Lecture – 30
Introduction to Gas Sensors

Hi, Welcome to this particular lecture now, in this lecture we will look at electronic module or signal conditioning circuit for gas sensor. Now when you talk about sensors there are several kind of sensors, so starting from thermal sensors Right? We have pressure sensors, force sensors then we have piezo resistive sensors for strain gauge, we have VOCs sensors which stands for volatile organic compounds, we have guest sensors Right? and so on and so forth. And a lot of other sensors as well that we we have not talked about but there is a slide which will explain a variety of sensors available in market, and from those sensors we will pick one which is the gas sensor will understand what kind of gas sensors are available will understand what is a principle behind the gate sensor, and then we will see how can we design an electronic conditioning circuit for that particular sensor.

Now, then I am talking about gas sensor if you think from engineering point of view or from industry point of view in in fact then you can use this sensor for sensing CO_2 Right? which is a leakage in our industry or you can use the sensor for understanding the leakage in a pipeline which is a chemical pipeline, and there is a there is an importance of measuring that particular leakage in an industry. Now when you talk from medical point of view if I have a group of sensors ie I can delineate a particular volatile organic compound from the breadth and that is called a studying the breath signature of a patient. For example, if a patient is suffering from a particular disease the the some of the world learning compounds will be in higher concentration compared to other VOCs. So, if a person is suffering from ketosis which is a diabetes then the so also our our breath has several kind of VOCs along with guests.

The VOCs assistance for volatile organic compost like I said, for example we are using petrol, diesel Right? now I don't say we we exert VOCs which are similar to petrol diesel, and just giving an example of volatile organic compounds. So, if you drop a petrol on the table it will evaporate, similarly drop our diesel on the table it will evaporate, drop acetone on the table it will evaporate, drop ethanol on a table it will evaporate, all things which are volatile in nature at room temperature are called volatile organic compounds. So, what I said is that we excel several VOCs like acetone, methanol you know IPA and and similar kind of uses along with CO_2 and humidity in in our breath. Now, if a person is suffering from particular disease certain VOCs are of higher concentration compared to remaining VOCs, if you can detect or if you can delineate those VOCs from the breath then what you can say you have developed or non-invasive way of measuring disease.

The point that I'm making is that if it is a if it is a cancer then also you can detect a certain VOCs in higher concentration compared to a person who is normal, and if you check the best signature of the cancer and the person suffering from cancer, and person who is not. So, the point here is that if I can design and fabricate a sensor and I can use two sensor or one or area of sensor along with electronic indistinct circuit then I can understand what is going on, and how can I see the change in resistance corresponding to the particular VOC. So, if it is a resistive sensor when you expose the sensor to a gas the resistance will change that resistance we need to convert to a readable format for changing from the change in resistance to a readable format what we need to use, we to design the signal conditioning circuit.

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Now let me play the first video for you so you know what kind of sensors are available in market. In our normal life we use different types of sensors that are commonly used in various applications all these sensors are used for measuring one of the physical properties like temperature, resistance, capacitance conduction, heat transfer etc., In this video we have seen different types of sensors along with their practical applications there are a few types of sensors such as temperature sensors, infrared sensor, proximity sensors, pressure sensors, level sensors, smoke and gas sensors, ultrasonic sensors and touch sensors are commonly used in most of the electronics applications.

Temperature sensors a temperature sensor is a device typically a thermocouple or RTD that provides for temperature measurement through an electrical signal. In other word a temperature sensor is a device that detects and measures hotness and CONUS and converts it into an electrical signal. There are different types of temperature sensors like LM35 IC, thermistors, thermocouples RTD etc., Temperature sensors are used everywhere like computers, mobile phones, automobiles, air conditioning systems, industries etc., IR sensor an infrared sensor IR is an electronic device that emits in order to send some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detect the motion. These types of sensors measure only infrared radiation rather than emitting it that is called as a passive IR sensor different applications where IR sensor is implemented on mobile phones, robots industrial assembly, automobiles etc., Proximity sensors a proximity or presence a sensor is the one which is able to detect the presence of nearby objects without any physic contact. They usually emit electromagnetic radiations and detect the changes in reflected signal if any. Proximity sensors are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors and motors that use sleeve type bearings.

Pressure sensors a pressure sensor is a device for pressure measurement of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer it generates a signal as a function of the pressure imposed. Pressure sensors can also be used to indirectly measure other variables such as fluid or gas flow speed, water level and altitude. Level sensors a level sensor is one kind of device used to determine the liquid level that flows in an open system or closed system. The level measurements can be available in two types namely continuous measurements, and point level measurements.

The continuous level sensor is used to measure the levels to a precise limit, but they give correct results where as point level sensors used to determine the level of liquid whether that is high or low. Ultrasonic sensors an ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. Ultrasonic sensor can be used for measuring wind speed and direction tank or channel fluid level and speed through air or water. Smoke and gas sensors, a smoke detector is a device that senses smoke typically as an indicator of fire commercial security devices issue a signal to a fire alarm control panel as part of a fire alarm system while household smoke detectors also known as alums generally issue a local audible or visual alarm from the detector itself.

Touch sensors touch sensors are also called as tactile sensors and our sensitive to touch force or pressure they are one of the simplest and useful sensors. The working of a touch sensor is similar to that of a simple switch when there is contact with the surface of the touch sensor the circuit is closed inside the sensor and there is a flow of current, when the contact is released the circuit is opened and no current flows. Touch sensors are used in a wide range of display applications from smart homes and appliances to security and industrial solutions. Dear viewers thanks for watching the video.

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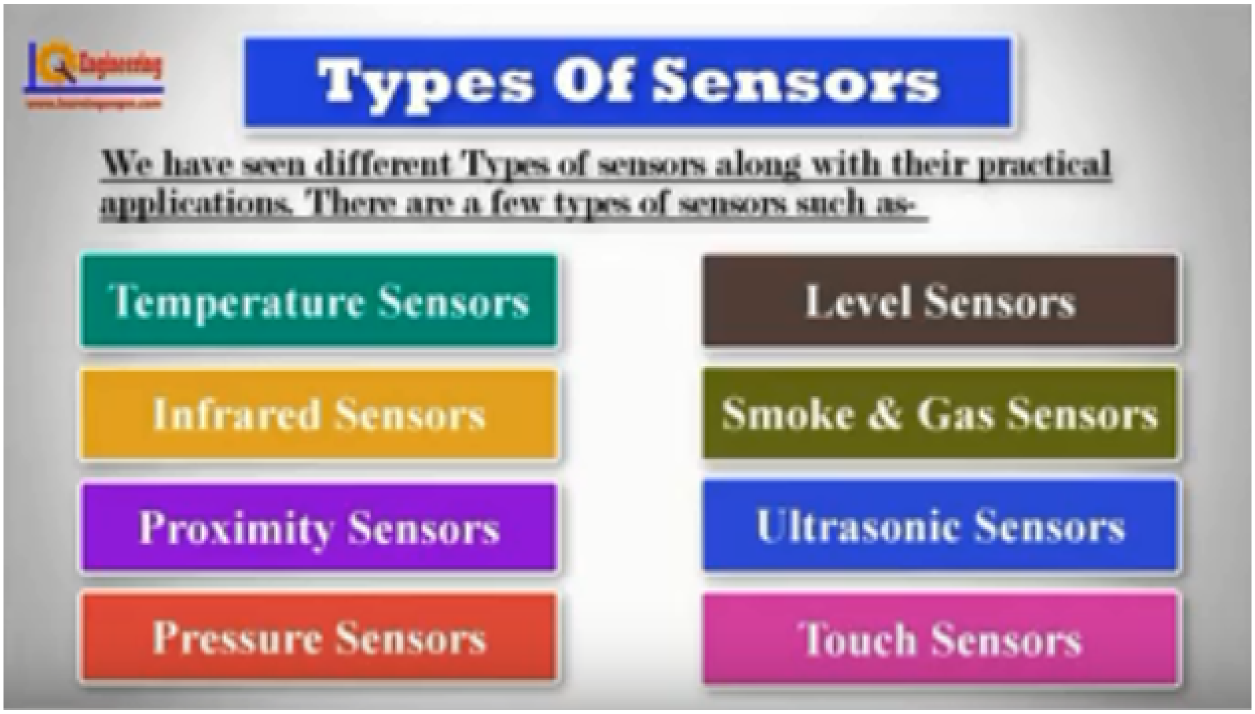

Okay? So, what you have seen in the video is that there are several kind of sensors and then from those kind of sensors.

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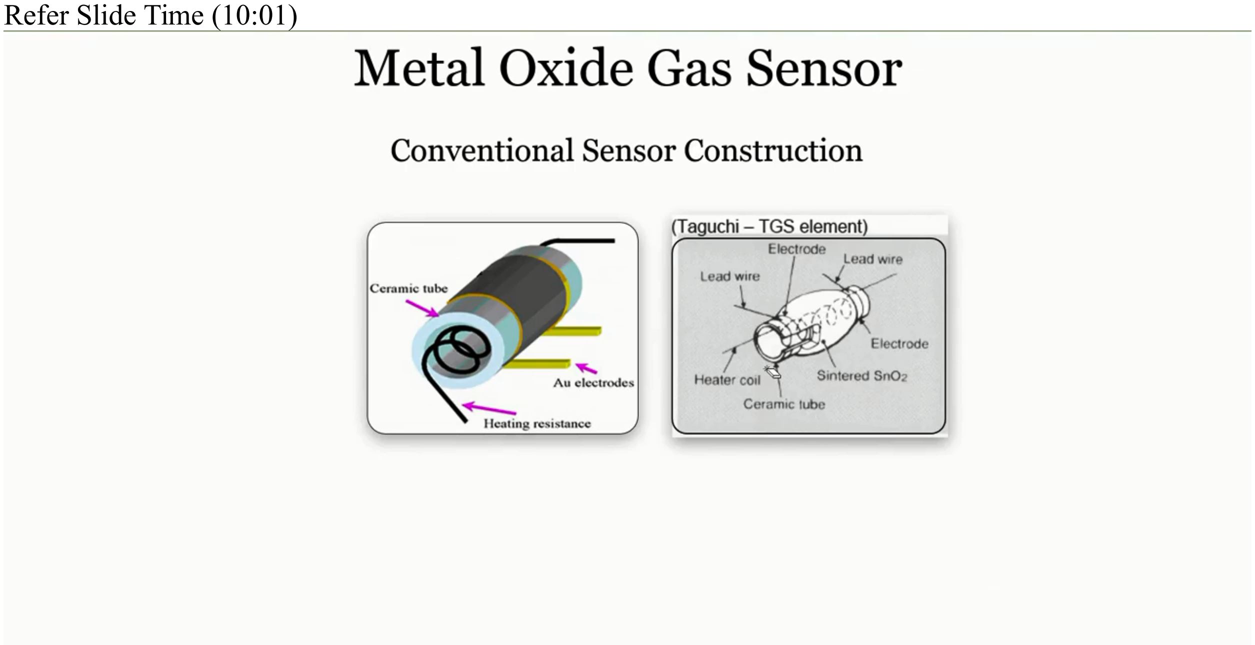

we will be talking about metal oxide gas sensor. So, when you talk about material oxide gas sensor this is the conventional sensor construction where you can see a ceramic tube and the ceramic tube has a center SNO_2 what does SNO_2 stands for SNO_2 stands for tin oxide alright? And then there are electrodes so let me first show you a few of the sensors and then we talk about the sensor construction it will be kind of easier. If I want to show you the sensor, I have brought a few of the sensors which we have bought from Taguchi. Taguchi is a company in Japan so if I show you the first sensor the first sensor if you can see it has a four different terminals as you can see in my hand and this four terminals is having and in the front there is a mesh. It's a there is a cover there is a roll of having four terminals and a cover so we will see what is the roll. I'll open the second sensor so you'll understand and actually I will show it to you a few of the sensors there is a second sensor again you can see here there are four different pins which you can see and in the front there is a mesh Right? There is a mesh in the front and if you see there are four different terminals which are here, now there is a role of this four different terminals and I'll show it to you in the in the slides now what each terminal hole is there alright? Same way if I show you another sensor I can show it to you right over here Right? and here what you see is again there is a casing and the top and there are four terminals and the bottom, again what's the role of these four terminals we will check in the in the next slide Right? and each sensor is meant for a particular application.

Now let me show you a sensor with kind of signal conditioning circuit. So now I am holding a CO_2 sensor which is right over here. So, if you see the CO_2 sensor yes, and in the back side there is a whole signal conditioning circuit which you can see here Right? So, this comes with a signal conditioning circuit but if I talk about other sensors, they don't come by signal conditioning circuits. For example, if I am showing it to you the earlier sensors that I have shown they don't come with similar conditions are case these three sensors Right? All three sensors they don't have any similar conditions circuit but this one has its own signal conditioning circuit, which is on the back side, this is the front side Right? So, it's kind of very easy to understand easy to see how the sensor looks like. Similar sensor if I want to design a signal conditioning circuit using Arduino or using Raspberry Pi3 what kind of circuit we can design we'll see in the slides.

Now if you focus on the on the slide what we see is there is a sintered SNO_2. SNO_2 order stands for tin oxide Right? Now there are lead wires so let me that I don't or give the number number to each of the wire. There's a lead wire one lead wire to heater coil is three one here and the second end of coil is given number four. Now, you can correlate why we have four different terminals at the backside of the sensor or four different pins for each sensor the two pins, pin number three and four are meant for heater, while pin number one and two are meant for elector’s electors alright? So, we have four then that's why each of those sensor were having four different terminals. Now there is a ceramic tube and within ceramic two there is a sintered tin oxide why it is called metal oxide because you see this is tin, this is indium, this is zinc, this is tungsten. If I want to have metal oxide then I will have tin oxide indium, oxide zinc oxide, tungsten oxide alright? So this is how the metal oxide semiconductor uses sensing material they use the we had to use a metal oxide semiconductor is a sensing material in the sensor while you require a heater to increase the sensitivity you know you will see why heater and how heater can help in increasing increasing the sensitivity in in few slides.

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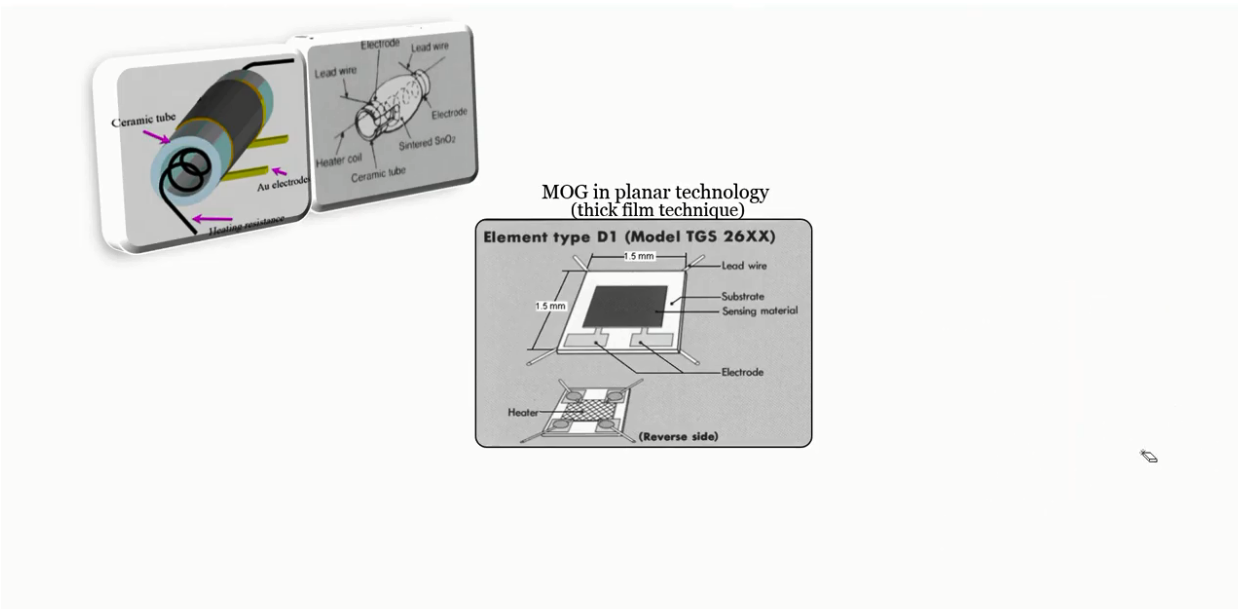

For now, this is a conventional way of fabricating a sensor if I see a second way of fabricating a sensor it is using a thick film technology. Now, if you know integrated circuit technology Right? then you will understand that there are several kind of technologies one is thin film technology, and another one is thick film technology. In thick film technology we use screen-printing screen-printing Right? So, using the screen-printing technology using the thick film technology we have fabricated a sensor and that's why it is called thick film technology.

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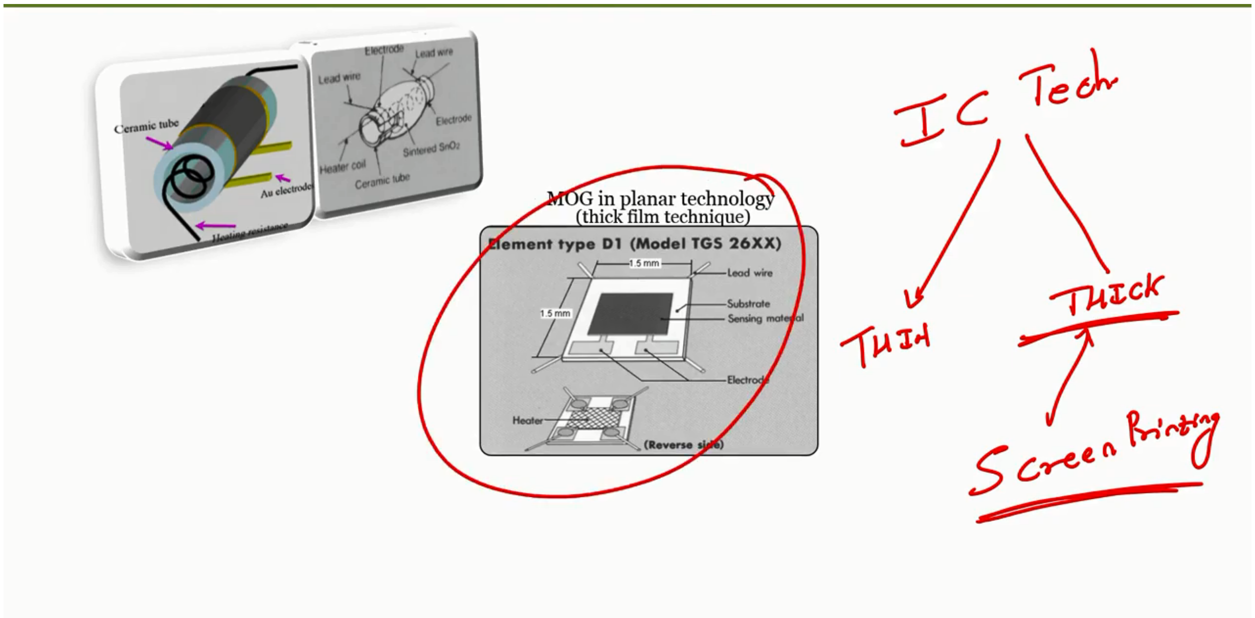

Now again the the front side of the sensor Right? if you see if you take a substrate substrate can be substrate can be silicon, substrate can be silicon dioxide, substrate can be alumina, substrate can be polymer also. So if I take this substrate this is a substrate and this is the substrate front side, this is substrate back side, then if I have an electrode Right? like this, and on that electrode if I if I use a sensing material which is my metal oxide semiconductor Right? on the back side I have a heater on the back side I have a heater this is a back side, there is a front side Okay?

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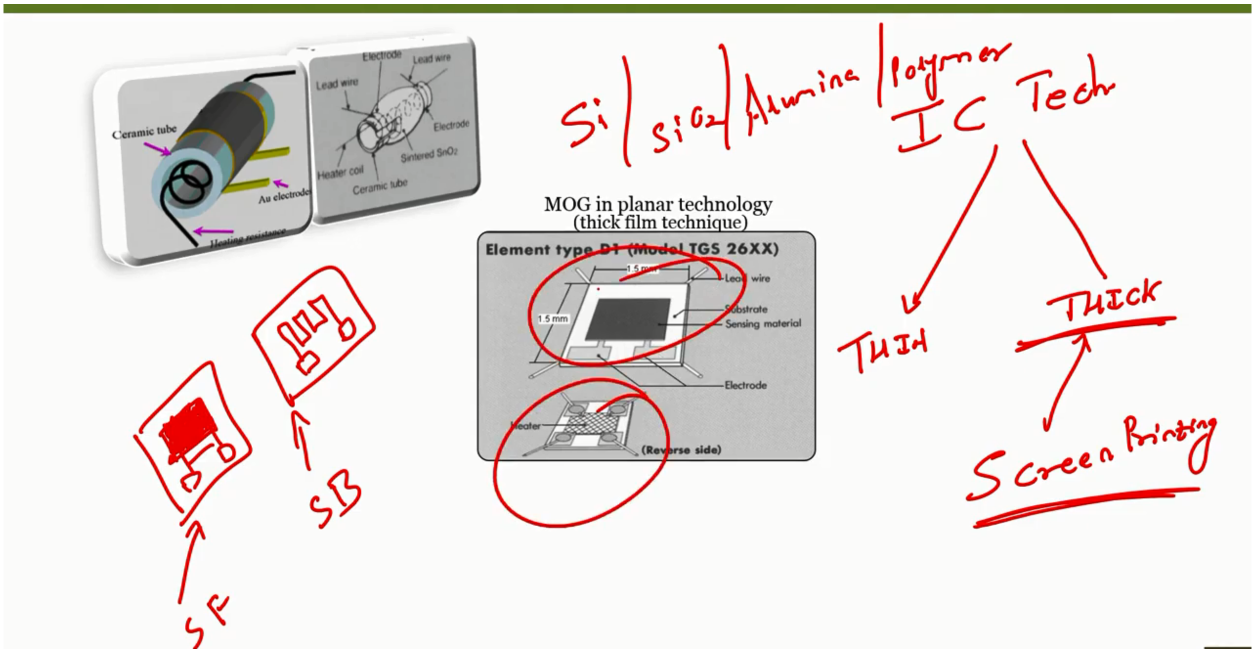

So, now what is the advantage of screen printing is that we can have high throughput we can fabricate lot of sensors very quickly Right? The disadvantage is that we cannot miniaturize it beyond a certain point we cannot make it tiny alright? So, there is a disadvantage again after you do the screen bending you are two centers the material you to heat or an ill the the semiconductor metal oxide, or metal oxide semiconductor to certain temperature so as to form the sensing layer. This is an example of that type d1 Right? which is model 2 G a at 2 T sorry, DGS twenty-six XX which is again from Taguchi.

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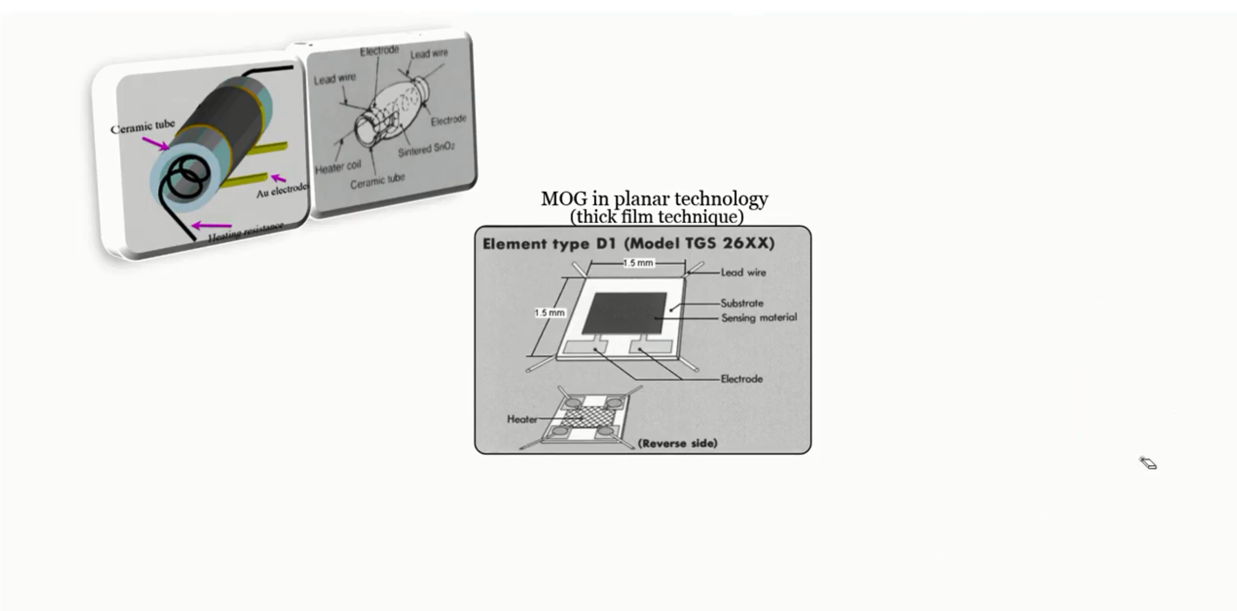

And then let us see the circuit electronic circuit,

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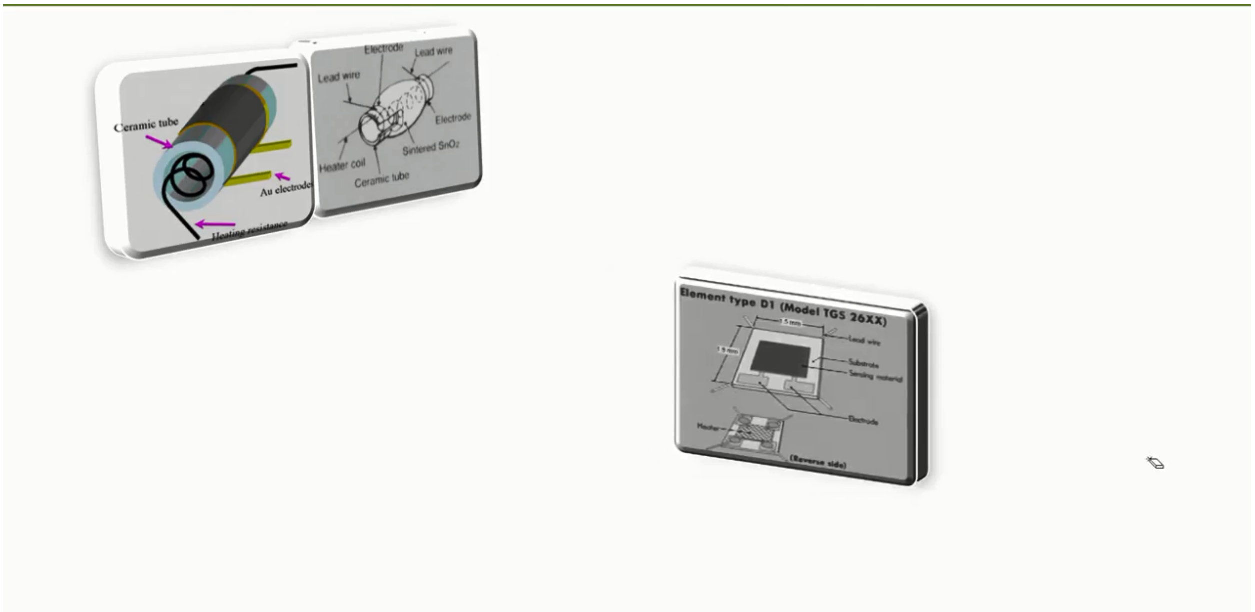

conditioning circuit for for using these sensors. So the first thing is we have to apply a voltage we will apply a 24 volts AC or DC which is your voltage across the semiconductor, and then we have a heater voltage which is your 5 volts and then finally you have a load register which is variable in nature alright? and the power consumption should be less than 15 millivolt. If I go for the delay equations then this is how the equations are placed where we have R equals two VC by V out minus 1 into RL equals to row by L by A row L by E is nothing but the resistance the distance and row is the resistivity, L is a length and A is the cross-sectional area if you if you increase, the length at a distance but increase if you decrease the area resistance will increase if you are increase the resistivity resistance radical increase if we decrease the resistivity resistance will decrease you cannot change the resistivity if I using the same material but you can always see in the length you can always in the area thus the resistance is depending on length and area and it also depends on resistivity but for a single metal you cannot change the resistivity. So, depending on what kind of resistance you want for a final heater you need to select that particular material or a metal for fabricating that particular heater.

So if you see the slide at the L is equals to the distance of elector is cross sectional area of sensing layer row is specific resistance of the sensor then we have specific conductivity we have new mobility we have n concentration of charge carriers and finally Q is a charge of the charge carrier. So, in a constant temperature we have mu constant that means R changes due to change of concentration of a charge carriers and by gas reactions. So if I talk about the working principle what happens is if I just zoom it out this gas sensors and say is the sensing material is consisted of several grains we called grains 'grains' Okay? and each grain we lose some electron and will cause a depletion layer a diffusion boundary around it while losing some electron it will have a depletion boundary around it Right? In presence of the oxygen in air Right? and this causes this depletion layer that I have drawn a curve the brain will cause some kind of resistance value which we call as a base resistor. Now, if I if I inject oxidizing gas so there are two type of gases oxidizing and reducing. If I use oxidizing gas, then the electrons will be depleted further from the depletion layer and the resistance of the sensing layer would increase, while if I use a reducing gas then the electrons will be donated and the depletion layer width will reduce causing the resistance of the sensing layer to decrease alright? So, based on what kind of gas we are using whether it is oxidizing gas or reducing gas we will see the change in the resistance this initial is a base resistance or our sensor base resistance. This is sensing resistance which is different than the base resistance either this resistance will decrease, or it would increase Right?

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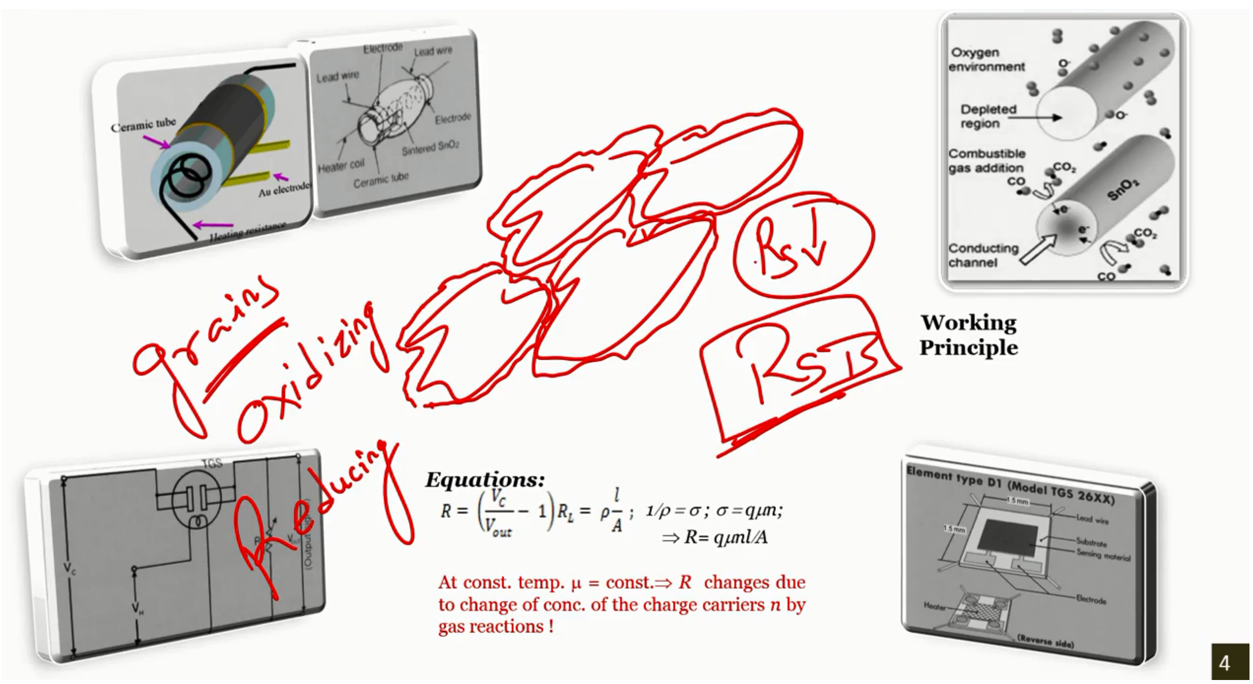

So that is what is a basic principle behind the gas sensor or metal oxide gas sensor in particular the same thing is shown here.

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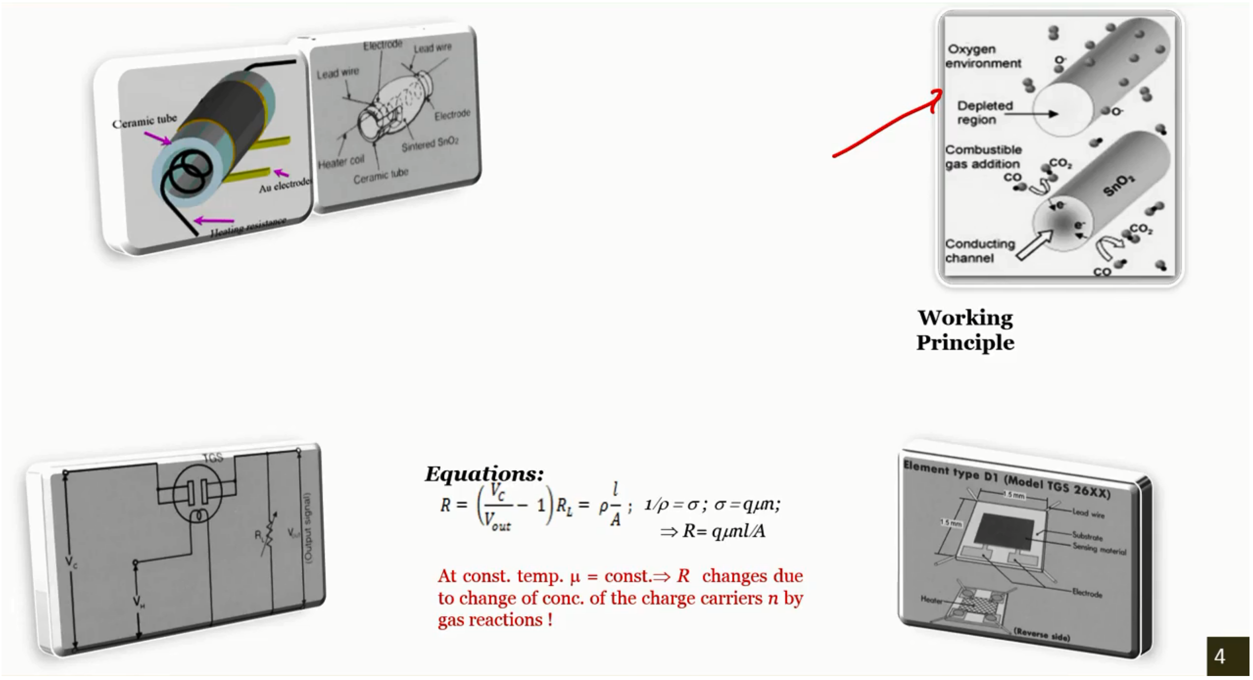

The in the presence of oxygen there is a creation of depletion layer if you have a combustible gas like CO_2 then the depletion layer would increase resistance would increase.

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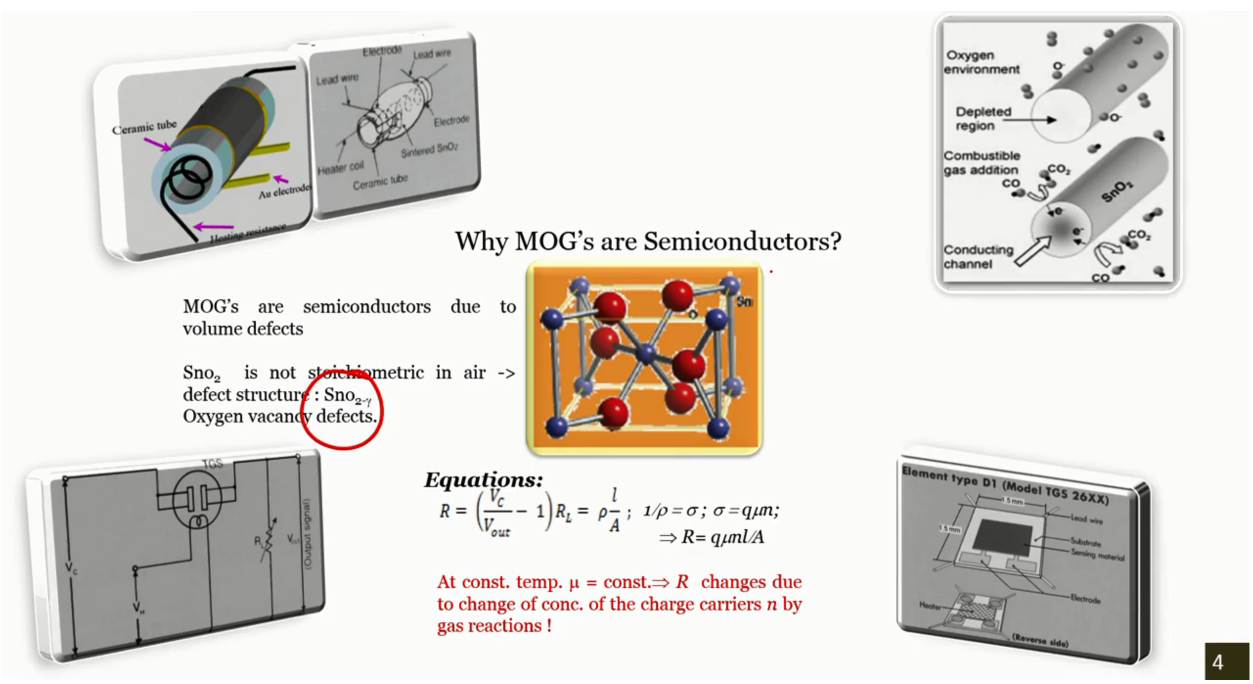

So, the question is why we have to use metal oxide semiconductor, gas sensors this is because of the volume defect Sno_2 is not stoichiometry in air but defects structure Sno_2 minus, this one Right? shows the oxygen vacancy defects so that's why we can use the Sno_2.

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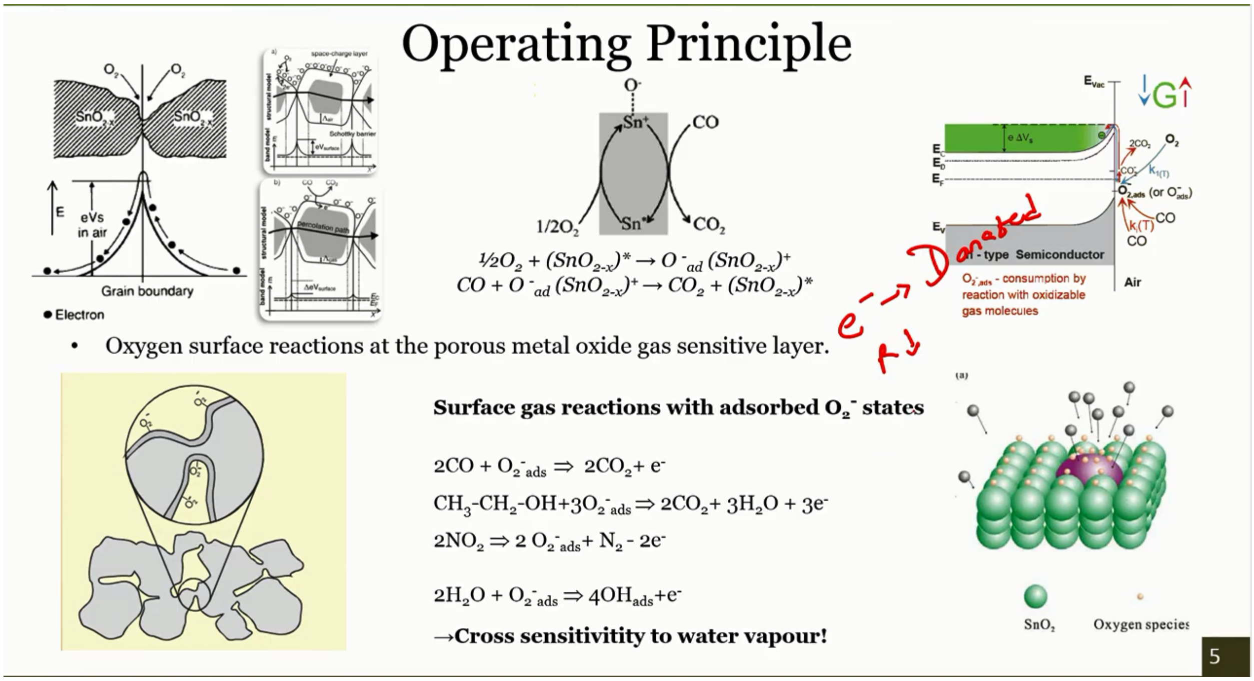

Same way if we are talking about the operating principle like I discussed each is consists of a few grains and there is a depletion layer which is a space charge layer today that is created in presence of oxygen and on on inducing oxidize gas or a reducing gas this depletion layer width will change. So if I talk about just CO_2 then you can see here that my my band my energy band diagram also changes with respect to the reaction of the CO_2 on to the semiconductor and here you can see that O_2 adsorption consumption by reaction with oxygen oxidizes about gas molecules how the energy band diagram changes where if I talk about the sno_2 then this is our reaction occurs that with Sno_2 if there is a the sensing modalities of sno_2 and if I use CO_2 as a guess to be sensed then this is a reaction that is involved so oxidants are phase reaction at the porous metal oxide sensitive layer surface gets reaction with adsorbed O_2 minus states and the reaction occurs as $2CO + O_2 - CO_2$ CO_2 + electron again you can see that we have CS_3 CS_2 OS +$3CO_2$ CS_3 CS_2 OS has nothing but your ethanol and if you have that then again you have electron that is released you have no_2 electron is you know released it is absorbed while you have h_2O then you have electron which is released. So, when there is a electron is released what happens is that the electron is released into the into the material the depletion layer would reduce, and that depletion layer reducing of depletion layer will cause change in the resistance which is the reduce resistance. So, you understand by this if the electrons are donated then what will happen resistance reduces Right? but if the electrons are taken up from the material resistance would decrease this is what is there.

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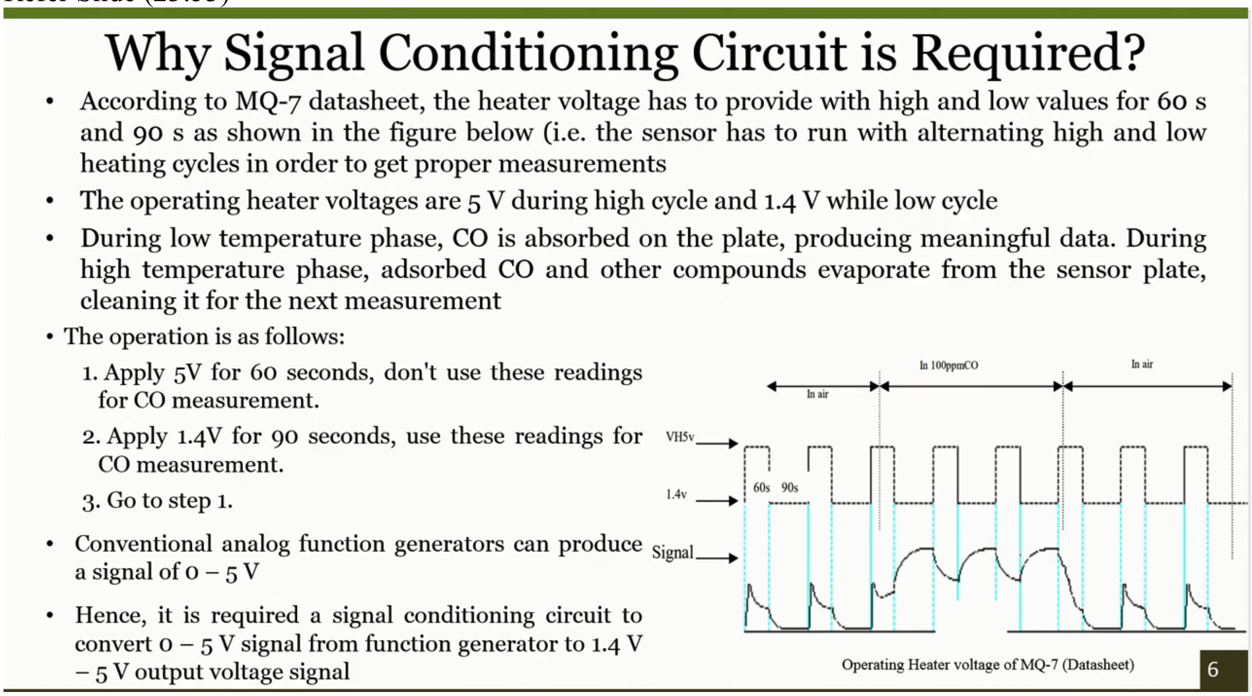

Now we need to know why we had to use signal conditioning circuit if you have such kind of sensors Right?

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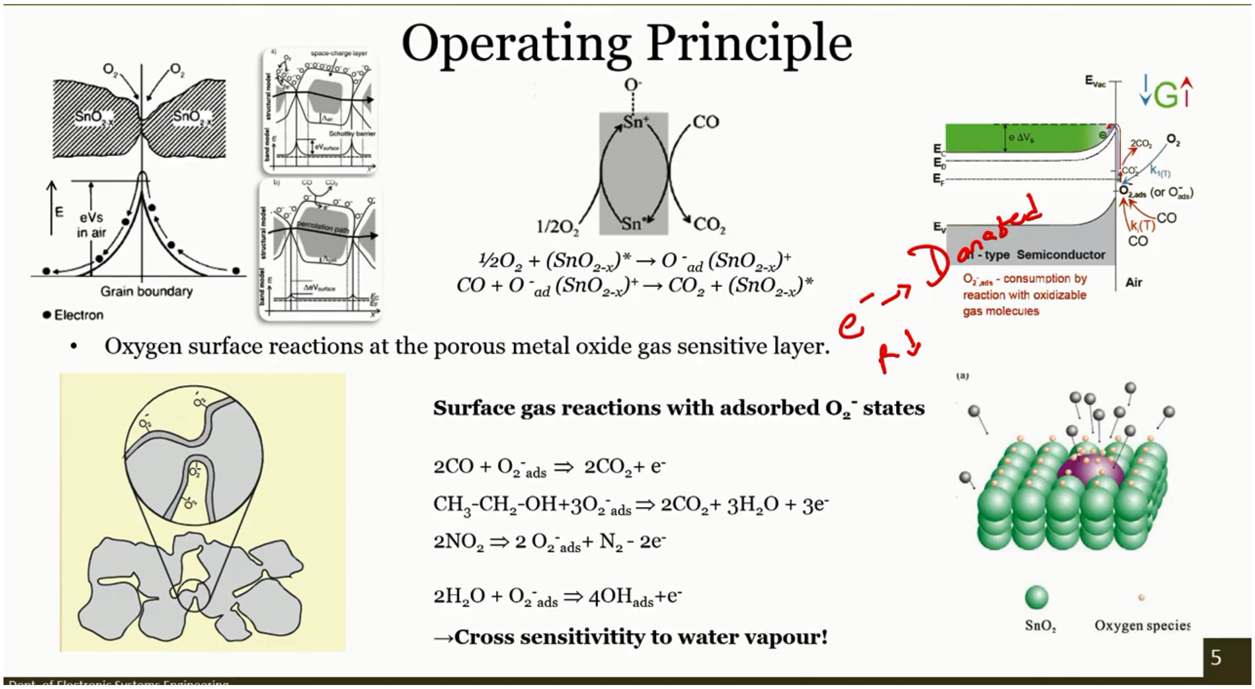

and then I'll show you one example where I'll show you how the process flow for fabricating such kind of sensor can be designed alright? So that you know that in your laboratory can you design such kind of sensors as well or not. So, if I see why signal conditioning circuit is required then,

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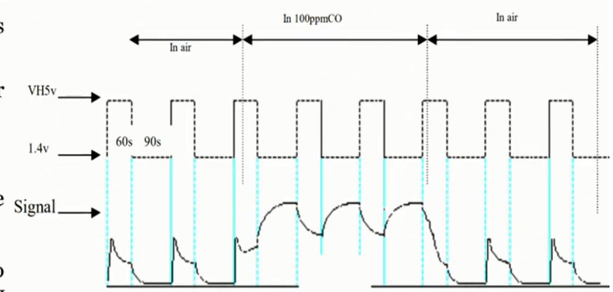
Why Signal Conditioning Circuit is Required?

- According to MQ-7 datasheet, the heater voltage has to provide with high and low values for 60 s and 90 s as shown in the figure below (i.e. the sensor has to run with alternating high and low heating cycles in order to get proper measurements
- The operating heater voltages are 5 V during high cycle and 1.4 V while low cycle
- During low temperature phase, CO is absorbed on the plate, producing meaningful data. During high temperature phase, adsorbed CO and other compounds evaporate from the sensor plate, cleaning it for the next measurement
- The operation is as follows:
  1. Apply 5V for 60 seconds, don't use these readings for CO measurement.
  2. Apply 1.4V for 90 seconds, use these readings for CO measurement.
  3. Go to step 1.
- Conventional analog function generators can produce a signal of 0 – 5 V
- Hence, it is required a signal conditioning circuit to convert 0 – 5 V signal from function generator to 1.4 V – 5 V output voltage signal



Operating Heater voltage of MQ-7 (Datasheet)

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Dept. of Electronic Systems Engineering

first is we are talking about MQ-7 and MQ-7 stands for gas sensor, so if you see MQ-7 gas sensor data sheet it the heater voltage has to be provided with high and low values for 60 seconds and 90 second as shown in figure below.

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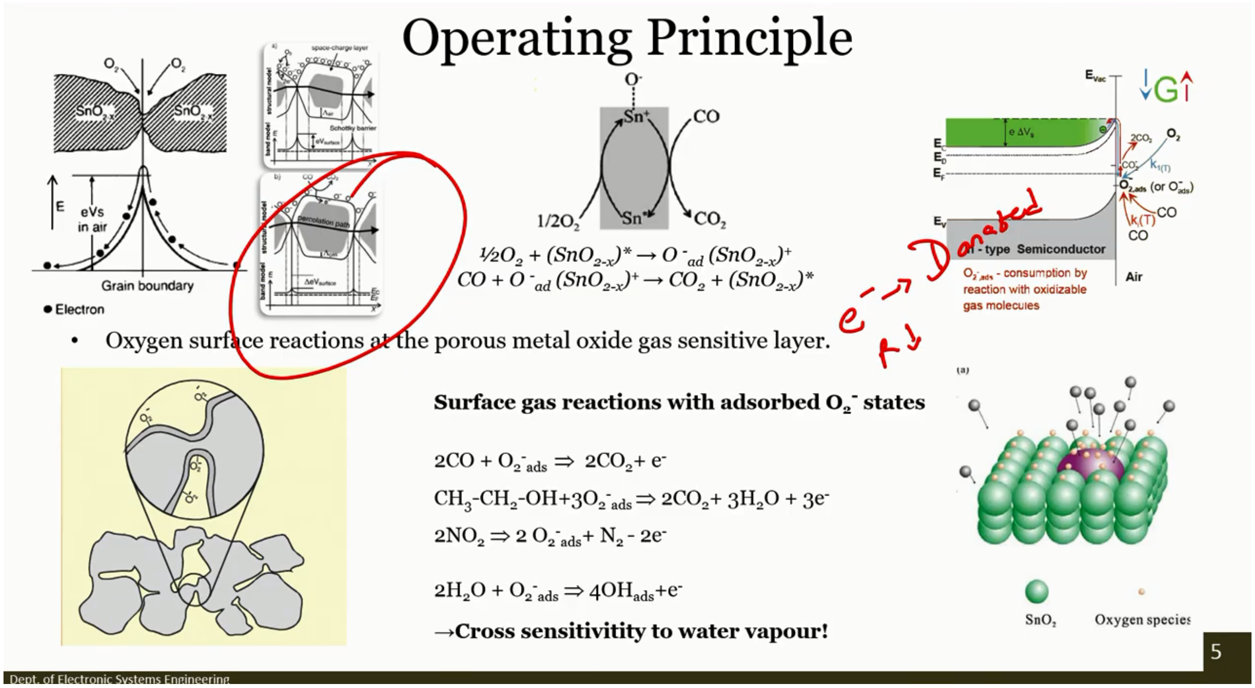

Now, before we go here let me just talk one more thing which I forgot if I see this particular thing what happens you know that when you heat the material when you heat the semiconducting oxide material the you have a higher sensitivity because a depletion layer also increases and you have more available sites for the gas to react. At a lower temperature you have these sites which are reduced but at a higher temperature you have a increase in the reaction sites so the gas molecules can react better at a higher temperature compared to a lower temperature. Now the absorption and adsorption will also be different at a different temperature also if I use the sensor at different temperature I can also use the sensor as selective sensor you see all the sensors any sensor that I have shown you would be sensitive to one or different guess, is this selective that is very important, but when you operate and when you use the sensor you will find that these sensors are not selective to make those sensors selective we need to change the temperature that is one way of increasing selectivity. Second way of introducing selectivity is by using the sensor in array and then you use machine learning technique, or you can say artificial neural network to delineate that particular VOC.

So, the role of heater is to increase the temperature of the semiconducting oxide and by increasing the temperature of semiconducting oxide you are increasing the sensitivity of the sensor alright?

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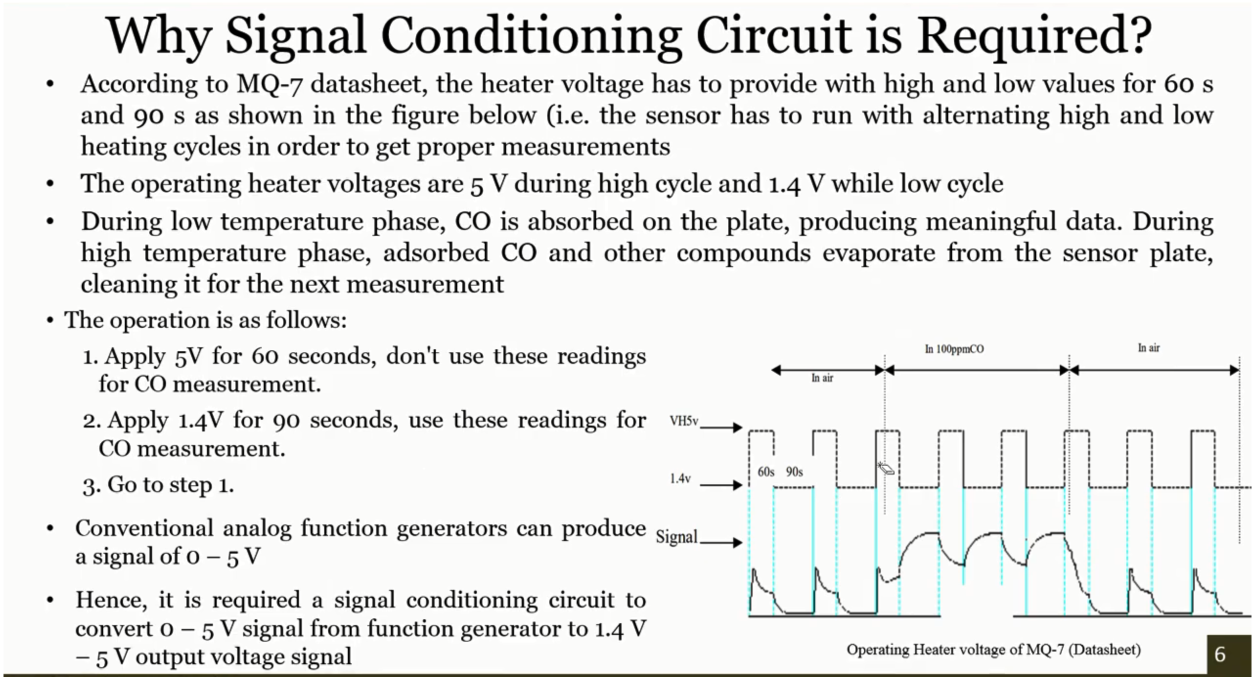

So, coming back to the slide the role of signal conditioning circuit so that the heater has to provide a high and low values at 60 in 90 seconds as you can see from, here Right?

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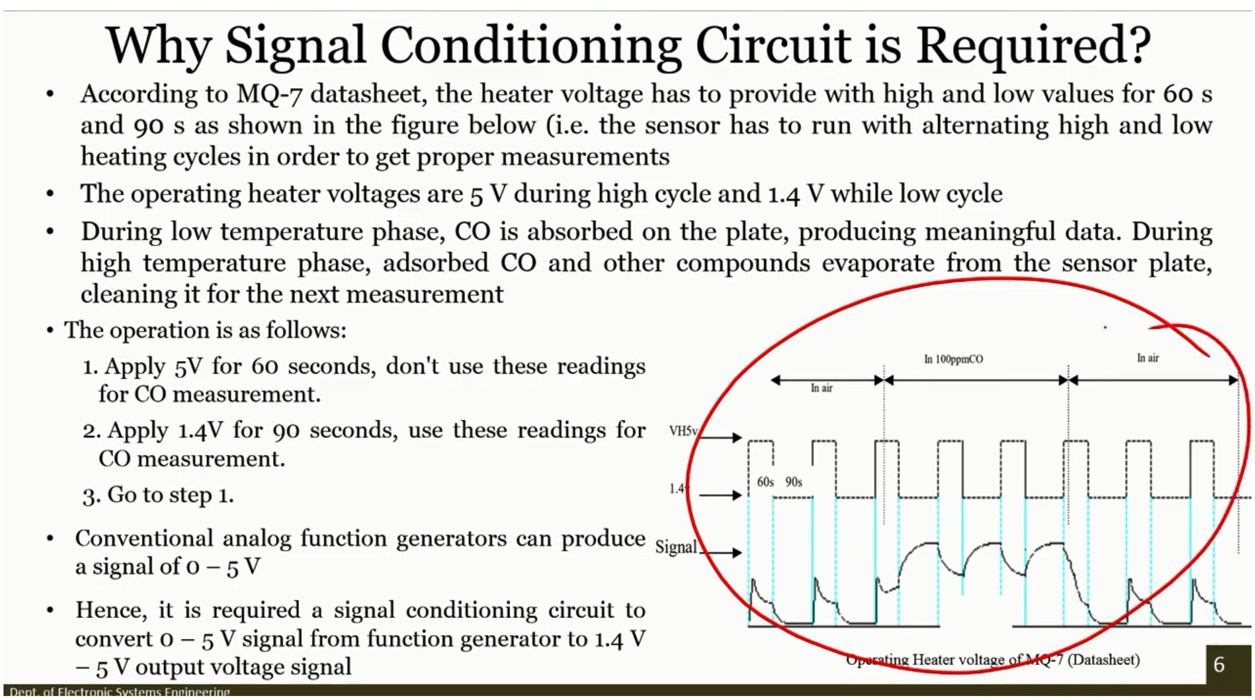

And then what will happen the sensor has to run with alternating high and low hitting cycles order to provide proper measurements the operating heater voltage are 5 volts, which you can see now you can see here we require from one point 4 volts to 5 volts Okay? So that's why you need to have a signal that you can convert from zero to one point four and maximum fine remains 5.

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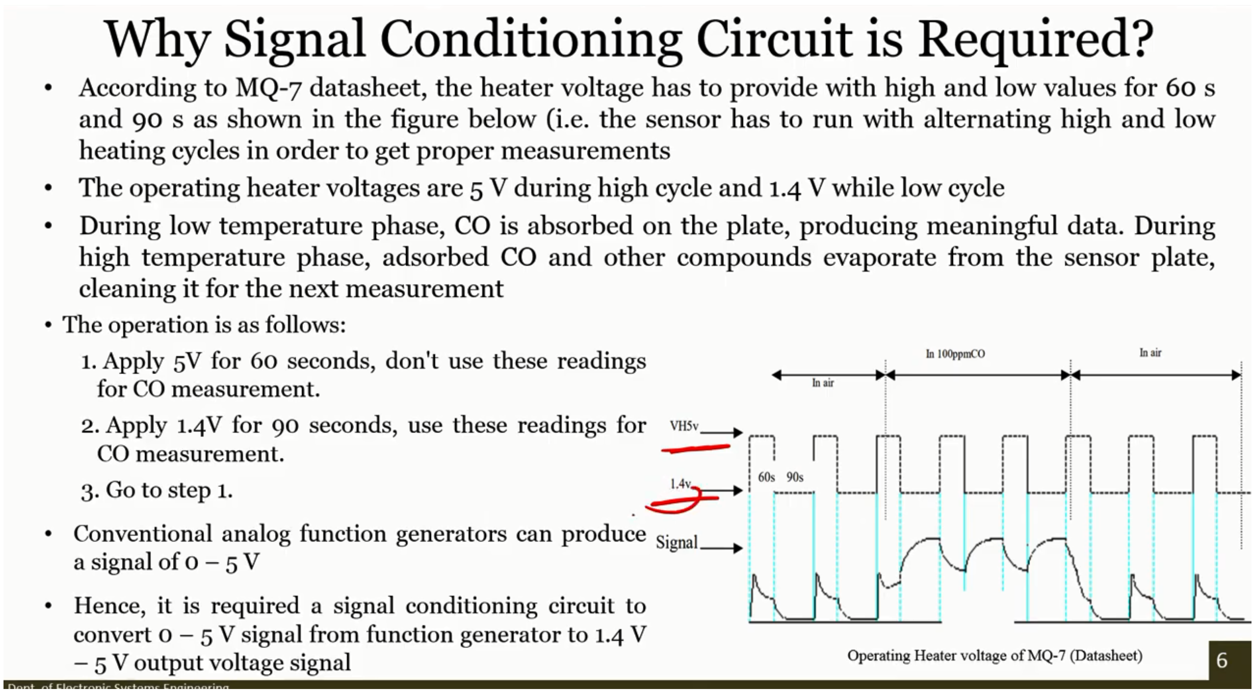

We will see how we can design this

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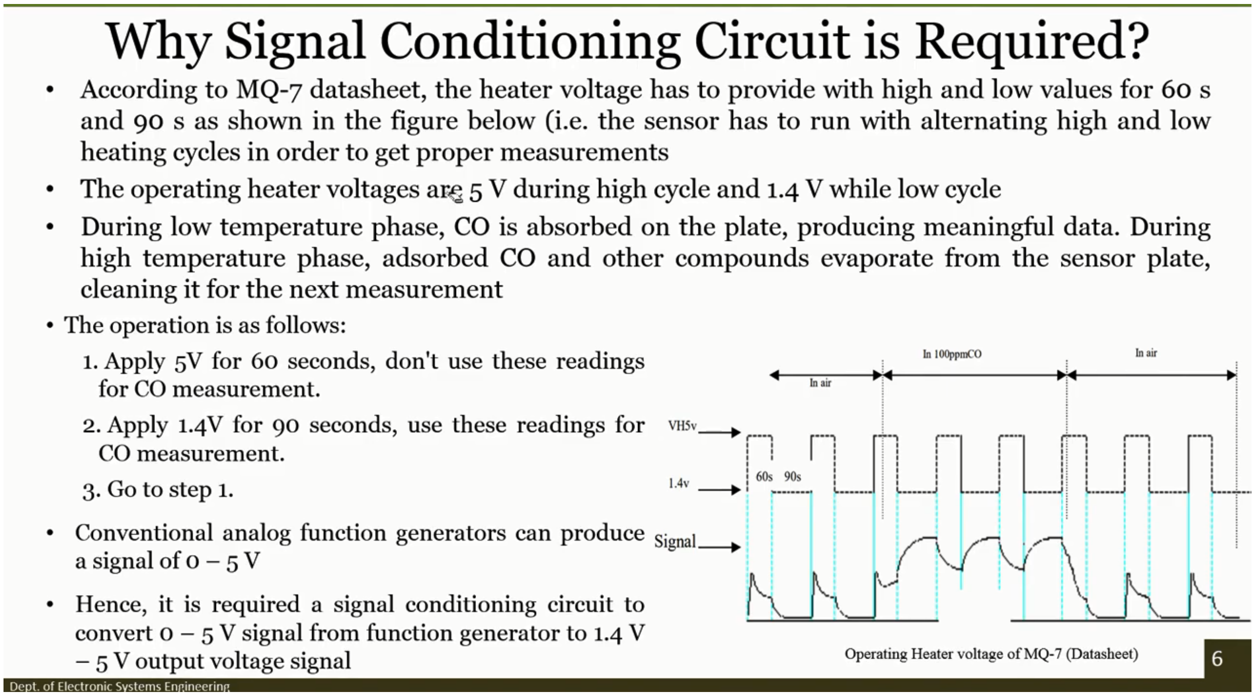

but anyway, the operating voltages are 5 was during high cycle while it is 1 point 4 volts while low cycle. So, during low temperature phase Co is absorbed on the plate producing meaningful data but during the high temperature phase your Co is adsorbed adsorb is it will come out adsorption. Absorb is will be absorbed in the sensing layer it will have reaction with the molecules Okay? and other compounds your plate from the sensor plate cleaning it for the next measurement that means that, whenever we apply one point 4 volts there will be absorption change in sensitivity change in resistance not sensitivity change change in resistance, and when we apply 5 volts the gases that were absorbed would be adsorbed alright?

So the operation is as follows apply 5 volts for 60 second don't use this readings for CO measurement apply 1.4 volt well then use this readings for CO measurement CO go to step 1 and do and follow the step conventional analog function render can produce a signal from 0 to 5 volts hence it is required that a Vedic we design a signal conditioning circuit to convert this 0 to 5 volts for foxes and it at 1 point 4 volts to 5 volts for the output signal.

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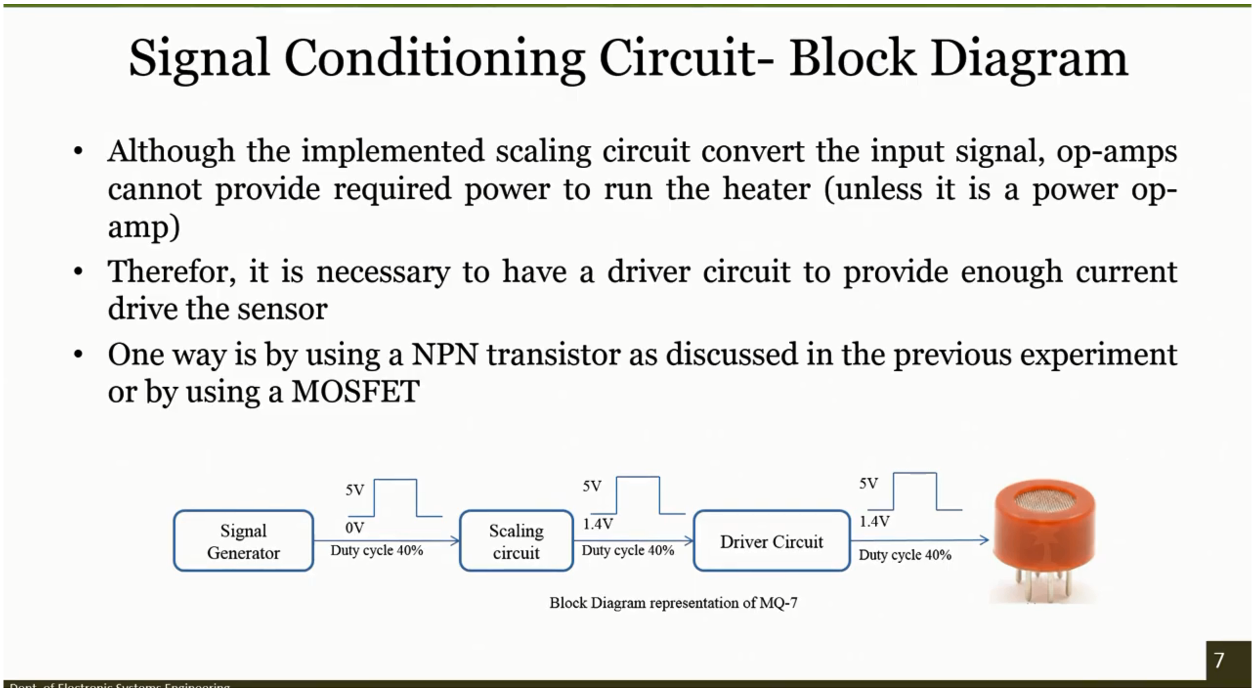

And if you can see the block diagram the block diagram is that there is a signal generator there is a scaling circuit, driver circuit and finally you can see the this is a sensor that we using although the implemented scaling circuit convert the input signal op-amps cannot provide the required power to run the heater unless it is a power op-amp. There's another disadvantage that until we use the power op-amp it cannot be used to run the heater or drive the heater therefore sorry for the mistake in this padding therefore it is necessary to have a driver circuit to provide enough current to dry the sensor, one way is by using NPN transistor as we have seen in the earlier experiments and we will see in the later experiments as well or by using a MOSFET.

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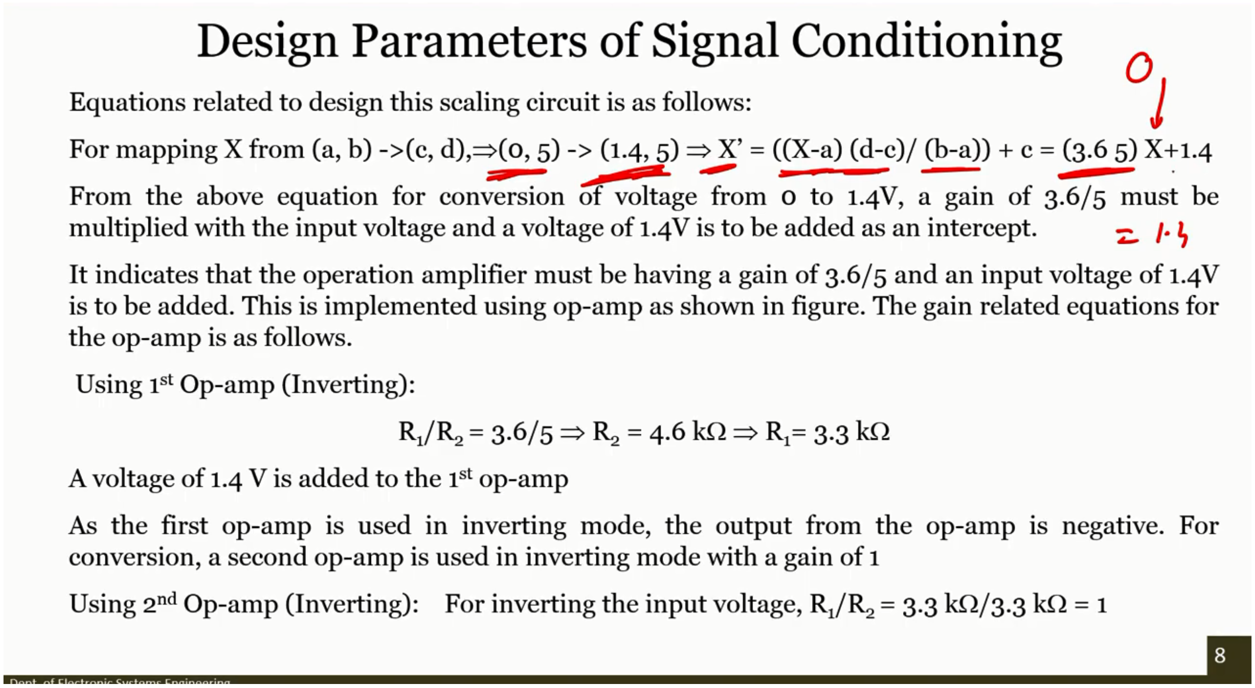

So how can be equation how can we design the circuit and what kind of equations we need to follow so you for mapping X from a, b to c, d that is from 0 to 5 volts we do convert to 1 point 4 to 5 volts what we require we require X there should be equals to X -a d - c divided by b minus a plus c so it should be three six points X by X plus one point four. If X is zero if X is zero, then we will have output as 1 point 4 volts Right? If X is 1 then we have our pull close to 5 volts Right? So, now I question Tucker was around zero to one point four again or 3.6 by if I must be multiplied with input voltage and voltage of 1.4 to be indicates intercept indicates that operation amplifier must be having a gain of 3.65 it's very easy to understand and an input voltage of one point 4 volts is to be added.

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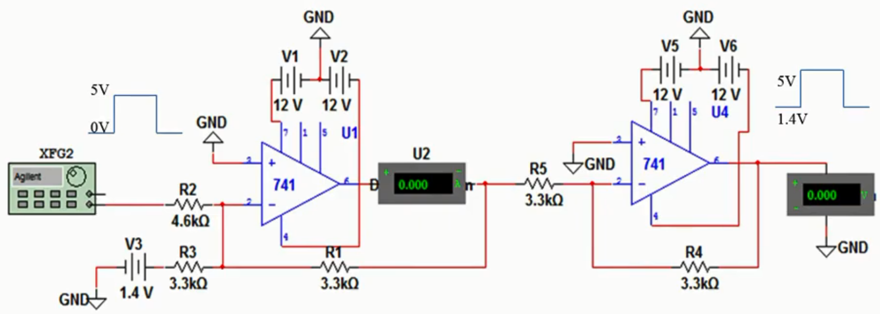
Circuit Design

The circuit is designed using op-amp for converting an input voltage of 0 - 5V from Signal generator to 1.4 - 5V



Scaling circuit using op-amp

This is implemented in the next figure which is right over here Right? So, this figure if you see and you can use a multi seem to understand whether the circuit can work according to what?

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Design Parameters of Signal Conditioning

Equations related to design this scaling circuit is as follows:

For mapping X from (a, b) ->(c, d),$\Rightarrow$(0, 5) -> (1.4, 5) $\Rightarrow$ X' = ((X-a) (d-c)/ (b-a)) + c = (3.6 5) X+1.4

From the above equation for conversion of voltage from 0 to 1.4V, a gain of 3.6/5 must be multiplied with the input voltage and a voltage of 1.4V is to be added as an intercept.

It indicates that the operation amplifier must be having a gain of 3.6/5 and an input voltage of 1.4V is to be added. This is implemented using op-amp as shown in figure. The gain related equations for the op-amp is as follows:

Using 1st Op-amp (Inverting):

$$R_1/R_2 = 3.6/5 \Rightarrow R_2 = 4.6\ k\Omega \Rightarrow R_1 = 3.3\ k\Omega$$

A voltage of 1.4 V is added to the 1st op-amp

As the first op-amp is used in inverting mode, the output from the op-amp is negative. For conversion, a second op-amp is used in inverting mode with a gain of 1

Using 2nd Op-amp (Inverting): For inverting the input voltage, $R_1/R_2 = 3.3\ k\Omega/3.3\ k\Omega = 1$

We are looking in that in the theory class then what we have is that the gain related equations for the op amp is as follows for inverting R_1 by R_2 it's 3.6 by 5 so R_2 equals to 4.6 kilo ohm and R_1 can be 3.3 kilo ohms Right?

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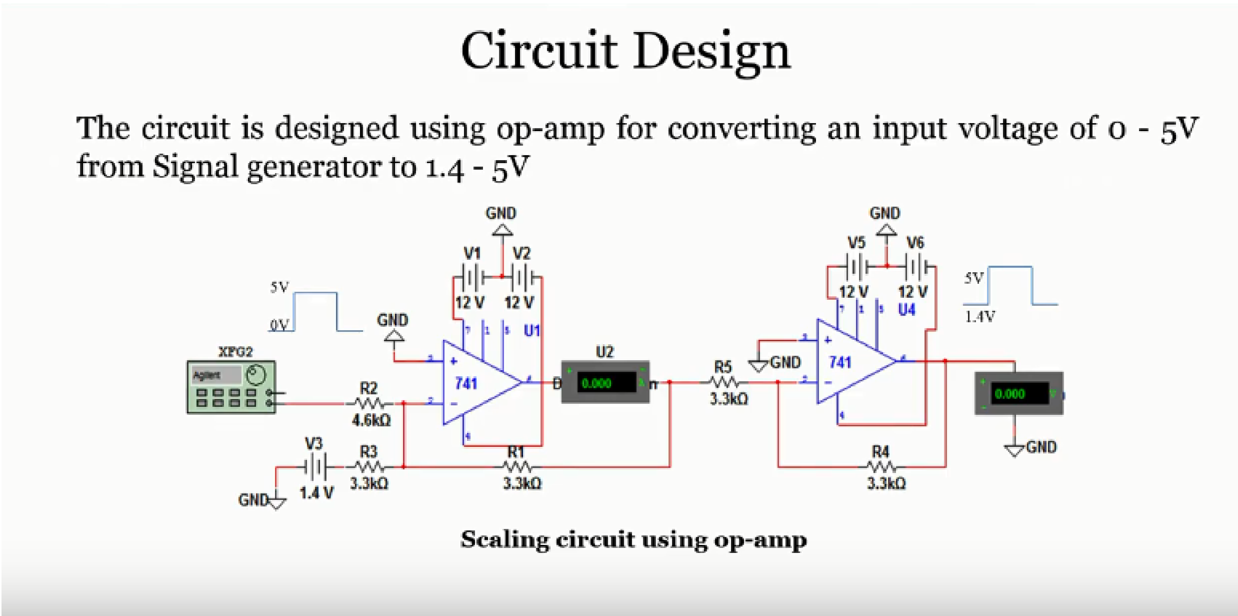

Design Parameters of Signal Conditioning

Equations related to design this scaling circuit is as follows:

For mapping X from (a, b) ->(c, d),⇒(0, 5) -> (1.4, 5) ⇒ X' = ((X-a) (d-c)/ (b-a)) + c = (3.6 5) X+1.4

From the above equation for conversion of voltage from 0 to 1.4V, a gain of 3.6/5 must be multiplied with the input voltage and a voltage of 1.4V is to be added as an intercept.

It indicates that the operation amplifier must be having a gain of 3.6/5 and an input voltage of 1.4V is to be added. This is implemented using op-amp as shown in figure. The gain related equations for the op-amp is as follows:

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Using 2nd Op-amp (Inverting): For inverting the input voltage, $R_1/R_2 = 3.3\ k\Omega/3.3\ k\Omega = 1$

my gain of 3.65 by 5 Right? So, a voltage 1.4 is added to the first op-amp if you again see,

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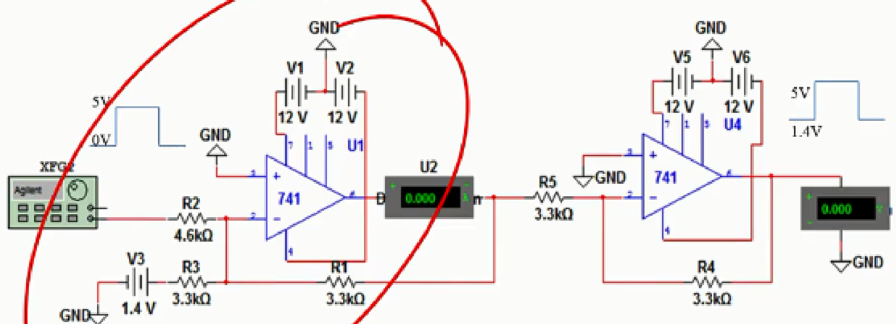
Circuit Design

The circuit is designed using op-amp for converting an input voltage of 0 - 5V from Signal generator to 1.4 - 5V



Scaling circuit using op-amp

what we are done is we have added 1.4 volts to the first operational amplifier

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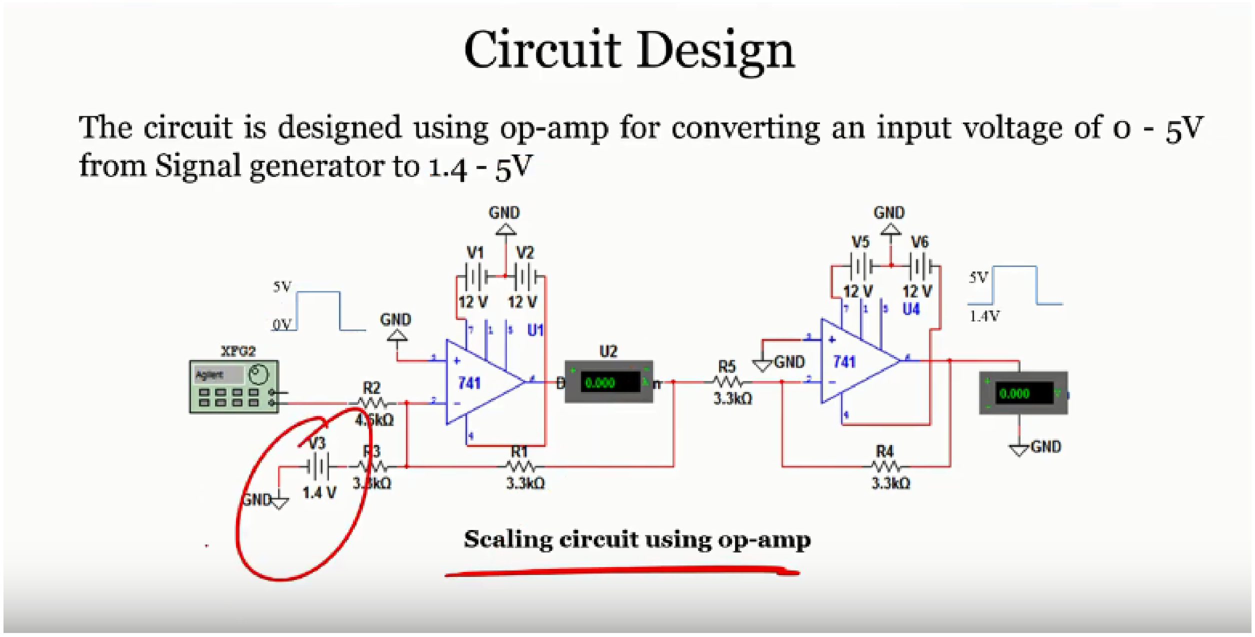

from the two-operation amplifier shown in the figure,

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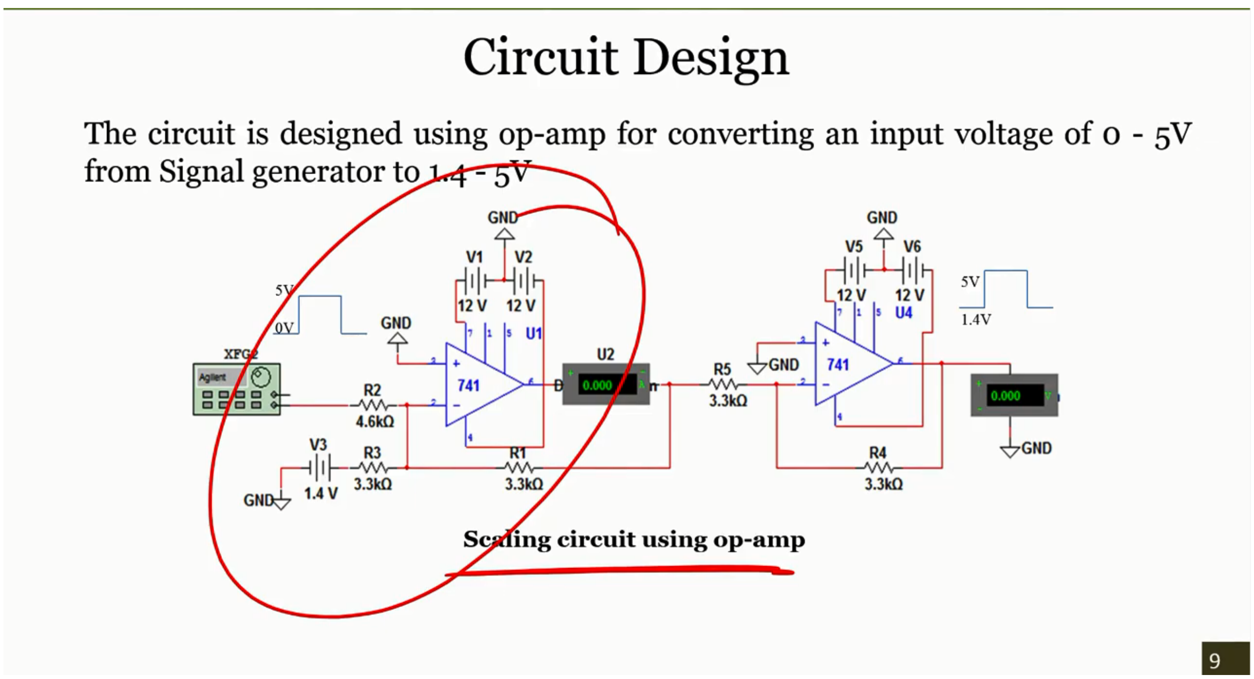

and as the first of them is used in writing mode the output from the op-amp is negative for this conversion a second of op-amp is used in a pneumatic mode with a gain of 1.

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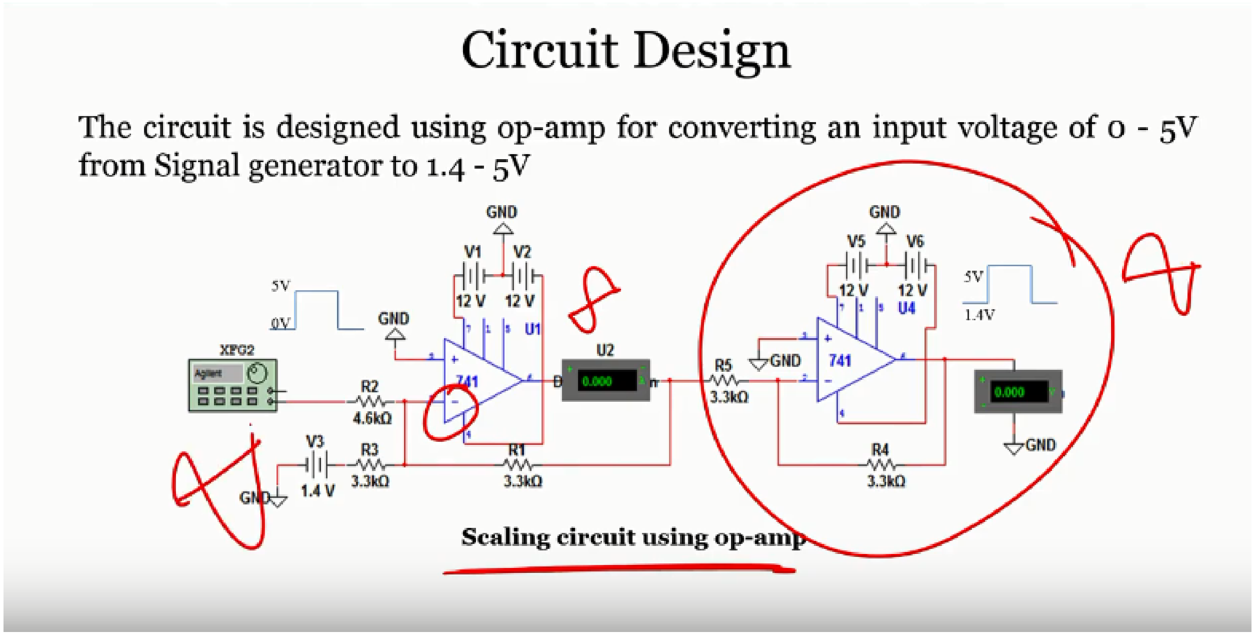

So, if you see this one where this op-amp as a gain of 1 and it's just to convert the input signal which is out of phase 2 in phase. So, it is a at the output there is a the phase would be shifted because of the inverting op-amp and here again we fuse inverting op-amp the phase will be shifted which is similar to face at the input signal. So that is the reason of using a two-stage operation amplifier again this can be act as a buffer or unity gain amplifier because again is 1 Right?

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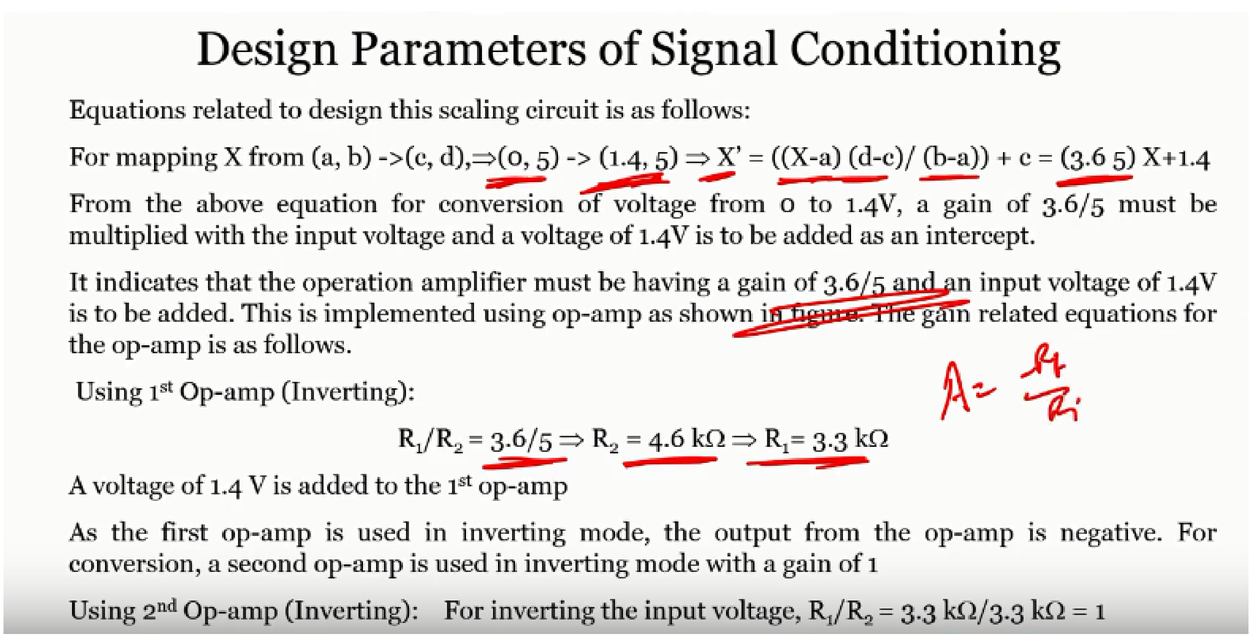

So using second op-amp we inverting input R_1 by R_2 equals 3 hours inverting input you already know for inverting amplifier our gain would be equals to minus RF by RI Right? that's why we just consider R_1 by R_2 if I have what the resistance value same which is 3.3 kilo ohm what will happen I have gain of 1. So, if I have enough if I have a lose 3.3 kilo ohm and 4.6 kilo ohm for up m1 and 3.3 kilo ohm for op-amp for R_1 R_2 for of m2.

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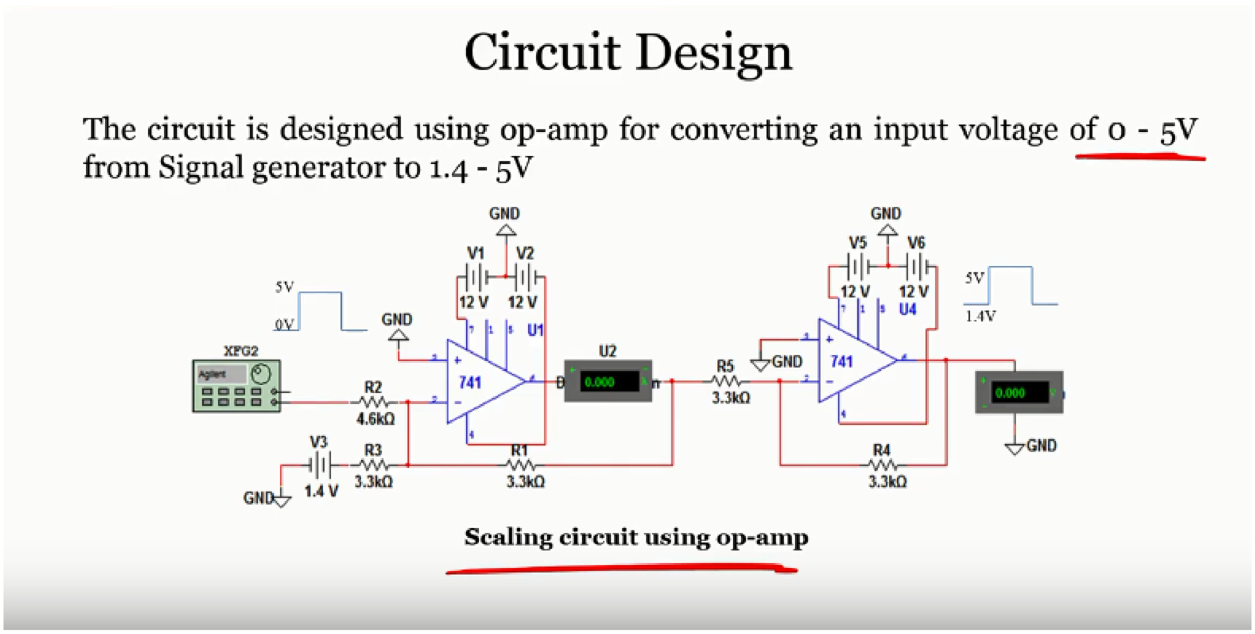
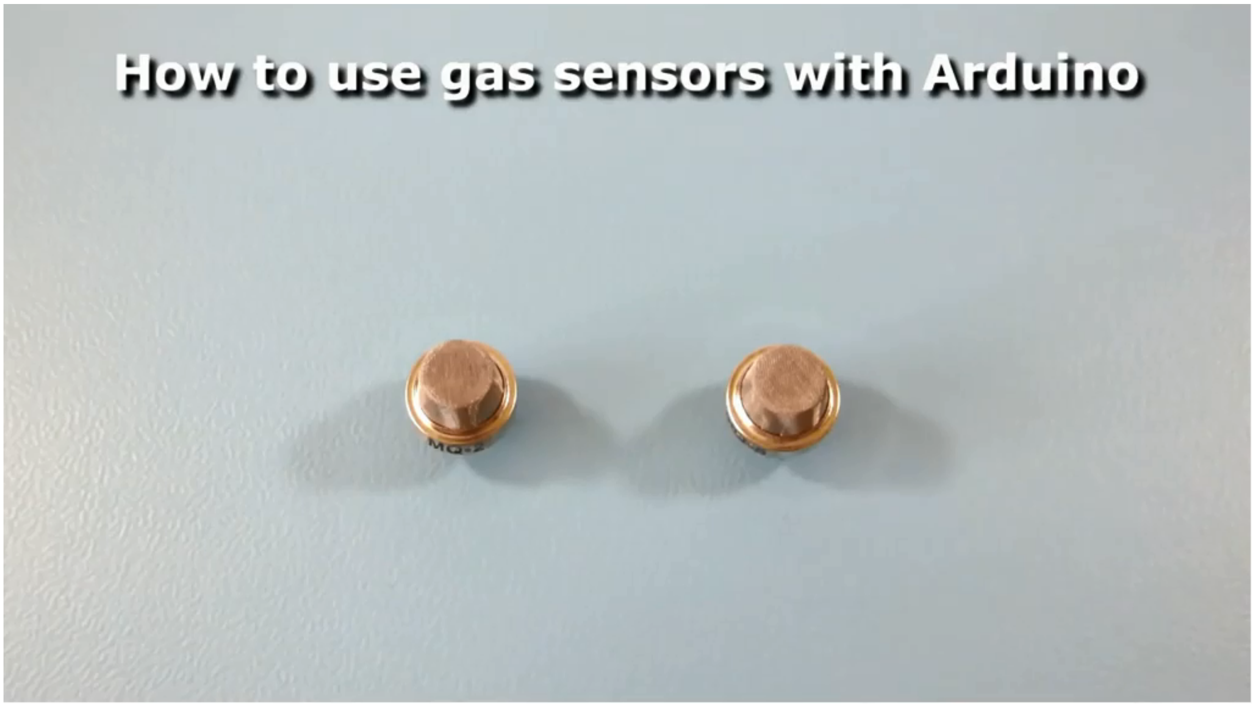


Then I can design my signal conditioning circuit right and this circuit can be used to convert the input voltage from 0 to 5 volts to 1.4 to 5 volts.

Video Start Time (32:02)

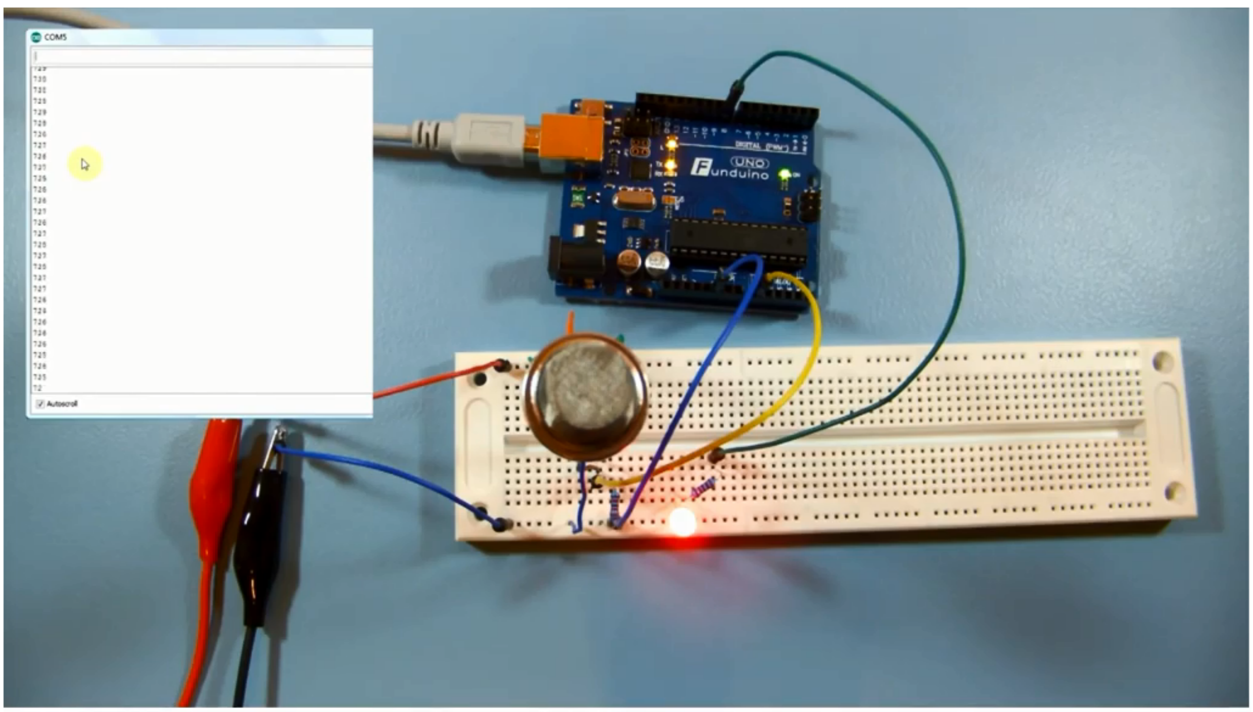


Now let us see a video how we can use the gas and serve it Arduino alright? and then I'll show you to you how you can use gas sensor with raspberry pi and then we will see how we can fabricate the gas sensor. We will see the process flow so let me just show it to you let me run this video first, hi these are MQ-2 and MQ-5 gas sensors and you can probably tell them apart only by the labels both require exactly the same connections but they detect different gases. In this tutorial I'll show you how to use one of them with Arduino will be reading volleys from the sensor and make the Arduino light and that'll be when gas concentration Rises about certain level. To build this project you'll need a few things a 5 volt DC power supply that can deliver at least 0.3 amps and MQ-2 or MQ-5 gas sensor in Arduino board, a breadboard, a few wires in LED, 120 ohm resistor, a resistor close to 20 K, a piece of heat shrink tubing, and a gust lighter or torch.

Let's start playing with the sensor the gas sensor has six pins these two middle legs are heater coil pins don't worry about polarity it's not important in this sensor. The next two legs are a pins and they should be connected to each other, the last pair is named P and these two pins should also be connected to each other. I'll connect my wires to the sensor using heat shrink tubing. Now let's connect the sensor to the breadboard one of the heater coil wires goes to the positive rail and the other one to ground connect both a wires to the positive rail on the breadboard, hook up the P wires to the same row into ground through a 20k resistor a jumper wire goes between the P pins and a zero pin on your Arduino board. Connect your red board crowns rail with the Arduino ground pin. Hook up your LEDs negatively to ground, and the positive lead to one of empty rows on the breadboard. Connect a 120-ohm resistor to the positive lead of your LED in the other end of the resistor through a jumper wire to your windows pin number eight.

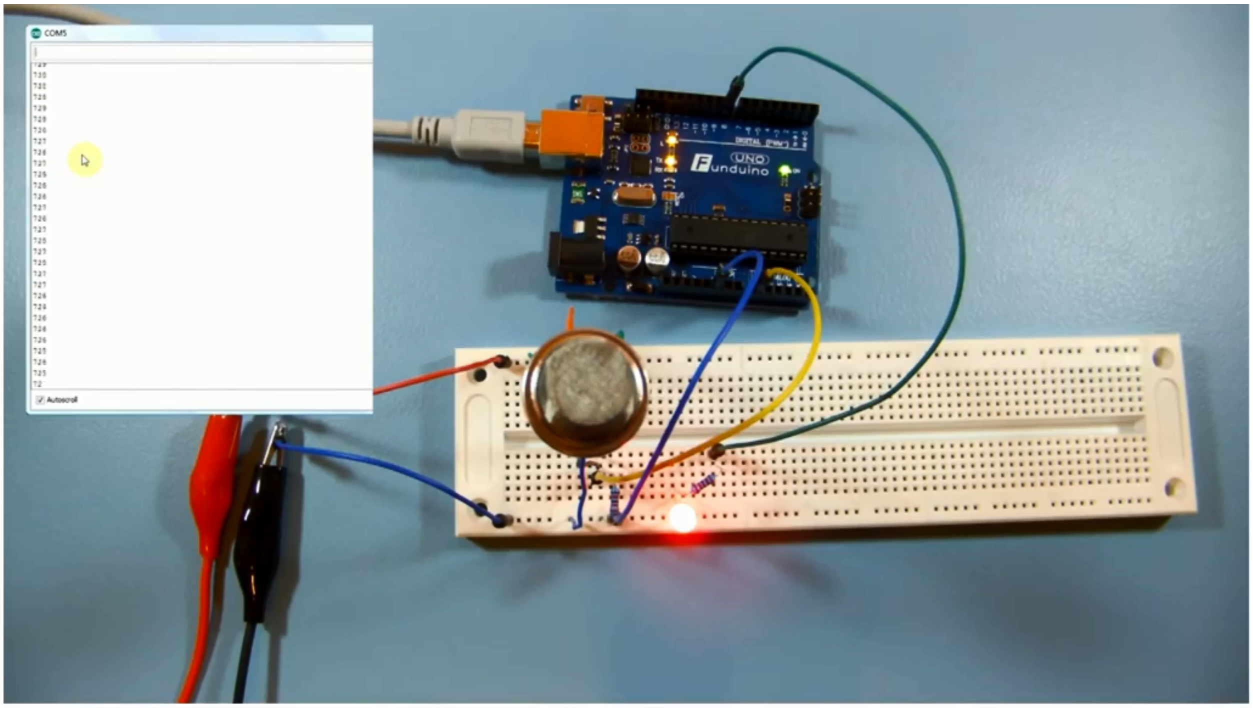
Connect the jumper wire to the positive rail on your breadboard, and another one to the ground rail hook up your power supply to these jumper wires and the Arduino to your computer. Download the code from my website and upload it to your Arduino you'll find a link in the description below now go to Arduino ide select tools serial monitor and you should see a value between 0 and 1000 23 if your sensor detects gas the volume goes higher readings from the sensor are reliable after about 2 to 3 minutes after powering up after about 3 minutes you'll notice the readings will go lower and stabilize at a certain base value now I'll try to give my sensor some gas from a mini torch as you can see the volume increases instantly when it reaches 500 the LED lights up you can adjust sensitivity by changing the sensor value in the code to match your needs now you know how to use the gas sensor with the Arduino

Video End Time: (36:36)



Okay? Now let us see the another video, where we are using Raspberry Pi

Video Start Time: (39:47)



let me play the video okay now if you see what we had to do is that I'll show it to you how can we design a gas sensor and what are the process flow for designing that particular sensor okay all right so till then you take care I'll see you in the next class bye

Video End Time: (44:10)

Now if you see what we had to do is that I'll show it to you how can web design a gas sensor and what are the process flow for designing that particular sensor Okay? Alright. So, till then, you take care.

I'll see you in the next class bye