Lecture No. 1 UNIT-1 [Fundamentals of Conventional surveying]

Surveying.

Topic(s) to becovered	Definition - principle - Classification of surveying.

	Lecture Outcome (LO)	Bloom's Level
	At the end of this lecture ,students will be able to	
Lo,	Gain knowledge on principle & Classification of surveying.	Understand.

TeachingLearningMaterial	Student Activity
Chalk / Table	Listen.

Lecture Notes

Surveying:-

It is the process by which determining the relative position of various points on the earth surface. based on distance, direction & elevation and representing the same through a plan / map drawn to a suitable scale.

Principle of Surveying.

1. To work from whole to the part
2. To fix the position of new station by atleast two independent process from fixed reference points.

Work from whole to the part:

a) Establish Control points Covering entire Area.

b) The Area is divided into No. of. parts by forming equilateral Triangle [30° - 120°]

c) It is Surveyed with Greater accuracy.

d) They are further subdivided into Smaller triangles with less accuracy and surveyed Inorder to prevent accumulation of error.

To fix New points

a) To fix the positions of New stations by atleast two Independent procedures.

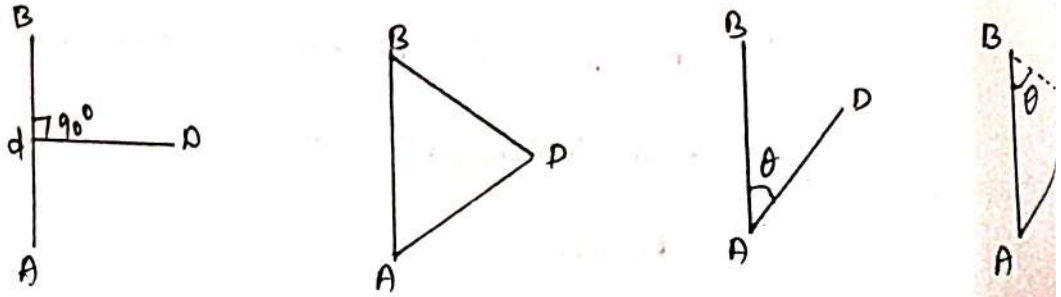
b) The new stations are fixed from points already fixed by

i) Linear Measurement

ii) Angular measurement

iii) Both linear & angular measurement

eg, To locate a point 'D' with respect to two or more given points of reference,



Classification of Surveying

Primary Classification

Secondary "

Primary Classification

1. plane Surveying
2. Geodetic Surveying.

Plane Surveying:-

i) Earth Curvature is not Considered

ii) Suitable for Small Areas $< 250 km^2$

iii) Conducted by State agency

iv) Degree of accuracy is Comparatively low.

Geodetic Surveying:-

i) Covers large Area.

ii) Curvature of Earth is taken into account

iii) Conducted by "Survey of India."

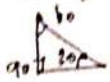
Secondary Classification.

1. Based on Instrument
   a) Chain Surveying
   b) Compass "
   c) plane Table "
   d) Levelling "
   e) Theodolite "

Based on Method:-

1. Triangulation - A triangle in which no angle is less than 30° & greater than 120°

   eg - Equilateral triangle 

2. Traversing

Based on object:

1. Archeological Survey
2. Geological "
3. Mine "
4. Military "

Based on Nature of field:

1. Land Surveying
2. Marine Surveying
3. Astronomical Surveying.

Suggested Questions / Assignments /Home works / any other

1. Explain the Classification of Surveying.

	Text Books/ ReferenceBooks		
S.No	**Title**	**Author**	**Publisher**
1.	Surveying	B.C. punmia.	Laxmi
2.			
3.			

Lecture No. 2 Equipments Used for Ranging & Chaining

Topic(s) to be covered	Chain - Compass - Tape - peg - Arrows

	Lecture Outcome (LO)	Bloom's Level
	At the end of this lecture, students will be able to	
Co1	gain knowledge on accessories required for Chain Surveying	Understand.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

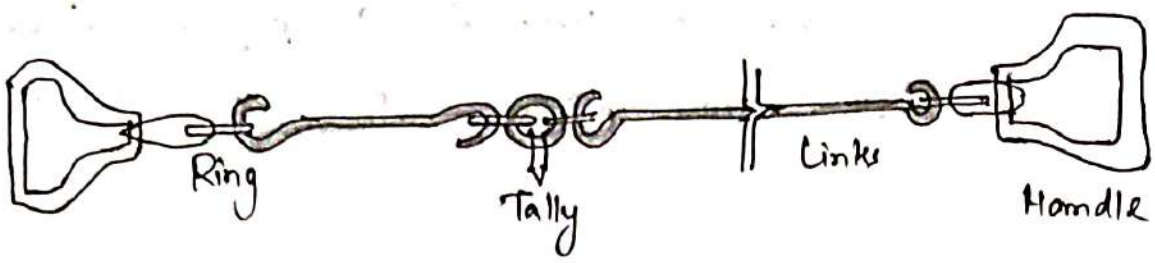
Lecture Notes

Chain:-

- The Chain is Composed of 100 or 150 pieces of Galvanized Mild steel wire 4mm in dia Called links.
- End of each link are bent into a loope & Connected together by means of three oval rings
- Ends of Chain are provided with brass Handle.
- Types of Chains Used in Surveying are
  - a) Metal Chain - 20m & 30m - 100 & 150 links - 0.2m/link
  - b) Engineers Chain - 100ft - 100 links - 1ft/link (20.12m)
  - c) Gunters Chain - 66ft - 100 links - 0.66ft/link (Converted chain) (20.12m)
  - d) Revenue Chain. - 33ft. - 16 links - 2 1/16 ft/Unit. (Cadastral Survey)

10 sq chains = 1 acre; 10 chains & 80 chains Makes 1 furlong; 1 chain = 1/8 mile.

- Chains are very suitable for linear measurement



Tapes:-

Tapes are made of various material

a) Cloth/linen tape - made of cloth - L 10, 20m W 12-15mm

b) Metallic tape - yarn & metallic wires - L 2, 5, 10, 30 & 50m

c) Steel tape - 6 width 6-10mm

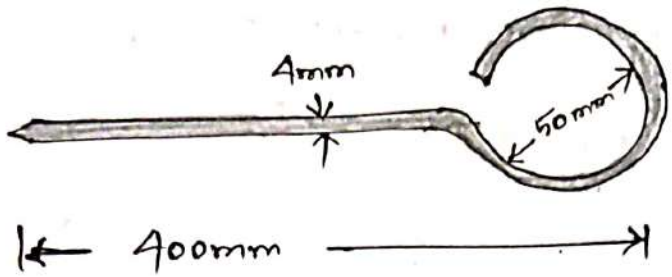
d) Invar Tape. - 36% Nickel & 64% Steel, 3, 30 & 100m, W 6mm Graduated - mm

- The linen tape used for subsidiary measurements
- Tape measures are made in lengths of 2, 5, 10, 20 and 3
- For work of highest precision Invar tape is used for the measurement of base lines in triangulation & in city work.

Arrows:-

- Arrows are called as marking or Chaining
- Used to mark at the end of each chain during the process of Chaining.

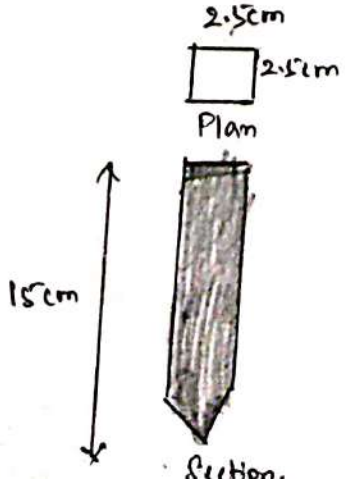
- Arrows are made of steel wire 4mm in diameter.
- Arrows are made 400mm in length are pointed at one end for Inserting into the ground.



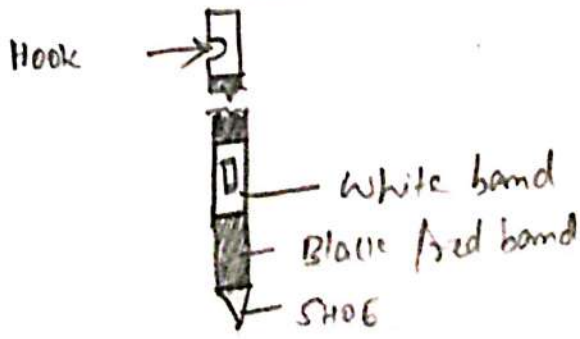
Arrows.

Pegs:-

- Wooden pegs are used to mark the position of Stations.
- They are made of Hard timber & are tapered at one end.
- They are Usually 2.5cm square & 15cm long
- They should firmly driven in the ground with the Steel Hammer with about 4cm projecting above the Surface of the ground.



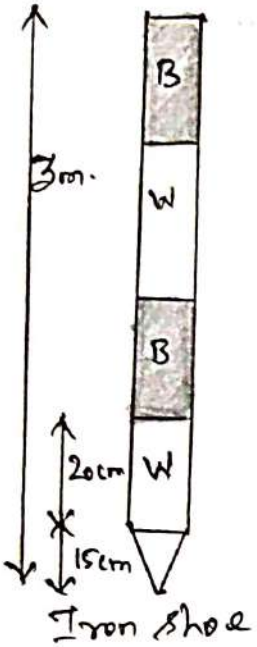
Offset Rods



- At top a stout open ring recessed Hook is provided Align offset line

Ranging Rods

- Ranging rod are made of well seasoned straight timber of teak, blue pine, sissoo or deodar.
- Used for marking the positions of stations conspicuously & for ranging the lines.
- They are Circular or Octagonal in C/s of 3cm nominal diameter & shod with Cross shoe 15cm long at the lower end.
- They are made of 2 sizes namely 2m or 3m & are divided into equal parts each 0.2m long.
- They are painted alternately black & white.



Suggested Questions / Assignments /Home works / any other

1. Describe briefly Instruments used for Chain Surveyi

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Punmia	Laxmi
2.			
3.			

Lecture No. 3 Ranging.

Topic(s) to be covered	Methods of Ranging - Direct Ranging - Indirect Ranging.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO_1	Gain knowledge on method of Ranging.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

Ranging:-

- The operation of establishing intermediate points on a straight line between the terminal points is known as ranging.
- It may be done by eye or a line ranger or a theodolite.

Methods of Ranging:

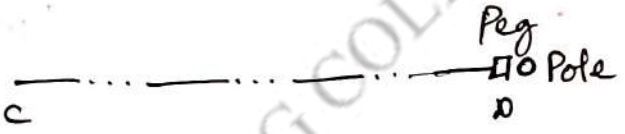
1. Direct Ranging
2. Indirect Ranging.

Direct Ranging:-

It is called direct when intermediate ranging rods are placed in line by direct observation from either end.

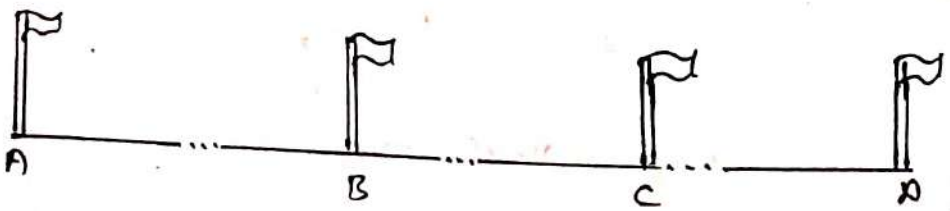
Ranging by Eye:-

To begin with, the ranging rods should be erected vertically behind each end of the line as in the figure.



To range a rod in line; the surveyor stands about 2m behind the ranging rod vertically at the begining of the line, while the assistant holds the ranging rod at arms length at the point where it is desired to establish the intermediate station.

The surveyor then directs the assistant to move its rod to right or left until the ranging rods appears to be exactly in a straight line.

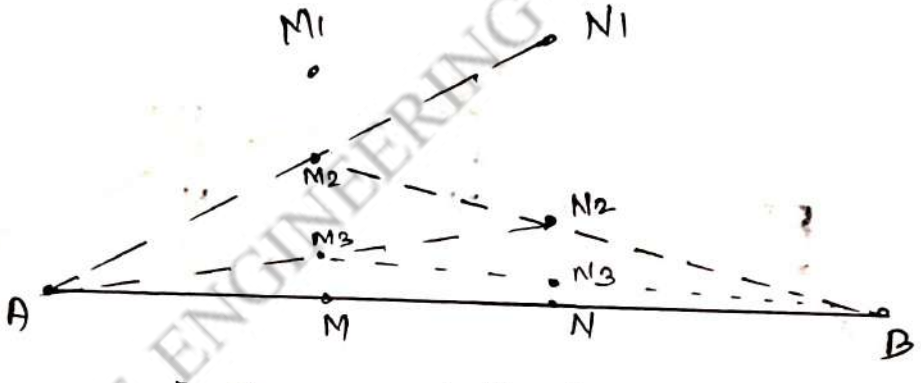


Indirect Ranging:-

Indirect ranging is resorted to when the ends of a line are not intervisible due to high ground or a Hill Intervening, & also when the ends of a line are not distinctly visible from one another due to the distance being too great. In such a case intermediate points can be fixed on the line by a process known as reciprocal ranging.

- Let A & B be the two station with rising ground
- Let 2 Chainmen with ranging rods take up position at M_1 & N_1.
- In such a way the Chainman at M_1 can see both the ranging rods at N_1 & B & the Chainman at N_1 can see the ranging rod at M_1 & A.
- The two Chainmen proceed to line in each other alternatively.
- The Chainman N_1 directs the Chainman M_1 to M_2 in line with A
- The Chainman M_2 directs the Chainman at N_1 to N_2

- By successively directing each other into line, their position will be changed until finally they are both in line AB exactly (ie the four ranging rods A, M, N & B are in the same straight line) when they fix their ranging rods.



Position of Indirect ranging points.

Suggested Questions / Assignments /Home works / any other

1. Write short Notes on
   a) Direct Ranging
   b) Indirect "

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Punmia	Laxmi
2.			
3.			

Lecture No. 4 Compass Surveying.

Topic(s) to be covered	

	Lecture Outcome (LO) At the end of this lecture students will be able to	Bloom's Level
LO1	Gain knowledge on Compass Surveying & type of Compass used in surveying	Understand.

TeachingLearningMaterial	Student Activity
Chalk Talk	Listen

Lecture Notes

Compass Surveying:-

The direction of a survey line are measured using a Compass.

Compass:-

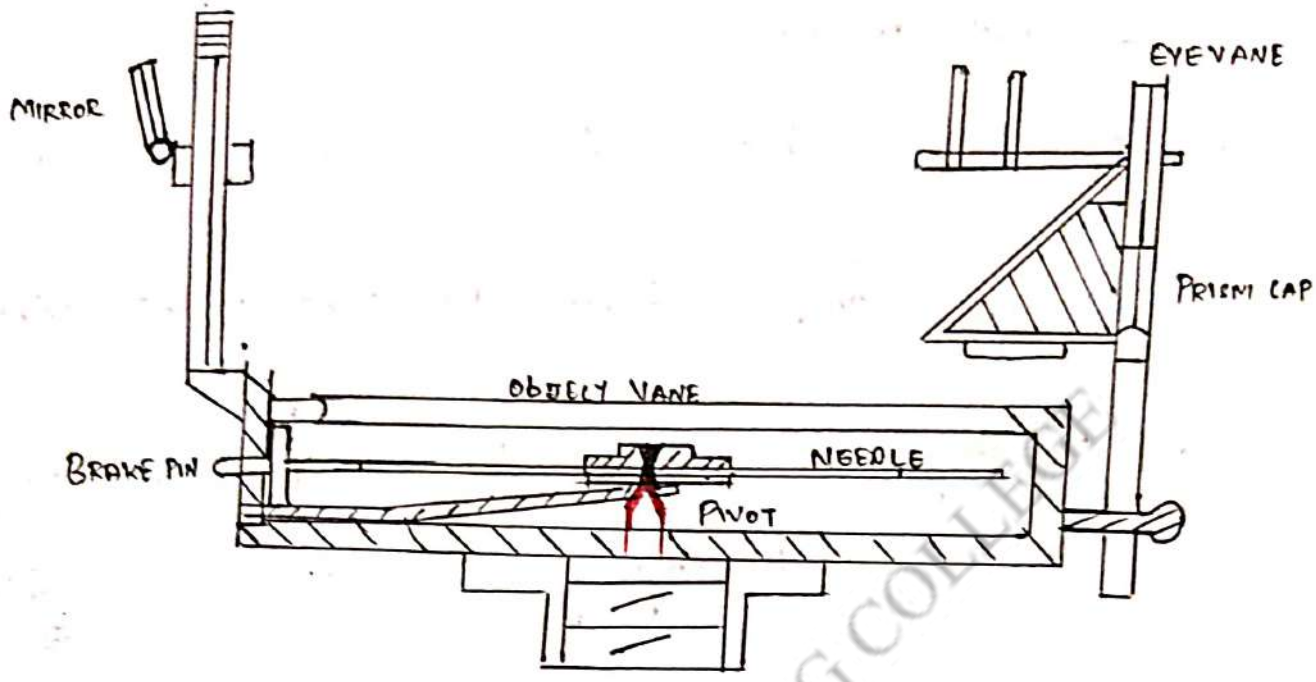
Compass is an Instrument used to measure Bearings or direction of Survey lines.

Types of Compass

1. Prismatic Compass
2. Surveyor Compass.

Prismatic Compass:-

- prismatic Compass is a Circular box of 8-10cm dia.
- It Consists of a broad magnetic Needle balan on a hard steel pivoted point
- Magnetic Needle is attached to graduated aluminiu ring.
- The ring is graduated from 0° to 360° Clockwise
- A prism is provided on the observer side to read the bearings.
- The object Vane Carries a Vertical Hair of fine silk thread.
- A Mirror is provided in the object Vane Sight the object.
- The side face of the prism is made of Convex lens.
- It reads whole Circle Bearing System
- When the Needle points North, the reading Under the prism should be Zero.



Prismatic Compass.

Surveyor Compass:-

- In Surveyor Compass graduated ring is attached to a Circular box.
- The Needle is in edge bar type.
- The Needle floats freely over the pivot
- Eye Vane Consists of a Metal Vane with a fine slit hole.
- It leads Reduced Bearing.

- The Ring is Graduated from 0^0 to 90^0
- Zero Degree is placed both in North direction & south direction.
- 90^0 is placed both in East direction & West direction
- Surveyor Compass Cannot be used without tripod.
- Reading & sighting the object Cannot be done Simultaneously.

Suggested Questions / Assignments /Home works / any other

1. Explain the working principle of Prismatic Compass.

	Text Books/ ReferenceBooks		
S.No	Title	Author	Publisher
1.	Surveying B.C. Punmia	B.C. Punmia	Laxmi
2.			
3.			
	Any other suggested Materials		

Lecture No. 5. Include angle problem.

Topic(s) to be covered	Compass Surveying - Included angle determination.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Solve Included angle problems in Compass Surveying.	Apply

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

Lecture Notes

The following is the observed Bearings of Closed traverse. Determine the included angles.

LINE	Fore Bearing.
AB	30^0
BL	270^0
CD	210^0
DA	90^0.

Answer.

Step 1: - Find Back Bearing of each survey lines.

i) Back Bearing of line AB = Fore Bearing of AB + 180°

= 30° + 180°

= 210°

ii) Back Bearing of line BC = Fore Bearing of BC - 180°

= 270° - 180°

= 90°

iii) Back Bearing of line CD = Fore Bearing of CD - 180°

= 210° - 180°

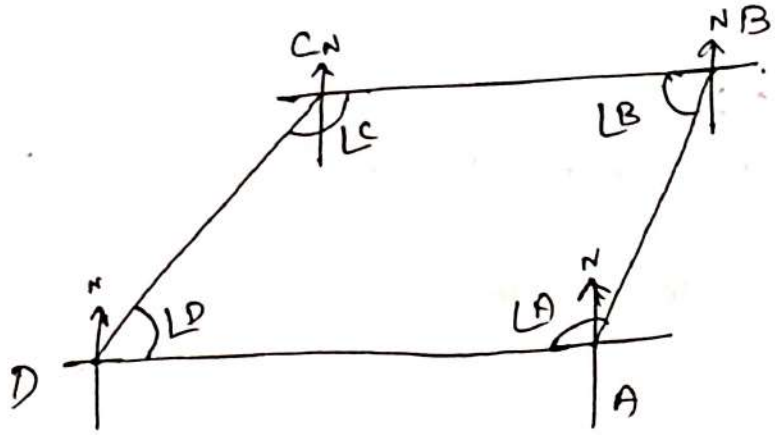
= 30°

iv) Back Bearing of line DA = Fore Bearing of DA + 180°

= 90° + 180°

= 270°.

LINE	Fore Bearing	Back Bearing.
AB	30°	210°
BC	270°	90°
CD	210°	30°
DA	90°	270°

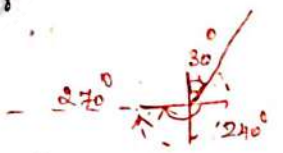


To find LA

LA = Bearing of previous line ~ Bearing of Next line

= Bearing of AD ~ Bearing of AB

= 270° ~ 30°



LA = 240° is exterior Angle, Hence we have minus it from 360°

$LA = 360^\circ - 240^\circ$

$\boxed{LA = 120^\circ}$

To find LB

LB = B. of BA ~ Bearing of BC

$LB = 210^\circ \sim 270^\circ$

$LB = 60^\circ$

- To find $\angle C$:

$\angle C$ = Bearing of CB ~ Bearing of CD

$\angle C = 90^0 \sim 210^0$

$\boxed{\angle C = 120^0}$

- To find $\angle D$:

$\angle D$ = Bearing of DC ~ Bearing of DA

$\angle D = 30^0 \sim 90^0$

$\angle D = 60^0$

Check :-

Summation of all angles = $(2n-4)90$

$\angle A + \angle B + \angle C + \angle D = (2\times4-4)90$

$120^0 + 60^0 + 120^0 + 60^0 = 360^0$

$360^0 = 360^0$.

Suggested Questions / Assignments /Home works / any other

LINE	F.B	B.B
AB	S 55°30'E	N 55°30'W
BC	N 68°15'E	S 66°00'W
CD	N 49°30'W	S 49°45'W
DA	S 20°15'W	N 17°45'E

Which stn are affected by local Attraction. Also find out Corrected bearing. if the mag. Declination is 4°W. Find out True bearings.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Punmia	Laxmi
2.			

Lecture No. 6 Local Attraction.

Topic(s) to be covered	Local attraction - problems solving local attraction.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Lo_1	Gain knowledge on local attraction	Apply

TeachingLearningMaterial	Student Activity
Chalk & Talk	Listen

Lecture Notes

Local Attraction

The magnetic Needle does not point to the magnetic north when under the influence of the external attractive forces.

The magnetic Needle is deflected from its normal position if placed in the vicinity of magnetic rock or Iron Ore, steel structure, Electric Cables such a disturbing influence is known as local attraction.

Magnetic Declination:-

The Horizontal Angle b/n True North Bearing & mag. North at the time of observation is mag. declination.

True Bearing = mag. bearing ± mag. Declination.

+ - Declination is in East
− sign " " " West

Following are the observed Magnetic meridian of the traverse legs. At what station local attraction is suspected ?

LINE	Fore Bearing	Back Bearing
AB	120° 30'	300° 30'
BC	78° 15'	256° 00'
CD	300° 30'	121° 15'
DA	210° 15'	27° 45'

i) Determine the Corrected Bearings of the fo legs

ii) Calculate the Included angles & Apply the c Check.

Answer:

The Bearing of the lines observe Station A and B may be Consid be Correct & they are free from l attraction.

i.e. Fore Bearing ~ Back Bearin

1. Given Fore Bearing of BC = $78^\circ 15'$

Correct Back Bearing of BC = $78^\circ 15' + 180^\circ = 258^\circ 15'$

But observed back bearing of BC is $256^\circ 00'$

$\therefore$ Error at C = $258^\circ 15' - 256^\circ 00'$ (Correct − observed)

Error = $2^\circ 15'$

2. Observed Fore Bearing of CD = $300^\circ 30'$

Error at C = $2^\circ 15'$

$\therefore$ Corrected Fore Bearing of CD = $300^\circ 30' + 2^\circ 15'$

" CD = $302^\circ 45'$

∠ Correct Back Bearing of CD = $302^\circ 45' - 180^\circ$

" CD = $122^\circ 45'$

But observed back bearing of CD = $125^\circ 15'$

$\therefore$ Error at D = $122^\circ 45' - 125^\circ 15'$ (Correct bearing − obs. bearing)

Error at D = $-2^\circ 30'$

3. Observed Fore Bearing of DA = $210^0 15'$

Error at D = $-2^0 30'$

∴ Correct Fore Bearing of DA = $210^0 15' - 2^0 30'$

" DA = $207^0 45'$

& Correct Back Bearing of DA = $207^0 45' \pm 180^0$

Correct Back Bearing of DA = $27^0 45'$

LINE	F.B	B.B	
AB	$120^0 30'$	$300^0 30'$	$= 180^0$
BC	$78^0 15'$	$258^0 15'$	$= 180^0$
CD	$302^0 45'$	$122^0 45'$	$= 180^0$
DA	$207^0 45'$	$27^0 45'$	$= 180^0$.

Suggested Questions / Assignments /Home works / any other

(1) To find out the included angles in a closed survey PQRSTP, the following observations were made. Calculate included angle after Correcting local attractions.

PQ N62°45'E S62°15'W ST S30°W N38°E
QR N21°E S20°45'W TP S54°30'E N53°5'W
RS N71°30'W S71°30'E

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Punmia	Laxmi
2.			

Lecture No. 7 Plane Table Surveying.

Topic(s) to be covered	Plane Table - Components - Merits & Demerits.

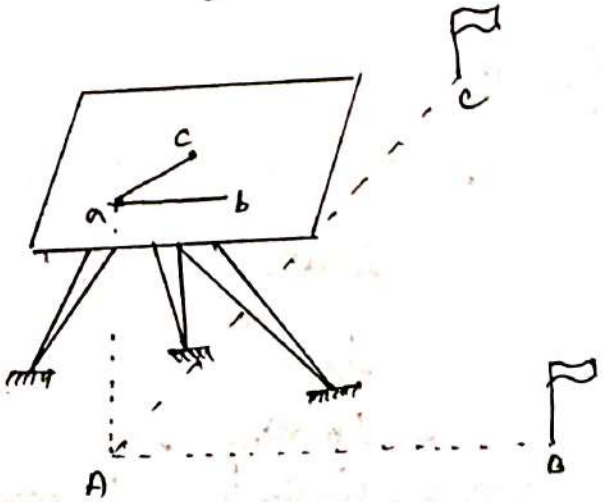
	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on plane table surveying.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

Plane Table is an instrument used for surveying by a graphical Method in which field work & plotting are done simultaneously.

A plane table is a drawing board mounted on a tripod. The principle used in plane table surveying is that an unknown point of interest can be established by measuring its direction from known points.



Components of plane Table.

1. Board
2. Tripod
3. Alidade
4. Trough Compass
5. Spirit level
6. plumbing fork.

Board:-

- It is made of seasoned wood
- The upper surface is kept smooth
- The table at the centre of the underside is attached to the tripod by means of a screw & wing nut.
- Size of plane table available are

  B_0 - 1500 x 1000mm

  B_1 - 1000 x 700mm

  B_2 - 700 x 500mm.

  B_3 - 500 x 350mm.

Tripod:-

- An open frame type light tripod is provid
- Levelling of board is achieved by manipulating legs
- Levelling screws or ball & socket joint is provided f facilitate levelling.

Alidade:-

- Alidade is a wooden or brass ruler
- It is about 50-60cm in length.
- Two vanes are hinged at its 2 ends
  - a) object vane
  - b) Eye vane.
- It is essential the plane of the vanes perpendicular to the underside of alidade while observations are made.

Trough Compass:-

- Trough Compass is 15cm long
- It is provided to plot the magnetic meridian
- It facilitate the orientation of plane table in magnetic meridian.

Spirit level:-

- The board should be level with the help of a spirit level.
- It is placed on the board in two positions mutually at right angles & the bubble is centered in each position to make the board horizontal.

Plumbing fork:-

- It is a hairpin shaped brass frame having two arms of equal length.
- One end is pointed on drawing sheet & other end frame carries a plumb bob.

Advantages:-

1. The observation & plotting are done simultaneous
2. The errors & mistakes in plotting can be checked by d
   Check lines
3. No great skill is required.
4. It is less costly than theodolite survey.

Dis advantages:-

1. It is not suitable for work in a wet climate
2. It is Heavy & awkward to carry
3. It doesnot give very accurate results.

Suggested Questions / Assignments /Home works / any other

1. Describe briefly about plane table survey its Components with merits & Demerits.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	McGraw Hill
2.			
3.			

Lecture No. 8. Radiation Method & Traversing method

Topic(s) to be covered	Radiation - procedure - suitability Traversing procedure - Suitability.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Lo1	Understand how to do Radiation method of plane table Surveying.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

Radiation:-

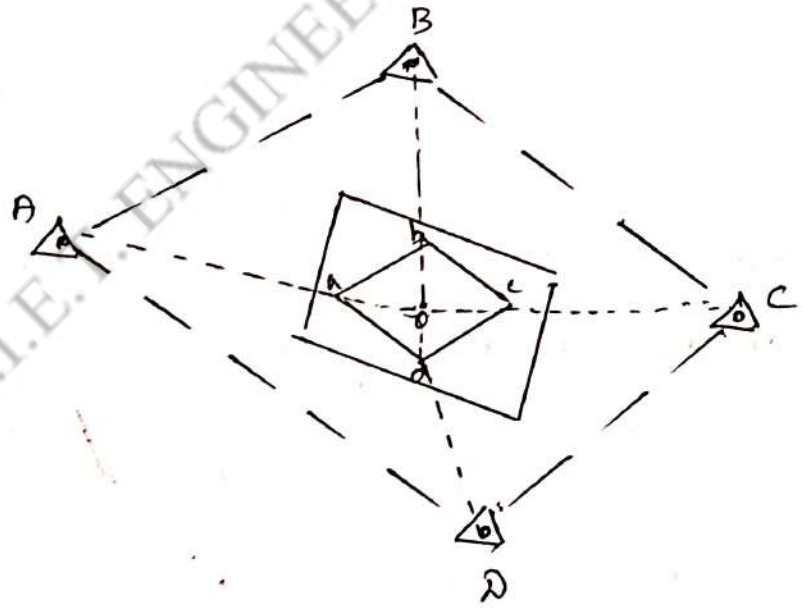
- In this method the instrument is setup at a station & rays are drawn to various stations which are to be plotted.
- The distance are cut to a suitable scale for actual Measurements.

Procedure:-

- Select a station O in the field.
- From the station O all other stations

are Accessible and Visible.

- plot North - South direction in the drawing sheet.
- Setup a plane table at O.
- place the alidade at O & successively sight station A, B, C and D
- Draw rays from O to the stations and cut the distances OA, OB, OC and OD to the Chosen Scale.
- Join A, B, C and D.



Suitability:-

- Suitable when the area to be surveyed is small & all the stations are visible & accessible from instr. station.

Traversing:-

- This method is similar to Compass traversing.
- The table is set at each of the station in succession.
- A foresight is taken to the next station & the distance is cut to a suitable chosen scale.

Procedure:-

i) Set up plane table at the initial station A

ii) Transfer Ground station A as 'a' on the drawing sheet.

iii) Draw a ray aB along the fiducial edge with the alidade pivoted against 'a'.

iv) Cut the distance ab to the selected scale.

v) Shift the table and set up at B.

vi) Orient the plane table.

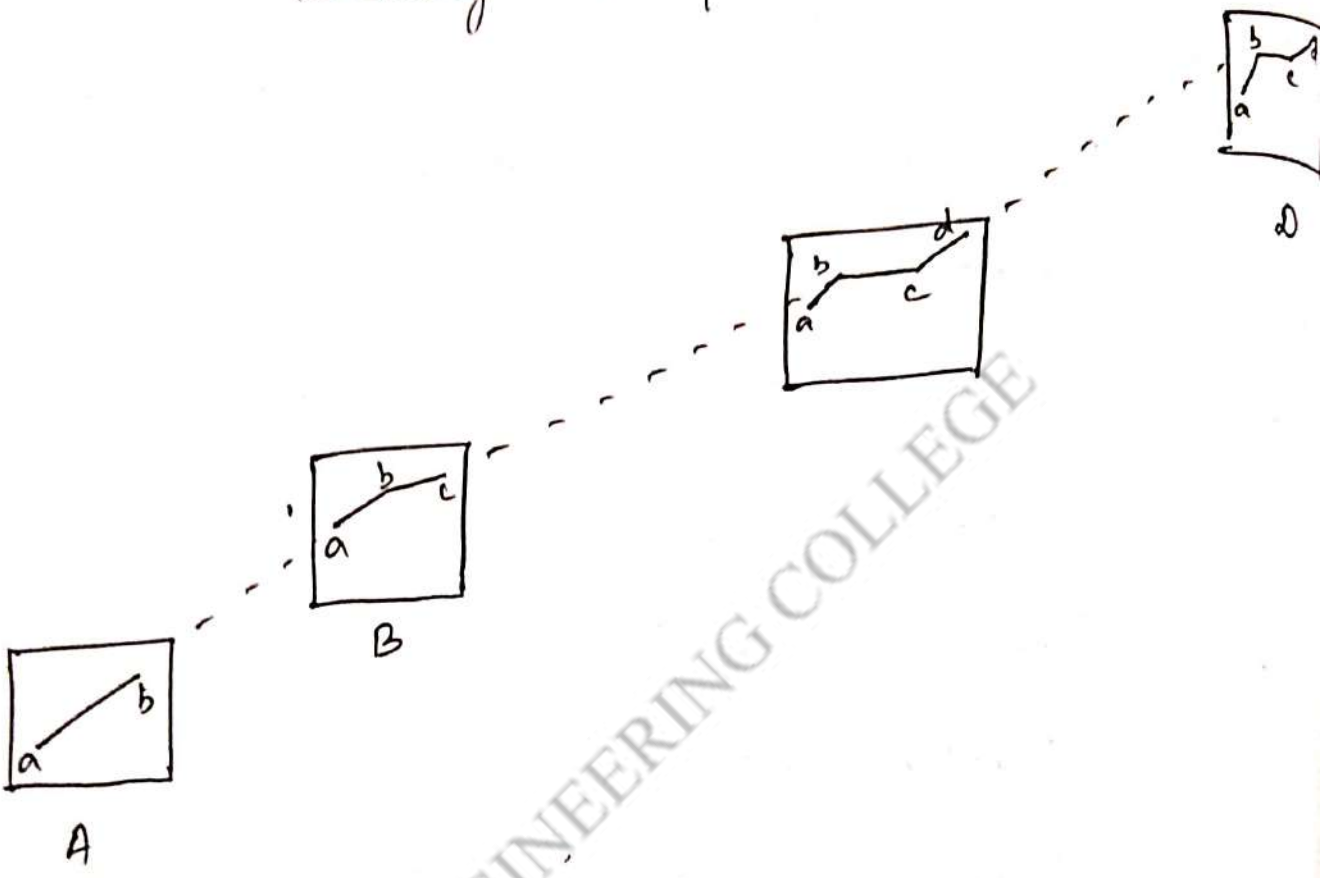
vii) place the alidade at B' & sight station C'.

viii) Draw a ray bc along the alidade & cut the distance bc to the selected scale.

ix) The procedure is carried out till all the station are traversed.

Suitable - Suitable for survey of narrow strip of terrain
eg survey of roads, rails etc.

Traversing with plane Table.



Suggested Questions / Assignments /Home works / any other

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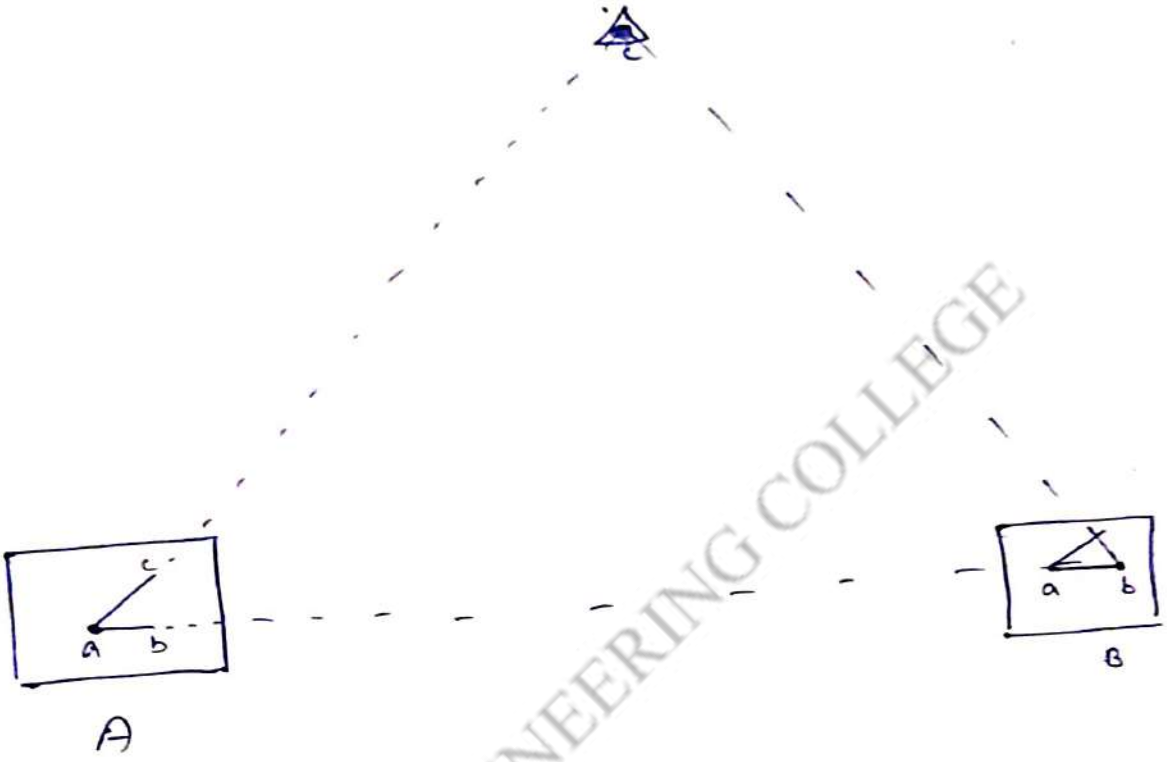
Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Dugal	McGraw Hill
2.			
3.			

Plane Table

③ Intersection Method

Procedure:-



i) Let A & B be the two inAccessible Stations.

ii) C is the stn to be plotted by Intersection.

iii) place the Plane Table at A. set it up.

iv) plot N-S direction.

v) Transfer Ground stn 'A' as 'a' onto the drawing sheet

vi) With the Alidade Centred at 'a', sight stn B. draw ray ab

& cut ab to a Suitable Scale

vii) With the Alidade at A a, sight stn. C & draw ray ac ~~& intersect~~

viii) Shift the table at B & set it up. place the Alidade at b

& sight C. draw a ray bc.

ix) The Intersection of 2 rays gives position of station C

c on plane table.

Lecture No. 9 RESECTION

Topic(s) to be covered	Resection after orientation by 2 points

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Understand how to do Resection method using plane table surveying.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

Lecture Notes

- Resection (2 points)

The two point problem consists of locating the position of a plane table station on the drawing sheet by observation of two well defined points, whose positions have already been plotted on plan.

- Procedure:-

1. Let A & B be the two stations plotted as a & b on the drawing sheet. It is required to plot station C, where the plane tabling is to be done.

2. Choose an arbitrary station D such that CD is approximately parallel to AB.

3. $\angle CAD$ and $\angle CBD$ should not be very acute, which is the necessary condition for good intersection of point

4. Set the plane table at D. Orient it approximately by Eye judgement such that ab is parallel to AB. Clamp the table.

5. Pivot the alidade against a, sight A, & draw a ray. Pivot the alidade against b, sight B & draw a back ray. The two ray intersection at d_1.

6. This will not be the Correct position of D as the Orientation at D is not exact.

7. Pivot the alidade against d_1 and sight C. Draw a ray d_1c & fix the position of C_1 by estimation

8. Shift the table to station C. set the table and Orient it by back sighting at station D.

9. Pivot the alidade against a, sight A & draw a back ray intersecting the line d_1C in C_2

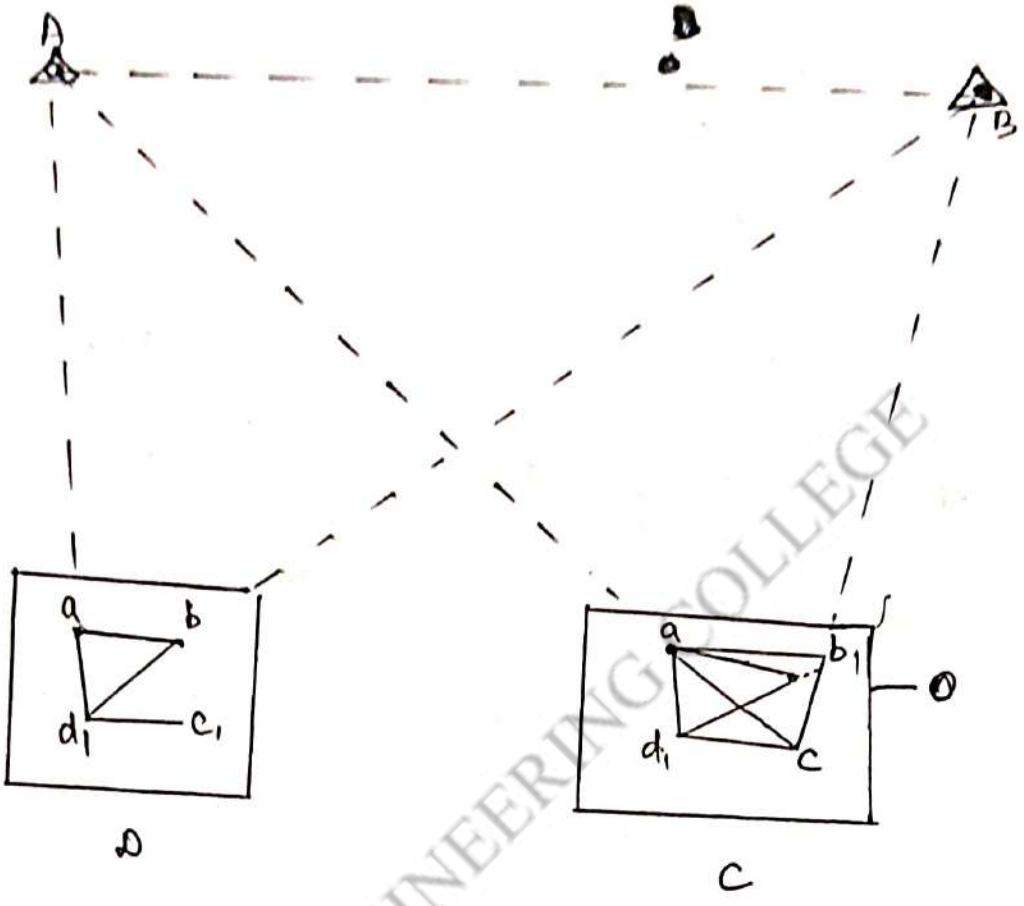
10. Pivot the alidade at C and sight B. Draw a ray to B.

11. If the Ray passes through the plotted point b, the orientation of the table is Correct and c is the Correct position of C. Whereas, if this ray Cuts the previously plotted line d, b at some other point, say b1, then position c is not Correct position of C. To eliminate this error the table must be rotated by the ∠b1ab. To do this a ranging rod O is fixed, in line with ab, far away from the plane table.

12. The alidade is kept along ab1 and O is bisected.

13. The alidade is kept along ab & the table is rotated till the ranging rod at O is bisected. It is Oriented now. The table is then Clamped.

14. With alidade touching a sight A and draw a back ray to C. Then, with alidade touching b, Sight B & draw a back ray to C. The intersection of these two rays gives the position of C.



Resection by two points

Suggested Questions / Assignments /Home works / any other

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Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1	Surveying	Duggal	McGraw Hill

Lecture No. 10 UNIT-II. LEVELING.

Topic(s) to be covered	Levelling – Basic definition.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
CO1	Gain knowledge on levelling & its basic terms used in Surveying.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

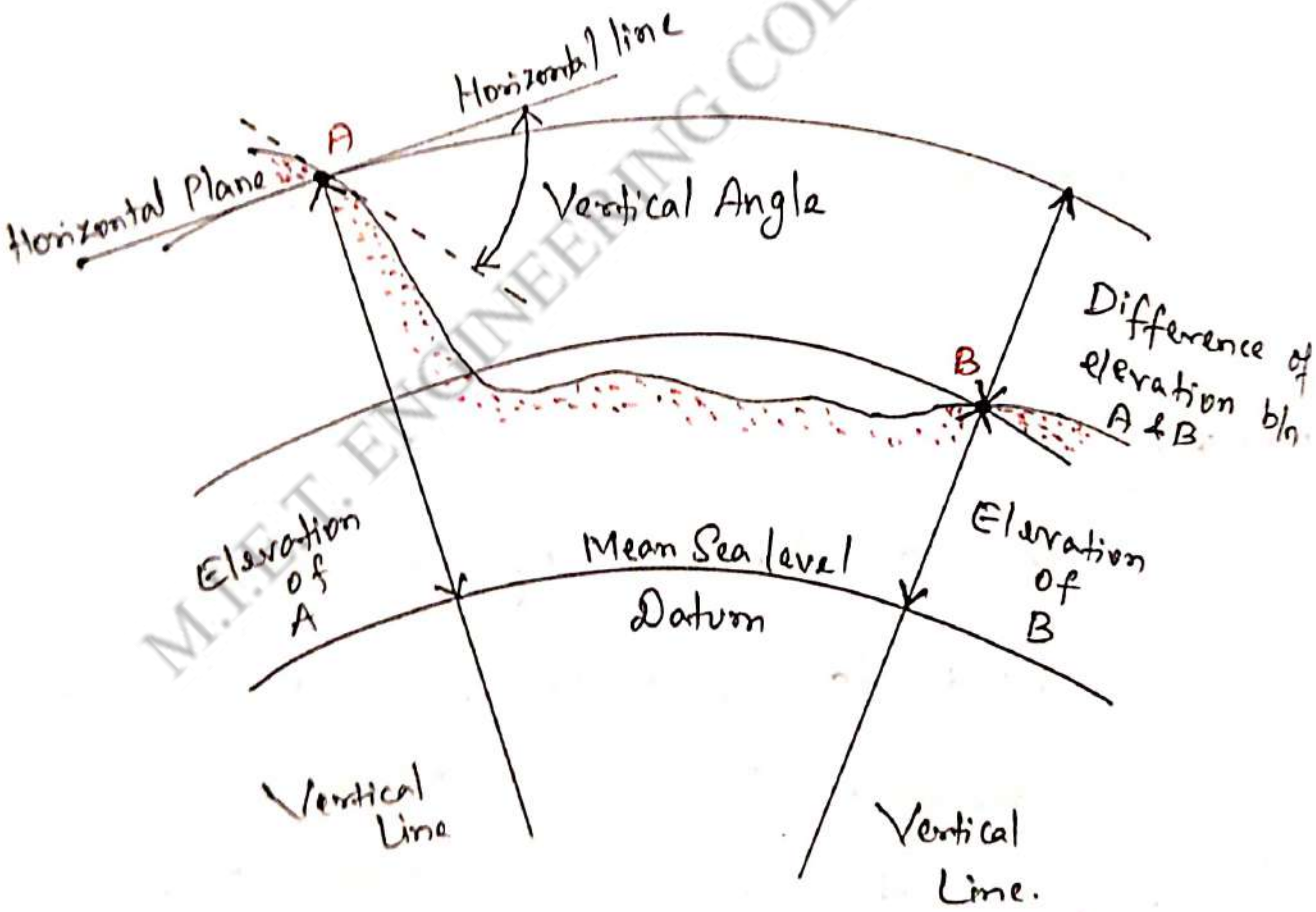
- **LEVELING:-**
  - Is a branch of surveying
  - Used to find the elevation of points with respect to each other on the surface of the earth is called levelling.

Datum:-

- Any surface to which elevation are referred.
- Datum is having a zero elevation.
- Mean sea level affords a convenient datum world wide.

Reduced levels :-

The relative position of a point interms of the Vertical distance, above or below a point is designated by its elevation. The elevation of a point above or below the reference surface (datum) having zero elevation.



Levelling Terms

- **Line of Collimation**

  L.o.c is an imaginary line passing through the optical Centre of the object glass and the intersection of Cross Hair at the diaphragm.

- **Station:-**

  Station is a point where the staff is Held.

- **H.I:-**

  Elevation of L.o.S with respect to datum.

- **Back sight:**

  - Back sight is the sight taken on the staff Held at a point of known elevation. is a "+ve" sight.

- **Fore sight:**

  - Fore sight is the sight taken on the staff held at a point of unknown elevation.
  - Is a minus sight.

- **Turning Point:**

  Is a point on which both Back sight and

fore sight are taken on a line of direct levels.

Bench Mark:-

Bench Mark is the fixed reference point of known elevation.

Types:-

1. Permanent B.M
2. Temporary "
3. GTS "
4. Arbitrary "

Lecture No. 11. Adjustments in Levels.

Topic(s) to be covered	Temporary adjustments. Setting up – Levelling up - Elimination of parallax.

	Lecture Outcome (LO) At the end of this lecture students will be able to	Bloom's Level
Lo1	Gain knowledge on adjustments in level	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

Temporary adjustments

These Consists of i) setting up
ii) Levelling up
iii) Elimination of parallax.

Setting up:

Setting up includes

a) fixing the Instruments

b) Approximate levelling by leg adjustment.

Fixing the Instrument:

The Clamp screw of the

Instrument is released. The level is held in the right hand.

It is fixed on the tripod by turning round the lower part with the left hand and is firmly screwed over the tripod.

Leg Adjustment:

The Instrument is placed at a Convenient Height with the tripod legs spread well apart and so adjusted that the tripod head is as nearly horizontal as can be judged by the eye.

Any two legs of the tripod are fixed firmly into the ground & the third leg is moved right or left in a Circumferential direction until the main bubble is in the Centre. The third leg is then pushed into the ground

LEVELLING UP

1. The clamp is loosened and the upper plate is turned until the longitudinal level axis of plate level is parallel to a line joining any two levelling [illegible] A & B

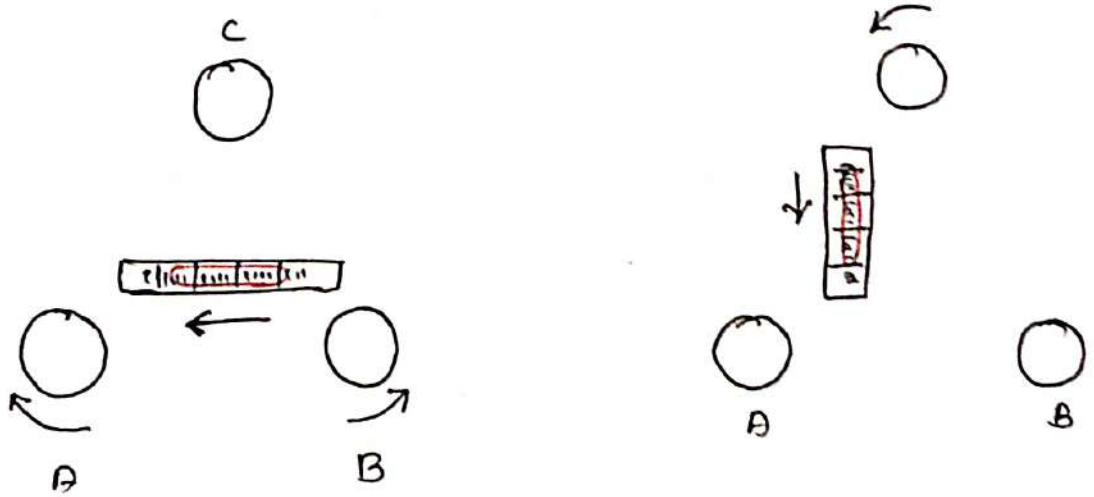
2. The two foot screws are turned uniformly towards each other or away from each other until the plate bubble is Central.

3. The telescope is swing through 90° so that it lies over the third foot screws.

4. The third screw is turned until the plate bubble is Central.

5. The telescope is swing again through 90° to its original position & above procedure is repeated till the bubble remains Central in both the positions.

6. The telescope is now swing through 180°. The bubble should remain Central if the instrument is in proper adjustment.



Levelling with foot Screws.

ELIMINATION OF PARALLAX:

a) Focussing the Eye piece:

1. The telescope is directed skywards or a sheet of paper (white) is held in front of the objective.
2. The eyepiece is moved in or out till the Cross hair appear distinct.

b) Focussing the objective:

1. The telescope is directed towards the staff.
2. The focussing screw is turned until the Image appears Clear & Sharp.

Lecture No. 12 Booking & Reducing the Level.

Topic(s) to be covered	Collimation Method - Rise & Fall Method.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Lo1	Book & Reduce the level to field.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

The observations are recorded in a level book. There are two methods of booking & reducing the levels of the points from the observed staff reading

1. Collimation Method (or) Height of Instrument Method.
2. Rise and Fall Method.

Collimation Method:

- The elevation of plane of Collimation

for the first set up of the level is determ by adding back sight to the reduced level a Bench Mark.

- The Reduced levels of intermediate points and the first change of point are obtained by subtracting the staff readings taken on these points.

- The Instrument is shifted to the second position and a new plane of Collimation is set by taking a back sight on the change point

- The Back sight & fore sight taken on the Change point, the levels of two plane of Collimation are Correlated.

- The Elevation of the new plane of Collimation is obtained by adding the back sight, take on the Change point from the second positi of the level to the reduced level of fir Change point.

- The the reduced level of successive points and the second Change point is obtained by subtracting their staff readings from the Elevation of the new plane of collimation.

Check:

$$\Sigma \text{ Back sight} - \Sigma \text{ Fore sight} = \text{Last R.L} - \text{First R.L}$$

Rise & Fall Method:

- It Consists of determining the difference of levels between the Consecutive points by Comparing their staff readings.

- The Rise & falls is obtained by Calculating the difference between the Consecutive staff readings.

- A Rise is Indicated if the back sight is more than the fore sight.

- A fall is Indicated if the back sight is less than the foresight.

The Reduced level of each point is obtained by adding the rise to, or by subtracting the fall from the Reduced level of the preceding point.

Check!

Σ Back sight ~ Σ Fore sight = Σ Rise ~ Σ

= last R.L ~ First R.L

ggested Questions / Assignments /Home works / any other

1. Explain Height of Collimation & Rise & fall metho

Lecture No. 13.

TYPES OF LEVELLING.

Topic(s) to be covered	Direct levelling - Simple - Differential - fly - check.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on types of levelling	Understand

TeachingLearningMaterial	Student Activity
Chalk Talk	Listen.

Lecture Notes

Types of LEVELLING:

a) Direct levelling

b) Indirect levelling (Trignometrical levelling).

Direct levelling

i) Simple levelling

ii) Differential levelling

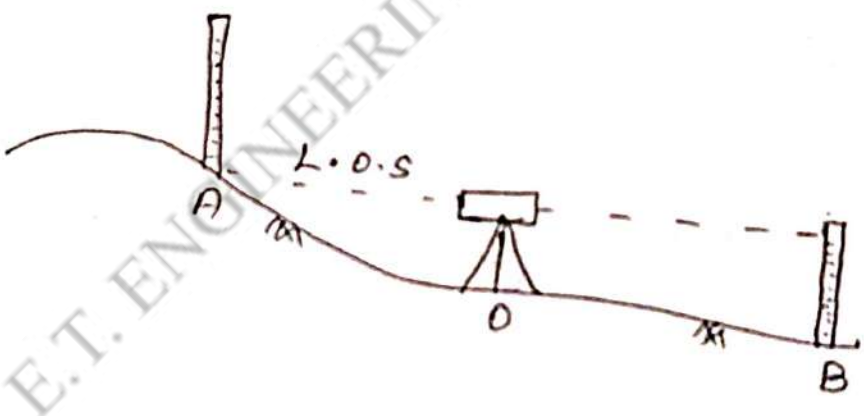
iii) Fly levelling

iv) Check levelling

v) Reciprocal levelling.

Simple levelling:-

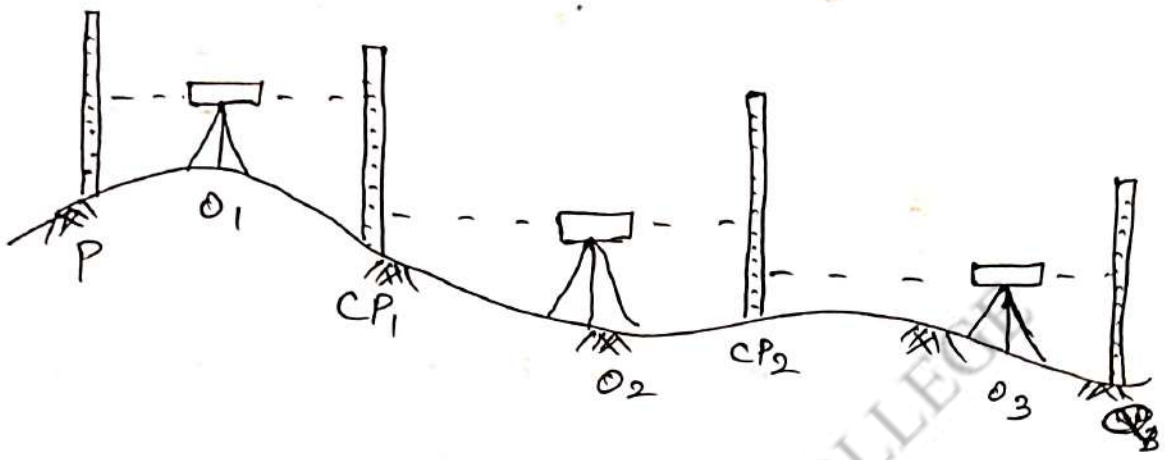
- It is the simplest operation in levelling
- When the difference of level between two points are determined by setting the instruments midway between A & B.
- The difference in staff reading is the difference in elevation between two poi



Differential levelling:

- It is also called as Continuous level
- It mainly adapted
  - i) When the points are at greater distance
  - ii) Where there are obstacles betw the points.

- The difference in level b/n points is Calculated by Reduction of levels.

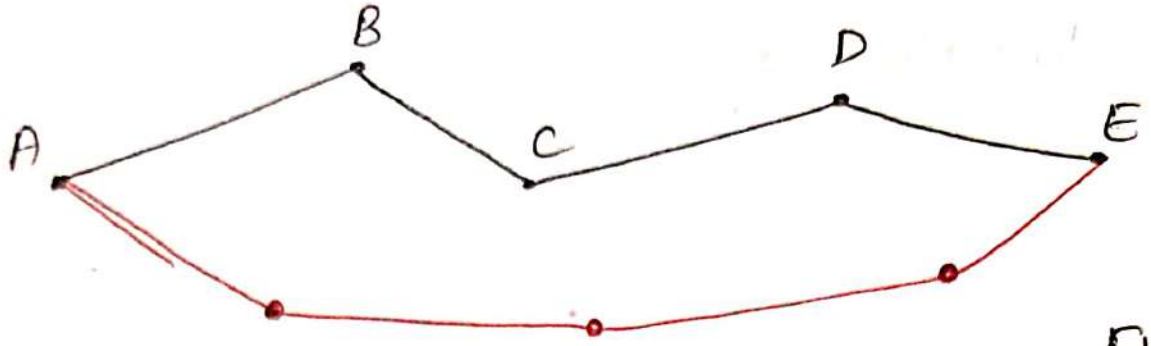


FLY LEVELLING:-

- It is an operation in levelling in which a line of levels is run to determine the approximate elevation along a route.

- When differential levelling is done inorder to Connect a bench mark to the starting point of the alignment of any project it is Called fly levelling.

- It is Carried out for reconnaissance of the linear structure such as roads, railways, tunnels, Canals, etc.



- Fly levelling
- Check level

Check levelling:

The fly levelling is done at the end of the days work to connect the finishing point with the starting point on that particular day is known as Check levelling.

Suggested Questions / Assignments /Home works / any other

1. Explain the different types of levelling.

Lecture No. 14 Reciprocal levelling.

Topic(s) to be covered	Reciprocal levelling. working principle - problem

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
L1	Gain knowledge on reciprocal levelling.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

Lecture Notes

Reciprocal levelling:-

- It is the operation of levelling
- The difference in elevation between two points is accurately determined
- This method is very useful when the instrument cannot be setup between the two points due to an obstruction such as valley, river. etc.

Procedure:

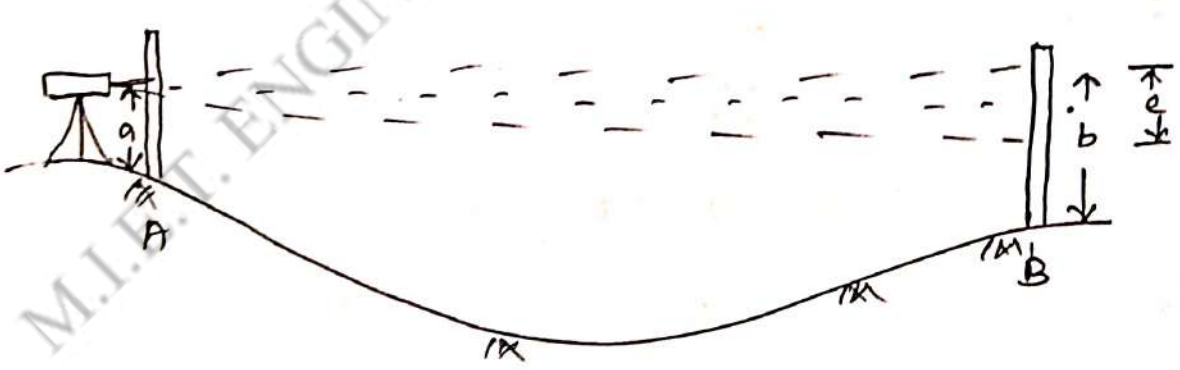
1. In this method the instrument is setup near one point say A on one side on the

Valley. and a reading is taken on the staff held at A, near the instrument I on the staff at B on the other side of the valley.

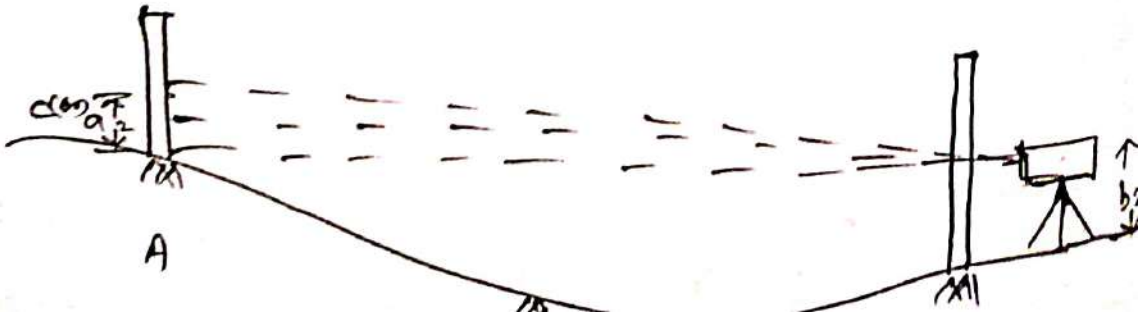
- Let these reading be a and b. The near instrument is shifted to B on the other side of the valley.

- Reading is taken on the staff held at B and that on A.

- Let these reading be c and d.



D



True Difference of level between A and B

$$h = \frac{(a-b) + (c-d)}{2}$$

- The following Notes are for to the reciprocal levels taken with one level. Find the level difference between P & Q

Instrument Station	Staff reading on a.	b	Remarks
P	1.385	3.005	R.L of Q = 120.000m.
Q	0.750	2.320	

1. True difference of level between P and Q

$$h = \frac{(a_1-b_1) + (a_2-b_2)}{2}$$

$$h = \frac{(1.385 - 3.005) + (0.750 - 2.320)}{2}$$

$$\boxed{h = -1.595m}$$

2. Error $e = \frac{(a_1-b_1) - (a_2-b_2)}{2}$

$$= \frac{(1.385 - 3.005) - (0.750 - 2.323)}{2}$$

$$= 0.025m \text{ (or) } 2.54cm.$$

Suggested Questions / Assignments /Home works / any other

Lecture No. 15. Curvature & Refraction.

Topic(s) to be covered	Curvature – Refraction – Combined Correction.

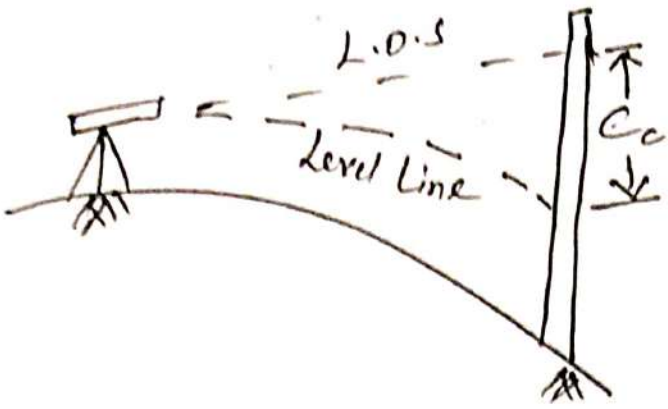
	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on Curvature & Refraction effects & how to eliminate these effects during Levelling	Understand. Apply.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

Curvature:

- For long sight Curvature of earth affects the staff readings.
- L.O.S. is horizontal but level line is Curved & parallel to spherical surface of earth.
- The Vertical distance between Line of sight and level line is called as Curvature Correction.
- Due to Curvature objects appear lower than they really are.



Curvature Correction is always Negative.

$$C_c = 0.0785 D^2$$

Where
C is in kilometre
D is in Metre.

Refraction:

- When a long sights are taken the line of sight is refracted towards the surface of Earth in Curved path.
- Due to refraction, Objects appears higher than they really are.
- Refraction Correction is always positive
- It is represented as C_R.

$$C_R = 0.0112 D^2$$

Combined Correction:-

- It is the summation of Curvature Correction & Refraction Correction. & it is always negative.

$$C_{Combined} = C_c + C_R.$$

$$C_{Combined} = 0.0673D^2$$

Two Bench A & B are 1200m apart across a river. The following reciprocal levels are taken with one level. R.L of A is 100.00m. The error in the collimation adjustment of the level is +0.005m.

Level at	Readings on A	Readings on B
A	1.485	2.365
B	1.035	1.400.

1. Here the staff reading at B is Higher than A
   Hence level difference h is "-ve".

$$H = (a_1 - b_1) + (a_2 - b_2)/2$$

$$H = (1.485 - 2.365) + (1.035 - 1.400)/2 = -0.6225m.$$

2. Correction due to Curvature $C_c = 0.0785D^2$

$D = 1200m$ or $1.2km$.

$$C_c = 0.0785(1.2)^2 = 0.113 \text{ (-ve)}$$

3. Correction due to refraction $C_R = 0.0112D^2$

$$C_R = 0.0112 (1.2)^2$$

$$C_R = 0.016m \text{ (+ve)}.$$

4. True difference after Correction.

$$H = 0.6225m - 0.113 + 0.016m$$

$$\boxed{H = 0.5255m.}$$

Suggested Questions / Assignments /Home works / any other

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	Text Books/ ReferenceBooks
S.No	

Lecture No. 16 H.O.C & Rise & fall problem.

Topic(s) to be covered	—

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Lo1	find level difference between Various points using H.O.C & Rise & fall method	Apply

TeachingLearningMaterial	Student Activity
Chalk & Talk	Listen.

Lecture Notes

1. The following Consecutive readings were taken with a level and a 4m staff on a Continuously sloping ground at a Common Interval of 30m.

0.785, 1.535, 1.955, 2.430, 2.985, 3.480, 1.155, 1.960, 2.365, 3.640, 0.935, 1.045, 1.630 and 2.545.

The R.L of first point A was 180.750m. Calculate the R.L of the remaining points by the Collimation system & Rise & fall System.

1. By Collimation Method

Station	Distance	Readings			Height of Inst	R.L
		BS	IS	FS		
A	0	0.780			181.530	180.750
	30		1.535			179.995
	60		1.955			179.575
	90		2.430			179.100
	120		2.985			178.545
	150	1.155		3.480	179.205	178.050
	180		1.960			177.245
	210		2.365			176.840
	240	0.935		3.640	176.500	175.565
	270		1.045			175.455
	300		1.630			174.870
B	330			2.545		173.955

H.O.C = R.L + B.S

R.L = H.O.C − I.S / F.S.

Check:-

Σ B.S ~ Σ F.S = Last R.L ~ First R.L

2.480 ~ 9.665 = 173.955 ~ 180.750

6.795 = 6.795

Readings

B.S	I.S	F.S	Rise	Fall	R.L
0.750					180.750
	1.535			0.435	179.995
	1.955			0.420	179.575
	2.430			0.475	179.100
	2.985			0.555	178.545
1.155		3.480		0.495	178.050
	1.960			0.805	177.245
	2.365			0.405	176.840
0.935		3.640		1.275	175.565
	1.045			0.110	175.455
	1.630			0.585	174.870
		2.545		0.915	173.955

Rise R.L + Rise = Unknown R.L

R.L - Fall = Unknown R.L

Check :-

Σ B.S ~ Σ F.S = Σ Rise ~ Σ Fall = Last R.L ~ First R.L

$= 2.870 \sim 9.665' = 0 \sim 6.795' = 173.433' \sim 180.7$

$= 6.795 = 6.795' = 6.795.$

There is a fall of 6.795 m at a distance o

$$\text{Gradient} = \frac{6.795\text{m}}{330\text{m}}$$

$$\text{Gradient} = 1 \text{ in } 48.56.$$

Lecture No. 17 Missing reading / Omitted Measurement

Topics to be covered: Problems on Omitted Measurement / Missing Reading of levels.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	find Omitted measurement on levelling.	Apply

TeachingLearningMaterial	Student Activity
Chalk / talk.	Listen

Lecture Notes

Following is the Page of a level field book. The readings in the level book were written with pencil & some of these got erased. The erased readings are marked with question marks. Calculate the Missing Reading.

Stations	B.S	I.S	F.S	Rise	Fall	R.L	Remark
1	?					150.000	B.M
2		2.457			0.827	?	
3		2.400		0.057		?	
4	2.697		?		?	148.070	CP
5	?		2.051	0.646		148.716	CP
6		2.500		1.068		149.784	
7		2.896			?	149.388	
8		?			0.124	?	
9			2.672	0.348		149.612	

Solution:

1. The Back sight reading at station 1 is missing. Th
I.S of station 2 is 2.457m & there is a fall o
0.827m from station 1 to station 2.

∴ The B.S at Stn 1 must be less than I.S at Sta

Back sight at Station = 2.457 - 0.827 = 1.630

2. The R.L of Station 2 is missing.
R.L of station 1 is 150m & there is a fall of 0.827
from station 1 to station 2.

∴ R.L of station 2 must be < R.L of Station 1

R.L of station 2 = 150 - 0.827 = 149.17m.

3. The R.L of station 3 is missing.
R.L of station 2 is 149.170m & there is a rise of 0
from Stn.2 to Stn.3.

∴ R.L of Station 3 = 149.170 + 0.057 = 149.230m

4. Fall from station 3 to 4 is missing. R.L of Stat
3 is 149.230m which is more than R.L of station 4
(148.070m).

∴ Fall from station 3 to station 4 = 149.230 - 148.070 =

5. Fore sight at Station 4 is missing.

The I.S at Stn 3 is 2.400m. There is a fall of 1.160m from Station 3 to station 4. Therefore the fore sight at station 4 must be > than I.S at Station 3.

Fore sight at station 4 = 2.400 + 1.160 = 3.560m.

6. Back sight at station 5 is missing. There is a rise of 1.068m from Stn. 5 to Stn. 6. Therefore, the Back sight at Station 5 must be more than the I.S at Station 6.

Back sight at station 5 = 2.500 + 1.068m = 3.568m.

7. Fall b/n station 6 & 7 is missing. Since R.L of station 6 is more, it is at higher level than Station 7.

∴ Fall between Station 6 & 7 = 149.784 − 149.388 = 0.396m.

8. Intermediate sight at station 8 is missing. There is a fall of 0.124m. from Stn. 7 to Stn. 8.

∴ The I.S at Stn 8 = 2.896 + 0.124 = 3.020m.

9. R.L of station 8 is missing.

R.L of station 7 is 149.388m & there is a fall of 0.124m from Station 7 to Station 8.

∴ R.L of station 8 = 149.388 − 0.124 = 149.26m.

Station	B.S	I.S	F.S	Rise	Fall	R.L
1	1.630m					150.000
2		2.457			0.827	149.173
3		2.400		0.057		149.230
4	2.697		3.560		1.160	148.070
5	3.568		2.057	0.646		148.716
6		2.500		1.068		149.784
7		2.896			0.396	149.388
8		3.020			0.124	149.264
9			2.672			149.612

Suggested Questions / Assignments /Home works / any other

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Lecture No. 11 Contouring.

Topics to be covered	Contouring - Contour - Uses - Methods of Contouring.

	Lecture Outcome (LO) At the end of this lecture students will be able to	Bloom's Level
LO1	Gain knowledge on Contouring	Understand

TeachingLearningMaterial	Student Activity
Chalk / talk	Listen

Lecture Notes

- Contouring:-

- Is the determination of elevation of various points on the ground & fixing these points of same Horizontal position in the Contour map.

Contour:

The Imaginary line joining the R.L of same elevation.

Uses:-

i) Terrain of the County can be studied from Contour map.

ii) Quantity of earthwork can be approximately computed.

iii) To select suitable site for various Engg. projects.

- Methods of Contouring:

1. Direct Method
2. Indirect Method.

- Direct Method:-

- It involves finding points on the ground with the value required Contours. Then These points are marked pegs & are plotted on the map. and is suitable for Measuring Small Areas.

Indirect Method:

1. By Square
2. By Cross Section
3. By Tacheometric Method.

By Square:

i) This Method is suitable for small area & fairly level ground.

ii) The entire area is divided into square/ Rectangles forming a grid.

iii) The elevation of the Contour are determined by Spirit levelling.

iv) The Contour lines are then drawn by Interpolation.

By Cross section:-

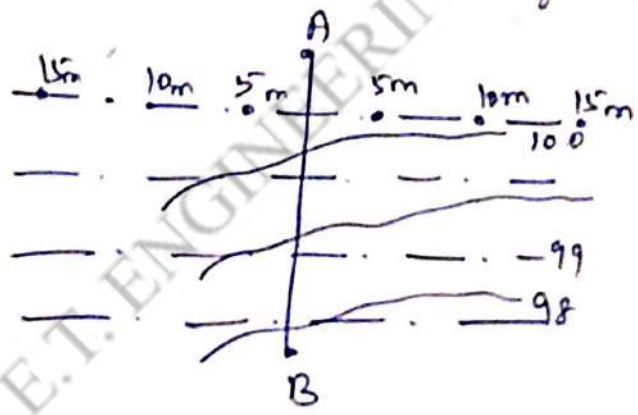
i) Transverse lines are projected on either side of the Centre line.

ii) Several points are Chosen at Reasonable distance on either side.

iii) Spot levels are given to these points by ordinary levelling

iv) C/s lines are plotted to the scale & the points on the lines are marked.

v) The Contours are drawn by Interpolation

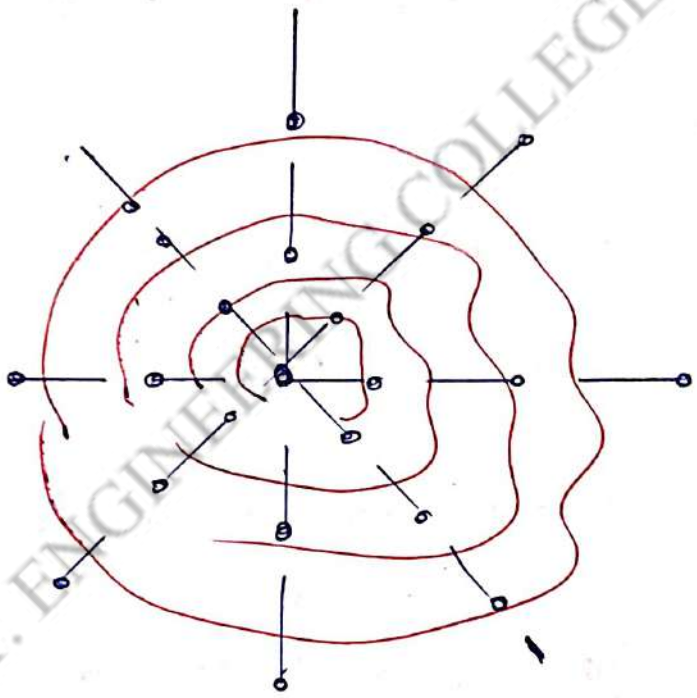


Tacheometric Method:-

i) It is also Called Radial line method

ii) A. No. of. Radial lines are set out at known angular Interval at each station & the points are fixed at Convenient distance apart on the rays & they are set by Compass.

- Suitable ~~state~~ for Hilly terrain.
- By this method both Horizontal & Vertical Control points are established.



Suggested Questions / Assignments /Home works / any other

1. Describe the various methods of Contouring.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying		

Lecture No. 19 UNIT-3 THEODOLITE

Topics to be covered	Theodolite - Uses - Classification - Measurement of Horizontal Angles

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
Lo1	Gain knowledge on Theodolite surveying	Understand

TeachingLearningMaterial	Student Activity
Chalk-talk.	Listen

Lecture Notes

THEODOLITE:

Theodolite is the most precise instrument designed for the measurement of Horizontal & Vertical angles.

Uses:-

- laying of Horizontal Angle
- locating points on a line
- Prolonging Survey line
- Determining difference in elevation.

Classification:-

1. Transit Theodolite.
2. Non-transit "

- Transit Theodolite:-

The Line of sight can be reversed by s
the telescope through 180° in the Vertical plane.

- Non-transit theodolite:-

- Is a plain theodolite
- Telescope cannot be transmitted.

- Measurement of Horizontal Angles using theodolite by

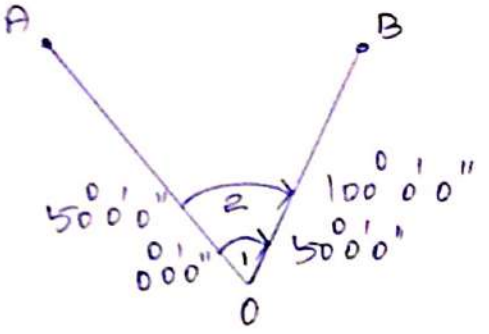
1. Repetition Method
2. Reiteration "

- Repetition Method:-

1. Set the Instrument at O. find the Horizontal angle AOB method of repetition.
2. The Instrument is Centered & levelled. set Vernier A to 0°0'0" & Ver. B to 180°. & turn the telescope to bisect A.
3. Turn the telescope bisect the ranging rod at B and the Ver 'A' & Ver 'B' (eg: 50°00'00")
4. Turn the telescope anticlockwise, Bisect A there is any change in reading.
5. Turn the telescope Clockwise. Bisect the ranging rod & Read the Ver A & B (eg 100°00'00")

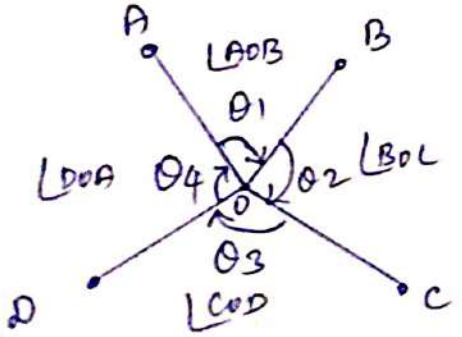
Change the face, observe the reading by following the same procedure.

$$\angle AOB = \frac{\text{Accumulated angle}}{\text{No. of repetition}} = \frac{100^\circ 00' 00''}{2} = 50^\circ 00' 00''.$$



- Method of Reiteration:-

1. Setup the instrument at O & level it. & Set the Ver 'A' to read Zero.
2. Direct the telescope towards A & bisect it. Read the two Vernier A & B.
3. Swing the telescope clockwise & bisect B & read Verniers.
4. Similarly bisect station C, D, & finally A & read both the Verniers in all the cases.
5. This method is Commonly used in triangulation Survey.

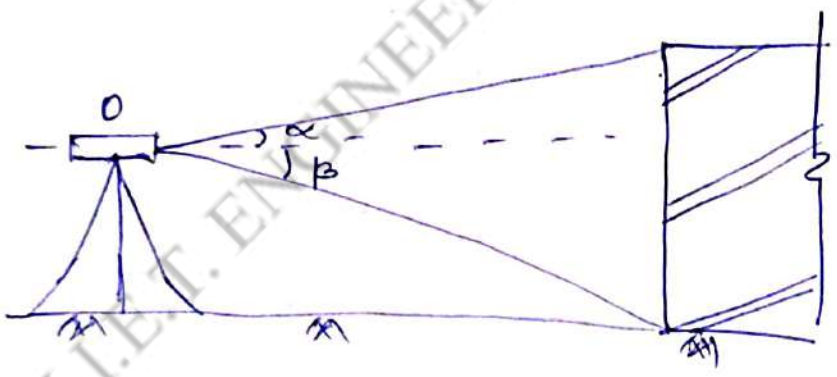


- Measurement of Vertical angles

1. Set the Instrument at O, level it & make the Vernier C & D to 0°0'0" mark of the Vertical Circle & the telescope is Clamp

2. The telescope is raised slowly to observe angle of elevation, bisect to the point A' note the Vernier C' & D' readings.

3. Change the face, take the readings, the mean value is the angle of elevation.



Suggested Questions / Assignments /Home works / any other

1. Write short notes on
   a) Repetation Method
   b) Reiteration "

Lecture No. 20 Tacheometry Surveying.

Topic(s) to be covered	Tacheometry Surveying - Tacheometer - principle of Tacheometer.

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on Tacheometry Surveying.	Understand

TeachingLearningMaterial	Student Activity
Chalk Talk	Listen

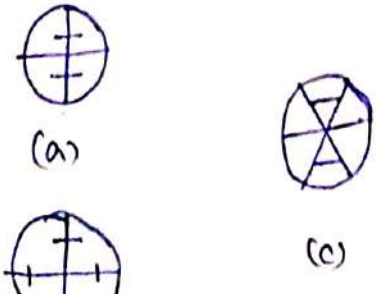
Lecture Notes

- **Tacheometry Surveying:**

  Is a branch of Surveying in which Horizontal & Vertical distance are determined by taking angular observation with an Instrument known as tacheometer.

- **Tachometer:-**

  - Is a transit theodolite fitted with a stadia diaphragm & an Anallatic lens.



Stadia Diaphgrams.

- Principle of Tacheometry:

  - Based on the property of Isosceles triangle, the ratio of distance of the base from the apex and the base is always Constant.

  Where,

  $= f/i$ — f - focal length of Objective
  i - Stadia Intercept.

Note:-

Multiplying Constant k or $f/i = 100$

Additive Constant C or $(f+d) = 0$.

- System of Tacheometric Surveying:

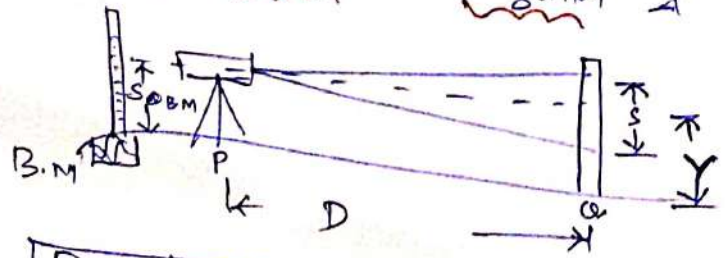
  1. Stadia System.
  2. Tangential System.

- Stadia System:- (fixed Hair)

  To find Horizontal distance between points.

  $D = k.s + c$

Case (1) Line of sight is Horizontal & staff held ⊥

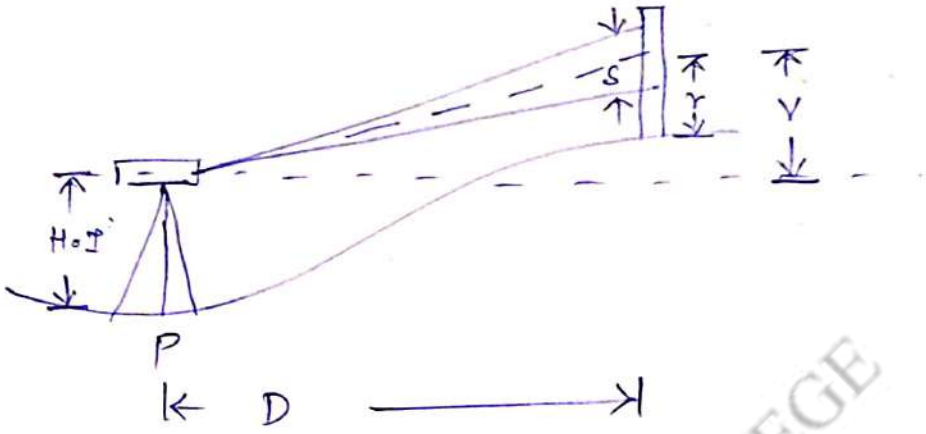


$D = k.s + c$ & R.L of Q = R.L of B.M + S_{BM}

Case (ii) Line of sight is Inclined & staff held Vertical.

- Here the angle measured may be of elevation / depression

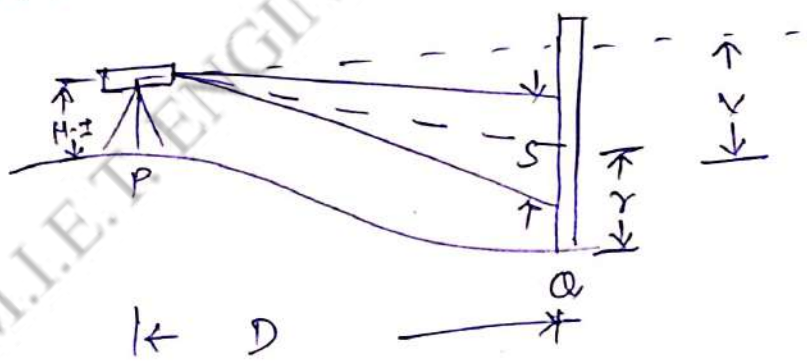
1) Angle of Elevation:-



$D = k.s.\cos^2\theta + c.\cos\theta$ & $V = k.s.\frac{\sin 2\theta}{2} + c.\sin\theta$

R.L of Q = R.L of P + H.I + V − r.

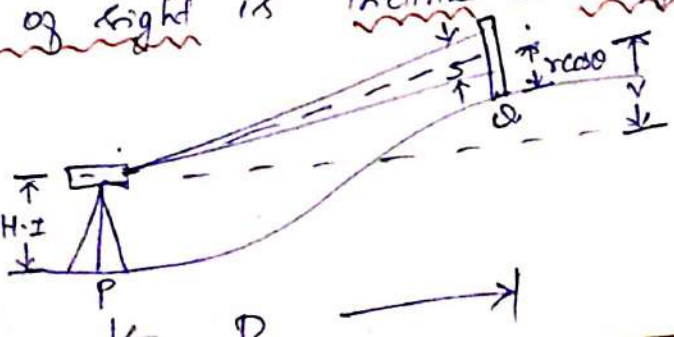
Angle of Depression:-



$D = k.s.\cos^2\theta + c.\cos\theta$ & $V = k.s.\frac{\sin 2\theta}{2} + c.\sin\theta$

R.L of Q = R.L of P + H.I − V − r.

Case (iii) Line of sight is Inclined & staff held normal.



$D = L \cdot \cos\theta + r \cdot \sin\theta$ Where $L = k.s.l.c.$

$V = L \cdot \sin\theta$.

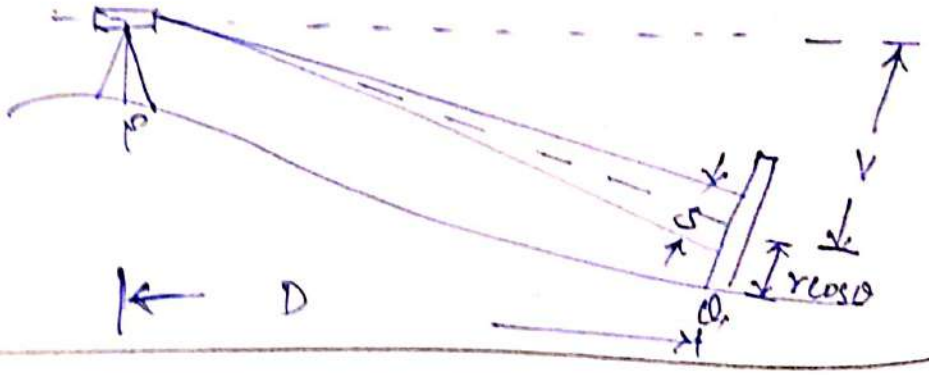
R.L of Q = R.L of P + H.I + V - $r\cos\theta$.

Angle of depression:

$D = L\cos\theta - r\sin\theta$

$V = L \cdot \sin\theta$

R.L of Q_1 = R.L of P + H.I − V − $r\cos\theta$.



Suggested Questions / Assignments /Home works / any other

Lecture No. 21 Stadia Tacheometer [problem]

Topic(s) to be covered	Stadia system - One angle elevation & one angle depression

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
L21	find the horizontal & Vertical distance b/n two points using stadia system.	Apply.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

Lecture Notes

- A Tacheometer was setup at a station C and the following readings were obtained on a staff held Vertically. K=100 & C=0.15.

Inst. at	Staff at	Vertical Angle	Hair readings B	M	T	Remarks.
C	B.M	$-5^{\circ}20'$	1.150	1.800	2.450	B.M 750.000 (R.L)
C	D	$+8^{\circ}12'$	0.750	1.500	2.250	

1. Calculate the Horizontal distance between Instrument station 'C' & staff station 'D'.
2. Find the R.L of D.

Formula Used:

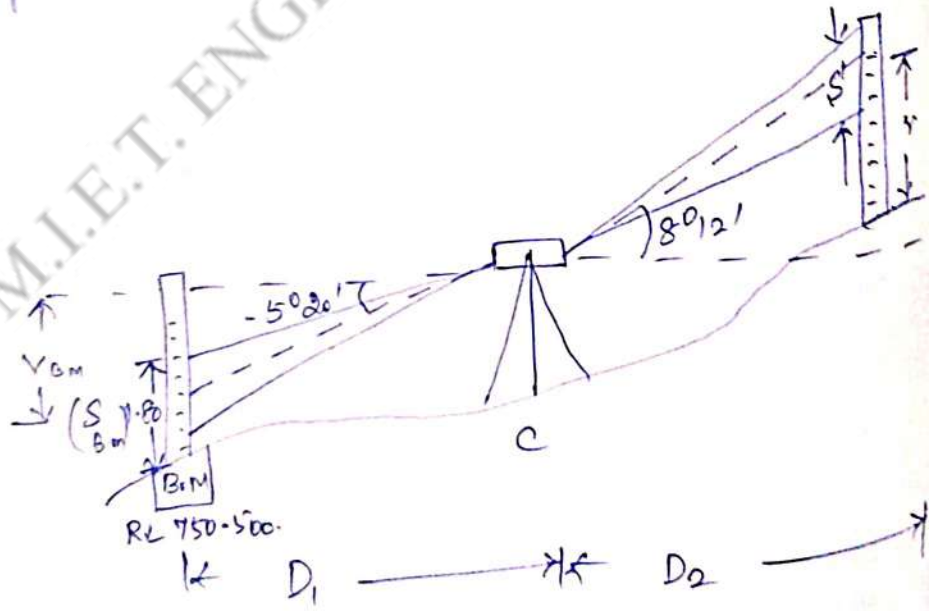
(i) Horizontal Distance between Instrument station to staff Station.

$$D = K.S.\cos^2\theta + C.\cos\theta.$$

(ii) Vertical Height between Line of sight to staff Central axis.

$$V = K.S.\frac{\sin 2\theta}{2} + C.\sin\theta.$$

Diagram:-



Observation to B.M

R.L of B.M = 750.500

K = 100 & C = 0

S = 2.450 - 1.150 = 1.300

θ = 5°20'

$D = k.s.\cos^2\theta + c.\cos\theta$

$D = 100 \times 1.300 \times \cos^2 5^\circ 20' + 0.15 \cos 5^\circ 20'$

$\boxed{D = 128.849m.}$

$V_{B.M} = k.s.\frac{\sin 2\theta}{2} + c.\sin\theta$

$V = 100 \times 1.300 \times \frac{\sin 2(5^\circ 20')}{2} + 0.15 \sin 5^\circ 20'$

$V = 12.044m.$

R.L of Line of sight = R.L of B.M + 1.800 + $V_{B.M}$

$= 750.500 + 1.800 + 12.044$

$\boxed{R.L \text{ of } L.O.S = 764.344m}$

- OBservation to staff station D.

$D = k.s.\cos^2\theta + c.\cos\theta.$

Where

$k = 100$

$s = 2.250 - 0.750 = 1.500$

$c = 0.15$

$\theta = 8^\circ 12'$

$D = 100 \times 1.5 \times \cos^2 8^\circ 12' + 0.15.\cos 8^\circ 12'$

$\boxed{D = 147.088m.}$

(ii) $V = K \cdot S \cdot \frac{\sin 2\theta}{2} + C \cdot \sin\theta$

$V = 100 \times 1.500 \times \frac{\sin 2(8^\circ 12')}{2} + 0.15 \times \sin 8^\circ 12'$

$\boxed{V = 21.19\text{m}.}$

(iii) R.L of D = R.L of L.O.S + V - r

= 764.344 + 21.19 - 1.500

$\boxed{\text{R.L of D} = 784.035\text{m}.}$

Suggested Questions / Assignments /Home works / any other
—

S.No	Text Books/ ReferenceBooks
	Title

Lecture No. 29. Stadia System (Problem)

Topic(s) to be covered	problems on Stadia system.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	solve problems in Stadia System	Apply.

TeachingLearningMaterial	Student Activity
Chalk / Talk.	Listen

Lecture Notes

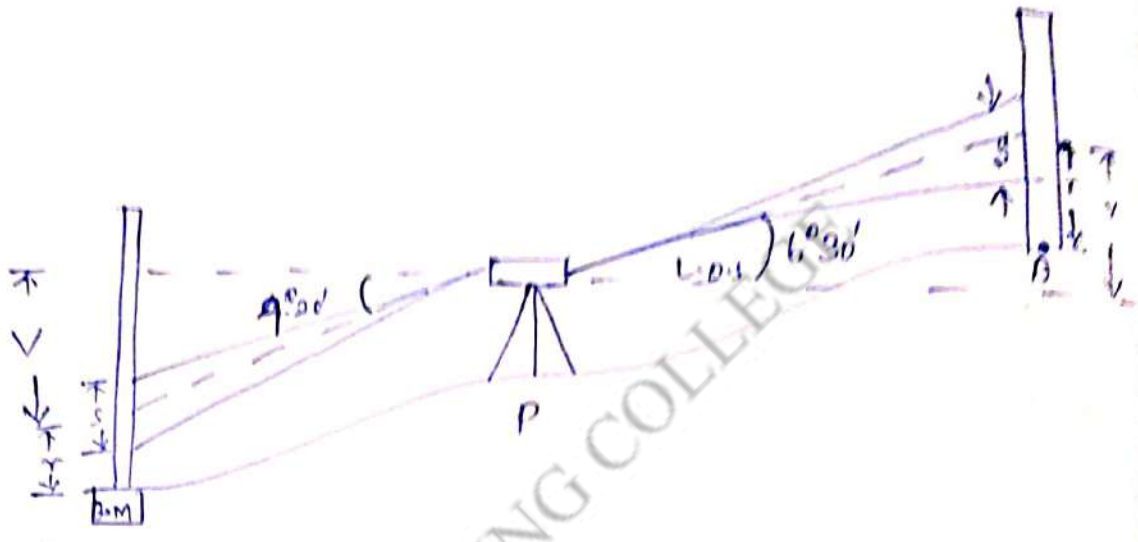
1. The following observation were taken with a tachometer fitted with an anallatic lens. The stagg being held Vertically. The Constant of tacheometry is 100 & 0. R.L of B.M is 255.750m.

Inst at	Staff at	H.I (m)	Vertical angle	Stagg readings
P	B.M	1.255	$-4^{\circ}20'$	1.325, 1.825, 2.325
P	A	1.255	$+6^{\circ}30'$	0.850, 1.600, 2.350
B	A	1.450	$-7^{\circ}24'$	1.715, 2.315, 2.915

Calculate R.L of B & the distance between A & B.

1. observation to B.M from station P.

a) Angle of depression.



25.375cm.

k .

$$V = k.s.\frac{\sin 2\theta}{2} + C.\sin\theta$$

$k = 100$

$s = 2.325 - 1.325 = 1.000m$

$C = 0$

$\theta = 4°20'$

$$V = 100 \times 1.000 \times \frac{\sin 2(4°20')}{2} + 0 \quad [\sin 4°20']$$

$$\boxed{V = 7.534m}$$

2. Observation to station A from P.

Angle of elevation.

$$V = k \cdot \sin\frac{2\theta}{2} + c \cdot \sin\theta.$$

$k = 100$

$S = 2.350 - 0.850$

$S = 1.500\text{m}$

$C = 0$

$\theta = 6^\circ 30'$

$$V = 100 \times 1.500 \times \sin\frac{2(6^\circ 30')}{2} + 0.\sin 6^\circ 30'$$

$V = 16.871\text{m}.$

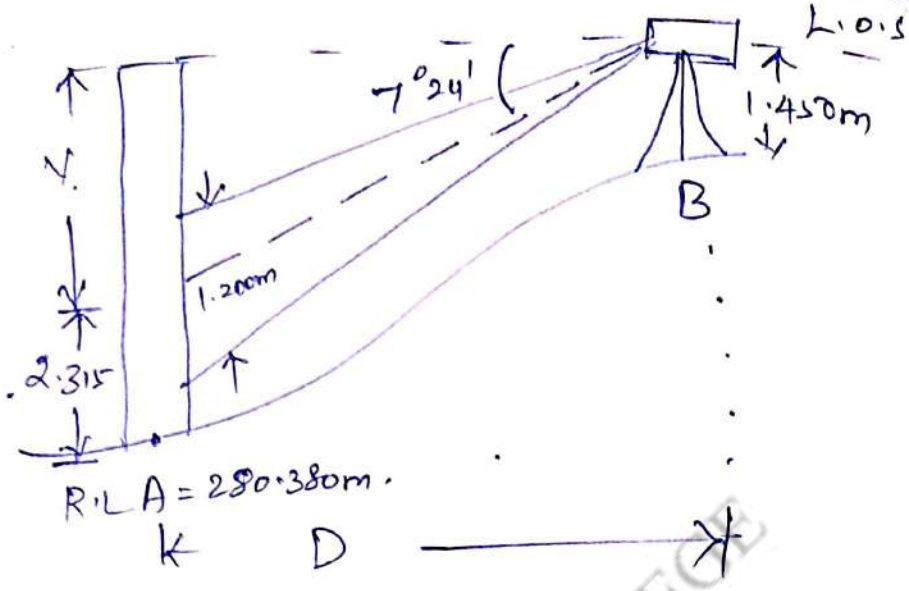
R.L of A = R.L of B.M $\pm$ $\gamma_{B.M}$ $\pm$ $Y_{B.M}$ $+ V_A - r_0$.

$= 253.750 + 1.825 + 7.534 + 16.871 - 1.600$

R.L of A. = 280.380m.

Observation to station A from B.

$$D = k.S.\cos^2\theta + c.\cos\theta.$$



- $D = 100 \times 1.200 \times \cos^2(7°24') + 0 \cdot \cos 7°24'$

$\boxed{D = 118.009m.}$

- $V = 100 \times 1.200 \times \sin\frac{2(7°24')}{2} + 0 \cdot \sin 7°24'$

$\boxed{V = 15.326m.}$

- R.L of B = R.L of A + 2.315 + 15.326 − 1.450 ⇒ 296.571m.
  280.380

Suggested Questions / Assignments /Home works / any other

←

	Text Books/ ReferenceBooks		
S.No	Title	Author	Publisher
1.	Surveying	Duggal	McGraw Hill
2.			
3.			

Lecture No. 23 TANGENTIAL SYSTEM

Topic(s) to be covered	Tangential Method – Both angles are angle of elevation – Angle of Depression – One elevation & other depression.

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
LO1	find distance & elevation b/n two points using tangential system	Understand

TeachingLearningMaterial	Student Activity
Chalk/Talk	Listen

Lecture Notes

Tangential Method:—

The Horizontal & Vertical distances from the Instrument Station to the staff Station are Computed from the observed Vertical angles to the Vane fixed at a Constant distance apart upon the staff.

Cases:-

(i) Both angles are angle of elevation.

(ii) Both angles are angle of depression

(iii) One angle of elevation & other angle of d

Case (i) Both angles are Angle of elevation:-

Let D = distance b/n Instrument station P an
Stagg station Q.

V_2 Vertical distance b/n the Instrument a
and the lower Vane.

S = Distance between Vanes – Stagg Inte

α_1 = Vertical angle to the upper Vane

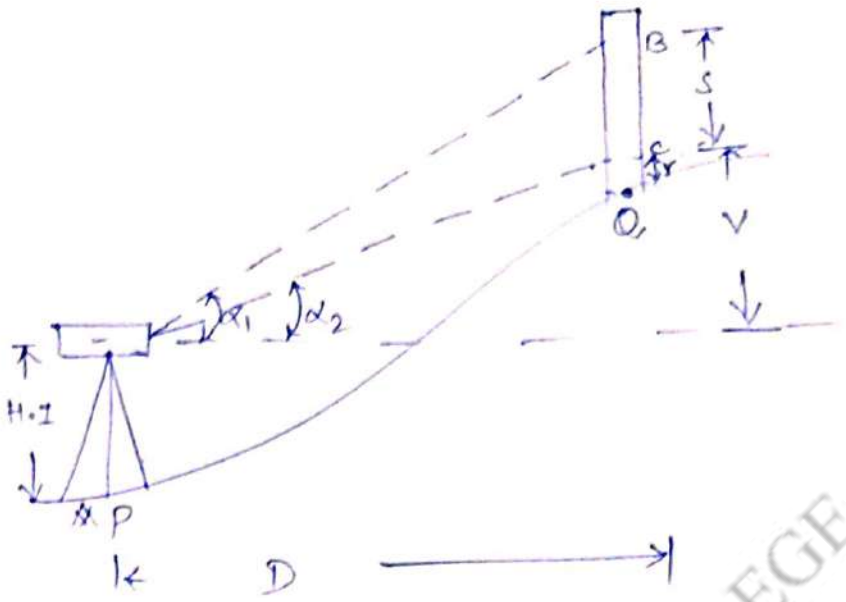
α_2 = Vertical angle to the lower Vane

h = Height of lower Vane c

H.I = Height of Instrument.

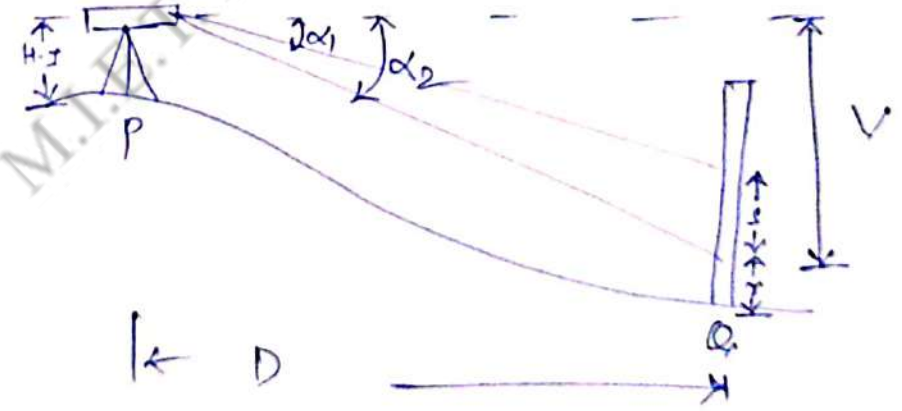
(a) Distance d/w D = $\frac{S}{\tan\alpha_1 - \tan\alpha_2}$

(b) Vertical elevation V = $\frac{S \tan\alpha_2}{\tan\alpha_1 - \tan\alpha_2}$ (or) D



R.L of Q_1 = R.L of P + H.I + V − r

Case (ii) Both angles are of angle of depression.

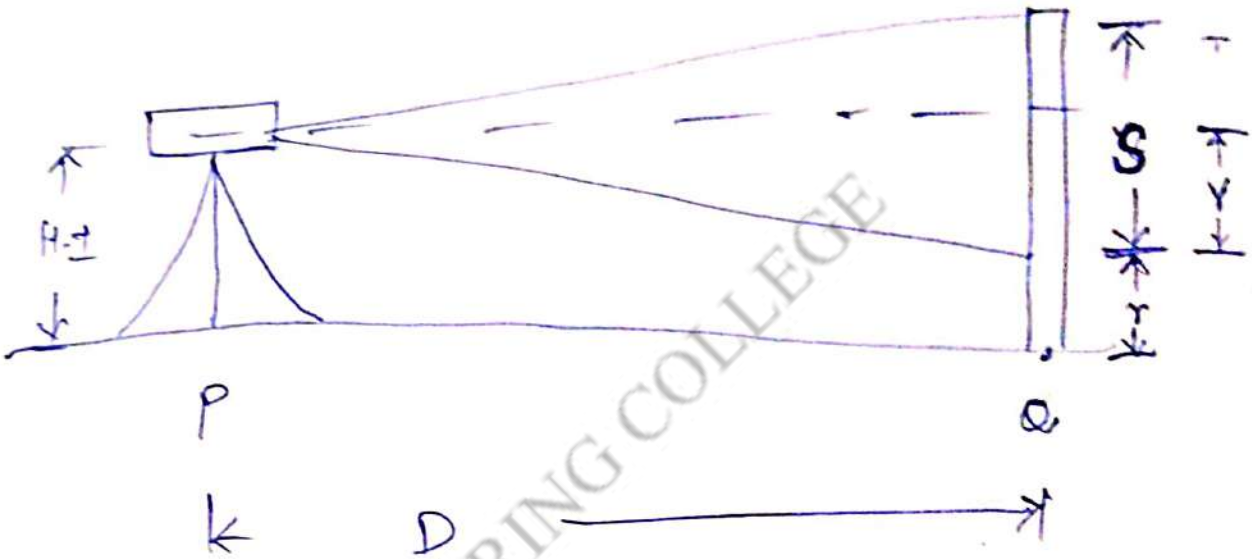


a) $D = \dfrac{S}{\tan\alpha_2 - \tan\alpha_1}$

b) $V = \dfrac{S \tan\alpha_2}{\tan\alpha_2 - \tan\alpha_1}$ (or) $D \tan\alpha_2$

c) R.L of Q_2 = R.L of P + H.I − V − r.

Case (iii) One angle of elevation & other at Depression.



a) Horizontal Distance $D = \frac{S}{\tan\alpha_1 + \tan\alpha_2}$

b) Vertical Distance $V = D \tan\alpha_2$.

c) R.L of Q = R.L of P + H.I − V − r.

Suggested Questions / Assignments /Home works / any other

Lecture No. 21 Tangential System.

Topic(s) to be covered	Problem on Tangential System.

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
Lo,	find distance & elevation b/w two points using tangential	Apply.

TeachingLearningMaterial	Student Activity
Chalk & Talk	Listen.

Lecture Notes

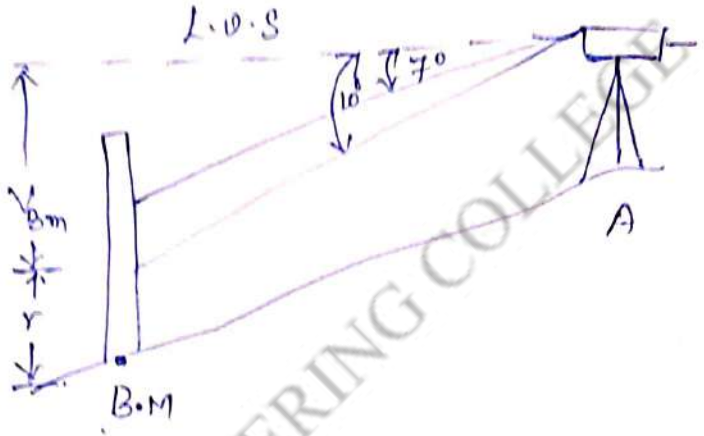
1) A Tacheometer was setup at a station A and the following readings were obtained on a staff held Vertically.. Find the R.L of station B. R.L of Bench Mark is 510.500m. Calculate the Distance between B.M to B.

Inst. at	Staff at	Target	Vertical Angle	Stagg Reading
A	B.M	Lower	-10^0	0.655
		Upper	-7^0	2.655
A	B	Lower	-5^0	1.250
		Upper	$+4^0$	3.200.

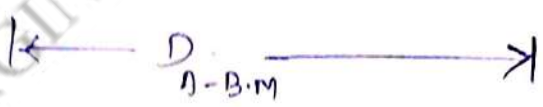
Soln:

1. Observation to Bench Mark.

Angle of depression.



R.L 510.600m.



Horizontal Distance between Bench mark to

$$D = \frac{S}{\tan\alpha_2 - \tan\alpha_1}$$

Where

$S = 2.615 \sim 0.655$

$S = 2.000m.$

$\alpha_1 = 7^0$

$\alpha_2 = 10^0$

$$D = \frac{2.000}{\tan 10^0 - \tan 7^0} = 37.35m.$$

• Vertical elevation between Line of sight to Plane at B and Ground

$$V = \frac{S \tan\alpha_2}{\tan\alpha_1 - \tan\alpha_2}$$

$$V = \frac{2 \tan 10^0}{\tan 14^0 - \tan 4^0}$$

$$\boxed{V = 6.574\,m}$$

(or)

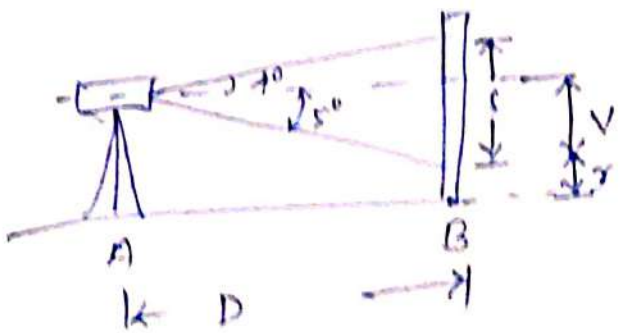
$$V = D \tan\alpha_2$$

$$V = 37.35 \tan 10^0$$

$$\boxed{V = 6.58\,m}$$

Observation to station B.

One angle elevation other angle depression.



Where $S = 3.200 \sim 1.250 = 1.950$

1) $D = \frac{S}{\tan\alpha_1 + \tan\alpha_2}$

$\alpha_1 = 4^0$

$\alpha_2 = 5^0$

$D = \frac{1.950}{\tan 4^0 + \tan 5^0} = 12.38m.$

2) $V = D \tan\alpha_2$

$V = 12.38 \tan 5^0$

$V = 1.083m.$

3) R.L of B = R.L of B.M + r + $V_{B.M}$ − V_B − r_B

= 510.500 + 0.655 + 6.574 − 1.083 − 1.250

R.L of B = 515.402m.

Suggested Questions / Assignments /Home works / any other

ture No. 25 Trigonometrical Leveling.

pic(s) to covered	Single plane Method & Double plane method. (Base inaccessible)

	Lecture Outcome (LO)	Bloom's Level
	At the end of this lecture ,students will be able to	
LO1	Gain knowledge on Trignometrical Levelling	Understand

TeachingLearningMaterial	Student Activity
Chalk/Talk	Listen.

Lecture Notes

Trignometrical levelling:-

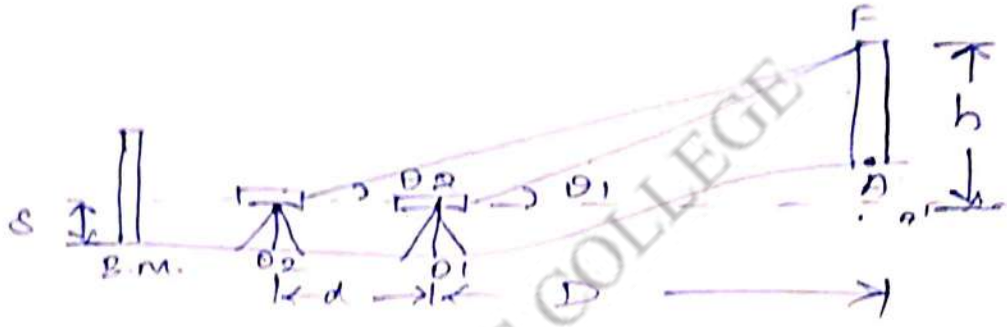
This is an Indirect Method of levelling in which the difference in elevation of the points is determined from the observed Vertical angles and measured distances.

The Vertical angles are measured with a transit & the distances are measured directly or Computed trignometrically.

- It is used topographical work to find the elevation of the top of buildings, Chimneys, Church Spires and so on.

Base of the object inaccessible - The instrument and the elevated object are in the same plane.

a) Instrument axes at same level.

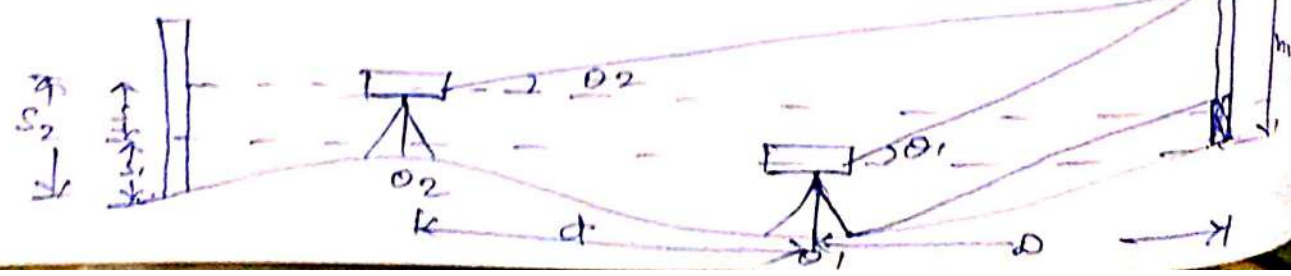


a) Horizontal Distance $D = \frac{d \tan\theta_2}{\tan\theta_1 - \tan\theta_2}$

b) Vertical Height $h = D \tan\theta_1 = \frac{d \tan\theta_2 \tan\theta_1}{(\tan\theta_1 - \tan\theta_2)}$

c) R.L of F = R.L of B.M + S + h.

(b) Instrument axes at different levels.



a) Horizontal distance

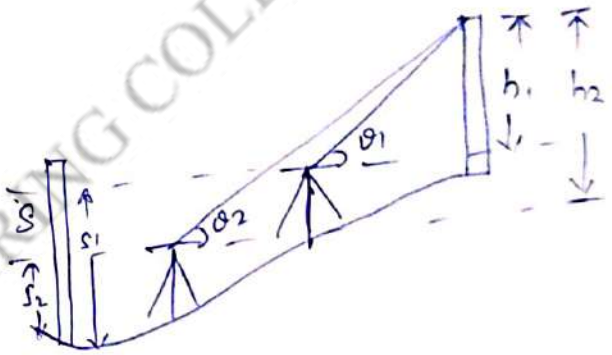
$$D = \frac{(S + d \tan\theta_2)}{\tan\theta_1 - \tan\theta_2}$$

b) Vertical Height

$$h_1 = \frac{(S + d \tan\theta_2)\tan\theta_1}{\tan\theta_1 - \tan\theta_2}$$

c) R.L of F = R.L of B.M + S_1 + h_1

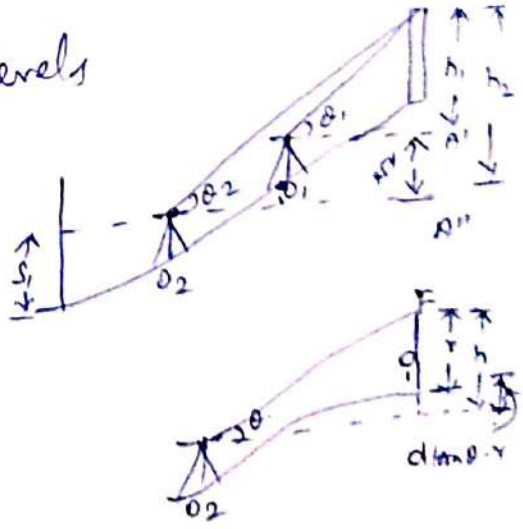
G Inst. axis O_1 higher than O_2.



a) $D = \frac{d \tan\theta_2 - S}{\tan\theta_1 - \tan\theta_2}$

b) $h_1 = D \tan\theta_1$

- Instrument axes at Very different levels



a) $D = \frac{d \tan\theta_2 - S}{\tan\theta_1 - \tan\theta_2}$

$$h_1 = \frac{d \tan\theta_2 - S}{\tan\theta_1 - \tan\theta_2}$$

Height of Station O_1 above the axis at O_2 = $h - r$

$= d \tan\theta - r$

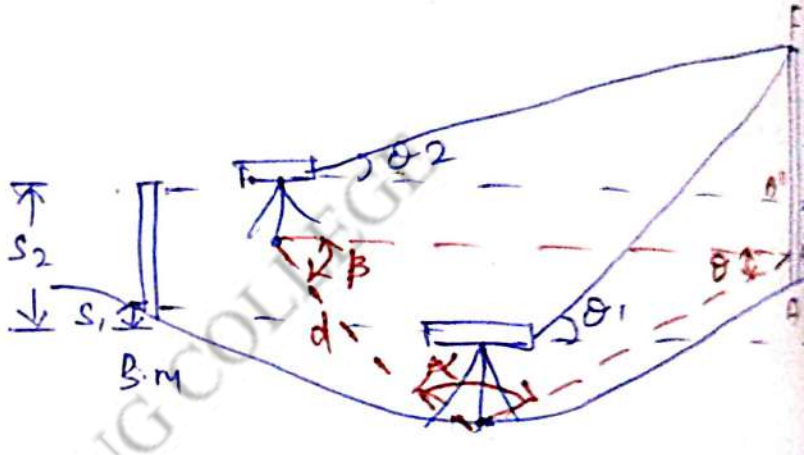
$$S = d \tan\theta - r \pm h'$$

R.L of F = R.L of B.M + S_1 + S ± h_1

- Double plane Method (Base Inaccessible)

$$O_2A' = \frac{O_1O_2 \sin\alpha}{\sin\theta} = \frac{d\sin\alpha}{\sin\theta}$$

$$O_1A' = \frac{O_1O_2 \sin\beta}{\sin\theta} = \frac{d\sin\beta}{\sin\theta}$$



$$h_1 = A'O_1 \tan\theta_1$$

$$h_2 = A''F = A'O_2 \tan\theta_2$$

R.L of F = R.L of B.M + S_1 + $d(\sin\alpha \tan\theta_1 / \sin\theta)$

(θ_2)

R.L of F = R.L of B.M + S_2 + $d(\sin\beta \tan\theta_2 / \sin\theta)$

Suggested Questions / Assignments /Home works / any other

Lecture No. 21. problem on single plane

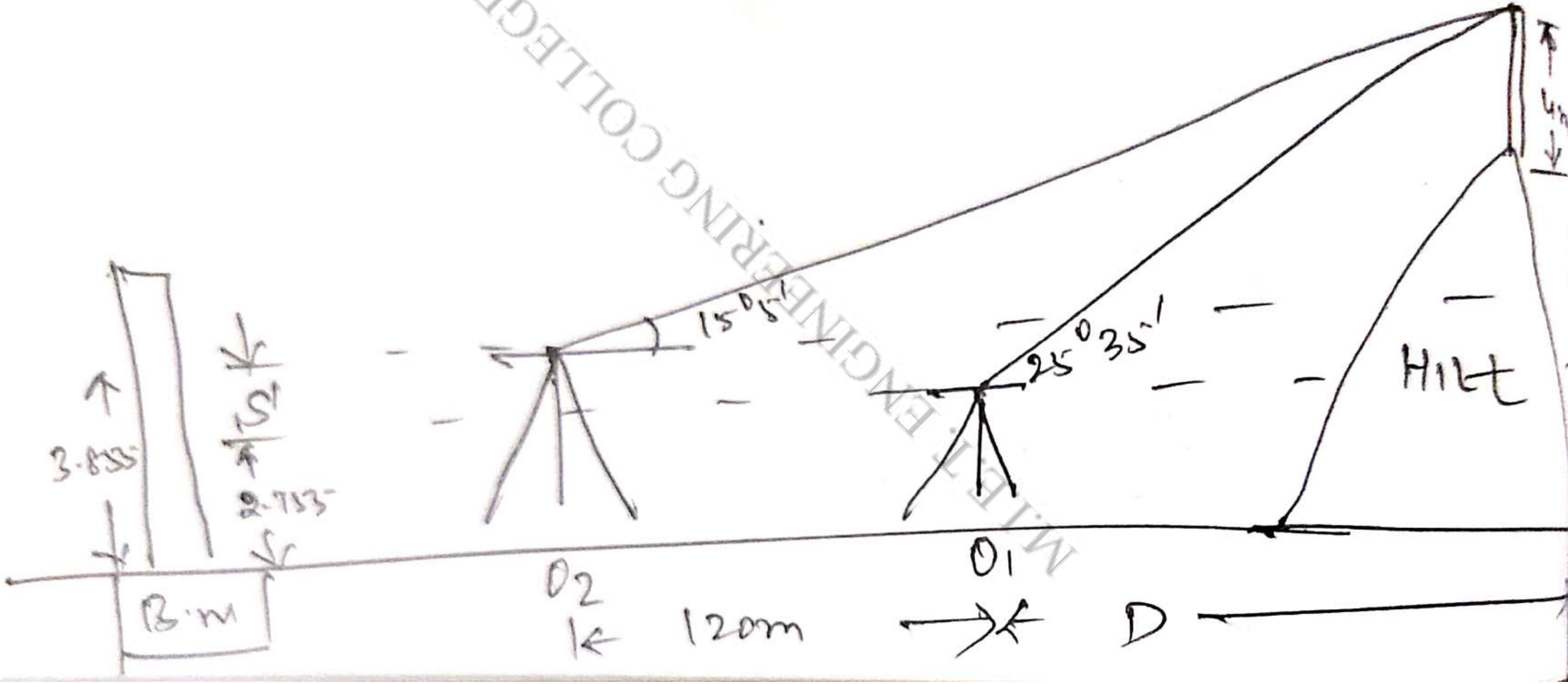
Topic(s) to be covered	problem on single plane.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	find Horizontal & Vertical distance between two points using single plane method.	Apply.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

Lecture Notes

1) In order to determine the elevation of top (F) of a signal on a Hill, Observations were made from two stations O_1 and O_2. The stations O_1 and O_2. The Station O_1, O_2 and signal F were in the same plane. If the angles of elevation of the top F of the signal measured at O_1 and O_2 were $25^\circ 35'$ and $15^\circ 5'$ respectively. Determine the elevation of the foot of the signal above its base was 4m.



R.L of Instrument axis at O_1

= R.L of B.M + Staff reading

= 105.420 + 2.753

= 108.173m.

R.L of Instrument axis at O_2

= R.L of B.M + Staff reading

= 105.420 + 3.853

= 109.273m.

Difference in elevation between the Instrument axes = S

$S = 109.275 - 108.175$

$S = 1.100m.$

Horizontal distance between O_1 & Hill station

$$D = \frac{d \tan\theta_2 + S}{\tan\theta_1 - \tan\theta_2}$$

$$D = \frac{120 \tan 15^\circ 5' + 1.100}{\tan 25^\circ 35' - \tan 15^\circ 5'}$$

$$\boxed{D = 159.811 m}$$

(5) $\boxed{V_1 = D \tan \theta_1}$

$V_1 = 159.811 \times \tan 25^\circ 35'$

$\boxed{V_1 = 76.511 m}$

(6) R.L of the foot of the signal at Hillside

= R.L of Instrument axis at O_1 + V_1 − Height

= 108.175 + 76.511 − 4.000

= 180.686m

Suggested Questions / Assignments /Home works / any other

—

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	McGraw Hill
2.			

Lecture No. 27 Problem on Double plane Method.

Topic(s) to be covered	

	Lecture Outcome (LO)	Bloom's Level
	At the end of this lecture, students will be able to	
LO1	find Horizontal & Vertical distance between two points using double plane Method.	Apply.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

1. To find the elevation of the top of a Chimney, the following observations were made from two Stations P and Q, 500m Apart.

(i) Horizontal Angle at Station P, between Chimney and Q = 60^0

(ii) Horizontal angle at Station Q, between Chimney and P = 50^0

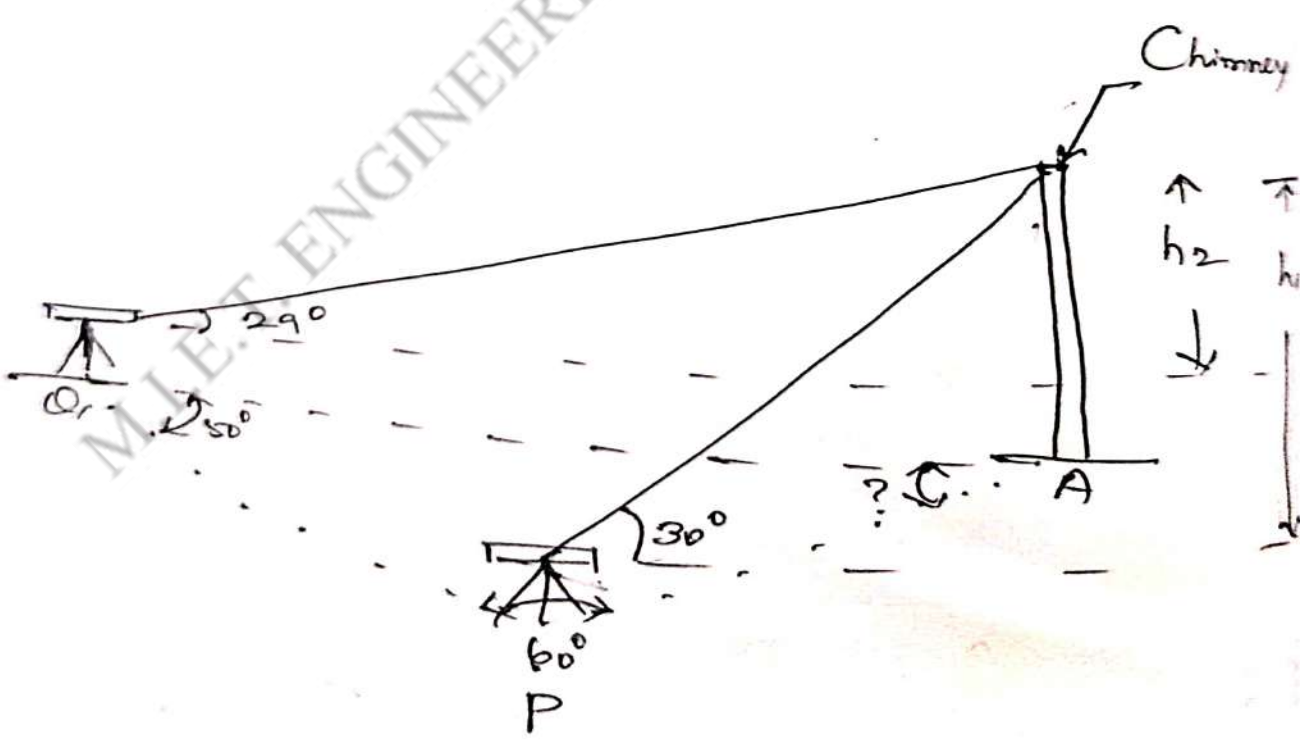
(iii) Angle of elevation from P to the top of Chimney = 30^0

(iv) Angle of elevation of Q, to the top of the Chimney = 29°

(v) R.L of the Line of Collimation at P = 22.5m.

(vi) R.L of the line of Collimation at Q, = 20.5m.

determine the elevation of the top of the Chimney.



Let P and Q be the Instrument stations and F be the top of the Chimney.

In triangle APQ : $\angle APQ = 60^0$

$\angle AQP = 50^0$

$\angle PAQ = 180^0 - (50^0 + 60^0)$

$$\boxed{\angle PAQ = 70^0}$$

Applying the sine rule.

$$\frac{PA}{\sin 50^0} = \frac{QA}{\sin 60^0} = \frac{PQ}{\sin 70^0}$$

$$PA = 50 \times \left[\frac{\sin 50^0}{\sin 70^0}\right]$$

$$\boxed{PA = 40.76m}$$

and $$QA = 50 \times \left[\frac{\sin 60^0}{\sin 70^0}\right]$$

$$\boxed{QA = 46.08m}$$

Also $\boxed{h_1 = PA \tan\alpha} = 40.76 \tan 30^0 = 23.533m.$

$\boxed{h_2 = QA \tan\alpha} = 46.08 \tan 29^0 = 25.543m.$

Hence, R.L of Chimney top = R.L of line of collimation $\pm h_1$ (or h_2).

R.L of F from observations at P = 22.5 + 23.533

$\boxed{P = 46.033m}$

R.L of F from observation at Q = 20.5 + 25.543

$\boxed{Q = 46.043m}$

Hence, elevation of F = (46.033 + 46.043)/2 = 46.038m

Suggested Questions / Assignments /Home works / any other

Engineering College, Trichy

UNIT- IV
Control Survey & Adjustments.
- Triangulation. -

Triangulation	- Classification of Triangulation - first order - Second order - third order.

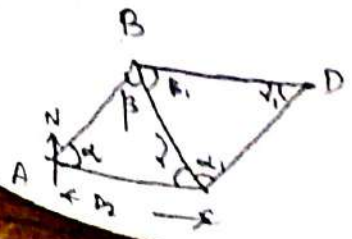
Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Gain knowledge on Triangulation	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk.	Listen

Lecture Notes

Triangulation :-

- Common type of Geodetic Surveying
- Entire Area to be surveyed is Covered with a frame work of triangles
- Length and direction of one side and all the three angles of triangles are measured precisely.
- The length and direction of the remaining two sides of the triangle can be computed.



- Classification of Triangulation System:-
  - Primary Triangulation [First order]
  - Secondary " [Second "]
  - Tertiary " [Third "]

- First Order (or) Primary Triangulation:-
  - Used to determine the size of Earth & shape of the earth.
  - Used to Cover Vast Area like a whole Country with Control points.

- Length of Base line - 8 to 12km.
- Length of sides - 16 to 150km
- Average Triangle Error - less than 1"
- Maximum Station Closure - Not more than
- Actual Error of Base - 1 in 50,000.
- Probable Error of Base - 1 in 10,00,000

2nd order (or) Secondary Triangulation:-

- This Triangulation System Consists of a network with in a first order triangulation.
- Used to Cover area of the order of region, small Country.

- Length of Base line - 2 to 5 km.
- Length of sides - 10 - 25 km.
- Average Triangle Error - less than 3"
- Maximum Station Closure - Not more than 8"
- Actual Error of Base - 1 in 25,000
- Probable Error of Base - 1 in 500,000.

Order (or) Tertiary Triangulation:

- Is a frame work fixed within and Connected to a second order Triangulation system.
- Serve for the purpose of furnishing the immediate Control for detailed engineering &

- Length of Base line - 100 to 500 Metres.
- Length of Sides - 2 to 10 km.
- Average triangle Error - less than 1"
- Maximum Station Closure - Not more than 1'
- Actual Error of Base - 1 in 10,000
- Probable Error of Base - 1 in 2,50,000.

ggested Questions / Assignments /Home works / any other

1. Describe briefly the classification of Triangulation

Satellite station.

Satellite station - Reason Case (i), Case (ii), Case (iii) & Case iv.

Lecture Outcome (LO)	
At the end of this lecture, students will be able to	Bloom's Level
Gain knowledge on Satellite stations	Understand

TeachingLearningMaterial	Student Activity
Chalk / talk	Listen

Lecture Notes

...ellite station:-

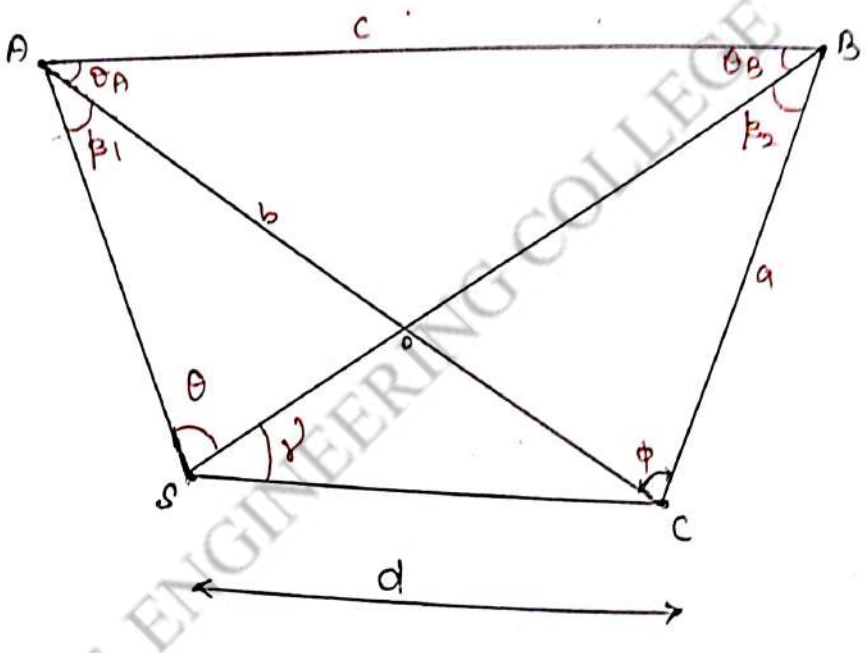
If the top of the tower or church spires is there in a particular selected triangulation system. It is impossible to setup instruments at these station.

In such a case a subsidiary station known as satellite station or Eccentric or False station is selected very near to the main station.

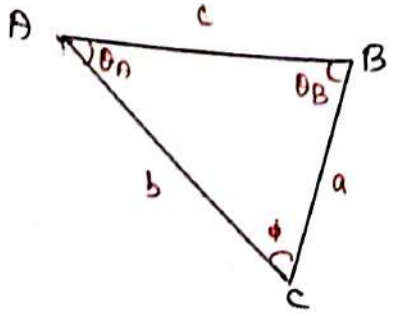
Case (ii).

Position 'S' to the left of the train

1. Corrected Angle $\boxed{\phi = 180^{\circ} - (\theta_A + \theta_B)}$



From triangle ABC.



$$\frac{c}{\sin\phi} = \frac{b}{\sin\theta_B} = \frac{a}{\sin\theta_A}$$

$$b = \frac{C \cdot \sin \theta_B}{\sin \phi}$$

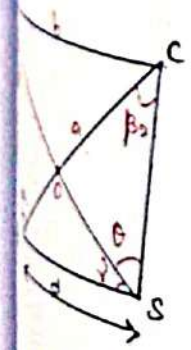
$$A = \frac{C \cdot \sin \theta_A}{\sin \phi}$$

$$\alpha = \frac{d \cdot \sin(\theta + \gamma)}{b \sin 1''}$$

$$\beta = \frac{d \cdot \sin \gamma}{a \cdot \sin 1''}$$

Corrected Angle $\phi = \theta + \alpha - \beta$.

ii) Station S to the right of B.



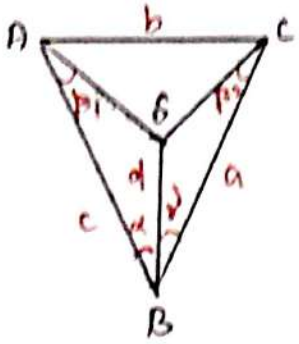
True Angle $\alpha = \theta + \beta_1 + \beta_2$

Where

B - True station

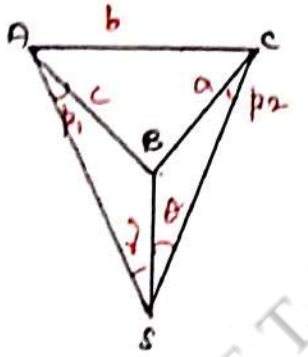
S - Satellite station.

Case (iii):- Satellite station S between A & B (upward of main station).



True angle $\alpha = \theta - \beta_1 - \beta_2$

Case (iv):- Satellite station S is downward of main station.



True angle $\alpha = \theta + \beta_1 + \beta_2$

Suggested Questions / Assignments /Home works / any other

1. Define Satellite Station.
2. Write short notes on different Cases of Satellite station.

Text Books/ ReferenceBooks

S.No	Title	Author
1.	Surveying	

Lecture No. 30 Reduction to Centre.

Topic(s) to be covered	Reduction to Centre - Reduction to Arbitrary Meridian - problems.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Lo1	Gain knowledge on reduction to Centre & Apply formulae to determine Correct direction of station.	Apply

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen

Lecture Notes

Reduction to Centre:-

The operation of applying Correction to the observed angles due to eccentricity of the station is known as Reduction to Centre.

Reduction to Arbitrary Meridian

Correction to any direction.

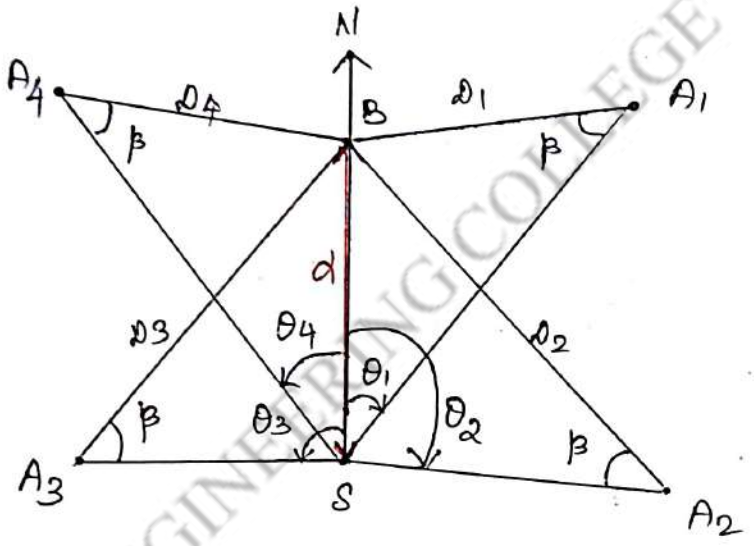
$$\beta = \frac{d \cdot \sin\theta}{D \sin 1''}$$

Where

d - Horizontal distance between True station to satellite station.

θ - Bearing.

D - Horizontal Distance between two station.



$$\beta = \frac{d \sin\theta}{D} \times 206265 \text{ sec.}$$

Note:-

Correct Bearing for Direction of AB

= Observed direction of SA + β [I st & II nd Quadrant]

and

= Observed direction SA − β [III rd & IV th Quadrant]

From an Eccentric Station S is Chosen 12m from A. from 'S' the following bearings were observed. Length of line AB, AC, & AD were measured & found to be 319.32m, 4085.15m and 3108.6om.

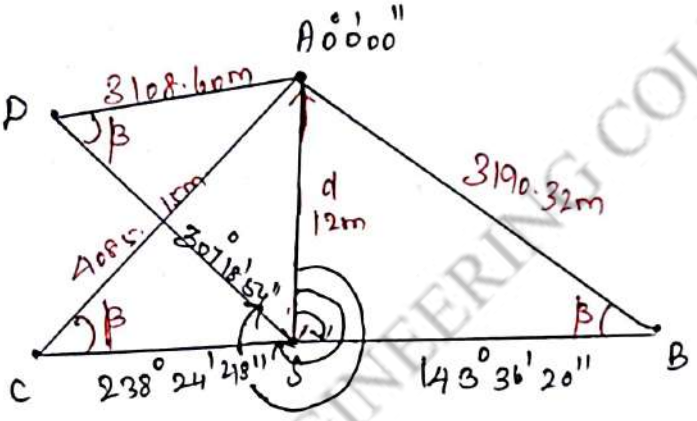
A = 0° 0' 00"

B = 143° 36' 20"

C = 238° 24' 418"

D = 307° 18' 54"

Determine the direction of B, C, D from 'A'.



Solution:-

Correction to any direction $\beta = \frac{d \sin\theta}{D} \times \frac{206265}{\sin 1''}$

1) From AB

d = 12m

θ = 143° 36' 20" (IInd Quadrant)

D = 3190.32m.

Correct Bearing of AB = Observed Bearing + β.

$\beta = \frac{12 \sin 143°36'20''}{3190.32} \times 206265'' = 460.33'' (or) 0°7'40.33''$

∴ Correct Bearing of AB = $143^\circ 36' 20'' + 0^\circ 7' 40.33'' = 143^\circ$

2. For LAB $\beta = \frac{12 \sin 238^\circ 24' 48''}{4085.15} \times 206265 = 0^\circ 8' 36.09''$

Correct Bearing of AL = Observed bearing − β

$= 238^\circ 24' 48'' - 0^\circ 8' 36.09''$

$= \boxed{238^\circ 16' 11.9''}$

3. For LAD

$\beta = \frac{12 \times \sin 307^\circ 18' 54''}{3108.60} \times 206265 = 0^\circ 10' 33.26''$

Corrent Bearing of AD = Observed Bearing − β

$= 307^\circ 18' 54'' - 0^\circ 10' 33.26''$

$= \boxed{307^\circ 8' 21.74''}$

Suggested Questions / Assignments /Home works / any other

1. Define Reduction to Centre

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	McGraw Hill
2.			
3.			

Lecture No. 31 Gales Table.

Topic(s) to be covered	Gale's Traverse Table - procedure - problems.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
L1	Gain knowledge on Traverse Computation using Gale's traverse Table.	Understand & Apply

TeachingLearningMaterial	Student Activity
Chalk / talk	Listen

Lecture Notes

- Gales Traverse Table:-

Traverse Computation are usually done in a tabular form. One such form is Gales traverse table. and is widely used because of its simplicity.

The following steps are involved in the Theodolite traversing & these are illustrated in Table.

1. In the case of theodolite traversing, the included angles are adjusted to satisfy the geometrical Condition. i.e Sum of included angle should be $(2n \pm 4)90°$. Use '+' sign - Exterior Angle
'-' sign - Interior Angle.

2. From the observed bearing of a line AB in table, of all other lines are Calculated & then these bea reduced to RB system.

3. From the length & RB of the lines, the Correcte Co-ordinate are worked out (latitude, (Departure Orgitude)

4. A check is done to find out whether the di Sum of latitude & algebraic sum of departure ar If Not a Correction is applied using the fo

5. The Independent Co-ordinates are then worked ou the Consecutive Co-ordinates. The origin is sele that entire traverse lies in the North-east q

• Problem - The Bearing, length, & Included angle of a traverse observed prepare traverse and T

1. LINE	LENGTH	Included Angle	W.C.B.
AB	255m	$\angle A = 93^\circ 18' 16''$	$140^\circ 42'$
BC	656m	$\angle B = 74^\circ 16' 25''$	
CD	120m	$\angle C = 123^\circ 42' 00''$	
DA	668m	$\angle D = 68^\circ 41' 16''$	

Solution:

Corrected Included Angles

1. Sum of Included angles of traverse = $93^\circ 18' 16'' + 74^\circ 16' 25'' + 123^\circ$
$68^\circ 41' 16''$
$= 359^\circ 57' 56''$

2. Theoretical sum of Included

Error = $360^\circ - 359^\circ 57' 56'' = 0^\circ 2' 4''$

$\therefore$ Correction of $\frac{0^\circ 2' 4''}{4} = 31''$ should be applied to each angle.

$\angle A = 93^\circ 18' 16'' + 31'' = 93^\circ 18' 47''$ & $\angle B = 74^\circ 16' 24'' + 31'' = 74^\circ 16' 55''$

$\angle C = 123^\circ 42' 00'' + 31'' = 123^\circ 42' 31''$ & $\angle D = 68^\circ 41' 16'' + 31'' = 68^\circ 41' 47''$

Calculation of Bearings.

(i) Bearing of line AB = $140^\circ 42'$ (Given) & Bearing of line BC = $214^\circ 58' 55'' - 180^\circ$

$\angle B = 74^\circ 16' 55''$

$214^\circ 58' 55''$

$= 34^\circ 58' 55''$

(ii) Bearing of CD = $34^\circ 58' 55'' + \angle C = 123^\circ 42' 31'' \Rightarrow 158^\circ 41' 26'' + 180^\circ = 338^\circ 41' 26''$

(iii) Bearing of DA = $338^\circ 41' 26'' + \angle D = 68^\circ 41' 47'' \Rightarrow 407^\circ 23' 13'' - 180^\circ = 227^\circ 23' 13''$

(iv) Bearing of AB $\Rightarrow 227^\circ 23' 13'' + \angle A = 93^\circ 18' 47'' \Rightarrow 320^\circ 42' 00'' - 180^\circ = 140^\circ 42' 00''$

LINE	WCB	RB
AB	$140^\circ 42'$	S $39^\circ 18'$ E
BC	$34^\circ 58' 55''$	N $34^\circ 58' 55''$ E
CD	$338^\circ 41' 26''$	N $21^\circ 18' 34''$ W
DA	$227^\circ 23' 13''$	S $47^\circ 23' 13''$ W.

To find Latitude & Departure | Latitude = L Cos θ | Departure = L Sin θ.

Station B

Latitude = $225 \cos 39^\circ 18' = 197.329$m. S

Dep = $225 \sin$ " = 161.512m. E

Stn C $L = 656 \cos 34^\circ 58' 55'' = 537.482$m N & $D = 656 \sin 34^\circ 58' 55'' = 376.097$m E

Stn D $L = 120 \cos 21^\circ 18' 34'' = 111.796$m N & $D = 120 \cos 21^\circ 18' 34'' = 43.808$m W

Stn A $L = 668 \cos 47^\circ 23' 13'' = 452.265$m S & $D = 668 \sin 47^\circ 23' 13'' = 491.610$m W

Corrections:

Quadrant (SE) | $\Sigma L = -0.316$m | & | $\Sigma D = +2.391$m.

Closing error $e = \sqrt{\Sigma L^2 + \Sigma D^2} = 2.411$m.

$\theta = \tan^{-1} \frac{2.391}{0.316} = 82^\circ 27' 39''$

8. Correction to Lat or Dep of any side = Total error in L or D × $\frac{\text{L or D of that side}}{\Sigma \text{L (or) D}}$

(i) Line AD = Correction for Southing = $0.316 \times \frac{197.329}{649.278 + 649.594} = 0.048\text{m}$ (-ve)

(ii) Line BC = (Northing) $0.316 \times \frac{537.482}{649.278 + 649.594} = 0.131\text{m}$ (+ve)

(iii) Line CD

North = $0.316 \times \frac{111.796}{649.278 + 649.594} = 0.0027\text{m}$ (+ve)

Line DA

Corr. to Southing = $0.316 \times \frac{452.265}{649.278 + 649.594} = 0.110\text{m}$ (-ve)

Correction for eastings
$= 2.391 \times \frac{161.512}{537.6\text{ts}}$
$= 0.360\text{m}$ (-ve)

Correction to eastings
$= 2.391 \times \frac{376.097}{537.609\text{ts}}$
$= 0.838\text{m}$ (-ve)

Correction to northings
$= 2.391 \times \frac{43.608}{537.60\text{ts}}$
$= 0.097\text{m}$ (+ve)

Corr. to northings
$= 2.391 \times \frac{491.610}{537.60\text{ts}}$
$= 1.09\text{bm}$ (+ve)

Inst Stn	RB	Quad	Length	CO N	S	E	W
A	39°B'	SE	245		197.329	161.512	—
B	34°28'35"	NE	656	537.482	—	376.097	—
C	21° 18' 34"	NW	120	111.796	—	—	43.608
D	47°23'13"	SW	668	—	452.265	—	491.610
				Σ 649.278	649.594	537.61	535.218
				−0.316		+2.390	

Correct (m)	N	S	E	W
	—	−0.048	−0.360	
	0.131	—	−0.838	
	0.0027	—	—	0.097
	—	−0.110	—	1.09
	Σ 0.1337	−0.158	−1.198	1.187
	+0.316			−2.390m

Suggested Questions / Assignments /Home works / any other

1. Define Gales traverse table.

Lecture No. 32 Trilateration.

Topic(s) to be covered	Trilateration - Difference in elevation. - Single observations.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on trilateration	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

Trignometrical levelling:-

- Is a method of levelling
- Elevation of stations are determined from measured Vertical Angles and known Horizontal Distances.

Difference in Elevation

1. Single observation
2. Reciprocal observation.

1. Single observations:-

This is used when the one of the is inaccessible, precluding the use of reciprocal Depending over a relative elevation of the observed station and the instrument, the vertical angle a depression or elevation. There are 3 cases d on the distance if its very larger more than 5 Medium 5-3 km. or smaller less than 3km. the numbers are guideline.

The practical surveyor distinguished the based on his experience.

- Very larger distance with elevation
- Very larger distance with depression
- Medium larger distance with elevation
- Medium " " depression
- Small distance with elevation
- Small " " depression.

Coefficient of refraction (m)

$$m = \frac{r}{\theta}$$

$$r = m \cdot \theta$$

where,

m - Value from 0.06 to 0.09

average value 0.07.

- **Refraction Correction** $(Cr = m \cdot \theta)$

Note.

i) Angle of elevation θ is "-ve"

ii) Angle of depression θ is "+ve"

- **Correction for Curvature.**

$$C_{Cur} = \frac{\theta}{2}$$ Angle of elevation

$$C_{Cor} = \frac{-\theta}{2}$$ Angle of depression

- **Central Angle** θ

$$\theta = \frac{d}{R \sin 1''}$$

- **Axis signal Correction.** (C) :-

$$\delta = \frac{S-h}{d \sin 1''}$$

Where,

S - Height of signal

h - Height of instrument

d - Distance b/n A & B

Note:-

1. Angle of elevation - δ is "+ve"
2. Angle of depression - δ is "-ve"

- Difference in elevation (H):- $H = d \tan [\alpha_1 - \alpha + \theta/2]$ (e

$H = d \tan [\beta_1 + \alpha - \frac{\theta}{2}]$ (de

Suggested Questions / Assignments /Home works / any other

—

Unit - IV

Reciprocal observation Problem.

Topic(s) to be covered	Problem solved using reciprocal observation

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Solve reciprocal observation for determining R.L of main stations.	Apply.

TeachingLearningMaterial	Student Activity
Chalk & Talk	Listen

Lecture Notes

1. Two Stations A and B are 3791.712m apart The following observation were recorded.

- Height of A = 1.463m
- Height of B = 1.494m
- Height of signal at A = 5.09m
- Height of signal at B = 4.511m.
- Angle α (A - B) = $+ 1^{\circ} 54' 30''$
- Angle β (B - A) = $- 1^{\circ} 50' 25''$
- R.L of A is 1275.60m

Find R.L of B and Assume R Sin $1'' = 30.88$m.

Answer:-

1. Axis signal Correction.

(a) Elevation Angle.

$$\delta_1 = \frac{S_2 - h_1}{d \sin 1''}$$

Where $S_2 = 4.511m$

$h_1 = 1.463m$

$d = 3791.712$

$\sin 1'' = 206265'' \text{ sec}$.

$$\delta_1 = \frac{4.511 - 1.463}{3791.712} \times 206265''$$

$$\delta_1 = 165.80'' \text{ (-ve)}$$

(b) Depression Angle.

$$\delta_2 = \frac{S_1 - h_2}{d \sin 1''}$$

Where

$S_1 = 5.090m$

$h_2 = 1.494m$

$d = 3791.712$

$$\delta_2 = \frac{5.090 - 1.494}{3791.712} \times 206265''$$

$= 195.6$

Central Angle θ

$$\theta = \frac{d}{R \sin 1''}$$

Where $d = 3791.712$

$R \sin 1'' = 30.88m.$

Central Angle $\theta = \frac{3791.712}{30.88} = 122.78''$

Curvature Correction $= \frac{\theta}{2} = \frac{122.78''}{2} = 61.39''$

Corrected Angle a) $\alpha_1 = \alpha - \delta_1 = 1^0 54' 30'' - 165.80''$

$\alpha_1 = 1^0 51' 44.192''$

b) $\beta_1 = \beta + \delta_2 = 1^0 50' 25'' + 195.678''$

$\beta_1 = 1^0 53' 40.678''$

Difference in elevation. (H)

$$H = \frac{d \sin \left[\frac{\alpha_1 \pm \beta_1}{2}\right]}{\cos \left[\frac{\alpha_1 \pm \beta_1}{2} + \frac{\theta}{2}\right]}$$

$\frac{\alpha_1 + \beta_1}{2} = 1^\circ 51' 44.192'' + 1^\circ 53' 40.618'' / 2 = 1^\circ 52' 42.41''$

$\frac{\alpha_1 + \beta_1}{2} + \frac{\theta}{2} = 1^\circ 52' 42.41'' + 0^\circ 1' 1.39'' = 1^\circ 53' 43.8''$

$H = 3499.712 \sin [1^\circ 52' 42.41''] / \cos [1^\circ 53' 43.8'']$

$H = 125.48m$ "+ve" Hence B is Higher than A.

6. R.L of B

R.L of B = R.L of A + H

Where

R.L of A = 1275.60

= 1275.60 + 125.48

R.L of B. = 1401.08m.

Suggested Questions / Assignments /Home works / any other

Lecture No. 34 Errors.

Topic(s) to be covered	Classification of Errors - Gross - Systematic - Random Error

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Lo1	Gain knowledge on Classification of Errors	Understand

TeachingLearningMaterial	Student Activity
Chalk/talk	Listen

Lecture Notes

- Classification of Errors.

Errors are classified into three types.

1. Gross Error
2. Systematic "
3. Random "

- Gross Error:-

Gross Errors are also known as Blunders or Mistakes are results from

a. Carelessness on the part of observer in taking or recording reading.

b. Faults in Equipments

- Adoption of wrong Technique.
- Mis Interpretation.

- The blunders or Mistakes results into massive errors
- It is simply by detected by Comparison with different Vicinities of errors.
- The maximum permisson error is an observation is
  It is used to separate mistake from the Random
  If any Error deviates from the mean by more
  the maximum permissible error, it is Considered
  a gross error & the measurement is rejected.
- After Mistakes are detected & eliminated from
  Measurement s, the remaining errors are usually
  Systematic error or Random error.

- Systematic Error:-
  - It works according to a System.
  - It follow an Indefinite pattern.
  - If an experiment is Continuous, Under the same Co
    Some pattern of Systematic error re-occur.
  - Types of Systematic Error - 1. Cumulative Error
    2. Compensating Error

Systematic Errors are dealt with mathematically using functional relationships or Models.

Random Error:-

- After Errors are Corrected & Systematic errors also are Corrected, a Survey Measurement is related with Random Errors only.
- This error is lesser
- It is equally liable to plus or minus thus partly Compensating in Nature.
- Random errors are Undetermined and they Can't be evaluated or quantified exactly.

True & Most probable Values:-

True Value:-

- The Value of a quantity which is free from any type of error is known as the true value.
- It Can never be found out
- The true value of quantity is Indeterminate.

Most probable Values:-

- Most probable value of a given quantity from

the given available set of observation is the one for which the sum of the squares of the residual errors is a lesser.

- The Most probable Value of a quantity is one which is Most likely to be true Value from any other Values.
- This is most likely to be true, but not likely to be absolutely free, from errors.
- In Case of direct observation of equal weight, the Most probable Value is the arithmetic mean.
- In Case of direct observation of unequal weights the most probable Value is the weighted Arithmetic Mean.

Suggested Questions / Assignments /Home works / any other

1. Differentiate True value & Most probable Value.
2. Define Random Error.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mc Graw Hill

Lecture No. 35 principles of least square - Normal eqn - Correlates.

Topic(s) to be covered	principle of least square - Normal equation - Correlates.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on Survey adjustments & Control	Understand

TeachingLearningMaterial	Student Activity
Chalk / talk	Listen.

Lecture Notes

Principle of least square:-

- The least square principle states that the SRF should be Constructed. So that the sum of the squared distance between the observed value of your dependent variable and the values estimated from your SRF is minimized.

- It is found from the probability equation that the most probable values of a series.

- Errors arising from observations of equal weight are those for which the sum of squares is Minimum.

- When a quantity is being deducted from a series of observations, the residual errors will be the difference between the adopted value and the several observed values.

- Normal equation:-

A Normal equation is the one which is formed by multiplying each equation by the coefficient of value whose normal equation is to be found and by adding the equation thus formed.

As the No. of Normal equation is the same as the Number of Unknowns, the most probable Value of Unknown can be found from these equations.

Consider a round of angle x, y, z along the horizon, at a particular station. Let us

The Geometrical Condition involves is $x+y+z = 360^{\circ}$. $= -d$. If the Angles are measured once, or if they are the means of equal numbers of equally precise measurement, the error in the round is $(x+y+z+d)$.

The Most probable Value of the angle can then be obtained by applying the Correction $-d/3$ with the Appropriate sign to the Value equally among the Angles.

CORRELATES: —

The second method of dealing with Conditioned quantities when determining the most probable Values of unknown involves the use of intermediate parameters, called Correlates or Correlatives.

The Corrections are first expressed

in terms of this parameter and then used in the Condition equations. The principle of least square is also used in terms of the correction, & the differentiation is carried out with respect to the correction themselves, instead of the value of the quantities.

A procedure is evolved for the correlates, & Hence the Corrections. The later are then Applied algebraically to the observed values to get the most probable values.

Suggested Questions / Assignments /Home works / any other

1. Write short notes on principal of least square.
2. What is Correlates ?

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher

Adjustments of Networks.

Topic(s) to be covered	Angle Adjustment - Station Adjustment - Figure Adjustment.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on adjustment of Simple Triangulation Networks.	Understand.

TeachingLearningMaterial	Student Activity
Chalk Talk	Listen.

Lecture Notes

- Adjustment of Simple triangulation Networks:-

After the field work is completed, it is necessary to adjust the measured or observed angles so as to satisfy the geometrical conditions involved in the triangulation Network.

Phase of adjustment

a) Angle Adjustment

b) Station "

c) Figure "

- ANGLE ADJUSTMENT :-

Angle adjustment means getting the Most probable Values for each of the Individua Angle & their weight from a set of repeated measurements or observations of each of them.

Each of the Individual Angle is measu Several times. If all the observations or measurement are made Under precisely similar Condition by sam Surveyor, they Can be Considered equally precisely & the same weight. If the Condition or the Observers differ they must be assigned weight on Sound basis. In the Absence of any other Cri the weights assigned are directly proportionally to the Number of time the angle is measured allowed to Gauss' rule.

- STATION Adjustment :-

Involves the Adjustment of all the angl Around a Station so as to Satisfy the geometrical relation or Condition involved

depending on whether the angle is measured close the horizon or not, & whether the observation are direct or indirect. In the first case, the horizon is closed by the measured angles, so that the sum of all these angles should come to 360°. If there is any discrepancy, Correction is indicated. If the observations are all of equal weight the Correction will be equal.

Angles	Observed Values	Correction	Corrected Value.
$\angle 1$	64°	-1°	63°
$\angle 2$	79°	-1°	78°
$\angle 3$	45°	-1°	44°
$\angle 4$	81°	-1°	80°
$\angle 5$	96°	-1°	95°
	365°		360°

Figure Adjustment:-

Involves adjust all the angles in a unit figure of the Network. After Station adjustment at all the

Station, we determine the most probable Value of the angle in Geometrical figure. So that the necessary Geometrical relation involving one or more condition Equations are satisfied.

The determination of Most probable values of angles Conserned in any geometrical figure therefore on fulfill the Geometrical Condition is termed the figure adjustment.

Suggested Questions / Assignments /Home works / any other

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Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mc Graw Hill

TOTAL STATION

Topic(s) to be covered	Total Station - Uses - principle of Total Station.

	Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
LO1	Gain knowledge on Total Station	Understand

TeachingLearningMaterial	Student Activity
Chalk Talk	Listen

Lecture Notes

Total Station:-

- A Total Station is also known as Electronic Tacheometer, is an optical Instrument.
- It is a Combination of an Electronic Theodolite - for measuring Horizontal and Vertical Angles, an Electromagnetic distance Measurement & a Micro processor with memory Unit.

Uses:-

To measure Horizontal & Vertical angles as well as Sloping distance of object to the Instrument.

Working principle of Total Station:-

1. The theodolite measures the Horizontal angle and the Vertical Angle of the line of sight from the Centre of Total Station to the Centre of a Target on a point to measure.

2. The sloping distance between the Centre of Total station and the Centre of the prism is measured by EDM.

3. EDM Instrument transmits an Infrared beam which is reflected back to the Unit with the Help of a prism.

4. It applies the timing measurement to Calculate the distance travelled by the beam.

5. Distance = Velocity × Time.

Volume

$$V = f \cdot \lambda$$

f - Frequency (Hz) & λ - wave length

7. It is possible to store the data in the memory of a storage device for minimizing the manual errors.

8. It also Consists of battery socket which Houses the battery.

8. A fully Charged battery works for about 3-5 hrs. Continuously.

9. Angles and distances are displayed on a digital Read out and Can be recorded at the press of a button.

Accessories of Total Station! -

(i) Tripod

(ii) Reflector prism & prism pole

(iii) Tribraches

(iv) Batteries & Charger

(v) Data & power Cable.

- Merits:-
  1. Quick setting of the instrument on the tripod using laser plummet.
  2. On board Area Computation programme to Compute the Area of the field.
  3. Greater Accuracy
  4. Integration of data base.

Demerits:-
  1. Costly
  2. Skilled personnel are required

Suggested Questions / Assignments /Home works / any other

1. Explain the working principle of Total station with Merits & Demerits.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mcgraw Hill
2.			
3.			

	EDM - Classification of EDM - Micro Wave - Light - IR.

Lecture Outcome (LO)	
At the end of this lecture ,students will be able to	Bloom's Level
Gain knowledge on EDM & it Classification.	Understand.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

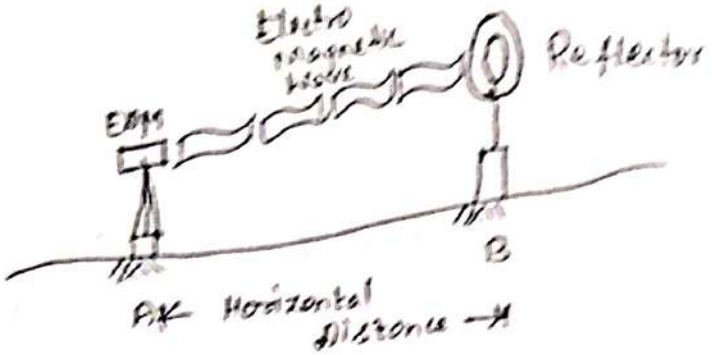
Lecture Notes

M :-

- EDM is an Instrument
- It uses Electro magnetic Energy
- Used to determine the length of a line.

iple :-

The Energy originates at an Instrument at one end of a line and is transmitted to the reflector at the other end from where it is returned to the originating Instrument.



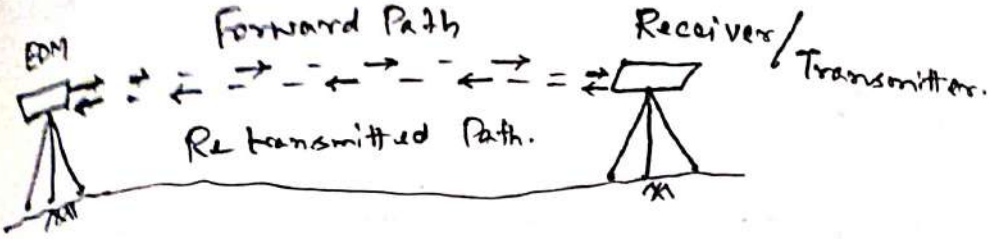
- Classification of Errors:-

1. Microwave Instruments
2. Visible light "
3. Infra red "

- Micro Wave Instruments:-

- It transmit high frequency microwave in the range of 3 - 35 GHz, Corresponding to wave length of about 1 - 8.6 millimetres.

- The Measurements involves two Interchangeable Instruments.



series of Microwave run through the Circuitry of receiving unit and are transmitted to the signal sending unit, which measure the phase difference between the transmitted and received signals.

Net phase difference get Converted into linear distance.

Contains longer wave length - Better penetration to fog is good for long distance measurement.

Distance in the range of 30-80 km Can be measured.

eg- Tellurometer.

Optical Instrument :-

It uses 0.4 - 0.7 μm (ie 400-700nm) wave length.

Light waves have shorter wave length.

Instrument uses in the range of 25km.

The amount by which transmitted & received signals are out of phase get measured. electronically and registered in metre by getting Converted to an equivalent distance.

eg- Geodimeter

- Infra red Instruments:-

  - Used IR Gladiation to Carry the measuring signals.
  - It have Gallium Arsenide Infra red emitting diode.
  - It produce Invisible Gladiation with a wave length of 0.9 μm. ie [700nm to 1 millimetre]
  - The Gange of Instrument is limited to 2-5k

  eg- Wild Distomat.

Suggested Questions / Assignments /Home works / any other

1. What is EDM ?
2. State the principle of EDM.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	MCGraw Hill
2.			
3.			

Any other suggested Material

FIELD Procedure

	Field procedure - preparation of instruments for measurement - setting up the instrument - levelling up the instrument.

Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Gain knowledge on field procedure using Total station.	Understand.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

- FIELD PROCEDURE

Preparation of Instruments for Measurements.

- Setting up the Instrument :-

a) Extend the leg of the tripod as far as is required & tighten the screws firmly.

b) Fixing up the tripod so that the tripod plate as Horizontal as possible & the legs of the tripod are fixed in the ground.

c) Now place the device on the tripod & protected it with the innermost fixing screw.

- Levelling up the Instrument :-

(i) After fixing up the device, level it up roug with the helps of the bull's eye bubble.

(ii) Turn two of the foot screws simultaneou in reverse directions. in which the bubble should

(iii) Now the third foot screw used to middle up the bubble

iv) To ensure rotate the device 180°. After th the bubble must remain within the setting Circle. If it doesnot, then readjustment is Mandatory.

v) For a level, the Compensator robotically tak Care of the final levelling up.

vi) The Compensator Consists of a fundamental thread - Suspended mirror that directs the Horizontal light rays to the midpoint of th Cross Hair Yet there is many be residual tilt over the telescope.

Procedure for running traverse:

- Initially the Instrument is set properly at the station points.
- Centering, levelling & focussing such temporary adjustments are made in the instruments.
- Using magnetic Compass the North direction is fixed
- The station point are feed in total station by using northing & Easting.
- The Instrument Height is measured by refering the bench mark.
- Setting the station points and data are observed.
- The reflective prism is placed on the station two and type of prism are selected as per our requirement & the readings are observed for the LCD Screen.

- The prism is shifted to another station & the temporary adjustments are made.
- Above procedure are repeated for all the station points.
- All the required readings such as distance, elevation & Angle are observed at the following station as similar.
- After Completing the above procedure the Fs button is pressed to activate the quick View option to see the graphical representation of the points Can be visible on the LCD Screen

Suggested Questions / Assignments /Home works / any other
1. Describe the field procedure to running traverse using total station.

	Text Books/ ReferenceBooks		
S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mc Graw Hill
2.			
3.			

Engineering College, Trichy Unit - V

Errors & Good practices in using Total Station.

	Calibration of Total Station - Errors - line of sight error - Tilting axis error - Vertical axis tilt - High Index error.

Lecture Outcome (LO)	Bloom's Level
At the end of this lecture, students will be able to	
Gain Knowledge on Errors & practices using Total Station.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk.	Listen.

Lecture Notes

Calibration of Total Stations:-

To uphold the precision obtained by Total Stations, there is much more importance on monitoring Instrumental Errors.

Instrumental Errors can be eliminated by viewing on both faces of the total station & averaging.

For Total Station Instrumental errors are Calculated & Corrected by means of Electronic Calibration actions that are Carried out at Several time and can be functional to the device on site.

The Electronic Calibration have to be Carried out on a total Station as follows

a) ~~Line of sight Error~~

(i) Before using the device and the Initial Store.

(ii) After long garage durations

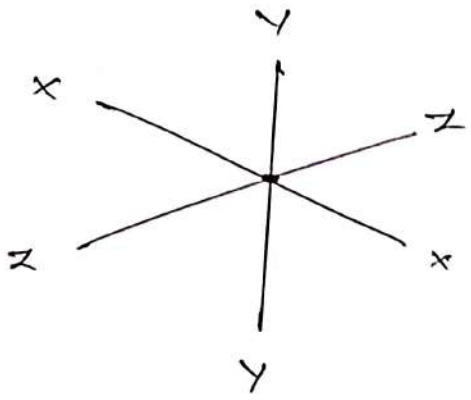
(iii) After tough or long transportations.

(iv) After long Intervals of work.

(v) Following huge changes in temperature.

(vi) Often for precision Survey.

vii) Before every Calibration, it is Vital to pe total Station sufficient to reach the Ambient temperature.



• Axis of total Station.

the total station have to meet the following

i) Line of sight ZZ Vertical to tilting axis XX

ii) Tilting axis XX at right angle to Vertical axis YY

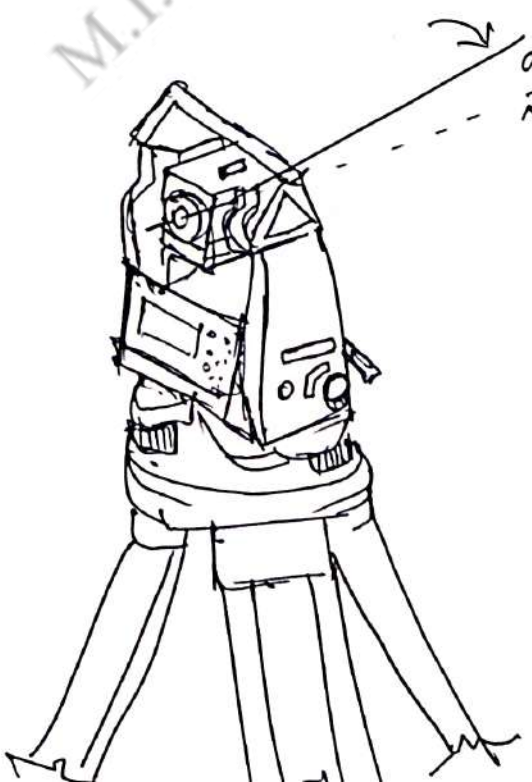
iii) Vertical Axis YY exactingly Vertical

iv) Vertical Circle reading exactly Zero at the Zenith.

These Circumstances are Not Met, the subsequent Conditions are used to explain the particular errors.

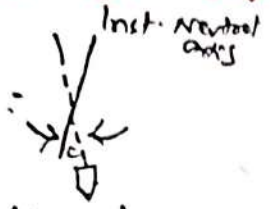
Line of sight Error (or) Collimation Error :-

- Divergence from the right Angle among the line of sight along with the tilting axis.



b) Tilting axis error :- Divergence from the right angle among the tilting axis along with the Vertical Axis.

c) Vertical axis tilt :- Angle among the plumb line along wi Vertical Axis.



d) Height - Index error h :- the Angle between the Zenith direction & the zero readi of the Vertical Circle. (i.e, the Vertical Circle reading when tele a Horizontal line of sight) is Not 90°, but 90° th.

Suggested Questions / Assignments /Home works / any other

1) List the types of Errors occurs in total station
2) Define Collimation Error

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	McGraw Hill
2.			
3.			

Method - GPS.

Lecture Outcome (LO) At the end of this lecture, students will be able to	Bloom's Level
Gain knowledge on Measuring principle of EDM & GPS.	Understand

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

learning principle

1. Pulse Method
2. phase difference method.

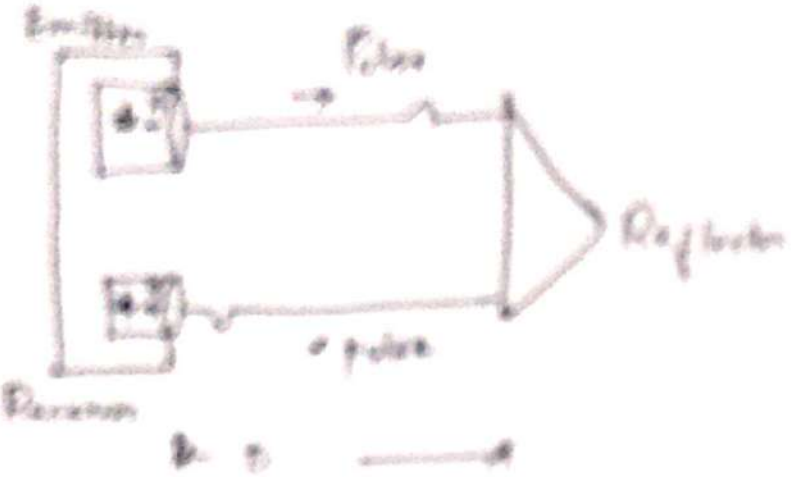
se Method:-

- A short (wave) intensive pulse of

Radiation is transmitted to a reflector target.

- The reflector target immediately transmit it back, along a parallel path to the

Receiver.



- The measured distance is computed from the velocity of the signal multiplied by time it took to travel the journey

$$D = \frac{C \Delta t}{2}$$

C - Velocity of light in the medium

D - Distance between instrument & Target

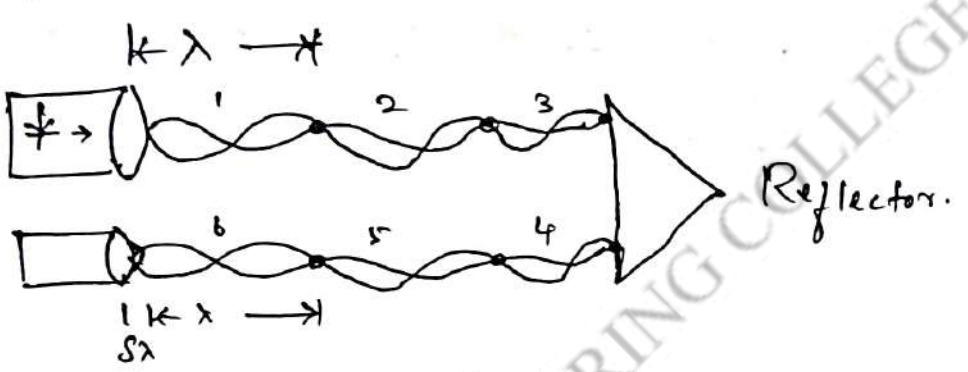
Δt - Time difference of pulse from Emitter to

- The distance is dependent on the velocity of light in the medium & accuracy of the known time

powerful laser system can obtain tremendous distances. often used with corner cube prism.

Difference Method:-

- Majority of EDM Instruments, use this form of measurement.
- Instruments measures the amount of $\delta\lambda$ by which the reflected signal is out of phase.



$$k\ 2D = M.\lambda + \delta\lambda$$

$$D = M.\lambda/2 + \delta\lambda/2$$

The Double distance is equal to the No. of full wave length (λ) plus the fraction of a wave length.

- From figure, as the emitted and reflected signals are in Continuous motion, the only Constant is the phase difference "$\delta\lambda$".
- Figure shows the path of emitted radiation from Instrument to reflector and back to Instrument, & hence it represent twice the distance from Instrument to reflector.

- GPS (Global positioning System)
  - Is a satellite based station.
  - Used to locate positions of objects anywhere on the earth.
  - Is based on the reception of radio signals emitted by satellite orbiting the earth.

Suggested Questions / Assignments /Home works / any other

1. List out the working principle of EDM
2. Define GPS.

Text Books/ ReferenceBooks

S.No	Title
1	

Segments of GPS.

	Space segment - Control segment - User segment

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
	Gain knowledge on GPS segments.	Understand.

TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

GPS segments: -

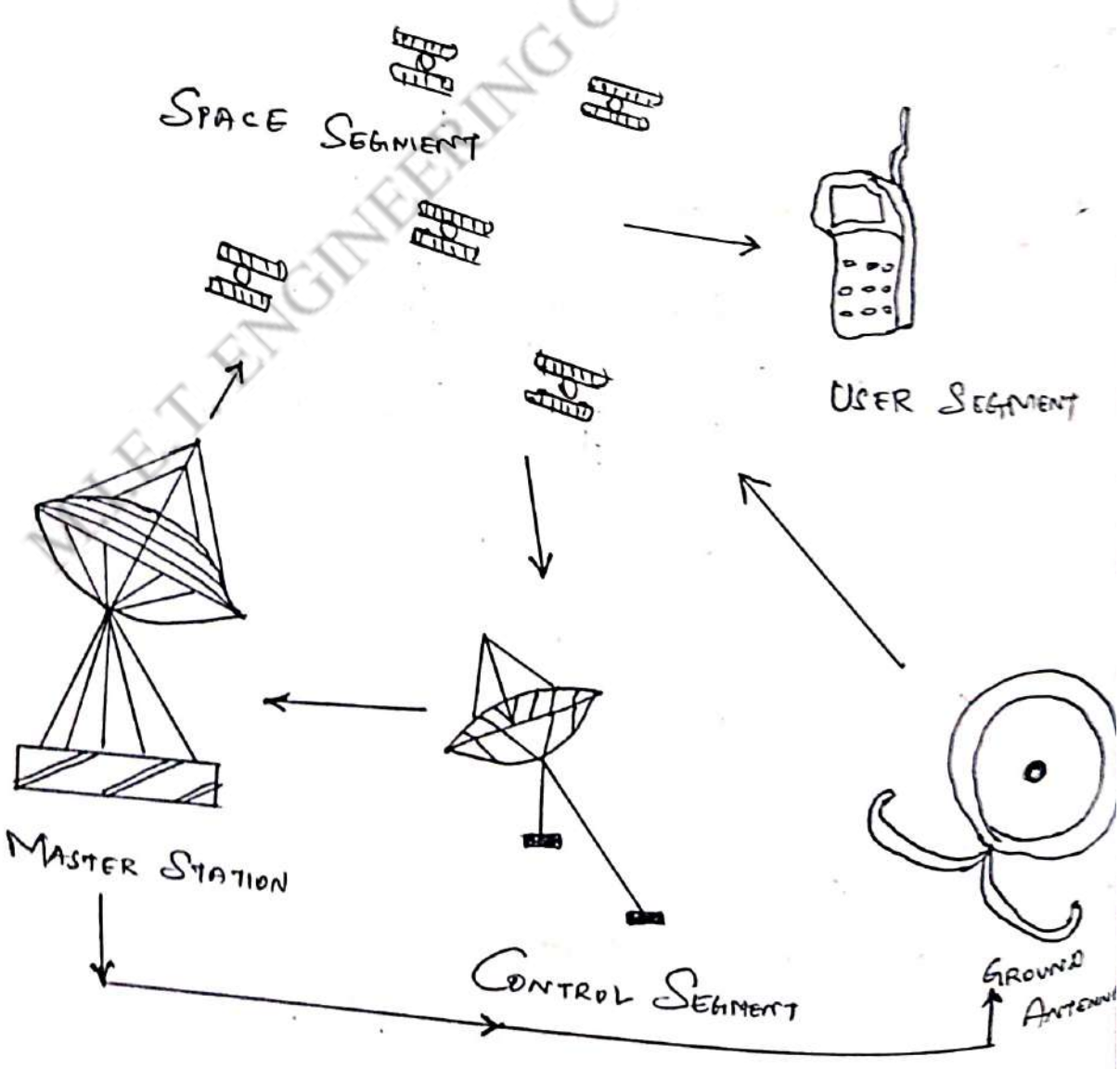
GPS segment consists of 3 segments.

1. Space segment
2. Control segment
3. User segment.

Space Segments:

- Space segment consists of the GPS satellites. [24 satellites around the Globe]

- Satellites that orbit the earth at 20 200 km every 12 Hours.
- There are 6 orbital planes, with Normally Four Satellites in each equally spaced (60^0 apart) and Inclined at about 55^0 with respect to Equatorial plane.
- Satellite Have a Speed of 3.9 km/second.



GPS SEGMENTS.

Each satellite Have High precise atomic clocks on board, which operate at a frequency of 10.3 MHz, two carrier frequency are generated to transmit signal codes.

They Constantly transmit one way signal, providing the position of each satellites and the time.

3. CONTROL SEGMENT :-

- Is a World wide Network of Monitor & Maintain the satellite in their proper orbit. It Consists of Master Control, Minor Control stations & Ground Antennas.
- Master Control station is responsible for overall Management of the remote monitoring & transmission sites.
- Minor Control station Collect satellite signal data & Retransmit it in real time to the master Control station for evaluation.
- Ground Antenna Monitor & track the satellite from Horizon to Horizon, it transmit Correct Information to individual satellites.

GPS USER SEGMENT! -

- The user segment of the system is GPS Receiver.
- It receives GPS signal and uses the received information to calculate its position & the time.
- User segment include Military & Civilians.
- Military GPS user segment integrated into fighter Bombers, Tankers, Helicopters, ships etc.
- Civilian Users GPS fall into one of four Categories
  a) Navigation
  b) Mapping
  c) Surveying
  d) Timing.

Suggested Questions / Assignments /Home works / any other

1. Explain the Various Segments of GPS with a Neat sketch.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mc Graw Hill
2.			
3.			

Any other suggested Materials

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Unit - V

Satellite Configuration.

	Satellite Configuration.

	Lecture Outcome (LO)	Bloom's Level
	At the end of this lecture, students will be able to	
	Gain knowledge on Satellite Configuration	Understand

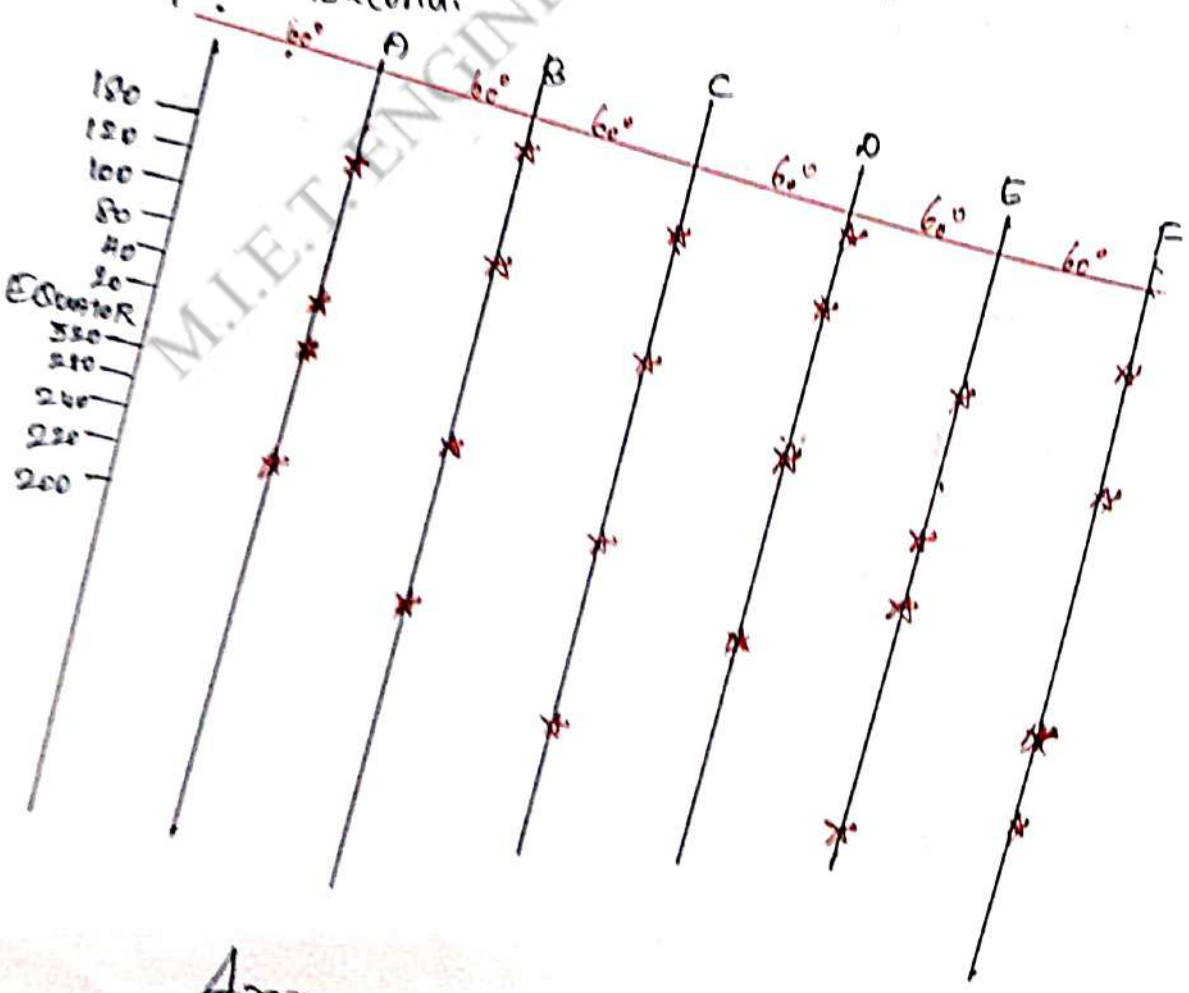
TeachingLearningMaterial	Student Activity
Chalk / Talk.	Listen.

Lecture Notes

Satellite Configuration:-

- Space segment consists of 21 GPS satellites
- It also contains an Addition of 3 Active spares.
- Totally 24 satellites are used for Monitoring Globe.

- Satellites are placed in nine Circular Orbits with an Inclination of 55°.
- Orbital Height of Satellite is About 20,200km to 20,600km from the Semi major axis.
- Orbital period is exactly 12 Hours of Sideral time.
- All the 6 orbits are nearly Circular.
- Satellites have a speed of 3.9 kilometre per second.



- Arrangement of Satellite in Orbit

From Figure Above,

A	- orbital plane 55° inclination
B	- "
C	- "
D	- "
E	- "
F	- "
*	- Satellite position.

GPS Satellite Vehicles are arranged on six planes each of them containing atleast four slots.

There are six orbital planes from A to F with a separation of 60° at right Ascension.

The position of Satellite with in a particular object plane can be identified by latitude.

Using fundamental frequency of 10.23 MHz, two Carrier frequency are generated to transmit Signal Codes C_1 & L_1, L_2.

- Selective Availability :-
  - Is a process applied by USA, intended to deny Civilian & Hostile foriegn powers the full accuracy of GPS by subjecting the Satellite Clock to a process known as "Dithering", which Alters their time slightly.
  - Broad Cast is slightly different from what it is reality.

Suggested Questions / Assignments /Home works / any other

1. Write short notes on Satellite Configuration.
2. Define Selective availability.

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mcgraw Hill
2.			
3.			

Any other suggested Materials

Signal structure.

	Signal structure - Satellite signals.

	Lecture Outcome (LO)	
	At the end of this lecture, students will be able to	Bloom's Level
	Gain knowledge on Signal Structure.	Understand

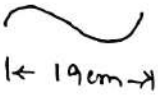
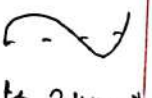
TeachingLearningMaterial	Student Activity
Chalk / Talk	Listen.

Lecture Notes

SIGNAL STRUCTURE! -

- Satellite have a fundamental frequency of 10.23 MHz.
- Satellite signal Consists of three Components.
  1. Two Microwave L - Band Carrier waves
  2. Ranging Codes Modulated on the Carrier Waves.
  3. Navigation Message.

Satellite Signals.

Carrier Waves	Frequency (f) MHz	Wave length λ	Modulation	Frequency (MHz)	Chip length
L_1	$154 \times f$	19cm.	C/A Code	1.023	293m
	1575.42.		P Code	10.23	29.3m
CIVILIAN SINGLE Frequency	(Single)		Message	50	—
		← 19cm →			
L_2	$120 \times f$	24cm	P Code	10.23	29.3
Military	1227.60		Message	50.	—
		← 24cm →			

- GPS Satellites Continuously broadcast satellite Position and timing data via Radio signals on two frequency's L_1 and L_2.

The Radio Signals travel at the speed of light and takes approximately 0.66 second to reach the earth.

The satellite signal requires a direct line to GPS receivers.

The L_1 signal is modulated with the Precise Code (P) and Coarse Aquisition Code [C/A]

The C/A code is available to Civilian GPS users and provide Standard positioning service (SPS).

Using SPS one can achieve 15 metre Horizontal accuracy 95% of the time.

Precise Code is broad cast on both L_1 and L_2 frequencies.

P Code, used for the precise positioning service (PPS) is available only to the Military.

- Military receivers can achieve beter accuracy than Civilian receivers.
- The codes are binary sequence of information generate by a complicated algorithm.
- The C/A code has a frequency of 1.023 MHz, wave length of about 300m contains a series of 1023 binary digi that are unique to each satellite.
- The P code, with a frequency of 10.23 MHz, wave length of 30m, 10 times more accurate than C/A code. The P code has a chip pattern. that takes 266.4 day to repeat.

Suggested Questions / Assignments /Home works / any other

1. Explain briefly signal structure of a GPS

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mcgraw Hill
2.			
3.			

	Hand Held GPS receiver - Geodetic Receiver.

Lecture Outcome (LO)	
At the end of this lecture ,students will be able to	Bloom's Level
Gain knowledge on GPS receivers.	Understand.

TeachingLearningMaterial	Student Activity
Chalk / talk	Listen.

Lecture Notes

HAND HELD GPS Receiver:-

- Is a device that uses the GPS, Combining modern geographic technology for every day use.
- Function of GPS Includes Navigation assistance and land survey data.
- GPS Receiver Collect signals from Navigation Satellite in orbit.
- Commercial Grade uses only the L1 frequency

and has an accuracy of about 10 feet.

- Accuracy of Recreational GPS Receivers usually falls within 50 feet.

- Hand Held GPS receives signals from max of three satellites hence it provides less accuracy.

Characteristics:-

- They are small in size
- Portable
- The operating power is derived from a battery.
- It consist of LCD Display.
- The display of information may be in geographical or Alpha Numerical format.

Geodetic Receivers:-

- These Receiver are essentially used

for Geodetic Surveying applications.

- It Receives both L_1 & L_2 frequencies.
- Carries phase data as observables.
- Accuracy of geodetic receiver is Higher
  i.e 1cm - Horizontally
  2cm - Vertically.
- They give Continuous Information or data.
- These can be operated for long duration using power back.

eg. Leica GS320, Trimble 5800, Solid GSR2650.

Components:-

1. A Base station 2. Rover.
   - It receives signals from atleast four separate satellites for a min. total of eight.

- **Antispoofing:** - Its intention is to deny Civilian & Hostile power access to the P-Code part of GPS signal.
  - To make use of C/A Code which have SA to it.
  - Antispoofing encrypts the P-Code into a signal called Y Code.
  - The Military equipped with special GPS receiver can read this encrypted P-Code.
  - For this reason, users of military GPS receivers usually get a position with an accuracy of around Millimetres, Civilian users only get 15-100m position accuracy.

Note!.

Military GPS receivers can decrypt the Y code.

Suggested Questions / Assignments /Home works / any other

1. Write short Notes on
   a) Hand Held Receivers
   b) Geodetic "

Text Books/ ReferenceBooks

S.No	Title	Author	Publisher
1.	Surveying	Duggal	Mcgraw Hill
2.			
3.			

Any other suggested Materials