Production Technology: Theory and Practice
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Lecture – 28
Lab - 05

(Video Starts: 00:22)
Hello and welcome to the course on manufacturing technology theory and practice, I have Mr. Aman Singh with me who is a very highly competent technical officer in this laboratory and Aman Singh will help me in operating the machine and he will show you all movements and the surfaces that can be produced. Particularly in this case it is the lathe, after that will go to other machines and Aman will help in operating those machines.

We are going to make this job and as you can see that we have selected this because we have all the surfaces; we have the cylindrical surface, we have the groove surface, we have the tapered surface, we have the threaded surface, we have the center holes. This is the job, this is the initial job from where the workpiece will be fabricated by removing the excess material from the surface so that exactly this kind of a surface can be obtained.

Mind one thing that in the drawing all these dimensions are given and the drawing should be perfect sothat an operator can make the part with the help of this drawing. If there is any mistake in the drawing, then the operator will not be able to make the exact part that you desire according to your design. So, drawing is one of the most important things because it is the language of an engineer. You have to express yourself correctly. So that such kind of a job can be fabricated.

Now the drawing that we have shown to you, this part will be fabricated. For that the workpiece is getting mounted in the 3-jaw chuck and as I have shown it to you that 3-jaw chuck can be tightened with the help of only one screw because this is a self-centering chuck and when you are rotating that screw all these 3 jaws will be rotated. Now, next step is that the tool has to be mounted on the tool post, this is how the tool can be mounted; this Allen key will tighten the screws and bolts and those bolts will tighten or fix the tool in the tool post.

This is the tool post and this is how the tool is tightened, this is the tool holder and everything is sitting on the tool post, this is the way that you can remove or maintain the height of the tool from this base. Now the tool is moved towards the workpiece and then the angle is fixed, at which angle the tool has to be mounted in the tool post. This is how the tool is tool is tightened, tool holder is tightened on the tool post and then the machine is switched on. The tool is being touched with the workpiece and it is ready for the feed.

This is the way the tool is given the feed. And now you can see that with the fine feed movement that tool is moving along the workpiece surface, so that a cylindrical surface can be fabricated. Now Aman is doing it by hand and you can see the small chips they are coming out of the surface of the workpiece. So, in fact, this feed can be also given automatically so that the movement of the tool can be made; this is the way that the automatic feed is given.

Before switching on you have to select the appropriate RPM using those handles that I have shown you earlier here you can see that this is automatic now, the tool is moving along the workpiece surface automatically and the value has been set prior to that and automatic feeding is given. First the entire length is being turned after it has been faced. So, first the facing has been done. This is the drill holder for the center drill. Centre drill will be making the center holes for keeping that part between the centers.

Now the center hole will be drilled and you can see the center drill is mounted on the drill chuck or the drill holder and now this will be rotated. This is the way that center hole is made; such center holes are made to hold the long parts between the centers. This is loosening the tailstock and the tailstock is no more required here. Therefore, the tailstock has been removed to the initial position. Now it is turned around and the facing will be done on another side.

Facing has to be done because we have to make sure that the face is absolutely perpendicular to the axis of the workpiece, again similar to the other side, the facing is done in that case, the feed is given as you can see, the direction of the feed is perpendicular to the workpiece surface because along the workpiece surface if you are applying feed then you will have the cylindrical

surface but here the facing has been made. This measures the length accurately and the length that has to be according to the drawing.

According to the drawing it has to be 105 millimeters and right now it is 107 millimeters. So, 2 millimeter has to be removed from this end. So, you are setting the movement of the tool. This is the micro setting and it is a 2 millimeter. As you can see 2 millimeter along the length of the shaft is being removed. So, now it is 105 millimeters according to the drawing. It is removed in few steps. These are the passes; each pass is removing certain length so that finally the 2 millimeter of the length is removed.

Now the shaft length will be exactly 105 millimeter which is according to the drawing. you can read it from the main scale and the vernier scale and you have to maintain that according to the drawing. Next step is to make the center hole. This is to be made like on the other side, the center drilling is being made here. The drill is being moved forward manually. Center hole is now made on both sides.

Next, the center drill is removed from the tailstock and now we will make the center and we will hold the workpiece from center to center because we have to turn the entire length of the workpiece. Therefore, to turn the entire length of the workpiece, it has to be held between these two centers. One center which is dead center, it is attached to the spindle in the 3 jaw chuck and this is the torque carrier, I have shown it to you earlier.

And now you can see how the transmission can be given, rotation can be imparted to the cylindrical job with the help of that torque carrier. The other end is with the revolving center and this is connected to the other end of the shaft. Now that torque carrier is tightened and the workpiece can be turned, the cutting feed is getting switched on. During that a lot of heat will be generated and the friction will be more; to reduce the friction and to reduce the heat, the cutting feed is switched on.

And here you can see that the feed is given, it is being adjusted and it will be automatically going along the axis of the workpiece. the workpiece which is selected is of mild steel, which is ductile

material, therefore, you can see the continuous chips are being formed, a lot of heat is produced because of the plastic deformation and the friction and that heat is removed to a large extent by the cutting fluid which is supplied in the cutting zone between the cutting tool and the workpiece.

Along the length it is turned and now the length will be measured and the diameter will be measured 21 points. So, the diameter is 21.3 millimeters that has been measured and here the diameter given is 20. As you can see, the diameter that we have to take is 20 millimeter. Now it is 21.5. So, 1.5 millimeter has to be removed, from both sides 1.5 / 2. Now that much is value is set here. And then again, the workpiece is turned so that the diameter is reduced according to the required size.

Well, the entire diameter of 20 millimeter now it is 20.7 it has come now to 20 millimeters which is required; he is making it along the entire length of the shaft, but what we will be getting is the 20 you can see that 20 millimeter diameter we will be getting only along the length of 15 millimeter. For the rest of the length, we will have these elements that we will be showing you gradually. Now, let us see what is the diameter that has been obtained this diameter is being measured by the micrometer.

And with the help of the main scale and the Vernier scale it has come out to be exactly 20 millimeters. This diameter is 20 millimeter. Then we have to have the groove along the length after the 15 millimeter from this end and so on. These elements will be fabricated gradually after that we are turning the workpiece and on the other side, these elements have to be made that means on other side the facing has been made then thechamfering will be made.

And then there will be the turning up to the diameter of 14 millimeter and the thread has to be cut, so these elements have to be made by turning the workpiece. As you can see now the entire length of the shaft is turned and the portion which was covered by the torque carrier, for that portion is now removed after it has been turned on the other side. Now the entire length is turned. Now you will be doing the step turning. Now you can see the step turning process is on and if you remember in the drawing, we have the steps.

First you have to get the 14 millimeter diameter on which the thread has to be made, right hand thread. Now what is done is that he is making the diameter of 14 millimeter along the length of 20 millimeter that will be 14.35. It has to go up to 14 millimeters 0.35 millimeter has to be still removed. It is within the tolerance level and therefore what we are getting is that diameter 14 millimeter. Now, within this diameter 14.01 according to the drawing, within the length of 20 millimeter you have to cut the thread.

Now along the length of the job he will mark the places where the grooves have to be made. The first groove and thread length will be 29 millimeter for taper length 51 millimeter and grooving 64 millimeter according to the drawing. The dimensions are taken, adjusted and then the machine is on These are the markings, that he is making, this is for the radius groove, that is a groove. This is the tool that you can see this is the tool for making the groove and this tool ia as well serving another purpose because that is the threading.

One tool has threading tool in one side and the grooving tool on the other side and this tool will be used for making the groove. So that is being mounted on the tool holder and the tool holder is fixed on the tool post. Now the tool is tightened on the tool holder. The dimension is taken by adjusting the dial of the machine, in few passes, the diameter has been reduced for the grooving, this is the grooving. This is 16.2 and if you see the drawing this is the one that has to be maintained which is 16 millimeters.

0.2 millimeter has to be removed along the diameter. This is now 16 millimeter. This is the total length. If you see the drawing, this length is 20 + 10 + 20 which is 50 millimeter and this length is after that diameter of 16 millimeter. So, it is turning now this length to maintain this 50 millimeter, so another 0.6 millimeter has to be reduced, so now it is 50 millimeter in length. Now, if you see the drawing, according to this drawing, we have to now make this 12 millimeter diameter of grooving and the 10 millimeter length of the groove.

After that we have to get this right-hand feed on the length of 20 millimeter from here. That has been done in few passes, now it is 12 millimeters diameter of the groove and this distance of 20

millimeter has to be maintained you can also see how the Vernier can be used to measure the length and that is probably more accurate than using the scale distances maintained. Now, that is the distance which has to be 20 millimeter on which the taper has to be made.

The length is made as 20 millimeter after the groove and on that 20 millimeter length, the taper training has to be done. So, now the taper turning has to be done. For that what Mr. Aman is doing is changing the angle of the tool. So that accordingly this taper can be turned as given in the drawing and that as per the drawing the angle is selected by changing the angle of the tool. Now it is tightened the tool holder and the tool post and the tool that is used is for the taper turning.

Now if you see that the feed will be not parallel to the workpiece surface, but at an angle with the workpiece surface and you will see that the taper is generated feed is given manually and since the feed is not parallel to the workpiece axis that is inclined to that. Therefore, there is taper surface generated along the length of 20 millimeters and that is being done in few passes. Now, the taper is turned along the length of 20 millimeter according to the drawing the tool post is again taken back to the initial position.

Well, what we have so far done is the turning of the cylindrical surface afterwards is the grooving and then the taper turning that you have seen and then the grooving. Mr. Aman Singh will now make the radius grooving. This is to get some exit point for the tool for making the knurling, for knurling you will see that the tool has to be changed to a knurling tool that I have shown it to you earlier and that knurling tool will be used for making the knurling surface within that distance that he has already marked.

Before the knurling, he will make the radius grooving and then the knurling. Now, the tool is being changed from turning tool, grooving tool to the radius tool because he will be making the radius grooving. Radius grooving is nothing but a groove with a certain radius with the semicircular shape and that is according to the drawing. In the drawing you must have noticed that there is a radius grooving, he has already marked that part where the radius grooving has to be made.

And the remaining part which is from the groove to the radius grooving knurling will be there. For the radius grooving the radius grooving tool has been used which is given the feed perpendicular to the workpiece surface with a cross feed. In that case, the radius grooving shape will be as per the shape of tool, here you can see that the cross feed is given and the tool shape is being conformed to the surface.

You can see that the radius grooving has been made with a cross feed given to the tool and cross feed is once again towards the center of the workpiece, so it is perpendicular to the workpiece axis. Now the tool is changed to the knurling tool. This is what the knurling tool is which you have already seen. And the knurling tool will be used to make the knurling certain knurl surface within that length which is remaining between the two grooves between the radius groove and the other groove on the left side that you can see.

Well, this is the knurling tool and a particular knurling tool has been selected. This is the knurling tool that has been selected and that knurling tool impression will be taken if you are giving the cross feed to the knurling tool, in that case the rotation will be slower. Initially the cross feed will be given for getting the depth of cut and then after that at very slow speed the longitudinal feed will be given to the tool so that the knurl surface can be obtained; as you can see now the longitudinal feed is given to the tool and the cutting fluid is applied.

So that the friction between the tool and the workpiece is less and the temperature occurring will be less or whether it will be carried away from the machining zone, this hand feed is given, as you can see that the knurling tool is loosely fitted in the tool holder and therefore, as the knurling tool is in touch with the workpiece it also rotates along with the workpiece. It is reciprocated with particular feed so that the appropriate depth of the knurl surface can be obtained. The knurl surface is obtained, you can zoom it and we can see that this surface that is obtained is a knurl surface.

Such kind of surfaces are used for gripping or for retaining the lubricant when the two surfaces are moving with respect to each other. Well now that the knurl surface is made, as per the drying

now, the thread will be cut in this surface in this along this length which is probably 20 millimeter and for that we have to make some adjustments and those adjustments, I have shown it to you those are the handles provided here.

According to those adjustments, he will find out and fine tune the pitch of the thread that will be cut here. Now for cutting the thread the tool has to be changed. This is the tool for the thread cutting and that tool is different from the one that we have used for the turning of the surface, how it is different is that this tool has the same profile as the profile of the thread this is 60^0. This is the 60^0 angle that means the profile of the thread will be at 60^0 angle.

This is being measured. this is 60 degrees; if you remember that this gauge measures the profile of the thread. Since the thread will be cut by this tool, so this tool also will have the same angle. As you can see that this feeds in here. Therefore, it will be 60 degree we can make sure so the now the thread profile thread that will be cut using this tool will have a profile of 60 degrees angle.

Well, there is another factor that in the case of the thread cutting, first of all the speed will be slower, cutting speed will be slower and the adjustments will be made in such a way that after the first pass the second pass will exactly follow the same path. So that the depth of the thread will be more, but it will be moving or the feed will be given to the tool along the same path that is the adjustment that has been made you can notice that

Certain depth of cut has been taken in the first pass and then the feed will be given to the tool with the adjustments that has been made now, the thread is being cut, then again the depth of cut is changed and the tool is moving along the same path, depth of cut is taken a little more now, with the increasing depth of cut the depth of the thread is becoming more and more in each pass and as you can see that for each pass the tool is tracing the same path as the previous one.

In each pass the feed is increased with respect to the previous one and finally, the thread is cut as you can see. There is a certain depth in the thread for that depth is achieved gradually in few passes because in one pass it is not possible because the force will be very high and the

temperature occurring will be very high and the tool may break even, if you see now the thread is made and the thread profile will be exactly 60 degree according to the tool and now the burrs are being removed by the file so that the thread is smooth.

These are the burrs which are remaining after the machining, after the turning and those burrs have to be removed otherwise, these burrs will disturb the thread from going into the threaded hole. Now you can see that in the drawing. If you compare it with the drawing, here we have the threaded portion, we have the thread within the distance of 20 millimeter and the thread diameter is 14 millimeter. This is the metric thread, therefore, it is given as M14.

The tool makes it metric that is the metric tool and the adjustment that is made is according to the specifications given for making that thread, after the thread you can see that there is a certain distance of 10 millimeters there is a groove that diameter is 12 millimeters. This is surface and after that there is tapered surface here within the 20 millimeter of the length and the taper dimensions are given.

After that there is this portion which is 16 millimeter diameter and within 15 millimeter of length which is here then the knurl surface here now surface dimensions are given, here it is written that this has to be knurl then there is a radius given for the groove that has been made here and after that it is turned within the distance of 15 millimeters and the diameter is 20 millimeters.

This is the entire turned finished product which has been made as you have seen from the workpiece which was initially used and according to the dimensions which are mentioned in the drawing, this finished part is being fabricated. Well, there are a few words about the setup for the thread cutting. Now, let us say the pitch for the thread is given as 2 millimeter; pitch means the distance between the 2 peaks of the thread.

If it is 2 millimeter according to this table, which is given on the machine, this 2 means you go to this that is T and the T stands for this kind of arrangement of the gears that we have. If you can see 54 number of teeth, 50 number of teeth and so on. So, according to this you have to make the

gear train with the help of the gearbox and then what you will get is exactly 2 millimeter pitch for the thread cutting.

This is the adjustment that has to be made before you cut the thread and if it is supposed to be 0.25, accordingly you will be making the arrangement for the gear train, that is the adjustment. Now, we will demonstrate the milling operations. Before we go for operating the milling machine, I would like to tell you that we have the milling machines which are vertical milling machine as well as horizontal milling machine.

The difference between them is as you know that if the axis of the milling cutter is horizontal in that case the machine will be called as a horizontal milling machine. And if the axis is vertical, in that case the milling machine is the vertical milling machine. In both of these milling machines, different kinds of milling cutters are used which we will be showing you here. And as you understand that cutters like face milling for example, all those can be made in the vertical milling machine.

And in the case of the horizontal milling machine, we have the flat surface, the slotting, various kind of grooves, those are made in the milling machine overall. Here if you see that there are different kinds of components and the tools that are being used, let us say here we are demonstrating the spur gear. This is the spur gear with the straight teeth, this is demonstrated here is the bevel gear as you can see that here it is the conical in shape.

And therefore, the difference between the bevel gear and the spur gear is that when the spur gear arrangement is made for transmitting the power then the 2 shafts between which the power is transmitted, they are parallel. Now, in case of bevel gear, as you understand that if another bevel gear is in contact with this and the power is transmitted, then the axis of the shafts of these 2 shafts will be perpendicular to each other whereas in case of spur gear it was parallel to each other. Now, here you can see that there is a helical gear.

If you remember your machining course, there was a concept of orthogonal cutting and the oblique cutting. In case of oblique cutting the tool is inclined or a tool is inclined with respect to

the cutting velocity vector. In that case of oblique cutting therefore, when the tool is getting engaged with the workpiece, it gets engaged gradually and therefore, more strength of the tool can be utilized; same principle is adopted and same benefit is achieved by the helical gear.

If the 2 helical gears are working then the torque carrying capacity therefore, increases. You can see that these are not the straight teeth but they are helical. Now, here if you see that this is a cutter adapter, it has a standard, this is an international standard and particularly we have now our Indian standards. According to the Indian standards also the adapters and other tools are being made. This is an adapter, meaning that with the help of this nut you can fix milling cutter in here.

For example, you can see already there is a milling cutter which is fixed here, similarly a milling cutter can be fixed here, this is the adapter and this is the adapter with the milling cutter. I will come to this milling cutter a little later. Now here this is the element which is called the arbor. Arbor is something on which the milling cutter is mounted and this is used for the horizontal milling machine; these two ends will be held on the spindle and the milling cutter will be mounted somewhere here with the spacers.

The whole attachment is called the arbor, so on the arbor the milling cutter is attached in the horizontal milling machine will go there and we will see that in here is the lathe dog, this is the collet, so this is the collet adapter for attaching the collet here, you can see that the collet is here, so you can attach different kinds of collects, these are the collets, these are the design of the the actual collet and this is C spanner for tightening or loosening.

This is called the step clamp set meaning that here you can attaching with different teeth you can see that there are teeth, so you can change the height, the height can be changed by engaging different teeth with respect to each other. Now, we have different kinds of cutters that you can see here for example, this is the side and face cutter, this is a milling cutter and this is called the side and face cutter mill because the sides and the faces can be milled with this cutter.

As you can see here this is the keyhole and in the keyhole there through the key it will be fixed on the shaft of the arbor of the milling machine, similarly, here we have the staggered cutter; staggered cutter is different as you can see that it is different from the side and the face cutters and here we have the helical milling cutter. Helical milling cutter as you can see, that there is a helical gear that we have shown here and this is the helical milling cutter.

This helical milling cutter is equivalent to the oblique tool in the turning process because as you can see that these are inclined. These helical milling cutters, when they will be engaged to the workpiece for removing material, it will get engaged to with the workpiece gradually and not it will not grab the workpiece at a time. Therefore, the life of the tool will be more because it is grabbing the work material gradually.

Here this is a slitting saw cutter for making a slit, making a slit like this for example on a shaft let us say so for that you will you know if you are using a key in that case on the shaft on which this will be mounted, there has to be a keyhole alsoso that keyhole on the shaft can be made with the cutter like this. This is the slitting saw cutter. This will make the slits also everywhere you can see that there is a keyhole here. So that keyhole is to fit the milling cutter on the arbor with the help of the key and these are the key holes.

One key hole is here, another key hole will be on the shaft and between these key holes there will be key. This will be slit on the key and the key hole of the shaft. This is the sprocket cutter. You know the chain and sprocket mechanism. So, that sprocket can be machined or cut with the help of the sprocket cutter. This is the sprocket cutter as you can see. This is the angle mill cutter. This milling cutter as you can see that this has a certain profile and with this the profile that you will be making will be according to the teeth of the milling cutter.

This profile will be conformed to the workpiece, this is the inserted face milling cutter. Here the milling cutter has the inserts like I have shown you the tools. These inserts are made of very expensive materials. Therefore, instead of making the entire cutter with the same material, otherwise it will be very expensive. The material of this holder is of different kind then the inserts and inserts are very expensive.

So, if the insert is worn out or it is broken, individually the inserts can be changed and otherwise what would have happened for example in these cases, either you you regrind the teeth or you throw out the entire milling cutter if it is worn out, but in this case you can change the inserts, use another fresh insert and the whole thing can be used as a new one. That is the advantage of those inserts because the inserts are very expensive, you cannot make the entire milling cutter with the same material as the insert material.

Here you can see the shell end milling cutter. This milling cutter is different from those milling cutters that we have shown and here also the material is the same for the entire milling cutter. Normally these milling cutters are made of different grades of high-speed steel, such as 'Moli' HSS, that are super HSS so, that we will discuss in the lecture classes. This is inserted face milling cutter again. This is used for the face milling, again they are inserts by the way; the face milling is used when you need good surface of the base as well as the vertical surface that is made.

Both the vertical surfaces as well as the horizontal surface are milled using the face milling cutter. Now here we have the ratchet cutter. The ratchet is cut using this milling cutter and you can see that this milling cutter is different from the other milling cutters that we have seen. This is the rack cutter, again. This kind of a cutter is used to make the rack for the rack and pinion, this is the special milling cutter which is called the Woodruff cutter.

For some reason this name is given as a Woodruff cutter but this is vertically mounted and it rotates about this vertical axis. This is the module cutter, this is for the certain module which is defined that is used for that, then this is the key way cutter, the key way that you are making on the shaft or on the circular part this key way is made using the cutters like this. This is also another face milling cutter.

These are also inserts and these inserts can be changed without throwing out the entire tool, this is the holder, on the holder you have the inserts. These inserts are mounted on this, so that this

inserts can be used as a tool and if there worn out, these inserts can be replaced by the fresh inserts. Thank you for your attention.

(Video Ends: 59:38)