GPS Surveying
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Lecture - 03
GPS Signal (Civilian Perspective)

Friends, welcome to the third class on GPS surveying. Today's class I will discuss on GPS signal. GPS signal I will discuss under three heads carrier waves GPS pseudo random noise code and Navigational data.

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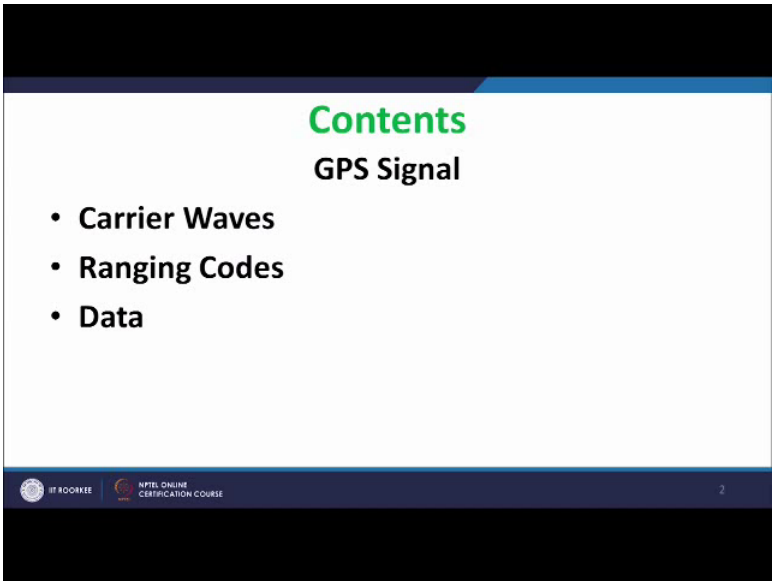

Now, users we do receive GPS signal from GPS satellite vehicles and then these GPS signals are we process to extract the information of our requirement. These GPS signals are actually some modulated carrier waves and it contains different types of carrier waves, different types of codes as well as different types of Navigational data and as a user what we do, we do try to extract the information or data which we want to extract or we want to derive.

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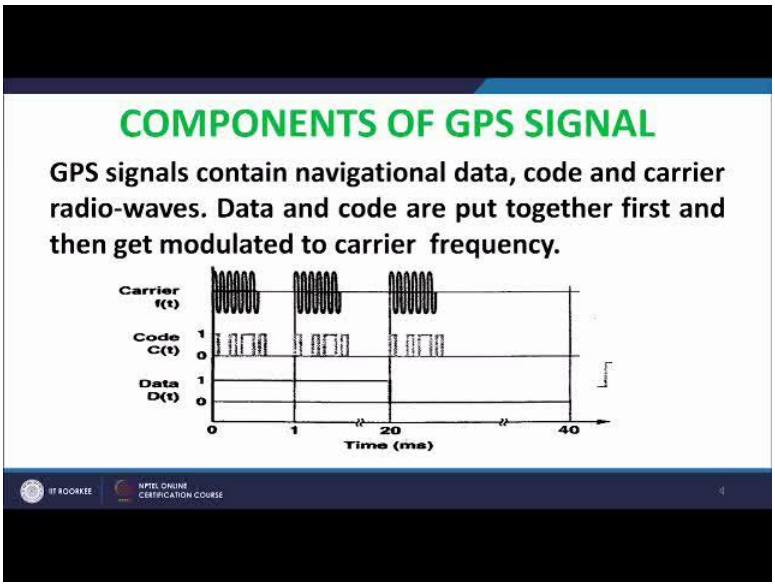

So, we need to know thoroughly the contents of a GPS signal. So, there lies the need of this class that we need to know as well as understand the contents of GPS signal. Now GPS signal is the modulated carrier wave consisting of carrier wave which is sinusoidal in nature then, it contains binary type of pseudo random code and also binary type of NAV data.

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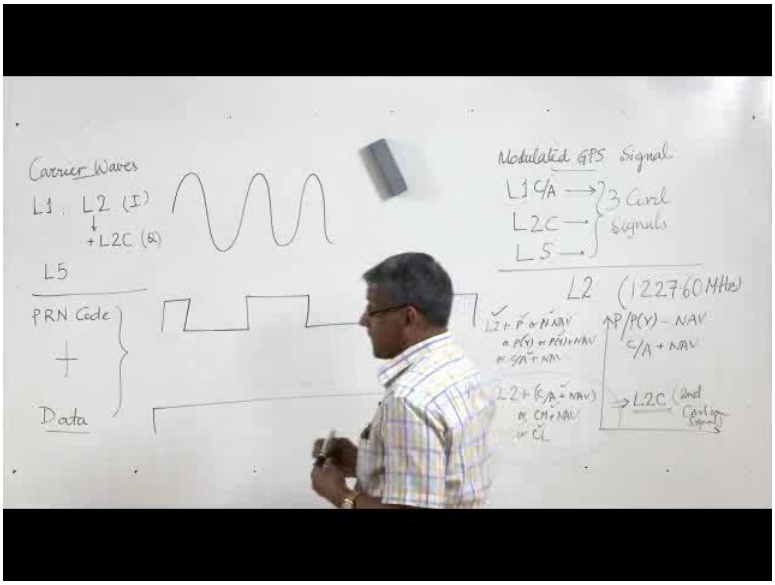

So, sinusoidal carrier waves binary pseudo random noise code and binary Navigational data. Now what it is done first this PRN code and data gets added through modulated

addition and then these two get modulated to carrier wave as a result we get modulated GPS signal. Now the carrier waves are used for or help in transmitting the GPS signals from satellite to the receiver without getting it lost in the atmosphere. The primary function of PRN code is to provide the identification of the signal; that means, from whose satellite it is coming and then data is the primary object or the primary information which users will make use to derive many important information for which this signal we are receiving.

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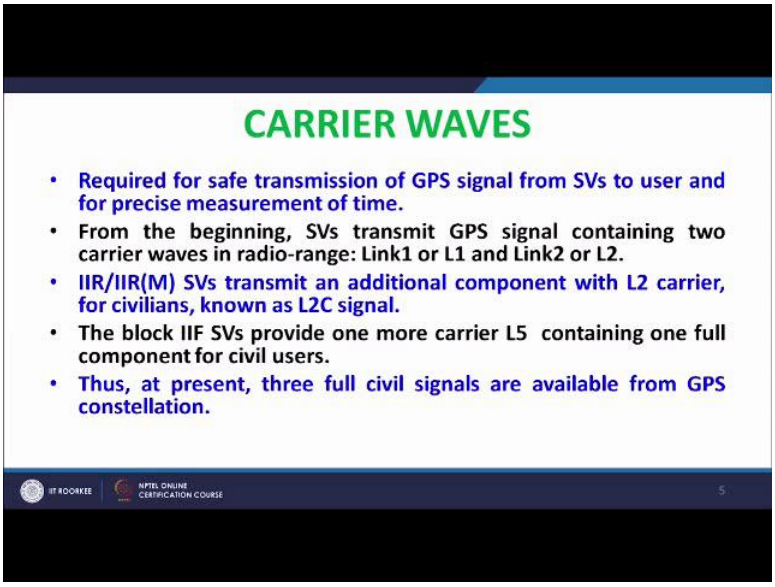

Now, there are different type of carrier waves that is available within a GPS signal, these from beginning GPS satellites are transmitting the L1 and L2 Carrier waves and later this L2 is also associated with one more civil signal that is called L2C signal that is in quadrature phase and that is in phase. And nowadays the signal L5 is also available from latest GPS satellites. So, in short if we see to the defined signals we can see we will see that L2 sorry L1 C A, L2C and L5 these are the three civil signals available for users to use.

Now let us discuss on these carrier civil waves first it is L1. Now L1 signal is having the frequency of 15 75.42 mega hertz this signal contains two type of codes in phase, it is the P code or for civilian it is the P y code and in quadrature phase it is the C A code and the L1 with C A code is having more power than L1 with P or P y code.

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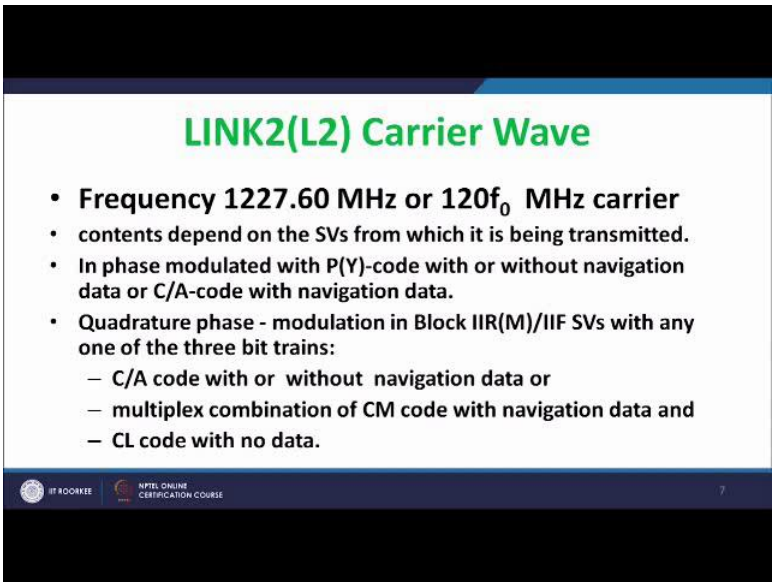

So, this civilian signal is more powerful. Next is the L2 signal, L2 signal is having the frequency of 1227.60 mega hertz; however, the content of L2 signal will depend upon the satellite from which this signal is coming.

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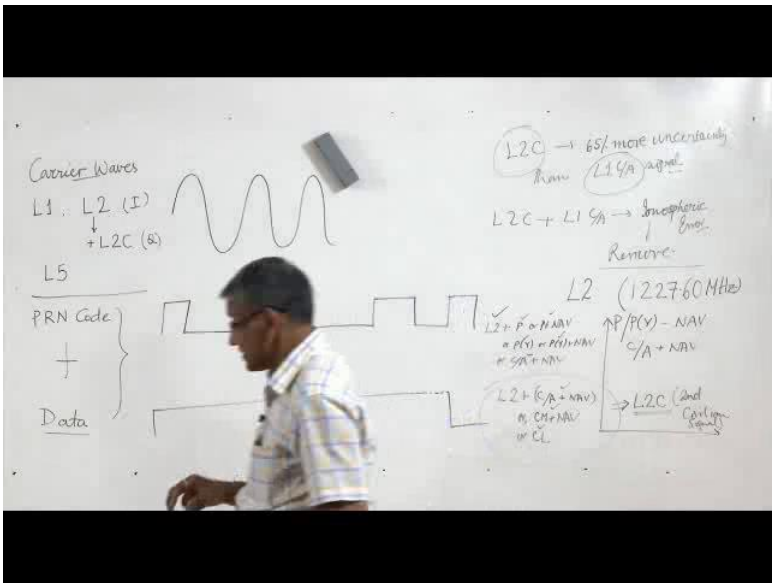

Now, in phase the L2 signal may contain P y signal with NAV data P or P y signal with or without NAV data and C A signal with NAV data. So, we can say L2 plus P or P y, P again it may be P with or P plus NAV or P y or P y plus NAV or C A plus NAV. So,

which of these combination 1 2 3 4 5, which one will be available in the particular signal it will depend upon from which satellite this signal is coming.

Now in quadrature phase it may be, there may be three combinations like L2 with plus it may be C A plus NAV data or CM plus NAV data or CL. So, out of these three only one type will be available. Now these part of the L2 signal is also known as L2C signal which is called second civilian signal, second civilian signal. Now this L2C signal is more powerful than the L1 C signal. So, L2C signal can be or will be available more under tree; however, L2C signal provides position having 65 person more uncertainty than what the L1 C A signal will provide. So, if we want to work under tree or little shade of tree then we will go for L2C signal, but if we want to have our position more accurately then we will go for L1 C A signal.

Of course, if we have the capability to capture both of them then that will be still better because that will not only L2C plus L1 C A both will provide us the measurement for ionospheric error which is the worst type of error available in GPS signal, and once we can measure the ionospheric error we will be remove it from our measurement. So, that is the advantage of having two civil signals.

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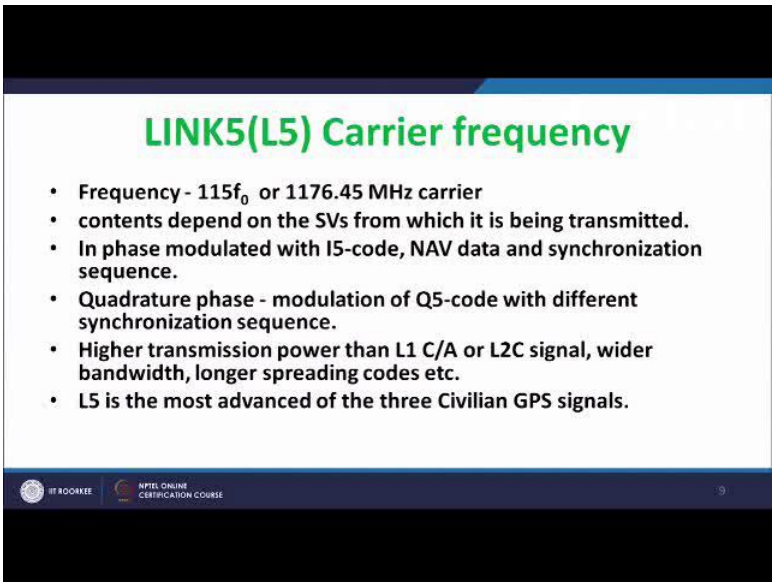

Then our L5 signal which is having the frequency of the order of 1176.45 mega hertz again the contents of L5 signal will depend upon the satellite from which we will get this signal.

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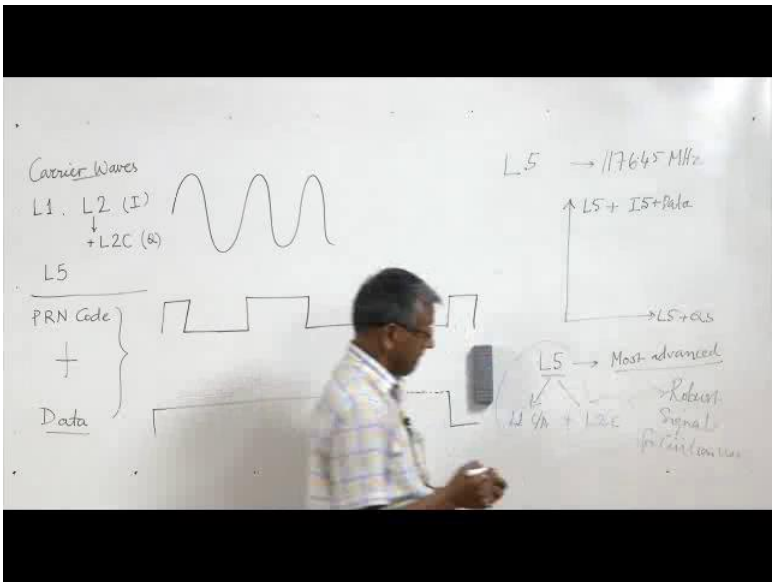

Now again in L5 also in phase the L5 signal will be associated with the I5 code and data and in quadrature phase the L5 signal will be associated with the Q5 code only. So, it will not be having any data; however, L5 signal is more powerful than L1 C A signals, as well as also L2C signal. Not only that L5 signal also having capability of wider bandwidth or longer spreading codes. So, L5 signal is a most advanced and developed signal. So, L5 signal along with L1 C A signal and L2C signal these three signals together provide very robust signals for civilian use. Now we can see there are three civil signals L5 L1 C A and L2C and all these three signal has its own advantage and they bring up obligation like, L1 signal which is having the maximum L1 C A this is the signal which is having the maximum frequency, so this is having the least ionospheric error.

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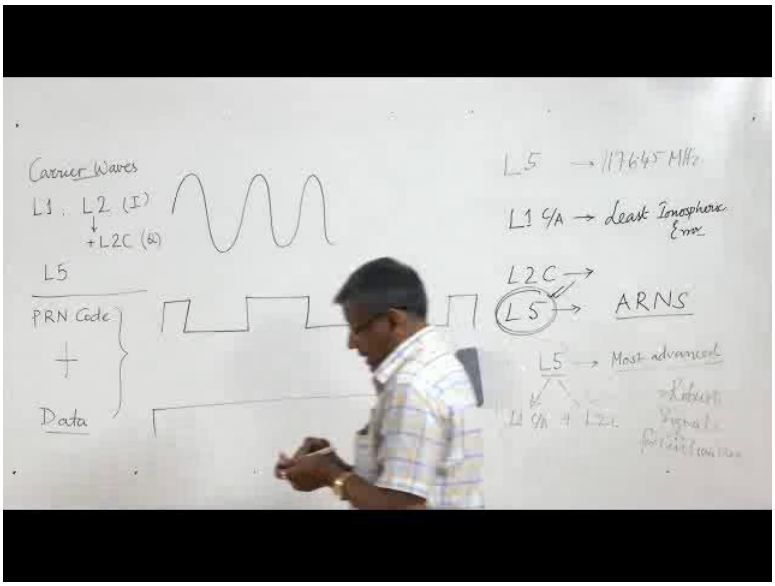

So, it will provides us very good position then, L2C signal is having the best cross-correlation performance and L5 signal is most powerful and its frequency works in the range of ARNS which stands for Aeronautical Radio Navigation Service then; that means, this L5 signal is most useful for aero-navigation, it provides very it is also powerful, so aero-Navigation becomes easy with L5 signal.

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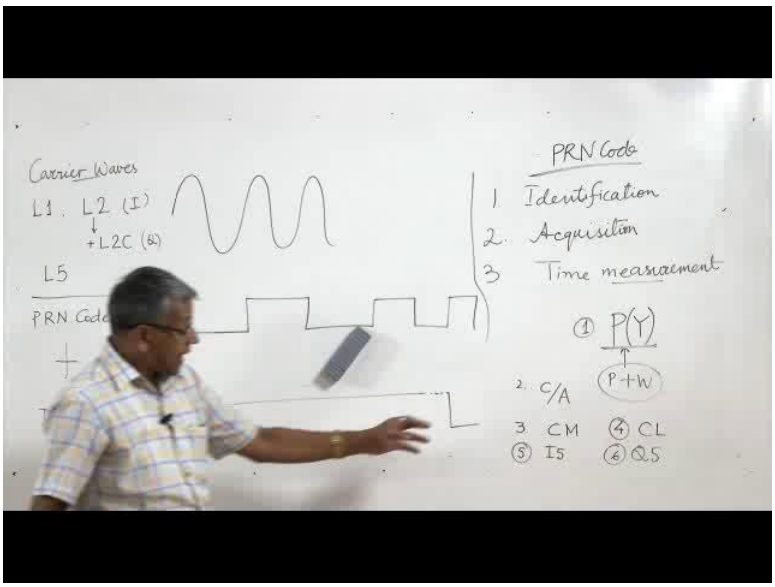

So, with these we can now look into the part of Navigational code PRN pseudo random noise code or ranging code it has defined (Refer Time: 15:41) the most important

function of PRN code is it provides identification to the signal, but another more important not less than identification is that PRN code provides the basic framework to acquire the signal by user. So, acquisition of GPS signal is possible because of the nature of PRN code. Further PRN code is also, it is acquisition of GPS signal by user number 3, PRN code provides the time measurement. So, these are the three important work that the pseudo random noise code provides to user.

In GPS signal there are six types of PRN codes that are available which are the most important initially it has been the P code or the precise code which is fundamentally has been developed for the military purpose, but later it is being opened for civilian, but it has been encrypted with another code which is w code, which is a 20 bits per second code and with this deformed P y code is made available for the civilian is then it is the coarse acquisition code C A code coarse acquisition code. Then, for the civilian code it is the CM, civil moderate code then, your CL civil long code then, I5 code for the L5 signal and then Q5. So, there are 6 types of codes that is available for civilians to use of course, P code is not for civilian code it is the P y code which is useful or which civilian can get access to C A code, CM code, CL code, I5 code and Q5 code.

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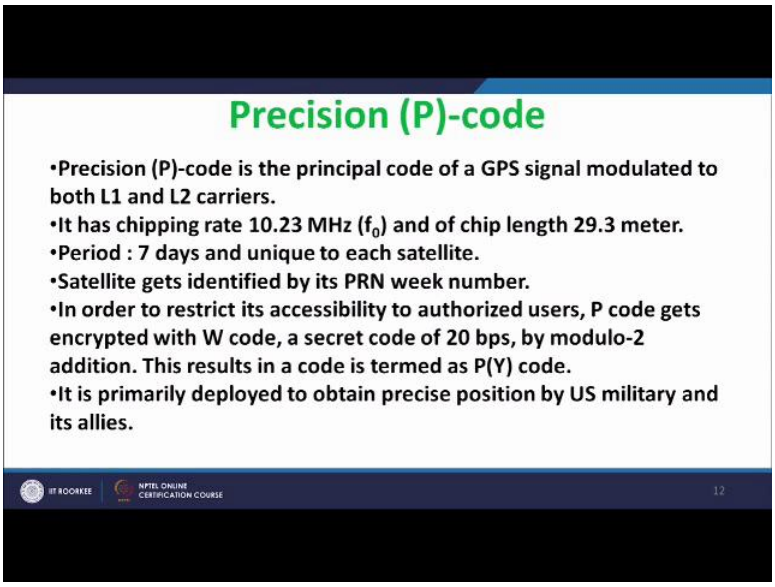

Now let me start with the P code or precision code the P code or precision code actually it is developed for the military use, but for civilians it is the P y code as I told you P y code is nothing but a P code encrypted with another code called w code and this P code

is having the chipping rate 10.23 mega hertz where as the w code is having 20 beats per second.

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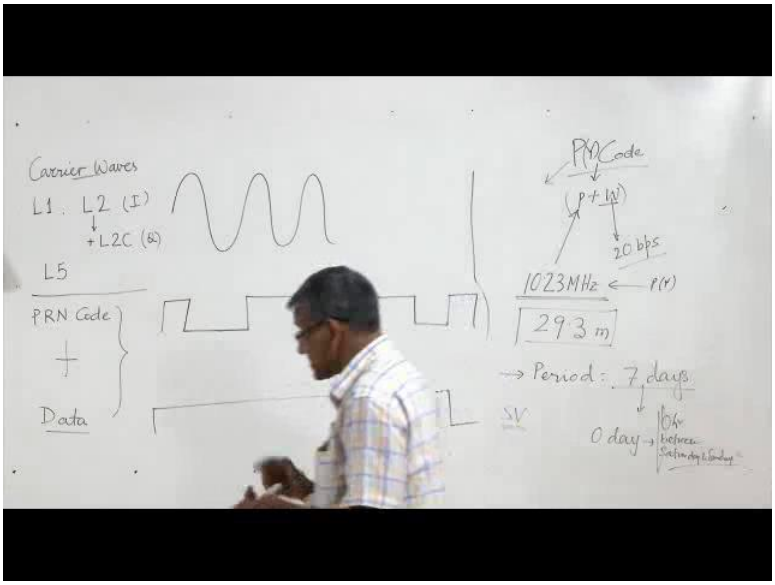

So, these two will give you P y code and this P y code is having the chip rate what is available for P code that is what is the chipping rate of P y code and having your chip length 29.3 meter; that means, with P code only theoretically we can arrive at an accuracy of 29.3 meter; however, at present we have many improved algorithm. So, we can achieve much more better accuracy than these.

Now these P codes are having period of 7 days; that means, the same code repeats after 7 days and these 7 days the first the 0 day start, 0 day starts at 0 hour between Saturday and Sunday, Saturday and Sunday. So, 0 hour and generally we go we tell it at 12 hour at night which is the 0 hour 0 hour from Saturday to Sunday to Sunday; that means, some 0 hour of Sunday is the time when the P code starts and the code continues and again it restarts the next 0 hour of Sunday. So, it is called 7 day. And each code from particular satellite particular 7 days code they use. So, that 7 days code identify also identifies the satellite vehicle, satellite vehicle is also identified by the week number of the P code which has been assigned to that particular satellite.

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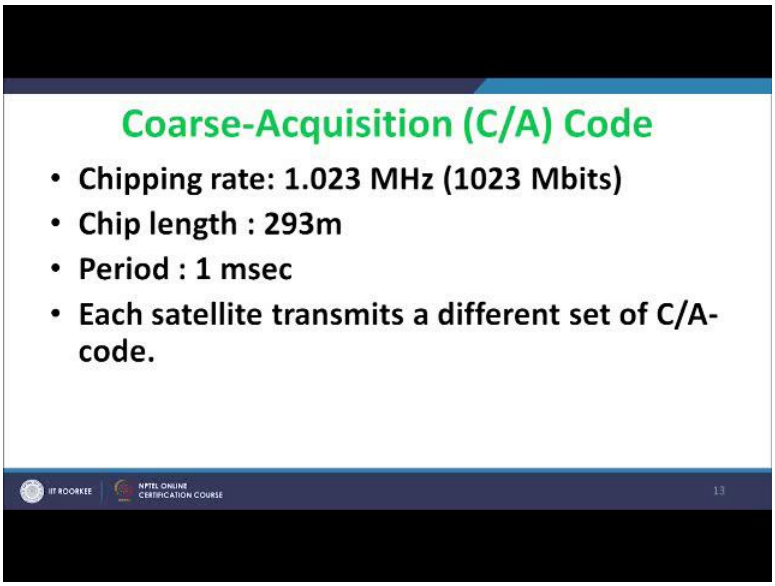

Next it is the C A code, C A code means the coarse acquisition code. Actually this is the most important code because the acquisition of GPS signal starts with this code and this provides the identification of the signal, it also provides the measurement of time first and it helps in acquiring the same NAV.

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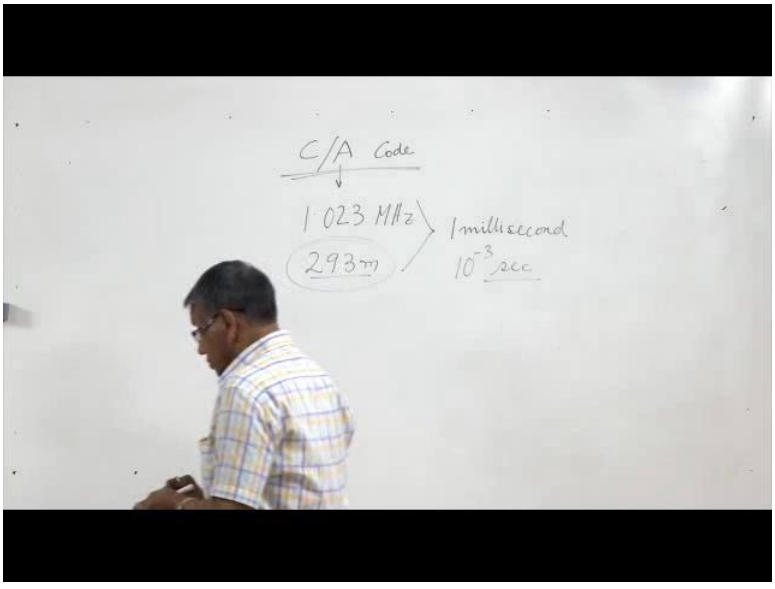

Now, the chip length, chip frequency, chipping rate is 1.023 mega hertz; that means, one-tenth of what P code is and it is chip length is 293 meter. So, this is the accuracy the accuracy that we can achieve using this C A code and each satellite have individual C A

code or particular C A code or particular C A code which provides the identification of this code. And another thing the period of this code is one millisecond; that means, at 10 to the power minus 3 second interval this code repeats.

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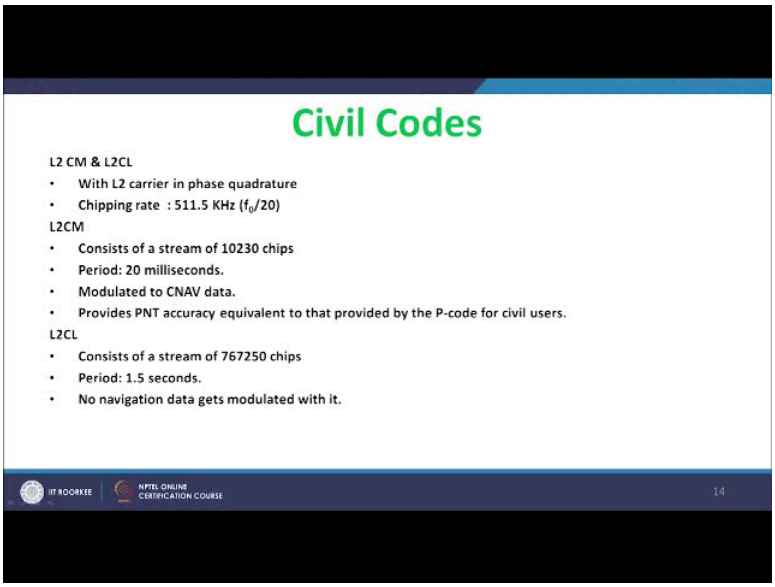

Next civil code, as I told you civil codes are available with the L2C signal which is the L2C L2 signal in quadrature phase.

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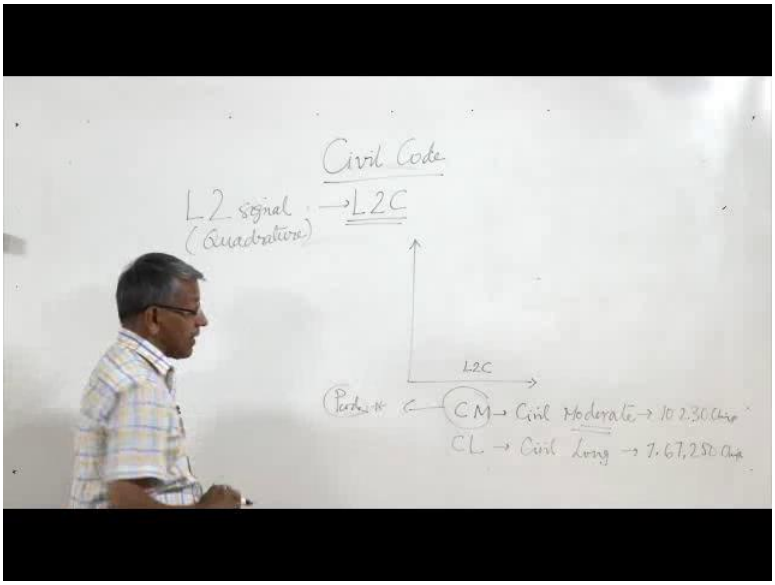

Now, this civil signal; that means, in phase it is the; that means, with the L2C signal will be in the quadrature phase of the L2 signal and this will be having that CM civil

moderate and CL code civil long, it is having 10,230 chips and the civil long having 7,67,250 chips. So, it is of moderate length and having the accuracy same as what P code provides. So, CM code is equivalent to P a code of military signal and CM code is also provided with the Navigational data. But our CL code does not have any Navigational data.

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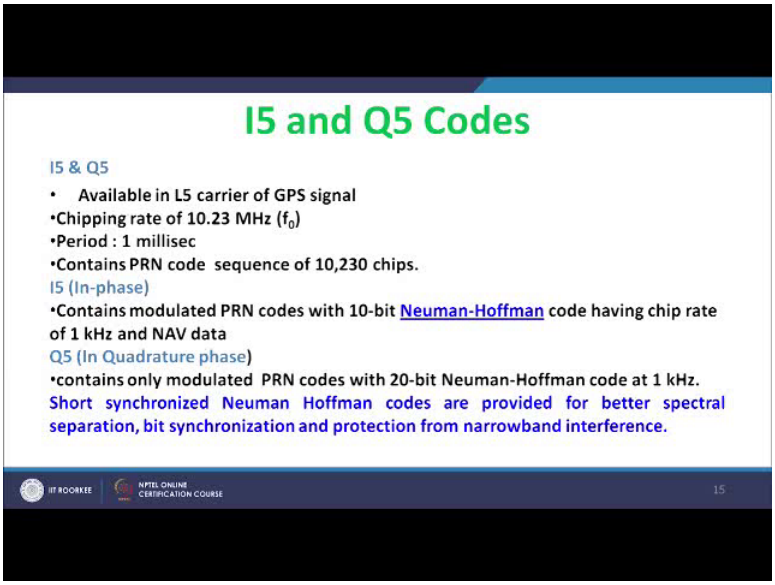

Next it is the I5 or Q5 codes, these two codes are available with the L5 signal and as I told you the I5 codes are available in phase with the L5 signal.

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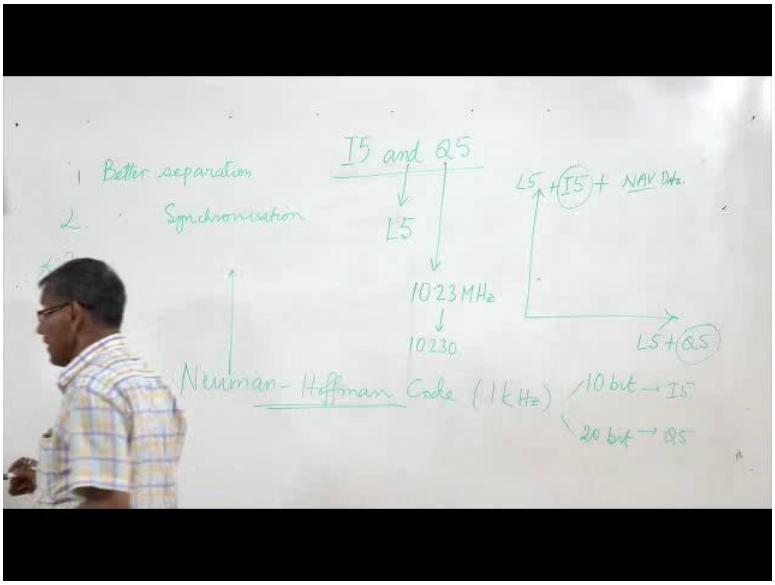

Whereas the Q5 code is available in the quadrature phase and also I5 signal is associated with the data NAV data, but there is no data available with the Q5 code. Now the I5 and Q5 code is having chip rate 10.23 mega hertz. So, as it is a P code and its PRN code sequence is 10.23 z. Now one thing which is unique to these I5 and Q5 code is that they are associated with a PRN code known as Neumann Hoffman code is having the chipping rate 1 kilo hertz and it is a 10 bit for I5 and 20 bit for Q5.

Now, this Neumann Hoffman code is added to I5 and Q5 for better separation, beat synchronization and there are three functions that it does - one is that it provides data separation, it provides better synchronization and most importantly this Neumann Hoffman code obstructs the GPS signals to get interfered with other narrow band signals, this is the most important thing. So, L5 signal is considered to be very powerful and very useful for the civilian use.

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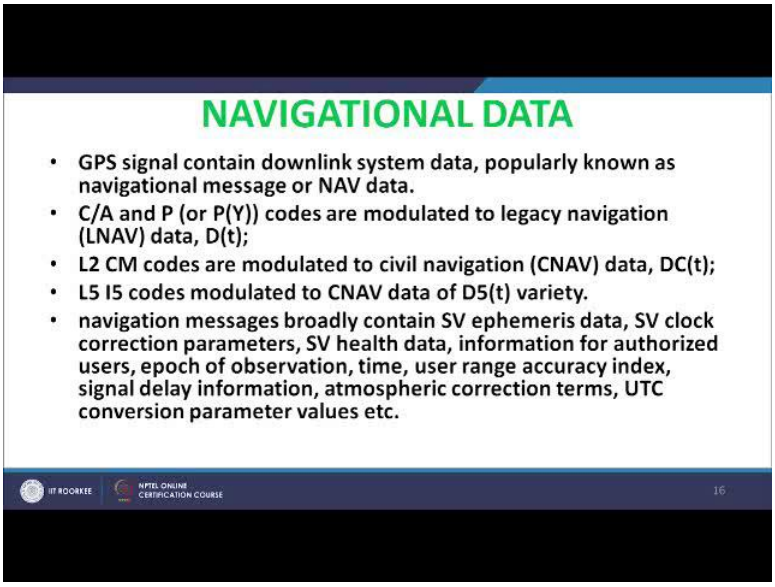

So, with this I want to talk next on Navigational data. Actually Navigational data is the most important information, Navigation data. This is the most important part for user because user looks for Navigational data.

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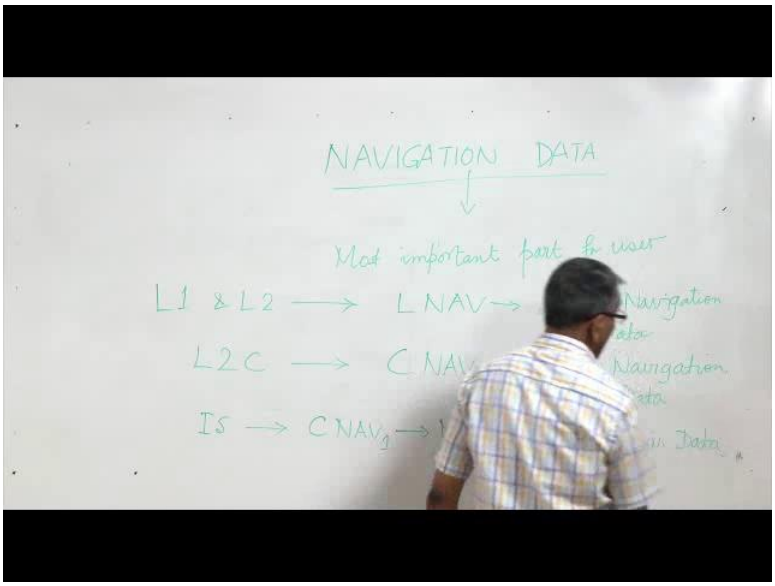

Now, before I go what is its content, let me first see that how many actually Navigation data that is available for in different parts of GPS signals are not same. For L1 and L2 signals, this Navigational data is of variety known as l NAV; that means, legacy Navigational data whereas the Navigational data that is available with the civil signal L2C it is the C NAV, it is called civil Navigational data.

Now in case of I5 because Q5, does not have any data Navigational data I5 it is also civil Navigational data, but of different variety. So, modified civil Navigation data, now what is the significance of this? The significance of this information is that while we process the GPS data we should not make use of all this signals together, only we will be able to process the signals which having the identical type of Navigation data this is the most important part. Now, what is the use of Navigation data?

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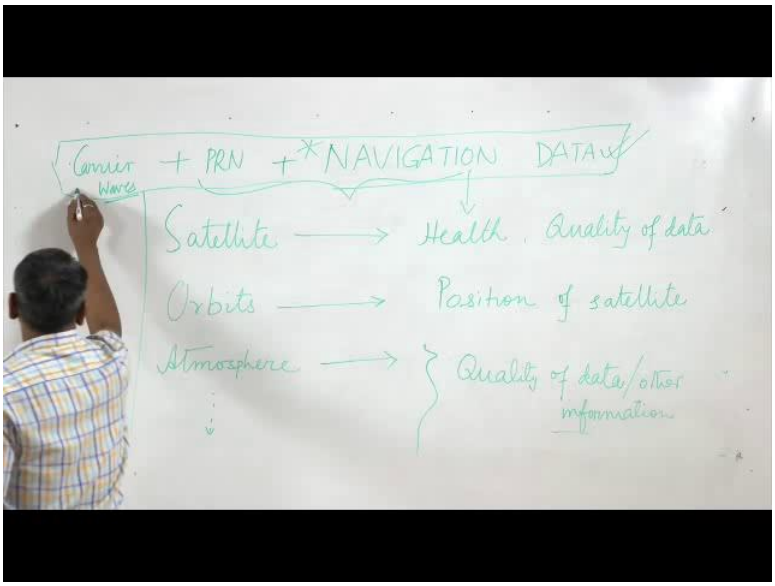

Now, the Navigation data actually contains a plethora of information about the satellites, its orbits - about satellite, about orbits, about the atmosphere through which it is coming and many other. So, now, the information about the orbits will provide the position of the satellites at the particular time of the transmission of the signal. Now satellite information provides you the help of the satellites and the subsequently the quality of the data that has been received by the user and this atmospheric information and many other information's which will also provides us information about the quality of data and other information.

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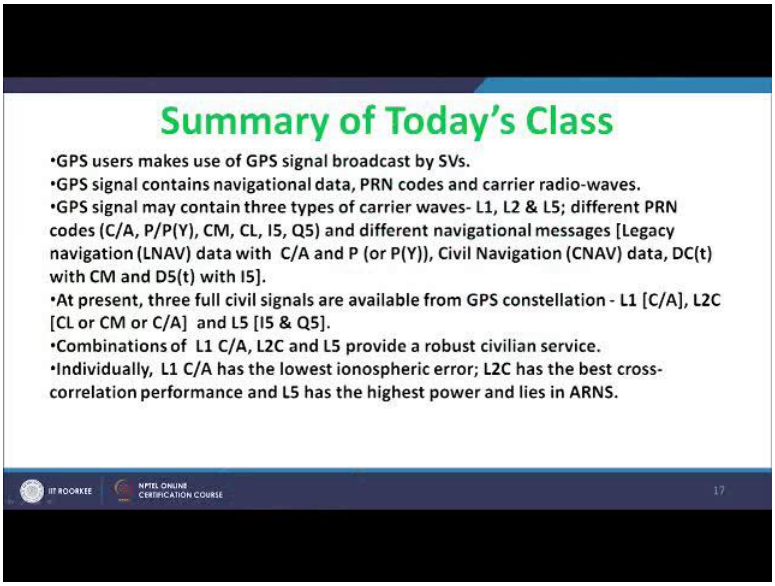

So, to summarize we can say like that actually as a user we are in need to have the Navigational data from the satellites, even if you get the Navigational data the identification of the data from which the data is coming from particular satellites, PRN codes are used and to these two data is having very low energy because these two are in binary format. So, if we have to get the data from satellites to receiver through such a huge distance of about 20000 kilometer we need to provide enough energy to this part of the information which is being done by making use of carrier waves.

So, these three makes the GPS signals which have been discussed in this class, and in the next class we will be discussing on GPS receiver.

Thank you.