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Course
On
Spur and Helical Gear Cutting

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Lecture 14: Gear Shaping -IV

Welcome to the 14th lecture.

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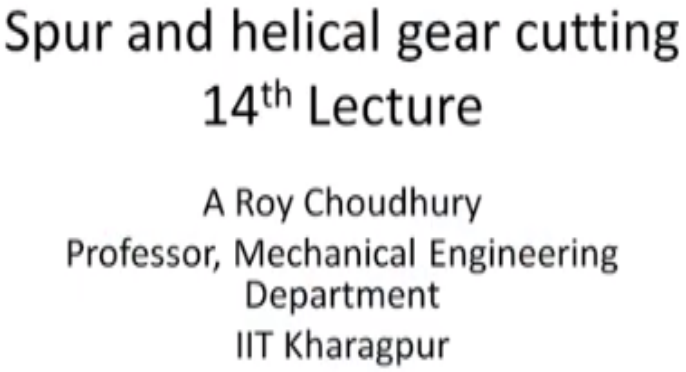

On spur and helical gear cutting and we were discussing one numerical problem on you know gear shaping spur gear shaping on the fellows gear shaper and let us continue with the last part of the problem okay. So let us quickly go to the problem statement yeah this is it.

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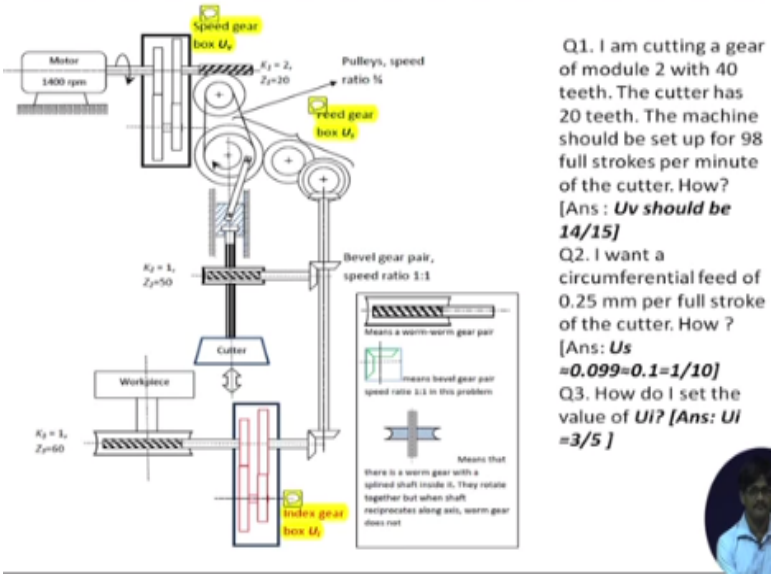

We have up till now finished up to this point that is the second question and we were discussing just to pick up the threads we were discussing the cutting of the spur gear on the fellows gear shaper the fellows gear shaper works on the principle of generation okay, so last question that we have left is how do I set the value of U I, now if you if you recall the discussion in the last lecture UI is situated here and UI is decided by the number of teeth that we are going to cut.

What is the number of teeth that we are going to cut? We are cutting a gear of 40 teeth and what is the basic idea, the idea is that UI should be set to such a value that the rotation that I am providing to the cutter and the work piece should be exactly equal to the inverse ratio of the numbers of Teeth on the cutter on the work piece so that they will be rotating as if they are rolling with 20 and 40 teeth respectively.

So the cutter is having 20 teeth and the cutter should be having a speed I mean rotational speed exactly twice of that of those work piece because 20 teeth and 40 teeth inverse ratio is defining as we just show that way on that much okay, so how do we solve it? What we do here is that we can start moving from the cutter move backwards right through these machine elements come to the main line and then you simply go forward and come to the work piece and whatever rotations per minute you come up with equated to the value of the rotations that is required, so let us start it right away. Suppose the cutter is rotating once if the cutter rotates once how many times do you think the warm gear is rotating here this one the worm gear rotate must be rotating once also

because they are sharing rpm if the worm gear is rotating once how many times do you think the worm will rotate surely the foam is going to rotate at a much higher rate given by this ratio 1/50.

So if a worm rotates 50 times it makes the worm gear rotate one rotate once sorry. So here if the worm gear is rotating once we come up with the idea that the form is rotating 50 times, so when we move backwards through machine elements then we take their reverse speed ratios generally when we are moving forward from worm to worm gear we get 1/ 50 here and here we will get 50/1 when we are moving backwards. So let us start writing down the values.

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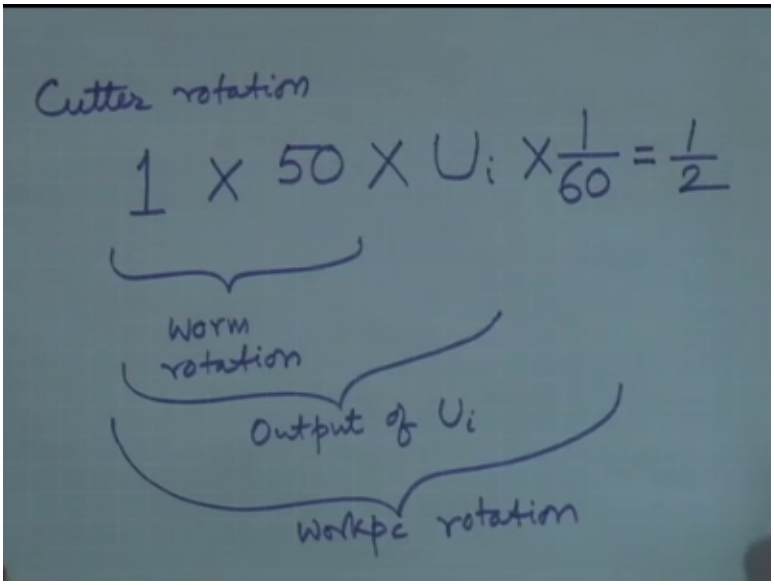

First of all cutter rotation, cutter rotation 1 we put the cutter rotation to be 1 and then we multiply it by so it is the same as the worm rotation and then we multiplied by 50/1okay, the reverse ratio to get the worm rotation, fine after that through the bevel gear pair we come to the main line it is just like a car backing off from a buy lane onto the main road, so you are going reverse and after reversing you come to the main road.

That means the, say the national highway and then you are moving forwards and then we are moving forwards all the ratios will again be taken as the straight ratios not reverse, so now we move through the two bevel gear pairs come down and enter UI so that at the output of UI this will be the rotation, so we write output of UI okay output of the gearbox of the index gearbox after this we have a bevel sorry a worm and worm gear pair and it is given key 3 = 1 and Z3 = 16.

So we have 1/60, now the you know ratios are not in Reverse anymore because we are moving forward through the machine elements worm to worm here we are moving so fine so this must be equal to work piece rotation and let us equate it to the work piece rotations that we would have for one rotation of the cutter for one rotation of the cutter the work piece rotates only half a time and we put it to be half here, so that is it we get the work piece rotation here work piece rotation now let us solve for UI.

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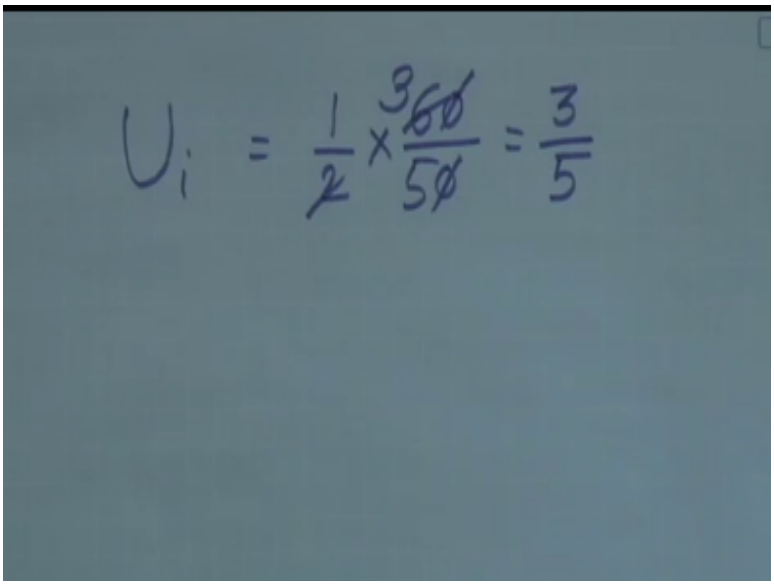

UI must be equal to ½ x 60/ 50 = 3/5 the value of UI comes out to be 3/5 so we have solved for UV.

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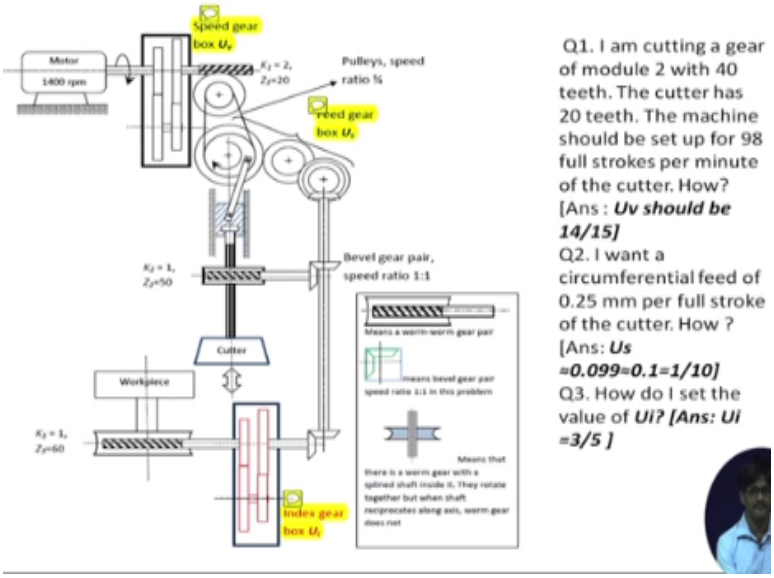

we have solved for US and we have solved for UI and this is the way in a very simple process we can solve for gearbox ratios corresponding to particular cutting conditions particular number of teeth and particular feed conditions okay speed feed number of teeth given these things we can easily find out the numerical values of the gear ratio gearbox ratios that should exist okay. So if time permits we will also take up other numerical problems of this type so that you will be quite conversant of how to set up gear you know fellows gear shapers in order to make them work properly okay.

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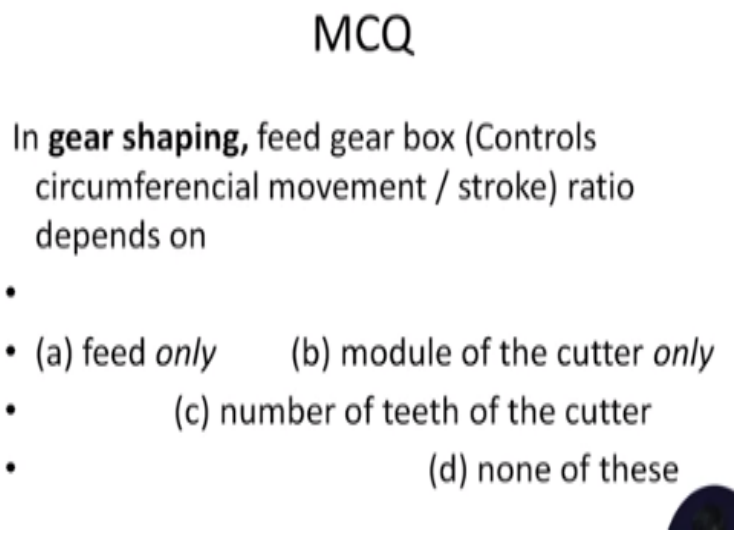

Next let us now take up a number of you know multiple-choice questions which will help us in learning more about gear shaping to start with, in gear shaping feed gear box okay remember the feed gear box controls in brackets I have put the function of the feed gearbox so in case some person cannot recall it exactly in the exam hall, in gear shaping PD air box which controls circumferential movement for stroke that ratio and feed gearbox ratio depends on feed only. Module of the cutter only, number of teeth of the cutter none of these okay now let us take the options one by one speed gearbox depends on the feed only now first of all you say feed gear box what was the expression.

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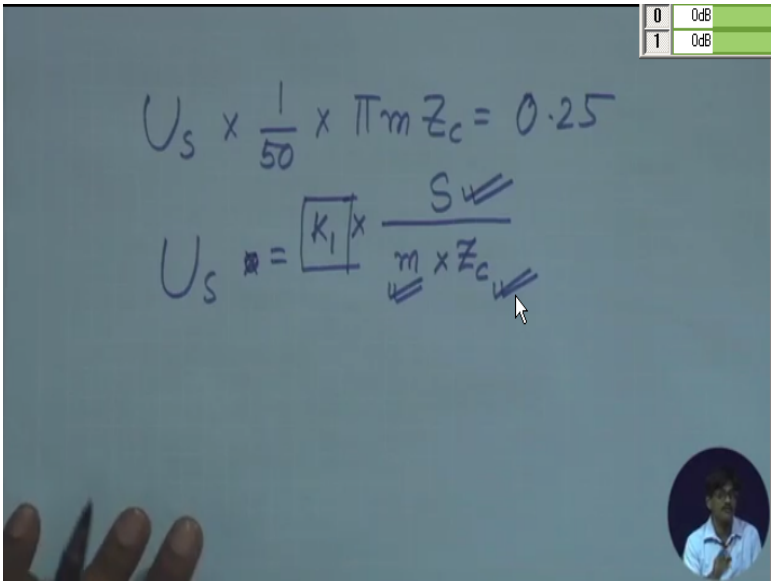

So let us quickly recall the expression it was something like this U_S was equal to $50*\pi*M*Z_C$ okay sorry so sorry I made a mistake remove this from consideration yeah this is it U_S into 1/50 into $\pi m Z_c$ equal to 0.25 okay now let us generalize it U_S equal to they will put this as a constant okay we are not you know if we are generalizing it so it comes as a constant and let's take it already to that side.

So it is equal to K_1 multiplied by π, π is also a constant so let us say that k_1 gulps down pipe and gulps down this collectively we are writing k_1 so what else is there M goes down M goes down number of cutter teeth that goes down and this we generalize as the feed okay we can call it F or we can call it F let us call it s so we find that the feed gear box ultimately depends upon some machine constants.

And it depends upon the fields specified okay speed speeds specified the module and the number of teeth on the cutter it depends upon these things and now let us come back to the problem so first option feed only that is not correct because apart from feed they are just now noticed it depends upon the module and it depends upon the number of teeth on the cutter so this is definitely not correct feed only is definitely not correct module of the cutter only definitely not because it depends upon the feed specified.

And also the number of teeth on the cutter number of teeth the third option number of teeth of the cutter now the moment you notice that only is not mentioned you have to accept this as correct yes it definitely depends on the number of teeth of the cutter you might say but it also

depends upon other things this is not fully correct no it is fully correct because it is simply stating that it depends upon number of teeth whether it depends upon something else is not our moderation.

This is correct yes it does depend upon the number of teeth so this one is correct and therefore they are definitely actually none of these is not correct so the correct option here is see now here when you deal with multiple choice questions of this type the moment you come across only you have to become very alert because you might find that yes it depends upon the feed which we have stated 0.25 in this particular numerical problem and therefore it depends but if you if you, you know come across this only be very alert does it only depend upon the field.

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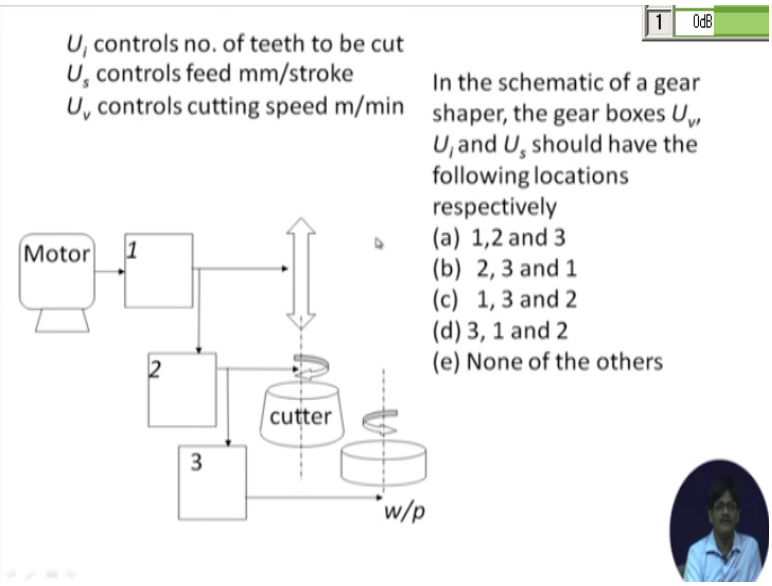

You have to ask yourselves okay so whenever you have only be cautious next problem what is this problem this problem after you know learning so much and discussing so much about fellows gear shaper it should be extremely simple for you first of all we have stated that U_i controls the number of teeth to be cut U_s controls feed in millimeters per stroke U_V controls the cutting speed in meters per minute and just jumbled it up okay you only know this thing very well so what is the question, the question is in this schematic of a gear shaper the gear boxes U_V U_I and U_s mind you I has been placed in the middle should have the following locations respectively.

So first option is that one should be U_V two should be U_I and three should be U_s second option that two should be in just a moment here should be this one two three should be U_I and two should be sorry and one should be U_s see is one should be U_V three should be U_I and two should be us both one three should be U_i one should be U_I and two should be U_s and none of the others.

So we know after you know so much discussion that without any exception this one should be U_V this one should be U_I and this one should be sorry this one should be U_s and sorry this one should be us and this one should be U_I and hence C option C is correct in this case option C okay.

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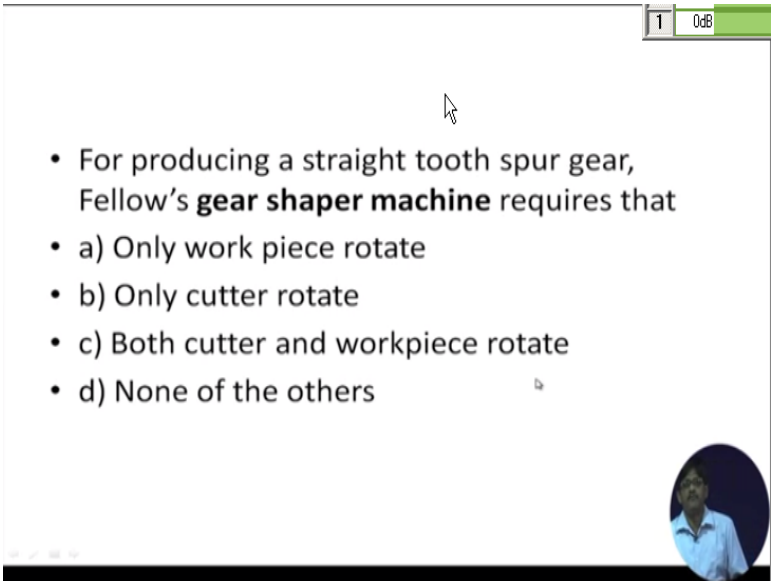

For producing a straight tooth spur gear the fellow's gear shaper requires that only work piece rotate only cutter rotate both cutter and work piece rotate none of the others so which one is correct only the work piece loaded but the basic condition which has to be satisfied in case of gear shaping is that both the work piece and the cutter should rotate as if they are rolling against each other as finished gears.

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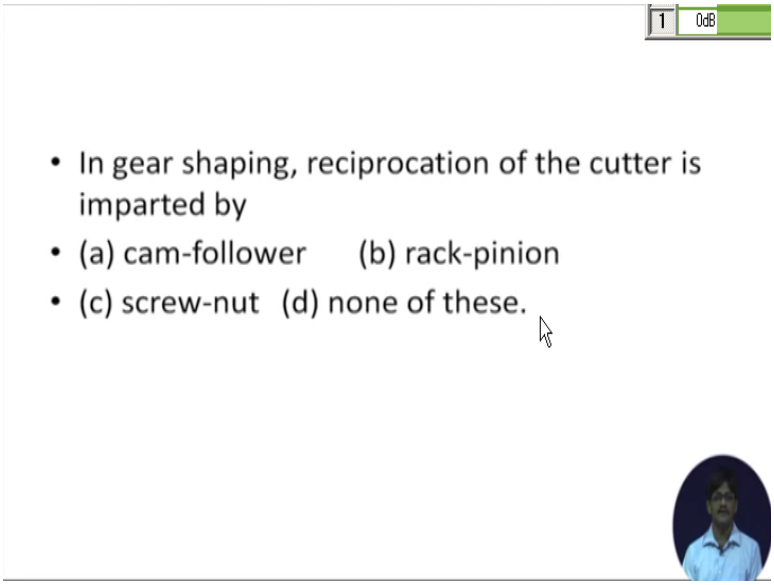

So only work piece rotate is not possible in the same manner only cutter rotate is not possible both cutter and work piece rotate is correct none of the others is therefore not applicable so hence here the correct answer is C both cutters and work piece rotate in gear shaping reciprocation of the cutter is imparted by cam-follower rack and pinion screw-nut none of these.

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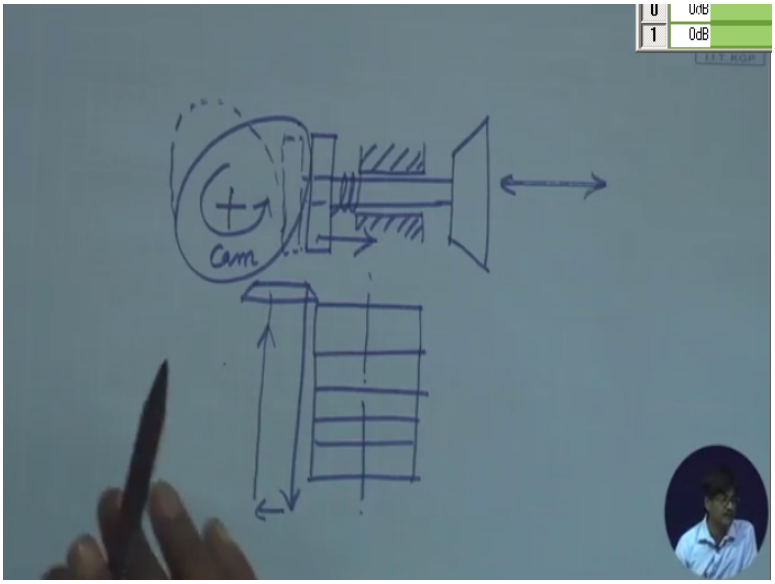

So in order to find out this answer and we just introduced what, what they exactly mean some of them you are already conversing with and some of them what is cam follower cam follower can be something very simple of this type suppose this is what we call as the disc cam and this is its center of rotation so you can very well understand that it is having a non circular profile a lobe structure and therefore it is going to push this body outwards.

If it is having a guide way if it is passing through guides it is going to push it outwards and if it is spring-loaded if there is a compression spring this is going to come back when this rotates and say it takes up some position of this type like that so if this rotates continuously this is going to execute reciprocation question is do we have that kind of you know a mechanism for imparting the reciprocating action no why not because in this case generally the problem is the stroke is not quite adjustable if you want to change the stroke length it's difficult.

So generally we go for crank connecting rod mechanism where it is easy to change that now why do we need to change the stroke in case of gears that is because the width of gear which is being

cut it might differ from case to case or you might be cutting a stack of gears like this a number of gears in a stack can be cut by a single stroke of the cutter okay up-down and gear number 1, 2, 3, 4, 3 they can be cut so this stroke length is very frequently it has to be changed.

So cam and follower is out but interestingly cam and follower is used in this particular mechanism I mean in this particular machine for the small amount of relieving motion which is required when the cutter goes up the cutter goes down the cutter relieves itself and again moves up this small motion can be realized by the help of a cam follower device okay.

So coming back to the question we have cam follower no rack and pinion rack & pinion is able to produce you know reciprocation but the problem is that you know so what we are calling it there are other many a much more easier methods by which we can have received reciprocation because if you use rack and pinion you have to have yet another device by the help of which reciprocation will be obtained rack and pinion can only change rotation to a to straight-line movement.

But it cannot bring about reciprocation okay so that's why it is not a good choice screw nut mechanism screw nut mechanism is also not used and therefore none of these is the correct answer none of these okay you might say that why is screw like you and not used screw nut mechanism is not used you might say because the screw will have to rotate very fast inside the nut and a lot of you know sliding where will take place unnecessarily.

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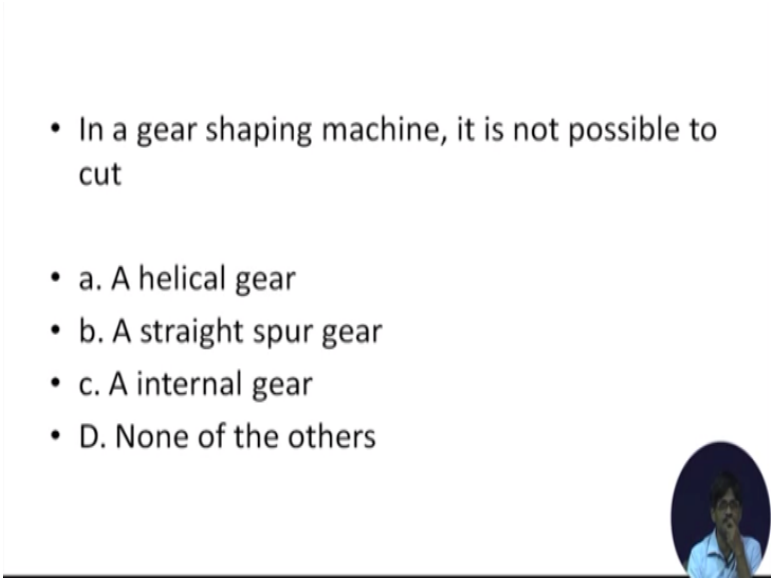

There are so many other easier options to obtain reciprocation and also screw and not won't be able to give you the reciprocation you have to have another mechanism or you have to have another type of controls which will give you this hip rotation screw and nut can only bring about you know rotation to linear motion.

That is not reciprocation okay, in a gear shaping machine it is not possible to cut a helical gear a straight spur gear and internal sorry that should be an internal gear none of the others we can cut too. So first of all helical gear helical gears can be cut on shaping machines though not as simply or elegantly as in on the hobbing machine, the hobbing machine can cut helical gears vary by a very simple procedure okay.

In gear shaping machines either we have to have a mechanical guide way which will make the cutter move in a helical manner all we have to have you know some sort of computer control, so it is possible to cut a helical gear, next option a straight spur gear on a gear shifting machine straight spur gear is the obvious thing which can be cut, so this is not correct an internal gear internal gear can be cut okay, internal gear can be cut, so none of the others is the correct answer.

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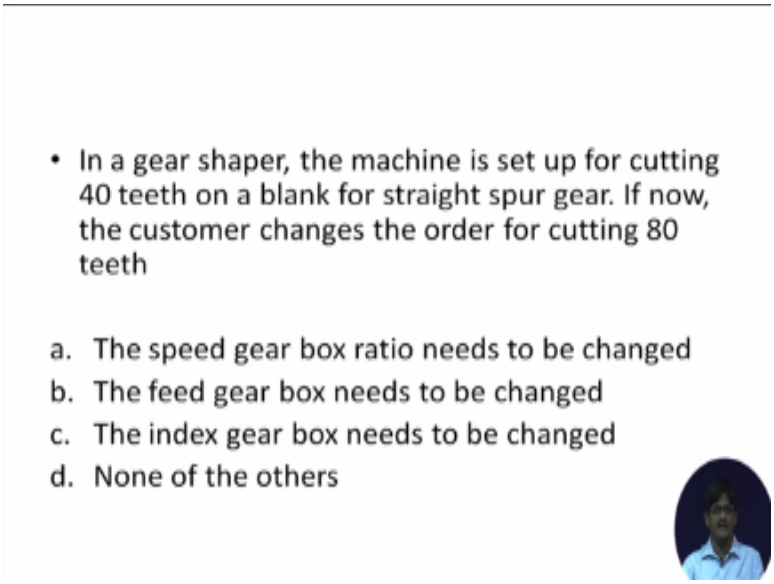

In a gear shaper the machine is set up for cutting 40 teeth on a blank 4 straight spur gear if, now the customer changes the order for cutting ATT the options are so I am set up the machine for cutting quality and suddenly the customer comes and says that no I want a GT, so the options are the speed gearbox ratio needs to be changed the field give box needs to be changed, the index gearbox needs to be changed and none of the others. The speed gearbox needs to be changed why we are not changing the speed if I am cutting a GT during snowfall it in here why do I really need to change the speed no not at all.

So the first option is not correct second one the filled gearbox needs to be changed am I changing the feed do I need to change the feed? not really you know speed is going to define the surface finish and the customer has not stated that he wants to change the surface finish no not at all, so we still have no need to change the feed gearbox, last of all the index sorry the third option the index gearbox needs to be changed this is correct yes the index gearbox needs to be changed, so that we can accommodate the ATT gear and have the proper rpm ratio between the cutter and the work piece, so that the ATT gear is cut correctly with correct geometry, so option C is correct and therefore none of the others is not applicable so the index gearbox needs to be changed.

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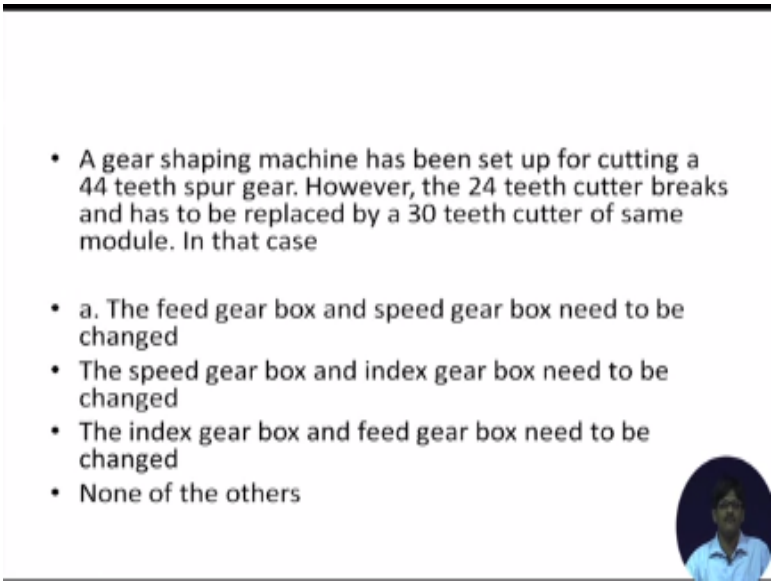

A gear shaping machine has been set up for cutting a 44 teeth spur gear, however the 24 teeth cutter breaks and it is damage to is gone and has to be replaced by a 30 deep cutter of same module in that case the feed gear box and the speed gearbox need to be changed, the speed gear box and the index gearbox need to be changed third option the index gear box and the feed gear box need to be changed none of the others, so let us see if my cutter number of teeth is changing what are the things that need to be changed?

First of all once the machine had been set I mean has been set for 44 teeth to be cut on a spur gear then you I must have been set with respect to the ratio of the numbers of teeth on the cutter and the work piece therefore you I will definitely get changed, second if the number of teeth of the cutter is changed we have previously learned that you s will change Y because us as we learnt that you s is equal to a constant multiplied by module and also the number of teeth on the cutter and also the feed it depends upon, so it depends upon the feed specified feed it depends upon the module of the cutter and also it depends upon the number of teeth on the cutter.

Therefore as the number of teeth is changing therefore we will definitely have a change in us so the answer should be the index gear box and the feed gear box need to be changed, so the third option is correct, the third option is correct let us see do we have any other options okay.

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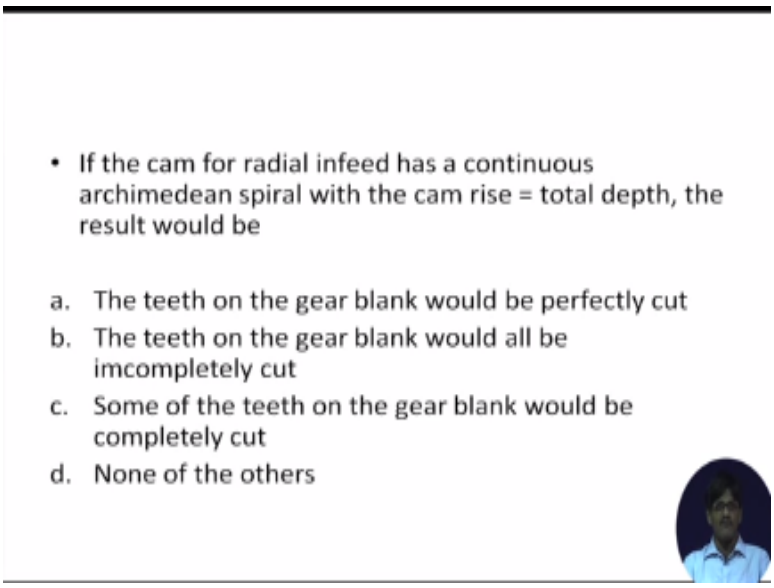

We can take another one if the camphor radial in feed has a has a continuous Archimedean spiral with the camera is equal to total depth the result would be the teeth on the gear blank would be perfectly cut the teeth on the gear blank would all be incompletely cut some of the teeth on the gear blank would be completely cut, now what is that the second option and the third option are the different would all be in oh no we will all be incompletely cut and third option is quite tricky so let us take them one by one. The teeth on the gear blank will be perfectly clapped their cut no absolutely wrong.

Because if you having an Archimedean spiral continuously rising from the from the beginning right up to the you know end that means the depth is continuously increasing and there is no teeth which is going to have the correct steps because the correct depth will only be reached at the very end where total depth is achieved. So teeth in the gear blank would not be perfectly cut second option the teeth on the gear blank would all be in completely cut this seems to be correct yes would all be incompletely cut maybe only the last one okay, that also for an instant only it will be having the correct depth some of the teeth on the gear blank would be completely cut what is this mean?

It means some of them would be completely cut no if you having continuous spiral basically the differences that you are nullifying the idle period or the dwell period of the cam during which it distributes the complete cut, that means the total depth for all the teeth for all the teeth the cam remains at a particular position there is no further radial in feed total depth has been achieved

and it simply goes on cutting, so that if each and every teeth have correct depth therefore option B is correct and naturally none of the others is not applicable so with this we come to the end of the fourteenth lecture we will take up other subjects in the subsequent lectures thank you very much.