Op-Amp Practical Applications: Design, Simulation and Implementation

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Lecture No – 07
Effect of Loading and Input Impedance: Part 4

Welcome to this module, here like I discussed in last module; what we are looking at? We are looking at the loading effect alright and if I use buffer between the inverting amplifier and a potential divider, whether it will remove the loading right.

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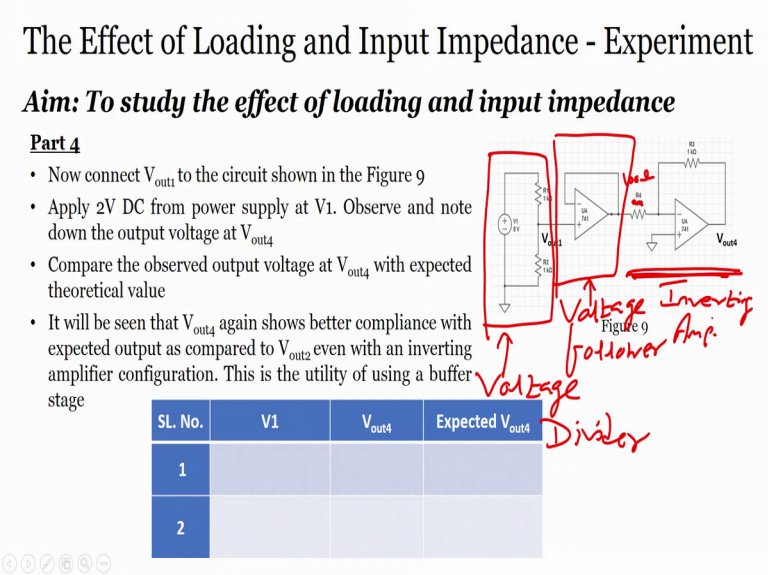

So, let us see first the screen and understand this is a part 4 of the same experiment, which is to study the effect of loading and input impedance.

So, here if you see this first circuit is your potential divider, second one is your buffer, third one is your inverting amplifier alright. So, we have buffer, we have voltage divider, we have buffer or we can say voltage follower. We have inverting amplifier right we have these 3 circuit ok. So, if I connect the potential divider this circuit to the buffer.

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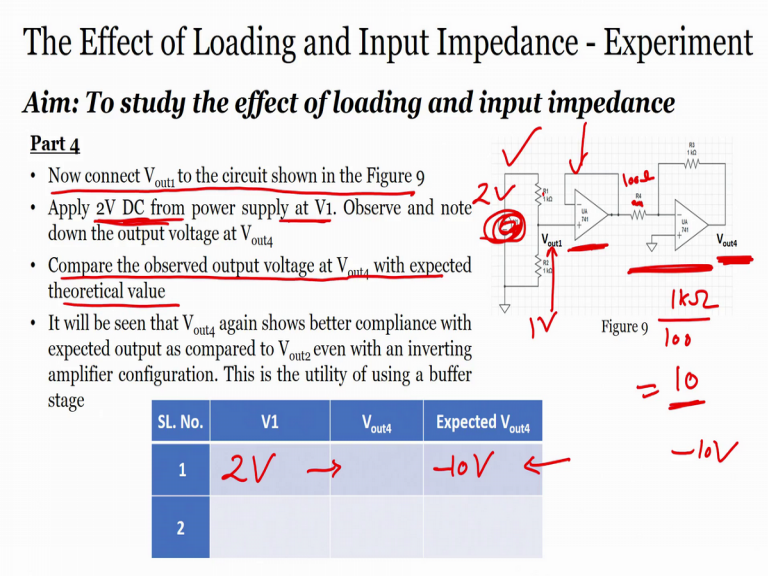

And the output of buffer to the inverting amplifier this inverting amplifier has a gain of 10, you see one kilo divide by 100 this is gain of 10 alright.

So, this is a gain of 10 which is my inverting amplifier. So, for understanding the importance of buffer, what we should do connect V out of to the circuit shown in figure V out is connected to your buffer. Then apply 2 volts DC from power supply to V 1 here we are applying 2 volts DC 2 volts alright. Observe and note down the output V out 4 here. So, we apply 2 volts we measure V out and we write down the expected V out alright.

So, for example, if I apply towards the output V out one here, here should be 1 volt right if the registers are same. This voltage I am applying to the inverting amplifier, inverting amplifier is a gain of 10. So, my V out 4 would be minus 10 volts right, so this is my expected output minus 10. Now let us see what is V out 4 alright, this is the experiment that we have to do. Again what is saying compare the observed output voltage V out 4 with expected theoretical value.

This is a third thing that we will do. Finally we will see what happens when we use the voltage follower alright. So, let us do one by one, first we connect the potential divider and the buffer and the inverting amplifier. Here you see we had not used non inverting amplifier.

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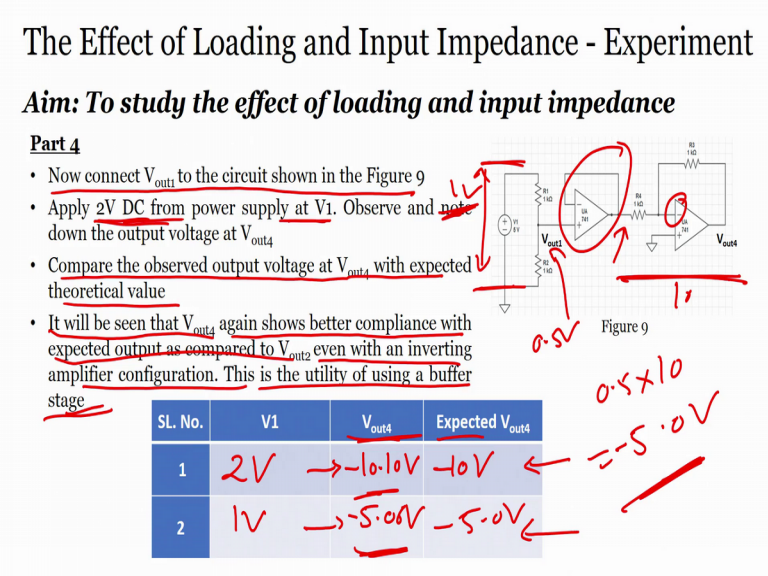

Here we have use the inverting amplifier. The advantage here or not advantage the ease of inverting amplifier compared to non-inverting amplifier is that the selection of resistors. You see the gain formula for the non inverting amplifier would be 1 plus R f by R 1 or R f by R a.

Inverting amplifier is minus R f by R a. So, when you when you understand that the when you take the example of non-inverting amplifier the register selection is very important. In case of inverting amplifier, it is little bit ease compared to the non inverting stage, and that is why we have considered here the inverting amplifier instead of non inverting amplifier alright. Of course, there is one con and that is the phase would be out of phase the input signal and the output signal, output signal will be out of phase compared to the input signal.

But then we had used one more stage to again inverted to make it the in phase with the input signal. So, let us see this circuit, actually how it we can operate it again I will ask someone to help us for this particle experiment as well.

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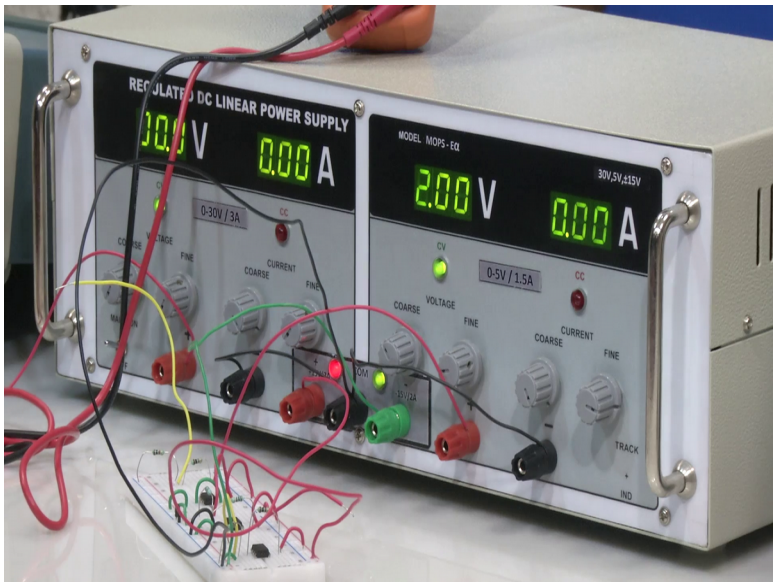

So, we are applying first voltage across the potential divider circuit which is 2, volts 2 volts is applied to the potential divider circuit, which is right over here right it is right over here. Now as we know the output is yellow color this wire. Output of this potential divider is connected to the buffer.

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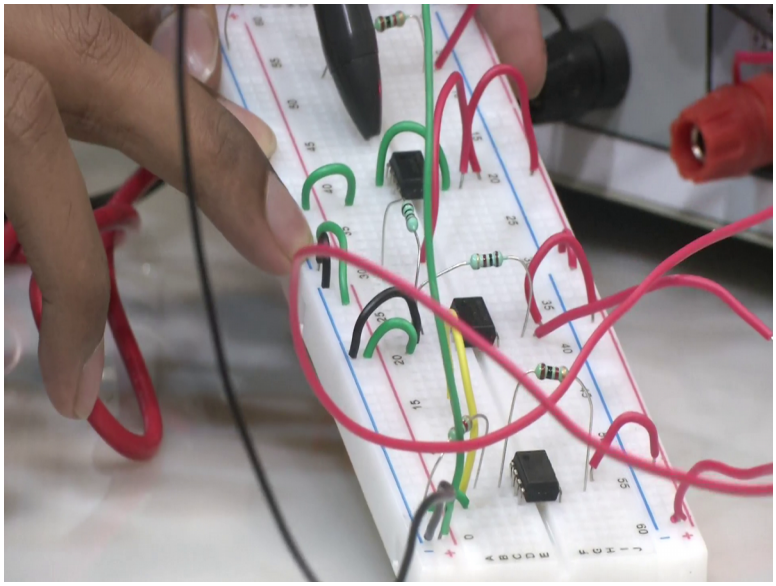

So, buffer you see this is the buffer circuit is a buffer where my pen is a buffer circuit alright. And we have seen that the how the buffer is that and the inverting and the output is shorted, and the non-inverting is grounded in the op amp is your buffer. So, the output

of this non inverting output of this potential divider is connected to the buffer. So, can you please connect it to the buffer ok. So, when you connect it to the buffer right and the output of this buffer is connected to the non; is to connected to the inverting amplifier. So, again potential divider, output connected to buffer, buffer output connected to the output connected to the inverting amplifier.

So, let us see now if I apply 2 volts at the input that is across the potential divider, what is my final output, final output that is output at the inverting output of the inverting amplifier.

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So, let us see we are apply we have applied 2 volts output of the inverting amplifier would be minus 10.10 volts. Let us write down what is output minus 10 point 10 volts alright. Let us apply 1 volt 1 volt at the across potential divider across here we are applying 1 volts 1 volt. So, when you apply 1 volt, what is output V out 4? That is output of the inverting amplifier, minus 5.06 volts.

We are writing on the screen minus 5.06 volts. So, when we applied one volt across the potential divider, what we obtain? We obtain minus 5.06 volts, but when you apply 2 volts we obtain minus 10.10 volts point 10.10 volts. Now what is the theoretical expected output V out 4? Expected output would be minus 5 volts alright, minus 5 volts; how? If I apply 1 volt the output V out 1 would be 0.5 volts this V out 1 goes here my gain is 10.

So, 0.5 into 10 this will be 5 volts right, because it is a inverting amplifier minus 5 volts very easy to calculate the expected output voltage.

Here what you see now, here you see that the loading effect that we were talking about is not any more valid because we have used the buffer. This is the importance of buffer right. So, what is the 4th point? It will be seen that V out 4 again shows better compliance with expected output as compared to be out even with an inverting amplifier configuration. This is utility of using a buffer stage. Now you understand what is the importance of using a buffer; that we have seen in earlier modules right we have seen voltage follower. The importance of few voltage follower in this kind of application is to remove loading effect, one-line answer right.

If you are asked in a question or in some interview what is the role of buffer right or voltage follower, then you can give this example suppose I have a sensor which is a resistive sensor and i connect resistive sensor to a potential divider and if I connect potential divider to the inverting amplifier, you will see a loading effect; that to remove that loading effect, if I put a buffer in between then I can remove the loading effect that is the use of my buffer. So, then you can you are not only explaining how you are using the buffer, but you are also explaining where to use buffer with a given example of a sensor right.

This whole circuit when you talk it looks clear understanding and it gives a clear understanding. And we are in fact scene in the experiment that how the loading effect can be removed right. So, if I quickly recall this is the part 4. So, what we have seen? We have seen 4 different parts. First is we have seen just a voltage divider right and we measure the output of the voltage divider. Then we have seen the inverting amplifier and the output of inverting amplifier, then what we have seen; we have integrated the inverting amplifier with the voltage with a potential divider and we have seen the effect of loading. Then we have connected the potential divider with the non inverting amplifier and we saw that there was no loading.

Then we have used potential divider, inverting amplifier and we kept the buffer in between and we again saw there is no loading right. So, doing this exercise we understood the effect of loading and how we can reduce the loading right. So, I hope that this particular experiment or setup experiments in several parts helped you out to

understand, what is loading and how we can reduce the loading effect by using a simple circuit or by using a simple op amp in a extremely simple configuration called voltage follower right

You do not require any passive components to connect with the Op-amp to make it voltage follower. So, the importance of voltage follower, one example we have given which is the reducing the loading effect alright. So, in the following modules we will see more experiments interesting experiments like this. Slowly and gradually as you go on understanding the modules, you will see the complexity of the circuit I am increasing it. We will see differential amplifier we will see instrumentation amplifier and then we will finish this set of experiments and we will continue. So, I hope that once again that you understood the effect of loading. I will see you in the next module by the time take care bye.