Electronic Systems for Cancer Diagnosis
Dr. Hardik J. Pandya
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture - 71
Experimental Set-up of closed loop control of temperature sensor

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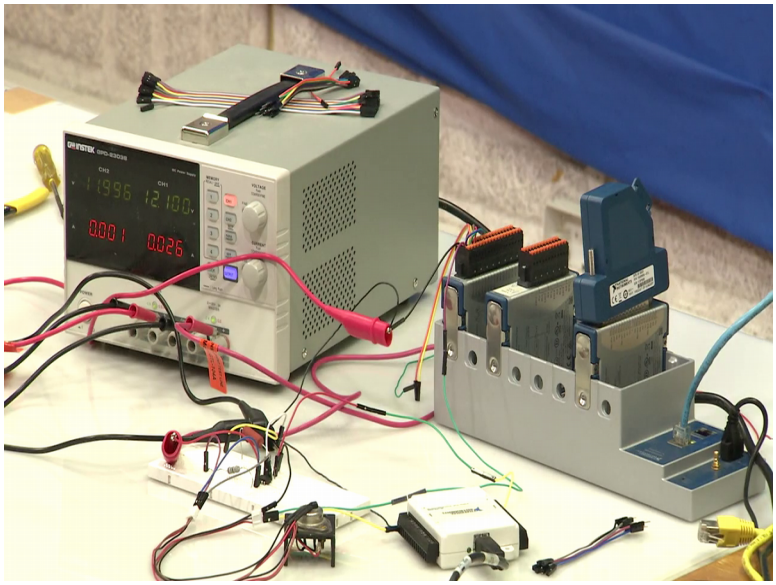

Welcome to the module.

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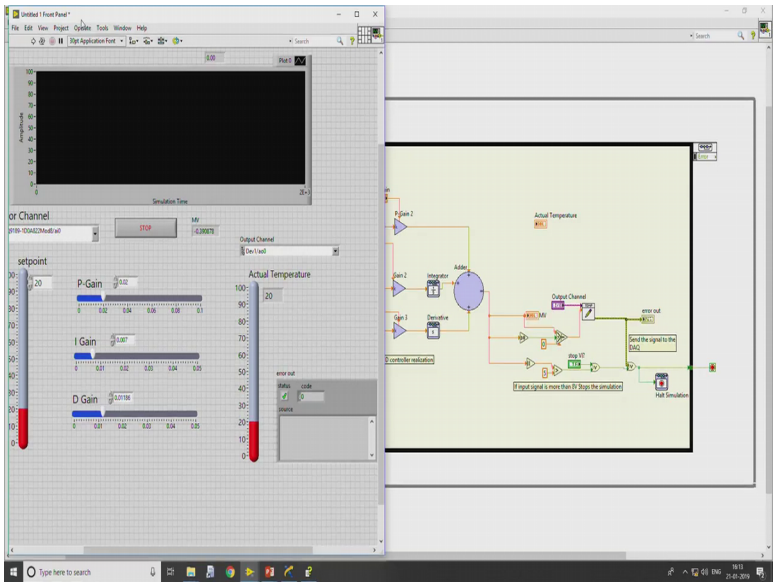

So, now we will see circuit board. So, this is our twin 3055 transistor, this is temperature sensor, and this is 741 IC. So, general purpose operational amplifier now let me build, let me build a circuit what we have seen in the inner in a presentation.

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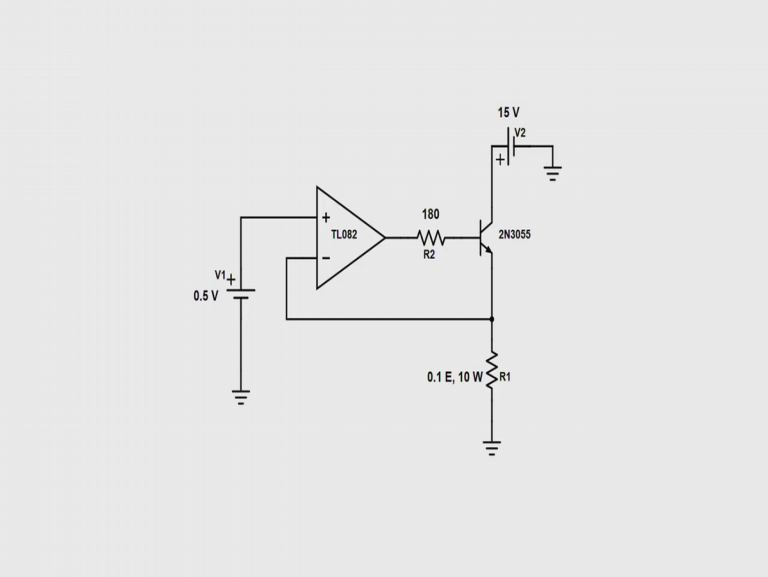

So, keeping on our presentation right so, when you look into the circuit. So, if we recall that a data sheet of 741 operational amplifier, so the second pin is nothing but your negative terminal. Whereas, the third pin of 741 is non-inverting terminal, where as the 4th pin is minus V c c and 7th pin is plus V c c and the output is nothing but 6th pin.

So, what I will be doing is that. So, this is 180 ohm resistor. I will be connecting the output which is nothing but 6th pin, so 4, 5, 6 the 6th pin with 180 ohm resistor to the base of transistor. So, this is 1 ohm 5 watt resistor. This should be connected across the negative terminal underground. So, the negative terminal in this case is 2nd pin, and the ground here somewhere here, I will be taking it, and I will be connecting it here. Similarly, even this, the negative terminal of an operational amplifier has to be connected to the emitter of transistor.

So, when we look into the connections of 2N3055 pin outs of 2N3055, the casing act as a collector whereas these two terminals act as base as well as an emitter. So, in this case, the red wire, so we have a 3 wires here. The red wire indicates the collector. So, even here we can see is a collector; in this case the red wire act as a collector. So, there the red

color wire, this act as a collector. Whereas the black color wire act as base, and the brown color y wire act as emitter.

So, what I will be doing is that, I will be connecting these three terminals to this. And in this case, the black is base. So, this will be connected to the base. Similarly, the brown is emitter, emitter will be connected to the 2nd terminal which is negative; and the first one is a collector. So, the collector will be connected to our power supply.

Now, similarly the sensor requires 5 volts. So, when you look into the data sheet of LM35 the red one indicates the plus 5 volts, the black one indicates the ground, and the brown indicates our output. So, I will be connecting with three male to male jumpers; red one with yellow; output with green and black with output. And output for this I will be using USB DAC.

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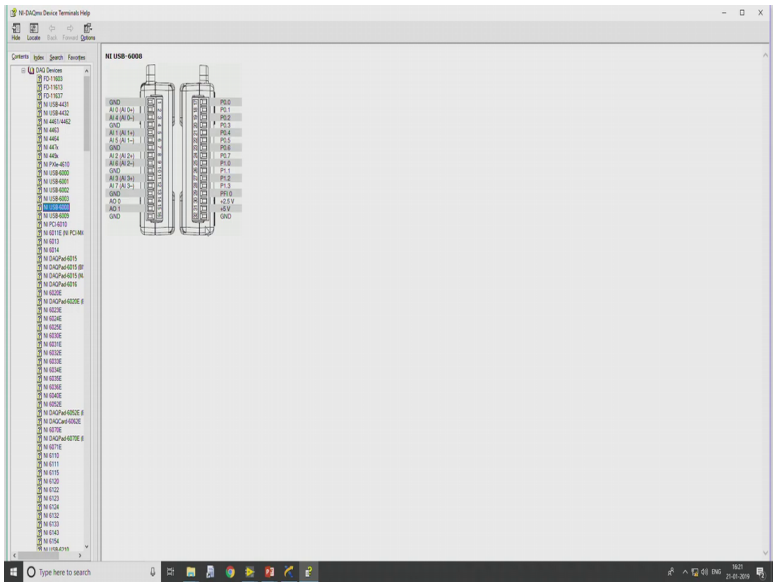

So, when we look into our USB DAC pin outs. So, 31st is 5 volts and 32 is ground. So, what I will be doing is, red I will be connecting it to 31st, and the black I will be connecting it to ground sensor. Now, so after connecting the power supply required power supply to this, the output of this particular terminal has to be connected to analog input channel in this case is AI0. So, what I will be doing is that, the output side which is nothing but green, I will be connecting it to this. So, to the input we have to provide analog output ok, there let me connect this power supply.

So, we also have to provide plus 15 to operational amplifier, and minus 15 as well. Along with this we require plus 15 to be provided to the collector of this. So, what I will do is that I will from the channel 1 the maximum voltage I will set to 12 volts, and the current the maximum current, I will set it to 2.5 amps. So, that more than 2.5 amps, this the power supply will switches off. And similarly even in case of channel 2, channel 2, 12 volts I am setting, the current is 1.5 amps when you press output, so both channels will supply, the same amount of output.

So, this is our channel 1, whereas this is our channel 2. So, what I will be doing is that, so the 15 volts should be connected to the 7th terminal ok, and where as this is our minus 15 terminal. So, the plus 15, I am replacing with this wire, connecting it to plus 5th the V c c terminal of operational amplifier. Whereas this is our ground, this ground I will be connecting it to this.

So, everything should have the same common ground. And similarly even minus, 15 so this is a positive terminal of that terminal. So, in this case this acts as a ground, because since we have to provide minus I will be connecting it. So, everything is having a common ground right now. Similarly, we also require to connect the output, which is nothing but 33 pin 32 pin to be connected to the same ground.

So, I will what I will be taking is, I will take another wire. So, in order to make everything as a common ground, I will be connecting it this here. Let me make the connections is ground. So, this is minus V c c, this I will connect it to the 4th pin. Similarly, we have to power LM35. So, in this case, it is required 5 volts; I will be connecting the yellow wire which is 5 volts in this case to this device. And ground should be grounded here, same common ground. And output which is brown in this case has to be acquired using this particular pin. So, now, the connections to the sensor is done.

So, now if we see the connections, so what we have made, so we have realize our circuit whatever we have seen, which is with operational amplifier as well as our 10 3 0 6 5 5 on this bread board, such that the base of a transistor is connected to the output of operational amplifier using this particular resistance 180 ohms.

Now, when you see that another terminal which is emitter in this case, so the emitter and you see the emitter the emitter is connected to the second terminal which is negative

terminal along with this the resistor 0.1, so 1 ohm 5 watt resistor is also connected across the out the negative terminal and the ground. And all grounds are connected shorted and as well as the output the analog output from the, which is generating from USB DAC is connected to the positive terminal of the operational amplifier, which is nothing but 3rd terminal.

Similarly, the power the required power to the operational amplifier as is providing using this particular power supply. So, this is channel 1 and this is channel 2. As of now I have not switched on the output. So, that then once I switch on the power, when you switch on it provides 12 volts as well as minus 12 volts. And the power to the transistor is connected to LM35, which requires a 5 volts in order to operate has been provided by using a USB DAC at the terminal pins of 31 and 32.

And similarly the input voltage which is been acquired by the operational amplifier sorry the in the sensor output voltage will be acquired using N I 9 2 0 7 USB DAC, so which is connected at this particular point. So, now all connections are made. So, let me switch on. So, this is right now the current flowing through this channel 1 is 24 mille amps. Now, I have not still provided the output yet. Suppose, if I collector, so it is drawing 1.8, just started heating ok.

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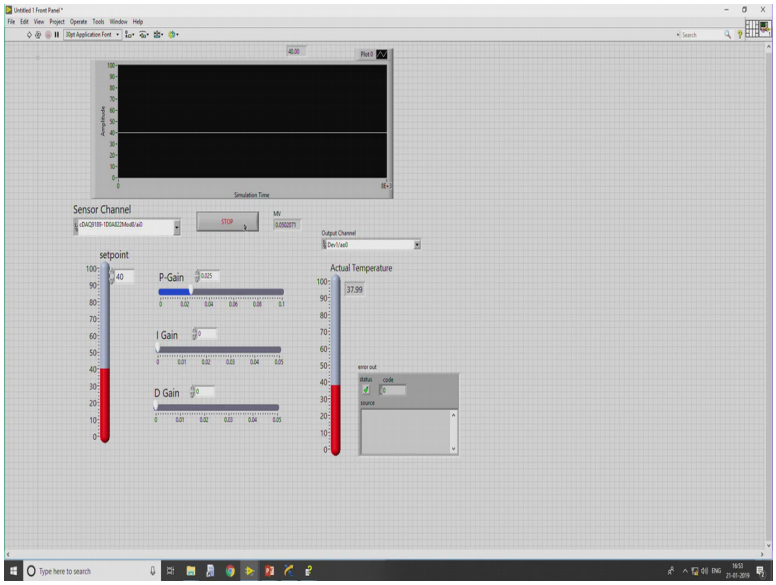

So, when we look into the P C, so here we can see right now the set point is 26.43. So, just make it as 25 ok. So, when I start running the system. The actual temperature right

now it is showing as 20 degree. So, this has been not connected yet. So, these are actual temperature. So, when I when I run the program right, so the actual temperature on top of the transistor is 30.81 whereas a set point is 25, so that is why the manipulated variable output is of minus volt. So, when we provide a minus voltage to the driver circuit, which makes the you know the system to be off.

So, when you look in to the power supply the current drawn will be as similar to the previous state which is, which is, which is nothing but right now the system is in off condition. Now, when I make the set point to 50 say now we can see the manipulator variable has increase to somewhere around 0.33. So, when you see the current drawn by the system is increase from 24 milliamps to somewhere around approximately 0.821 amp keep on increasing. So, as a result when it comes very close to the set point, the current drawn by the system will also decrease. So, here we can see from the graph. So, that the white one indicates a set point, whereas a red one indicates the actual output on top of the transistor.

So, the temperature on the transistors slowly, slowly increasing, so, right now the temperature is at 44 degree. And the time it is required to take in order to reach to the set point entirely depends upon external environmental factors as well as what is a gain that we have set to the system. So, right now I controller gain as well as d controller gain in this case is 0, which means that the, the controller right now which is influencing the plant is a P controller. So, it is a p e, it is working base upon the p controller.

So, let me try to increase the gain to 0.025, excuse me. So, it started increasing, increasing, so 50 right. So, here we can clearly see that it is now it is trying to maintain the temperature on the plant is equivalent to the temperature of the set point right. It will not even go beyond that within the range of plus or minus 2 percent or to 5 percent of tolerances error band, within that range it is trying to maintain the temperature on the plant to be of constant.

Suppose, if I further increase to 70 degree, now here we can see the temperature increase to 71 degree. So, the manipulated variable also changed. So, by drawing really high amount of current, so approximately of 2 amps of current, the sensor also the plant also heated to very high temperatures. So, we can see from power supply, so it is drawing power and keep on varying. So, since a temperature actual temperature is higher than the

set point temperature, the manipulated variable is of 0 right now. So, minus voltage which is nothing but 0 which means using external environment it has to cool.

So, let me decrease to 40. So, the temperature the actual temperature right now is at 57 degree, but the said temperature is 30, I will make it as 30 degree. So, by nature since we do not have any forced convention, so by using an natural convection, heat has to be dissipated to the environment. So, it will start cooling it. So, as a result once it reach to 30 degrees, it will again try to maintain the same temperature. As long as it is the actual temperature is higher than the set point temperature, the manipulated variable will be in negative, which means that the system is in off condition right.

Now, it will, it is not providing any power to pass through the transistor as a result the system that means, it is a 0 volts, which means that it will not heat the transistor. So, we can see that it slowly decreasing you can observe the response. Let me change the set point to 35 degree, so that it will not take much time just to understand.

Now, if we observe that when the set actual temperature is slowly reaching towards the set point, so just I will make it as 40, now the temperature is 37 degree. So, since the difference is little higher, it also pushes little energy and started heating. So, here we can clearly see it started heating. And now again after reaching to the actual temperature value, it is trying to maintain the 40 degree centigrade. You can see what is the actual temperature here, so, now the both the temperature the plant as well as set point, when you see the plant temperature it is at 40 degree, whereas the required temperature is also 40 degree both with almost approximately the same value even at output side.

So, with this we can understand the working the working of a P controller as well as implementation of the P controller using the data acquisition device as well as a lab view. So, this particular process is called software in loop. So, this is because this is called as software in loop, because the software is acting as a controller, whereas a plant is externally connected externally connected. And these two things are interfaced using data acquisition, so this that is why this is called software in loop. The software which is written the lab view programming will be will be in loop with the plant, so where the plant is sitting outside right.

So, the similar way we can even implement the PI controller as well as PID controller it is not necessary that the same P I controller and PID controller to be implement for all

the times in order to control, even we can develop our own algorithm say similar to that of fuzzy logic as well as neural network and interface it to the real world signal in order to understand the working of any system or any algorithm using functionality of any system.

So, with this I will stop.