INDIAN INSTITUTE OF SCIENCE BANGALORE

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NPTEL ONLINE CERTIFICATION COURSE

Electronic Modules for Industrial Applications using Op-Amps

Module 7

Lecture-38

With

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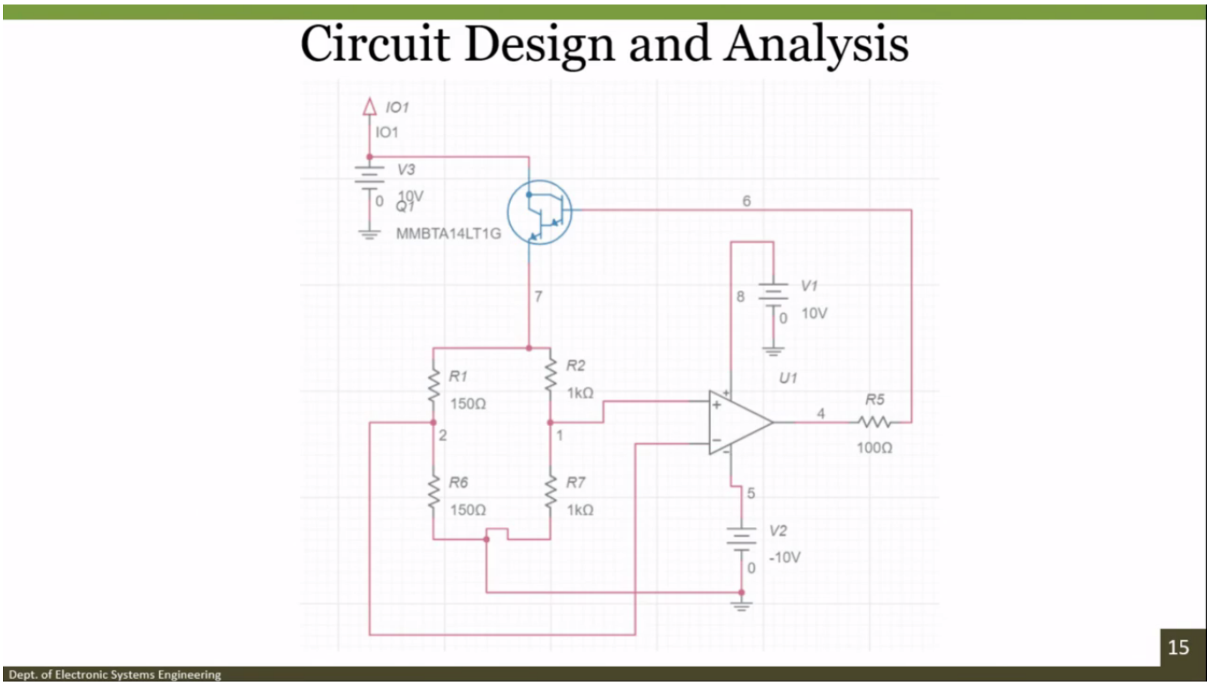
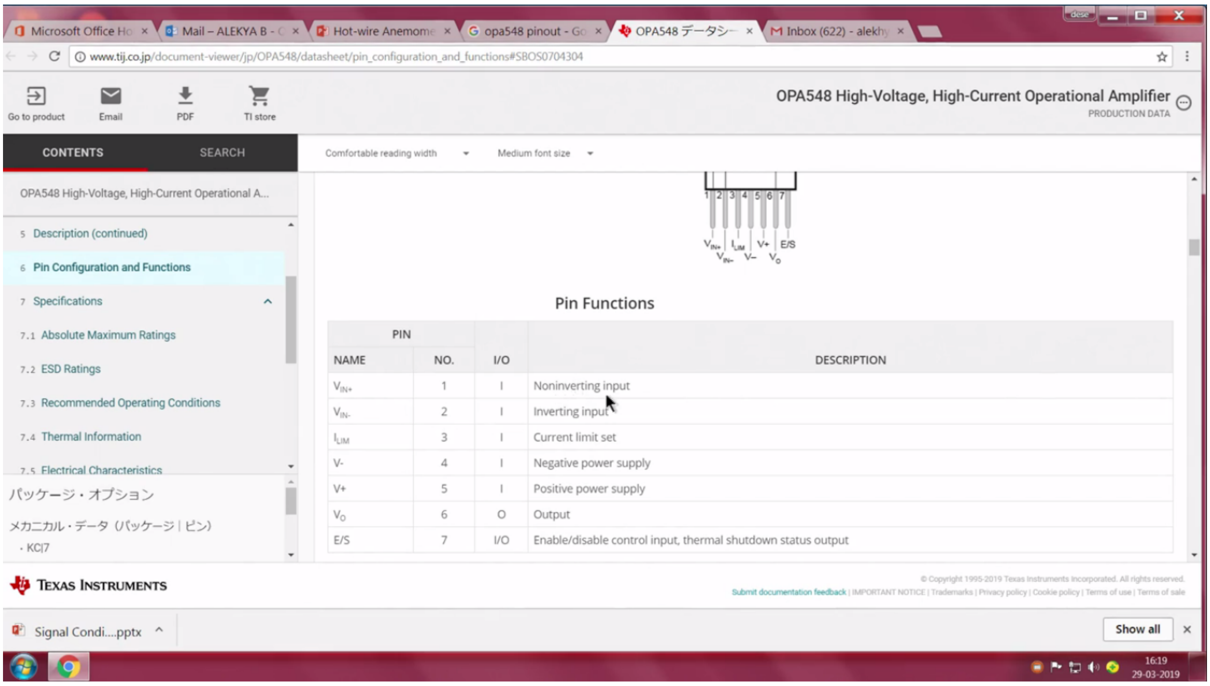
Hello everyone! In the previous module we were discussing about the hotwire anemometer. Nowt that we've seen how the circuit looks, how can you simulate that using multi-sim, let's see how we can rig up the circuit.



So as I mentioned the bridge connection is like this, like we have the heater here, the Pt100 if that becomes the portion where the sensor where you want to integrate this with the anemometer. So your sensor would come here. This is a series resistor, 150 ohm series resistor and R7 would be your temperature compensation resistor and then in series is your 1 kilo ohm resistor.

All of this, the output of these two will be given to your comparator here and then given to your transistor in case you don't have an op-amps which can drive high currents.

Now that we've seen this circuit, let's see how do we rig up the entire circuit.

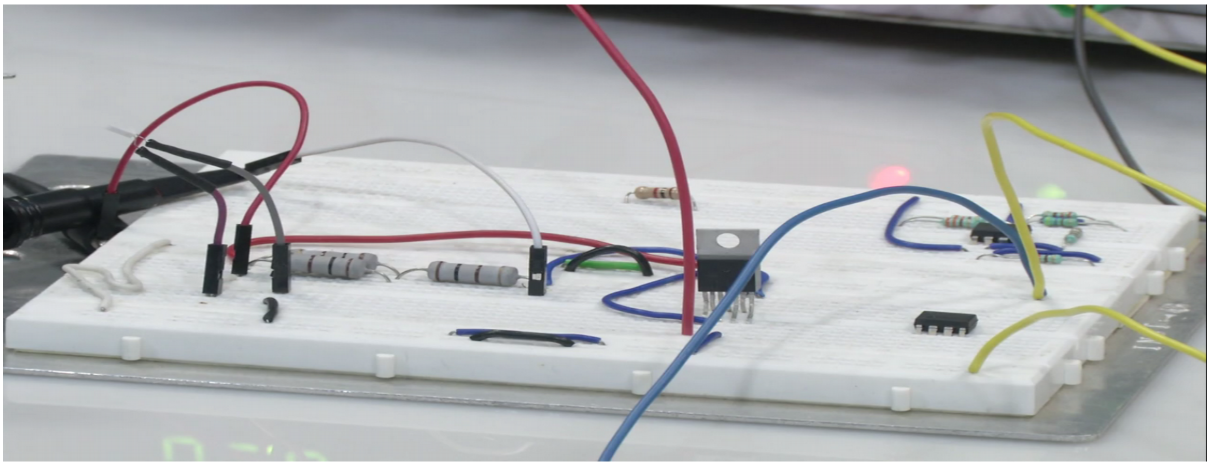


For that I'd like to show you the pin functions of the IC what we are using. So we have an OPA548 here. So it can support high currents. So this is the pin out here, and the explanation for each of this, the functions of each pin here like the non-inverting input, the inverting input, current limit set.

So if you clearly read through the data sheet of OPA548, you would understand that this pin here, the third pin, the current limiting pin here could be connected to the V- in case you are okay to run it at the current what the op-amps can support. But if you are working with devices where you require very small currents and you need to limit the amount of current that flows through your device then accordingly you can connect the I limit to a resistor and then build your circuit.

For now we are okay with the op-amps can drive through and hence, we have disconnected the I limit to V- here and it would become more clear once you read through the entire data sheet how each pin could be connected, and the positive power supply output and the enabled pin.

So we'll see how to get the hotwire anemometer circuit using the OPA548 today.

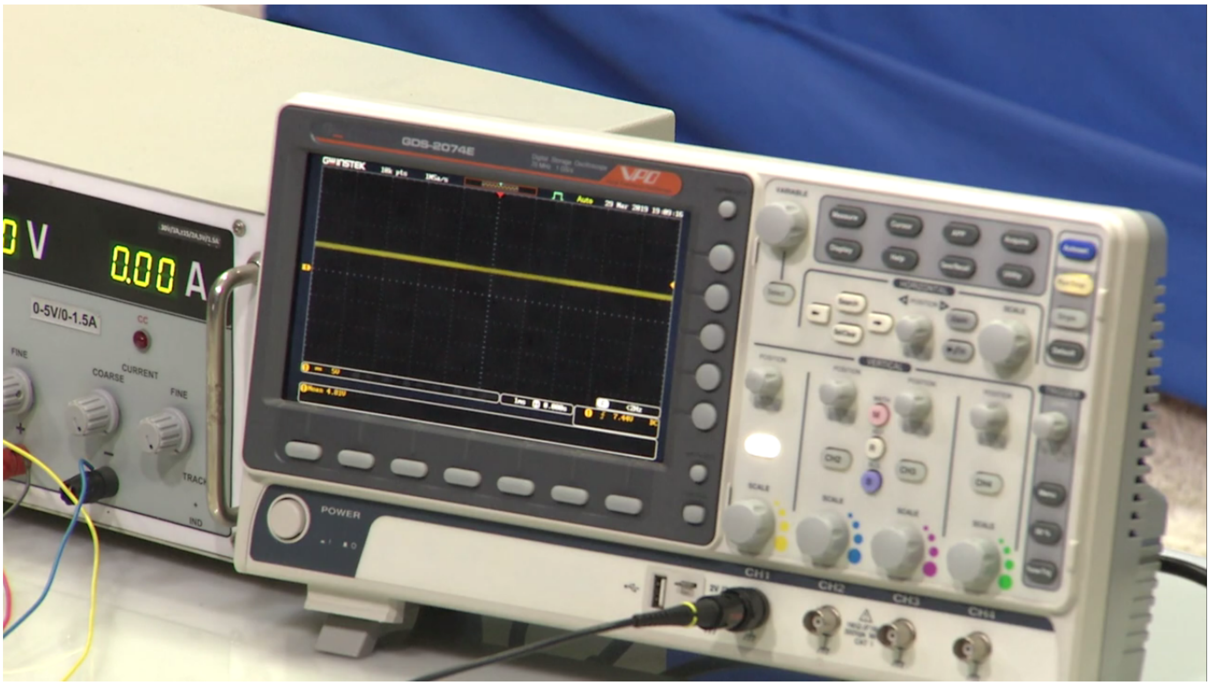


So initially this is the circuit what the board you see here. So the two resistors here are 100 ohm, this is 100 ohm, and the two connected in parallel, 50 ohm. So this net R value, 150 ohm if connected in series with the tiny Pt100 what you see here, the blue small chip here is nothing but your Pt100 sensor and then we have connected instead of giving the compensatory circuit, we have given a constant reference voltage through the circuit.

So based on the flow, the change, based on the change in temperature there is a change in resistance and you will see how the feedback mechanism here would again enable this resistor to maintain the constant temperature irrespective of your flow.

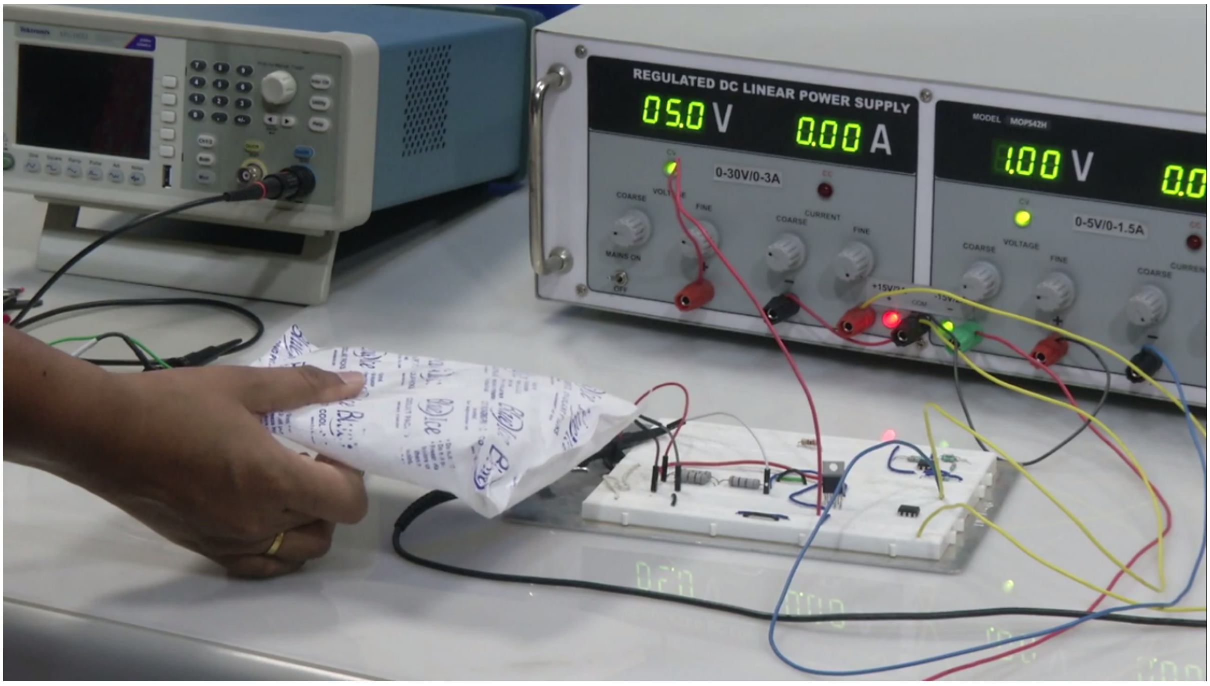
This is the op-amps which can support the high currents, the OPA548 op-amps what I was talking about.

Now that we've seen how to connect and I've given a constant reference voltage of five volts that is as load varies, the resistance of this varies, however, it is always being compared with five volts so that your feedback drives current accordingly and the temperature remains constant.

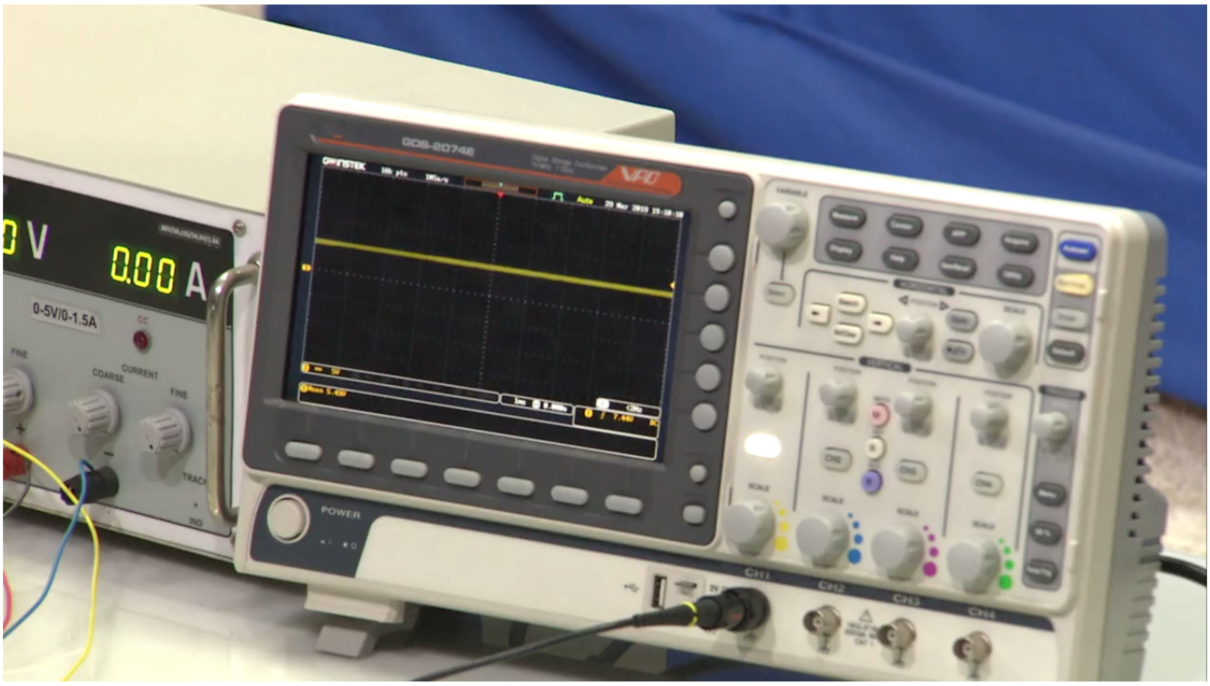


Now for steady state without flow let’s see what is the output voltage. Looking at the oscilloscope here, here you can see the set voltage of 5v and here the voltage across sensor that is the Pt100 is showing 4.8v which is close to your set value. Now what happens when air flows through your Pt100.

Assume in order to simulate the airflow mechanism as air flows it takes away the heat from your resistor and so there is a drop in temperature.



Just to simulate I have an icepack here which I would just keep it on the Pt100 here. Now what I want you to see is as I keep the icepack on your Pt100, let’s see the variation in the voltage levels here on my CRO.

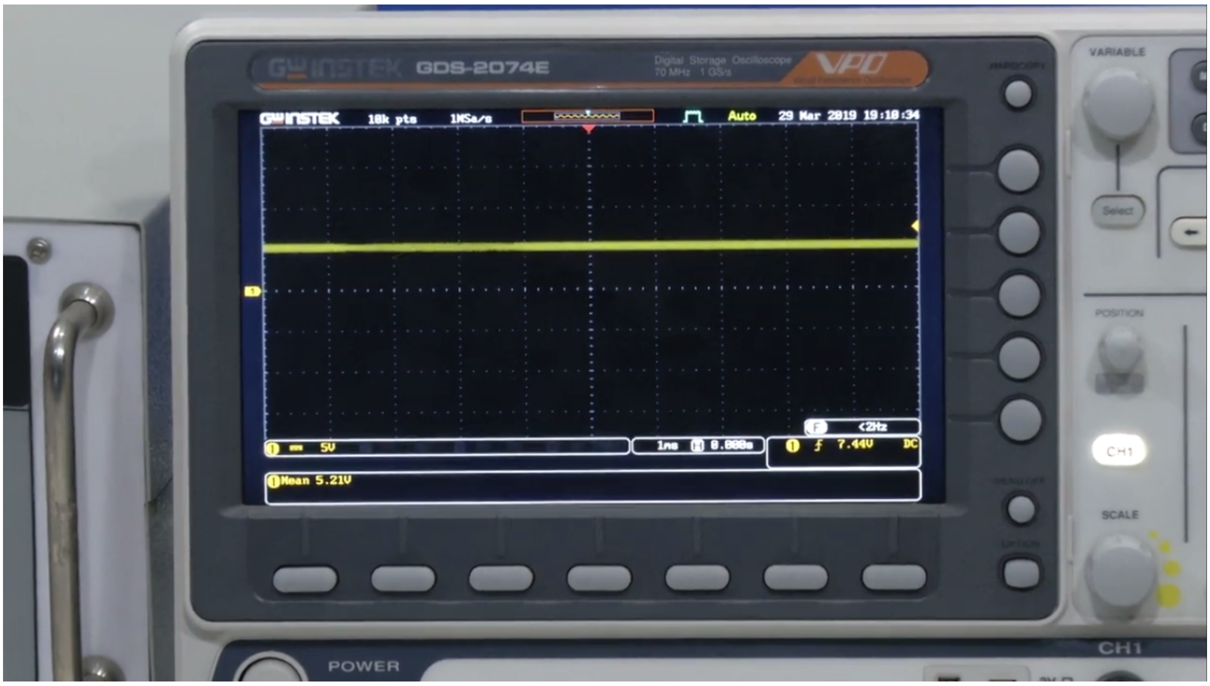


So when I cool, assume there is air flow and is taking away the heat from your Pt100, the voltage varies. So you see the voltage is going up to 5.6v. So we have a reference voltage which is 5v, the differential voltage is rapidly increasing. So now it is 5.48.

Let’s say I remove the icepack. So this voltage difference is vast. So based on this voltage difference there is current which is being driven to your heater so that it again comes back to the room temperature or maintains constant temperature.

Now that I have removed the icepack, again as you can see it is very quickly it has come back to the normal state but it is now having a voltage of up to 4.8v which was the steady state condition.

Now you can do further experiments as to just to check the response time. So the minute I get the icepack close to the sensor the change in voltage is immediately detected in fraction of a second. So now it has gone up to 5.8v.



Now the voltage difference once I removed, so now that I have the icepack close to the heater, you see the difference in voltage. As I get it back, let’s see how sensitive our op-amps or the device, the Pt100 sensor is. So when I have the icepack close, let’s see how quickly it would rise. The change in voltage can be observed from the CRO. So now 5v, so as you see the voltage is rapidly increasing.

The differential voltage here tends to drive current in order to maintain your Pt100 at the desired temperature. The minute I removed the icepack you see the voltage variation has rapidly come down. So now it is 4.8 which is ideally the steady state condition.

Considering how quick the response is you could always choose the OPA548 which is a high-power amplifier in order to get better efficiency while you are working with your circuit and have a very quick response time. So now we’ve seen how a Pt100 can be used in your circuit and have a closed loop feedback so that you could measure the velocity of the air which is flowing through your load.

Irrespective of the change in load you can always have a feedback mechanism in order to keep your sensor at a constant temperature and this parameter will help you understand the velocity at which the air is flowing from King's law which was discussed in our previous lecture.

So from the equation you could derive the direction proportionality between the velocity and the change in voltage and then plot the rate at which the air would be flowing across your device.

So this was a brief explanation as to how to rig up your anemometer circuit and then check the feedback mechanism. That's it for today. Thank you.

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