Digital Land Surveying
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Lecture – 21
Measurement of Distance

Welcome students, this is the 21st lecture on digital land surveying and mapping in today's class I will tell about how to measure distance or the theoretical background for the measurement of distance by total station. So, I will first give some introduction to measurement of distance using total station then actually total station measure the distance using the concept of electronic distance measurement.

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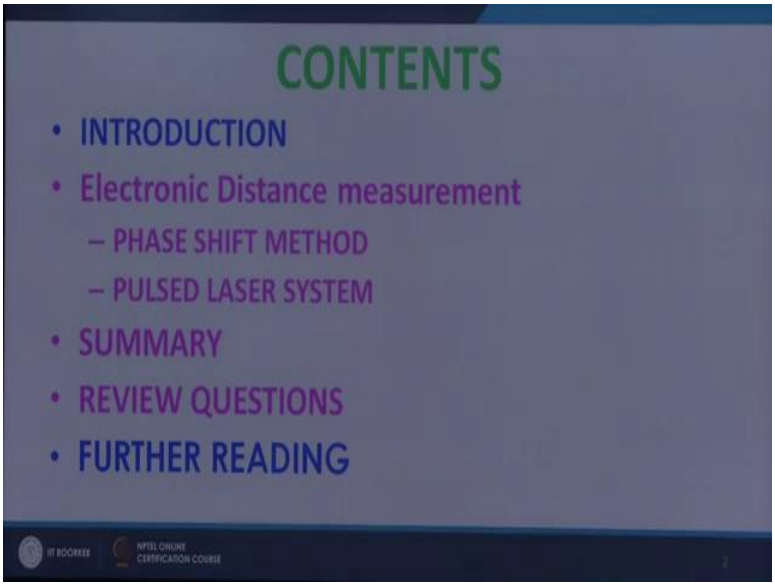

And there are 2 methods phase shift method and pulsed lasers system method. So, these are the 2 waves how EDM measures. So, I will talk a brief on it followed by summary review question and further reading.

Now, as I already told that total station measures the slope distance between the instrument and the target. So, what we do in case of total station suppose we want to measure the distance between 2 points say A and B.

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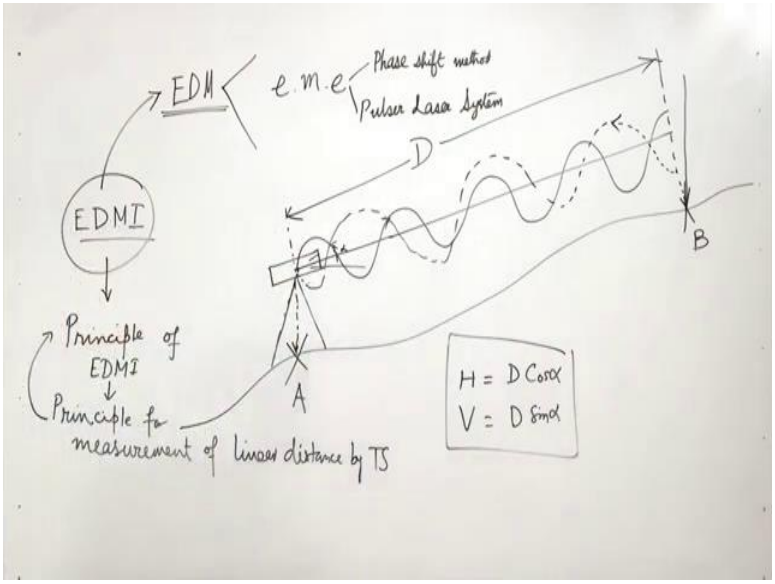

So, what we do we set up the total station about this centering our; these already we have discussed about centering. So, the telescope of the total station will be bisected on a target. Now target may be any reflector or any object depending upon the type which we will like which I will discuss in the next class. So, suppose the target is this one. So, we do get the slope distance between this point and this point actually. So, this is the distance D which the total station provides and also comes from measure that horizontal angle and vertical angle simultaneously. So, from horizontal slope distance vertical angle it provides the horizontal distance the cosine of alpha if the vertical angle is alpha and vertical distances is D sun alpha. So, this is the background theory how we get the horizontal distance and vertical distance from slope distance.

Now, a total station makes use of and measurement EDMI; that means, electronic distance measuring instrumentation inside the total station there is a element called EDMI already I told you and this is the telescope of the instrument. So, EDMI is used for measurement or the slope distance. So, the basic principle of EDMI principle of EDMI is the principle for measurement of distance using principle for measurement of linear distance by total station. So, by principle of measurement of distance by total station automatically indicates that; what is the principle of measurement of distance by EDMI?

Now, EDMI makes use of the EDMI means electronic distance measuring in electronic distance measurement principle makes use of electromagnetic energy. So, now, what it

does the EDMI inside this total station fast it sent some electromagnetic wave. So, this is the electromagnetic wave which it sends to the target and target sends is back. So, measurement of distance using total station the electromagnetic waves travels twice the distance which it will measure. So, that is what it is there and this measurement of distance is being done in EDMI by 2 methods one is called phase shift method and the other is pulsed laser system these are the 2 method by which this measurement of distance takes place. So, I will be explaining one by one.

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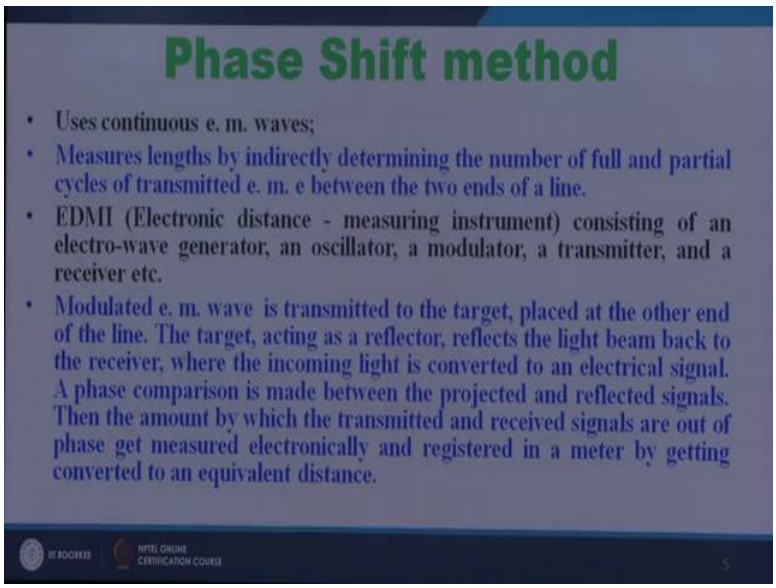

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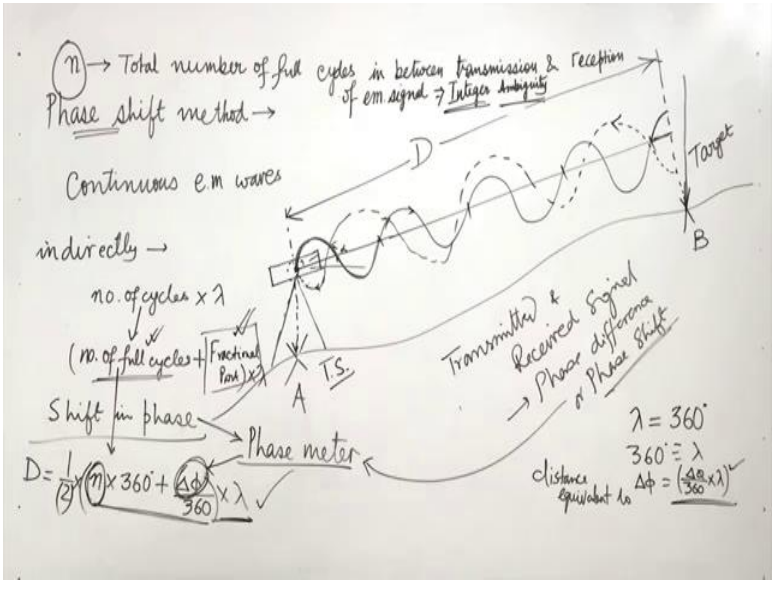

Now, let me start with the phase shift method in the phase shift method. Now in the phase shift method actually the EDMI makes use of continuous electromagnetic waves like the one I have shown in this figure you can see that in this type of electromagnetic wave measurement in the when we use this type of continuous waves for measurement of distance then we will make use of the phase shift method and in this method we measure the distance indirectly whether the distance indirectly.

Now how actually in this method we measure the numbers of cycles numbers of cycles multiply by the wavelength of that electromagnetic energy. Now here you can see whenever we will send some electromagnetic wave it will have some 1, 2, 3, 4; 4 full cycles and some fractional part. So, there will be number of cycles will consist of number of full cycles number of full cycles plus some fractional part of the cycle. So, fractional part multiplied by the wavelength T as you see from this diagram the incident signal the phase of the incident signal that has been sent from the EDM and the phase of the received signal is different. So, actually inside this EDMI there is an element to measure these shift in phase shift in phase.

This shift in phase provides the fractional part and 2 cycle we have to do some other methods. So, that phase meters that phase meter that is available inside the EDMI makes use of phase mete EDMI make use of a phase meter to measure the shift in phase between the transmitted and received signal and from there the fractional part is being the define or found and there is another element called multiple element through which number of circles we do continued. So, in the phase shift method of measurement of distance there are 2 significant way or significant part of measurement one is to find out what is the number of full cycles and another is to find out what is the fractional part of the waves that has been transmitted and received transmitted and received signal. There are phase difference, phase difference between or phase difference or you can say phase shift of the transmitted signal and the received signal that is what we do measure.

So, that is and that EDMI as I as you can see now that EDMI is the instrumentation that is available inside the EDM oh and that is inside the total station and this EDMI actually consists of an electromagnetic wave generator it has its own way to generate particular wavelength of light wavelength of electromagnetic energy and oscillator modulator then a transmitter and a receiver and some other accessories. So, these are the basic components all electronics component and. So, whenever we will made on EDM or the

total station to measure the distance it will transmit a modulated electromagnetic wave to the target this is our target this is our target and this is our total station.

So, as you made on the total station that total station will send an modulated electromagnetic wave or energy as it is shown by the form line that is transmitted and this will be placed as I told you that will be placed at that points or about the points between which we want to get the distance the target acting as reflector reflects back. So, after reaching it will reflect. So, this is reflecting to the receivers where incoming light converted to electrical signals, this electromagnetic energy will be converted to some electrical signal and if phase comparison made between the projected and the reflected signal.

So, there will be a comparison between the phase of the transmitted and the received signal and then the amount by which transmitter and receiver signals are out of phase get measured electronically that is what I call there is an instrument or part of the electromagnetic called phase meter which will measure the difference in phase and registered in a meter by getting converted to equivalent distance and then the meter means measurement. So, it will measure the equivalent distance. So, this is the basic or behind measurement of distance between your instrument and the target.

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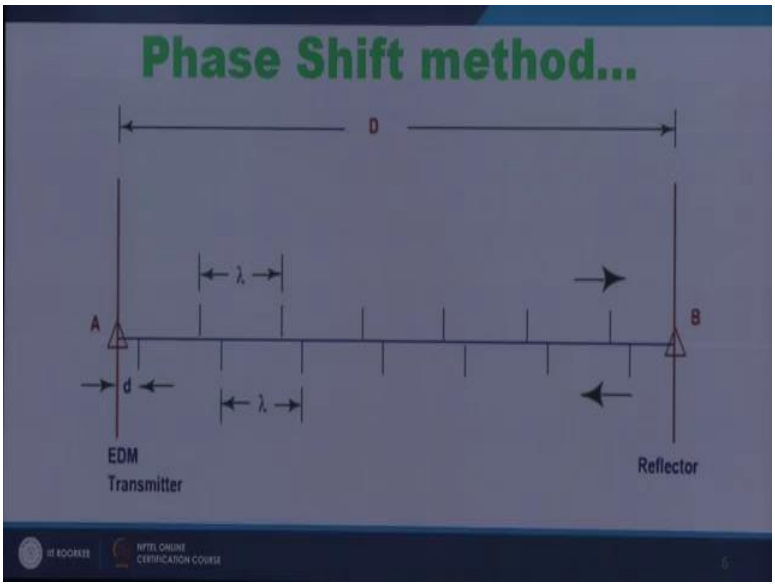

So, now if you see diagram let us say that our EDM transmitter is placed at which is this one and this reflector B that is D one. So, it is transmitting some signal. So, having this

full length and then there is a partial length and when it will come back this plus this will make a full cycle then one cycle that one cycle like that. So, ultimately there will be a fraction of the signal which the EDM will have a fractional part.

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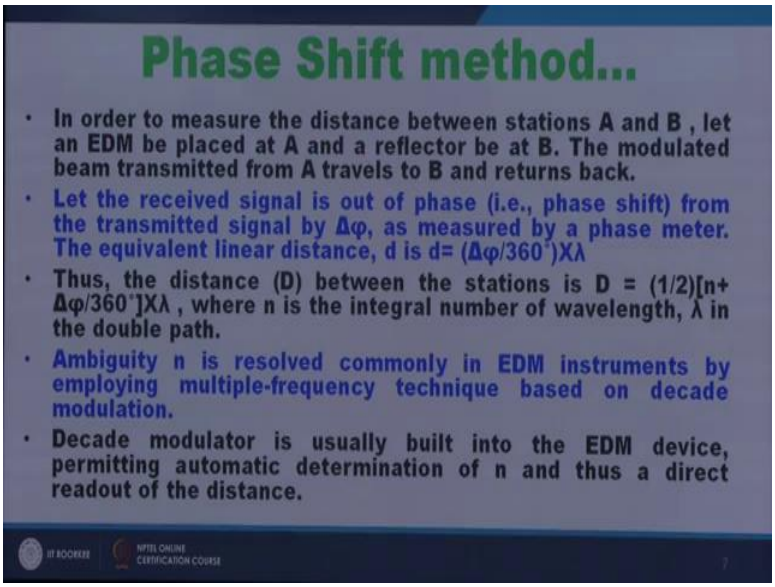

So, this is the idea what I had drawn it here you know another wait it can be represented like this D the distance it is the slope distance between A and B. So, in order to measure the distance between this stations A and B let an EDMIs placed at A and a reflector means target is placed at B that modulated beam transmitter from A travels to B and returns back.

Now, let the received signal is out of phase by del phi. So, as measured by the phase meter one wavelength means 360 degree. So, like if I, so, this is the wavelength means the wave will be having phase 360 degree. So, 360 degree is equivalent to one lambda. So, corresponding to del phi which is the del phi is the fractional part of the phase which is defined from transmission and reception. So, it will be equal to del phi divided by 360 into lambda. So, this is the distance equivalent to equivalent to del phi is equal to this much. So, this is that can be computed easily inside this EDMI and if there are n numbers of cycle.

So, I have told you that number of full cycles of fractional part. So, if there are n numbers of cycles then n plus del phi or n numbers of cycles then it will be n plus del phi by 360 degree into lambda. So, that will be the distance d, but this will be distance D will

be half of this because a this is the distance that is covered this will be the distance this is the number of cycles perceptional part for going and coming and that multiplied by will be there twice the distance D. So, D will be half.

So, we can get the slope distance the by having this relation now of in this relation this del phi is the shifting phase then that is being given by the phase meter. Now the there is the problem in finding out this n; that means, n is the total number of full cycles in between transmission and reception of electromagnetic signal between the instrument and the target and this number has a specific name this is called integer ambiguity integer because there are full numbers of cycles it is an integer number ambiguity because the EDMI originally is unable to know it has an element which make use of multiple frequency multiple frequency technique.

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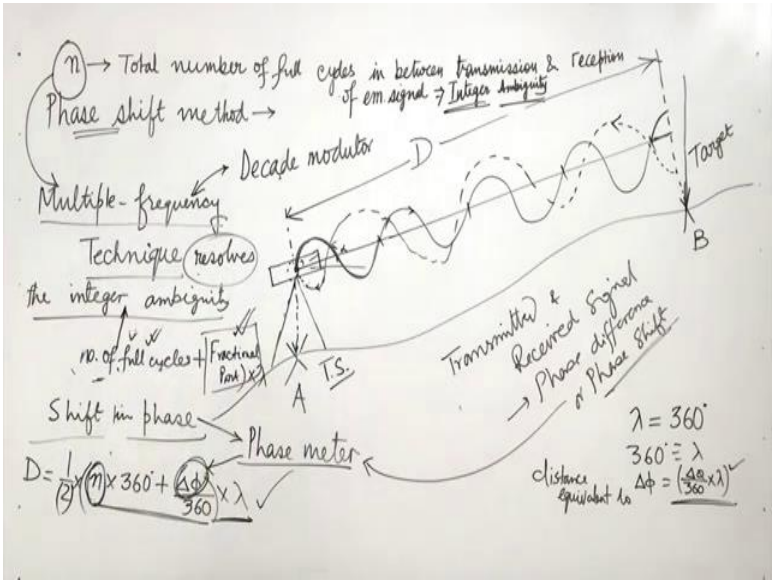

So, by using the multiple frequency technique the integer ambiguity get result multiple frequency technique results the integer ambiguity.

Now, resolving these are ambiguity means to determine what is the number of full cycles that the signal has done or taken in transmitting and receiving that the signal from the instrument to target. So, number of full cycles is also known as and these are ambiguity and multiple frequency technique is the method and there is a element called decade modulator decade modulator is the part of the instrument which makes use of multiple frequency technique to resolve integer ambiguity. So, decade modulator is usually built

in EDMI device permitting automatic determination of in design ambiguity does a direct readout of the distance. So, this is the background this is the way how the distance D between the instrument and the target is being determined.

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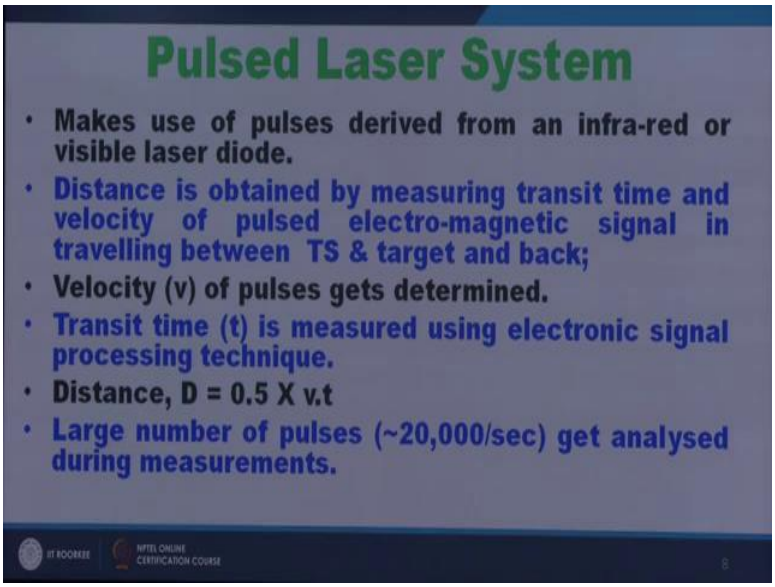

And the next method is your pulsed laser system now pulsed laser system.

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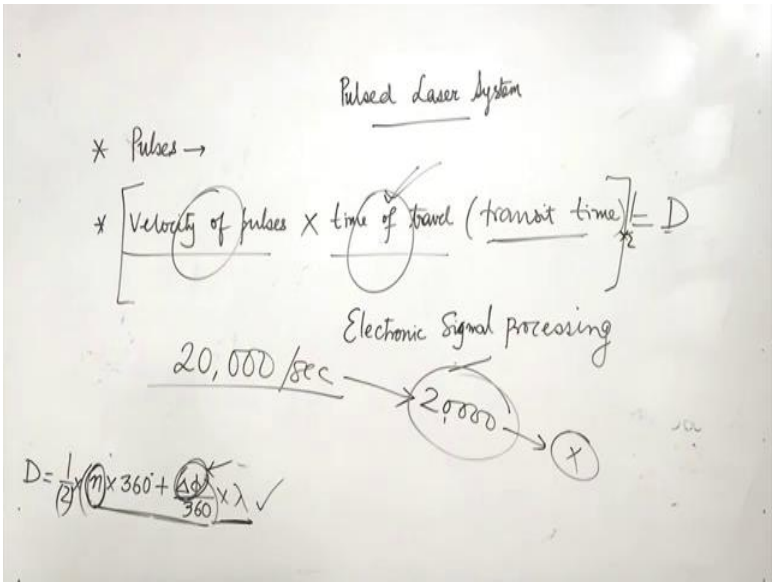

Now, pulsed laser system make use of pulsed signal in pulse; that means, it is not a continuous wave, but some pulses it use it makes use pulses and this pulses may be in the infrared or invisible laser visible beam bend and make use of infrared or visible laser

diode by making use of infrared or visible laser diode some pluses are being sent from the instrument to the target and to get it back.

Now, in this case the measurement of distance is very simple velocity of the pulses or velocity at pulse pluses multiplied by the time of transmission time of travel or we call transit time transit time means the time taken in transmission time taken in between transmission and reception. So, these velocity of pulses multiply by time of travel provides us the distance D this is also slope distance it is half at this it is D is half of this.

So, this is a very simple or easy way and we will measure the velocity of the pulses has to be measured and using our instrument it is done easily and the time of travel there is an electronic signal processing technique electronic signal processing technique is used to determine the time of travel and. So, distance is half of velocity of this. Now actually you are theoretically if we send the single pulse and get it back from there we should be able to get our distance, but to invert the accuracy instead of a signal single signal we make use of a repeated signal may be up the order of 20,000 signals per second.

So, that is the reason why we you make use of electronic instruments 20,000 say pulses per second give us 20,000 data and from this 20,000 distance data we will get only one distance. So, it is a mathematically we do can do it; however, the distance measured by using pulsed laser system will be less accurate than phase shift method the measurement. So, nowadays most of the total station instruments make use of phase shift method the measurement of distance.

So, with this I like to conclude today's main discussion. So, what we have found that the total station makes use of electronic distance measuring principle to measure the slope distance between the instrument and the target taking the distance using total station we need that the line of sight the line of sight between the instrument and that target should be free; that means, there should not be any obstruction a total station makes use of electromagnetic energy to make the 2 measure the distance. So, EDMI is associated with total station. Now this EDMI basically walks whether the energy is continuous mode or in the pulse mode if it is a continuous mode then it is the phase shift method which it made use in the phase shift method the distance is basically measured indirectly by finding out the number of cycles of waves that it used to transmit and to receive it back and that number contains 2 part.

One is full number of cycles another is the fractional part fractional part is the shift in phase between the transmitted and the received signal and the full number of cycles that is called integer ambiguity the phase shift part the EDMI computes or measures or observes through phase meter equivalent distance and the number of cycles it, (Refer Time: 25:21) it finds using a module decode modulator. So, and whether in a pulse laser system it is simple method simply the velocity of transmission of the velocity of the electromagnetic energy multiplied by the transit time and; however, the distance measured by phase shifts method is more accurate than the pulsed laser system. So, most of the total stations nowadays makes use of phase shift method that measurement for its distance.

With this I will conclude today's class and next class I will like to discuss more on how the distance is being measured using total station.

Thank you.