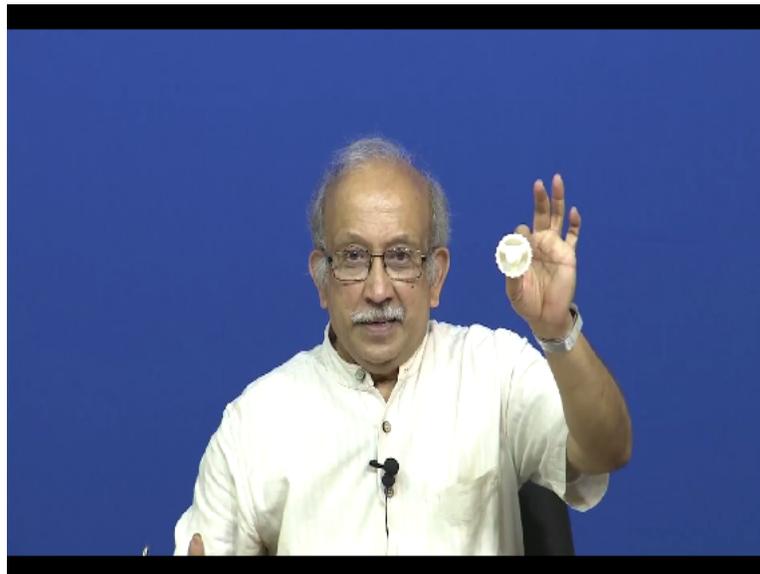


**Physical Modelling for Electronics Enclosures Using Rapid Prototyping**  
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**Lecture – 12**  
**3D Printing Detail 1**

Hello. Let me get back to a practical example of where we can use, this so called, 3D printing or rapid prototyping versus the conventional prototyping. So I will give you 2 examples.

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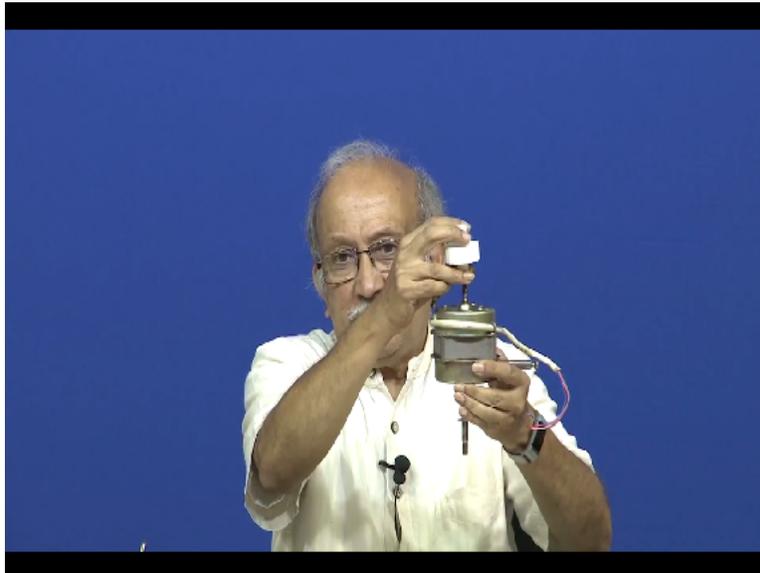


For example, here you see a, it is called a full planetary drive. So we have 3 elements here. We have a planet carrier, then we have the sun gear, I am sorry, we have the sun gear and then we have the ring gear. So it is also differential. Not long ago, meaning about 30 years back, building it was not easy to the extent that so many parts had to be assembled together. Now this is one place where your 3D printing helps a lot. If I can imagine a project, I will call the whole assembly a project.

Imagine the sequence of the various parts, the way it is assembled, I can have a beautiful this thing including, can you see here, all the gears, everything. Here there are everything, is beautifully sitting there without the, anything and there are no axles. There is no metal and it works. Now comes the important thing. Where do we use such a thing? In a place like say electro-mechanics where, you know, simple lab demonstrations all that, it does make sense.

There is no issue about it.

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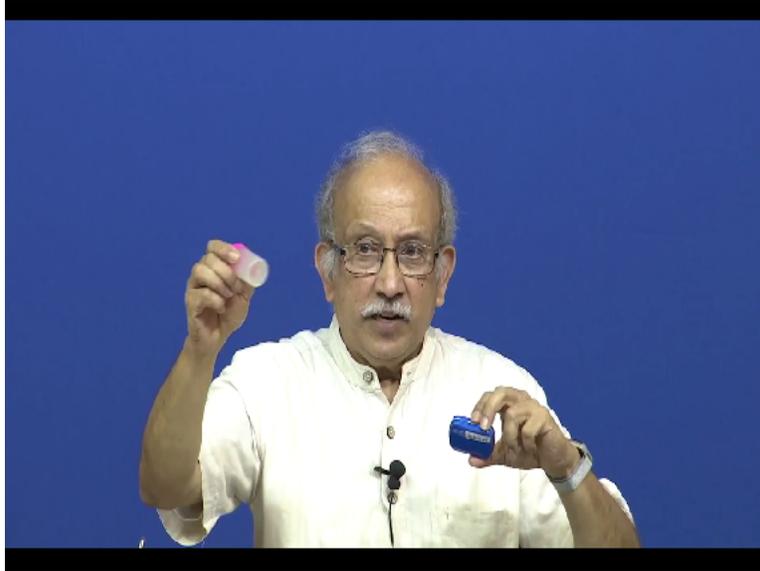


But if you go to practical real life examples, this is taken from a fan motor, a pedestal fan motor. So here a lot of details about how the impeller or the fan is fitted. Then you have the motor itself. At the back, here a small mechanism to do other things other than running the propeller or the impeller. This is where generally I will show you if possible on the internet later, we have a reduction drive to make this whole thing oscillate about this plane at very slow things.

Right now, it is not, what do you call, you will not have too much of control on the speed of oscillation or the total angle of oscillation. So we just try to reduce it here and then have a fixed pivot and then we have something here and then when it moves, this whole thing moves like that. Same thing, when it is suspended from a ceiling, instead of having this worm drive, probably something like this will make sense.

So as it rotates here slowly, I mean, as it rotates past here, the last portion rotates slowly and if it is mounted on gym ball movement, this whole thing can move like this. Now comes the important thing.

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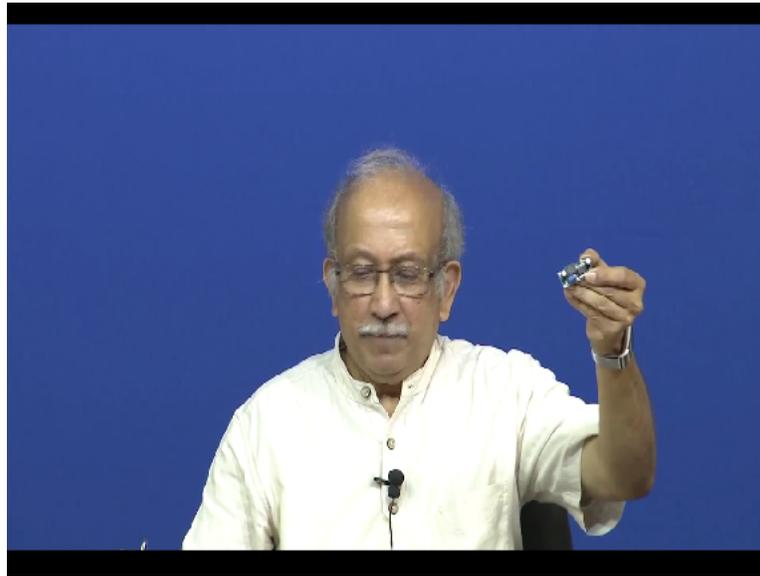
We end up with classical example of, what to do with small containers like this. This container is probably; I do not know what it is. Long long ago, we used to get films in it, what you call 35 mm, silver argent films used to come in this, celluloid films. And later on, important things got replaced by metallic. Advantage of this, is a soft and you can also rotate it and then you can do whatever you want with it.

Disadvantage? It will break. Whatever you do, the whole thing will break. In contrast, this one is rigid and it can take any amount of beating. This for some other reason, traditionally these have been coming in these sorts of things and it says mints, impact mints. Mints are that small things people chew and it was imperative at one time that you package them in this tin cans or tin boxes. Now this tin box can easily be replaced by this, there is no issue about it.

However, when it comes to some other special applications like this, we still have a small problem. You have a worm drive directly, a worm wheel which is fitted on this axis. Now this worm wheel on this axis makes sense but as the reduction keep increasing, you end up with the, the last pinion having to take tremendous amount of torque and by definition, pinions are small compared to the gear. The assembly have, later I will show you at the end of the lecture.

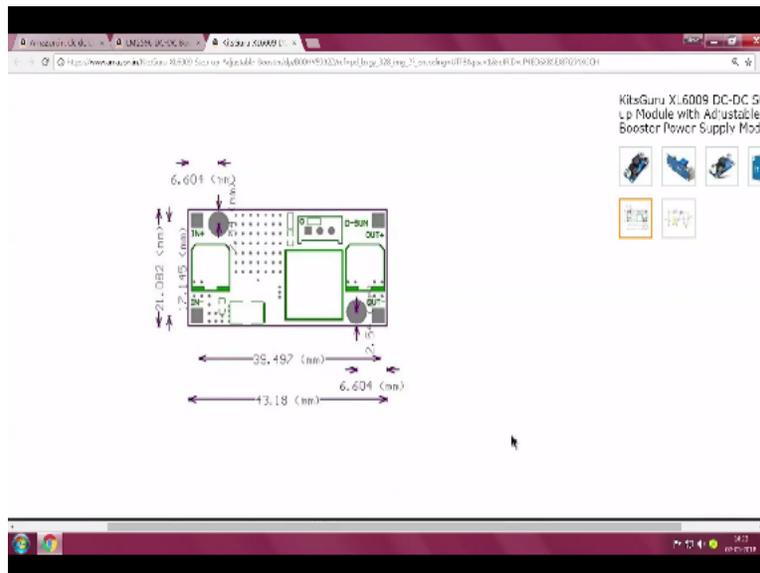
We have the small pinion and then you have the big gear, tremendous torque is seen by the last member, often it fails.

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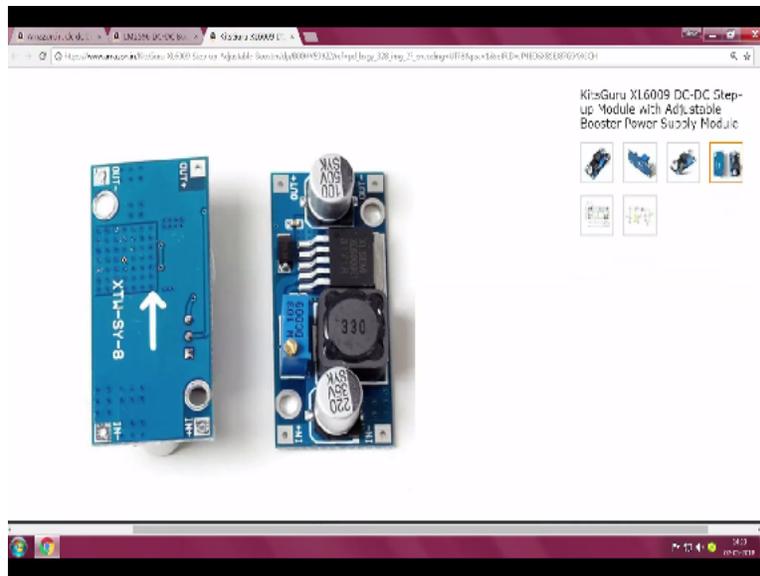
Before I get back to that, I will show you another simple example where traditionally we have been using this rapid prototyping.

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You see, this is a picture of some bottom portion of this buck converter. In this case, it is a step-up model. I am sorry, then it is a small boost converter. Step-up model with adjustable booster power supply. The issue being it comes like this.

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Can you show this? You see here, this is the tiny small thing. I need to make a box which will carry this and this, herein lies the problem. The problem is it is not just about a box. Now back to the monitor. We need power supply control of switching losses and provide a heat sink. You see here at the bottom; Can you see at the bottom? what we have here? Part of this has small landing where this side of the heat sink, there is a power device here with a switching regulator, I mean, rather switcher.

And then you have a small landing gear here in which you have through holes which are metalized. Now the applications note says this can supply safely a certain current given a certain input-output voltage differential and the total losses. While favourable conditions, the efficiency is 95% and you have 5% losses. Some conditions may occur where the losses are higher. Now we need to dissipate heat of the order of, a watt or more.

So there is a tendency for it to, tendency for this to get hot. So in spite of all this being done, they have made a provision here by which we are expected to attach a heat sink to this. Now further going back, I need to do something to make an enclosure to put it inside because the whole thing is exposed. You see here I have a positive output terminal, negative output, I am sorry, positive output and negative output.

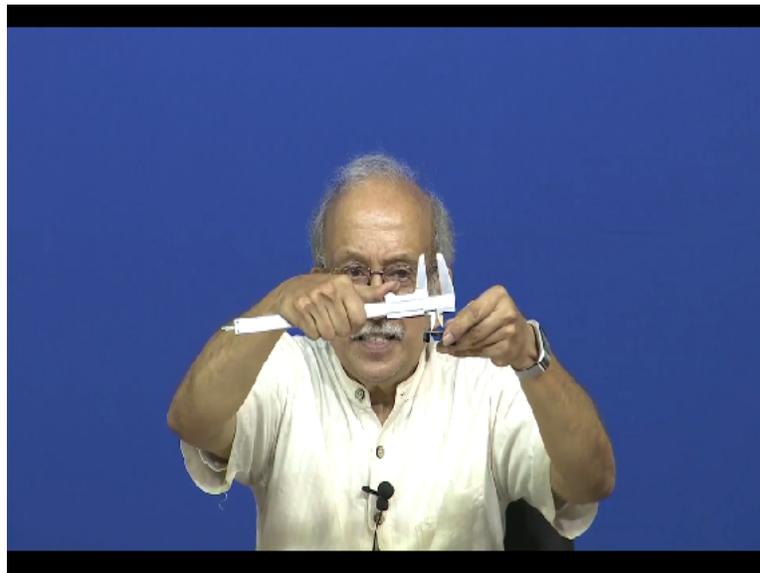
Similarly, a negative in and positive in and then these 2 other holes are for the mounting. Now if

I go back to the catalogue details, everything I want, want from the printed circuit board, footprint has been given here. One of the first things I have given here, you will notice is, can you see outside size 13.18 mm and 21.08. So I can round it of to 22x13 or logically, it is probably 1 inch 25\*, a little more than 1/2 inch, say 3/8 inch.

And a little data also is given about the mounting hole. Can you see here? There is a mounting hole here with, what do you call, offset from the, that place. Similarly offset from here and given all these dimensions saying you have 6.604 6.604 that is given this 13-all these, what do you call, mm, there seems to be some error. So it is possible for us to get back into, what do you call, yes, that was a mistake, actually 39.47, so this is 43.18.

It is not this thing. So we know the center distance of these vertical distance of these holes and all that. Now on the other monitor, the other dimension that has not been given is, if you look at this, see here what has not been given is, we have lot of this active devices. If you have to make an enclosure for it, very critical thing about height of the modules have not been given. While in the back dimension, it is valid. Now you see here, there is a slight variation from the actual.

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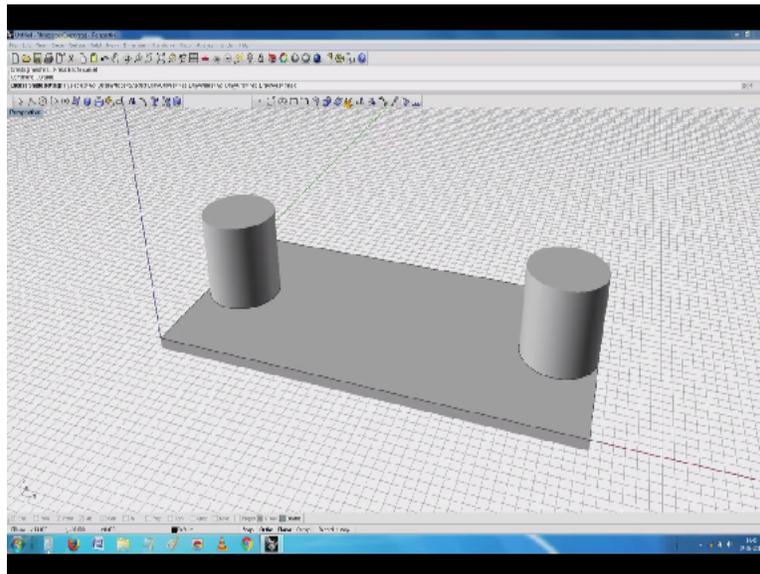


See here, now this is where I need this Vernier and I need to take authentic dimensions of what are the components. Whatever is specified here can easily be verified. This is correct. There is no issue about it. Similarly, there is no issue about it. And there is not much of a problem about the

size of the heat sink and all these things. But we do have a problem or we have this about what to do with this large capacitors?

You have noticed here these capacitors are slightly larger than what has been shown in the catalogue. No quickly, I will try to follow the dimensions that are given in this and see what best I can do and most important is, how best to deal with the heat? Is there a way in which I can deal with the heat given this?

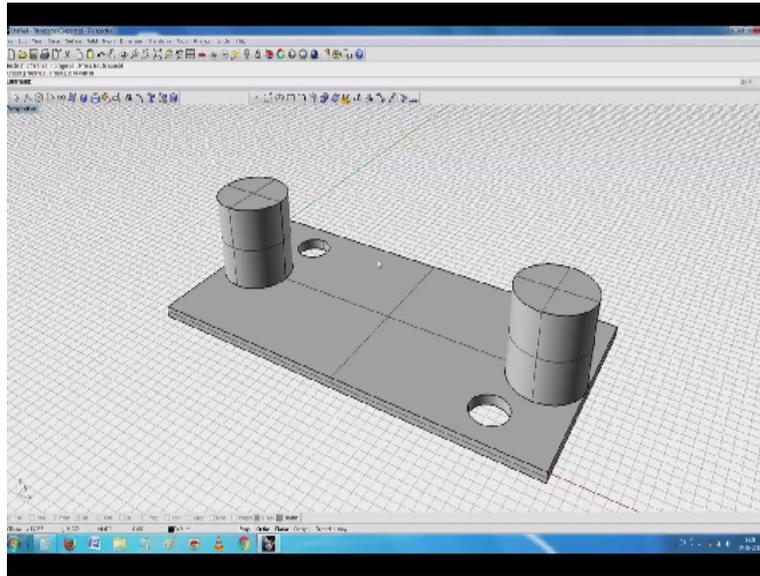
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So if you go to my other, what do you call, computer where I have got this opened, I start with basic outline that is given here. In this case, it says 43.18 mm. So I start a line. Vertical it says 21, so I conveniently I can round it off to 22. I have my basic, what do you call, printed circuit board ready. This is where I will be probably forced to go back to this whole this thing and in my case, just for the sake of convenience quickly, you need not worry about it.

I will, it is, it reads 14 mm. So I will make 2 circles which are 15 mm height here and diameter is, yes, which is 8 mm. Height of each capacitor reads 12. Something. There is a little about this thing. So I will make it as these 2, I will extrude them to make... See this is the a PCB with the most prominent components that is the, what do you call, capacitors which are projecting out are mentioned here and very quickly, let me go over to, yes, 43.2-13.2 which will come to, I think I need to punch up the calculator. The mounting holes are 30 mm apart.

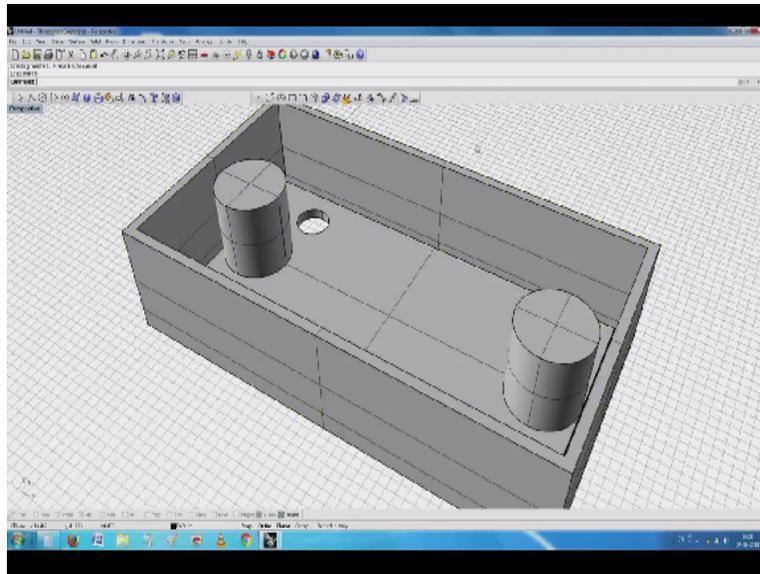
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So I will come here and add 2 mounting holes to my drawing and mounting holes here look like, they are 3 mm holes. And then if I go to the other direction, same thing it says, yes, 5 mm, 21-5 mm is 16 mm, okay. So I need to draw 1 more line. So I am ready with, what I would say, basic concept of how to mount this printed circuit? I will remove these, what do you call, all these reference lines which are of not much use for me right now.

I can get back to it. I can now make 2 openings in this. See these 2? I need to extrude them so that I can continue with; see I have managed to get an opening that is required, right. This is the, what do you call, device which I have on which I now need to build the, what do you call, box around it. Invariably all our rapid prototyping exercise will be related to how to take reasonable measurements and then how to, what do you call, try to build an enclosure about it.

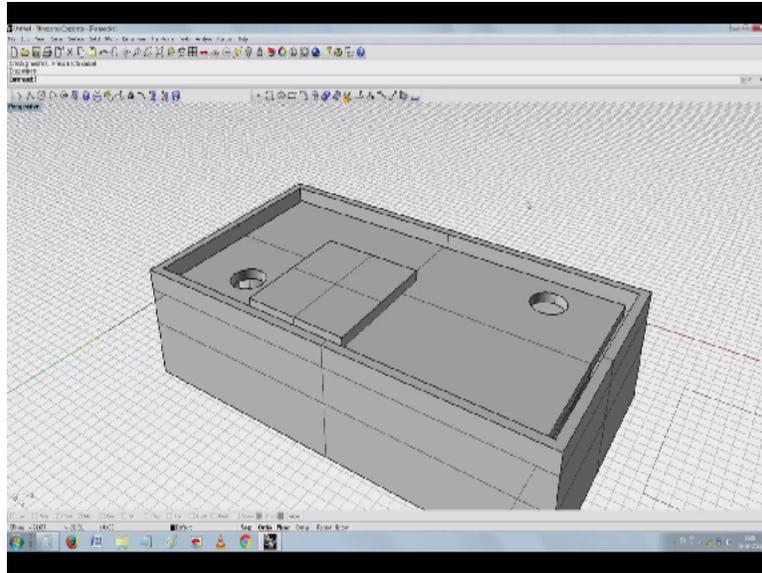
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So right now at the very first level, I will try to just stick to this thing here and then try to just draw a line. See, I have got a reasonably good starting point for a, for making small enclosure. Now I will pick these 2 which are of, then you will, naturally you will ask the question, sir is there any basis for it? Yes. Basis is, what is a reasonably practical thickness that we can build up in a rapid prototyping setup, typically in a 3D printing.

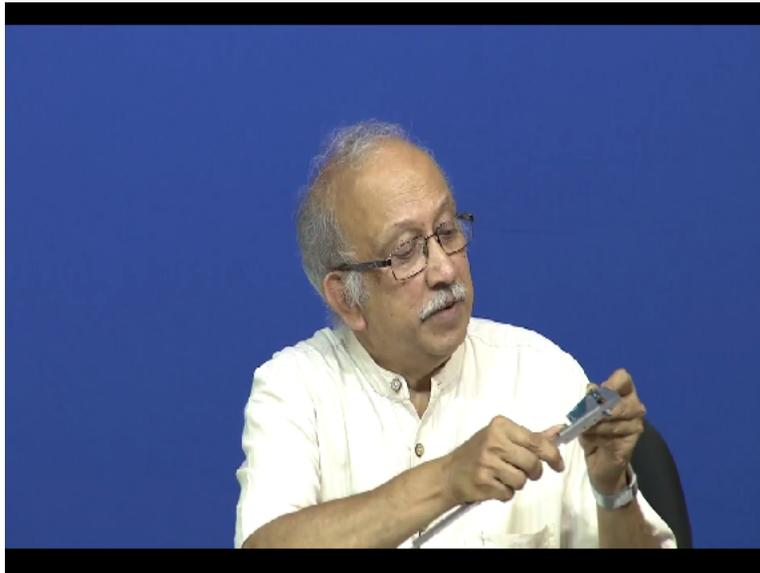
So that you need to consult the manual and then something which is also a little related to this is, how much of, what do you call, strength which is related to, say I will take a, extrude a planar (()) (22:36) and make sure that this covers it. See already I have a starting point for my enclosure for this. It is fairly easy. Is it not? Except that you may notice that this box does not seem to have a bottom. It is both a bug and partly intentional.

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So one way we interpret which does not need a heat sink, can probably be open on one side and this need to be made with a metallic or aluminium piece. So it is easy. I have a, mean, that they have in the, if you see the, this catalogue here. I am sorry, this one, you will see this dotted line. This is the place for the heat sink. So how do I play with the heat sink. Easiest thing is I go about measuring it, sees that on the, this space which I have which I unfortunately, now I cannot show you, but still you can see it. I will try my best to see whether I can tilt it and yes.

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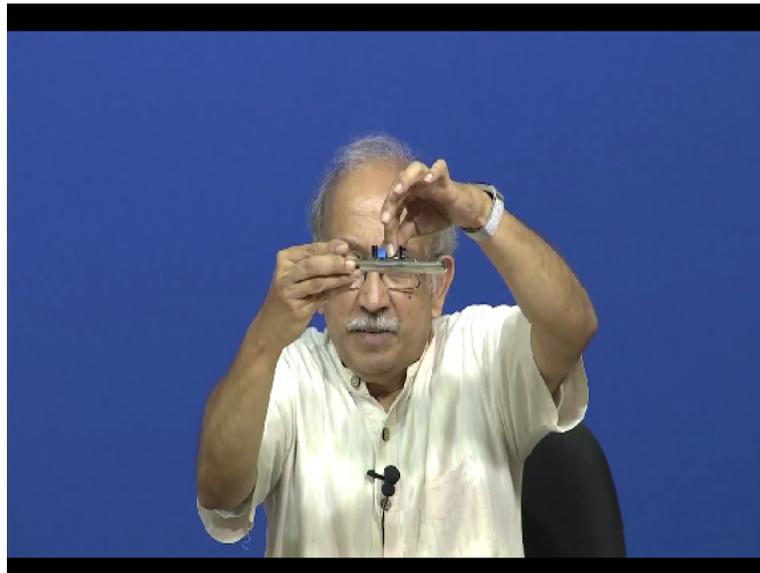
Yes, it is better to measure on the top. See that from 1 inch, it is about 11 mm. So I will take it as 10 mm and then from the other edge, it is safe to take 22 mm. So I have 10 mm and 22 mm. Once again as before, I go back to my original drawing here and try to draw lines to build the,

those things here. So the heat sink can probably start here, from this side, 22 mm, that, that area represents the total amount of pad that I need to give and then I can go inside also a little and then this again shows 14 mm.

So I will take 1 more line here, make it 14 mm. If you this small rectangular area, that forms a tab which is supposed to touch it. Please show this sir? You see here and added to this we have a small problem of there are, there being the leads here. Though in the front it is clearly surface mount or SMT type of a printed circuit board, these large capacitors and then this, what do you call, pot, I think it is a Beckman pot.

This Beckman and these things still continue to come in lead through hole variants. So this hole if I now take a, what do you call, height thing about it. Yes, it is very small. Still a minimum of 1 mm is needed on this.

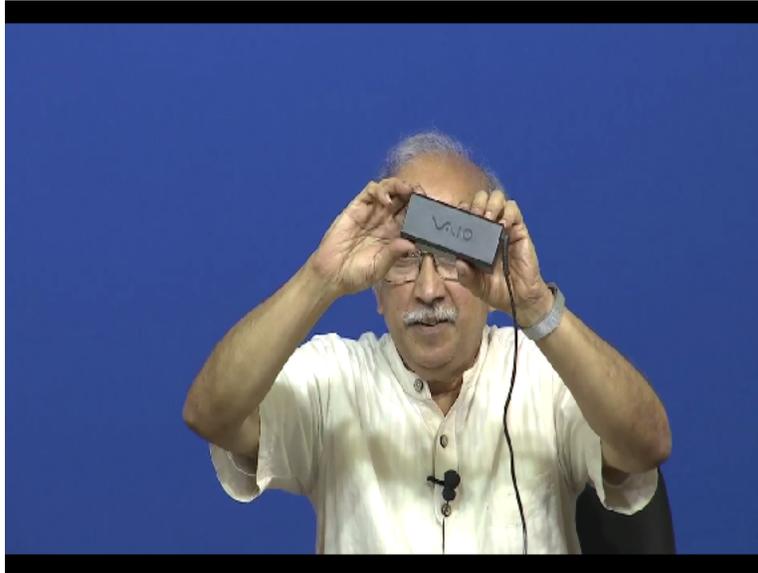
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So if I were to keep it on a, what do you call, a flat surface and measure it, measure the height, I will say that about 1 mm gap is there in between. So I need to make a heat sink tab which is, which just forms this, this small area which I have here. Let me just take it out. This is the basic heat sink tab which I need at the back so that it makes a contact. This whole thing I will make it into a, I need to a little bit of further trick.

I will get on to it later. I will join this whole thing, built into a plane or make it into a solid. Can you see, slowly that small heat sink tab is sitting at the back of it. Now comes our, this thing. Now if you see, if you see the materials carefully, even if you were to take a power supply like the one I have here, have a look at this power supply.

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This is taken from computer. It says Vaio which is meant typically. So if you have to open one of them, at least some of the power supplies invariably had a big heat sink sheet here and because of various practical purposes, the whole thing is enclosed and these days, several of these plastics are capable of taking higher temperature and if you can make a touch, a lot of heat can be made to lose from this.