Integrated Circuits, MOSFETs, OP-Amps and their Applications

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Lecture – 59
Experiment: Peak detector circuit using Op-Amp

Welcome to this module in this module like I discussed in the last module we will be discussing the application of on op-amp application of an op-amp is a peak detector. Now guys you see slowly and gradually I am trying to show you several applications.

We have studied just from characteristics of op-amp just input offset voltage input bias current very simple right and then we move to little bit complex circuits and here you see that we have reach to the circuits where you can really use the circuit in some actual electronic module. For example, if you talk about peak detector you will seen one of the a DC to use this comparator and you are comparing the voltages which is a flash a DC.

So, now what we are looking at the electronic circuits that we can design using op-amp and those circuits you can further use it in more complex circuits. So, this little bit increasing the complexity of the application. Here you will look at the op-amp how it can be use is a peak detector ok.

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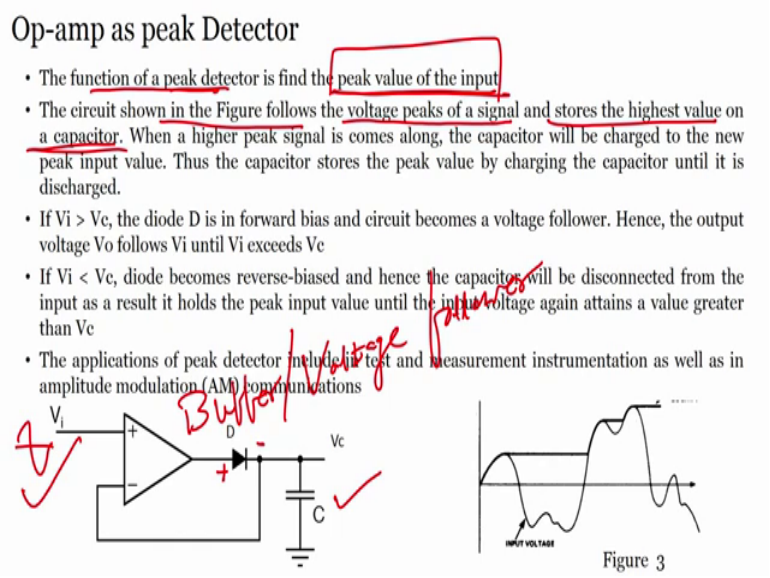

Figure 3

So, let us see on the screen how it how you can design this. So, when we talk about op-amp is a peak detector the first thing that you have to see is the function of the peak detector. So, function of the peak detector is nothing, but to find the peak value peak value of the input right.

So, what is the peak value of the input if you if you want to know you can use the circuit which is your peak detector alright; that means, if I have input signal right like this what is my in peak of the input size is this the peak or is this the peak if this a peak or this is the peak right which one is the peak of my input signal.

If I want to understand right if I want to understand then I can use the circuit which is the peak detector the circuit shown a in the figure which is here right it follows the voltage peaks of a signal and stores the highest value is stores the highest value on a capacitor; that means, we have capacitor we have capacitor here. Now, we apply input signal here ok.

You apply input signal here then based on the input signal, based on this input signal my if the my anode is positive compare to cathode my anode is positive compare to cathode this will nothing this will like as a voltage follower, this will become a voltage follower, or it will become a buffer right, buffer voltage follower, it will become buffer, or it will become a voltage follower right.

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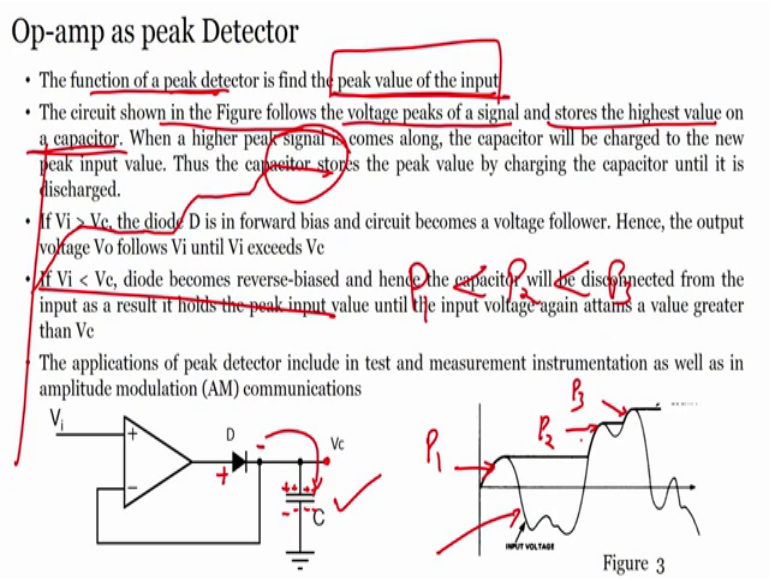

Figure 3

So, when it is a voltage follower or buffer what will happen that my capacitor will start charging my capacitor will start charging and here that the output we will be able to see a signal able to see the signal right. So, when I have the input voltage which is less right instead of just a sine view input voltage which is varying in nature which is varying in nature like you see this my input voltage. I will write here or I just draw the same signal the red one the red point that I have drawn is my input signal.

Now, which is the peak I want to know so initially when it reaches to this particular value right my capacitor will start charging and it will store this value until a peak which is higher than the earlier peak will appear my capacitor will remain saturated or it will have same voltage.

As soon as I see the signal at the input higher than the previous signal higher than this particular signal right you see the capacitor again start charging again start charging you will again keep on holding the same signal. You keep on holding the same signal until another peak appears which is higher than the previous peak which is higher than this peak.

So, you can see this peak is higher than the this peak right if I say P 1, peak 1, P 2, peak 2, P, P 3, peak 3 then P 1 is less then P 2 is less then P 3 that is why if I just draw the capacitor signal then what I look at it I look at the signal like P 1 then it is holding it then as soon as peak 2 appears peak 2 holding it peak 3 holding it.

So, if I just see this graph right then I can see that my signal that appeared the input the peak value is this one, peak value is this one right, super easy to understand and super easy circuit to implement right.

What you will require you just require you just require 1 diode, you require just 1 single diode and a capacitor and of course, of course, an operational amplifier right operational amplifier.

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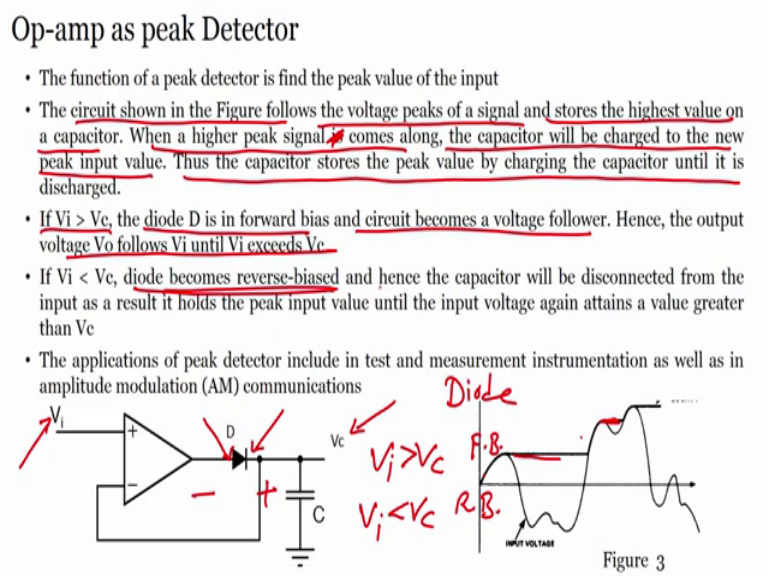

So, let us see the circuit shown in figure follows the voltage peaks of a signal and stores the highest value on a capacitor that is what we discuss when a higher peak signal is come comes along comes along the capacitor will be charged to the new peak input voltage or new peak input value right.

This is what we see from here to here thus the capacitor stores a peak value by charging the capacitor until it is discharged right. So, it will hold the value this capacitor can hold the value until you discharge it until you discharge it.

If V i is greater sorry if V i is greater than V c if V i this signal is greater than the voltage across capacitor diode D is in forward bias agreed. Because you see then this will be at higher potential compare to here that is why anode and cathode. So, diode will be in forward bias, but what will happen if V i is less then V c V i is less then V c then diode would be in previous bias correct.

So, now, first let us see the first condition V i is greater than V c when V i is greater than V c by diode, diode is in forward bias. So, for bias circuit becomes a voltage follower, because when forward bias is that it will be like so circuit becomes by voltage follower, hence the output voltage v o follows V i until is exceed c V c voltage.

Now, what if V i is less than V c V i is less than V c in this case in this case my diode will be reverse bias right. Because my input signal that is a signal or voltage at anode is

less than the voltage at cathode voltage at anode is less than the voltage at cathode ; that means, my diode is reverse bias or diode becomes reverse bias, diode becomes reverse bias. And hence and hence the capacitor will be disconnected.

Hence, the capacitor will be disconnected right as if the D a circuit is, circuit is open. So, if I draw that when their diode is not there and what will happen I have just op-amp right diode is not there.

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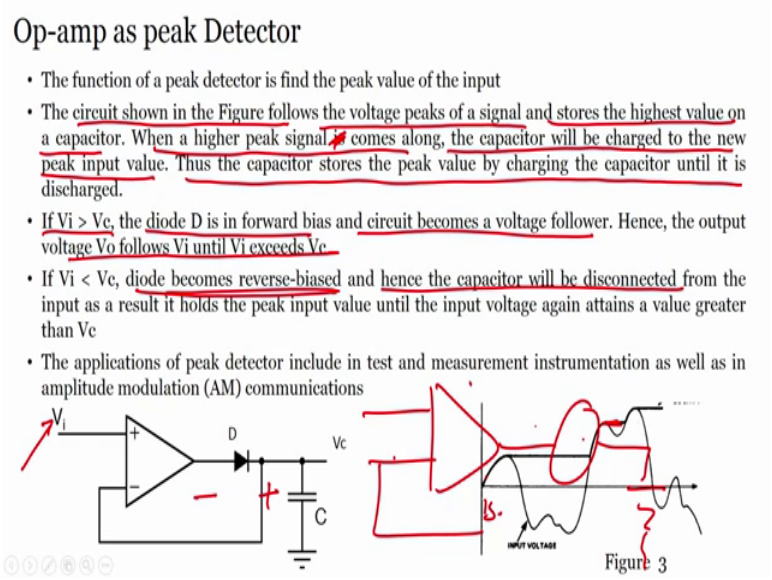

So, I have no capacitor here. So, as circuit is disconnected right because diode cannot operate because it is in the reverse bias, circuit is disconnected or diode is disconnected from the circuit. And hence the my capacitor holds a peak input value until the input signal again attains a value greater than V c right; that means, initially if V i is greater than V c capacitor will start charging.

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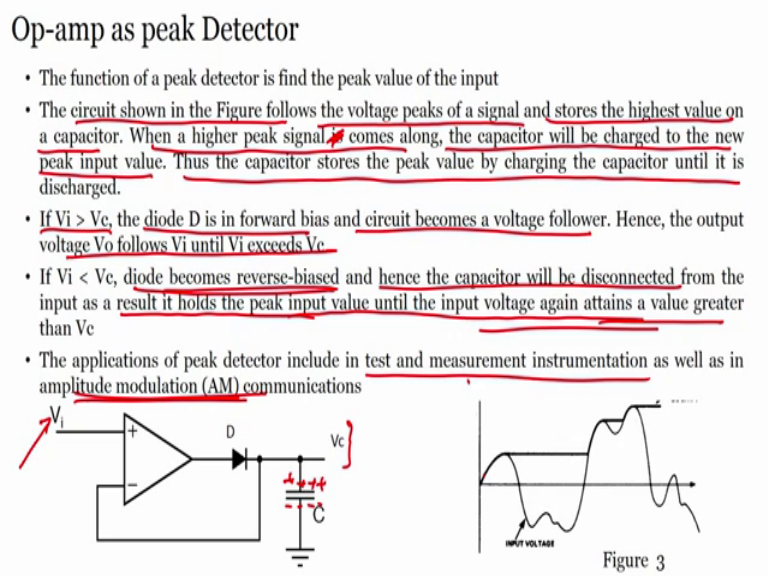

When V i is less than V c this diode is disconnected. So, capacitor will hold this value again when you are input signal is greater than your V c than again your diode will conduct and your capacitor will again have a different charge value, different charge value, or different voltage across the capacitor.

Like, application of this peak detector understand now we are also showing the application right I told you that slowly and gradually we are moving to a circuits or we are moving to the point that, now you guys can design the circuit and also understand what exactly the application of this circuits are to the application of peak detector, include in test and measurement instrumentation includes in test and measurement instrumentation as well as in amplitude modulation, communication, amplitude modulation communications.

You may have studied in electronic communication course in your undergrad. What are amplitude modulations? What are frequency modulations right and what kind of circuits are there for amplitude modulation, and frequency modulation?

So, if we talk about amplitude modulation communications then you will see similar circuit what we have shown today which is your peak detector, which is are peak detector. So, now, it is very easy right very easy to design this peak detector it is very easy to understand the peak detector.

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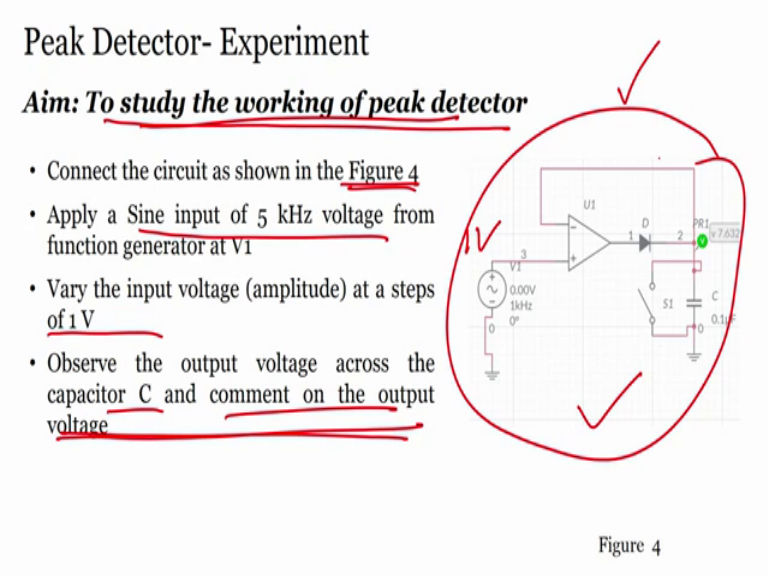

And let us try to implement this peak detector on the breadboard, on the breadboard. and then for implementing this peak detector we will take the circuit which is shown here which is shown here and we will also implement on the on the multi same multi same So, that you guys understand how it is different when you are using breadboard and how it is different when we are using multi same.

So, to study the work the study the working of peak detector that is our aim right. First is we can correct the circuit as shown in figure 4, it is exactly similar circuit this is the nothing, but if you if you connect it then the you can you can connect the capacitor directly to the you can short the capacitor to the ground.

Hence the capacitor will be out if you correct here right so that is as a switch apply a sine view input 5 volts, 5 5 kilo hertz, voltage from generator at V 1 having 5 kilo hertz we to apply at the as at the input signal. And we can vary the voltage in the step of 1 volts observe the output across the capacitor C and comment on the output voltage, comment on the output voltage.

So, for designing for showing you the experiment this particular experiment on breadboard. Let us welcome Anil Vishnu and he will show us how we can implement the circuit on the breadboard and we will be able to see the circuit.

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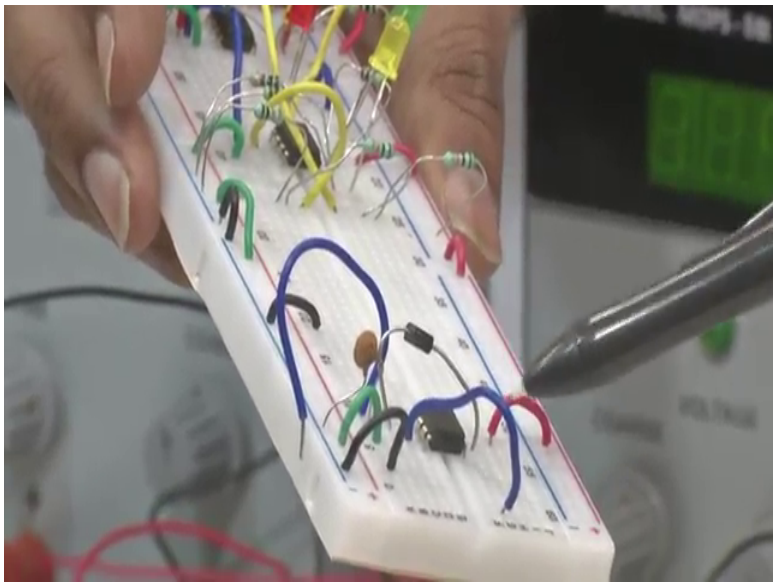

So, if you now can see the breadboard. If you can have see the breadboard yeah you can open the trope that may show you; so, then the breadboard if you see the breadboard here and in my hand yeah.

So, what you are able to see you are able to see a capacitor right if you can focus yes. So, is a capacitor then we have a diode we have a diode, we have operational amplifier, right we have an operational amplifier, and my diode is connected my diode is connected. So, this anode to cathode is connected to the capacitor to the capacitor alright.

So, this capacitor is connected to the cathode is connected to the cathode. And then I had to measure the output you from here I had to observe the output from here right I had to apply the bias voltage across the across the operation amplifier alright.

So, when I do all these things when I apply bias voltage across operation amplifier apply the input at the op-amp I will be able to see the output from the operation amplifier is what we will do today. And for that we have to we have to attach the 5 kilo hertz when we says; that means, we have to use the function generator, we have to use the function generator.

So, we have our DC power supply, then we have function generator, and we have oscilloscope 3 things we have DC power supply, function generator, and oscilloscope.

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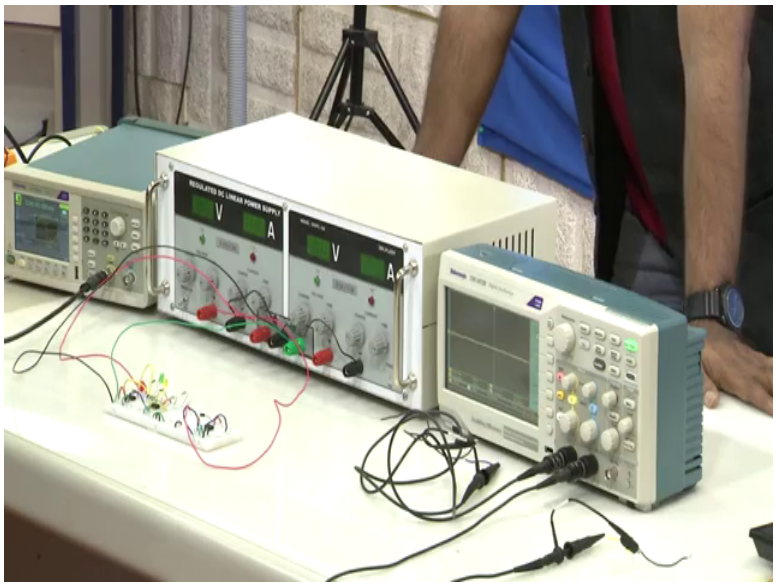

The first is we are connecting the bias voltage. So, plus 15 minus 15, plus 15 and minus 15, across the op-amp, across the op-amp, you can see this. Now, we have to apply the input voltage where to apply the input voltage 5 kilo hertz 1 volt peak to peak to the 5 kilo hertz, 1 volt peak to peak to the input of the operational amplifier or input of the peak detector um.

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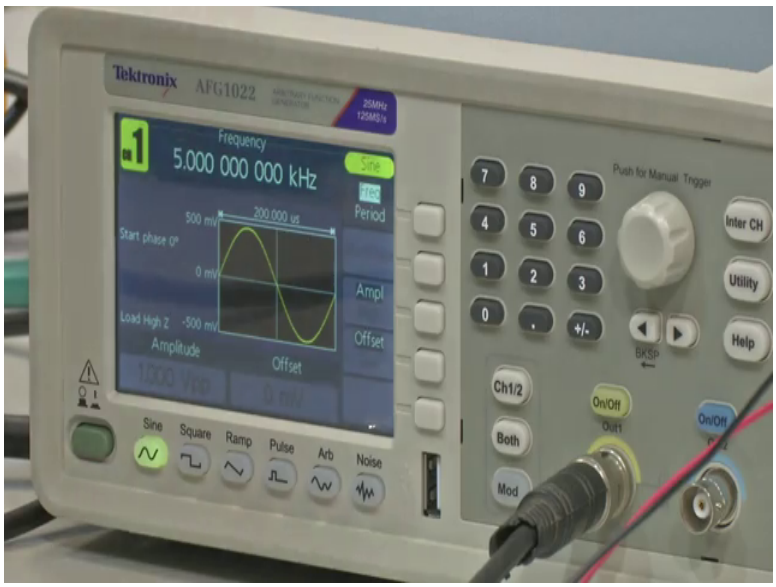

So, now, you can see you can see right that now we are connected the probe first probe 1, and then we are connecting the output of the peak detector, output of the peak detector to

the oscilloscope. So, you can see the signal input signal and then we can also see the corresponding output signal right ok.

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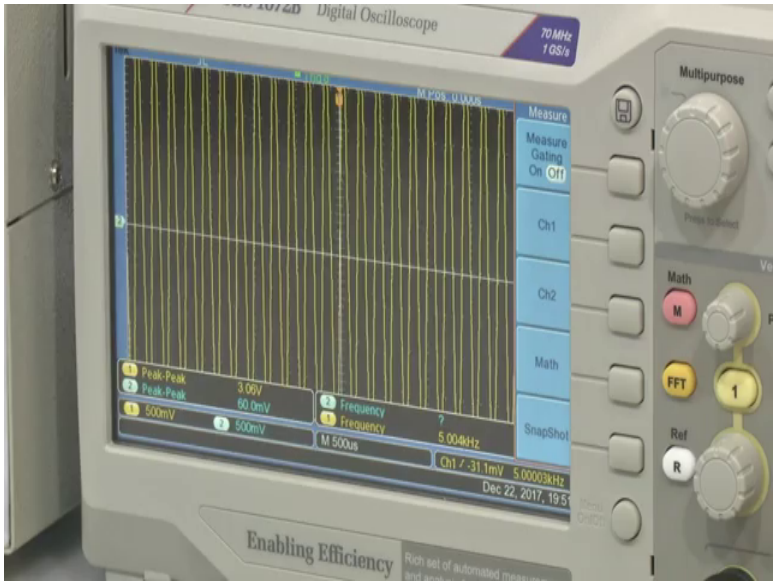

Now, this is at 1 volt, right we are apply 1 volt, and frequency is 5 kilo hertz, frequency is 5 kilo hertz.

Student: (Refer Time: 14:19).

Yeah, so now we are slowly increasing the voltage you can see now 2.6, you can see it is following, it is following the peak maximum peak right, it is following the maximum peak of the voltage you can see now it is connected ok.

So, now you are again he is decreasing and you can see it is following the input signal the increasing again it is following the input signal right. So, you can see it is working excellently and you can clearly see the follow of the peak detection the highest peak that you can find in the input signal it is following it.

So, this is how you can you can increase the voltage height and in the input signal or decrease voltage in the input signal and try to see how you can how you can design the peak detector and what is the output or the peak detector when you are changing the input signal alright so yeah that is enough.

So, now let us see let us see the same circuit let us see the same circuit in the in the multi same, and how we can design this how we can design the similar circuit that we have design on the breadboard, right on the breadboard are using the multi same, using the multi same So, for designing the same circuit on the multi same we will do the same thing and we will ask Sitaram to join us.

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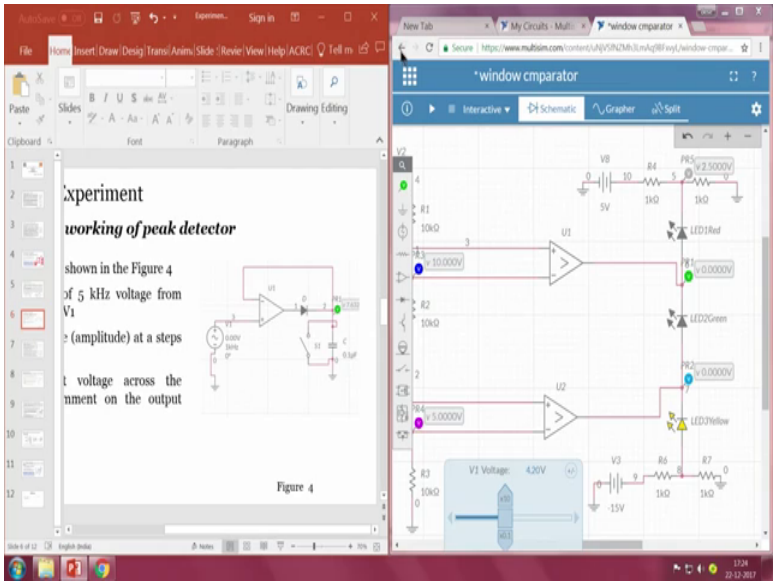

So, Sitaram is with us and now if you see the screen if you see the screen what we are doing we are creating a new file we are saving, a new we are creating a new file. And we are saving the old files so that if you want to run these simulators, again we can use the same circuit.

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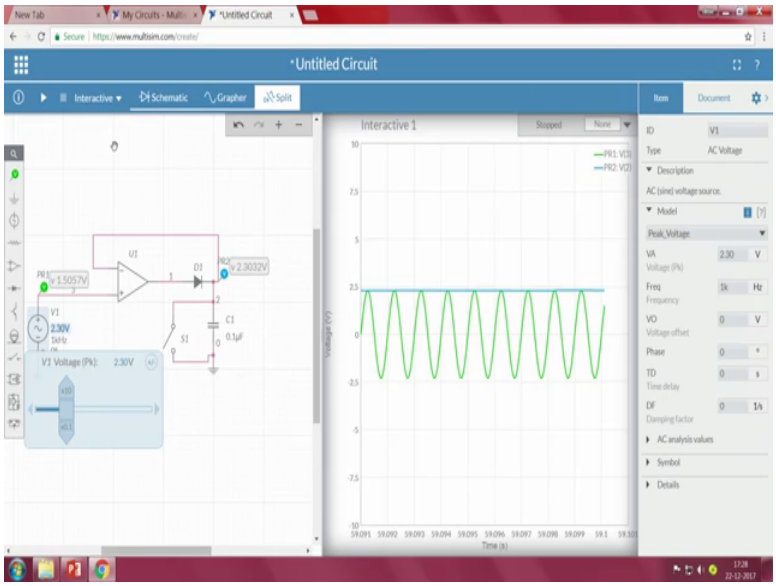

So, we have we have created a new file a blank file and then here we will again do the same thing we will drag the operation amplifier or a comparator. So, operation amplifier because the voltage follower that we can use it voltage follower. And then we are connecting the output of the op-amp to the diode we are exactly trying to make the same circuit which as which you can see on the left side of the screen alright.

We are trying to design the circuit which you can see it on the left side of a screen using the multi same. So, when a whatever he is trying to implement look carefully right look carefully and try to do at home this is a free software, this is a free software you can try and test your circuits, ground recognize the signal right the signal and then connect the inverting to the output right.

Now, do not forget guys to ground the power supply or the output. Otherwise you will not be able to see the output voltage whatever we are trying to observe. Now we are selecting the switch right, we are selecting the switch, and he has to connect the switch across the capacitor as you can see is connecting it as you just drag it and drop it.

Now, we are looking at the voltage at the input and we are looking at the voltage at the output, or a connect to capacitor across the capacitor and we are looking at the output signal.

So, when you impress simulation you will be able to see that right now high voltage is about 1 volt, and may output voltage is also close to 1 volt, if I change my voltage, if I change my voltage, you see my output is following my output is following the highest voltage that is available in the input signal right.

You see it is only showing the highest voltage at a peak voltage in the input signal, peak voltage in the input signal. So, that is the beauty of stimulation that you can play with the voltage other input and immediately you can see the changing the output you really do not require the DC source, or the function generator or the oscilloscope to get this results.

But when you actually fabricate or design the circuit and if you use the breadboard you will find lot of actual effective practical difficulties and that is why it is always good to not only do the simulations, but also try your circuits on the breadboard.

Now, you can see here when he is changing the voltage you can clearly see that the output is following the peak of the input voltage output is following the peak or detecting the peak of the input voltage right, if you decrease a voltage it is following we increase a voltage it will just detect the peak it will detect the peak.

So, excellent, excellent way of quickly looking at the circuit working of the circuit and this is how you can implement the peak detector, this is how we can implement the peak detector. So, the point is that you can you can understand you can understand the theory which we have understood now.

How peak detector works then we can make the circuit which we have made on the breadboard and finally, you are able to look at the finally, you are able to look at the simulation right using the multi same

So, having said that now we have to still see we are not we are not done we have to see further applications of the operational amplifier and in the next class, but I will try to show you is the another application of operational amplifier that is your clamper.

What is clamper you clamp right you clamps so, we will see how you can design a clamper it is a c l a m p e r clamper, and we will also perform the simulation on the clamper and on the breadboard as well will see on the breadboard as well. So, or another,

let us not do on the breadboard because we have now already know we already know that how we can implement the circuits on breadboard.

And we I do not want to show you the same circuit on the breadboard or because now I am sure that you are able to perform the experiments by yourself the idea of idea of you of the of the idea of me showing the experiments to you was that you are you are able to now demonstrate whatever things you are learn in this in the theory in terms of experiment using the breadboard.

And I feel that to this exchange whatever we have done it is good enough for you to as a getting a basic understanding of how to use equipment of how to use the breadboard or how to implement the circuits.

You take care. Bye.