Manufacturing Processes – II

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Lecture No. 4
Interrelations among the tool angles expressed in different systems

Friends, our subject is Manufacturing Processes II and module II is still running and subject is Mechanics of Machining and today is lecture - 4. The topic today is interrelations among the tool angles expressed in different systems and what are the instructional objectives or content of lecture today.

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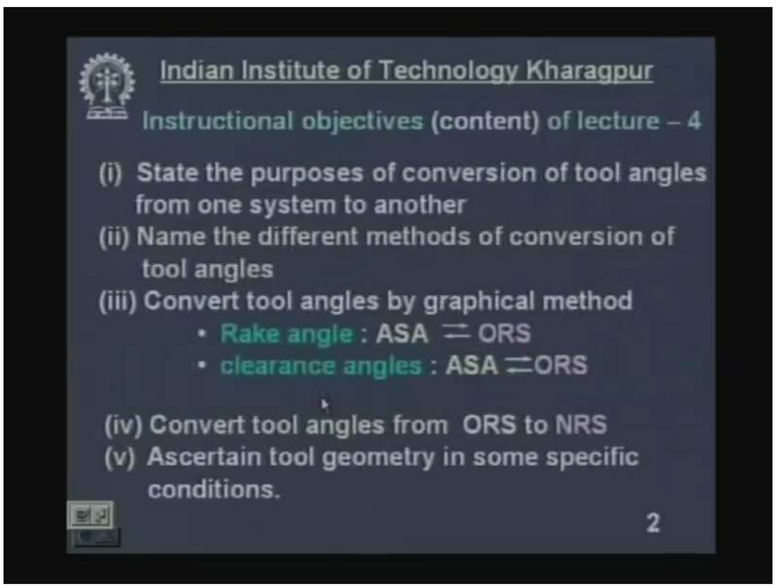

State the purposes of conversion of tool angles from one system to another. Why do we need conversion of tool angles from ASA to ORS or ORS to NSA and so on? Name the different methods of the conversion of tool angles. There are different methods what are those? Convert tool angles by graphical method. Rake angle from ASA to ORS and vice versa, clearance angles from ASA to ORS and vice versa. Next convert tool angles from orthogonal rake system to normal rake system and last ascertain tool geometry in some specific conditions. Now what are the purposes of conversion of tool angles?

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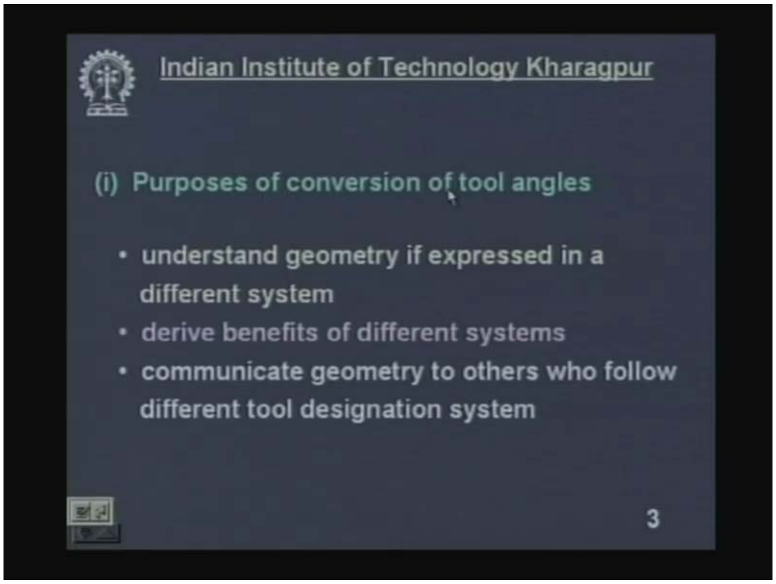

To understand geometry if expressed in a different system. Suppose you are conversant with a particular system of tool designation, say orthogonal rake system but you have got a book written by a foreign author who dealt the cutting tool geometry in ASA system. You may not be able to understand, then what you have to do? You have to learn both ASA system and orthogonal system and also convert the tool angles given in the book in ASA system in to ORS system for your understanding, your visualization and study. Now next, derive benefits of different system. Now there are different tool designative system ASA system, orthogonal system, normal rake system, maximum rake system, work reference system, each system has got certain advantage.

Now we have to derive the advantages. To derive for example, say ASA system is very convenient for tool manufacturing tool inspection and so on. Then orthogonal system, orthogonal system is very simple. It is very useful say general study, research, analysis and so on but orthogonal system does not provide the exact tool geometry if lambda inclination angle is not zero. Thirdly if you want to resharpen the cutting tool then ORS system is not that very convenient whereas normal rake system that gives the true picture of the cutting tool and it enables very easy resharpening of the tool.

So if you want to derive the benefits we should convert tool angle from one system to another to derive the benefits. Now communicate geometry to others who follow different tool designation system. Suppose you do research on a machining process with a cutting tool in ORS system. Now you go to a conference and say USA and there people are more conversant in ASA system. How will you communicate the tool geometry that you have dealt with to them who are knowledgeable about ASA system that means, you have to convert your tool angles from ORS to ASA, and then tell them this is the geometry actually in ASA system for there understanding and this is mutually true vice versa also. Now what are the different methods of conversion of tool angles?

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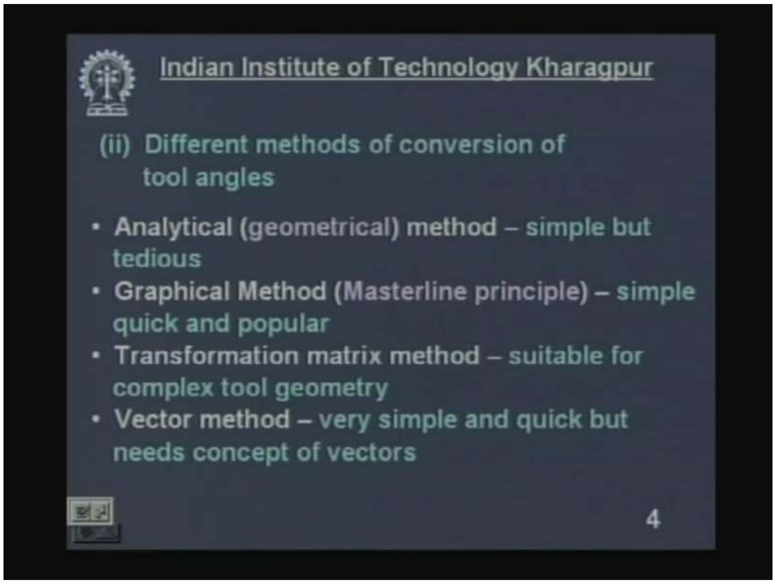

There are basically four methods. First is analytical method it is geometrical method very simple but tedious. It takes lot of time and monotonous. Graphical Method based are Masterline principle, it is very simple, quick and very popular. So most of the people you know learn this method first. Transformation matrix method is a little complex method but very suitable for complex tool geometry. Say for example, say geometry of cutting, say drill geometry for horn tools then for conversion of tool angles say hob cutters or gear shaping cutters for such complex shaped cutters or cutting tools the transmission matrix method is appropriate for conversion and vector method is Universal, very strong powerful method as well as very simple and quick but it needs concept of vectors and matrix. So our concentration will be on graphical method master line principle. So conversion of tool angles by graphical method using master lines.

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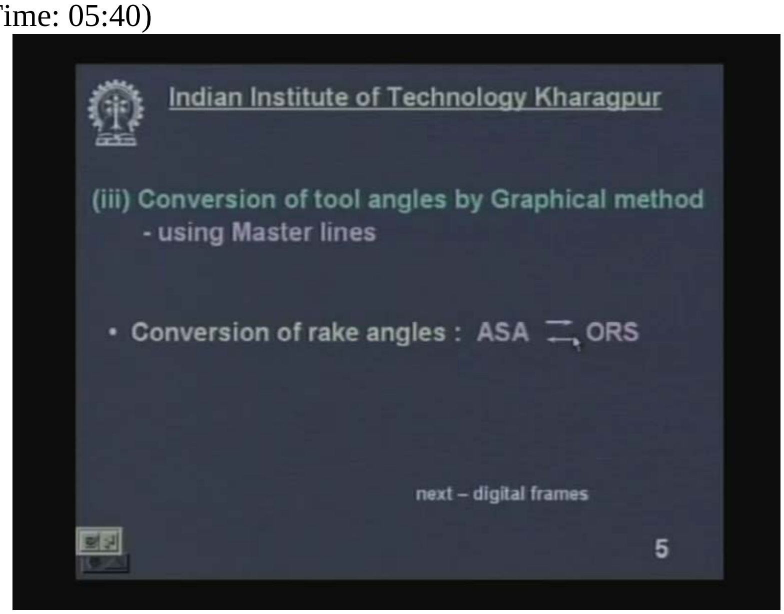

Now let us start with conversion of rake angles. You know the cutting tools have got three important angles. One is rake angle, next is clearance angle and third is cutting angle and beside that finally the tool nose radius. So let us start with conversion of rake angles from ASA system to ORS and vice versa.

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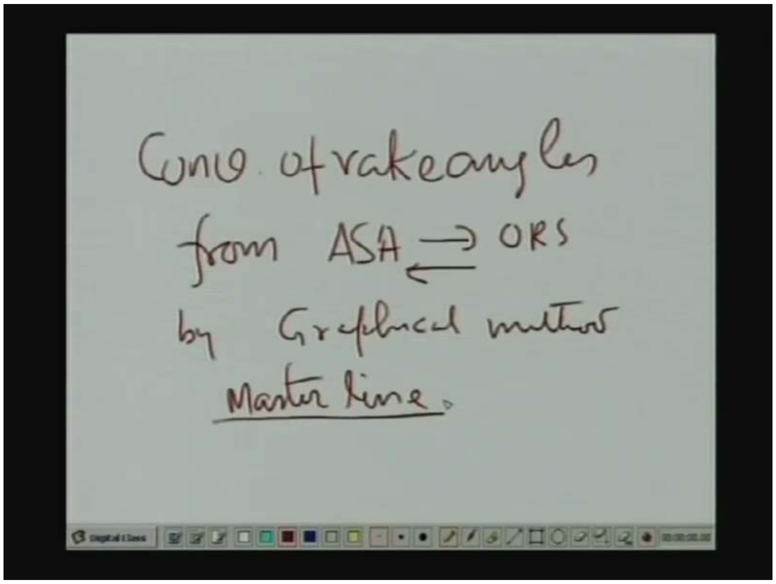

So first of all say rake angle, we shall deal with conversion of rake angles from ASA to ORS and vice versa. So let us start with this. By graphical method, this is based on master line principle, then what is master line? First of all you have to understand the master line concept. See this is master line, let me show you the master line for rake surface.

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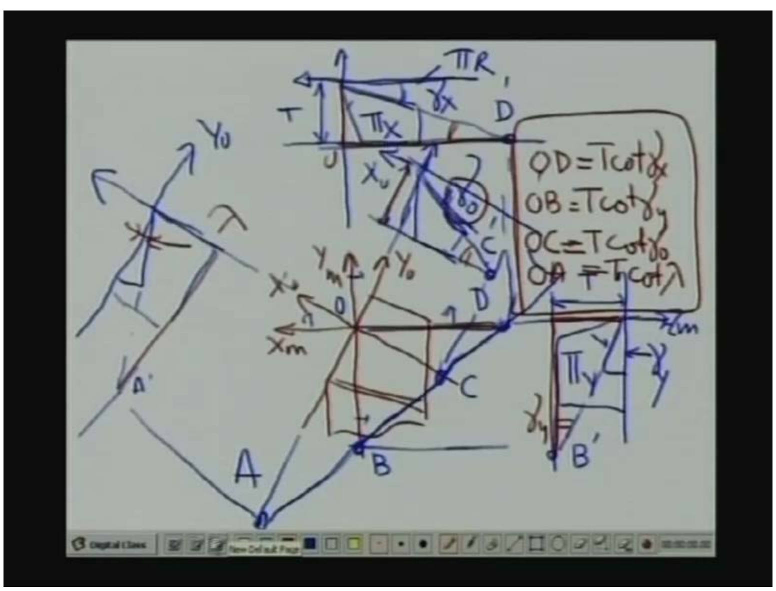

First you draw a cutting tool. This is a top view of the cutting tool. It is drawn in orthogonal rake sorry pi r reference plane, then you visualize the other planes. This is machine longitudinal plane pi x, this is machine transfers plane pi y, this is cutting plane pi c and this is orthogonal plane pi o. Now this is xm, this is ym, this is xo orthogonal, this is yo and zo and zm perpendicular to the plane.

So again I repeat this is pi x plane, this is pi y plane - machine transverse plane, this is orthogonal plane and this is cutting plane. Now you show the rake angles in different planes. Say first of all, let us take the section of the tool in machine longitudinal plane and show the cutting tool section. This is section of the cutting tool and in which plane the diagram has been drawn, the section is taken on pi x plane. So this is pi x, machine longitudinal plane and what is this axis this is xm, what is this is axis y this is zm. So this is zm and this is xm and what is this angle? Angle between the reference plane and the rake surface, so this is gamma x that is side rake.

Now what you have to, this is the bottom surface of the tool and these are rake surface you extend the rake surface until it meets the bottom surface suppose it meets at point D prime. Say at certain distance, this rake surface meets the bottom surface and if you project it on this diagram on the view drawn in reference plane so this is point suppose D. So D is situated on the bottom plane which is parallel to the reference plane or it is horizontal plane. Now you take the cutting tool section along machine transfer plane in this direction. So this is the cutting tool and which plane the diagram has been drawn, pi y machine transverse plane by take a section by this machine transverse plane.

So this is obviously zm and this is ym axis, xm is perpendicular to the plane and what is this angle? this is rake angle in which plane? pi y plane, so this is gamma y that is back rake. If you extend this rake surface up to the bottom plane of the tool then meets at a point say this is point B prime and on this diagram if you project it this is the point this is the distance suppose this is o oD this is oB. So B and D both of situated on the bottom surface and if I join B and D by a straight line then what is this BD. BD is situated on the bottom plane which is also parallel to the reference plane. This is reference plane, this surface is reference plane, this plate now what physically what is the meaning of this.

This is the line of intersection between the rake surface of the tool if extended and the bottom surface of the tool. So this is the line of intersection between the rake surface and the bottom surface if it is extended on this direction it will meet a point D and B. Now you can extend it. So this line is called Master Line for rake surface for a Master Line for rake surface, similarly Master Line for clearance surface will also appear. Now what is this point? Say this is point C. It means if the rake surface is extended along this orthogonal plane this will meet the bottom surface at point C and that point C will be always situated on the line of intersection.

Physically it means that if you take the section draw the view of the cutting tool from here extend it. So this is orthogonal plane and this is the cutting tool, this is the rake surface, this is rake angle orthogonal rake and this axis is zo, this is xo and so on. Now if you extend this rake surface then it will meet the bottom surface of the tool at point say C prime and if it is extended it meets point C. Now what is the thickness of the tool? This is the thickness of the tool say T, here this is the thickness of the tool T. Now look at this tool from this side along this direction along xo and now but this view that we will get of the tool will be in the cutting plane. So you draw the diagram in the cutting plane. So this is yo and this is zo and what is the view?

Now if this is extended like this, this will also meet certain point and if it is extended this will be point, this will be somewhere A prime and this will be extended here. This will be A. So we get DCBA were this rake surface if extended meets the bottom surface along machine longitudinal plane, machine transverse plane, orthogonal plane and cutting plane. Now here you can see, that what this length OD? If we put it here OD equal to this OD this intercept. This intercept is equal to this intercept how much is this? This is equal T what is this angle same gamma x, so this OD. OD is equal to T multiplied tangent cotangent of gamma x so T cotangent gamma x.

Similarly OB is how much? OB this is OB this equal to T, this is gamma y, so this is equal to T cotangent of gamma y, T cot gamma y then what is OC? OC will be T what is this angle? gamma O, so this will be T cotangent of gamma O and what is OA? This much this angle is lambda for inclination angle of the cutting tool. So OA will be equal to T cotangent lambda. So this will be very useful. Now you get the concept of master line. Now this concept will be know utilized to convert the tool angles from to one system to another.

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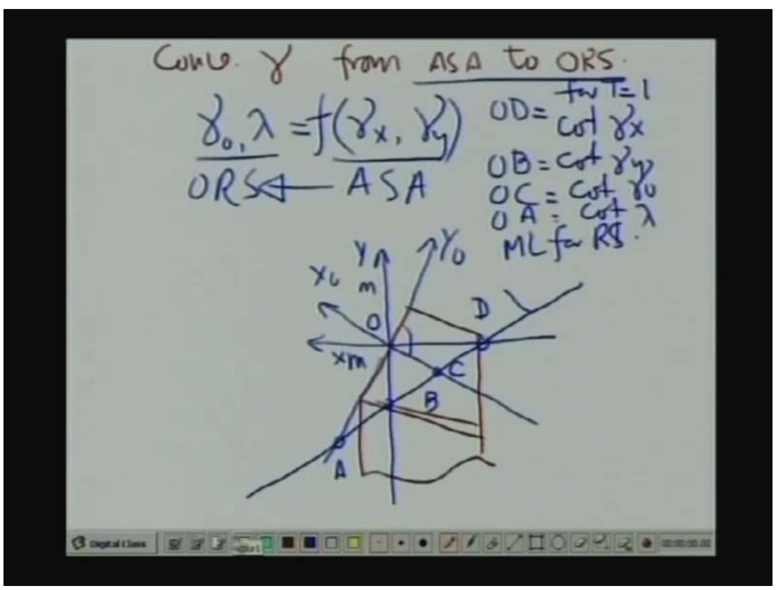

Now say conversion. First you start say convert rake angle from ASA to ORS. Now let us draw the diagram again. This is the cutting tool top view drawn in reference plane pi and then you visualize the different planes - machine longitudinal plane, machine transverse plane, cutting along the cutting edge and orthogonal plane and mind that this is ninety degree and this is xm, ym. This is xo, this is yo, and zo zm perpendicular to this point o.

Now here suppose this is the master line, suppose this is the master line for rake surface and this point is D, this point is C, this point B and this point is A. What we observed last time that OD is equal to T, the thickness of the tool multiplied by cotangent gamma x. If T is one, say unity for T is equal to unity OD is equal to cotangent of gamma x. OB is equal cotangent of gamma y. OC is equal to cotangent of gamma O and OA is equal to cotangent of lambda we get it now.

We have to proof now we have to convert from ASA to ORS. Now what is the meaning of conversion from ASA to ORS that means if the tool angle the value of the tool angles are given in ASA system then what will be the value of the rake angles of the same tool that is the question that means, the meaning is determine gamma O and lambda which is also a rake angle from the given values of gamma x and gamma y that means, this is a function of gamma O and lambda is an this is a ORS system and this is ASA system. So from ASA system to ORS we have to convert now how this will be converted. Now we are discussing about conversion of cutting tool angles. So first we shall show the conversion of rake angles.

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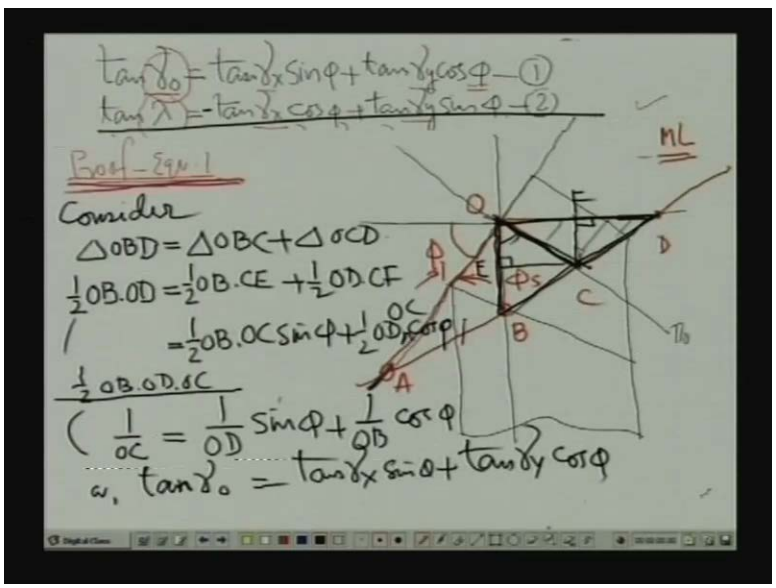

You know the rake angles, there are side rake, back rake or orthogonal rake even lambda intersecting angle is also a rake angle. So first conversion of rake angles from ASA to ORS that means, let us write say tangent of gamma o is equal to tangent of gamma x sin phi plus tangent of gamma y cosine phi. The other one is tangent of inclination angle lambda is equal to minus tangent of gamma x cosine phi plus tangent of gamma y sin phi instead of cosine phi. Say equation number one and equation number two.

Now actually what we are going to do now, what we are going to do that if the values of gamma x, the gamma x and gamma y gamma x and gamma y are known to me then and phi is also known that is the tool angles are given in ASA system we have to determine the rake angles gamma o and lambda in ORS system that means to find out rake angle orthogonal rake and lambda that is in ORS system as function of gamma x, gamma y and the cutting angle phi. The principle cutting angle phi and we know that principle cutting angle phi is equal to ninety degree minus phi s where phi s is approach angle and this approach angle is given in ASA system.

So if phi s know from where you can determine phi and put the values of gamma x gamma y and phi in to these equations number one and two we can determine the values of orthogonal rake and inclination angle lambda that is from the given values of the rake angles in a ASA system, we are determining the rake angles in ORS system. So now, how to proof this equation? We have to proof these equations. See equation number one proof of equation number one. How shall we do it? Let us take the help of this drawing. Draw this diagram this is the principle cutting edge, auxiliary cutting edge. This is the tool and this is machine longitudinal plane pi x, machine transverse plane pi y, cutting plane pi c and orthogonal plane pi o and now you draw this master line. Suppose this is the master line for the rake surface, now suppose this is point O, this is point A, this is point B, this is point C and this is point D.

What are the intercepts I remind you that OD stands for cotangent of gamma x OB cotangent of gamma y, OC cotangent of gamma O orthogonal and O is cotangent of lambda and this is phi and this is phi s. Now, we have to proof with the help of this equation. The equation number one now how we shall proceed? Consider triangle OBD this triangle is a right angle triangle OBD. This area is equal to area of the triangle OBC plus the triangle OCD. Now all these are triangles. So what is OBD area of the triangle OBD this is a right angle triangle so this will be half of OB in to OD OB in to OD. What about area of the angle OBC this will be half base in to altitude draw a perpendicular here see E so this will be half of OB in to CE.

Similarly the triangle OCD will be half of the base multiplied by the altitude this say F half OC OB OD in to CF. Now what is CE? CE is equal to OC sin phi. What is half OD CF is equal to OC cosine phi cosine phi OC cosine phi. Now divide both sides by half OB OD OC you divide both side by half OB OD OC then what you get here. One by OC is equal to one OD, OD is D OD is absent. This is sin phi plus one upon OB cosine phi or one upon OC. OC is equal to cotangent of tan gamma. So this is cotangent of gamma O. So this will be tangent of gamma O. Similarly one upon OD will be tangent of gamma x sin phi and OB is equal to tan sin phi. So friends similarly, we can prove the equation number two.

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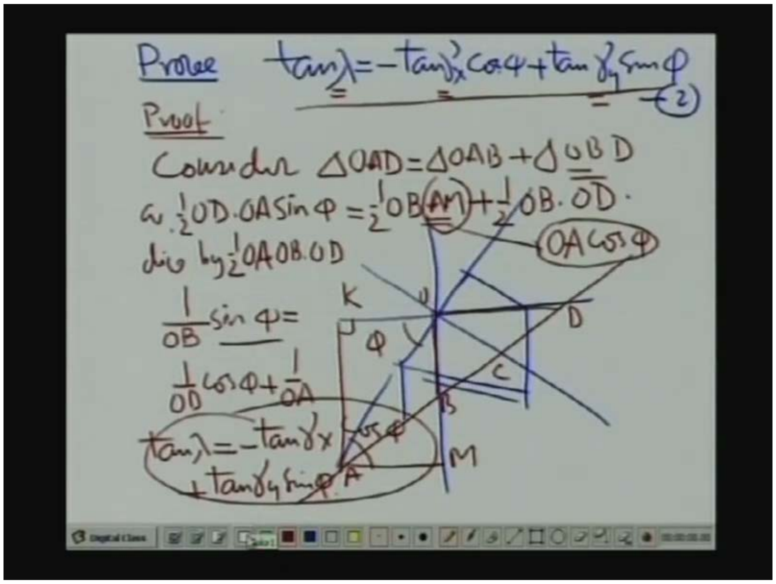

Consider the triangle OAC. Lambda is equal to minus tangent of gamma x cosine phi, plus tangent of gamma y sin phi. This is equation number two. This has to be proved. Now approach will be same. You draw the diagram, the master line OABC and D and this is phi. Now this has to be proved. Proof in the same way you choose a triangle from here, then split in to two. Now in the previous one, equation we consider OBD, now we shall consider a different way how. You see which angles are involved lambda that means OA has to be taken gamma x which corresponds to OD. So this line has to be taken and gamma OI corresponds to OB.

So we have to take the angles and split in such a way that OA, OB and OD get involved.
Proof: Consider triangle OAD. OAD is equal to triangle OAB plus triangle OBD. Now you understand how what is the trick that this triangles have to be chosen according to the elements which have to be correlated. Now what is area of OAD or we can write first see OBD you bring OBD first, triangle OBD or you can do it other way also not necessary. Now what is the area of the triangle OAD? OAD it is the base and this is the height and suppose this is k, so this is half OD multiplied by OA and what this angle phi, so this is sin phi is equal to triangle OAB. So this area will be this is the base in to this is the height suppose scaled and what is this angle this is phi. So this will be half OB in to the height AM plus OBD that is very simple right angled triangle OB in to OD.

Now here what is AK? This sin phi but what is say for example AM. AM is equal to OA cosine phi. So this OM this is OA cosine phi. Now you divide both sides by half OA, OB and OD then what happens here, we get one upon OB sin phi is equal to one upon OB OA cancels. So this is OD cosine phi plus half OB OD that is one by OA. Now what is OB? OB stands for cotangent gamma y OD O tangent gamma x and OA cotangent lambda. So here, we will get you come to this one by OA is equal to tangent of lambda is equal to you take this one on that side so that will minus one upon OD. OD is cotangent one upon OD will be tangent of gamma x cosine phi plus one upon OB is equal to tangent of gamma y and sin phi. Here you compare this expression with this expression, this is how it has to be proved. Now this is ASA to ORS. Now you have to prove: Convert ORS to ASA.

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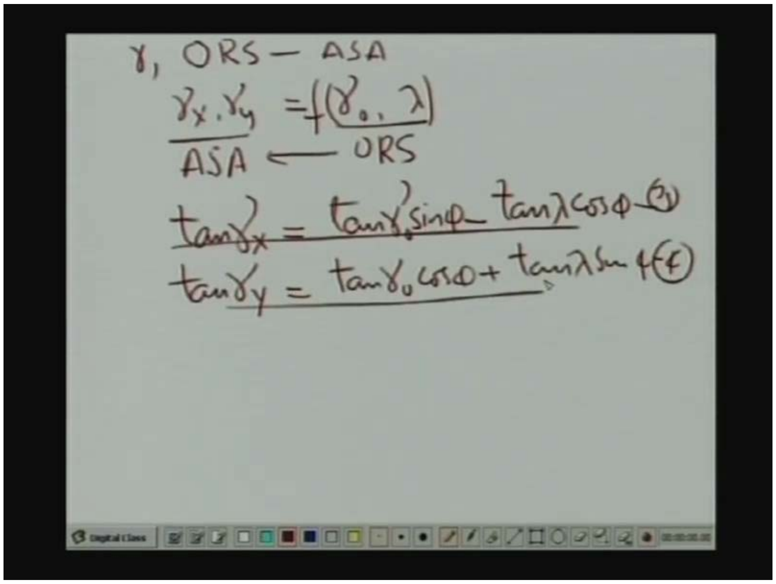

What is the rake angle? We are considering rake angle, conversion of rake angle from orthogonal system to ASA that means, if gamma O and lambda are given,, you determine gamma x and gamma y. Suppose the tool geometry is specified in ORS system, you have to find out the rake angles in ASA system that is conversion from ORS to ARS and these are function of that is. Now what are the equations ultimately the equations will appear that tangent of gamma x is equal to I am writing in advance, then we shall prove tangent of gamma O sin phi minus tan lambda cosine phi and tangent of gamma y will be tangent of gamma O cosine phi plus tan lambda sin phi. So this is equation number three and this is equation number four. Now this has to be proved. How we can prove this?

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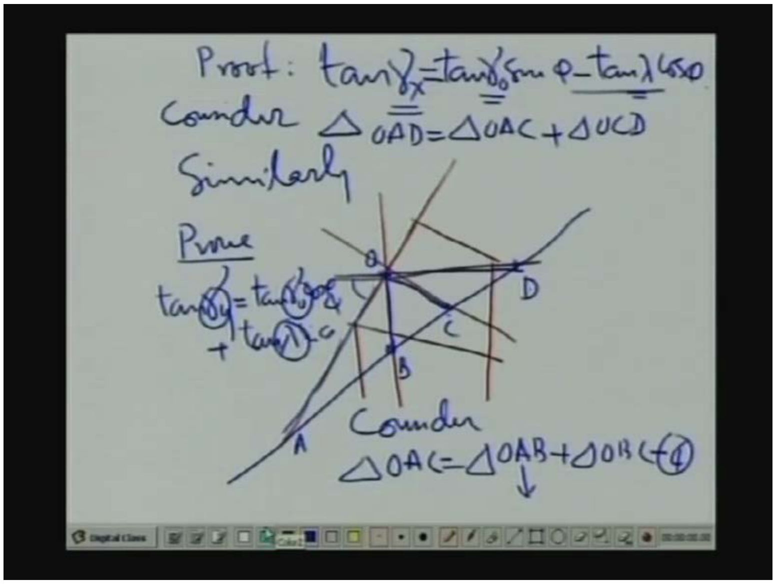

We can go to the same method. You draw the master line for the rake surface. Suppose this is the master line OA, this is B, this is C, this is D and this is phi. Now prove proof of tangent of gamma x is equal to tangent of gamma O sin phi minus tan lambda cosine phi. Now how to prove this? Consider you start from considering some triangles, consider area of the triangle. Now it has to be done in such way that these angles under consideration should be involved gamma x that means OD gamma O OC and gamma and lambda OA.

So we have to consider area this one and orthogonal rake this one and lambda this one. So OAD area OAD which involves OA and OD that is the lambda and gamma x is equal to now you involve OC triangle OAC plus triangle OCD, now you proceed you will come to this level it will be proved. Now if you want to prove say similarly what you can prove that, prove tangent of gamma y is equal to tangent of gamma O cosine phi plus tan lambda sin phi. Now here gamma O gamma y and lambda have to be involved gamma y that is OB gamma OC and lambda OA.

So what we have to do? We have to start from, consider area of the triangle this one this one and this one has to be involved OAC. OAC that involves OA that is lambda and OC gamma O is equal to area of the triangle OAB. OAB that is OB will be involved that corresponds to gamma y plus triangle OBC. Now you proceed you will be able to prove this. Now this can be done, this equation number for this can be done in another way

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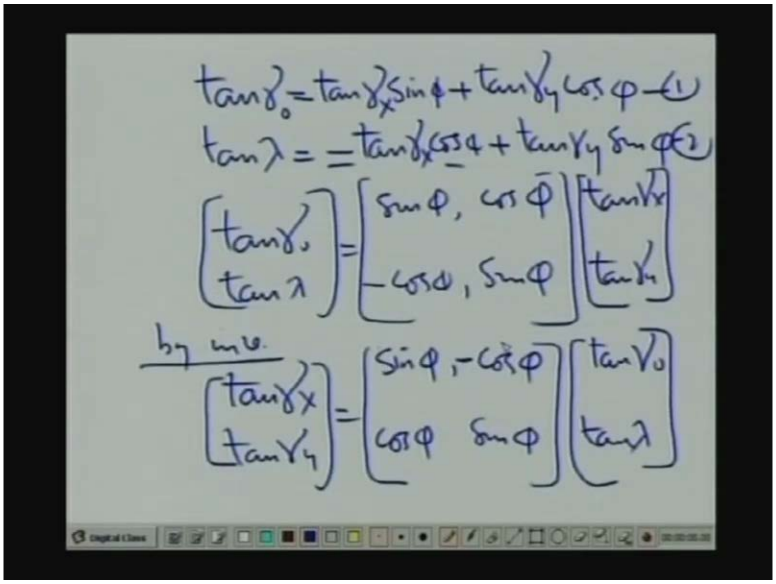

What we observe that tan gamma O is equal to when we converted from ASA to ORS we got tan gamma O is equal to tan gamma x sin phi plus tan gamma y cosine phi and tan lambda is equal to minus tan gamma x cosine phi plus tan gamma y sin phi. Now these two equations can be written say this was the equation number one and equation number two in matrix form. That is tan gamma O tan lambda is equal to the matrix sin phi cosine phi minus cosine phi sin phi and then gamma x gamma y tangent of gamma x and tangent of gamma y.

Now here this is the matrix form and this matrix is called transformation matrix, this is a column matrix. From this equation, this has to be utilized to determine the value of gamma O and lambda from the given value of gamma x and gamma y utilizing this transformation matrix then it should be noted that the value of the determinant of this transformation matrix should be always one that is unity. Now if you by inversion what do you get. If you do the inversion then this will come this side, tangent of gamma x tangent of gamma y will be the transformation matrix on this side we shall get tangent of gamma O and tangent of lambda. So gamma x and gamma y will function of gamma and lambda and inside we shall get sin phi cosine phi cosine phi sin phi and this is minus this value has to be unity.

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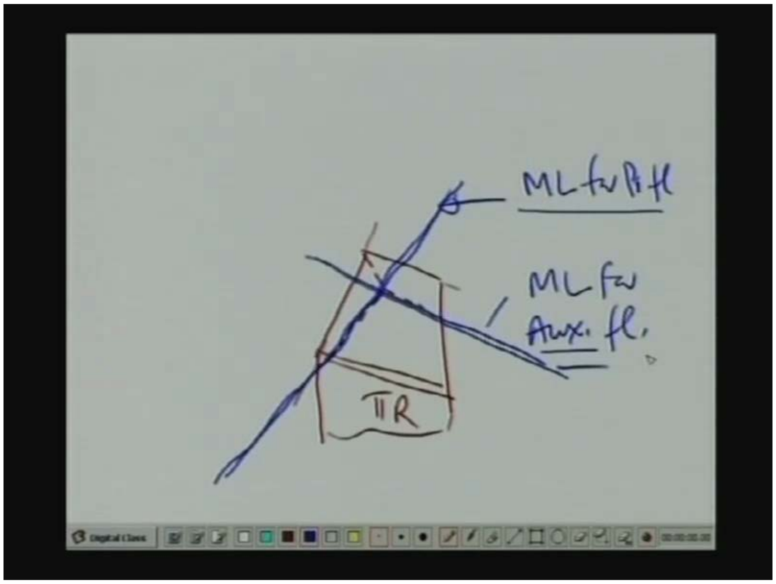

Now next is conversion of clearance angles in the same system then we have to take help of this master line. Now what is the master line for the flank surface or the clearance surface. You draw the tool, if you draw the tool so this is the top view drawn in reference plane pi R. Now is that the complete view the top view of the cutting tool. No this is not the top view, this is correctly drawn because there will be two more doted lines.

So these doted lines will appear why because this flank surface perpendicular to this plane and the auxiliary flank perpendicular to this plane are not really perpendicular. If this surface the cutting plane is perpendicular to the pi R but the flank surface is inclined to that to provide clearance angle. Similarly the auxiliary flank is inclined from the auxiliary cutting plane to provide auxiliary plane surface. For example, say so what is this really this line. This clearance surface is inclined for which it will meet the bottom surface of the tool in a different line not along this line because of the angle alpha.

So this is nothing but the line of intersection of the principle flank with the bottom surface of the tool. Now what is the master line for rake surface. The lining intersection of the rake surface on and the bottom plane. Here this gives this line represents the line of intersection of the principle flank and the bottom surface of the tool. So is it not master line for principle flank this is the master line for principle flank and what about this line this is the master line for auxiliary flank so this way you get two master lines.

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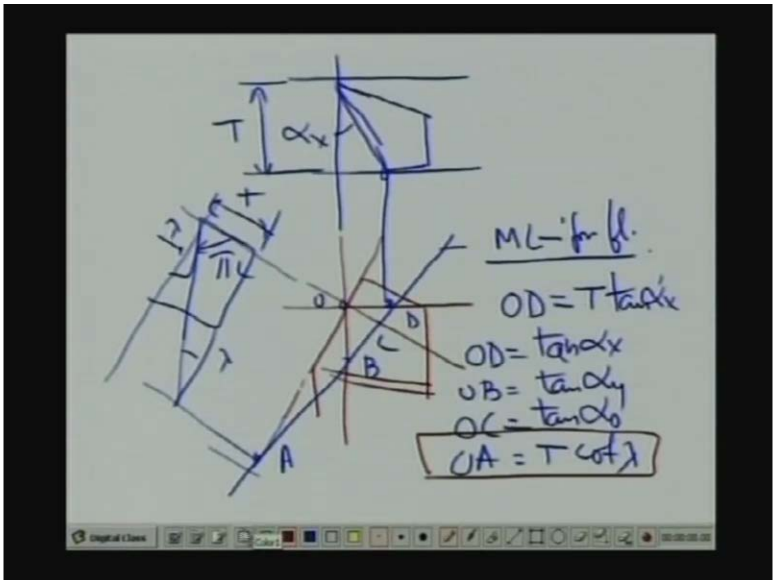

Now if we redraw this is the cutting plane and orthogonal plane and suppose line this is the master line okay say this O this D again for convenience C B and A. This is not the proper we can draw a better way. Suppose this will be more convenient and then draw the master line this is the master line for principle flank. Now what is the significance of this. Significance of this is, if you draw this tool the sectional view of the cutting tool in machine longitudinal plane then this is O, this is D, this is C, this is B and this is A.

Now you draw this one, this D this is the clearance surface and this point D corresponds to this point and this is the bottom surface and this is alpha x and this is T then what is OD? OD is equal to T tangent of alpha x, if T is unity then OD for T is equal to unity T is will be OD will be tangent alpha x similarly OB will be tangent of alpha y and OC along the orthogonal plane tangent of alpha orthogonal and what is OA? Now OA is a typically different you can see here, this is the rake these are tools draw in cutting plane and this is lambda and this is T, then what is OA and this is lambda. In case of lambda, this OA will be T cotangent of lambda, so this has to be noted that remains cotangent others are tangent unlike rake angle it where it is cotangent. Now again we have to prove from this by the same principle what we can prove, say alpha conversion of alpha from ASA to ORS.

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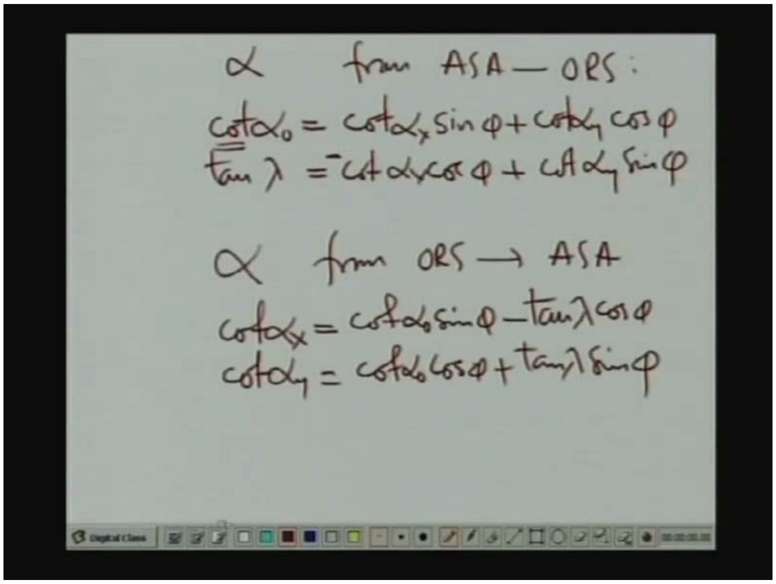

By considering the same principle, the same triangle concept the master line and all this things you can prove that cotangent of alpha o will be equal to cotangent of alpha x sin phi plus cotangent of alpha y cosine phi. Now here you see the difference, in case of rake angle these are tangent. Now these are becoming cotangent. Then lambda has to be written as tan lambda because as I told you the previous frame the lambda offset is just opposite.

So this will be cotangent of alpha x minus cosine phi plus cotangent of alpha y sin phi. If you do proceed in same way alpha from say ORS to ASA then what will be the equation? Cotangent of alpha x will be cotangent alpha o sin phi minus. Now when you talk about lambda it should be just opposite lamb tan that has to be remembered. Tangent of lambda you can prove it by the same principle as the equations have been proved from rake angles this will be sin and so this will be cosine. If one is sin and the other one will be cosine and cotangent of alpha y will be cotangent of alpha very easy to remember this two will remain same if it is sin this will be cosine. If it is minus this will be plus others will remain same it was cosine now it is sin phi so this can be proved in the same fashion. Now come to rake angles normal.

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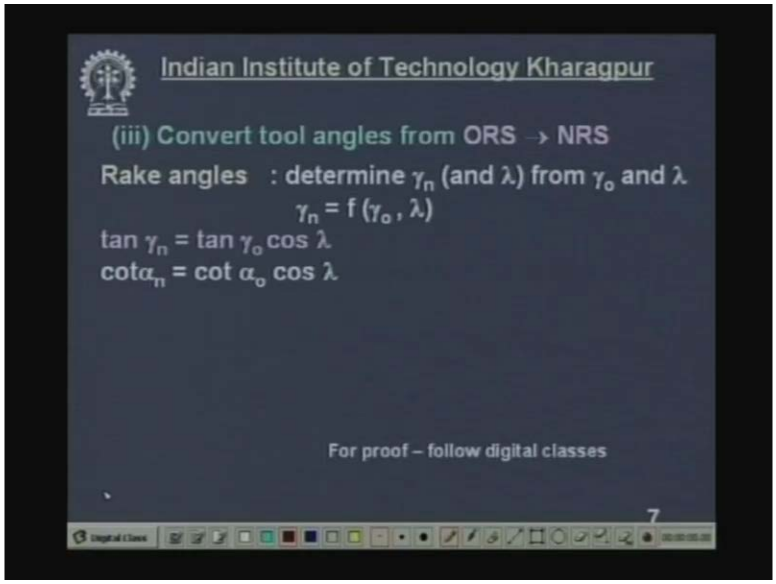

Conversion: Convert tool angles from orthogonal system to normal rake systems. Now rake angles, it means determine gamma n and also lambda from gamma o and lambda. So gamma and lambda are in orthogonal plane or system and gamma n that is in normal rake system. So there two basic equations as I told you importance are the rake angle and clearance angle.

So one equational will be tan gamma n is equal to tan gamma cos lambda that is if the values of rake angle and lambda are given in ORS system you can determine gamma n.
Similarly from this equation if you know lambda and alpha o you can determine alpha n but how to prove this this has to be proved now let us you how it can you proved?

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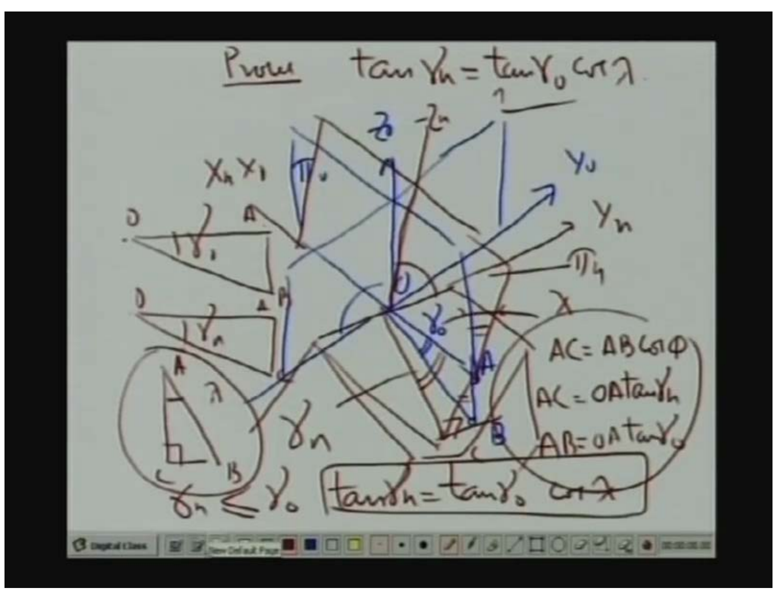

Say prove tangent of gamma n is equal to tangent of gamma o cosine lambda. Now for that you have to draw a diagram in a three D. Suppose this is the tool and no in a better way. Now draw a velocity vector that is Zo velocity vector. This is orthogonal plane, this is Yo cutting plane and this is a right angle and this is orthogonal plane pi o and this is suppose this point is O and this is point A. This point A is situated on the reference plane, but not on the rake surface.

If you extend it only then this will meet the rake surface at say point B and OB is a lines of a intersection between the orthogonal plane and the rake surface. So this angle is rake angle and this is nothing but orthogonal rake. Now you draw the normal plane, this Zo is not perpendicular to the cutting edge. So this is the cutting edge Yn. This is Xn and Xo and now you draw a line perpendicular to this one that is Zn. So this will be normal plane and what is this angle lambda if you extended suppose it is meeting at point C OC is situated on the rake surface and it is a line of intersection between the normal plane pi n and the rake surface. This is also rake but this has been drawn in normal plane. So this gamma n.

Now this is lambda this is also lambda here you can see that OAB, OAB this is gamma o then OAC, OAC this is gamma n and ACB A this will be right angle C and B this angle is lambda ah now this is lambda from here what we get that AC is equal to AB cosine lambda what is AC? AC is equal to OA, OA tan gamma n and what is AB? AB OA tan gamma O then what do we get out of this equation finally, tan gamma n is equal to tan gamma O cosine lambda. So this is a final expression this is the proof of this one. So for this equation it is evident that gamma n will be less than or equal to gamma O. Now how to prove the clearance angle? That is cotangent of alpha n will be equal to cotangent of

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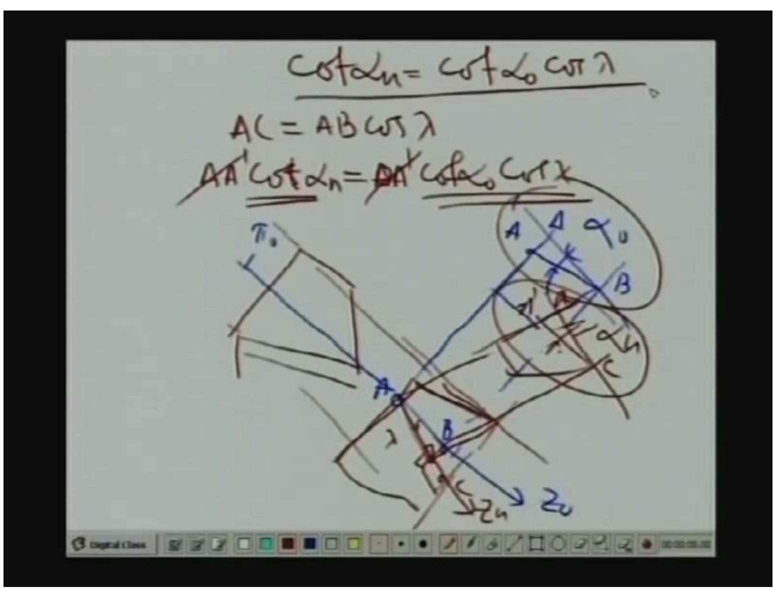

alpha o cosine lambda. This can be proved by, you draw another diagram here, you extend this diagram suppose this is the view, you take one orthogonal section. This is pi o orthogonal section and cut it so this is point B. Suppose this is point A and this point B and you cut this plane, this cutting tool what you get? This is clearance angle and this is rake angle. This is point A, this point A prime and this is point B and this is clearance angle in which plane orthogonal plane alpha o but this is Zo a velocity vector but this is not perpendicular to the cutting edges.

Now you draw a plane perpendicular to the cutting edge from A. Suppose this is point C and this is perpendicular to the cutting edge. Now you take the section like this. Here we will see that this is C A A prime and this alpha n. Now from this triangle and this triangle what we get and this lambda angle between Zzo and Zn, so this right angle what is AC? AC is equal to AB cosine lambda from here. AC is equal to AB cosine lambda and what is AC? AC is equal to AA prime AA prime cotangent of alpha n this is alpha n and what is AB? AB is equal to AA prime cotangent of alpha o cosine lambda. So this A prime cancels what remains cot alpha n is equal to cot alpha o sin lambda. So this is the proof this can be proved. Now let us quickly go through some interesting features. Now we got lot of equations.

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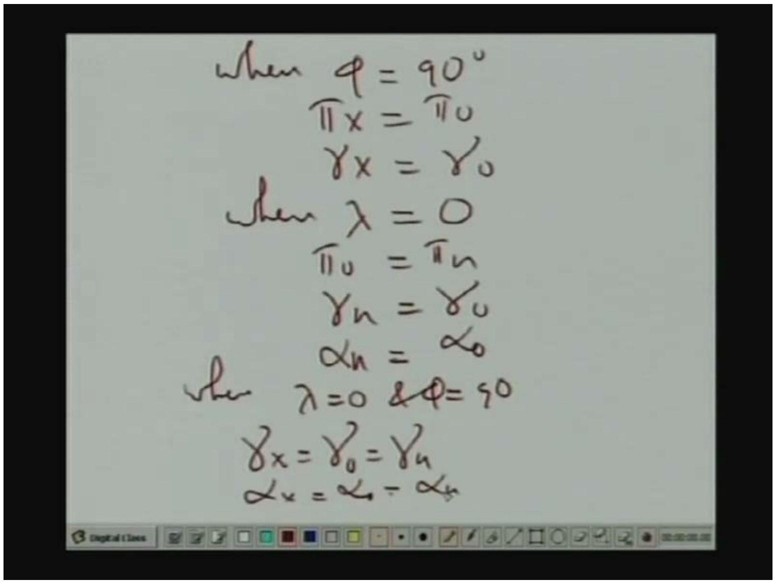

Now when phi is equal to say ninety degree what we get when this happens, then pi x is equal to pi o or gamma x is equal to gamma o when lambda is equal to zero that means pi o and pi n are same that is gamma n will be equal to gamma o alpha n will be equal to alpha o and when lambda is equal to zero and phi is equal to ninety than gamma x is equal to gamma o is equal to gamma n and alpha x is equal to alpha o is equal to alpha n.

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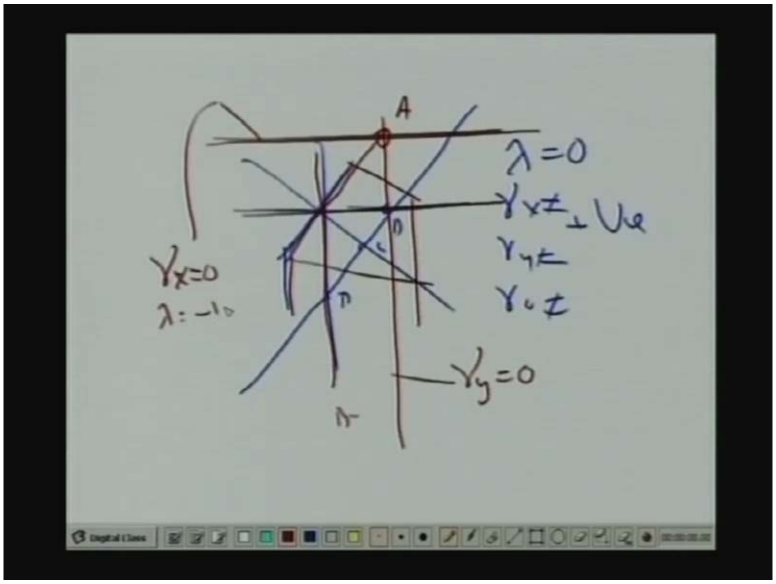

Suppose the master line is parallel to the cutting edge, then you quickly draw the planes what do you understand from this? If it is parallel to the cutting plane, then where is A so this is D, this is C, this is B, there is no where A so A is at the infinity that is cotangent of lambda is zero so lambda is zero if this master line parallel to this cutting edge which corresponds to lambda now this will be zero and this other angles are gamma x gamma y and gamma o these are not zero and these are all positive on this side. Now if the master line be like this parallel to this plane that means it corresponds to gamma y is zero because this there is no point B where is point B. Now if it is like this the master line then it is parallel to this angle so this corresponds to gamma x is zero but interestingly here if you extend it the point A comes over here on the opposite side. So lambda is negative and this OC if it goes in this way so C goes there in opposite direction. So gamma o is also negative and D this gamma x is zero lambda.

Thank You.