Principles of Communication Systems - Part II

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Lecture - 01
Introduction to Digital Communication Systems

Hello, welcome to another module in this massive of and online course. So, in this module let us start looking at digital communication system. So, this will introduce you to the typical structure; alright, the typical working of a digital communication system.

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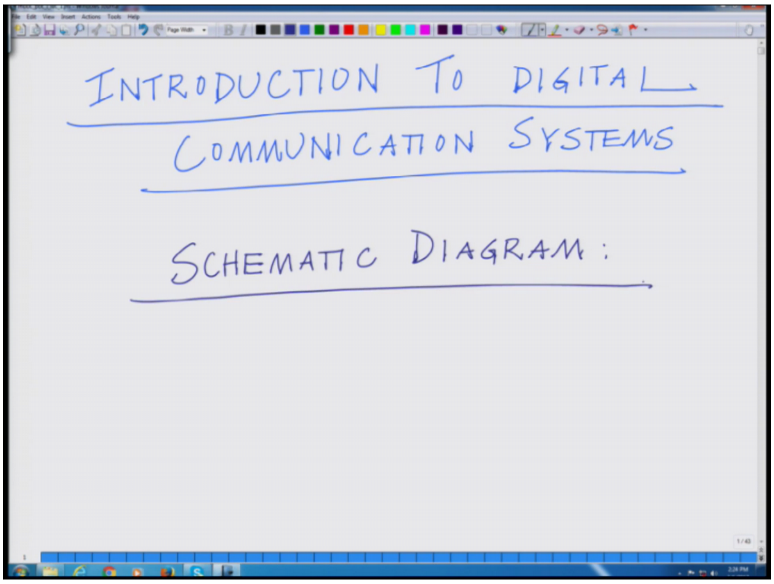

So, this module will focus on an introduction to digital communications systems and if you look at typical digital communication system; let us look at schematic for a digital typical communication system; a schematic diagram of a digital communication system a schematic diagram of a digital communication system will be as follows.

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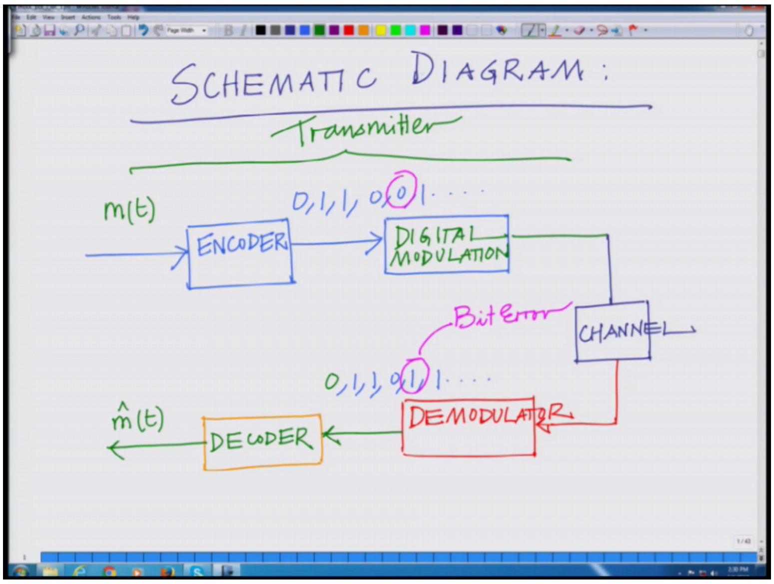

I have message signal that I want to communicate m t; typical analogs is signal you simply modulated and transmute this message signal empty; however, and digital communication system, the process is very elaborate first it has to go it is passed through an encoder, now what the encoder does is basically the encoder converts the message into a stream of bits. So, the encoder confer instance we have a stream of bits such as 0, 1, 1, 0, 0, 1.

So, what the encoder is doing is taking your message and it is converting into the stream of bits and you might have seen in previous modules, this is the archive through the first sampling followed by quantization of the samples, alright and representing the quantize samples, alright, using an appropriate each sample can be represented using in appropriate number of bits alright. So, sampling followed by quantize that is quantizer the sampling followed by the quantizer converts this and followed by this encoding operation converts the message signal and analog message signal empty it was stream of digital information bits that is the combination of binary information symbol 0s and 1s.

Now, this stream of bits from the encoder is passed through a modulation that is a digital modulation scheme. So, this is given as input to a digital modulations scheme which is pass through the; which is pass through a channel. So, this is then subsequently pass through a subsequently pass through a channel or let me write at this way this passes through a channel the channel can be various type it can be a wire line channel get be up to state pair or can be a coaxial cable it can be also be a wireless channel that is it can be a radio channel we will look at some this different channel types pass through channel and the output is then pass through a demodulators.

So, we have modulation operation and at the receiver we have a demodulator. So, we have a modulator the received information bits a demodulated followed by of course, you have to pass through a. So, at this point now you have the demodulated bits. So, basically you have 0, 1, 1, 0, 1, 1, now notice that purposefully I have return a different set of bits for instance if you look at here all right the fifth bit here if you can get closely observer the fifth bit here is a 0, but the fifth bit here is a 1 and this is a very important point the demodulated stream of the bits need not be exactly equal to the transmitted stream of the bits or the modulated stream of bits alright this arises from bit error and the receiver.

So, this is one of the important challenges in communication, correct. So, there are bit errors that arise during the demodulation process alright and naturally alright naturally it is desire able to have as few bit errors has possible that is to lower or minimize the probability of bit error infect probability bit error that is the probability with which a received bit is in error is a very impotent metric to characterized the performance of communication system which we look at in feature modules, alright. So, this something to this is something to keep in mind right the demodulator stream of bits is not exactly equal to the modulator stream of its and this arises due to various factors for instant such as the noise at the receiver the feeding wire the feeding channel if the channel is wireless channel and. So, on at this is basically termed as a bit error this is followed by your decoder.

So, you have the stream of bits followed by decoder basically in which in the decoder you can you can basically converts the bits to your and followed by appropriate suitable. So, this is followed by decoder and this gives you your estimated signal m hat t communication signal m hat t and if you notice this chain corresponds to you are transmitter the top portion that is a all the operation before the channel and the bottom portion this corresponds to the operation at the receiver.

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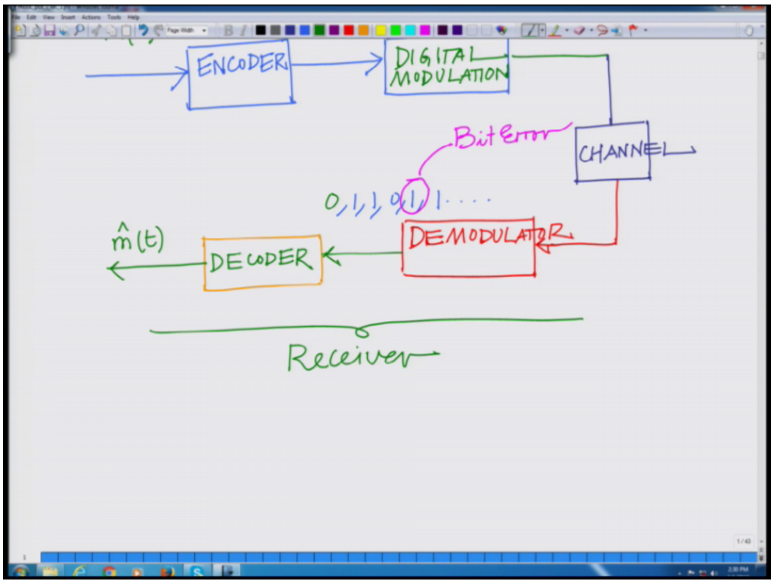

Then naturally goes without saying because operations are the transmitter performed the transmitter modulated by a carrier frequency. So, the signal is encoded convert to swim of bits digitally modulated followed by multiplied by carrier signal than its add the transmitter then its transmitter over the channel at the receiver its down converted followed by demodulated, alright and followed by decoding of the demodulated information bits roughly these are operation that take place, so the transmitter and receiver in a typical digital communication system.

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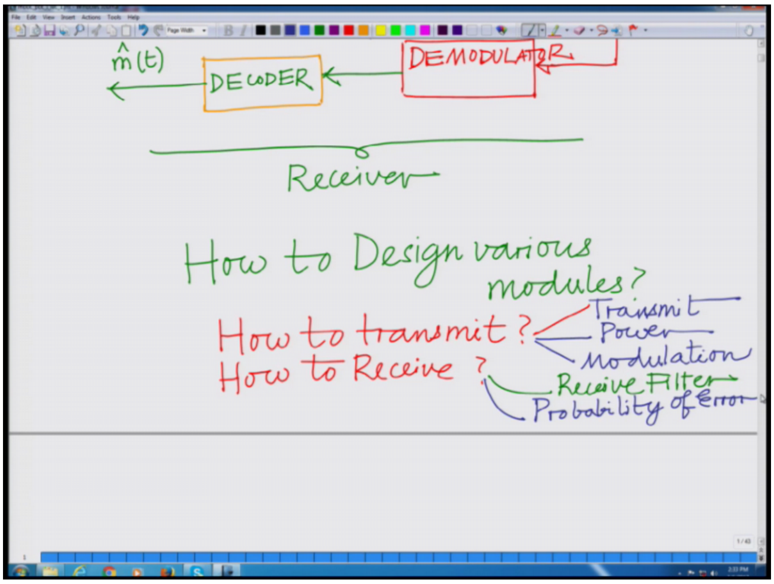

Now, the key top parts of the theory digital communications systems is basically how to design the various module how to design how to design the various the module namely how to transmit what is the optimal transmit processing how to receive for instants what is the optimal filtering operation that can be employed in the transmitter what is the optimal modulation that can be employed the transmitter.

What are the modulation schemes for a instant when you look at transmission? One think you look at is transmit filter what is energy or power of the transmit signal what about the digital modulation schemes and at the receiver also we can look at what are the receive filters for instants what is the optimal if your familiar with a communications system how to design a filter such that the signal power is maximize noise power is minimize. So, that the signal to noise power ratio is maximized what is the proper performance of the different modulation schemes for instance what is the probability of error associated with the modulation schemes which characterizes the ultimate performance.

So, probability of error associated by the different these are the various issues. So, there are several issues right which we are going to look at through the various modules at some these are basically how to desire in the different modules in the transmitter how to design different module and the receiver and what is the overall performance how do you characterized the overall performance of this communications system for the various purpose for the various depending on the various modules that have been design and cooperated for various purposes and that is the main aim of this courses look at the overall working of digital communication system and design these modules efficiently and also study their performance.

Now, how to transmit signal? So, in a digital communication signal, the transmitted signal corresponds to a series of symbols.

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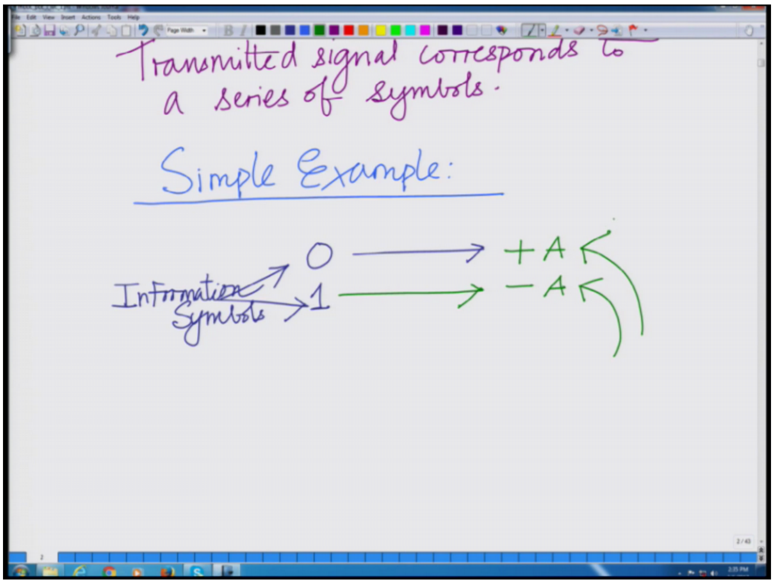

So, naturally the transmitted the transmitted signal corresponds to a series of symbols for example, let us take a simple example to start quick let us take a simple example let us see we take the information symbol 0 we map it. So, this is your infer these are your information we have 2 information; information symbol 0; the binary information symbol information symbol 0 and information symbol 1. So, these are your information symbol 0l information symbol 1; this can be mapped now we have to transmission or channel we have to map to physical signal. So, we have to map it to some voltage levels. So, let us say this is map to the level minus A this is the map to the level. So, 0 is mapped to the level plus A and 1 is map to the level minus A.

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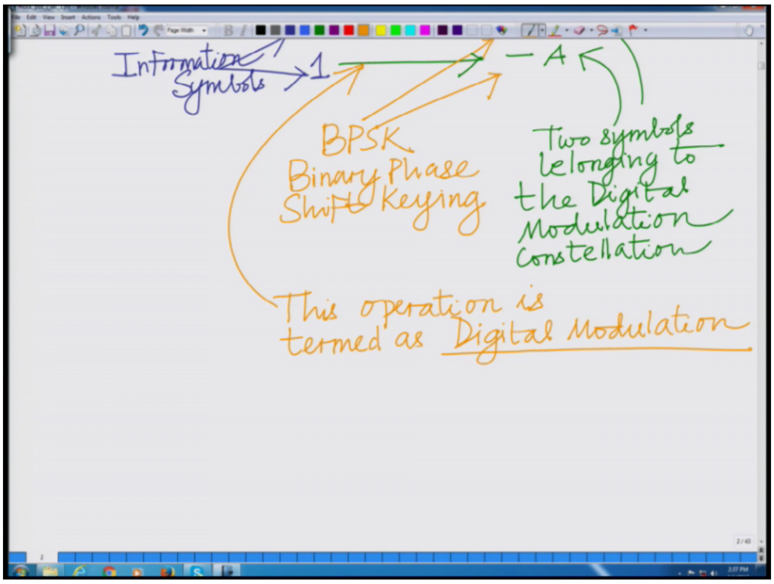

So, let us say these are 2 symbol belonging to the digital constellation these are 2 voltage levels or let us say these are 2 symbols belonging to the to the; to symbol belonging to the digital modulation or this is also known as constellation.

So, naturally we have binary information symbols these have to be mapped to a set of digital modulation alright a symbol belonging to a digital modulation constellation in this particular case the mapping is the very simple 0 to map to minus A 1 is map to the voltage level plus A, alright. So, there are 2 different voltage level minus A plus A and minus A and both of them are opposite in phase, alright. So, one as phase 0 the other as phase 180 degree alright plus A and minus A, alright, so therefore, this constellation which correct comprise of this to symbols plus A and minus A which are different in the phase right one of the phase amplitude of the both of them is same that is a the phase of one is 0, the phase of other is 180 degree.

So, we have to 2 different phase, alright. So, binary phase constellation; so, this is known as the binary phase shift key in constellation which one of the simplest constellations we will look at the several others as we proceed through the various modules. So, this constellation is term as BPSK that is your; that is your binary phase shift key symbol constellation and therefore, this is a mapping, alright. So, we are mapping to a binary phase shift key constellation and this operation is termed as basically this is nothing, but a modulation this operation is A; this mapping this operation is termed as operation or rather digital modulation.

Although conventionally we can simple call simply call it as modulation this is basically more space basically this is digital modulation we are basically mapping the information bits information symbol binary information bits to symbol belong into a digital constellation.

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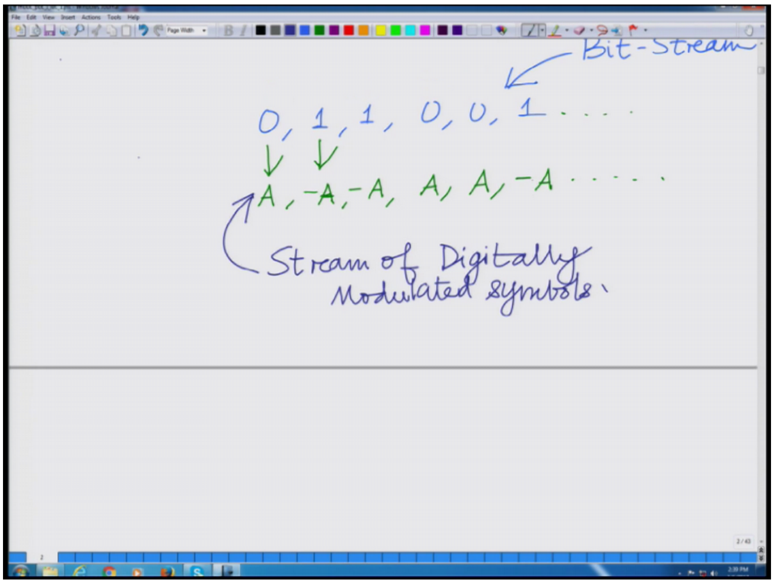

So, now let us look at again or example below let we have this digital information bits stream. So, you can also call this series of digital information symbols as a bits stream. So, this is your bits stream this your bits stream and for instance 0 we are mapping to well A 1 we are mapping 2 minus A. So, we are mapping to a digital modulation stream this is a digitally modulated stream minus A minus one is map to minus A minus A 0 is map to A 0 is map to A 1 is map to minus A and so on. So, this is the stream of digitally modulated symbols this is the stream of digitally modulated symbols.

Now, how do you transmit this; obviously, we cannot just simply transmit the stream of digitally modulated symbol. So, I have to be basically transmit some signal, correct. So, I cannot simply transmit signal I cannot simply transmit voltage level I have to take the air of some signal I have to transmit it over some signal right a some physical signal that can be transmitted over the channel, alright. So, this is this signal this particular templates signal that is use to transmit the; this voltage levels of the digital modulation termed as a pulse.

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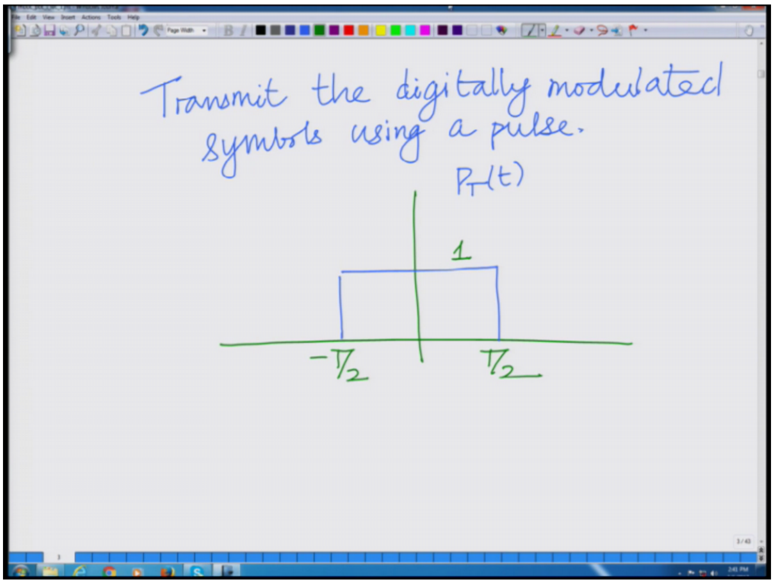

So, this particular signal is termed as a pulse how do you transmit the digital modulated symbols. So, we transmit the digitally modulated symbols using a pulse for instance a typical pulse a typical pulse can be of the form. So, this is let us say a pulse P T we are already seen an example of the pulse one of the previous modules pulse can be of height 1 from minus T by 2 to T by 2. So, capital T is the width of the pulse.

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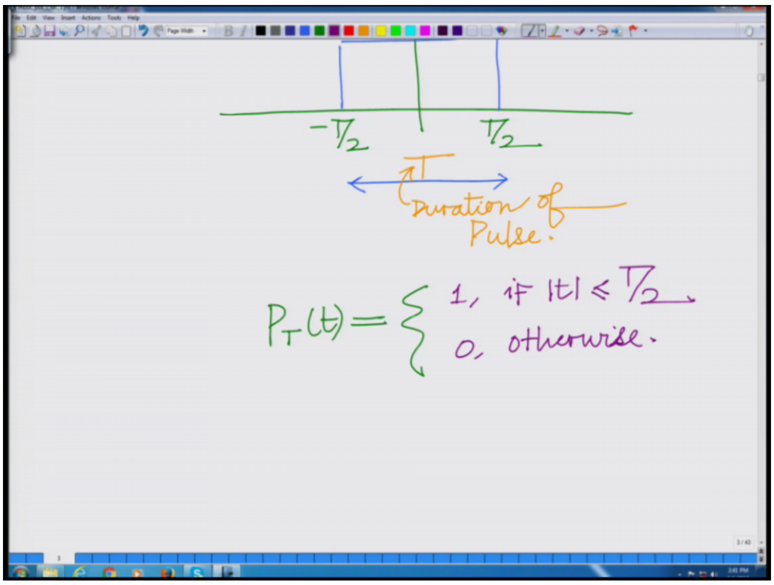

So, this is the width of the pulse or duration of pulse this is the duration of the pulse; pulse is from minus T by 2 to T by 2 this is denoted by p sub capital T of t where P sub capital T of t equals well this is equal to one if mod t less than or equal to capital T over 2 0 0 otherwise. So, this is or pulse now what we are going to do with this pulse if have to illustrated in a very simple fashion the first symbol let us say this is my time access.

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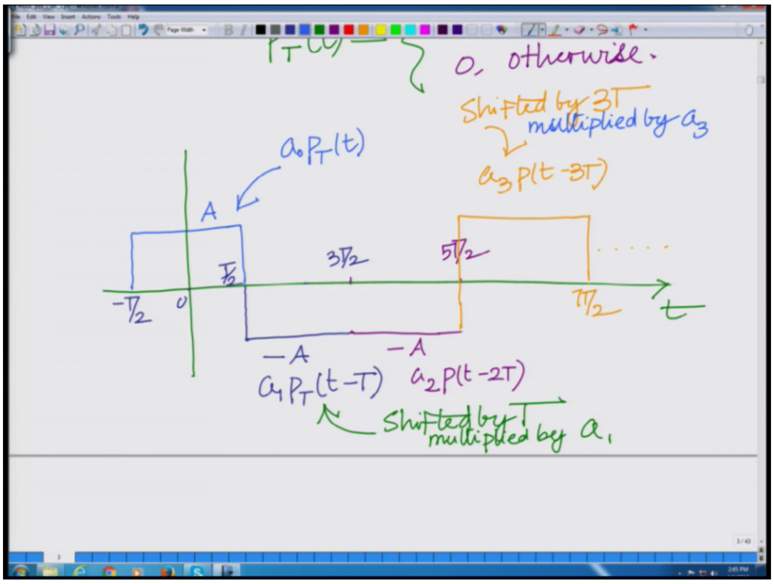

So, the first symbol is basically in a naught into. So, this is my first symbol of height A because remember the first digital modulation symbol is A. So, this is a naught into P T of t.

So, take the symbol multiplied by the pulse now the second symbol is more interesting you shift the pulse by T. So, you shift the pulse by. So, this is from minus T by 2 to T by 2 you shifted by t. So, this is at 0. So, this shifted to t. So, minus T by 2 to 2 by to 2 to 3 T by 2 that is and multiplied by. So, this level is minus A. So, shifted by t and multiplied by A 1. So, this is A 1 P T t minus t. So, shifted by T by t and multiplied by A 1 shifted by t and multiplied by A 1 second you shifted; obviously, the next one you shifted by 2 t that is therefore, this will go from well T by 2 3 T by 2 to 5 T by 2.

So, shifted by T, so this will also be since A 2 is also so shifted by 2 T multiplied by A 2. So, A 2 P T minus 2 T third symbol will naturally be shifted by 3 T and multiplied by well A 3. So, this will be 5 T by 2 to 7 T by 2. So, this will be multiplied by 7 T by 2 and infect it will go on in this fashion and this is A 3; A 3 P T minus 3 T. So, this is shifted by 3 T pulse shifted by 3 T multiplied by A 3.

So, what you are doing is corresponding to the kth pulse your shifting the pulse by k t k type is symbol duration and multiplying it by a k that is the whole idea and therefore, you are transmitting symbol digital modulations symbol after symbol right each symbol a k is transmitted in the kth duration correct. So, its is transmuting and the way you are doing it way it is done is by shifting the pulse by k t multiplying it by the or the modulating it with the digital modulations symbol that is a k P T minus k T and now the net digital digitally modulated signal alright the digital communication signal that is transmitted corresponds to basically the sum of all this shifted and multiplied pulse or shifted and modulated pulses.

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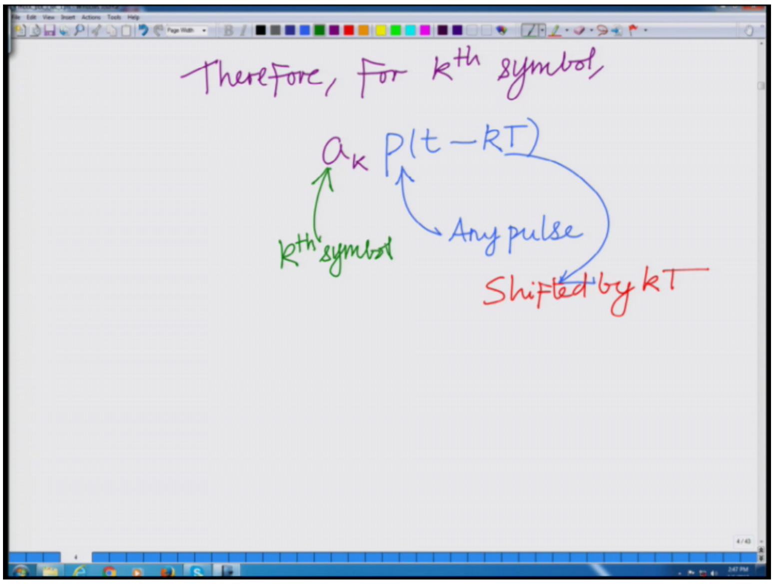

So, what we are absorbing is basically it is very simple it is therefore, for kth symbol you have a k the pulse P I am just calling it P T minus k T, their P is any pulse not necessarily P subscript T capital T. So, this is any pulse shifted by k T where T is the symbol duration and a k is a kth symbol.

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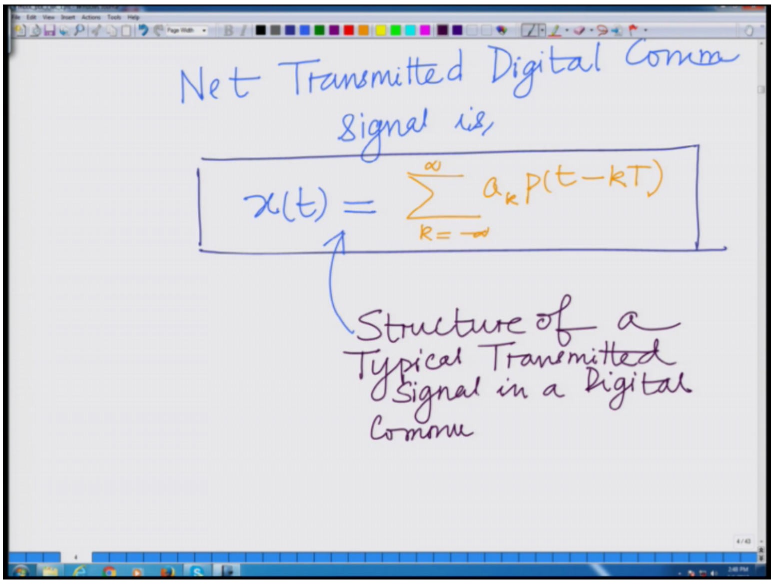

Therefore the net signal; net transmitted digitally modulated signal on net transmitted digital comm signal is you can call it x t denoted by x t; x t is basically you are summation k equal to minus infinity because you can have endless infinite stream of digital symbols P T minus k T, alright and this is going to be you are this is your typically. So, you have transmitting symbol after symbol by shifting the pulse by k times T where T is symboled capital T is a symboled duration modulating by the kth information symbol or kth digital modulation symbol that is a k, alright and the sum of this shifted modulated pulses is what constitute basically you are digitally modulated that is the transmitted signal in this digital communication system.

And therefore, this is your structure of a typical digital communication signal which is very interesting this is the structure of a typical transmitted signal in a digital transmitted signal in a digital communication systems structure of the of a typical transmitted signal in a digital communication system, alright.

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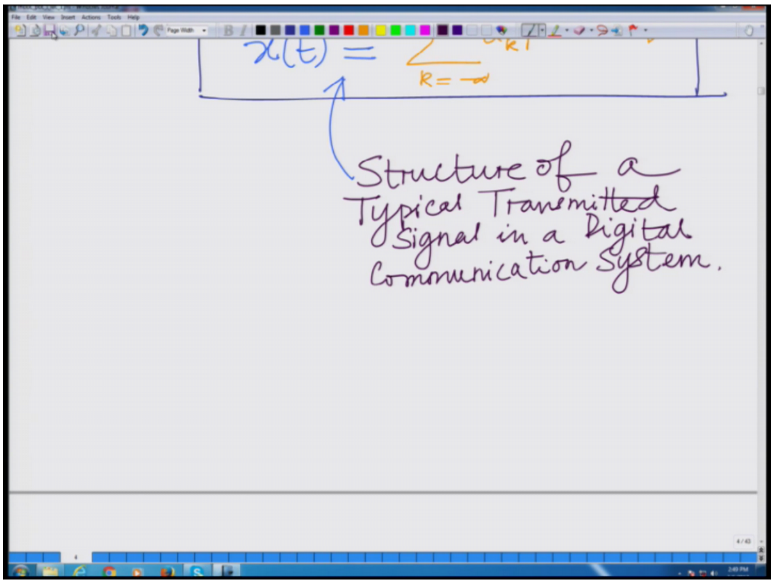

So, basically in this module we have seen a brief introduction to a digital communication system at typical schematic diagram illustrating the various components or modules at the transmitter and receiver and all also incorporating the also showing the place of the relevance of the channel in this typical schematic of a digital communication system and also we have seen overview or brief introduction to the process of mapping or modulation of the information bits to a digital modulation consultation followed by the transmitted the structure of a typical digital digitally modulated communication signal employing a pulse shaping filter, alright.

So, this P T which is basically your pulse is nothing, but a filter can be implemented as a filter. So, this is also known as pulse shipping filter, alright. So, we will stop here and look at a; look at other aspect in the subject with modules.

Thank you.