G.P. Dhangar

Surveying-I

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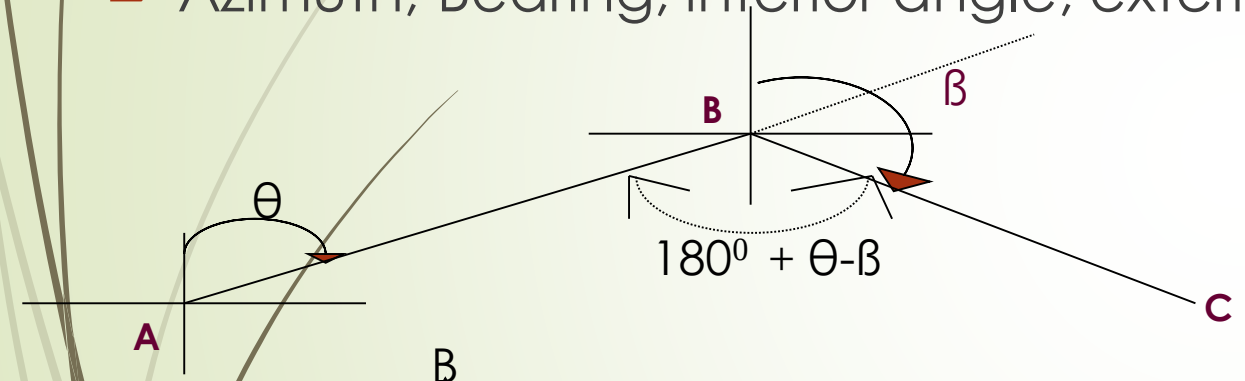
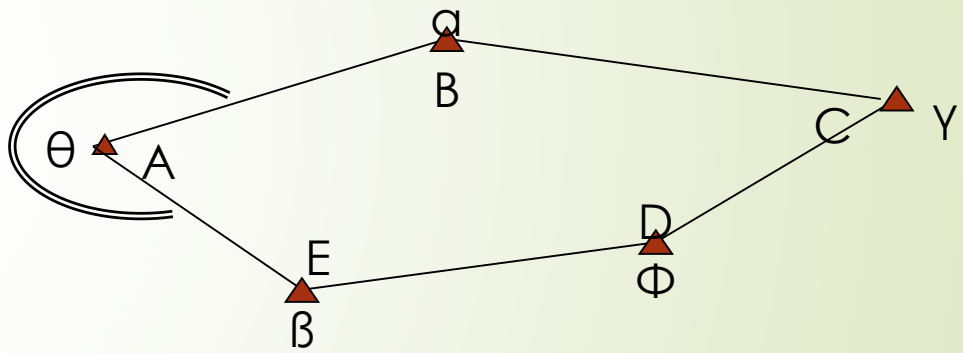
Topics covered – Compass Surveying

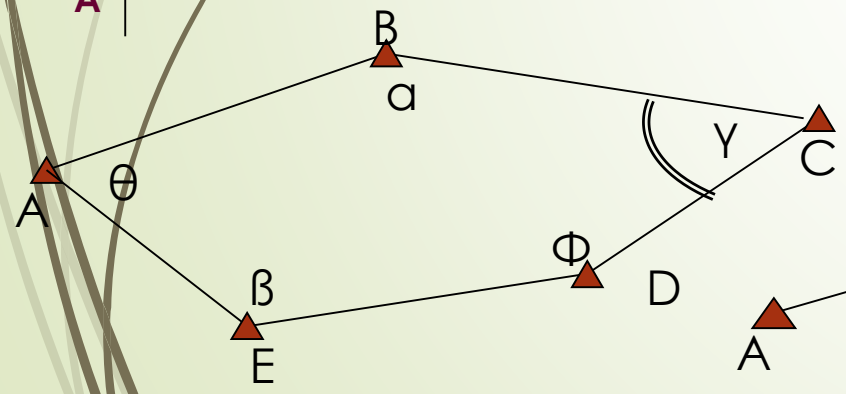
- Meridian & Bearing
  - - true, magnetic and arbitrary
- Traverse - closed, open.
- System of bearing - whole circle bearing, Reduced bearing, fore bearing, and back bearing, conversion from one system to another. Angles from the bearing and vice versa.
- Prismatic, Surveyor, Silva and Bronton (introduction) compass
- Local attraction with numerical problems.
- Plotting of compass survey (**Parallel meridian method in detail**).

Definition

- Limitation of chain surveying
- Angle or direction measurement must
- Azimuth, Bearing, interior angle, exterior angle, deflection angle





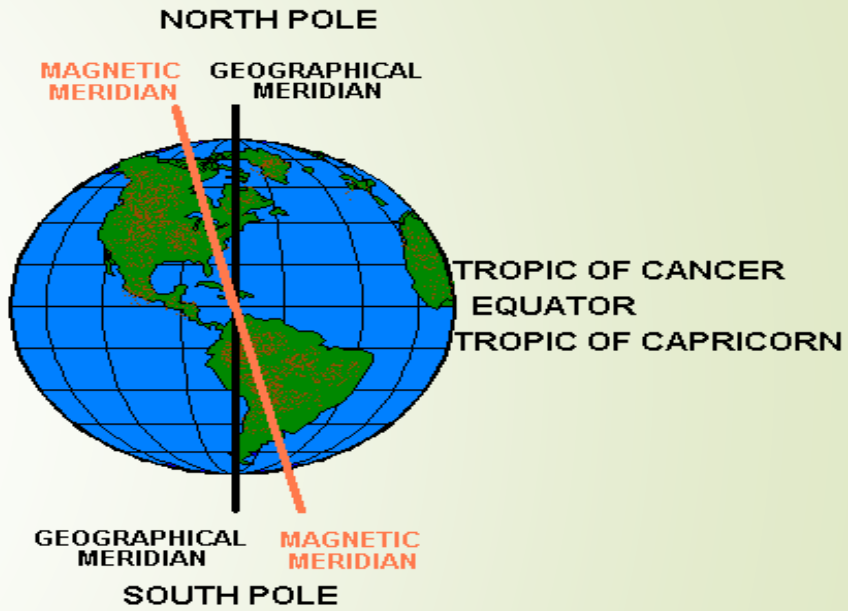


Compass surveying

- Compass used for measurement of direction of lines
- Precision obtained from compass is very limited
- Used for preliminary surveys, rough surveying

5.1 Meridian, Bearing & Azimuths

- Meridian: some reference direction based on which direction of line is measured
  - True meridian (Constant)
  - Magnetic meridian (Changing)
  - Arbitrary meridian
- Bearing: Horizontal angle between the meridian and one of the extremities of line
  - True bearing
  - Magnetic bearing
  - Arbitrary bearing

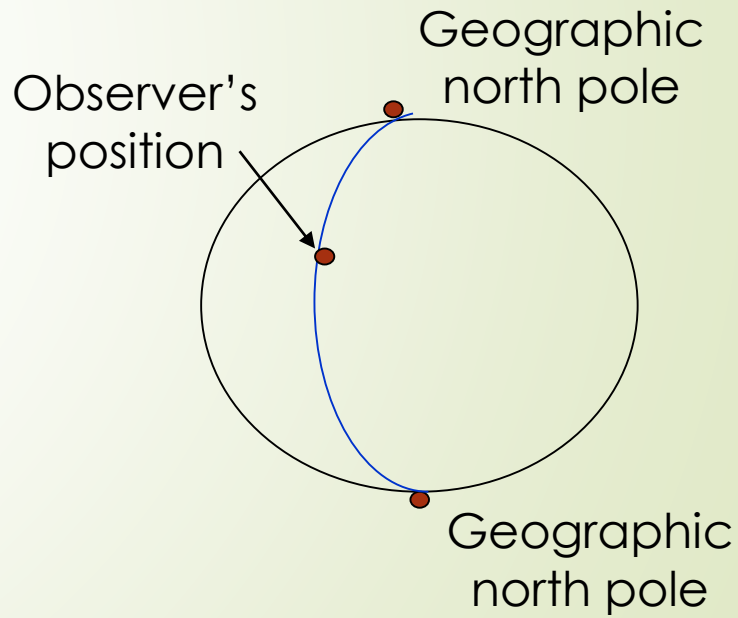


Source: www.cyberphysics.pwp.blueyonder.co.uk

5.1 Meridian, Bearing & Azimuths

Contd...

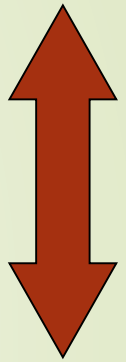
- True meridian
  - Line passing through geographic north and south pole and observer's position
  - Position is fixed
  - Established by astronomical observations
  - Used for large extent and accurate survey (land boundary)



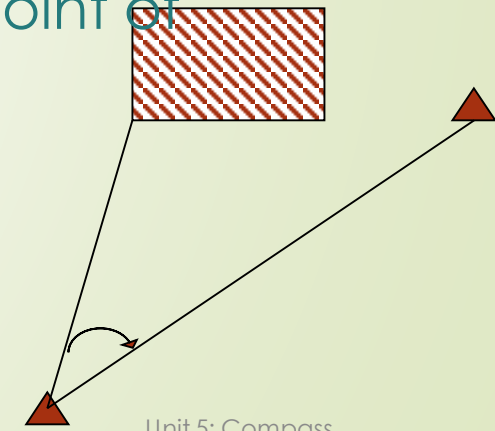
5.1 Meridian, Bearing & Azimuths

Contd...

- Magnetic meridian
  - Line passing through the direction shown by freely suspended magnetic needle
  - Affected by many things i.e. magnetic substances
  - Position varies with time (why? not found yet)

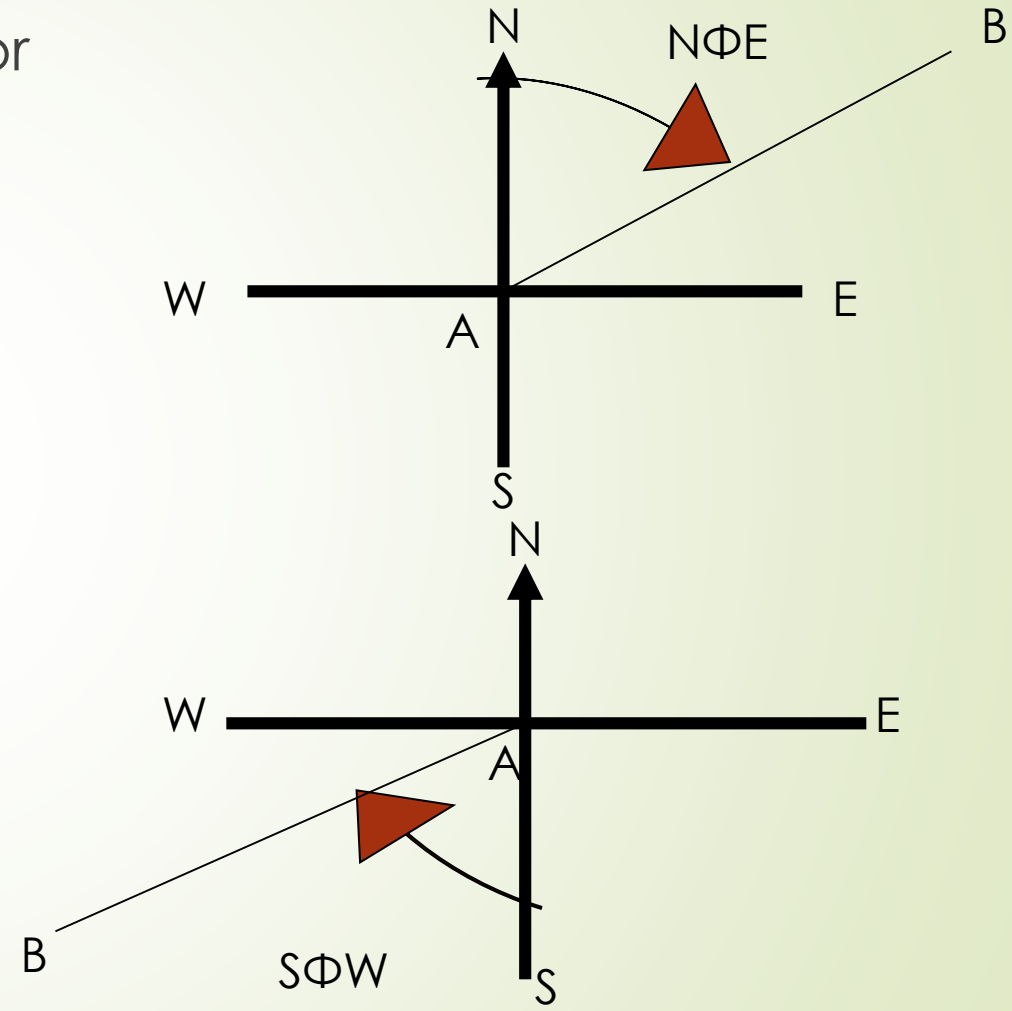


- Assumed meridian
  - Line passing through the direction towards some permanent point of reference
  - Used for survey of limited extent
  - Disadvantage
    - Meridian can't be re-established if points lost.



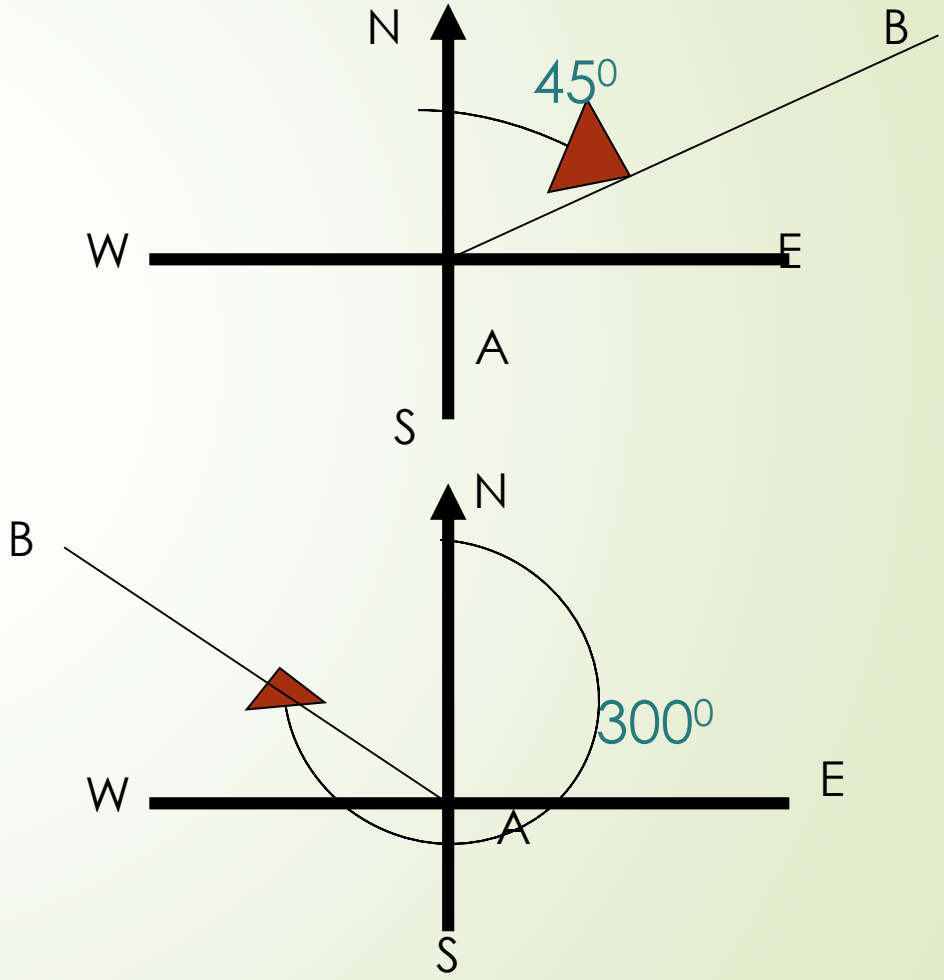
Reduced bearing

- Either from north or south either clockwise or anticlockwise as per convenience
- Value doesn't exceed 90^0
- Denoted as N ΦE or S Φ W
- The system of measuring this bearing is known as Reduced Bearing System (RB System)



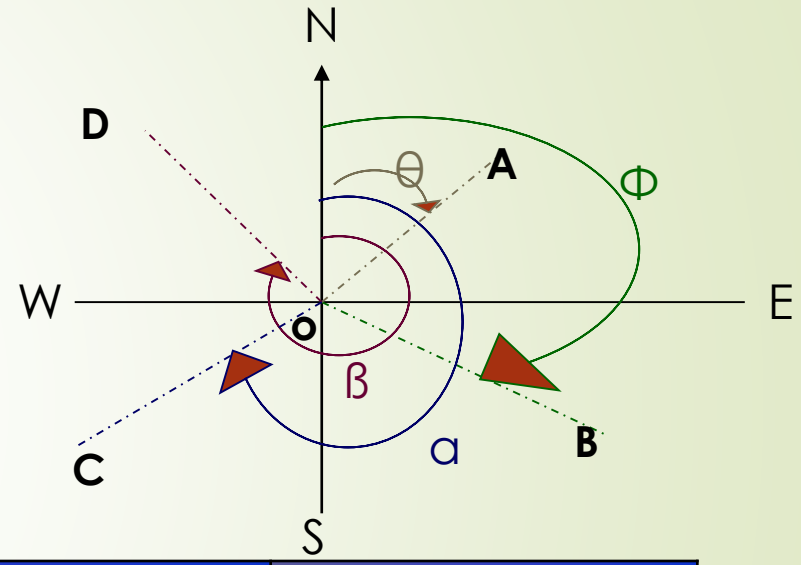
Whole circle bearing (Azimuth)

- Always clockwise either from north or south end
- Mostly from north end
- Value varies from 0^0 – 360^0
- The system of measuring this bearing is known as Whole Circle Bearing System (WCB System)



5.2 Conversion from one system to other

- Conversion of W.C.B. into R.B.

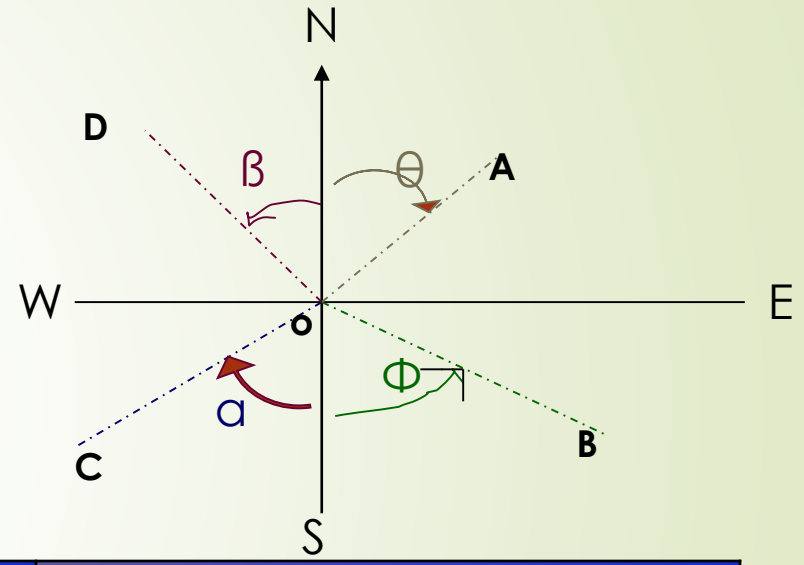


Line	W.C.B. between	Rule for R.B.	Quadrants

5.2 Conversion from one system to other

Contd...

- Conversion of R.B. into W.C.B.



Line	R.B.	Rule for W.C.B.	W.C.B. between

5.2 Fore & back bearing

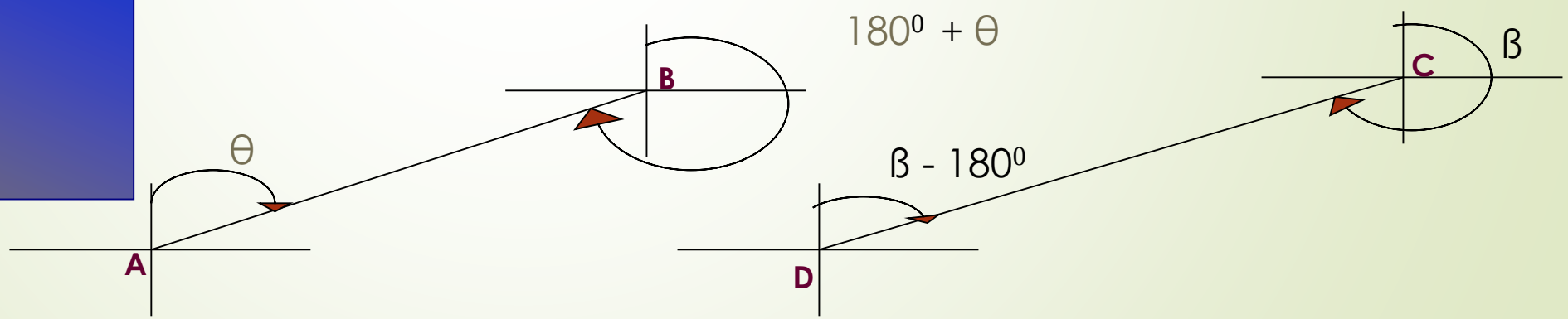
- Each survey line has F.B. & B.B.
- In case of line AB,
  - F.B. is the bearing from A to B
  - B.B. is the bearing from B to A
- Relationship between F.B. & B.B. in W.C.B.

B.B. = F.B. ± 180^0

Use + sign if F.B. < 180^0

&

use – sign if F.B.>1 180^0

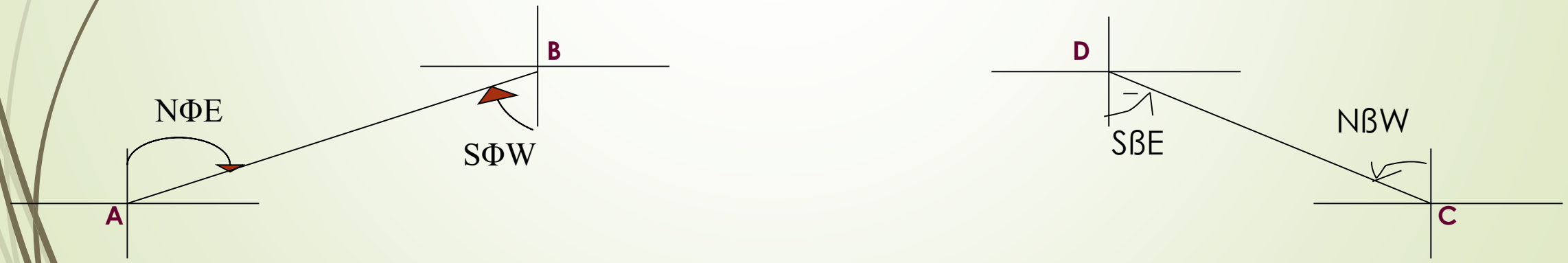


5.2 Fore & back bearing

Contd...

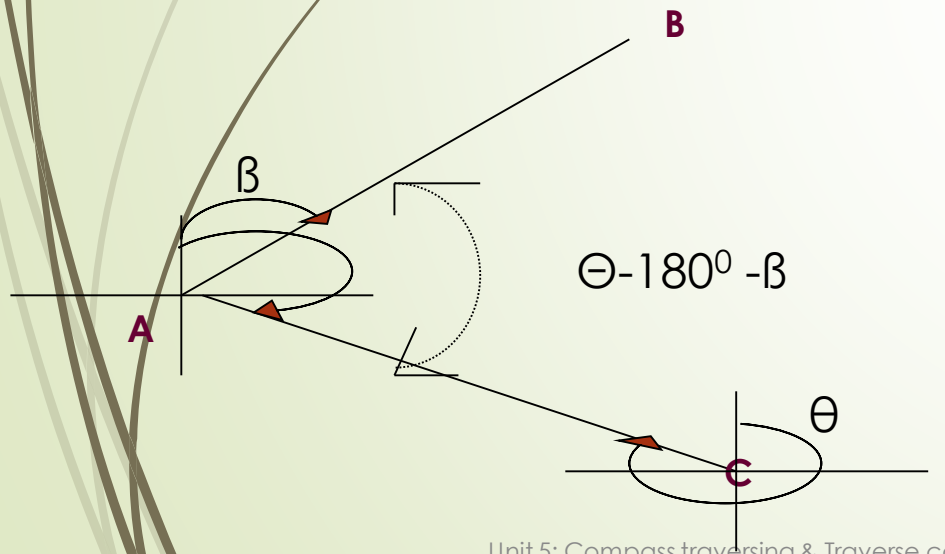
- Relationship between F.B. & B.B. in R.B. system

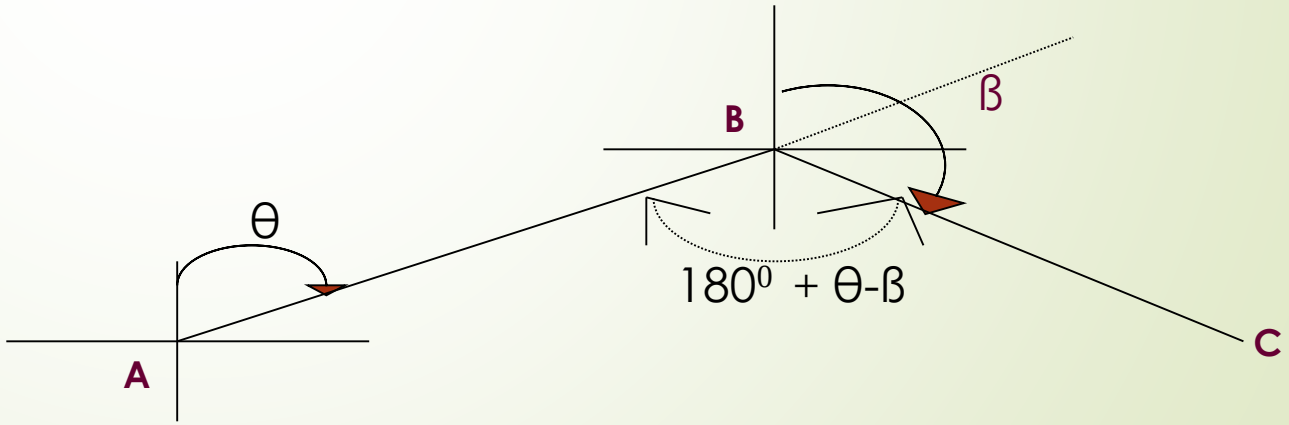
B.B.=F.B.
Magnitude is same just the sign changes i.e. cardinal points changes to opposite.



5.2 Calculation of angles from bearing and vice versa

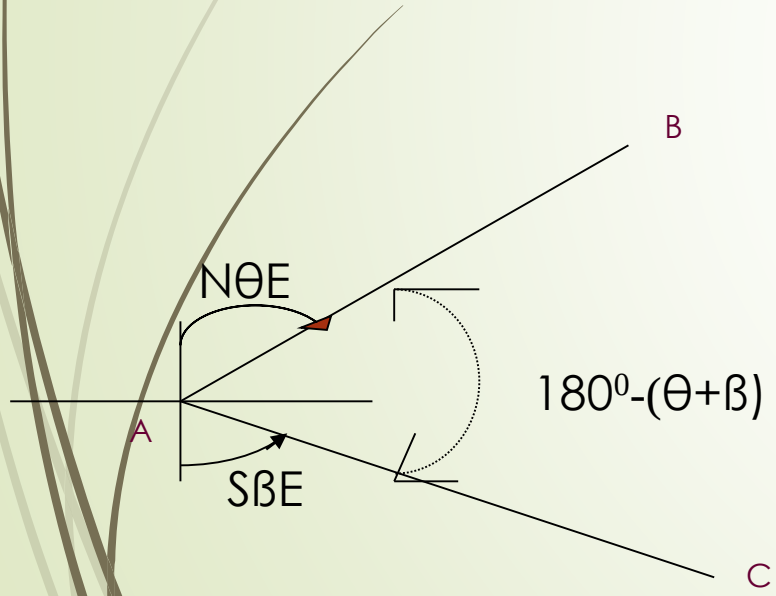
- In W.C.B.system (Angle from bearing)
  - Easy & no mistake when diagram is drawn
  - Use of relationship between F.B. & B.B.
  - Knowledge of basic geometry

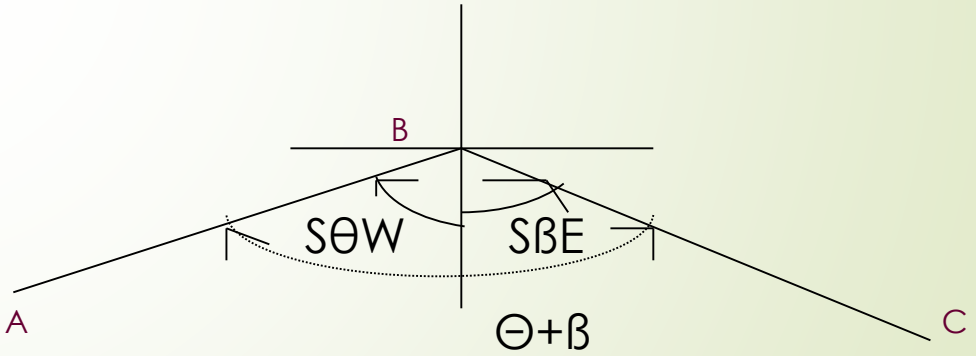




5.2 Calculation of angles from bearing and vice versa Contd...

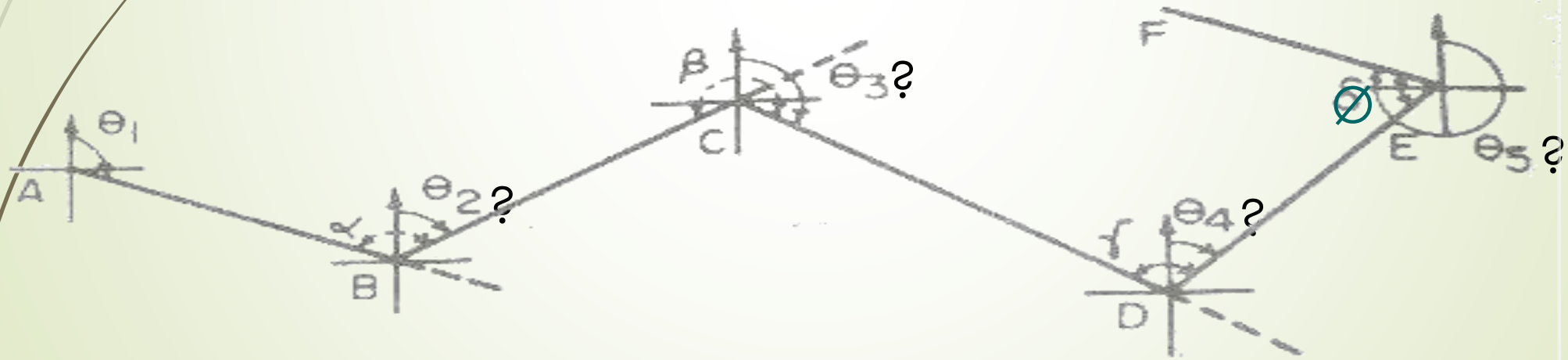
- In R.B. system (Angle from Bearing)
  - Easy & no mistake when diagram is drawn
  - Knowledge of basic geometry



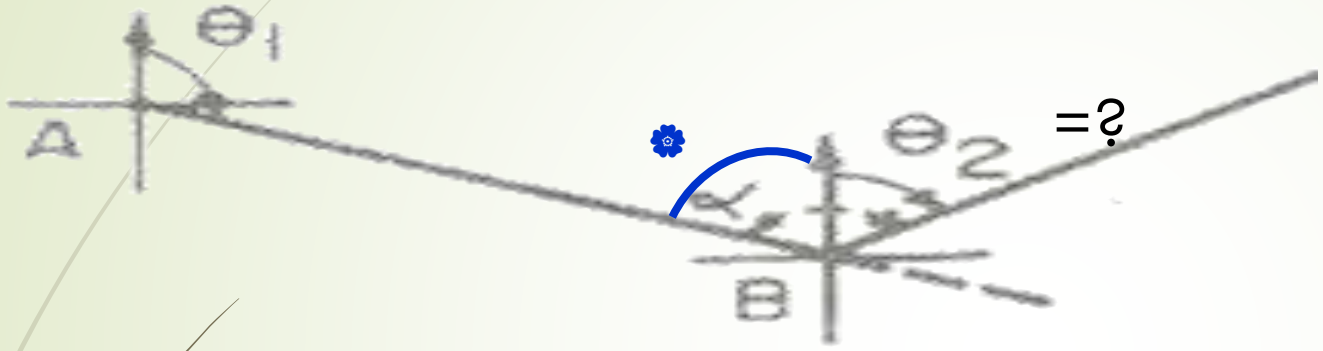


5.2 Calculation of bearing from angle

- Normally in traverse, included angles are measured
- if that has to be plotted by co-ordinate methods, we need to know the bearing of line
  - Bearing of one line must be measured
  - Play with the basic geometry
  - Diagram is your good friend always



5.2 Calculation of bearing from angle

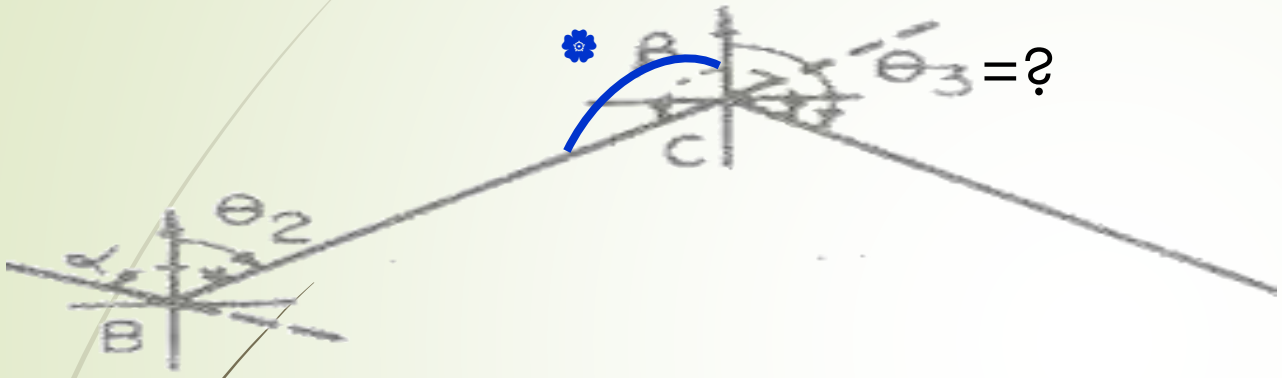


Bearing of line AB = θ_1

Back Bearing of line AB = $180^0 + \theta_1$

- = 360^0 – BB of line AB = $360^0 - (180^0 + \theta_1)$
- is also = alternate angle of $(180^0 - \theta_1)$ = $(180^0 - \theta_1)$

5.2 Calculation of bearing from angle



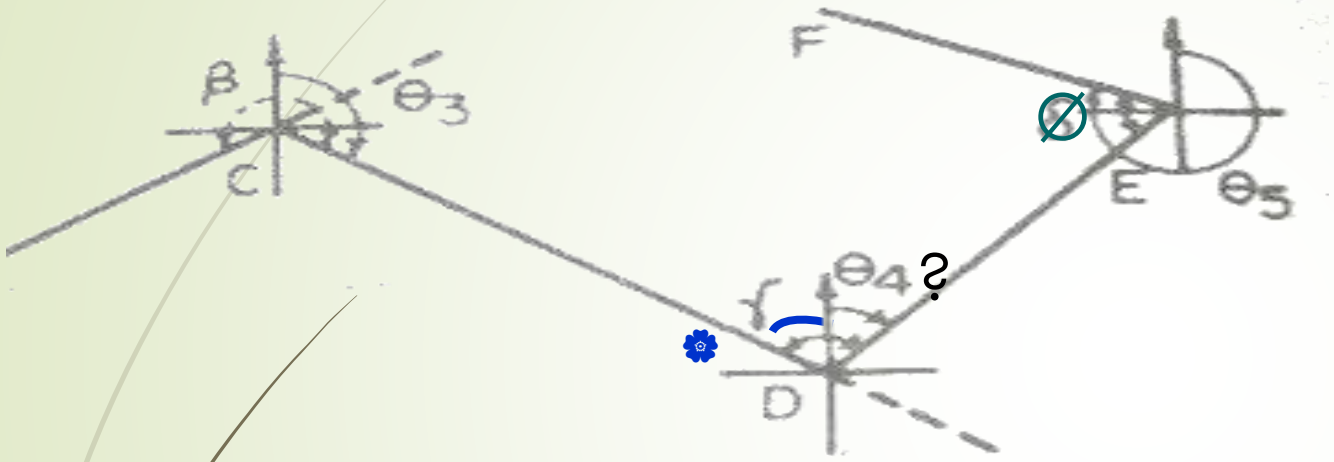
Bearing of line BC = θ_2

Back Bearing of line BC = $180^0 + \theta_2$

❁ = 360^0 – BB of line BC = $360^0 - (180^0 + \theta_2)$

5.2 Calculation of bearing from angle

Contd...



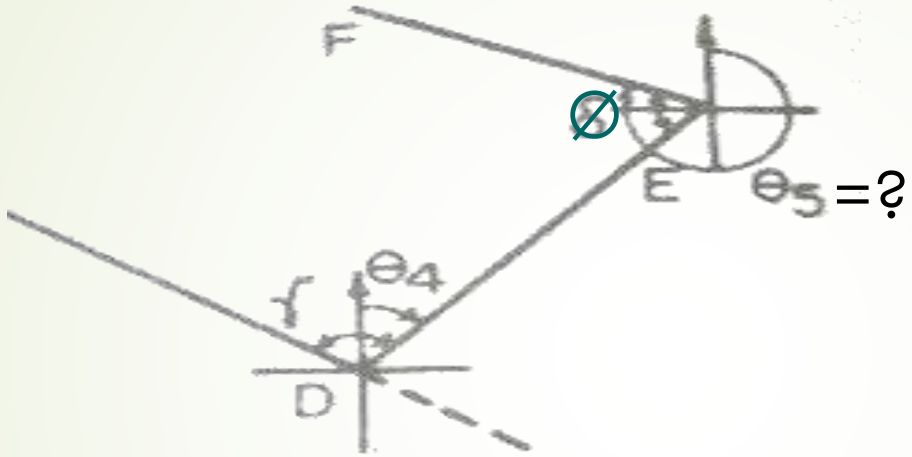
Bearing of line CD= θ_3

Back Bearing of line CD = $180^0 + \theta_3$

✿ = 360^0 – BB of line CD = $360^0 - (180^0 + \theta_3)$

5.2 Calculation of bearing from angle

Contd...



Bearing of line DE= θ_4

Back Bearing of line DE = $180^0 + \theta_4$

Fore Bearing of line EF = θ_5 = BB of line DE + Ø = $180^0 + \theta_4 + Ø$

5.2 Numerical on angle & bearing

- What would be the bearing of line FG if the following angles and bearing of line AB were observed as follows: (Angles were observed in clockwise direction in traverse)

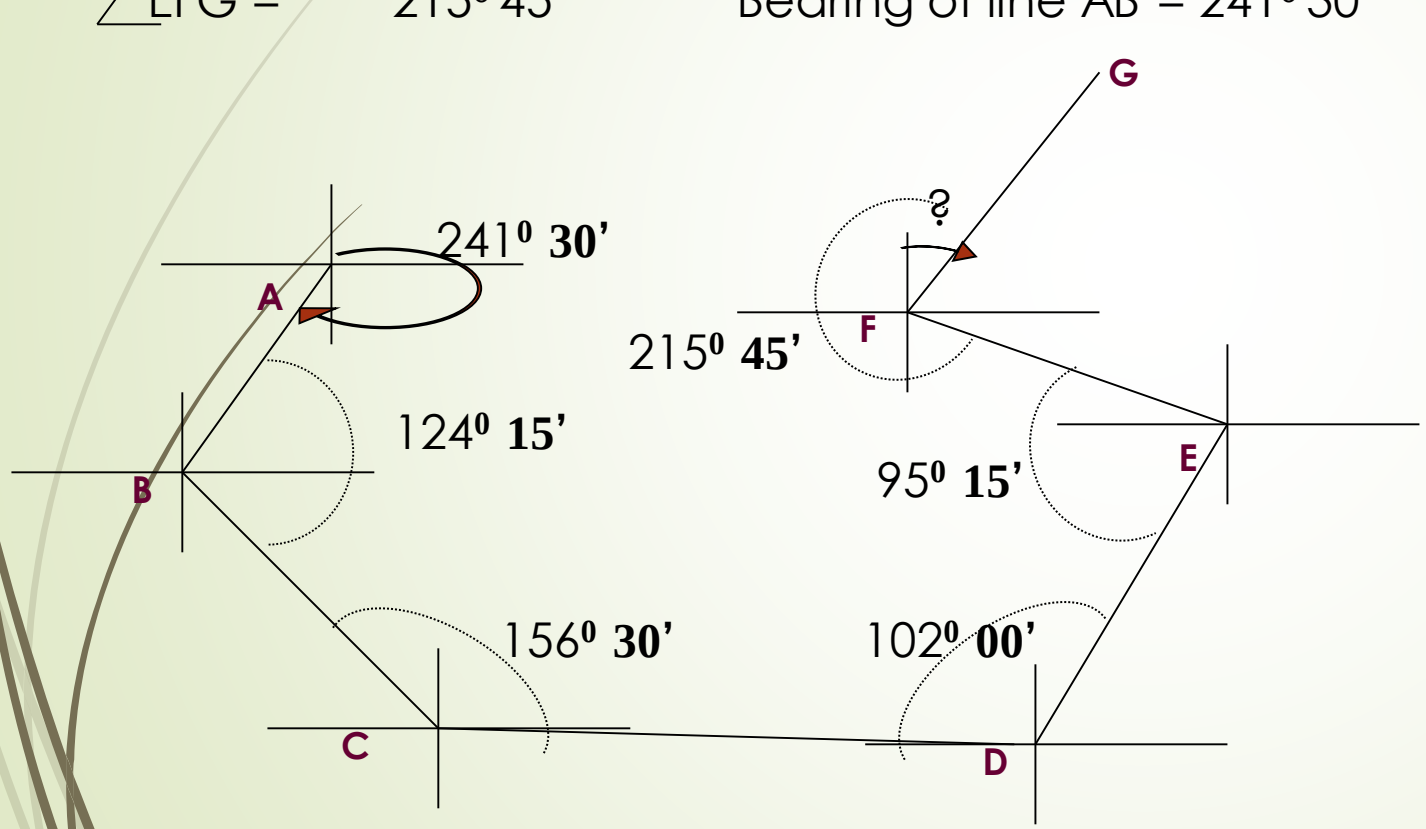
$\angle ABC = 124^0\,15'$ $\angle BCD = 156^0\,30'$ $\angle CDE = 102^0\,00'$ $\angle DEF = 95^0\,15'$

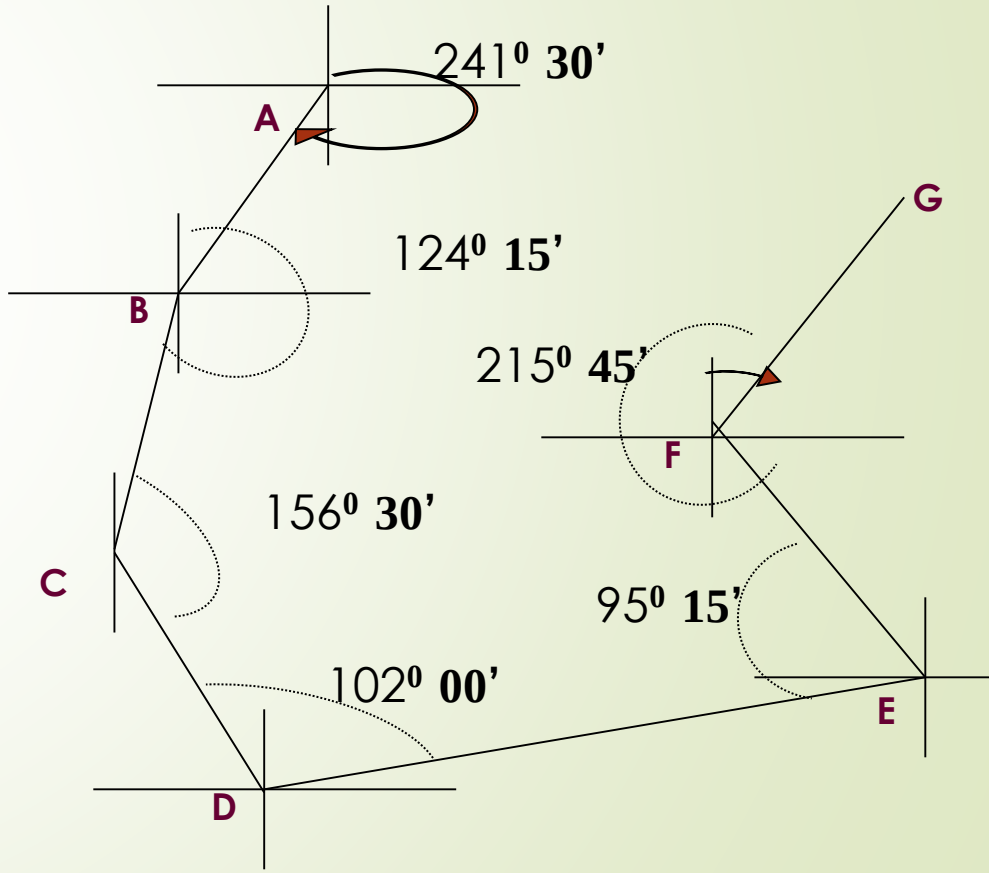
$\angle EFG = 215^0\,45'$ Bearing of line AB = $241^0\,30'$

5.2 Numerical on angle & bearing

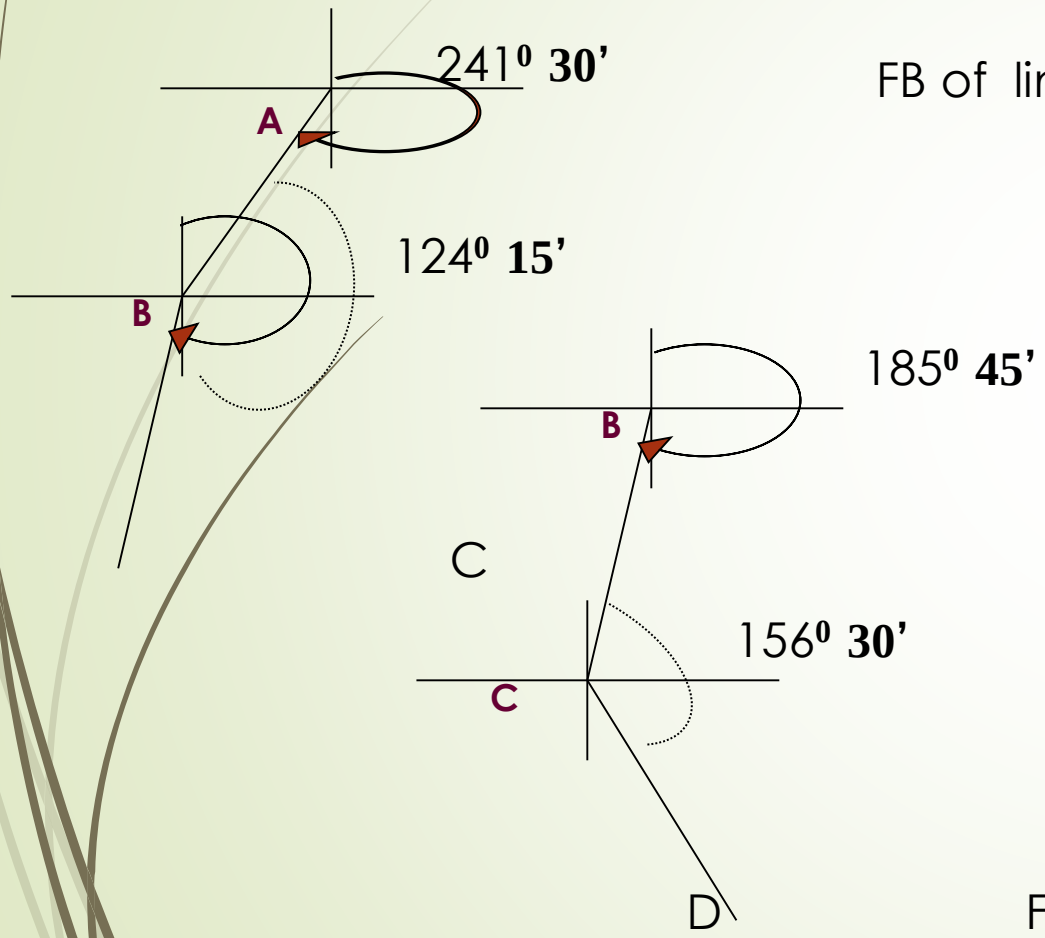
∠ABC = $124^0\,15'$ ∠BCD = $156^0\,30'$ ∠CDE = $102^0\,00'$ ∠DEF = $95^0\,15'$

∠EFG = $215^0\,45'$ Bearing of line AB = $241^0\,30'$





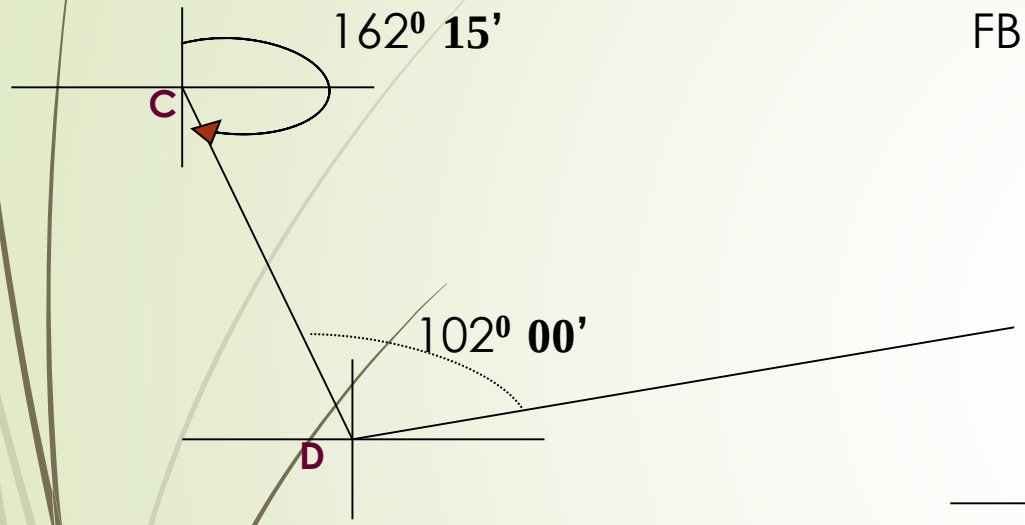
5.2 Numerical on angle & bearing



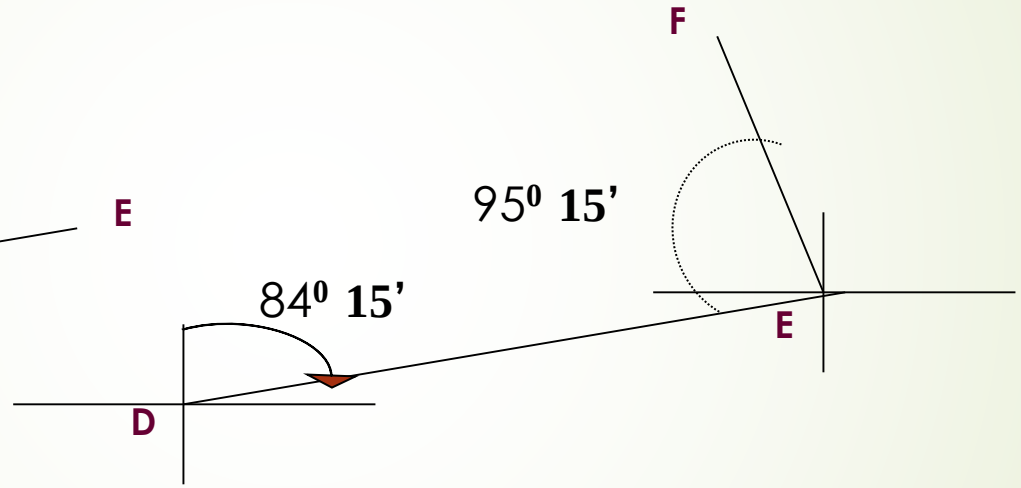
FB of line BC = $(241^0\,30' - 180^0) + 124^0\,15' = 185^0\ 45'$

FB of line CD = $(185^0\ 45' - 180^0) + 156^0\,30' = 162^0\ 15'$

5.2 Numerical on angle & bearing



FB of line DE =102^0 00’ - (180^0- 162^0 15’) = 84^0 15’

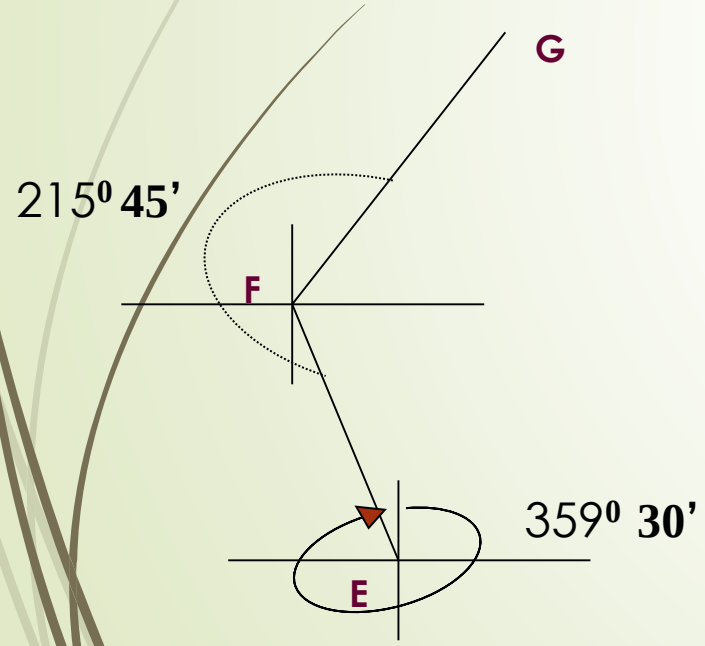


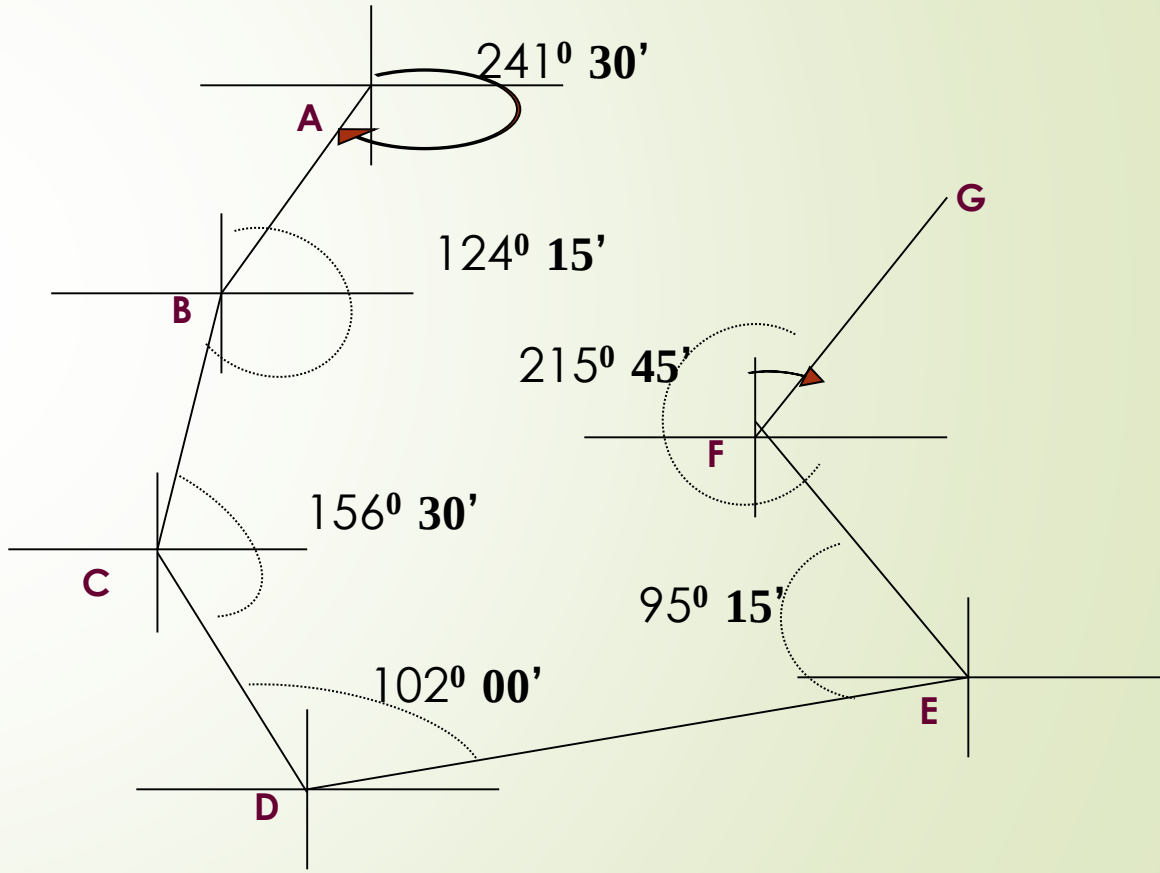
FB of line EF = (84^0 15’+180^0) + 95^0 15’ = 359^0 30’

5.2 Numerical on angle & bearing

FB of line FG =215^0 45' - {180^0+(BB of line EF)}

FB of line FG =215^0 45' - {(180^0 +(0^0 30')} = 35^0 15'





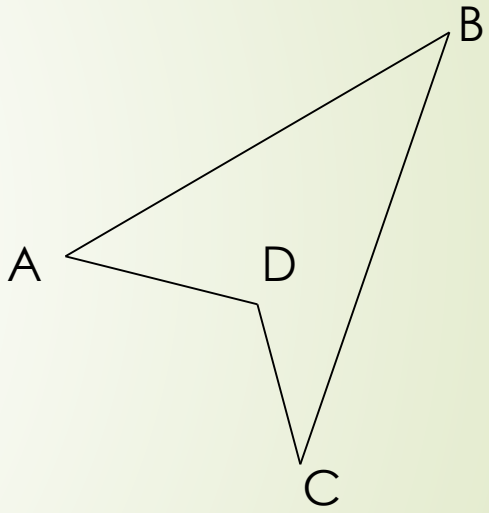
5.2 Numerical on angle & bearing

Contd...

- From the given data, compute the missing bearings of lines in closed traverse ABCD.

Bearing of line AB = ?
Bearing of line BC = ?
Bearing of line CD = N27^0 50'E
Bearing of line AB = ?

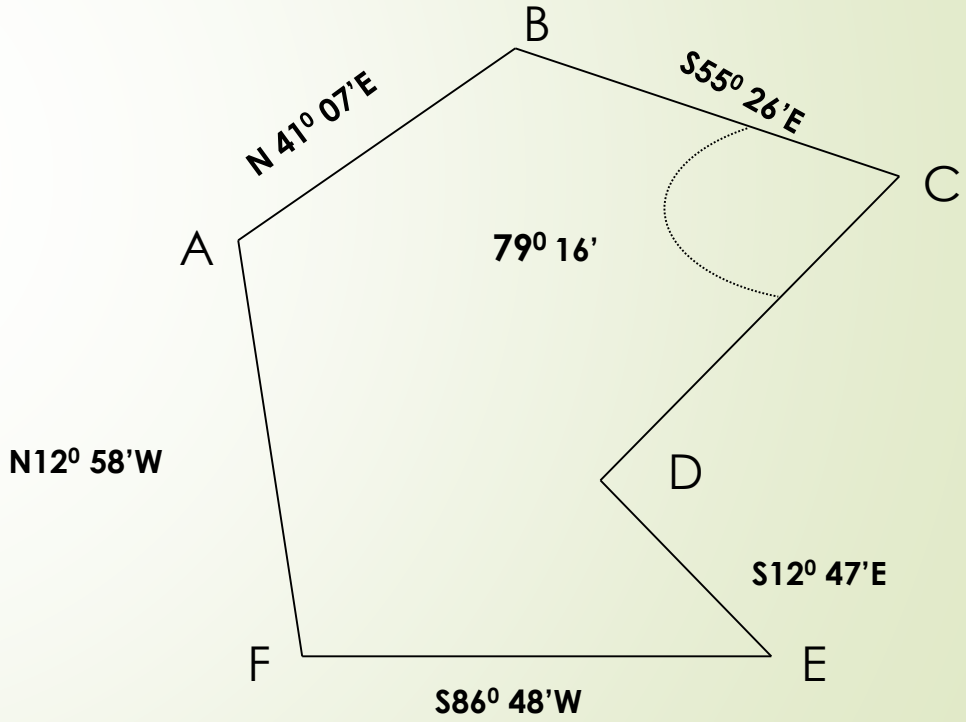
$\angle A = 81^0\,16'$
$\angle B = 36^0\,42'$
$\angle D = 226^0\,31'$



5.2 Numerical on angle & bearing

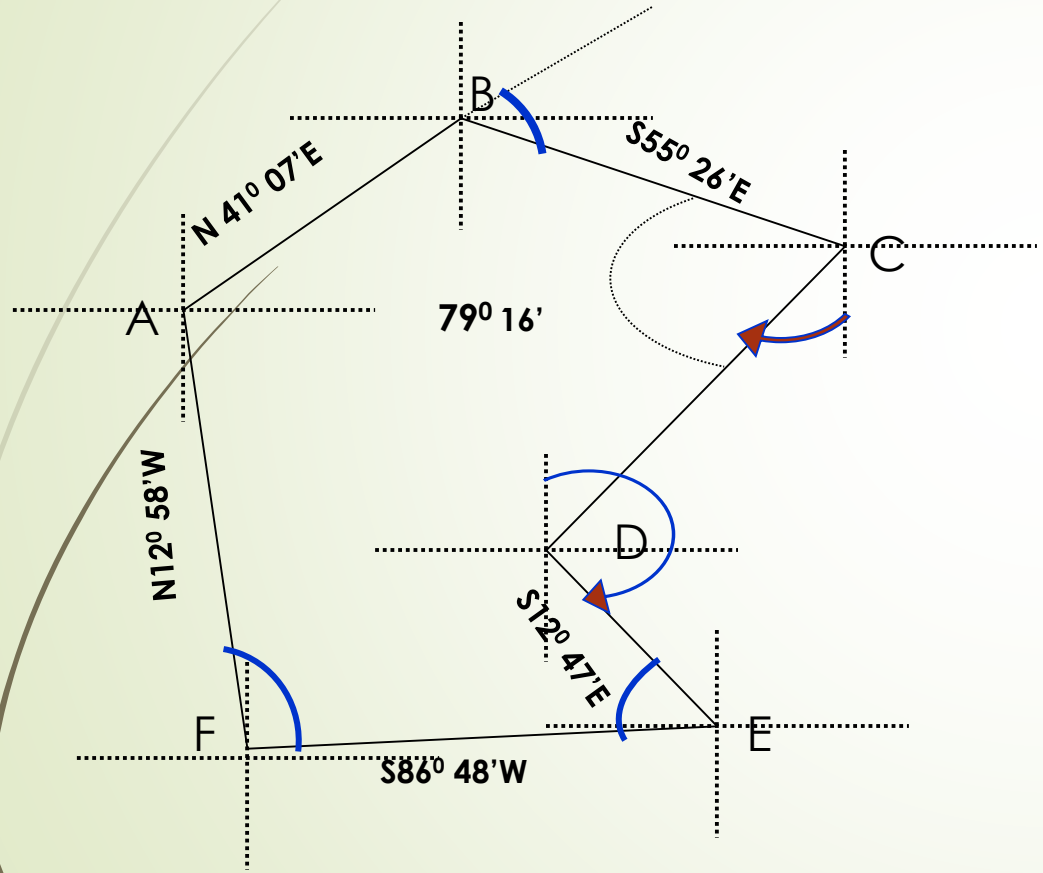
Contd…

- For the figure shown, compute the following.
  - The deflection angle at B
  - The bearing of CD
  - The north azimuth of DE
  - The interior angle at E
  - The interior angle at F



5.2 Numerical on angle & bearing

Contd...



Deflection Angle at B = 180^0 - (41^0 07'+55^0 26')

= 83^0 27' R

Bearing of line CD = 180^0 - (79^0 16'+55^0 26')

= S45^0 18' W

North Azimuth of line DE = 180^0 - 12^0 47'

= 167^0 13'

Interior Angle E = 180^0 – (12^0 47' + 86^0 48')

= 80^0 25'

Interior Angle F = (12^0 58' + 86^0 48')

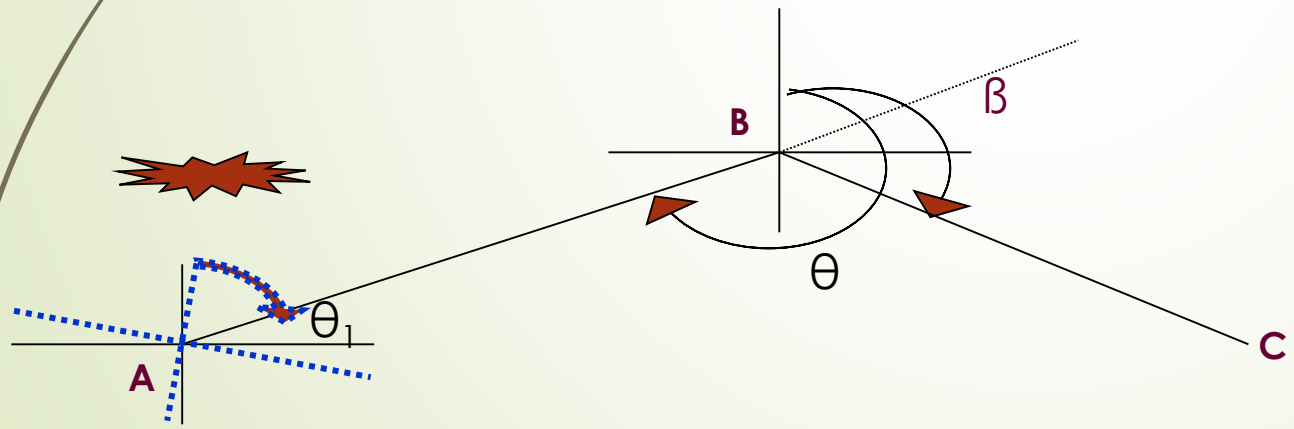
= 99^0 46'

5.4 Error in compass survey (Local attraction & observational error)

- Local attraction is the influence that prevents magnetic needle pointing to magnetic north pole
- Unavoidable substance that affect are
  - Magnetic ore
  - Underground iron pipes
  - High voltage transmission line
  - Electric pole etc.
- Influence caused by avoidable magnetic substance doesn't come under local attraction such as instrument, watch wrist, key etc

5.4 Local attractions

- Let Station A be affected by local attraction
- Observed bearing of AB = θ_1
- Computed angle B = $180^0 + \theta - ß$ would not be right.



5.4 Local attractions

- Detection of Local attraction
  - By observing the both bearings of line (F.B. & B.B.) and noting the difference (180^0 in case of W.C.B. & equal magnitude in case of R.B.)
  - We confirm the local attraction only if the difference is not due to observational errors.
- If detected, that has to be eliminated
- Two methods of elimination
  - First method
  - Second method

5.4 Local attractions

- First method
  - Difference of B.B. & F.B. of each lines of traverse is checked to not if they differ by correctly or not.
  - The one having correct difference means that bearing measured in those stations are free from local attraction
  - Correction are accordingly applied to rest of station.
  - If none of the lines have correct difference between F.B. & B.B., the one with minimum error is balanced and repeat the similar procedure.
  - Diagram is good friend again to solve the numerical problem.

Pls. go through the numerical examples of your text book.

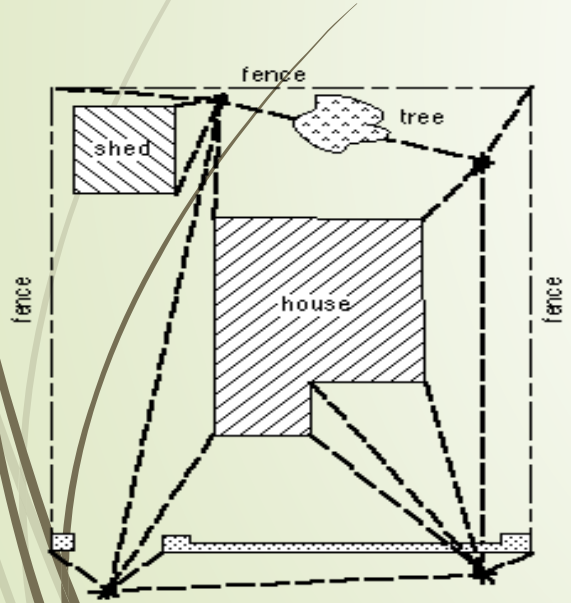
5.4 Local attractions

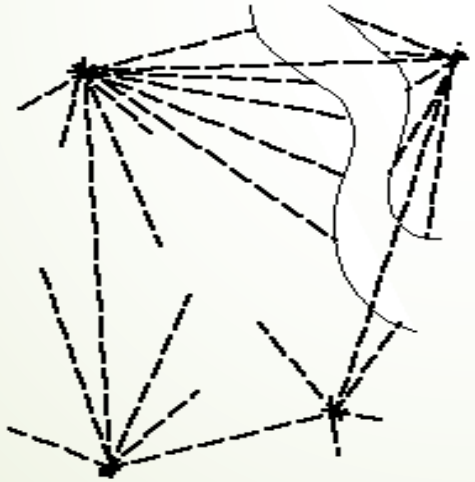
- Second method
  - Based on the fact that the interior angle measured on the affected station is right.
  - All the interior angles are measured
  - Check of interior angle – sum of interior angles = (2n-4) right angle, where n is number of traverse side
  - Errors are distributed and bearing of lines are calculated with the corrected angles from the lines with unaffected station.

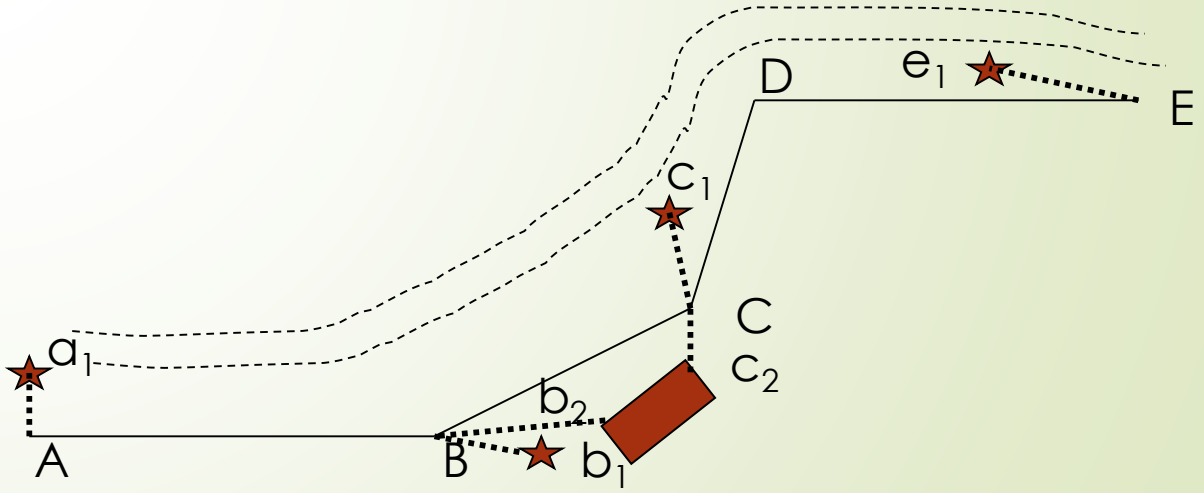
Pls. go through the numerical examples of your text book.

5.5 Traverse, types, compass & chain traversing

- Traverse
  - A control survey that consists of series of established stations tied together by angle and distance
  - Angles measured by compass/transits/ theodolites
  - Distances measured by tape/EDM/Stadia/Subtense bar

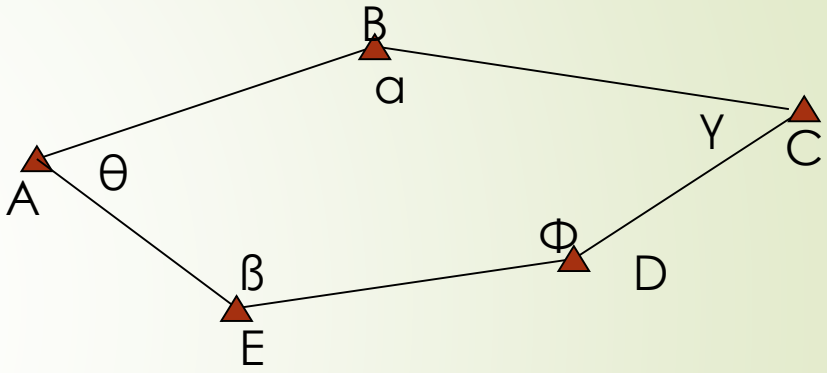


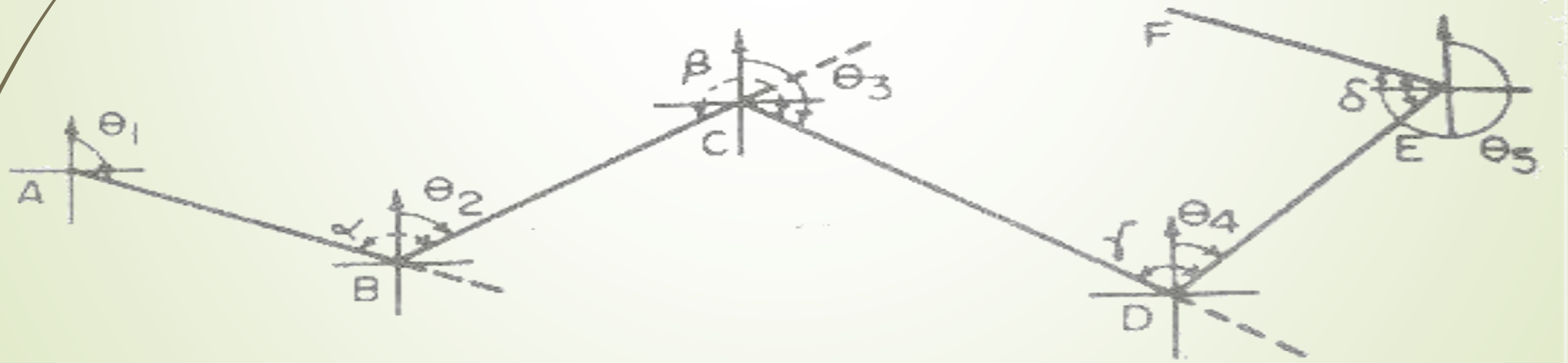




5.5 Traverse, types, compass & chain traversing

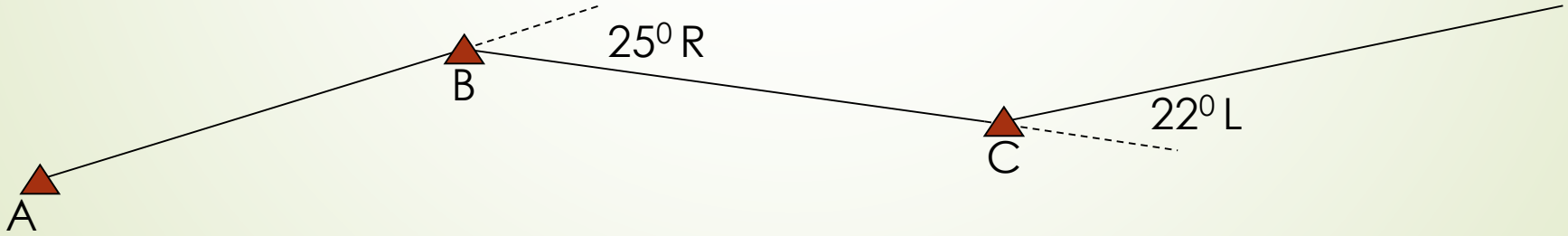
- Use of traverse
  - Locate details, topographic details
  - Lay out engineering works
- Types of Traverse
  - Open Traverse
  - Closed Traverse





5.5 Types of traverse

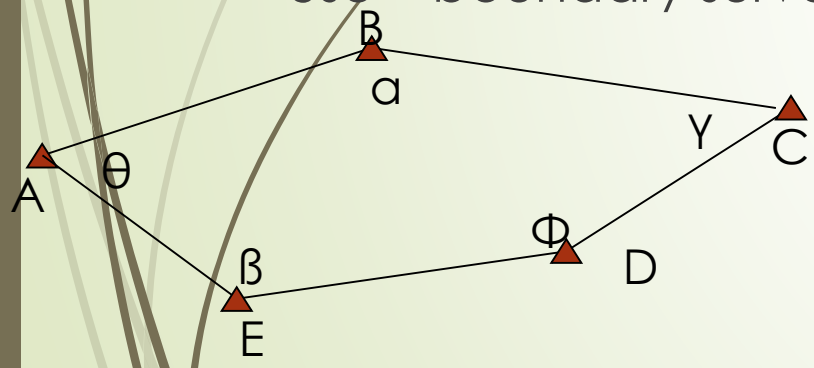
- Open traverse
  - Geometrically don't close
  - No geometric verification
  - Measuring technique must be refined
  - Use – route survey (road, irrigation, coast line etc..)



5.5 Types of traverse

Contd...

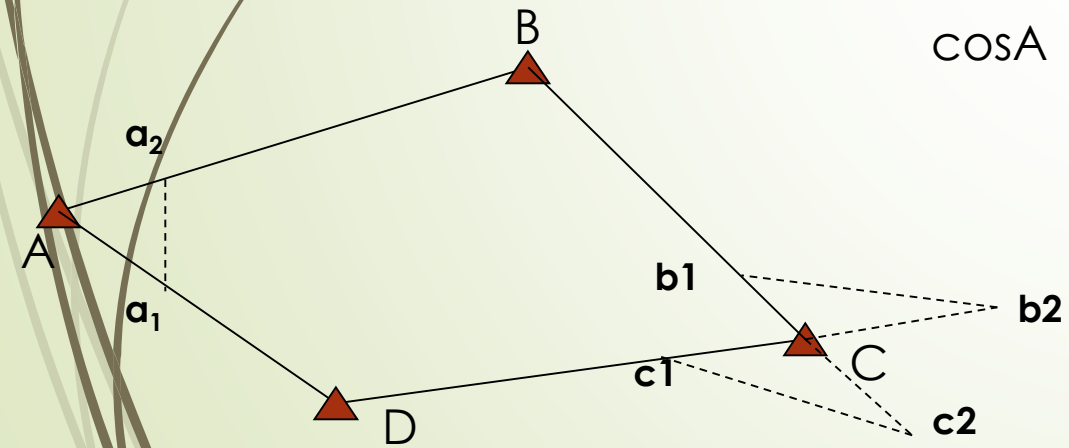
- Close traverse
  - Geometrically close (begins and close at same point)-loop traverse
  - Start from the points of known position and ends to the point of known position – may not geometrically close – connecting traverse
  - Can be geometrically verified
  - Use – boundary survey, lake survey, forest survey etc..



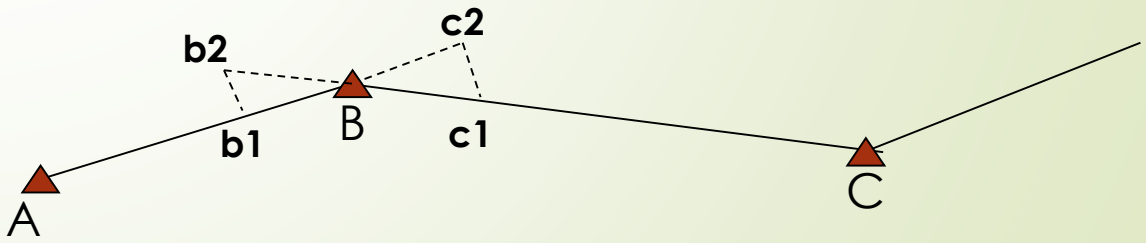
Co-ordinate of A &D is already known

5.5 Methods of traversing

- Methods of traversing
  - Chain traversing (Not chain surveying)
  - Chain & compass traversing (Compass surveying)
  - Transit tape traversing (Theodolite Surveying)
  - Plane-table traversing (Plane Table Surveying)



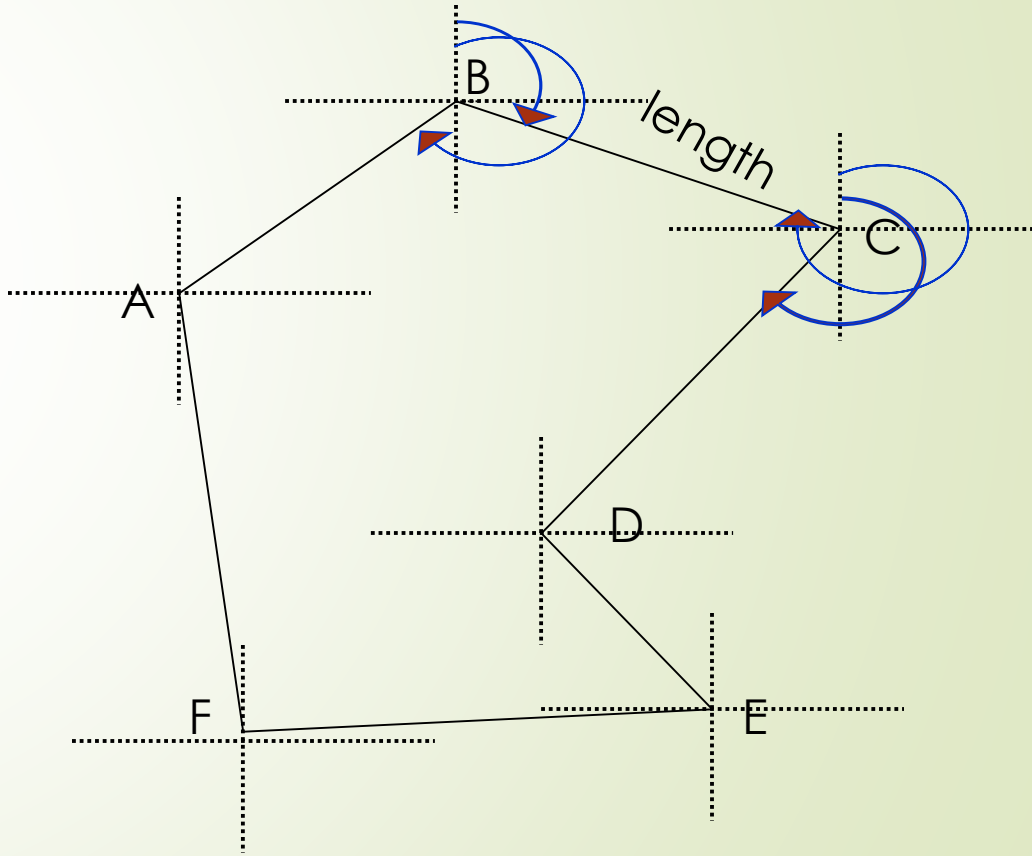
$$\cos A = \frac{Aa_2^2 + Aa_1^2 - a_2a_1^2}{2 \times Aa_2 \times Aa_1}$$



5.5 Methods of traversing

Contd...

- Chain & compass traversing (Free or loose needle method)
  - Bearing measured by compass & distance measured by tape/chain
  - Bearing is measured independently at each station
  - Not accurate as transit – tape traversing



5.5 Methods of traversing

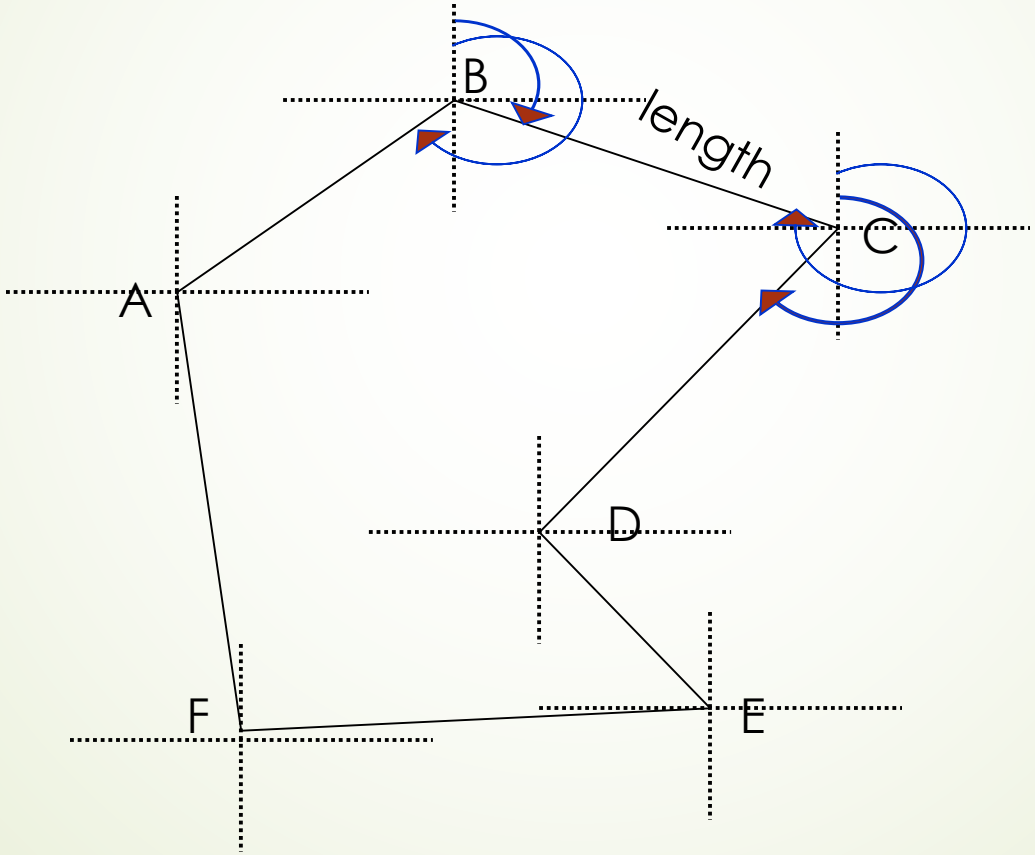
Contd...

- Transit tape traversing
  - Traversing can be done in many ways by transit or theodolite
  - By observing bearing
  - By observing interior angle
  - By observing exterior angle
  - By observing deflection angle

5.5 Methods of traversing

Contd...

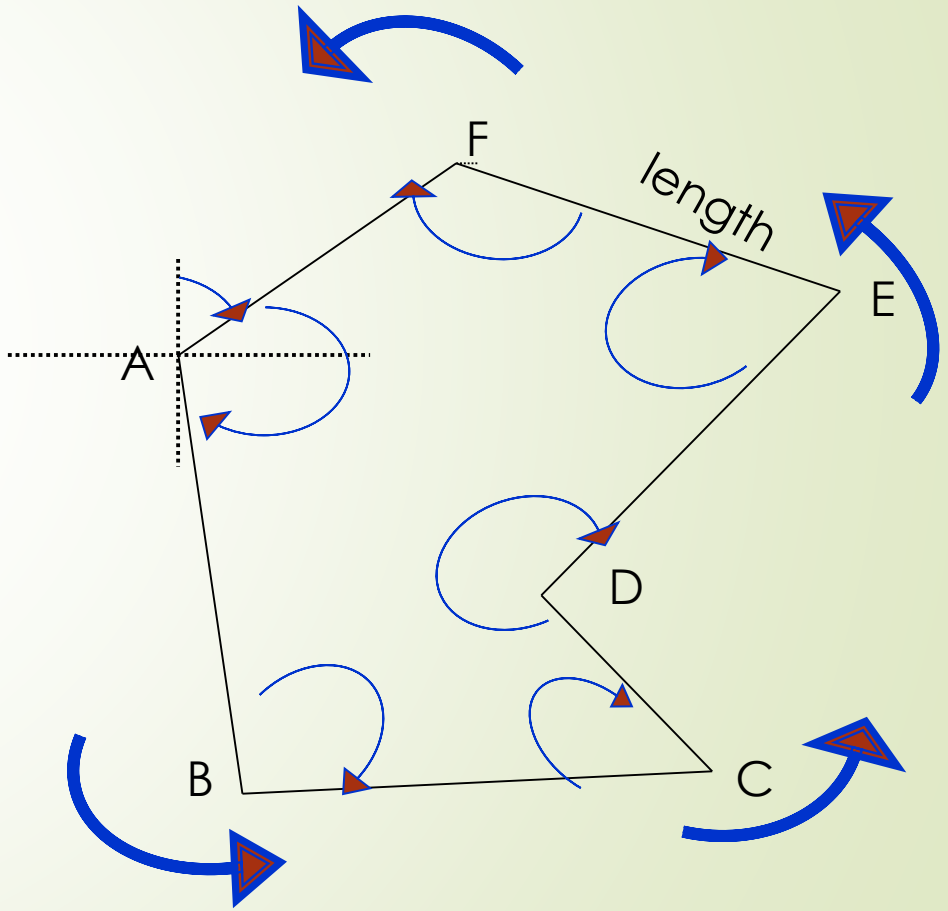
- By observing bearing



5.5 Methods of traversing

Contd...

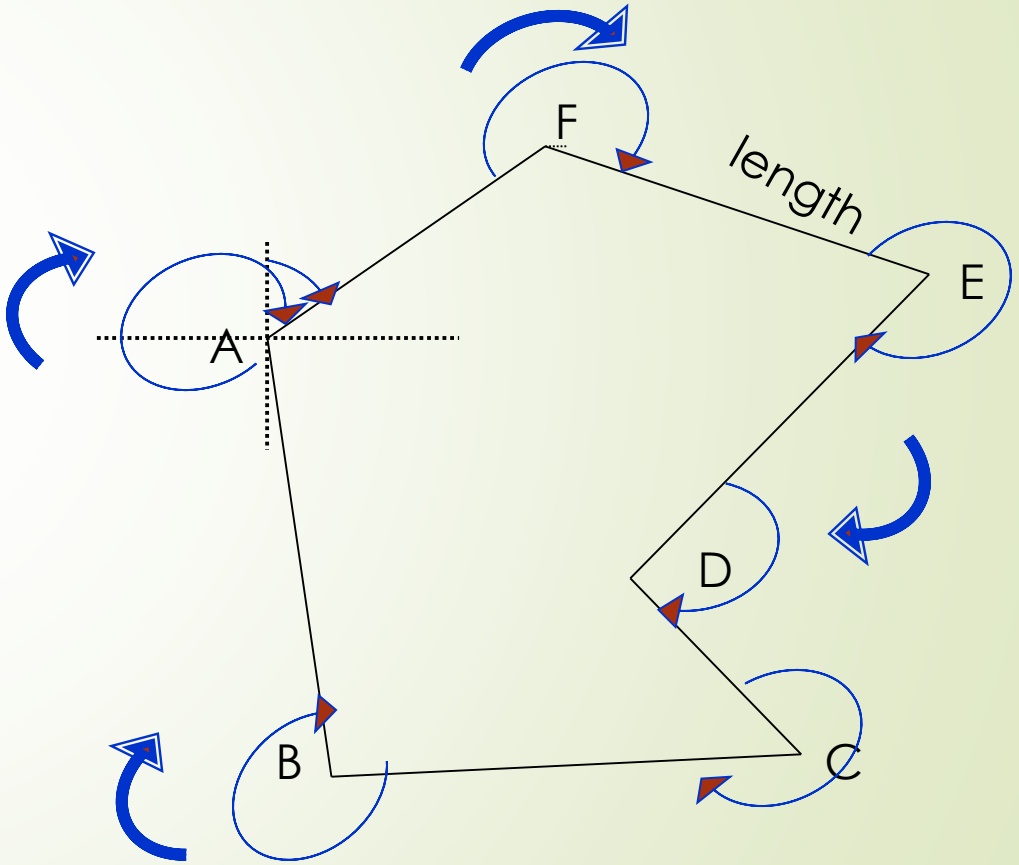
- By observing interior angle
  - Always rotate the theodolite to clockwise direction as the graduation of cirle increaes to clockwise
  - Progress of work in anticlockwise direction measures directly interior angle
  - Bearing of one line must be measured if the traverse is to plot by coordinate method



5.5 Methods of traversing

Contd...

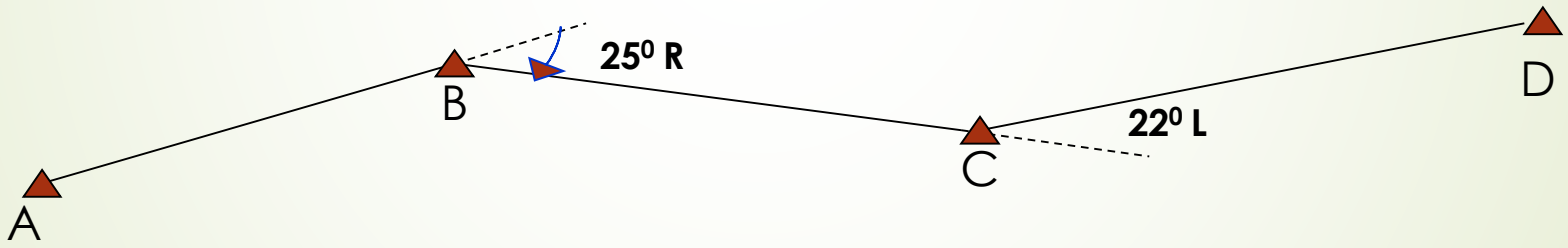
- By observing exterior angle
  - Progress of work in clockwise direction measures directly exterior angle
  - Bearing of one line must be measured if the traverse is to plot by coordinate method



5.5 Methods of traversing

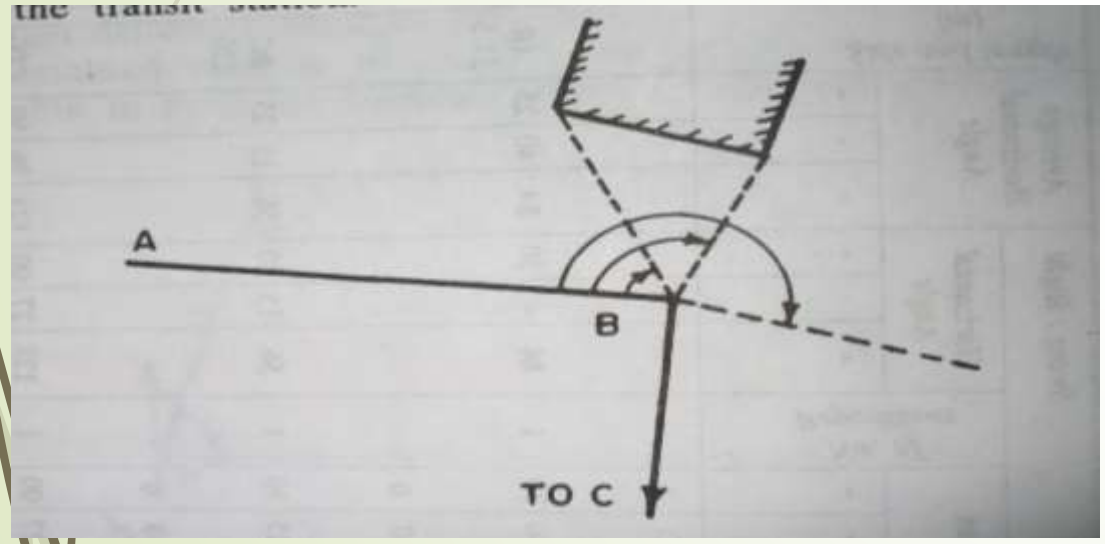
Contd...

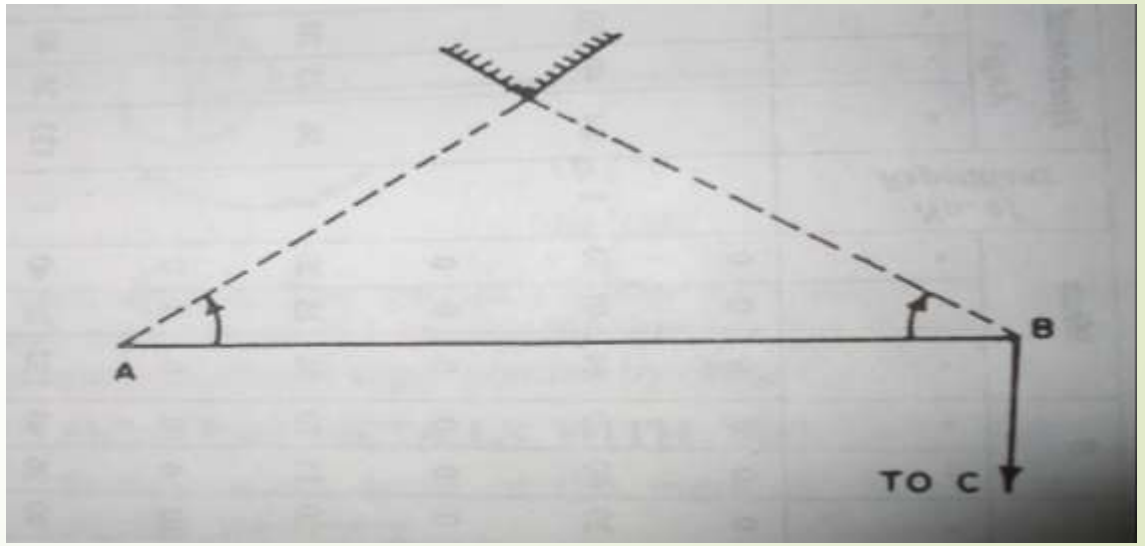
- By observing deflection angle
  - Angle made by survey line with prolongation of preceding line
  - Should be recorded as right (R) or left (L) accordingly



5.5 Locating the details in traverse

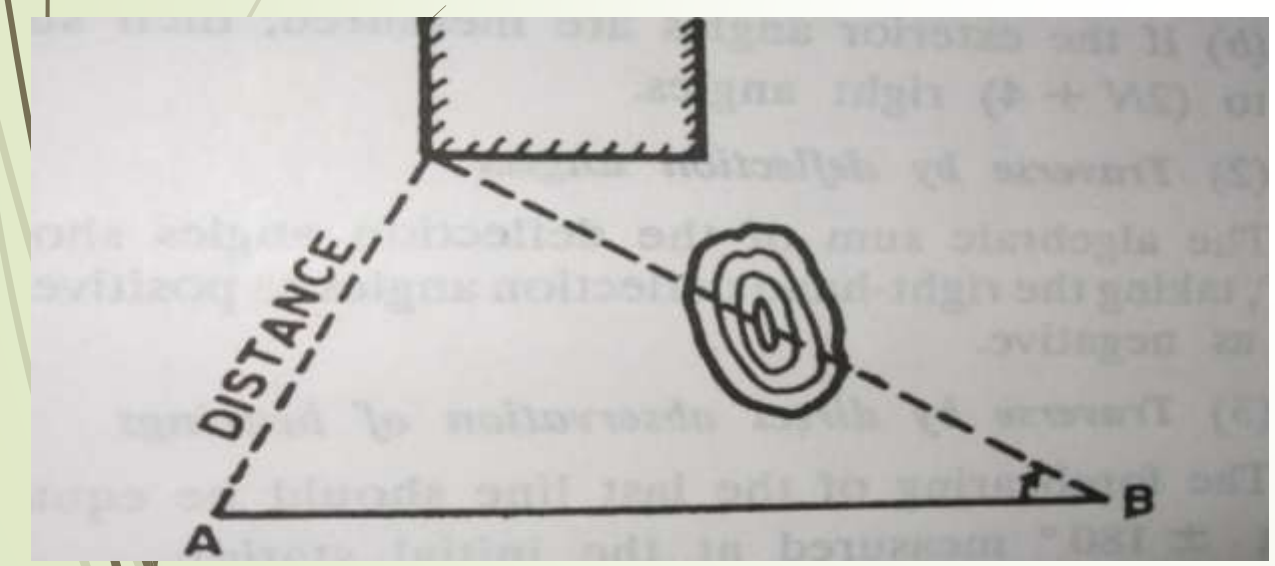
- By observing angle and distance from one station
  - By observing angles from two stations

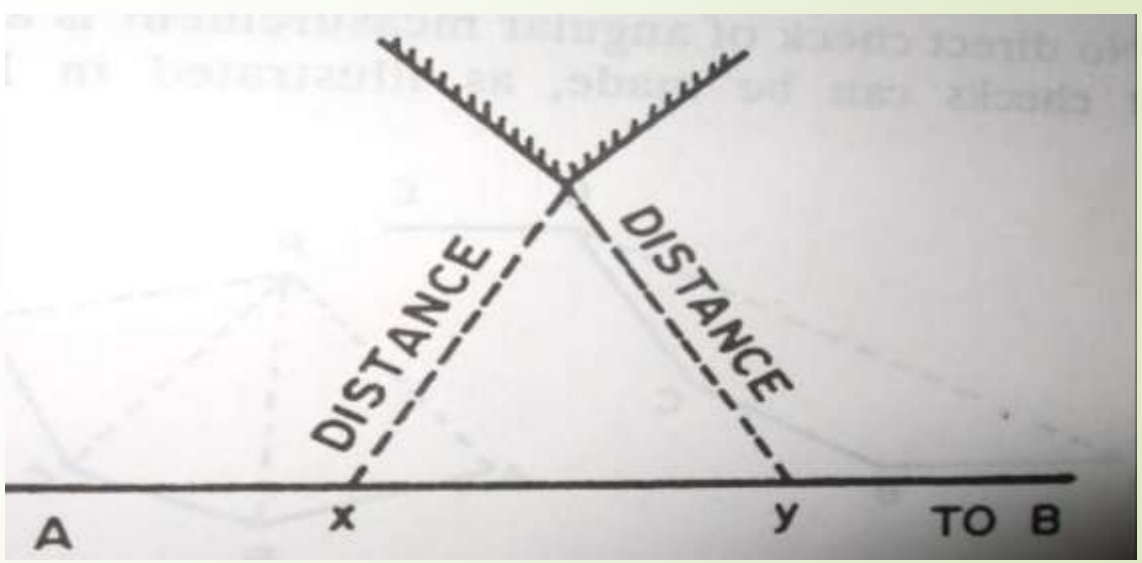




5.5 Locating the details in traverse

- By observing distance from one station and angle from one station
- By observing distances from two points on traverse line





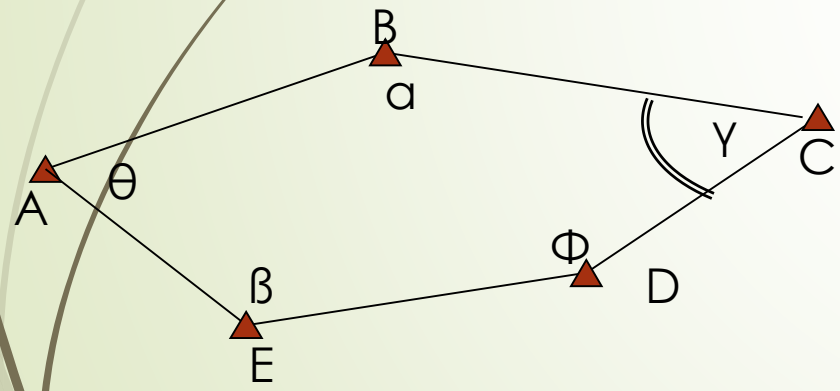
5.5 Checks in traverse

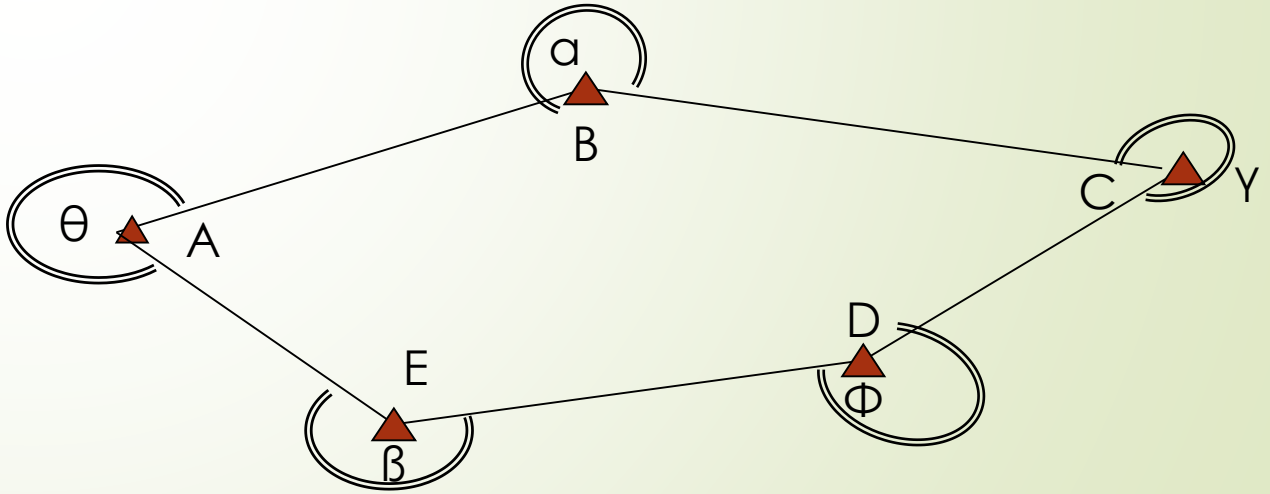
- Checks in closed Traverse
  - Errors in traverse is contributed by both angle and distance measurement
  - Checks are available for angle measurement but
  - There is no check for distance measurement
  - For precise survey, distance is measured twice, reverse direction second time

5.5 Checks in traverse

Contd...

- Checks for angular error are available
  - Interior angle, sum of interior angles = (2n-4) right angle, where n is number of traverse side
  - Exterior angle, sum of exterior angles = (2n+4) right angle, where n is number of traverse side

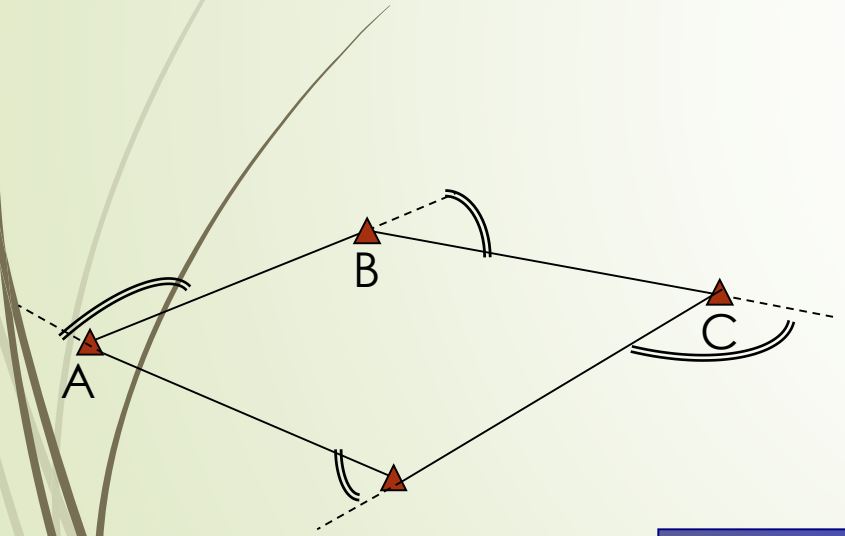


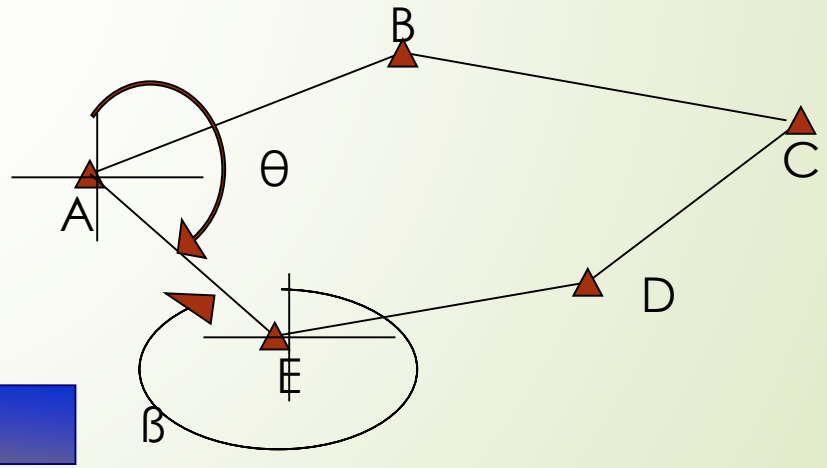


5.5 Checks in traverse

Contd...

- Deflection angle – algebric sum of the deflection angle should be 0^0 or 360^0.
- Bearing – The fore bearing of the last line should be equal to its back bearing ± 180^0 measured at the initial station.



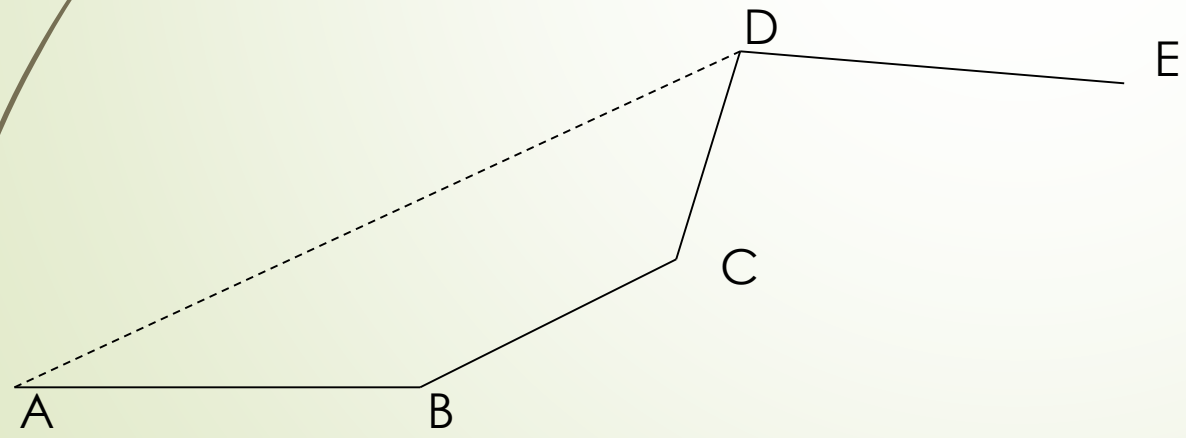


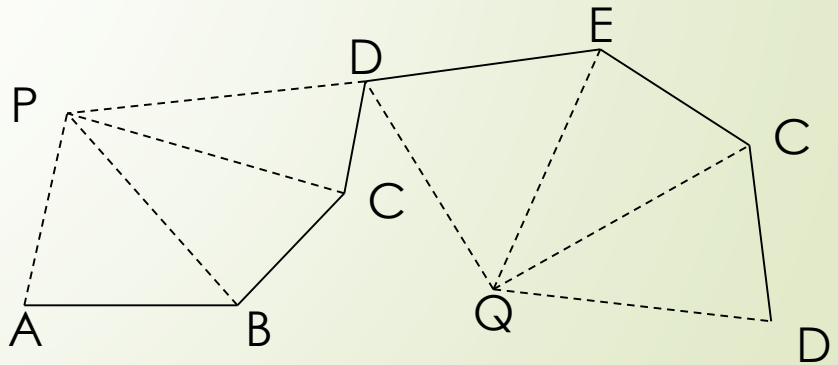
ß should be = θ + 180^0

5.5 Checks in traverse

Contd...

- Checks in open traverse
  - No direct check of angular measurement is available
  - Indirect checks
    - Measure the bearing of line AD from A and bearing of DA from D
    - Take the bearing to prominent points P & Q from consecutive station and check in plotting.





E

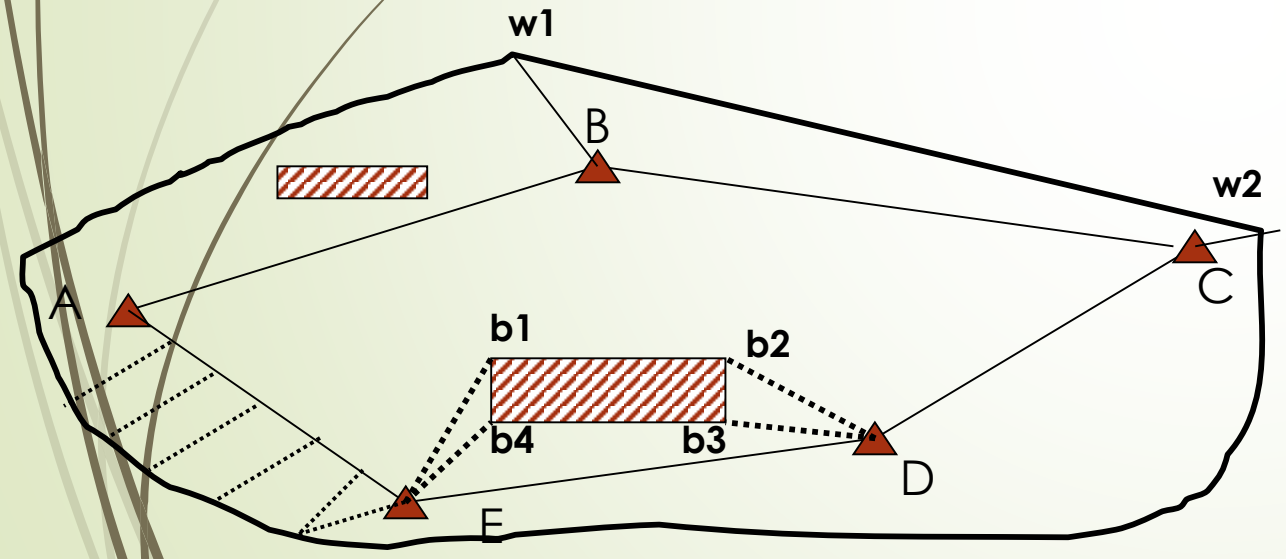
5.6 Field work and field book

- Field work consists of following steps
- Steps
  - Reconnaissance
  - Marking and Fixing survey station
  - First Compass traversing then only detailing
  - Bearing measurement & distance measurement
    - Bearing verification should be done if possible
  - Details measurement
    - Offsetting
    - Bearing and distance
    - Bearings from two points
    - Bearing from one points and distance from other point

5.6 Field work and field book

Contd...

- Field book
  - Make a sketch of field with all details and traverse in large size



Line	Bearing	Distance	Remarks
AB AE BA BC CB CD DC DE ED EA			

Line	Bearing	Distance	Remarks
Bw1 Cw2 Db2 Db3 Eb4 Eb1			

What is Chain SURVEY

- Chain survey is the easiest type of survey in which area to be surveyed is divided into a number of triangles.
- Because all the geometrical figures only whose shape and size are determined when the length of the sides are known.
- The perpendicular distance, called offsets, of various objects in the field from the line, are measured and recorded in a book called field book.
- From this records in the field book, the whole area can be plotted on a drawing sheet to a reduced scale.

Chain surveying instruments

- Chain
- Tape
- Arrows
- Ranging Rods
- Offset Staff
- Optical Square

Different types of Chain in Chain survey

- It is a steel wire with links connected by steel rings. It has brass handles at both ends. There are many types of chains of which the Engineer's Chain and Gunter's chain are commonly used in most of the country.
- The Engineers chain is 100 ft, long and Gunter's chain 66 ft. The Engineer's chain consists of 100 links each one a foot long and at every 10 links a tally is attached to facilitate reading. The Gunter's chain is also divided into 100 links each link is 7.92 inches.

- In a metric, a small brass ring is given in every one-meter interval. Brass tallies are also given at each 5.0 m length of the chain. Every tally has a complex shape which indicates 5, 10, 15m from any one side of the chain. However, metric chains are prepared in 20 m and 30 m length.

Metric Chain

Revenue chain

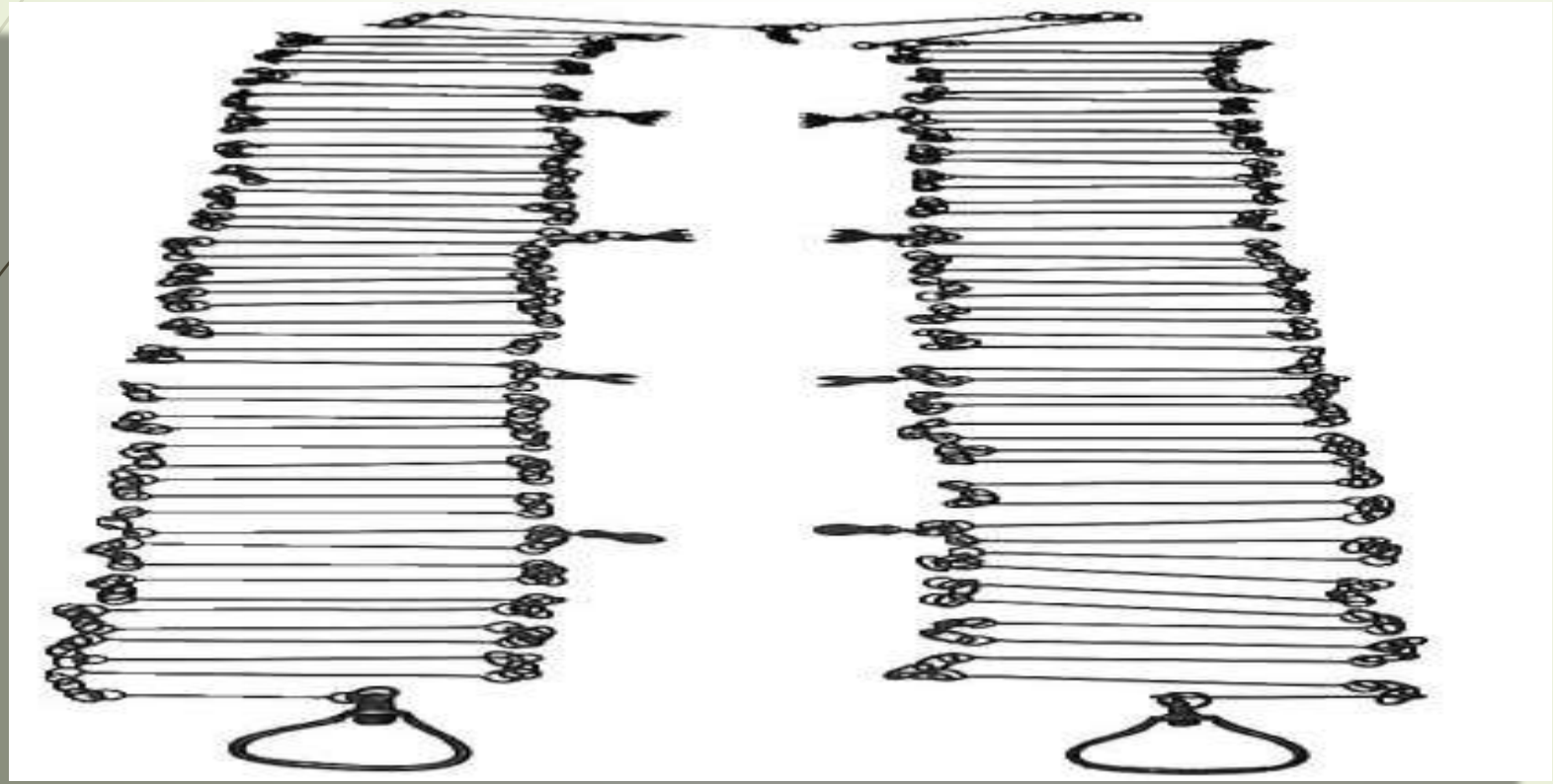
- Revenue chain is 33 ft long chain. It consists of 16 links. This chain is used for length measurements in feet & inches for s
- mall areas.

Steel Band or Band Chain

- Steel bands are preferred than chains as they are more accurate and easy to use. The disadvantages are they get broken down easily, and it's difficult to service in the field. The length of the tape is 20 and 30 m, 12 to 16 mm wide and 0.3 to 0.6 mm thick. They are numbered at every meter. Brass studs divide them at every 20 cm.

Engineer's Chain

Günter's Chain



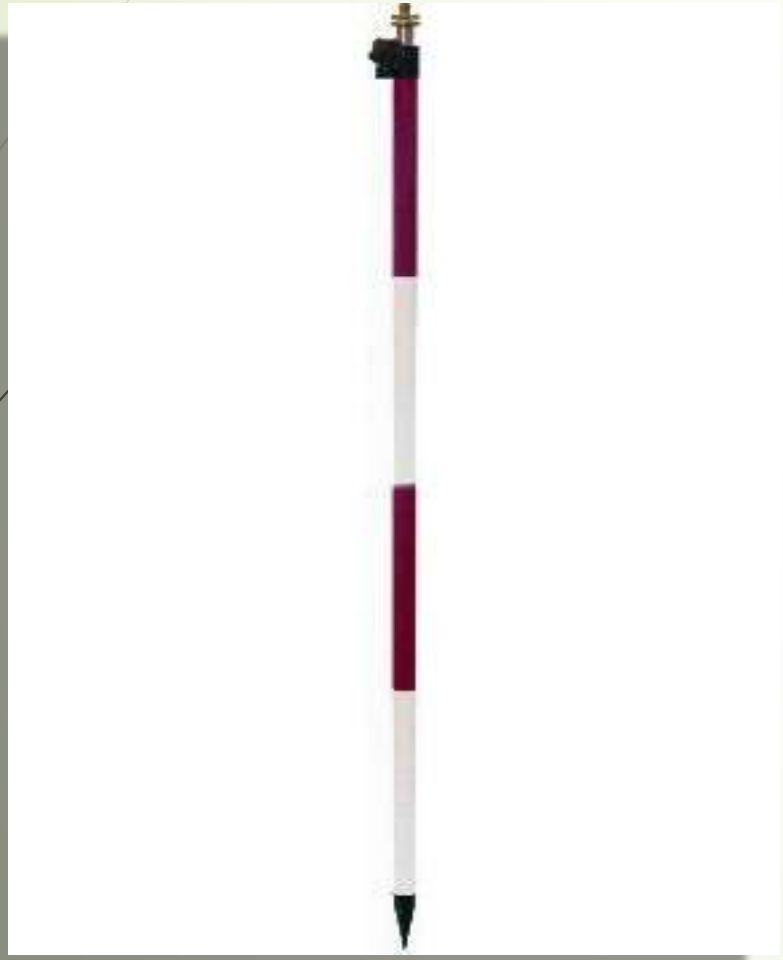
Instruments In Chain Surveying

Arrows

Arrows

Ranging Rods

Offset Rods



Pegs

- **Pegs:**These are wooden blocks of conical shape %sect in fixing stations.
- Arrow: They are of steel wire 15 inches long pointed at one end, and the other end is looped for a convenience of handling. They are used for making chain length on the ground.
- Ranging Rods: They are about 10 ft. Long, 1.5 inches diameter round or hexagonal wooden poles painted with black and white alternative bands Each band is of one-foot length.
- Offset Staff: They are wooden rods 10 feet long. Each foot is painted black and white alternately. They are used for measuring short lengths.

Optical Square

- It is used to find the foot of the perpendicular from a given object in the field to a given chain line to take the offset. It consists of a wedge-shaped hollow brass box of about 2 inches sides and 1.25 inches depth with a brass handle about 3 inches long fixed at the bottom. Two plane mirrors set at 45 degrees are fixed to the inclined sides of the box. There are two slits above these mirrors. In using it, a ranging rod is held at an object for. Which an offset is to be taken. A man is holding the optical square in his right-hand stands on the chain line. He looks towards the front ranging rod on the chain line with the open face of the optical square towards the ranging rod at the object. Now the man looks through one mirror while the other mirror is turned towards the object. Then he walks along the chain line forwards and backward till he sights the image of the ranging rod at the object in the mirror and the front ranging led in the slit in the same line. The position of the man on the chain line gives the exact point at which the perpendicular from the object meets the chain line.

Line Ranger

Procedure of Chain surveying

- Field work in Chain surveying: In includes reconnaissance. Selection of the station, measurement of lines and taking offsets of different objects in the field
- Reconnaissance: This is the preliminary survey in which to the survey party will examine the plot to be surveyed in order to know as to how the works can be executed in the best possible ways. The party will note all details like roads, buildings, canals, ditches, culverts and the difficulties and obstacles that may arise during the carrying out of the work. The party should locate the suitable points for stations by driving pegs. Sometimes a small triangle or a circle is made around the stations and the pegs are inserted into the centers. The party should then make a rough sketch of the plot showing the possible stations and from there the arrangement of different lines. It is important to give a north line on the rough sketch and though the sketch is not prepared according to the scale, it should represent the approximate positions of the different things in the plot and hence to be a good guide for further work.

- Stations: These are points on the ground fixed by driving pegs. Every station should be located with respect to three permanent objects i.e. the distances from these objects to the stations should be measured very accurately and recorded in the field book. The advantage of taking this measurement is that if in future the peg at the station is lost, then it can be located again by knowing descriptions and distances of these objects. The selection of a particular station depends upon the fallowing important considerations:

- The triangle should be a well-defined one, i.e. nearly equilateral triangle.
- Every main station should be visible from the other two
- There should be a minimum number of obstacles in Ranging and chaining
- The chain line should run near the boundary of the plot
- The chain line should be as few as possible
- The chain line should be over an approximately leveled ground In the case of chaining along the road, it is always better to run chains on one side of the road to avoid interruptions by vehicles.
- It is better not to cross the road frequently
- Offsets should not exceed one chain
- Check and tie lines should be provided in sufficient number so that all the main lines, of sets and other details, can be checked thoroughly

- Tie lines and check lines: A tie line is one which connects two points on the two main lines of the triangle. It helps in taking offsets of the objects falling within the triangle and which are too far away from the main line. A checking line is also a tie line which helps in checking the accuracy of the work after plotting in a drawing sheet. A checking line or tie line is never extended beyond the main lines.
- Measurement of lines and taking offsets: In Fig the main station A is located with respect to three permanent objects and a ranging rod is fixed to the station. One ranging rod is fixed at main station B and another at an intermediate point in between A & B. The three rods will be in a straight line when only the intermediate rod is visible if a man looks from A to B. Now measurement of line AB is taken by the chain. The chain should be properly stretched so that there is no sag in it. As the measurement proceeds, offsets are taken on both side's of the line AB and recorded in the field book. In this way, all the lines including tie and check lines are measured and offset taken and recorded in the field book.

Advantages and disadvantages of chain Survey

- This type of survey work is suited for a small plain ground
- It requires simple instruments
- Plotting of maps is very simple and easy

- But this type of surveying is not suitable for undulation land where chaining operation is tedious and subject to errors. This method is not generally recommended for a crowded city with a large number of buildings and obstacles because it cannot be divided into well-conditioned triangles. In the case of route surveying.
- i.e the survey work of a road, irrigation canal, railways, water and sewer lines, tunneling etc, this method is not recommended at all.

Thank you