Design of Mechatronic Systems
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Lecture 06
CD-ROM Part ll

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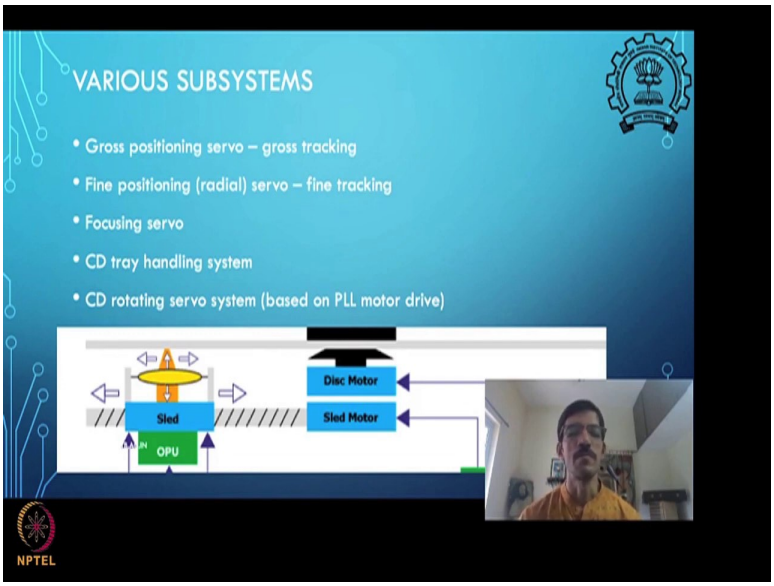

Then we can come back up to this now classification of these different subsystems that are normally there. So, we have seen this gross positioning that is happening there, so these gross tracking that happens, but that is not sufficient. So, if you see the positioning accuracy that we had talked about was about 100 Nano-meter and you can imagine like no stepper motor drive can create that kind of high precision positioning, whatever fine micro stepping that you think it can have simply because of this mechanical maybe you think about.

What prevents the positioning to happen, so finally, even if you have very fine positioning sensors available would you be able to position like by using this kind of a stepper motor the system the head or the laser spot on the surface of CD within the accuracy of 100 Nano-meters, that certainly not possible. So, what we do? So, then there must be some kind of a fine tracking or some kind of a fine motion system that is that will be there into inside the CD.

And as we open up then we get more onto that we will observe that, so we should look for now what is a fine tracking or fine positioning system there, then there needs to be something needs to be getting like the laser see this CD surface may have some undulations, small undulations in the

range of few microns or you may put some kind of a small little scratch on the surface of CD and still like is scratches almost in the microns kind of a dimension, but still that will be harmful for the data to be read on this from the surface.

So, the surface may have some few microns undulations and then you need to kind of tightly focused laser on to the surface from where the data is to be picked up, there must be some kind of a focusing servo or it is like auto focusing that is happening inside the CD. So, there must be some kind of a small fine motion that is given for focusing direction. Then we have seen this tray handling system tray operation system and things like that. Now, of course you need to have a CD rotation system here, so this motor should kind of drive the CD to make sure that it rotates since in some control kind of fashion. So, let us explore little more now.

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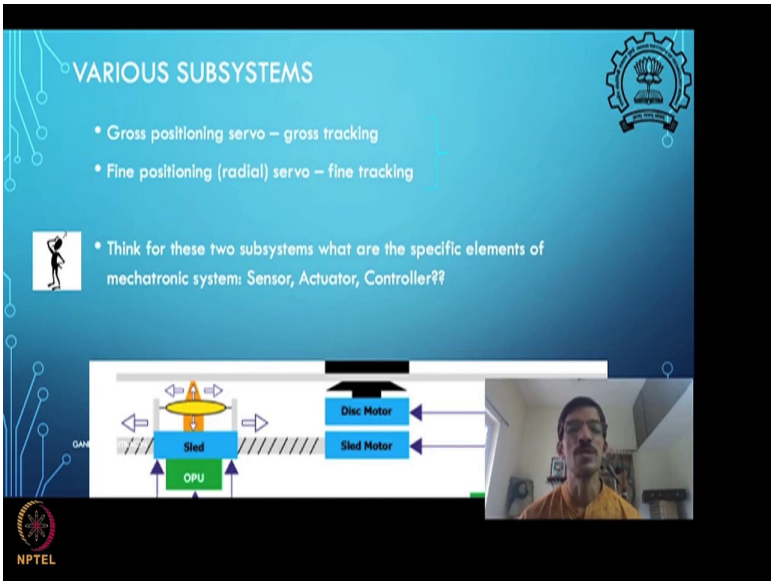

Now, here again another thought that okay, so these all these pauses are where you need to really pause the video and think about yourself, do not rush through just this lecture otherwise you will miss out on things see the though thinking and keep preparing your mind to get to understand is very very important part of the process which I am giving you the clues but if you follow them only then things will happen, so please do that.

So, now let us think of these two subsystems only, this gross positioning system that you already seen some part of it and then fine positioning system, fine tracking, how it can be this be possible? So, suppose we know now we need that fine kind of tracking there, how do you do you

suppose you are supposed to do that? How would you think based on your knowledge so far? What kind of sensors actuators that you induce in the system?

So, do some thinking you may say okay look this is a very fine positioning which is required I may use piezo actuators which will give you fine positioning, okay fine, like know that can be one possibility. How would you kind of set up such kind of a drive, Piezo typically need very high voltage to operate, we have such a high voltage operation possibility, any other kind of actuator comes to your mind which can do this job, like that you need to kind of think about, what kind of a way we sense that what it is really on the track or not on the track.

So, say for example if you put a sensor on the system side here, is there sufficient to kind of get us know that okay it is on the track or not on the track? those kind of things. How do you kind of get a feedback from the CD surface, which can tell us that, so many many different kinds of questions can come here, so we should kind of based on whatever our knowledge think about these different kind of questions and list them down or like think about okay what comes to your mind as a thought to give a solution to these different questions that are coming up. So, let us move on, I mean, after your thinking is done, you can move on.

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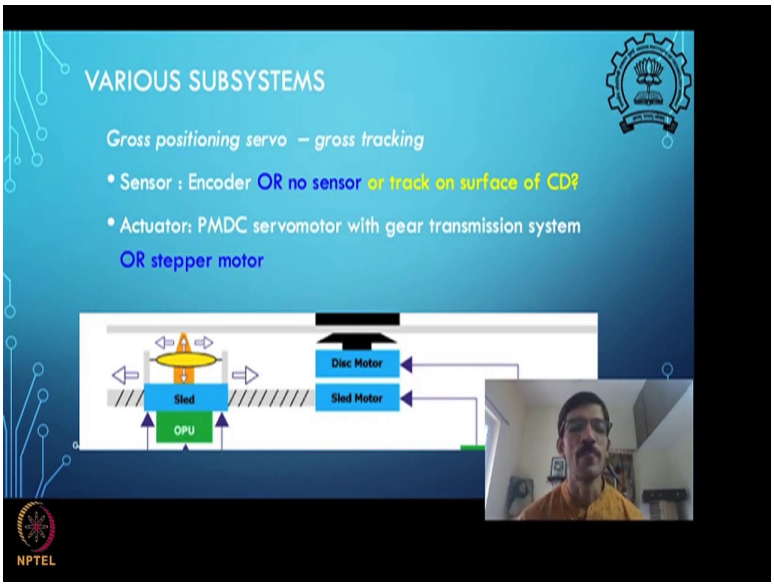

To see further now, what we open up and actually check out. So, these questions we can have say sensors for the sensors some encoder possibility or we can use make use of that track on the surface of CD itself to see if we can use that as a sensor. So, actuation what kind of actuation you

can have? So, you can have some CD ROM drives have actually this servo motor possibility, servo motors were used as actuators, some others say use stepper motor as actuators, the things like that can be possible for gross positioning.

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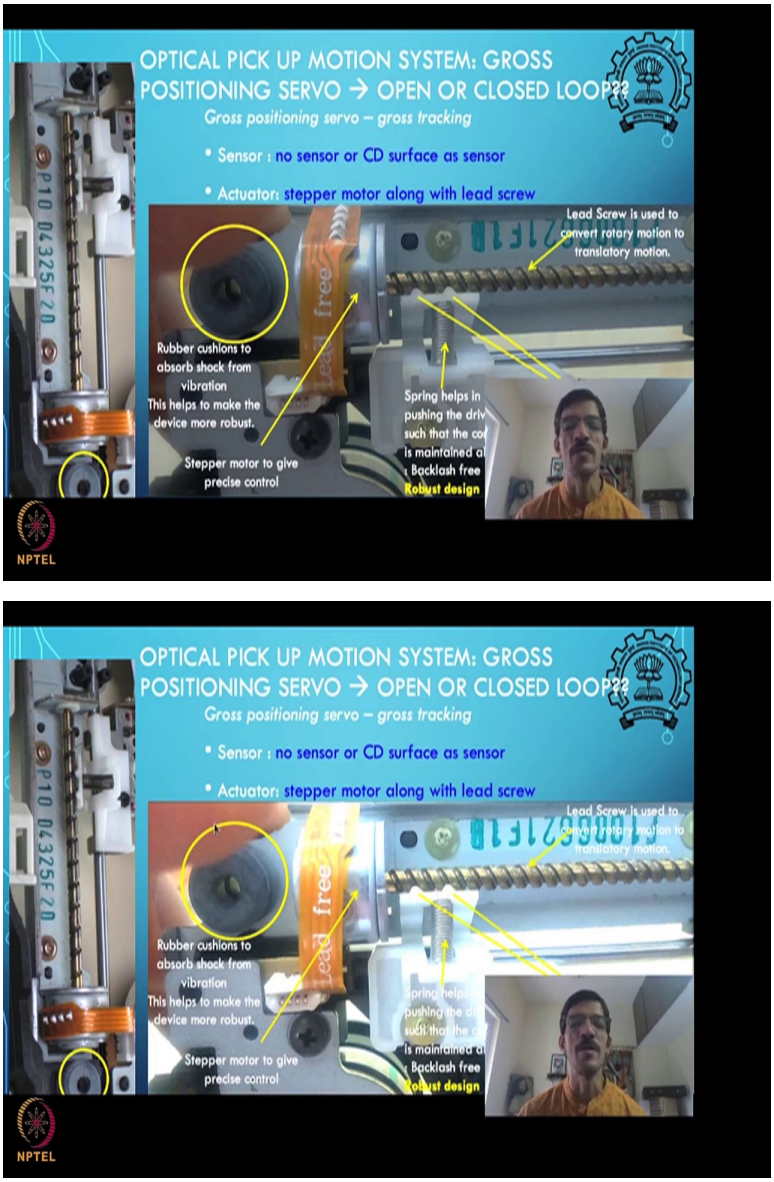

So, again I am flashing the **same picture here**, we can see this is from the some view from some other CD ROM drive and this is from the currently open CD ROM drive that we are talking about, so this is the same picture as we saw. So, do you see any sensors up here? Or positioning sensing? So, you see that the stepper motor typically does not have any sensors that are needed

for sensing the position, you observe that there is like only the shaft coming out of the sensor and that is no sensor up here.

See typically the motor shaft we should not need to have a sensor, if at all the sensor is there in the system. So, either motor shaft or the sliders moving back and forth needs to have some slide position sensing possibility, but if you observe carefully that is not there in the system. So, there is no sensor in this gross positioning kind of a system only stepper motor and we rely on the steps of the stepper motor to make sure that position desired position is achieved.

And then of course actuator is this stepper motor along with this lead screw and this mechanism this is a way is useful for preventing the backlash you heard this term backlash, you see if I have only say for example only one teeth going into the slots here then depending upon some kind of a manufacturing tolerances and errors thus this lot size and my teeth size may not match perfectly, there will be some kind of a within some kind of tolerance accuracies few microns kind of accuracies it will be not matching, that means that much kind of a back and forth motion I will have around in the slot.

So, imagine you have a hole in which there is a rod which is smaller in size is pushed and now we can move the rod in the linear **direction any** radial linear direction back and forth in the hole that much kind of you will see that kind of thing is a backlash in the system. So, these clearances that are given typically for smooth motion happening that we will result into some kind of a backlash in the system.

So, this backlash is some problem which in mechanical systems you think of gears you will have a backlash you think of any kind of motion transmission systems, they will have some backlash that is going to be there. And now what we do here is we are using these two stubs here, which are pushed against the two opposite surfaces of this grooves, that way and then the spring is making sure that that is pushed and that force is maintained, and that takes care of this backlash, that will not allow the backlash to come into play.

So, that is how this backlash is handled by using this kind of spring loaded stuff here. We will see in other cases when you **have a gear transmission** system instead of screw transmission, how you take care of backlash. So, this is just to focus on this, you have this little kind of shock absorbing element here.

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These is the other system like this as this if you see this has only two wires coming out of this motor and then there is a gear system in this like a bevel gear system and then there is this gear, think what is missing in this **location A, think** about that, what is missing I have removed something from there what it should have been to kind of like you can think about, so that the motion from the bevel gear is transmitted to this rack here.

And if you observe carefully this area, you see the small little springs sitting there and this rack is having two parts, the top rack and the bottom rack, are exactly same pitch and everything but they are in the two parts the top part and the bottom parts are separate there. So, what are they for? So, think about that, this spring there and then top part and bottom part and what is there in this location A, so think about these issues.

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This is another kind of mechanism in which you see the same spring loaded stubs for the gross positioning system.

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Now, on the guide rails, so you see this guiding system, so this is like you know I would say one view and this is opposite side view, so this is a view from the opposite side then the side. So, say this is like you know head which is seeing the surface this is a lens which is seeing the surface of a CD and let me get the pointer properly, so this is a lens of a CD. And you observe these locations, these are the locations where the head is touching these rods, this is one on this side

only one kind of a touch there, on the side there are two touches are there, there two places it is touching.

Now, carefully if you observe, then you will find that this touch is happening here on all the sides, as you see here, the rod is covered on all the sides by this hole and this hole also, but on this side there is only one support here and then that to the rod is not completely covering, the rod, the support is only covering half side that you cannot see here, actually the cross section view actually will show you that, maybe where some where we have this separately open mechanism that is removed from the rod kind of a thing we will be able to see that.

But here you presume that you know you take my words that this is only up to half of a distance. Now, you think why this is done in this way. Again, I am not going to kind of give you answers right now, I want you to kind of think about this question, why this construction is happening this way only. Like that you need to have now you can see from the pictures only, but if you have actual drive, you can kind of see this main make many of such kind of observations and then think about and come up with, why that people have done it in that way. So, that is where our like nice concepts are going to get developed. So, think about this issue.

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And you see here in detail, now these again the same thing I am saying right now this is a spring here and then these two racks are like one on top of each other. So, a lot of things to think about,

so how do you kind of get the spring loaded rack done? What is the purpose here? That you think about.

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So, this is like normally the larger view of the same thing you can see the spring very clearly here. And then there is a top and bottom rack and then this top rack is moving with respect to bottom rack in the direction of this laser pointer this half, you know direction of motion of the rack it is they can relatively move with respect to each other.

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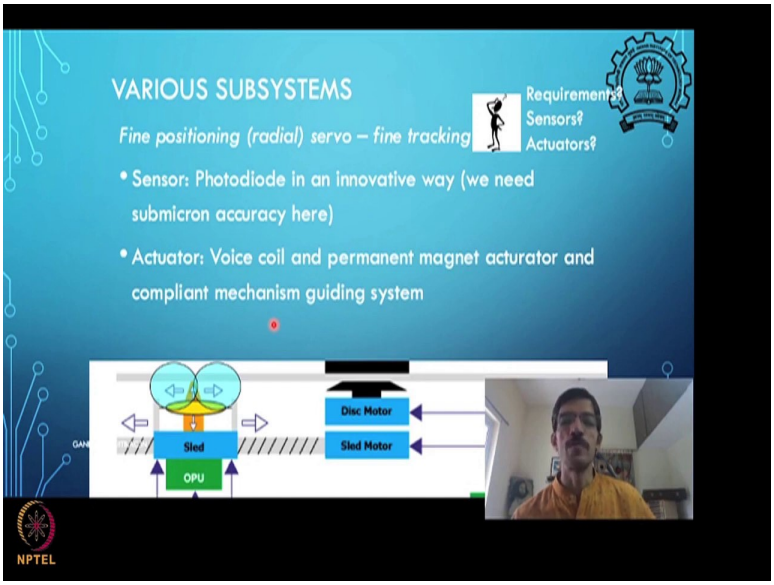

Now, let us think about the fine tracking, what are the requirements, what are the sensors, what are the actuators and we can open up and talk about that. So, the sensor that is used here is some kind of a photodetector here and actuator is some small kind of a little voice coil actuator that is sitting up here.

So, we will see this as you open up this will be evident, but now we need to think about how we can create this kind of a closed loop system here, so that you can have a fine tracking and fine focusing that is happening here. What kind of sensors should will be needed, what kind of actuators will be needed for that thing to happen. So, maybe I will leave you with a small kind of actual observations.

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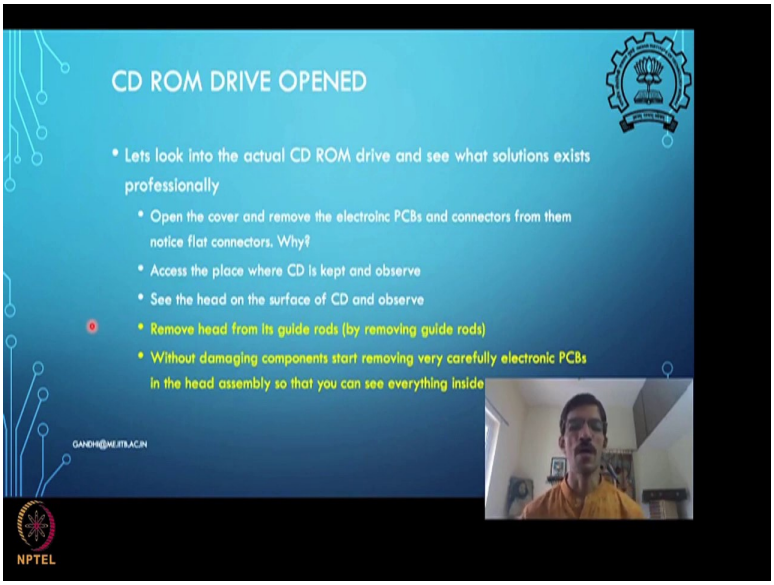

And then so we can remove the head from the guide rod and start observing what is there inside the head means the optical pickup head.

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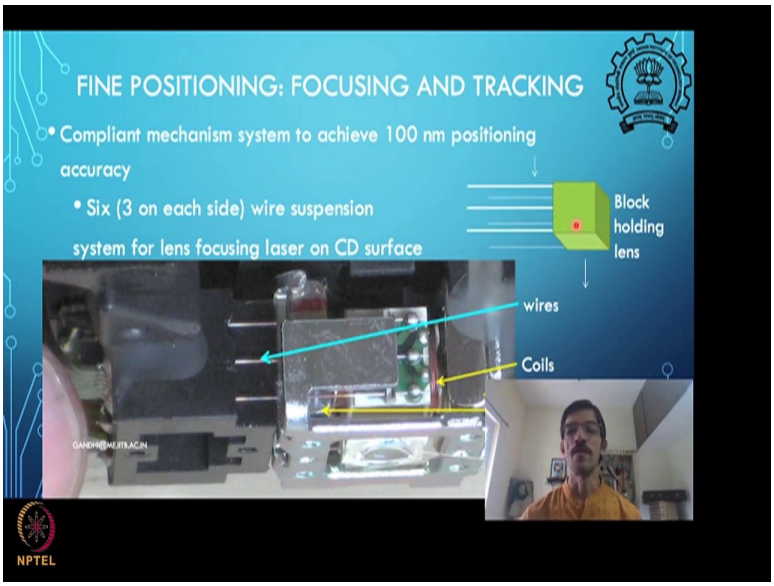

We will start looking at. So, if you see the head you will find this there is this block, which is held in the head by these wires. And you see these are the wires up here, this is a block, the block has a lens inside it. So, the lens moves up and down direction means this focusing kind of a direction, this block can move up and down, can this block get stretched front and back in this direction? Think about that.

Can these block move sideways in this? So, there are three directions it can move or it can tilt, can this block tilt also? Think about that. So, tilting is possible or not or tilting of this block is possible in any direction, twisting is possible, so you think about the six degrees of freedom any rigid body has, now what are the degrees of freedom this block will be able to move into? Given the constraint that you know you have these wires which are holding this block here, these wires are simply some kind of a small compliant kind of a wires. As you operate them you see how so they may not be stretchable but they certainly are bendable.

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So, you can see these wires operating actually. So, here you see that this is a block up here this lens here and then these wires are connected to this block from inside and coming out here and getting into this small little black portion here. What is there in this black portion we will see, we will think about. It is very interesting construction done for some purposes. What is there inside the block, wire is not fixed here, there is some small space and then wire is fixed inside this black part somewhere towards the end.

So, we will see why that is done in that way. And if you push the lens down, you can see that this wire is you can see this wire it goes like from here it goes and comes here. So, there are these

three wires that are used in parallel and they are doing, they are getting bent when this block is pushed down and up. Now, this pushing down and up action will happen not by somebody moving it up and down, but there are some kind of coils you can see here and then there is some magnet that is there.

So, the coils are suspended in the magnetic field and when the current is passed they kind of start doing this surface small, up and down or some kind of sideways motions. And that is what is kind of important for the fine positioning. Now, think why they have put such a kind of mechanism there. What is this mechanism, how this mechanism is helping us to do the positioning with a such Nano-metric kind of accuracy.

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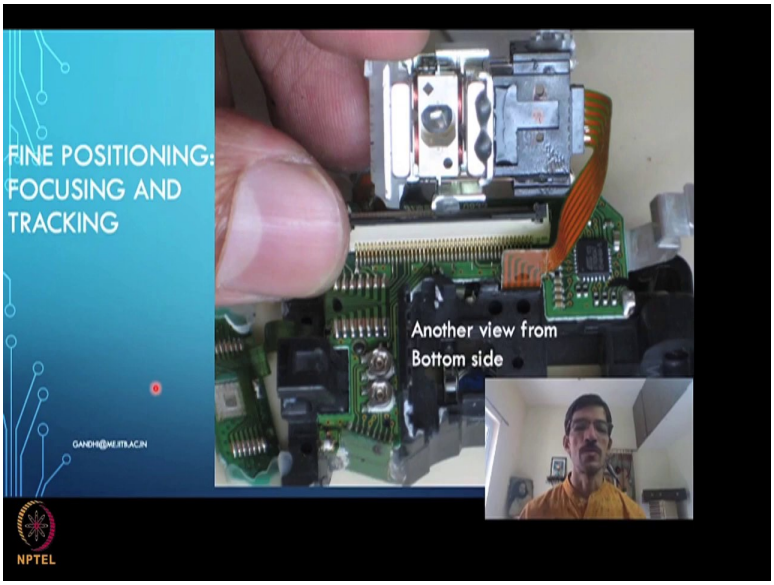

So, I would leave you right now at this point and then like will we discuss things more, so you can see these are coils up here and then there is there are these two magnets. So, these two little dots that you see are actually a glue to kind of secure that magnet in position or anything like that.

So, this is do not worry about these two black spots are actually glue and then like know that you have these coils the magnets are fixed and the coil and this lens assembly is actually moving. So, I leave you with this right now and think about now how do you kind of make sense of all these components together to really think about system, which have this kind of a Nano-positioning possibility. So, we will stop here for this lecture.