Op-Amp Practical Applications: Design, Simulation and Implementation

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Lecture – 05
Effect of Loading and Input Impedance: Part 2

Welcome to this module and if you have seen in the last module, what we were looking at? We were looking at the loading effect. And we have seen the potential divider; we have seen a inverting amplifier; we have seen the output of the potential divider and we have seen the output of the inverting amplifier. Now, this particular module is to understand further loading effect.

That is why if you see last module, this module and the next model, you will have just a same aim with different parts, alright? Same aim with different part. Aim will be to study the effect of loading and input impedance, but part would be different, alright.

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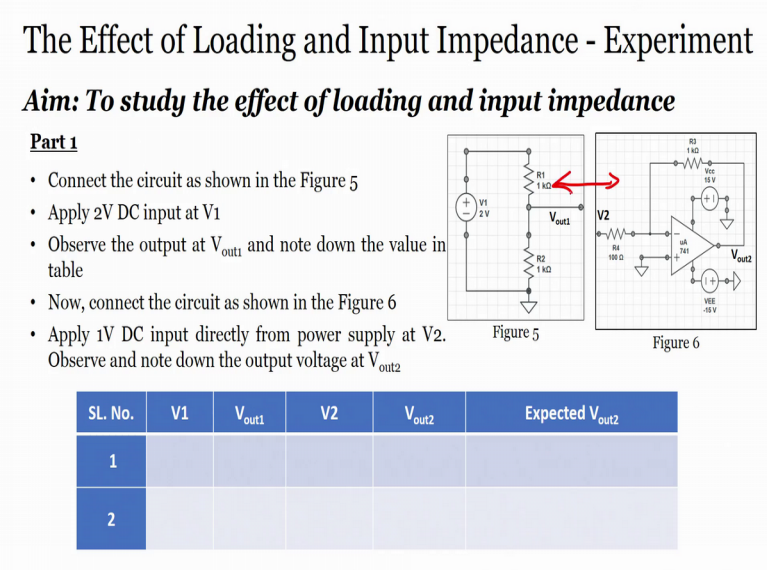

So, this is the; for part 1 which we are studying the last module. And let us see when we integrate this both, when we integrate this and this what happens, alright?

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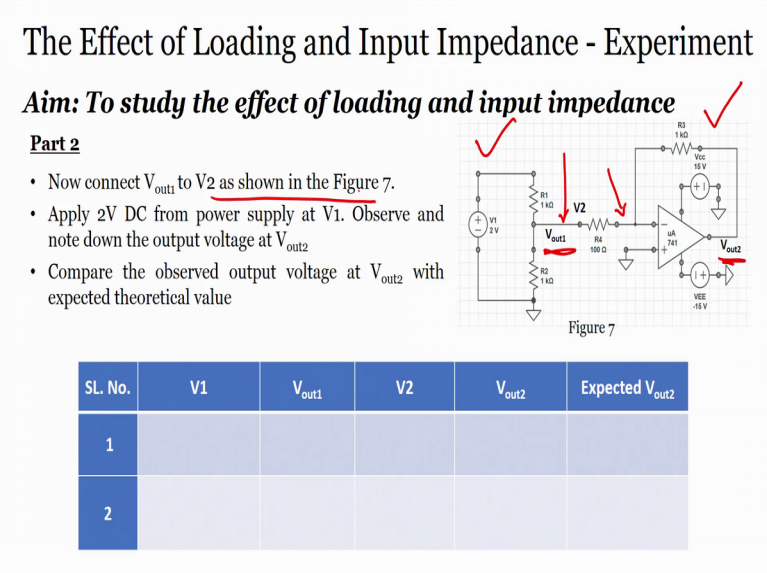

So, this is the circuit. What is circuit? That we have now potential divider, we have this potential divider which is this circuit, we have inverting amplifier which is this circuit and we have to integrate it; that means, the output of the potential divider the output of the potential divider is the input to the inverting amplifier, right? The output of the potential divider is the input to the inverting amplifier that is the case. Now to understand this, what is the output voltage and output voltage V out2, first is we have to understand what is the V out1 and V out2, when we connect it in this particular fashion. To do that, first is connect V out1 to V 2 as shown in figure 7. So, if you see this figure if you see this figure what you say? We have to connect the V out1; V out1 is this one to V 2. V 2 is this one right. So, we are connecting V out2 V out1 with V 2, done.

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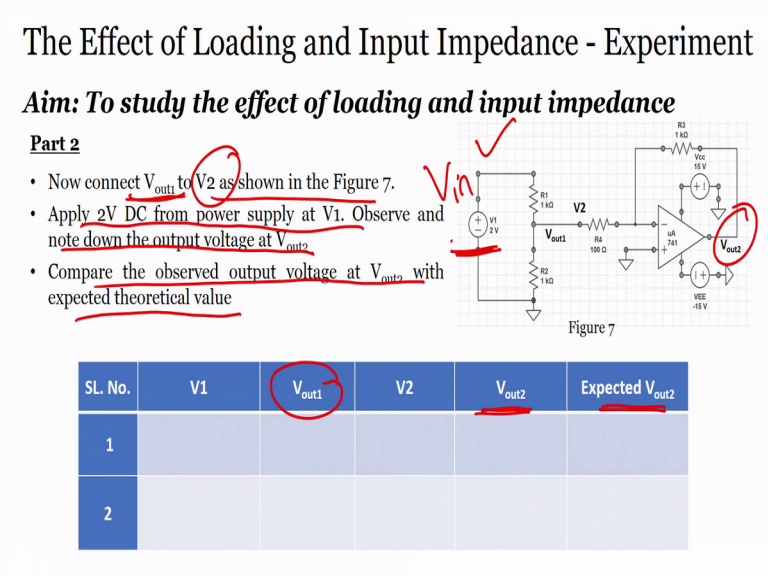

Then apply 2 volts DC power supply at V 1, we are applying 2 volts DC power supply at V 1, done. Then observe and note down the output voltage V out2. So, when I apply input here, I have to observed output V out2 here, alright.

And compare the observed output voltage V out2 with the expected theoretical value. So, I have to just use V out2 an unexpected output. I do not know I am not worried about this, because now I am directly connecting V in and V out, alright. So, these experiment you can ignore this column if you want, if not is similar column to a last one. So, it becomes easier for you when you perform the experiment that is why I had kept the similar kind of table, alright.

So, the point here is that now instead of measuring the output voltage at the potential divider and then separately measuring the output voltage in the output of the inverting amplifier, here what we are doing? Here we are measuring the output voltage at the inverting amplifier directly and the input voltage is applied at the input of the potential divider.

That is what we are doing, alright. So, let us perform the experiment, so that we understand what is the change? So, you had to connect the circuit as shown in the screen, right this is a circuit, remember, right. Do not do any mistake. It is very easy, we are applying voltage across; so, even it is written like this, right if I directly take a resistor.

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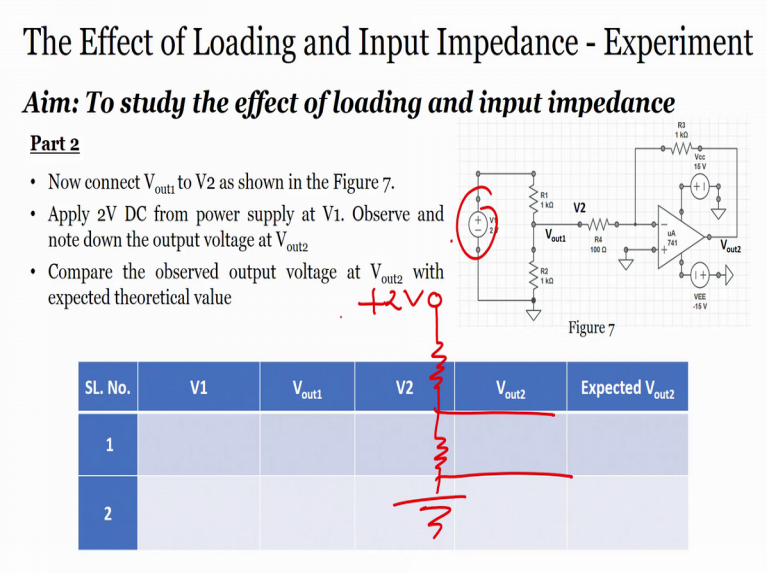

Let us say I take a resistor, 2 registers I ground it, right? I apply voltage plus 2 volts. This is potential divider, when I am measuring the voltage across this register, alright.

So, do not get confuse as if you see circuits like this or if you circuit like this, because this is when you apply plus 2 volts, this plus 2 volt is with respect to ground. That is why you see always plus minus like this, alright. So, this is also potential divider. It is also called voltage divider.

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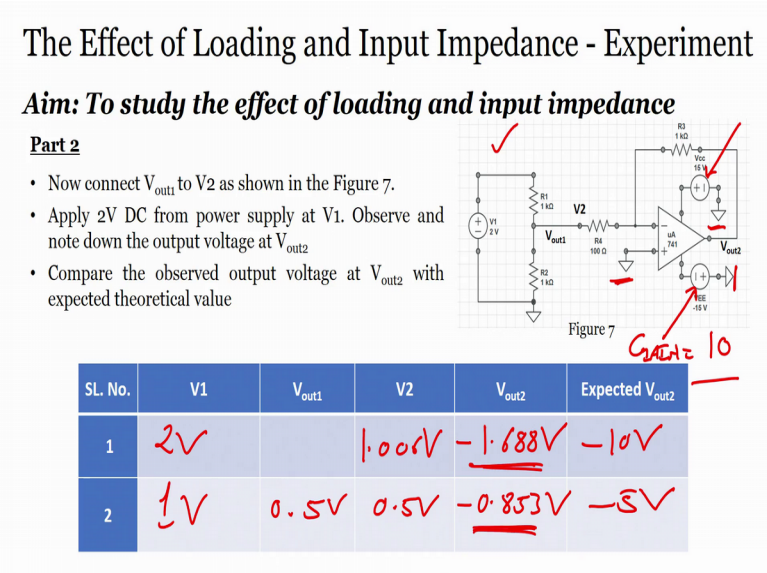

So, let us see when we connect the circuit this is one which is easy; the inverting amplifier, the non-inverting terminal is grounded. This is another way of showing ground. This is another way of showing ground. So, do not get confused if you have circuit like this or another if you wanted go in detail every symbol has his own perspective; it is own understanding.

But we are we are not interested right now to understand what are the symbols. We just assume that this is the symbol for ground. This is ground, this is ground. This is plus V cc, this is V ee minus 15 volts plus 15 volts applied across the op-amp. Inverting terminal is connected to the output of the potential divider. Register R 4, register R 3, R 3 is 1 kilo ohm, R 4 is 100 ohm; that means, gain of this amplifier is nothing but 10, right 10 is a gain. So, gain of this inverting amplifier is 10, alright. Now let us connect the circuit and if you see again Suman is there to help us.

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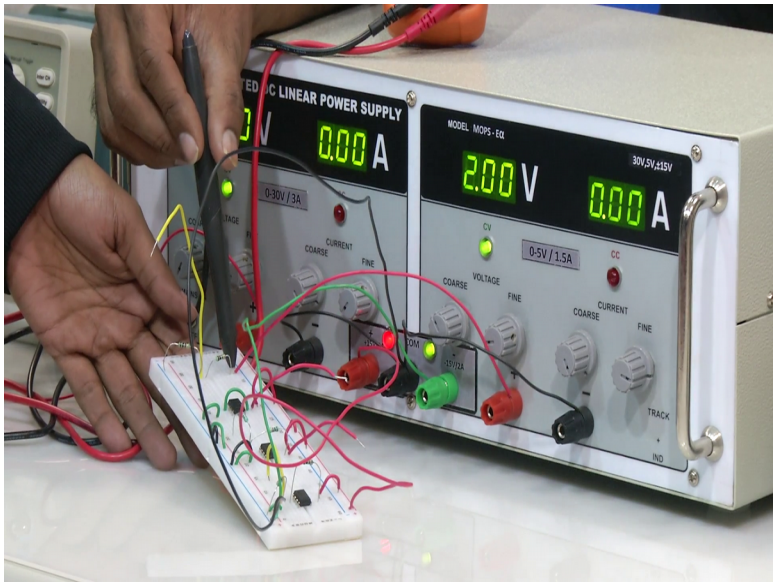

If you see, the DC power supply and the breadboard and the breadboard right, so, he has applied the voltage to the input of the potential divider here, voltage at the input right, how much voltage he has applied? You can see 2 volts, 2 volts here, correct? So, 2 volts he has applied at the across the potential divider, across the potential divider. Now this is the output, this is the output of potential divider that he will connect at the input of the inverting amplifier. So now, if you this was inverting amplifier, right if you can see clearly it will be helpful, yes.

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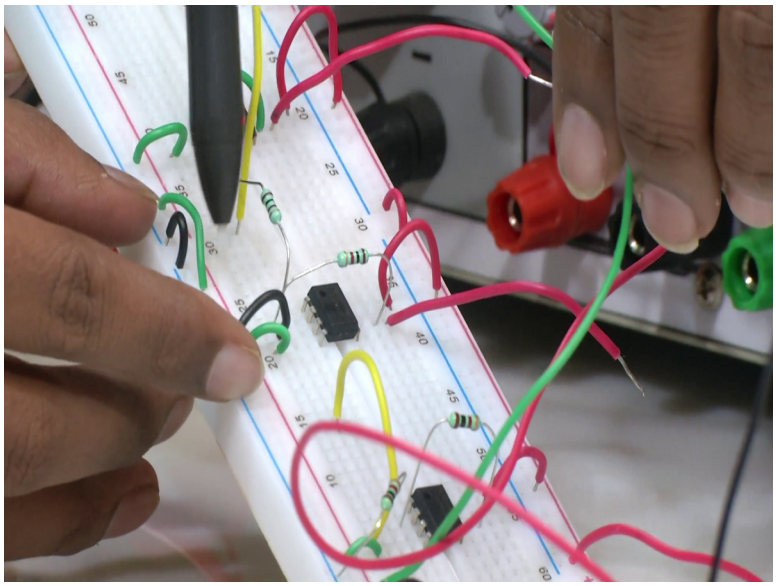

So, this is the inverting amplifier, right? What he has done is he has connected this one which is the output of the potential divider to the input of the inverting amplifier, alright. Now what we have to measure? What is the output of the inverting amplifier? So, output voltage he has to measure from here with the help of multimeter and we will see what is output voltage.

So now, the input voltage is 2 volts, input voltage is 2 volts. For 2 volts, I think we will see the clipping. I do not know, maybe you may not see because 2 volts will give us 1 volt at the output and 1 volt when we have a gain of 10. So, our output should be minus 10, right, we will not see the clipping because 2 volts is not given to inverting amplifier, 2 volts is given to the non-inverting to the potential divider.

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And what we see is minus 1.689 volts. That is because, that is the output at the inverting amplifier. This is the output of the inverting amplifier.

So, let us write down here. We apply V 1 2 volts, V out2 equals to V out2 equals to 1.688 volts, alright. So, this is and it minus because this is the inverting output. So, what is the out, what is the input at V 2? Let us see. What is the voltage across V 2? So, we are measuring now the voltage across V 2 and V c is 1.006 volts, alright. So, this is the output at the inverting amplifier, ok. So, this is one way of doing it. Let us do another way. Let him apply 0.5 volts at the input, 0.5 volts at the input.

1 volt; let us apply 1 volts at the input. So, that we can see the output at the potential divider would be 0.5 volts; the output of the potential divider 0.5 volts, right. So, we are applying 1 volts at the input, 1 volt at the input, output at the potential divider 0.5 volts or V 2 would be 0.5 volts, right? Now let us see V out; let us see V out. 0.853 minus 0.853 volts right. So, if you see right, what is the gain? Gain is 10; that means, if I have V 2 of 1 volts, my expected output should be minus 10 volts, right.

If I have a V 2 which is 0.5 volts, my expected output should be minus 5 volts, right. But what is my output? My output is minus 1.688 volts. My output is minus 0.853 volts, right? Let us do one more experiment, alright. One more experiment, let us apply, 0.5 volts in the input.

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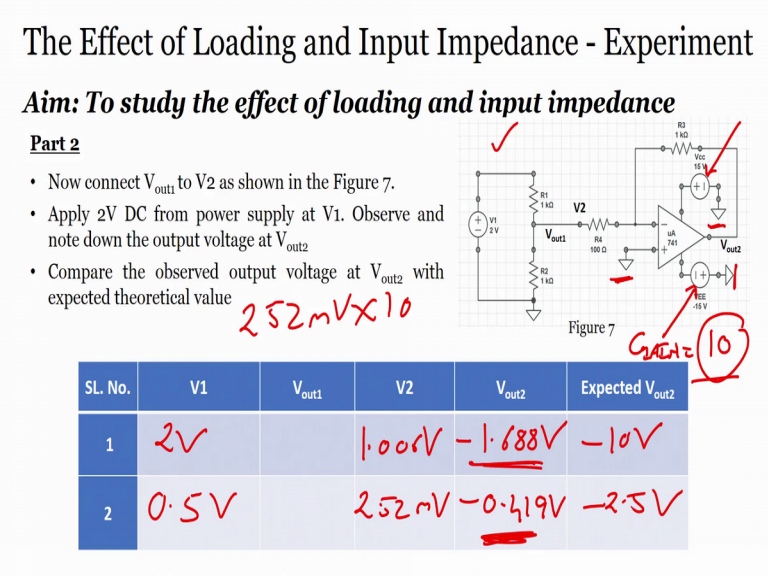

Maybe we are doing something wrong. So, I am trying one more time. Let us see, 0.5 volts. So, we have applied 0.5 volts at the as a input to the potential divider circuit, voltage across the potential divider circuit. And we are measuring the output voltage 252.5 millivolts, V out2, V out2 is minus 252. Is it V 2? V out2, right?

V 2 is 252 millivolts. What is V out2? Can you measure V out2? V out2 we measure, the value is if you can see on the multimeter, the value at V out2 would be minus 0.419 volts, minus 0.419 volts. Now again it is strange, isn't it? Why? Because 252 millivolts if I have a gain of 10, then 252 right or 2.52, let us say 252 millivolts that is like this, is easy. 252 millivolts into 10 will give us minus 2.5 volts, minus 2.5 volts.

What I am observing? Minus 4.19 volts. There is something wrong with the circuit. There is something wrong with the circuit, isn't it? Because what we are giving is input as 1 volt, our output should be minus 10, but we are getting 1.688. If I giving input as 252 millivolts, output should be minus 2.5, we are getting output as minus 0.419. So, what is wrong? Is a circuit wrong? What we can think? Is this circuit not behaving properly? Or our connection is wrong, right? No, the answer is not, the circuit is correct right, but we here we are looking at the loading effect, right. This is how the loading effect will work. Because of the loading effect, the expected output and the actual output will have so much of difference. This is what I wanted to convey in the lecture and then now we can see in the experiment also; that when we connect 2 different circuits, there is

a loading because of the second circuit on the first one or the output of the second circuit will not be equal to the expected output, because of this particular loading effect.

So now, we will see how we can remove this loading effect in the following module, alright. So, what you understand is, when you take a potential divider, when you take a inverting amplifier if you integrate it at the expected output which is not actual to your experimental output, right. This is your loading effect. So, let us see this is short module to understand what is the loading effect. Now, let us continue the next experiment in the next module, alright. By that time, you take care and I will see you next module.

Thank you.