lec03

Introduction to Fabrication Process Technology and Op-amp

Hi, welcome to this, particular module and the last module what we have seen, we have seen what are the silicon wafers, and how what, what is a clean room, and what is a counting procedure for working in a clean room environment. In this module let us see the application, of silicon dioxide, in a indicator circuit industry, and then we will look at the op amps, Right?

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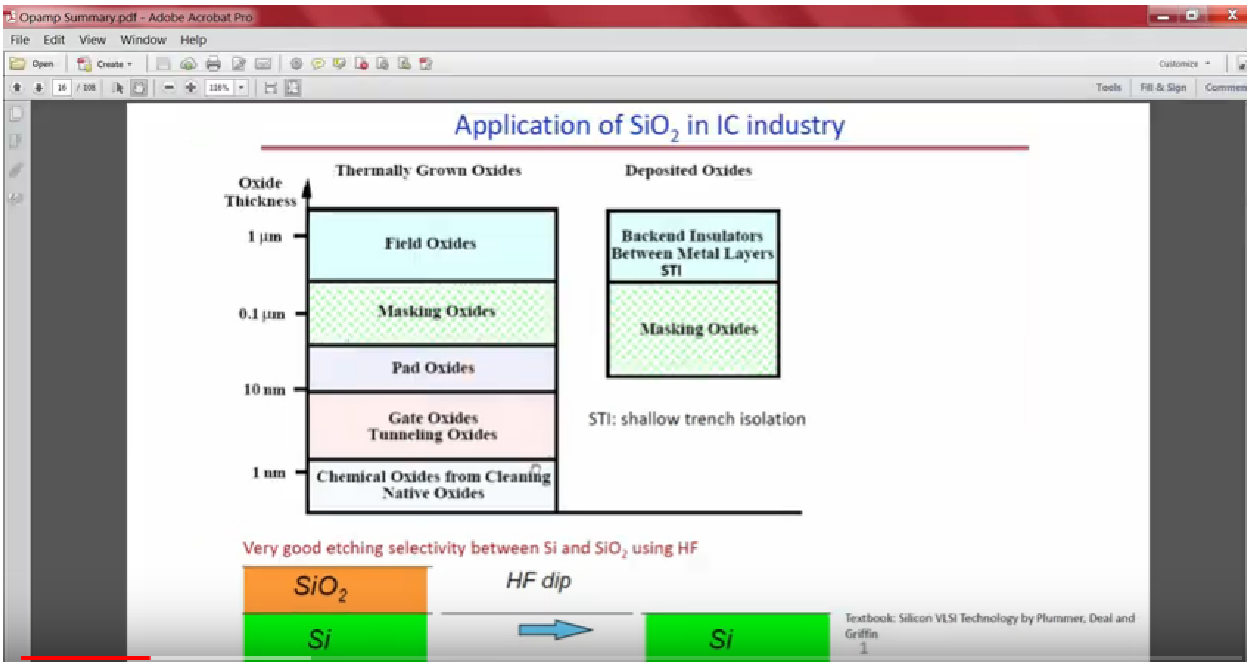

So, if you see the slide, when you see application of silicon dioxide it IC industry, what do you see? that depending on the thickness, of oxide the application of oxide changes, if it is 1 micrometer, then we use this as a field oxide if it is 0.1 micrometer, it is a masking oxide so, let me give an example, of a masking oxide in once, we once we look a t this so, then you have from 10 nanometer onwards, we have pad oxides from 1 to 10, it is gate oxides and then you have a chemical oxide from chemical native oxides now, you for the deposit oxides you have back-end insulators, between metal layers, and then you have a masking oxide**.** So, let me like I said give you an example, of the masking oxide Right?

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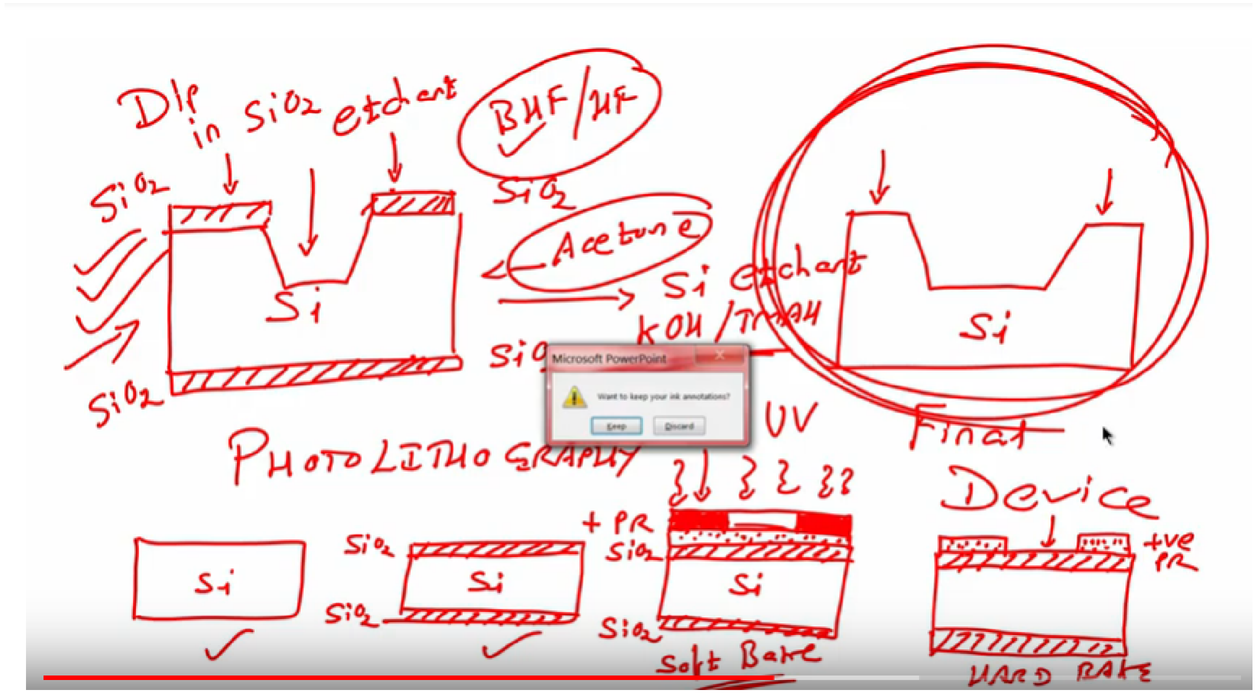

And what I'll do is, I'll open a PowerPoint, and what I'll show you today is how, can we use silicon dioxide as a masking oxide, silicon dioxide is masking oxide hmm, all Right? So, I have a silicon wafer all Right? What I want is a pit in a silicon dioxide this is silicon wafer, silicon wafer I want to etch silicon wafer; this is my final device, final device all Right? How, can I fabricate this kind of device, for that I had to protect this layer, and this layer Right?? from edging so, what I will do is I'll grow a silicon dioxide silicon dioxide now, depending on the type of growth the silicon dioxide will either grow on both the sides, or on single side, if I use thermal oxidation I can grow silicon dioxide on both the sides of a silicon wafer now, I will protect silicon dioxide in this area, and this area, with the help of photolithographic, all Right? what will happen is that I had to use a photo resist, spin coat on the wafer, use the mask exposed with UV and protect the photo resist only in this region, what do I mean let me just quickly, draw it for you so, you don't you understand if you see my earlier, courses you will understand how the photo reservoir, fee works, Okay? This is silicon wafer, this is oxidized silicon wafer, and this is oxidized silicon wafer, with photo resist, all Right? then on this had to do, pre-baking called soft baked, soft baked after soft baked, I load the masks, I load the masks such that the assume that this is a positive photo resist, positive photo resist characteristics that the unexposed region will be stronger and the exposed region will be weaker. All Right? this is my mask it's positive photo resist now, I will expose this wafer with, UV with, UV when I expose the wafer with UV ,and I develop the wafer, when I develop the wafer so, I expose for with UV, unload the mask and develop the photo resist that is called developing of wafer, then what will I have, I'll have, I'll have photo resist only in this region you got, it so, this is a process for so, my photo resist will be saved only in this region now, this is what is shown you over here, Right? After this I will dip this wafer, dip in sio2 etchant Right? If I dip the wafer in sio2 etchant, by sio2 enchant, and this buffer hydrofluoric acid, or either fluoric acid, the energy buffer hydrofluoric acid, is used then what will happen? The silicon dioxide will get H in this region; will get H in the region which is not protected by my photo resist, like this Okay? and then I can add silicon wafer so, I after this I can remove my photo resist, or strip of my photo resist, by dipping the wafer in acetone, if I dip the wafer in acetone, then I will be able to remove the photo resist, or strip of the photo resist, from the top of the silicon dioxide, and then I will dip this wafer further into silicon etchant now, there is a dry etching, there is a wet etching, if I put in KOH, or TMAH, Right? It will start etching silicon and I'll end up with this particular device. Right? So, what will happen? Still, that after when I etch it, if I keep this wafer, I keep this wafer, in silicon etchant what will happen you know, this will happen, this will happen, but what I, want I want just silicon Right? So, after this if I dip the wafer in BHF again, what will happen? silicon dioxide will get etched, and I'll end up with this one so, the point that we are making here, is that silicon dioxide, will act as, a mask ring oxide, when I want to add silicon only in a particular area, only in a particular area, which is Right? Over here Right? The process is take a silicon wafer, grow oxidize silicon wafer, Right? got grow oxide, and then on that you spin coat photo resist do, a soft baking, note the mask, expose with you we, then unload the mask, develop the wafer, Right? after dropping the wafer, you can do a hard baked if I go, as per the process after hard bake, I can remove my photo, remove my silicon dioxide, with the help of sio2, when I H, my silicon dioxide sorry, if I want to etch my silicon dioxide, I can etch my silicon dioxide, with the help of BHF, and then after etching my silicon dioxide, I can strip of photo resist by, dipping in acetone Right? Once I strip the photo resist wafer will look like this, which is Right? over here, and then after that, I can etch my silicon with the help of silicon etchant, in this case when I am etching, my silicon my SIO 2, will protect the remaining silicon surface, except where it is not, there so, this means that silicon dioxide is acting as a mask, for etching when we are going to etch silicon Right? And once we are done we can dip this wafer in a BHF, to achieve, what we want here? All Right? Again a detail photolithography resist, process is shown, in my earlier courses so, just if you want, you can just, go that videos and you will know, it now, what we are going to see further is.

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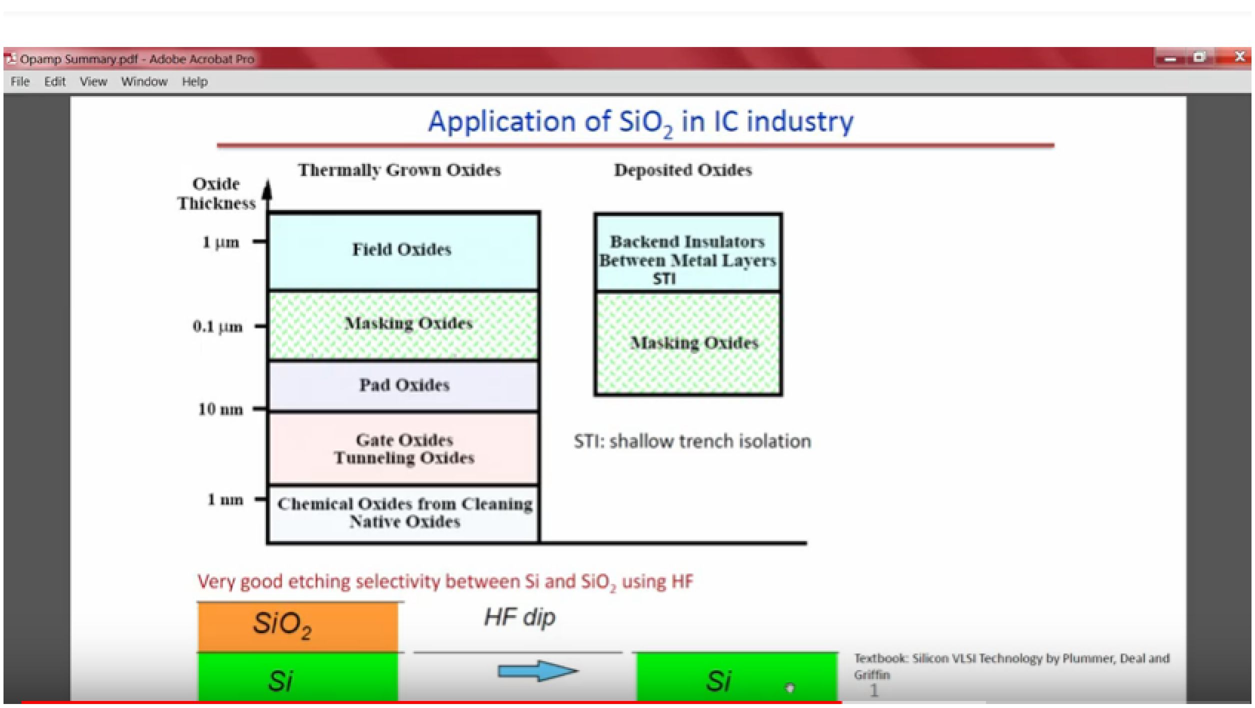

So, what we are seen here, is the masking oxide Right? same way, we can use the field oxide we can use as a gate oxide, where there is a thin layer of side, in MOSFET and then, what we see here that very good a chance selectivity, between silicon, silicon dioxide, if I use HF, we I told you a hydrofluoric acid, or buffer hydrofluoric acid, if I dip this wafer in hydrofluoric acid, I will etch my silicon dioxide, and I'll end up with my silicon. Right? So, if I dip this wafer, in a Jeff, then I'll have my silicon. Okay? Because HF, will not edge silicon, it will only, at silicon dioxide or you can say there is a good edging selectivity, between Si and SIO 2, all Right?

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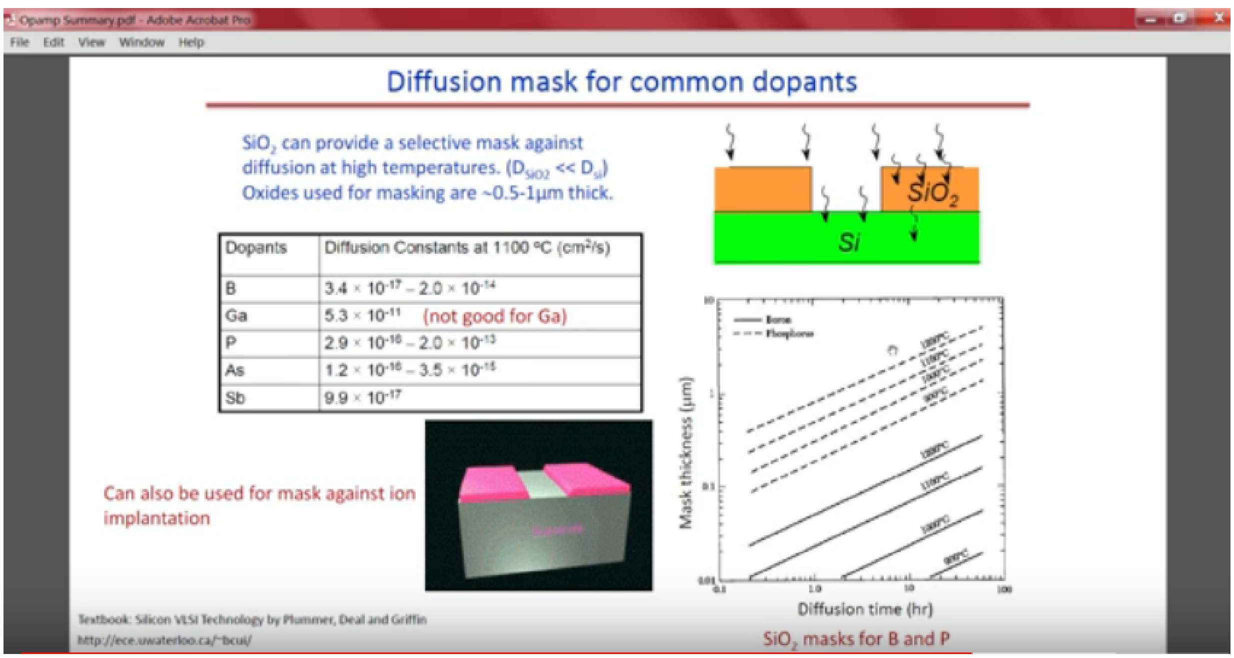

Now, further if I want to also dope, the wafer, then similar way if I want to edge the silicon wafer, instead of that if I want to dope the silicon wafer, only in this region, only this region, Right? then if I have using lithography, if I protect this area, this 2 area and I dope it, then my dope, will only reach in this particular silicon wafer, Right? So, this is just silicon substrate, silicon dioxide is shown in pink color, if I dope it, it will dope in the substrate. Now, depending on the type of dopants, whether it is boron or phosphorus you had to select the thickness, of the silicon dioxide, silicon dioxide mass thickness, depends on the type of the material that you are diffusing, when you want to diffuse, for let's say 10 hours Right? And it is boron then you have to use close to and if I have, if I, if I have the way for a 1200, degree centigrade I can, I can, I need a thickness of close to 0.2 microns Right? So, this is the graph, this is the plot showing you that what time with respect to time and temperature what should be the thickness of my mask, silicon dioxide mask, Okay? So, if I have a low temperature, then my thickness should be less, if I raise my temperature well it is an I require the thickness clothes 2.0, but if I go for phosphor, my thickness should be even higher. all Right? So, this is how the silicon dioxide mask for boron and phosphorus work the, the point that, I that we are making here, is that silicon dioxide can be used as a masking oxide Okay?

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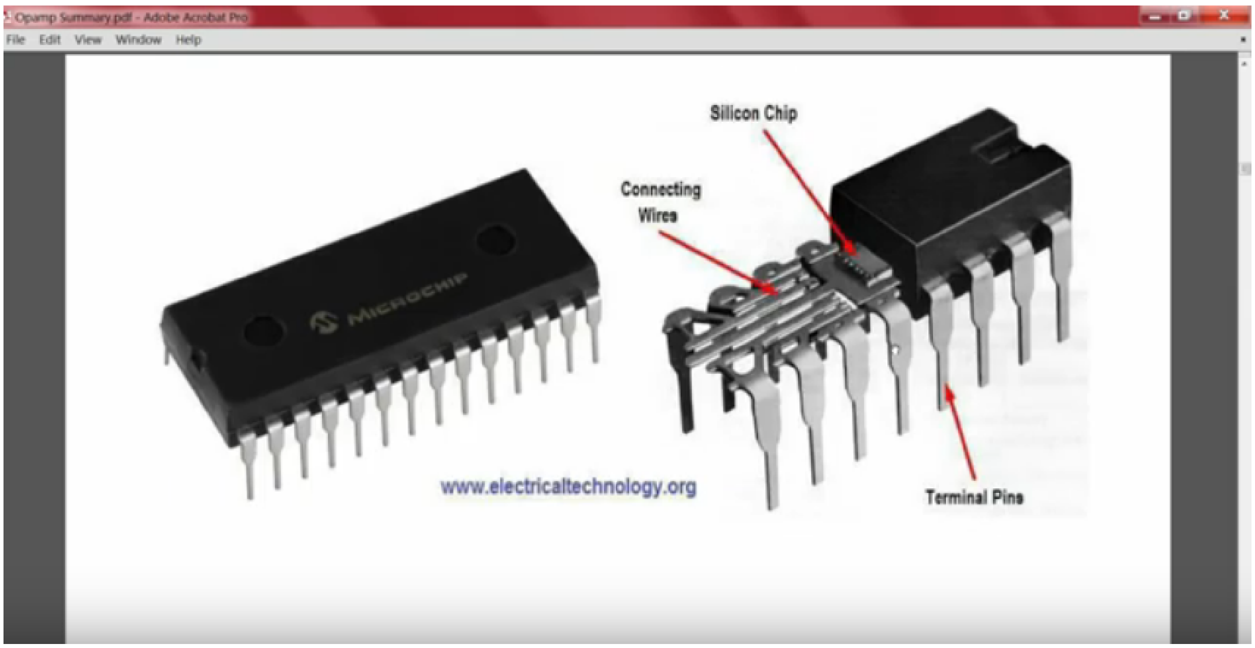

Now, you already have seen that so,

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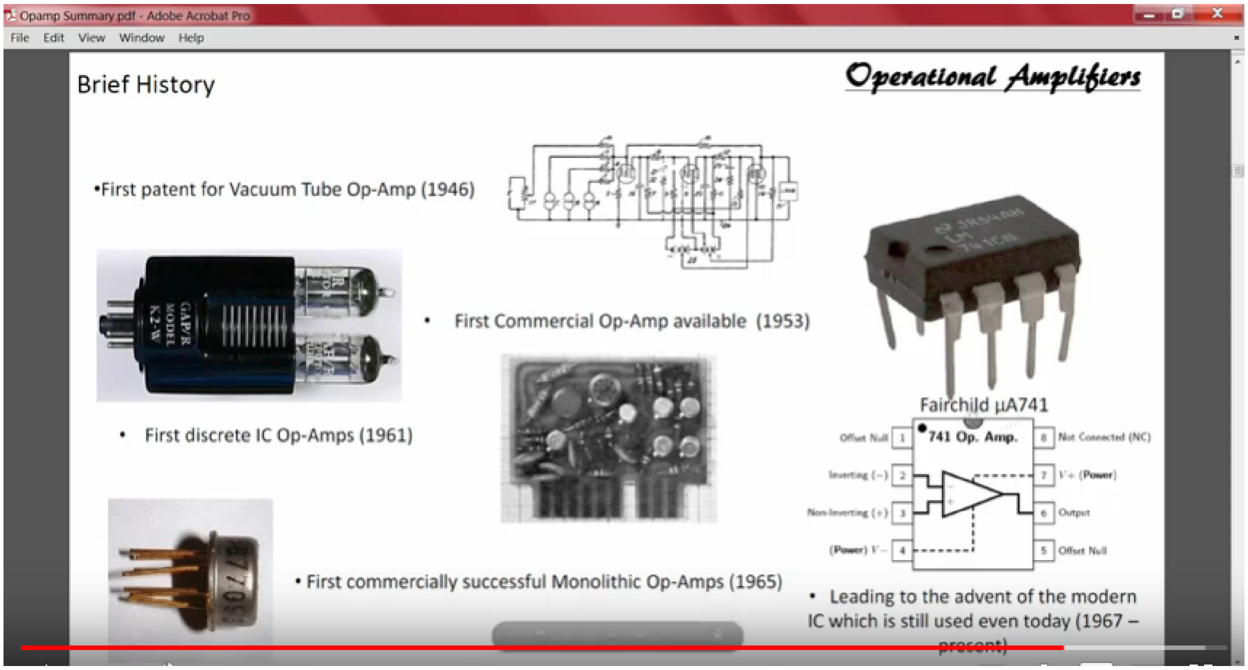

let us see quickly operational amplifiers, and this is just knowledge that, the first operational amplifier, the first patterned actually, for vacuum tube, op-amp, was in 1946, where the first commercial op-amp, available was in 1953, and then first discrete IC op-amp, in ended 61 followed by first commercial success for monolithic op- amps in 1965 and, then from 1967, onwards leading to advent of modern IC, we use even today the 741, generalized op-amp, Right? It's from Fairchild depending on the manufacturer the, the symbol would change the, the terminology, would change however, we will see that as a part of this course somewhere there what exactly mu a stands for and how can we understand from that whether it is it can, be military-grad or Pam, or it is a commercial of them. Okay? Now, the quick way, of our identifying is there is a notch, on the left side here, there is a pin number one, and it goes to be number eight, if it's a 741, generalized open. Okay?

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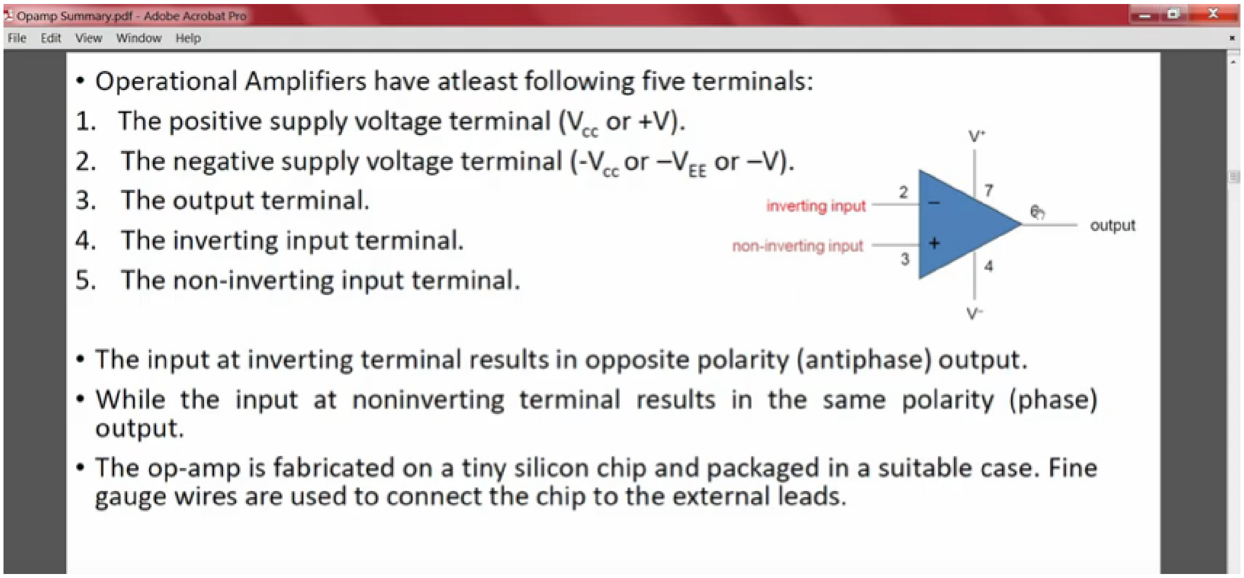

Now so, the op-amp, have at least five terminals, there is a positive supply VCC, negative supply minus VCC, or minus Vee, there is an output terminal number six, there is an inverting input terminal number two, non-inverting input terminal number three, Right? So, one, two, three, four, and five, at least I terminals are used, there is another terminal between, one and, one and, five and that is for offset, we will, we'll talk about that later and then there is a eight.

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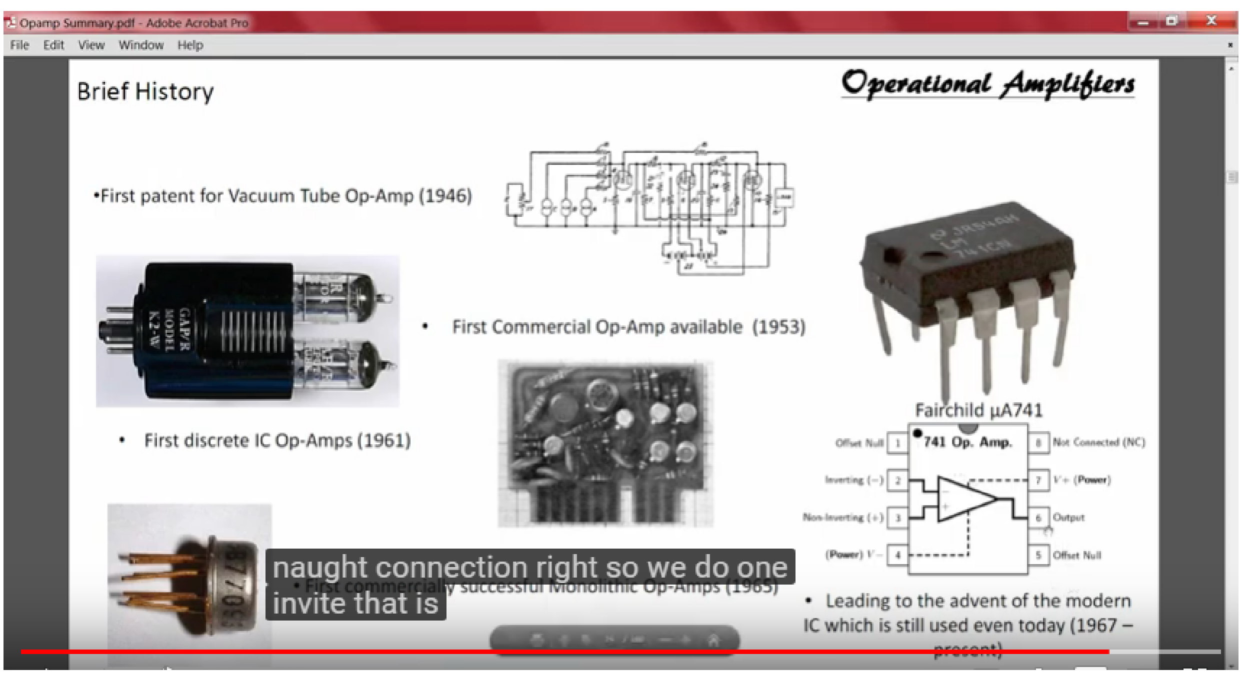

Which is for naught connection Right? So, we do one invite that is offset, done and it is not connected.

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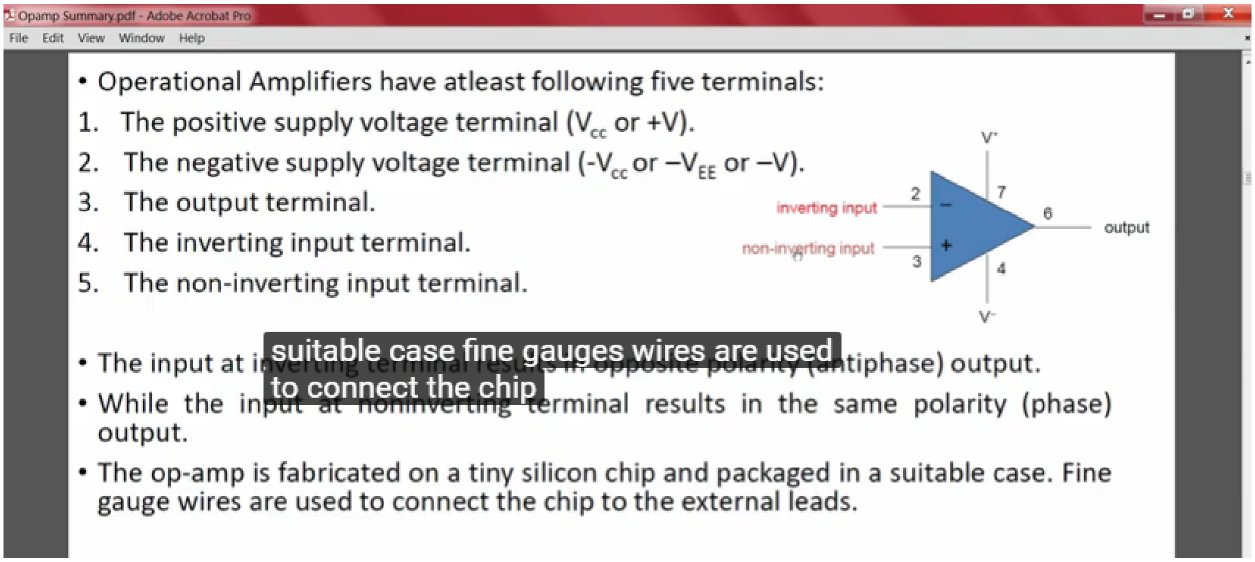

Now, the input if I apply, input at, the inverting terminal my output would be 180, degree out of phase with respect to input, if I apply the input signal, to non random you know? my output will be in phase with respect to input terminal. Okay? The op-amp, is fabricated on a tiny silicon chip, and packaged in a suitable case fine gauges, wires, are used to connect the chip; to the external needs we already know this.

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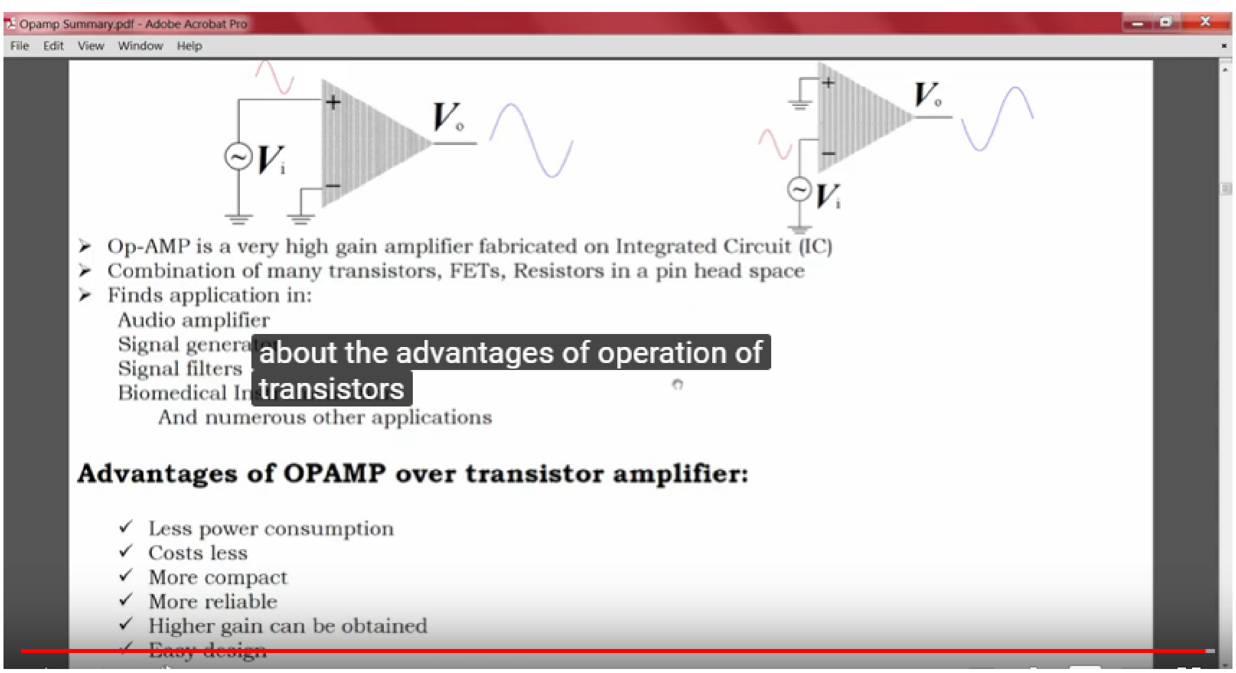

Now, if I go further up a , me is a very high gain amplifier fabricated, or integrated, circuit combination of many transistors, FPT, resistors in a head pin, head space it finds application, in audio amplifier, signal generators, signal filters, biomedical instrumentation, and numerous other applications. all Right? The advantage of op-amp, overturns assembly, fat we don't understand it why we had to go for operation amplifier, or what are the assembly fire so, operational amplifier has many advantages such as low, power consumption it can cost us know, it is more compact, more reliable higher gain, and it's easy to design. These are the advantages, of a person amplifier, over the transistor amplifier. all Right? So, let us understand till now, for this module about the advantages, of operation of transistors, the next, part it will see further on the open, till then you take care I'll see, in the next class bye.