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Course
on

Spur and Helical Gear Cutting

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Lecture 16: Gear Shaping - II

Welcome viewers to the sixteenth lecture of the series.

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Spur and helical gear cutting, so last lecture in the last lecture we were discussing about the uniqueness of the locations of the gearboxes in case of hobbing machine.

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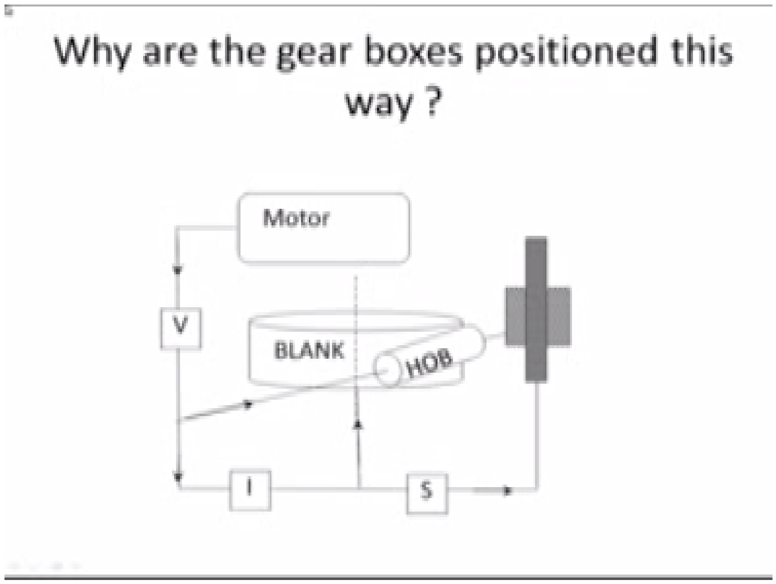

And if you look at this was the accepted position and this was the changed position and we noticed that the location of I in this particular position unfortunately is going to change the HOB rpm and that would result in a different cutting speed and that is going against our basic resolution that one gearbox should affect only what it is intended to and nothing else change in speed should be controlled by the change in UV change in speed.

So this is not acceptable let us take up any other positions which might be acceptable what if we could keep V here and I here in this case V if V is change yes it is going to change the hob rpm and it is exactly meant to do, so okay from the motor we get some rpm and from that particular rpm we are changing it to some other a scheme and providing it to the hob, so V is serving it is purpose but the problem is as V is lying in the loop now between hob and blank a change in V is definitely going to bring about a change in the rpm ratio of the urban blank which means that you are going to start cutting a different number of teeth something you never intended to do I mean never intentionally wanted to do.

So we cannot be placed here because it starts interfering with the indexing or selecting the number of teeth for cutting another one what about this can we have this sort of a location V is in the correct position because a change in V changes the rpm of the hob but a I instead of this location has been shifted here does it cause any problem it is still in the loop between the hob okay if I pass between the hob and the blank.

And therefore there is absolutely no problem it can control the number of teeth to be cut however we see that it is also in the line between the blank and the vertical movement of the hob this is a threaded element a screw rotating inside a nut and configured in such a way that if the screw rotates and does not translate and if the nut does not rotate but translates only.

The due to the rotation of the screw the nut will suffer a translational motion and accordingly the hob will have it is longitudinal feed vertical longitudinal feed, so unfortunately this particularly longitudinal feed is going to be affected if you put I here because it is defined as millimeters of hob movement per rotation of the blank, so here we find once I is placed here and it is changed okay.

No matter that it will be I mean definitely it will change the number of teeth to be cut the purpose it is supposed to serve but it is also so our going to change the number of millimeters per box revolution because it is simply going to change the number of millimeters we are moving with respect to the blank rotating rotation therefore this is also not affected why because it does change the number of teeth correctly but it also affects the feed which it is not supposed to carry out.

So this is also not affected I mean this is also not accepted what about this one if it place S here it does control the number of millimeters of movement that means Launcher movement of the hob with respect to rotation of the blank ok rotation of the blank that is in one rotation of the blank how much is the job or the hob coming down so it does control it because it is in that particular line with respect to the blank rotation you can change those number of millimeters you are bringing it by up or down.

Unfortunately it is now also in the loop between the hob and the blank and therefore it start it will start affecting number of T being cut which is not at all acceptable okay therefore this is also not a correct concomitant configuration.

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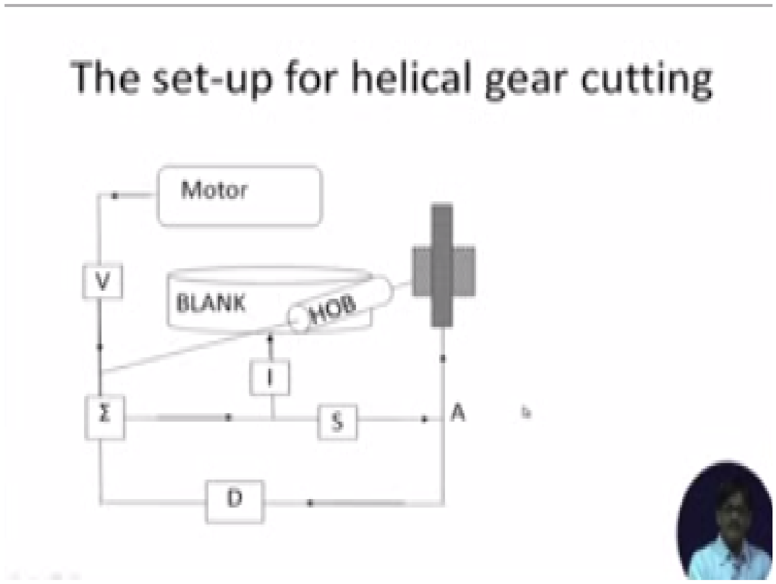

Now we will introduce in brief in very simple language the setup for helical gear cutting what is helical gear cutting for this let us have a quick look.

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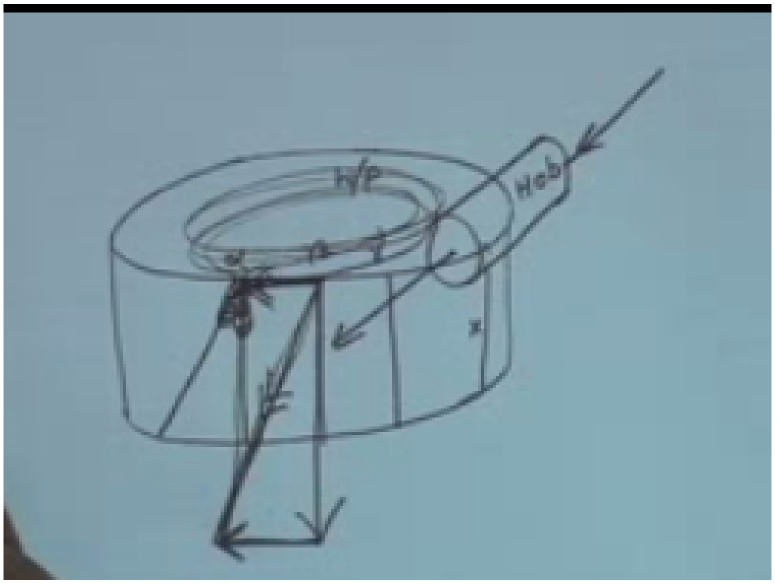

First of all H on this particular figure if I have a blank on which if I have matched the rotational ratio of the hob with the work piece if this rotational ratio is matched then say the Meridional plane X comes under the hob okay it gives a cut so this way each and every say let us call these meridians α, β, γ, x all these are going to get cuts which are going to be vertically downwards exactly just because they are synchronized they are matched they are exactly given the rotational ratio that they are supposed to have.

So cuts take place this way but in case of helical cutting we want the cuts to take place this way, so scientists medical scientists thought this way I am moving down in this manner I want to move down in this manner when I am cutting helical threads, so it basically boils down to the addition of a velocity vector during cutting action how do I provide this velocity vector can I provide it by making the hob move this way but in that case it will lose contact, so this velocity vector can be provided by you know rotation of the work piece the work piece can rotate and therefore provide this velocity.

So an additional where velocity will be obtained by rotating the work piece okay, so that the final resultant vector lies in the direction of the desired helix angle this is the basic idea how do I rotate the work piece now here I can point out one thing which you have to know which you have to think about I will say the work piece is already rotating the work piece is already rotating so howcome you are going to think of rotating the work piece do by virtue of this rotation only it is having synchronization with the rotation of them of the hob.

So this means we are basically talking of an extra rotation what is this extra rotation that means in addition to the rotation of the work piece in order to synchronize with the rotating hob I put some additional rotation how much will be this additional rotation this additional rotation will be such that one complete extra rotation will be carried out by the time the hob moves by one lead of the helix angle thread okay, let us have a look at it on the figure.

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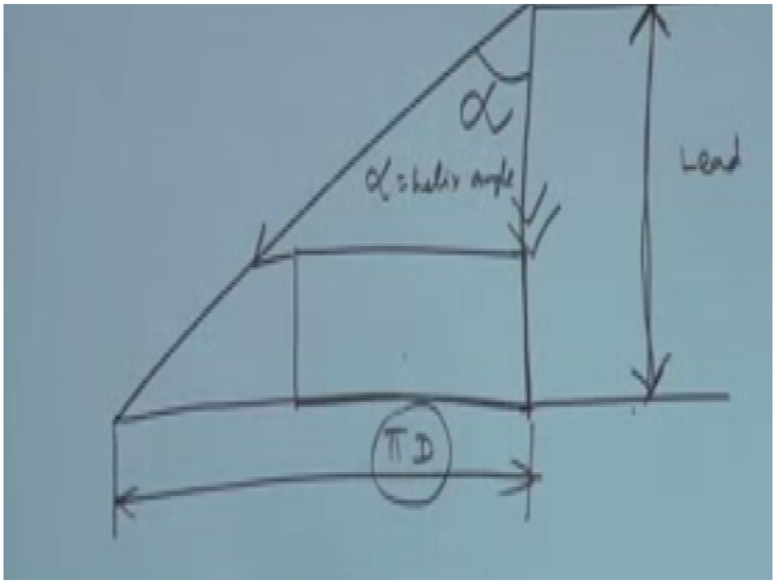

This is our work piece and therefore if we unfold the full work piece this comes out to be say Π D okay circumference, now that the helix should be such that this is equal to lead off the helix and this we know as α the helix angle and therefore helix angle is tan ∝ Π D/ l so α equal to helix angle so we have to find out how much is this motion downwards this is the feed motion I want to move this way if I can move exactly Π D amount that means if I can rotate once by the time I am carrying out the lead motion.

Then my job is done, so how many times in order to move Π D okay how many times does the job have to rotate it has to rotate by one times only one time single rotation which is extra to the molar rotational motion it is already having, so for this one rotation we will ensure that lead amount of motion will take place for the warm gear for the warm gear sorry for the warm the worm when it is being fed down it will execute exactly lead amount of motion by the time the cutter sorry the work piece of this once.

So work piece rotates once lead of the helixes is this much have these cutter moves like this or that amount and therefore this ellipse angle will be a okay, so having understood this let us start doing some calculations oh by the way.

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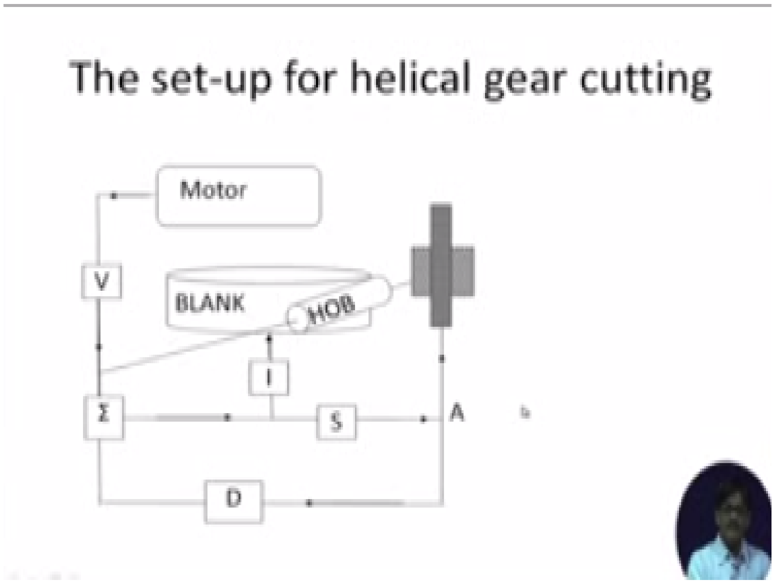

Now if we look at the figure in order to make this possible that means in order to make this extra rotational addition possible we are incorporating another separate line what is the separate line since power has come up to this point after which it enters a vertical screw by the rotation of which this nut is moving downwards, okay there itself I have taped the power here and as passed it through a gearbox and added up the result of that gearbox with the you know will the the input coming directly from the motor.

So this is a feedback this is called the differential gear box okay, sorry this is called the lead change gears and changing the lead with this that means different helical helices angles will be cut with the help of this and this is the sign of Σ these two rotations will be added here now how do you add rotations addition of two inputs to produce a single output is referred to as a differential process I am sorry the mechanism which does it is referred to a differential mechanism.

So this represents a differential mechanism okay differential mechanism from the differential mechanism the output ultimately passes through to the blank rotation and basically this gave us suppose already existing those, so these two inputs are added together and give to the work piece so that it undergoes an additional motion, okay we will see how this works, so we are now accepting that we have 1, 2, 3, 4 gearboxes and vertically and a differential mechanism for adding these two inputs okay.

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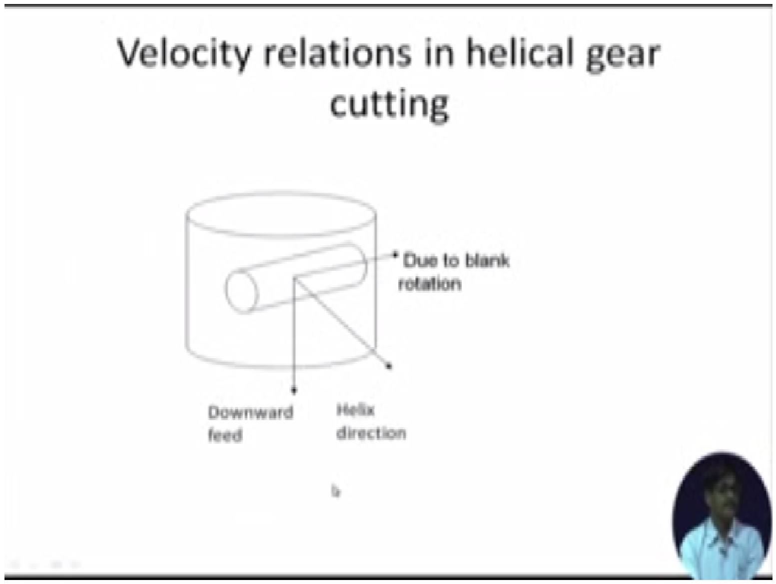

This is the velocity relation which we have already discussed that means the hob has downward motion and the blank will be given extra rotation because of which there will be a tangential motion the resultant of both the velocities will give rise to the helix direction.

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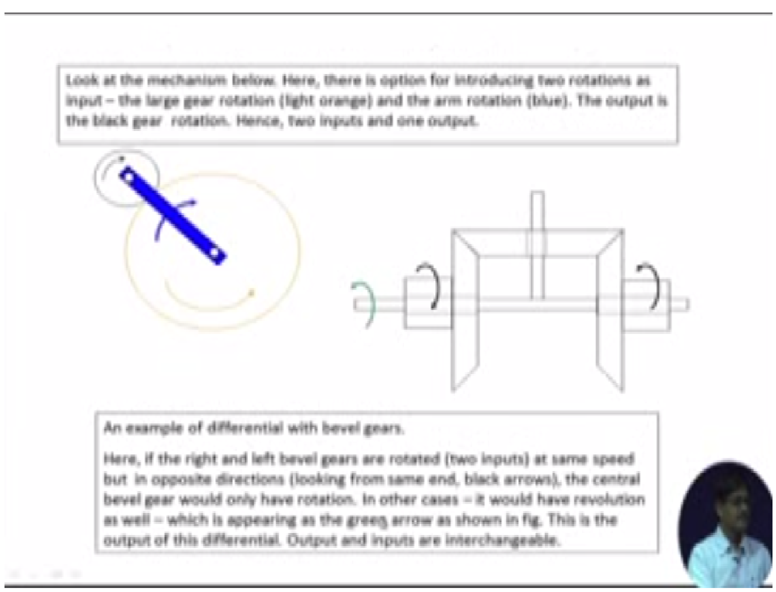

Now a word evolved differentials what is a differential can be the Sun planet mechanism where I am having this large orange colored gear which is having its own rotation okay it is rotating who is it connected to it is connected to another gear in mesh and these two are pinned okay they are having pin connection with an arm this blue arm, so I can look at the blue arm also which are shown by a blue curved arrow, so I can rotate the orange gear let us have a look at again at the figure I can rotate the orange here I can rotate the arm and give to these two inputs the output of the you know black gear will be defined.

And therefore two inputs are considered here and there is one single output rotation of this particular gear okay, this is a differential called Sun and planet mechanism and here we have another differential or the bevel gear differential let us see what is the scheme of operation this is one bevel gear which is getting input from one source this is another bevel gear which is getting its input from another source maybe ultimately they are drawing power from the same motor but they are coming through different paths having different rates of rotation.

So these two bevel gears are rotating at different rotations per minute what will happen if they have you know equal rotational value but opposite in direction that means one is rotating clockwise one is rotating counterclockwise what will happen to this gear in contact with them in that case this gear will remain in position and just rotate about its axis because this is rotating say 80 rpm clockwise 80rpm counter clockwise. So this will remain in position and rotate because let us draw a figure.

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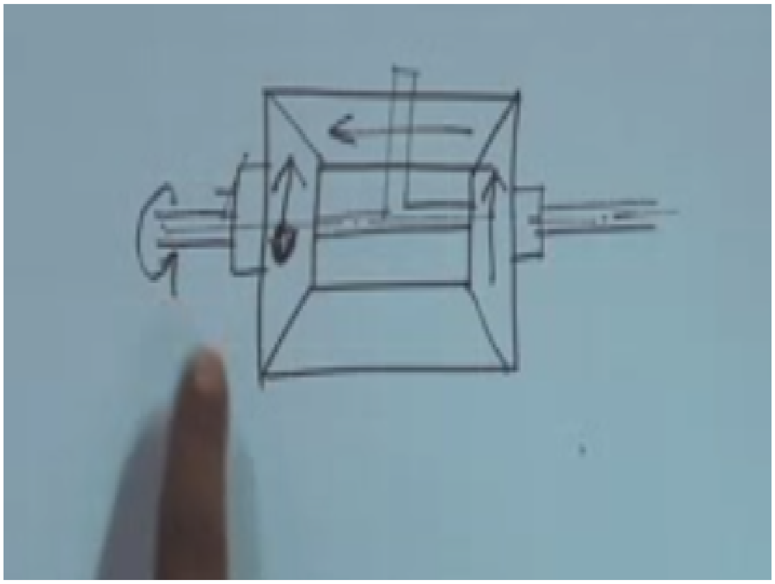

This is the figure I have one gear at this place yeah, so I am rotating this one this thing I am rotating this one this way and therefore this gear will be rotating this way okay if these are equal in magnitude it will simply remain in position and rotate but suppose I had rotated this one in this direction what would have happened same rotation both of them in the same direction in that case this would have been driven you know round and round and round this way physically and we would have noticed we would have noticed a rotation in this final resultant shaft because both of them are moving this way.

And therefore this gear this gear is going to move this way now and therefore this shaft would have rotated okay and this would have moved this way like that so by addition of these two inputs rotations I can get the final output rotation here.

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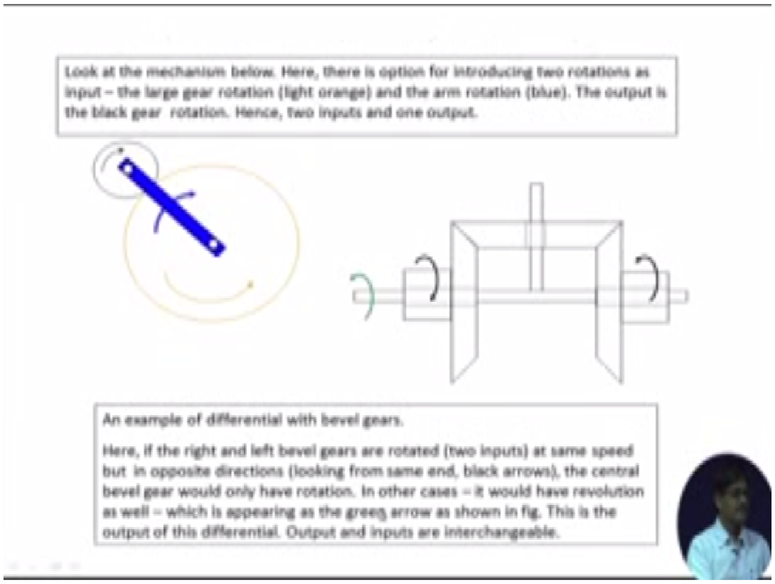

So having understood this okay we can move on to our final discussion about gear hobbing setup.

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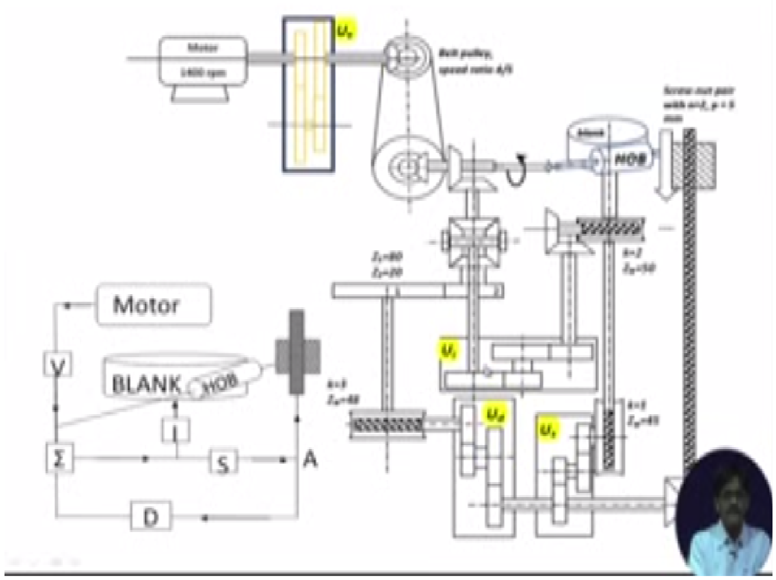

This is a gear or being set up now how is it different from this one that we have studied just now this one is a schematic diagram where the details are not provided but ultimately when we are discussing about gear hobbing everything has to be considered so let us see what other things that we are supposed to consider here first of all as we discussed the motor power source single power source from the single power source first of all let us look at the gear boxes first gear box that we should come across is V yes UV is there UV with yellow color.

After that there is a bifurcation here let us see it is traveling, traveling yes there is bifurcation there is bifurcation here what happens at that bifurcation one side goes directly to the hob and the other side goes to the differential mechanism okay let us track them down yes one side is going to the hob and the other side is going to the differential mechanism that is good what is happening to you know this hob it is connected to the work piece and they rotate together and this differential mechanism.

Let us see what is happening here the differential mechanism gets one input from the motor which is basically this one it has another input coming from the lead change gears it is having another input coming from the lead change gears okay, so this is one input this is another input and the output must be as we discussed this shaft sorry I made a slight mistake the first input is this and the second input is through these two gears 1 and 2 not this gear shaft in between inside what is this particular gear shaft then this gear shaft must be containing the output okay the output.

Where is the output going in the schematic diversity figure the output is supposed to go to this particular index gearbox wait a minute this index gearbox should have been here okay let us go we will be you know definitely matching and finding out weather we have by chance put the wrong figure, so in that case from here we are supposed to get the index gearbox yes it should have been here okay can I quickly make this change let me see how fast I can do it okay I think this should be this should suffice.

I cannot remove the small line how does it matter, so this is the configuration which is correct so let us read once again motor UV that is speed gearbox speed gearbox bifurcation, so there is a bifurcation here one side goes to the hob one side goes to the hob one side goes to the differential one side is going to the differential next from the differential gets another input the differential gets another input this one it must be from the lead change gears yes it is from the lead change gears.

The differential has an output the differential has an output which is going to in this gearbox yes the differential is having an output which goes to the index gearbox from the index gearbox there is a bifurcation from the index gearbox rather by bifurcation yes is it yes from here it goes to the work piece and it also goes to U_S bifurcation here there is a bifurcation after this bifurcation it reaches the blank on this side which it reaches U_S on this side and from U_S it is supposed to come out from U_S it is supposed to come out the bifurcation is there yes there is a bifurcation one goes to U_D yes one goes to U_D and the other one goes to the screw.

The other one goes to the screw yes the other one has gone to the screw okay, so this figure is correct it matches with this one figure now let us see what we are supposed to do here we are supposed to first of all determine we are first of all decided I mean tested it and found out that everything has been correctly configured as regards the locations of the gearboxes okay and next let us take a numerical problem.

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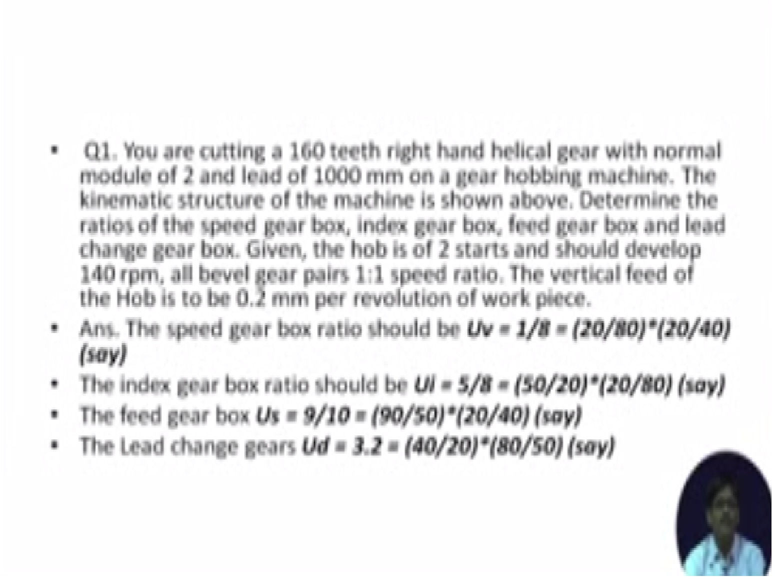

You are cutting a 160 teeth right and helical gear with normal module of two and a lead of thousand millimeters on a gear having machine the ratios of the speed gearbox index gear box feed gear box and lead change gearboxes sorry determine that the change the ratios of the speed gear box index gearbox speed gearbox and lead change gearboxes given the hobbies of two stars and should develop 140 rpm all bevel gear pairs are one is to one speed ratio the vertical speed of the hob is to be 0.2 millimeters per revolution of the work piece.

Answers are provided answers are UV should be 1/ 8 in this gearbox U_I should be 1/8 eight the feed gear box should be 9 / 10 and the lead change gearbox Ud should be 3.2 okay so once the answers are given the figure is given you already have prior knowledge of working out this sort of a problem on gear shaper I expect that you will be able to solve this problem fully yourselves from the figure that I have given you just ahead of this one, so today I am not formally solving it I mean in this lecture I am not formally solving it I will take up the solution the next day in the mean time I would suggest that please try to solve the problem yourself because you know how to solve this sort of problems from previous practices okay.

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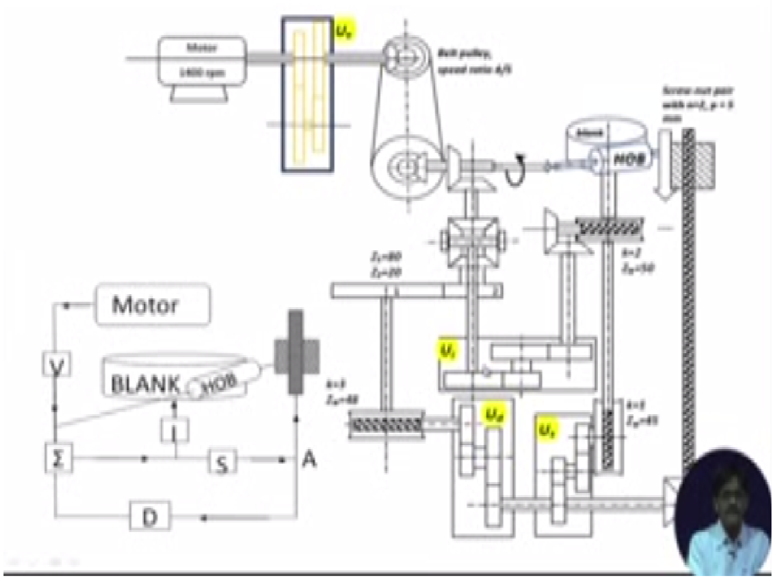

Let us have a quick look here for example is there any mechanism which is not known to us how it operates we have bevel gear etc… the differential the differential is something which is at present not known to us I would suggest that when you are solving for the initial part of the problem consider that you are not cutting a helical gear at a by the way have I provided the helix angle.

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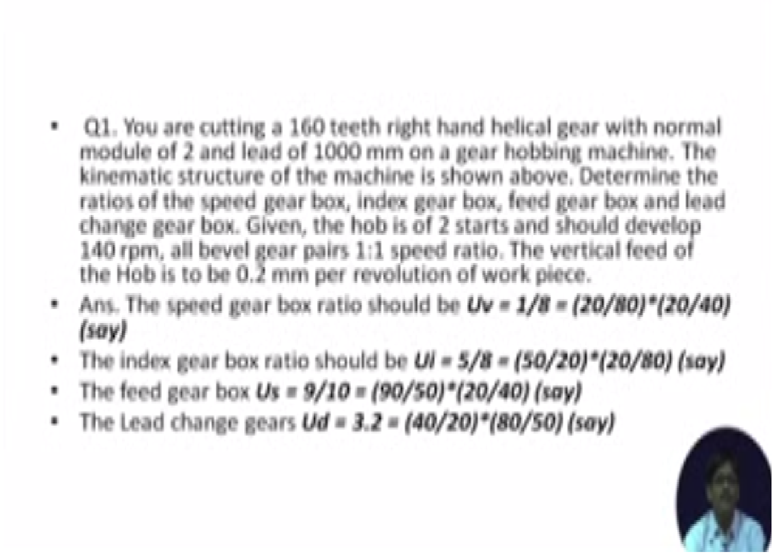

I have not provided the helix angle then this how you can find out the helix angle you can find out the helix angle from the value of the lead okay we know Tan $\propto$ sorry tan θ equal to that the helix angle is equal to tan $\propto$ Π D / L okay by the way you do not yet know.

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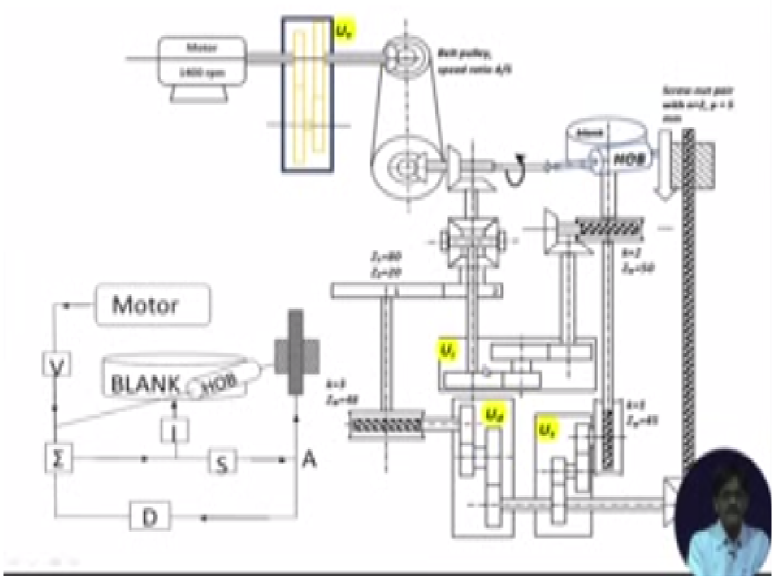

How to work with the differential in the differential items suggest that when you are finding all the initial values consider the output rpm of the lead change gears to be 0 and that way you can first set the values of V I and S that means Uv U_I and U_S can first be found out by considering the output of the lead change gears to be 0 rpm and then we will find out the final value of D so with this we come to the end of the 16^{th} lecture thank you very much.