Introduction to Abrasive Machining and Finishing processes

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Lecture – 25
Summary of the Course: Introduction to Abrasive Machining and Finishing Processes

So, now we are coming to the end portion of this particular course on Introduction to Abrasive Machining and Finishing processes. Just I want to summarize what we have studied in this particular course.

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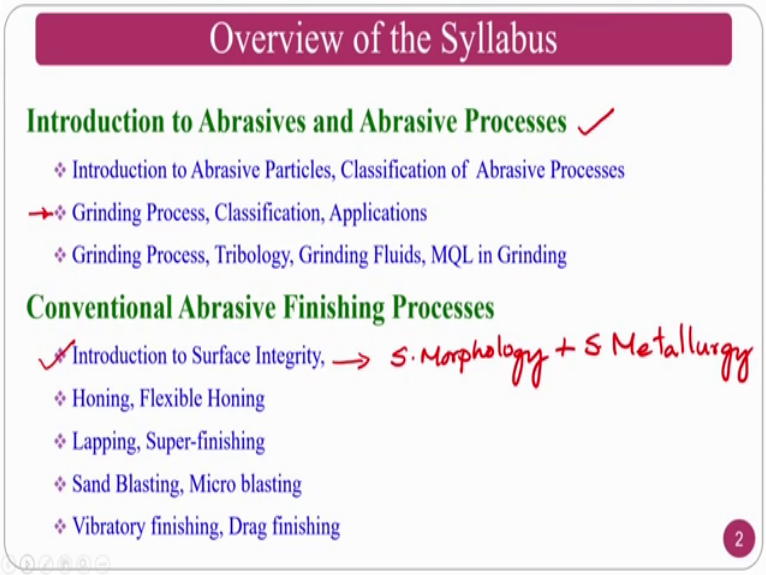

So, overview of the syllabus just let me show you that part we have covered if not in that week sometimes I would like to say sorry, because some of the things are not covered as per the scheduled given in the first slide. In the first presentation I have given the week wise topics, but because of the some of the video editings, some of the proto longing, of some of the concepts, some of the mechanisms to explain you better. So, this week the syllabus and weeks may not be matching properly, but there may be some of the changes instead of third week syllabus, it may some of the part of third week syllabus may go into the fourth week or like that fourth week into the fifth week.

So, there may be some changes. So, for this I beg your apology for the same and what I have covered in this particular course is like this. So, first we started with Introduction to

Abrasive course and Abrasive Processes, where in we have studied introduction to abrasive particles, how the abrasive particles are generated, how and these are prepared and classification of abrasive particles like, whether type of abrasive particles, message of abrasive particles and other things.

Then we move on to the grinding process where in we studied about classification of grinding, ranging from surface grinding process to the centre less grinding process and various applications. Surface grinding process normally we can apply for flat surfaces, then you can go for cylindrical grinding surface finishing processes where you can hold between the centers. Then you can go for the creep feed grinding where you can remove the material in a high quantity and proceed towards the centre less grinding process.

Then the grinding process tribology, grinding fluids and sustainable grinding process where in you can make this process sustainable by using the minimum quantity cutting fluid another technique is using the green cutting fluid and other things. So, conventional finishing processes and we will also see the introduction to surface integrity because this abrasive finishing processes are mainly for the generation of good surfaces ok. Surface integrity is stands for surface morphology and surface metallurgy ok. So, these two things we have seen in the grinding process then we have gone to the honing process and the another variant of this honing process is flexible honing process, where you have a spheres which are attached to a wire and how the flexibility can be incorporated in a honing stick.

That we have seen then we move on to the lapping process and super finishing, sandblasting and micro blasting, vibratory finishing and drag finishing what are the drawbacks of vibratory finishing like this thus the component which are there on the periphery of that the bowl will have more motion rather than the components that are there in the centre to avoid that one there will be a drag finishing process, where you can hold the component and the medium will be rotated. So, that all the components which are there at the respect locations we will get the similar surface finish.

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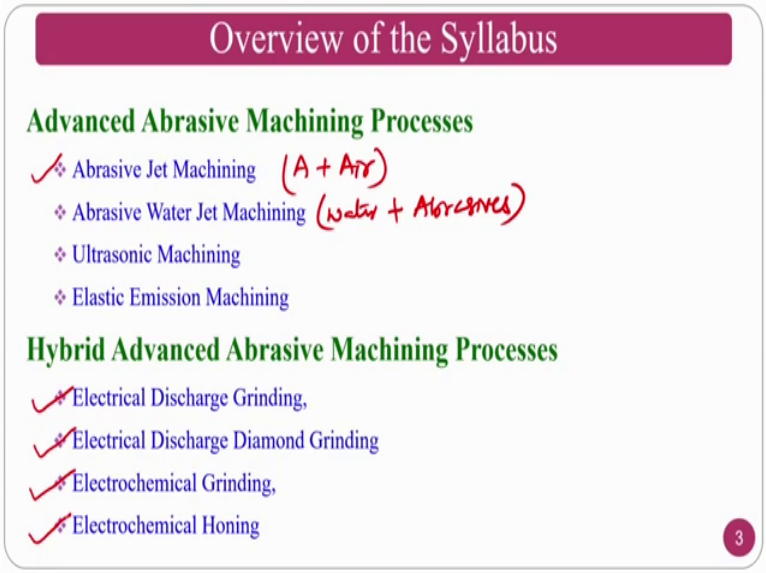

So, then we move on to the advanced abrasive machining processes where we have seen the abrasive jet machining process you uses abrasives plus air and abrasive water jet machining water plus abrasives and then you are going to use ultrasonic machining process where the ultrasonic motion is given to the tool so that it will hit the abrasive particle that comes in contact with this tool.

So, that the kinetic energy will be transformed and this will go and hit the work price similarly the material will remove ok. Then we have seen the elastic emission machining process. Then we move on to hybrid advanced abrasive machining processes, where in we have seen the electric discharge grinding, electric discharge diamond grinding, electrochemical grinding, electrochemical honing and other processes.

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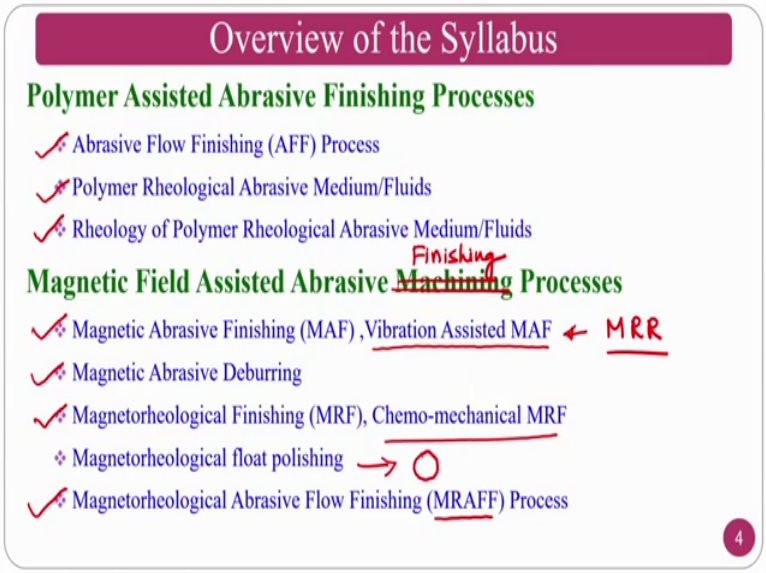

So, then we moved on to the polymer assisted abrasive finishing processes and we have seen abrasive flow finishing process, polymer rheological abrasive medium and fluid composition and other things and this is a complex part of this particular process. Then we have gone to the rheology of polymer rheological abrasive fluids are medium and at last or the finally, what we have studied is magnetic field assisted abrasive machining processes and finishing processes mostly you can it call it as finishing process.

So, the first one we have studied is magnetic abrasive finishing process followed by the magnetic deburring process at the same time there are some studies about vibrations assisted MAF, which I have not thought in this particular syllabus because of the time constant and other thing, but I can say that if you are going to give vibrations to this particular process what is going to improve is your material removal rate will improve ok.

So, the vibrations assist this MAF process to remove the material removal rate. So, the magnetic abrasive deburring the deburring of the chips that are adhere to the work piece can be removed. magnetorheological finishing process and chemo mechanical MRF is studied where CMP Chemo Mechanical Polishing is combined with magnetorheological finishing process and we are came up with a hybrid version that is called chemo mechanical MRF process, in the second go what we have done is magnetorheological finishing process is clubbed along with the abrasive flow finishing process and we

named it as magnetorheological abrasive flow finishing process and we also studied slightly about magnetorheological float polishing techniques, where you can do the finishing of spherical particles.

We have also studied magnetorheological float polishing techniques to finish the spherical particles are spherical shapes, but not very big spheres which is size constraint of small small spheres are which are made up of ceramics and other things can be finished using magnetorheological float polishing technique ok.

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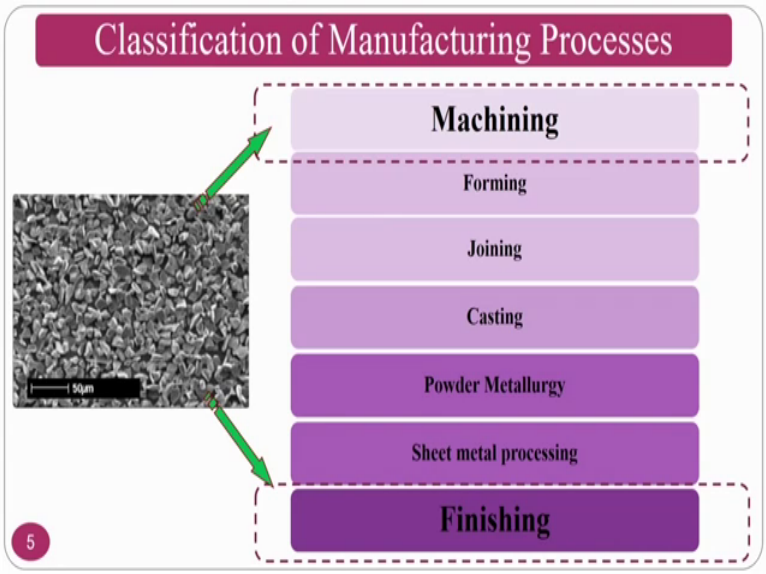

So, as we have seen that this abrasive processes mostly comes in the machining region as well as finishing region ok.

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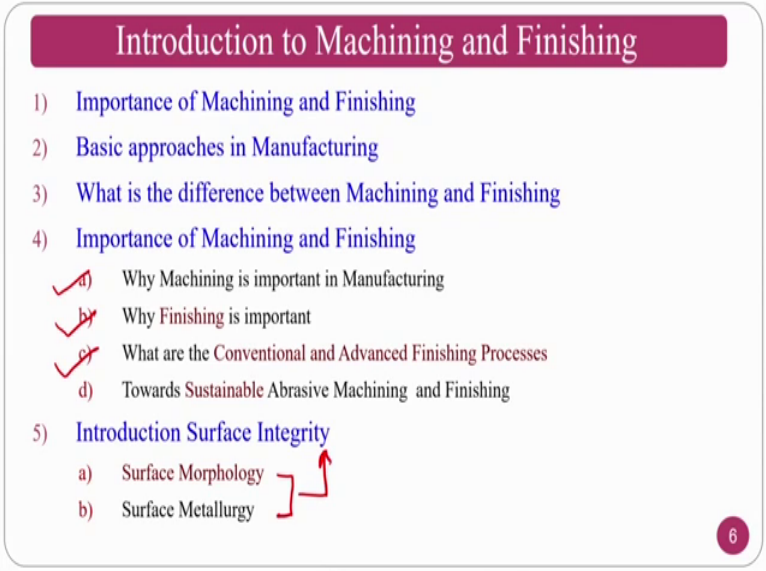

So, introduction to the machining and finishing importance of machining and finishing basic principles manufacturing and other things we have seen, why machining is important in manufacturing, why finishing is important in manufacturing these are all we have seen conventional and abrasive finishing processes. What are the things that come under this umbrella we have seen and introduction to surface integrity which deals with the surface morphology and surface metallurgy this two combinedly called as surface integrity ok.

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This we have seen and why we have to study abrasive machining and finishing processes that you have to understand ok. So, why we have to study is that finishing is one of the final processes on particular component. if you see here this is a welding region and if you are going to sell your product assume that this is a gas pipeline or the petrol pipeline what is going to happen is chemical reactions will takes place at the metallurgical changes locations.

Where the metallurgical changes locations are there these are the metallurgical changes locations. So, you have to do the polishing operation so, that you can achieve from this to this, at the same time finishing of knee implant and hip implants are most important. If you see here see if you are going to put the implant one and implant two. So, implant one will have very rough surface and your body fluid flows on this one and it will stagnant there and a rusting will occur another thing.

If you have a smooth surface like this what will happen the flexibility of your knee will be good at the same time your body fluids do not have much space to stay there ok, because of which rusting will decrease enormously and the life of the component will goes up, that is a beauty about the advanced finishing processes, that is why you need to study this particular course in detail and this is the beauty about the finishing of finishing using conventional finishing techniques and advanced finishing techniques that are used by abrasive particles ok.

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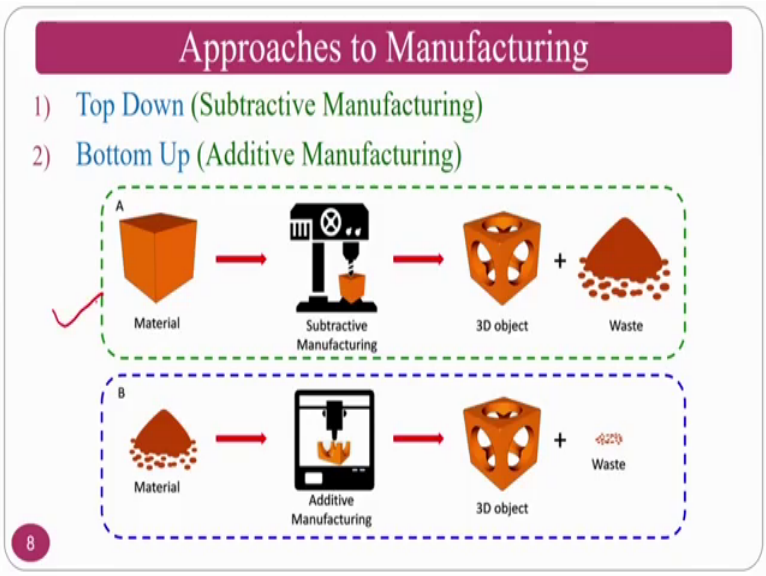

So, manufacturing we have two approaches and the approach that our process will belongs to is top down approach which is nothing, but the subtractive manufacturing process and people are following nowadays additive manufacturing also, but what our abrasive machining and finishing processes comes under the umbrella of subtractive machining processes or obstructive manufacturing processes.

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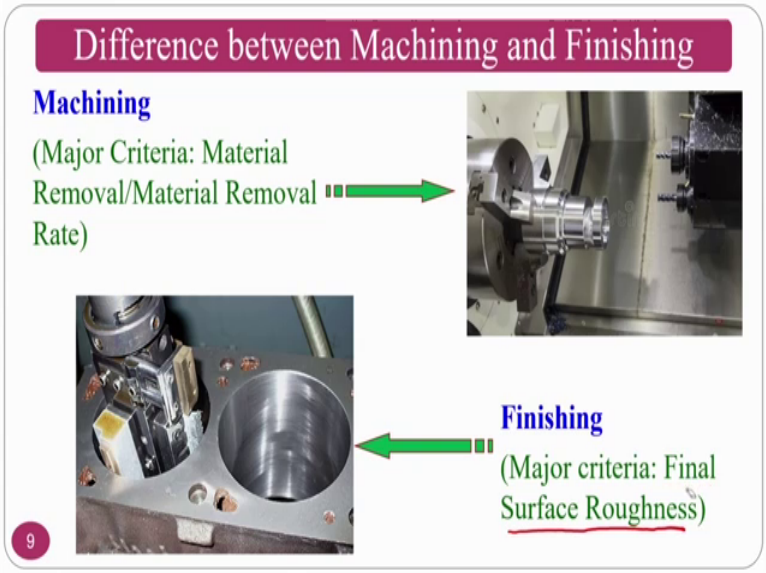

And you should know what is the difference between a machining and finishing if you have not there in my first lecture this lights will be much useful to you, if you have seen it then you can revise it what you have seen in the first class. The in a machining process you are mostly worried about how much material is removed, the major criteria is material removal or material removal rate are we have achieved, how much material is removed like the diameter is changed from 100 mm to 80 mm or not. That is my criteria in a finishing my criteria is what is the final surface roughness that are achieved whether achieved nano surface finish or a micro surface finish or which type of surface finish that I achieved ok.

That is most important in terms of finishing process hope you understood machining you will worry about material removal in finishing you do not worry about material removal, but you worry about the final surface roughness.

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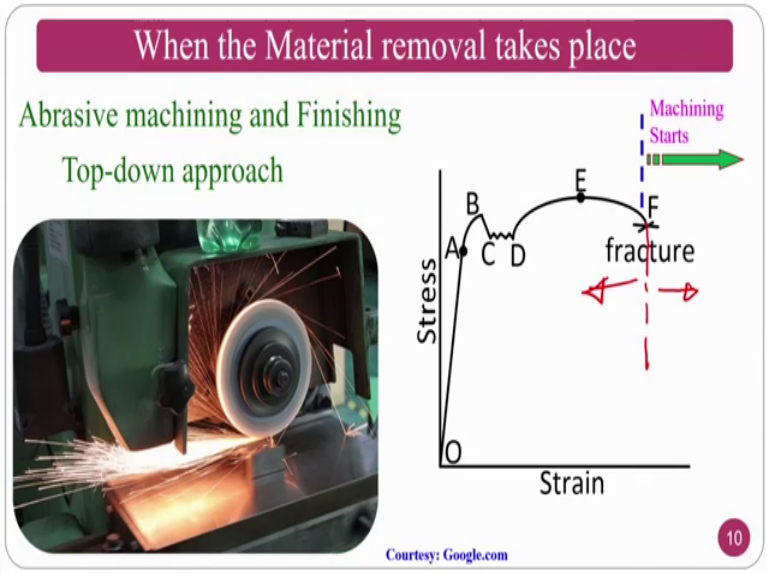

So, then grinding comes under the top down approach at the same time where the machining or the finishing starts is after the fractures. So, in the metal forming process and other processes we will follow in this region and metal cutting and finishing processes we will follow after the fracture.

So, because the material is shared out from the parent material ok, that is where in the engineering terms as per the metal forming is concerned fracture is already done, because the material removal processes like grinding, honing or conventional abrasive processes or unconventional abrasive processes wherever you see the material is detached or material is shared out from the parent material; that means, that it is severely plastic deformation and fracture is taking place; that means, that what you are going to see is the where the metal forming stops is a starting point for the metal cutting or machining processes or the finishing processes.

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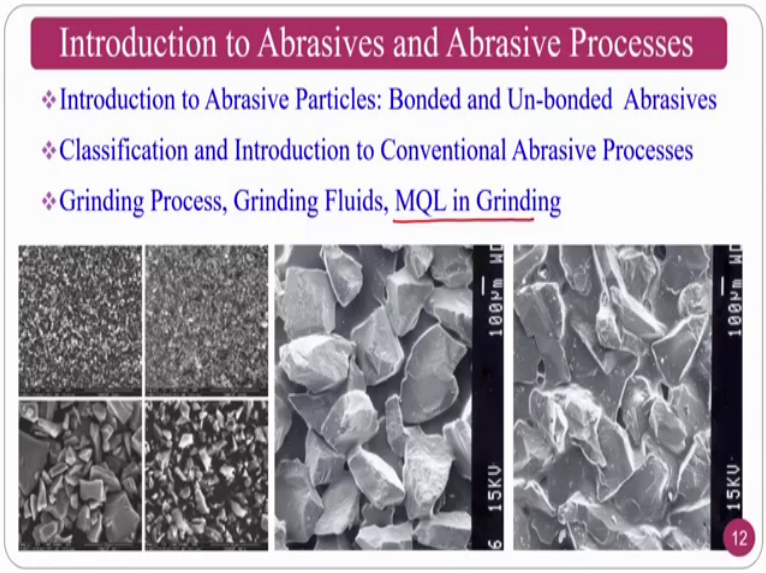

So, we will see what we have studied in detail. So, we have seen the abrasive particle sizes and how to convert the size of the abrasive particles from the messais and we have seen also the bonded abrasives what do you mean by coated abrasives in some of the cases the people will coat.

So, the abrasives are braze to the grinding wheel or braze to a wire, then on top of it they will gives the coating also ok, that we have seen at the same time the good thing that we have studied is how to protect our staff, even though if you are an engineer in a company how to protect for that purpose you have to find some sustainable solutions. Where in we have introduced you the grinding fluids which are biocompatible enough which prevent the environmental pollution up to the maximum extend which will also reduce the problems that are faced by the operators; that means, that the system and surroundings will be maintained environmentally good or you mean to say eco friendly you can do.

So, further purpose we have achieved we have studied two things one is minimum quantity lubrication in grinding process, I am very thankful for the help by given by Professor L. Vijayaraghavan of IIT Madras and the second thing we have studied is biodegradable or eco friendly cutting fluids development I am very thankful for this particular part to the my research group, where we have done our own fluid in collaboration with IISC Bangalore and how the BOD, COD and other things are to be

taken care before you are going to dump into the nearby water bodies are I think. So, that the ecosystem can be maintained these are all things we have studied.

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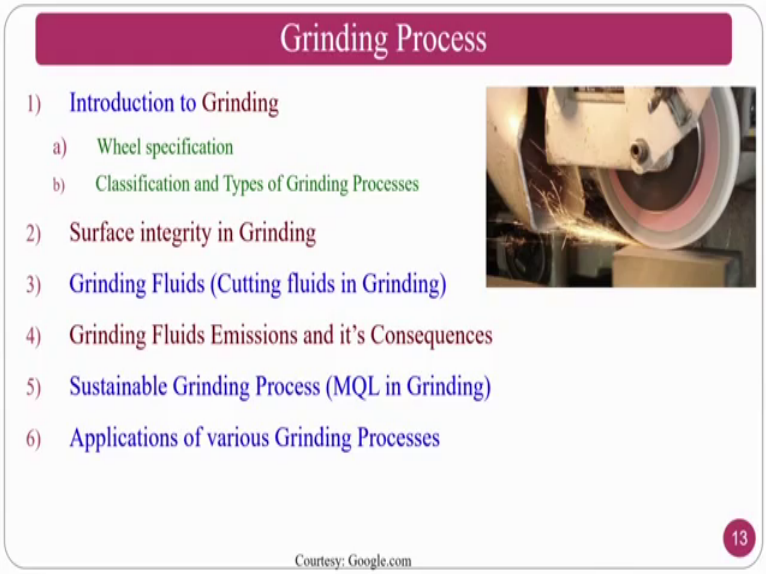

Then we move on to the surface integrity in grinding and wheel specification in the wheel specification we have seen what type of abrasive particle, size of abrasive particles, grid means how the abrasive particle is held by the bonding material and structure whether it is a open structure or a closed structure. In open structure you will have the abrasives are placed the part, in closed structure the abrasive particles density is more and at last what is the binding material, whether it is a clay, vitrified bond, rubber bond, metallic bond or some what type of bonds that you can use and what is its applications in various sectors.

Vitrified bond has its own applications, metallic bond has its own applications we have seen electric discharge grinding, we have seen electric discharge diamond grinding, electrochemical grinding and all these processes we will use metallic bonding.

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So, another processes which we have seen is a belt grinding process, where you have seen how the knee implants or fabricated or polished or finished in belt grinding people can go for a robotic arm with different motions and you can rotate or you can give some feed as per the requirement so that the moving belt can finish the implant materials. Lapping, buffing, super finishing and we have also seen the good process called pitch polishing for the lens manufacturing and other things and we have seen the sand blasting, micro blasting, vibratory finishing and the drag finishing operation.

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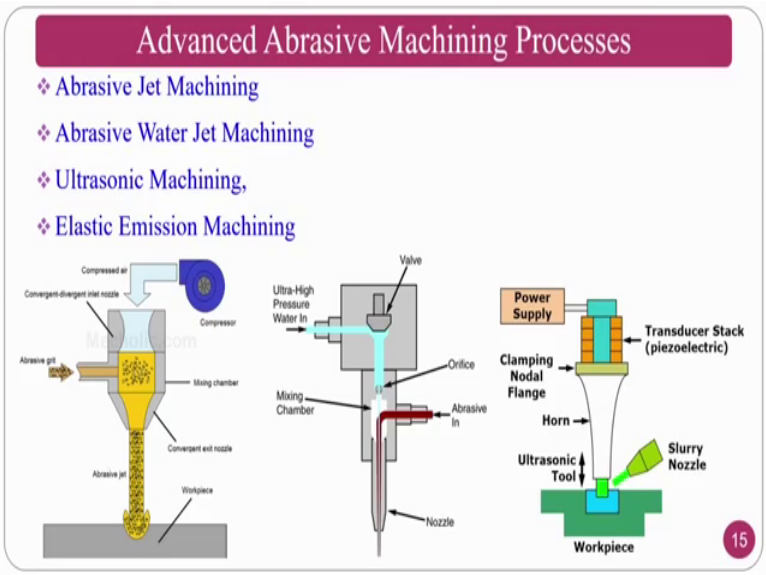

In the advanced abrasive machining processes we have seen abrasive jet machining then we have seen abrasive water jet machining and we have seen ultrasonic machining and elastic emission machining we have seen.

As I said in the previous slide in the abrasive jet machining we will take the assistance of the air to give the velocity to the abrasive particle whereas, in abrasive water jet machining we will take the assistance from the water to gain some a kinetic energy to the abrasive particle and hit the work piece. What is the beauty about this abrasive water jet machining compared to abrasive jet machining is confinement of the jet will be much better because in air the divergence is one of the problems ok. So, then move to ultrasonic machining process where you are going to feed this abrasive slurry between your workspace and the tool and the ultrasonic motions are given to the tool.

So, that tool will hit the abrasive particle which will come in contact with it then the abrasive particle gains the kinetic energy and hit the work piece the kinetic energy imparts the fracture if it is a brittle material and this fragments are carried away by the abrasive slurry. In elastic emission machining we have seen that spherical polymer ball will be there and the abrasives and the carrier medium will be there.

So, you can put some pressure there would not be any physical contact between your ball which is as made up of polymer and the surface, but there will be a chemical interaction between the atoms of the work piece and the fluid. So, that the atom by atom material removal will takes place and you can get a very good super finishing in this particular process.

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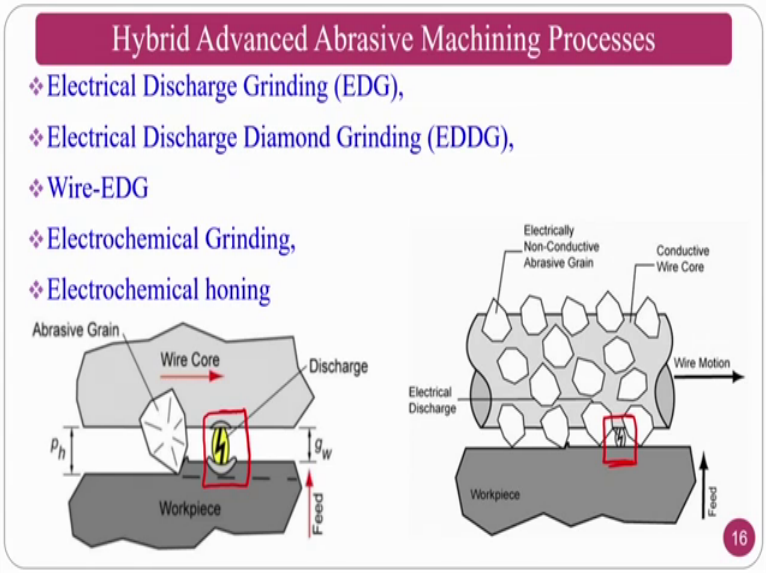

So, hybrid advanced abrasive machining processes, where we have seen electric discharge grinding wherein there will be a metallic wheel you will have a dielectric fluid and you can rotate it and the material removal in electric discharge grinding is purely by the spark.

You know idiom how the idiom works idiom works whenever you have a negative terminal whenever you have a positive terminal negative terminal releases your electrons, this electrons will hit the dielectric molecules dielectric molecules will again generate electronics because normally the dielectric fluid is a deionized water, deionized water means the ions are removed from it mostly removed the ions are mostly removed from it; that means, that electrons are dominating; that means, whenever you have one molecule of dielectric hit by a electron from the negative terminal, that we will generate lot of electrons.

The electrons are very small in size this electrons will proceed towards positive terminal in between it will hit again one set of dielectric molecules and generate millions and millions of this electrons. And these millions of electrons will go and hit the work piece the kinetic energy of this electrons will convert into the thermal energy. So, that the melting and evaporation takes place on the work piece similarly ions will move against the motion of the electrons and these ions will hit the tool material also, but the size of

the electron is smaller compare to the ion. So, the kinetic energy gains by electron will be more.

So, the thermal energy produced at the positive terminal will be high. So, the work piece material removal rate will be high and the ions are bigger in size and it has to move against the gravity and this number also very less. So, the tool material removal is very less, we have seen electric discharge diamond grinding process where in the diamond particles are brazed on a metallic wheel and where what you can see is there will be a spark because of each work piece will become thermal is off and then the diamond particle will remove the material.

Wire EDG we have also seen the diamond particles that are brazed on a wire and wire idiom similar mechanism you can see here like electric discharge diamond grinding the wire where the bare material is there the spark will be generated on the diamond particles will remove the material ok. Then we move on to electrochemical grinding process and then we have also seen electrochemical honing process.

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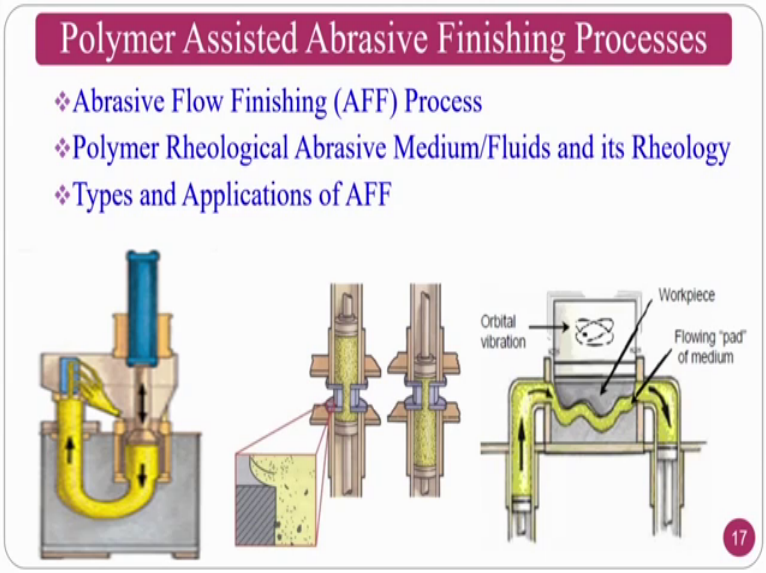

Then we move on to Polymer assisted abrasive finishing processes, where abrasive flow finishing we have studied then the polymer rheological abrasive medium and its rheology we have studied and types of abrasive flow finishing processes and their applications we have studied.

We can do a complex surface finishing can be done by the abrasive finishing process only, we can do the polishing or the finishing of any type of complex surfaces can be done only by polymer rheological abrasive medium, because here we do not require any external source like magnetic field based or something if you have a knee implant. It is very difficult for a magnetorheological finishing process to finish if at all if you want to finish the basic problem is the finishing time will be very high ok.

Because you have a electromagnet and electromagnet distance is constant because of which what will happen the field strength will be varying for the continuous curvature of the knee implant, but in case of polymer rheological abrasive fluids the fluid itself can do because of its viscoelastic nature. Because of this viscoelastic nature the viscous component tries to move axially along the direction of extrusion pressure radial force is by the virtue of the elastic component. So, there would not be any external source that is why you can do the finishing of any type of complex surfaces you using this abrasive flow finishing process especially using polymer rheological abrasive fluids.

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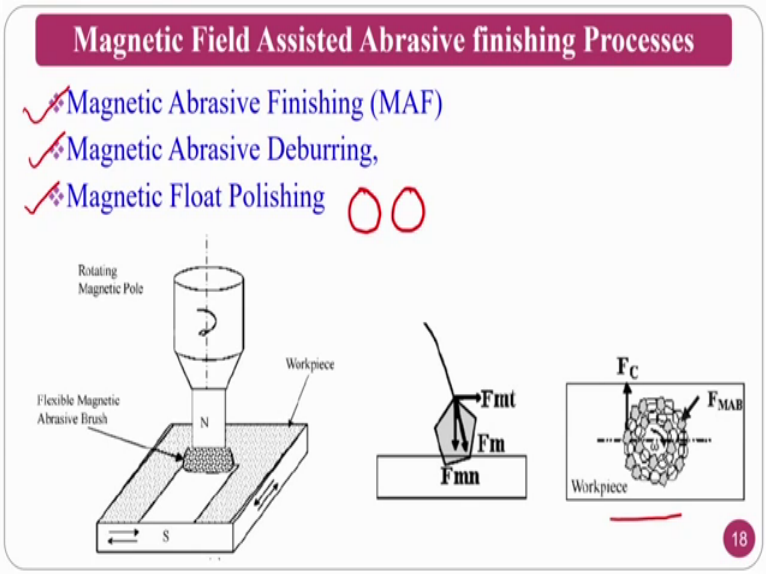

Then we move to the magnetic field assisted abrasive flow finishing processes where in we started with magnetic abrasive finishing process, then magnetic abrasive deburring process and magnetic float polishing process. In magnetic abrasive finishing process you can do for the flat surfaces and you can do go for the cylindrical surfaces internal cylinders as well as external cylindrical surfaces, and we move on to the deburring

operation using magnetic abrasive finishing process that is why this process is called magnetic abrasive deburring process.

And the burs that are generated during the drilling and micro drilling process can be removed by this magnetic abrasive deburring process. Then we move on to magnetic float polishing process where you can finish the ceramic spheres using this particular process. This particular magnetic abrasive finishing process and magnetic abrasive deburring process normally uses bonded abrasives where CIP particle are sintered with abrasive particles and this will become a bonded abrasive particle and then you can make a flexible magnetic abrasive brush and you can use it against the work piece to finish ok. There are two varieties of flexible magnetic abrasive brush we have studied one is static another one is pulsating in the pulsating the beauty about this particular thing is that you will get pulse there will be a gap and pulse.

Whenever there will be a gap this flexible magnetic abrasive brush will collapse instantaneously for a moment read time and then, again it will form a magnetic chains because of which what will happen because of this collapsing nature of this flexible magnetic brush. The new cutting edges will come into existence at the same time new abrasive particles also will come into existence because you are going to form new chain. That is why finishing efficiency is much better compared to static flexible magnetic abrasive brush that is why in pulsating flexible magnetic abrasive finishing process the surface finish that you are going to achieve is much better as well as material removal also will be better compared to static flexible magnetic abrasive brush.

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Then we have moved to magnetorheological abrasive finishing process where, the magnetorheological abrasive finishing process will be used for finishing of the contact lenses or many types of lenses.

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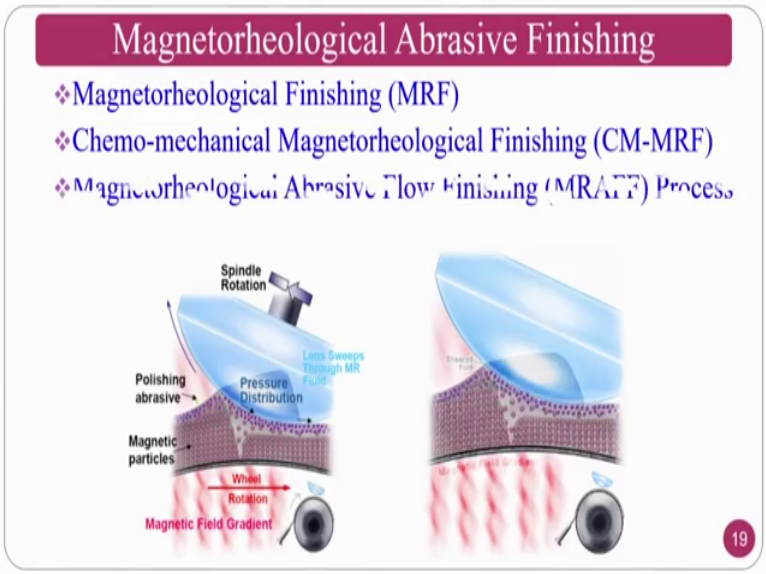

And this can be blended with chemo mechanical magnetorheological finishing process.

So, that this chemical action as well as magnetorheological action will come into place and do the polishing operation in a nanometer level or sub nanometer level and other

things. And later we have seen that magnetorheological finishing process can be blended with abrasive flow finishing process.

Abrasive flow finishing process the forces cannot be controlled because there is no controlling unit like magnetic field, but magnetorheological fluids will have CIP particles that is pure iron particles whenever you are going to put a magnetic field, then this chains will form and you can control the viscosity by external magnetic field. That is why the fluid of MRF process and the machine structure of abrasive flow finishing process are clubbed both and came up with a good solution that is called magnetorheological abrasive flow finishing process.

However in order to improve the magnetic field distribution and other things for cylindrical work pieces and some of the other work pieces rotational magnetorheological abrasive flow finishing also came into existence and the distribution will be uniform and the surface finish that is generated on a cylindrical tubes will be good. But what we have to notice between polymer rheological fluids and magnetorheological fluids is controlling ability is good in magnetorheological finishing fluids, but you cannot finish the much complex surfaces in magnetorheological finishing fluids, because of electromagnets are kept at certain distance if the curvature changes from point to point then the problem is the magnetic field intensity will go down as the distance increases because of which, what is going to happen is the finishing rate or the surface finish that you are going to achieve will be different from location to location.

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The list of the reference books and materials that are specified for this particular course is Principles of Abrasive Processes, this is the very good book for conventional finishing processes like grinding, lapping, honing almost all the abrasive processes. And you can also follow Professor V.K. Jain's, Micro manufacturing at the same time professor V.K. Jain's another book is there on Nano finishing Science and Technology published by CRC press, this also will give some of the insides of magnetic field assistant finishing processes as well as polymer rheological abrasive fluid based finishing processes also.

So, another book you can see is Advanced methods of machining by Professor Joseph Mc Geough and if at all you want to understand the grinding process and in deeply and other things you can follow Professor G.K. Lal's book Introduction to Machining Science, normally this particular process will have single point cutting tool, multi point cutting tool this particular book written by professor G.K. Lal have the single point cutting tool, multi point cutting tool and abrasive processes for specifically for this particular course you can go through the abrasive processes which are majorly written is conventional abrasive finishing processes and conventional abrasive finishing processes.

Ghosh and Malik Professor Amitabha Ghosh, Professor Ashok Kumar Malik has also written the manufacturing book where you can see the grinding process particularly about this particular course and other conventional machining process. So, Astakhov this metalworking fluids is the one of the good books that can give the insides of what are the

cutting fluids used for at the same time what are the positiveness for the mechanical point of view and what are the negatives about the environmental point of view.

Not only this books this particular slides mostly are taken from the research papers also ok. So, this particular course is a blend of research publications research books and common textbooks and many more; that means, that you are going to gain a blend of knowledge of various things in this particular course about abrasive machining and abrasive finishing processes.

So, what I want to say at this point of time is this particular course is a introductory course for abrasive machining and finishing processes; that means, that I am not going to cover any mathematics or mechanics or something or beyond that, because this particular course is just a introduction to make you understand how the process look like, and how the process works, and what are the applications, what are the capabilities of this particular process along with what are the advantages of this process is explained in this particular course.

I am very thankful for many people particularly the audience which is comprises of many people like students at the B. Tech level, masters level, research level, that is a PhD students and some of the assistant professors and faculties from various institutions across India who are listening to my classes sincerely, at the same time over asking me many doubts also I am very thankful whenever you people are asking questions we are also finding some answers and we are giving you the feedback that makes me this particular course a continuously learning course and I am sorry if I have spoken some of the words repeatedly.

So, I am very thankful to Professor Kijwan Haji who is currently the Head of the Central for Educational Technology, he has given me the opportunity to deliver this course and I am grateful to him. I am very grateful to those people who really involved their patients work in recording my course in editing my course taking feedback from me and my TAS. Then a reediting the course again making this particular course in a beautiful format to show you all Head of the Department of Mechanical Engineering Professor S. K. Dwivedy; who allowed me to teach this particular course from the Department of Mechanical Engineering IIT, Guwahati.

I am very thankful being a part of very good department, Department of Mechanical Engineering at IIT, Guwahati thanks to MOOCS and IIT, Guwahati. So, who are sitting at IIT Madras and who are sitting at IIT Guwahati and helping us giving the feedbacks in uploading the assignments, uploading the question papers and giving us the feedback what we have to do, how we have to do and other things and thanks to Professor V.K. Jain and the other professors like Professor Ramesh Babu, Professor P.K. Jain, Professor N.K. Jain.

So, many professors from whose references I have taken material at the same time I am very grateful to Professor V.K. Jain who has generously who shared some of his slides.

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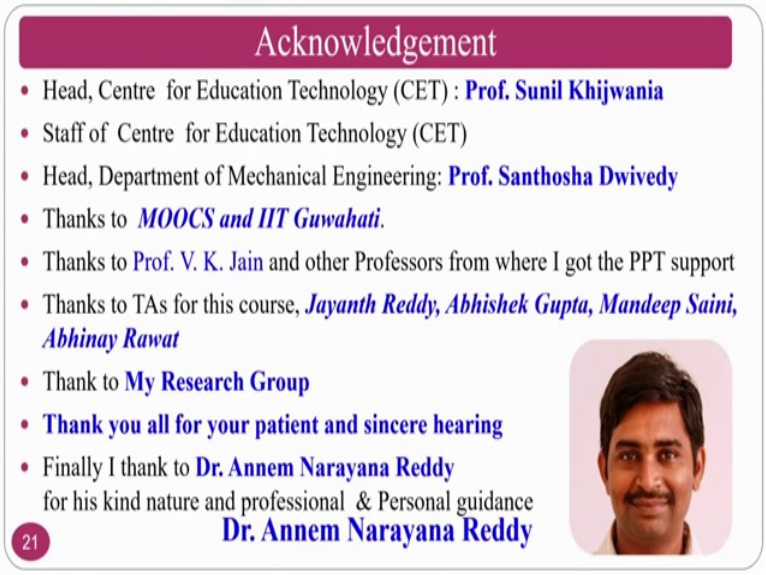

So, thanks to TAS like Jayanth Reddy, Abhishek Gupta, Mandeep Saini and Abhinay Rawat who are helping me in looking at the videos finding the errors helping in editing the videos and I am also thankful for my research group, who are also helping in weaving the videos, giving the feedback whether, I am where the mistakes are there how to overcome in the next video whenever I am shooting and other things.

I am very thankful to my research group who also assisted me in making this particular course and as I said I am very thankful to all the people who are registered for this course really and I am very grateful if you have learnt something out of this course and if you can give back to the society in terms of environment friendly nature, sustainability or if

you can do some of the research at the B. Tech level some of the research at the masters level or PhD level if my slides if my teaching is helpful for you.

Then I am very very grateful to all of you who utilizes this services and at last, but not least I am very grateful to my friend who recently expired and he is very great friend of me and at the same time he gave me lot of knowledge about the especially not about advanced machining and finishing processes, but in general who helped me in growing personally as well as professionally I am very thankful to Dr. Anyam Narayan Reddy and that is all about my course I am very thankful to all the people directly indirectly who helped me to make this particular course successfully.

Thank you and [FL].