

## Module - 9

# Modern Surveying Instrument



**Subject:- Surveying**  
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# Introduction

- In surveying distance measured directly with the help of the tap or a chain , so this method is known as Direct Distance Measurement.  
(DDM)
- Fairly good accuracy.
- It is difficult when any type of the obstruction is crested.
- Expensive and time consuming method.
- Taking a reading more accuracy is required.

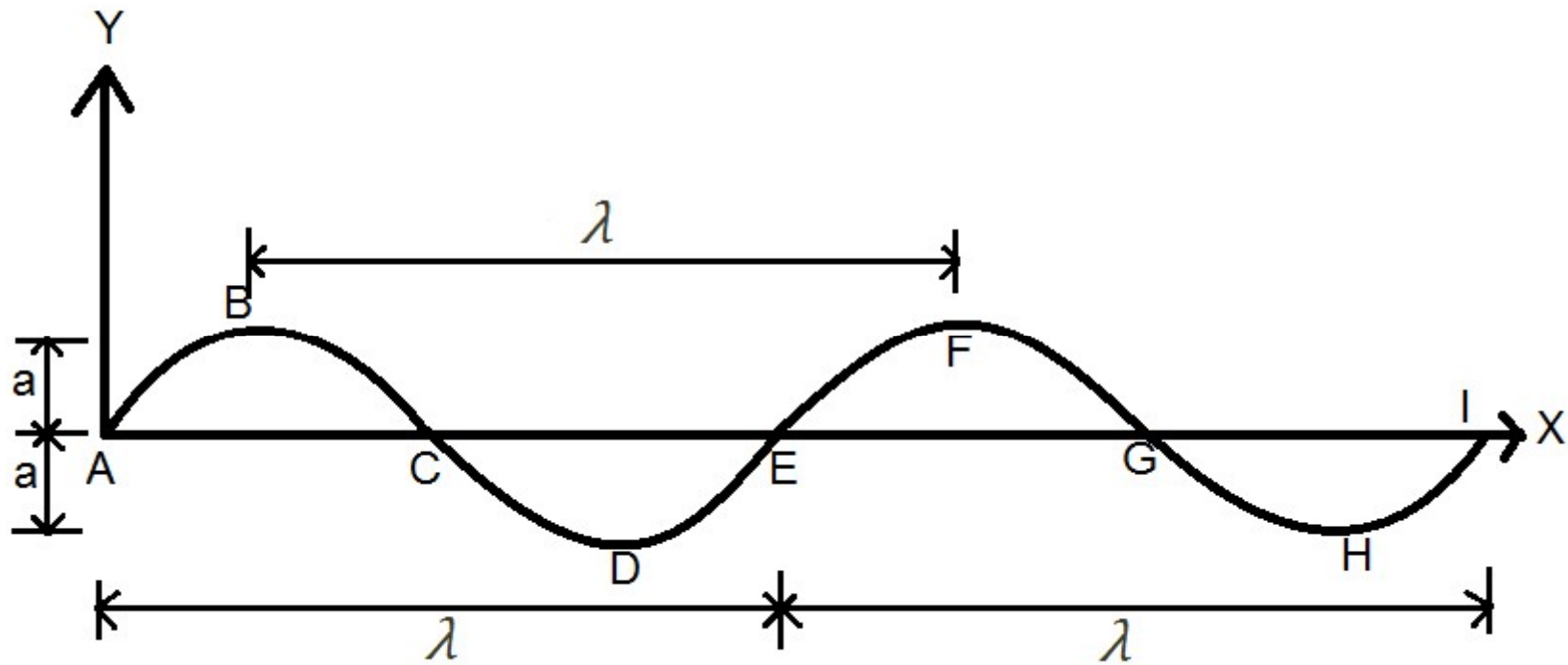
- The distance is measured with the help of the Optical Distance Measuring instrument (tacheometer), so this method is known as Optical Distance Measurement (ODM).
- Higher accuracy is required.
- This method is used to measure the short distance because the ranging of tacheometer is 100 to 150m.
- In short time the development generated in surveying instrument so generate modern instrument.

- Electronic distance measuring instrument have been recently developed.
- High accuracy distance measured.
- EDM is a one type of the modern instrument to measure the distance between the two visible point.
- Electromagnetic waves are generated and transmitted in EDM

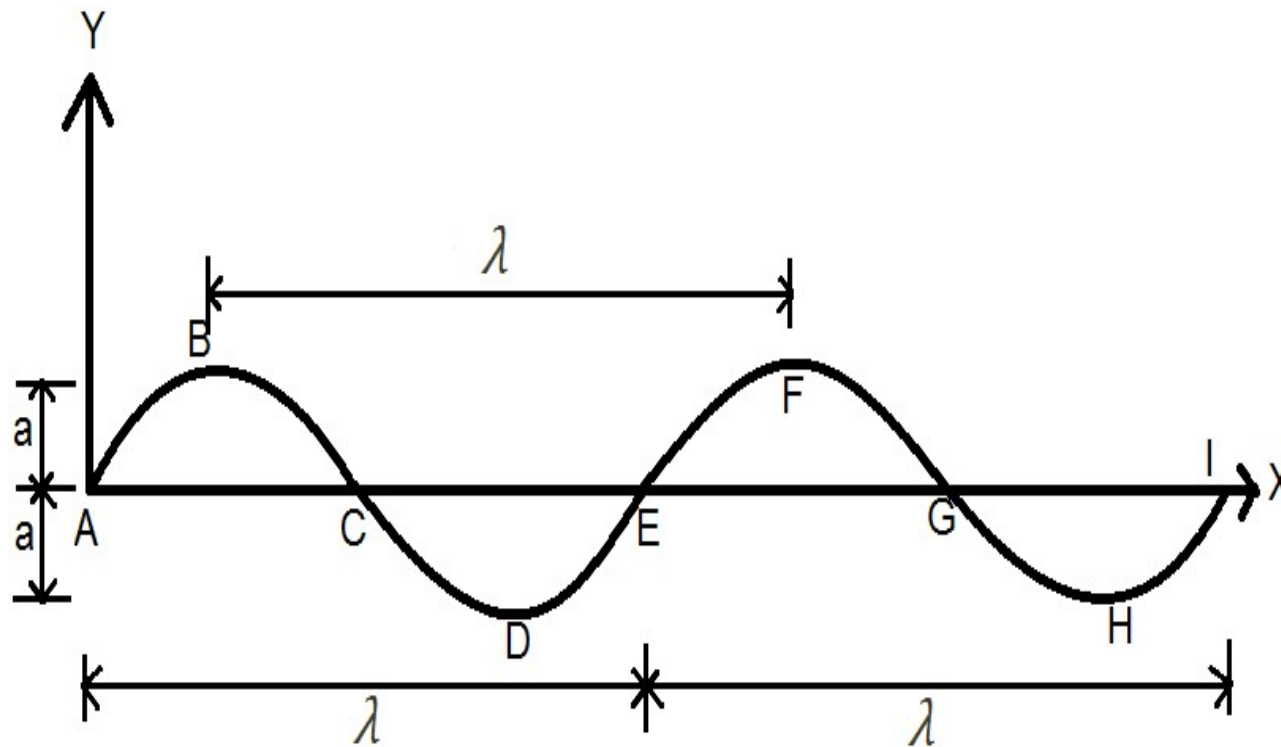
# Electromagnetic Waves

- The electromagnetic waves generated depends on many factors but principally, on the nature of the electrical signal used to generate the waves.
- No medium are required.
- Waves travels in vacuum.
- EDM method is based on generation, propagation, reflection, subsequent reception of electromagnetic waves.

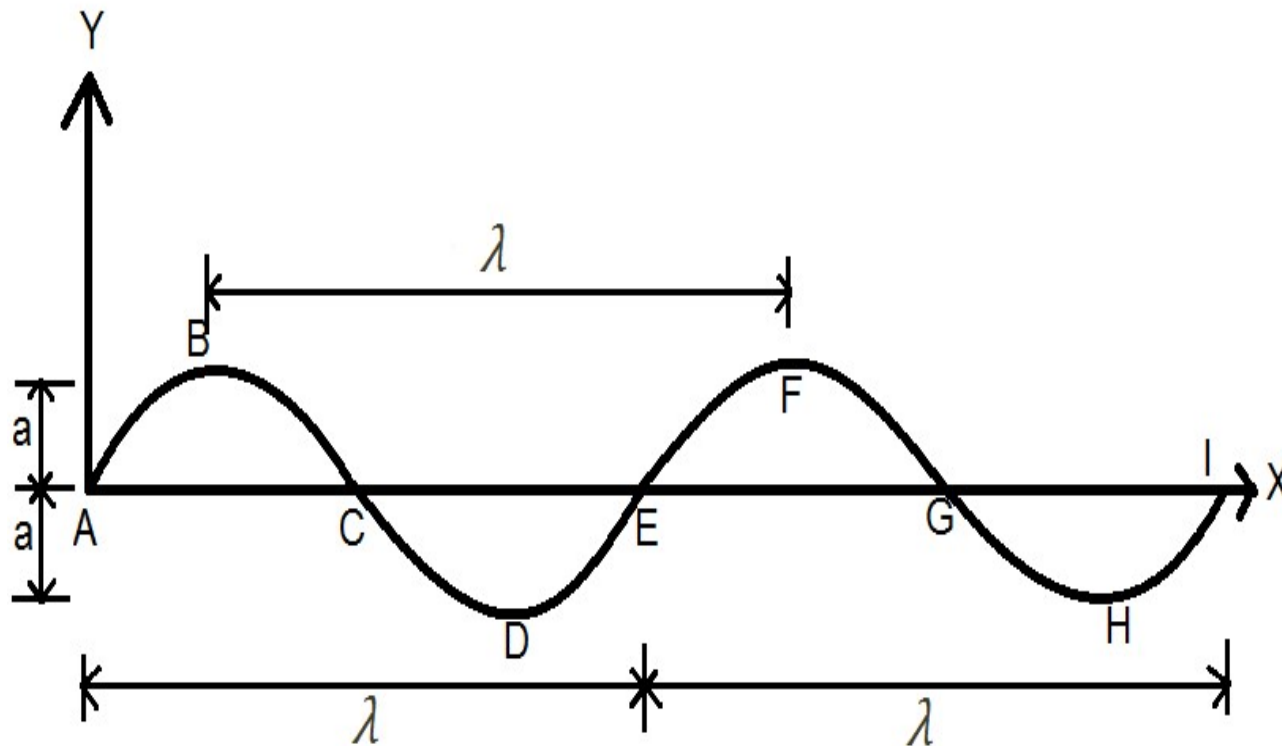
# Properties of Electromagnetic waves



- The wave complete the cycle from identifying point like A to E, B to F, C to G, D to H

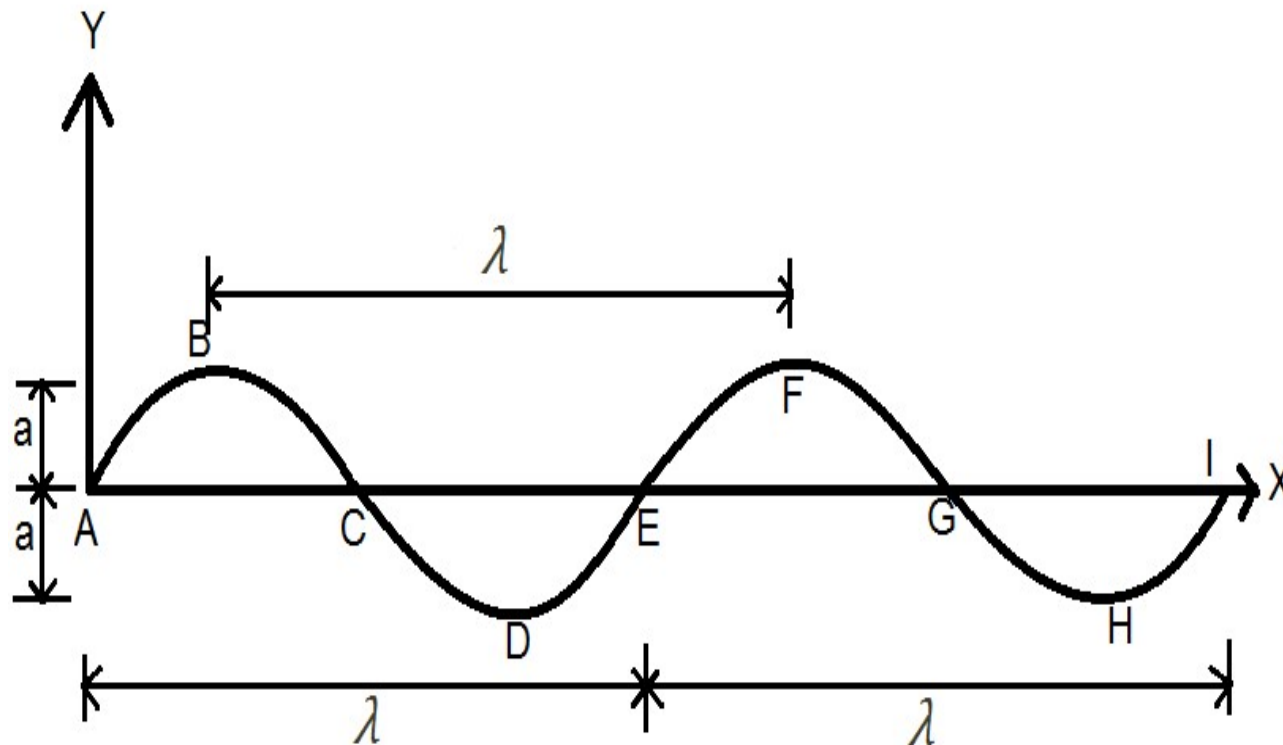


- The length traversed in x-direction by the wave when it complete one cycle is termed as wave length.
- It is equal to distance which separates two identical point.

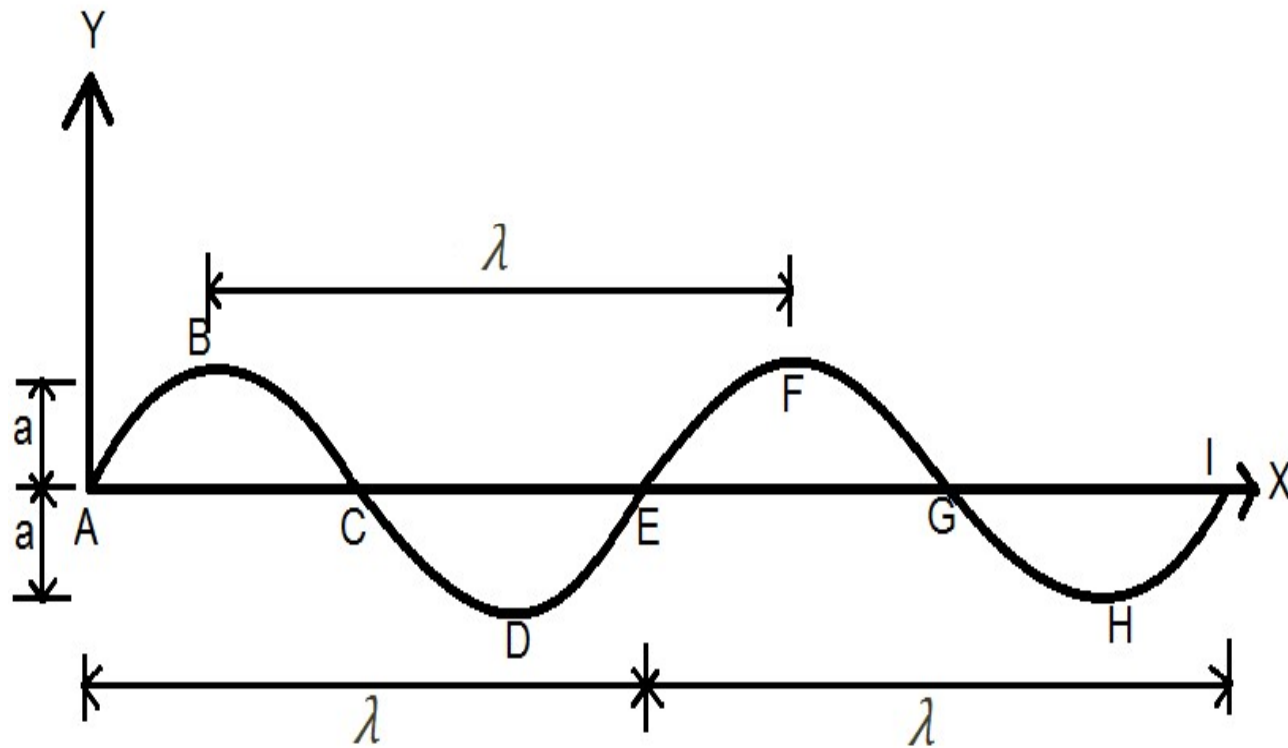




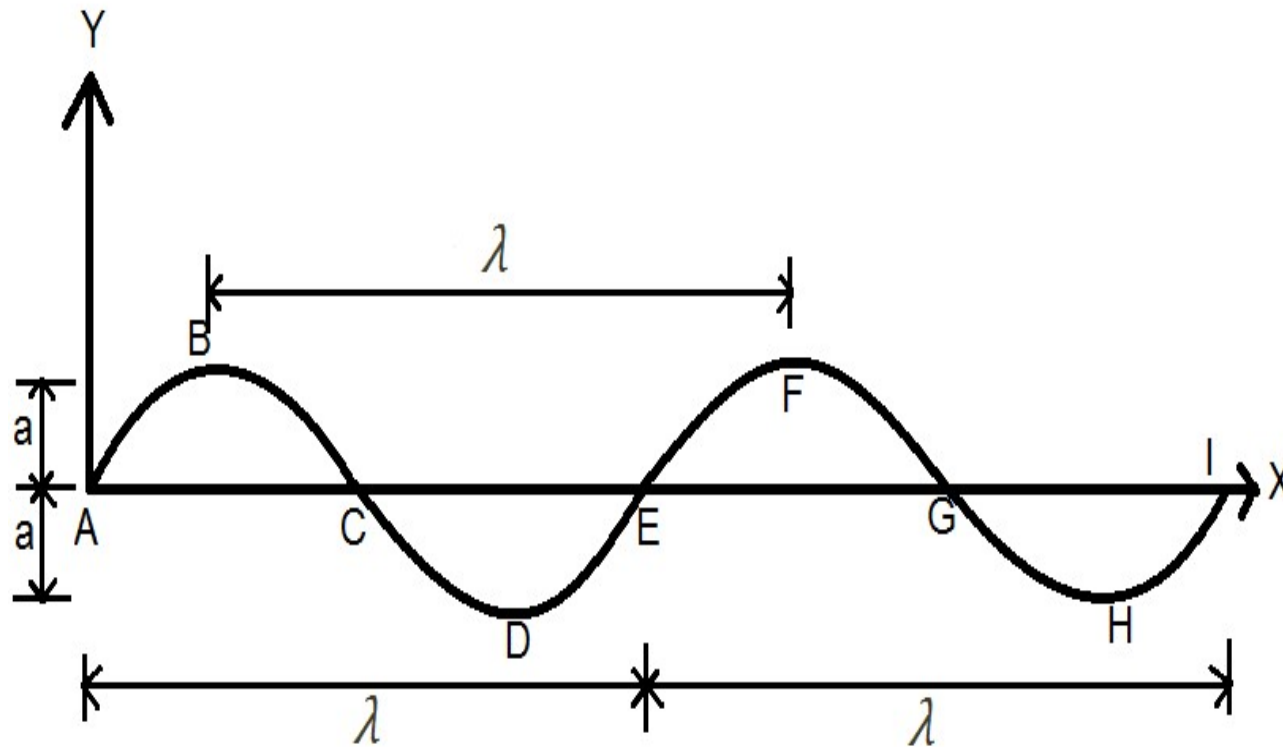
- The wave complete the cycle from identifying point like A to E, B to F, C to G, D to H



- The time taken by the wave to travel one cycle, a distance equal to one wave length is termed as period.



- The velocity ( $v$ ) of the wave is the distance travelled by in one second.

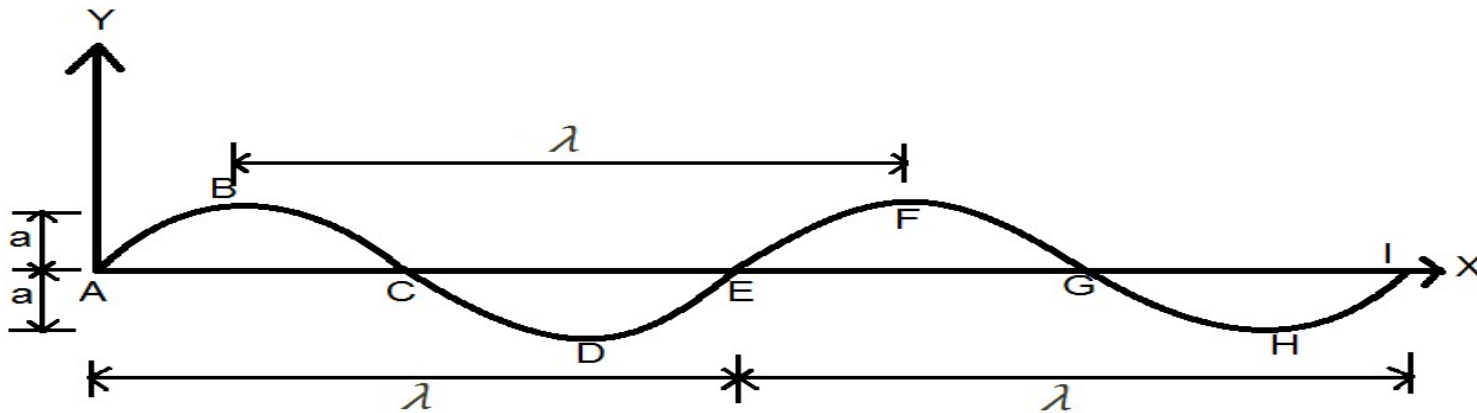


- $T = \frac{1}{f}$
- $\lambda = v * T$
- Here  $v =$  velocity
- $T =$  Time
- $f = \frac{1}{T} = \frac{v}{\lambda}$
- $f \lambda = v$
- The velocity of the wave in vacuum is termed as speed of light, denoted by symbol  $c$ ,
- $C = 3 \times 10^8 \text{ m/s}$
- $f = \frac{1}{T} = \frac{c}{\lambda}$

# Phase of the wave

- Another property of the wave known as phase of the wave and denoted by symbol  $\Phi$ .
- It varies from 00 to 3600 for one cycle.

Point	A	B	C	D	E	F	G	H	I
Phase $\Phi^{\circ}$	0	90	180	270	360 or 0	90	180	270	360 or 0



# Electromagnetic Spectrum

- Electromagnetic waves are energy carrying waves.
- They carry composite energy due to electrical and magnetic fields.
- Type of electromagnetic waves is known by its wave length or frequency.
- All the travel with a velocity  $3 \times 10^8$  m/s.
- These include  $\gamma$  – rays, X – rays, ultraviolet rays, visible light, infrared rays, micro waves and radio waves.

- There are three type of the waves commonly used in EDM.
- Microwaves
- Infrared waves
- Visible light

# Electronic Distance Measurement

- This instrument is used to find the distance between two point with the help of the EDM.
- The accuracy of this instrument is very good as compare the other distance measure instrument.
- Eliminate the chaining and or taping.
- Easy to handle and operate.



# Principle of EDM

- The basic principle is the indirect determination of the time required for a light beam to travel between two stations.
- EDM is based upon the measurement of phase difference between the transmit and received signals.
- The electromagnetic waves travels with the speed of light, which is app  $3 \times 10^8$  m/s.
- The time of travel will be measured in microsecond and can be measured, knowing the speed of wave the distance can be calculated.

- In short distance measured with electromagnetic velocity.
- Accurate velocity is required to get exact distance.
- EDM used either infrared (Light wave) or micro wave (Radio wave).

# Types of EDM instrument

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graph TD; A[Types of EDM instrument] --> B[Microwave instrument]; A --> C[Visible light instrument]; A --> D[Infrared instrument];
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Microwave instrument

Visible light instrument

Infrared instrument

# Microwave instrument

- First develop in south Africa in 1950.
- Longer range category instrument.
- Instrument range are 3 to 30 GHz.
- Transmitted over long distance like 100 km.
- Tellurometer comes under this categories.
- Tellurometer was the first instrument which used microwaves in measurement of distance for surveying purpose.
- Maximum range of the microwave instrument is 30 to 80 km, with accuracy of  $\pm 15$  mm/km

# Visible light instrument

- The electro optical EDM instrument use visible light.
- A geodimeter comes under this type of the categories.
- Range of this instrument is 5 km to 25 km.
- 5 km during day time ranging and 25 km in night time ranging.
- The first generation of these instruments was developed in Sweden in the early 1950 by Dr. Erik Bergsten.
- Frequencies used in the visible light instrument is of the order  $5 \times 10^{14}$  Hz
- The range of such this instrument is lesser than microwave instrument.
- Accuracy of this instrument is  $\pm 0.2$  mm/km.

# Infrared instrument

- The instrument in which a beam of light is used as the carrier and which gets back reflected from a kind of mirror located at the other end.
- At the one end active instrument and one reflector are required.
- And at the other end one mirror is provided at the other end.
- Suitable for only small distance measurement.
- In infrared EDM instruments, the near infrared radiation band of wave length  $0.9 \times 10^{-6}$  m is used as a carrier wave length.
- The range of such instrument is limited 2 to 5 km.

# There are different EDM instrument

Tellurometer

Geodimeter

Distomats

# Tellurometer

- Electromagnetic Device.
- Use to measure the horizontal distance.
- Invented by Dr. T.L Wadley of South African National Institute for Telecommunication Research.
- In this type of the instrument radio waves are used instead of light waves.
- System consist of two identical unit (1) Master unit (2) Remote unit
- Each unit can switch to operate



- Two operators are required
- Two operators can speak to each other using telephonic sets connected to the instrument.
- The low frequency waves are used for the measurement.
- Master transmitted a series of microwaves and pickup by the remote.
- Distance are measure with the help of the radio waves.
- The tellurometer is a first instrument to measure instrument with light weight power supply of 12 volts or 24 volts.

- Many improvement have been made after the first model MRA - I appear in 1957.
- The size and weight has been reduced.
- Procedure have been simplified.
- The instrument range is increase like 100 Km.
- Accuracy is obtained like  $\pm 10mm$ .

# Geodimeter

- A Geodimeter is a first-generation of Electro-optical instrument.
- This instrument is developed by Dr. Bergstrand of Sweden in 1950.
- Instrument uses light waves.
- The instrument has transmitter and receiver.
- 12 volt battery source is essential.
- The light beam is directed on to a reflector at the other end of the line which is measured.
- The reflector reflects back to the transmitter.

# Distomats

- Distomats are latest in the series of EDM instrument.
- Wild heerbrugg manufacture EDM instrument under the trade name Distomat.
- Following are the popular model :-
  - Distomat DI 1000
  - Distomat DI 5S
  - Distamat DI 3000
  - Distomat DIOR 3002
  - Tachymat TC 2000

- The use of Distomat is similar to that of tellurometer.
- Two instrument are used at both the end of the measured point.
- Communication system is provided.
- The range of instrument is 20m to 150m.
- Distance is automatically displayed on screen.
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# Total Station

- Combination of Electronic theodolite and EDM.
- Various surveying operation are done like linear measurement, angular measurement, elevation measurement.
- Linear measurement :- we use direct or indirect method of measuring linear measurement.
- Angular measurement :- we use prismatic compass, vernier transit theodolite, electronic digital theodolite.

- Elevation Measurement :- we use dumpy level, tilting level, auto level, digital electronic level.
- All the above instrument only one solution is total station.

# Use of Total Station

- It measure the distance.
- It gives difference in elevation or height.
- It measure the angle (Horizontal as well as vertical)
- It measure the height above datum.



# Special purpose of Total Station

- Nine type of the surveying programs.
- Distance Stake out measurement :- by inputting the distance to be determine by the machine, the difference between that distance and the actual measured value is displayed.
- Lot staking Measured :- The input distance from design or the measured distance can be divided in to N equal sections, and separate sections measured.

- Offset point measurement :- This function enable the widths to be right and left of a center line to measured easily to setting the instrument at the center.
- Remote Elevation measurement :- to determine the height of the target object like height of the building.
- Co-ordinate measurement :- in this measurement the co-ordinate point as an origin point and from the center.

- Remote Distance Measurement :- this function is used to measure the height difference, slope, horizontal distance etc.
- Resection measurement :- two known point can be measured to determine the instrument point co-ordinate.
- Traverse Measurement :- instrument point coordinates and directional angle.
- Co-ordinates stake out :- instrument point co-ordinates, back sight co-ordinates, measurement point co-ordinates can be carried out.

# Features of Total Station

- Control panel
- Angle measurement
- Distance Measurement
- Onboard software
- Internal/external memories
- Data recording and transferring
- Power supply
- Accessories : Extra battery, ranging pole, tripod