Automation in Production Systems and Management
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Fundamentals of Robotic Systems
Lecture - 50
Numerical Examples

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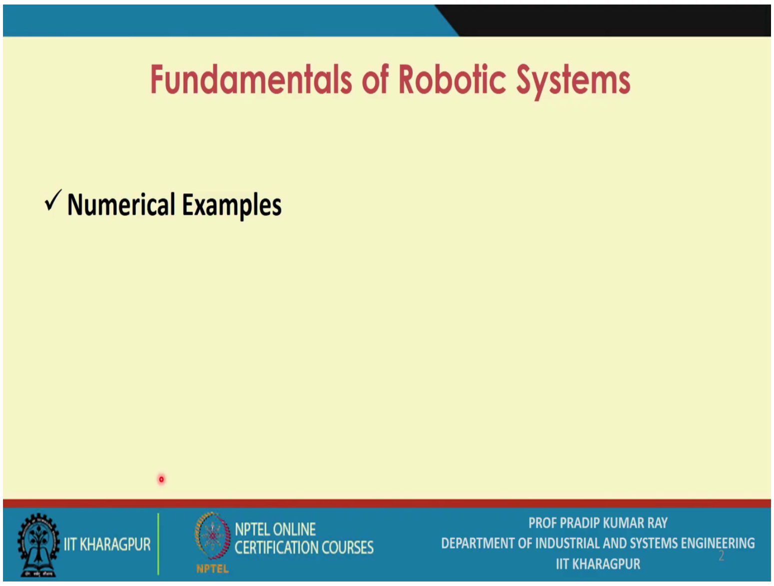

During this session on Fundamentals of the Robotic Systems. I will be the referring to a few numerical examples. For almost all sorts of the industrial operations or manufacturing operations, robots can be used.

The robots are used only under certain conditions.

Suppose the work involves the huge workload or amount of material handling for longer period of time, if you engage human labour, there is a risk of an injury and this is referred to as an occupational health.

You create your work system, you create the manufacturing systems; you design your workplace in such a way that the occupational health is guaranteed.

The manufacturing system, when it was introduced is a factory system with the introduction of the industrial revolution way back in 1780, first we design the job and then we search for the person; the whole process was fit man to job- FMJ.

Later on we started considering a system jobs created as per the ability or capability of the humans.

As per the anthropometry, we try to adopt fit job to man in a work system.

But still you will find that for all sorts of situations this fit job to man is not possible. There are the jobs like working at a particular height.

You will be preferring to engage a robot for that one or an automated system, instead of engaging the human labour.

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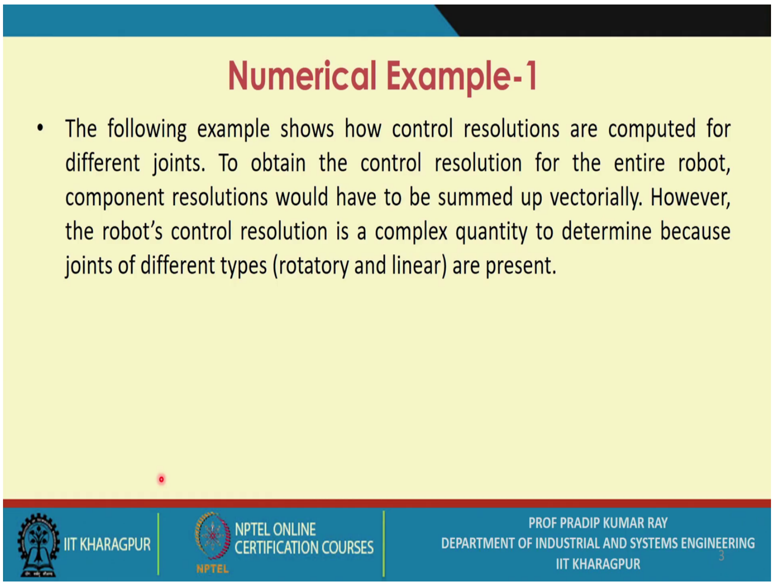

Let me just refer to the numeric few numerical examples during this lecture session. Now, this example shows how control resolutions are computed. To obtain the control resolution for the entire robot component resolutions would have to be summed up vectorially.

However, the robots control resolution is a complex quantity to determine because the joints of different types (rotatory and linear) are presents.

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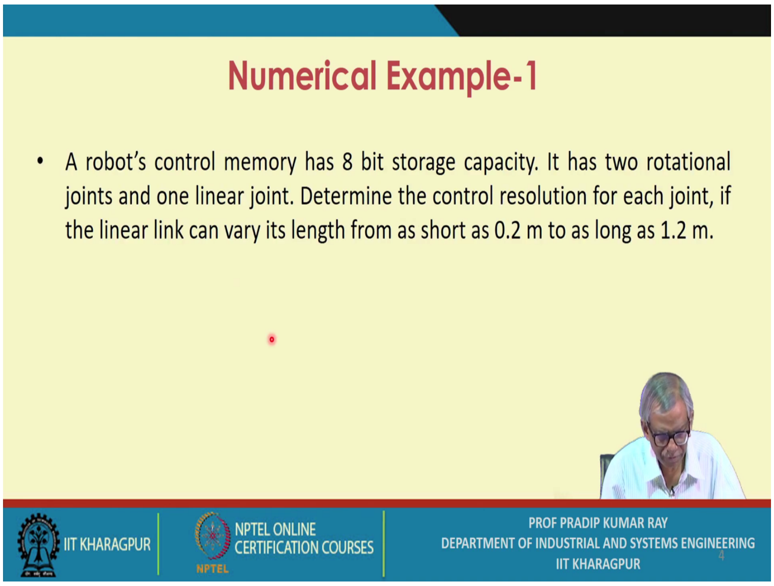

A robot's control memory has 8-bit storage capacity, there will be a movement robot arm from one location to another. Suppose its memory has 8-bit storage capacity, it has two rotational joints and one linear joint.

Determine the control resolution for each joint if the linear link can vary its length from as short as 0.2 meter to as long as 1.2 meter.

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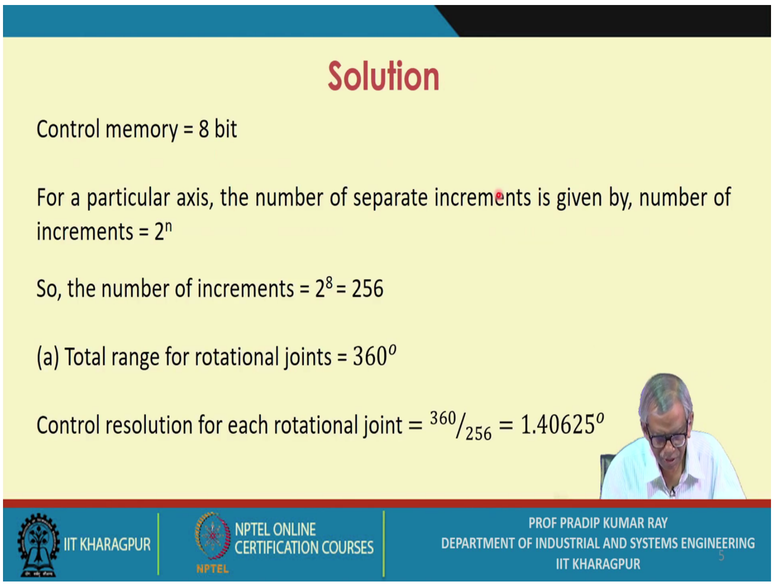

Control memory is 8 bits. For a particular axis, x axis, the number of separate increments

is given by 2^n. So, the number of increments = $2^8 = 256$

(a) Total range for rotational joints = 360°

Control resolution for each rotational joint = 360/256 = 1.40625°

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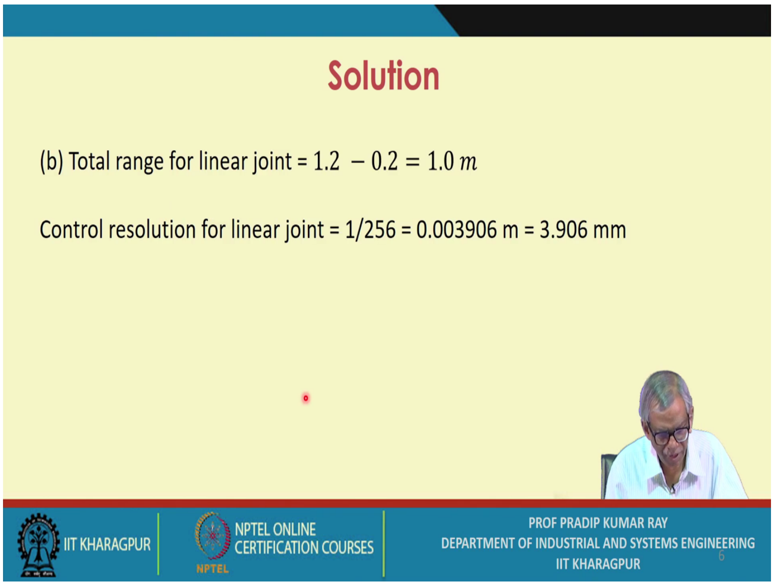

(b) Total range for linear joint = $1.2 - 0.2 = 1.0\ m$

Control resolution for linear joint = 1/256 = 0.003906 m = 3.906 mm

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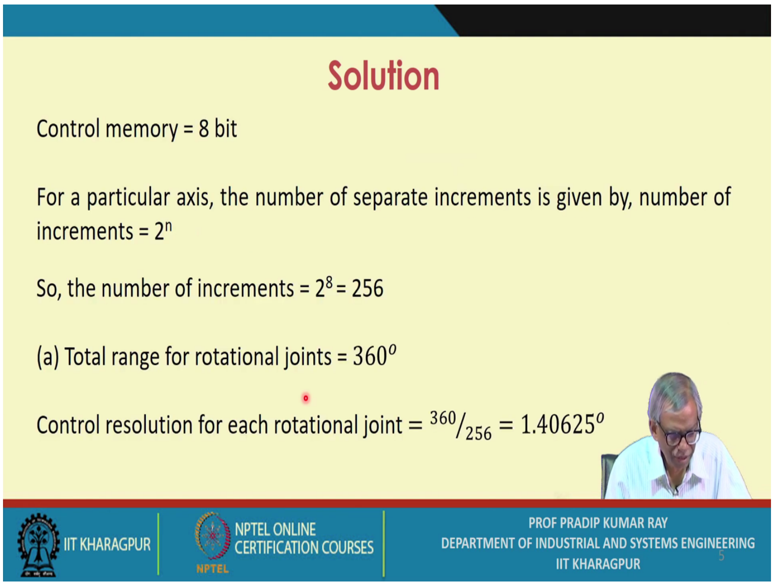

Control resolution depends on the control memory and that will be specified. When you design a particular robot, this information will be given to you.

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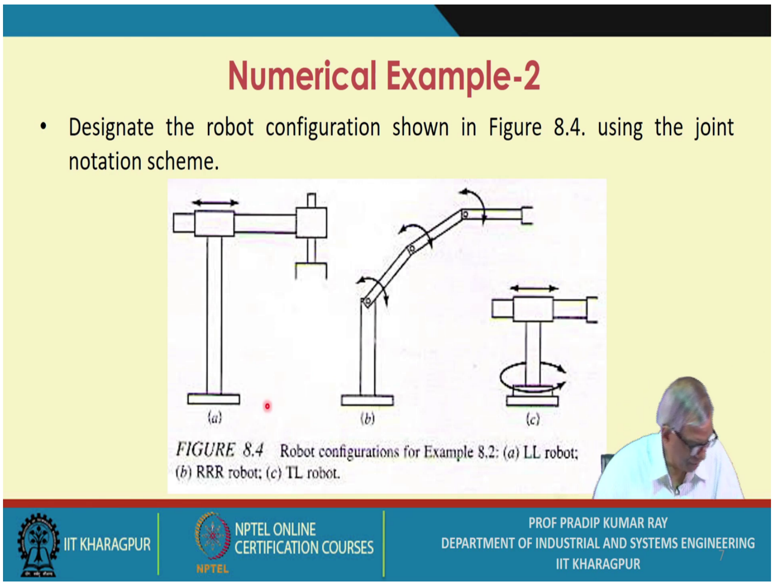

Second example; designate the robot configuration shown in figure. Let us talk about this particular robot configuration. This is linear, this is also linear movement taking place.

This particular link moves, this remains fixed, this is the base, this remains fixed, this link is to move in horizontal direction.

This is linked to it the another linear joint. This link moves over these two linear joints. This is referred to as LL robot; that means, a robot is specified with respect to the types of joints.

The joint is related to a particular link and the link is moving and the joint may move but along with the link. This is physical configuration and this one is the second type of robot. This is the rotational joints, this is also rotational joints and this is also rotational joints.

This is the base, so how do you specify this particular robot configuration?. First is R, from the base you start. First is rotational, then the next one is rotational and the third one is also rotational. This is specified as RRR. Next one is rotation T, the twisting and this are basically the linear.

How do you specify this particular robot configuration from the base? First one is the twisting and the second one is the linear, this is TL robot.

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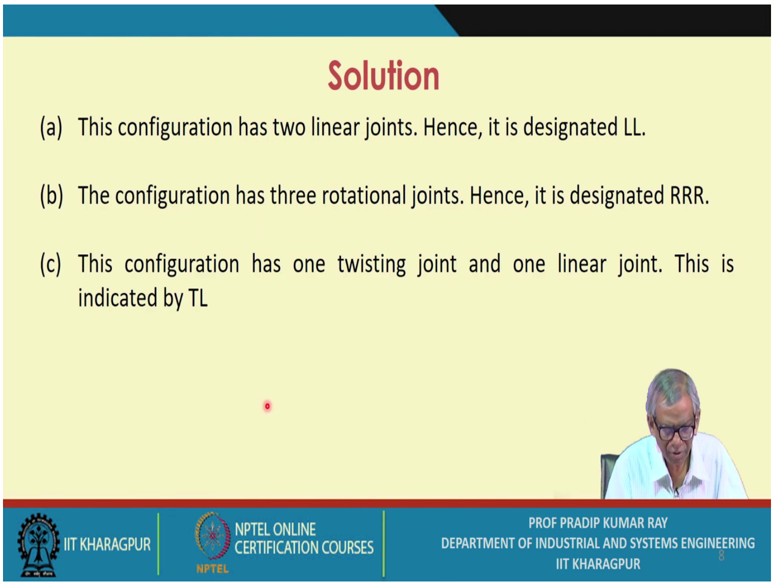

This configuration has two linear joints, the first one. Hence, it is designated as L-L. The second one is R-R-R.

The third one is very simple, the first is a twisting joint with the base and one linear joint, T-L.

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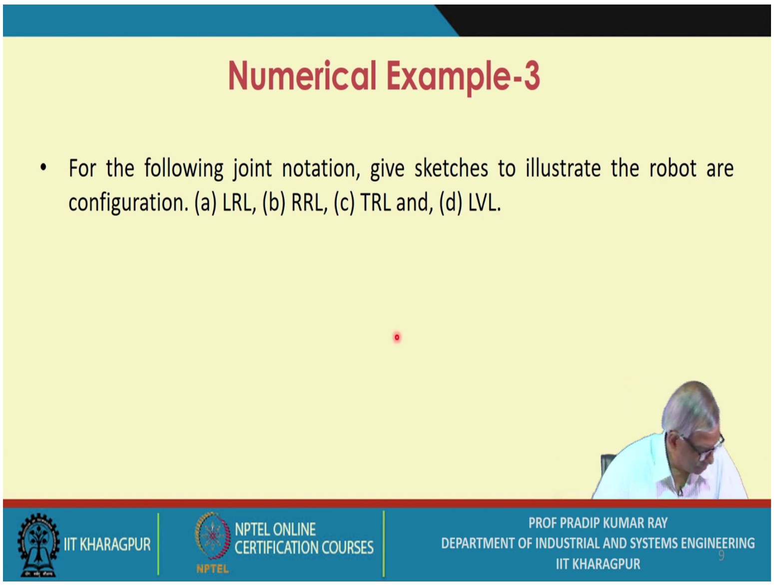

Let us refer to the third example. For the following joint notation, give sketches to illustrate the robot are configuration. (a) LRL, (b) RRL, (c) TRL and, (d) LVL.

There are four kinds of joints; linear, rotational, twisting, and revolute. You start from the base the base of the robot and you identify in the first, which one is the first joint and then its type, then you identify the second joint and its type and so on. So, this way you complete the exercise and the configuration is specified.

The specifications are given in terms of the joints used in a robot.

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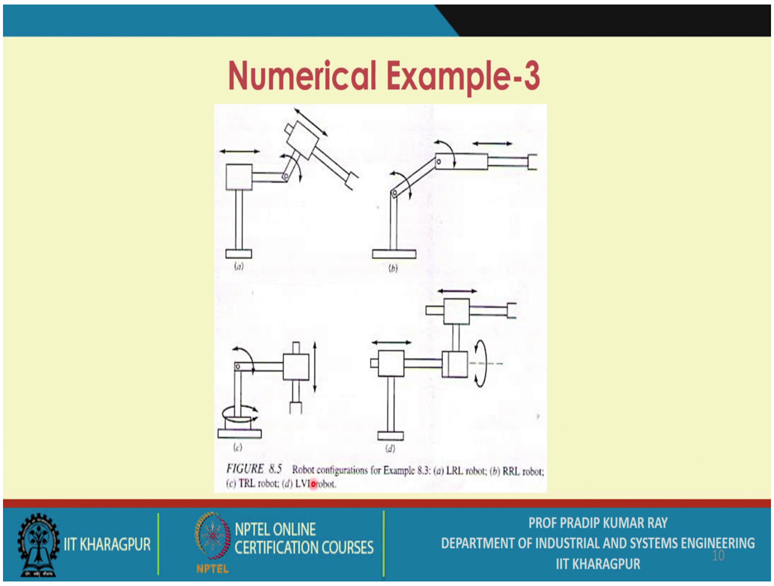

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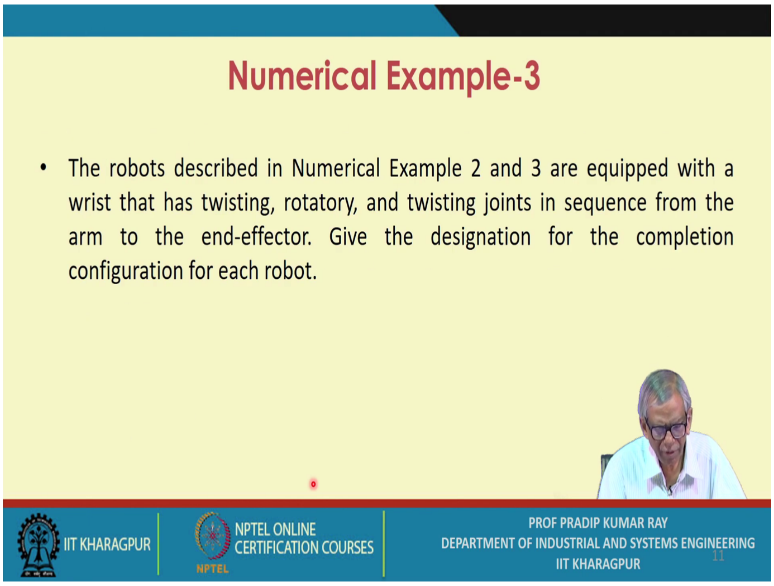

First one is the L, then rotational and then again linear. So, LRL, this is just one configuration, you can have another configuration also with LRL. First one is configuration remains same, but the size of the robot is an important issue.

When you design the robot; the dimensions are to be specified and to what extent the dimension is basically determining a particular configuration. The dimension of this one and the dimension of the second link, third link, the fourth link, whether they are interrelated or not, is to be checked.

The design should be optimal one. Optimal in the sense that operations can be performed with different types of objects, object size, object weight, object the shape must be known. With respect to one particular configuration how many shape varieties you can handle.

What could be the range of the object weight? Those design should be as perfect as possible. There is a perfect matching with not only with one type of object, but the several objects.

In that case we say, the robot design is versatile. It is not that you identify one operation of one type, one set of characteristics of the object and one kind of process plan and you design a particular robot. To what extent in a particular robot you can include the flexibility dimension?.

This is the first one. The second one is basically RRL. The first one is the rotational, the second one is also rotational, and it is connected with another link, and the movement takes place horizontally, linearly. This is RRL.

The third example is TRL robot; this is the twisting across the base 360^o, entire system is twisting around the base 360^o and this is rotational; this direction it should move and this one is your linear.

It is not that for any dimension you can have, this will be feasible by the robot configuration. The last one is a bit the complex one; this one is linear, this is convolute, the entire one is revolving, this is linear. So, it is LVL robot.

The robots described in numerical example 2 and 3 are equipped with a wrist that has twisting, rotatory and twisting joints in sequence from the arm to the end-effector. Give the designation for the of the complete configuration for each robot.

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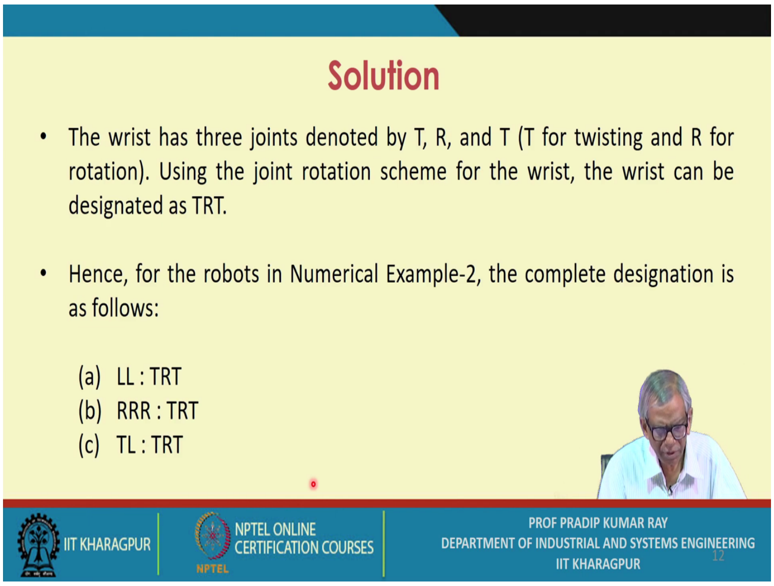

The wrist was having three joints denoted by T, R and T. T for twisting and R for rotation. Using the joint rotation notation scheme for the wrist, the wrist can be designated as TRT. Hence, for the robots in numerical example two the complete designation is as follows; LL:TRT RRR:TRT and TL:TRT.

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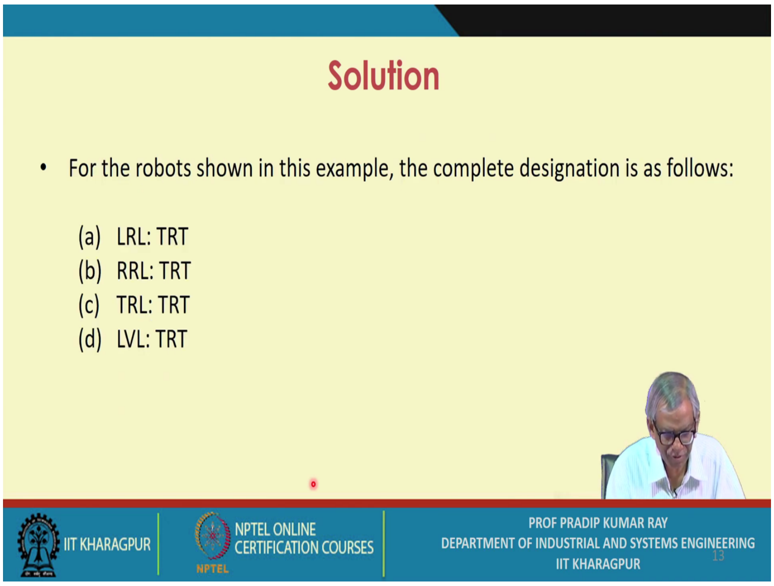

For the robots shown in this example, the complete designation is as follows:

a) LRL: TRT

b) RRL: TRT

c) TRL: TRT

d) LVL: TRT

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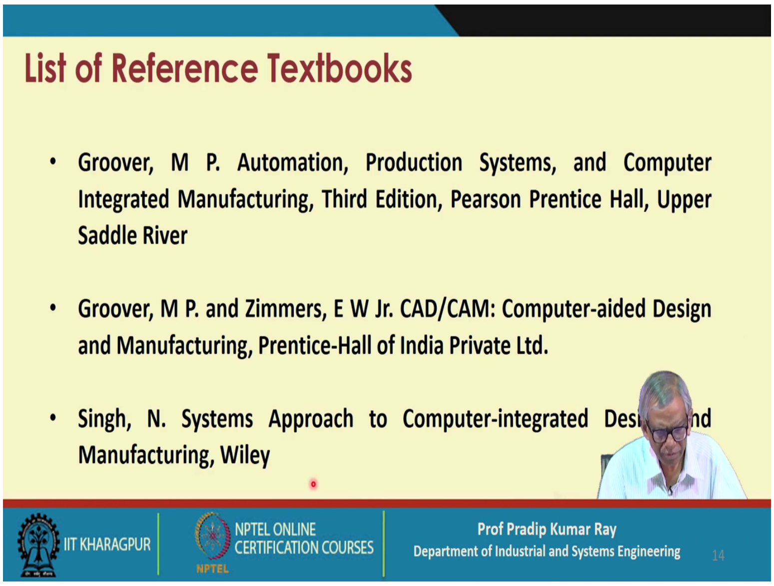

The robot is an integral part or one of the main components of the subsystems in automated system.