Integrated Circuits, MOSFETs, OP-Amps and their Applications

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Lecture – 18
Characteristics of an op-amp (Contd)

Welcome to this module. And this model is a short module, where we will look at the DC offset parameters of opamp; is also called opamp specification. And we will quickly rewind whatever we have done in this particular lecture.

So, if you can come on the screen what do you see is even though the input voltage is 0, there will be an output, right?

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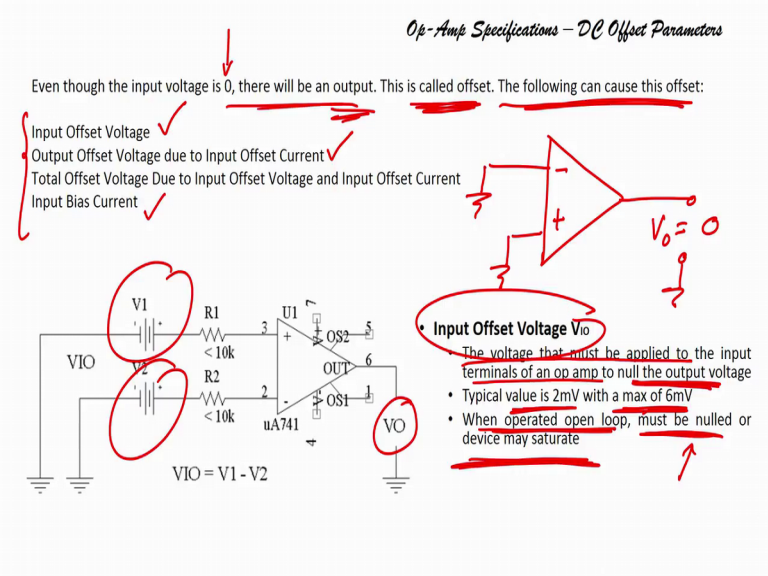

So, what you would should do when you are in the laboratory, try to ground you are a non-inverting terminal and the inverting terminal, right at n c what is the output voltage VO, see what is output voltage VO, ideally it should be 0, right ideally should be 0.

But what you will find that even though input voltage is 0, there will be an output either it will be an output. This is called offset, this is called offset. The following can cause this offset, what? First is input offset voltage, we have seen, right? Output voltage offset this is input offset current we have seen input offset current. The total offset voltage due to input offset voltage and input offset current, and input bias current.

We have seen every parameter, and these are the parameter, these are the parameters, these are the parameters, that will cause the offset, that will cause an offset. So, what is imp input offset voltage? We have seen nothing but input offset voltage, that the voltage that must be applied to the input terminals of the opamp to null the output voltage to make the output voltage 0.

You see here, you see here, we are applying a small amount of input voltage, such that my output voltage will become 0; when I up, when I connect both my input terminals to ground, when I connect both my input terminals to ground, my output voltage should be 0. But it is not 0, that is why I have to apply some amount of voltage, at the inverting and non-inverting amplifier so that I can get the output voltage equal to 0. That is to null my output voltage, typically if you come back on the screen what you will see, typically the value is 2 millivolts, and the maximum the value is 6 millivolts. Typically, value is 2 millivolts and maximum is 6 millivolts.

When operated in an open loop condition, right? Must be nulled or device may get saturated, right? Because a small amount of input voltage, the output voltage will keep on increasing in case of the open loop gain, where the open loop has infinite gain as we know. So, output will be saturated, that is why before we use in open loop or in a closed even we have to always try to null the output voltage. This nulling can be done by help of the input offset voltage VIO.

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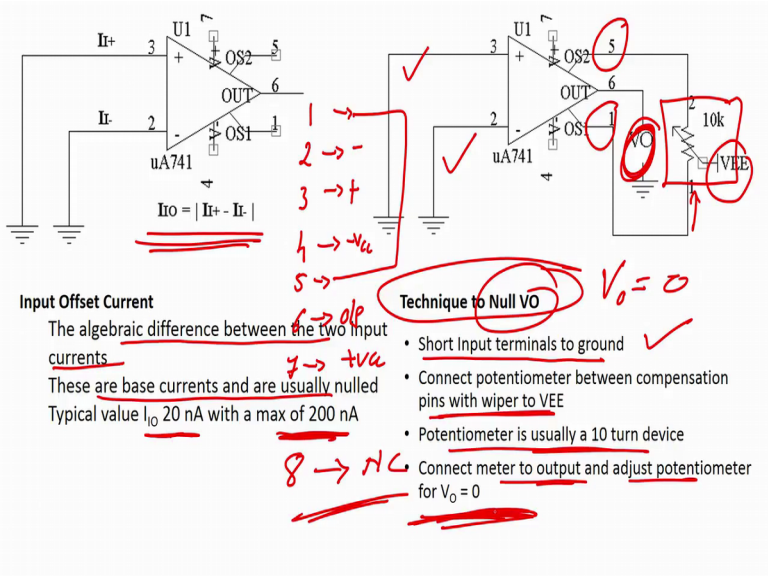

So, if you move to the next one, input offset current. We have seen this, the there is a big difference between the input currents there will be difference between the input currents is my input offset current. These are the currents and are usually nulled typically value is 20 nanometer, the maximum of 200 nanometer. Minimum is 20 nanometer, maximum is 200 nanometer.

So, what is a technical to null the output voltage VO, right? What is it I need to make VO equal to 0. So, first is you do this thing. Short input terminals to ground you see, short input terminals to ground you have grounded, connect the potentiometer between compensation and vee wiper. See we are connecting now between 5 and 1, right what we are connecting a potentiometer. You see we are connecting potentiometer.

Now, this is the role of your another terminals another pins of the operation amplifier, you know there are commonly pins 8 1 2 3 4. Let us see one is here we are not connected 1, right? Inverting 3 is non-inverting, minus VCC, not connected. 6 is output. 7 is VCC, right? Between 1 and 5 is used for offsetting the nulled VO to null. And 8 is not connected.

So, 1 and 5, between 1 and 5 you can connect the potentiometer, right? Connect the potentiometer between the pins with wiper to vee. Now, now what we have to do? Potentiometer usually 10 10 device, we know that connect meter output, and at this potentiometer such that my output voltage becomes 0. By connecting this, to co to vee, right and then if I change my potentiometer, if I keep on changing a potentiometer, I will reach a value of output voltage VO equals to 0.

This is our technique to null your output voltage VO.

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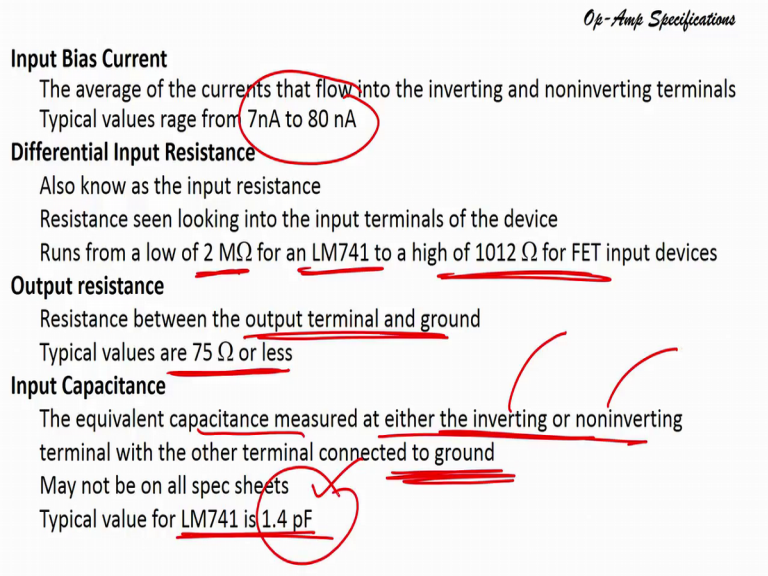

So, and what we have seen, we have seen input bias current, right? To quickly say the average of the current that flows in the inverting and un inverting terminals, the value is around 7 to 80 nano ampere, differential input resistance also known as input resistance is nothing but the resistance, when you look at the input terminal of the device, the value runs from 2 mega ohms for LM741 to s I s 1 0 1 2 for FE input impedance FET input device, output resistant resistance between the output terminal and ground.

These are output resistance, typical value is 75 ohms or less, input capacitance equivalent capacitance measure which we neither inverting a non-interval terminal. These are input capacitance with respect to ground, may not be on all specifics sheets. So, specification sheets, when we see a specification sheet of an operational amplifier. You may not be able to see the input capacitance. Typically, the value of input capacitance for LM741 is 1.4 peak picofarad.

So, what is that? The equivalent cir the equivalent capacitance measure as either inverting or non-inverting. The either inverting or non-inverting terminal with the other terminal; that is, connected to the ground, all right? So, capacitor between inverting n ground or non-inverting n ground. Between inverting n ground or non-inverting n and typically value is 1.4 picofarad.

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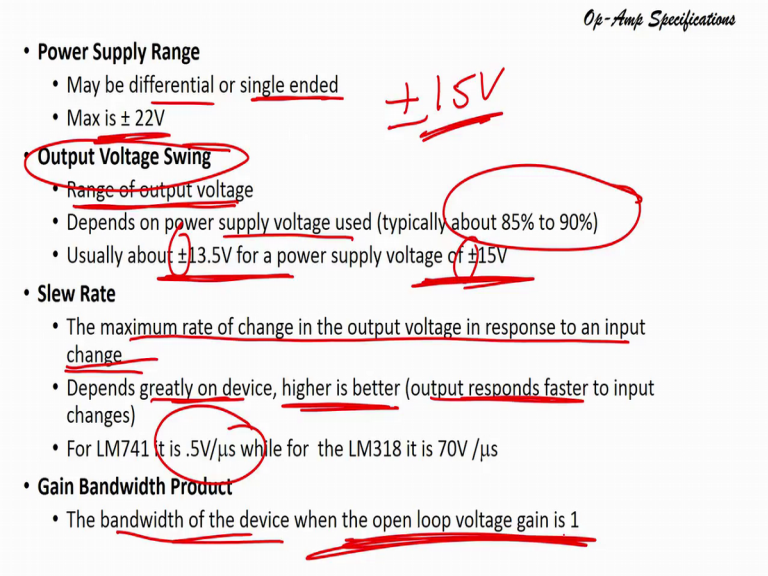

Typical value is 1.4 picofarad. What is power supply range? Power supply range may be may be differential or single ended power supply, we have seen in the starting of this lecture. Maximum is plus 20 plus minus 22 volts. Most of the time what we use is, plus minus 15 volts

Most of the time we use is plus minus 15 volts, right? Output voltage swing. Output voltage swing is what the range of output voltage, right? Depends on power supply voltage, and typically is about plus minus 13.5 volts. Now this is when your output voltage is plus minus 15 volts.

So, this is how much output voltage can swing, it can swing maximum to 85 to 90 percent of the supply voltage, all right? So, range your output voltage depends on the power supply voltage, and usually about 85 to 95 percent. Usually about 13.5 volts plus minus 13.5, if my supply is plus minus 15 volts. If my bias is plus minus 15 volts

Slew rate the maximum rate of change in the output voltage in response to a input change. Maximum rate of change of output voltage with respect to the input, depends greatly on the device. Higher is better right higher is better. And output responds faster to the changes; that means, slew rate also shows that was how fast my output change is; when I change my input, how fast my output changes when I change my input.

That is the function of the that is a function of the slew rate. So now, if you go to last line for LM741 it is about 0.5 volts per microsecond, by then 4 1, it is 0.5 volts per microsecond. And for LM318, it is about 70 volts per microsecond. Finally, the gain band width product is nothing but the bandwidth of the device, when the open loop gain is 1. And the bandwidth of the device is called my gain bandwidth product.

So, these are all the opamp specifications, these are all the open parameters or most of the opamp parameters that we have covered in this particular lecture, all right?

Our next lecture would be of using the operational amplifier for different applications; like, different circuits inverting, non-inverting, differential amplifier, integrator, right summer, comparator. So, we will see how the op amps can be used for the different circuits in our next lecture. Till then you see this particular specifications whatever I have told you. And this whole entire lecture was divided into 4 different modules. If I am correct then look at all the modules, understand all the modules, then you will understand what are these specifications of an operational amplifier, all right.

So, I will see you in the next class, and till then you take care, and let us see what we learn in the next class, all right. Bye.