# Experimental Physics - III

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## Lecture - 03
## Cathode Ray Oscilloscope (CRO)

I will continue discussion on the basic tools and instruments in the laboratory. I was discussing about the Cathode Ray Oscilloscope CRO.

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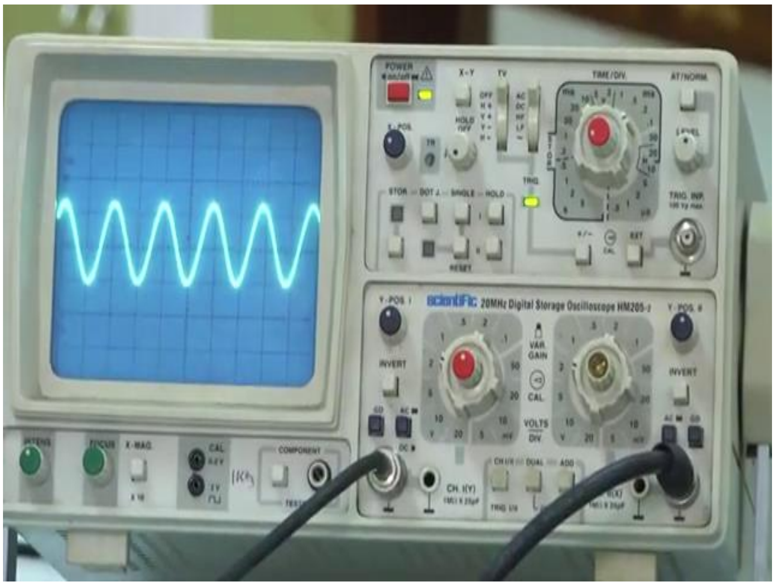

that CRO this is the intensity now we can change the intensity of this lines display, that is casing of electron beam from the on the screen. you can change the intensity of this display. This is the focusing this is the focusing you can focus make this line very sharp (Refer time: 01:00) and there is x shift, x shift you can change along the x along the y ok.

this is the y, y shift shifted because here this two channels are there channel 1 and channel 2 this are these two are independent. This is the y scale, this is the voltage scale, I can change the voltage scale, so that is the you can have seen y.y is not changing because I have to select this channel 2, so here option is there. I select channel 2 then it is channel 2 is active and this there are dual mode both I can see together ok.

one is for channel one and another is for channel two. Let me keep it here and other one let me keep it here. you can shift along the x axis along the y axis, so along the y axis there are two scale two channel. both channel you can see together both channel 1 after one other, so now one channel you can make active channel one other one make active. you can select channel 1 or channel 2 or dual both.

And that is for time x axis is the time scale basically, this you can change the scale using this one. time is related with the frequency and amplitude is related of the with the voltage volt for a signal. Now let me give a signal to this CRO and so these are BNC cable, these are very this actually this connection coaxial connection you can get very nice connection you can get using the BNC cable.

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this is the BNC cable, so I have given I have given it is a now (Refer Time: 04:00) channel 1 is selected. If I select channel 2 so it is nothing no signal is there. channel 1 that is there. from here as I told how to find out the voltage, how to find out the frequency, you can get from this scale. now today one thing I will see triggering, here this auto triggering.

And this triggering level let me just take down this one triggering level at which level it should trigger I mean start it should it the signal starts at which level, so that this is triggering level. Here it is an auto trigger we have kept in the normal mode it is an auto trigger it is triggering automatically. But if I want to select that triggering should start at particular phase, then at means at which level I want to trigger.

I have to use this one just pace sorry, I have to pace it. it is a I think I can choose the triggering level, so here level is there. here you can see if I change this level you see ok.

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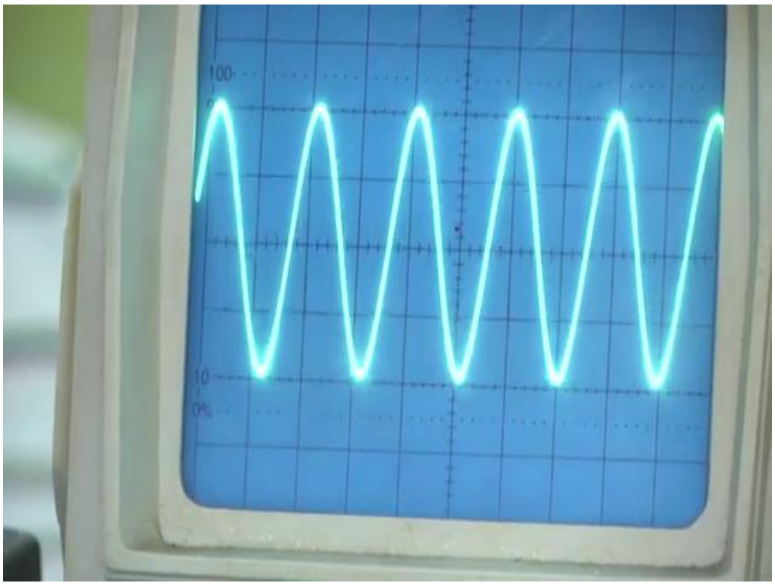

at which here we can see at starting point should be higher that I can select ok, starting point should be just here so it will start I think yes. starting level, you can you can choose starting level you can choose starting level you can choose. I can choose this is the starting level.at this level so when signal is coming, so always it will the starting point will be this.

trigger will start triggering will start at this level, so that is the manually one can select. for measuring the phase up to (Refer Time: 06:39) phase difference of the two signal. this can be so thus taking the another signal. here just comparing these two signals one can find out the phase difference between these two.

But to find out the phase difference between this two it is we use different methods it is called that is that super position of two waves along the x and y direction of same frequency. You will get the Lissajous figure and then from Lissajous figure you can see the Lissajous figure you can find out the phase difference ok, so that I will discuss.

Other way two if you can this is the one another one if you take if we can hold, then you can see the phase difference between these two, but these are not the good way do that. using the Lissajous figures method it is easy to find out the phase difference between two signals. As well as one can find out the frequency ratio of the two signal, so that I will show you today ok.

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So here this is the signal one signal it is amplitude is here you can see this 8 volt amplitude is 8 volt here I have kept at two. it is one two three four divisions, so eight volts each is division is 2 volts.

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And then I will take the second I will take the second signal. that is that signal is at channel two. So now, it is at channel one now I will select the channel two. This just take me at the middle take me at the middle and here it is also at two this channel two, the scale I have selected this 2 volt per division.

here you can see it is 2.5 division 2.5 more or less I have to take slightly up, then you can see but it is 2.5. 2.5 division 2 volts per division so it is 5 volts. here you can see this is 5 volt I think I will choose that yeah you can see this 5 volt. But that is high kilo Hertz that frequency of this signal is 5 kilo Hertz that also one can find out as I discussed earlier ok.

what is the this starting from here to this way, it is the one two I think 2.5 here, what is that here it is 0.1. as I told here 0.2 showing, but it will be 0.1 because it is somewhat distorted this knob. 0.1 here it is point it is a two division I think yeah always I take time one two one two division it will be two divisions ok.

So two multiplied by 0.1 0.2, so 1 by 0.2 is 1 by 0.2 is 5 it is in milliseconds, so it is kilo Hertz so it is kilo Hertz ok, so that I have discussed. Now if I take this two signal what is the phase difference.

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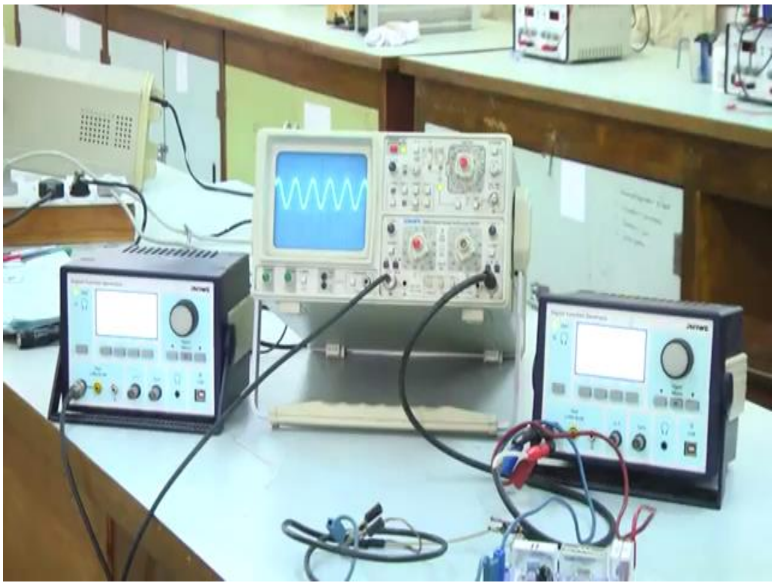

These two signals are having; these two signals are having the same frequency. then what is the phase difference between this two if I want to find out.

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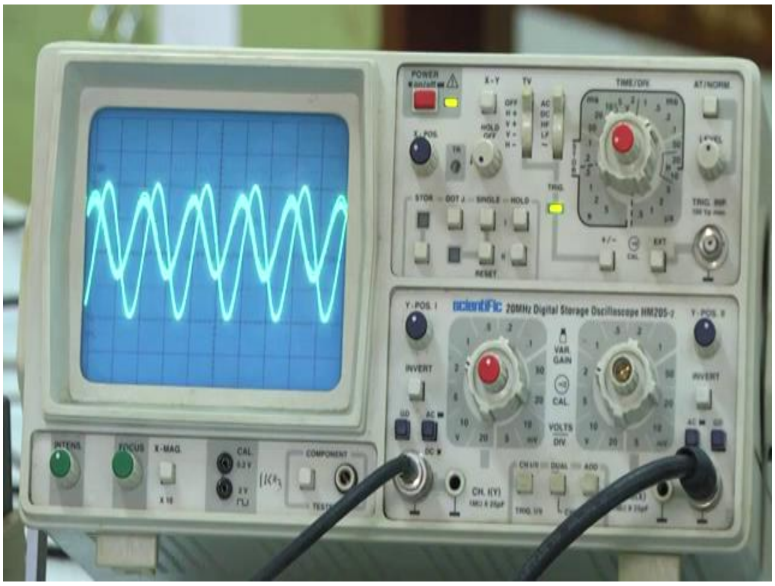

as I told I can see this both, but I can see the both signal. I have put in dual mode both signal I can see, but you can see this are they are not fixed ok, one relatively one is slightly changing because this is a high volt. Somehow this it is slight fluctuation of the slight fluctuation of the frequency. it may change so at lower frequency this really do not we do not see this type of movement.

as well as this is not the good way to measure the frequency, measure the phase difference of two signals. But using the Lissajous figure it is very convenient. Lissajous figure know this I think I should tell you slightly about this Lissajous figure, you know this for that only we need dual beam oscillator scope.

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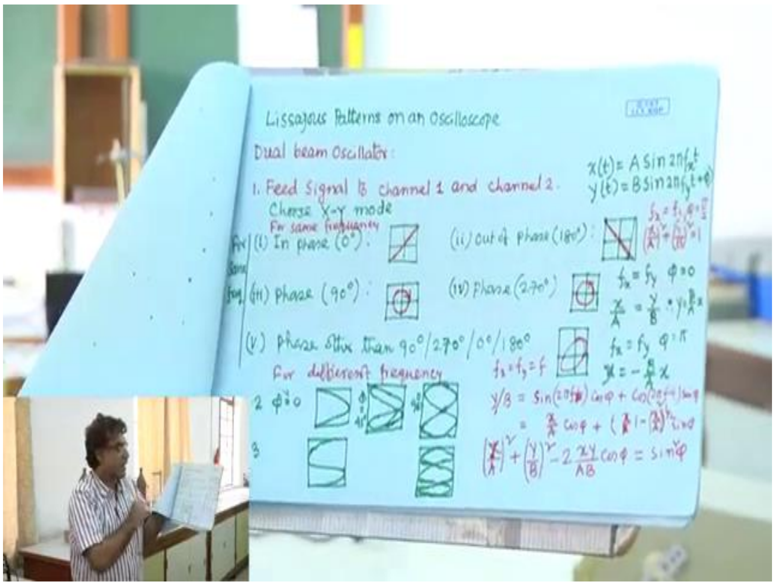


Means two channel should be there two channel should be there two channel should be there, dual mode dual beam oscillators CRO. Now here you can see that you can when you will get the Lissajous figure. one signals you have put that along the x axis and another signal you have to put along the y axis ok.

in CRO for a particular channel whatever signal we had seen. x is automatically it is time axis and y is voltage axis. So now, in dual mode; in dual mode it is not dual mode in when you put this signal to channel 1. So that means this voltage this actually this voltage here x t means it is the how voltage is varying v t ok, that voltage variation along the y axis it shows as a function of time. But there is option in the there are option in the CRO that that is called x y mode.

when you will use the x y mode means two signal you are putting in these two channel. one will be applied one x axis will be for x axis will be x axis will be voltage axis and y axis also will be voltage axis. Time axis it will be this time axis time that one will not work. this is the for time it is always for x axis, this is the voltage for channel voltage along the y axis for channel 1 this is for channel 2.

But in x y mode; x y mode so this time axis will not time axis will not work. Only this channel 1 it will act as a say x voltage will be applied along the x and here y voltage will be applied along the y ok, so that is called x y mode. that option is there here x y mode. Dual so you will so if you use the x y mode; x y mode then for this two. two signal along the x and this is the along the y and from they are if f x and f y is same f x and f y is same, then what will happen depending on the phase difference phi depending on the phase difference phi.

if phase difference phi is 0 then you will get this the plain. And then it is for 180 degrees it will be just opposite, 90 degrees it will be ellipse or circle. whether ellipse or circle it depends on the; it depends on the amplitude. If the amplitude both the amplitude is same then it will be circle otherwise it will be all the times it will be ellipse ok.

270 it is a one is left handed and the another is handed circle or ellipse and then for other than this angle it will be; it will be ellipse. It will be ellipse, now from the ratio of an axis and y axis one can find out the phase this phase difference between these two that is phi. This is the method that one can find out the phase difference between the two signal of same frequency.

And if frequency is different then frequency is different than one can find out the ratio of the frequency of the two signals. here we will see the multiple loops in the Lissajous figure. depending on the number of number of loops, depending on the number of loops one can find out the; one can find out the ratio of the; ratio of the; ratio of the frequencies of the two signals.

if ratio is one is to two ok, so this kind depending on the phase difference this kind of things here, you see these are as if this you are getting this line this line. this type of phi 0 for phi equal to 0 you will get this, for phi equal to 45 you will get as if this and for 90 degrees you will this type of ok.

Two loops you will getting two loops.it is a this you will get for 1 is to 2. along the x and along the y if you see there is how many loops are there. Depending on that you will get them. this it is an it will be equal to the ratio of the number of the loops along the x axis and along the y axis. That is that way one can find out the ratio of the loops using the Lissajous figure. that just I will show you how to.

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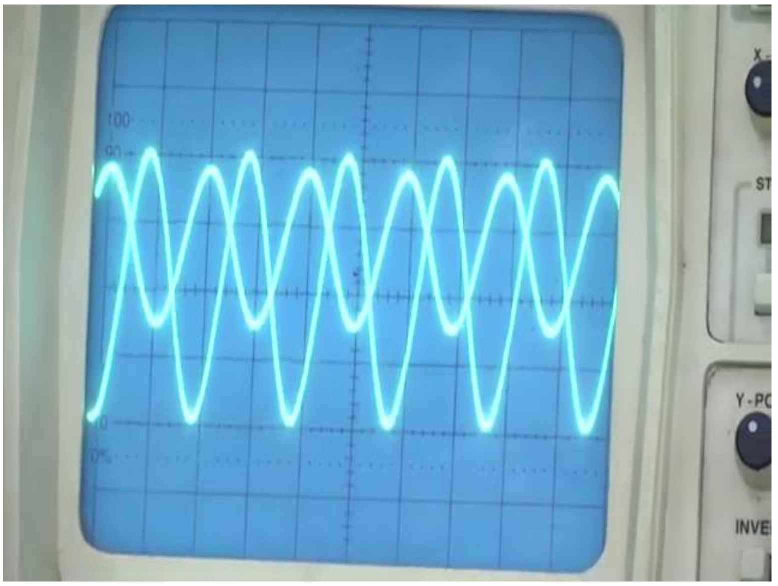

So here nice things you see, but somehow this two you see this two, now they are in same phase. Now this phase between these two are changing here I can see why it is changing probably some fluctuation somewhere it is coming, so that is why is change is there that I can see in this CRO.

Now, if I use them this x y mode you see these two means, one signal is along the x and another signal is along the y then these two are of same frequency. But amplitude is different amplitude is here 8 volts and there 5 volts. Now what so in x y mode as I told one signal will be along the x and another signal will be along the y, there will be superposition and you will get the resultant pattern and that is Lissajous figures.

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And then this is nicely I can show you when they are in phase, as I told you will get the straight lines immediately I can show you are getting straight line and that it is changing see since this one was moving.

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this phase is changing you see just you see 90 degrees, phase difference 90 degree, phase difference 0, phase difference 45, phase difference 90 degree, phase difference 180 degree ok, phase difference 0 if this. Now 90-degree phase difference 0 ok.

Now, when I can show you this you see now you will see the 90 degree, just it is you see it is a 90-degree phase difference is 90 degrees. Now they are in phase I can show they are in phase when they are in phase just if I put they are in phase. Now I will straight line now I will just tell they are in out of phase they are in out of phase out of phase 180 degrees. I was getting this way now again they are in phase; you see they are in phase you are getting straight line along this ok.

it is not the way to do but somehow here one is that I think this initial phase this phase difference is the omega here both are same. But there this two are not same source. If their slight change is there between this omega t; omega t plus 5. if slight change is there between omega 1 and omega 2. omega 1 minus omega 2 into t plus 5, so del omega t.

So if that del omega is not 0 then you cannot get the constant phase difference phi. that is why since this two are different source. Here it is showing exactly same, but is slight difference is there. del omega will not be hopefully I am able to tell you properly ok.

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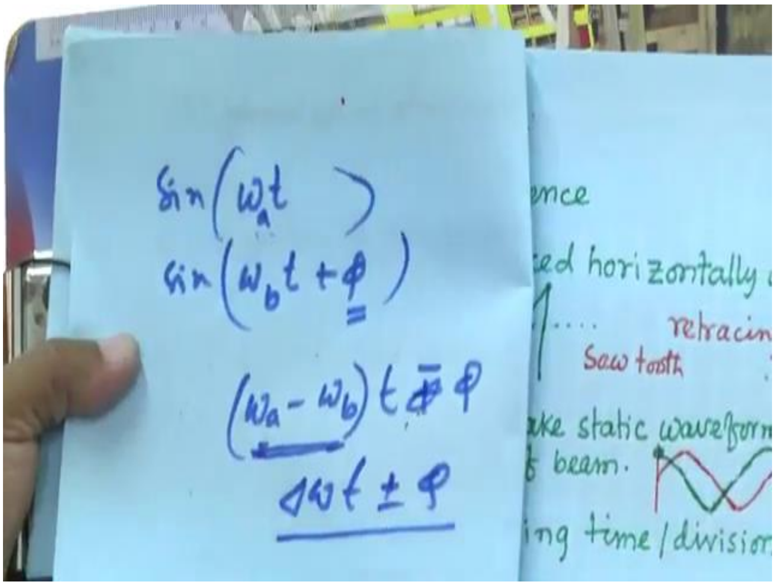


What I am trying to say that so one signal it has as I told omega t plus omega t and another signal omega also this as an omega, b omega t plus phi right. This sin this sin etcetera whatever this here. for same frequency the this should happen that was I was telling. if so then only this the phi will be there. But if slight difference is there if slight difference is there these two.

phase difference this is the phase difference or this can be minus whatever this is the phase difference. But when these two 0, so only this it is a remain constant. But if slight difference is there, so this delta omega t minus plus minus phi or whatever so this will be the phase.

the since two other two different source I am using; two different source I am using. this I think this del omega is not this omega 1 and omega 2 are not exactly same. That is why and this is also high frequency 5 kilo Hertz. in lower frequency does that happen so reason I could tell you why this slight shifting is there.

But that I am using because that I am using to show you this Lissajous figure ok, so that so if you take two signal and then if any phase difference is there between these two from Lissajous figure you can find out this. that is what I was showing you; I was showing you ok.

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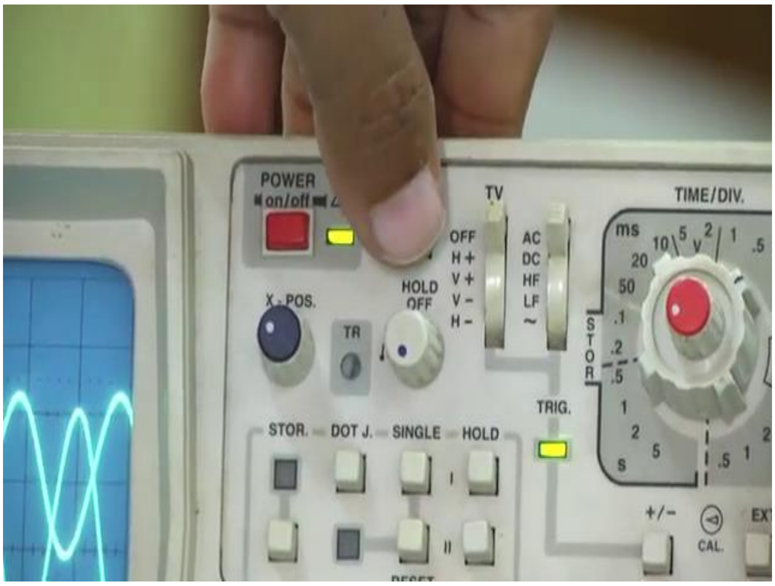


So different figure with time it is changing; with time it is changing why del omega because of del omega t. But so I think this is the for same frequency if I take different frequency; if I take different frequency, as I told these also I can make static. But there I have to change the frequency (Refer Time: 24:32). this I can do just this I can do using a same signal. this this from this I am taking signal this one ok.

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And another same signal I have used the circuit ok, LC I think this one CR circuit; CR circuit this CR circuit we have used. another signal same signal we are taking to this CR circuit and putting here.

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that signal we will be putting here, so they are of same; they are of same frequency dual mode I will.