Introduction to Machining and Machining Fluids

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Lecture – 01
Introduction

Dear viewers, welcome to my course on Introduction to Machining and Machining Fluids, and myself Doctor Mamilla Ravishankar; assistant professor at IIT, Guwahati in the department of mechanical engineering. Welcome to my course. In this class, I am going to start about what is the syllabus of this course, why we have to study this course and all those things, ok.

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So, that first why we have study this course on manufacturing is the one thing. So, the one of the primary courses in manufacturing is machining and machining fluids also plays a major role. That is why we are going to study in this course on machining and machining fluids. So, if you see a manufacturing plays a very major role in any countries GDP. So, as a developing nation India if at all want to move ahead so their manufacturing has to be improvable a lot.

If you see the many companies like Honda, GE and all those these are companies are the one of the good companies in the manufacturing arena and they are expanding their bases in India because they play a major role in manufacturing ok.

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So, if you see in this slide, you can see the temple pillars also developed based on machined components. If you see the pillars these are all machined using the machining process ok.

So, coming to the syllabus we are going to see; what is the syllabus of introduction to machining and machining fluids?

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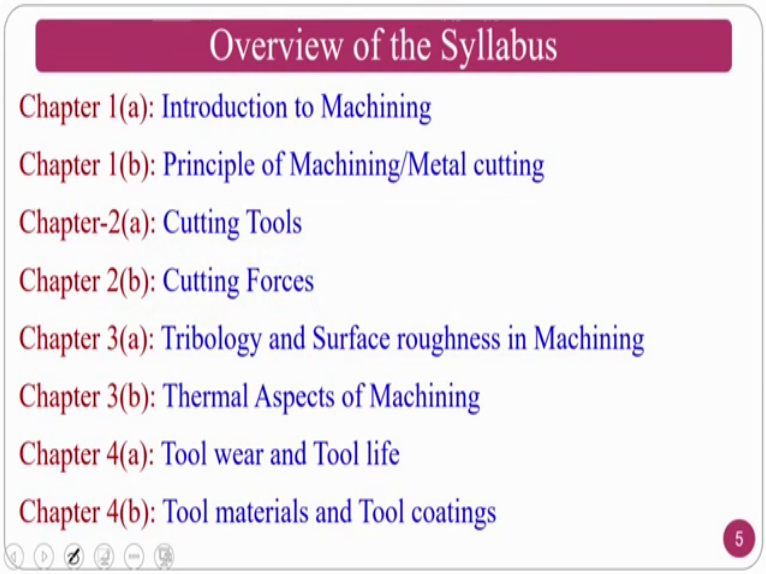

So, the overview of this course chapter 1 to 8 we have complete chapters. So, the chapter one a introduction to machining one b principles of machining or metal cutting.

So, coming to the chapter 2, we have the cutting tools and cutting forces chapter 3, we have Tribology and surface roughness in machining thermal aspects in machining. So, chapter 4 deals with tool wear and tool life tool material and tool coatings.

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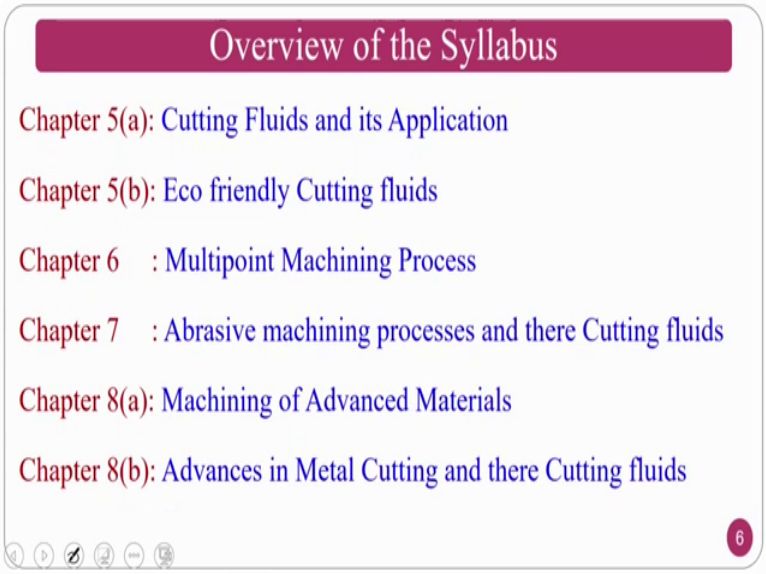

So, chapter 5, we deal with cutting fluids and its application eco friendly cutting fluids and chapter 6 deals with multi points machining process where which is called as the practical machining processes.

Chapter 7, we deal with abrasive machining processes and chapter eight we deal with machining of advance materials and machining advances in machining processes ok. So, this is the overview. However, I am going to explain you in detail what I am going to teach; so in the chapter 1 introduction to machining.

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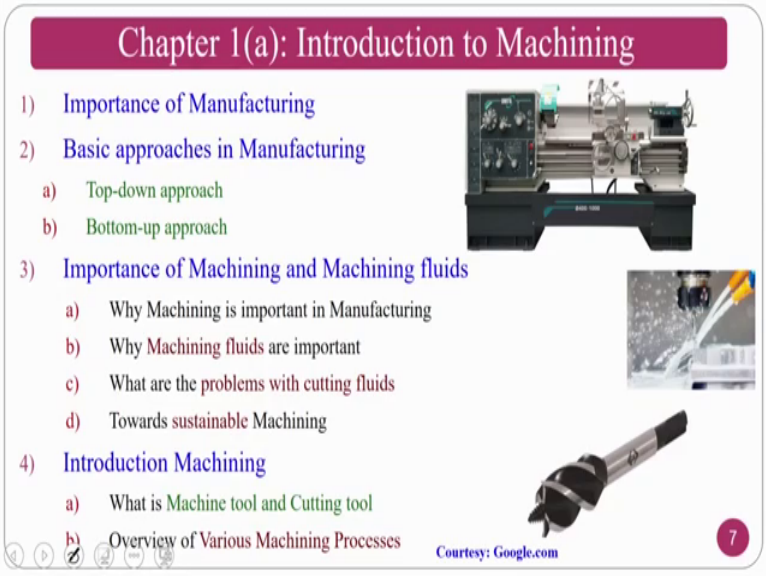

We are going to see the importance of manufacturing why the manufacturing is important or for a mechanical engineer at the same time; why the manufacturing is important for a country and all those things.

The second we deal with the basic approaches in manufacturing there are 2 approaches one is top down approach and bottom up approach in the manufacturing; however, we are going to study mostly top down approach where we take the solid stock and we do the machining process to the required shape.

So, we do not touch the bottom up approach; however, we give some introduction to the bottom of approach like 3 d printings and all those things the importance of machining and machining fluids. So, in the manufacturing we have to see; what is the major role of machining and machining fluids as per the course is concerned.

Why the machining is important for manufacturing why machining fluids are important what are the problems with the cutting fluid and how we have to make the machining process a sustainable process which is what the nowadays world is looking at.

So, then we goes to then we go to introduction to machining what is the machine tool and what is the cutting tool what are the difference between a machine tool and a cutting tool and all those things the overview of various machining process we do.

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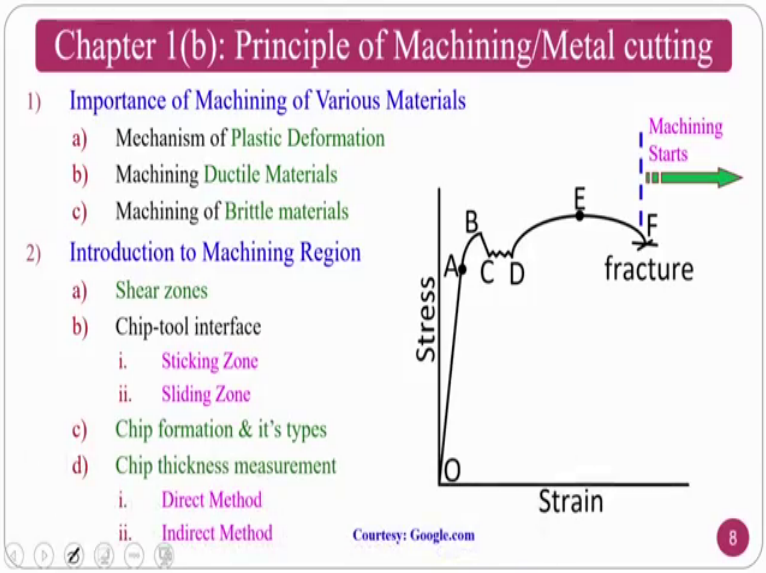

Then we go to the 1 b where principles of metal cutting or machining we deal with, so mechanism of plastic deformation. So, normally machining process is considered as the severe plastic deformation process if you see the stress strain diagram the machining starts from this position. So, the machine machining starts after the severe plastic deformation the fracture starts from there the machining starts.

So, the mechanics machining of ductile materials which is shown in this a stress strain diagram; so, the machining starts from this position. So, the machining of brittle materials where the stress strain graph will be slightly different which we deal when we are going to into the complete in detail to the course.

Then introduction to machining region what is the machining regional what are the zones what are the shearing zone chip tool interface and all those things what is the sticking zone what are the sliding zone sticking zone refers to were the metal. Metal interaction is there and in sliding zone the chip moves and abrades.

Those who we also deal with chip formation and types what are the different types of chips forming and all those things and we also measured practically and theoretically we also deal with the chip thickness measurement direct method and indirect method.

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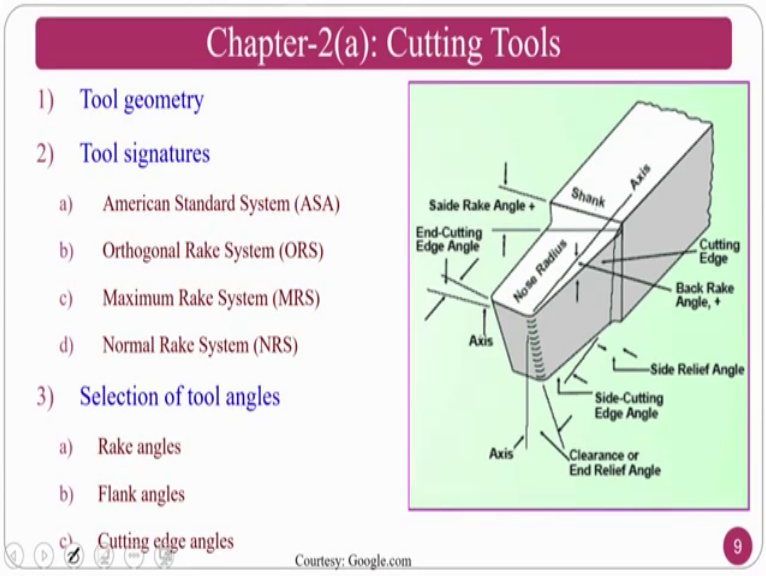

So, in the chapter 2 we dual we deal with the tool geometry and tool signatures in the tool signatures we deal with American standard system that is ASA system ORS system, MRS system and NRS system, some of the systems, I will teach you and some the systems I may give some assignment also. So, that you can also learn in a good way the selection of tool angles what how to select the rake angle what is the importance if I select more rake angle less rake angle and all those things flank angles and the cutting edge angles if at all I want to choose for particular operation.

So, how to choose you can see in this picture what are the angles what are the surfaces what are the vary the cutting edges and all those things.

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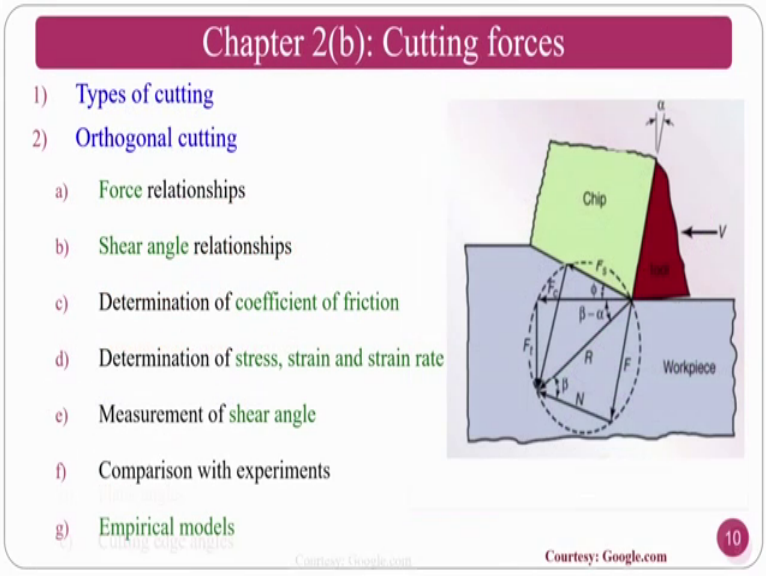

So, chapter 2 b deals with cutting forces normally types of cutting there are 2 types of cutting one is orthogonal cutting and oblique cutting.

So, mostly we deal in this course is orthogonal because this is a introductory course the orthogonal cutting we also see the forced relationships shear angle relationship determination of coefficient of friction the coefficient of friction is most important thing I mean to say is one of the most important thing.

Because what are the frictional losses and what is the useful energy what is the energy that is wasted in the process and all those things determination of stress strain and strain rate also we do measurement of shear angels comparison with the experiments and some of the empirical models also we see.

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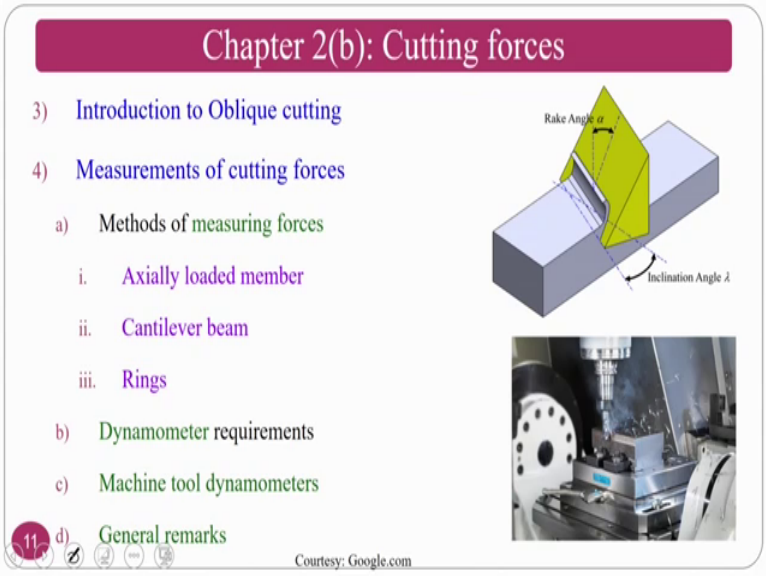

So, continuing to these cutting forces we also see introduction to oblique cutting we do not go in deep to the oblique cutting we do partially what is oblique cutting and all those things measurement of cutting forces axial. So, in the measurement of cutting forces we see how to measure experimentally the cutting forces like axially loaded member cantilever member's rings and all those things.

Some of the things I will explain some of the things you may have to learn for the assignments the dynamometer how the dynamometer works what are the its requirements how it measure the forces machine tool dynamometers and general remarks about it chapter 3 what we deal with is the Tribology and surface roughness in machining.

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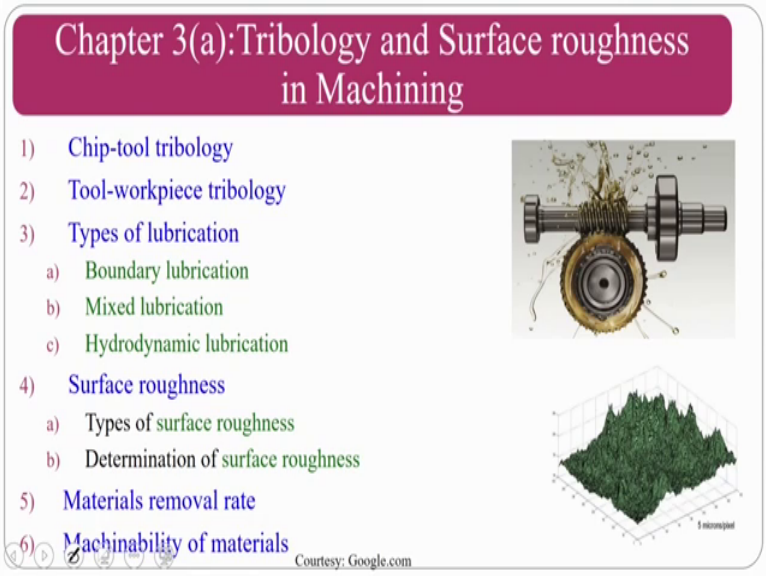

The tribology plays a very important role in the chip tool region that is called a chip tool tribology tool work piece tribology and types of lubrication there are 3 types of lubrication one is boundary lubrication mix lubrication and hydrodynamic lubrication basically as a manufacturing engineer if at all you see you require a hydrodynamic lubrication in the machining region.

But; however, you do not achieve it, but to achieve that one how and what we have to do I will teach in this course the surface roughness the surface roughness how to get a good surface roughness what is the problem in machining what is the roughness depend on which input parameters it mostly depends and all the things

types of surface roughness determination of surface roughness in the machining normally if your r a is proportional to f square by eight r and all those relationships I will teach you the material removal and material removal rate the machine ability of materials the ease of machining is nothing, but the machine ability.

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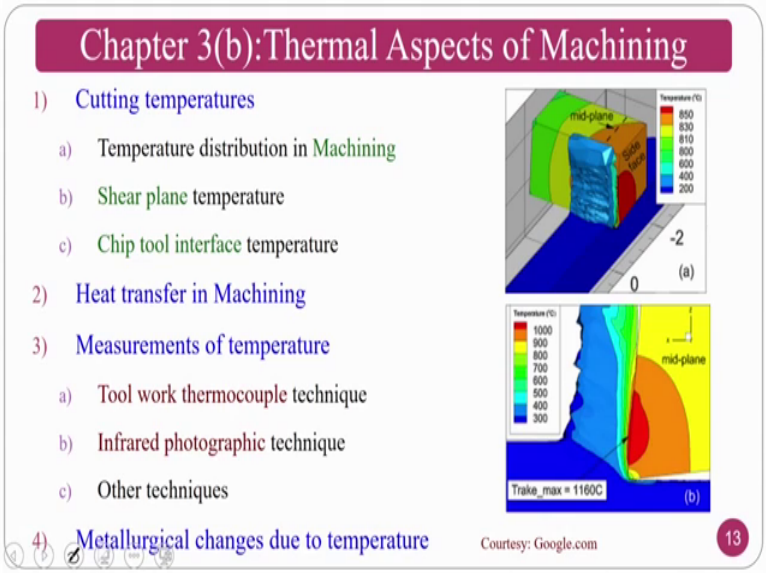

So, how to machine different materials in the chapter 3 b we deal with the thermal aspects of machining you can see in the picture how the thermal aspects are determining the tool temperatures and the chip temperatures and all those things.

The cutting temperature if you see the temperature distribution machining shear plane and chip tool interface normally chip tool interface carries highest temperature. So, heat transfer in machining. So, heat transfer means there is a temperature distribution and heat transfer to the 3 components that is the chip tool and the work piece how the heat is transferred and the measurement of this temperature tool work thermocouple technique infrared and the other techniques also we will see and we also see some of the advanced things that is called metallurgical changes due to temperature. Normally, what are the metallurgical changes that takes place on the surface of the work piece.

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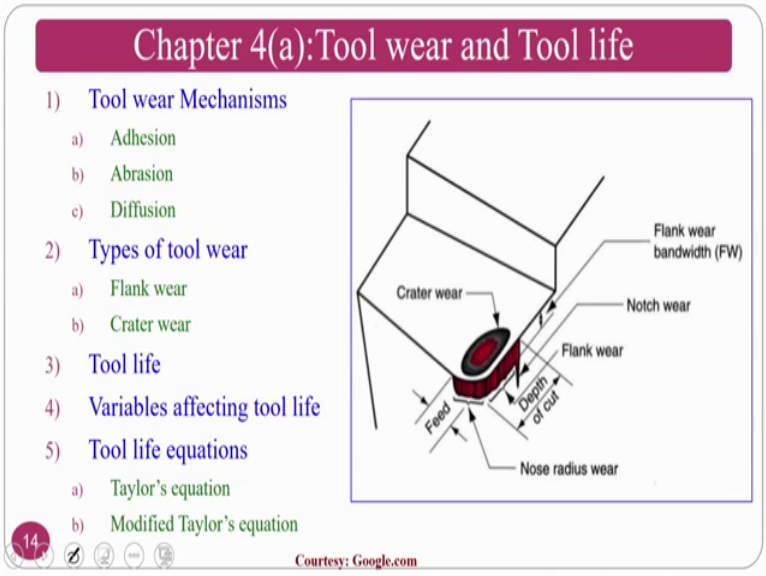

So, chapter 4, normally, we deal with the tool wear and tool life. So, what are the tool wear mechanism there are commonly said mechanism are 3 one is adhesion abrasion and diffusion.

So, what are the types of tool wear lucky you normally at the basic level we teach the flank wear and crater wear. However, there are many wear like notch wear cutting edge wear and all those things we may touch those also the tool life. So, there are many criterias of tool lives.

So, some of the criterias, we deal with where various variables affecting the tool life what are the input conditions affect what the tool materials that affect and all those things there are tool life equation normally there are 2 commonly used equations one is Taylor tool life equation another one is modified Taylor tool life equation.

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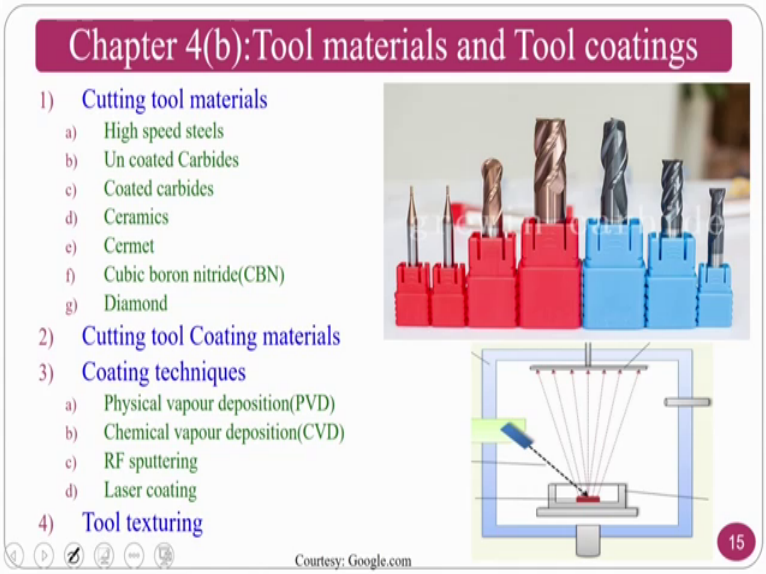

So, chapter 4, we also deal with tool materials and tool coatings in order to improve the tool life. So, what are the tool materials available that is high speed steel uncoated carbide and coated carbide ceramics cermets CBN and diamond not only this we also deal with some of the coating materials on the tools to improve the machine ability there are many varieties. However, we deal with 2 types of coating one is soft coatings another one hard coatings soft coatings provide better lubrication and all those things hard coatings provide better tool life.

So, the coating techniques also we deal with what PVD physical vapor deposition chemical vapor deposition radio frequency sputtering laser coating and this are the things we see at the same time we also see the tool texturing in order to improve the tool chip interface Tribology, we do the some of the nano texturing micro texturing.

So, that also we deal how this will improve the tool life.

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So, in the chapter 5, we deal with cutting fluids and the application as our course if you see it is the introduction to machining and machining fluids. So, machining fluids normally are the cutting fluids. So, this chapter also plays a very important role where you learn mostly about the cutting fluid basics as well as some of the advances in the cutting fluids like cutting fluids classification based on lubrication criteria based on cooling criteria and all those things.

What are the functions of the cutting fluids types of cutting fluids if you see the types of cutting fluids cutting fluid additives there are many additives which improve the performance of cutting fluids like biocides emulsifier rust inhibiters and all things at the same time this are mechanically very important, but if you see the environmentally they are slightly adverse effective.

So, they causes some of the problems to the operator and all those things. So, how to find a some optimum solution and all those things we will study in this chapter emission and health hazards Rheology of the cutting fluids normally the Rheology is nothing but the signs of flown deformation.

In this case, since the cutting fluid is a liquid normally what is the thing that we study is the flow properties. So, if you know the better flow properties of the cutting fluid if we can design a cutting fluid with better flow properties what will happen the flow ability

will increase to the intricate regions of the chip tool interface and the flank surface and work piece interface.

So, that it will improve the tool life at the same time will give the better surface roughness. So, the rheology aspects also we will study we study the biodegradability because after the multiple utilization of this cutting fluid if we dump into the a nearby water bodies or the soil bodies it will deteriorate the that eco system depend on the whether you are dumping into the water or whether you are dumping into the soil it will destroy I cannot say completely destroy it will have its own impact on that one.

So, the cutting fluid applications if we see the cutting fluid application normally you can apply flood cooling minimum quantity lubrication high pressure there are many varieties of application techniques are there at the same time this application techniques will vary depend on their standard of distance from machining region angle of impingement whether you are putting 45 degrees whether you are putting ninety degrees or whether you are putting sixty degrees and all those things it will vary.

If at all I want to send to the chip tool interface at what angle if I send and. So, that it will have the maximum affect that all things we will study. So, area of cooling if at all I am increasing the standard of distance what will happen my area of covering will be ; obviously, increases.

But the scene I want is a optimum area. So, for that purpose what will be my standard of distance if my standard of distance is less. So, it can cover only less area if my standard of distance is more. So, my covering area will be more, but I have to design my standard of distance so that my area of cooling will be the machining region.

So, once I calculate or experimentally measure my area of machining depend on that I can play with these input parameters like standard of distance angle of impingement so that the area of cooling and lubrication will be proper. So, as you know the cutting fluid application techniques there are different techniques that I have already told you that MQL and high pressure techniques and all those things.

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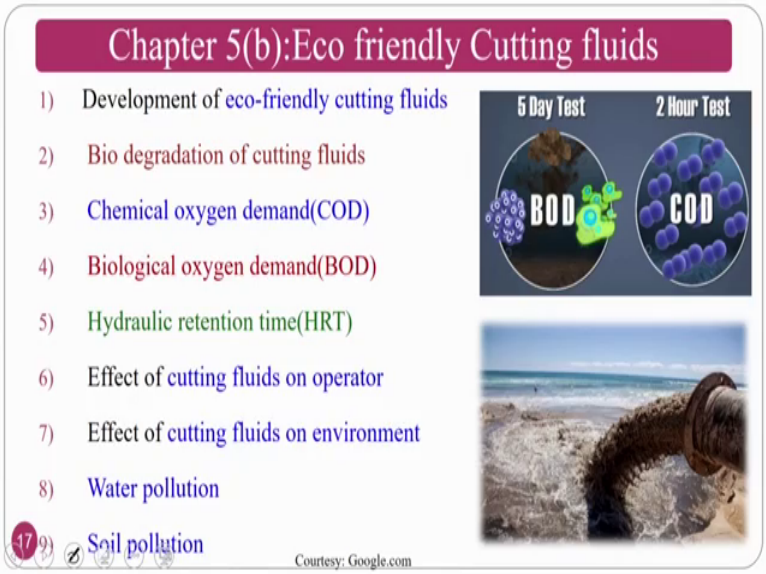

So, chapter 5 b, we deal with some of the echo friendly cutting fluids how to develop the echo friendly cutting fluids.

So, bio degradation of cutting fluid how to do the bio degradation so that the chemical oxygen demand biological oxygen demand, what is this chemical oxygen demand what is this biological oxygen demand what is a hydraulic retention time effect of cutting fluid on operator see; that means, that what are the effect of the cutting fluids on operator.

What is its causes if it is enters into the nose what will happen if it a falls on a skin what will happen; these are the things we will study the effect of cutting fluid on the environment c it will causes how it causes various adverse effect to the environment water pollution soil pollution and all these things, we study.

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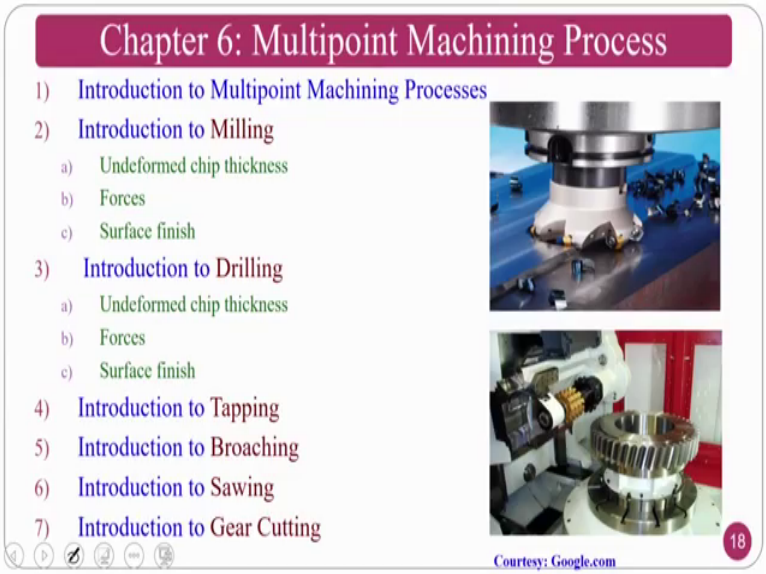

So, chapter 6, we deal with multipoint machining processes which is also some of the text books call it as practical machining processes. So, we do the study about introduction to multi point machining processes. So, we start with milling process introduction to milling what is undeformed chip thickness forces how the better surface finish is achieved in this milling process.

Then we go to the introduction to the drilling process and we see its slightly the introduction mechanism of that one and mechanics of that one forces surface finish undeformed chip thickness. So, we also study about the tapping process how to make internal and external threads on it using the tapping process the broaching is another process where if at all we want to do for the high aspect ratio applications.

Sawing if at all you want to do the parting operations we can use a sawing operation and gear cutting operation how to do the gear cutting operation and all those things.

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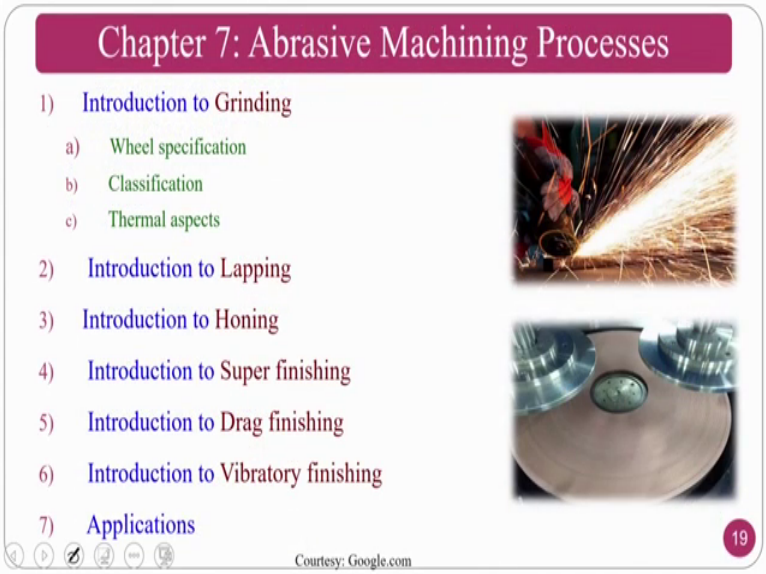

In the chapter 7, we see abrasive machining processes it comes under the multipoint cutting tool, but it is one of the abrasive processes basically ok.

So, the grinding process is one of the abrasive processes where we study about the wheel specification how to design the grinding wheel classification thermal aspect of grinding we and the conventional finishing process like lapping honing what are the effects of this processes on the surface finish of the product.

Lapping gives very better surface honing gives not only the surface finish it also gives such crochet patterns how it will generate this generation is due to the reciprocation and rotary motions of the tool, what is intra what is super finishing operation drag finishing vibratory finishing these are all the finishing processes that are commonly used for the bio implants. So, at the end of this course you should also see the practicality of the process and practicality of this course you should appreciate the course whenever you see we have studied the basics now we have to apply for this mechanism to the advanced applications.

So, we also see the obligations chapter 8, it is.

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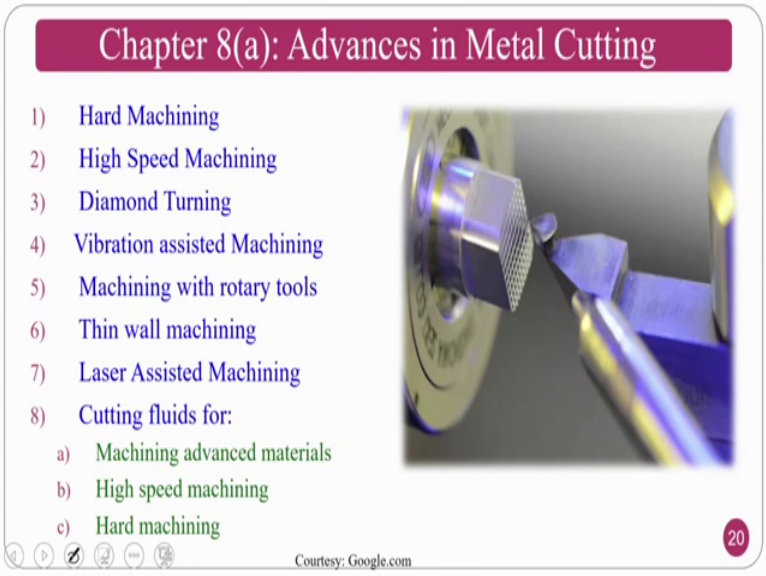

Completely introduction to the advances in metal cutting operations like hard machining what is hard machining till now, we have studied normal machining what is hard machining whenever you are we are machining the hard materials normally the HRC that is Rockwell hardness value is above 54 or 55 not only that it will depend your input parameters also.

So, normally it will depend on the work piece hardness basically. So, high speed machining whenever you are working or whenever you are operating the up this machining process at very high speeds. So, in terms of milling it is tool rotation in terms of turning it is work piece rotation.

So, they based on the rotary element this will decide diamond turning diamond turning normally it comes under the one of the finishing processes, but it is one of the advances in machining process vibration assisted machining normally vibrations are provided to the tool so that it will enhance machine ability.

Machining with rotary tools thin wall machining thin wall machining also plays a important in aerospace applications laser assisted machining normally laser assisted machining is one of the advance processes because if at all I want to machine a brittle material.

Normally, the in the conventional machining process if you see, if I want to machine a brittle material with tool normally in a conventional machining the tool is much much harder than work piece. So, what will happen there is chance of brittle fracture in order to avoid that what is what the researchers do is just they pass the laser on the work piece surface ahead of the tool. So, that it will partially soften the work piece; that means, we are converting the brittle material into ductile regime or ductile mode then we are doing the machining operation with the conventional cutting tools that is nothing but ductile regime machining of brittle materials.

So, indirectly what we are doing is we are converting the brittle material into the ductile mode then we are machining it that is called laser assisted machining process then we also look for the cutting fluids what are the advance cutting fluids that are used in high speed machining hard machining and machining of advance material like high speed machining.

The basic drawback of high speed machining is temperature will be very high how to overcome this one. So, you need to choose the cutting fluids whose cooling ability is higher there our cooling ability is most important factor rather than lubrication in hard machining operation lubrication should be higher cooling can be lower only thing is that it cannot be 0, but the thing is that how to optimize both the things that is what I mean ok.

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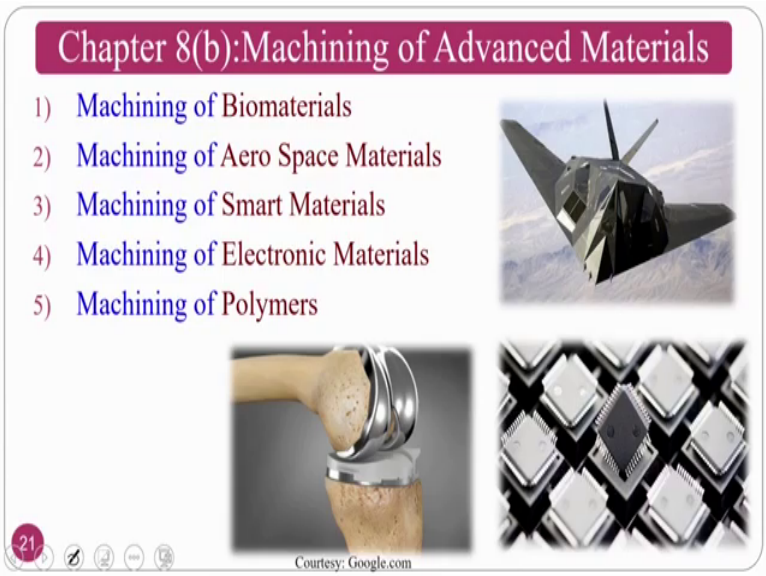

So, see we also study about machining of advance materials some of the advance materials as per now is concerned biomaterials. So, if at all I want to machine this me implant materials, how I have to do it because whenever if I do the temperature is very high and if I am using very hard tools what will happen if the temperature is very high, this surface what will happen is metallurgical changes which hampers the operators health when after some time of the implant inside.

So, in order to prevent all these things we have to take care of this material when the machining operation is going on the aerospace materials titanium alloys it is very difficult to machine the titanium alloys because the heat transferring heat dissipation ability of that material is low.

Whenever you are doing the machining operation the temperature stays mostly on the surface which will impart to the tools. So, the thermal softening of tool takes place and the tool life will goes down. So, we have to take some precautions while machining the airspace materials.

Machining of smart materials we do machining of the electronic materials and machining of polymers and composites. So, we also deal with machining of slightly composites when because the composites contains the reinforcement as well as matrix. So, whenever it is the tool is touching reinforcement what is the physics whenever it is touching the matrix what is the physics all these things we study ok.

So, that is all about my course introduction and thank you for registering for my course and from next class onwards we deal each and everything in detail in the course introduction to machining and machining fluids.

Thank you.