Sensors and Actuators
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Lecture – 62
Basic aspects of 3D Printing

This module focus on how to use the 3D-printing technique. Now, 3D printing as you know has evolved several tens of folds from the last few years, and now it has been people are exploring you know the beauty of 3D printing into several different applications, right from automotive to medical devices. What kind of materials you can use; and then how the fabrication of this particular casing can be done using the 3D-printing module. I am just giving you an example, ok.

There are several kinds of 3D printers, including metal 3D printers. We will be not talking about metal 3D printers; we will be talking about two small modules that we have in the laboratory. I will request Sayed to discuss this 3D printer and take it over.

If you have any questions, again you are free to ask me. Let me again remind you there would be a sudden live show session as a part of this particular program. Apart from live-sessions, there are, there is a forum in which you can ask any technical questions, alright. So, feel free to use the forum in the best possible manner. You take care and I will hand over the lab to Sayed. Bye.

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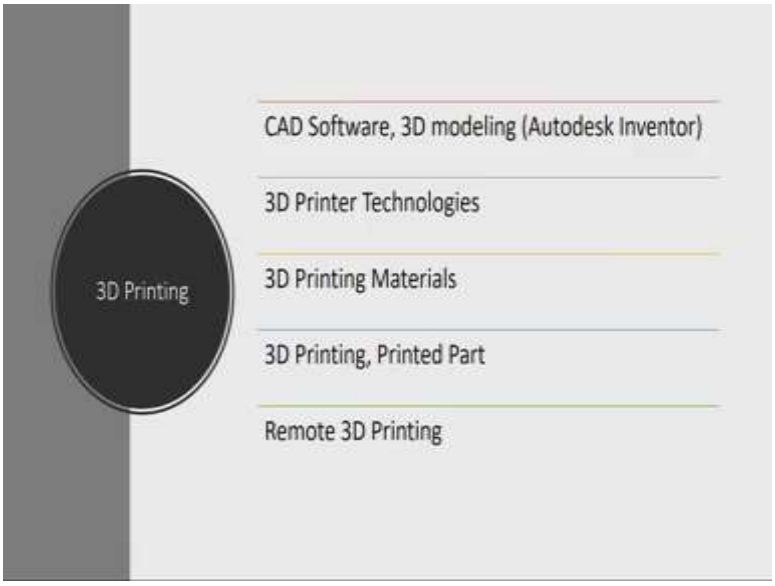

I will be explaining about 3D printing. In the 3D-printing there is CAD software, 3D modeling with Autodesk inventor. 3D printer technologies, what all different types of 3D printers are available. And then 3D printing material; 3D printing and a printed part, I will show you how to 3D print; how 3D printing will look like and a 3D printed part, and remote 3D printing and remote controlling of 3D printer.

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In the last session, I explained about sign up for a student account in Autodesk inventor, downloading, 3D modeling using CAD software. Here I in that video I use Autodesk inventor for that and basics of modeling, basics of Autodesk inventor, how to use different options to create objects and I explained most of the things using an example of an enclosure for switch and I explained about how to make an enclosure for the switch. So, today I will be explaining 3D printer types.

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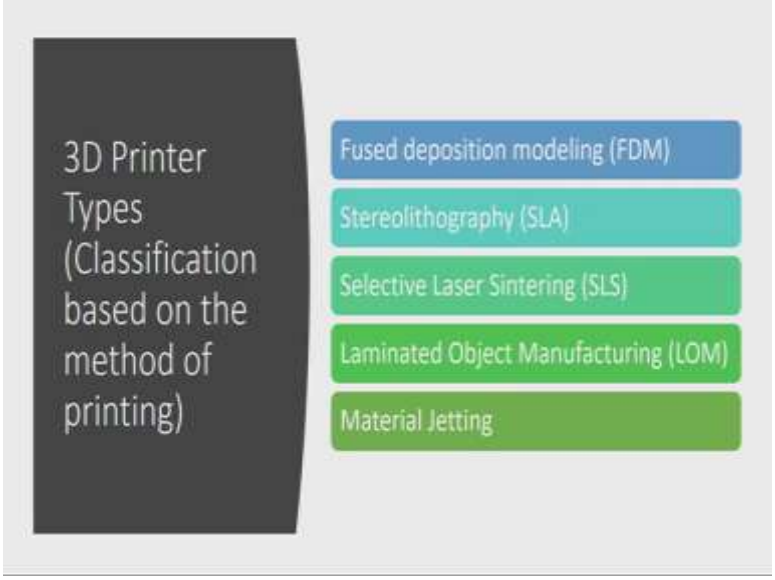

So, I will explain about 5 different types of 3D printers or 5 different types of 3D printing technologies. And there are more than 5 number 5 different types, but all different types can be similar to the 5 numbers I am explaining here.

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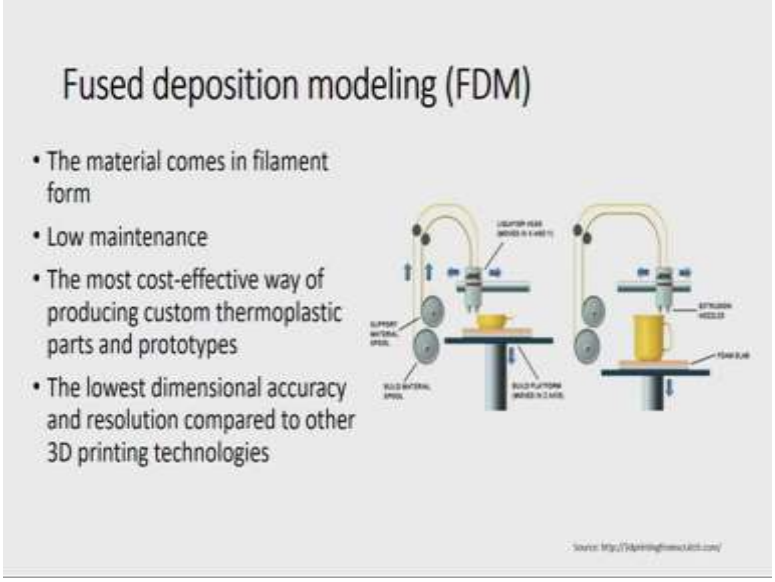

The first type I am going to explain is fused deposition modeling, modeling 3D-printer. So, the material will be stored as a filament and the filament comes in a rolled form. So, the 3D printer will take the filament from the rod and heat it and will deposit on a surface. In that fashion here you can see there are two photos, a cup is being made, so

here you can see a build materials pole there is a; this pole is where 3D printer filament is stored.

And next, here you can see a support materials pole. And while printing something or while making a 3D printable object, the 3D printer may require some support. Suppose, here we are making a cup, so the cup handle is something which is coming out of the main body. So, while printing the 3D printer may require some support structure to support the handle being made. So, that is why the 3D printer is using support material.

And then here liquefier head it is shown. The liquefier head means it will melt the materials, both build material and the support material and deposit on a frame which will move in the Z-axis and it is the most cost-efficient way of producing custom thermoplastic and parts for prototypes. Of course, that is for low volume. And the FDM 3D printing as the lowest dimensional accuracy and the solution compared to other 3D printing technologies.

But, one more thing is the FDM 3D printer as is seen, industrial-grade FDM 3D printer and home use or personnel use 3D printers for FDM 3D printers. Thus, the accuracy and the dimensional accuracy may differ, but as we stack different kinds of different technologies, this is one of the this FDM 3D printer will give only lower-dimensional accuracies.

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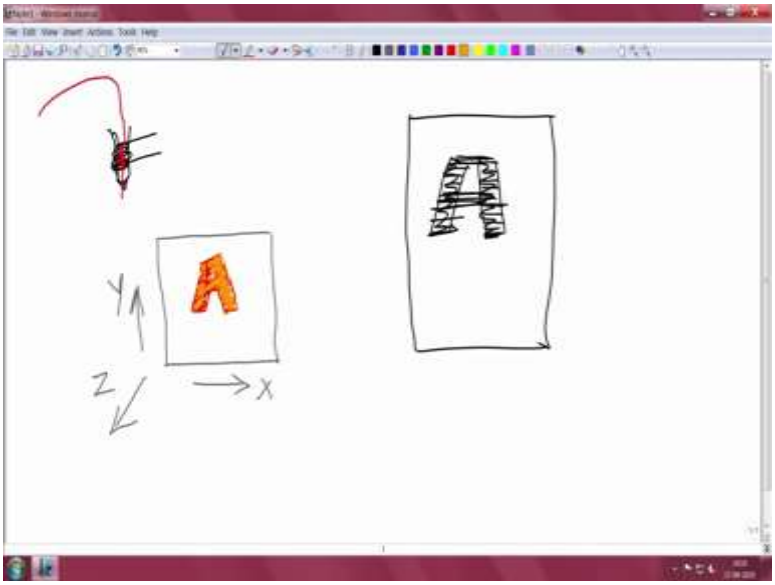

Suppose we are printing a document in an A 4 sheet. So, this is the A 4 sheet and the printer will print line by line, suppose line by line it will print suppose this is a big letter A. Letter A will be like this. This is a two-dimensional printing, but in three-dimensional printing, there will be a nozzle, there will be a heater here and the material will and the material will come through the heater and the material will be melted from here and it will be deposited through the nozzle. And it is collected on a plate that is also called build-plate.

So, the build plate is here and suppose this is X-axis, this X-axis and this is the Y-axis and the axis towards you is a Z-axis; axis towards you is Z-axis. So, the 3D printing nozzle will go somewhere here, somewhere here. And before 3, before doing 3D printing we will do some processes to give the file to the 3D printer so that 3D printer will know what object we have to print and how to print the object. So, the object will be cut into layer layers cut into different layers, and the nozzle will deposit material layer-by-layer.

Suppose, we are we want to make a three-dimensional A, here we here I just showed a letter A and we want to make a three-dimensional letter. So, the nozzle will go to the build plate and it will start the positive material and during the first layer will be like this and it will fill with the material. The nozzle will move in X and Y axis deposit material like this, and then the middle plate will move far away from the nozzle or the nozzle will move far away from the build plate both are possible in FDM 3D printers. I will show both types of FDM 3D printers in the next video.

Here the build plate will move away from the nozzle and then again it will deposit the same material. I will show it in a different color. Again, it will deposit material on top of the first layer will be like this. So, if you are looking from the top, you will only see these orange colors that are we have two layers of media. Similarly, the nozzle will deposit multiple layers to make a three-dimensional object. Here I explained it as a with the example of the three-dimensional letter A.

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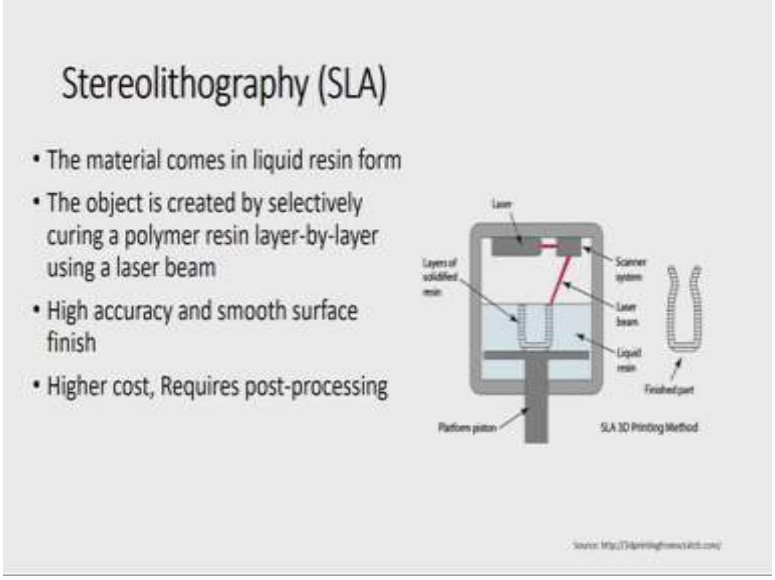

Next is stereolithography. Here, there is some difference from the previous FDM 3D printer. This will be, here the material will be a liquid, a liquid resin the specialty of the resin is when a UV light is shown to the liquid it will solidify.

Previously, in FDM 3D printers there will be solid materials solid plastic material that will be heated for making it easier for the portion of material. Here in stereolithography, the material will be liquid and as you can see in the picture there will be a laser source and laser scanner system and then the laser beam is shown to the liquid resin. Here the liquid resin is there. And layers of u shape are the layers of solidified resins and the right side after the completion of the object you can see the finished part. Here there is a platform piston. The platform will be on the top side when the printing is started. Once the first layer is finished the piston will move downside and the next layer will be info progressed.

Here the objects are created by selectively curing the polymer resin layer-by-layer using a laser beam. One of the advantages of this SLA 3D printing is its high accuracy and smooth surface finish. The high accuracy and smooth surface finish come at a cost. Compared to FDM 3D printers, the cost of the material the liquid resin is very high and compared to FDM 3D printers the SLA 3D printer most of the prints will require post-processing, post-processing stage. In FDM 3D printing, if we are not using some support material we can almost print a finalized part and know most probably will not require

any post-processing, but here in SLA stereolithography, you will require a post-processing stage.

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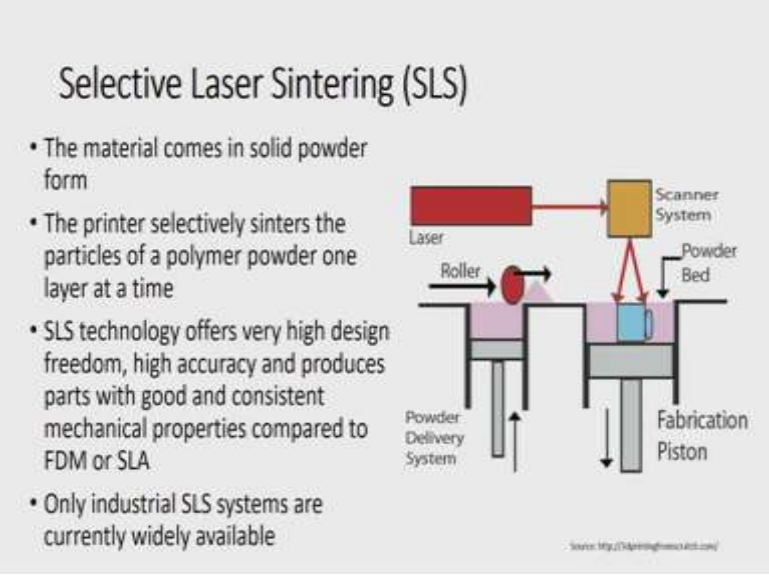

Next is Selective Laser Sintering, SLS. In short, it is called SLS. The materials come in powder form, so it will be in solid powder form. In the SLA, in the SLS stereolithography, we discussed this before the material is coming in liquid form. Here in SLS, the material is coming in powder form. Here in the image in the picture, you can see there are can we, ok, there are two reservoirs one there is only one the, there is one reservoir and next is the printing volume.

Initially, there the piston on the reservoir will be at the bottom and the fill material will be stored in the reservoir. And the fabricate in the build volume the fabrication will be at the top side and the roller here, you can see the roller will move from left side to the right side the definite quantity of powder is transferred from the reservoir to the build volume. And the thickness of the powder delivered to the build volume is controlled, and the roller will move from left side to right side and again it will come back to the initial position such that the uniformity of the layer delivered to the build volume is consistent.

And then a laser, so as is there. And a laser scanner system that will direct the laser beam to the X, Y-axis or which are required. And in this also here the laser scanner and laser pointing system are similar to the SLS 3D printing method, but the only difference is instead of a liquid resin here we are using a powder material. So, here the materials from

the reservoir are transferred to the build volume, then the laser is pointed and the material is heated and the material which is exposed to the laser will be sintered and the material will adhere together.

In this method also, the 3D printing is happening by solidifying the powder layer-by-layer. And one of the main advantages of SLS technology is it offers very high design freedom and high accuracy and produces parts with good and consistent mechanical properties compared to the previously discussed FDM or SLA.

Here one more advantage is when the layers are built we are filling the powder, the material powder to the total build volume. So, already there will be a support material. So, we similar to we are making in FDM or SLA 3D printing, there are there will be no support structure is required in SLS 3D printing. Currently, there are the SLS 3D printing is used in industrial, there are some small scale SLS 3D printer, but it is not popular as FDM or SLA 3D printers.

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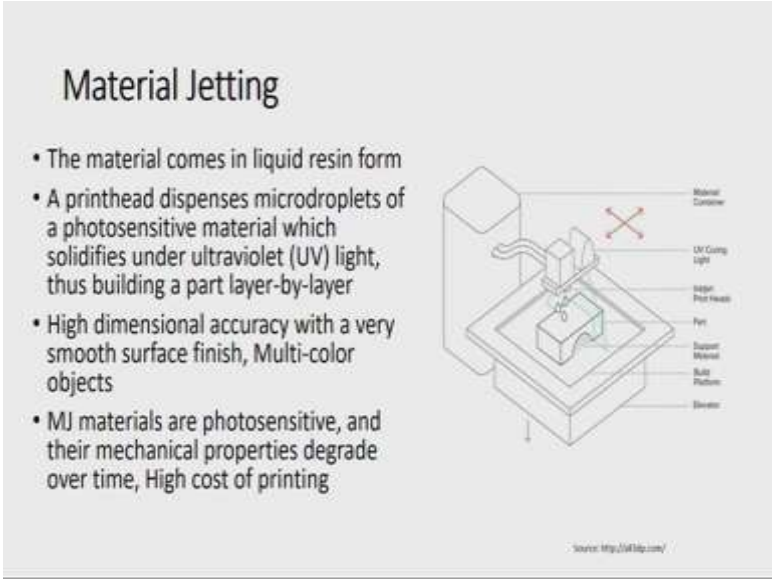

The next technology is material jetting. This is similar to a normal inkjet 3D printer. In normal printers a paper will be in the bottom side and ink cartridge will be there and ink nozzles will be there. The ink nozzle will go over the over the paper and it will deposit printing ink on the paper.

Similarly, here the printer will use a UV curable ink and the printer head will move on the build surface and the printer nozzle will deposit printing ink and then a UV light will pass through, the UV light will also be attached on the head, then the layer will be cured. And then the 3D printing head will move over this and again it will deposit material deposit ink or material and then it will be shown to UV light it will be cured. So, similarly, the material jetting 3D printer will deposit ink UV curable ink and it will be cured layer, the UV light will cure the ink which is deposited and layer-by-layer the 3D object is made.

One of the advantages of these materials jetting 3D printer is it offers very high dimensional accuracy and a very smooth surface. It has an inherent advantage of making multicolor material jetting is. Material jetting, materials are photosensitive and their mechanical properties will degrade over time. So, the objects made using material jetting cannot be used for a prolonged time or which cannot be used for some dynamic applications. It has, it also the as high cost of printing. The material jetting 3D printer comes at a very high cost and the material also is at high costs.

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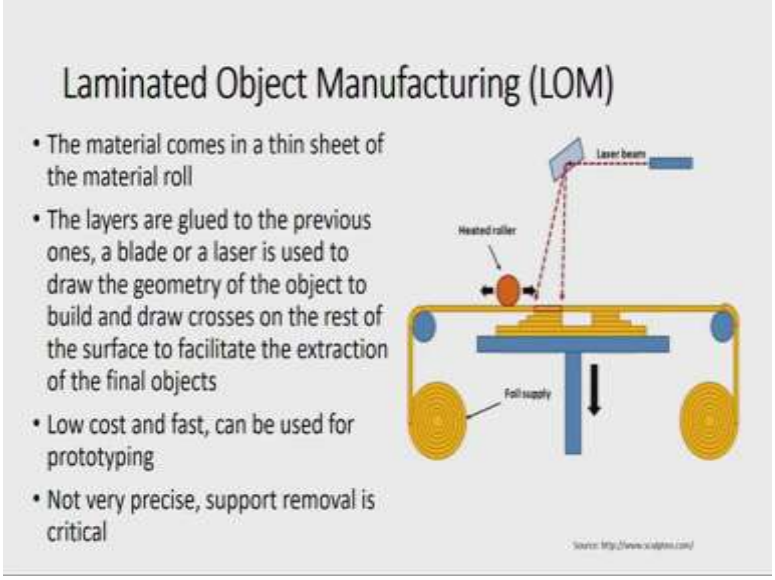

Next is laminated object manufacturing. Here in laminated object manufacturing, in FDM 3D printer the material comes as a filament and it is heated and deposited on a plate. In SLA 3D printing, there will be a resin; the resin will be selectively cured to make the final object. In SLS 3D printing, the powder will be there and a laser using a

laser beam the powder is sintered to make the object. In material jetting the light cure, UV light curable material is deposited through micro orifices and it is cured using a UV light. Here in this case in laminated object manufacturing made using layer-by-layer of a thin sheet of some material rod, this can be paper or can be plastic.

Here you can see there are two roles one is foil supply and the role on the right side is the waste collection. And there is a heated roll, you can see it will move from left side to right side. And the build plate will move down once a layer is completed. In the top, there is a laser source and the mechanism for finding the laser beam in the X Y axes of the build plate. So, initially, the build plate will be at the topmost position and over there the foil will be there and the heated roller will roll over the foil and then the laser beam will cut the layer according to the file given to the 3D printer. Then, the laminated object manufacturing the multiple layers are glued together if the foil is up if the material used is a paper or it will be glued using heat if that is a polymer.

And one of the main advantages of laminated object manufacturing compared to the other types is this is having the object will be having very with very low cost and the printing will be very faster compared to others. And this laminated object manufacturing also is not popular. Since it is not very precise and supports material removal is very critical and this may damage the 3D printed object we require.

In the material jetting there is a combination of; there is a combination of materials jetting and selective laser sintering; that means, instead of giving a laser pointer to heat the material make microdroplets of glue and it will be dispensed to the material. So, instead of the laser pointer in the SLS 3D printer, the 3D printer will use glue to bind the material together that is called, which is a similar technology as the material jetting.