Metal Cutting and Machine Tools
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Lecture - 15
Numerical problems on lathe

Welcome viewers to the fifteenth lecture of the course Metal Cutting and Machine Tools. So, today we will be solving some numerical problems and also find out something about the feed drive of the lathe.

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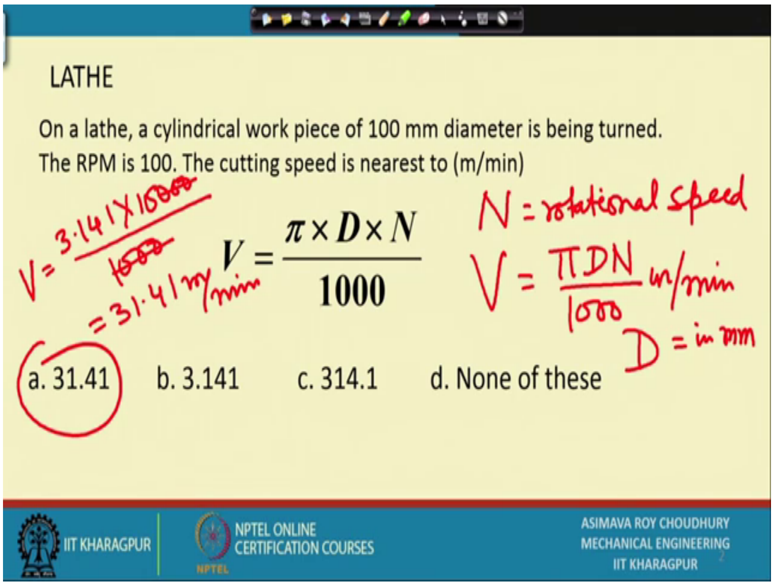

To start with on the lathe; a cylindrical work piece of 100 millimetre diameter is being turned; the RPM is 100, the cutting speed is nearest to in meters per minute; 31.41, 3.141, 314.1 and none of these. So, in many cases what happens is when a student is first getting to know about cutting speed; there is confusion about what is cutting speed and what is rotational speed? Rotational speed say we refer to as N; N is equal to rotational speed. In that case, the velocity is defined as pi D N by 1000 meters per minute, where D is in millimetres; D is the outer diameter of the cylinder.

So, in that case we can quickly calculate this is velocity will be equal to 3.14159, etcetera. So, those things we neglect 3.141 into what is the diameter? 100 what is the RPM? 100. So, another two 0's; pi D N by 1000; so, this goes out with this and we have 31.41 meters per minute; so this is the correct answer.

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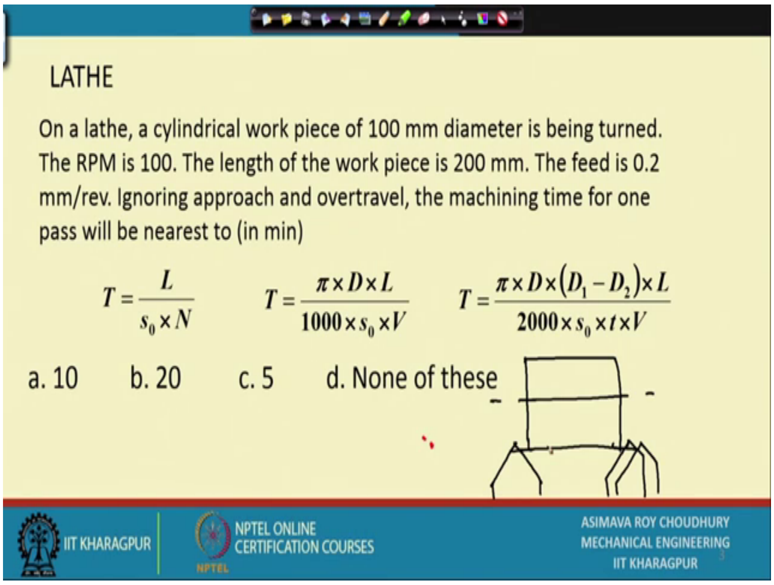

Next on the lathe, a cylindrical work piece of 100 millimetre diameter is being turned; the RPM is 100, the length of the work piece is 200 millimetres; the feed is 0.2 millimetres per revolution; ignoring approach and over travel the machining time for one pass will be nearest to in minutes 10 minutes, 20 minutes, 5 minutes none of these.

So, here first of all what is approach and over travel? So, if you have a cylindrical job of this type say we are seeing it from the side and it appears to be like this; in that case if the tool is here, the tool might be starting a little away from the job and this might be the position. And over travel might be in order to be absolutely sure that it has fully machined it; you might be moving the tool a bit away from the work piece even after completion.

So, these things are approach and over travel; at this moment, for this problem we have stated that you can ignore it. So, therefore, we need not bother about what is approach and over travel and let us quickly find out what should be the value and machining time for one pass.

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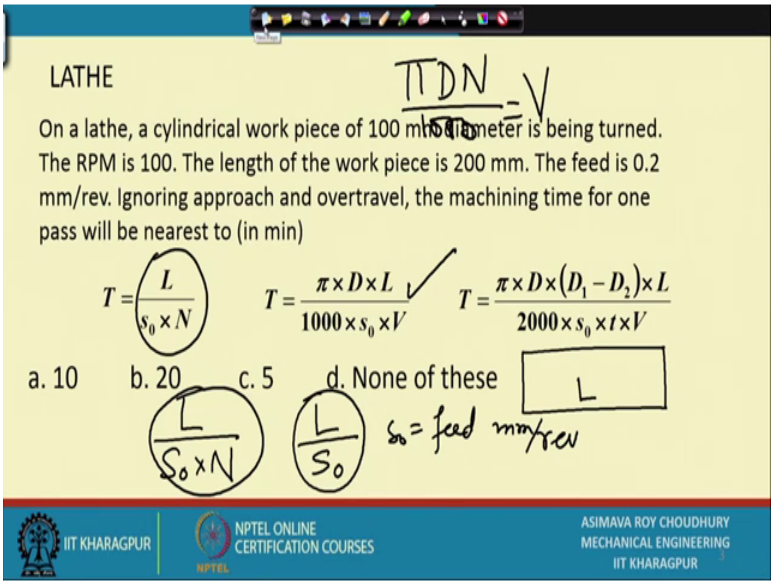

So; that means, first of all what is the length of the job say the length of the job is L; if this is L we are covering it by the feed motion; the feed motion is 0.2 millimetres per revolution of the job. So, per revolution we are eating away 0.2 millimetres. So, how many revolutions would we need in order to eat away L? L divided by S 0, where S 0 is the feed in millimetres per revolution. And therefore, this must be the number of revolutions that we have in order to cover the full job. If these many revolutions are required how many minutes would be required for that? Definitely divided by N; since N is the number of revolutions per minute.

So, this should be the answer to our question; now what are these calculations? N might not be given; if N is not given we have to find out the value of N from this calculation. And if you remember pi D N by 1000 is equal to the cutting velocity; so that might come in handy.

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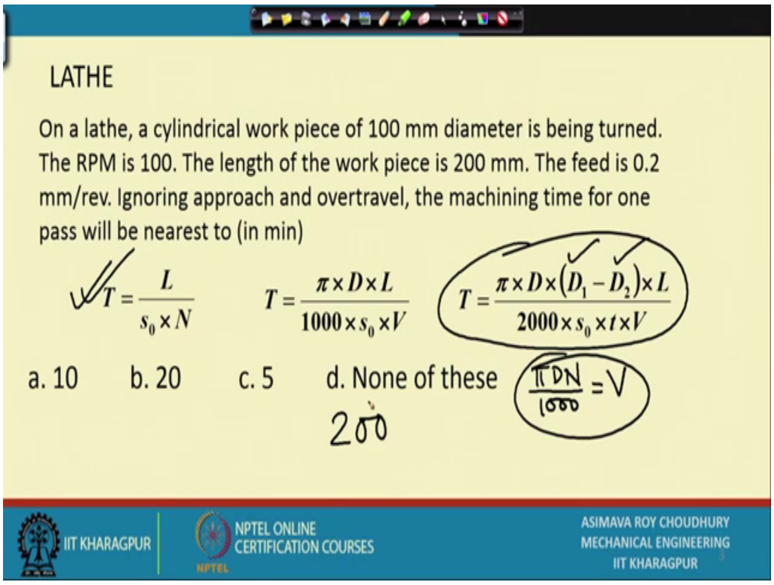

So, first of all just a moment; let me remove all the written material, so if V is given in that case we can find out N from V pi. D N by 1000 is equal to V and just by shifting terms from this side to that side numerator to denominator etcetera we can find out M.

So, I am not working it out simply if you replace and you will get it; what is this expression then? This expression says that if there are more number of passes, I mean number of passes more than 1; in that case how to find out the machining time. I leave this to you to find out how it works; I will just mention just see this D 1 and D 2, they are the initial and final diameters and t is the depth of cut.

So, quickly you can find out how many number of passes you require and other than that I mean divided by 2. So, that will give you the number of the depth of cut and from there you can easily find out how many passes you require; I am leaving this to you, I am sure you can work this out. So, with this one let us try to find out whether we can do it; what is the length of the job? It is 200 millimetres just let me clear the board.

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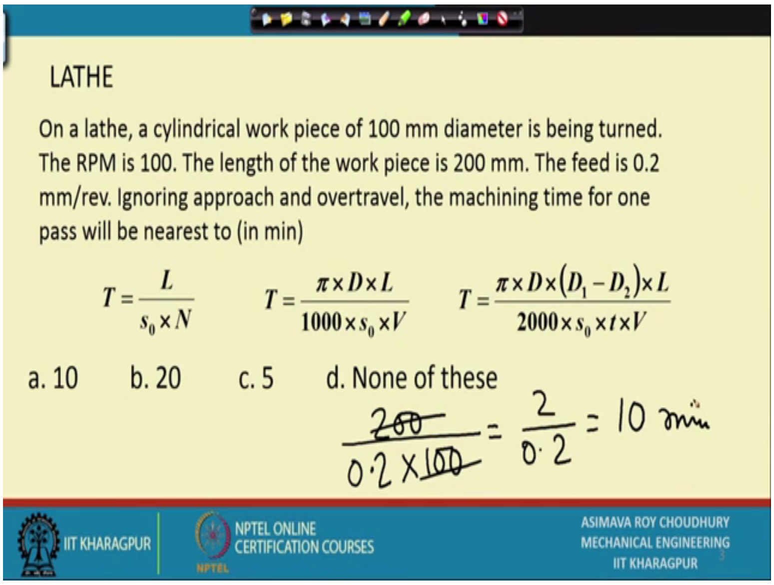

200 millimetres we have let us divide it by the feed that is 0.2 and then let us further divide it by the RPM that is 100. So, this cancels out 2 divided by 0.2 and it comes out to be 10 minutes.

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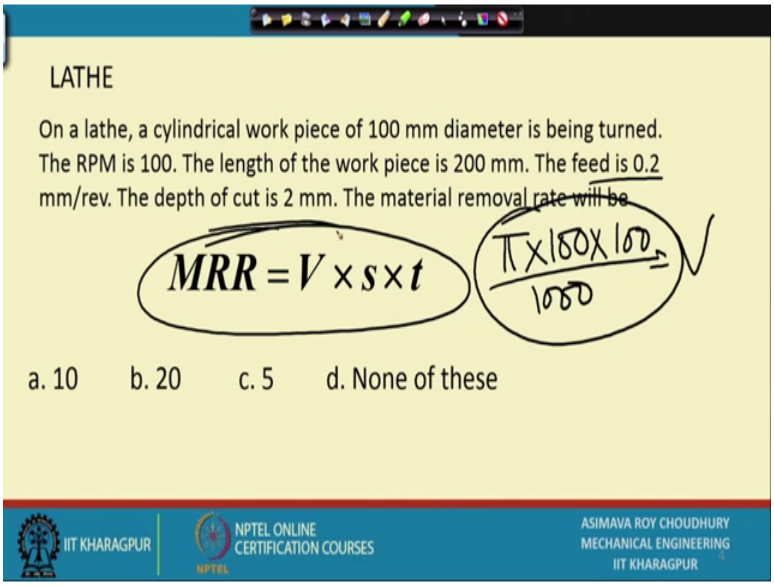

So, on a lead a cylindrical work piece of 100 millimetres diameter is being turned; the RPM is 100, the length of the work piece is 200 millimetres, the feed is 0.2 millimetres per revolution, the depth of cut is 2 millimetres; the material removal rate will be now material removal rate is given by this expression cutting velocity into feed into depth of cut. So, is the cutting velocity given yes cutting velocity is given because we can find it out pi into what is now D; D will be, D is given 100; pi D N by 1000 that will give us D that will give us V. So, V is known feed is known, depth of cut is known; so we can easily find it out. So, I am not working this out; I am sure you will be able to work this out.

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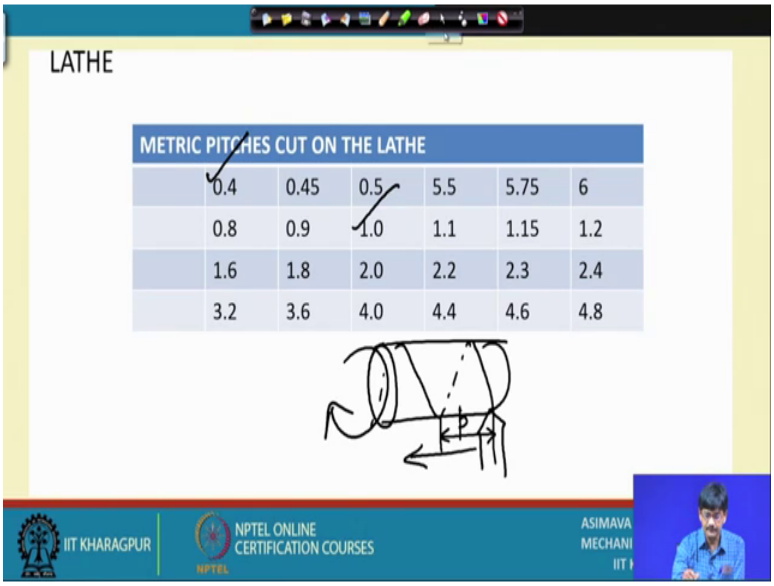

Next, now on the lead we might be having the problem that we have to cut out different threads, how do we cut threads? We have learned that we use the lead screw for cutting the threads and if we can rotate the work piece.

So, this is the work piece which is rotated and by the side of it the cutter moves; the work piece is rotated, cutter is moved this way. And this defines the helix how is this helix defined on the job? Per rotation it will be undergoing this movement and what is this movement for single start threads, we can directly set this is equal to pitch.

So, we write pitch is pitch given; yes when you are asking an operator to cut a thread, we will be specifying the thread and from that specification the pitch of the thread will be available. And on the lathe you might find that there is a chart given in which they claim that if you want to cut this pitch you set the gears in a particular manner, if you want to cut this pitch you set the gears in another manner etcetera.

So, we will have a quick view how this works and in fact, you will notice that there might also be 2 such charts in which metric pitches are given.

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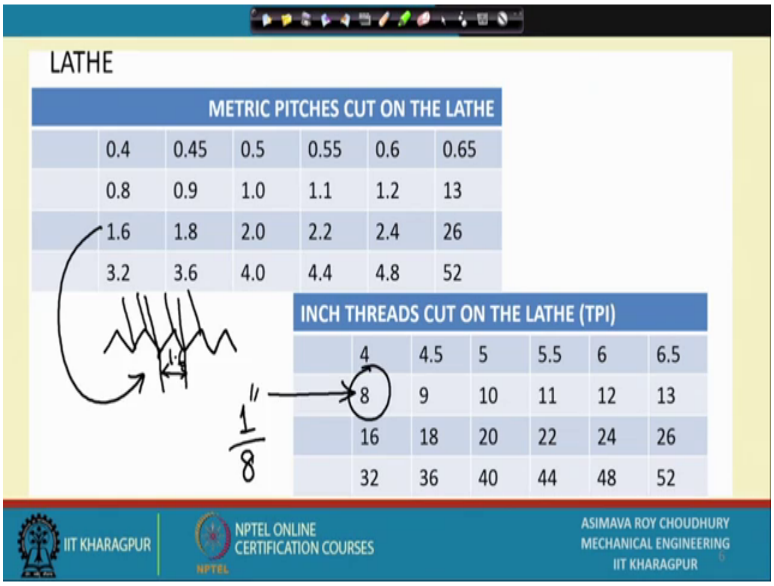

Which means these are the threads which can be cut and they mean to say that if this is a thread etcetera, in that case this if you want this to be say 1.6; they will say that set up the gears in a particular manner which I have not shown up till now and you will get 1.6 pitch. In addition to that on the same lathe perhaps, if you know it is equipped that way if you want a different type of thread altogether to be cut; for example, inch threads; what is the characteristic feature of these threads? They are specified in threads per inch, this is not pitch; this is threads per inch. So, the pitch will be coming out as 1 inch divided by 8; so, threads per; this means one eighth inch is the pitch.

Now; that means, here the pitches are going to come as sort of reciprocal numbers of these numbers. Unit apart because this is in millimetres and that is in inches; unit apart these if they come as 8, 9, 10, 11, 12; these will come as 1 by 8, 1 by 9, 1 by 10, 1 by 11 like that. So, if on the machine you are somehow making available these threads; you also have to make available the reciprocal threads. So, let us have a quick look how these things are tackled on the lathe.

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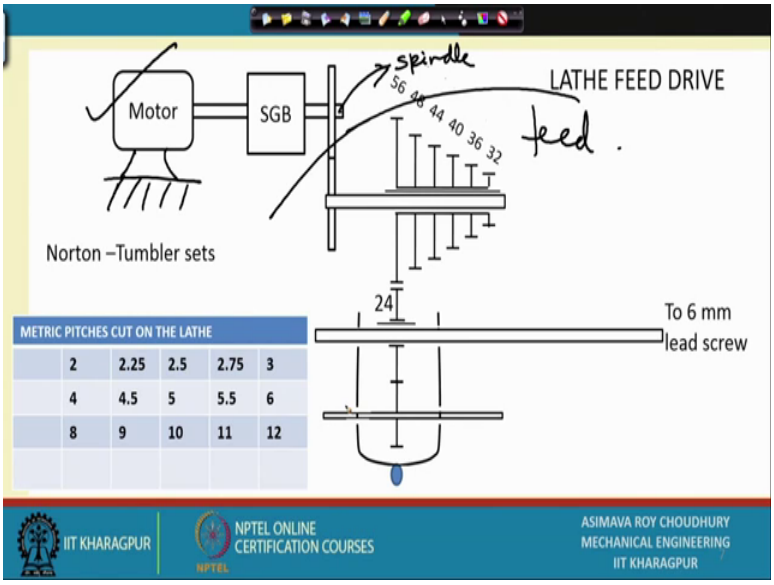

So, on the lathe we have already come across a motor; the basic motor which is providing power to the or to all the processes and in the machine; except if you are giving manual feed. But otherwise its providing all the power and we had that speed gearbox which is leading on to the spindle, which has not been shown for simplicity.

So, this leads to the spindle I will write it down; so, that you will remember just moment this is to cross; this will do spindle; so, every no misunderstanding. So, this leads to the spindle and we tap power towards this side and actually we are on the feed drive now. So, this whole thing is the feed drive; so let us take a different colour and drive; this is the feed drive feed.

So, what is there on the feed drive? What we do is, we take a cone sort of thing; this is sometimes told this collective is known as the Norton-Tumbler set, this is the tumbler gear; it tumbles. So, this Norton has teeth; this Norton gear set has teeth which are differing by say 4 and 6 like that say 56, 48, 44, 40, 36; if you have closer numbers of teeth then you will have trouble in engaging another gear from the side; you at least have to have 5 by 4 teeth less on adjacent gears, otherwise you cannot engage another gear from the side that is fine.

So, we have 56, 48, 44, 40, 36, 32 like that now why are we doing this? We are doing this with a particular purpose; the purpose is this on this side we have another gear which can be preferentially or selectively connected with either 56 or 48. So, this 24 gear can be connected with 56; it can also be connected with 48, but; obviously, the center distance is going to be different.

Because these two shafts; this shaft and this shaft they are fixed. How can I attach 24 to selectively and sequentially to these and these gears? It is possible if you have an idle gear. So, this idle gear is here and I will bring this towards this side by rolling action and attach them one by one. So, what sort of connections would I have in that case?

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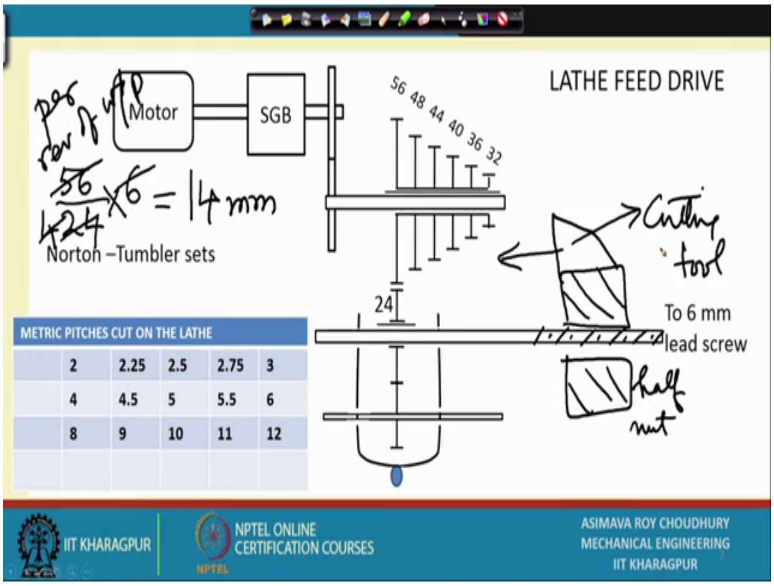

Suppose it is possible; if I connect 56; let us say 56 and that connects up with 24 at this moment it is not connected, there is a clear gap in between; we will see how it is connected. So, 56 by 24 connection this ultimately leads to a 6 millimetre lead screw that is interesting what happens let us see. So, multiplied by 6 will be the movement of the cutter; so, this is the lead screw directly and on this there is a nut which is connected; if you remember we discussed about the half nut. So, half nut and the tool will be moving and this is our cutting tool; it is all very roughly drawn, but I am sure you can follow the basic idea; so, it will be moving.

Now, what will be this movement like? This will be the movement per rotation of the work piece. So, per revolution of work piece we will have this amount of motion; let us see how it works; 4 that is good, this cancels out 14 millimetres. So, per rotation of the work piece this will travel 14 millimetres that is fine, but where does it lead to? It leads to this that if you instead connect to 48.

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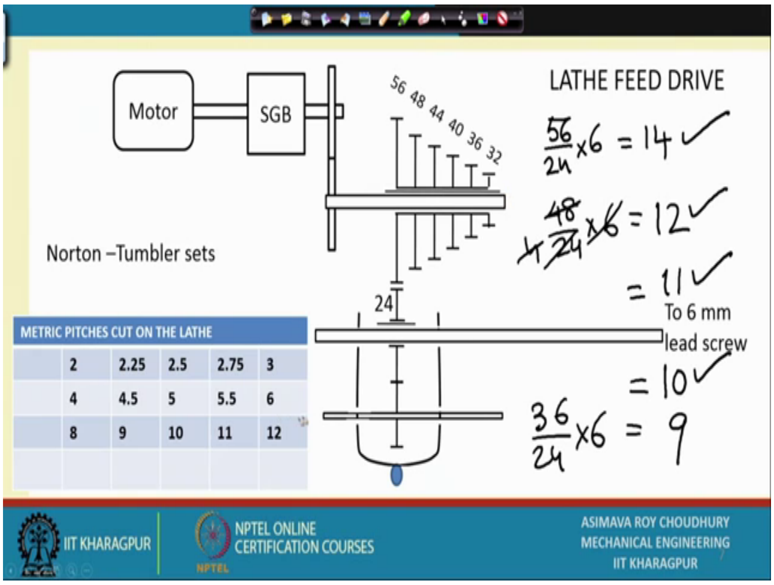

So, if we if we connect to 56; we get this; 6, this is 14; if I connect to 48, I will get 4, 12 and therefore, you can easily guess that if I connect it to 44; I will get 11, if I connect it to 40; I will get 10. So, all these millimetres of pitches are now available with me.

So, 12, 11, 10 all these things are going to become available 36 divided by 24 into 6 is going to give me 9. So, this makes it possible to get all these pitches cut; now but how does this operate? This one is keyed to this shaft in such a way that it can slide and take up different positions. So, let us have a look how it works this is the way it works; so, it can slide that is good, but what is this one doing? Just a moment, what is this one doing? This one is another gear which is always in connection with this and this can be moved this way by rotational action.

So, let us have a quick look how it works.

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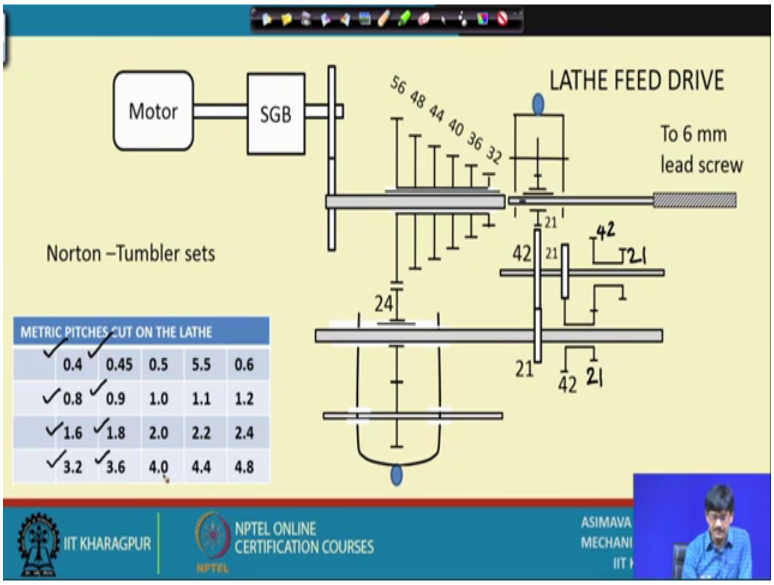

Just a moment what is this? We will come to that rotational action, let us we have a quick look at that; this is it

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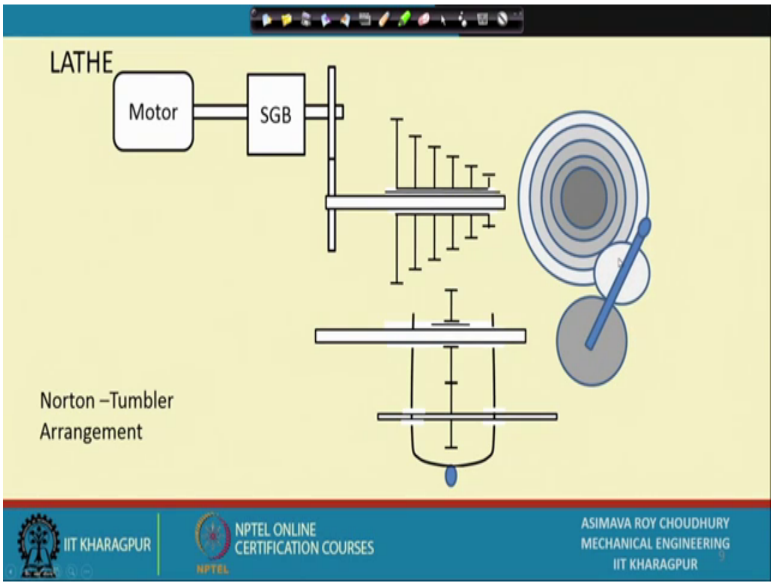

This is what we were seeing; so, in the other view it looks like this; this gear is here and this gear is here and this holding device; this handled device is here. So, this comes and suppose we locate it, so that I want to in connect up these 2. So, I have slid it up to this point and after that in the other view what it looks like is; shown in the other view, these gears are shown in this view and this one comes and you know I attach it. So, even though the center distance of this gear and that gear and these gears they are not going to allow direct connection, I have an intermediate gear by the help of which I am connecting up these gears; this is the Norton-Tumbler set.

So, the calculations that we have done 56 by 24, 44 by 24 all these things become realities. So, let us see further calculations; so, now, we are sure that I can get 10, I can get 9, I can get 11, I can get 14, but I am not getting say 1.0, 0.9, 0.8 neither am I getting say if you have a look at this one; say half's and one forth's and one eights, 3.2; if I get can I get half of it, can I get one forth of it, can I get one eighth of that; how is that possible?

This is possible it is made possible by a device called the meander drive; when a river comes to the plains from after crossing the hills and the foothills, it starts moving this way and we call it meandering. Now, what does it do when it meanders? That is not really our problem here, but ultimately oxbow lakes are formed, but let us not involve ourselves with geography. Here also the power is going to meander that is the power flows this way let me see; the power flows this way and it comes this way and it may go this way etcetera.

So, this is what we are referring to as meandering drive; how it does it work here? What we do is we directly do not connect that 6 millimetre lead screw to this shaft anymore, but we connect it to this one. In between we have three these three shafts what are these three shafts doing? First of all here we are already having that reduction that we talked of and after that we are going to get half of that, we are going to get one fourth of that and we are going to get one eighth of that; let us have a quick look how it works. First of all we have kept 2 gears of 21 and 42 numbers of teeth so that the RPM is halfed here.

So, if you get 20 RPM you will get 10 RPM here, but once again we have put 21 gear here and the same Norton-Tumbler arrangement. So, that again we are going to remove that half and this is 1 is to 1, but if we move this and connect it up here where the number of teeth is 21; again we will get half that is fine. So, 1 is to 1 here and if we shift this and connect it to this one, we will get half here; this one is again half 21 to 42 and this is again half.

So, that we are going to get one fourth here because 21 is existing here please remember that. So, 1 is to 1; if we shift this and connect it up to this one that is 21 to 21 we will get half and if this power comes this way and its appearing here; this is just a moment, this is 21, this is 42, this is 21 like that. So, if it is connected here I will get one fourth and if I connect it here I will get one eighth.

So, that if I am getting 3.2; I can get 1.6, I can get 0.8, I can get 0.4. If I am getting 3.6 I can get 1. 8, I can get 0.9, I can get 0.45; these are half's, one fourths and one eighths, but how do I get? Suppose I am getting 4; let us let us look at yet another table, this shows how this is moving and of course, it rotates and comes and gets connected that we have already seen in this case, so I am not repeating it.

So, our last concern is how are we making the connection between; making the connection so that we can get decimals; I mean 1 by 10 also, 1 by 5, 1 by 10, 1 by 15. We have seen how we are getting these rows, we have seen how we are getting these columns, half, one eighth, one fourth like that, but how can we multiply these by 10 or divide these by 10 so that we can get finer threads or we can get coarser threads like that. So, for that let us quickly have a look this we have seen; so this ultimately takes this place.

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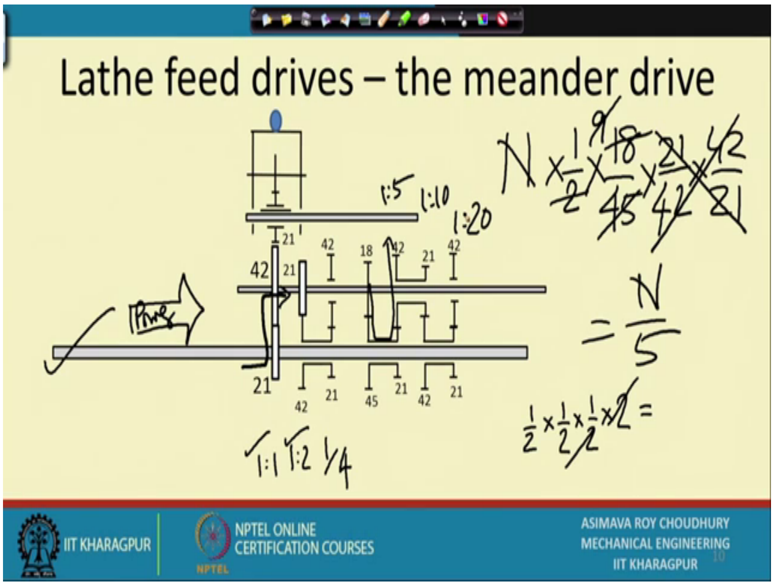

For that, we have another drive which can give us one fifth, 1 by 10 like that. For example, say it is here that your power is coming from; power is coming this way. And this is the ultimate place where you have to land up with the power. So, if you have 21 and 42 and 21 here; first one will give you 1 is to 1; whatever you are coming with, you go out with that.

Next if you are tapping the power from this one, you will get 1 is to 2. So, all those things we have already established; they are available here. And if the power comes and meanders this way; you are going to get what you call it; here 1 just let me see; 21 is to 42 is to 21; 1 is to 1 and after that if you connect up here, then you will get 21 is 42; so half and again 1, so half.

So, this is available; this is available and after that if you get another half here. So, it is basically half into what I call it; another half into another half multiplied by due to the 21 gear 2. So, this will cancel out; you will get one fourth; so, you can get one fourth. So, this way 1 is to 1, 1 is to 2, 1 is to 4 that can be available and if you make another channel of this type; you will get one eighth also; that is if you connect it up and make a 21 gear, you will get one eighth also; so that we have just left there.

In addition, if we extend it to get those ratios of 5 is to 1, 10 is to 1 etcetera; we can imply these 2 gears; how come this center distance is accommodating to different gears? Because as some of the teeth; you will find that it must be same 42 plus 21 is 63 and 18 plus 45 will also be 63; so this 18 by 40; so, whatever RPM I am coming with say N. So, that is coming here and it is getting multiplied by half. So, N into half into; then the power daily flows this way comes here 18 by 45 multiplied by; now it goes this way 21 by 42; multiplied by 21.

So, just a moment where we last of also here; from here power flows this way, this way; then this way, then this way and be able to tack from here. So, this is where I made a mistake; it is an idle gear, so it will happen this way into 42 by 21. So, this one cancels out as a whole and we get 2 cuts out with this one 9 and we get one fifth; N by 5. So, N by 5 will be available here and as you can see 21 is here; so half of that will be available here. So, this will give us 1 is to 5; this will give us 1 is to 10 and this will give us 1 is to 20.

So, this way ultimately we see that on the lathe whatever feeds we require they can be obtained by the Norton-Tumbler arrangement and the meander drive and this is called extended meander drive. So, here what happens is one question up till now is not answered that is I am getting say pitches of 1.6, 1. 8 to 2, 2.2 etcetera; how do I get if the inch system is there? See 1 by 8, 1 by 9, 1 by 10 like that what is the way in which we can obtain that. In order to obtain that what we do is, if we can reverse the gear ratios then we will be obtaining it.

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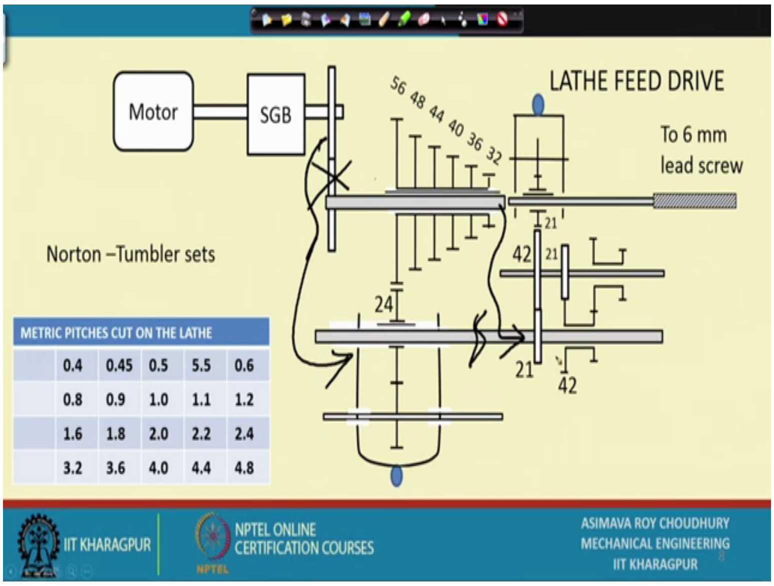

So, instead of giving power directly this way; we give the power here, so this is not given; this connection is removed at that time, we give the power here, we give the power here and move in the opposite direction now; from here to here we will be moving. And then we will be giving this one will be disengaged at that time and the power will be ultimately coming from here to this one.

Just the opposite we will do and that way we will be able to realize all the inch threads per inches; mind you if you have threads per inch, the unit is different so that a 127 teeth gear will be coming in handy. For that, I will be trying to give you some; I will be uploading some text notes which will be coming in handy for you to understand; what is that? So, this way we can cut metric threads, we can cut different you know ascending order of metric threads, we can have multiples and submultiples of metric threads for the system of 2, 4, 8 and we can also cut threads per inch in the inch system.

Thank you very much.