GEOMATICS (CE20203)

Autumn 2022-2023

Chapter 1

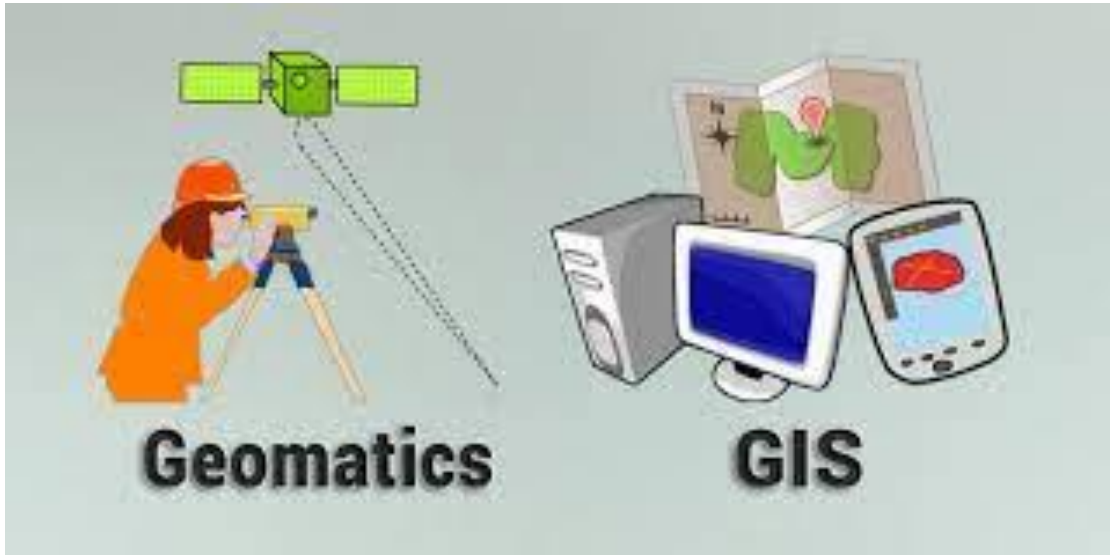
Basic concepts, Principles of Geomatics and type of surveying

Content

- A brief intro. to the concept of surveying, mapping, remote sensing and GIS
- Necessity of Geomatics
- Introduction to the common tools of surveying: Traversing; Triangulation; Trilateration; closing errors in traversing and their adjustment.

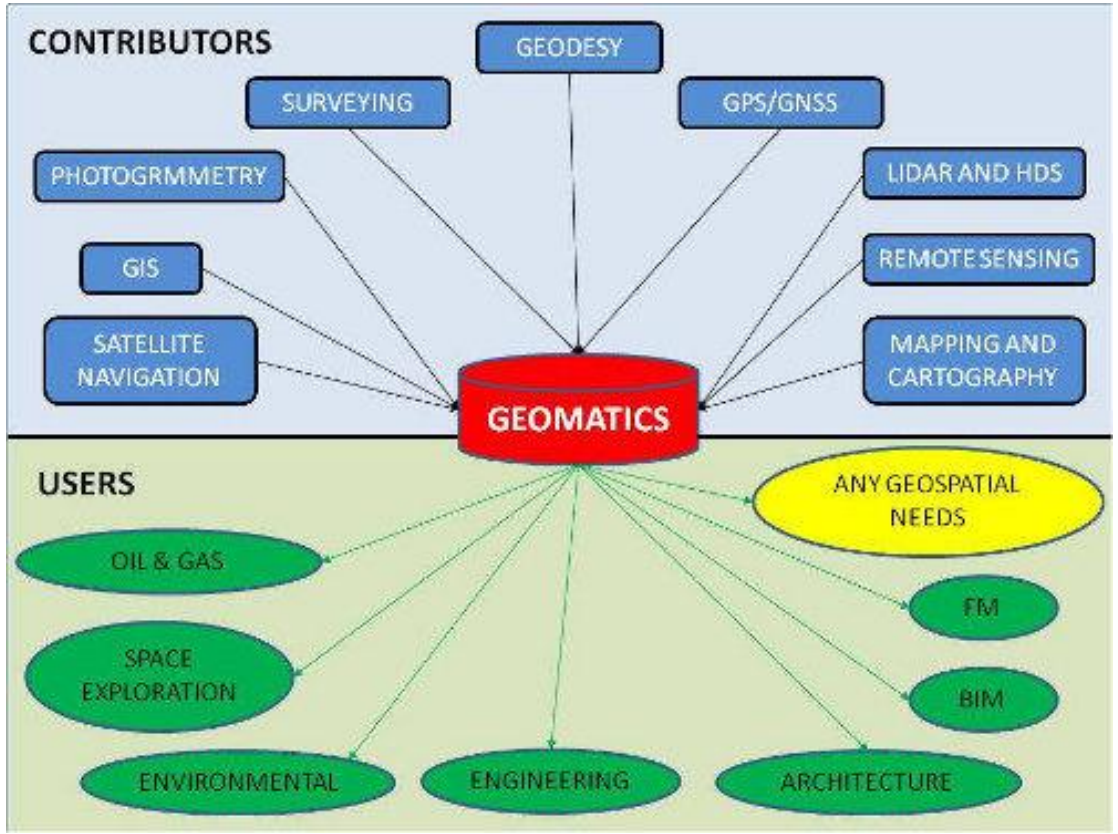
Introduction

- Geomatics refers to methods & technologies used to
  - Collect
  - Store
  - Process
  - Analyze
  - Distribute &
  - Present geographic data



Introduction

- Geomatics encompasses geodesy, GIS, GPS, hydrography, photogrammetry, remote surveying, land surveying, Land information system (LIS), Global Navigational Satellite system (GNSS), Light Detection & Ranging (LIDAR) etc



Land Surveying

- ***Need and objective***: To prepare maps primarily for topographical (location of hills, valleys, rivers, villages, forests etc), cadastral (boundaries), Engineering (details of roads, railways, bridges, tunnels), Military, contour (for capacity estimation, road alignment, canal alignment), geological (for knowing information on soils, rocks, minerals below GL), archaeological types
- Land surveying can be classifies into
  - Surveying – taking measurement in horizontal planes
  - Levelling – taking measurement in vertical planes

Land Surveying

- Different types of land surveying are

  - *Topographical surveying*
  - *Cadastral surveying*
  - *Engineering surveying*
  - *City/village surveying*

Classification of surveying

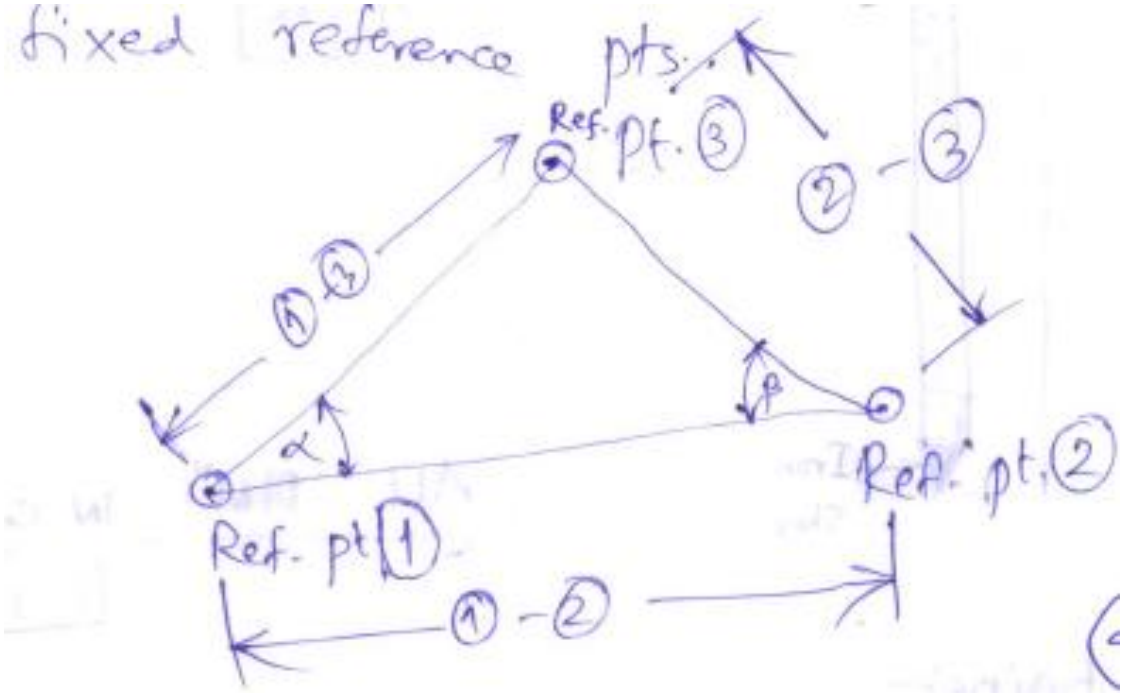
- ***Primary Classification***
  - Plane surveying <= 250 km^2 - Mostly planer lines, triangles
  - Geodetic Surveying > 250 km^2 - Mostly spherical lines, spherical triangles
- ***Secondary Classification***
  - Instruments
  - Methods
  - Objectives
  - Nature of field

Classification of surveying

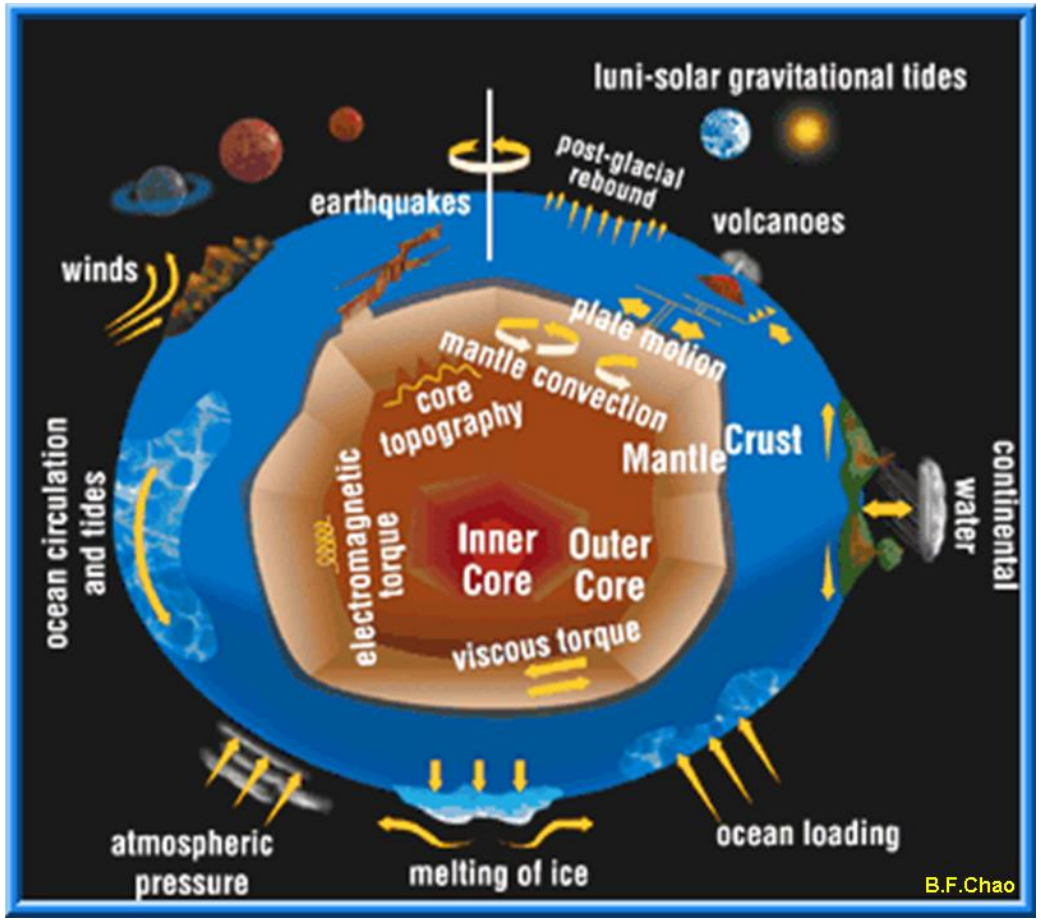
- ***Based on instruments***
  - ✓ Chain Surveying, compass surveying, plane table surveying, Theodolite surveying, Tacheometric surveying, Photographic surveying, Total station surveying, Drone surveying, etc
- ***Based on methods***
  - ✓ Triangulation, Traversing
- ***Based on objectives***
  - ✓ Geological, Archaeological, Military, Mine etc
- ***Nature of field***
  - ✓ Land Surveying, Marine Surveying, Astronomical surveying

Basic principles of measurement

- To work from whole to part
- To locate a new point/station by at least 2 measurements from fixed reference points



GUESS THE PICTURE??



Geodesy, the study of earth

GUESS THE PICTURE??

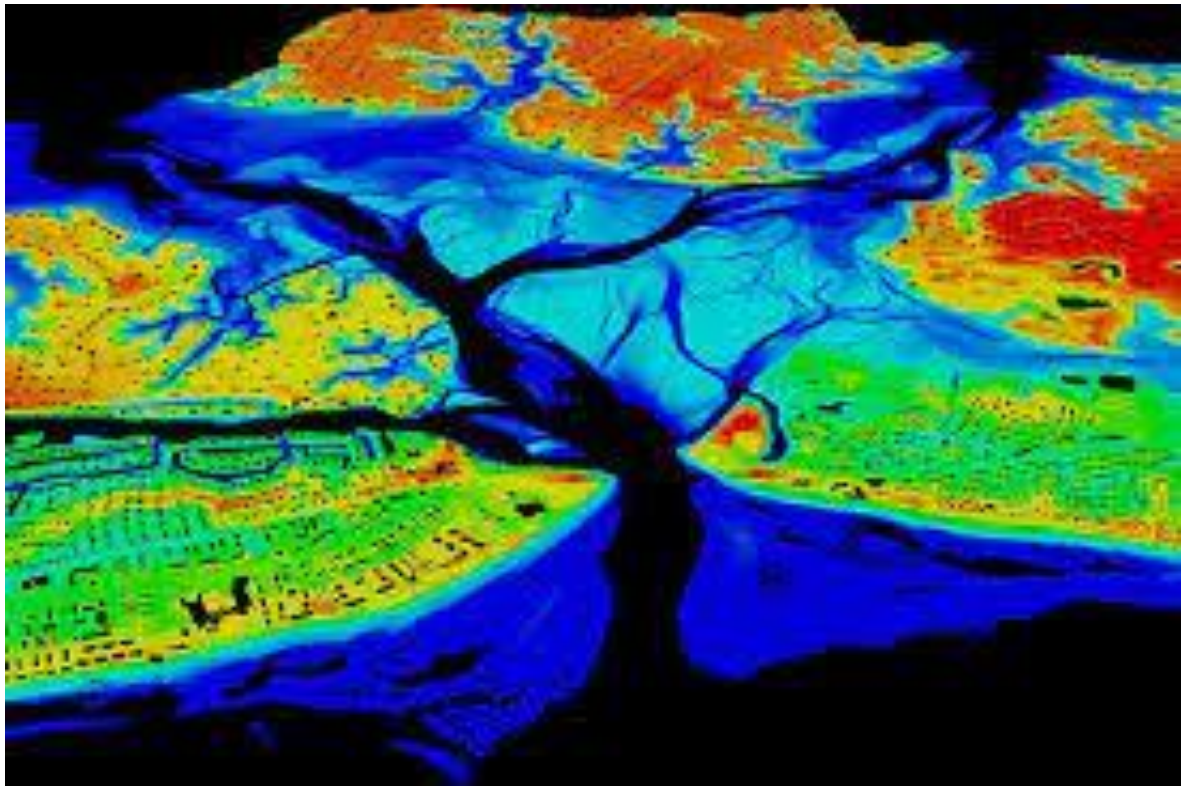
A

B

C

A – Topographical survey
B – Cadastral survey
C – Aerial survey

GUESS THE PICTURE??



LIDAR (Light Detection and Ranging) Survey

Accuracy, precision and flexibility

Triangulation Method

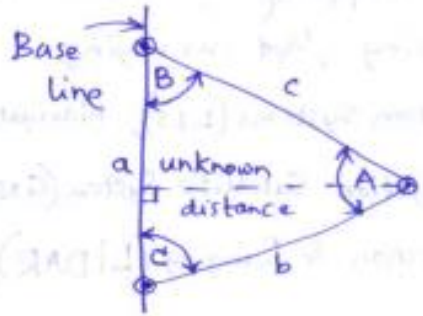
- Triangulation relies on *timing differences in the reception of signals*, moving at the speed of light
- The entire area is divided into triangles
- One side of a triangle called ‘base line’ is measured precisely
- All triangles in the network of triangles are measured with a transit theodolite
- The other sides of triangles are computed subsequently, using sine rule

i.e;

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

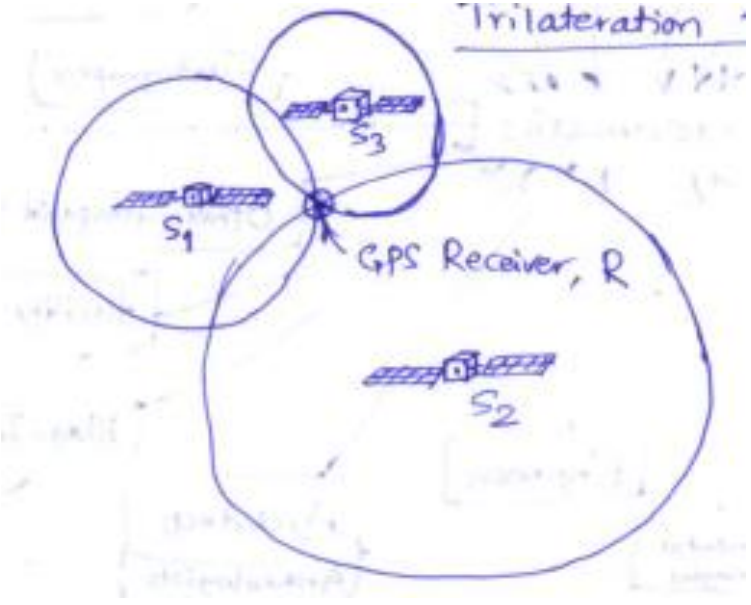
here a, b, c are side lengths; (unknown)

A, B, C are corrected ∠'s



Trilateration Method

- Trilateration involves measuring only distances, very precisely
- It is generally used in GPS
- The position of a GPS receiver is accurately determined by measuring distances from 3 neighbouring satellites obtained through optical signals
- Trilateration relies on signal strength



S1, S2, S3 are 3 neighbouring satellites

Trilateration Method

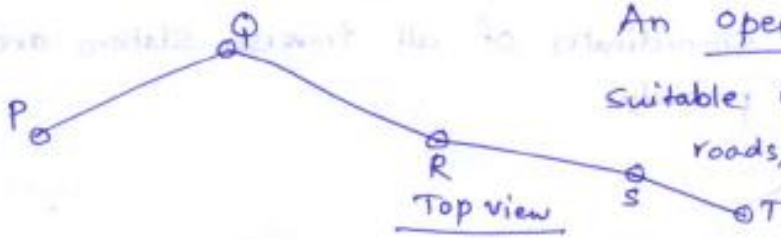
- With the receiving of the 1st optical signal from satellite S_1, the GPS receiver (R) location is established on the spherical surface with centre @ S_1 & radius S_1R
- With the receiving of the 2nd optical signal from S_2, the location of R is narrowed down on the circular rim of the convex lens with the 1st side radius = S_1R & the 2nd side radius = S_2R
- With the receiving of the 3rd optical signal from S_3, the location of R is exactly fixed on to a point on the circular rim of the convex lens which is at a distance S_3R from the 3rd satellite S_3.

Traversing

- This is a type of surveying which involves a series of connected survey lines between adjacent survey stations

Top view

A Closed Traverse is suitable for surveying of ponds, forests, estates etc.



Top view

An open traverse is suitable for surveying roads, rivers, coast lines, etc.

Traversing methods

Chain Traversing

- Only chain and/or tape is used,
- Multiple no of tie stations [T1, T2,……,T10] are used to measure chain angles $< T_1AT_2$, $< T_4BT_3$ etc which are fixed by tie lines T1T2, T3T4, T3T5 etc.

Compass Traversing

- Fore bearings & back bearings of traverse legs are measured by a prismatic compass
- Traverse sides are measured by chain or tape,
- Corrections to observed bearings are applied;
- Closing error is adjusted graphically

Traversing methods

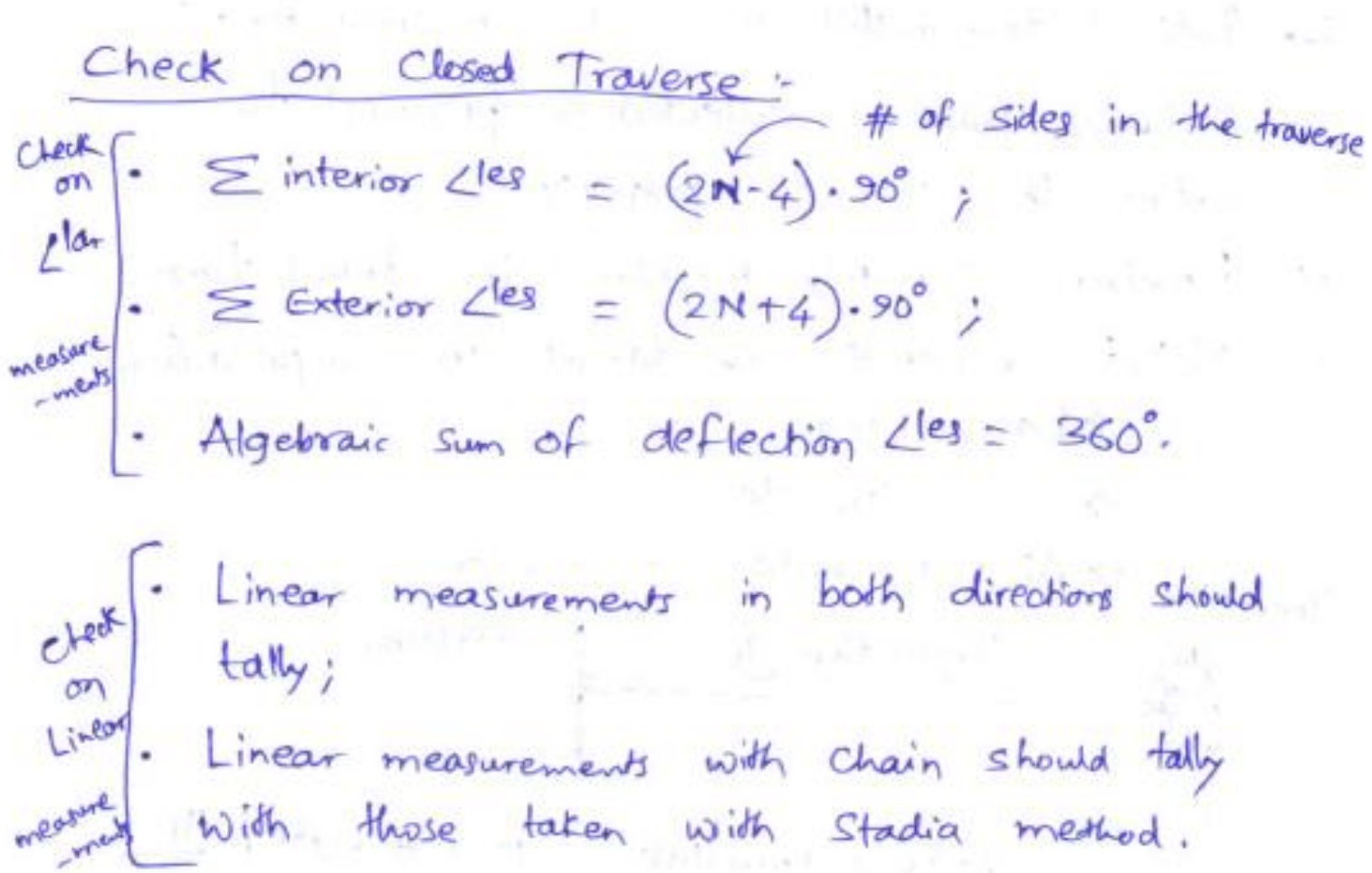
Theodolite Traversing

- *Horizontal angles* between traverse legs are measured by a theodolite
- Traverse leg lengths are measured by chain/tape or by stadia method
- Magnetic bearing of the starting leg is measured by a theodolite
- Magnetic bearing of other sides are computed
- Independent co-ordinates of all traverse stations are found out precisely

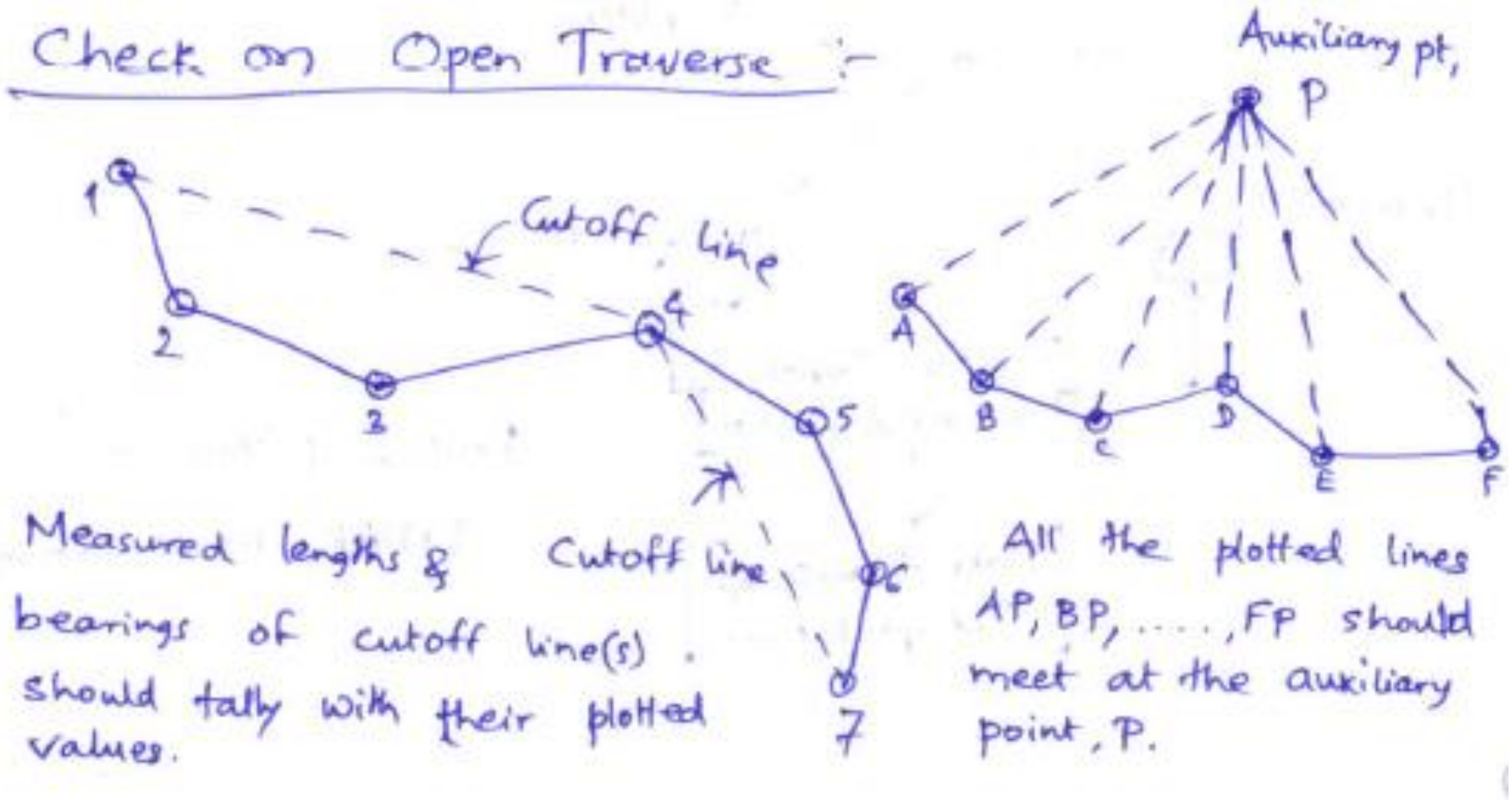
Plane table traversing

- A plane table is set @ every traverse station
- All traverse sides/legs are plotted to a suitable scale
- Closing error is graphically adjusted

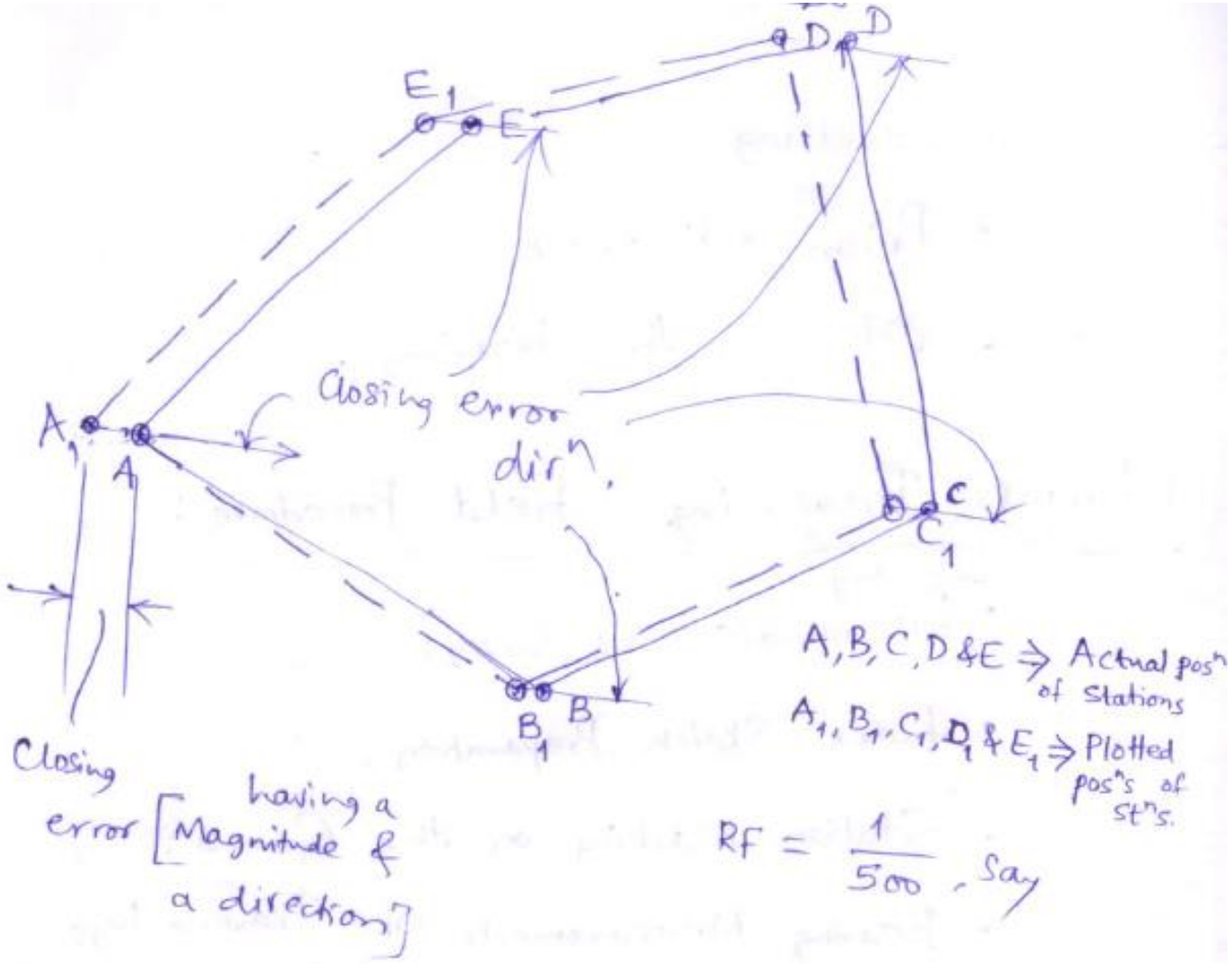
Check on Closed Traverse



Check on open Traverse



Closing Error Adjustments



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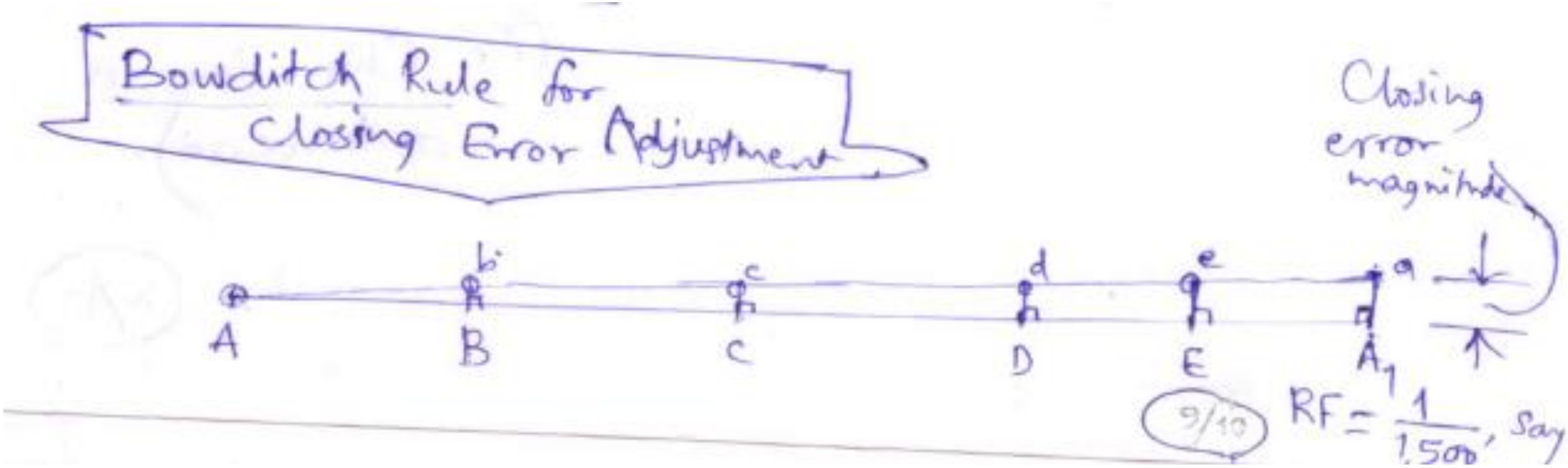
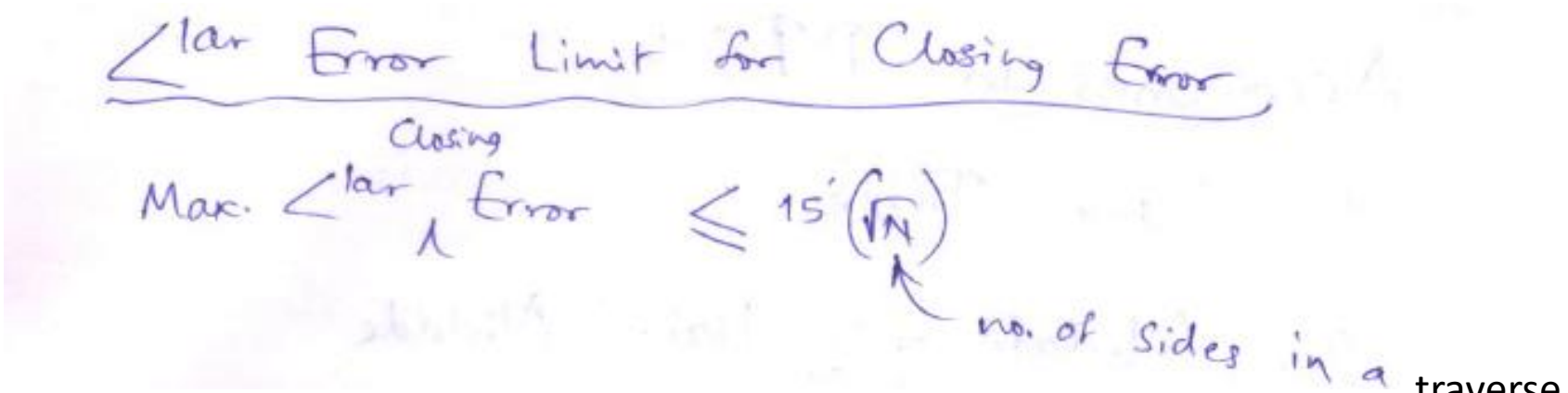


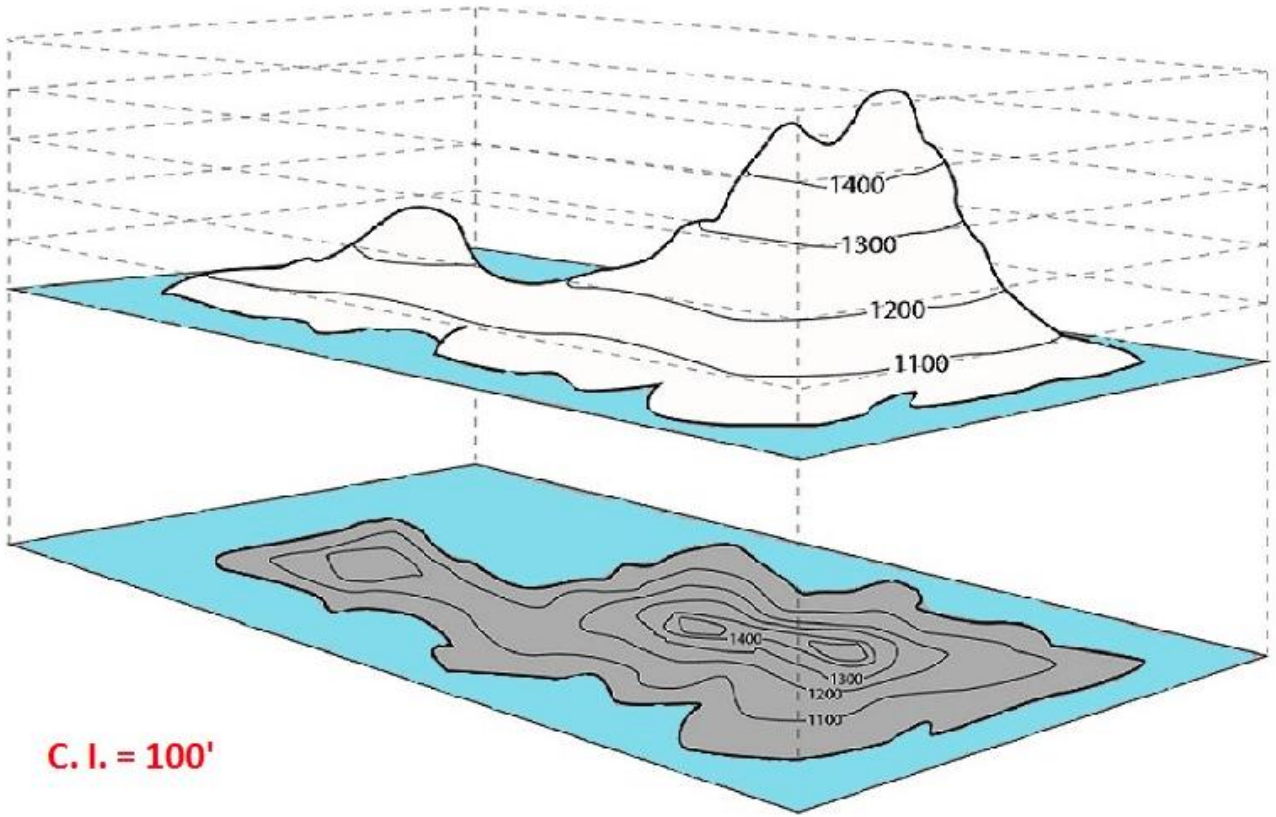
Closing Error Adjustments



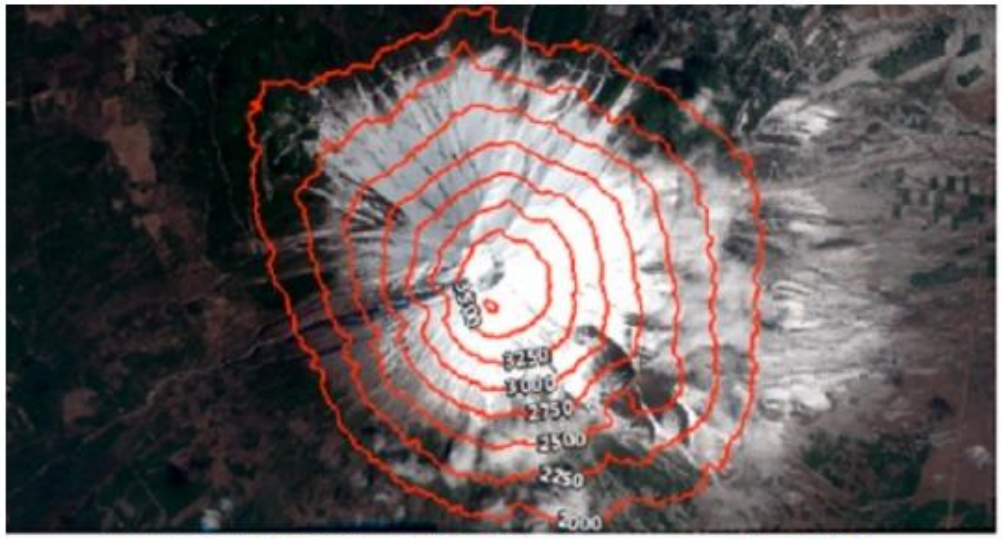
Linear closing Error Limit

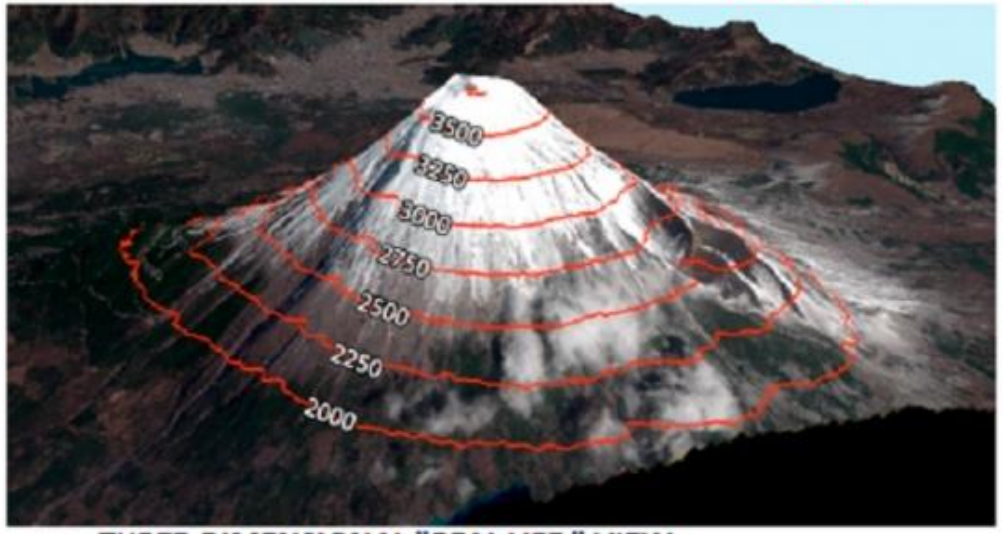
Relative closing Error = (Closing error magnitude) / (perimeter of traverse) ≤ 1/600

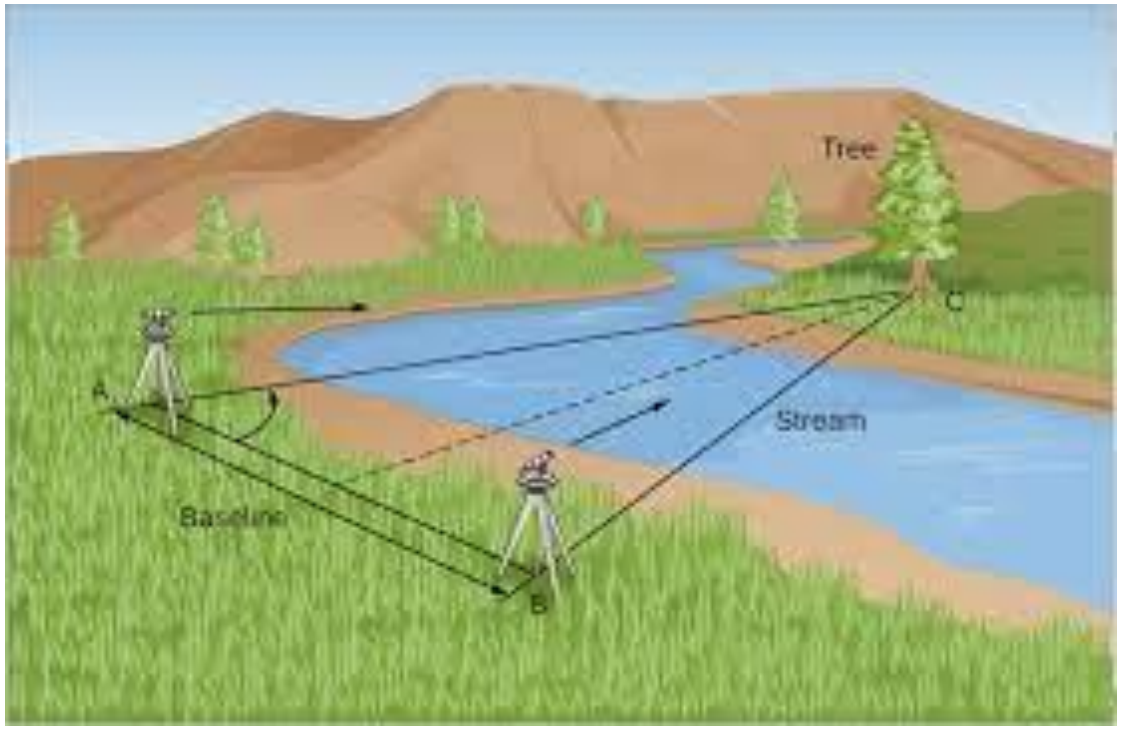
Contouring

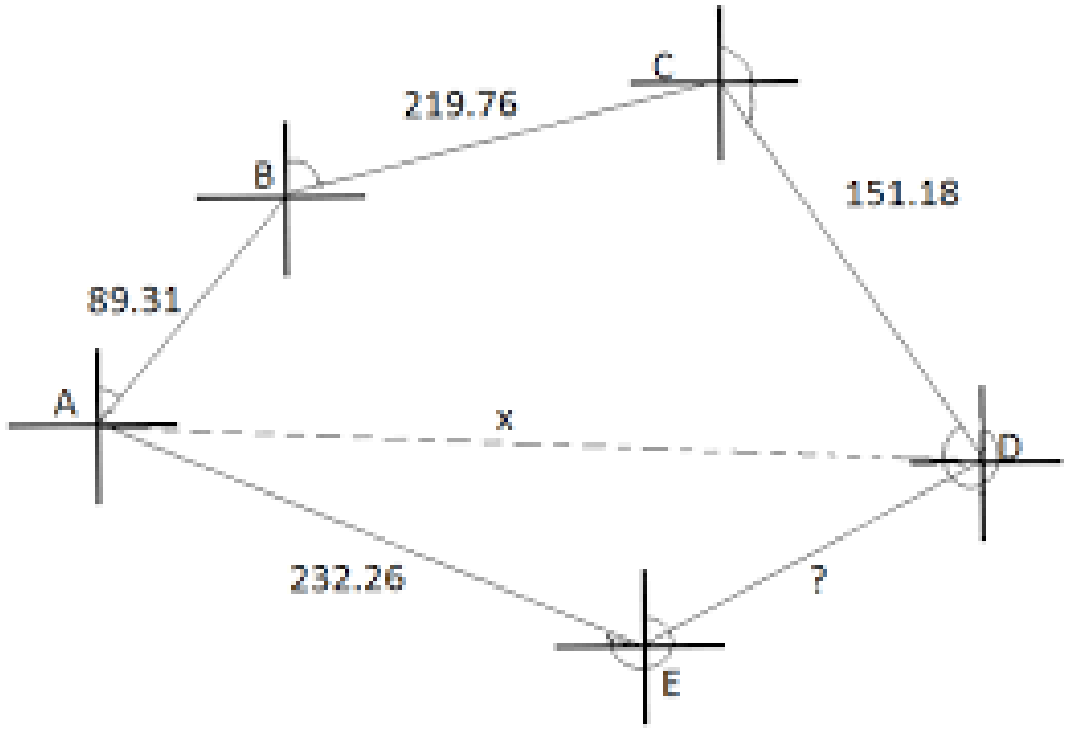


C.I = Contour Interval

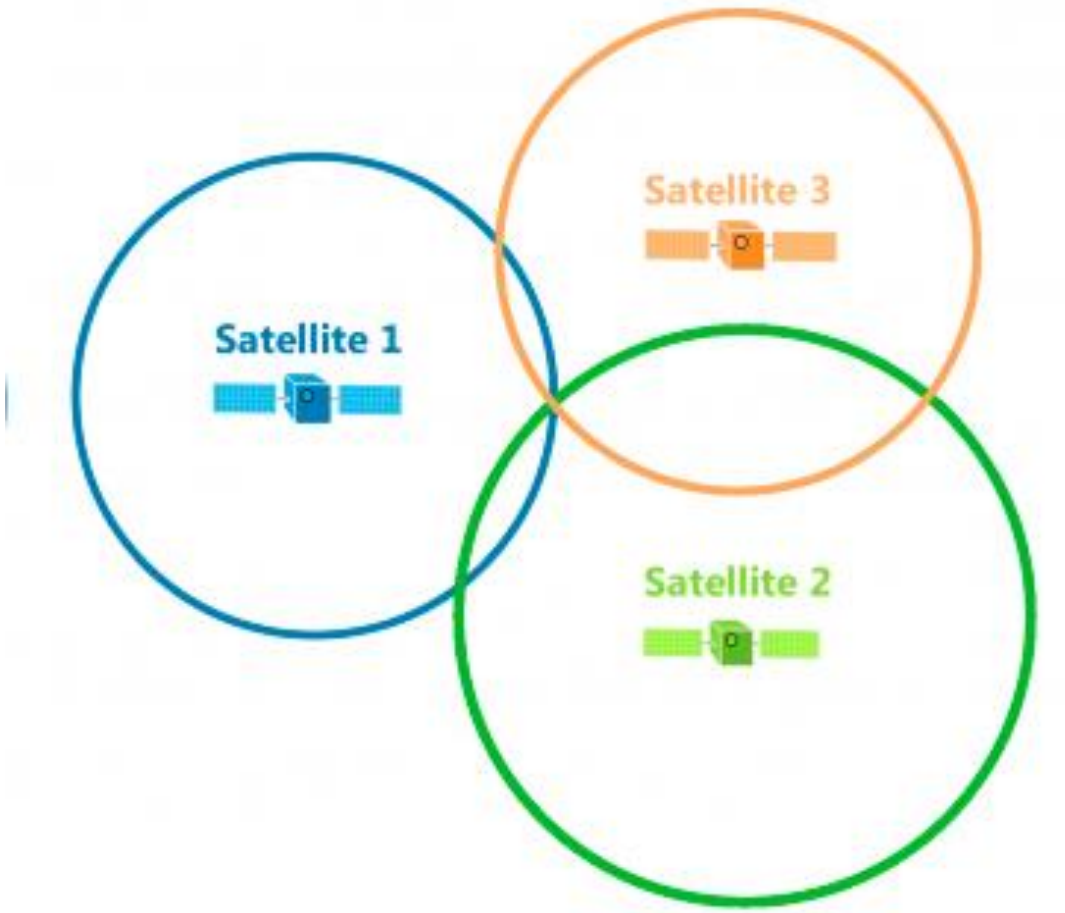




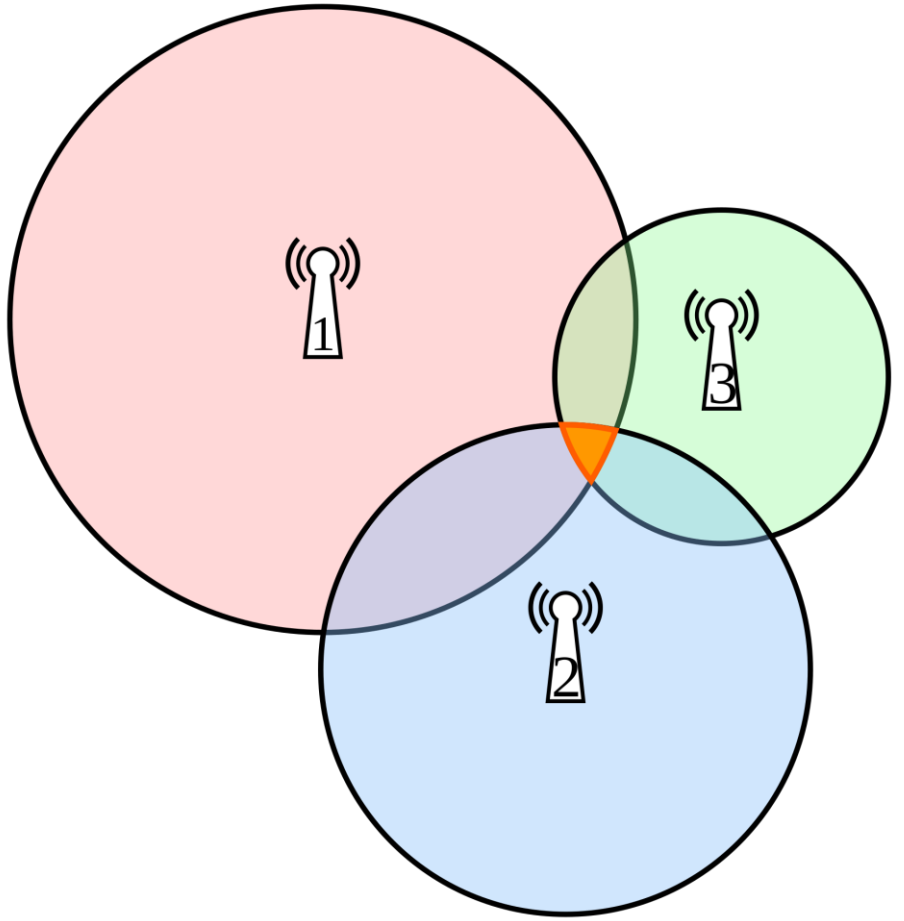

Tree
C
A
Stream
Baseline
B


C
219.76
B
151.18
89.31
A
x
D
232.26
?
E

Trilateration



Point of intersection of three circles



Overlapping region of the three circles

Triangulation vs. Trilateration

Triangulation	Trilateration
1. All angles are measured in triangulation	1. All sides are measured in trilateration
2. Distance of baseline is measured	2. Azimuth of the initial line is measured
3. Some check base lines are also measured to control scale error	3. Some check angles are measured to control azimuth error
5. Intervisibility between stations is essential	5. For small areas it is possible to measure distances without intervisibility
6. There are more internal checks in comparison with trilateration in the sane geometric figure	6. There are less internal checks in comparison with triangulation in the sane geometric figure
7. The side lengths are computed on the basis of measured angles applying sine law	7. The angles are computed on the basis of measured side lengths applying cosine law