Op-Amp Practical Applications: Design, Simulation and Implementation

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Lecture – 06
Effect of Loading and Input Impedance: Part 3

Welcome back, so in the last module what we have seen is the effect of loading right. If you remember what we are done, we have connected the potential divider to the inverting amplifier. And we saw that the expected output was different than the experimental output. So, let us see if we connect the potential divider circuit to sorry, to a non inverting amplifier in this particular case, what will be the output and can we still see the loading effect or not right.

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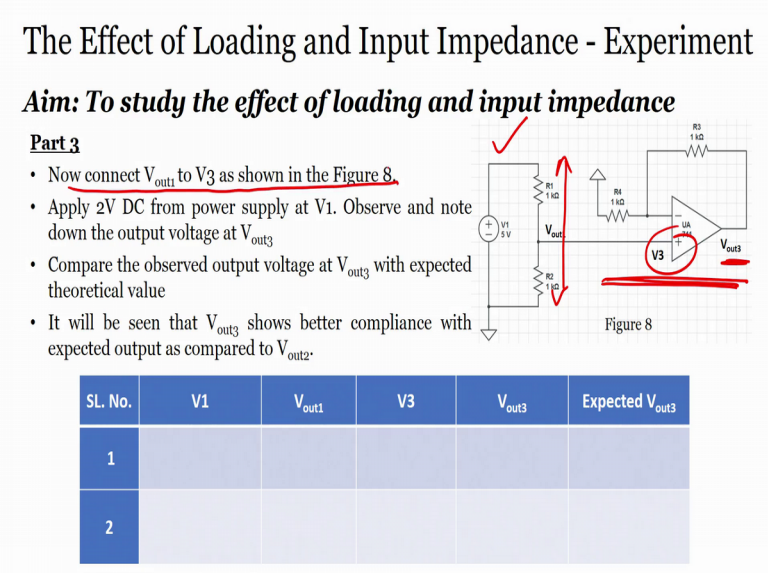

So, for that if you come to the screen right, this is again the aim is same, but there is a third part of the same aim, which is to study the effect of loading.

So, here as you see this is same circuit which is potential divider and this is your non inverting amplifier. We have already seen what is non inverting amplifier, we have already seen how you can use non inverting amplifier in your experiment right. So, you apply a voltage to the non inverting terminal of the non inverting amplifier through the potential divider circuit, right and you measure the output V out 3. So, what is that? Connect V out 1 to V 3 as shown in figure, let me just clear this one.

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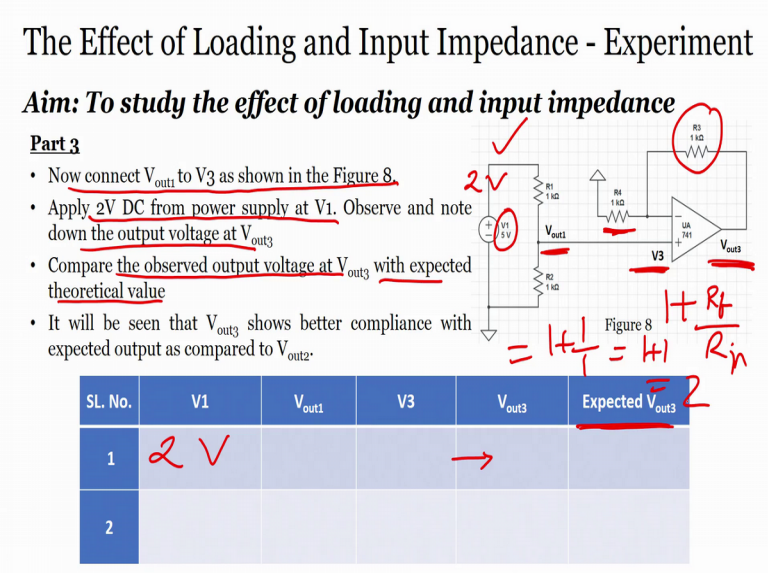

V out 1 is connected to V 3 as shown in figure alright. Apply 2 volts DC from power supply at V 1. So, here instead of 5 volts, we are applying 2 volts DC, we are applying 2 volts DC, alright. Observe and note down the output voltage V out 3, here you measure V out 3; that means, that if I apply 2 volts, what is my V out 3? What is my V out 3, I have to measure alright. Compared the observed output voltage V out 3with the expected theoretical value, right? Now what we have seen? We have seen non inverting amplifier in non inverting amplifier, what is gain? The gain of the non inverting amplifier is given by 1 plus R f by R 1 right.

This is the gain. So, here what is R 1, R f? R f is your 1 kilo ohm, R 1 or R in is 1 kilo ohm. So, if both is 1; that means, that 1 plus 1 by 1 this is 1 plus 1 this is equals to 2. So, my gain is 2 easy, very easy to understand the gain of the non inverting amplifier.

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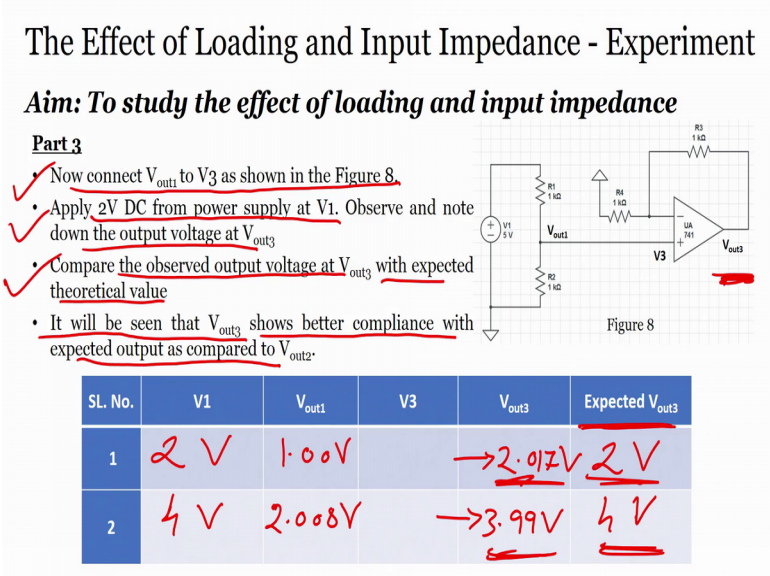

So, I have a gain of 2, right; that means, if i apply 2 volts if my expected output would be expected output should be 2 volts across R 1 and R 2. So, this is 1 volt, 1 volt by gain of 2 1 volt into 2, so output will be 2 volts right.

So, my expected output at V 3 is 2 volts right. If I apply here 4 volts, 4 volts right, so if I apply 4 volts my V out would be 2 volts 2 into 2; 2 volts into 2, 2 is your gain this is your gain this is V 4 volts. Now, this is non inverting amplifier that is why I am not writing minus. Last circuit if you remember, it was inverting amplifier then we have to use negative sign because of phase shift. So, in this particular case, let us see; if I apply 2 volts to the potential divider circuit and if I measure the voltage output at the end of the non inverting amplifier.

So, if I apply 2 volts at the potentially divided circuit has a input and if I measure the output at a non inverting output of the amplifier right. So, what is the output? And let us consider the case which I have written on the screen which is 2 volts and 4 volts and let us see what is the experimental output and compare with the theoretical output alright. So, let us see, let us focus on the breadboard once again. Again we have Suman with us to help us. So, he is going to apply 2 volts across the potential divider circuit.

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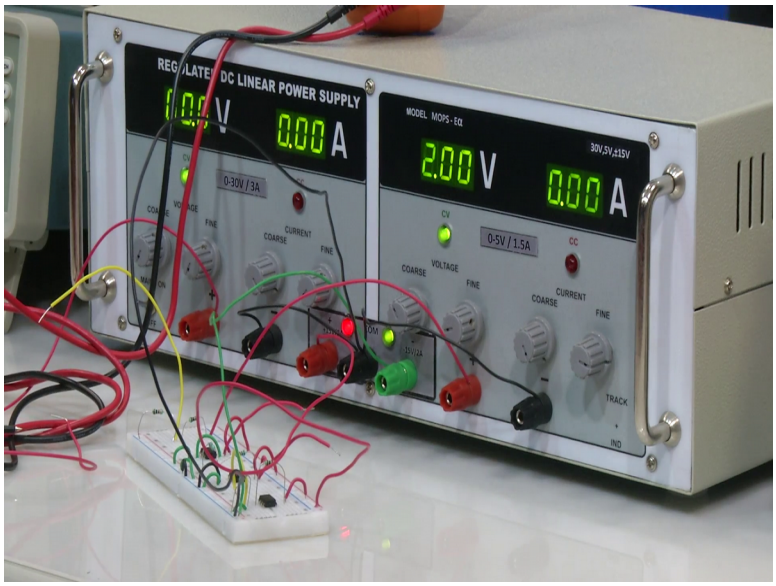

Across the potential divider circuit, he is applying 2 volts. As you can see on the DC power supply, you can see 2 volts, which is given to the potential divider circuit which is same like last time if you remember right.

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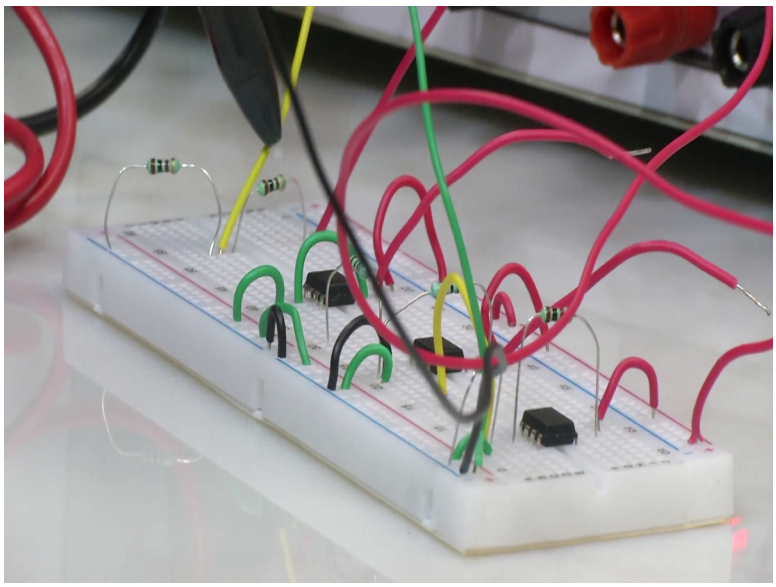

This is a potential divider circuit which is this one and we have applied 2 volts across it. This is a potential divider circuit, we are applied to volts and then yellow colour wire is the output is output is a voltage across resistor R 2 alright. So, let us see what is the value

of resistor R 2, voltage across R 2. Voltage across R 2 is 1.009 volts, voltage across R 2 is 1.009 volts.

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This voltage we are applying to the non inverting amplifier. So, what let us see what is the output at the non inverting amplifier; output of the non-inverting amplifier. The output of the non inverting amplifier, when we apply voltage or connect the output of the potential divider is 2.017 volts; that means, that when he applied a input of 2 volts across the potential divider, across the potential divider 2 volts he applied. He found that the output this one was 1.00 some volts and the output V 3 was 2 point, sorry was close to 2.017 volts, which is extremely close to 2 volts, which is extremely close to 2 volts. Here, we are not getting any loading effect; we are not getting any loading effect. Let us taken another example in which we are applying 4 volts as input alright, 4 volts at the input of the potential divider across the potential divider 4 volts across the potential divider. And when we apply 4 volts across potential divider, the output of the potential divider, output of the potential divider will show us the voltage, this is 4 volts at the across the potential divider. What is the output at the resistor R 2? 2.008 volts.. So, let me write down here on the screen; 2.008 volts, very good. Let us measure the V out 3 which is here, V out 3.

So, let us see what is V out 3? V out 3, 3.99 volts. So, let us write down here on the screen 3.99 volts; again see this right; that means, that what we are say we are looking at

we have connected the V out 1 to V 3, then we are applied 2 volts, then we are compared the theoretical and experimental value. What we see is it will be seen that V out3 source better compliance with expected output as compared to V out 2.

So, the point is a point here is that; if I go and integrate my non inverting amplifier with the potential divider as the circuit instead of using inverting amplifier, with the potential divider as a circuit, then I would see that the loading effect in the case of non inverting amplifier would be less or will be extremely less or negligible compared to the inverting amplifier. In case of inverting amplifier, we can see that the expected output was 4 volts or 2 volts or 10 volts and the in the experimental output was half of it or one-fourth of it.

That was because of the loading effect right, but here in case of this particular experiment, what we see is if you use non inverting amplifier the loading effect is not there. So, guys you have to understand now that if you want to remove the loading effect what kind of amplifier you have to use, right? And if I use inverting amplifier I will have a loading effect, if I use non inverting amplifier I will not have loading effect. So now, again why we took this example because a potential divider we have said initially that one of the registers of the potential divider you consider as a sensor right. You consider one of the register of the potential divider as a sensor.

And V gain of sensor, it can be any sensor that will show change in resistance. What kind of sensors are used that can show change in resistance? One is your strain gauge, another one is a temperature sensor, another one is your 4 sensor, another one can be thermistor, right which is temperature sensor thermistor other can be for mass flow measurement. So, the point is whenever you have to use a sensor which can show change in resistance and if you put this sensor as a potential divider then to reduce the loading effect you use the non inverting amplifier.

That is just of this particular experiment. Now we can understand that if I want to remove the loading effect from the sensor or the output of the sensor or the output of potential divider, to the when I connect or interface the electronic module, I can use the non-inverting terminal non inverting amplifier. But what if I use a buffer between non inverting amplifier and between a inverting amplifier and a potential divider? So, we will buffer solve the problem. Buffer is what? Voltage follower right, we have seen voltage follower circuit in previous modules right. So, how voltage follower circuit will work? I

have also given you an example right by telling that election and then the mike and the speaker right.

So, either speaker either the loudspeaker, the final amplifier that is generally used this common collector amplifier or voltage follower at the input is common emitter amplifier or high impedance, input impedance amplifiers. So, the point is if I use the same voltage follower in the circuit, where I have integrated the potential divider with the inverting amplifier in between right; p otential divider, inverting amplifier, buffer voltage follower. So, if I integrate this can I reduce the loading effect? Can I reduce the loading effect? So, in the next module let us see this particular experiment, where we will use the buffer between the inverting amplifier and the potential divider, alright?

So, I hope that in this particular module you got an idea of what is loading and how we can reduce the loading by using non inverting amplifier connected with the potential divider. So, I will see you in the next class, thank you for your time. And I will see you next class with the new circuit, where you will really understand how we can remove this loading effect.

Thank you.