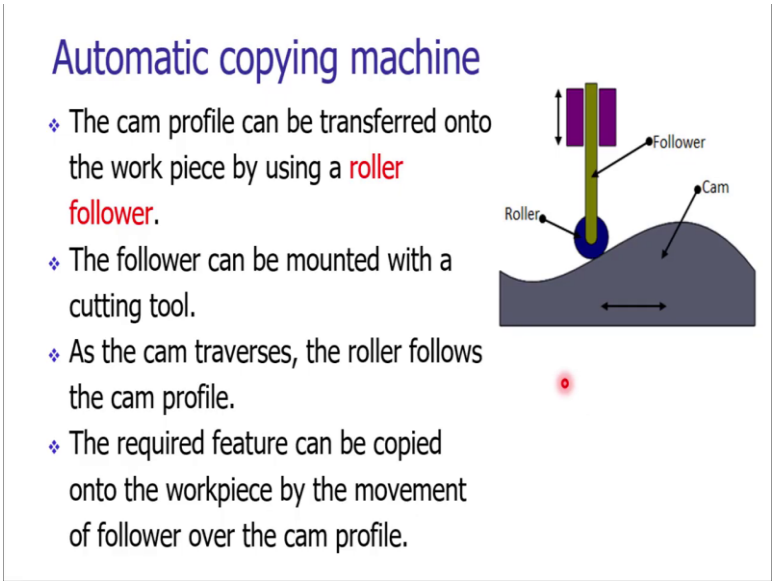

One more interesting application of the cam is in automatic copying the surface profile. Let us consider we are having a profile and we are considering that profile as the cam itself. There is a follower which is having the roller attached to it to its end and that roller is in contact with the cam profile. As we translate the cam, the roller will move in upward direction or it will even move in a downward direction based upon the shape of the cam profile itself.

The translatory motion of the other end of the follower is in proportion with the profile of the cam. We can easily generate the cam profile by having the translatory motion due to the translatory motion of the cam itself. The follower can be mounted with the cutting tool. As the cam is traversing, as the cam is moving, the roller is following the cam profile. And in this way, we can generate the required feature on the workpiece.

As we are connecting the follower to the tool, the movement of the follower will be transmitted to the movement to the tool and the tool is generating the required profile on the workpiece. In this way, we can easily copy the profile of the master workpiece, we can generate a multiple number of workpiece based upon the master workpiece.

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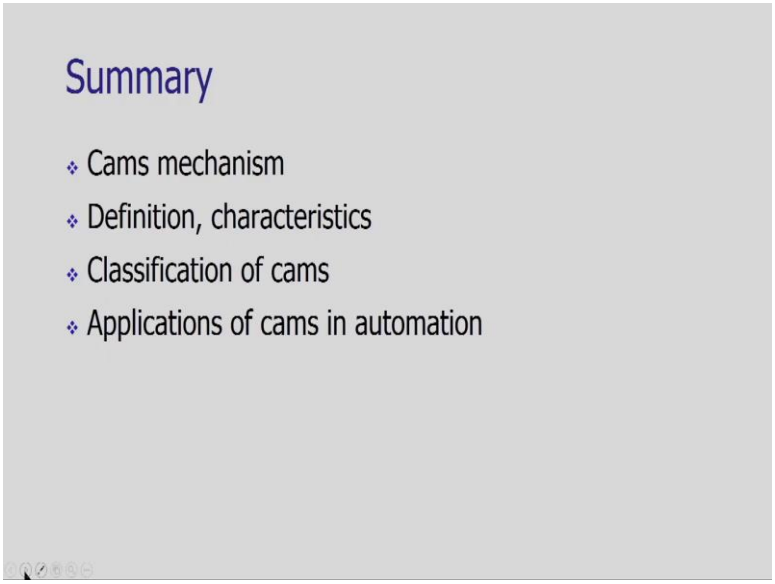

Well we are at the end of week-7. Let me summarise the last lecture of week-7 that is lecture-3. In this lecture, we studied an important mechanism that is cams. We learnt the definition of the cam, we saw various characteristics of a cam. After that we studied various types of cams which are used in automation. And at the end of the lecture, we had a discussion on applications of cam in automation.

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Well with this, I conclude week-7. Let us see what is there in week-8. In week-8, we are continuing our discussion on mechanisms. And in week-8, we will be focusing on the

indexing mechanisms, tool magazines and transfer systems which are used in the manufacturing automation.