Engineering Graphics and Design
Professor Naresh V Datla
Department of Mechanical Engineering
Indian Institute of Technology, Delhi
Week 12: Animation
Lecture 1
Example 10

Welcome back to the NPTEL online course on Engineering Graphics and Design. We are on the last week of the course week 12. In this week, we will be looking at how to do animations of the assemblies we have already learned about in the last lectures. So, in this lecture, we will be having two examples and show you how to assemble and then do animations because these are important to present your ideas to your audience.

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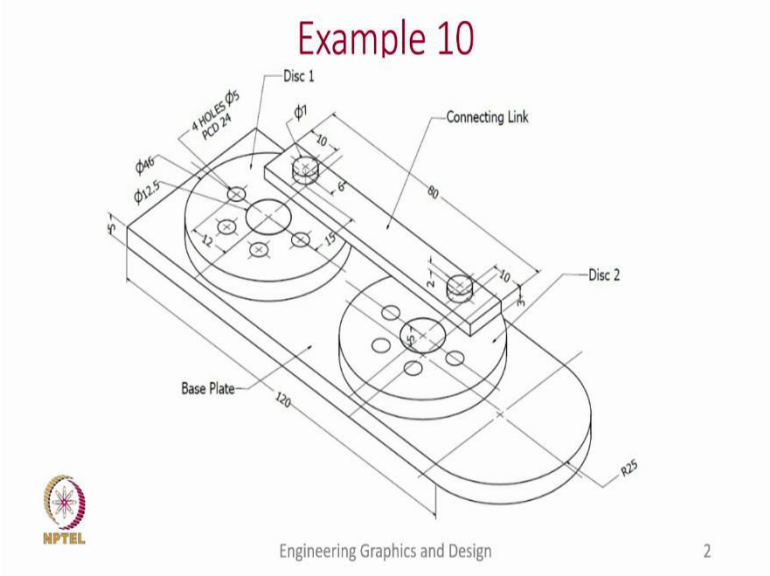

In this lecture, we will start with this example 10. Where there is a base plate at the bottom, on which there are two discs and connecting these two disc is a connecting link. So, the idea is, if we give rotate one of the disc, that link will help rotate the second disc. So, this in general is called the crank and rocker mechanism. So, we will see how to do it in the Inventor software.

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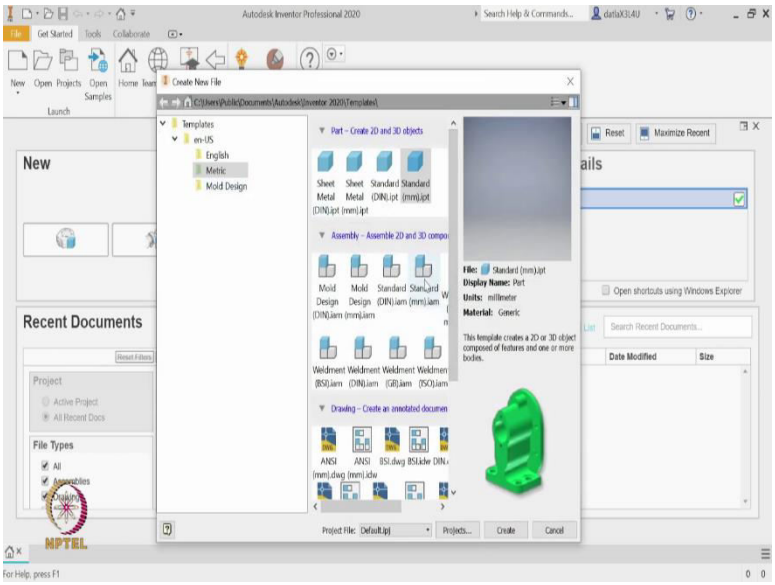

We are at the initial interface of the Autodesk Inventor. So, let us get started with the choosing the assembly template, we will choose the Standard (mm).iam. Like last week, where we have seen in assemblies, we have followed the bottom-up approach. Where we have already created the part models, we will import those part models into the assembly environment and start creating the assembly.

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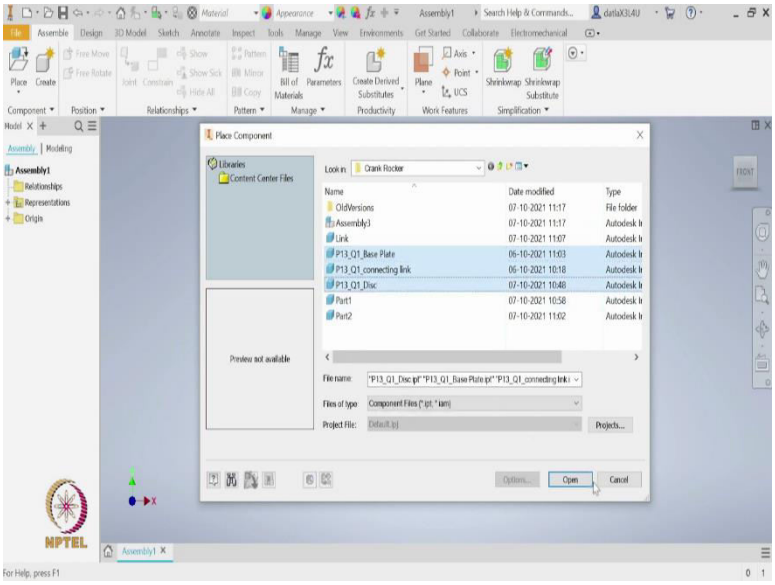

So first, let us start with the place. So, we are already in this folder of crank rocker, and I have to choose this Base Plate, Connecting Link, and the Disc.

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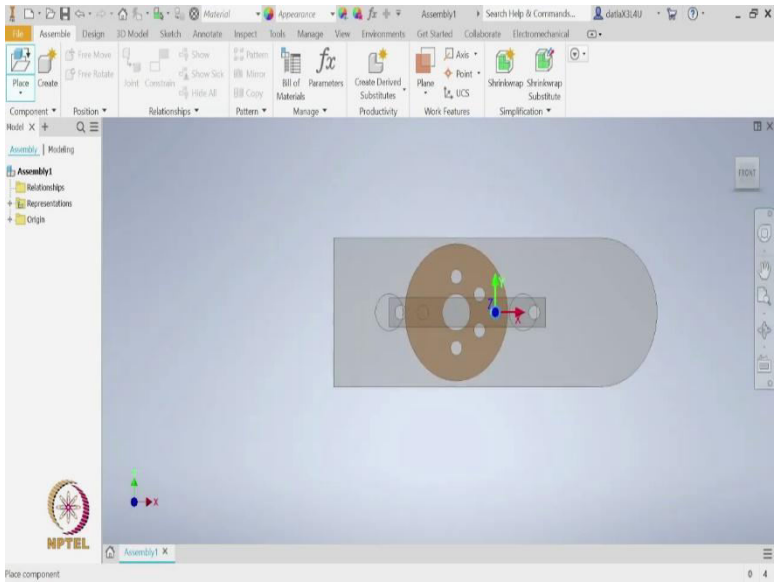

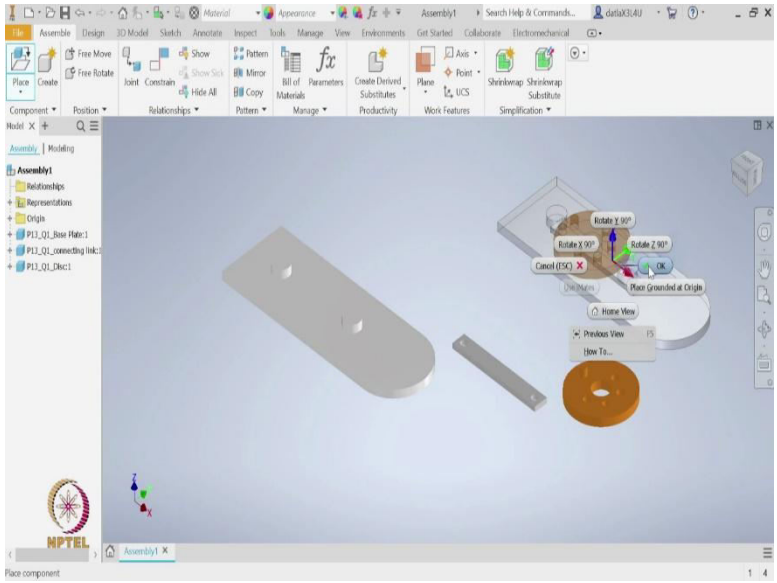

So, we will click once and then right-click and say ok.

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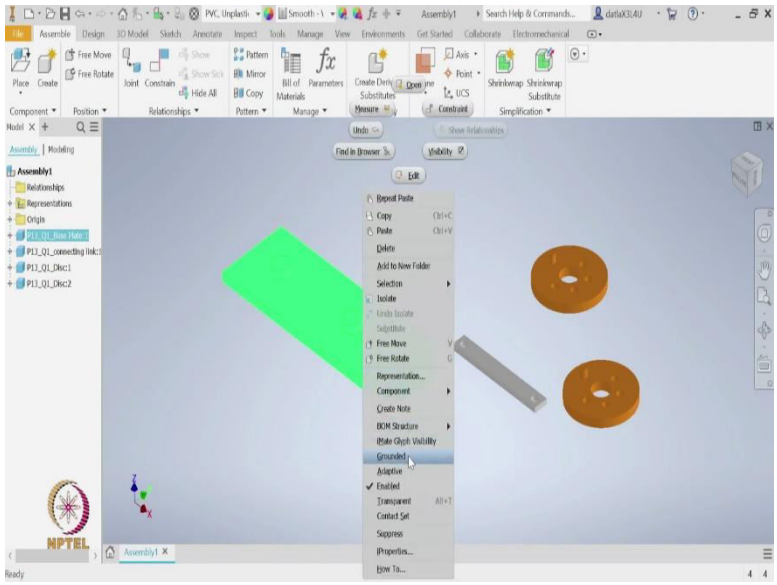

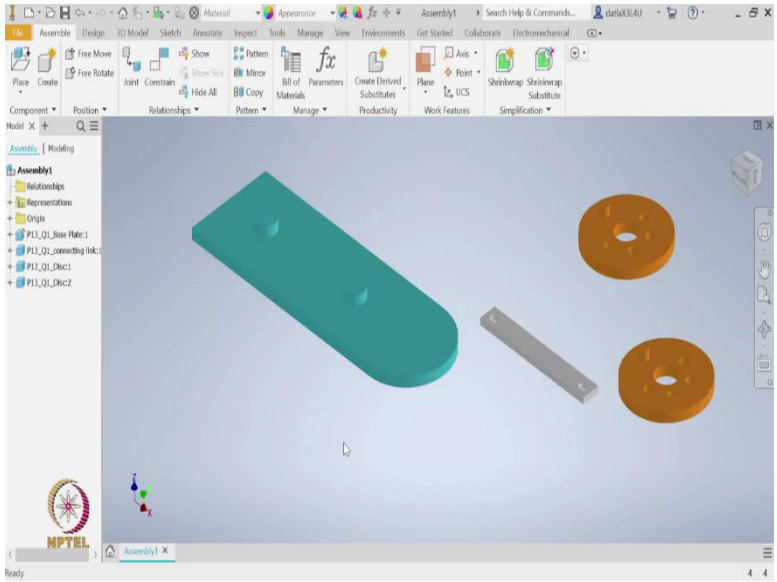

So, now we have the base plate, the connecting link, and one disk. Since in the problem we have two-disc, the first thing we will do is we will copy the disk, I will choose Ctrl C and Ctrl V for the second disk. And first thing we do in the assemblies is first ground one of the components, here I will be grounding the base plate, right-click and choose ground. So just for contrast, let me change the color of the base plate. So let us go back to the problem and see how we proceed by applying the constraints.

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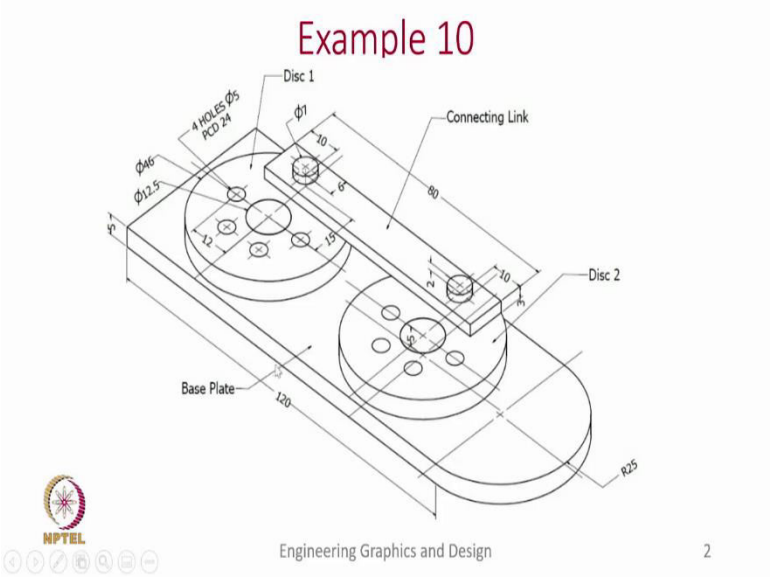

First, we will bring these disks and match it with these centres. We have two centres on the base.

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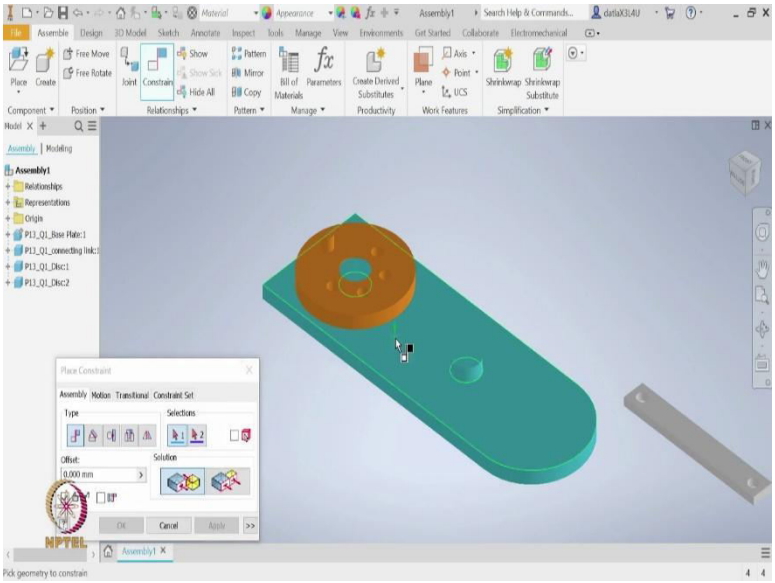

As we can see here, these are pin one and pin two, we need to match these pins with the center of the disks. So, we know that we can do using constraints. So I go to the constraint, choose the mate, and then choose the axis of this pin, and then the axis of this disk. Let us apply.

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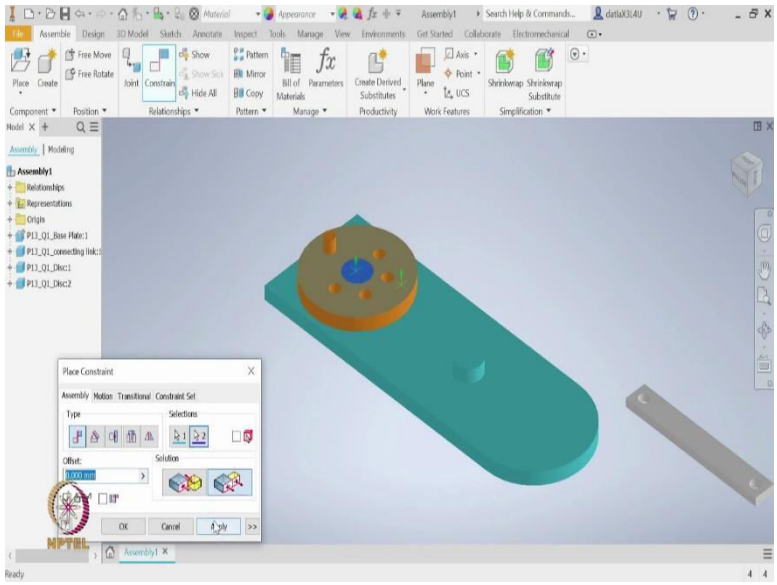

And secondly, I will flush, I will use the flush option between the top face of the disk and the top face of the pin, and apply.

Similarly, let us do the same with the second disc. First, I will apply the flush between top face of disc can top face of the pin, apply and then coincide the axis of the pin with the axis of the disk, and apply.

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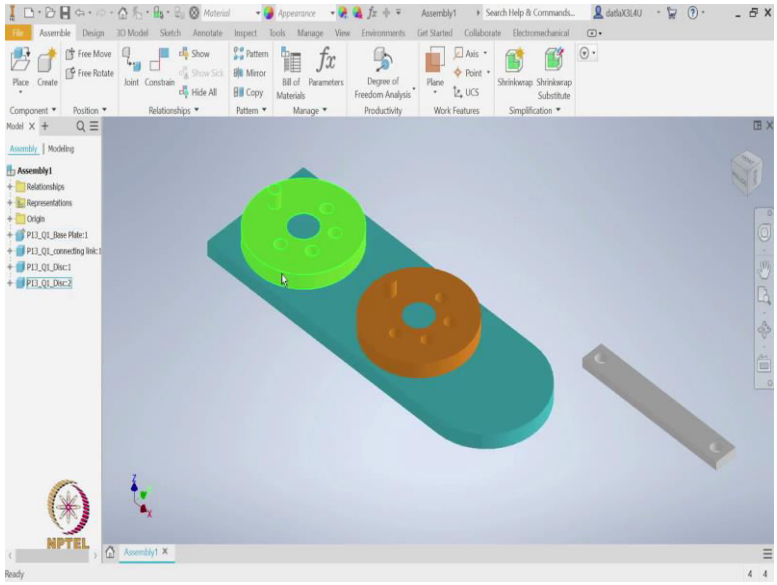

Now, we are able to bring the two-disc into the right plane as well as the right axis. Now that we have placed both the disc in right the positions, we need to make sure the orientation of the disc is also controlled. Which means currently it has one degrees of freedom, where it can

rotate about this axis in the constraint plane. But let us create an angle constraint such that we can control the angle of rotation of this disc.

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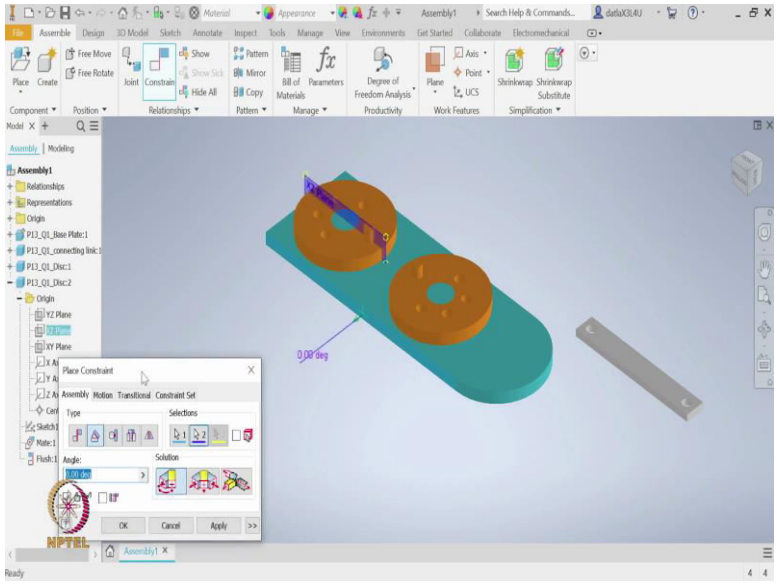

So, for that I go to constraint choose the angle constraint and using this directed angle. So first I will choose, I need to choose two planes, I will choose maybe this face of the base plate should be parallel to let us say the we will choose one of the axes of the disc. I will go to the part model, select the origin and see which of these planes. I will choose the plane where the pin is already positioned so this is the XZ plane.

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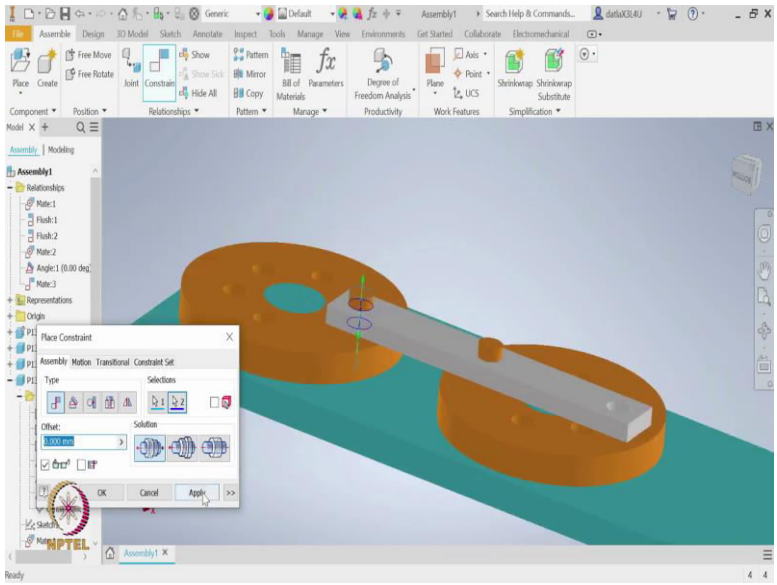

And then currently I will give this angle as zero and apply. Now that the disc is properly aligned, now let us bring in the link and connected with the pin on the disc. So first we have to mate the top face of the disc and the bottom face of the link. Let us apply and see how it is.

Now I will align the axis of the pin as well as the axis of the hole we have on the link. So again, go to constrain let us choose the axis of the pin and the axis of the hole. And similarly, I can do this first let us apply this constraint and then apply the same for the other pin as well.

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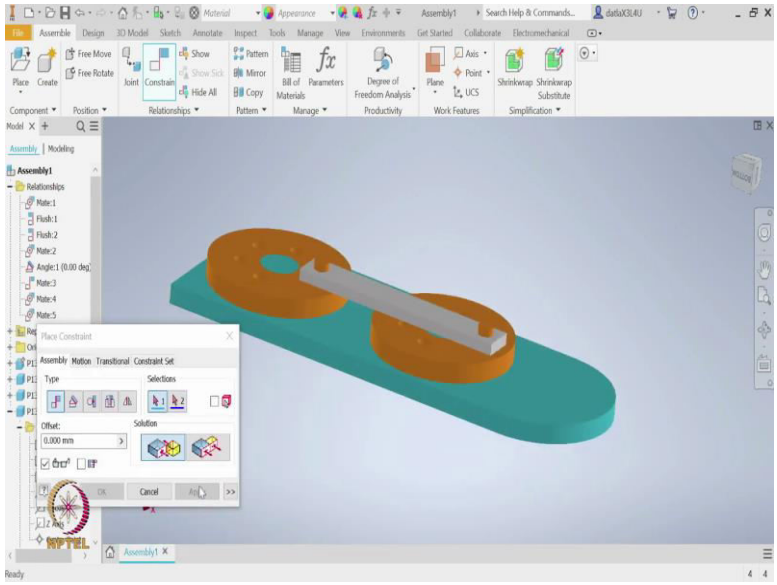

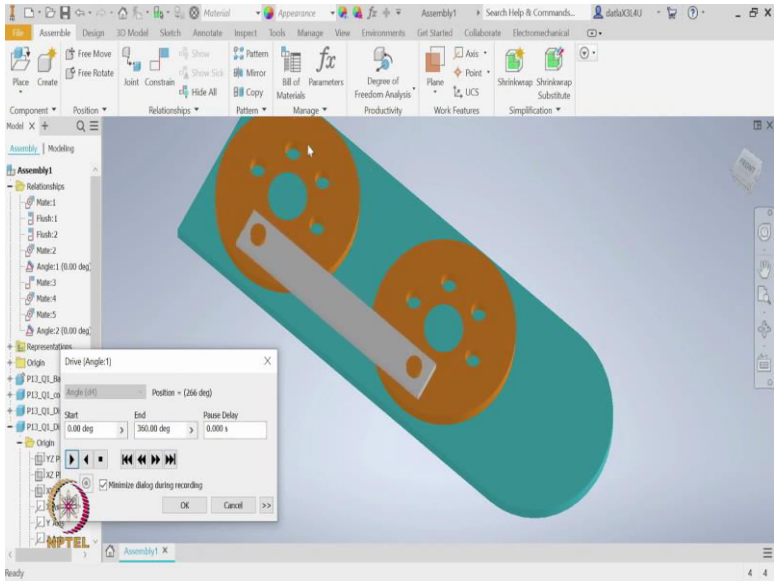

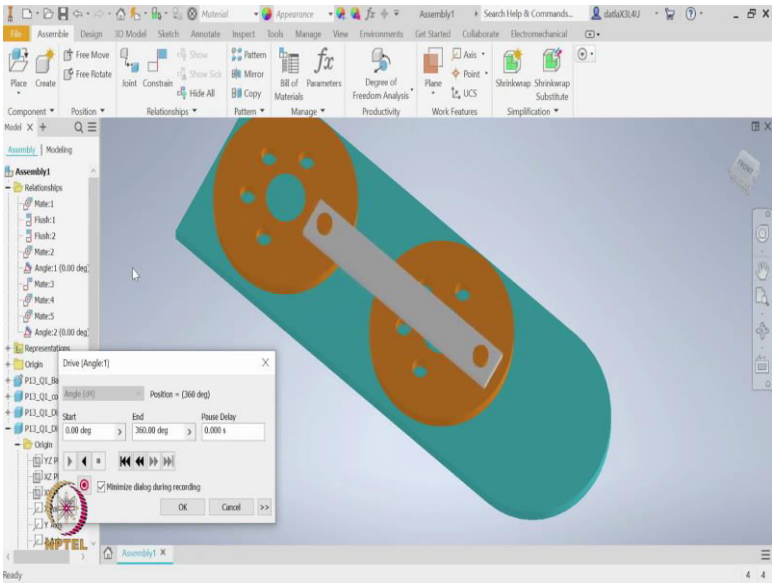

So first let us see what is the degree of freedom we can see it is the link is still free to rotate. Now let us mate the axis of this pin with the axis of the hole let us zoom in, and apply. So now we have the connecting link passing through both the pins.

So, the last thing we need to do is when this pin one moves, we need to make sure this link is horizontal, for that I will give an angle constraint between the this face of the link and this face of the base. So, I have said that the angle will be zero. So with this we have done with what is required to assemble this device.

Lastly, what we need to do is for us to animate, we need to go into one of these relationships. So, in this device, what we are looking at is if we rotate this Disc 1, we want the Disc 2 also to rotate by the means of this connecting link. So how can we connect that? that can be conducted by this Angle 1, if you recall an Angle 1 is what which talks about the orientation of the disk with respect to one face of the disk.

So let me click on that angle, right-click and then select Drive. It opens up a dialog box where it says initially when we were creating that constraint, we said the angle is zero degrees. But now we can give a range to that angle, we will say it is changing from zero to let us say 360 degrees. So, which means it will make a complete rotation.

And then now let us animate and see by playing this forward button. So, we see that we are only given the specified the rotation to the first way but since we have mentioned the constraints, now this first disc is driving the second disc, with this problem we are able to give a degree of freedom to one of the components and see how the other components

respond. There is another way of specifying this using a parametric equation. To do that, we will slightly modify the problem.

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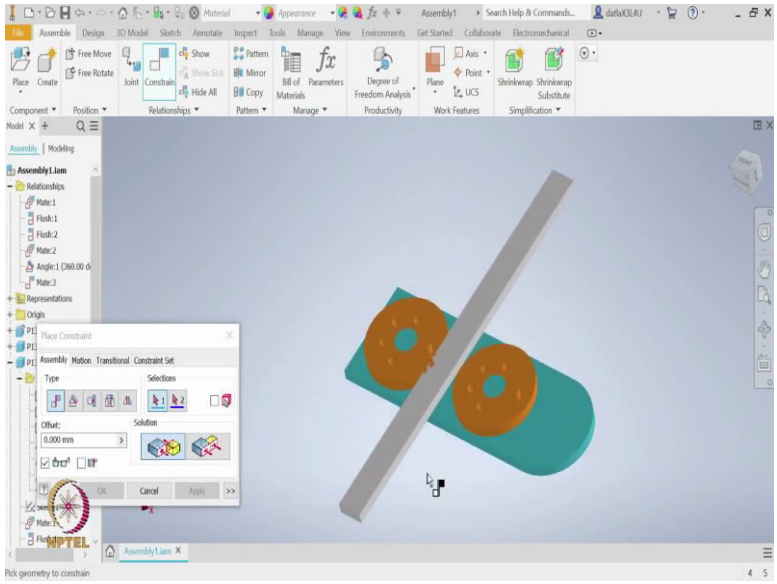

Now what I will do is I will remove this connecting link. So let us say I will select the connecting link and that part I will now delete. So, it has correspondingly deleted the relevant relationships which we have created with that part.

Let us say, now, what I will do is I will modify the problem saying that between these two rollers, I will have another link and once we move the first disc that will drive this link. So this is similar to what we see in a sugar cane roller. So, between the two wheels, you have the sugar cane and it is squeezed to get the juice.

Similarly, we will see that these are the two rollers and between these two rollers we will place a bar which will be squeezed so let me first import that bar. Let us Place select this Link and I will place it somewhere here, right-click and ok. I will apply a mate constraint between the top surface of the base plate and the bottom surface of this link apply.

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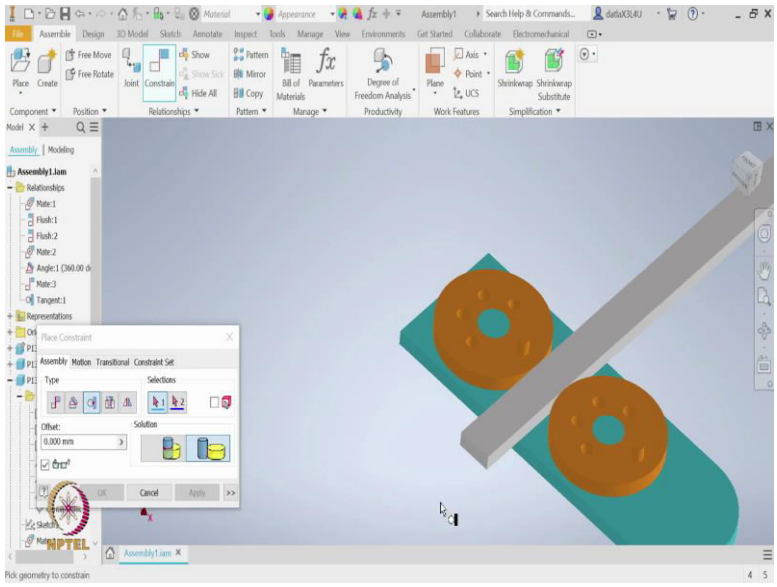

And secondly what I will do is I will apply a tangent constraint between the roller surface and this face of the link. Here, I am choosing the outside constraint. So let us apply it.

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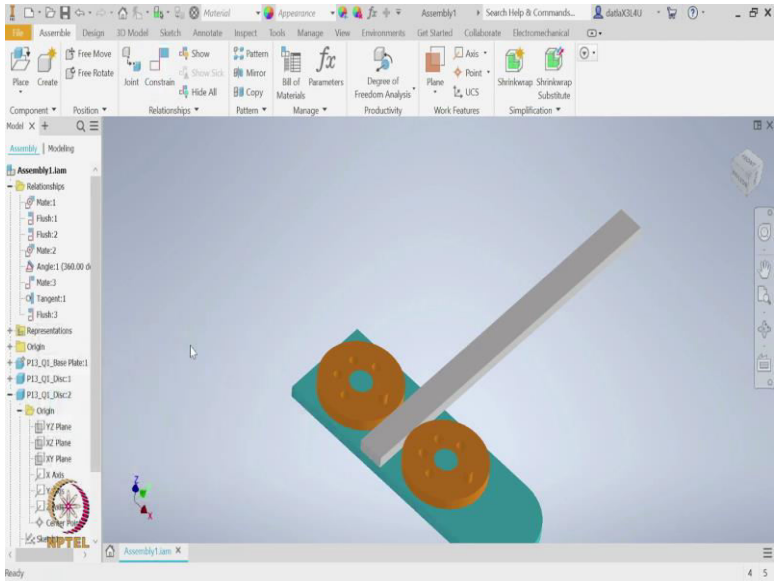

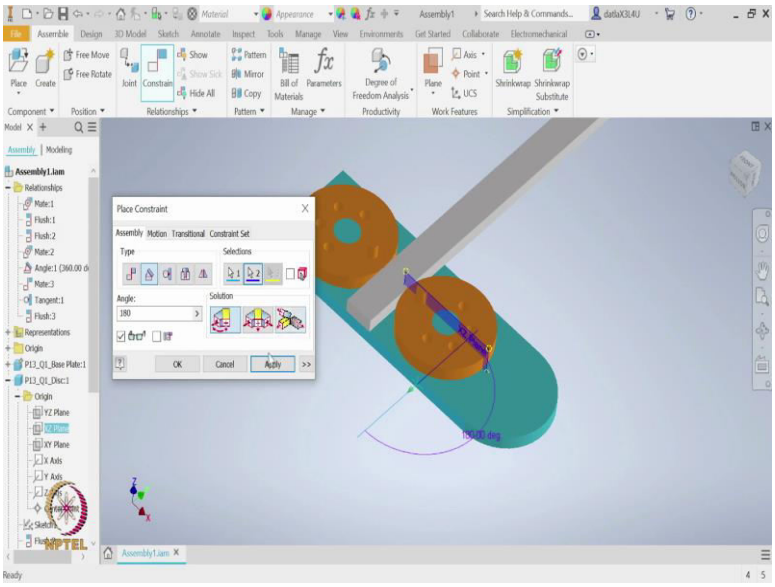

And lastly what I will do is I will apply a flush constraint between two phases, this phase of the link and this phase of the base plate, apply. So now what I am done is I have the two disks and a bar between them. Once you roll one of the disc that should drive the bar as well as drive the other disk. First let us start with looking at how these disks should be.

Now to give you a realistic field, I will make sure that the pin of the second disc is placed close to the bar, such that we have both the pins close by to the bar and when they rotate, we have a feel about how these discs are rotating relative to the bar.

For that I will apply an angle constraint using the directed angle, so first I will select this surface of the base plate and second, I will select the one of the planes for this disc it is the XZ plane, and now I will specify this angle as 180.

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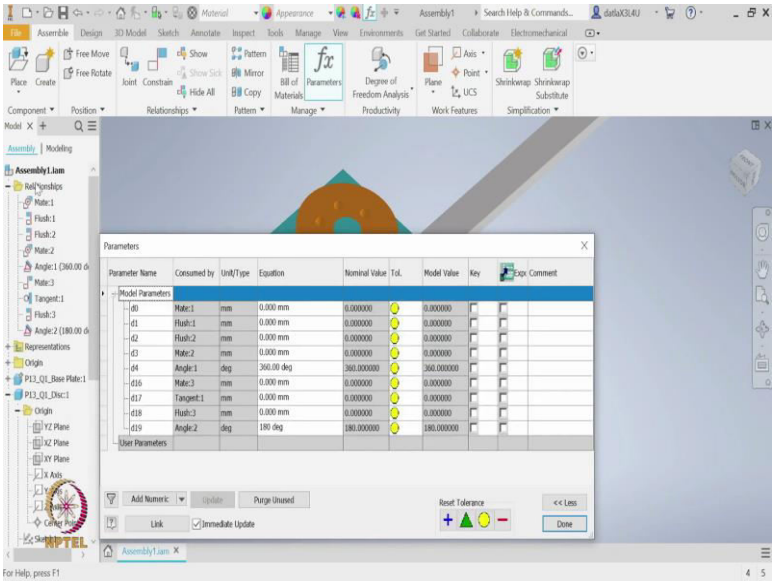

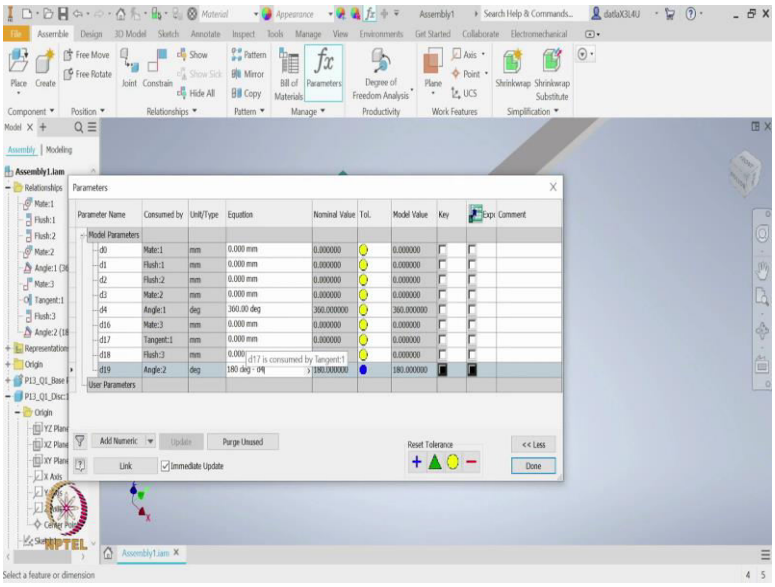

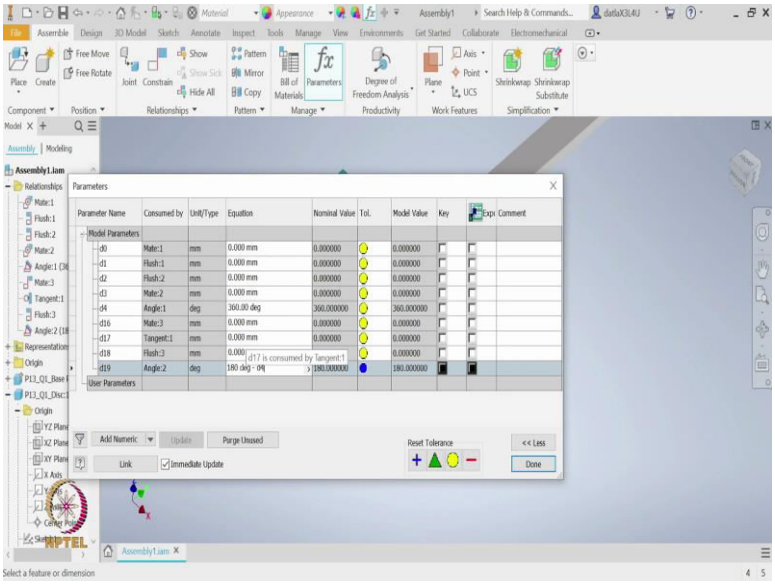

Now we see that these two pins are closer to the bar and I will apply. Previously I was mentioning that we will be looking at parametric equations. To do that we click on this tool f(x) for parameters. So, it then it opens up a dialog box where it shows all the relationships we have specified. So, each one is given a variable name like d0 d1 d2. So, for example, the Angle 1 which is used for us to specify the rotation of the first disc is here shown as d4.

Similarly, the Angle 2 which we just specified for the other disc or the second disc is specified with this parameter d19. So now what I will do is I will go here and then you can double click on the equation to specify the equation, we say the initial angle is 180 degrees and then let us say it is minus the other angle which is d4.

So let us say done and let me once check how this works out. So again, I go to Angle 1 right-click and say Drive and then see how this animation works out. Now we see when the first

wheel is rotating even the second wheel is rotating. Now as we expect they should be rotating in opposite directions.

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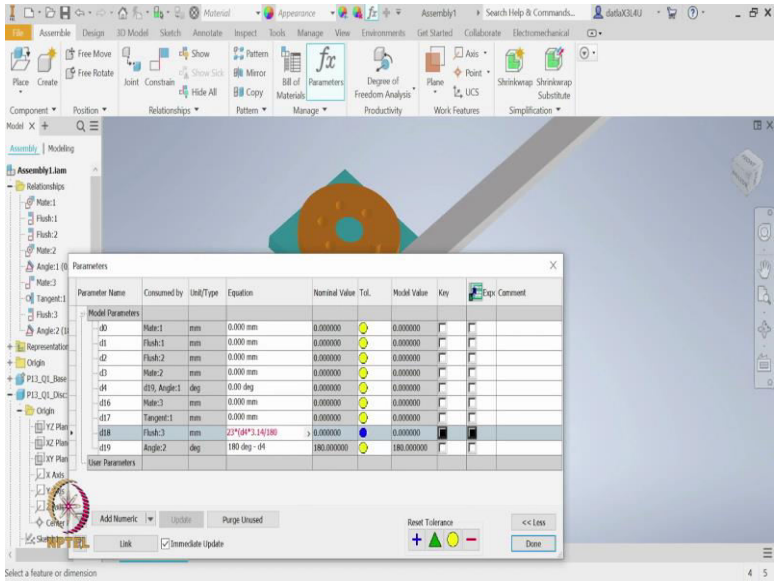

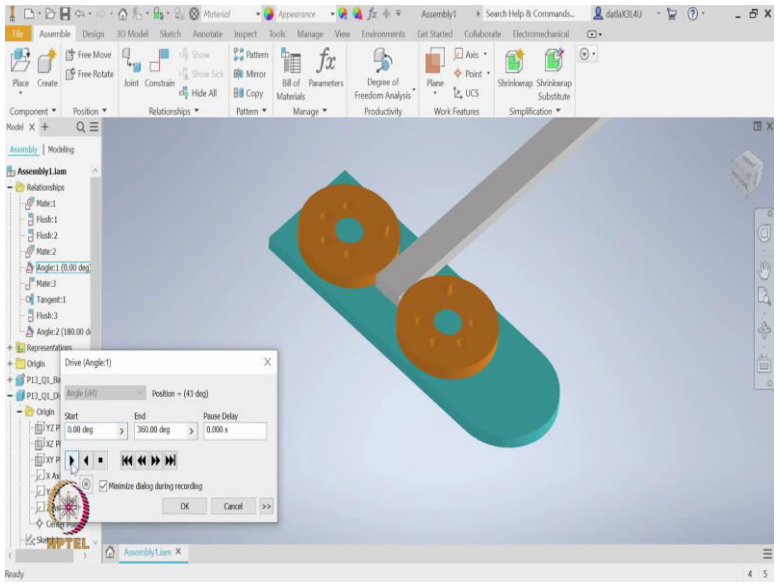

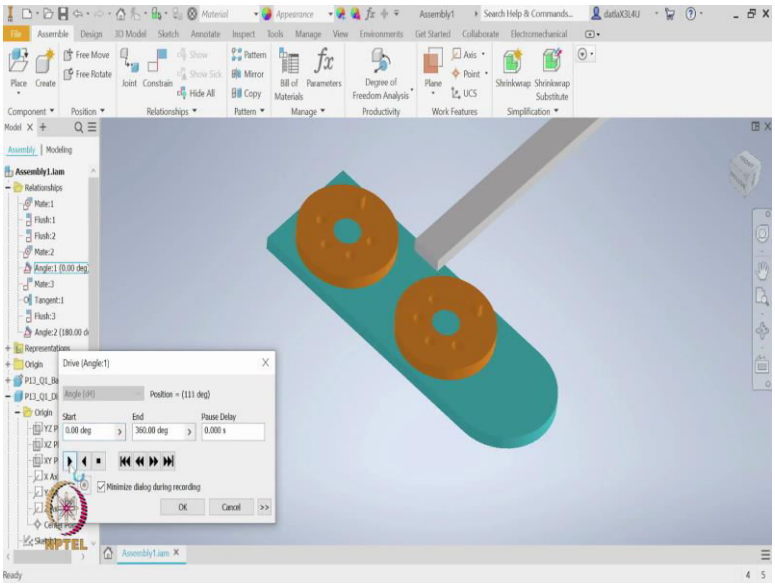

And lastly, what we need to specify is how this bar moves when the disc one rotates. For that again go to these parameters tool. For the bar, we have specified this moment through the flush command. So, the flush command is d18, so let us modify that equation. So how do we modify, if we specify that the angle of rotation of the disc one is theta, the amount of translation of the bar will be r theta.

The only difference is theta should be in radians. So, what we will do is first we know that the radius of this disc is 23. So that is r times. So theta is given by d4. I need to convert these degrees to radians. So, I will multiply it with 3.14 divided by 180.

Maybe I need to specify the unit. So let us say this is mm. And let us say if it takes this. So, in this equation, previously, I made one mistake saying that this 180, we need to ensure that this is in degrees, because d4, as you can see the Angle 1 is in degrees.

So, to be consistent, make sure you have this degree written for 180. Then, let us say done. And now let us go into Angle 1 right-click Drive. And let us see how the animation looks like. So we see. So, this is not what we required because the bar is going in the opposite direction.

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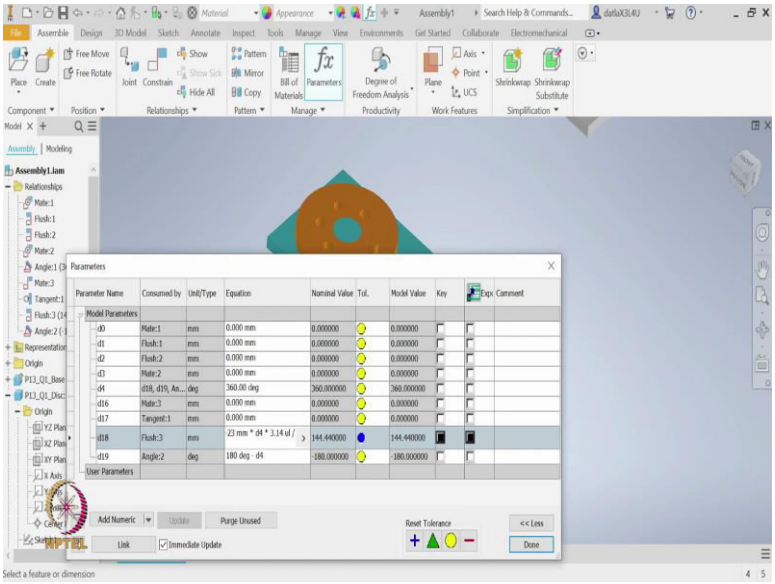

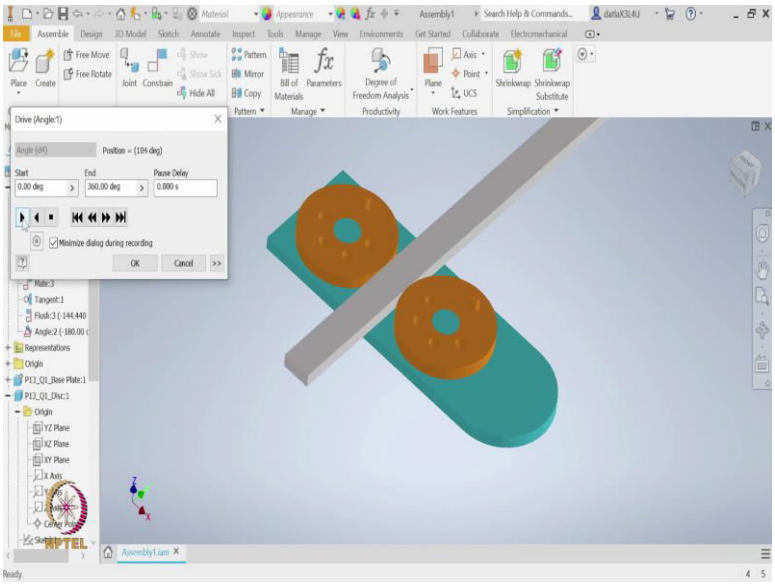

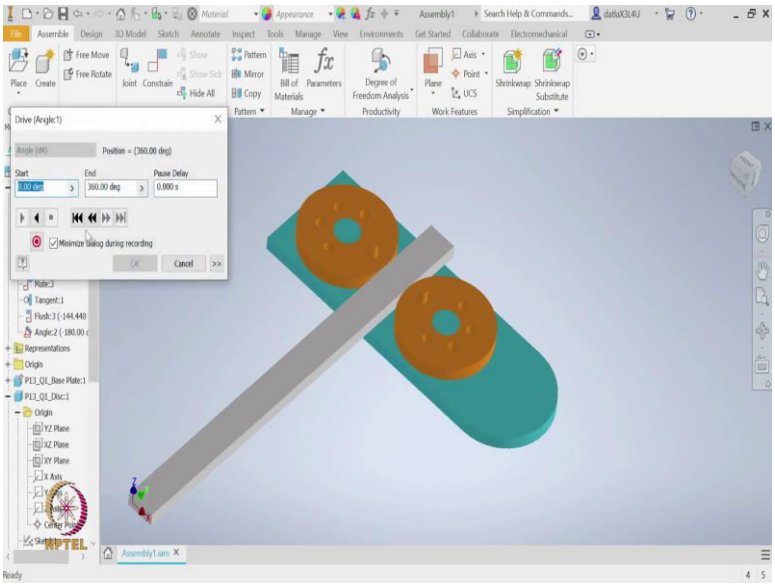

So instead, what we will do is we will go back to the parameter and say, this should go in the negative direction. So, we will mark this as negative. And now let us see how it looks. Now let us go to Angle 1, right-click on Drive, and now let us animate and see how it works out. So now we see that the bar is moving in. But if you clearly notice the rotation of the disc is not consistent with the movement of the bars.

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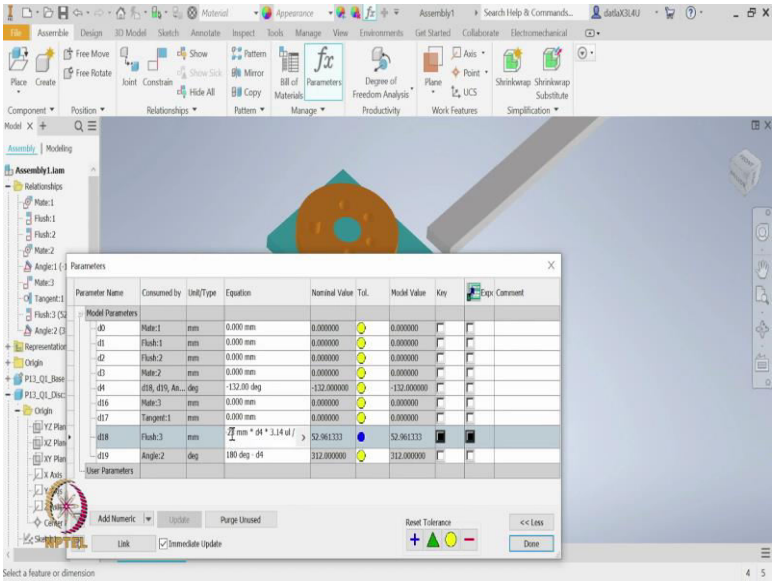

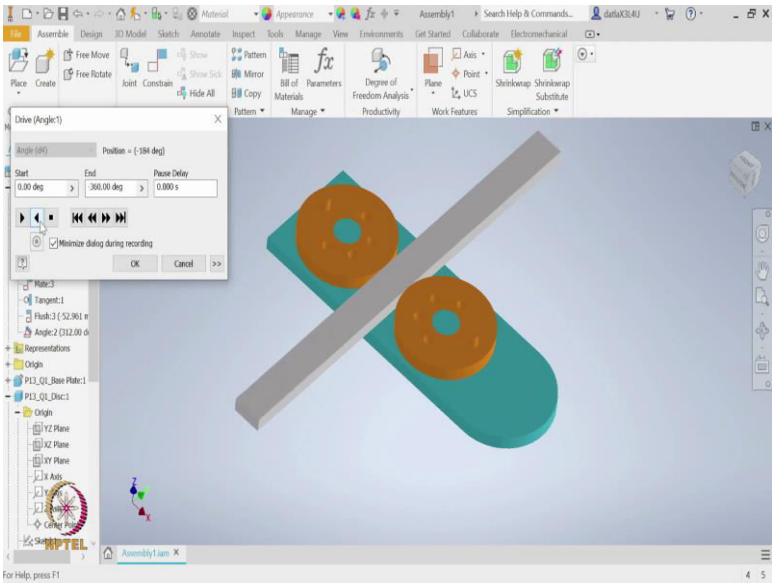

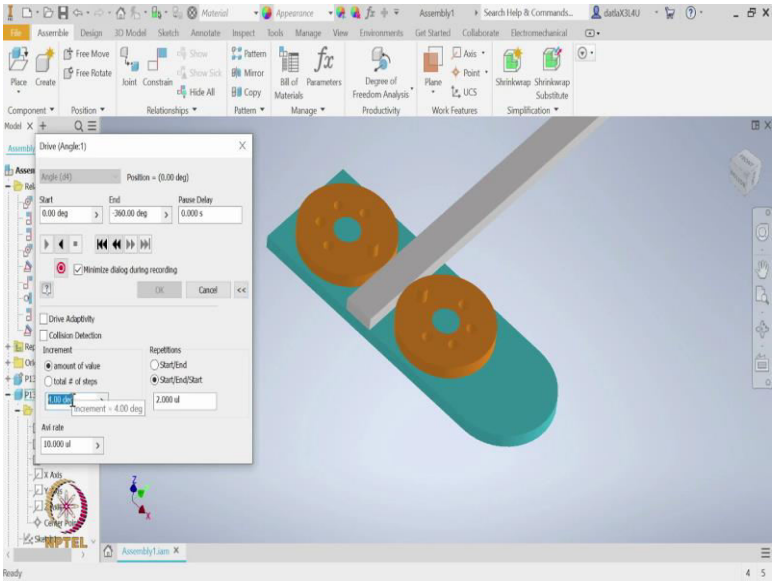

So let us slightly analyze the problem, we were planning to have this bar to the move to the left, for the bar to move to the left, we see that this disc should be rotating clockwise. So instead of giving moving from zero to 360, we should have it the other way, it should go from zero to -360.

So let us make that change in the angle. So, we say it is going from zero to -360. And then let us see how things go. Now again, the problem is it is the bar is now going in the opposite direction.

So, I will come back to the parameter and then remove this negative sign, done. So now if I go back to Angle 1 and animate, hopefully it should work well. Now let us animate and see, we now see that the rotation of the disc matches well with the movement of the bar.

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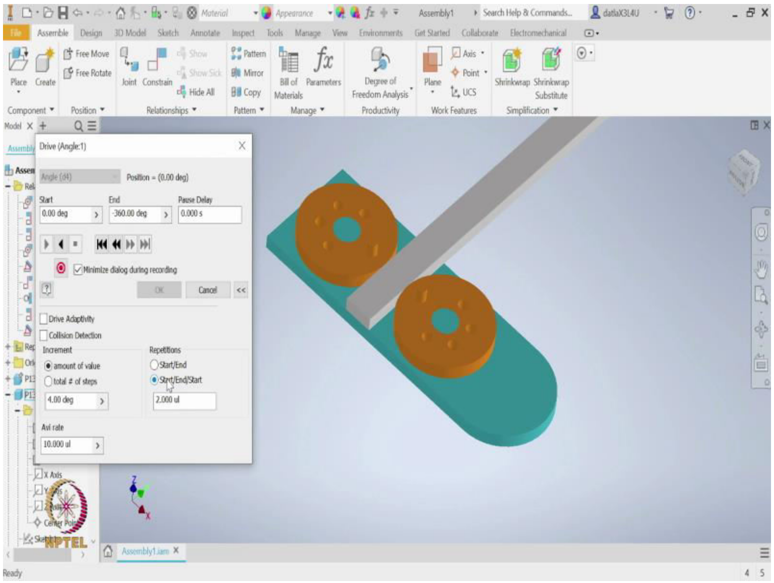

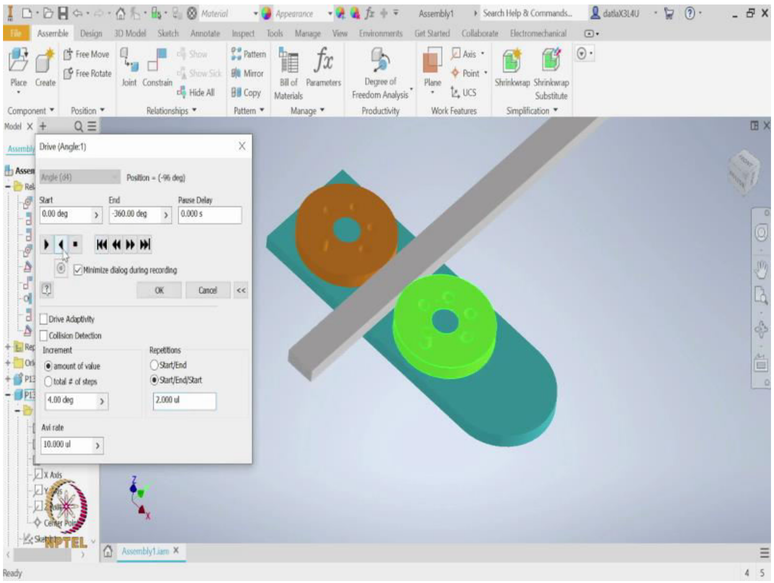

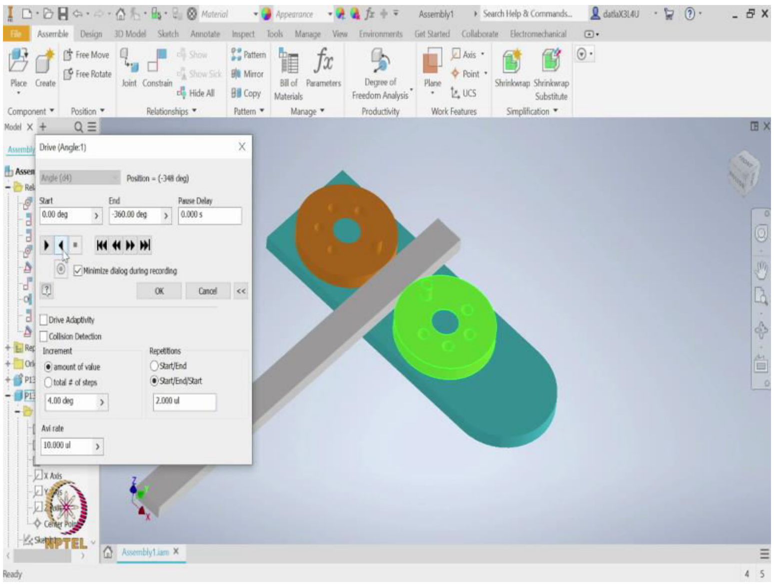

There are few more options we can do with this Drive dialog box. For that we need to click on these two arrows, then it opens up few more options. The first we can increase the speed or decrease the speed by saying how many degrees of increment you want in each step.

So previously I had one, now I am changing it to four degrees, so it will now play it four times faster. And in the repetitions, you can choose either it goes from start to end, so if you are saying 0 to 90, it will go from 0 to 90 and stop there.

But if you want it to again come back to the initial position then we choose the second option where we say start end start. But here remember like for one cycle you need to give 2, and if you say 20 it will do 10 cycles. So, I will just leave it at 2 and let us play it and see how. So it has gone in one direction and came back to the initial position. And also, now we have seen that the speed is faster.

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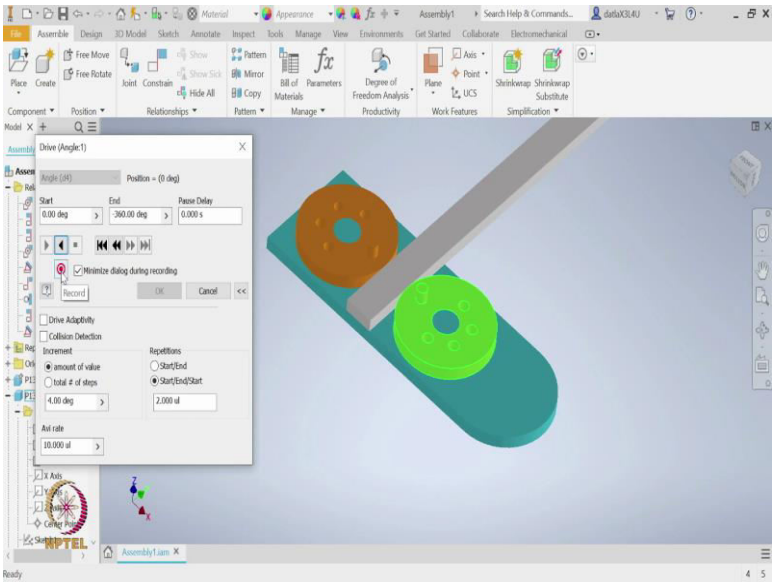

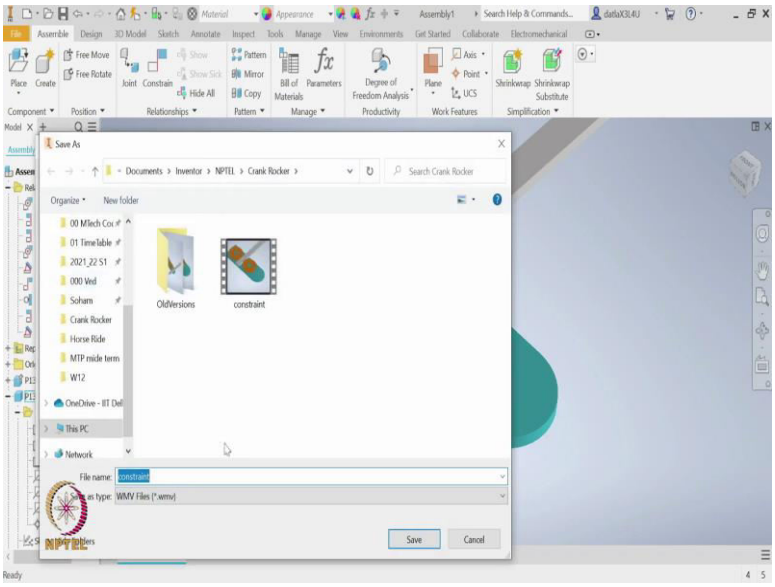

We can also record this animation to do that. We click on this record button, then it opens up we can choose the folder where we can save it let us say Save, and when we save it has two options for the video file. One is the WMV and the other is the AVI files, AVI file the file size will be big as well as the file quality is also good but if you are fine with the low-quality WMV will save some space.

Let us say save, so here we can choose what are the network bandwidth. As of now, we will go with the default broadband option. And secondly, we can also control the size of these video file I will go with 640 by 480 and click ok.

So, now when I say play now whatever I see on the screen it is being recorded. So, the moment it comes to the start and in start, now it comes back which means it has captured this window and saved a file in your destination folder we have just chosen. So, in summary, what we are looked in this lecture is first we have repeated the assembly of this crank and rocker mechanism. And then we have also looked into how to animate this assembly using that Drive option.

Later in the Drive option, we have seen, by changing it to a different problem how to apply these parametric constraints, where we can write equations about how to apply these constraints. The good thing about this is you can make these animations more physics-based where you can bring in your physics equations.

So, for example, let us say if you have a ball thrown, so for you to say the parabolic profile it follows you can plug in those equations and make sure these animation follow the laws of physics. So, with that, I will conclude this lecture. In the next lecture, we will look at another

example where we will take a device and start assembling and animating that device. Thank you for your attention.