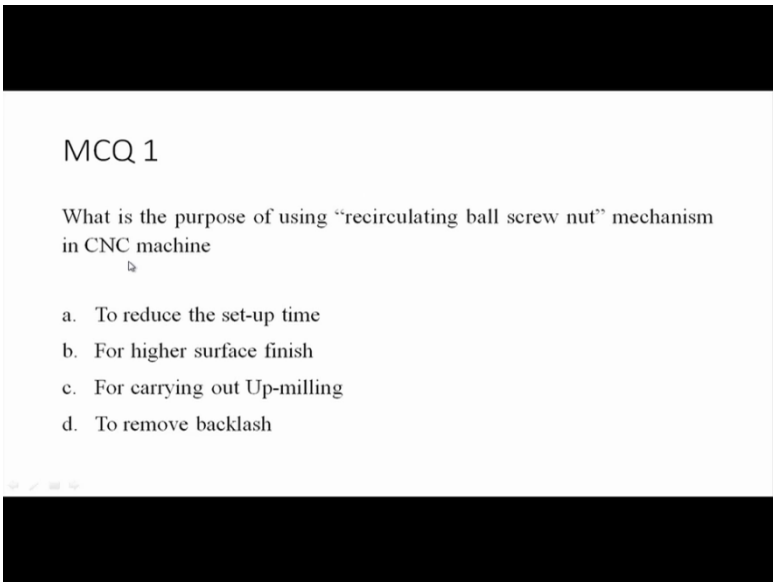
Computer Numerical Control of Machine Tools and Processes
Professor A Roy Choudhury
Department of Mechanical Engineering
Indian Institute of Technology Kharagpur
Lecture 10
Questions MCQ Discussion on Motors, Encoders, Decoders and Programming Practice

Welcome to the 10th lecture in the open online course "Computer numerical control of machine tools and processes". So in this lecture after having finished 9 of the initial lectures, we will have some discussion, multiple-choice questions and numerical problems on the last 4 lectures. We have already completed several numerical problems in these 4 lectures and therefore, multiple-choice questions which have not been discussed to that extend in the previous lectures, we will pay special attention to those in this particular lecture, so let us go right ahead.

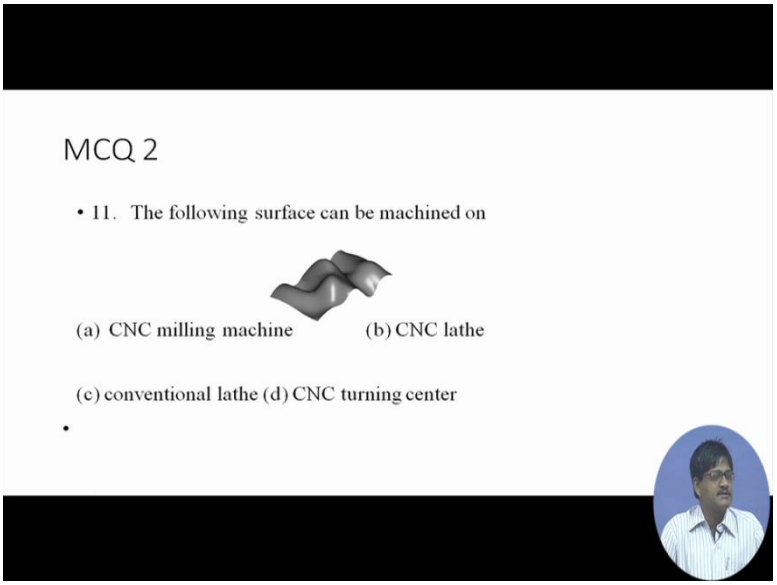
(Refer Slide Time: 01:19)



Question number 1, so what is the purpose of using "recirculating ball screw nut" mechanism in CNC machine? To reduce the setup time, for higher surface finish, for carrying out up milling and to remove backlash. To reduce the setup time perhaps this is not very obvious, is not it? So there is no real correlation between reduction of setup time and using recirculating ball screw, so first option no, that means option A no, for higher surface finish no, for carrying out up milling. Now up milling and down milling are two processes in which the direction of rotation of the cutter and the direction of feed of the cutter, they are different I mean the combination is different.

It is in down milling that it has to be ensured that the machine feed screws should be completely free of backlash, so if we are talking about up milling, the question of having recirculating ball screw mechanism to ensure that up milling can be carried out is not correct, so to carry out up milling is not the correct option. Last option is to remove backlash and this is correct, so option D to remove backlash is correct.

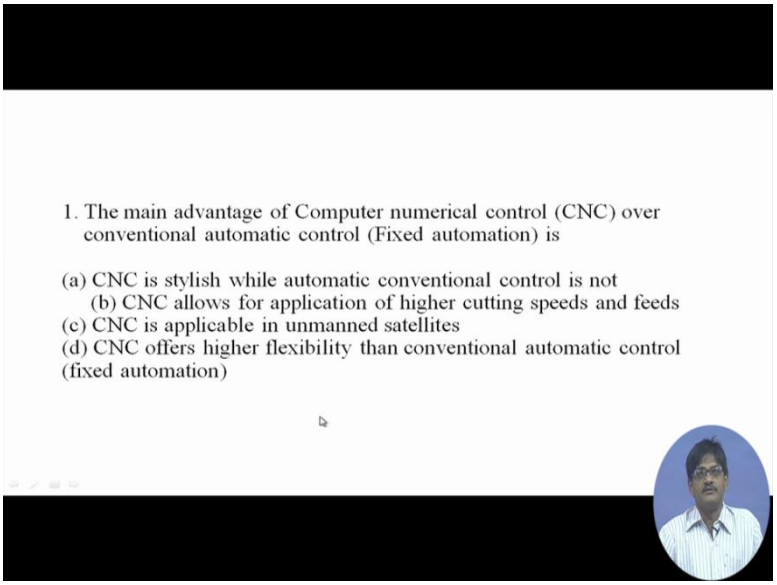
(Refer Slide Time: 03:14)



MCQ2, the following surface can be machined on… So what is your surface like? The surface is an even, smooth but the surface is having undulations and they are irregular undulations and this sort of a surface is referred to as a free-form surface. So we have the application of such surface as in engineering practice? Yes we might have a car body which is not a regular surface, it can be different in different cases, it may be smooth but it may not have regular geometrical or what you call it regular mathematical mathematically defined features on it, it might be having irregularities or a dye surface. So it can be machined on a CNC milling machine, a CNC lathe, a conventional lathe and a CNC turning center.

Among these machines, the last 3 that means B CNC lathe, conventional lathe and CNC turning centre, these are all generally producing surfaces of revolution and therefore, they cannot produce such an irregularly shaped surface, so the correct option is CNC milling machine.

(Refer Slide Time: 04:59)



The main advantage of computer numerical control over conventional automatic control which is referred to sometimes as fixed automation is, so the advantage of CNC over fixed automation is being asked for. 1st option is CNC stylish while automatic conventional control is not. And then B: is CNC allows for application of higher cutting speeds and feeds. C: CNC is applicable in unmanned satellites. CNC offers higher flexibility than conventional automatic control (fixed automation). So 1st of all comes the question, what do we consider as an advantage. We consider as advantage some feature of CNC machine which is desirable in certain machining situations and which is not present with fixed automation.

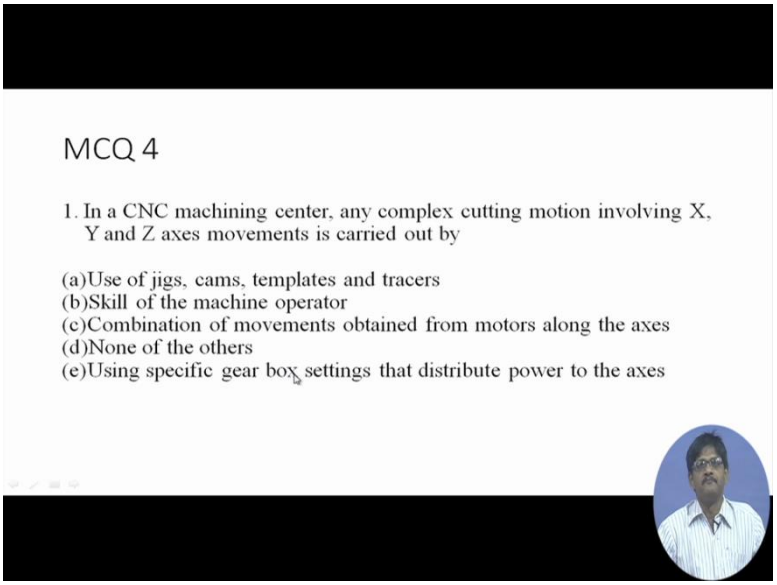
So, let us see CNC stylish okay CNC might be more stylish in some way; some people might be finding it more glamorous and stylish than conventional control, but it will in no way matter when say the product quality is being considered, so the 1st option is definitely not correct. CNC allows for application of high higher cutting speeds and feeds. However, higher cutting speeds and feeds can only be achieved if there is certain improvement in cutting tool materials and in certain combinations of cutting tool materials and work piece material which will permit the adoption of such speeds and feeds. CNC has way nothing to do with those combinations so this is also not correct, so we have dropped 2 options.

3rd is CNC is applicable in unmanned satellites, okay. Maybe yes, CNC is applicable in unmanned satellite and it is better than fixed automation but there are 2 points to be considered here. Is this the main advantage of CNC over fixed automation? No, because we might not at all be concerned with unmanned satellites but still we would consider CNC to be having some advantages over fixed automation, so it is definitely even if there will be some

advantage, it is definitely not the main one. Secondly, CNC is applicable in unmanned satellites, but fixed automation might be equally applicable in unmanned satellites, so this statement to start with might not be correct, it might be misleading, wrong, so 3rd option is also dropped.

CNC offers higher flexibility than conventional automatic control. Yes, this can be considered as the main advantage because in situations where we have low volume of production, there this is the main advantage of computer control over fixed automation, so the option D is correct. By the way, it is considered to be an advantage in the previous case let us go back, it is considered to be an advantage because since the since a specific part is being made in a small lot or batch say 50 pieces and after that you have a different part design being selected in machine, so it is easy to change over from part 1 to part 2 in case of CNC because we need only change few lines in the program or just select a different program itself. So change over difficulty is in change over from one part design to another is much less in case of CNC.

(Refer Slide Time: 09:32)



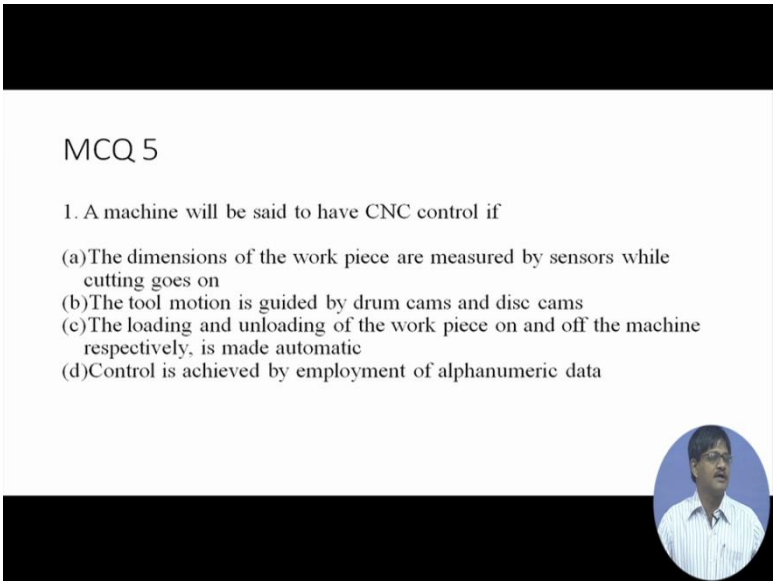
In a CNC machining centre, any complex cutting motion involving X, Y and Z moments is carried out by… So that means we are talking about the CNC machining centre now, which we have learned about in classification. Any cutting motion involving X, Y and Z axis axis movement is carried out by… Use of jigs, cams, templates and tracers. B: skill of the machine operator. C: combinations of movements obtained from motors along the axis. D: none of the others. E: using specific gearbox settings that distribute power to the axis. So 1st one, use of jigs, cams, templates and tracers, that some physical devices are being referred to

and these physical devices are not actually present in CNC machining centres or for that matter any CNC machine, so first is not correct.

Skill of the machine operator, definitely not because human intervention is the least in CNC machines, they are basically automatic machines. Now, combination of movements obtained from motors along the axis, yes this is a good candidate, but let us check out the other option as well. None of the others, and last of all using specific gearbox settings that distribute power to the axis. So this means that if I am having a motor, from that motor I am deriving power and through a gearbox maybe I am getting a particular RPM 2X that RPM multiplied by 2 to Y and that RPM multiplied by 3 to Z, so that means specific discrete combinations of rotations per minute may be available in the different axis, but that is it, nothing beyond that.

If you want another ratio to exist between the axis velocities, you might go for a different gear combination setting gear setting might be going for a different gear setting, but that is it you have discrete options before you. If you want to go for something in between or if you want to change that gear setting while during a cut, you do not have those options through option E, so that is definitely not the case with CNC machines, so this is also not correct. Therefore so only C seems to fit the bill, so combination of movements of obtained from motors along the axis. The motor rotates; produce a particular ratio of speed along axis and that defines the motion which takes place ultimately in space.

(Refer Slide Time: 12:45)



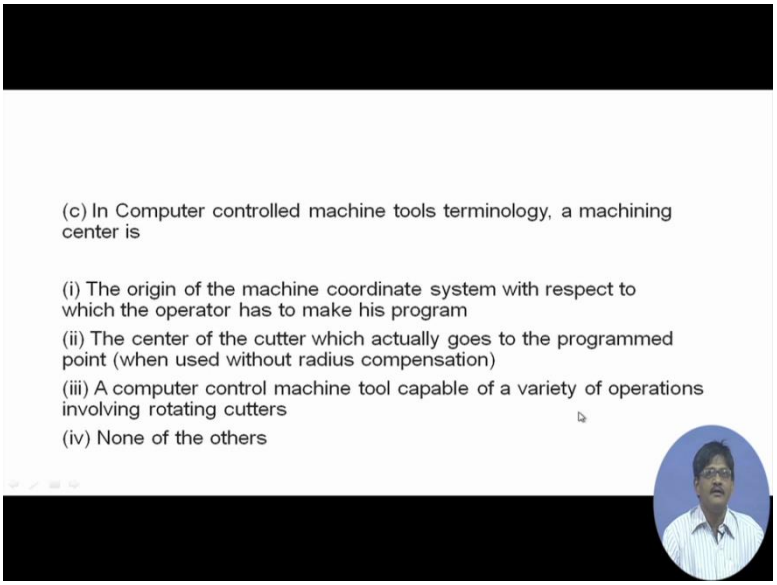
A machine will be said to have CNC control if… The dimensions of the work piece are measured by sensors while cutting is going on, what does it actually mean? It means that

some kind of online monitoring is taking place of the part quality, so now is this CNC really? No, it is basically online monitoring. That part of the measuring exercise might be CNC, but the machine is in no way CNC if this is being carried out. So, second option is the tool motion is guided by drum cams and disc cams. So it is suggesting that some physical devices are guiding the tool, no this is not CNC. Cams are physical devices which can guide the tool through its motion cycle.

Then comes the loading and unloading of the work piece ON and OFF the machine respectively is made automatic. Now, machine might well be CNC even though loading and unloading of the job might be manual, generally those machines are referred to as semiautomatic machines and therefore, the actual machine movements have not been explained in C and they have not been made clear and therefore, only the aspect of loading and unloading becoming automatic does not render the machine CNC, so not even C. Last of all D: control is achieved by employment of alphanumeric data. This fits the bill because alphanumeric data in the definition of CNC you will find.

In some way we are removing physical devices and bringing in instructions in the form of codes or letters or numbers or signals okay, some sort of basic language communication has been talked of instead of physical devices. You can tell a person that I do not like you or you can hit him on the head with a club. I do not like you stand for CNC, while hitting in stands for communication of information through physical devices.

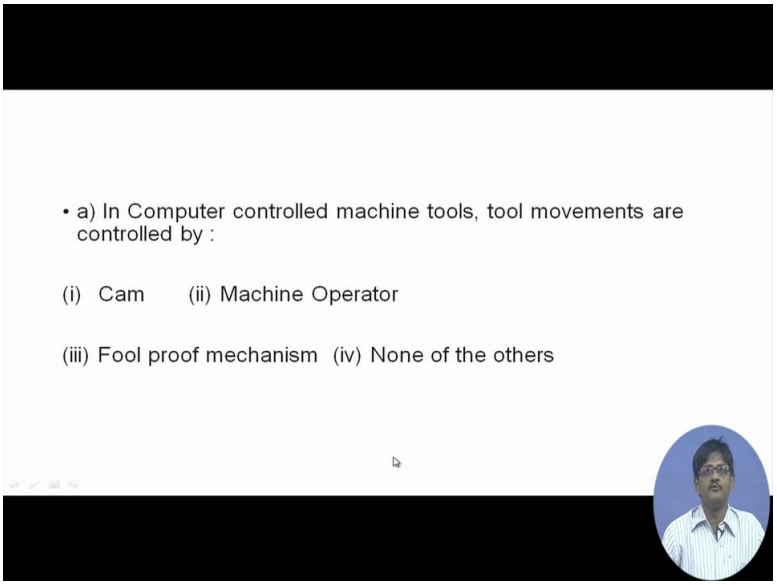
(Refer Slide Time: 15:22)



In computer controlled machine tools terminal clergy, machining centre is… A: I mean option 1: the origin of the machine coordinate system with respect to which the operator has to make his program, so this refers to the origin of the machine coordinate system, absolutely not. Origin of machine coordinate system is a particular physical quantity X, Y, Z coordinate value in the coordinate system, it is nothing to do with the machine, it is the machining centre which is a machine tool essentially, so 1st option is incorrect.

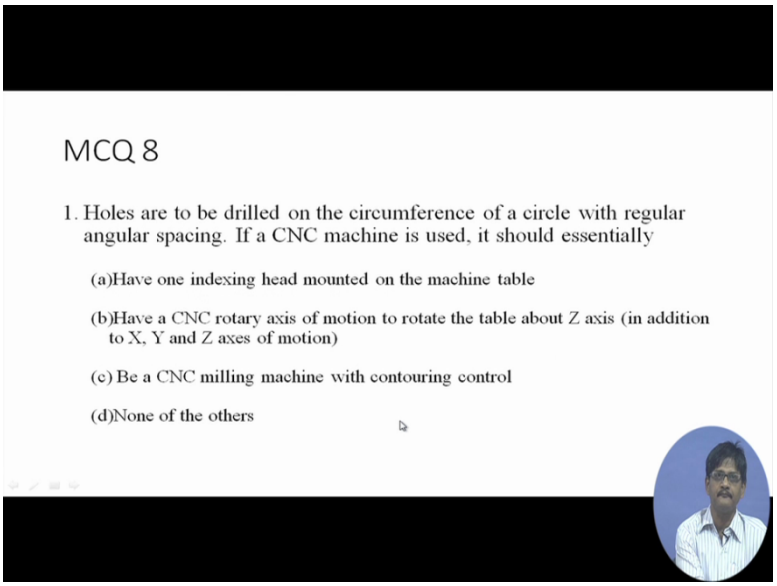
Then the centre of the cutter which actually goes to the programmed point when used without radius compensation. So the centre of the cutter, say the drill center the milling cutter, if it is say an end mill, the centre point of the milling cutter axial point, no this is also has nothing to do with the machine tool. Then a computer-controlled machine tool capable of a variety of operations involving rotating cutters that is it this is the definition of the machining centre, so "none of the others" is not correct, number 3 is correct.

(Refer Slide Time: 16:46)



In computer-controlled machine tools, tool movements are controlled by… Cam, machine operator, foolproof mechanism, none of the others. So it is obvious, Cam is a physical device, machine operation human intervention, foolproof mechanism means a mechanism which is present in conventional manually operated lathes and definitely it is not so, so none of the others is the current answer here.

(Refer Slide Time: 17:16)



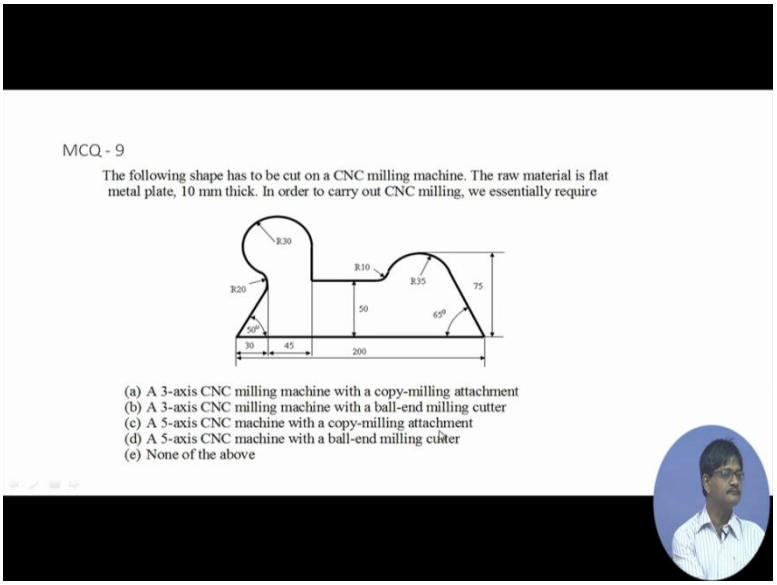
Holes are to be drilled on the circumference of a circle with regular angular spacing, that subroutine we had done, So if a CNC machine is used it should essentially… Have one indexing head mounted on the machine table in order to carry this out, and have a CNC rotary axes of motion to rotate the table about Z axis, so it is asking for a rotary axis in addition to

X, Y, Z motion in order to carry this out, and be a CNC milling machine with contouring control circular circumference for circles has number of holes, so maybe it should be a milling machine, so that circular interpolation is possible and you can reach those points by circular interpolation and carry out those drilling operation in those respective places, and none of the others.

Well the 1st one is not correct, we have learned in the program that instead of rotating the job physically, we are rotating the coordinate systems physically, so A is a out. B: have a CNC rotary axis of motion to rotate the table, absolutely unnecessary so B is also out, we are doing everything virtually inside the memory. C: Be a CNC milling machine with contouring control, now what is that? Why do we need to move by circular interpolation through those holes? We can just reach those holes as we know their coordinate positions, circular motion as such is not necessary.

And point-to-point machines are those machines in which once you reach the end point, everything is I mean the path is not important, you need not necessarily move through those points in a circular manner, you just have to attain those positions okay, so none of the others is the correct answer here.

(Refer Slide Time: 19:23)

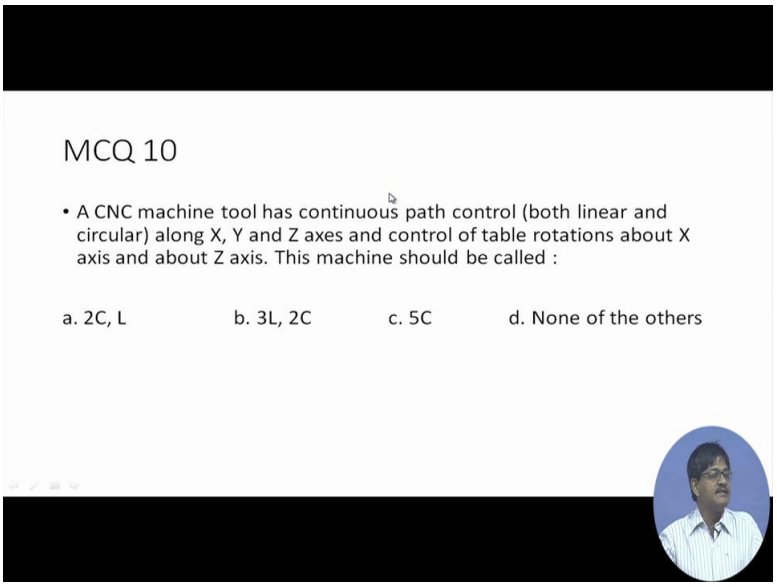


The following shape has to be cut on a milling machine; the raw material is flat metal blade 10 millimetres thick. In order to carry out CNC milling we essentially require… What do we require? We require okay we require circular interpolation, we require straight-line interpolation, all these things are required in 2 axis okay, and the 3rd axis need not have

circular interpolation facilities. It can have linear interpolation so that it can linearly begin to the cut and start it. So the options are a 3 axis CNC milling machine with a copy milling attachment, no we we are not going to copy anything because we are going to program for it, so 1st is out, A is not the correct answer.

Then comes a 3 axis CNC milling machine with a ball-end milling cutter, now what are we going to do with the ball ended milling cutter, ball ended milling cutters are generally used for free form surfaces, so this is also out. Next is a 5 axis CNC machine with a copy milling attachment, out, why 5 axis; As we have discussed, only 2 axis continuous control with the 3rd axis linear that is enough, so the correct answer is "none of the above". Now you you are finding in many of these MCQs I am putting none of the above why is it so? It really tests out your confidence.

(Refer Slide Time: 21:12)

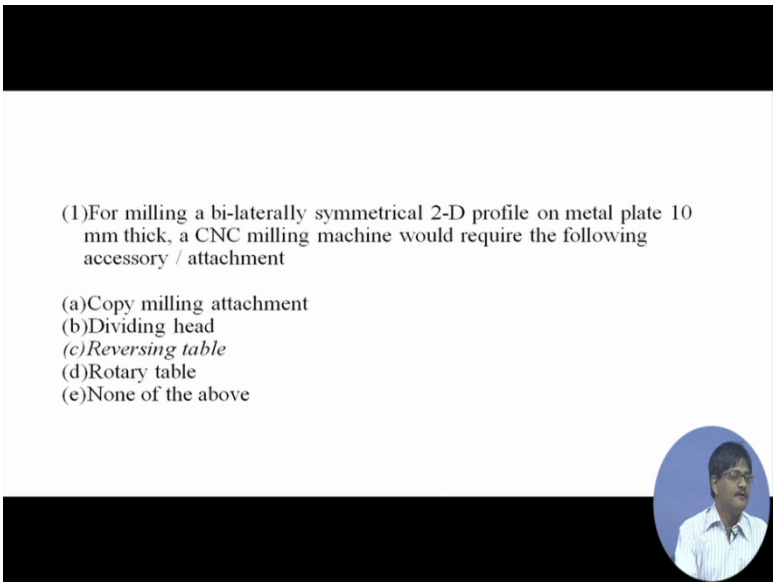


A CNC machine tool has a continuous part control both linear and circular along X, Y, Z and control of table rotation about X axis and Z axis, so we are talking about both linear and circular interpolation possible for X, Y and Z and control of table rotations about X axis and about Z axis, so the machine should be called… First: 2C, L why 2C, L? Because obviously we are 1st talking of 3C and then 2 other axis as well, from that judgment A is out. Then we are saying 3L, 2C, but why 3L? It is specifically mentioned that X, Y, Z they are supposed to have continuous path control both linear and circular, so B is out.

C: 5C, 5C seems to be possible because X, Y, Z, they are contributing to 3C. Together with that circular axis of rotation that means rotation about X and about Y if they are possible

okay, then we consider them to be individual C or continuous axis, so 5C is possible I mean correct, and none of the others, no. Of course here is slightly ambiguous that whether this control of table rotation is done at a controlled rate or not, we have not mentioned it, so this ambiguity is there, it should be mentioned in order to remove any doubt. So considering that this table rotation is fully controllable extent wise and velocity wise in that case we will say that 5C is correct that means C is correct.

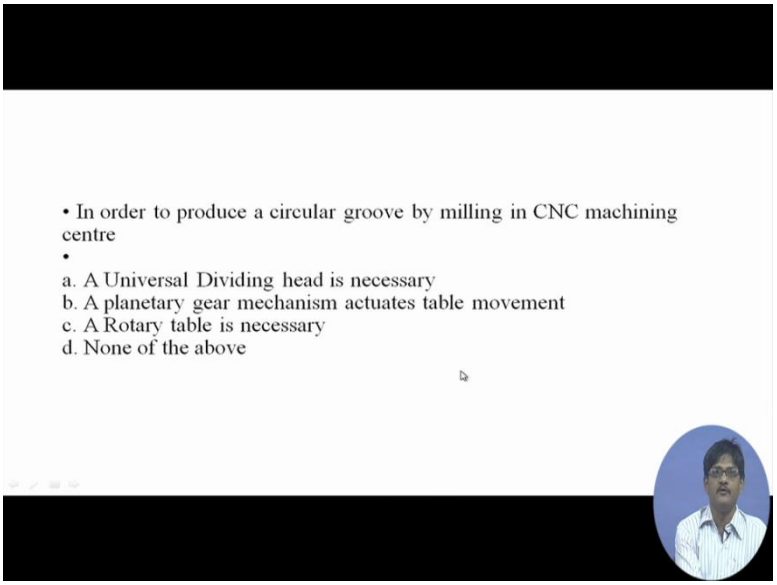
(Refer Slide Time: 23:31)



Next; for milling a bilaterally symmetrical 2-D profile on metal plate 10 millimetres thick, so we have a bilaterally symmetrical path now. A CNC milling machine would require the following accessory or attachment; let us see. Copy milling attachment is out, it is a physical device. Dividing head is out, it is a physical device. Reversing table that means you do one side and possibly reverse it and do the other side okay let us see, and rotary table okay you can perhaps rotate it and do the other part automatically perhaps that way and none of the above. So it is written, it would require that means it essentially requires otherwise, it cannot do it this is the meaning.

Is it possible that if I do not provide you with these pieces of equipment, does it mean that you cannot do the 2-D profile which is bilaterally symmetrical; no. You can straight cut ask for mirror imaging, or you can simply do the other side painstakingly writing all the lines of programs, so both are possible, so that way, this is having the answer none of the above.

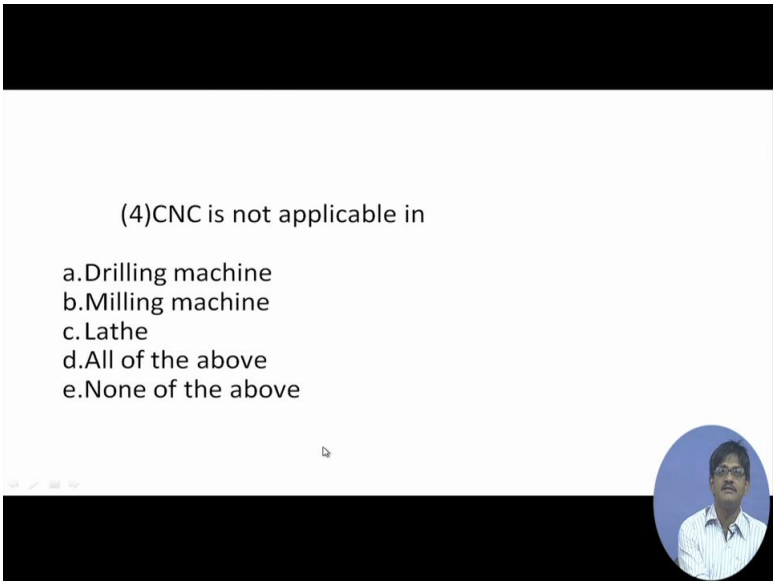
(Refer Slide Time: 25:05)



In order to produce a circular group in milling in CNC machining centre, I want to cut a circular groove, so I require… a universal dividing head, no I do not. A planetary gear mechanism which actuates the table moment, no I really do not need it. Or rotary table, no why because I can simply use circular interpolation and none of these things will be required. So it means that when you are asking for a rotary motion I mean circular groove, the basic idea is the CNC machine table does not have to rotate.

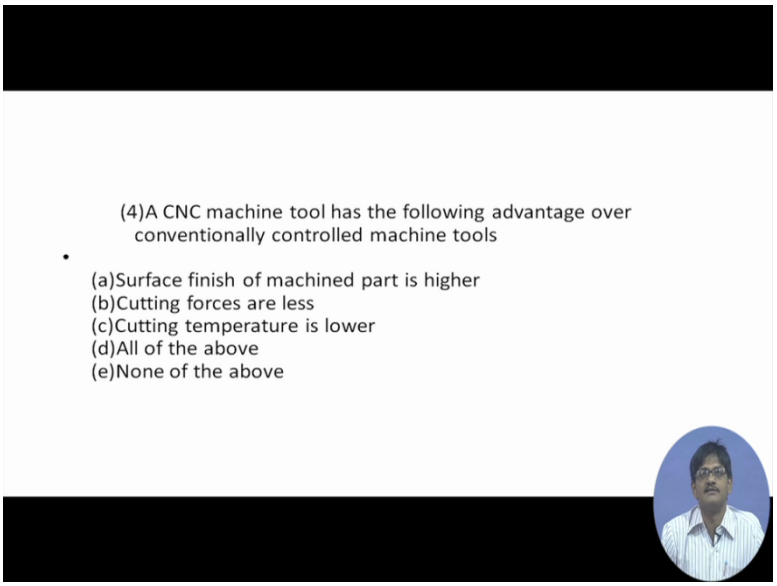
It can simply combine X and Y motion so that it will be undergoing rotary or rather circular motion, it does not have to rotate about a particular axis, no not at all, this is the basic idea of this question rotary devices are not necessary. And planetary gears, gears are going to give specific results, discrete options, so they are also out, so answer is none of the above.

(Refer Slide Time: 26:23)



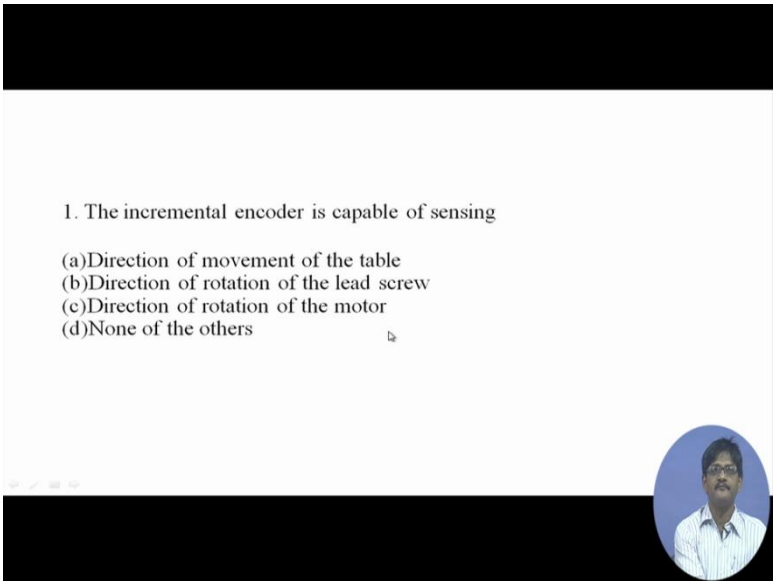
CNC is not applicable in: Drilling machine, Milling machine, Lathe, all of the above, none of the above, so CNC is not applicable. CNC is applicable in every one of them, so the answer is none of the above.

(Refer Slide Time: 26:42)



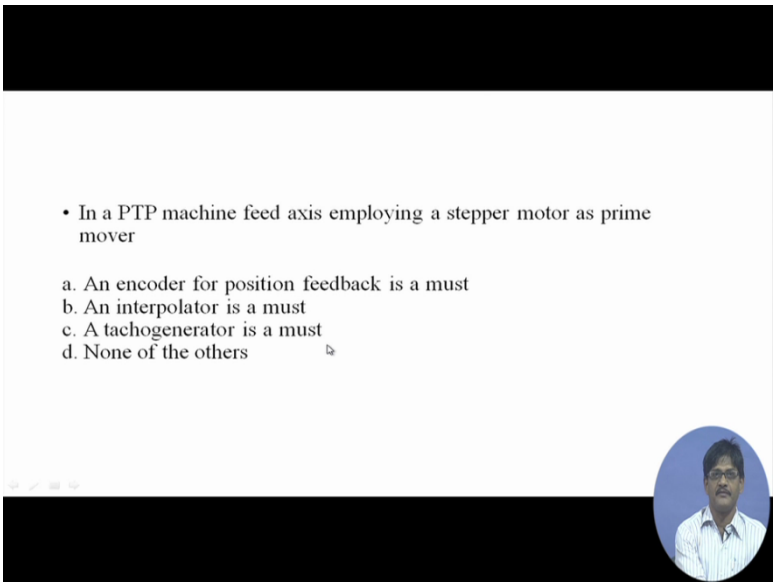
CNC machine tool has the following advantage over the conventionally controlled machine tools, let us see. Surface finish of machine part is higher; no, surface finish depends upon something else, it depends upon tool geometric, it depends upon the feed applied, et cetera, so it has nothing to do with CNC. Cutting forces are less; no. Cutting temperature is lower; no, none of the above is the correct answer.

(Refer Slide Time: 27:17)



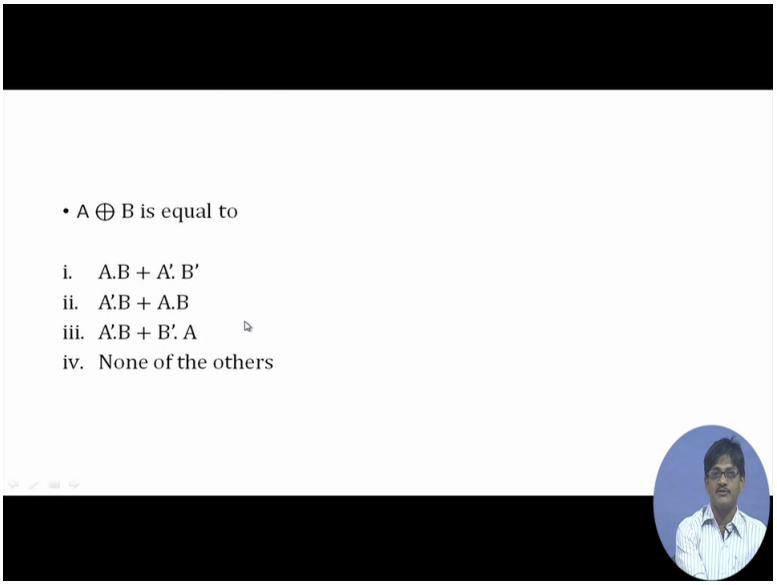
The incremental encoder is capable of sensing, so incremental encoder remember capable of sensing: direction of movement of the table, no. Direction of rotation of the lead screw, no. Direction of rotation of the motor; no, none of the above.

(Refer Slide Time: 27:38)



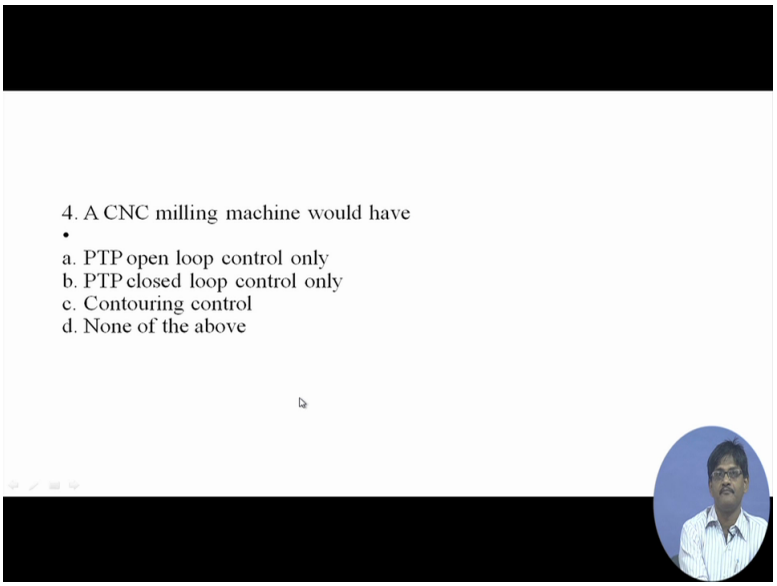
In a point-to-point feed axis employing a stepper motor as a prime mover, so point-to-point machines stepper motor: an encoder for position feedback is a must, no because stepper motors can well operate in open loop in a point-to-point system. And interpolator is a must, no interpolator is not required in point-to-point machines. A tachogenerator is a must; no. None of the others is the correct answer.

(Refer Slide Time: 28:15)



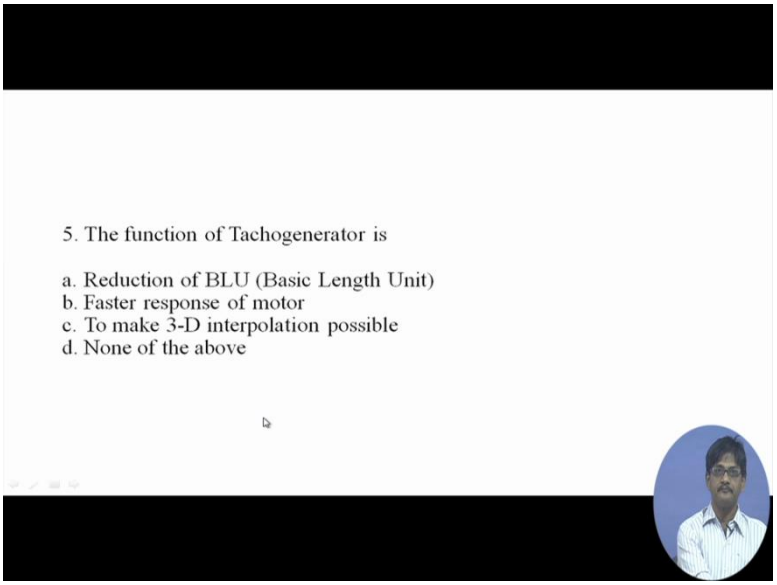
A EXOR B is equal to… A AND B OR A dash AND B dash, A dash AND B OR A AND B, A dash AND B OR B dash AND A, C is a correct answer. That means option 3 is the correct answer, you can check it out through truth table.

(Refer Slide Time: 28:44)



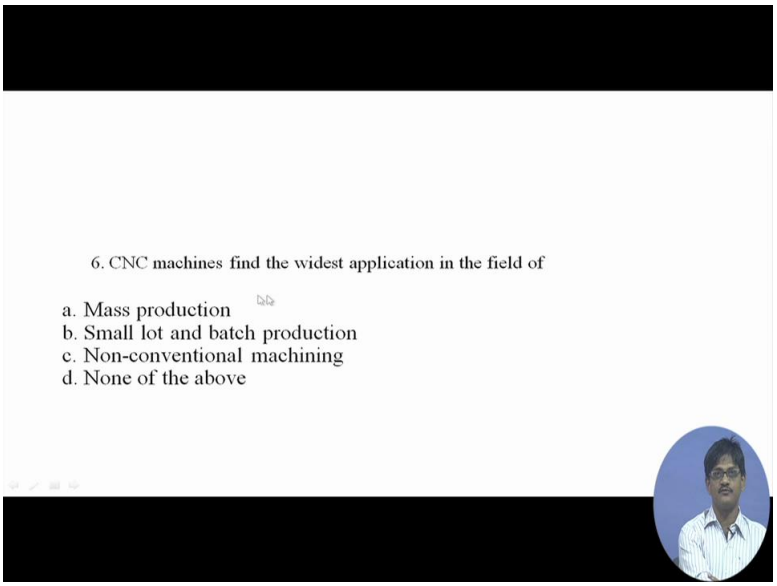
A CNC milling machine would have… Point-to-point loop control only; no, CNC machine CNC milling machine is capable of circular interpolations, straight-line interpolations so option A is not correct. Point-to-point closed loop control only; no for the same reason. Countering control; yes, None of the above, no, so option C.

(Refer Slide Time: 29:11)



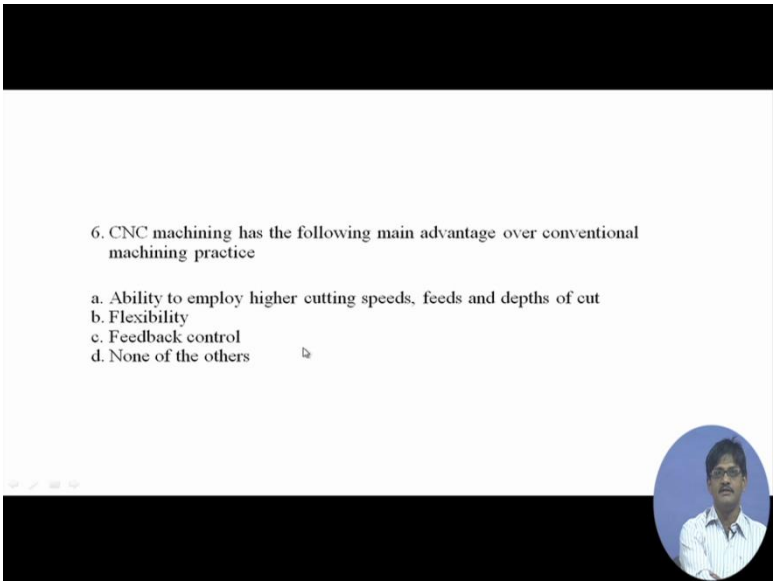
The function of the tachogenerator is… Reduction of basic length unit; no, faster response of the motor, yes. To make 3-D interpolation possible; no, none of the above; no, so the correct answer is faster response of the motor.

(Refer Slide Time: 29:35)



CNC machine find widest applications in the field of… Mask production; no, small lot and batch production; yes. Nonconventional machining like ultrasonic machining, laser beam machining, then electrical discharge machining, et cetera. Well CNC might be applied, but it is definitely not its widest application field okay, so small lot and batch production is is actual field of application.

(Refer Slide Time: 30:09)

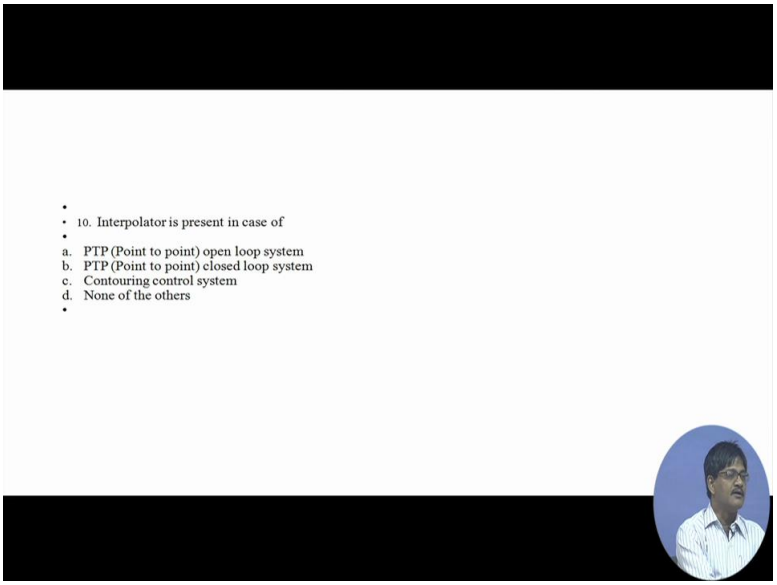


CNC machining has the following main advantage over conventional machining practice… Ability to employ higher cutting speeds, feeds; no, flexibility is the answer. And C is feedback control, feedback control is not an advantage, feedback control is actually a mean to ensure that proper quality will be maintained and proper movements will be carried out, so it is not an advantage but it is one of the supporting foundations to ensure proper working.

(Refer Slide Time: 30:51)

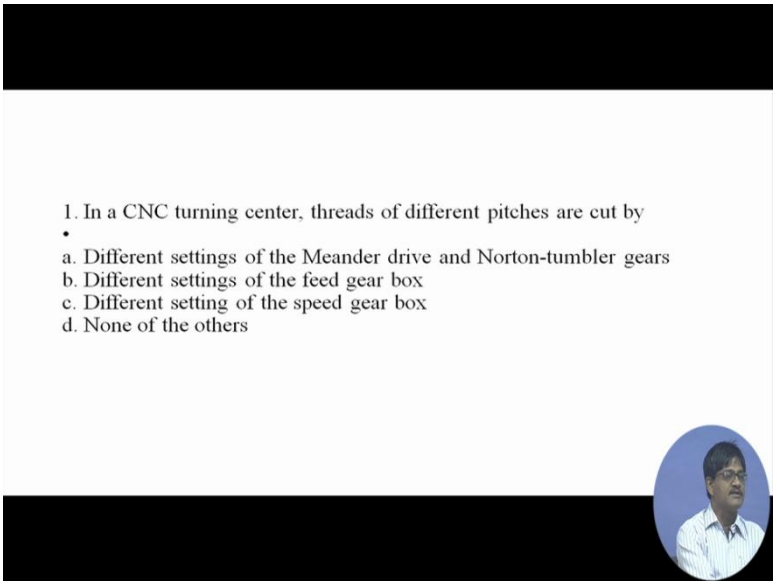
So on the CNC lathe: two-dimensional programming is sufficient, three-dimensional programming is necessary, one-dimensional programming is sufficient, here the correct answer is A because we only have motion along the axis of rotation and we have motion radial to the axis of rotation, 2 axis of motion they are necessary on the CNC lathe.

(Refer Slide Time: 31:18)



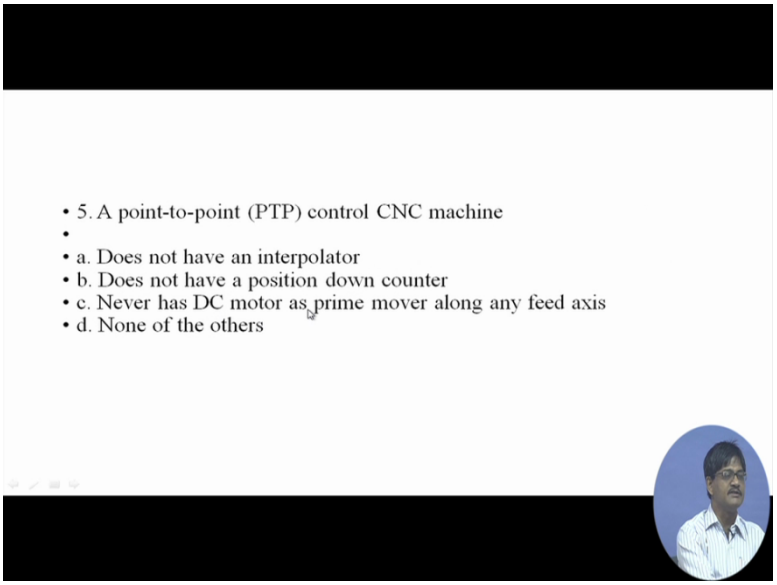
Interpolator is present in case of… Point-to-point open loop system; no, point-to-point closed loop system; no, contouring control system, C is the correct answer.

(Refer Slide Time: 31:34)



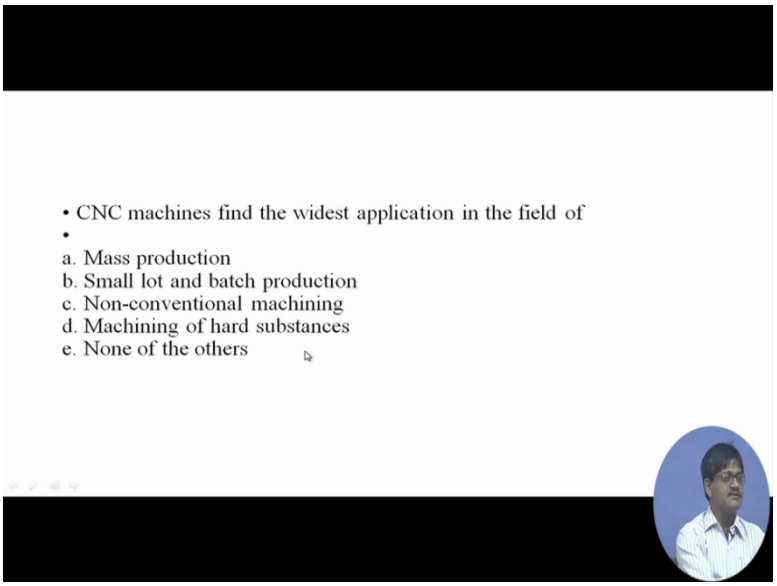
In a CNC turning centres, threads of different pitches are cut by… Different settings of the meander drive and Norton Tumbler gears; no they do not exist in this machine. Different settings of the feed gearbox, no. Different settings of the speed gearbox, no. None of the others.

(Refer Slide Time: 31:58)



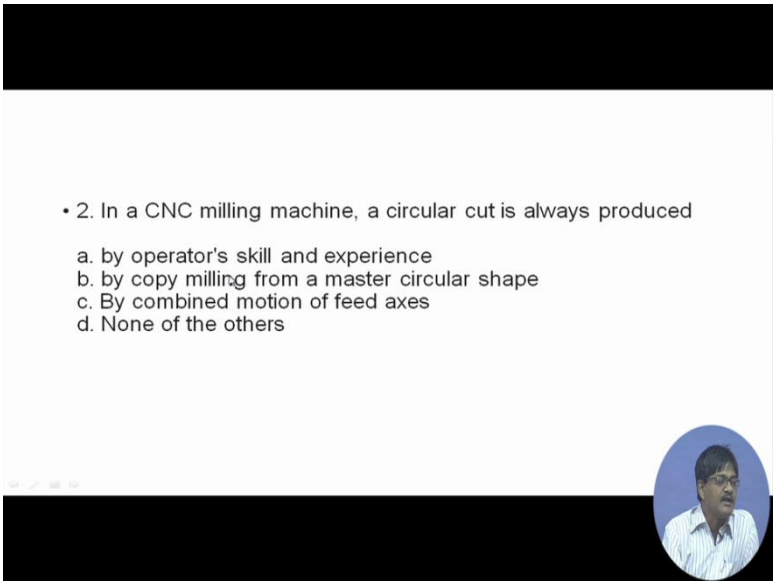
A point-to-point control CNC machine… Does not have an interpolator that is correct, does not have a position down counter, that is not true position down counter is present in all the CNC machines, never has DC motor as prime mover along any feed axis that is not correct, you can well have DC motors with closed loop, none of the others, so the correct answer is does not have an interpolator.

(Refer Slide Time: 32:26)



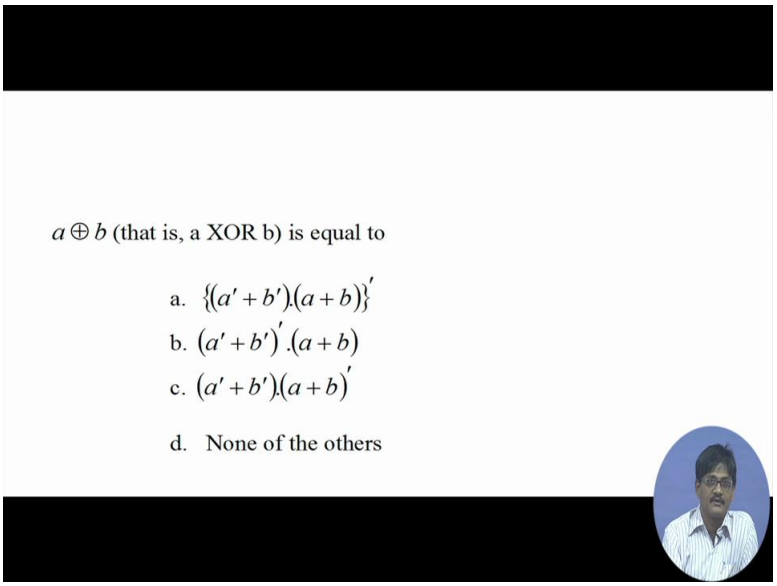
CNC machines find the widest application this we have already done, the correct answer will be small lot and batch production.

(Refer Slide Time: 32:35)



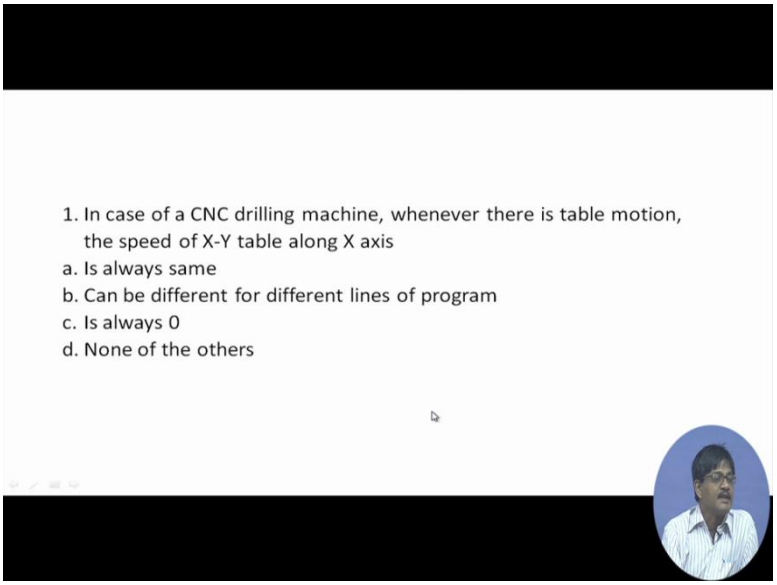
In a CNC milling machine, a circular cutter is always produced, we have done something similar to this; my operator's skill and experience; no, by copy milling; no, my combine motion of feed axis; yes C is the correct answer.

(Refer Slide Time: 32:50)



A EXOR B, I am not solving it, I am sure the amount of Boolean algebra practice that we have had, I am sure that you can carry this out.

(Refer Slide Time: 33:03)



In case of a CNC drilling machine, whenever there is a table motion, the speed of X-Y table along X-axis… is always same; no it can be 0, it can be the maximum speed possible or it can be 0 so it is not always same. Can be different for different lines of program, yes it can be different, it can be 0 or it can be maximum speed, so it can be technically different. Is always 0, no in that case we will not have had that axis of motion at all, none of the others., so strictly speaking B fix the bill, in all motions, X-motion might not always be present, so it can be 0 at times, it can be the maximum speed of the motor at times, okay. So with this we come to end of the 8th lecture, there are some other MCQs also which we I did not discuss just a because of drop of time, but I will definitely share it with you another sessions of lectures that are going to come, thank you very much.