NPTEL

NPTEL ONLINE CERTIFICTAION COURSE

Course
On
Analog Communication

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Lecture 02: Fourier Series (Contd.)

Okay so let us come back to the concept of channel okay so what do you mean by channel let something we want to discuss we have already discussed about different forms of channels like let us say it just one is wireless channel which is their media that we know and other is twister part okay which is being used for our telecommunication transmission.

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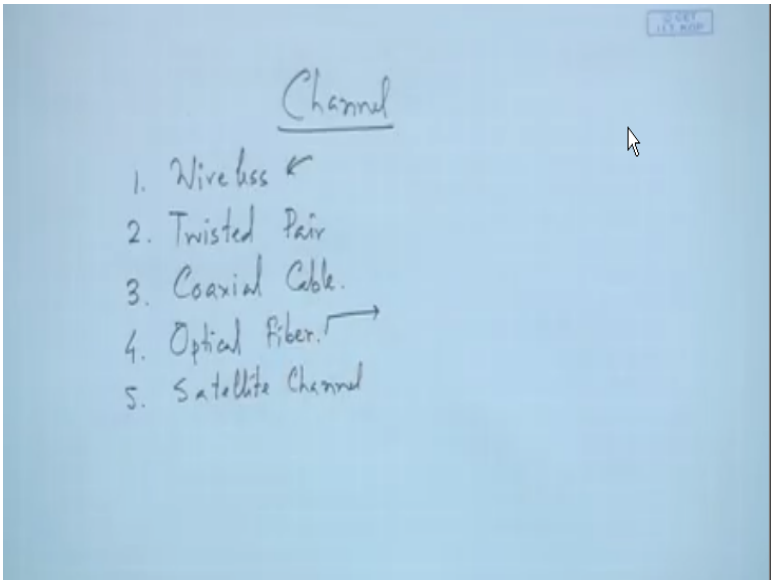

So third is coaxial cable this is being mostly used for the broadcasting television signal this also something we have seen already and fourth part may be a optical fiber this is one which supports it so the fifth might be satellite channel so on and so forth so there are multiple channels that

have communication channels especially that are available through all of them actually the mode of transmission is electro kinetic okay.

So for wireless it is not guided so it just radiated electro kinetic wave where as for all other cases it actually guided electro kinetic waves optical fiber it still electro kinetic wave but either visible optical region okay let us say that frequency such that it is called optical electro kinetic wave oaky and so all of them are mostly electronomic wave so that only signal propagates so on channel which our channel we pick.

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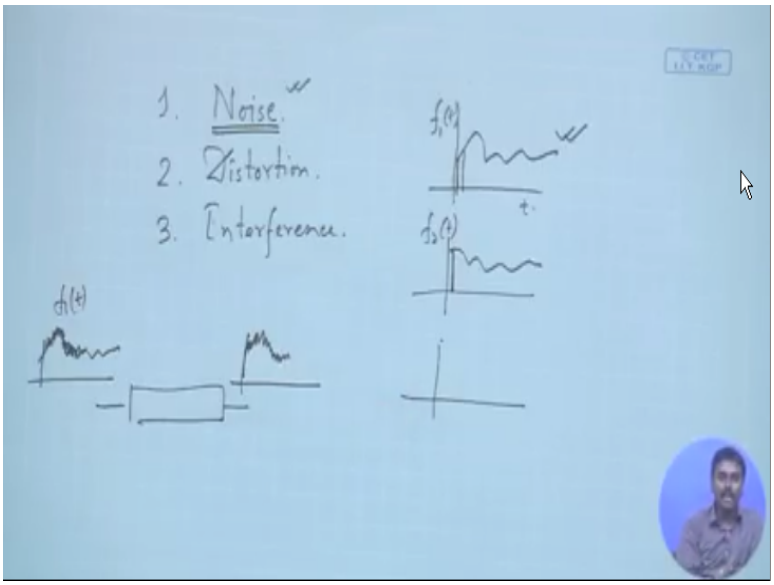

Now what channel can do let us start discussing about these things the first thing which channel can do let me list out first what are the things that channel dies and then we will discuss about them so the first thing is channel can introduce noise it is true of this it is most important part of communication, what is noise? And how noise affects so communication engineer must know very well about noise and that is probably the biggest enemy of our channel okay.

So second part is distortion and the third part is interference let us talk about them one by one so what is noise? Noise is a again what we are doing we are trying to transmitted electrical signal which is being for entity you can already it way and in the channel what type is happen due to different region okay so there are might be this random electronomic waves which can be added with this particular transmitted signal.

So what is generally say channel is if you say the characterize the channel has already the channels okay for doing mean by already channel as if its like a simple added of the signal for whichever signal gets means we put as input to this channel if there are multiple such signals it will just add up those signals.

So suppose I have a signal if one f1t okay so I am just writing down a voltage of that signal and this is the variation with respective time that this is called the function t for suppose this is my signal that has been put into the channel and then if there is another signal that is also being kept out for put inside the channel let us say f2t okay so what the channel will do.

The channel will simply add these things so at time instance when you take this voltage and this voltage it will add and put this things okay so every time instance if you point wise add these two signals you will get a composite signals which is the typical quite area of a already channel if the channel is additive we generally say that channel is linear okay but there are non linear channel also were simple addition by it does not work.

It might be may be $(f1t+f2t)^2$ so it might be quite start creating all those square cube terms so those are non linear channel but here we are just saying our channel is let say that one characteristics of the channel that it is a simple already channel but it means number of signals ascending the channel they will be just means amplitude added or in terms of electronomic.

We already know we will see that similar effect so that whenever you can work that electro composite electronomic waves into our signal it is just be addition of those to signals now what is noise? Noise is inside the channel there are electro kinetic waves which are being generated it might be due to lightening it might be due to curious radiation coming from outer space.

It might be the radiation other form of radiation that has generated on art and doing her reflected back from the ironist whatever t is there might be multiple random signals which we have no idea because it is generated from elsewhere we have no idea and this might be generated without our control and this might means be an input in the channel.

So we cannot help it because we are using this channel so there will be some curious signals always being generated or created inside that particular channel if it is wireless I have talked about all those examples like electronomic radiation for outside and all those things even for

wired also it cannot be fully shielded so all those from outside some electronomic radiation can leak in into the channel.

And it can cope up along with my signals and then definitely the channel is additive or linear we should say then that signal will be added in the noise segment this random signal which I have no hand in generating I have no control in it, it will be nay way generated and added to my signal that is called noise so if you see therefore the noise is just another random signal and calling it random because I have no control on it.

If can be generated without my knowledge and without my influence so that is why it is actually random source of information so this particular is always inevitable it will be present in the channel and it will be added so when we say noise you might be saying okay is noise just being added at the channel precisely not, voice also can be added at the transmitter.

Because transmitter also would be having some hardware in the hardware you will have et say all components consistor some recessitor and all of the components juts take a simplest for component let say recessitor whenever my signal it has to be transmitted so it has be process today whenever hardware so it must be passing through of particular recessitor and inside the recessitor what will happen.

Even if I suppose I transmit this signal or I passed this signal through the recessitor it will not be completely suppose I have a recessitor through which I am passing this signal this f1t whatever it is okay the output what will happen see through the recessitor all the actually creating this voltage time varying voltage this f1t and according to current will be flowing now what we happen inside the recessitor there are multiple carrier electrons there also being linear motion due to this motion they will random movement.

So what will happen on top of this there will be some random signal which will be added and my output signal will look like this so it is almost followed the pattern of my f1t original f1t but it will also have this small things added which is just being generated due to boundary motion of the electrons okay.

So this will be true for any hardware any electronic device we put so in transmission or transmitted they will be electronics which will generate this noise in receiver also there will be hardware which will also generate this noise so noise is not just it is one of the means my

channel is one of the source as we are discuss but noise will also be generated at the receiver noise can also be generated and the source where from an actually starting my transmission.

So everywhere there can be noise but channel is one of the sources of noise so there is why whenever we are collecting channels we need to understand also what should be the noise what should be how much noise will be added what is the characteristics of that noise and all those things so we are talked about it is a random signal I have no knowledge about it how it will vary with time I have no knowledge about it.

It is not my generated message so I do not know exactly how it will be generated okay so the pattern at which it will be varying that will be completely random it is true oaky but I have to still get some characteristics and that will be our major focus of this course how do you characterize noise and in presence of noise how do you come back noise in the transmitted side as well as the receiver side.

So that noise does not actually change my voice signal so you have already seen suppose my voice signal looks like this f1t and on that f1t I start putting noise so what we have control the voice signal will be little bit worried and how much it will be worried how much I can tolerate all those things has to be in consideration wherever the transmitted.

And possibly as much I can get read of that and as much your f1t I can generated at the receiver that much the communication will be or the communication will have that much clarity okay next is distortion what do you mean by distortion let us try to think about that whenever we talked about the channel generally the channel any form of channel you see the channel will have some low cost effect.

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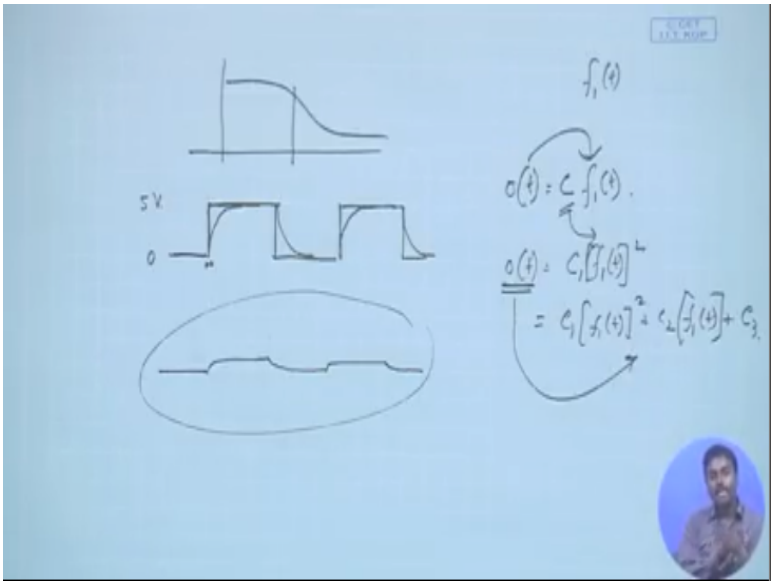

That means it can carry frequency up to some value beyond that it will not be able to carry those frequency, those frequency into surprised so that is the low cost characteristics though channel transfer function it will just see it is almost look like this so up to some cut of frequency probably it will be almost carrying means that signal but after that it will be hugely acting inverted okay so this happens.

Suppose our signal has multiple components different frequency component then what will happen some of the frequency component will be actually equivalent carried but some of the frequency component might get it will suppressed that is the effect term that we all know about low positive filtering we will has red little bit on signals and systems so let say I am transmitting this kind of signal okay.

So this is voltage level let say 0 which is voltage level let say high volt okay so I am try transfer this kind of signal now this is what will be later on seeing also but this where at this edge or this edge or this edge all those high frequency components are there because at the neglible time the voltage level is varying it.

So that actually calls for very high higher frequency very small amount of time voltage change or happening so high voltage high frequency components are involved in that part is the part where signal range almost constant over times required not much of high frequency components again so what happens in a high frequency component will be suppressed so basically has a effect is particular part will be smoothen it cannot really sharply jumped.

Because the high frequency component will be suppressed so the output of a channel if we take the channel as low possible now what will happen it will look like this almost like charging discharging of the transmitter okay because of that works as a low positive so this is what will be happening basically you can see I am probably transmit something because of the low positive nature of the channel.

The signal is getting little bit too started okay not only that as you go along a huge distance there will be a high loss associated with the channel because channel might have absorption law so it little take away of the some of the energy of the electro kinetic wave it might be due to radiation in the air it might be going different direction so the entire problem of the portion of that radiated energy will be linked.

So what will happen? If I transmit some out of the energy at the end this will really become very small something like this so my one now will come close to 0 because the energy level is getting depleted and also the signal form is getting little bit distorted so this is actually the part of the distortion that we generally see in the channel it is low cost effect due to the absorption and at innovation of the channel okay.

There are other distortion we are talking about but we are just assuming we have been assuming that the probably channel is linear okay in a linear channel forget about the noise if no other signals are present my signal only is being carried out if the noise is efficiently small then noise signal will be particularly only that signal will be carried out through the channel. But what might happen if the channel is no long linear be able to suppose that channel out if we say we suppose I gave f1t and the channel is not a linear one.

So if it was linear may be there is constant term C into f1t let C is that attenuation so that till attenuate from here to here the signal level okay so let say C is .1 or .01 depending on how far your receiver he is what kind of absorption or loss or attenuation of the particular channel has so depending on that those signal strength will be little lesser.

But single quality will remain the same but instead of that if the cannel has not linearity then what will happen OT will be some C1 let say another constant into $f1t^2$ okay if might be it is juts your quadratic or it might be in quadratic with all other terms let say C1 $f1t^2$+C2 f1t so that the channel function let say and see through it.

If it is like this then what is happening the OT is not proportion to the ideal when it was linear it was proportion all to f1t now more long that it is proportional to f1t so there will be added distortion okay do to this squaring or if you have even hard or non linearity in the channels let say all those things.

Then there will be added distortion so the signal value is like different because there will be square term added by some other linear term and some constant terms so there will be some distortion due to that non linearity of the channel so there are multiple ways that channel can be this distortion one is low pass filtering effect the second is the distortion itself which can also keep the channel non linear okay.

Due to that linear distortion is coming up and then you have some attribution which significant reduces the energy level of the signal so that is the second part of our discussion what channel can do the third part is which is also in evitable which is called interference see the interference comes when multiple signals are being transmitted simultaneously over the same channel even if you take clear very nice clear that we have discussed about modulation there will be still some portion of that other signal which comes inside the band of our desired signal.

And that will create again some amount of means impurity into your signal because that is the different signal which is now getting super linked force with your signal that will contaminated the signal so pattern of your signal which carries the information actually will not be sustained if not happens so these are the three source that can contaminate within your channel so you have to be very careful about noise of course you have to very careful about this distortion.

And that is why we have discussed about the channel o you need to characterize the channel you need to know exactly what kind of nose it gives what are the random what are the signature of those noise then you need to all know what kind of distortion that channel gives if it is non li8nera how what kind of non linearity what are the positions of those non linearity so all those things has to be known.

If it has a low pass filtering effect what is the characteristics of that low pause due to that what kind of distortion that signal will get and also if you as a attenuation how much attenuation it gives so all those things has to be known and then you have to also know if there are other signal which are present what the effects of the interference these three things should be very clear

whenever you are transmitting because eventually what will happen as we are discussed that many signal you transmit.

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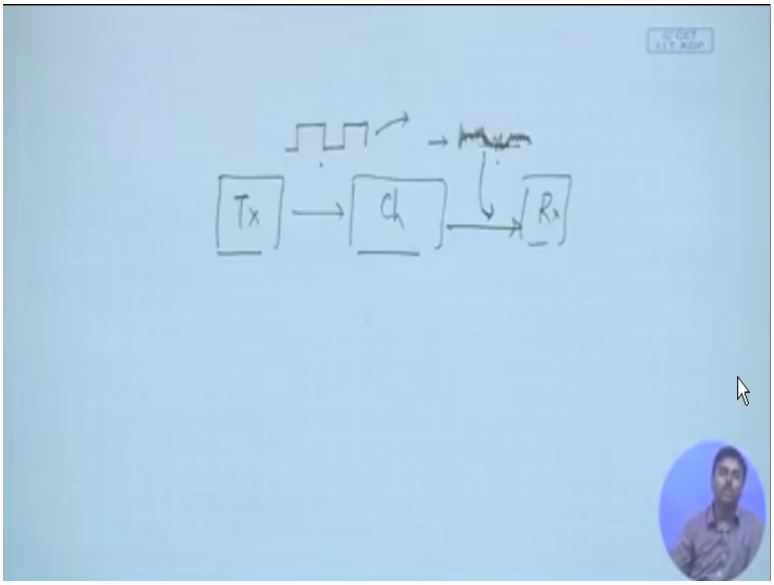

So we had this transmitter they have this channel and we had this receiver so this is actually the transmitted signal so transmitted signal may be very nice but what might happen due to the channel I am just taking out the interference and as well as non linearity of the channel so even if you take out that what will happen after passing it through a channel this particular signal will become light waves.

This would something like this and on top of that there will be noise added at randomly so this is actually going to be your received signal and that is why we said transmitted signal and received signal might not look alive it might be completely different so this is one fact that we have to leave it and this is fact that we need to build with mostly in communication that would probably channel will give some distortion some of the noise interference to the signal.

And received signal will not be completely faithful representation of the transmitted signal so therefore what I need to do first of all we need to characterize this how much distortion how

much noise will be added and we need to know how to come back this and to get back my original signal because that is the whole purpose of communication.

So this is something will be trying to do in our computation okay so next what will start means will probably that next section of our next part of next half of our course will talk about modulation little bit so I am just here it is going through all the models of the communication that has required why they are required and what kind of things very briefly without giving any details of it very briefly making it familiar with these concepts.

Once we get some hold of this and we know actually what are the things we need to considerate then will actually go into the case of each other so our next target is that modulation we have already discussed very lightly what modulation is now will try to characterize those modulation techniques what are the different modulation techniques that we have how do we actually characterize themselves okay.

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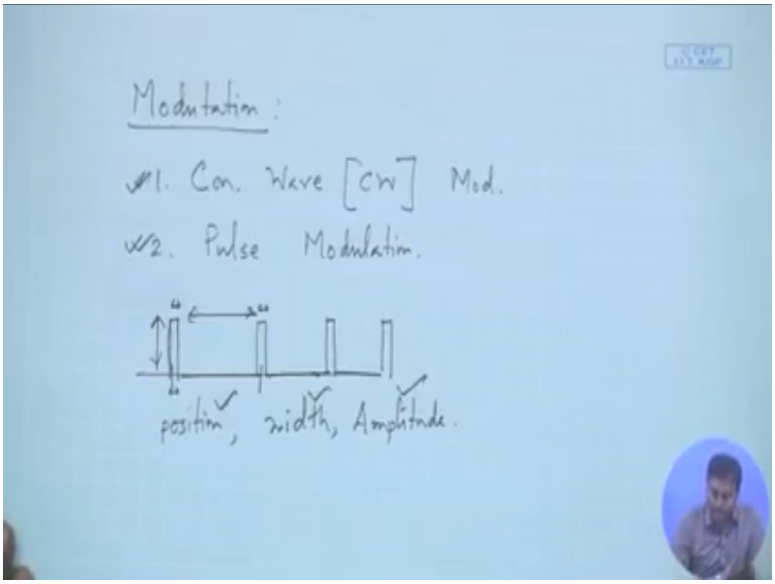

So in modulation especially in analog communication will be talking our two forms of modulation one is called continuous wave or CW modulation and other one is pulse modulation okay these are the two most common version of modulation what is called continuous wave modulation the other one is pulse modulation.

So basically whatever example we have given that modulating the amplitude of a carrier or modulating the frequency of the carrier let actually called the continuous wave modulate modulation that means the carrier wave is continuous okay that means continuous means it is actually in time if you just go everywhere in time any time instance you defines there is some it has a continuity over the time.

And there is some amount of amplitude you will be getting all this okay so that is actually continuo's wave modulation in pulse modulation what we do we actually take a signal and the signal looks like this it periodic pulse so there is no longer continuous kind of signal it is just defined what this small duration the waste of duration it has nothing again for a small duration it is defined.

And that is called as pulse and this is actually a pulse periodic pulse that goes around so if somehow I can put by information inside this pulse okay now what are the criteria that has each of this pulse is few things one is the weak of the pulse okay like for the time to see what are the characteristics or what are the basic features that have what are the main things that have which we can modulate.

Where we can introduce our signal okay there are also we are almost looking like that so we are trying to see what the characteristics are basic features of this pulse so one is this pulse with another one is this pulse amplitude okay like the sinodial there was a amplitude the pulse also has some amplitude pulse have some width okay.

So this will be in time how much may be second or micro second is pulse width that is another thing and then if the pulse is periodic I can also vary the procedure location of the pulse so I can slightly deviate the location of the pulse so that is called the position of the pulse. That also another variable it that I can get so position width and amplitude and for modulation I can sue all three of them.

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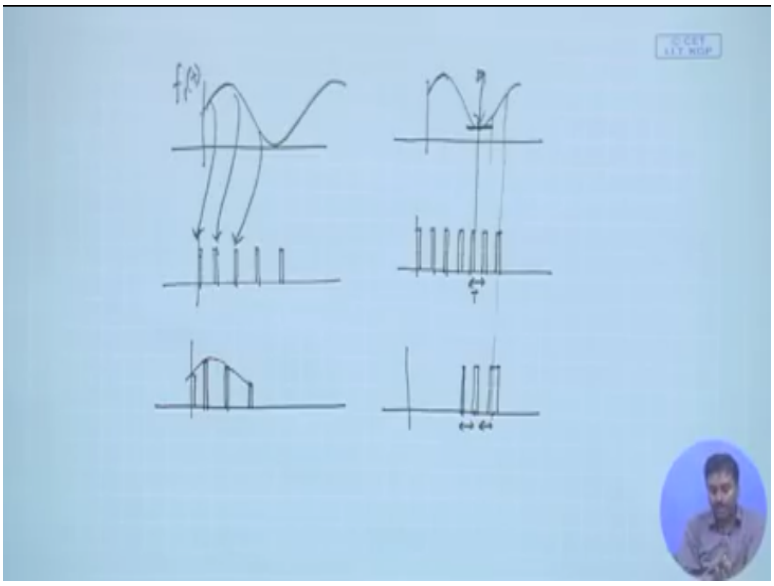

Suppose I need to transmit this signal let say this signal okay and I have pulse train which is coming like this so in pulse amplitude modulation what will do will actually borrow the amplitude and put it and every time instance with this so basically the amplitude of this pulse will be modulated or will be shape of this signal so here the pulse amplitude is with this here it will be little bit higher here it will be something like this.

So that if you just connect the tip of these pulses will see this signal being formed okay so that is actually called the pulse amplitude modulation so the pulse amplitude is now being modulated according to your message signal which is let say f1t okay the second part is that I have again this signal right I have this pulse what I do is I actually modulate the width according.

Almost like frequency so as the my mechanism of modulating this width is as I increase the amplitude for as I see the increase in the signal amplitude I actually either increase or decrease the width of this course okay so basically here they will be so there should be a minimal width which is resolve to the minimal part of the signal okay.

And accordingly I will be varying double from here to here there will be some scaling or varying the width so let say this is the minimal part so here the pulse should be of minimal wave and then whenever it implies here it is implies slightly so the pulse which should be the move here it is increased slightly more.

So here the pulse will be more the period or the center of this pulse should have the same frequency has this whatever time it has is time the center of this pulse will have the same time

but width of the pulse is now getting modulated according to the message signal so basically what is happening the pulse is being carried now and there is a characteristics of the pulse which gives us indication about the signal.

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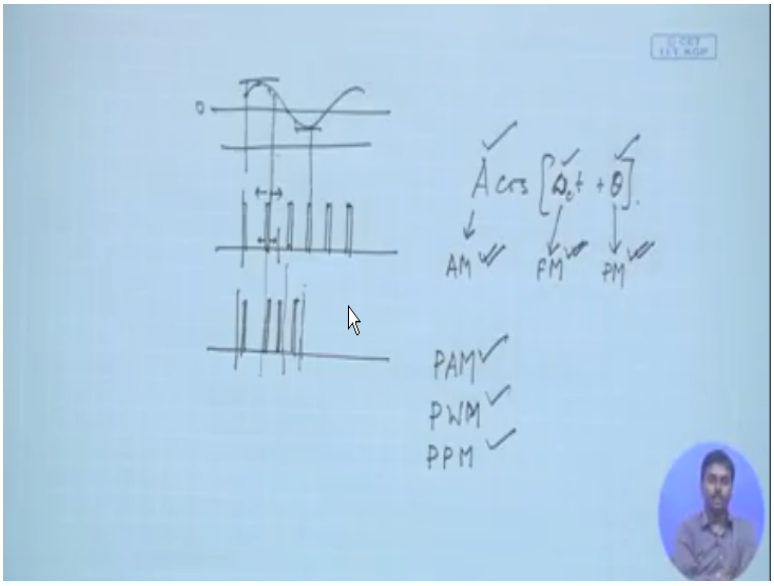

If you just look to the width of the pulse strain you will get review of the signal how it should worry over time same thing can be done over the pulse position so for pulse position what we do we have a again a signal and let say these are the pulses periodic pulse width same reputation interval and then when we modulate the position now again what we do we actually vary the position of the pulse so from here center I can actually take the pulse here and there and how much I pushed the pulse the right or left side that depends on what is the signal strength.

So let say I always if the signal is positive I go into this direction and let say my real is if the signal is any time getting negative and it goes this direction and we say that maximum signal level let say this and suppose that signal 0 is over here okay, and the minimum signal level which is this that is the maximum right shift and left shift of the pulse so let say that we have decided up to this so here the pulse will be maximum let say negative it will be left shift right so it should go maximum let should go.

So that is the center of this that should go this pulse because it is little bit less negative so it should be less left so this should be more placer to the center of the pulse, and so on which one at this 0 level there is nothing this is again say this part is positive, so it should be positive shifted

so this should be on this side and this is more positive and let say this one again should be positive shifted on this side so if you now see the pulses they are now disturbed in position so we remain the same.

Amplitude remain the same just the position of the pulse is there in different and the position and location of the pulse now gets a information about what the corresponding signals there, so this is another form of modulation so we are now dealt with a continuous wave modulation in the continuous wave we have seen that there are two parameters that can be modulated.

We have the carrier we can modulate the amplitude we have already demonstrate the how the amplitude can be modulated we can modulate the frequency that also we have demonstrated that how the frequency can be modulated we have taken their digital or binary signal for that you can as well take this kind up signal again but will see the same result only their there was a proper radiation of amplitude.

Here probably gradual variation of amplitude will be happening or gradual variation of the frequency happening so we have amplitude modulation and we have then frequency modulation but let say whenever we talked about frequency there is also another term called phase so generally represented as A cos ωct+ some phase θ okay.

Basically we have ideas say just ωct but there should be some initial phase also so which is θ so we actually have three parameters and accordingly we must had three modulation one is called amplitude modulation one is called frequency modulation and Fm which you are familiar with an another one is called phase modulation PM.

And similarly for a pulse we have free information carrying things which are pulse amplitude modulation that is called PAM then pulse width modulation PWM and then the last one is pulse position modulation is called PPM so there are three pulse modulation there are three continuous wave modulation which will be dealing with later on right now I have just given very brief of this modulation will try see that relative merit of them how do you mathematically realize them.

How do you generate them how do you demodulate them so all those things should be part of this course say this is just introduction to this part and will later on see how this things can be covered later.