Automation in Production Systems and Management
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Fundamentals of Robotic Systems
Lecture - 48
Robot Motion Analysis; Robotic Joints and Links

During this week we are discussing Fundamentals of the Robotics. During the third lecture session two very important aspects related to robotics will be discussed.

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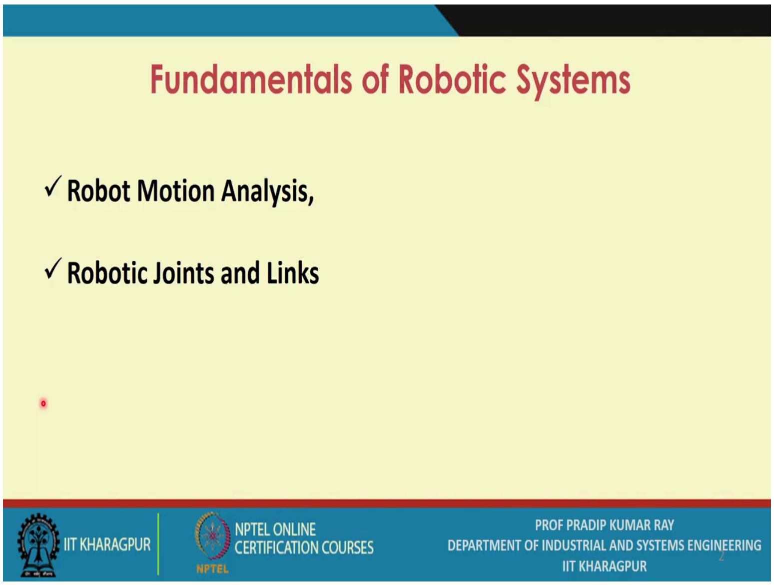

We will be discussing about Robot Motion Analysis and Robotic Joints and Links.

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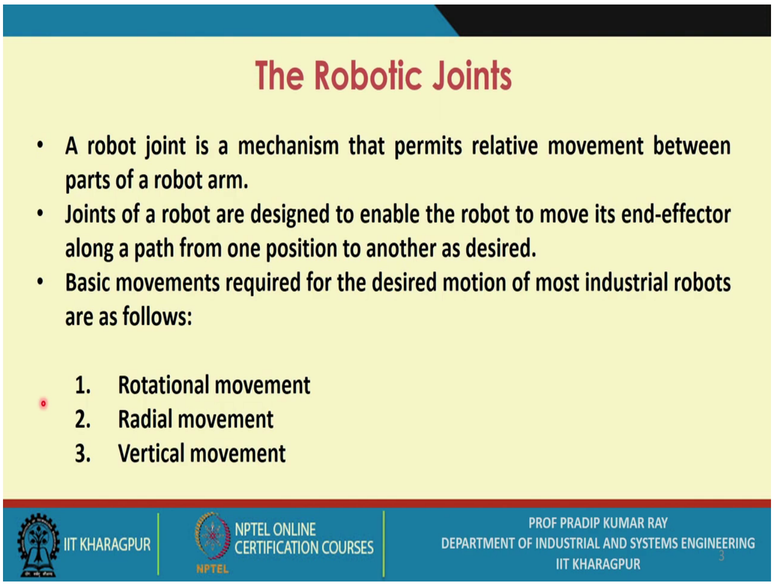

Let us first talk about the robotic joints.

A robot joint is a mechanism that permits relative movement between parts of a robot arm. The joints of a robot are designed to enable the robot to move its end-effector along a path from one position to another as desired. The basic movements required for the desired motion of most industrial robots are: Rotational movement, Radial movement, and Vertical movement.

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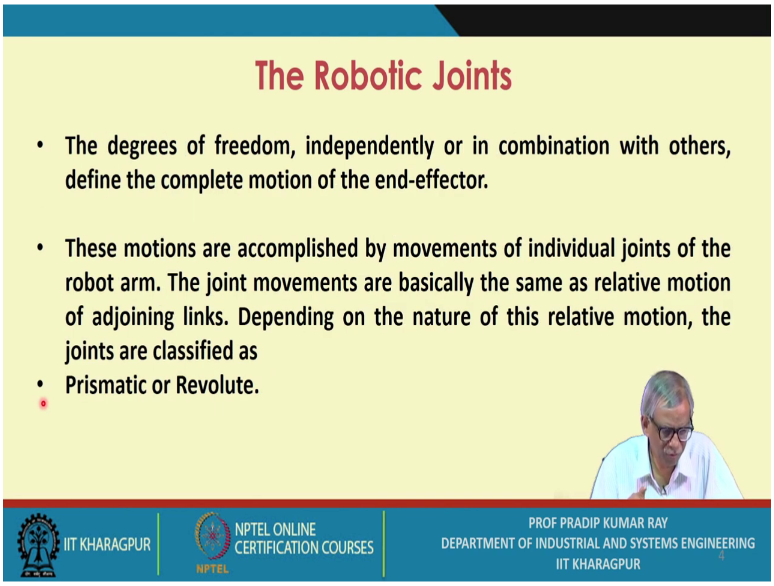

These degrees of freedom, independently or in combination with others, define the complete motion of the end-effector.

These motions are accomplished by movements of individual joints of the robot arm. The joint movements are basically the same as relative motion of adjoining links. Depending on the nature of this relative motion, the joints are classified as prismatic or revolute.

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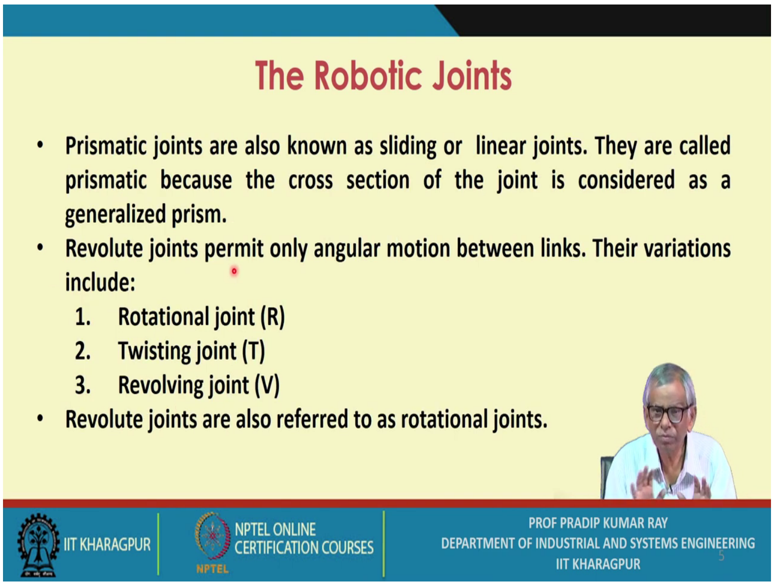

Prismatic joints are also known as sliding as well as linear joints. They are called prismatic because the cross section of the joint is considered as a generalized prism.

Revolute joints permit only angular motion between links. Their variations include:

1st one is the rotational joint referred to as R that is the notation we used. 2nd one could be joint twisting, and the 3rd one is revolving joint. These are the three kinds of the revolute the joint you come across in a particular robot. And the revolute joints are also referred to as the rotational joints sometimes.

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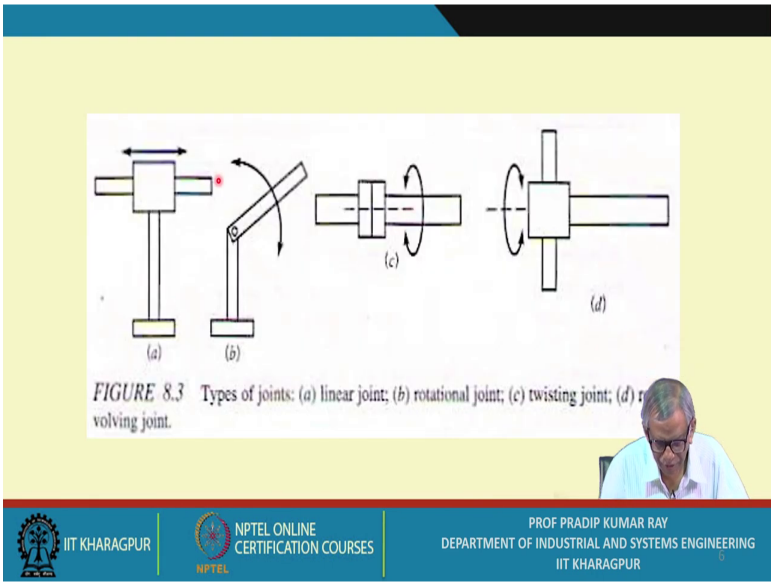

When you look at these figures, you will understand that how a particular name is given to a particular joint, this one is the linear joint. The joints can move in a linear direction, horizontal direction. This is basically the rotational joint, the third one is the twisting joints. This is the twisting joints and this one is the revolving joint; entire thing is revolving. These are the four types of the joints you come across.

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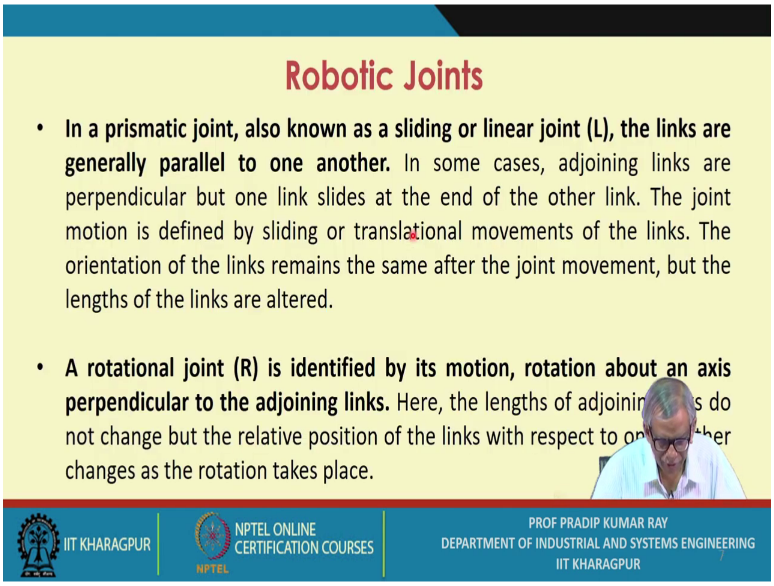

In a prismatic joint, also known as a sliding or linear joint (L), the links are generally parallel to one another. In some cases, adjoining links are perpendicular but one link slides at the end of the other link. The joint motion is defined by sliding or translational movements of the links. The orientation of the links remains the same after the joint movement, but the lengths of the links are altered.

A rotational joint (R) is identified by its motion, rotation about an axis perpendicular to the adjoining links. Here, the lengths of adjoining links do not change but the relative position of the links with respect to one another changes as the rotation takes place.

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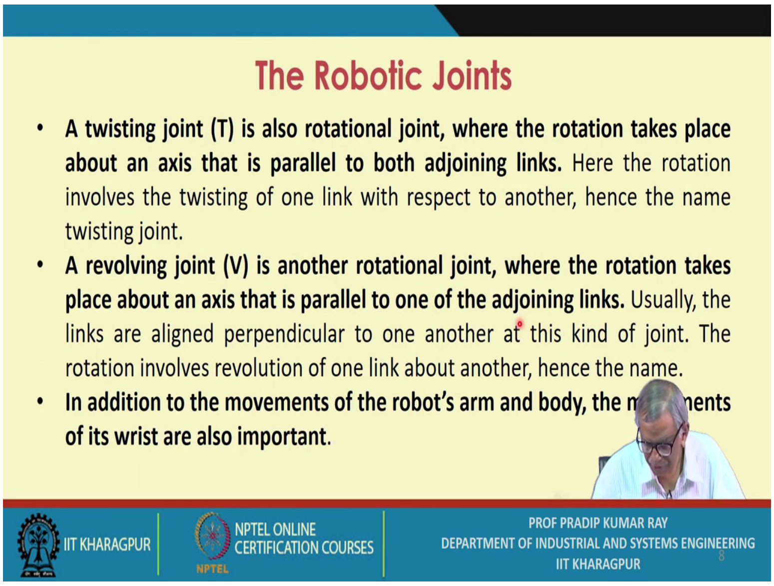

A twisting joint (T) is also rotational joint, where the rotation takes place about an axis that is parallel to both adjoining links. Here the rotation involves the twisting of one link with respect to another, hence the name twisting joint.

A revolving joint (V) is another rotational joint, where the rotation takes place about an axis that is parallel to one of the adjoining links. Usually, the links are aligned perpendicular to one another at this kind of joint. The rotation involves revolution of one link about another, hence the name.

In addition to the movements of the robot's arm and body, the movements of its wrist are also important.

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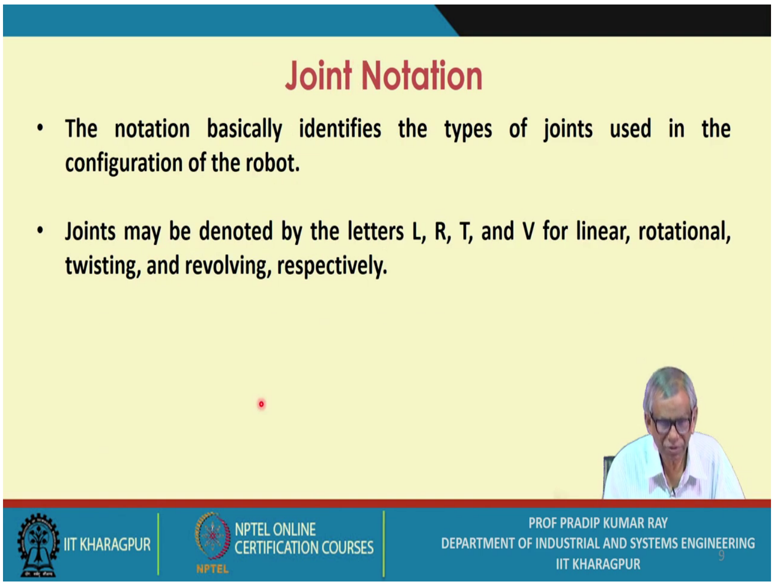

This notation basically identifies the types of joints used in the configuration of the robot. The joints can be denoted by the letters L, R, T, and V for linear, rotational, twisting, and revolving, respectively.

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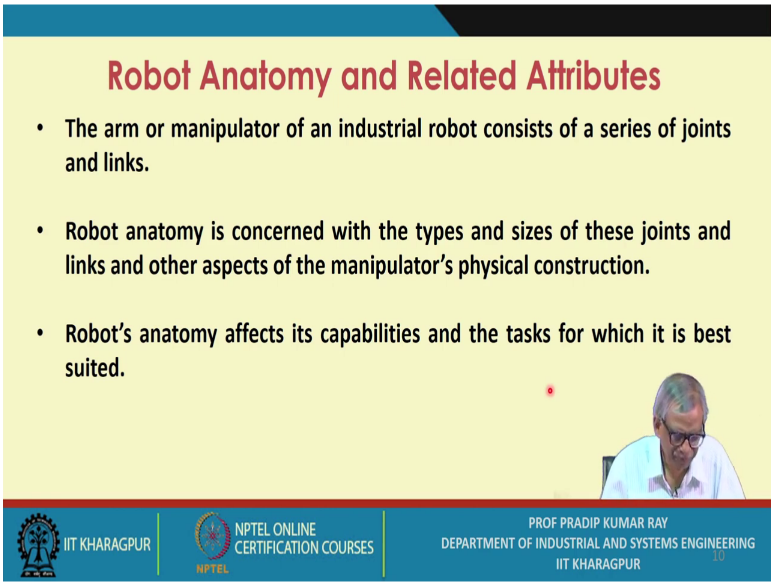

The arm or manipulator of an industrial robot consists of a series of joints and links. Robot anatomy is concerned with the types and sizes of these joints and links and other aspects of the manipulator's physical construction. The robot's anatomy affects its capabilities and the tasks for which it is best suited.

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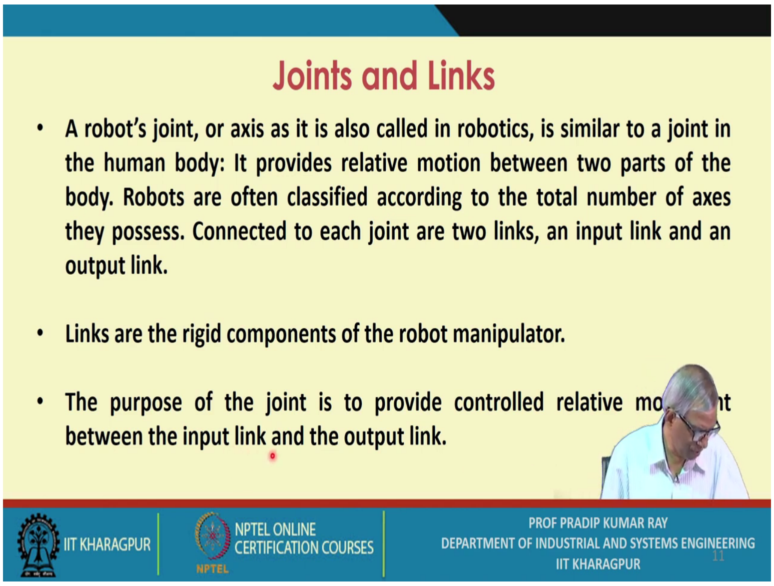

A robot's joint, or axis as it is also called in robotics, is similar to a joint in the human body: It provides relative motion between two parts of the body. Robots are often classified according to the total number of axes they possess. Connected to each joint are two links, an input link and an output link.

Links are the rigid components of the robot manipulator.

The purpose of the joint is to provide controlled relative movement between the input link and the output link.

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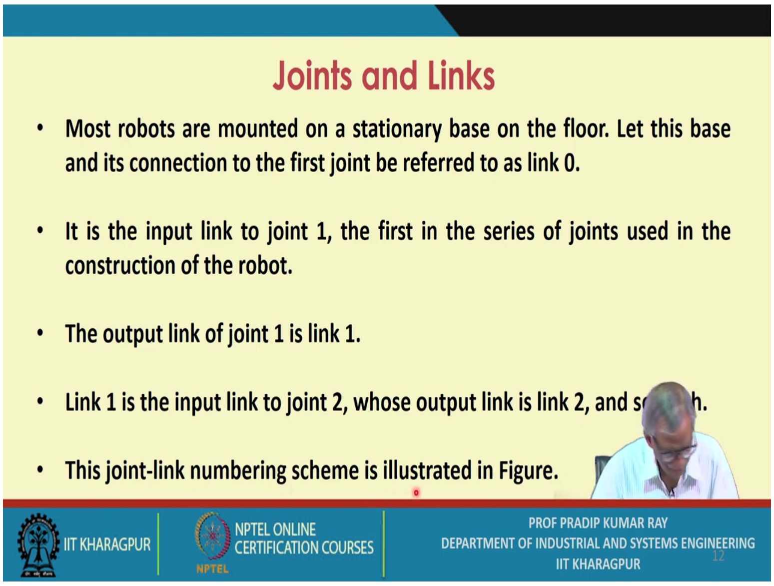

Most robots are mounted on a stationary base on the floor. Let this base and its connection to the first joint be referred to as link 0. It is the input link to joint 1, the first in the series of joints used in the construction of the robot. The output link of joint 1 is link 1. Link 1 is the input link to joint 2, whose output link is link 2, and so forth. This joint-link numbering scheme is illustrated in Figure 8.1.

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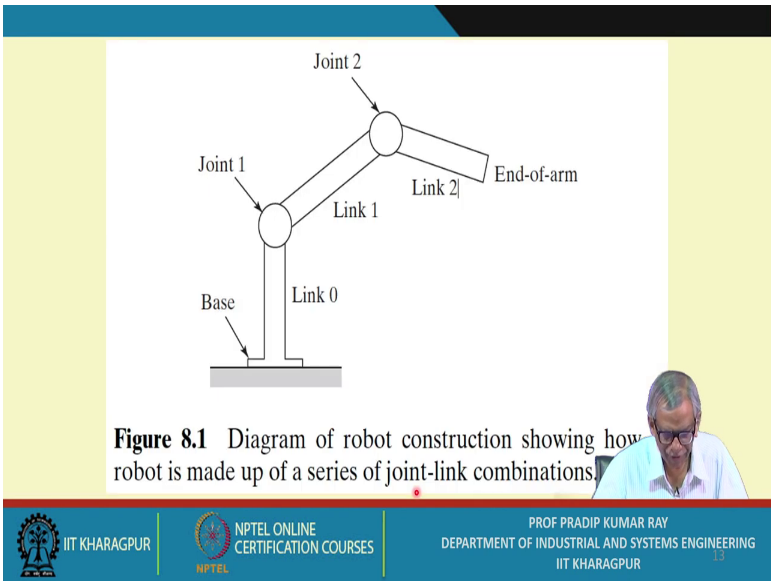

So, this is the base you have, then the first link 0, then you have the joint 1, then you have the link 1, joint 2, then link 2 and then the end of arm.

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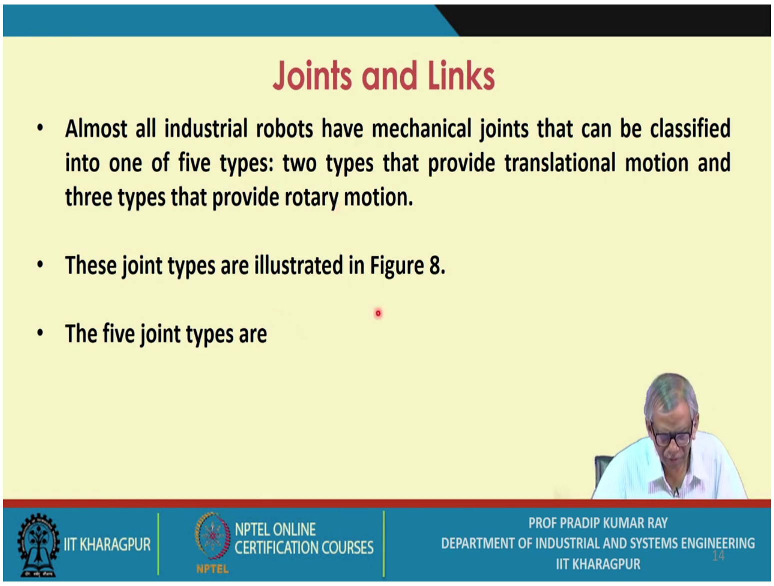

Nearly all industrial robots have mechanical joints can be classified into one of five types: two types that provide translational motion and three types that provide rotary motion. These joint types are illustrated in Figure 8.2. The five joint types are as follows.

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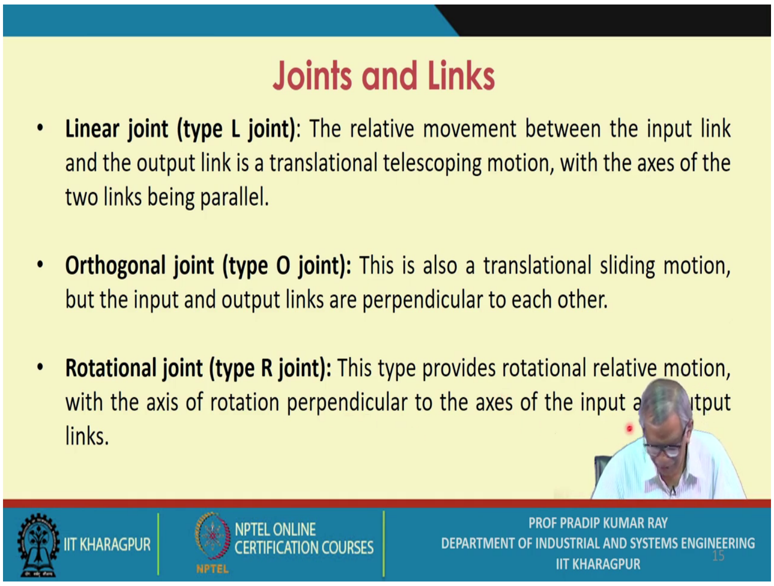

Linear joint (type L joint): The relative movement between the input link and the output link is a translational telescoping motion, with the axes of the two links being parallel.

Orthogonal joint (type O joint): This is also a translational sliding motion, but the input and output links are perpendicular to each other.

Rotational joint (type R joint): This type provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.

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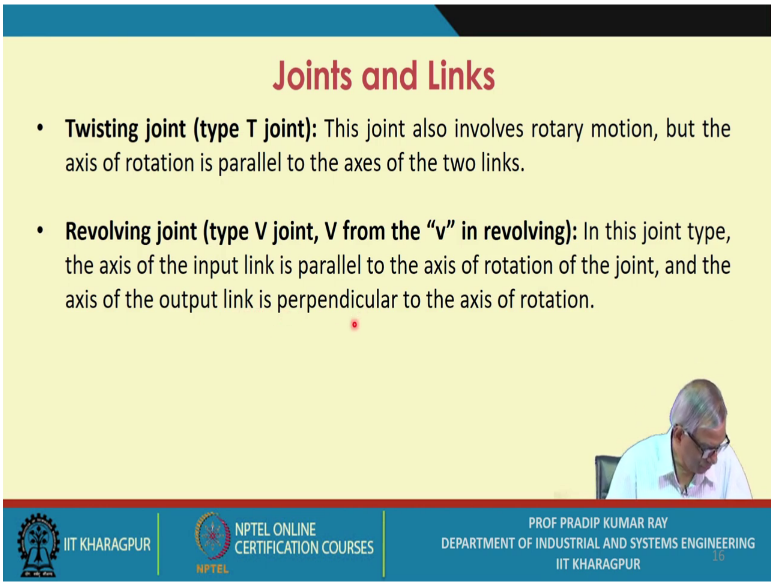

Twisting joint (type T joint). This joint also involves rotary motion, but the axis of rotation is parallel to the axes of the two links.

Revolving joint (type V joint, V from the "v" in revolving). In this joint type, the axis of the input link is parallel to the axis of rotation of the joint, and the axis of the output link is perpendicular to the axis of rotation.

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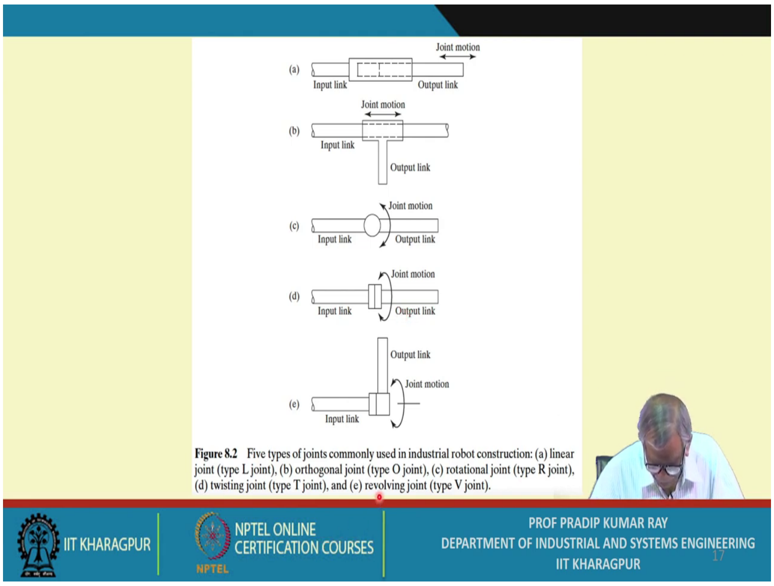

These are the five types of joints, the first one is the input link, this is the joint motion, this is one type. This is the second type, this is the third one, this is the fourth one right, the sliding type and this is basically the linear.

The first one is basically the linear; the second one is the orthogonal joint, this is the orthogonal, the type O joint; then you have the rotational; and then you have the twisting joint, and the fifth one is the revolving joint.

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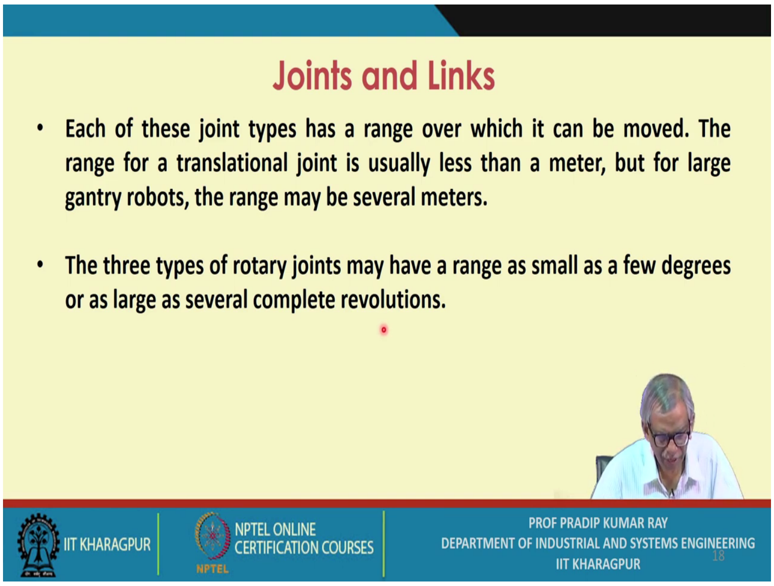

Each of these joint types has a range over which it can be moved. The range for a translational joint is usually less than a meter, but for large gantry robots, the range may be several meters.

The three types of rotary joints may have a range as small as a few degrees or as large as several complete revolutions.

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