Computer Networks and Internet Protocal
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Lecture 57
Layer 1: Physical Layer-III

Hello, so we will be discussing our this layer on Physical Layer considerations. As we have done for last couple of lectures; that different aspects of physical layers, we will be also we will be seeing today also some other few more important aspects of physical layer consideration. As I mentioned in earlier lectures also, we this is our bottom most layer, one of the important layer for communication where the communication aspects come into play and so, and heavily dependent on the media considerations right.

So, how you communicate whether it is through wireless, wired, what sort of communication media, it plays a important role that how the data will be pushed into the things.

Finally, this layer is also at end of the thing that this layer is also in responsible that how much bit rate will be able to achieve right. Whatever we may be doing different sort of encoding compression at the upper end, but nevertheless finally, pumping the traffic through this should be on the physical layer right.

So, there are different physical layer consideration and most of the cases we will see this physical layer is more dictated by the communication paradigm. It is a major aspects of communication paradigm and lot of things which are happening which are there prevalent theories and practices which are prevalent in the communication systems, we are inheriting there or we are discussing therefore, that matter to for this physical layer consideration. So, today also we will discuss about couple of things like one is the encoding techniques other is the your multiplexing techniques, encoding, modulation, multiplexing techniques right.

So, those type of techniques which are there in the which are needed at the physical layer. Again let me emphasize that this are a vast communication topics right. So, we will basically try to see the overview upon the consideration what is required for our network point of view what we have seen earlier.

So, we will just to see a overview of the different type of techniques which are prevalent into the things right. So, if you look at the encoding decoding techniques, so what is encoding? It is a process of converting a data of or a given sequence of characters symbols, alphabets etcetera into specified format for efficient transmission of data, right.

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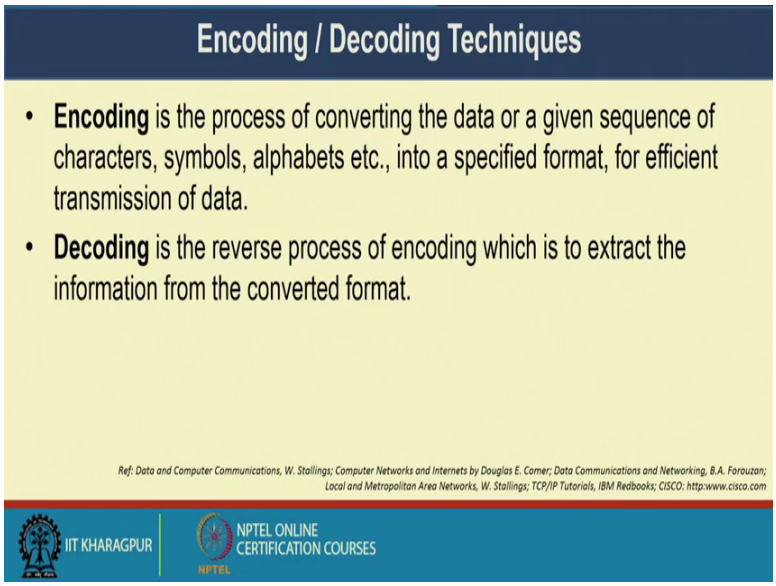

So, that is flatly like that decoding is a reverse of encoding. So, I it is a process of converting a data which is generated by the system into given sequence of some character say symbols alphabets etcetera, in a particular format to a efficient transmission of data.

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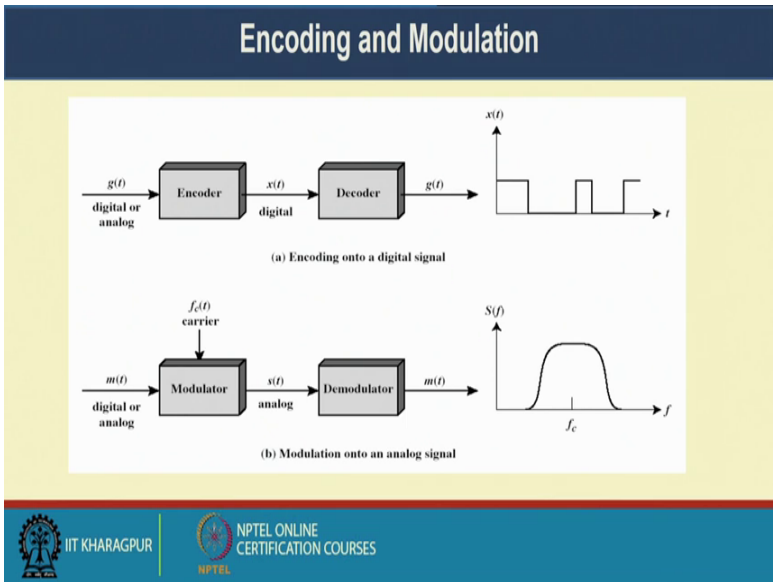

So, what we are doing giving a digital or analog signal analog data, we want to encode it either through a encoder, and who generate a intermediate signal which is transmitted through the media. And put it to the decoder which generate the signal bank or generate the data value. Now these there can be a analog data with digital signal, digital data, analog signal, analog data, analog signal, digital data. So, they are different variation of the things.

Now, there is another technique called modulation; which is basically with that it is modulated with respect to a carrier frequency right? Why is this is done we will come to that right, see while I encode; while I just encode into analog signal. Now that as we have seen earlier that the signal has some frequency phase and amplitude or a composite signal has different frequencies a set of frequencies. Now as this frequency range should be within the within the range of the frequencies which that channel can carry right.

So; that means, if it is not in those range I need to modulate this frequency through a through a carrier. So, that it fits into this channel carrying capacity right. So, I require a carrier frequency by which I can put this range into the particular things, like say this there this one; it could have been in some other range here or some other range, but if my particular media can carry within this range then I put a carrier frequency f c and modulate it such that it is within that particular range. So, we will see those

considerations. So, these are again as I (Refer Time: 05:24) these are core communication phenomenon.

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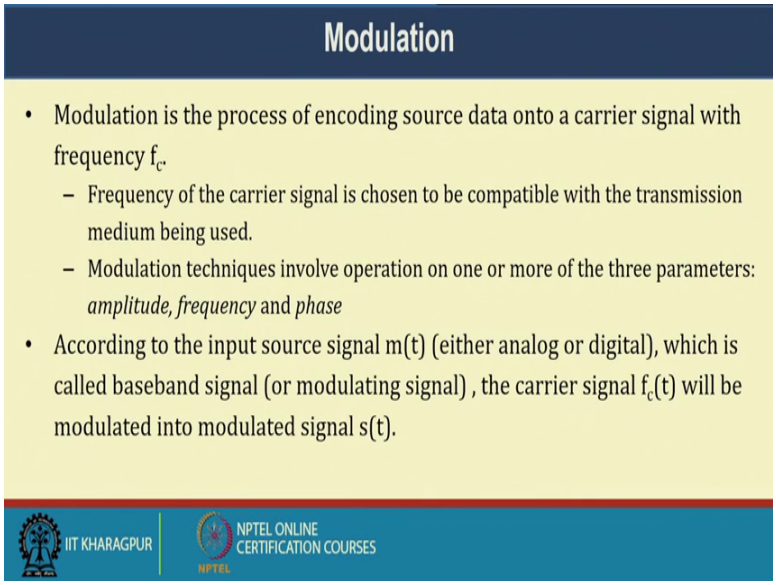

So, other thing is modulation is a process of encoding source data, encoding we have seen encoding source data into a carrier signal with a carrier frequency of frequency f c. Frequency of a carrier signal is chosen to compatible with the transmission media use that too at the (Refer Time: 05:46) then it should be linear thing. So, the modulation techniques involves can be 3 different things; it can be amplitude modulated, frequency modulated, phase modulated.

The carrier frequency carrier signal is modulated that way, according to the input source signal m t either analog or digital which is called the baseband signal or modulating signal. The carrier signal f c will be the modulated into modulated signal s t right. So, that that we have seen so we have a source signal m t carrier signal f c and modulated to a some signal s t, which is carried through this channel in a faithful manner; that means, with less with minimal distortion or minimal loss type or loss there or I can get the signal with maximum S N R.

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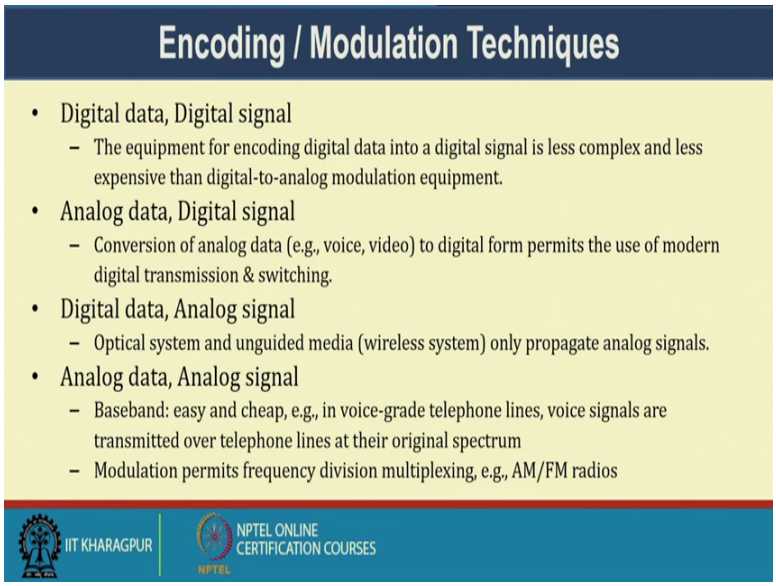

Now, as you are telling that encoding techniques or encoding or modulation techniques there are there can be 4 option, one is digital data digital signal, analog data analog signal, digital data analog signal and analog data analog signal right. So, this can be the 4 option so we can have this sort of 4 variant. So, all our this techniques what are there are if we can (Refer Time: 07:00) to this 4 things are absolutely fine right.

So, digital data digital signal the equipment for encoding data into digital is less complex because it is on some levels we will see that. Whereas analog digital signal conversion of analog data like voice, video into digital form for communication or different type of use of modern digital transmission, and switching through using the same data network to transmit the data and sort of things digital data analog signal. There is optical system guided media wireless that propagate analog signals where digital data needs to be converted to analog signal.

And then we have analog data analog signal that is baseband easy and cheap that is voice grade telephone lines, what we do was signaling modulation permits frequency division multiplexing or F D M like for FM radio and am FM radio.

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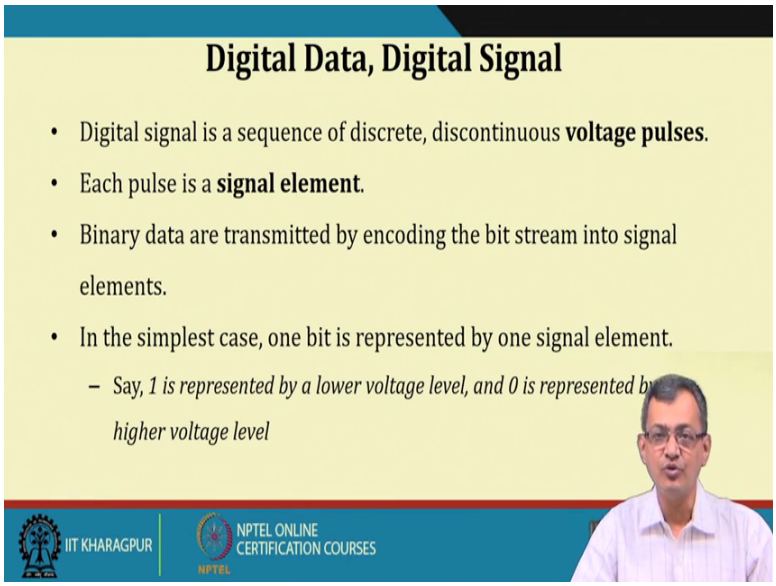

So, digital data digital signal digital sequence of discrete continuous voltage pulses right. So, each pulse is a signal element, binary data transmitted encoding bit stream to signal the simplest is the one is represent by some voltage say by a lower voltage. And 0 is represented by a higher voltage 2 voltage level that is the simplest thing, but I can have more I mean more complex scenario with multi-level set sort of things.

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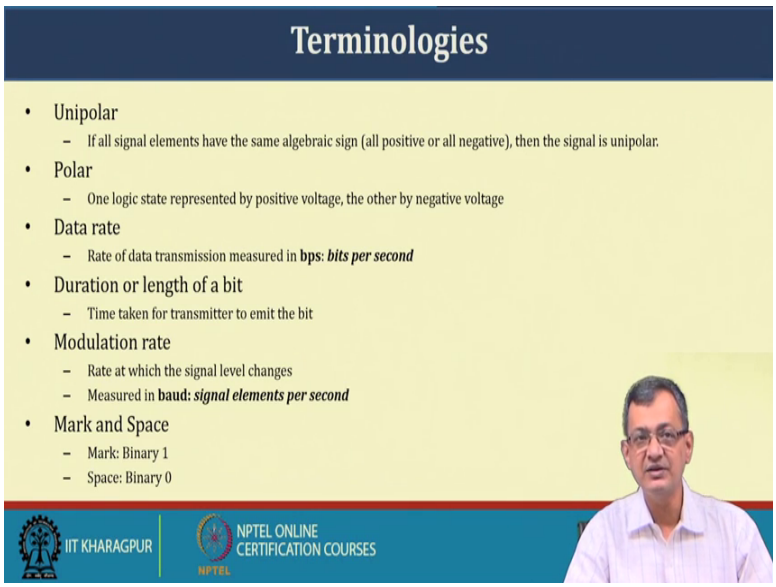

Such few terminologies there is a thing there is a concept called unipolar. If all signals have the same algebraic sign positive or negative, polar one logic state represent by positive voltage other as by negative voltage data rate

The rate of data transmission bits per second, duration or length of bit already we are seen time taken for transmit or emit the bit. Modulation rate the rate at which the signal level changes measured in baud signal elements per seconds. And there is a mark and space that is mark is binary one space 0 and type of thing. So, these are some of the terminologies which are used in this type or in this paradigm of this encoding decoding multiple signal so on.

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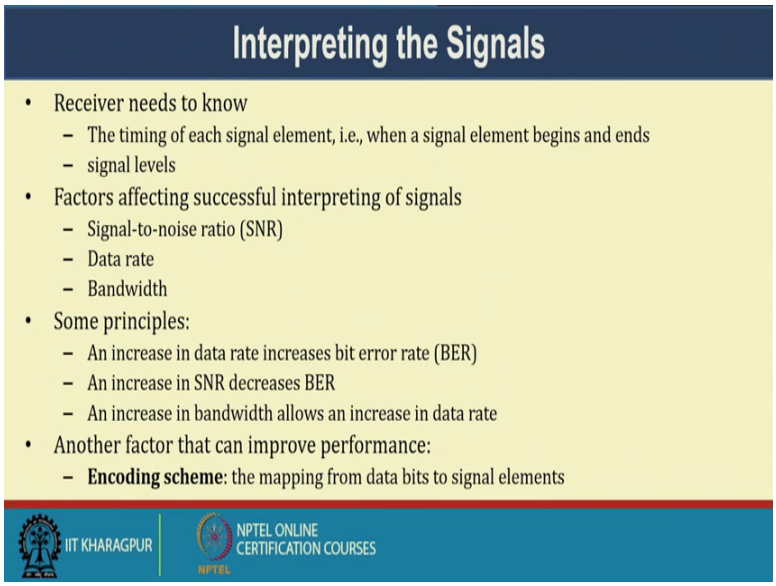

How to interpret the signal; thus receiver needs to know the timing of each single element right.

Otherwise it will not able to synchronize when the signal element begins and ends. So, and if there are signal levels accept only positive and negative if there multiple signal levels. There are some of the factors which are important that is signal to noise ratio, we have discussed data rate band width these are the affecting successful interpreting of signal if the huge degradation it may not be able to faithfully regenerate.

Some principle and increase data rate, increases bit rate error right. If you increase the data rate there can be bit rate error, an increase in SNR decreases B E R an increase in

bandwidth allows an increase in the data rate. So, we are not going to the detail of the things, but these are which can be proved and observed.

So, we request some encoding scheme right with the (Refer Time: 10:10) or the plain signal, it may not be possible to maintain all those parameters. So, some of encoding scheme which may improve performance, so the mapping the data bits into some signal elements. So, we have the encoding scheme. So, we have data bits data at one end and we need to map to the some signal element which need to be which can be transmitted.

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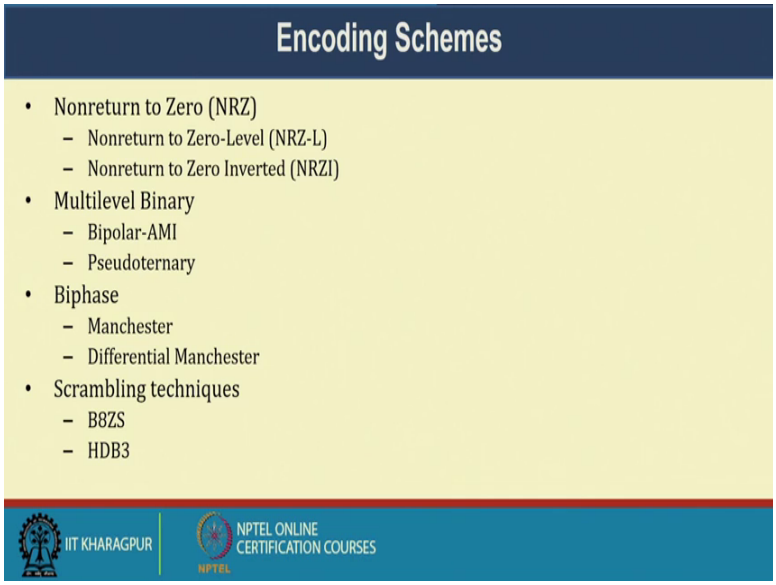

So, there are some of the popular encoding schemes we will just quickly look at those not may not be the all. So, non-return to 0 or NRZ or at NRZ L NRZ inverted, then in bipolar AMI, Pseudoternary AMI Pseudoternary things which are multilevel binary bi phase Manchester encoding differential Manchester and scrambling techniques and type of things. So, there are different type of encoding techniques right, like to give a gist of the things.

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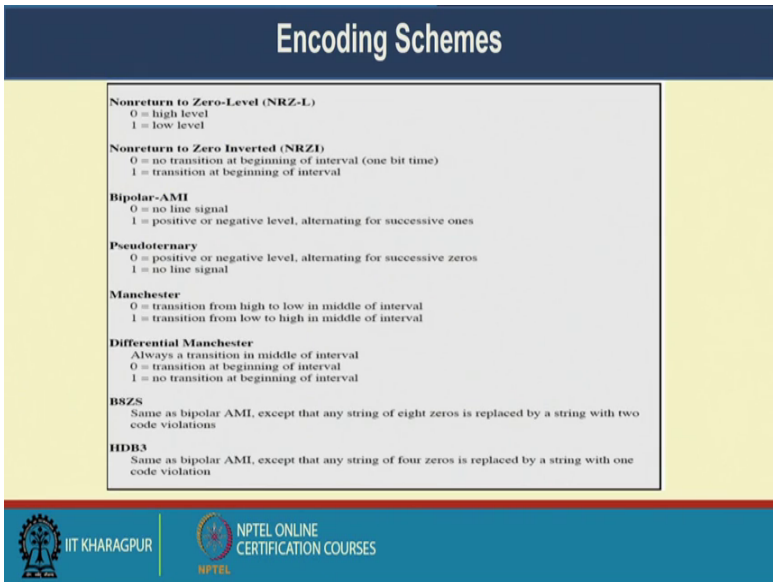

So, this is the different ways like non return to 0 level; is 0 is high and 0 is represented by high level. And one is represented by low level similarly if I am consider as an one of the popular thing is the Manchester transition from high to low level is a middle of the interval transition with a low level to high level is the middle of the interval differential Manchester is also popular.

And these are the things which are and several other things we are not going to details on the things. The important that while encoding we need to we at what we are trying to do as we have seen that we want to ensure better bit rate, better signal to noise ratio and so and so forth.

Along with that we need to have minimum error or in other sense we need to what you are looking for that it is easily identifiable right. That which with what sort of data is there it is easily identifiable. So, that once the error is less it leads to less regeneration transmission and saving in band width.

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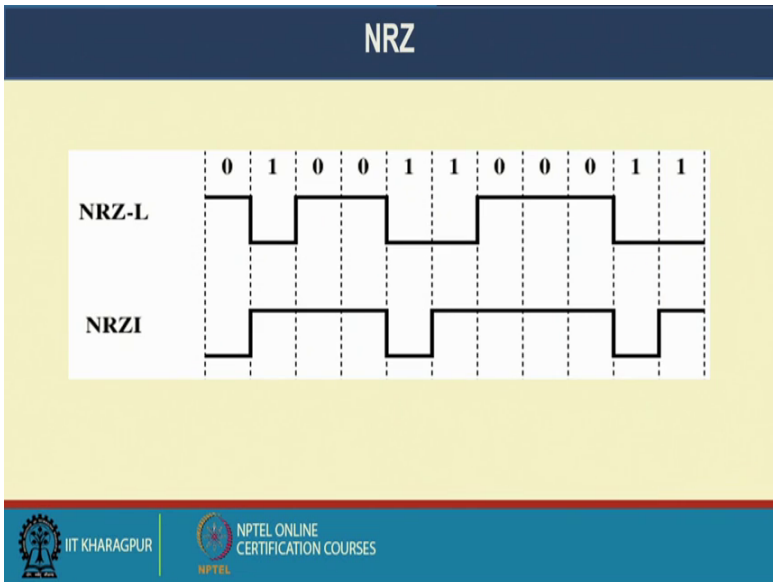

So, this is the NRZ as you can see that it is 0 is high, 1 is low. Here also 0 is high 1 is low and this way representation is there right. So, there is a plain thing N R Z I is a variant of the things, if you look at the Manchester encoding on the other hand like Manchester what you say that 0 transmission from high to low at the middle of the interval, in case of 1 transmission from low to high at the middle of the integral.

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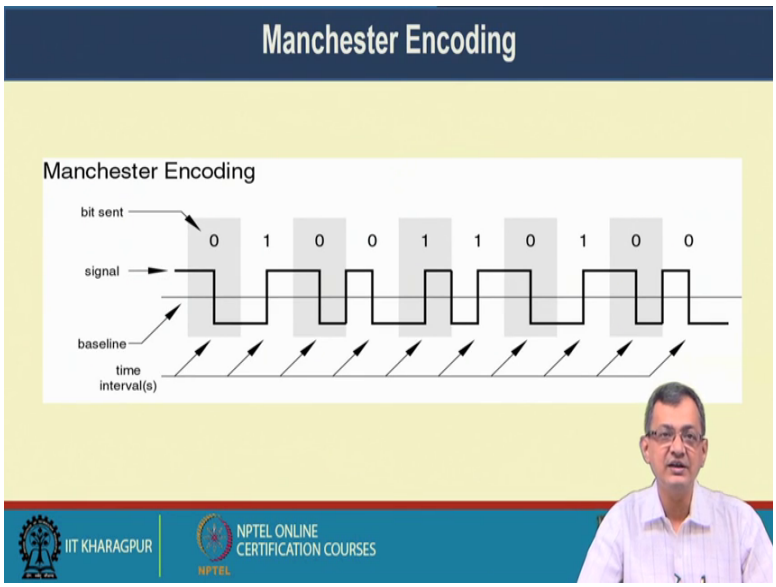

So, you see that at in case of 0 in the middle of the interval it is high to low and in case of 1 again it is low to high and it goes on like this right.

So, what we see in the middle of the interval is not at the fringe where the data may be something degraded it the; so, that we can have this encoding scheme where the at the middle of the interval.

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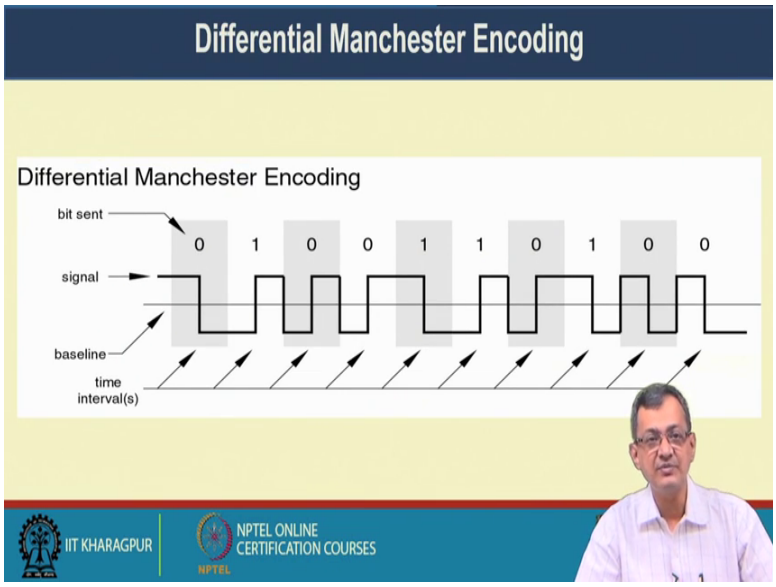

So, variant of differential Manchester, it always there is a transition in the middle of the interval along with there is some consideration. Like always a transition in the middle of the interval 0 transition from at the beginning of the interval and 1 no transmission at the beginning of the interval.

So, there is always transition at the middle and 0 and at the middle at the beginning and for one there is no transmission. See by this what we are trying to do we have a better representation of these, signal which is less prone to error less prone to degradation and typo and faithfully construction of the things easily identified by the receiver so and so forth. So, there are few more scrambling techniques etcetera said which are there in this particular encoding techniques.

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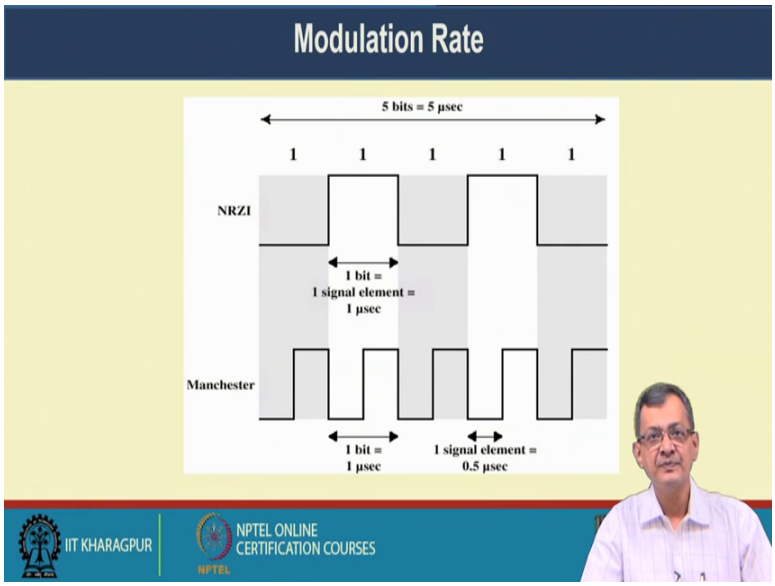

So, differential Manchester encoding, and as we have seen that modulation rate one bit one signal type of things. So, we can have different models and rate for different type of encoding things right. So, we with more complex encoding we have a better modulation rate, but what is more difficult in this type of cases. Now here we the your circuitry will be complex right.

So, if you use only 0 and 1 that is one thing, but if you want to detect the transition not only that you need to transit at the middle of the things or at the beginning of the things your circuit becomes more complex. So, that your electronics part becomes more complex never the let us you get more advantage out of it.

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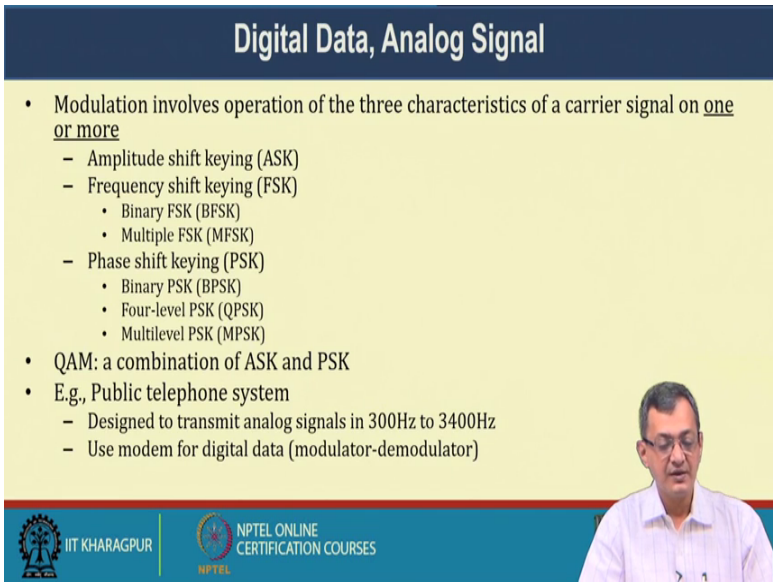

Digital data analog signal so modulation involves operation of 3 characteristic of signal into one or more like what we say; there is amplitude shift key frequency shift key. So, there are 2 variant the most that popular one is that; binary FSK. So and other one is multiple F S K and then we have the phase shift keying that is on the phase.

So, one is on the based on the amplitude another on the frequency another on the phase right. And there is a another thing or QAM which is combination of ASK and FSK, like what we see that public telephonic system design to transmit a data from 300 hertz to 3400 hertz right.

So, use modem digital modulator or this to put the signal on a higher thing because those will be highly degraded right 300 hertz to 3400 hertz. This type or this frequency bandwidth low frequency band would be high deteriorated or the there will be fall in S N R. So, we can modulate the data into higher things.

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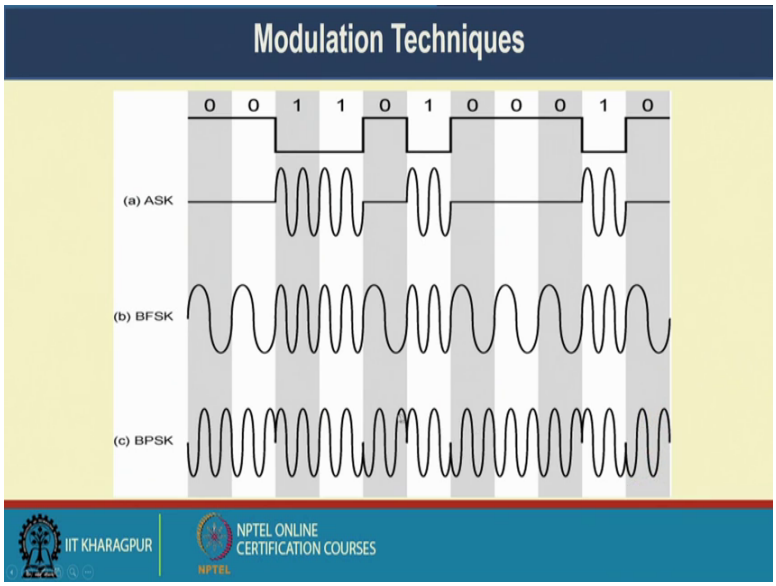

So, if we look at if we this is my data that 0 0 1 1 0 1 0 0; so it is 0 is represented by high and 1 is represented by 0 voltage. And if it is ASK so, what we say it is a 0 frequency is sorry the amplitude is 0 for 0 and amplitude is 1 a particular value for when the data is 1.

So, we see that it is like this ASK is transmitted like this right. This is easy to implement, but on the other sense other end. So, so long you have this type of flat signals or what we say DC signal. It is difficult to maintain those things right difficult to maintain those things over a media or difficult to identify, where things are there where how many 0s and 1s type of things are there.

Variant of or the other part is when we do a frequency division multiplication key or frequency shift key or to be more specific binary shift key; that means, we are using 2 frequency, 1 for 0 and 1 like if you see here is 1 for 0 a particular frequency f 1 another frequency f 2 for 1 and go so and so forth right. So, this is based on the frequency shift key or FSK right.

So, first one is the ASK where the amplitude of the things are considered here the frequency and the finally, we have a PSK or phase shift key more importantly what we say; here B P S K means there are 2 phases are used, like if you in this case one phase for the 0 next phase for the 1 right and again for the 0 and 1 and so and so forth. This is based on the phase of the thing the phase of the signal is considered or 2 phases are

considered for doing that. So, which are 180 degree apart so the sorry, 90 degree apart so that you have 2 distinct things so there is there.

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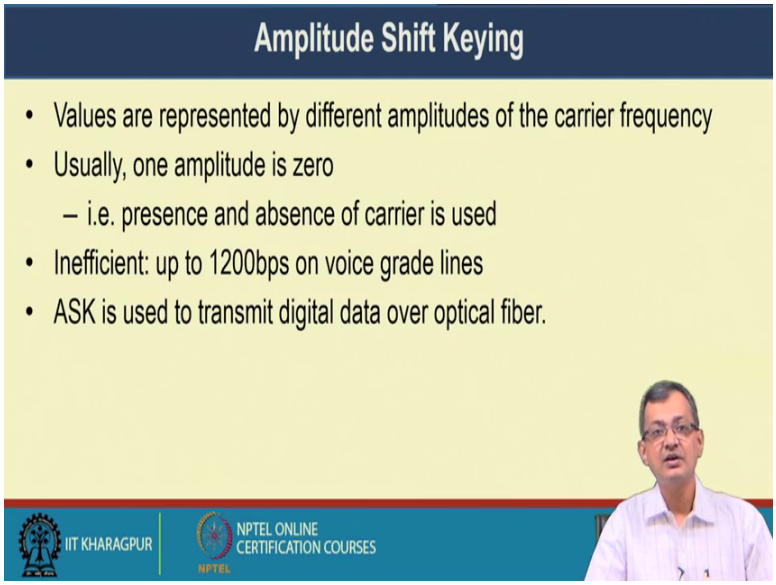

So, what we see that amplitude shift keying values are represented by different amplitude of the carrier frequency usually 1 amplitude is 0 in the presence and absence of the things inefficient, up to 1200 bps on voice grade signal is possible. And ASK is used to transmit digital data over optical fiber.

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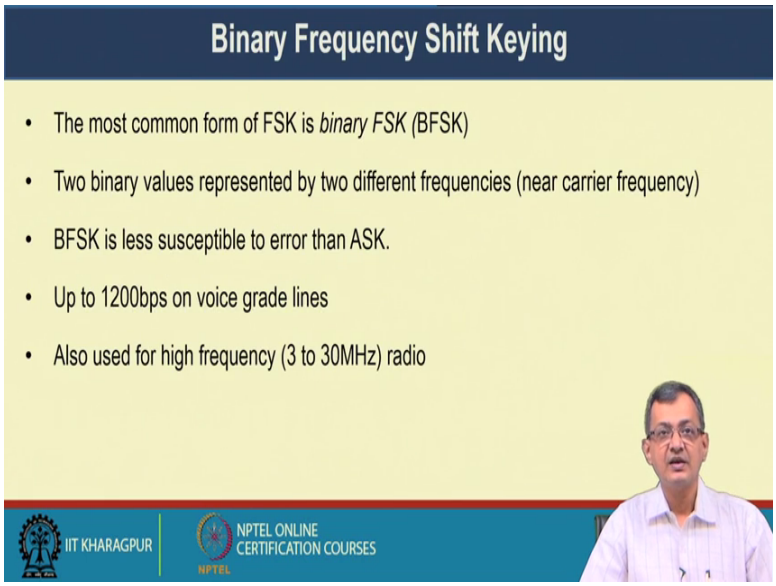

Binary frequency shift keying the most common form of FSK is a binary FSK or BFSK. 2 binary value represented by 2 different frequency, near the carrier frequencies right. So, that instead of one you have we have 2 things.

Now, carrier frequency is important because the carrier frequency is decided based on the frequency range of the channel which can which it can faithfully transmit right. So, 2 frequencies are selected, near the carrier frequency what we expect that the various signs are able to these 2 are also able to faithfully transmitted along then region.

So, BFSK is less susceptible to error than ASK and up to 1200 bps voice grade line also use for high frequency to 3 to 3 megahertz radio things right. So, it is less susceptible to error than ASK that amplitude shift keying.

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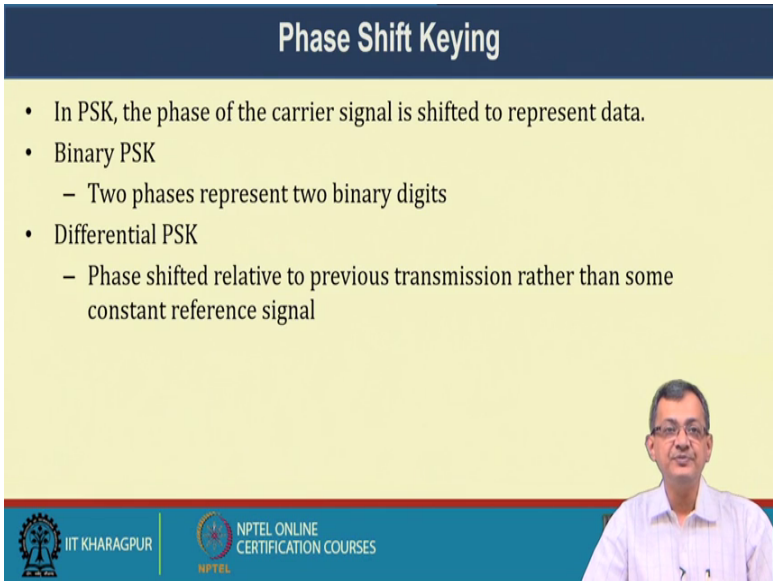

And phase shift keying the phase of the carrier signal is shifted to represent the data alright. So, binary PSK that is binary phase shifting keying 2 phase represent 2 binary digits, right, differential PSK. So, phase shifted relative to the previous transmission rather than some constant reference signal right.

So, it is based on the previous transmission the phase is shifted rather than following a constant reference signal to do them. So, there are the 3 predominant techniques.

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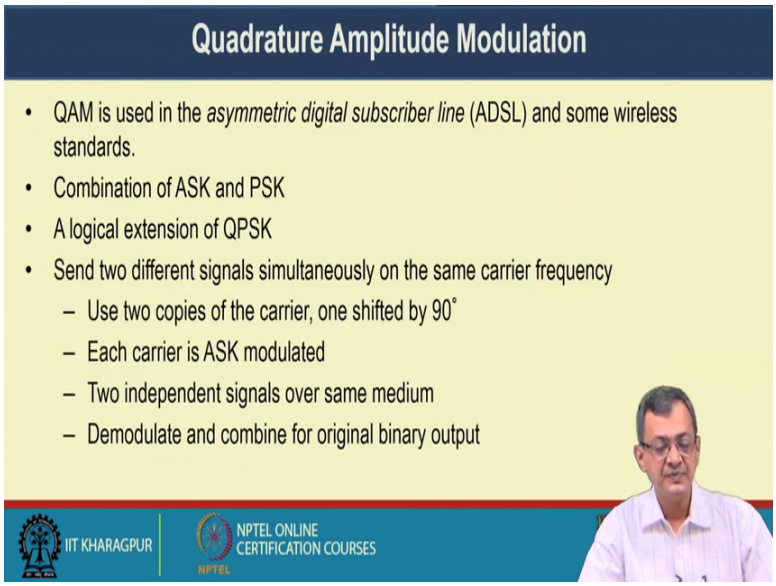

There is a another technique which is called QAM, that is quadrature amplitude modulation right or QAM which is a mix of ASK and PSK. And this QAM is used for asymmetric digital subscriber ADSL or some incase of some wireless standards right.

So, combination of A S K and P S K, logical extension of QPSK, that quadrature PSK. So, this amplitude mixed with the quadrature PSK, send 2 different signals simultaneously on the same career right use 2 copies of the carrier once shifted by 90 degree. To independent each carrier is ASK modulated alright, to independent signal over the same medium demodulation and combination of the binary things.

So, if I have 2 binary things then I can have totally 180 degree apart as I was mentioning that 90 degree. So, it should be out of phase that is one 80 degree apart, where as in this case we have a quadrature like 90 degree apart right. So, quadrature QPSK, so it is career modulated by thing. So, I can have independent of the amplitude I can have either 2 or quadrature 4 in the PSK type of things like, 4 type of 4 phases out of this within that signal length. So, I can have multiple level of thing so to say right.

So, 2 independent single can be same medium modulated and combination if the binary origin and binary output.

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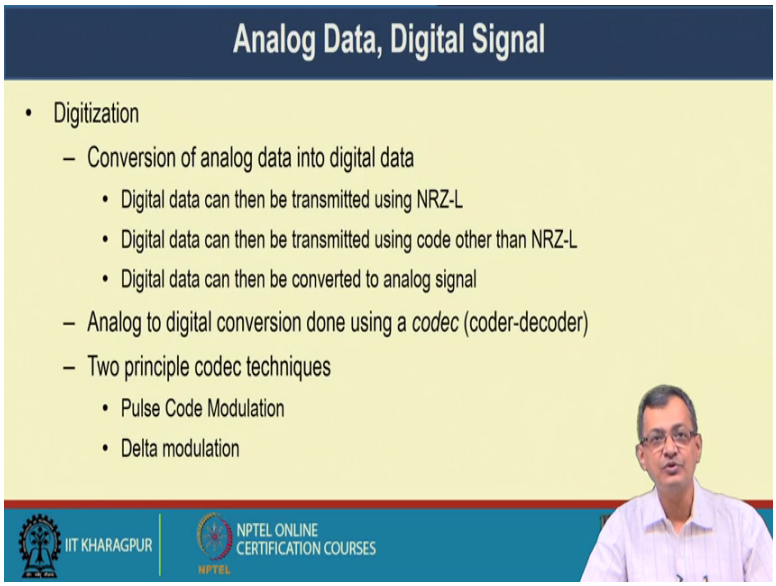

So, these are these are the some of the techniques where we have those these sets of things, where we have this digital data analog signal conversion; with the things and primarily looking at different these are the prominent ASK, BPFSK and BPSK or binary frequency 2 frequency 2 level of amplitude here, we have 2 signal at 180 degree apart.

And then we can have a quadrature FSK along with that quadrature PSK, and along with the ASK to have a QAM which is pretty popular and we can have multi-level of transmission.

And we have finally, not finally, that analog data to digital signal there is another conversion that is the analog digital signal. So, it is a process of digitization I have analog data I want to digitize that signal right. So, that data can be transmitted using conversion to analog data to a digital data and data can be transmitted using NRZL, data digital data can be transmitted using other than NRZL and so and so forth.

Analog to digital conversion is using some a concept called codec coder and an decoder. So, what we say codec there are 2 principal codec one is pulse code modulation and delta modulation again core communication techniques those who are from the communication background have studied this so there is 2 techniques to convert.

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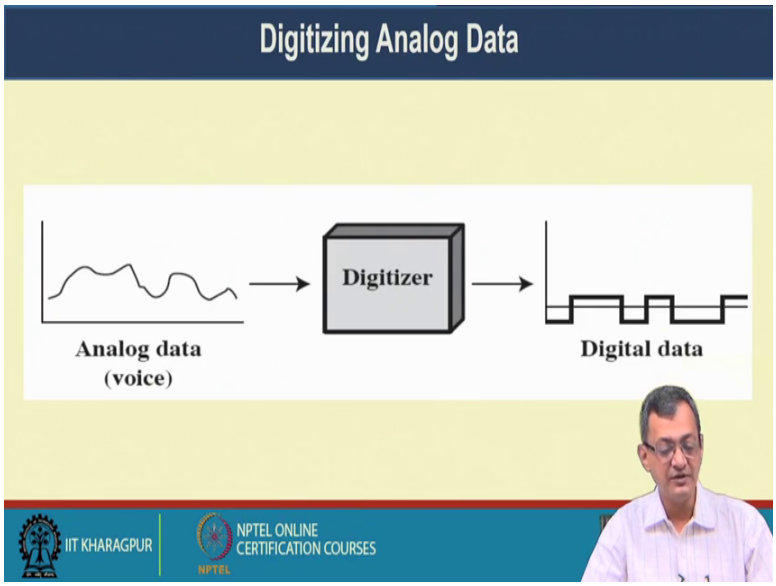

So, I have a analog signal digital digitizer and a digital signal.

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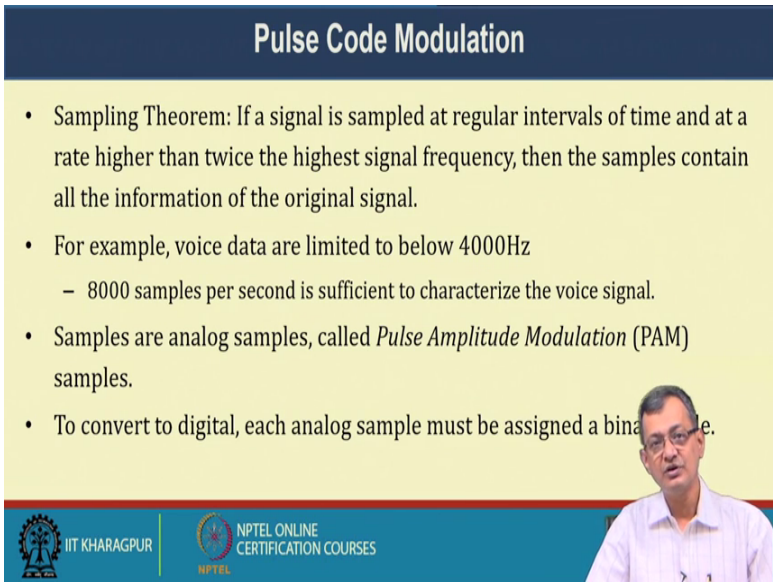

So, in the PCM it is a sampling theorem if the signal is sampled at a regularly at a rate higher than twice the highest frequency, signal frequency then it can be faithfully regenerated. In other sense, if I have a voice great thing of 1000 hertz or 4 kilo hertz my sample should be somewhat the rate of the 8000 samples per second; for efficient reproduction of the voice signal right.

So, samples are analog samples called PAM samples that is pulse amplitude modulated samples. To convert to digital data analog must be assigned a binary code right. So, all analog signal that should have a binary code alright.

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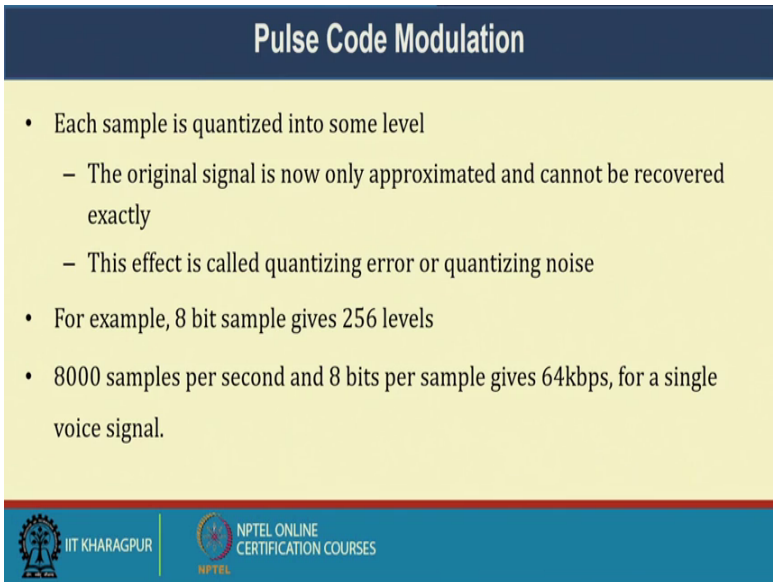

So, this is sample is quantized to some level right. So, if I have a sample like quantized in the some level. So, I may so a digitized value then I have a quantization value the original signal is now only approximated.

And cannot be recovered exactly, the effect the effect is called quantization error or quantizing noise. So, what we are doing? We have a analog signal converted to a digital signal, but the these values is going to be quantized right to be in some levels.

So, that the more finer the quantization better is the reconstruction, but there is always a challenge of that how much data load can be there. So, say for 8 bit it gives a 256 levels for 8000 samples per 8 bit we can gives a 6 kbps for a singing voice channel right. So, this is for faithful reconstruction of the things right.

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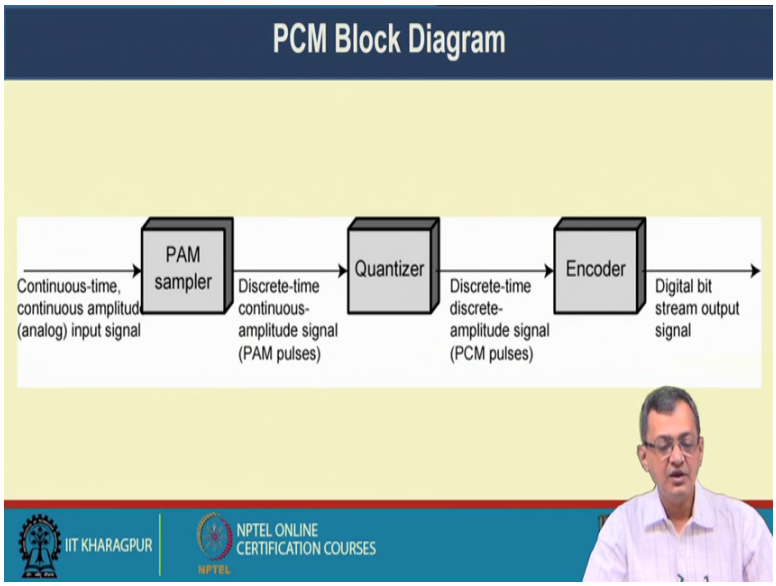

So, PCM block continuous time data is coming, so a sampler is there discrete continuous this a quantizer which quantized into 2 different PCM pulses a encoder digital bit streams out to the signal. So, this is where the analog to digital conversion is there.

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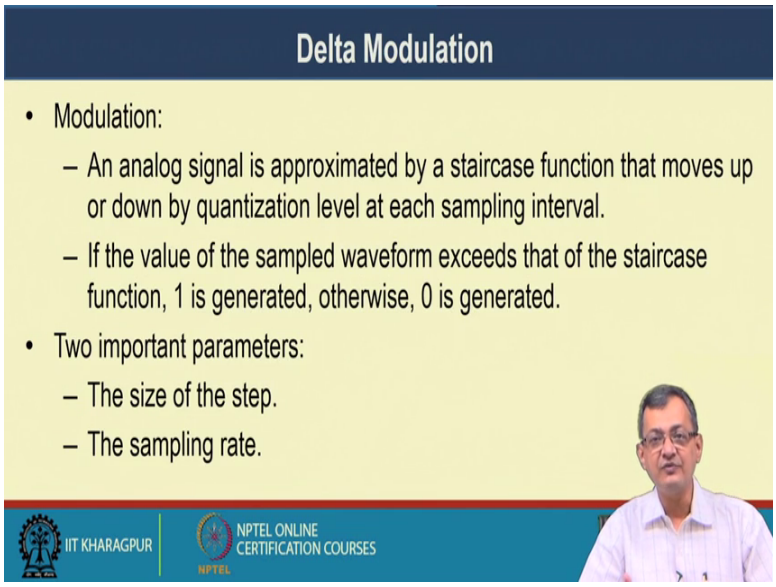

The variant of that or a another thing is a delta modulation. So, a analog signal is approximately by a staircase function that moves up or down based on the thing, based on the movement of the analog signal. If the value of the sample waveform of the

staircase one is generated otherwise 0 is this 0 is generated. So, step and the sampling rate also plays a important thing again you people are picture you see in the things.

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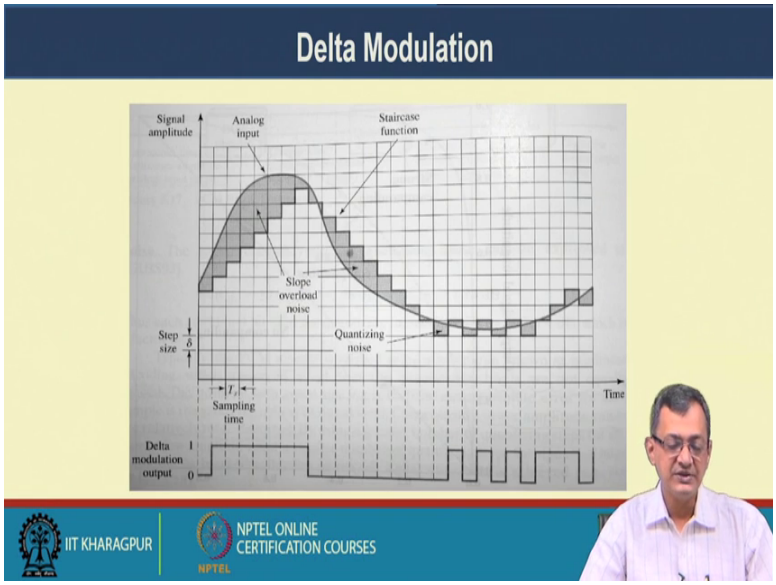

So, this is where it is follow this step or staircases. And it goes on generating this 1 and series of 0's and 1 type of things based on the staircase phenomenon. So, one it is here this is 0 to 1 and then it is 0 again, then it goes on up and down and type of things.

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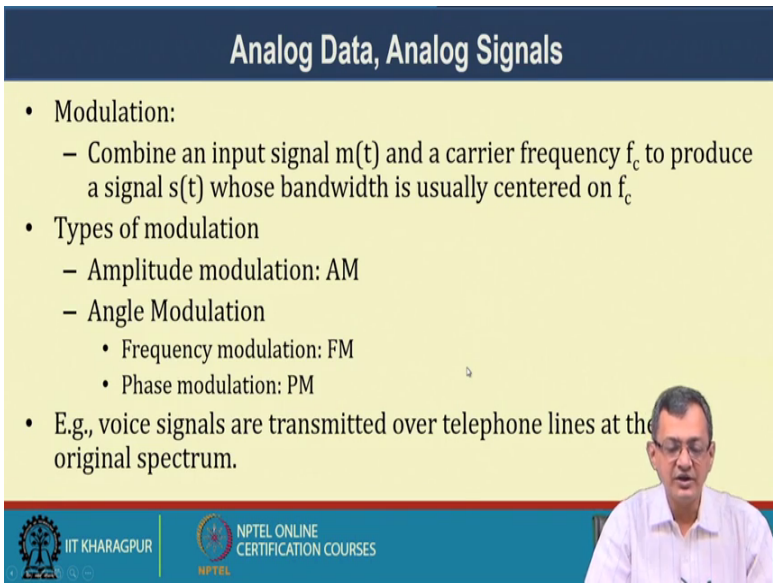

So, analog data to analog signal so modulation combining an input signal carrier frequency. To a carrier frequency they are telling that it is a modulation and what we

have. So, we have on a carrier frequency we have a carrier frequency the analog signal is the carrier frequency is modulated based on the analog signal.

So, can be amplitude modulated where the amplitude is changed, it can be frequency modulated frequency of the carrier frequency is changed and phase modulation phase for the carrier frequency is changed. Why carrier frequency because we want to use the range of allowed frequency on the things right.

And the usually the your normal data may be very low frequency data in a low range which is which may not be faithfully transmitted to the transmission medium or prone to several attenuation effects.

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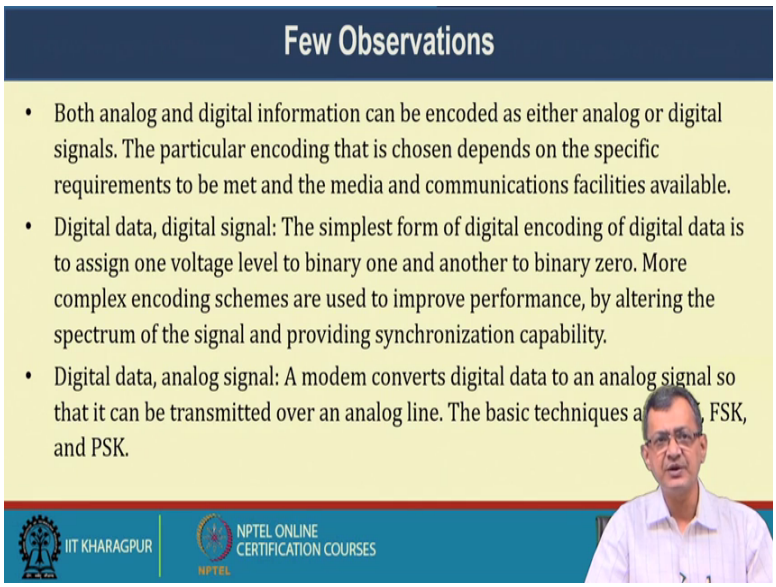

So, what we see few observations both analog digital form can be encoded either analog or digital signal. The particular encoding is chosen for the specific purpose, then we have seen the digital data digital signal we have looked into digital data analog signal, analog data digital signal, analog data and analog signal.

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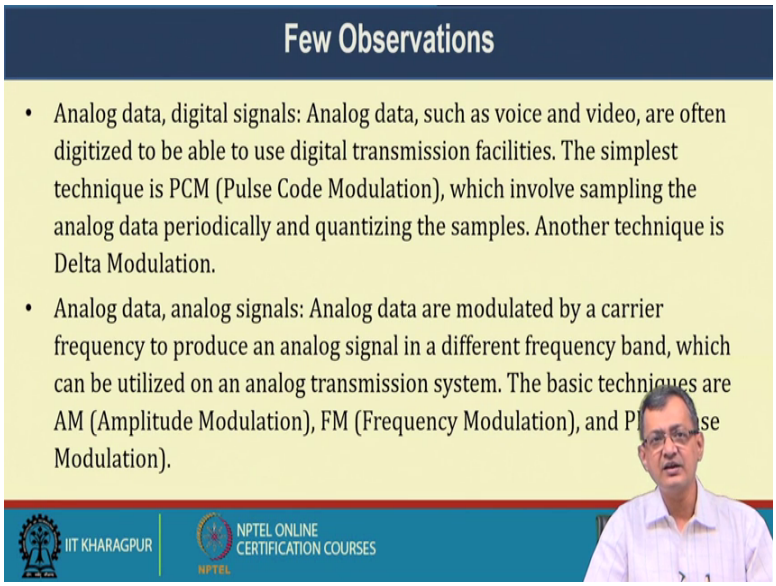

So, these are the different variants of these are the different possibilities. And as I mentioned these are code communication what we are looking and is more overview, if you those who are interested can go deep into the any standard communication book or literature.

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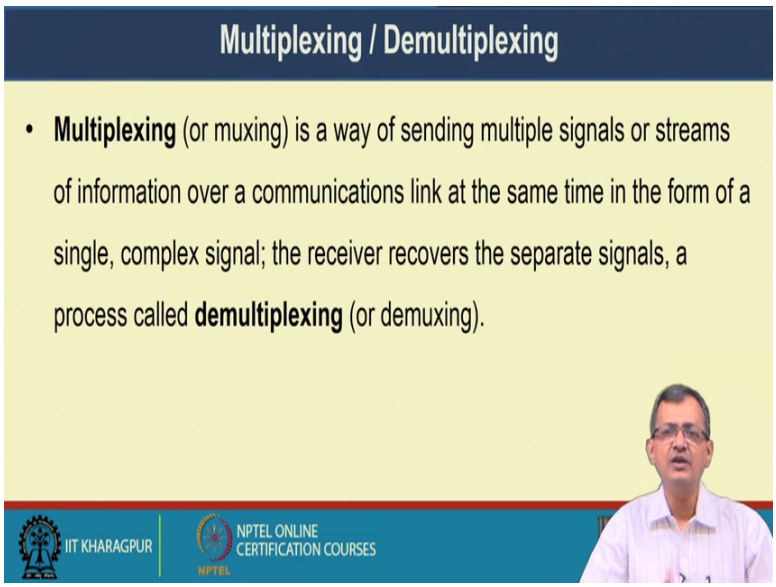

Other part what we thought that you are mentioning is the multiplexing and the demultiplexing. So, is a way of sending multiple signal or stream of information over

communication link in the same time in a form of a single complex signal and Demuxing the reverse of the things.

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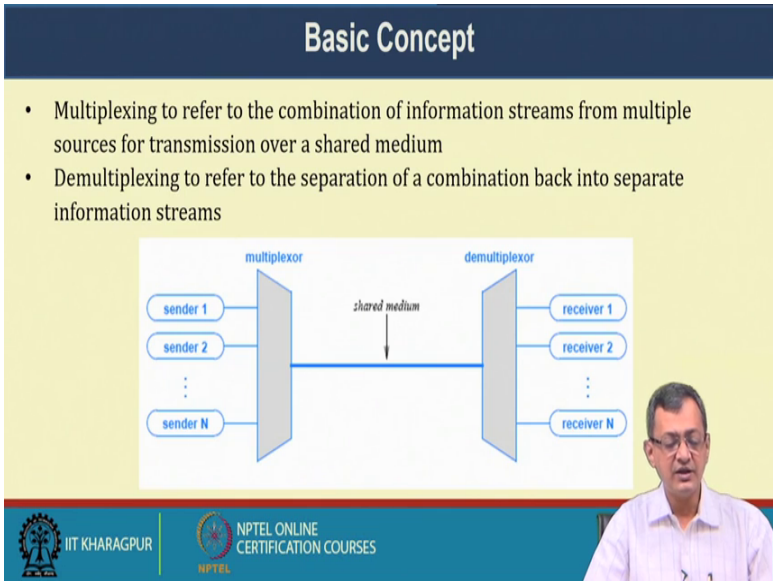

In most of the cases what happened I need there is several signal that need to be pumped through a S N R medium. So, there is a need of multiplexing the signal and sending the things and demux at the other end right. So, provided this signal is able to carry the things or in another sense if I say; like it for say covendensing say I have different type of different carrier frequencies.

And things are being say modulated at different carrier frequency and pumped to the things and I extract every a carrier frequency and extract the data out of things. So, that if the channel capacity is there then I can multiplex the data into the things right this is a frequency division.

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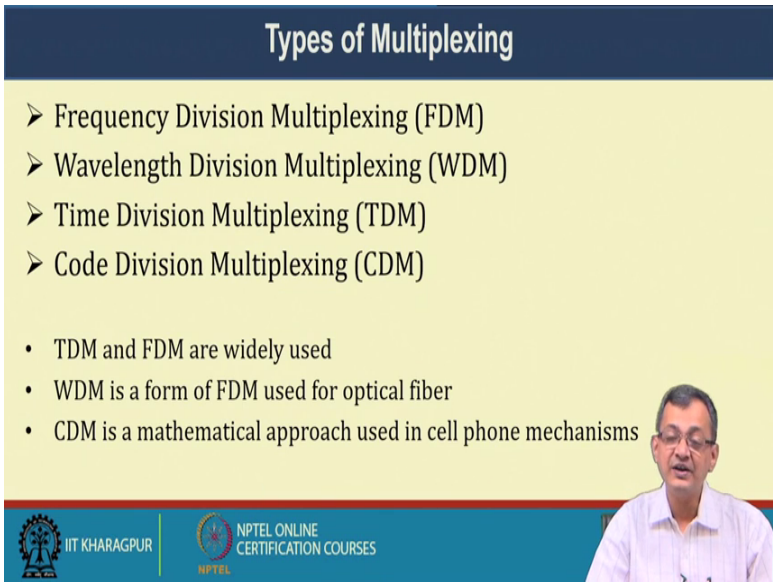

I can have different type of like that multiplexing Frequency division multiplexing is one of the popular thing. Wavelength division multiplexing is sort of a frequency the philosophy is same, but at the wavelength level. Other than other 2 a Time division multiplexing and Code division multiplexing right; TDM and FDM are widely used. WDM is a form of FDM used for optic in optical purpose where the wavelength is important CDM is a mathematical approach for cell thing so it is encoded.

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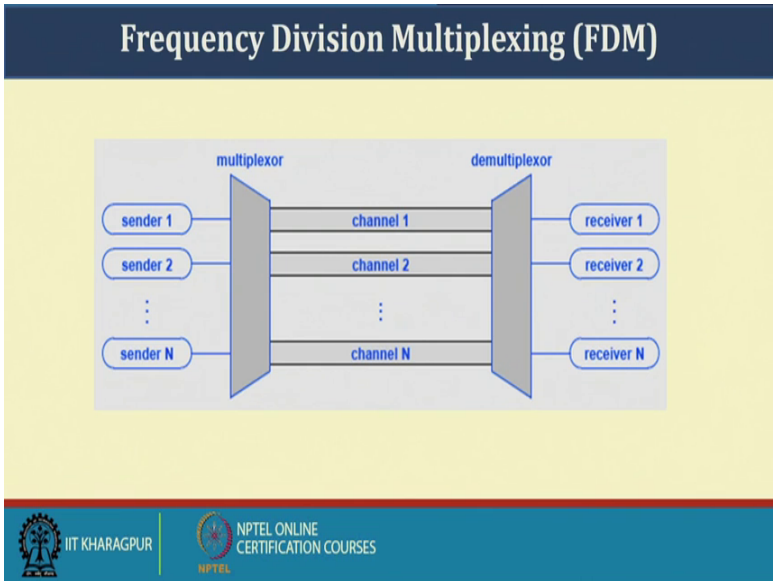

So, frequency as I mentioned there are different channel or so to say different carrier frequency which are thing. So, these are different channels what I have separate channel. I can plus them into different carrier frequency and carry and the receiver does that.

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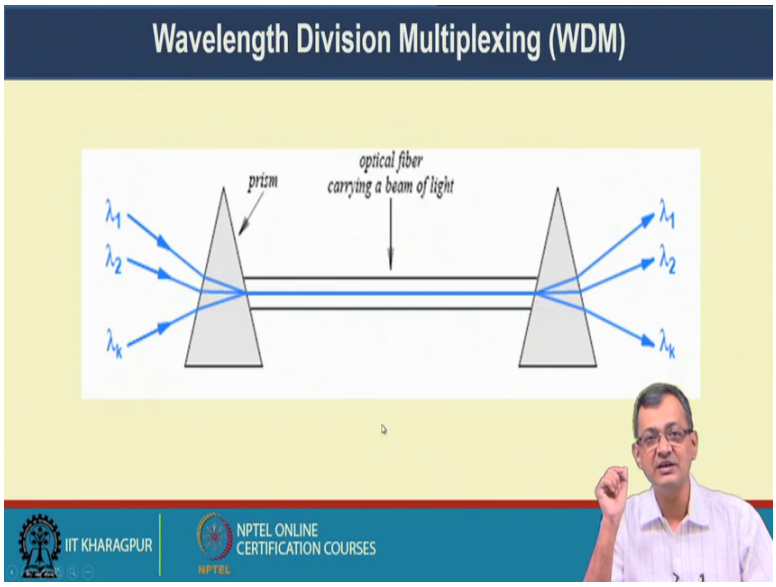

In case of WDM, it is same the conceptually same instead of different frequency we are using different wavelength.

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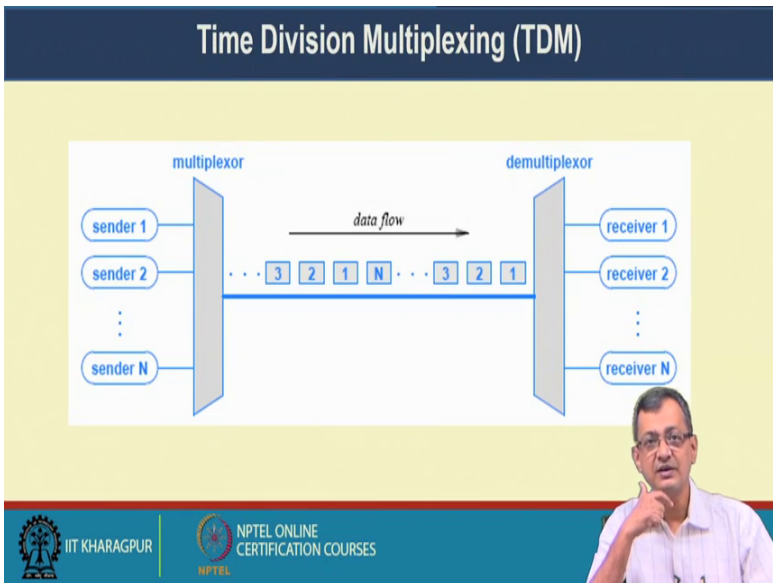

In time division multiplexing we have different sender and the data flow time slots are given and the every data is this time slot 1 2 3 4 and type of things.

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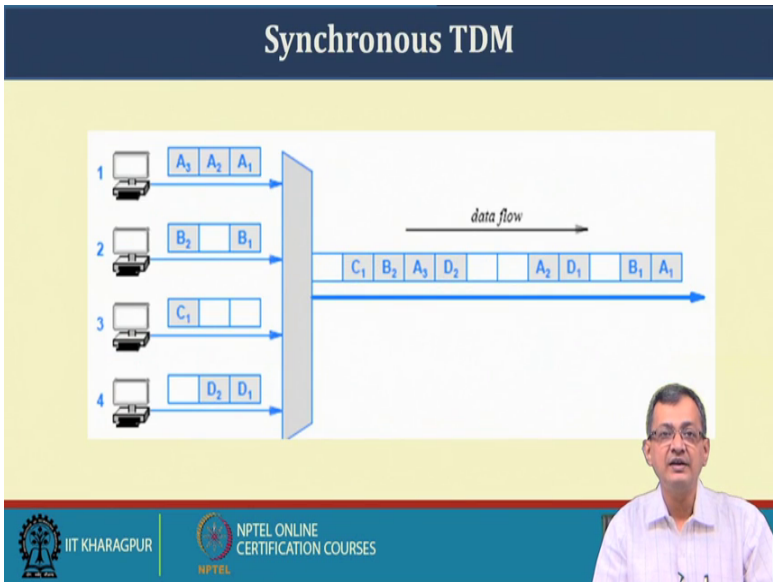

And there is a concept of synchronous TDM, where even that every time slot for every station like this is no data C 1 C 2 A 3 D 2 then no data no data A 3 and like that. So, every fixed time slot that is synchronous easy to detect and type of at the other end.

Where are you have statistical TDM what we send where the data is there. So, it is more better utilization is a easy lot of blank data or underutilized data sets will be there, but in this case we have a more compact representation. And that helps us in better utilization of the chair length so, that is a statistical TDM time variation multiplexing.

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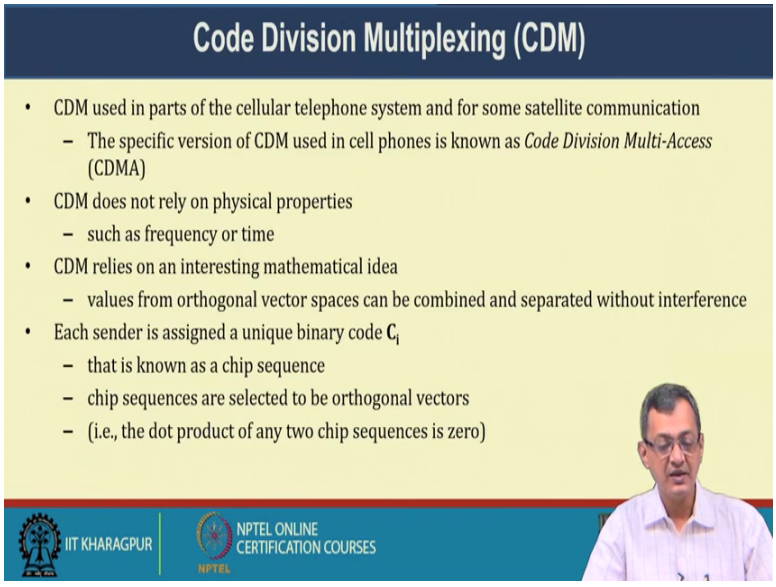

And there is a concept of code division multiplexing it is a more mathematically formulation; that means, a code is generated which is which we called a chip, which is encoded based on the code which is decoded at the things it is more used in our mobile technology.

So, used in the part of the cell telephone system and some satellite communication specific version of CDM is called say used in CDMA in cell phone, called code division multiple access or CDMA technique. CDMA technique does not rely on physical properties such as frequency or time CDMA relies on a mathematical idea value for the orthogonal vectors of the things; like if you see that if the each sender is assigned to a unique code or sometimes called chip is C 1.

So, there is a known cheap sequence for when you every sender is assigned a chip right. So, these are orthogonal vectors and; that means, that their dot product will be 0; that means, that the other end as we know, the this chip sequence that can be extracted. So, this is a very interesting phenomenon that handling 3 handling the different data set with orthogonal binary code sequences right. So, that is exploited in the in case of in for code division multiplexing or CDMA technique.

So, what we try to see today is that different type of encoding modulation and multiplexing techniques which helps in faithful communication or of the data through these communication channel right. So, though again I mention though is a communication related phenomenon, but it is we tried to have a overview of the what are the different aspects which are there. So, with these let us conclude our discussion today.

Thank you.