Manufacturing Processes II
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Lecture No. 20
Configuration, kinematic System, working principle and applications of shaping planing and slotting machines

Good afternoon friends. Today our subject is continuing Manufacturing Processes - II

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and now we are passing through Module number 4: General Purpose Machine Tools. Today's lecture topic will be Configuration, kinematic system, working principle and applications of shaping machine, planing machine and slotting machines. All of which are reciprocating type machine tools. Now what are the objectives of the topics today?

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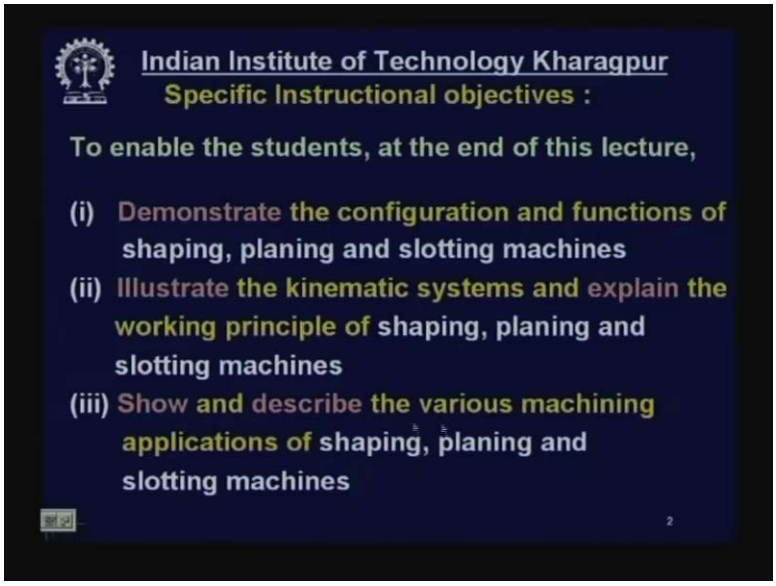

The configuration and functions of shaping machine, planing machine and slotting machine: Next the kinematic systems and the working principle of shaping machine planing machine and slotting machine and third various machining applications of those machine tools.

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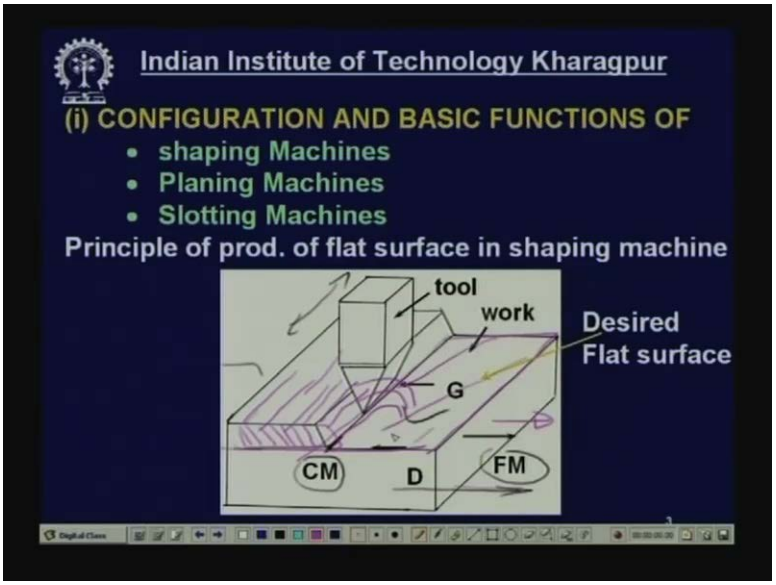

Now let us come from the configuration. Configuration means that the getup general view in a vision in general say getup configuration and basic functions of shaping, machine planing machine and slotting machines and all these machines are taken together because they are basically used to produce flat surfaces and the working principle is based on reciprocating of the cutting tool relative to the job. Now start from the shaping machine. Principle of production of flat surface in shaping machine; Now this is the surface, this is the surface

which is going to be machined. This is called desired flat surface. Now this is produced. This is the work piece and this is the layer of material which has to be removed, this portion. Now this is the cutting tool, the the cutting tool reciprocates like this and because of the linear motion forward linear motion is called the cutting motion and the work piece is moved in this direction that is called feed motion.

So combination of this cutting motion and feed motion will produce the flat surface. How does it? Now when this tool moves forward, suppose there is a layer a layer a material is getting removed by the forward motion of the tool. So this layer will be removed in one pass then the tool will go back. When the tool will go back, then the work piece will move by a little amount called feet and then the next layer this layer of material will be removed. So layer by layer this entire surface material will be removed and we get a constant flat flat surface. Now this is to be observed that there are two motions: one is cutting motion, one is feed motion. Cutting motion there are two parts: One is cutting tool and the job the cutting tool in shaping machine moves fast giving the cutting motion and the work piece moves slowly in the transverse directing and that is called feed motion and resulting the flat surface.

Now what is planing machine? In planning, the slight difference is there. What is the slight difference? Instead of the cutting tool the job will reciprocate. It is a large job that will reciprocate as if the tool is stationary and then instead the job moves in this direction. The tool will move in this direction. So relatively matters remain the same. So this is the cutting motion given by the reciprocation of the job mount on the table and the tool is given the feed motion that is the characteristics of planing machine. Now what is slotting machine? In the slotting machine, the whole this this is horizontal work. This entire work is going on say in a horizontal plane this cutting motion all these things are horizontal plane, both the motions but the slotting machine all the work will be vertical in the vertical plane perpendicular to the surface. But the basic principle of slotting and shaping will be exactly same. So far as tool work motion general feed and cutting motion are concerned. So often the slotting machines are called vertical shaping machine or vertical shaper because it is nothing but if a shaping machine works in a vertical plane, the the tool reciprocates in a vertical direction. This will be nothing but a slotting machine. Now next is configuration of basic and basic functions of shaping machines.

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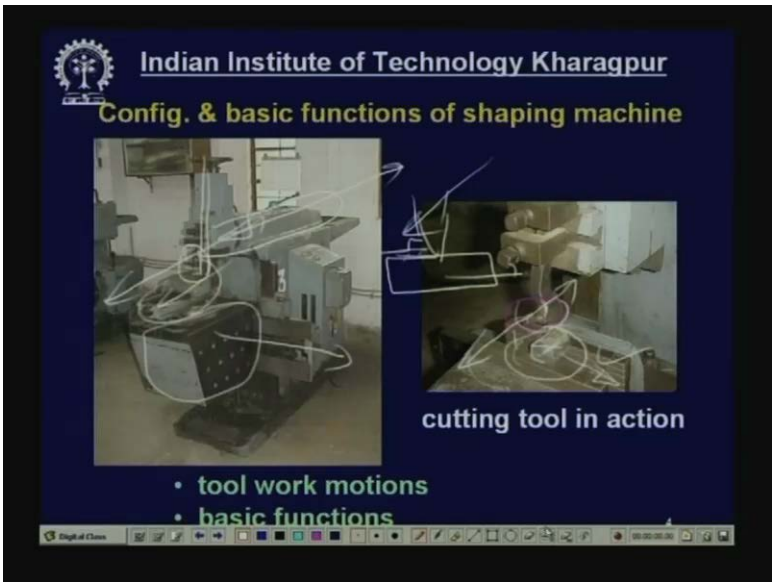

Now this is a very common shape of shaping machine which has got the main starting point important point is this one. This is the cutting tool okay this is the cutting tool and this is the work piece, this is a cylindrical work piece. Now at the top a flat surface has to be cut and that that surface will be produced by reciprocating of the cutting tool with a depth and the job will move slowly in this direction. This work piece is mounted on a vice. This is called vice. The vice is mounted this is the vice which is mounted on the machine bed and this is the cutting tool this cutting tool is here. This cutting tool reciprocates these are mounted on the head a slide vertical slide that is connected with a RAM and this RAM reciprocates. So the result is that the cutting tool reciprocates like this and the work the table is holding the vice. On the vice, the job is mounted on the vice and the table moves in this direction along with the vice so the job is moving in this direction.

As a result this is the work piece and this is the cutting tool and this is the material removal. So this reciprocates this moves in this direction feed motion and this is cutting motion. So this is how shaping machine works. Now tool work motions: you have told the tool reciprocates that is called cutting motion and the work piece that is moved slowly in the transverse direction and that is called feed motion slow motion. What is the basic function very simple and this type of shaping machines or any shaping machines are used mostly for making flat surfaces in different planes. The flat surface in horizontal plane mostly it can be in the vertical plane, it can be the inclined plane and this can be interior also in the side surface from slots and features, grooves can also be machined. In such special application now this can be used for making some small you know gears or few teeth of gear for maintenance purpose this thing should be told in more detail all right. Now come to planing machine configuration and function of planing machine:

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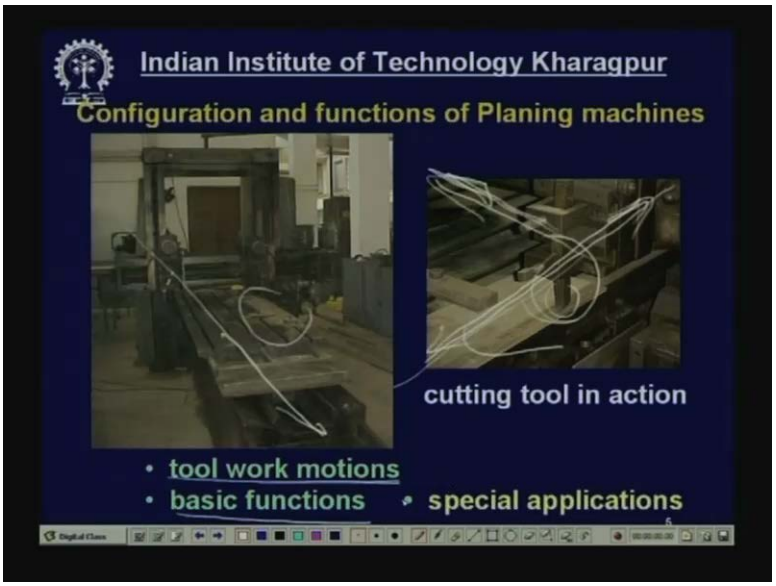

Please recall I told that the difference between shaping and planing lies in shaping machines are small. You know they are used for small jobs and light cuts. But planing machines are very large machine tools larger machine tools they are used for large jobs with a long cut and heavy cut with a long high depth and feed. So this is the planing machine and this is the table. This is the table which reciprocates this is the table which reciprocates over a long distance you see and the work piece is mounted here. So in this diagram you see this is the cutting tool and this is the work piece. So the work piece reciprocates being mounted on the table. Table slides over the guide of the machine torque bed this is called bed and this is the cutting tool. So the cutting tool moves gradually in this direction. So the tool is given the feed motion slow feed motion and the work piece is given the fast cutting velocity.

This is the basic difference in principle with from shaping machine. Besides that planing machines are very large. So the tool work motions I explained that the work moves reciprocates giving the cutting motion fast cutting motion and the cutting tool moves slowly in the transverse direction giving the feed motion and basic function again is very similar to that of shaping machine that is production of flat surface in a horizontal plane, in vertical plane and in inclined plane and little bit from side also. Beside that some special work some special applications are also there which will be told in appropriate time. Next let us see the slotting machine configuration and functions of slotting machine.

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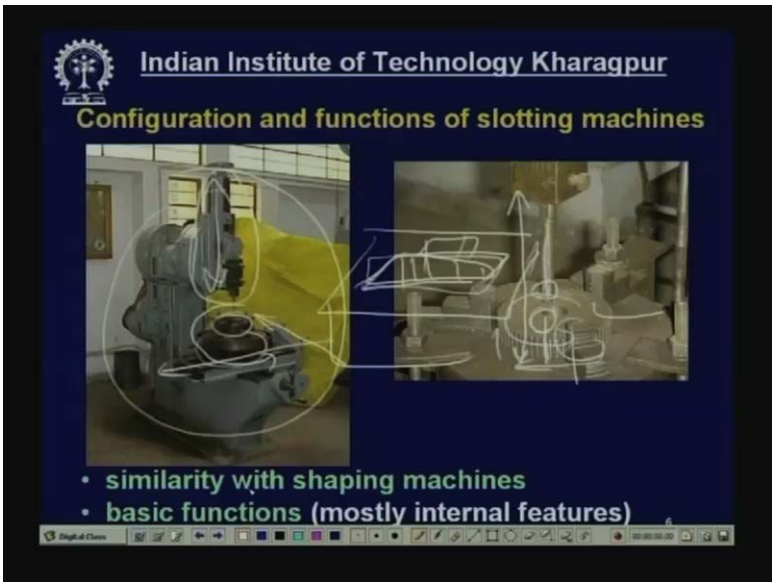

I already told the slotting machine is nothing but a vertical shaper. What is shaper? In shaper the cutting tool reciprocates but in horizontal plane. In slotting machine, this is the cutting tool mounted in a tool holder and this reciprocates vertically up and down and this is the work piece say it is a gear were a slot has to be cut like keyway, a slot has to be cut along the axis and by this cutting tool which has to reciprocate. So here we find that the cutting tool reciprocates at high speed giving the cutting motion and the work piece is moved either in this direction or in this direction or rotation slowly and these are called feed motions. This is the configuration of the slotting machine. This tool is mounted on the head. This is called the cutting tool head which moves up and down by certain eccentric mechanism or crank and connecting mechanism and the work piece shown over here is here that is mounted on a table.

The table is mounted on this flat table which can move in this direction one feet slowly it can move in this direction. This is called feed motion and in addition to shaping machine where the rotation is not there here the table can rotate also or the job can rotate all right and basic functions will be very similar again to the shaping machine because is nothing but vertical shaper production of flat surface. But just you remember, it produces small, flat surfaces, small grooves, small slots but all in the vertical plane and these are all internal features say this internal surface suppose there is a block where a square hole has to be made. So this is the square hole. So this surface is vertical surface have to be made. This is internal surface all in say slot has to be made. All these internal features are done in slotting machine because the internal features like internal flat surface pocketing say grooving and keyway cutting cannot be done in shaping machine. So these are the basic but beside that some other functions are also there some it can be applied slotting machine can be applied for some or few more work but it is not that versatile that is to be remembered. It is not neither productive, nor accurate, nor versatile.

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Now let us see the kinematic systems and working principles of this various machine tools shaping machines, planing machines and slotting machines. Now kinematic system: What is kinematic system? It is a kinematic structure comprising number of kinematic chains each chain you know is responsible for transmitting the power and motion from the source that is electric motor from electric motor to the tool or to the job. If there are three motions there should be three kinematic chains and each kinematic chain is again comprised of number of mechanisms say belt pulley mechanism than gear mechanism, rack pulley mechanism, worm and worm wheel mechanism and so on. So this is very vital part of the machine tools the kinematic system and then we shall discuss how does the machine work with help of this kinematic system. Let us start from the shaping machine.

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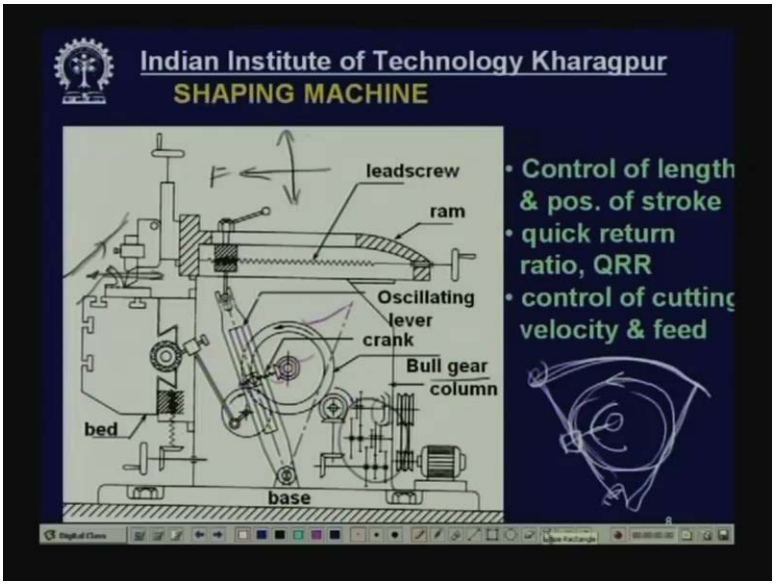

This is the kinematic structure of shaping machine. Now look this is the cutting tool. This cutting tool reciprocates in this direction and the work piece that is mounted here on the table this will move perpendicular to this cutting motion and horizontally. So if the cutting motion is in the vertical plane like this, this is this is horizontal plane the job will be moved in this direction. This is feed motion and this is cutting motion. So the tool will move in this direction and the job will move in this direction okay perpendicular to that but this will be very fast motion cutting motion and feed motion of the job will be very slow. So these two motions are there. Now the question is how these motions will be attained at the tool and the job. Where is the source? This is the source before that let me tell you the salient parts. This is the machine tool, this is called ram which reciprocates along with the tool, this is called belt on which the job is mounted directly or indirectly with a vice and this is called the column and this is called the base which is fixed on to the foundation.

Now this motor rotates, rotational power goes through v belt in to the shaft through this clutch it goes in to this cluster gears and ultimately through this gear box. This is called gear speed gear box comes in to this place and then rotates this pinion with the help of this bevel gear. Now this bevel gear rotates again this bull gear. This is called bull gear okay this is the bull gear, large gear. On the axis of the bull gear there is a bevel gear and on that in connection in mesh there is another bevel gear this bevel gear is connected with a screw. The screw passes through a nut and this nut moves along the slot of a lever and this lever oscillates. You know it oscillates like this, it oscillates and above this hinge. So when the one this is the say link this is the link which is hinged over here and this is the block which is rotating here which is rotating like this along with the bull gear. As a result, this will come from here to here. So this as so this end will oscillate like this. When this will rotate, this block will rotate, the crank will rotate in this direction lie along this path. So this end of this one lever will move like this okay this will move like that.

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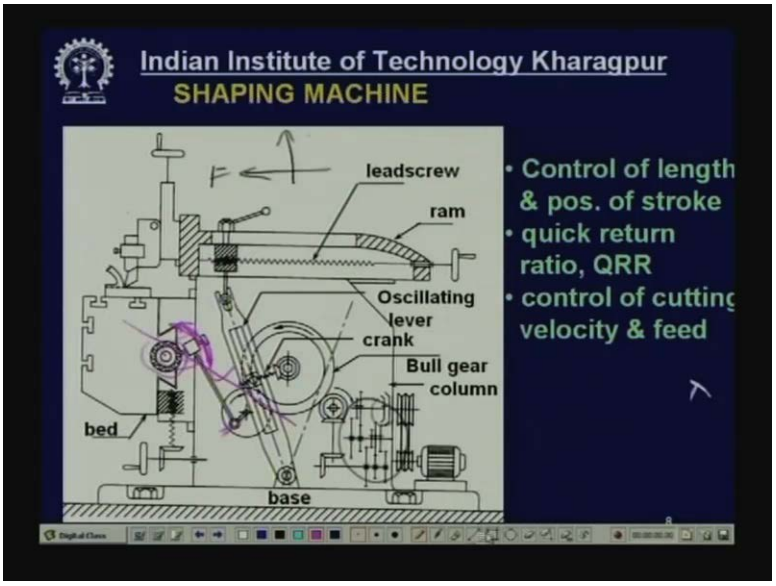

So this rotary moves this oscillatory motion will be converted in to translatory motion of this one of the ram. So this is fixed with this lever this is nut, nut is fixed to the screw, screw is fixed with this ram so the ram will travel like this and on that the tooling head. This is called the compound slide is mounted and fixed on that this clapper box is fixed on the clapper box this is the tool holder in the tool holder there is a cutting tool. So along with the ram, this cutting tool reciprocates this is how we get all the motions. Now this how do we get the feed motion of the job? This is obtained by when this bull gear rotates along with that there is another gear in mesh so this gear also rotates. So there is a slot radial slot on which a pin is fixed and this is the connecting rod. So when this rotates this end you know oscillates like this. This one oscillates, this is called 'ratchet pawl system' this is called pawl and this is ratchet so this ratchet rotates. Now it is mounted on a screw this screw is fitted with a nut and the when the screw rotates this one moves perpendicular to this plane. So when the screw is rotated by this one intermittently so when the bull gear rotates, this one also rotates and this one oscillates, so this job rotate the the this job moves intermittently along with the movement of the pawl.

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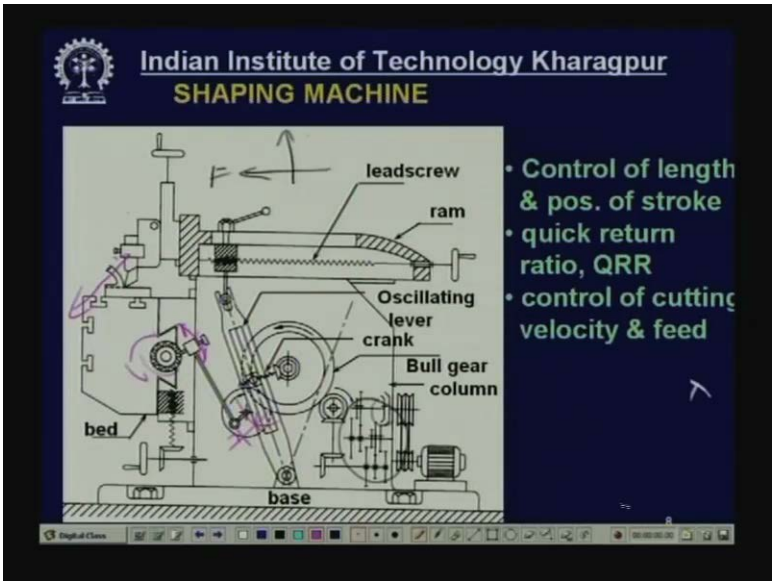

Now the amount of so this amount of movement or the rate of feed depend upon that how much angle this ratchet rotate that will depend upon the amount of oscillation. This will depend upon this radial distance which can be time to time changed this extrinsity. This is how we get automatic feed. Now by changing the pawl by 180 degree we can change the direction of rotation by changing the direction of rotation the table can be moved in this way or in this way so this is feed.

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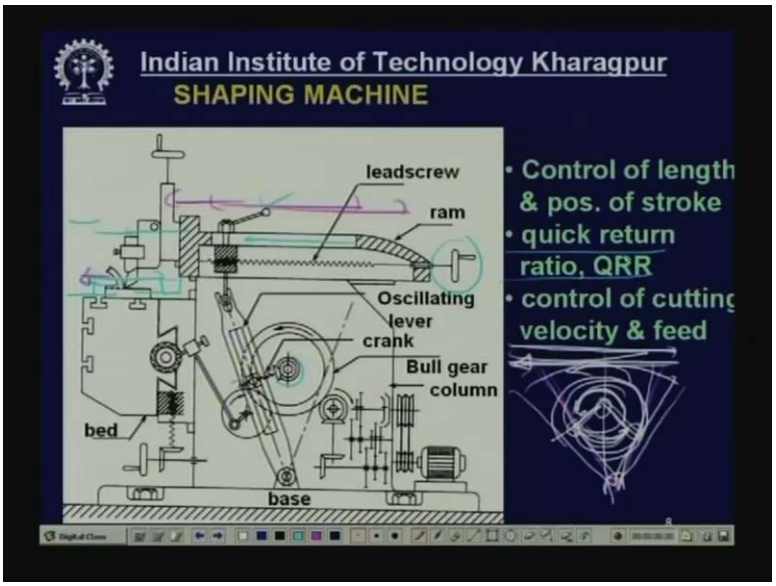

Now next question is the control of length and position of stroke. The length of the stroke this is called stroke length this is called stroke length all right not visible stroke length. Now how this can be increased? This is coming from the reciprocation of the ram, this comes from the oscillation of the lever. Now if this crank length is increased then this will be rotating over a oscillating over a wide distance. So this stroke length will increase that means this distance, the crank length has to be increased. The distance between this of this nut forms the center. How this can be done? This to be done by rotating this gear bull gear this bevel gear. This bevel is rotated when this bevel gear will be rotated by the screw, the nut will move away or to away or towards the center. When this is moved away that is say this is the levers is rotating like this the center when this crank length will be increased then the circle will be bigger and the oscillation the stroke length will also increase. Now this is how it is done.

Now one thing to be noted that it is rotating suppose in this direction. So from here to here when it moves the crank moves from here to here at a constant speed. The cutting tool moves forward that the cutting stroke and when moves from this point to this point over a smaller angle, then the tool goes back. This is called return stroke. This angle is smaller than this angle. So this return will be much faster. So this is called quick return mechanism whole thing is called oscillating lever mechanism and this is quick return effect because of the smaller angle and big angle and this ratio of this angle and this angle that is total time of cutting and return called quick return ration that saves time. Now what about the stroke length? Stroke length has been discussed not the position of stroke. This is the position of stroke which has to be shifted from say here to here. This can be done say it can be here it can be here this can be done by loosening this nut and then by rotating the screw and as a result through the nut, nut will be here fixed like that through this nut the screw will move.

When the screw will move along the screw this ram with also move forward little forward and then you tighten this one. So by that, you can in fix the initial position of the cutting tool

here or here or there and then by adjusting rotating this one, you can adjust the length of stroke. So these two things are very important that control of length of stroke and position of stroke then quick return ratio. What is quick return ratio?

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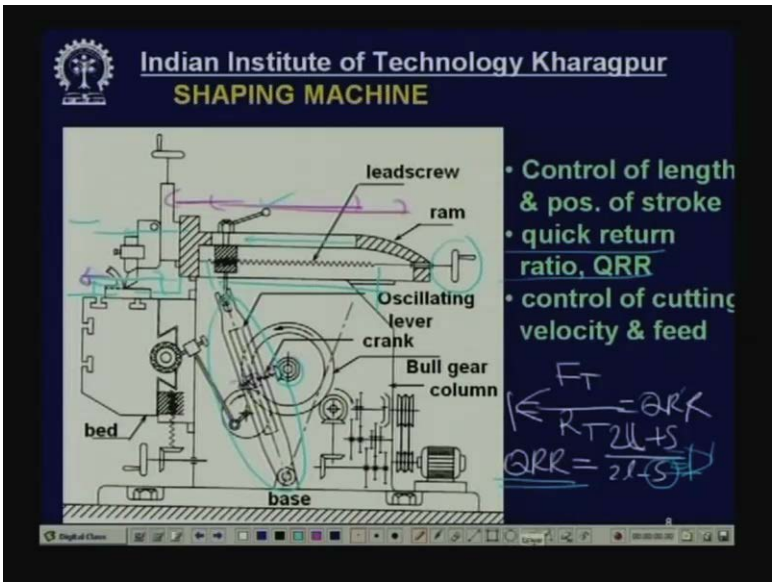

Quick return ratio is say time forward time. Forward time divided by return time. Return time is faster. This is called quick return ratio. This is greater than one. This will be greater than one so this saves time and this quick return ratio this will be equal to 2 L plus S divided by 2 L minus S. What is L? L is the length of this lever length of this lever okay and what is this stroke length the stroke length. So when the stroke length is very small, this quick return effect is also very small. So we loose the benefit of quick return effect. If S is large the stroke length then this ratio is quite greater than one. If S is very close to zero then this will become this is becoming one so there is no quick return effect. Now next point is the control of cutting velocity.

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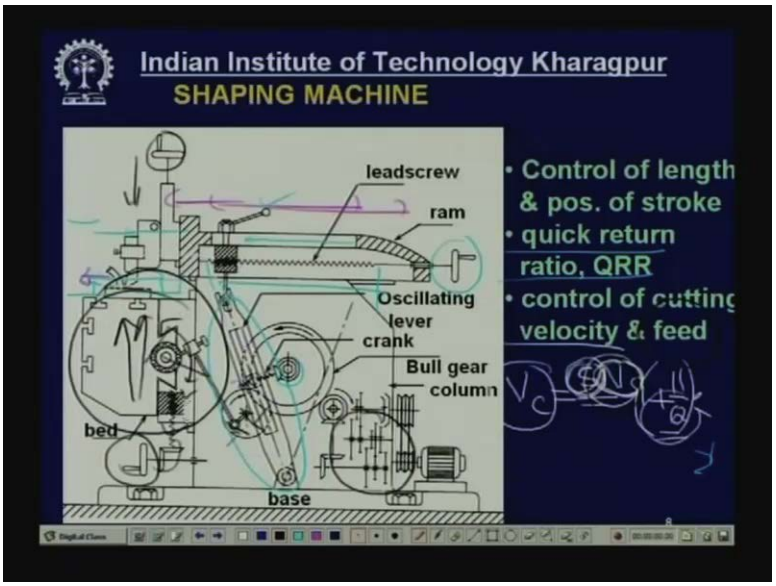

Now the cutting velocity: How we control the cutting velocity? Cutting velocity denote by V c will be equal to length of stroke that is S by number of strokes per minute and this is the total length divided by or equal to 1 in to 1 by Q. Q is the quick return effect so stroke length and NS. Now the quick return ratio is more or less fixed. Now if we want to increase the velocity we have to increase either stroke length or this number of strokes per minute the reciprocating rate how many reciprocation occurs in 1 minute. Now the stroke length is decided by the length of the job. So for controlling the cutting velocity better you control the number of strokes per minute so how do you control it?

Now here you see that when the power comes from the motor through this one, there is a gear box. There is a gear box this gear box called speed gear box by operating the cluster gears with the help of levers, we can increase or reduce the number of strokes per minute or speed and feed how do you control feed? We control by controlling the length of this one the extrinsity. Thus we will control the amount of oscillation and the amount of rotation of this feed lid feed drawn or movement of this one and again this tool can be moved downward also by operating this wheel or this bed can be raised as and when required for vertical feed or for you know placing the job appropriately with relative to tool by rotating this wheel. So when you rotate this wheel, this wheel gears will cause rotation of the screw and the nut will move. This nut is a part of this whole thing and the whole bed will move upward or downward depending upon the direction of rotation. So all these things are the particle for the shaping machine. Now kinematic system of and working principle of planing machine: How does planing machine work?

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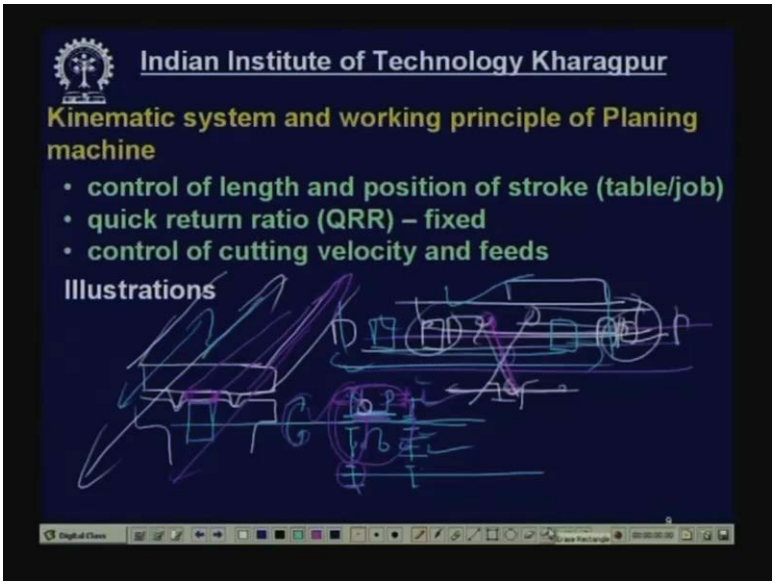

Planing machine: Suppose this is the table. This is the work table which has got big projection and then it is resting on bed and resting on the wheel and this this this is the long one is the bed and this bed reciprocates in this direction okay on this guide. Now how at the bottom surface here suppose this is the bed okay and at the bottom of the bed there is a rack. A rack is fitted a long rack is there at the bottom and that is in mesh with a pinion okay and this pinion is rotated when the pinion is rotated, then this rack will move either in this direction or in that direction depending upon the direction or rotation of this shaft.

Now on this shaft there are gears. Suppose there is 1 gear large gear and there is 1 small gear like this okay and they are loosely mounted and there is 1 idler and there is 1 gear there is 1 gear this is this is shaft. Now here you see, there are 2 gears only 1 and 2 and there are 3 gears one two one idler is there and so one one idler is there and this three. So the direction of rotation of this gear and this gear are different. Now when these two gears will rotate, this shaft will not rotate but if there is clutch suppose there is a clutch and this move can move is connected with this with a spline connected with the shaft. So when this clutch will be engaged with this gear then this will rotate in a particular direction when this will move in this direction then the direction of rotation will change.

Now how will you get quick return effect? This is small this is large gear. So the shaft will rotate at lower speed so this will be engaged with this one for the cutting stroke that means when this will go in this direction that is called cutting stroke and when in the return stroke this will be connected with this one here this clutch and than this is rotating faster. So, the return will be much faster, and this clutch will be operated by some mechanical no locks or stops. Suppose this is the table this is the table and that is moving on the bed. On the bed there is a lever like this and there are mechanical stops here this is fitted two pieces. Now this end with be here, this end will be here. So when this table will move along with the job, this will strike here and this will incline like this and when this will strike here, this will get inclined like this that means these two stops will strike here and this end will move either

this way or this way. When this will move in this way then it is a cutting stroke when this move in this way then immediately the return stroke will stop.

So these two stops will control the direction of travel control travel and how to control the length of travel by the distance? These two stops can be put here or here with a larger gap or closer and that will decide the length of stroke. How will you decide the position of stroke? Position of stroke: This one you can shift it here this one you can shift it here without changing the gap so by shifting the position of these two, we can change the position of stroke and by changing the gap between these two stops, we control the length of stroke. This is how it is actuated and then the feed motion.

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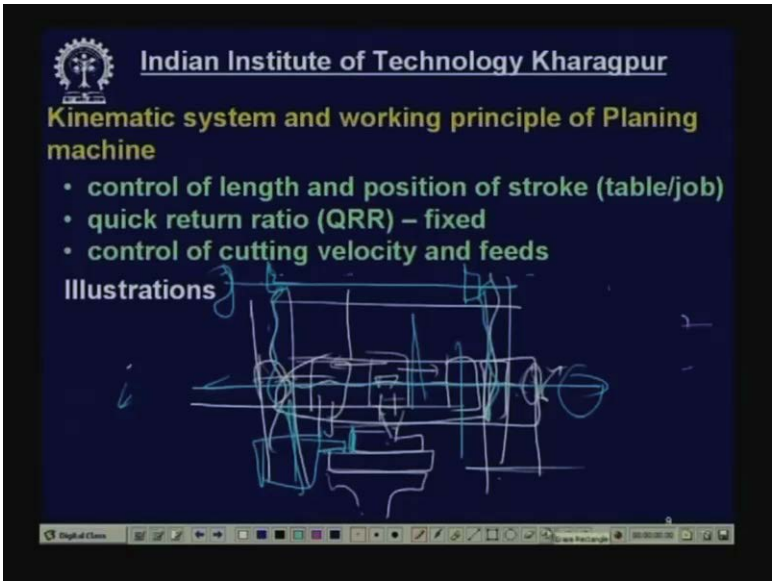

The feed motion this is the tool suppose this is the tool in a planing machine. This is the cutting tool and this is the work piece mounted on the table and that moves on a guide bed and this is the mount on the table. Now there is a screw okay and when the screw rotates there is a nut. So when the screw rotates then this will move in this direction or in this direction and this rotation is this is connected to the movement of the table. So when the table moves reciprocate this also intermittently rotates by 'ratchet pawl' mechanism and there may be number of tools 2,3 number of tools and this one is mounted to 2 vertical levers and this entire thing can be moved by set of screws upward. So the cutting tools can be moved in this direction in this direction or in this direction horizontally by rotating the screw and the whole thing the tool can be moved upward and downward by rotating the screws all right by a pair of bevel gear here and a pair of bevel gear here this will be rotated. So the whole grill can move up and down and on the rale these two tools or number of tools can move up and down. So there can be tools on the side also from the side which will move up and down and do the machining work at the side of the job. So these are the various you know principles of planing machines. Now see the slotting machine: Kinematic system and working principle of slotting machines:

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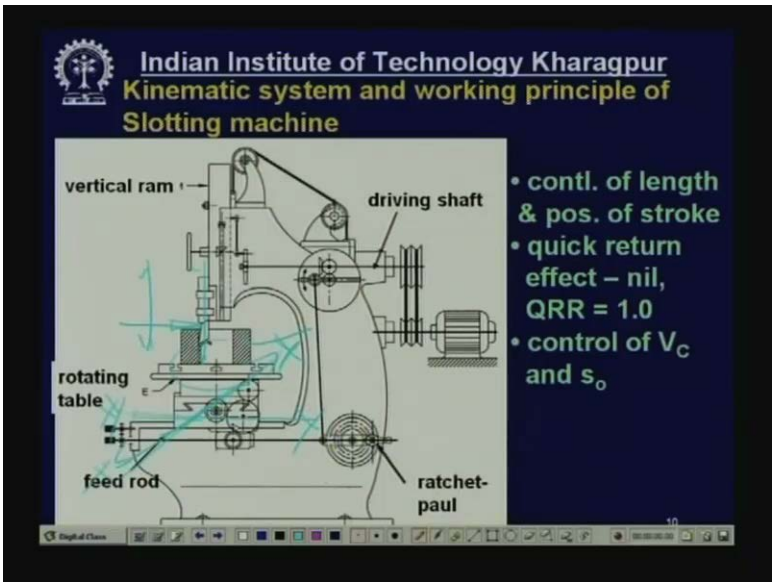

Now this is the configuration of slotting machine. Now again identify or start from the tool. This is the tool okay this is the tool this tool moves vertically up and down. This moves up and down and this is the work piece which is mounted on the table rotary table which is mounted on another block or slide which can move in this direction as well as in this direction. So this is y y and this is x x also you can say this is x x longitudinal and this is y y cross feed and in addition to that the table can rotate also. Anyway so this cutting tool reciprocates just like shaping machine. In shaping machine, the tool reciprocates in horizontal plane but in slotting machines in vertical plane and the work piece moves along x axis, along y axis or it can also rotate. Now how these are how the movements are accomplished?

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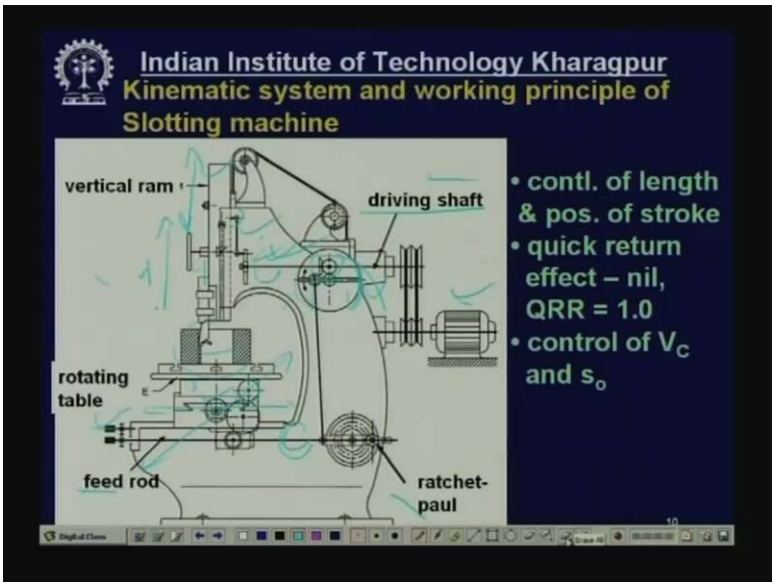

So let us see first how this tool can be reciprocated. Come to the power. This is the source of power then power goes from the belt pulley in to the shaft. What is the most important shaft called driving shaft. On to the driving shaft there is a disk. On the disk there is a slot and there is an eccentric mechanism and there is a cutting rod. So, when this rotates this connecting rod oscillates and this is the cross head which is connected to this top slide. So when this rotate the top slides moves up and down just like crank and connecting rod mechanism there is a cross head and this slide which moves vertically up and down along the guide has got one clapper mechanism in which the tool holder is fixed in to the tool holder the cutting tool is fixed. So when this rotate the shaft rotates this cutting tool moves up and down now rotate this feed motions. Now when this shaft rotates, from the shaft the rotation is transmitted in to this disk by bevel gears when the disk which has got also slots and there is an eccentric mechanism. So there is a one bar, second bar, third bar, forth bar. It is basically a four bar mechanism.

So when this disk rotates this end this lever or this oscillates like this. So, this one also oscillates just like you know the 'ratchet pawl system' we use in shaping machine. So this shaft will rotate this gear will rotate intermittently and that is connected with bevel gear. So this will rotate intermittently. So rotation of the shaft will be transmitted in to rotation of this one but this will rotate intermittently. So when this rotates one this rotates slightly. Now this rotation of the shaft called feed rod is transmitted to another screw called lead screw. Now when this lead screw rotates the entire block moves forward and backward and this is connected. This motion is connected to through bevel gear rotation of this wheel. Now when this wheel is engaged with this wheel which is nothing but a gear fitted in to the screw that gives this table the upper slide x-motion feed motion and when this is engaged with this gear this is connected to the worm that is connected to the worm wheel inside that makes this job rotate all right. So this rotation rotation of this one or rotation of this shaft causing intermediate rotation of the shaft feed rod that causes that helps you can move this one. So this will move forward and backward by a clutch or you can engage this gear with this gear then we get cross feed or when this will be engaged with this worm then because of the worm wheel rotation the job will rotate slowly. So all this three feed motions can be attend.

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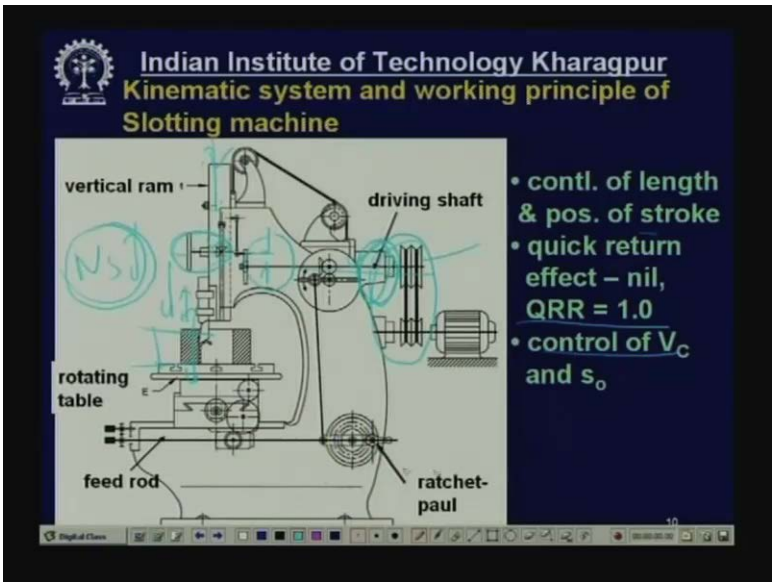

Now have a look in to the controls: Control of length of position of stroke. Now length of stroke: this length of stroke can be controlled by changing this distance this extrinsity but if you increase it, the stroke length will increase than control of position of stroke. Now here this arrangement is very similar to shaping machine by rotating this one, the position of the screw with respect to the nut, this gear behaves as a nut will change as a result keeping this one fixed this ram we have not the ram but the head will move forward or backward. So this way we can adjust the position of tool in advance and then by controlling this one, we can control the length of stroke quick return effect. There is no quick return effect because the mechanism is not oscillating lever mechanism quick return effect exists in shaping machine and planing machine but in slotting machine it is not there. So it is one and control of cutting velocity control of cutting velocity will control will be governed by the length of stroke but that will be decided by the stroke required job and the number of strokes per minute number of strokes per minute that is NS. So this will be decided by that can be changed ah by the rotation rpm of the shaft by changing the gear pulley sorry the belt pulley you can change the pulley or there can be one speed gear box here. To operate to change the speed of rotation that will help changing this one. So this is how this slotting machine works.

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Now the machining applications: this is the most salient part for manufacturing process because we have to produce jobs. So machining applications of this three machine tools of of reciprocating type. I already told that these are the all this threes are suffocating type used mostly for making flat surface and some others features bounded by flat surfaces. Now what are the applications of shaping machine planing machine and slotting machine which will be very similar. Let us see the machining operations done in shaping machines.

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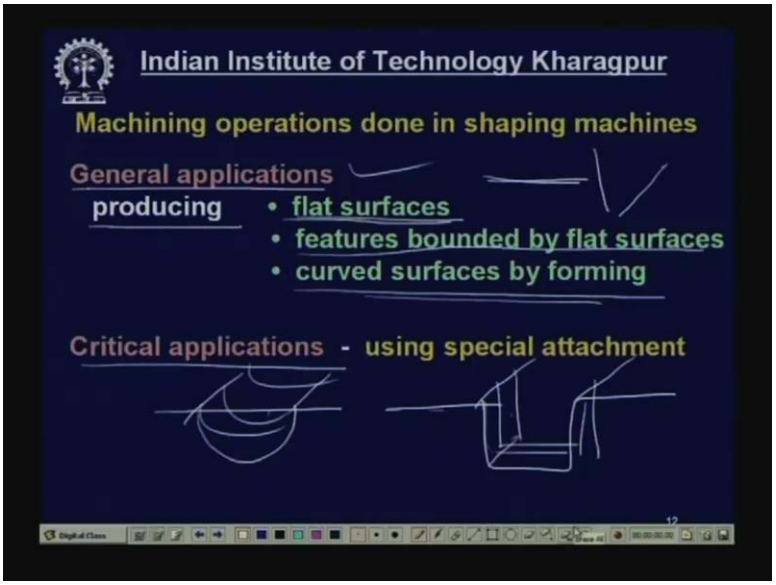

General application: There are two category; General applications and critical applications. These are most common producing flat surfaces all right flat surfaces in horizontal surface

horizontal plane, vertical plane or inclined plane. Features bounded by flat surfaces like a slot. Suppose we want to produce a slot like this. So this slot will be bounded by one surface, another surface and another surface. So three flat surfaces constitute the slot. Curved surfaces; if we want to make a groove like this say it is called curved surfaces by form tools. So these are the various things. Now we shall and critical applications will be shown later on discussed that using special attachments. As I told that shaping machines all the machine tools are used for all this three machine tools for making basically flat surfaces specially shaping machine.

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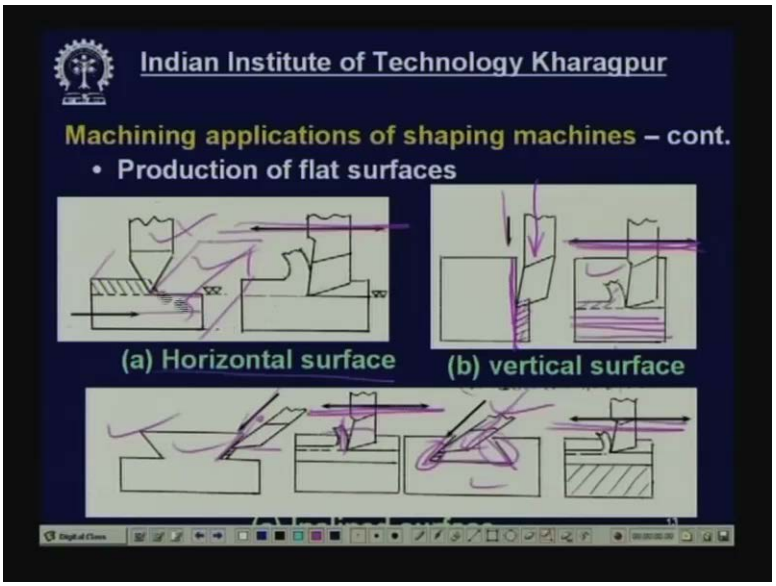

Now machining application of shaping machines production of flat surfaces: Here you see production of flat surfaces. This is flat surface. This is the tool which reciprocates now in shaping machine you can see the tool is always reciprocating in all applications in horizontal the plane. Now, we want to remove this material and make this flat surface on this job. So this is the flat surface okay this is the 3 D and like this. So this is the motion and the job will be fed in this direction will produce this flat horizontal surface then we want to make this vertical flat surface this vertical flat surface. There the cutting tool has to move reciprocating like this and the feed motion will be given to the tool and this will gradually move down and remove this material layer by layer in the form of chips. So first chip, then next chip, next chip and like this all the layers will removed and we get a flat surface vertical this can produce inclined surfaces also.

Here you see these are ductile guide. This is a ductile guide we want to make the surface. So the cutting tool has to be held. So the cutting tool has to be held not in vertical position in an inclined position. So this swiveling is possible in shaping machine. Now, this will reciprocate forward and backward okay. So this cutting tool is held with little inclination, this is called clearance angle and this is the rake angle will be there this is the rake angle has to be there and then this must be moved along this axis, along the surface it has to moved

that is called feed motion but this is the cutting motion internal surface say for the same ductile guide this is the guide this is the slide and we are want to making this want to make the surfaces this has to be done by this and here also the tool will reciprocate and the tool will be held inclined fashion and this is gradually moved in this direction to remove this material similarly here and we get the entire surface machining applications of shaping machine. Next is features bounded by flat surface:

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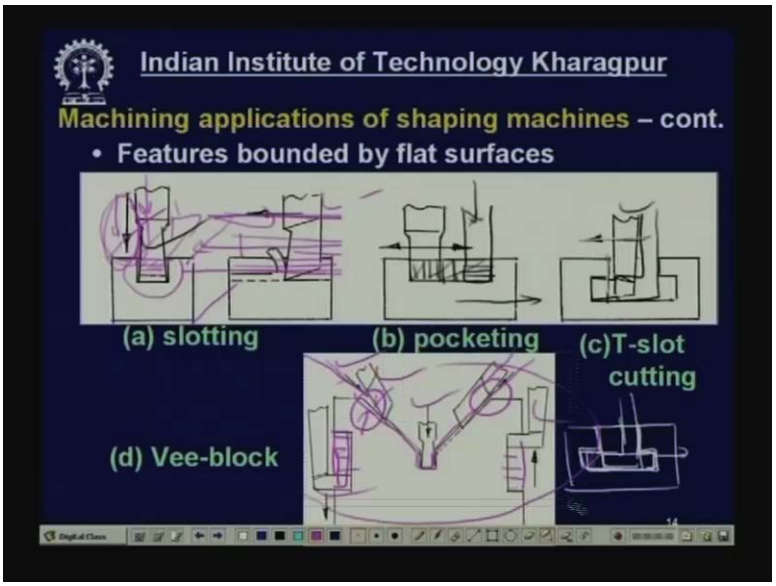

Here you see that these are slot, this is a block, this is the block like and we want to make one slot like this a slot. Now this will be done by the shaping tool and first of all this was flat now layer by layer material will be removed. So this material will be removed layer by layer. So this tool will reciprocate first layer remove a layer than the tool will be moved slightly down that is called feed motion. There is a feed motion then this motion will be repeated you remove another layer so you continue this cutting motion and this motion and than you get the slot remember this feed motion is intermittent and this is reciprocating this is the forward stroke cutting stroke this is the return stroke after the tool comes over here at the end of the return stroke only that this feed motion is given by a little amount and then it remains stop than layer is cut the tool comes back again it is given a feed motion.

Now if you want to produce a pocket like this, now say wider this is the slot. This is the wider slot. Suppose we want to make a part like this like this so a pocket so how do you start? You have to start this is the cutting tool which has to first cut a slot like this like this okay and then this will be removed moving by in this direction given feed and then you travel this job in this direction. So tool will advance and remove this material. So, entire material will be removed. Now this is example of cutting the T slot. This is the T slot in the machine tools and this is the cutting tool which will be first started from here. First this slot will be made. Now let me show you that, suppose this is the work piece okay. So first you make a slot like this, so this slot and then entering the tool. So this is the tool you now move

move the job in this direction that means this tool will gradually enter here, then you reverse it the tool will reverse and make this slot here. So ultimately you get the T slot, this is T slot. So here also this cutting tool is reciprocated in this direction. This is feed and this tool will be reciprocating perpendicular to the axis.

Now this shows making a v block. This is a block what are the surfaces important surfaces? This is one surface. This is the v surface which on machine this surfaces this slots. Now this tool will move in this direction. There is feed motion. Remember the cutting motion is always there perpendicular to the job. This is the moving and because this is the cutting motion. So the reciprocation will be always there. All the tools will move perpendicular to the plane shown over here in this direction and this arrow shown over here, these are all feed motions. So this will be fed in this direction parallel to this. This will be feed in this direction, this angle has to be maintained for clearance this angle for clearance and this tool will make the slot and this tool will gradually move upward and remove this material layer by layer. This can move upward this will also move upward and remove the material layer by layer. So all the surfaces can be produced in this fashion. Machining applications of shaping machine that is machining of curved surface.

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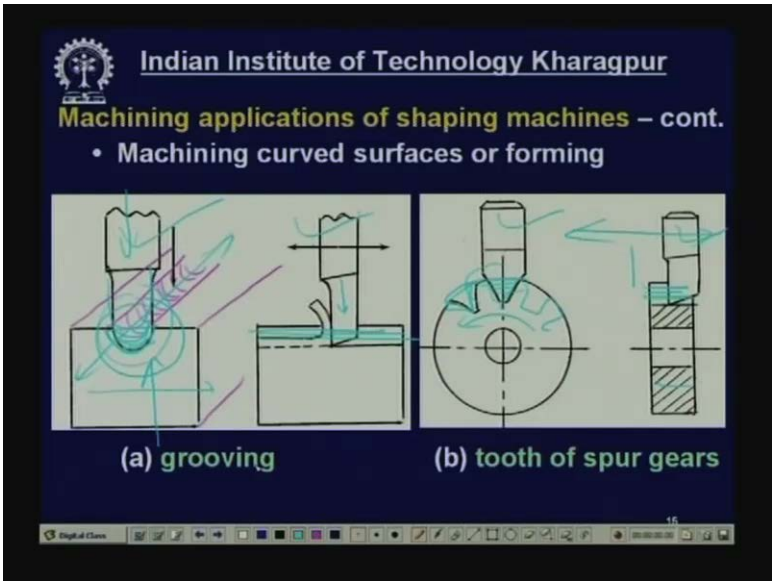

This is a curved surface that means suppose, this is the block in which we want to make one curved surface, a curve groove like this. This can be oil groove or for some purpose. In that case, the cutting tool this has to be a form like this this cutting tool. So this cutting tool starts like this then it will remove the material gradually. This tool will gradually move down layer by layer the material will be removed and this will come to the final position and then this motion of the tool will produce the job. Here the job does not move in this direction. The tool is feed in this direction or job is raised in this direction and you get this form. This is called form and this kind of tool is called form tool okay form tool. Now observe that in shaping machine, planing machine, in slotting machine all this machine tool all the tools are

single point tool only. So productive is much less but it can be form tool or it can be single point tool.

Now here is another example say cutting the teeth. Actually we do not cut the teeth. What we cut? We cut or remove the material remove the material in between the tooth. So this is the cutting tool. This is the cutting tool, this will reciprocate in this direction and this is the work piece held and then this tool will remove gradually move down and remove the material layer by layer layer by layer but the form of the tool will produce the form of the tooth gap. So, this is how now after that this will be rotated by one tooth gap and you can make another tooth. So indexing is necessary. So this is one application of gear making but remember that really the gears are not manufactured. These are manufactured by this machine. This is a very slow working machine only for repairing work one or two teeth can be cut for repair work and maintenance work but not for mass production because the process is neither very productive nor very accurate. Some special applications of shaping machines:

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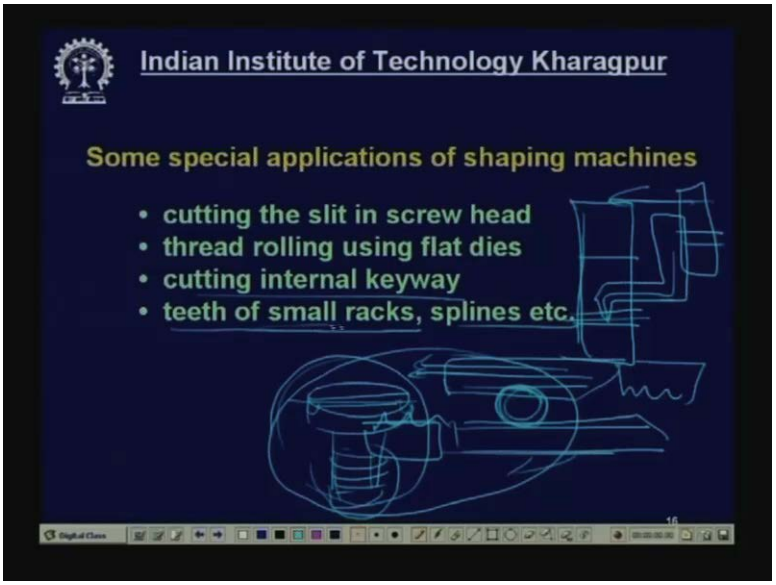

Cutting the slit in screw head: These are these are done using some you know, this is the screw head suppose these are small screws made by some machine and you know there are some slits are made okay for the use of the screw drive, these slits are made in shaping machine and for that one attachment is necessary for quick production. Now thread rolling using flat dies. Now thread rolling so there is a die with a thread and there is a work piece blank and this is another die with a thread all right and this is stationary and this will be moving in this direction and this part this part of the screw will remain inside and when this will move the threads that is here because on the side surface there are threads. Here also there are threads so these threads will produce the thread on this piece. So there will be thread produced and this can be done in shaping machine with a special attachment. Cutting internal keyway. Yes, it can be cut but with little difficulties. Suppose this is the work piece

and this is the gear blank and one keyway had to be cut then the cutting tool has to be like this which has to be mounted. So, this is the shaping head. So this will reciprocate and the cutting tool is a 'l type' that will produce teeth of small racks splines can also be done but these are all external racks rack is always external splines internal not internal external splines I have made. Now come to machining applications of planing machine.

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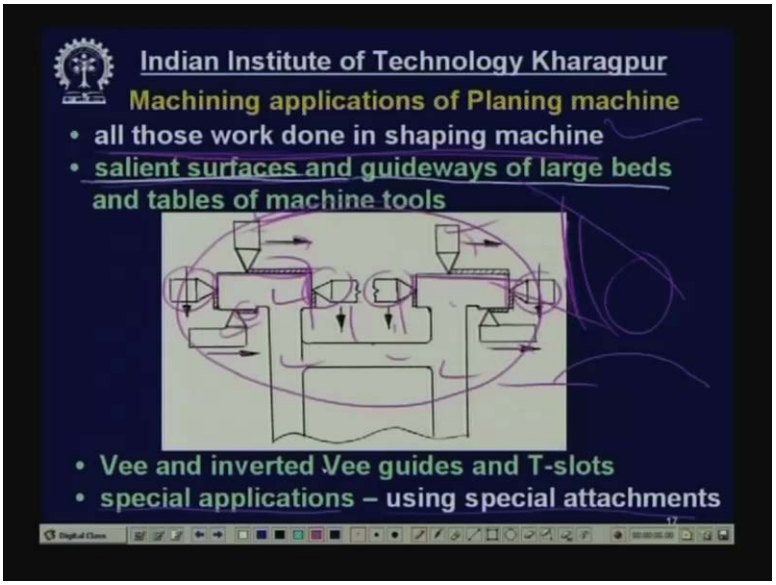

Here suppose this is what I have done in planing machines. All those work done in shaping machine can also be done in planing machine salient surfaces and salient surfaces and guide ways of large beds. Now this is example. This is this is you know a bed of a machine. Now this surface this surface this surface are to be machined okay this surface are to be machined. Now this is such a big job may be 2,3 meter long have to machined in shaping machine this one. This this tool this two tools and this two tools four tools will move will reciprocate for the cutting action perpendicular to the plane but it will feed motion in this direction. All of them will move simultaneously and remove this material and make these surfaces flat.

This tool, this tool and these four tools will move vertically down all of them simultaneously and they will produce the flat surfaces. So this way many many you know applications are there for making the beds or tables or machines tools are done in this way salient surfaces and good tables. Now vee and inverted vee guides are also T slots also made in say planing machines. Special applications using special attachments can be done say some curved surface can be made. Some you know if there is a rod, in the rod if you want to make a helical groove, then that can be done in a planning machine with special attachments that you can see, book. Lots of example are given. Now come to machining applications of slotting machine.

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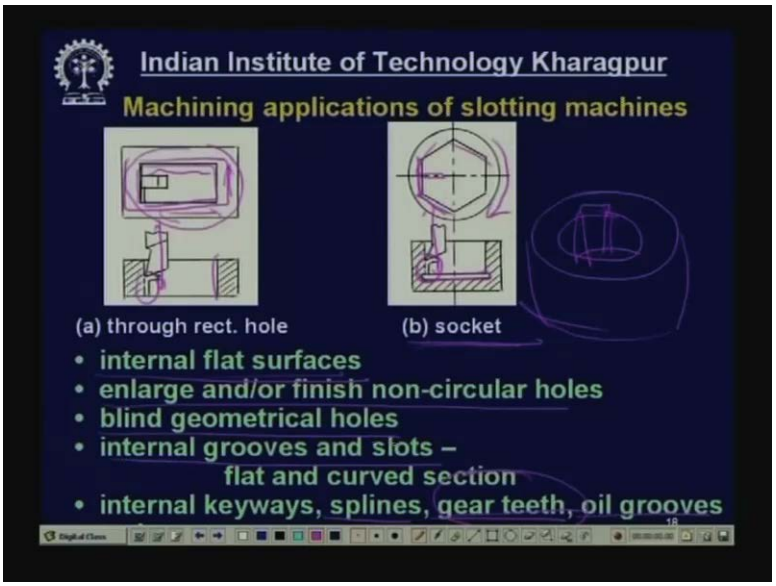

In slotting machine the work is vertical always. So this is the job. The tool is reciprocating the tool is reciprocating in the vertical direction all right and that is removing this material. So this is a block were the rectangular slot has to be cut bounded by four flat surface but vertical flat surfaces. So, this will move in this direction and the job will move either in this direction or in this direction gradually. See this is one application. So internal flat surfaces most of the work are internal which cannot be done in shaping. Now enlarge and finish non-circular holes. See these are non-circular holes. If you want to finish or enlarge then this is the process.

Now making blind geometrical hole; this is hexagonal hole and up to this much not through, this is the socket basically the socket used to operate nuts and bolts. So this can be done by moving this tool vertically up and down and there is research made in advance so that it does not disturb and this is the material removed. After removal, the finishing this surface the tool will be withdrawn and the job will be indexed by say one sixth of a revolution and this surface will be brought here. So in though in this way all the surfaces will be made. The tool will be in one position but the job will be rotated internal grooves and slots internal grooves and slots suppose this is a this can hole, so you want to make a slot here. Say keyway, then internal keyways splines gear teeth yes internal gear teeth can also be cut but in small scale either one or two pieces. Oil grooves all are internal.

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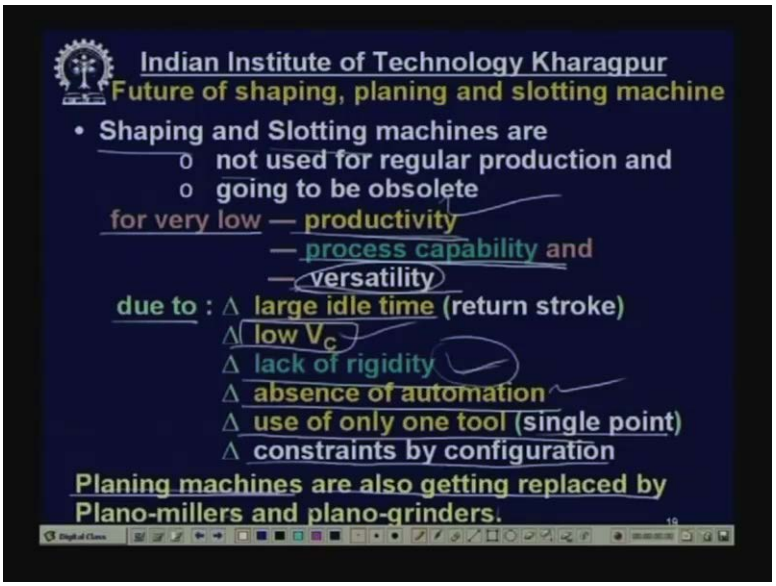

Now future of shaping, planing and slotting machine; this has to be done because we have already covered lathes which are productive machines and drilling machine, milling machine. These are all productive machines used for batch production, piece production, lot production but shaping and slotting machines specially are not used for regular production and going to be almost obsolete because of their poor performance. Why because they are for very low productivity. Productivity is very low process capability accuracy is also very low. Versatility range of activity is also very limited but why are they so? Due to why the productivity is low? Due to large ideal time return stroke is ideal so huge of wastage of time no cutting in velocity because it is a stroke like, you know impact like so velocity cannot be high lack of rigidity of the machine tool. So we cannot give large feed large depth and the job will undergo deflection, deformation. So both productivity and process capability will be lost.

Absence of automation that also reduces with the productivity use of only one cutting tool at a time the in shaping and planning, shaping and slotting a single point tool that reduces the productivity and constraints by configuration also you know do not allow versatility. Now planing machines; these are little more versatile and more productive than shaping and slotting machine because they are raged and rigid and many operations can be done but planing machines are also getting replaced by plano millers and plano grinders instead of single point tools milling milling cutters large number of milling cutters if required grinding wheels are also used for finishing. So, single point tools used in shaping, planing machine are becoming obsolete. All shaping machines are now converted or from inception. Plano millers and plano grinders are used shaping machine using single point tool are becoming almost obsolete.

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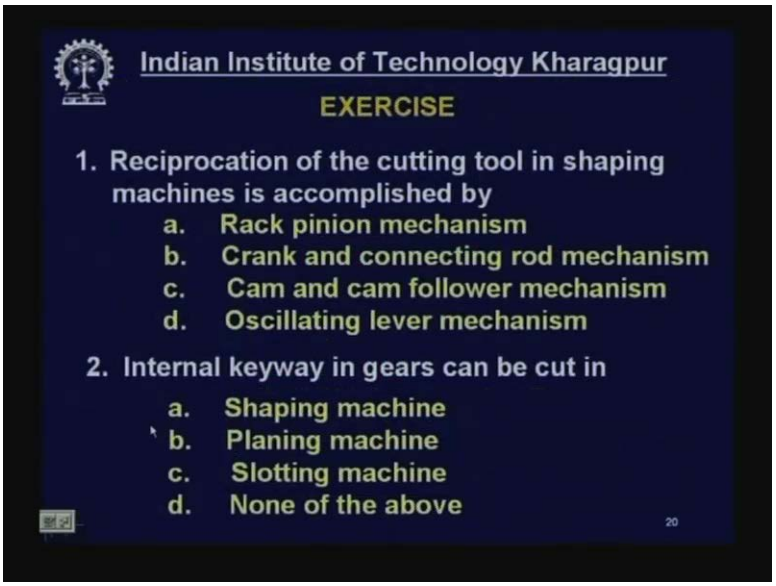

Now after going through this lesson you can practice I have give some exercise, 10 exercise these are like this. There are four options and you have to select one of the correct answer say reciprocation of the cutting tool in shaping machines is accomplished by which one? So there are four options. You have to select the correct one. Now look so reciprocation of the cutting tool in shaping machine. Now rack pinion mechanism no, that is for planing machine crank and connecting rod mechanism no, that is for slotting machine. Cam and cam follower mechanism no, oscillating lever mechanism yes, so you have to tick select. So this way internal keyway in gears can be cut. There are four options, internal keyway in gears okay this is a internal work. So be careful can it done by shaping machine, planing machine, slotting machine. None of the above you understand that slotting machine is the answer.

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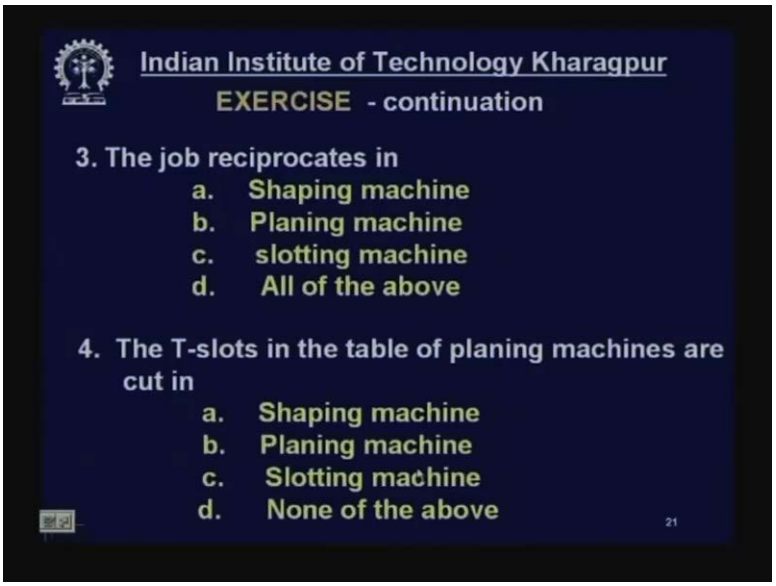

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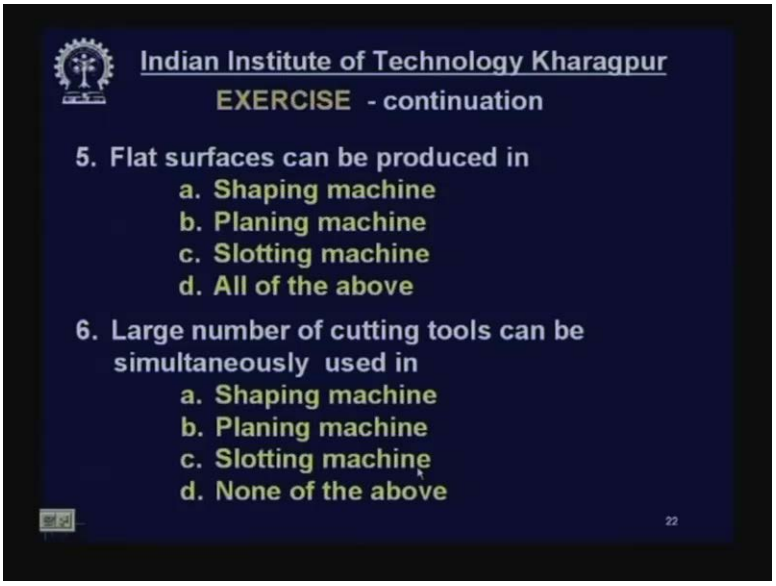

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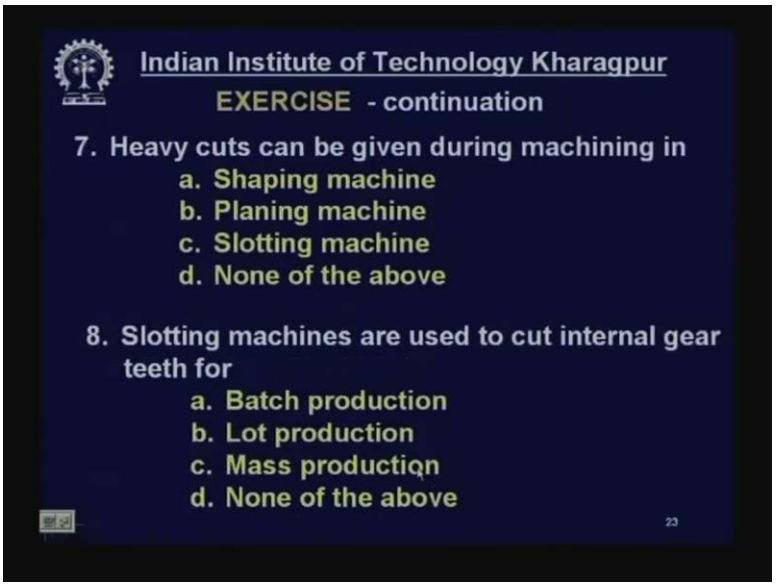

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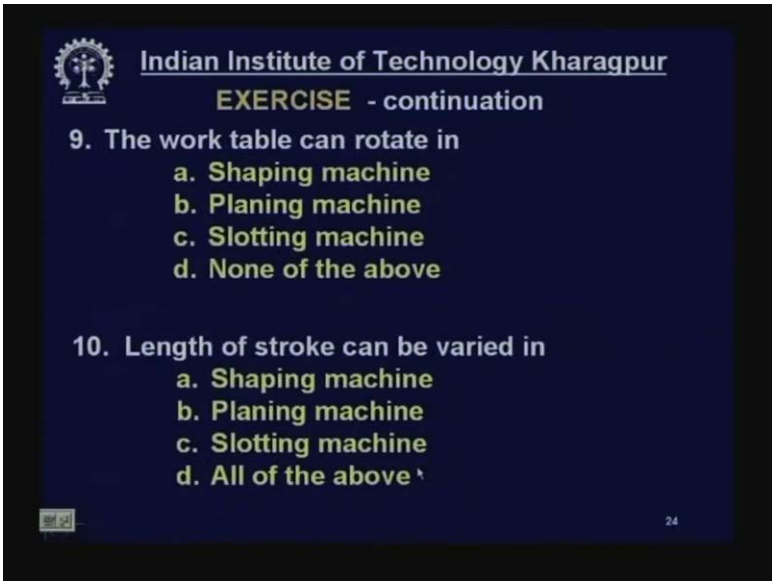

Now this way you can practice all this ten questions and all the answers will be given in the next lecture. So you can check your answer from the next lecture okay.

Thank you.

Preview of the next lecture

Lecture No. 21

Mounting of jobs & Cutting Tools in Machine Tools

Now we are going through Module- 4 that is general purpose machine tools and now lecture - 4.5:

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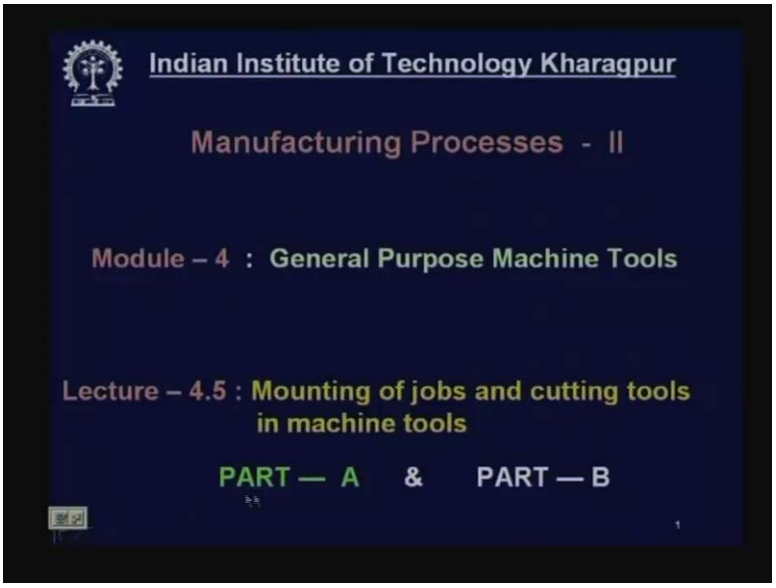

Mounting of jobs and cutting tools in machine tools. This will be taken in two parts; part A and part B. Today in this lecture we shall cover part A. In the next lecture we shall cover part B because it is a bigger course. Now the specific instructional objectives as a whole of this lecture material.

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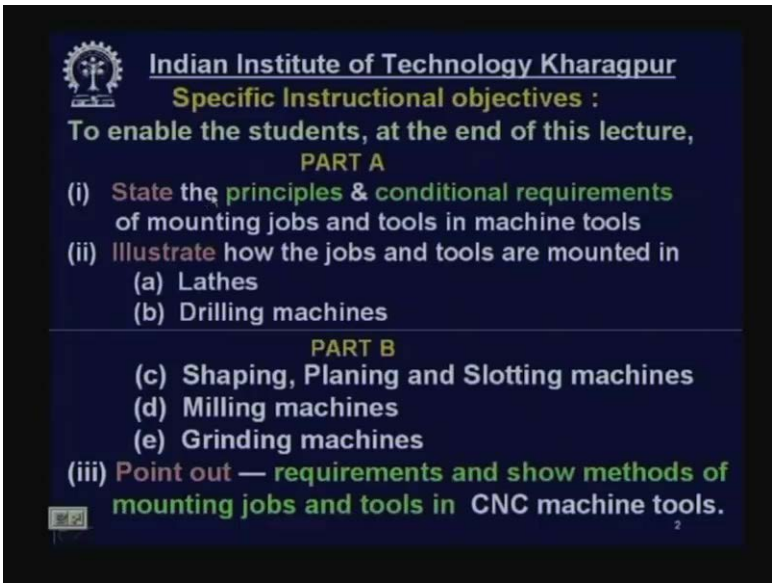

This will enable the students, state the principles and conditional requirements of mounting job and tools in machine tools. Now here you see that the performance of machining system is very much affected by or indirectly you can say that the perfection of mounting of job and the tool play very important role on the perfection of the working of the machining system. Therefore if you want very good machining performance from the system then the cutting tools and job have to be mounted very carefully, judiciously, methodically and accurately. Now this part A states the principles and conditional requirements of mounting jobs and tools. In machine tools this conditions have to be fulfilled to get good performance for a machining system. This course will also enable this lecture illustrate how the jobs and the tools are mounted in different machine tools like lathes, drilling machines. Now up to lathe and drilling machines will be covered in this lecture. In the next lecture, we will will be covering part B shaping, planing and slotting machines like reciprocating machines, milling machines and grinding machines. Then next, it will also cover point out requirements and show methods of mounting jobs and tools.

Thank you.