Module 3

Conventional and Advanced Survey Techniques

MIT-WPU
॥ विश्वशान्तिर्ध्रुवा ॥
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Maps and their uses

- A map is a picture or representation of the Earth's surface, showing how things are related to each other by distance, direction and size.
- Types

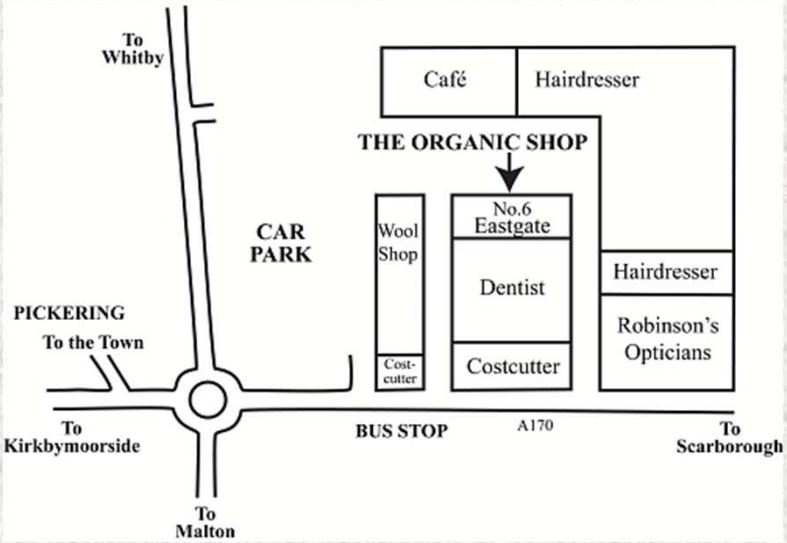
1) Topographic
2) Location
3) Cadastral
4) Forest
5) Geological
6) Environmental
7) Biogeographic

Topographic maps

- Shows 3 dimensional world in 2 dimensions using contour lines.
- Many hikers use especially in areas where there are no roads with signs
- Useful to geologists to record the types of rocks
- Useful to engineers for planning roads, buildings or any other structures
- Scale 1cm = 2.5km (R.F. _____?__)

Location map

- Map shows boundary locations of site w.r.t. neighbour hood marks
- R.F. for this map 1:2500 to 1:500



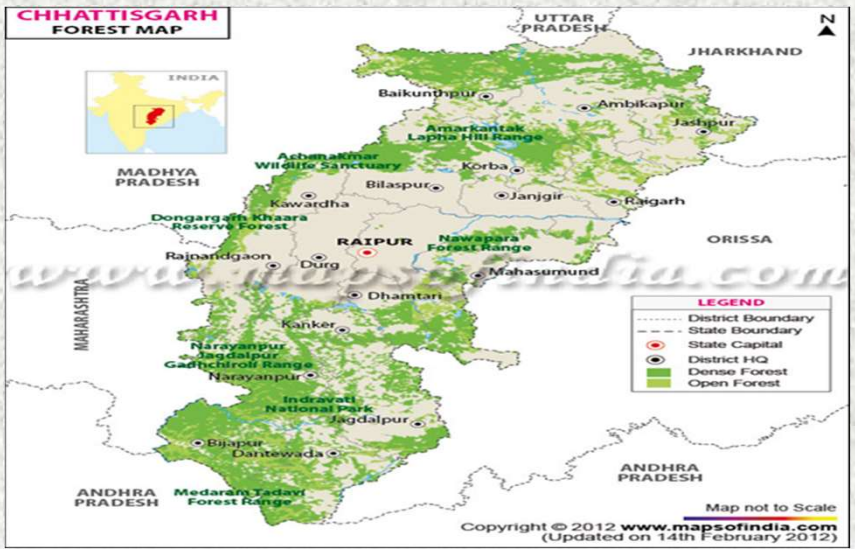
Cadastral map

- Word cadastral is derived from the French cadastra, Greek katastikhon
- It is a map showing the boundaries and ownership of land
- Purpose of map

1) Provides a cartographic record of official and private land surveys and subdivisions.
2) Facilitates the administration and transfer of lands
3) Records land ownership
4) Assists in the valuation and taxation of land
5) RF - 1:1000,1:2000,1:5000,1:25000

Forest map

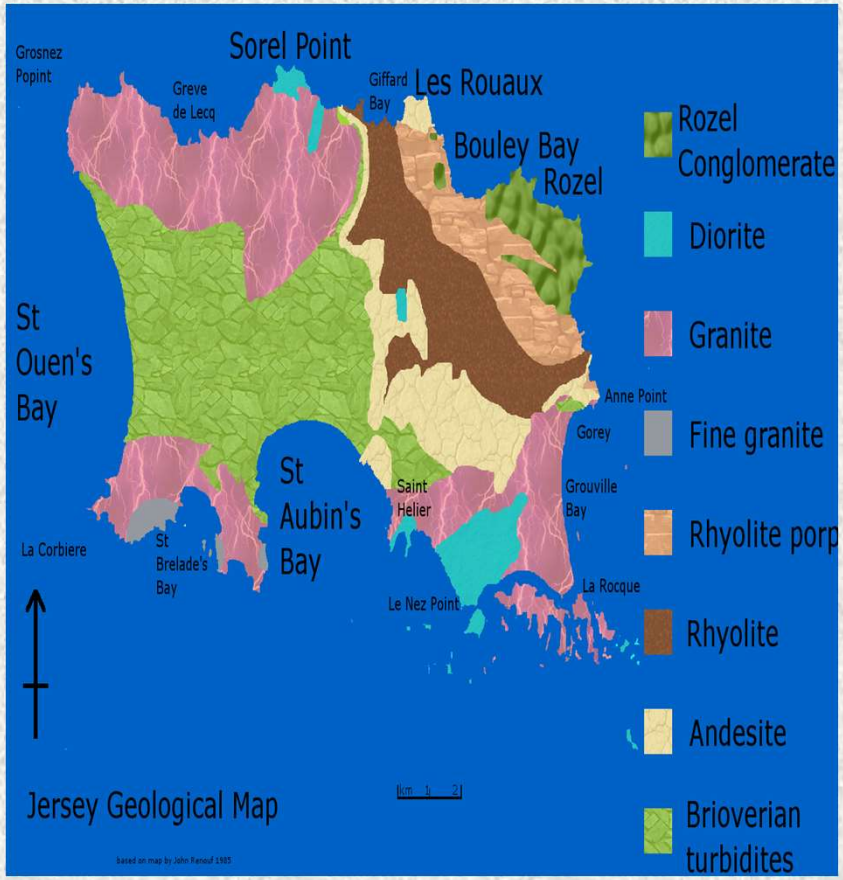
- Shows data like national parks, santuries, biosphere reserves, forest classes, boundaries and density of vegetation
- Satellite updated vegetation information like dense and open forests, scrubs, mangroves etc. can be provided.
- Scale 1: 50000, 1:250000



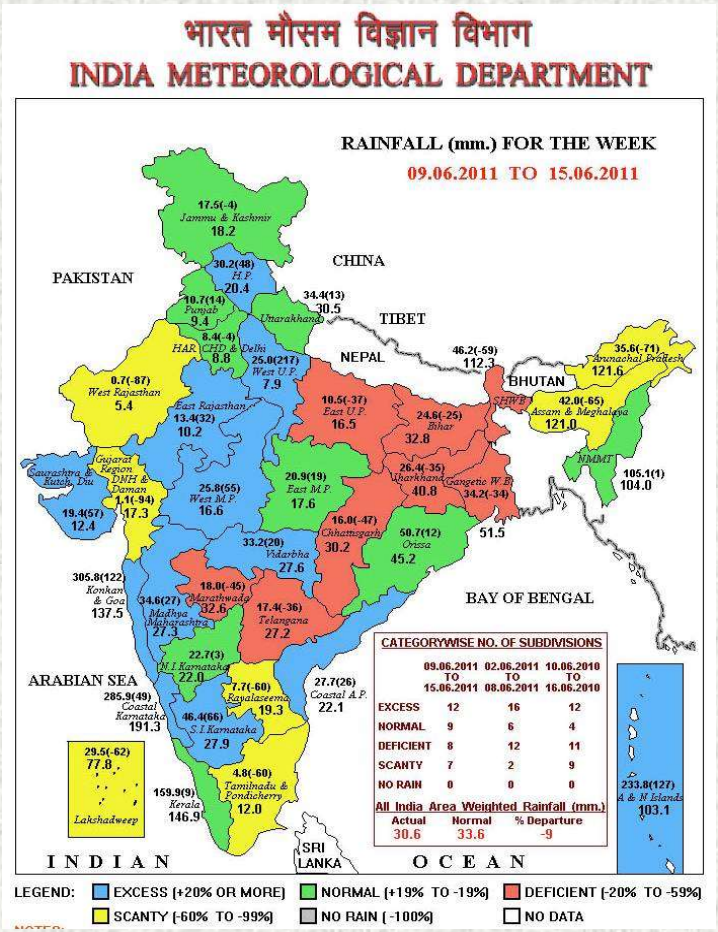
Geological map

- Shows geological features
- Rock units or geological strata are shown by colour or symbols to indicate surface coverage.
- Use – 1) Determine the relationships between different rock formations which can be used to find mineral resources, oil and gravel deposits.

  2) To know what type of rock or support strata you have for your structure, to avoid any mishap such as differential settlement, tilt or total collapse of structure

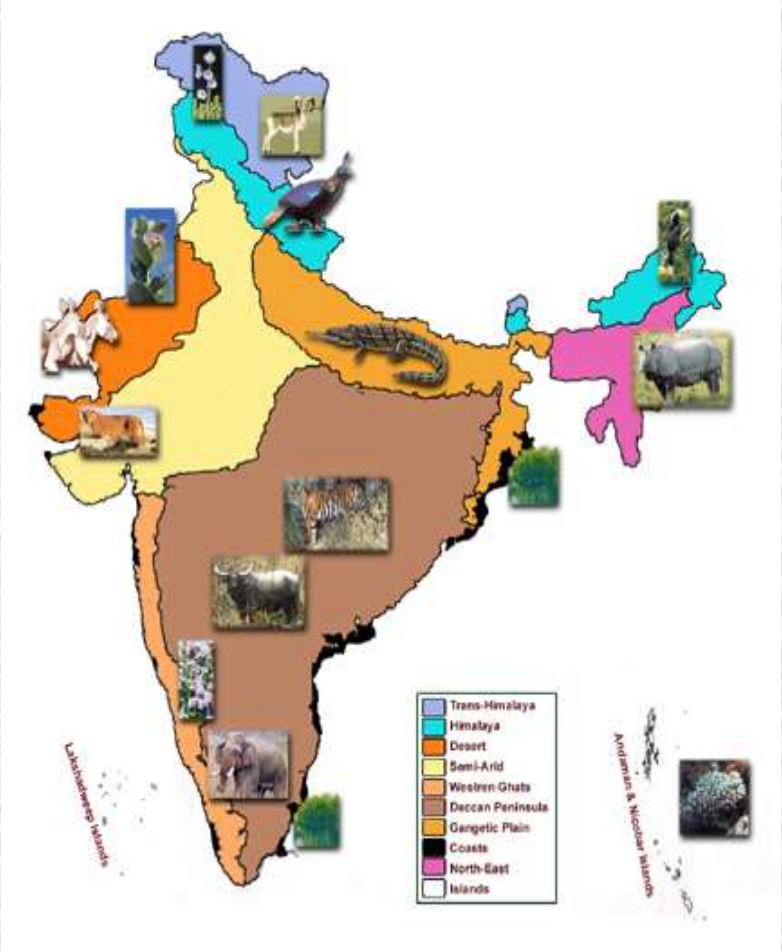


Environmental map



- Types of map which include the environment in which we all live.
- Maps that illustrate "physiographic" features such as forests, grassland, woodland , tundra, grazing land, ocean floors and ocean sediments.
- " Meteorological" maps shows climate, weather and wind
- Use – Meteorologists, oceanographers, geographers, city planners depend greatly on these maps to record and forecast their specific field.

Bio-geographical map



- Scientists involved in the study of animals, plants, and other living organisms use maps to illustrate where these groups live or migrate.
- Use – 1) important to many zoologists

  2) People who monitor endangered species need to know if the range of migration have become larger or smaller through time.

Representative Fraction (R.F.)

Definition :- when a scale is represented by a fraction whose numerator is invariably unity, it is called a representative fraction.

To form the RF , both the numerator and the denominator must be reduced to the same denomination.

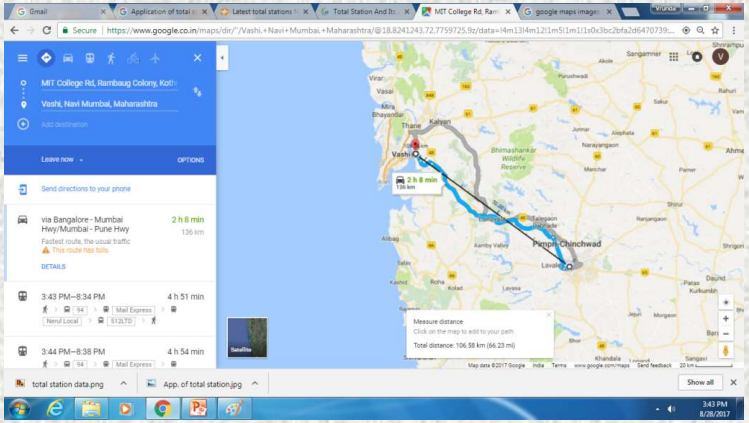
Scale 1 cm = 1 km

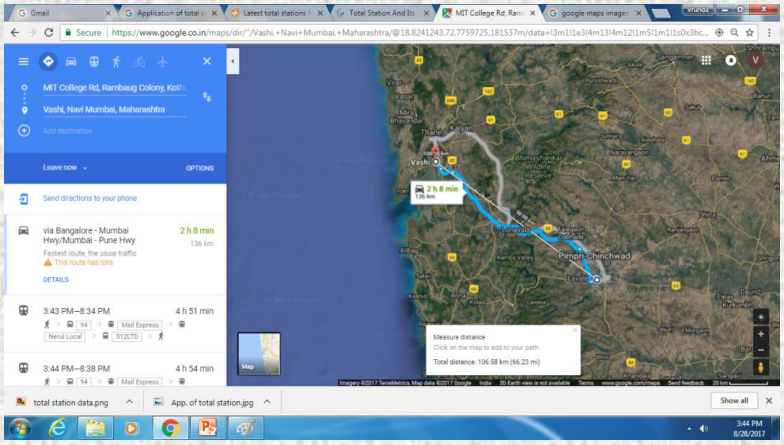
RF 1: 100,000 (1cm = 100000cm)

Type	Representative Fraction (RF)	Scale
Geographical map	1: 16000000	1 cm = 160 km
Topographical map	1: 250000	1 cm = 2.5 km
Location map	1: 500 to 1: 2500	1 cm = 5m to 25 m
Forest map	1: 25000	1cm = 0.25 km
Cadastral map	1: 1000 to 1: 5000	1 cm = 10 to 50 m

Google map

Exercise :- Illustrate any five applications of Google map.





- **Google Maps** is a web mapping service developed by Google. It offers satellite imagery, street maps, 360° panoramic views of streets (Street View), real-time traffic conditions (Google Traffic), and route planning for traveling by foot, car, bicycle (in beta), or public transportation.
- Google Maps' satellite view is a "top-down" or "birds eye" view; most of the high-resolution imagery of cities is aerial photography taken from aircraft flying at 800 to 1,500 feet (240 to 460 m), while most other imagery is from satellites.
- It is updated on a regular basis.

Primary classification of Surveying

- Surveying is the field of applied science and engineering that deals with spatial information about positions of point on, above or below the earth's surface.

- Surveying is primarily divided into two types considering the curvature of earth's surface.
  i. Plane Surveying
  ii. Geodetic Surveying

Primary Divisions of Surveying

Plane Surveying

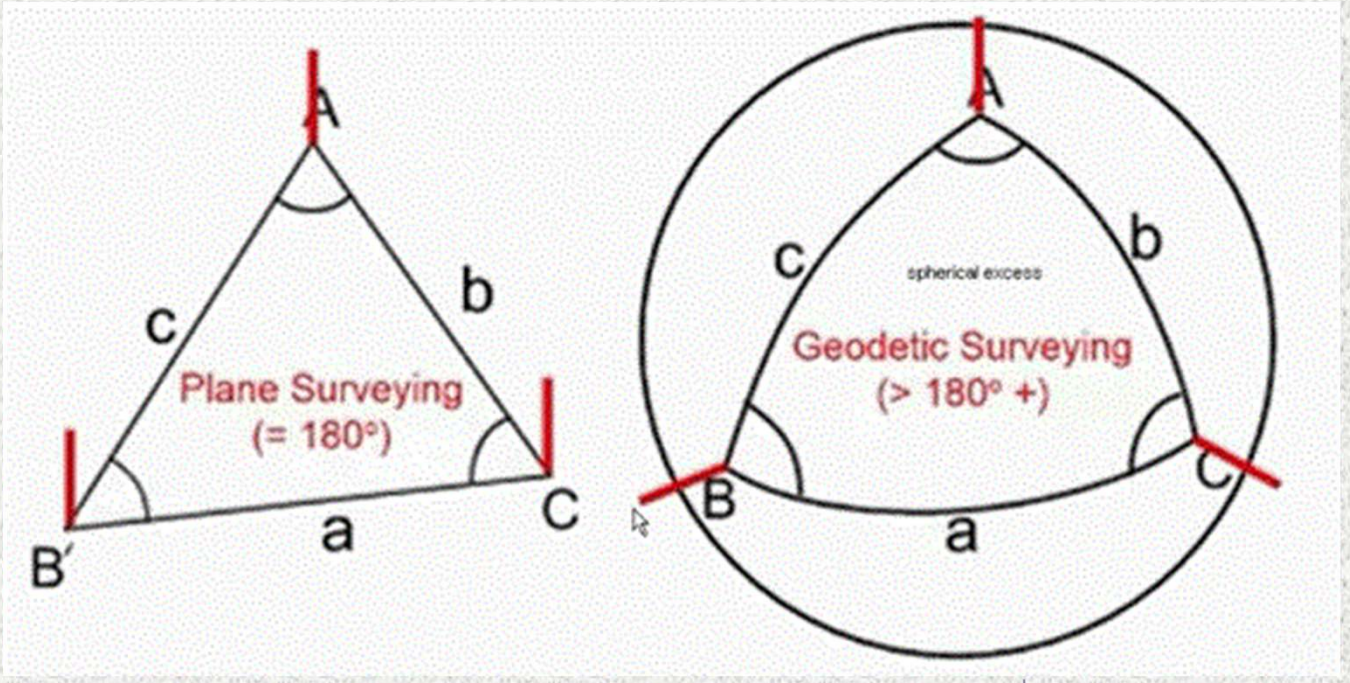
- The plane surveying is that type of surveying in which earth surface is considered as a plane and the curvature of the earth is ignored.
- In such surveying a line joining any two stations is considered to be straight.
- The triangle formed by any three points is considered as a plane triangle, and the angles of the triangle are considered as plain angles.
- Surveying is carried out for a small area of **less than 250 km^2** .
- It is carried out by local or state agencies like Irrigation department, Railway department.

Primary Divisions of Surveying

Geodetic Surveying

- The geodetic Surveying is that type of surveying in which the curvature of the earth is taken into account.
- It is generally extended over larger areas.
- The line joining any two stations is considered as curved line.
- The triangle formed by any three points is considered to be spherical and the angles of the triangle are considered to be spherical angles.
- Geodetic surveying is conducted by the **Survey of India Department** and is carried out for a **larger area exceeding 250 km^2**

Plane surveying& Geodetic surveying



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Difference between plan surveying and geodetic surveying

No.	Plan surveying	Geodetic surveying
1.	The earth surface is considered as a plane surface.	The earth surface is considered as a curved surface
2.	The curvature of earth surface is ignored.	The curvature of earth surface is taken in account.
3.	Line joining any two points is considered to be straight.	Line joining any two points is considered to be curve.
4.	The triangle formed by any three points is considered as a plane triangle.	The triangle formed by any three points is considered as a spherical triangle.
5.	The angle of triangle is considered as plane angle.	The angle of triangle is considered as spherical angle.
6.	Carried out for a small area $<250km^2$	Carried out for a large area $>250km^2$

Fundamental Principal of Surveying

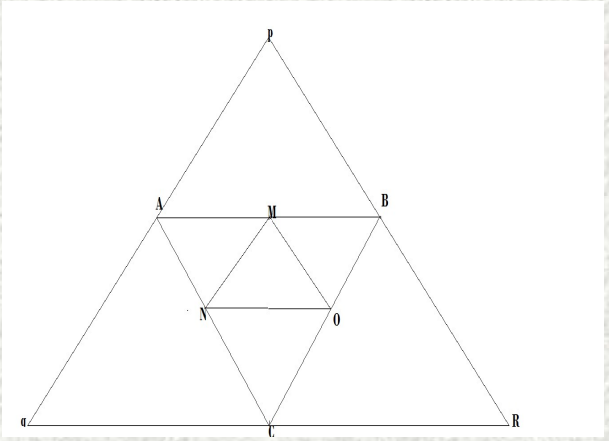
Two basic principles of surveying

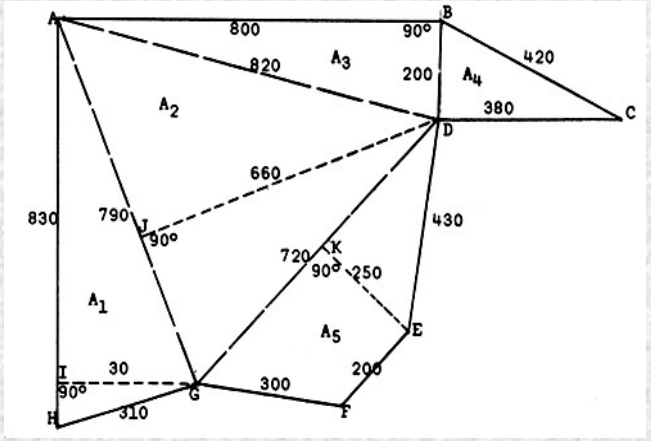
i. Always work from the whole to the part

ii. To locate a new station by at least two measurement form fixed reference points

i. Always work from the whole to the part

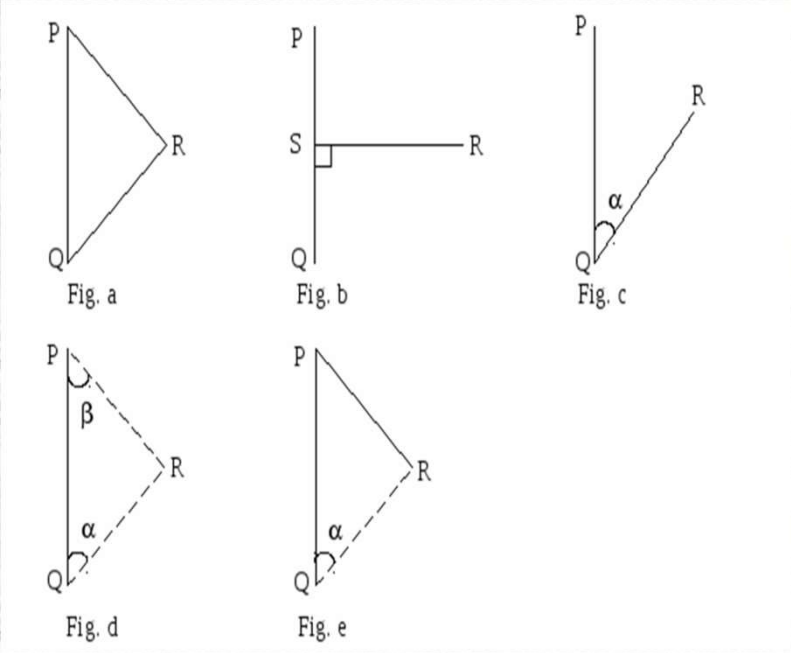
- The entire area or a very large area *(town, field)* is to be surveyed first.
- This main framework is in the form of polygons or triangles.
- The main framework is further subdivided into smaller areas for detail surveying.
- ***This principle prevents the accumulation of errors in the surveying and localizes the errors of measurement.***

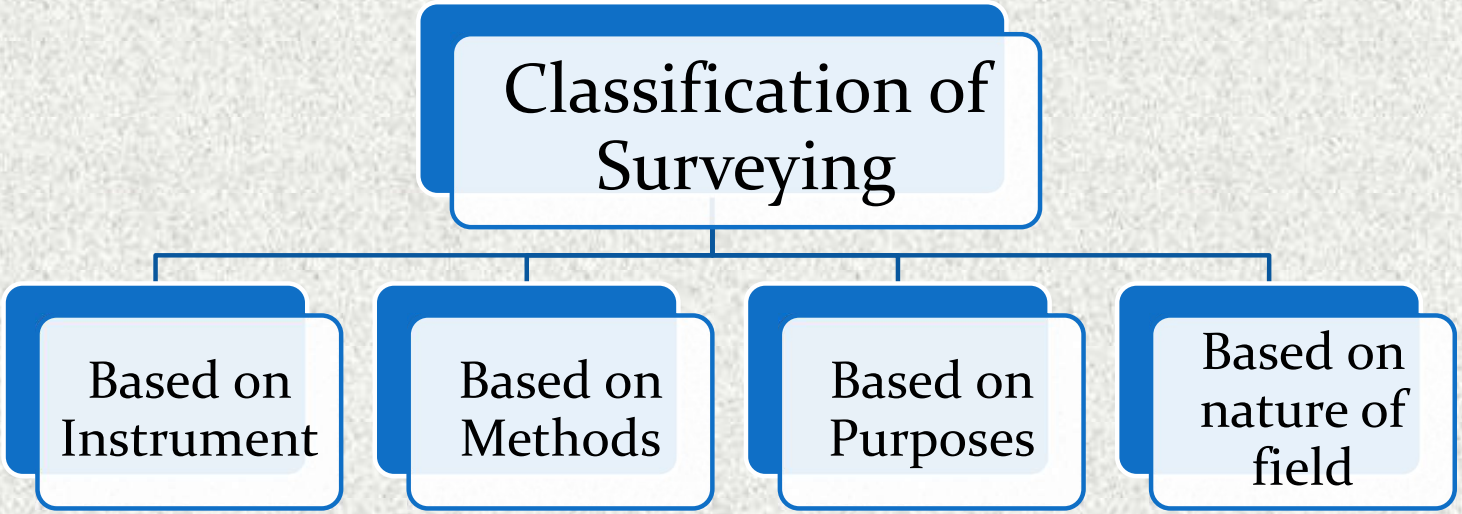




ii. To locate a new station by at least two measurement form fixed reference point

- If positions of ‘P’ and ‘Q’ are known and position of ‘R’ is to be located it can be done by:
  - *Two lengths ‘PR’ and ‘QR’ (fig a)*
  - *Perpendicular distance ‘RS’ and distance ‘QS’ (fig b)*
  - *Angle at ‘Q’ and length ‘QR’ (fig c)*
  - *Angle at ‘Q’ and ‘P’ (fig d)*
  - *Angle at ‘Q’ and length ‘PR’ (fig e)*





Classification based upon Instrument

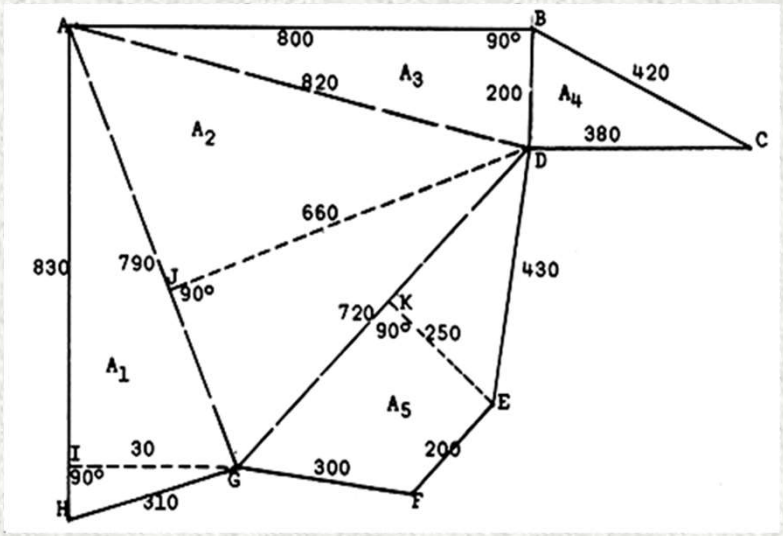
a. Chain Survey
b. Compass Survey
c. Chain and Compass Surveying
d. Plane Table Survey
e. Theodolite Survey
f. Tachometry Survey
g. Leveling Survey
h. Photogrammetric Survey
i. EDM(Total Station) Survey

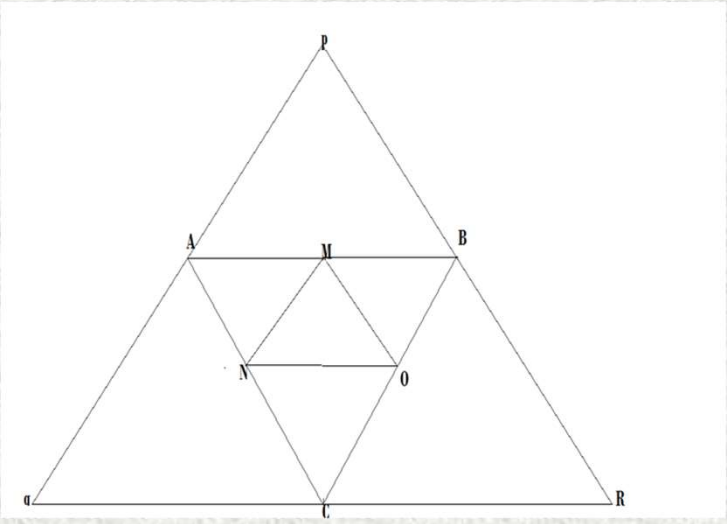
Classification based on methods

a. Triangulation
b. Traversing
c. Trilateration

Triangulation

- Triangulation is based on the trigonometric proposition that if one side and two angles of a triangle are known, the remaining sides can be computed

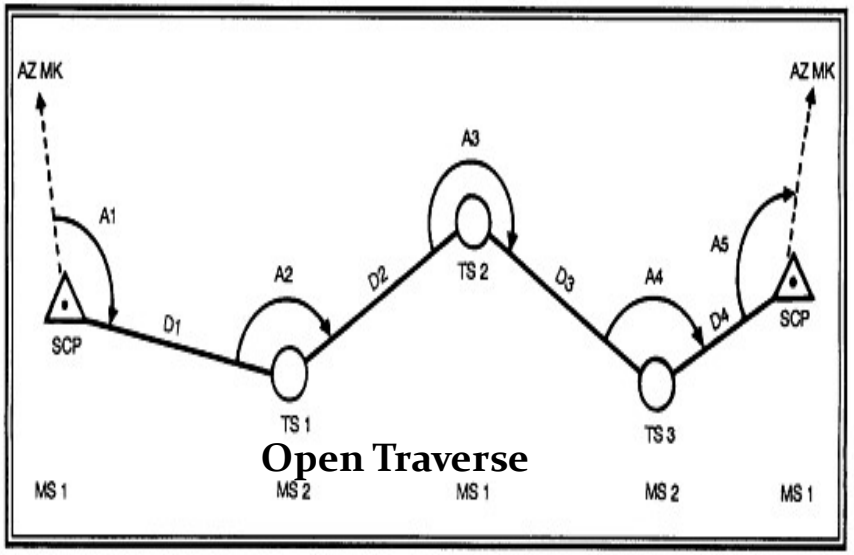




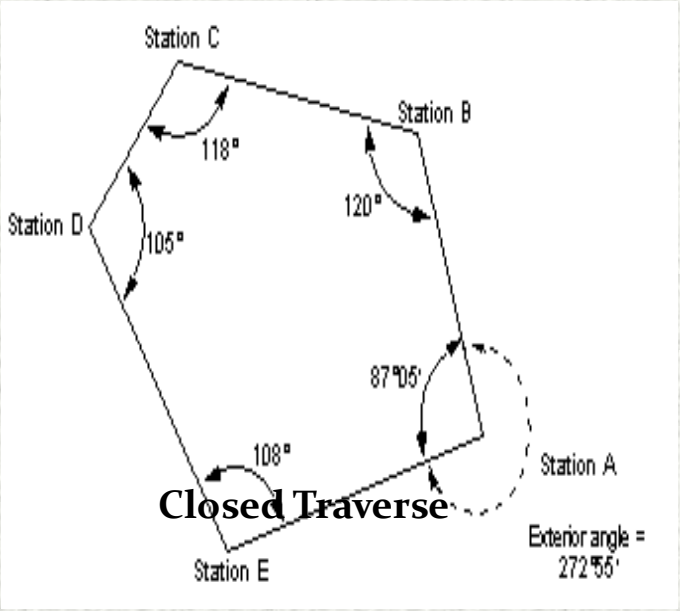
Traversing

- Type of survey in which a number of connected survey lines form the framework and the directions and lengths of the survey lines are measured with the help of angle measuring instrument and Tape.

Figure 5-6. Operational concept for div arty or TAB survey party



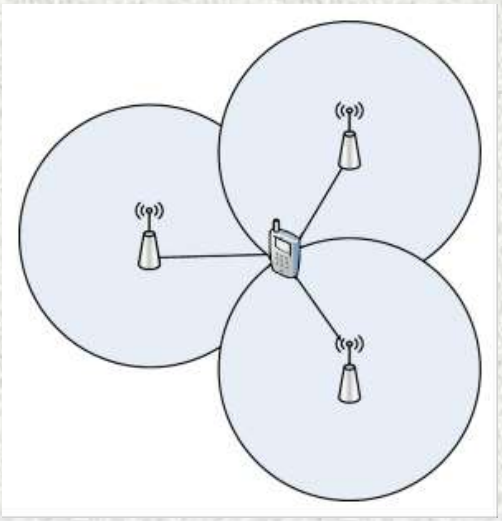
Open Traverse

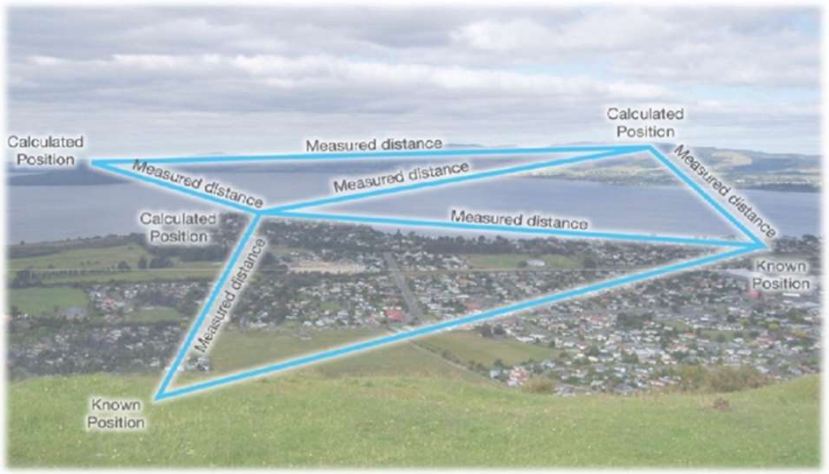


Closed Traverse

Trilateration

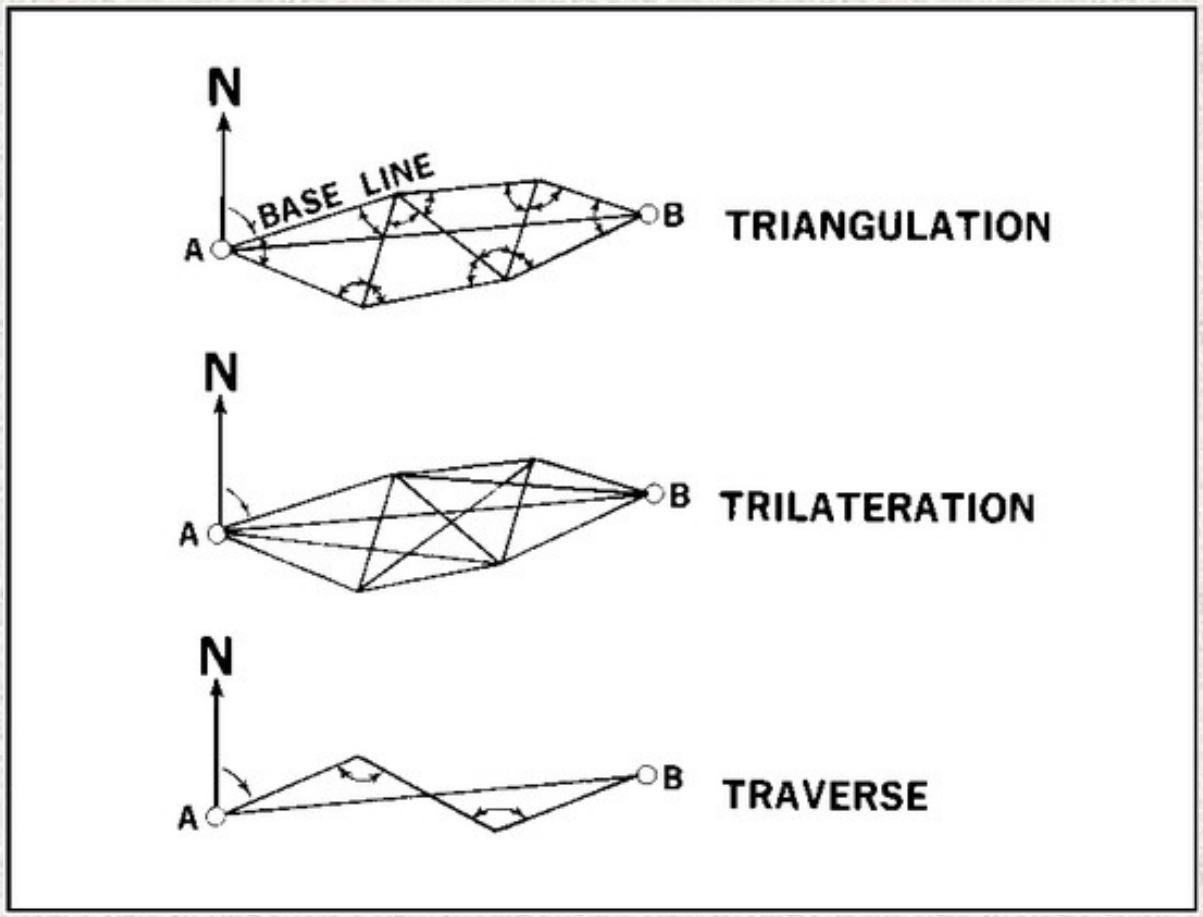
- Trilateration is the process of determining absolute or relative locations of points by measurement of distances, using the geometry of triangles.
- In contrast to triangulation, it does not involve the measurement of angles.
- GPS is based on Trilateration.





Trilateration Network

Er. Pramesh Hada, Assistant Professor, nec

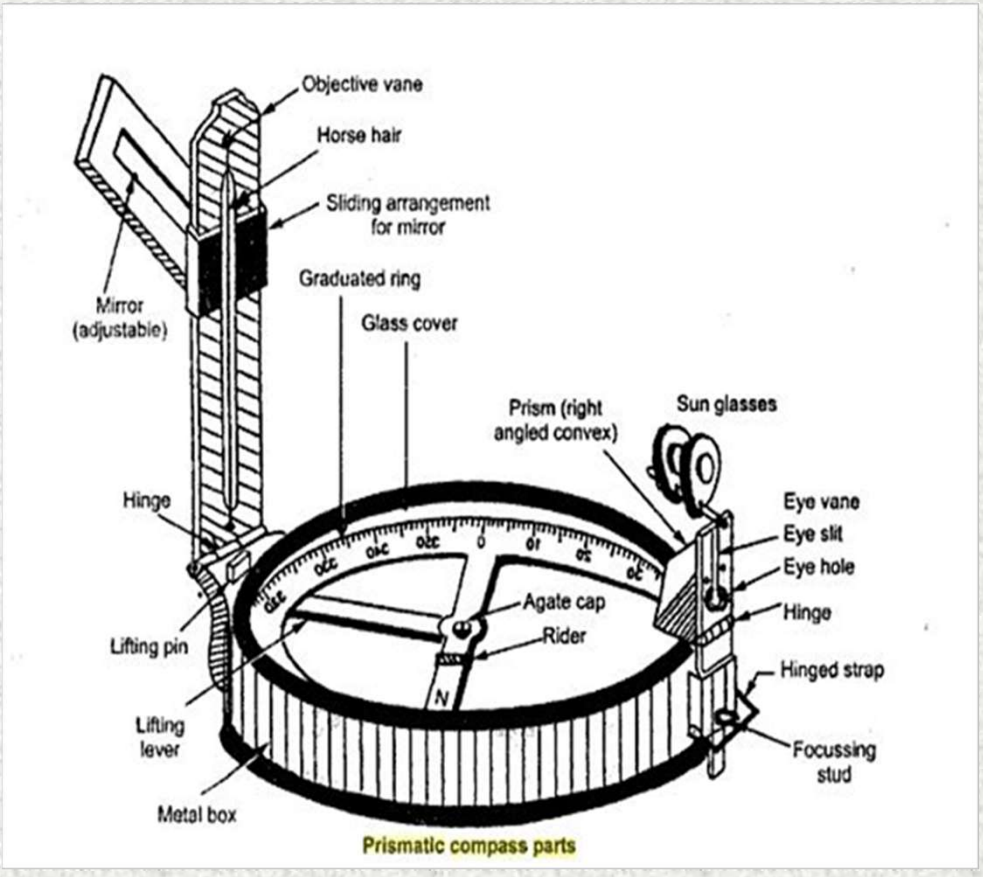

N
BASE LINE
A
B
TRIANGULATION
N
A
B
TRILATERATION
N
A
B
TRAVERSE

Conventional Survey Methods

Prismatic compass

Parts of prismatic Compass

- Needle
- Graduated ring
- Eye vane
- Object vane
- Prism
- Prism cap



Prismatic compass parts

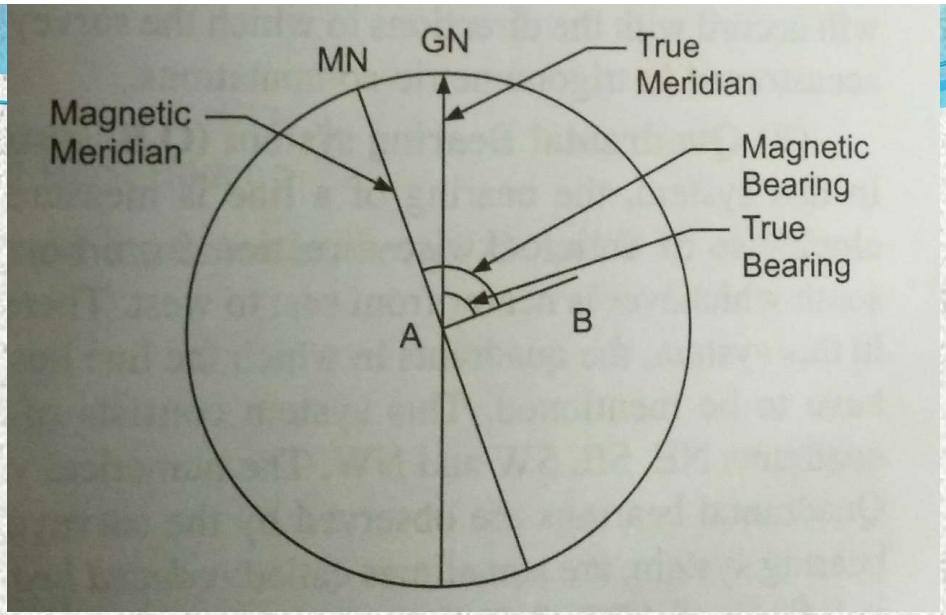
Bearings

- The bearing of a line is the horizontal angle which it makes with a reference line (meridian).
- Depending upon the meridian , following are the type of bearings :

1) <u>True Bearing</u>: The true bearing of a line is the horizontal angle between the true meridian and the survey line. The true bearing is measured from the true north in the clockwise direction.

2) <u>Magnetic Bearing</u>: The magnetic bearing of a line is the horizontal angle which the line makes with the magnetic north.

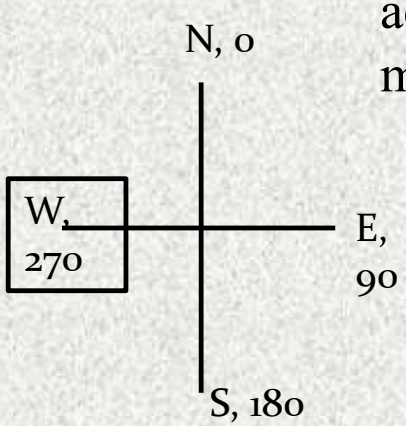
3) <u>Arbitrary Bearing</u>: The arbitrary baring of a line is the horizontal angle which the line makes with the arbitrary meridian.

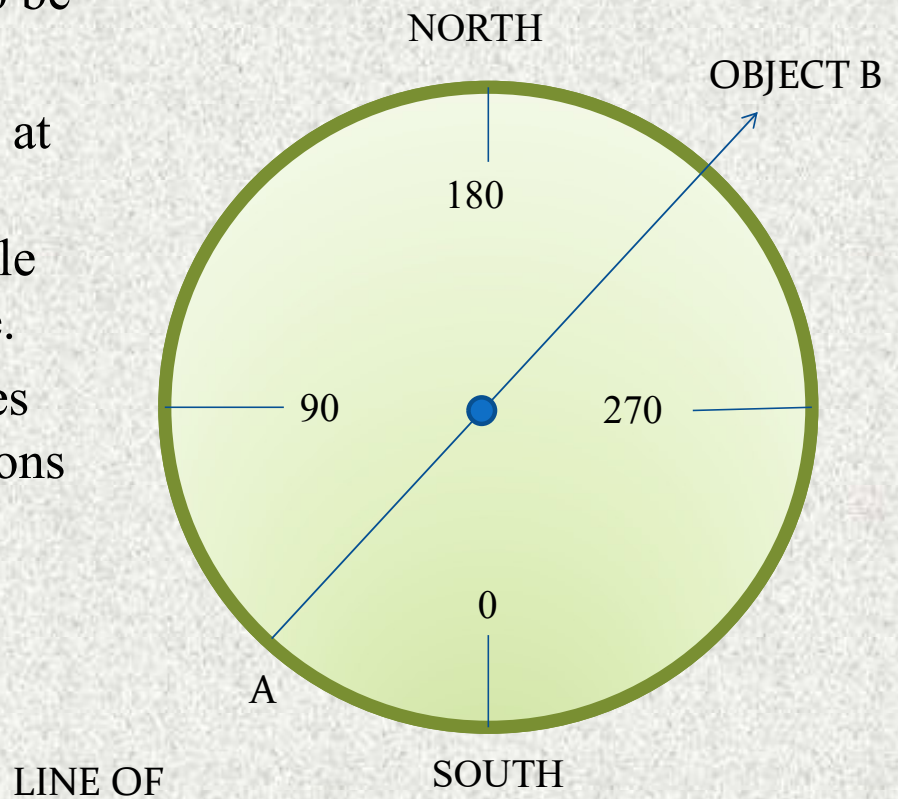


- A line passing through the geographical North pole, geographical South pole and any point on the surface of earth is known as '**True/ Geographical Meridian**'.
- Angle between true meridian and a line is known as **True Bearing.**
- The direction indicated by freely suspended and properly balanced magnetic needle is called '**Magnetic meridian**'.
- The angle which a line makes with magnetic meridian is called as '**Magnetic Bearing**'.

Observing Bearing of Line

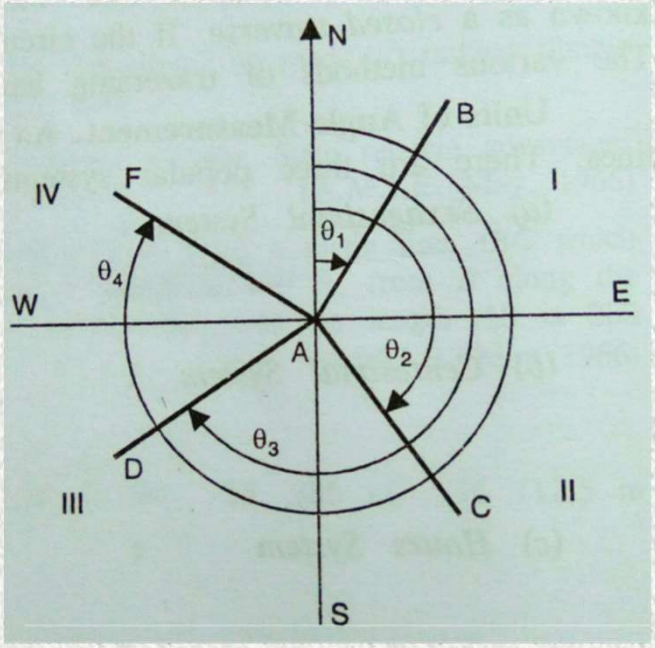
- Consider a line AB of which the magnetic bearing is to be taken.
- By fixing the ranging rod at station B we get the magnetic bearing of needle with respect to north pole.
- The enlarged portion gives actual pattern of graduations marked on ring.



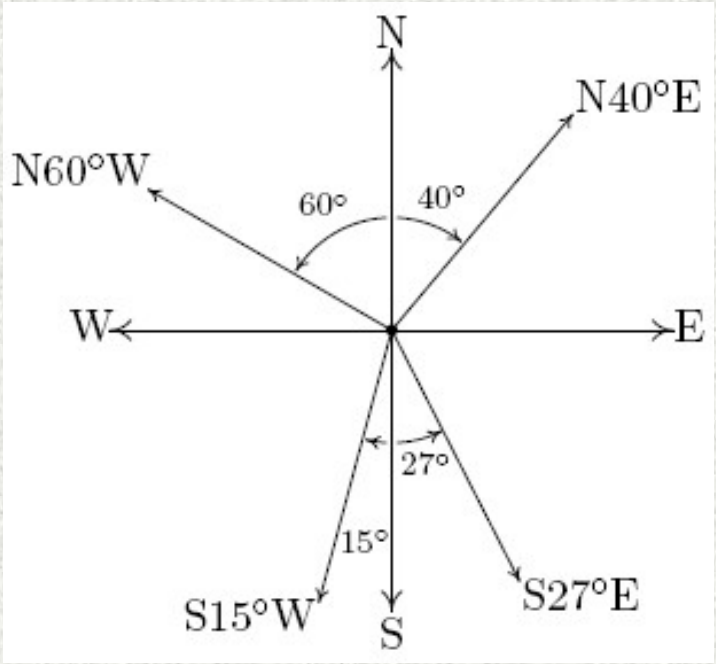


Whole Circle Bearing

- **Whole Circle Bearing System (W.C.B):-** The bearing of a line measured with respect to magnetic meridian in clockwise direction is called magnetic bearing and its value varies between 0^{O} to 360^{O}.



Quadrantal Bearing



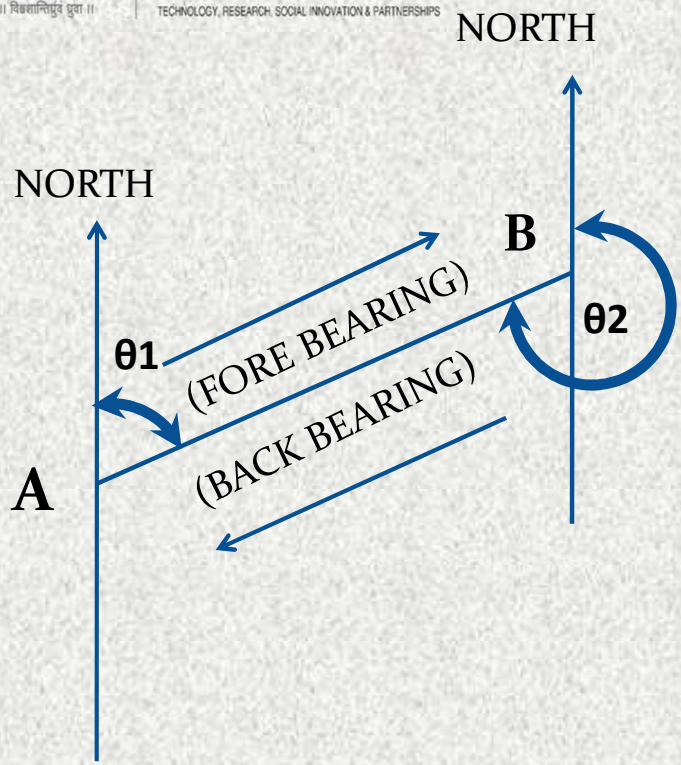
- **Quadrantal Bearing System (Q.B):-** In this system, the bearing of survey lines are measured with respect to north line or south line which ever is the nearest to the given survey line and either in clockwise direction or in anti clockwise direction.
- When the whole circle bearing is converted into Quadrantal bearing, it is termed as "REDUCED BEARING". The reduced bearing is similar to the Quadrantal bearing.

Whole circle bearing and Reduced Bearing

W.C.B OF ANY LINE	QUADRANT IN WHICH IT LIES	RULES FOR CONVERSION	QUADRANT
0 TO 90	I	RB=WCB	N-E
90 TO 180	II	RB=180-WCB	S-E
180 TO 270	III	RB =WCB-180°	S-W
270 TO 360	IV	RB=360° - WCB	N-W

Fore bearing and Back bearing and computation of angles

- The bearing of a line measured in the forward direction of the survey lines is called the 'fore bearing'(F.B.) of that line
- The bearing of a line measured in direction backward to the direction of the progress of survey is called the 'back bearing'(B.B.) of the line.

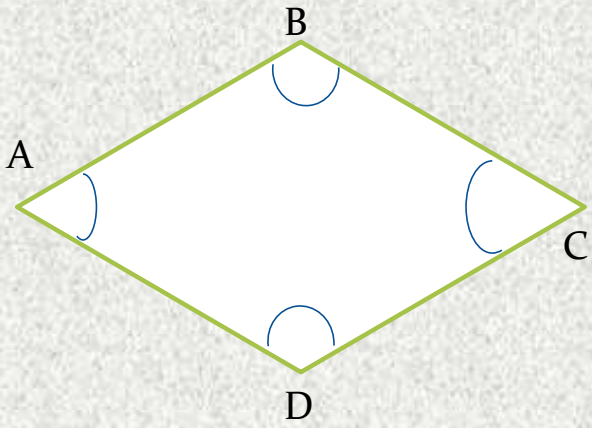


FB of AB = θ1(from A to B)
BB of AB= θ2(from B to A)
Remembering following points:

1) In the WCB system ,the differences between the FB and BB should be exactly 180˚.
   Remember the following relation :
   BB = FB + 180˚/ FB - 180˚
   + is applied when FB is <180˚
   - is applied when BB is >180˚
2) In the reduced bearing system the FB and BB are numerically equal but the quadrants are just opposite.

Computation of Angles

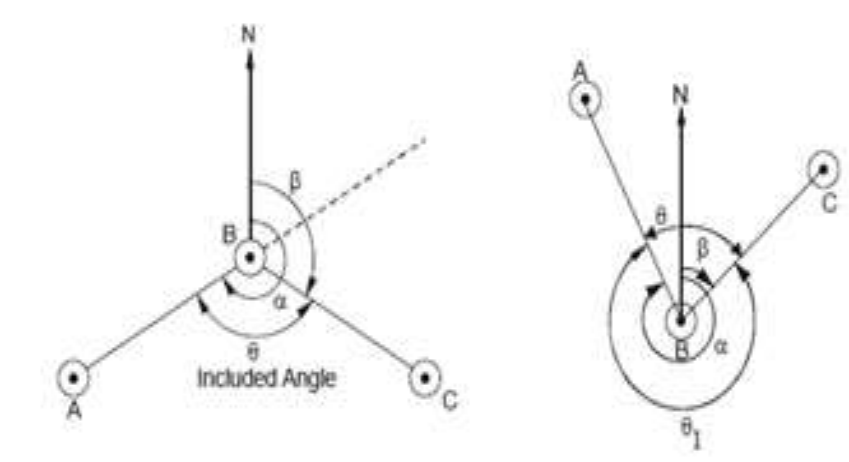
- Observing the bearing of the lines of a closed traverse, it is possible to calculate the included angles, which can be used for plotting the traverse.
- At the station where two survey lines meet, two angles are formed-an exterior angles and an interior angles. The interior angles or included angle is generally the smaller angles($<180^{O}$).



Included angle and excluded angle

- AT STATION B, FB of BC and BB of AB were measured. Difference of these two bearing give included angle B.

- AT STATION B , BB of AB and FB of BC were measured. Difference of these two bearing will give you exterior angle B.



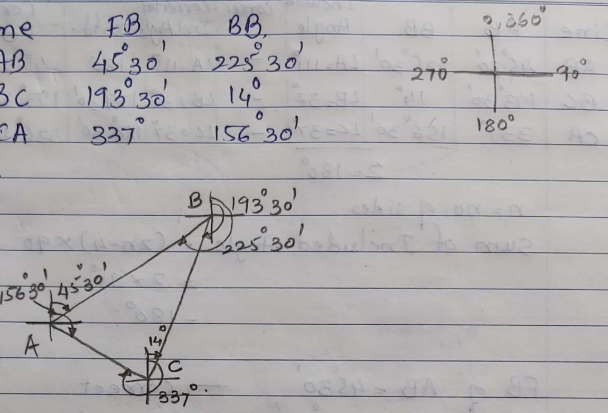
Example 1

The following are bearings taken on a closed compass traverse. Compute the included angles and correct them for observational errors. Determine the correct bearings of the lines.

Line	Fore Bearing	Back Bearing
AB	45° 30’	225° 30’
BC	193° 30’	14°
CA	337°	156° 30’

Assignment/ Test Page No.

Example	Line	FB	BB
1	AB	$45^\circ 30'$	$225^\circ 30'$
	BC	$193^\circ 30'$	14°
	CA	337°	$156^\circ 30'$



Included Angles.

$\angle A$ = BB of CA − FB of AB
$= 156^\circ 30' - 45^\circ 30'$
$= 111^\circ$

$\angle B$ = BB of AB − FB of BC
$= 225^\circ 30' - 193^\circ 30'$
$= 32^\circ$

$\angle C = 360^\circ$ − FB of CA + BB of BC
$= 360^\circ - 337^\circ + 14^\circ$
$= 37^\circ$

Assignment/ Test Page No.

Line	FB	BB.	Included Angle	corre.	corrected Incl. Angle	Diff.	Corrected FB	Corrected BB.	Rem
AB	45°30'	225°30'	∠A=111°	-	∠A=111°	180°	45°30'	225°30'	free fr local
BC	193°30'	14°	∠B=32°	-	∠B=32°	179°30'	193°30'	13°30'	
CA	337°	156°30'	∠C=37°	-	∠C=37°	180°30'	336°30'	156°30'	

$\Sigma = 180°$

n = no. of sides

Sum of Included Angle $= (2n-4) \times 90°$

$= 2 \times 90°$

$= 180°$

FB of AB = 45°30' — correct

BB of AB = 225°30' — correct

FB of BC = 193°30' — correct.

BB of BC = FB of BC − 180°

$= 193°30' - 180°$

$= 13°30'$

BB of CA = 156°30' — correct.

FB of CA = 156°30' + 180°

$= 336°30'$

Example 2

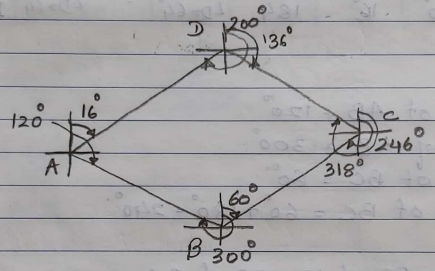
The following are bearings taken on a closed compass traverse. Compute the included angles and correct them for observational errors. Determine the correct bearings of the lines.

Line	Fore Bearing	Back Bearing
AB	120˚	300˚
BC	60˚	246˚
CD	318˚	136˚
DA	200˚	16˚

Assignment/ Test Page No.

Example 2

Line	FB	BB
AB	120°	300°
BC	60°	246°
CD	318°	136°
DA	200°	16°



1

Included Angle -

$\angle A$ = FB of AB − BB of DA = 120° − 16° = 104°

$\angle B$ = 360° − BB of AB + FB of BC = 360° − 300° + 60° = 120°

$\angle C$ = FB of CD − BB of BC = 318° − 246° = 72°

$\angle D$ = FB of DA − BB of CD = 200° − 136° = 64°

Sum of Included angle = 104° + 120° + 72° + 64°

= 360°

Assignment/ Test Page No.

Line	FB	BB	Diff.	Included Angle	corr.	Corrected Incl. Angle	Corrected FB	Corrected BB.	Remark
AB	120°	300°	180°	∠A = 104°	-	∠A = 104°	120°	300°	
BC	60°	246°	186°	∠B = 120°	-	∠B = 120°	60°	240°	
CD	318°	136°	182°	∠C = 72°	-	∠C = 72°	312°.	132°.	
DA	200°	16°	184	∠D = 64°	-	∠D = 64°	196°	16°	

1) FB of AB = 120°
2) BB of AB = 300°
3) FB of BC = 60°.
4) BB of BC = 60° + 180° = 240°.

5) ∠C = FB of CD − BB of BC
   72° = FB of CD − 240°.
   FB of CD = 312°

6) BB of CD = 312° − 180° = 132°.

7) ∠D = FB of DA − BB of CD
   64° = FB of DA − 132°.
   FB of DA = 196°. ——— (Check) — ok.

   FB of DA − BB of DA = 180°.
   FB of DA = 180° + 16° = 196°.

Example 3

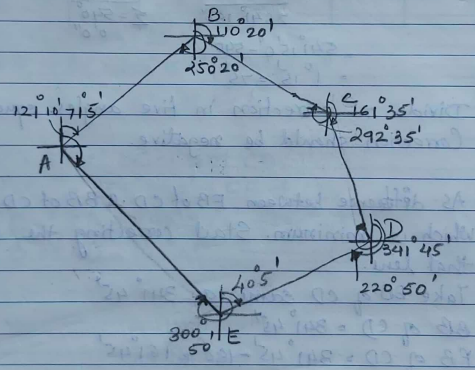
The following are bearings taken on a closed compass traverse. Compute the included angles and correct them for observational errors. Determine the correct bearings of the lines.

Line	Fore Bearing	Back Bearing
AB	71° 05’	250° 20’
BC	110° 20’	292° 35’
CD	161° 35’	341° 45’
DA	220° 50’	40° 05’
EA	300° 50’	121° 10’

Assignment/ Test Page No.

Example 3

Line	FB	BB
AB	71° 05'	250° 20'
BC	110° 20'	292° 35'
CD	161° 35'	341° 45'
DE	220° 50'	40° 05'
EA	300° 50'	121° 10'



Included angle

$\angle A$ = BB of EA − FB of AB = 121° 10' − 71° 5' = 50° 5'

$\angle B$ = BB of AB − FB of BC = 250° 20' − 110° 20' = 140° 0' 0"

$\angle C$ = BB of BC − FB of CD = 292° 35' − 161° 35' = 131° 0' 0"

$\angle D$ = BB of CD − FB of DE = 341° 45' − 220° 50' = 120° 55' 0"

$\angle E$ = 360° − FB of EA + BB of DE = 360 − 300° 50' + 40° 5' = 99° 15' 0"

Σ = 541° 15' 0"

Sum of Included angle = (2n − 4) × 90°

= 540°

Line	FB	BB	Diff.	Inclu. Angle	Correct	Cor. Inclu. An.	Corrected FB	Corrected BB	Remark
AB	71°05'	250°20'	179°15'	∠A=50°5'	-15'	49°50'	72°15'0"	252°15'0"	
BC	110°20'	292°35'	182°15'	∠B=140°00'	-15'	139°45'0"	112°30'0"	292°30'0"	
CD	161°35'	341°45'	180°10'	∠C=131°0'0"	-15'	130°45'0"	161°45'	341°45'	
DE	220°50'	40°05'	180°45'	∠D=120°55'	-15'	120°40'0"	221°5'0"	41°5'0"	
EA	300°50'	121°10'	179°40'	∠E=99°15'	-15'	99°0'0"	302°5'0"	122°5'0"	
				Σ=541°15'0"		Σ=540°0'0"			

$= 541°15'0" - 540°$

$= 1°15' = 75'$

Divide 75' correction in five angles equally.
Correction should be negative.

As ~~difference~~ between FB of CD & BB of CD is 180°10' which is minimum. Start correcting the Bearings from that line.

Take BB of CD same as 341°45'

1) BB of CD = 341°45'
2) FB of CD = 341°45' - 180° = 161°45'
3) CD = BB of CD - FB of DE.
   120°40'0" = 341°45' - FB of DE
   FB of DE = 341°45' - 120°40'0"
   = 221°5'0"

4) LE = 360° - FB of EA + BB of DE.
   99°0'0" = 360° - FB of EA + 41°5'0"
   FB of EA = 360° + 41°5'0" - 99°0'0"
   = 302°5'0"

5) $\angle A$ = BB of EA − FB of AB.

$49°50'0'' = 122°5'0'' - FB \text{ of } AB.$

$FB \text{ of } AB = 122°5'0'' - 49°50'0''$

$= 72°15'0''$

6) $\angle B$ = BB of AB − FB of BC

$139°45'0'' = 252°15'0'' - FB \text{ of } BC.$

$FB \text{ of } BC = 252°15'0'' - 139°45'0''$

$= 112°30'0''$

7) $\angle C$ = BB of BC − FB of CD.

$130°45'0'' = 292°30'0'' - FB \text{ of } CD.$

$FB \text{ of } CD = 292°30'0'' - 130°45'0''$

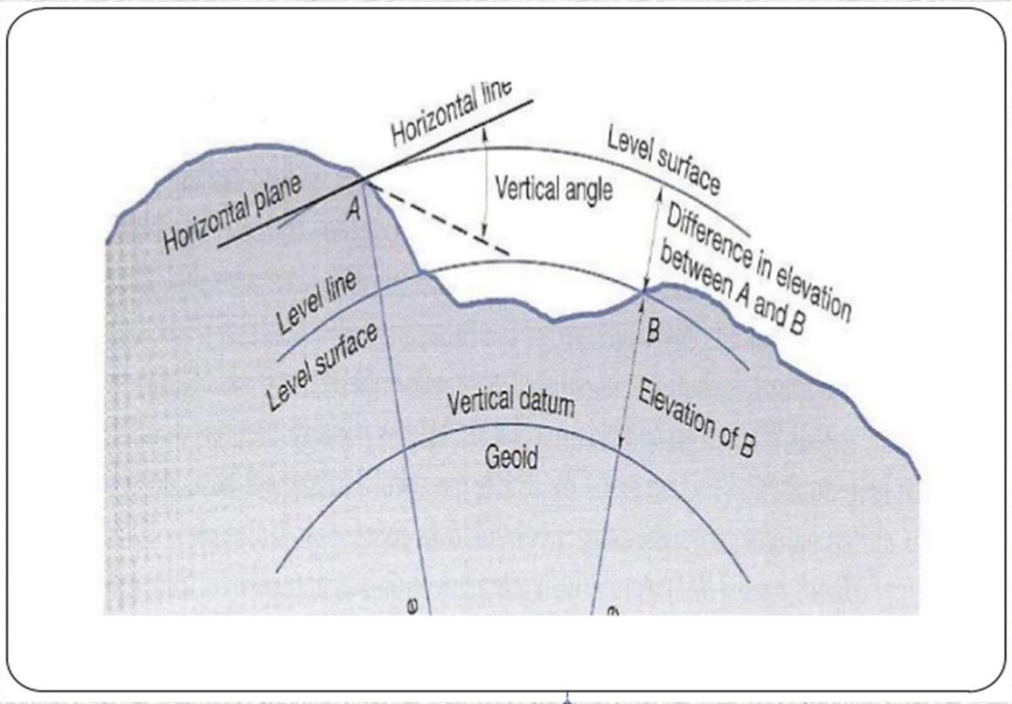
$FB \text{ of } CD = 161°45'$ ——— (check) - ok

Levelling

(An art of measuring the relative heights or elevations of the points or objects on the surface of the earth is called as levelling.)

Important terms used in levelling

- Level surface
- Level line
- Horizontal line
- Horizontal surface
- Vertical line
- Datum surface
- Mean sea level
- Bench mark (B.M.)



Definition of some terms

- The **Geoid** is the shape that the surface of the oceans would take under the influence of Earth's gravitation and rotation alone, in the absence of other influences such as winds and tides.
- The **Level Surface** is any surface parallel to the mean spheroidal surface of the earth.
- The **Level line** is a line laying on a level surface.
- The **Horizontal line** is a straight line tangential to the level line and perpendicular to plumb line.
- The **Horizontal surface** is any surface tangential to level surface at given point.
- The **Vertical line/ Plumb line** is a line at any point normal to the level surface
- The **Datum Surface** – Line is any arbitrarily assumed level surface or line from which vertical distances are measured.

Bench Marks

It is a fixed reference point whose elevation with respect to some datum is known.

1) GTS Bench Mark

   Department of Survey of India

   GTS maps

2) Permanent Bench Mark

   Established from GTS Bench Mark

   PWD, Irrigation department

3) Arbitrary Bench Mark

4) Temporary Bench Mark

- Auto level practical

https://www.youtube.com/watch?v=cbgt7yJRAhI

https://www.youtube.com/watch?v=lVVbF1M198Q

Levelling staff

https://www.youtube.com/watch?v=QxOBdKbhjd8

Change point

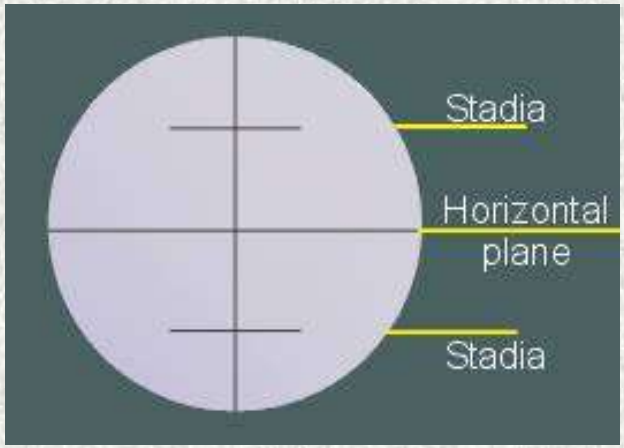
https://www.youtube.com/watch?v=K61Qhf2CcTY

Fly levelling

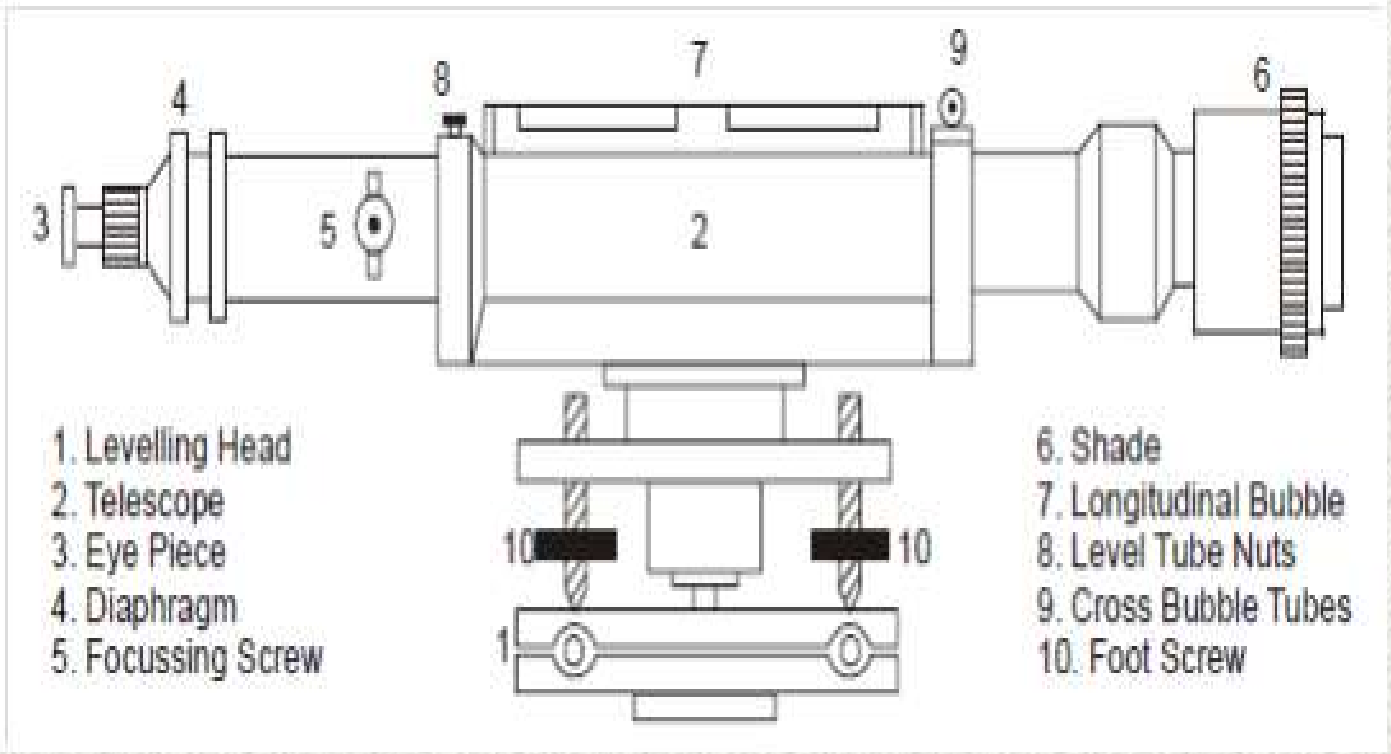
https://www.youtube.com/watch?v=jIxCx00SWOY

Parts of dumpy level/Auto level

- Tripod stand
- Levelling head (base plates, Three foot screws)
- Telescope (Eyepiece, Object glass)

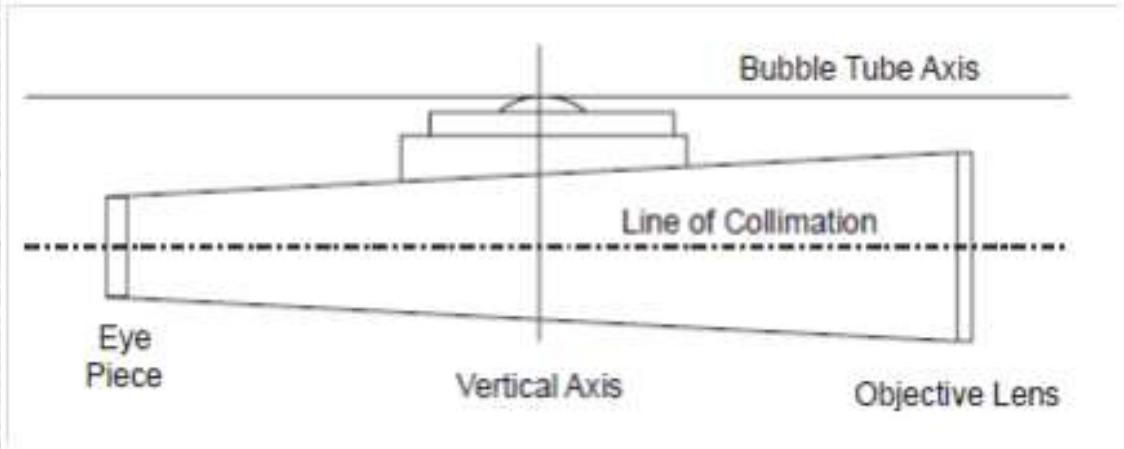


Dumpy Level/Auto level



Axes of Dumpy Level/Auto level

- Line of collimation
- Axis of telescope
- Axis of the level tube
- Vertical axis



Levelling Staff

- The least count is 5 mm.
- It consists of three telescopic lengths (1.2m+1.3m+1.5m).
- The reading on a self reading staff appears to be inverted and hence the readings are taken from top to bottom (Applicable to dumpy level).
- Show the reading 2.585m on the staff

Main reading = 2.5m

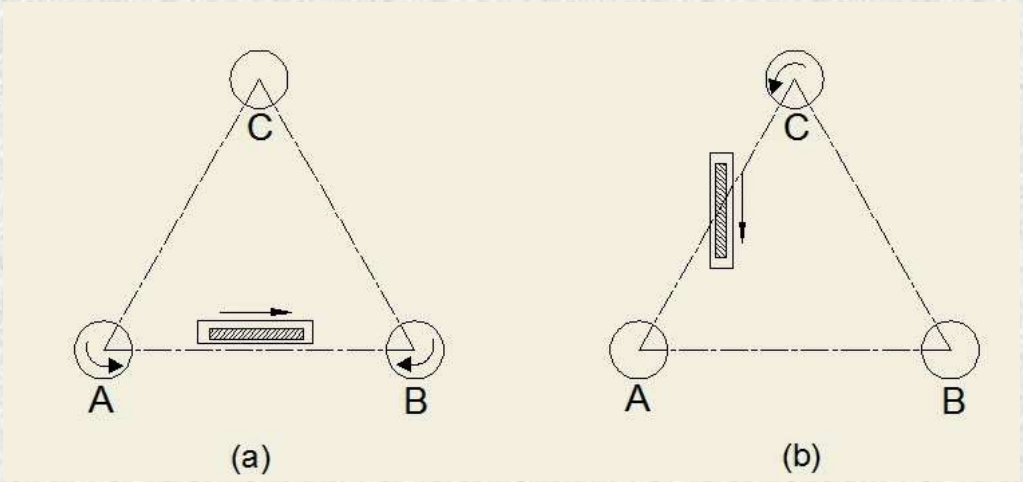
No of parts – 17 (17 x 0.005) = 0.085

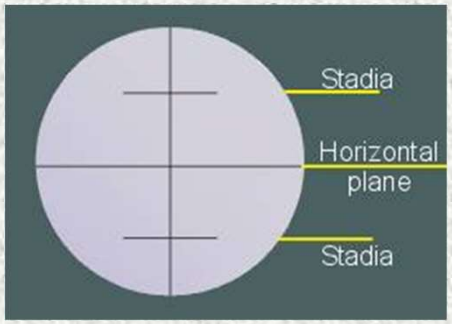
Reading – 2.5 + 0.085 = 2.585

- https://www.youtube.com/watch?v=QxOBdKbhjd8

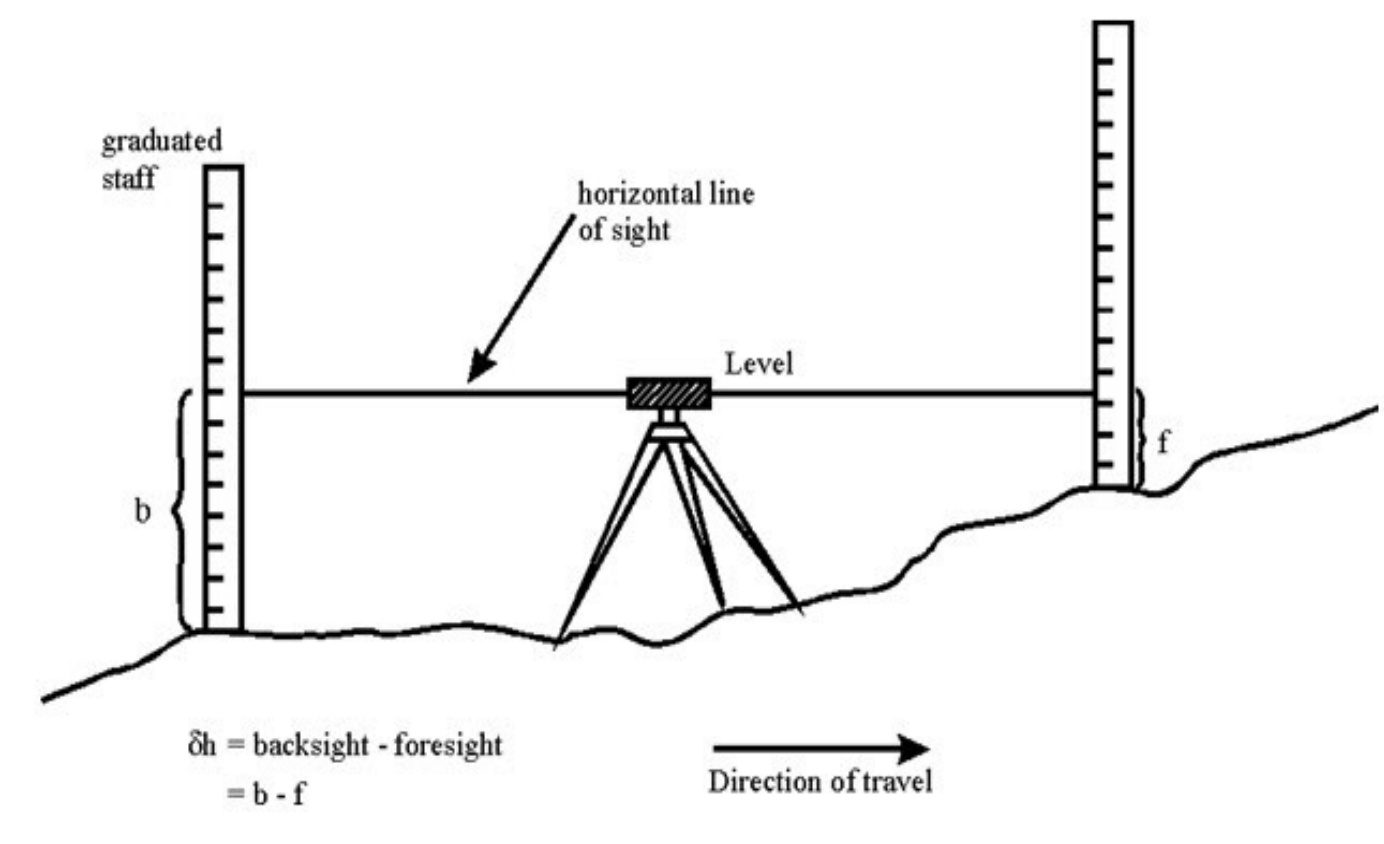
Temporary adjustment of Dumpy Level

Setting up the dumpy level → **Levelling** → **Focusing the eyepiece** → **Focusing the object glass**

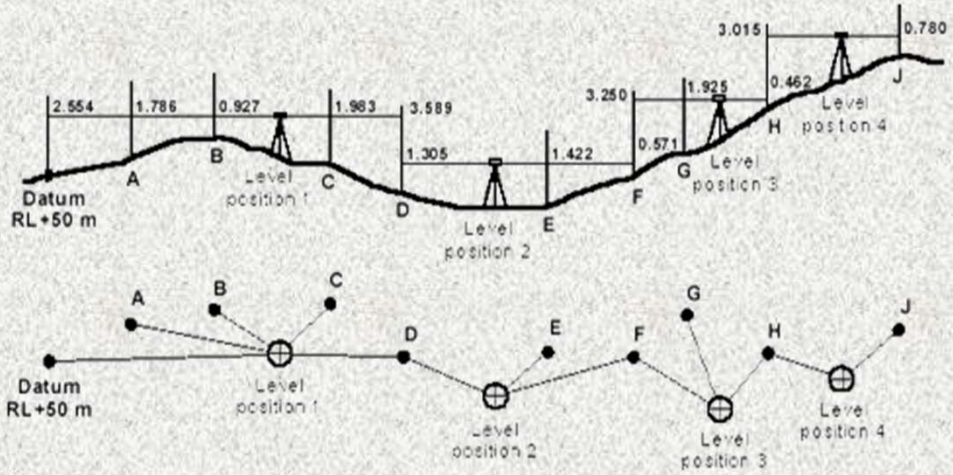


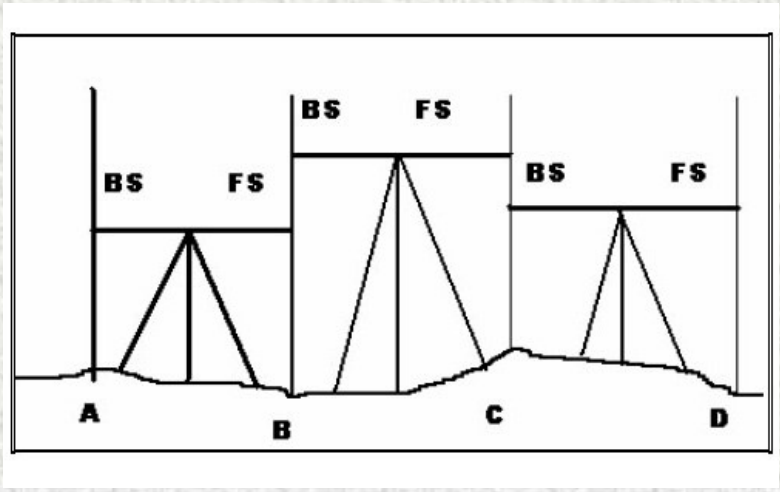


Simple Levelling



Differential Levelling, Fly Levelling





Methods of calculating Reduced Level of different points

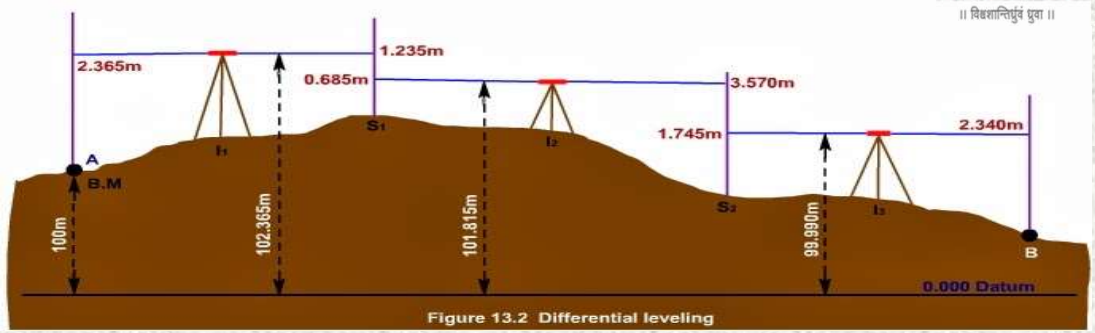


Figure 13.2 Differential leveling

- **H. I. Method**

1. H. I. = R.L. of B. M. + BS Reading
2. R. L. of IS Station = H.I. – IS Reading
3. R. L. of (CP) FS Station = H.I. – FS Reading
4. New H.I. = R.L. of FS(CP). + BS Reading
5. Arithmetic Check

∑B.S.- ∑ F.S. = Last R.L. – First R.L.

- **Rise and Fall method**

1. Calculate diff. between two consecutive points
2. Rise (Difference is + ve)
3. Fall (Difference is - ve)
4. R.L. of point = Previous R.L. + Rise
5. R.L. of point = Previous R.L. – Fall
6. Arithmetic Check

∑B.S.- ∑ F.S. = ∑Rise - ∑Fall = Last R.L. – First R.L.

Video links for levelling

- https://www.youtube.com/watch?v=Hj9-UvyMQQ8&feature=youtu.be
- https://www.youtube.com/watch?v=QxOBdKbhjd8&feature=youtu.be
- https://www.youtube.com/watch?v=HskvUezC6bM&feature=youtu.be

Collimation Plane Method

Problem :- 1 The following readings were taken with dumpy level.

1.580, 0.635, 2.035, 1.765, 1.660, 0.925, 1.035, 1.960.

The instrument was shifted after third and fifth readings. The R. L. of the first point was 950.00m. Rule out the page of the level book and calculate the R.L.s of all the other points by collimation plane method. Apply usual checks. **(Ans :- 950.000, 950.945, 949.545, 949.650, 949.540, 948.615, Arithmetic check - -1.385)**

Solution of problem 1

Station	B.S.	I.S.	F.S.	Collimation Plane / Height of Instrument (H.I.)	Reduced Level (R.L.)	Remark
1	1.580			951.580	950.000	Bench Mark (B.M.)
2		0.635			950.945	
3	1.765		2.035	951.310	949.545	Change Point (C.P. 1)
4	0.925		1.660	950.575	949.650	Change Point (C.P. 2)
5		1.035			949.540	
6			1.960		948.615	Change Point (C.P. 3)
	∑B.S.=4.240		∑ F.S.=5.655			

Arithmetic Check: -

∑B.S.- ∑ F.S. = Last R.L. – First R.L.
4.240-5.655 = 948.615 – 950.000
-1.385 = -1.385

Solution

1) Collimation plane st 1 = RL of BM + BS reading of st 1= 950.000 + 1.580 = 951.580 m
2) RL of st 2 = Collimation plane st. 1 – IS of st 2 = 951.580 – 0.635 = 950.945 m
3) RL of st 3 (CP1) = Collimation plane st. 1 – FS of st 3 (CP1) = 951.580 – 2.035 = 949.545 m
4) Collimation plane st 3 (CP1) = RL of pt 3 (CP1) + BS of pt 3 (CP1) = 949.545 + 1.765 = 951.310 m
5) RL of pt 4 = Collimation plane CP1 – FS of st 4 (CP2) = 951.310 – 1.660 = 949.650 m
6) Collimation plane st 4 (CP2) = RL of pt 4 (CP2) + BS of pt 4 (CP2) = 949.650 + 0.925 = 950.575 m
7) RL of pt 5 = Collimation plane CP2 – IS of st 5 = 950.575 – 1.035 = 949.540 m
8) RL of pt 6 = Collimation plane CP2 – FS of st 6 (CP3) = 950.575 – 1.960 = 948.615 m

Collimation Plane Method

Problem :- 2 The following readings were observed on a continuously sloping ground. The readings were taken on the C/L of the road, with a 4m levelling staff, at a horizontal interval of 20 m , the first reading was taken on a B.M. of R. L. of 250.000m. Tabulate the readings in the level page of field book by collimation Plane Method.

2.960, 1.625, 0.875, 3.780, 2.560, 1.245, 3.885, 2.375, 1.245, 0.540.

i) Calculate R.L.s of all points.

ii) Determine the longitudinal gradient of the road.

(Ans :- 250.000, 251.335, 252.085, 253.305, 254.620, 256.130, 257.260, 257.965, Arithmetic Check- 7.965, slope-1:17.6)

Solution of problem 1

Station	Hori. Dist.	B.S.	I.S.	F.S.	Collimation Plane / Height of Instrument (H.I.)	Reduced Level (R.L.)	Remark
1	0	2.960			252.960	250.000	Bench Mark (B.M.)
2	20		1.625			251.335	
3	40	3.780		0.875	255.865	252.085	Change Point (C.P. 1)
4	60		2.560			253.305	
5	80	3.885		1.245	258.505	254.620	Change Point (C.P. 2)
6	100		2.375			256.130	
7	120		1.245			257.260	
8	140			0.540		257.965	Change Point (C.P. 3)
		∑B.S.=10.625		∑ F.S.=2.660			

Arithmetic Check: - ∑B.S.- ∑ F.S. = Last R.L. – First R.L.
10.625-2.660 = 257.965 – 250.000
7.965 = 7.965

Gradient of the line = 7.965/140 = 1/ (140/7.965)
= 1:17.577 (17.6)
= 1:17.6 (Rising)

Rise and Fall Method

Problem :- 3 The following readings were taken with a level and a 4 m staff. The instrument was shifted after 5th and 8th readings. R.L. of starting point is 150.000m. Find the R.L.s of all the point by rise and fall method. Apply usual checks.

2.865, 3.345, 2.935, 1.950, 0.855, 2.790, 2.640, 1.540, 0.935, 0.850, 0.190.

(Ans:- 150.000, 149.520, 149.930, 150.915, 152.010, 152.160, 153.260, 153.345, 154.005, Arithmetic Check- 4.005)

Rise and Fall Method :-

3] 2.865, 3.345, 2.935, 1.950, 0.855, 2.790, 2.640, 1.540, 0.935, 0.850, 0.190,
R.L of starting Point is 150.000 m. The instrument was shifted after 5th & 8th readings.

Sr. No.	BS	IS	FS	Rise	Fall	R.L.	Remark
1	2.865					150.000	start Pt.
2		3.345			0.480	149.520	
3		2.935		0.410		149.930	
4		1.950		0.985		150.915	
5	2.790		0.855	1.095		152.01	CP1
6		2.640		0.150		152.160	
7	0.935		1.540	1.100		153.260	CP2
8		0.850		0.085		153.345	
9			0.190	0.660		154.005	CP3.
	Σ = 6.590		Σ = 2.585	Σ = 4.485	Σ = 0.480		

Arithmatic Check :-

ΣB.S − ΣF.S. = ΣRise − ΣFall = Last RL − First RL

6.590 − 2.585 = 4.485 − 0.480 = 154.005 − 150.000

4.005 = 4.005 = 4.005

calculations :-

1) Fall at Pt.2 = BS of pt.1 − Is of pt.2.
= 2.865 − 3.345
= +0.480 (fall)

2) RL of pt.2 = RL of pt.(1) (st.Pt.) − fall
= 150.000 − 0.480 = 149.520 m.

4) Rise of Pt.3 = Is of pt.2 − Is of pt.3.
= 3.345 − 2.935 = 0.410 (Rise)

5) RL of pt.3 = RL of Pt.2 + Rise at pt.3.
= 149.520 + 0.410 = 149.930 m.

6) Rise of pt.4 = IS of pt.3 - IS of pt.4.
= 2.935 - 1.950 = 0.985 (Rise)

7) RL of pt.4 = RL of Pt.3 + Rise at pt.4.
= 149.930 + 0.985 = 150.915 m.

8) Rise of pt.5 = IS of pt.4 - FS of pt.5.
= 1.950 - 0.855 = 1.095. (Rise)

9) RL of pt.5 = RL of pt.4 - Rise of pt.5.
= 150.915 + 1.095 = 152.010 m.

10) Rise of pt.6 = BS of pt.5 - IS of pt.6.
= 2.790 - 2.640 = 0.150 (Rise)

11) RL of Pt.6 = RL of pt.5 + Rise of pt.6.
= 152.010 + 0.150 = 152.160 m.

12) Rise of pt.7 = IS of pt.6 - FS of pt.7.
= 2.640 - 1.540 = 1.100.

13) RL of Pt.7 = RL of pt.6 + Rise of pt.7.
= 152.160 + 1.540 = 153.260 m.

14) Rise of pt.8 = BS of Pt.7 - IS of pt.8.
= 0.935 - 0.850 = 0.085.

12) RL of pt.8 = RL of pt.7 + Rise of pt.8
= 153.260 + 0.085 = 153.345.

13) Rise of pt.9 = IS of pt.8 - FS of pt.9
= 0.850 - 0.190 = 0.660.

14) RL of pt.9 = RL of pt.8 + Rise of pt.9
= 153.345 + 0.660 = 154.005 m.

Rise and Fall Method

Problem :- 4 The following consecutive readings were taken with a level and a 4 m staff on a continuously sloping ground at common interval of 30 m:

0.855(on A), 1.545, 2.335, 3.115, 3.825, 0.455, 1.380, 2.055, 2.855, 3.455, 0.585, 1.015, 1.850, 2.755, 3.845(on B).

The R.L. of A was 380.500m. Find the R.L.s of all the point by rise and fall method. Apply usual checks. Determine the gradient of AB.

(Ans :- 380.500, 379.810, 379.020, 378.240, 377.530, 376.605, 375.930, 375.130, 374.530, 374.100, 373.265, 372.360, 371.270, Arithmetic Check – 9.230, Gradient – 1:39)

4] Continuously sloping ground, 4 m staff.

0.855 (on A), 1.545, 2.335, 3.115, 3.825, 0.455, 1.380, 2.055, 2.855, 3.455, 0.585, 1.015, 1.850, 2.755, 3.845 (on B).

RL of A was 380.500 m.

Sr.No.	BS	IS	F.S.	Rise	Fall	RL.	Remark.
1	0.855					380.500	pt A
2	30	1.545			0.690	379.810	
3	60	2.335			0.790	379.020	
4	90	3.115			0.780	378.240	
5	120	0.455	3.825		0.710	377.530	CP1
6	150	1.380			0.925	376.605	
7	180	2.055			0.675	375.930	
8	210	2.855			0.800	385.130	
9	240	0.585	3.455		0.600	374.530	CP2
10	270	1.015			0.430	374.100	
11	300	1.850			0.835	373.265	
12	330	2.755			0.905	372.360	
13	360		3.845		1.090	371.270	pt. B.
	Σ = 1.895		Σ = 11.125	Σ = 0	Σ = 9.230		

Arithmatic check :-

$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall = Last\ RL - First\ RL.$

$1.895 - 11.125 = 0 - 9.230 = 371.270 - 380.500$

$-9.230 = -9.230 = -9.230$

$$\text{Gradient of Line} = \frac{\text{Vertical Dist. (RL difference)}}{\text{Horizontal Dist.}}$$

$$= \frac{9.230}{360}$$

$$= \frac{1}{360/9.230}$$

$$= \frac{1}{39}$$

$= 1 : 39.$

Problem :- 5 Data from a differential leveling (FLY LEVELLING) have been found in the order of B.S., F.S..... etc. starting with the initial reading on B.M. (elevation 150.485 m) are as follows :

1.205, 1.860, 0.125, 1.915, 0.395, 2.615, 0.880, 1.760, 1.960, 0.920, 2.595, 0.915, 2.255, 0.515, 2.305, 1.170.

The final reading closes on B.M.. Put the data in a complete field note form and carry out reduction of level by Rise and Fall method. All units are in meters.

B.S. (m)	F.S. (m)
1.205	
0.125	1.860
0.395	1.915
0.880	2.615
1.960	1.760
2.595	0.920
2.255	0.915
2.305	0.515
	1.170

Problem 6: The following is the page of leveling field-book. Fill up the missing reading and complete the page. Apply usual check.

Sr. No.	B.S.	I.S.	F.S.	Collimation plane	R.L.	Remark
1	2.650			*	100.000	B.M.
2		3.740			*	
3		*			98.820	
4	4.640		*	*	98.380	CP1
5		0.380			*	
6	1.640		*	*	102.060	CP2
7		2.840			*	
8	*		3.480	104.900	*	CP3
9			*		102.700	Last point

Answer 6:- Arithmetic check - +2.700.

Sr. No.	B.S.	I.S.	F.S.	Collimation plane	R.L.	Remark
1	2.650			*102.650	100.000	B.M.
2		3.740			*98.910	
3		*3.830			98.820	
4	4.640		* 4.270	*103.020	98.380	CP1
5		0.380			*102.640	
6	1.640		*0.960	*103.700	102.060	CP2
7		2.840			*100.860	
8	*4.680		3.480	104.900	*100.220	CP3
9			*2.200		102.700	Last point

Problem 7: Calculate the missing readings marked with *

Sr. No.	B.S.	I.S.	F.S.	Rise	Fall	R.L.	Remark
1	*					463.875	B.M.I
2		*		0.550		*	
3	0.965		3.655		*	*	C.P.I
4	*		1.400		*	461.885	C.P.II
5			1.025	*		463.875	B.M.I

Answer 7: Arithmetic check - 0

Sr. No.	B.S.	I.S.	F.S.	Rise	Fall	R.L.	Remark
1	*2.100					463.875	B.M.I
2		*1.556		0.550		*464.425	
3	0.965		3.655		*2.105	*462.320	C.P.I
4	*3.015		1.400		*0.435	461.885	C.P.II
5			1.025	*1.990		463.875	B.M.I

Rise and Fall Method(FLY Levelling)

Problem :- 8 During a fly levelling work the staff readings were obtained at a regular interval of 25 m. The readings were as under.

B.S. – 0.565, 0.990, 2.775, 2.350.

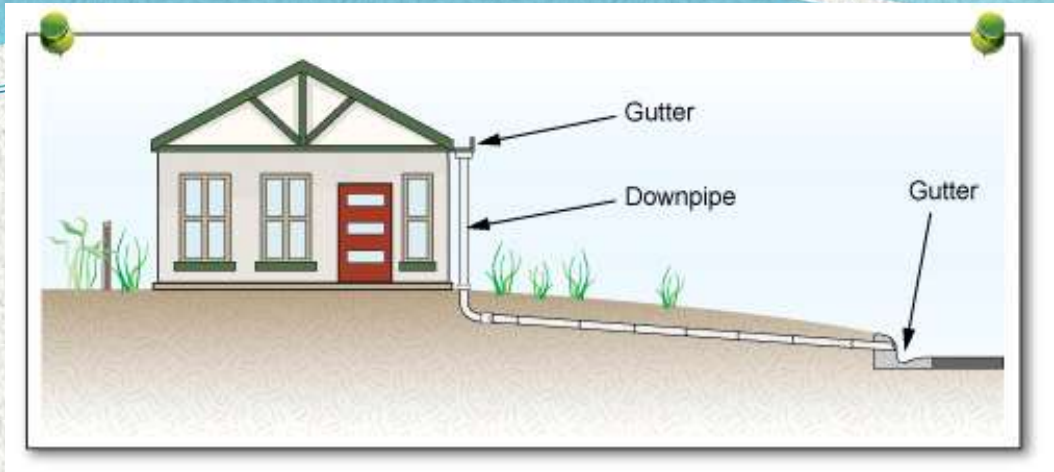
F.S. – 1.685, 1.350, 2.055, 3.450.

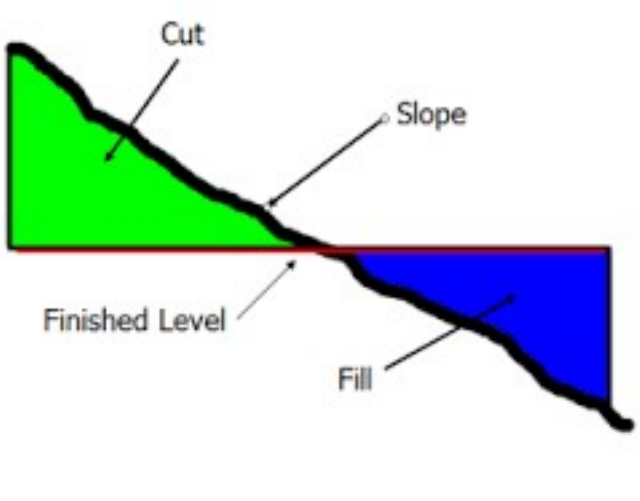
The work was begun from a point whose R.L. was known to be 255.555. enter the readings for rise and fall method to determine the RLs of all stations. Also, find the nature and magnitude of gradient. Apply the usual checks.

(Ans :- 255.555, 254.435, 254.075, 254.795, 253.695, Arithmetic Check- -1.860, Gradient – 1:53.76(falling))

Applications of levelling

- Calculation of the depth of cutting and filling.
- Setting out grades for sewers.
- Setting out gradients for roads, railway tracks, pipe lines.
- The estimation of reservoir capacities etc.
- Find the undulations of ground.
- Plotting the contour maps, ground profile from which various construction works like dam, bridges, water mains and industrial sheds etc. can be progressed.
- Useful for water supply line, railway track, electric transmission towers, drainage pipe lines etc.


Gutter
Downpipe
Gutter


Cut
Slope
Finished Level
Fill

Contours

- **Contour** :- a contour may be defined as the line of intersection of a level surface with the surface of ground having same elevation above datum surface.
- **Contour lines** :- the elevations and depression (the undulations)of the surface of the ground are shown on a map by means of contour lines.
- **Contour Interval** :- the vertical distance between any two consecutive contours is called the contour Interval.
- **Horizontal Equivalent** :- The horizontal distance between consecutive contours is termed as horizontal equivalent.
- **Station** :- It is an important point on the ground at the beginning and end of a survey line.

Uses of Contour lines or Contours

- Using contour maps, information regarding the topography of country is obtained. e.g. flat, undulating, mountains.
- Most economical or suitable site for engineering work such as reservoir, canal, sewer, road or railway
- Quantities of earthwork may be computed.
- Determine the area of the drainage basin and the capacity of the reservoir.
- Ground profile can be easily drawn in any direction
- Inter visibility of two given points can be ascertained
- A road, rail or canal for a given slope and grade can be aligned.

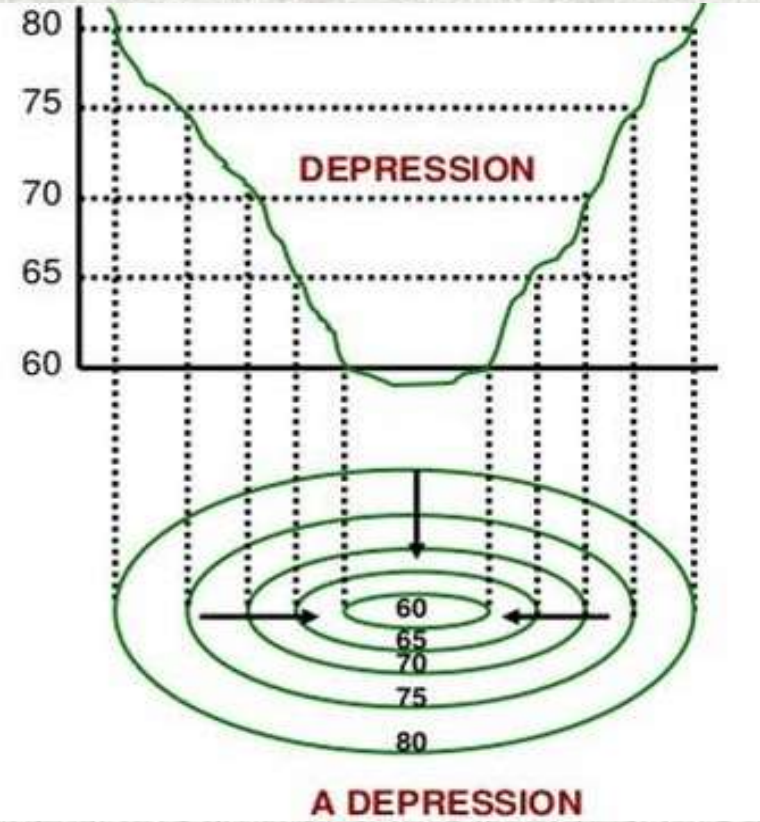
Characteristics of contour

- All points in a contour line have the same elevation.
- Flat ground is indicated where the contours are widely separated and steep-slope where they run close together.
- A uniform slope is indicated when the contour lines are uniformly spaced
- A plane surface when they are straight, parallel and equally spaced.

Characteristics of Contour Lines

- **Valley/Depression**

A series of closed contour lines on the map indicate a depression if the higher values are outside

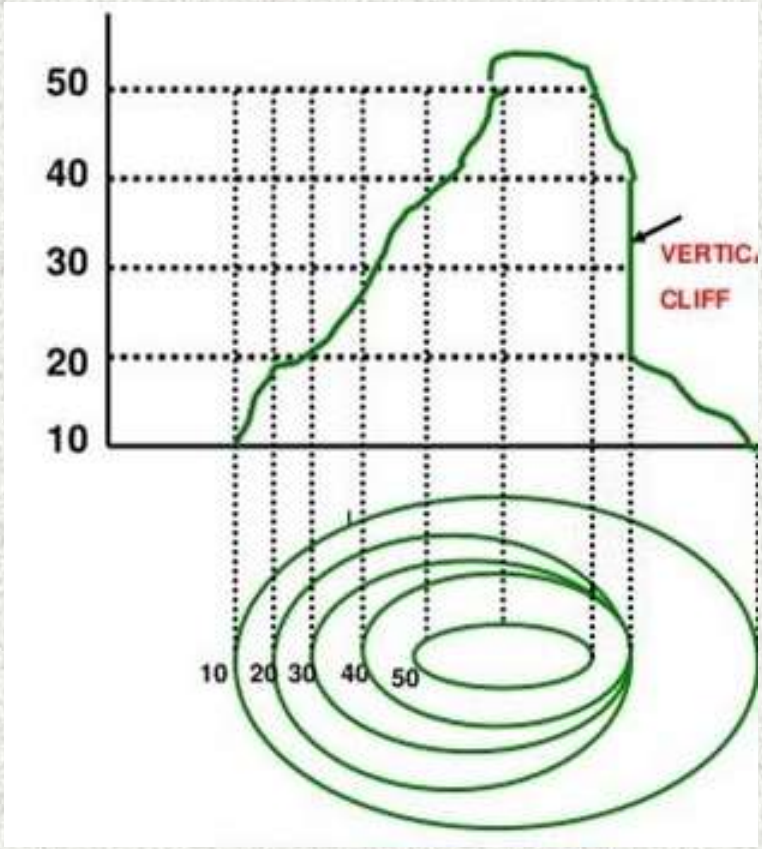


Characteristics of Contour Lines

- **Hill**

Hill ,Vertical cliff

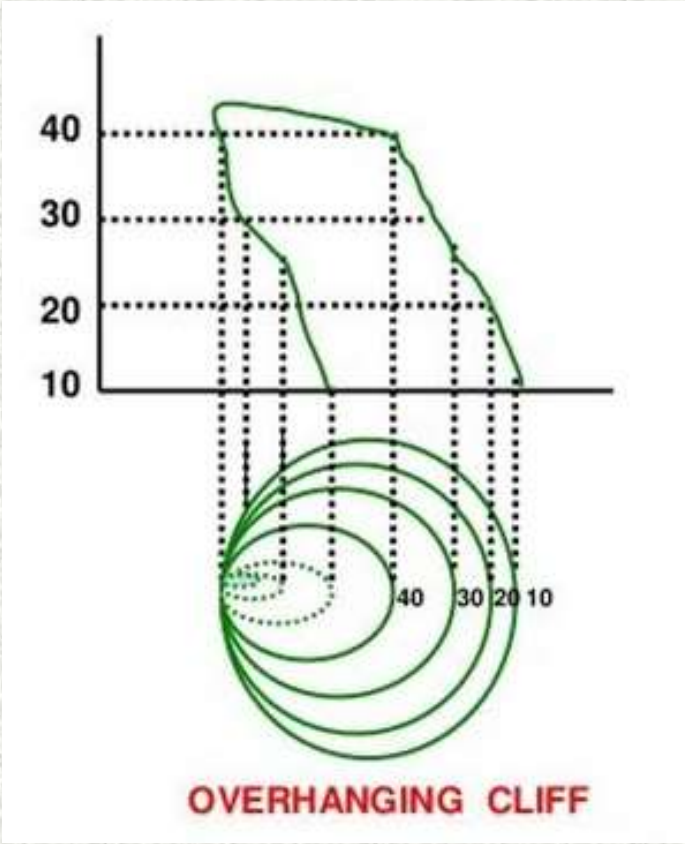
Contour lines never run to one another except in case of a vertical cliff



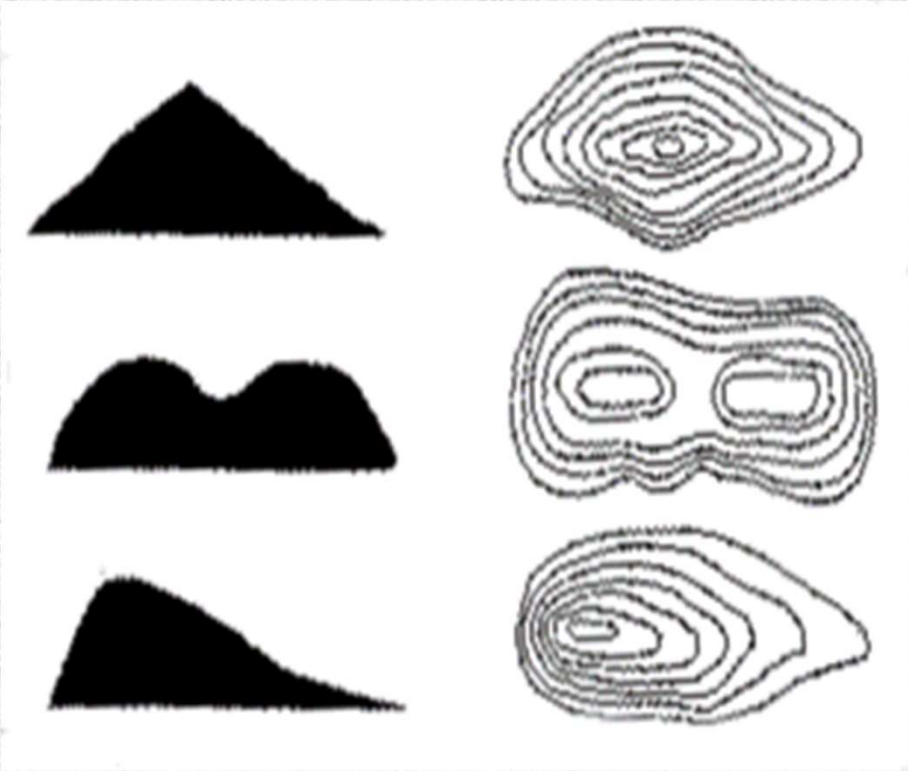
Characteristics of Contour Lines

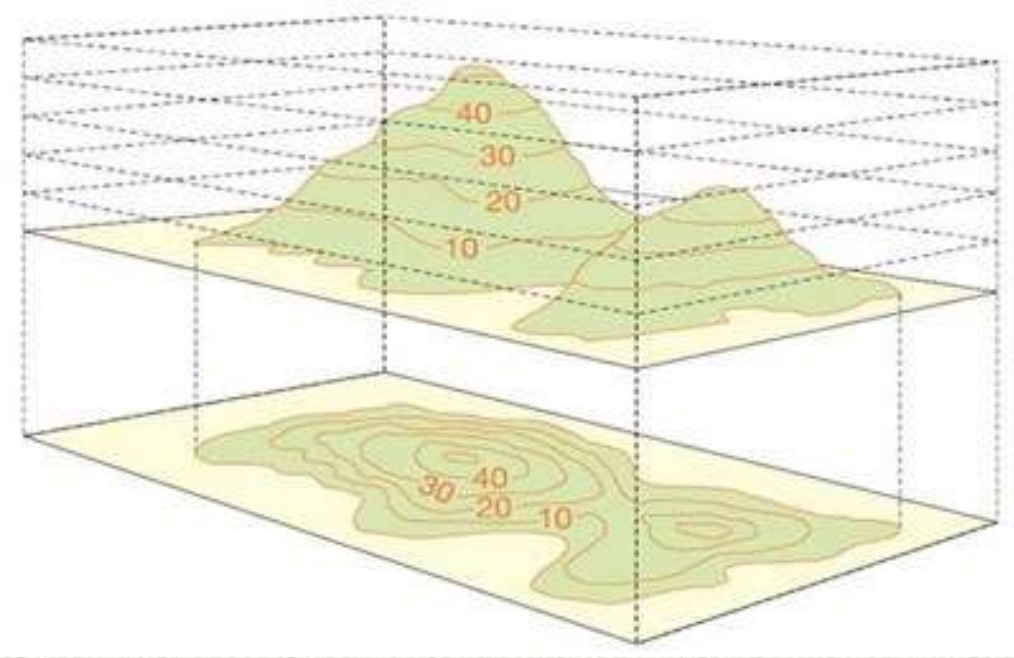
- Overhanging cliff

Contour lines cannot merge or cross each other on map except in case of an overhanging cliff



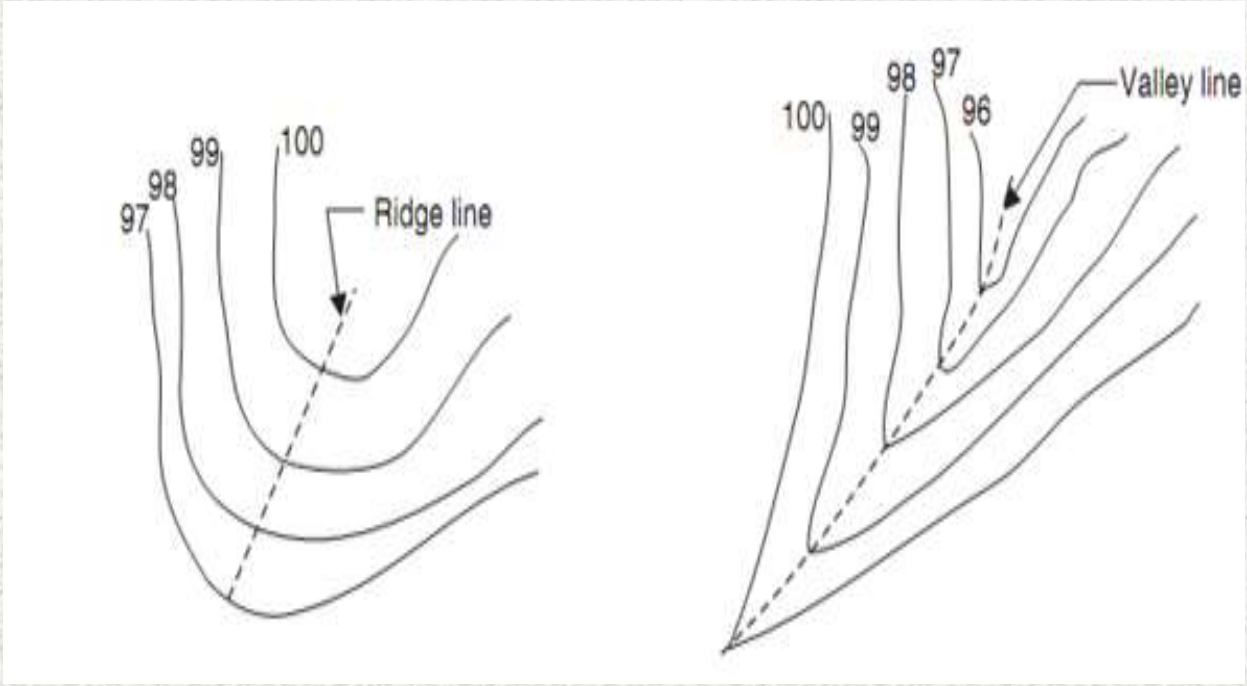
Characteristics of Contour Lines





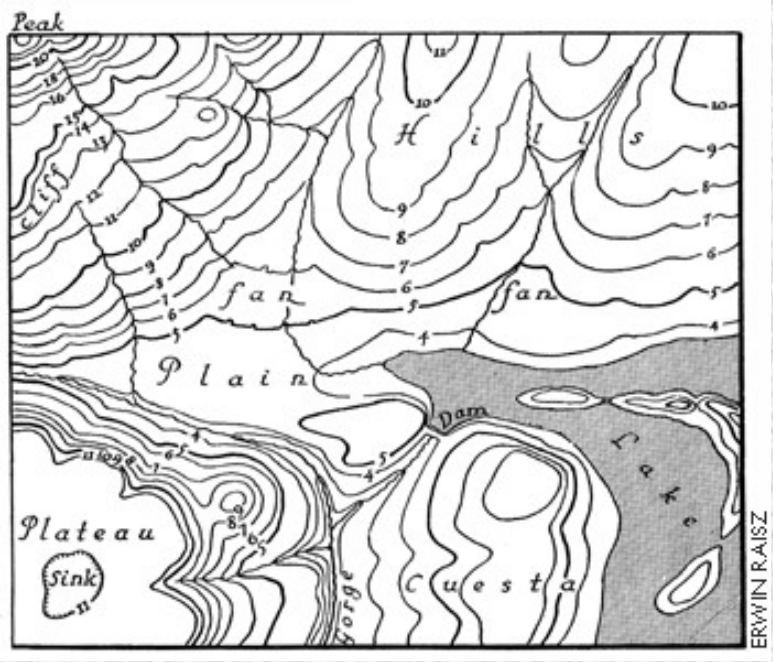
Characteristics of Contour Lines

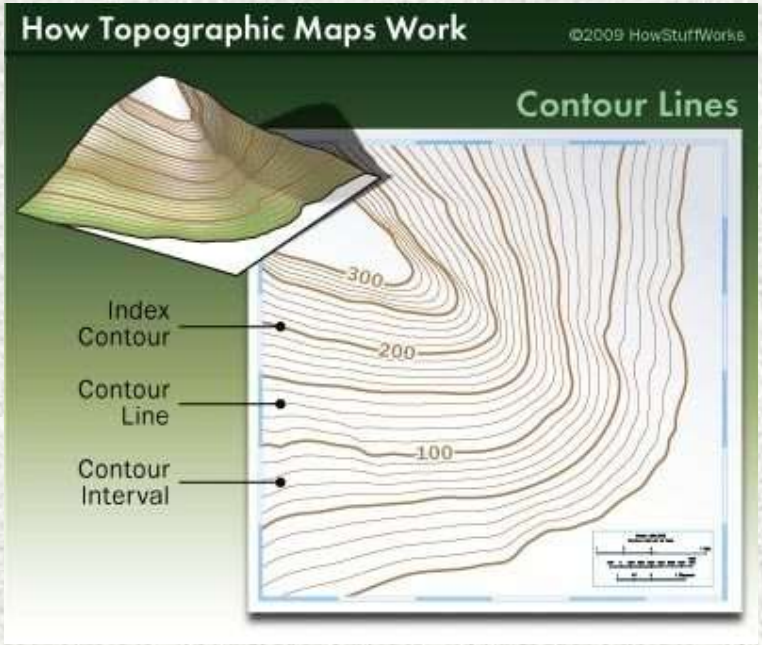
- Ridge Line and Valley Line

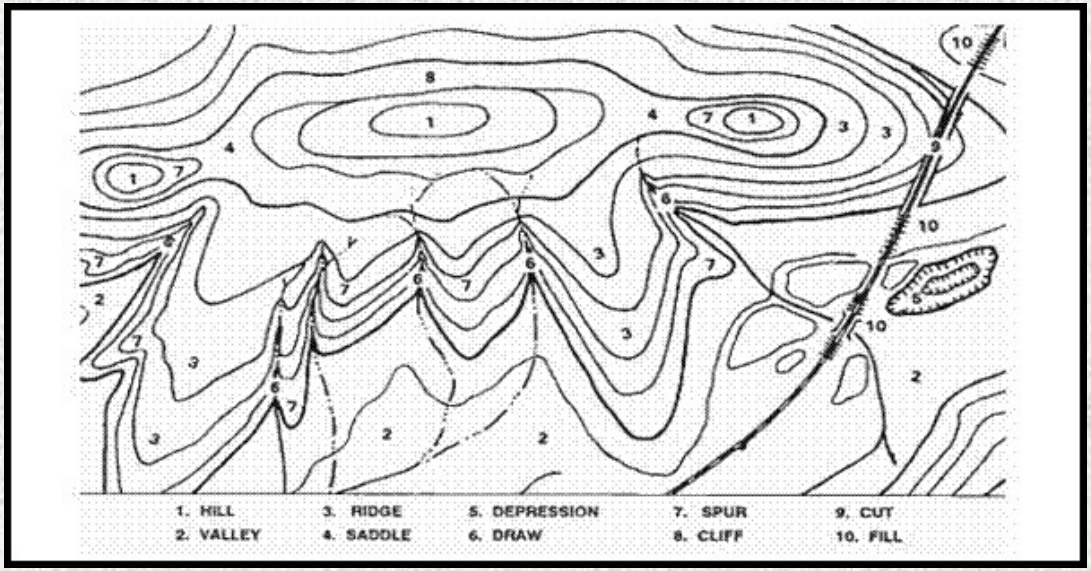


Exercise:- Identify the contour characteristics

Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY PUNE
MIT-WPU
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS






1. HILL
2. VALLEY
3. RIDGE
4. SADDLE
5. DEPRESSION
6. DRAW
7. SPUR
8. CLIFF
9. CUT
10. FILL

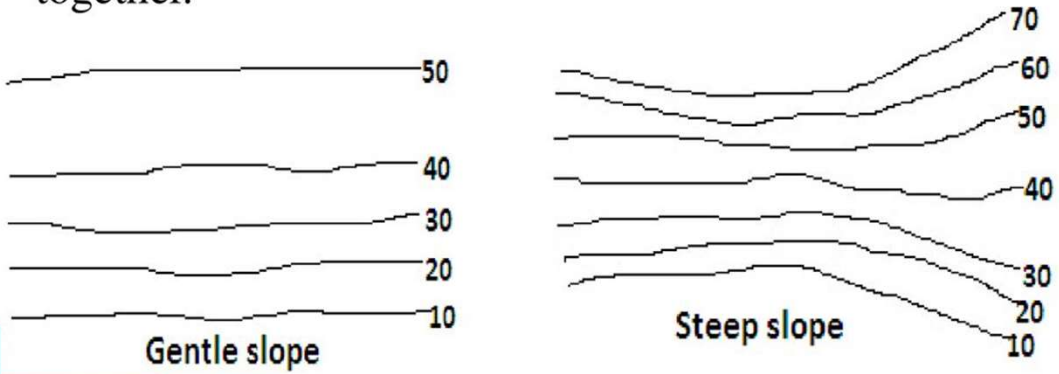

1300
1400
1500
1600
1700
1800
Google

Characteristics of Contour Lines

CHARACTERISTICS OF CONTOURS

i) All points in a contour line have the same elevation.

ii)Flat ground is indicated where the contours are widely separated and steep- slope where they run close together.

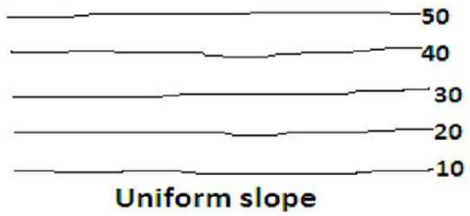


- Gentle slope
- Steep slope

Characteristics of Contour Lines

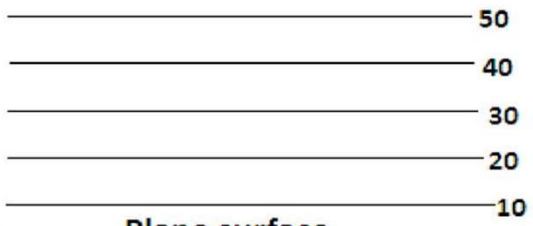
CHARACTERISTICS OF CONTOURS

iii) A uniform slope is indicated when the contour lines are uniformly spaced and



Uniform slope

iv) A plane surface when they are straight, parallel and equally spaced.



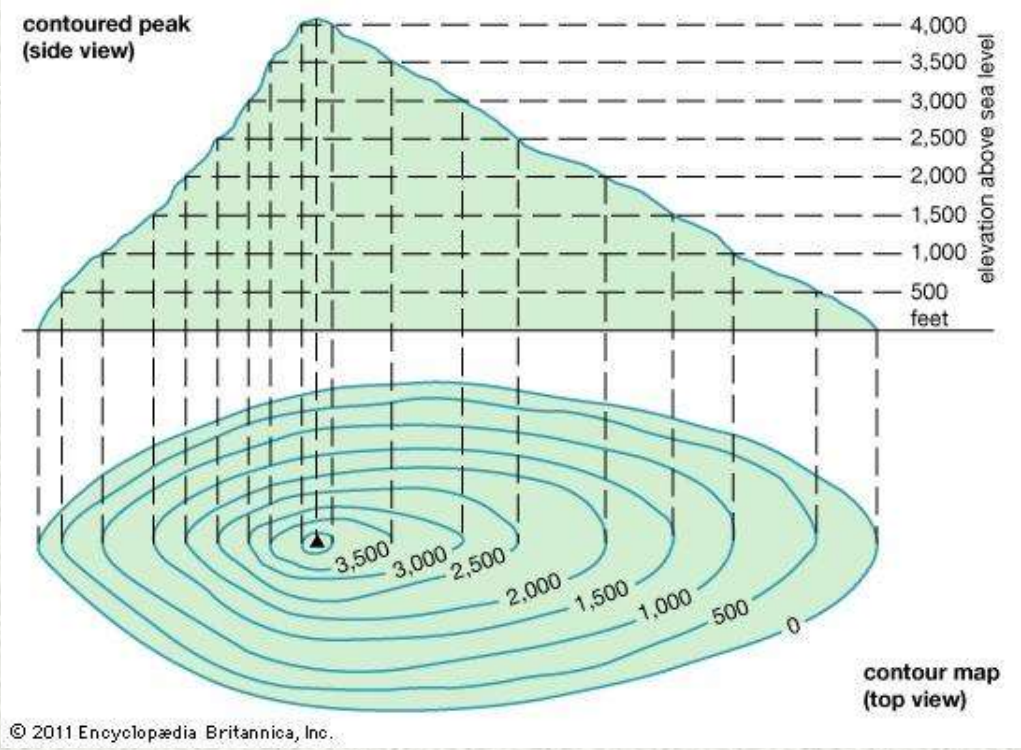
Plane surface

- Uniform slope
- Plane slope

Method of contouring

- Direct Method
- Radial Method

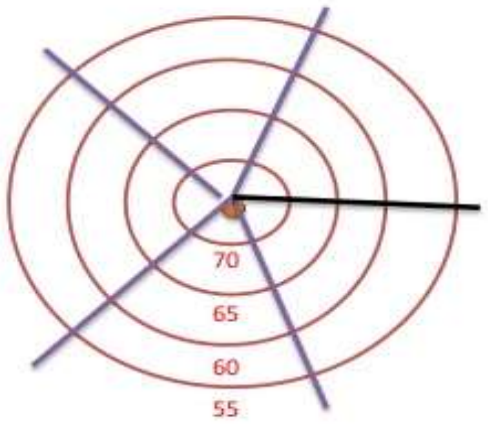
- Indirect Method
- By cross sectioning
- By method of squares
- Tacheometric contouring



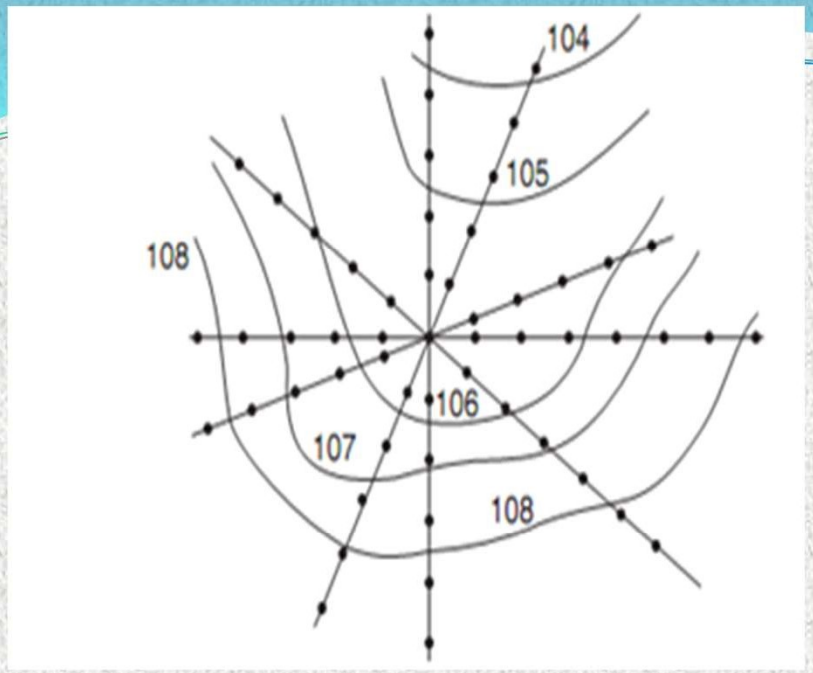
Radial method

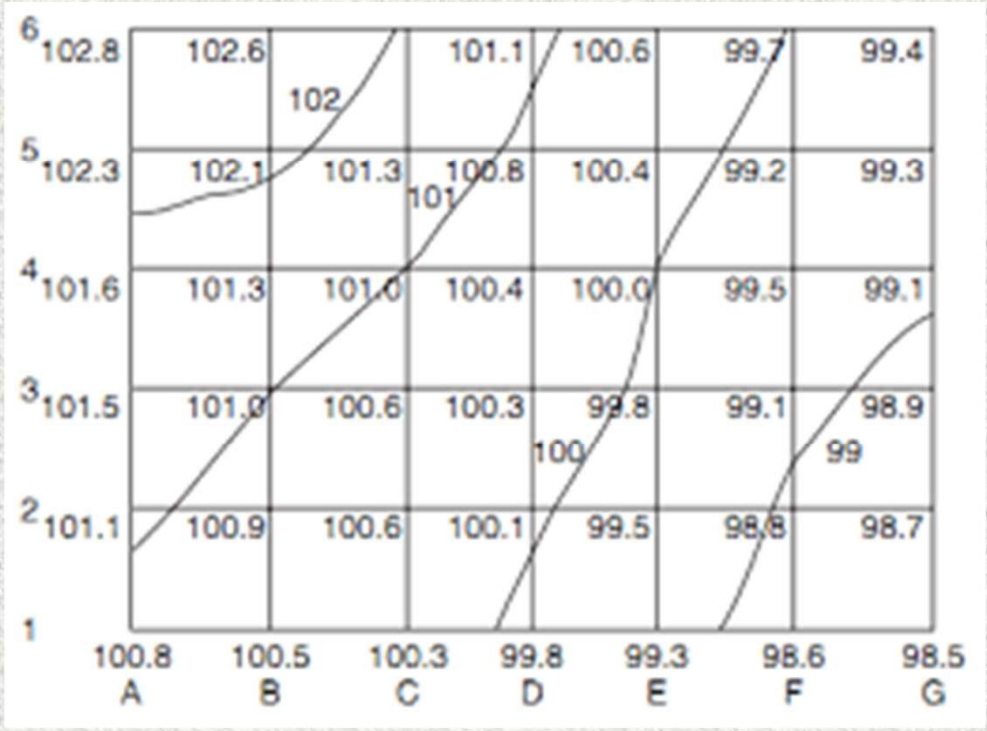
Direct Method By Radial Lines

- This method is suitable for small areas, where a single point in the centre can command the whole area. Radial lines are laid out from the common centre by theodolite or compass and their positions are fixed up by horizontal angles and bearings.



RADIAL LINES METHOD OF CONTOURING


104
105
108
106
107
108


6
102.8
102.6
102
101.1
100.6
99.7
99.4
5
102.3
102.1
101.3
101
100.8
100.4
99.2
99.3
4
101.6
101.3
101.0
100.4
100.0
99.5
99.1
3
101.5
101.0
100.6
100.3
99.8
99.1
98.9
100
99
2
101.1
100.9
100.6
100.1
99.5
98.8
98.7
1
100.8
A
100.5
B
100.3
C
99.8
D
99.3
E
98.6
F
98.5
G

Modern Survey Methods

Modern Survey methods

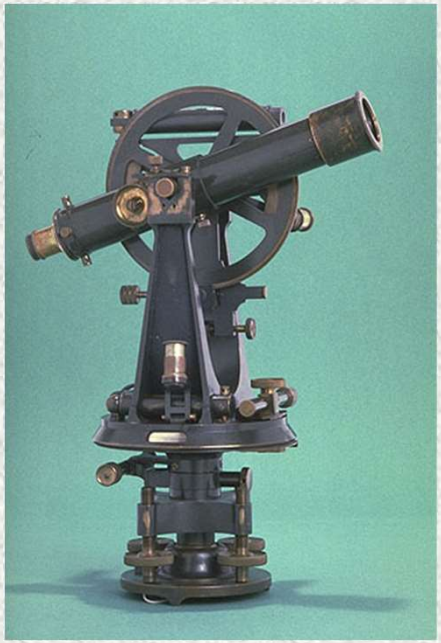
- Levels- Dumpy Level, Auto Level, Digital Level
- Theodolite – 20” Theodolite, 1” Theodolite, Digital Theodolite
- Electronic distance meter (EDM)
- Laser level
- Total station
- GIS, GPS
- Digital planimeter

Theodolites - Types of Theodolites

Theodolites are used for finding horizontal angles, vertical angles, layout work of buildings, establishing of points in one line or alignment work in surveying.

- Vernier Theodolite
- Optical Theodolite
- Digital Theodolite

- Vernier Theodolite



Vernier Theodolite

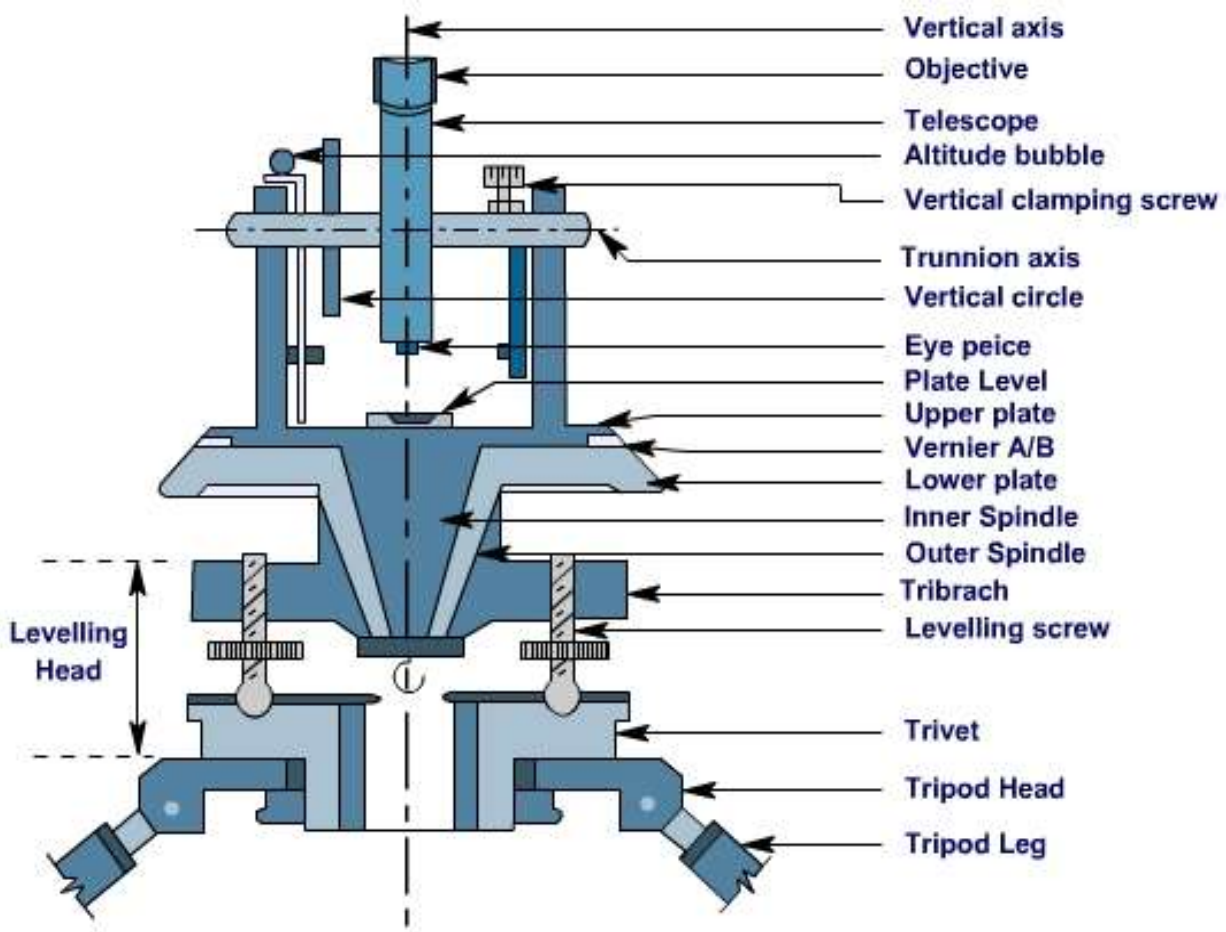


Figure 20.4 Sectional view of a Thedolite

Parts of Digital Theodolite

- Telescope
- Clamp screws- horizontal clamp, vertical clamp
- Leveling head
- Circular level (Levelling)
- Optical plummet (Centering)
- Display window
- Tripod

Special features of Digital Theodolite

- Duel side display and key board
- Built in illumination for night operations
- Rechargeable battery with auto power cutoff
- Compatibility with EDMs
- Co-axial clamps and slow motion screws
- Least count is 1”

Applications of digital Theodolite

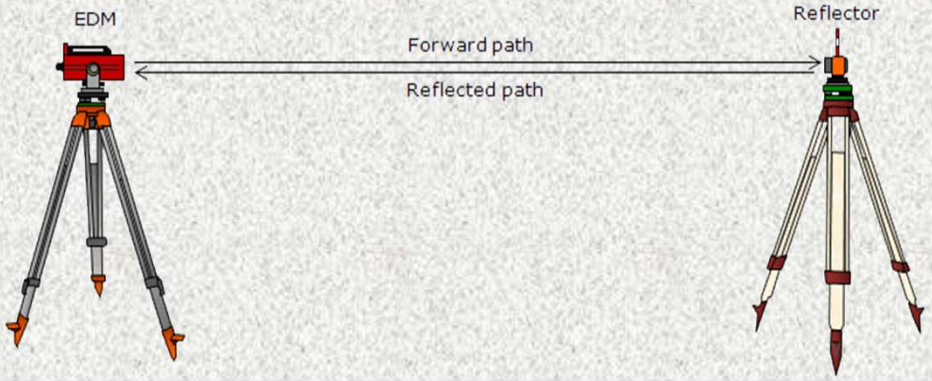
- For long road or railway bridges, alignment of piers and their centre to centre dist. can be measured.
- Measures horizontal angle and vertical angle precisely upto 1” even during night time
- Triangulation work can be completed with highest precision
- Ease of operation, day-night observations are possible

EDM(Electronic Distance Meter)

- It is a new advanced ,well modified, electronic equipment which gives very high accuracy and quick work in distance measurement.

Basic Principle of EDM

- Let the distance between P and Q be ‘d’ which is to be measured.
- A wave is transmitted from the transmitter at the station P with certain phase angle .
- There is a reflector at the other end Q which consists of prism. The wave reflects from pt. Q.
- It is received back at the transmitter end at P with different phase angle.
- For finding the distance the phase difference between transmitted wave and reflected wave is measured and converted into distance .



Types of waves

- **Electromagnetic waves:- measuring waves**.

  Frequency in the range of 500 mHz to 705 mHz.

  They cannot be transmitted.

- **Carrier waves** :- Electromagnetic waves can be superimposed on another wave called the carrier wave.

  - High frequency

  - The process of superimposing one wave to another wave is called as **modulation**

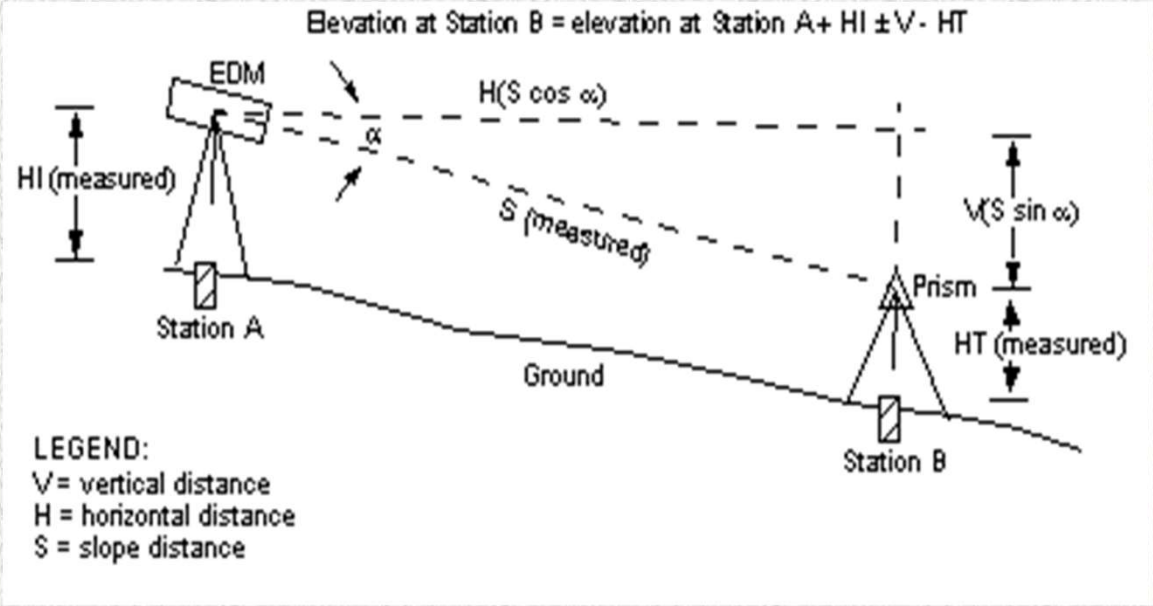
  - At the receiver end, the reverse process of modulation is **demodulation** occurs in which the measuring wave is separated and from phase difference distance is measured.

Parts of E.D.M.

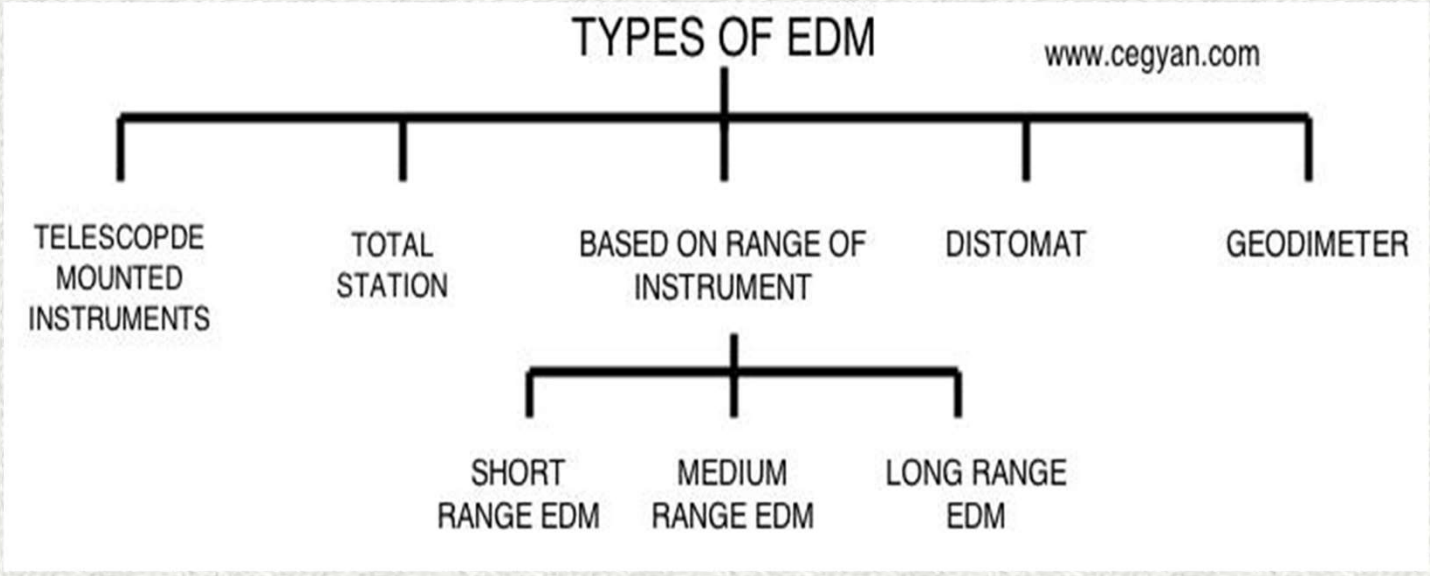
- Levelling Head
- Control panel
- Horizontal clamp and tangent screw
- Vertical clamp and tangent screw
- Optical plumet
- Telescope

Advantages of EDM

- Measurement of horizontal distance precisely.
- Measurement of vertical distance more accurately.
- Measurements of N and E co-ordinates.
- Measurement of inclined distance on slope.



Types of E.D.M.


TYPES OF EDM
www.cegyan.com
TELESCOPDE MOUNTED INSTRUMENTS
TOTAL STATION
BASED ON RANGE OF INSTRUMENT
DISTOMAT
GEODIMETER
SHORT RANGE EDM
MEDIUM RANGE EDM
LONG RANGE EDM

Total station video links

https://www.youtube.com/watch?v=d_DoEB4zWEQ

https://www.youtube.com/watch?v=d_DoEB4zWEQ

https://www.youtube.com/watch?v=hKWFieP941Y

https://www.youtube.com/watch?v=P6mYlb3Oh1s

Types of E.D.M.

1. Telescope mounted instruments

Line of sight of theodolite and EDM are parallel.

2. Total station

EDM and digital theodolite

3. Distomat

EDM uses **infrared light** waves

(20m to 10 km).

Instrument uses infrared beam with amplitude modulation to a frequency of about 15 MHz

Temporary adjustments of the theodolite consist of

i) Centering ii) levelling iii)focussing

4. E.D.M. s based on range

Short range :- upto 5 km.

Medium range :- upto 100 km.

Long range :- greater than 100 km.

5. The Geodimeter

Emits carrier waves or modulated pulses of light from a **tungsten filament** that are returned by a reflector system having prism at the other station.

Frequency 10 MHz

The reflected light returned to the instrument is converted into electrical pulses by photocell.

Distance upto 25 km.

Application of Electronic Total Station

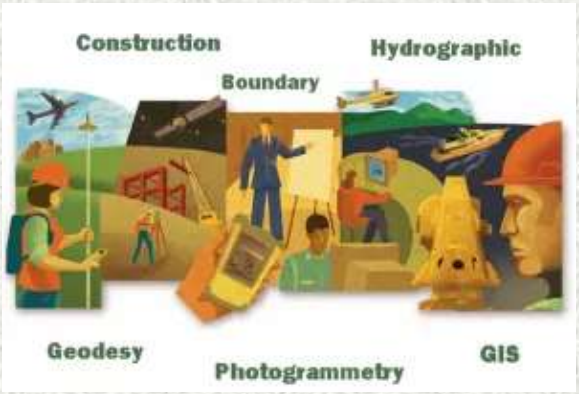
- Measurement of sloping distance, horizontal and vertical distance
- Vertical and horizontal angles are accurately measured
- Measurement of area
- Measurement of N and E coordinates

Application of Total Station

Deformation Monitoring
Applicable for buildings, underground projects and tunnel monitoring

Tunnel Construction
Used for drilling and orientation with reliable machine guidance

Mini Triangular Networking
Ideal for control survey or layouts in small-to-medium-sized triangular network



Application of Total Station

- General purpose angle measurements
- General purpose distance measurements
- Provision of control surveys
- Contour and detail surveys
- Contour and detail mapping
- Setting out and construction work
- Area and volume calculations
- Co ordinate Geometry calculations
- Road alignment 2D and 3D
- Different surveys (Topographic, Hydrographic, Cadastral , Project construction, Road and Rail, Mining)

Digital planimeter

- Rollers
- Tracing arm
- Control panel
- Unit, Scale, hold, memo

GPS (Global Positioning System)

- GPS is a fast and accurate method of determining the locations of any point of interest anywhere on the face of earth of any time.
- The technology collects and processes signals from satellites in orbit around the earth to determine the location of points of interest on the ground.
- Types of GPS

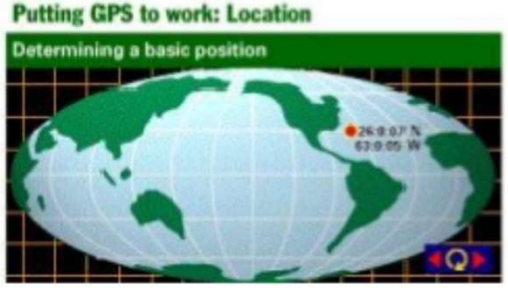
- Single Frequency
- Dual Frequency

Applications of GPS

- Determining the boarders, making existing utilities like highway, piling. municipal amenities.
- Monitoring well, soil boring and other types of sampling locations.
- Establishing state plane coordinates or geodetic coordinates
- Used in topographic survey
- Used in mine exploration
- Used in baseline survey and traverse control survey or traverse verification surveys
- Used in natural resource mapping
- Used in communication tower site survey

Application of GPS

Location

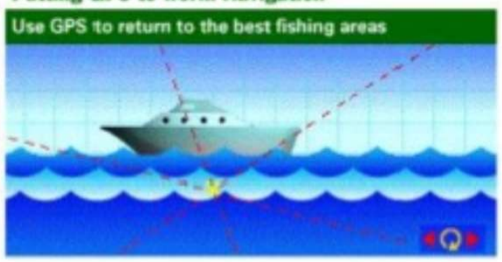


Determining a basic position

Tracking

monitoring the movement of things

Navigation



getting from one location to another

Mapping

creating maps of the world

GIS (Geographic Information System)

- GIS is a tool of mapmaking and analyzing things that exists and event that happen on the earth surface
- It is a computer based system designed to accept large volume of geographic data derived from variety of sources, effectively store it, analyze the things and display these data in a required format.

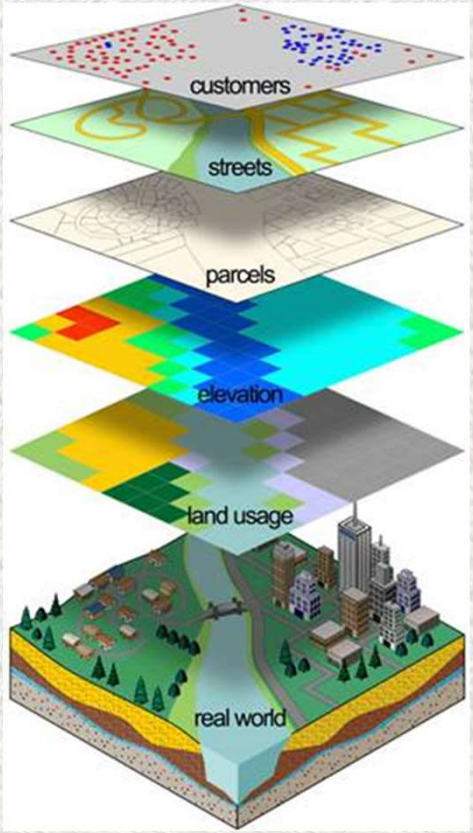
GIS (Geographic Information System)

GIS (Geographical Information System)

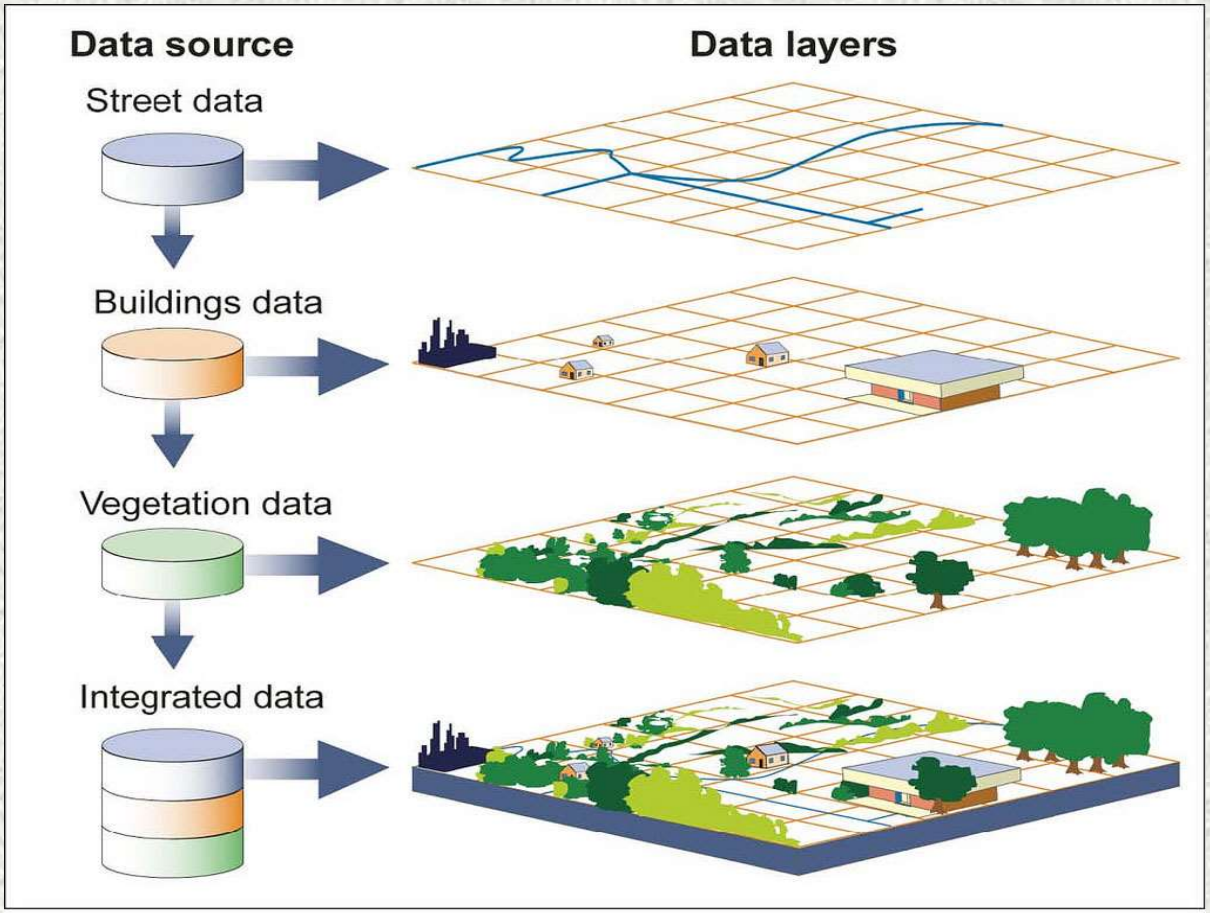
- GIS may be defined as a computer based information system which attempts to capture, store, manipulate, analyse and display spatially referenced and associated data.
- GIS data consists of two different data namely,

  Spatial data - In the form of vector used for map making

  Attribute data – In the form of Charts, tables, descriptive text about the places located in the map.



Data stored in layers



Source: GAO.

GIS gives you power to-

- Create map
- Integrate information
- Analyze the data
- Solve complicated problems
- Present powerful ideas
- Develop effective solutions

Application of GIS

- GIS is used to improve organizational integration. Data can be collected once and used many times
- GIS is used to make better decision.
- GIS is used for making maps.
- GIS is used for every organizations of the defense industry for many nations around the world.
- Architect makes the design, planning in proper and precise way quickly with the help of GIS
- GIS provides the analytical capabilities that form the hub of successful precision agricultural system
- GIS is used in libraries and museums, in education, in conservation of water and wastewater, in transportation in universities, in mining and earth sciences.

Applications of GIS

Natural Resources

Business

Education

Transportation planning

Government

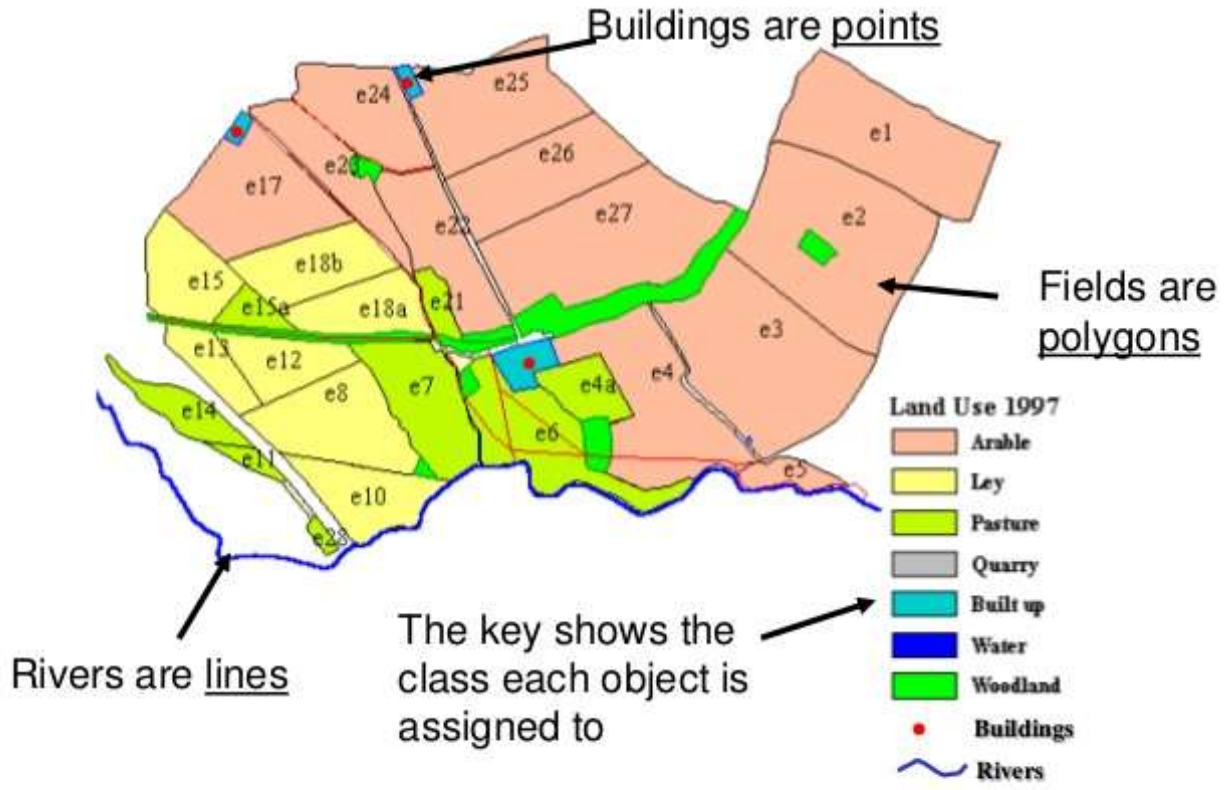
Mapping & charting

Public Safety

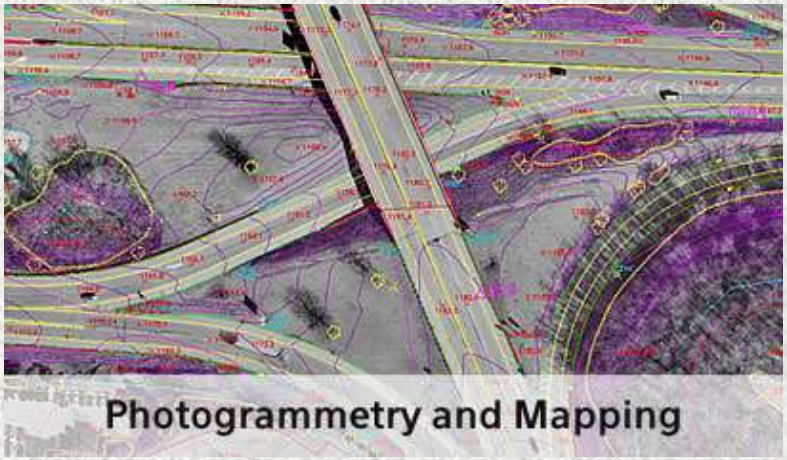
Digital Mapping

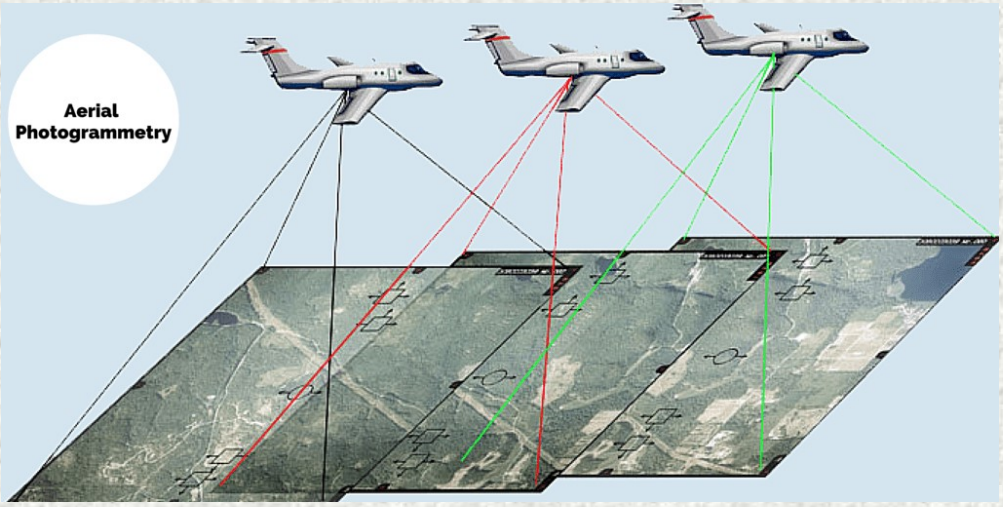
- New tool that is being used in modern surveying along with the advanced instruments
- Advancement in mapping technique is replacing conventional stereo-plotters
- Made map making more efficient and accurate.
- Advantages
  - Map making is quick.
  - Scale of map can be easily changed and viewed
  - Maps can be made as per users requirement
  - Updating the existing map with latest information is neat and easy
  - Creating 3 D maps are very easy

Data structures: how vector data is displayed



Photogrammetric Survey





Photogrammetric Survey

Definition :- Photogrammetric surveying or photogrammetry is the science and art of obtaining accurate measurements by use of photographs.

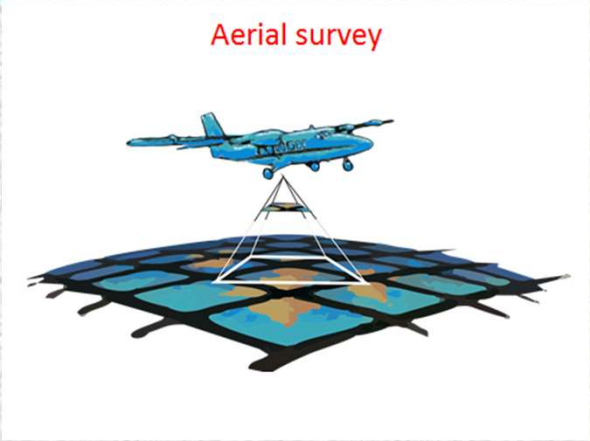
Purpose (Use) :-

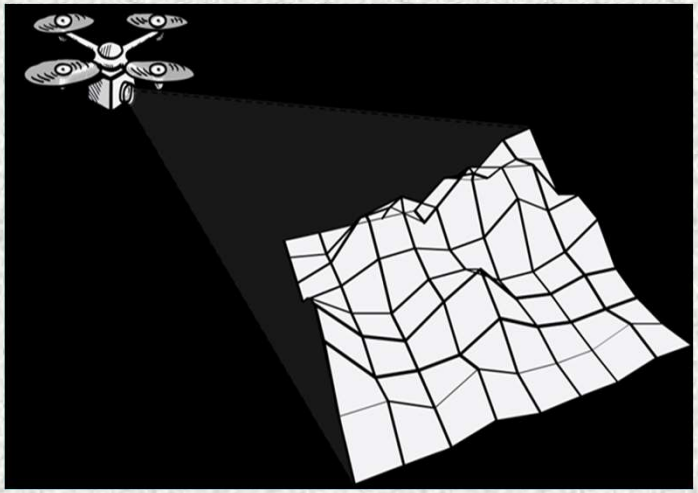
1. Construction of planimetric and topographic maps
2. Classification of soils
3. Interpretation of geology
4. Acquisition of military intelligence
5. Preparation of composite pictures of the ground

Types :-

1. Terrestrial Photogrammetry
2. Aerial Photogrammetry

Aerial Survey





- **Aerial photography** is the taking of photographs of the ground from an elevated/direct-down position.
- Usually the camera is not supported by a ground-based structure.
- Platforms for aerial photography include fixed-wing aircraft, helicopters, unmanned aerial vehicles ("UAVs or drones"), balloons, blimps and dirigibles, rockets, pigeons, kites, parachutes, stand-alone telescoping and vehicle-mounted poles.
- Mounted cameras may be triggered remotely or automatically; hand-held photographs may be taken by a photographer.

Aerial Survey

Applications/Uses:-

- Archaeology
- Fishery surveys
- Geophysics
- Hydrocarbon exploration
- Land survey
- Mining and mineral exploration
- Monitoring vegetation and ground cover
- Reconnaissance
- Monitoring wildlife and insect population
- Transportation projects in conjunction with ground surveys (Roadways, bridges, Interstate)

Aerial Survey should be distinguished form satellite imagery technologies because of its better resolution, quality and atmospheric conditions.

In order to carry out aerial survey, a sensor needs to be fixed to the interior or the exterior of the airborne platform with line of sight to the target it is remotely sensing.

Thank you