Surveying-I

CE-205 (T)

Lecture 3

Chain and Compass Traversing

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Compass Traversing

- A type of survey that involves both linear as well as angular measurements is known as Compass Traversing.
- In Traverse surveying the directions of survey lines re fixed by angular measurements and not by forming a network of triangles as done in chain surveying.
- A traverse survey is one in which framework consist of a series of connected lines, the length and directions of which are measured with a chain or tape and angular instruments respectively.

- The routine of changing and offsetting is the same as in chain surveying.
- The running of check lines is not necessary.

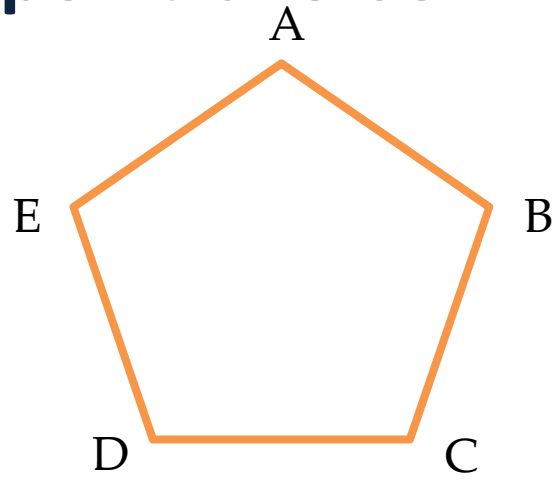
Types of Traverse

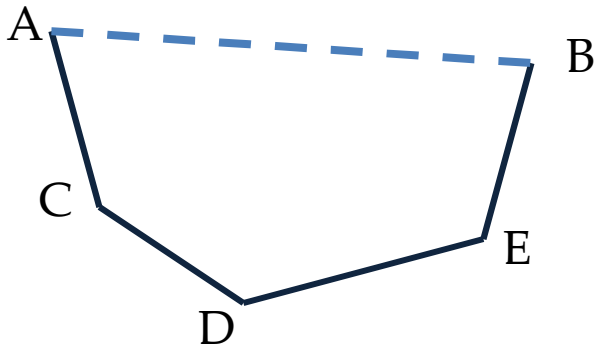
- There are generally two types

1) Closed traverse **2) Open traverse**

1) Closed traverse

- A traverse is said to be closed when a complete circuit is made i.e when it returns to the starting point forming a closed polygon OR when it begins and ends at points whose positions on plan are known.
- The work may be checked or "balanced".
- Suitable for locating bounders of lakes, woods etc and for the survey of moderately large area.





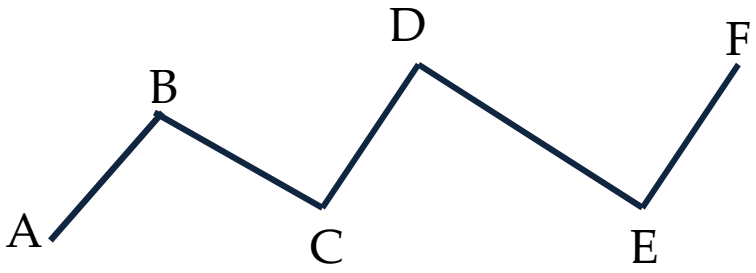
Types of Traverse

- There are generally two types

1) Closed Traverse 2) Open Traverse

2) Open Traverse

- A traverse is said to be open or unclosed when it does not form a closed polygon.
- It consist of connecting lines extending in the same general direction and not returning to the starting point.
- Similarly it does not start and end as points whose positions on plan are known.
- It is suitable for the survey of long narrow strip eg River, coast line, road, railway etc.



Method of Traversing

- The different methods by which the direction of the survey lines may be determined are as follows:

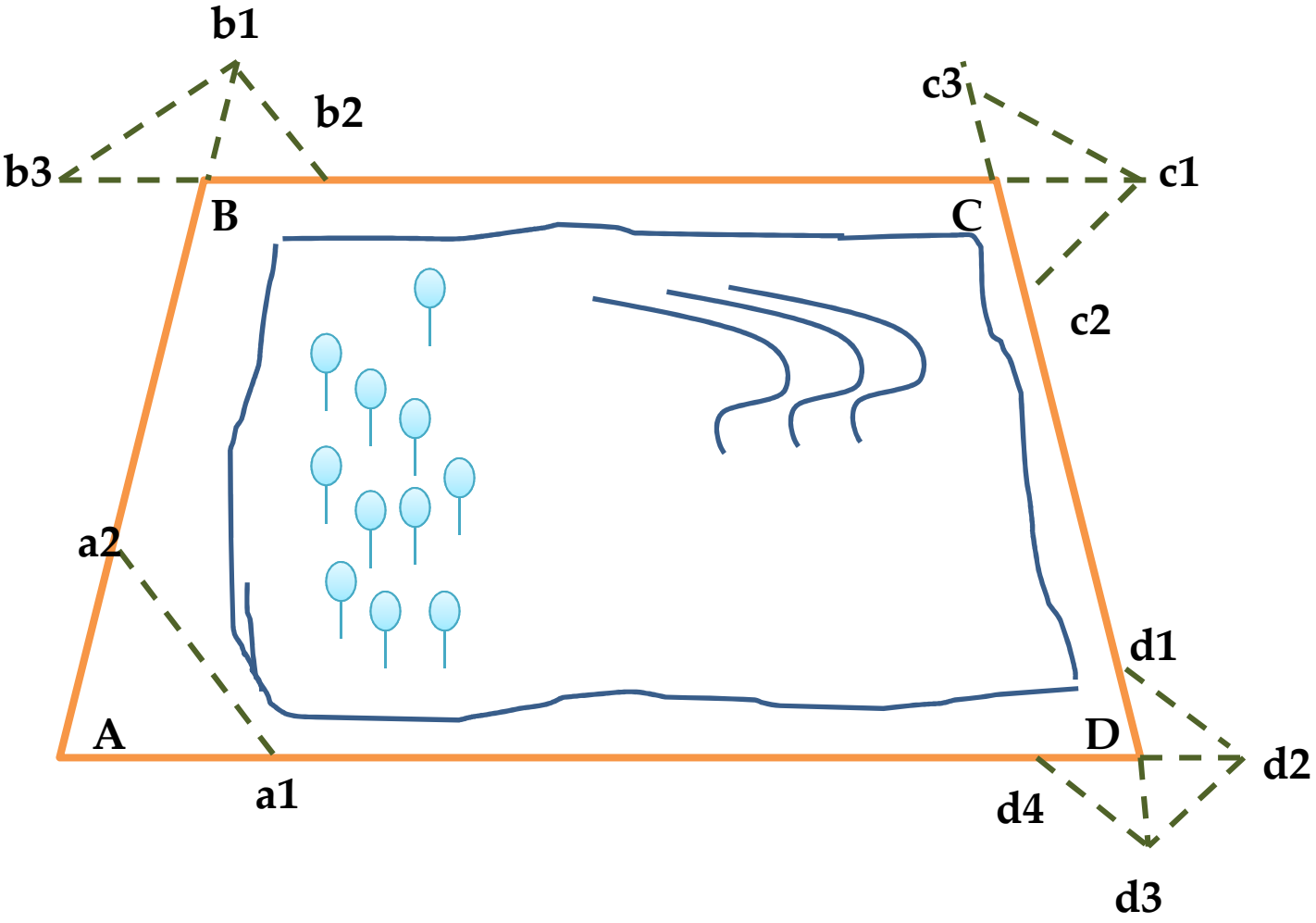
1) By the Chain angles.
2) By the free or loose needle method.
3) By the fast needle method.
4) By the measurement of angles between successive lines.

1) Method of Chain Angles or Chain Traversing

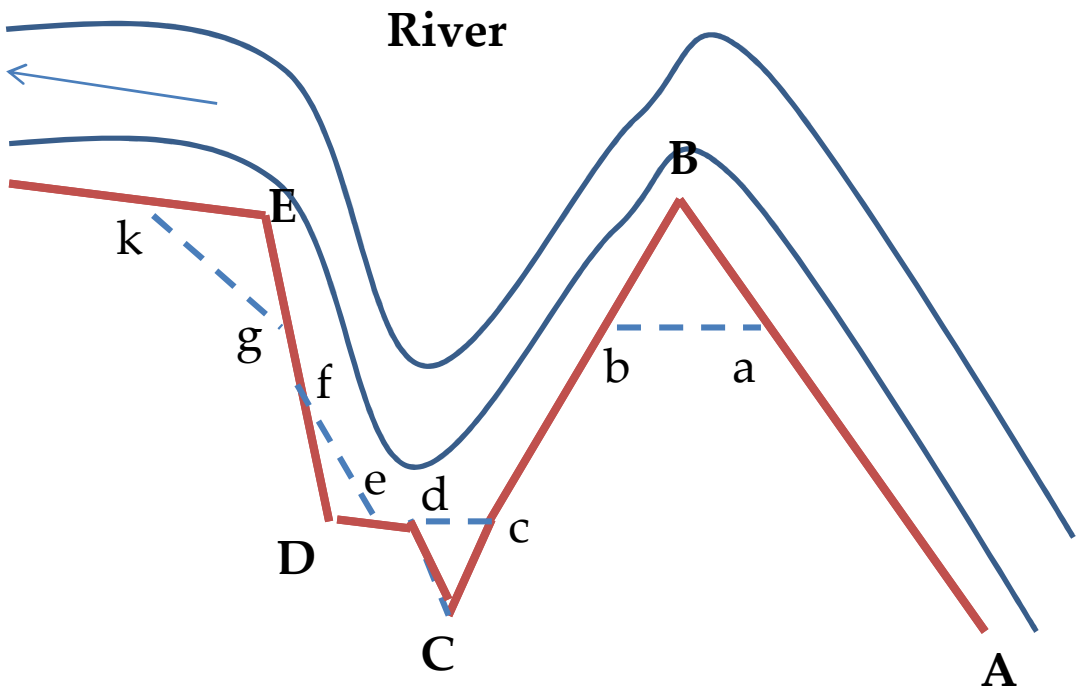
- In this method entire work is done with the chain or tape only.
- When survey of an area such as lake, wood, standing crops etc is required, so area cannot be divide into triangles.
- A traverse is therefore to be run round the area and in the absence of an angler instrument, the angles between the successive lines are fixed by measuring the lines with a chain.
- Angles fixed by measurement are known **as Chain Angles.**

1) Chain Angles or Chain Traversing

- The angles at the station are fixed by internal tie lines such a1,a2, or external such as b1,b2, c1,c2, d1,d2.
- The angle at A is fixed by measuring the distance a1 and a2 suitably chosen on AD and AB, b3 to check accuracy.



In open traverse
Angeles at B and C fixed by ab and cd and so on.



2) By the Free or Loose needle method

- In this method an angular instrument such as Compass or Theodolite is set up at each of the successive stations and the bearing of each line is taken with reference to the magnetic meridian and not with reference to the adjacent lines
- Hence the errors are not cumulative but compensating.

- The result obtain are not generally so accurate as those obtained by methods 3 and 4

3) By the fast needle method

- In this method a theodolite is used for determine the bearings of each line.

- The method of observing bearings will be describe later.

4) By the measurement of angles between successive lines

- In this method a theodolite is used for measurement of angles.
- The horizontal angles measured in a traverse may be 1) included angle 2) deflection angles between successive lines.

- The method of included angles is the most accurate method and is generally used for large surveys and accurate work.

Instruments for measurement of Angles

- In order to plot a survey line on a paper, its Length and Direction must be known.
- The direction of a survey line may be defined either
- 1) By horizontal angle between the line and line adjacent to it (i.e between successive points) **OR**
- 2) By the angle called BEARING, between the fixed line of reference (called Meridian) and the line.

Instruments for measurement of Angles

- The Instruments used for angular measurements are

  1) Compass 2) Theodolite

- We will talk about Compass that only measures the bearings of a line.

- **The Compass** does not measure the angle between two lines directly, but measure the angle between the magnetic meridian and the line.
- **The Theodolite** measures the angle between two line directly and also bearing of a line.

Compass

- The compass consists essentially
  - (a) a magnetic needle
  - (b) a graduated circle
  - (c) a line of sight

- We have two types of compass
  - 1) Prismatic compass
  - 2) Surveyor Compass

Prismatic compass

- Prismatic Compass comprises of a magnetic needle attached to the circular ring made up of aluminium.
- The needle is on the pivot and will orient itself in the magnetic meridian Therefore the north and south ends of the ring will be in this direction.
- The line of sight is defined by the objective vane and the eye slit, both attached to the compass box.
- The object vane consist of a vertical hair attached to a suitable frame while the eye slit consist of a vertical slit cut in to the upper assembly of the prism unit, both being hinged to the box.

Prismatic compass

- When an object is sighted, the sign vanes will rotate with respect to the N-S end of ring through an angle which the line makes with the magnetic meridian.

- A triangular prism is fitted below the eye slit, having suitable arrangement for focusing to suit different eye sight.

- The readings increase in clockwise direction from 0^o at South end 90^o at West end 180^o at North end and 270^o at East end.

Using and Adjustments of Prismatic Compass

- The compass may be held in the hand but for better result it is usually mounted on a light tripod which carries vertical spindle in a ball and socket joint to which the box is screwed.

- The following are the adjustments usually necessary in the prismatic compass:
- Centering
- Leveling
- Focusing the prism.

Adjustments of Prismatic Compass

CENTERING:

- The center of the compass is placed vertically over the station point by dropping a small piece of stone below the center of the compass, it falls on the top of the peg marking that station.

LEVELLING:

- By means of ball and socket arrangement the Compass is then leveled the graduated ring swings quite freely. Clamped then level.

FOCUSSING THE PRISM :

- The prism attachment is slid up or down focusing till the readings are seen to be sharp and clear.

Observing Bearing:

The compass centered over station A of the line AB and is leveled.

- Having turned vertically the prism and sighting vane, raise or lower the prism until the graduations on the rings are clear and look through the prism.
- Turn the compass box until the ranging rod at the station B is bisected by hair when looked through the prism.
- Turn the compass box above the prism and note the reading at which the hair line produced appears to cut the images of the graduated ring which gives the bearing of line AB.

Surveyor Compass

Assignment

Bearing of a line

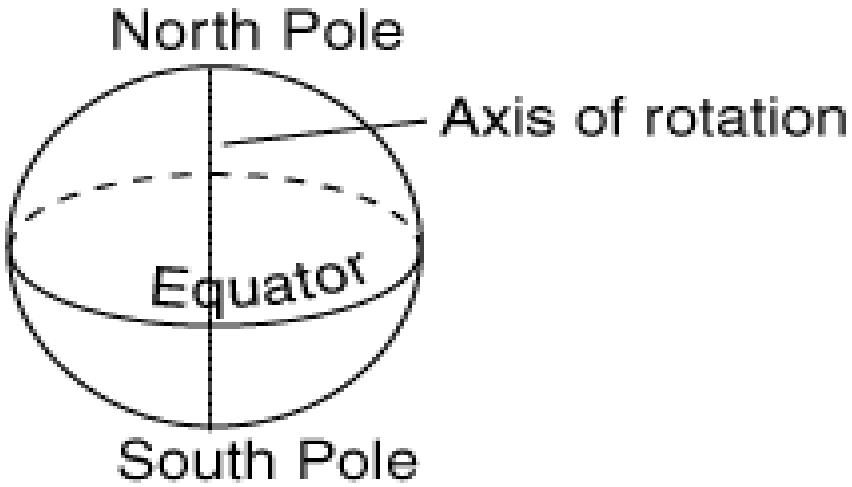
- The angle of any line with respect to some reference direction or meridian is known as Bearing of a line.

- The reference direction employed in surveying may be
    1) True Meridian
    2) Magnetic Meridian
    3) Arbitrary Meridian

True bearing

- The point of intersection of the axis of the earth and the earth surface is known as north and south geographical poles and the intersection of north and south geographical poles is known as True Meridian,

- The horizontal angle between the line and the true meridian is known as True Bearing.

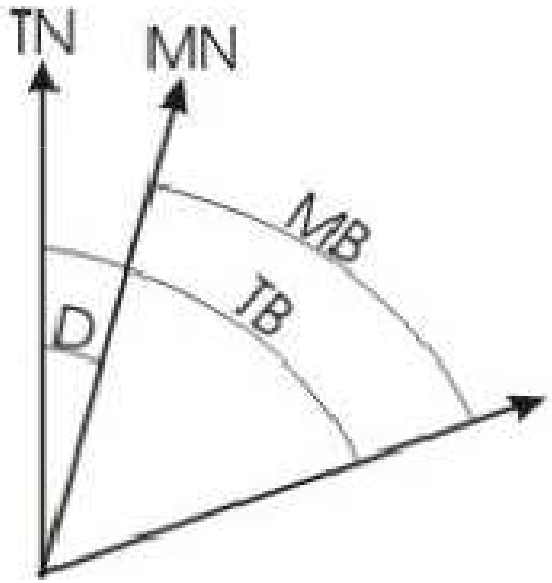


Magnetic Bearing

- The direction indicated by a freely suspended magnetic needle is known as Magnetic meridian and
- The horizontal angle between any line and magnetic meridian is known as Magnetic meridian

Arbitrary Bearing

- Any fixed point can be taken as Arbitrary Meridian and the angle is called Arbitrary Bearing.



Types of North

True North:

The direction of North pole from the observer

Grid North:

The direction in which the grid lines point towards the top of map.

Magnetic North:

It is the direction in which the compass needle points

towards the magnetic pole.

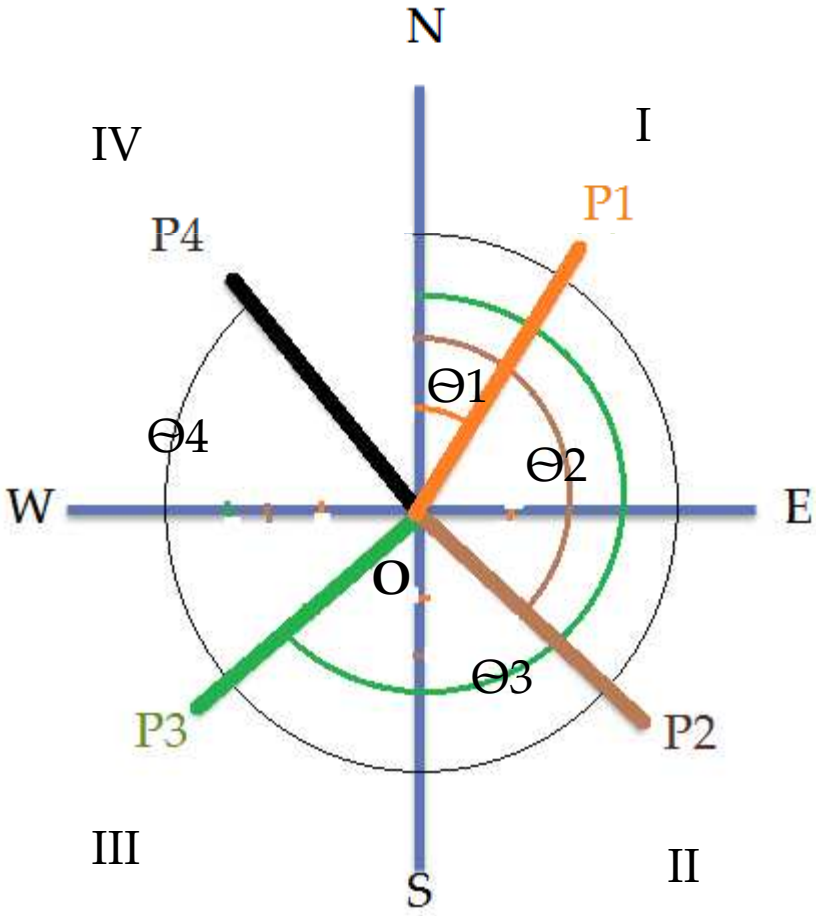
Designation of Bearing

- There are two systems of notations used to express the bearings

1) Whole circle bearings 2) Quadrantal bearing

1) Whole circle Bearing

- In this system bearing of a line is always measured in Clockwise direction from north point of the reference meridian
- Then angle measured is known as Whole circle bereaving (W.C.B)
- It may have value from 0^o to 360^o.
- In this system the angle is completely specified by the value of angle only
- The bearings observed with prismatic compass are the W.C.B.



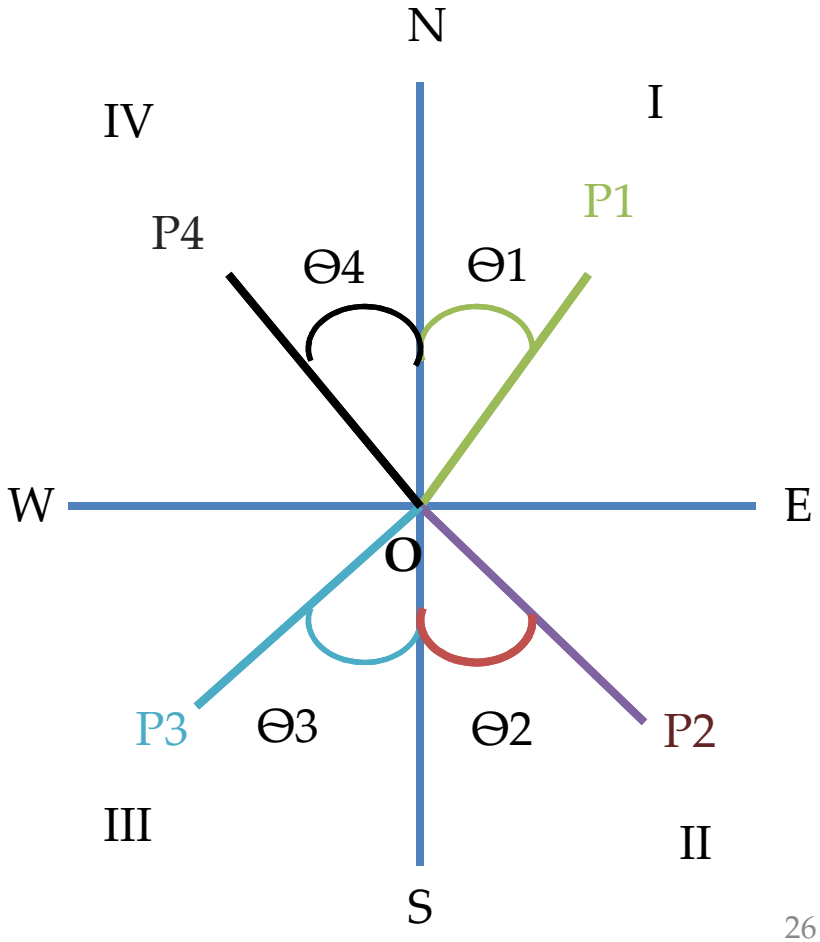
Designation of Bearing

- There are two systems of notations used to express the bearings

  1) Whole circle bearings 2) Quadrantal bearing

- **<u>2) Quadrantal bearing</u>**
- In this system the angle is measured C.W or A.C.W from north or south which ever is nearer to east or west.
- The whole circle is divided into 4 quadrants by two per lines, N,S and other E,W.
- Designation of quadrants:
- There are two notations to express the quadrant bearing of a line

  (a) Θ NE and (b) N Θ E.



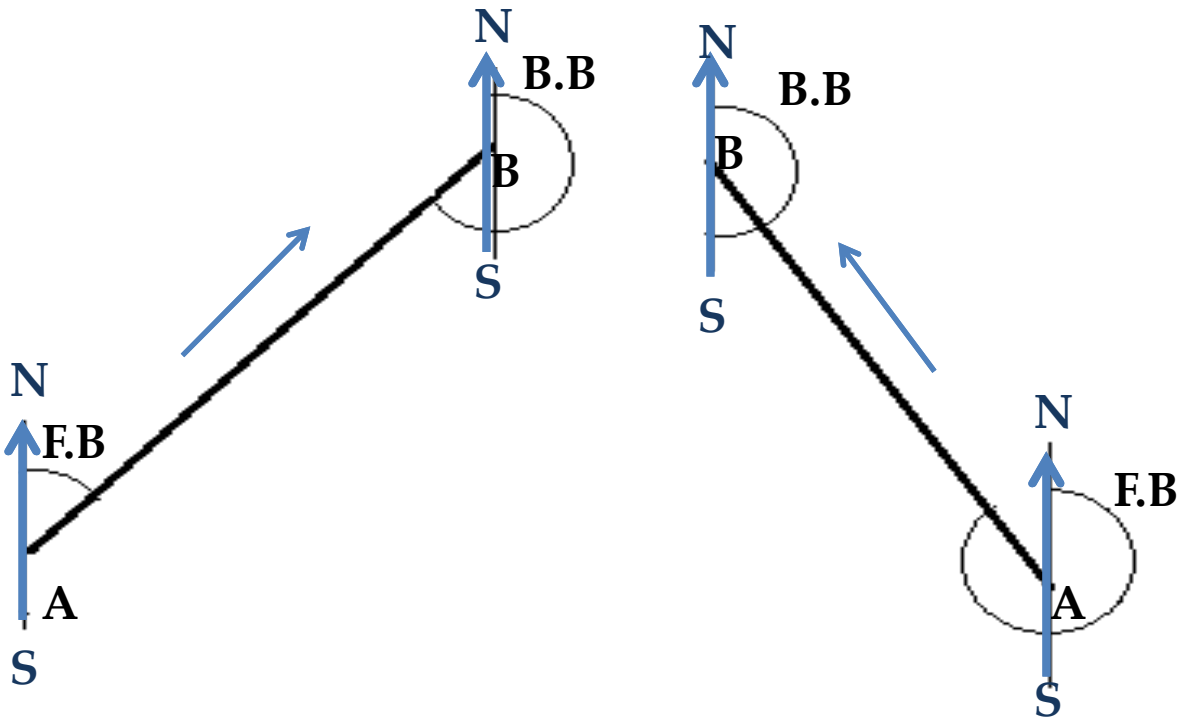
Reduced bearings

- When W.C.B of a line exceeds 90^o, it must be reduced to corresponding angle less than 90^o, which has the same numerical value of the trigonometrically functions.
- This angle is known as Reduced Bearings (R.B).
- To obtain whole circle bearing following table may be used.

CASE	W.B.C between	Rule for R.B	Quadrant
I	0^o to 90^o	W.C.B	N.E
II	90^o to 180^o	180^o – W.C.B	S.E
III	180^o to 270^o	W.C.B – 180^o	S.W
IV	270^o to 360^o	360^o – W.C.B	N.W

Fore bearing and Back Bearing

- Every line has 2 bearings, one observed at each end of the line.
- The bearing of a line in the direction of the progress of survey is called Fore or Forward Bearing (F.B).
- While its bearing in opposite direction is called Back or Reverse bearing (B.B)



Fore bearing and Back Bearing

- The B.B and F.F differ exactly by 180^o

  $F.F - B.B = 180^o$

In W.C.B

- The B.B may be calculated by the following rule:

  $B.B \text{ of a line} = F.B \pm 180^o$

Use plus (+) sign for $F.B > 180^o$ and
Use minus (-) sign for $F.B < 180^o$

IN Qaudrantal:

- The F.B and B.B are numerically equal but with opposite letters

E.G F.B = N 30^o S , the B.B- S 30^o E

Example on Bearings

Example 1:

Convert the following W.C.B to Quadrantal Bearing.

(a) 68° 32’ **(b)** 132°12’

(c) 236° 37’ **(d)** 334° 52’

(a) 68° 32’

W.C.B = 68° 32’

Quadrantal Bearing = N 68° 32’ E

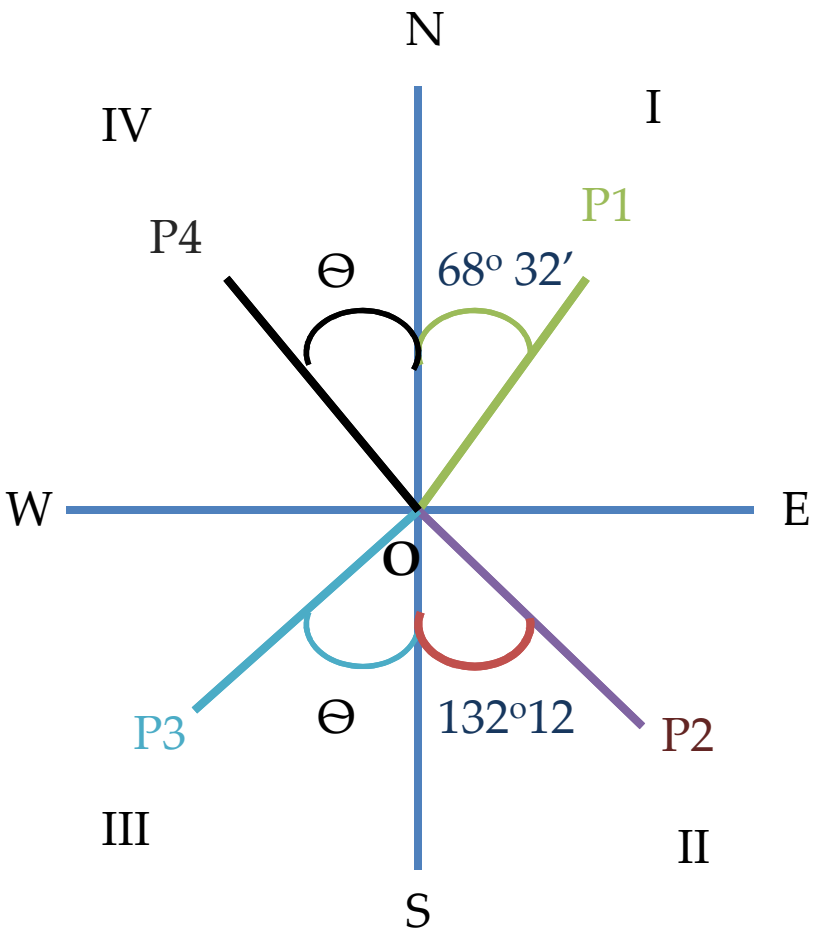
(b) 132°12’

W.C.B = 132°12’

Quadrantal Bearing = 180° - 132°12’

= 47° 48’ S.E or

= S 47° 48’ E



Example 2:

Convert the following Reduced bearings to W.C.B.

(a) N 36°16’ E **(b)** S 47° 26’ W

(a) N 36°16’ E

R.B = N 36°16’

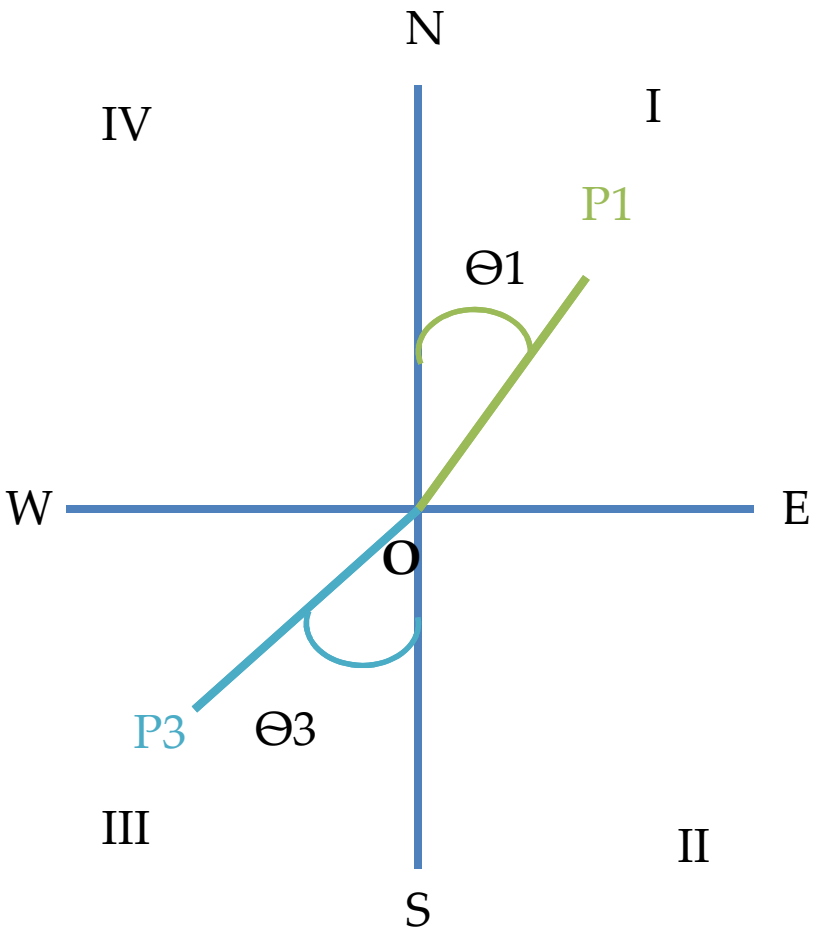
W.C.B = R.B = 36°16’

(b) S 47° 26’ W

R.B = S 47° 26’

W.C.B =180° + 47° 26

= 227° 26’



Example: 3

The following are the observed Fore Bearings of line.

(a) AB = 38° 14' , (b) BC= 318° 26'

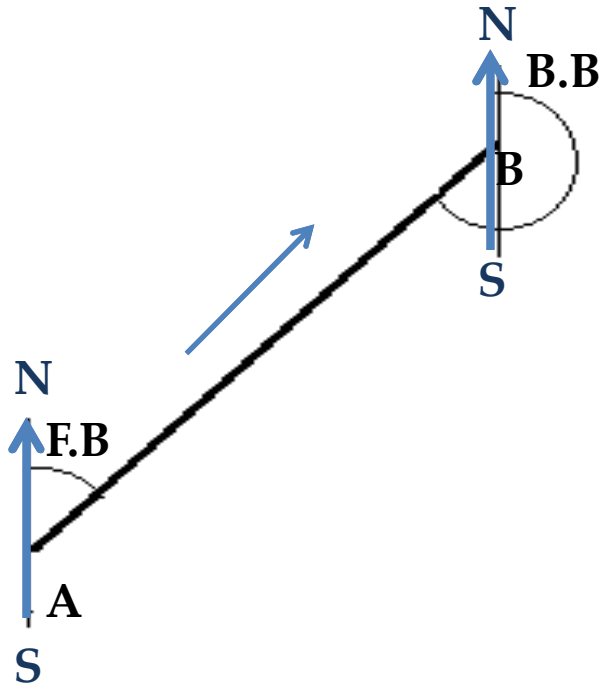
Find their Back bearings

Solution:

F.B of AB =38° 14'

B.B of AB = 38° 14' +180°

=218° 14'

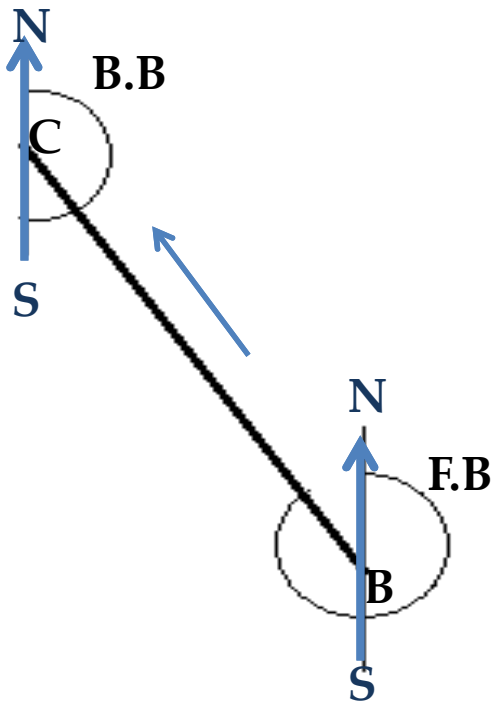


Solution:

F.B of BC =318° 26'

B.B of AB = 318° 26' -180°

= 138° 26'



Example: 4

The fore bearing of line are

(a) AB, S 43° 18’ E **(b)** CD, N 65° 24’ W

Find their Back bearings.

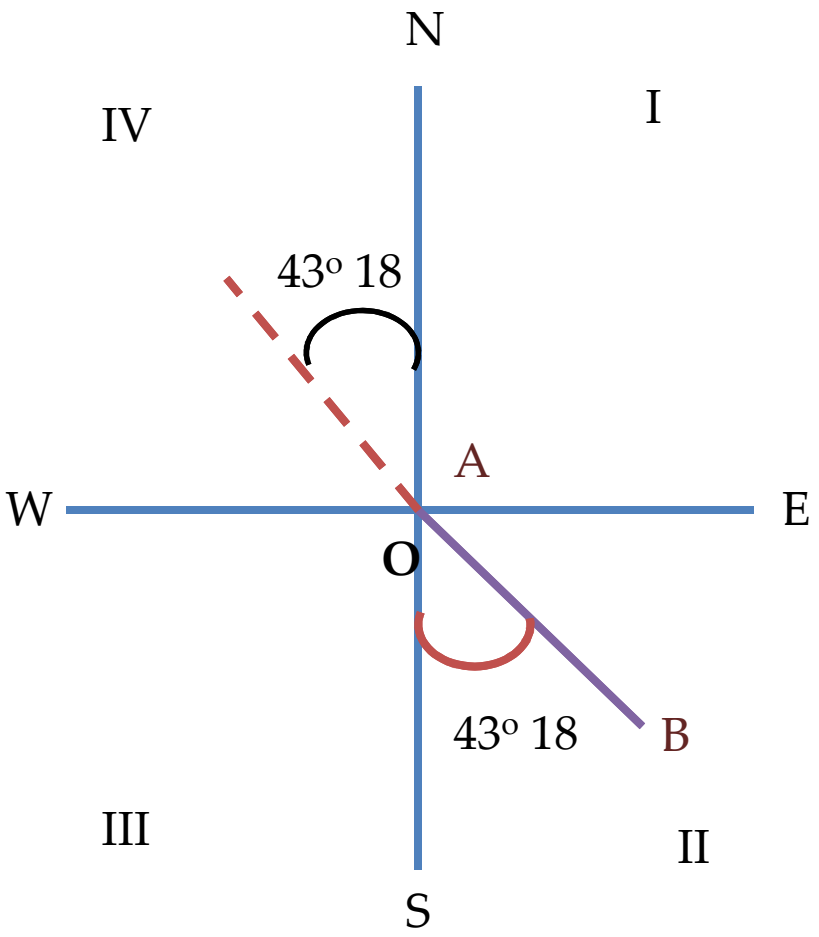
Solution:

F.B of AB = S 43° 18’ E

B.B of AB = **N** 43° 18’ **W**

F.B of CD = N 65° 24’ W

B.B of CD = **S** 65° 24’ **E**



Calculation of Angles from Bearings

- When two lines intersect at a point two angles are formed called Interior angle and Exteriors angle
- The sum of these two angles is equal to 360^{o}.
- By interior angle is usually meant the smaller angle of these two angles but not always.
- The following rule may be applied to find the included (interior) angle Between the lines whose bearing are given.

- The following are different rules to find the angles from the given bearings
- Two cases
- CASE 1 Given the W.C.B
- CASE 2 Given the Reduced bearings.

CASE 1 Given the W.C.B of lines

We have further two cases

1) when he bearing of two lines as measured from the point of intersection of lines are given:

RULE:

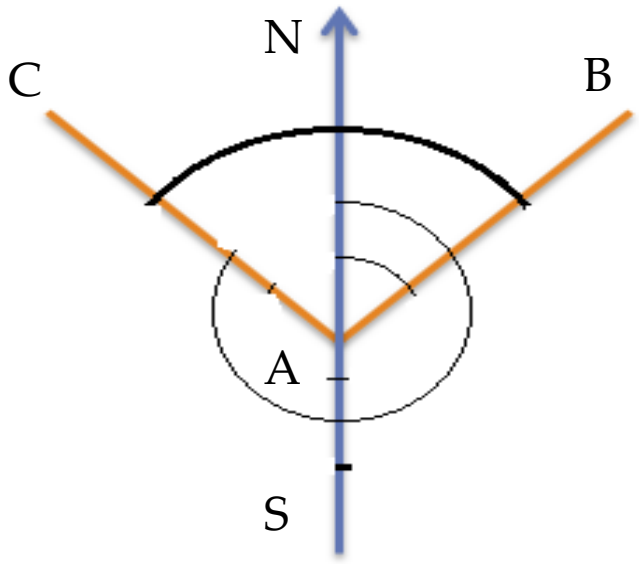
- Subtract the smaller from the larger ,
- if the difference is more than 180^o then it be exterior angle then to get interior angle subtract it from 360^o.

<u>Example:</u>

Bearing of AB and AC given

LBAC External angle = Bearing AB- Bearing AC

LCAB Internal angle = 360^o - LBAC

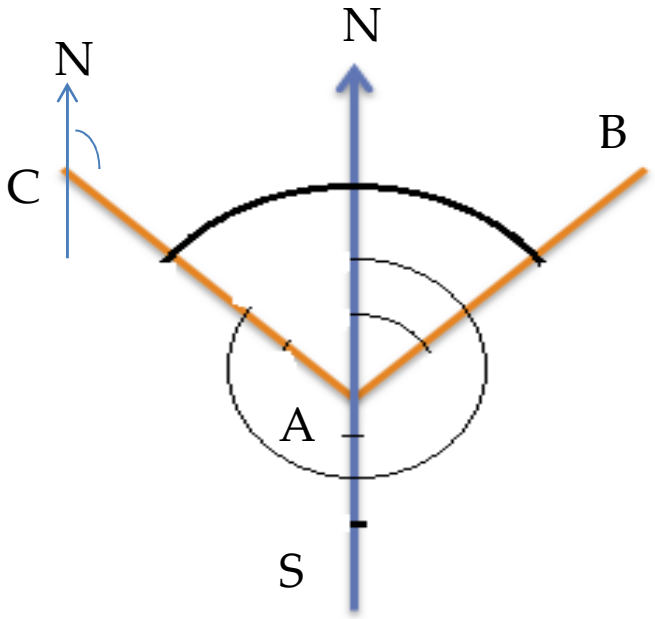


CASE 1 Given the W.C.B of lines

- **2)** When bearing of two lines are given:
- Express both bearings as if measured from the point where the lines meet and then apply the above rule.

Example:

- If bearing of CA and AB are given.
- Bearing of AC must be obtain which is equal to B.B of CA.
- Bearing (F.B) of AC =B.B of CA = bearing of CA(F.F) +- 180o
- The included angle L CAB then obtain by above rule.



CASE 2 Given the Reduced Bearings of lines

- In this case the Whole circle is divided into 4 quadrants
- **RULE:**

A. if lines are on the same side of same meridian.

Included angle= difference of two Reduced bearings

B. if lines are on the same side of different meridian

Included angle= 180^o – sum of two reduced angle

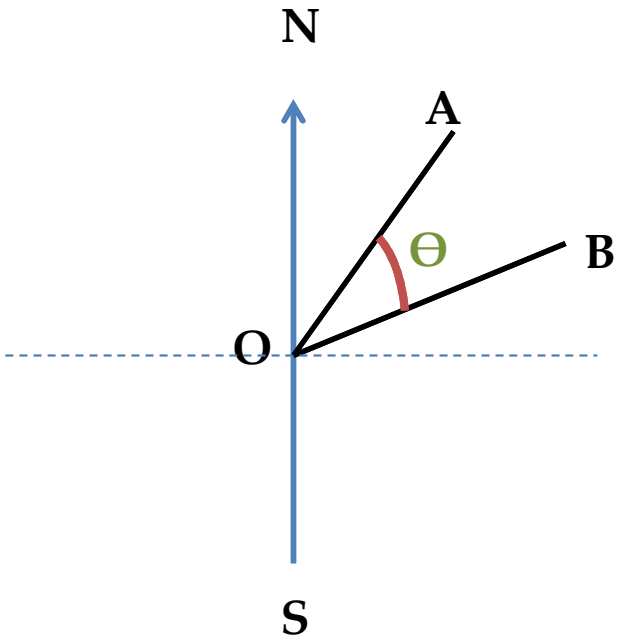
C. if lines are on different side of different meridians

Included angle= 180^o – difference of two reduced bearings

D. if lines are on opposites of same meridian

Included angle= sum of two reduced angle

- .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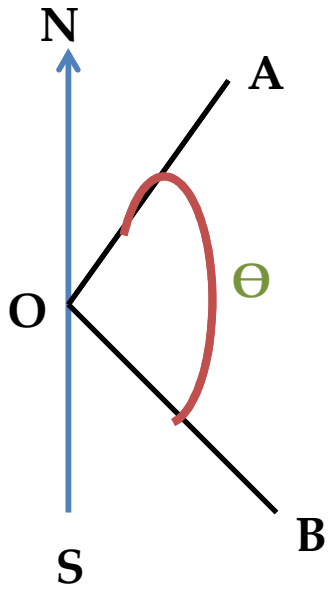
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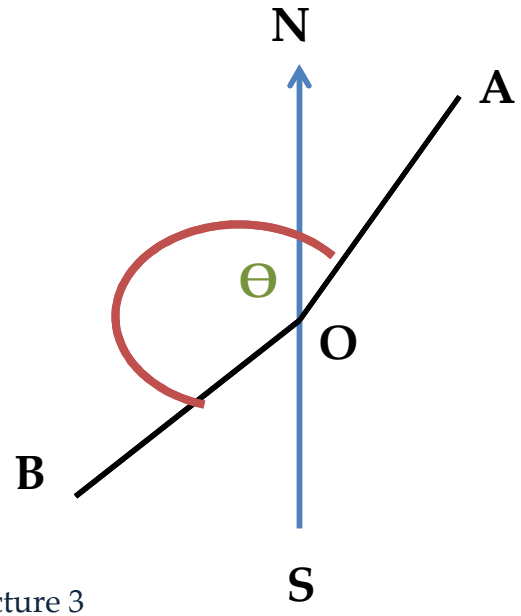
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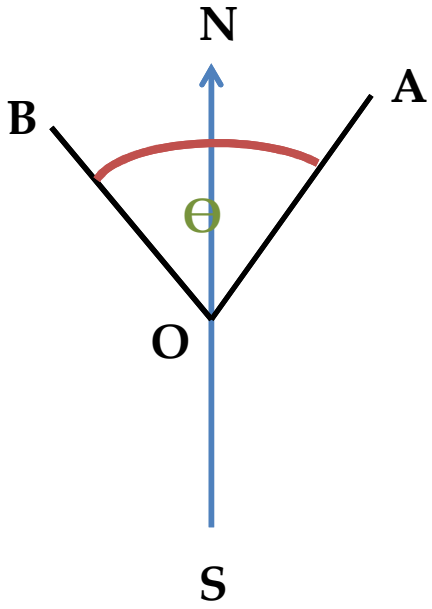
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Calculated Bearings

- Bearing of a line may be either observed or calculated

- Observe bearings are those which are directly obtain by field observation
- Those obtain by calculation are called calculated bearings
- Bearing of a line = given bearing + included angle

Example:

W.C.B of AB is 30^o and the ĹBAC 110^o

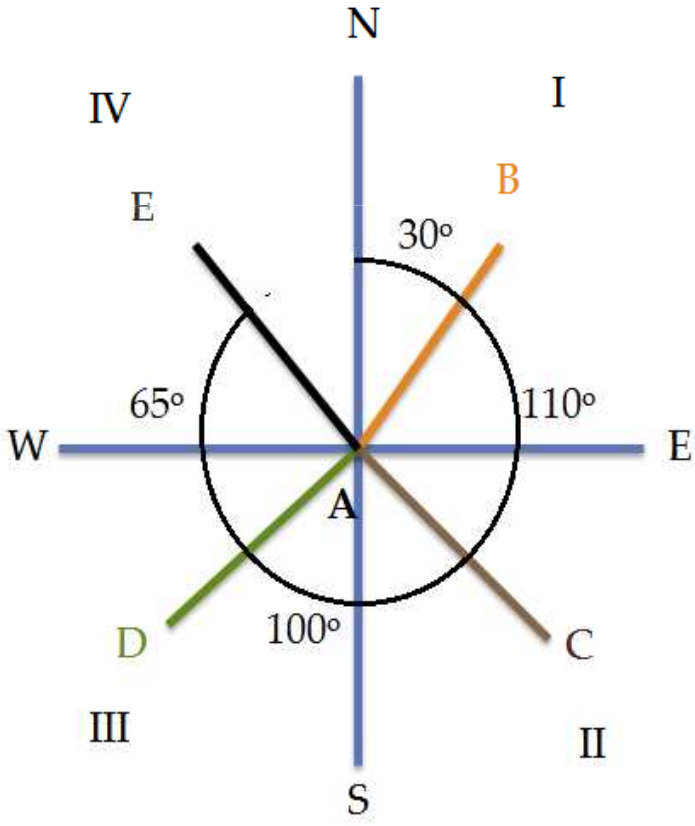
ĹCAD 100^o and ĹDAE65

Bearing of AB= 30^o

Bearing of AC= $30^o + 110^o = 140^o$

Bearing of AD= ?

Bearing of AE= ?



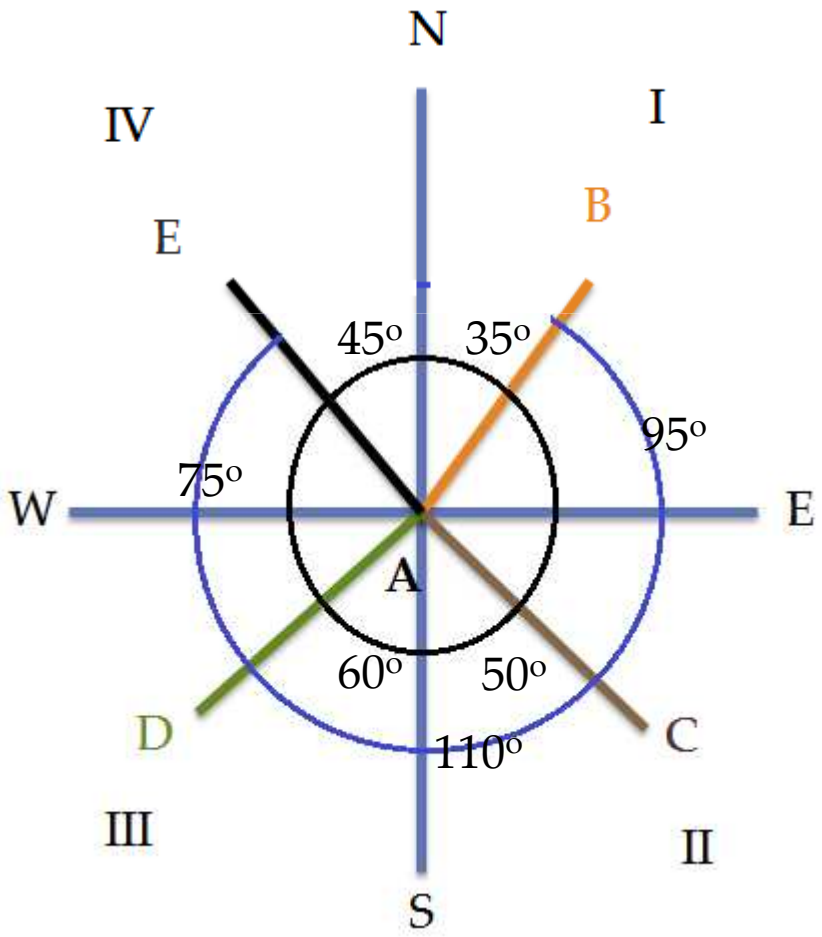
- If observe reduced bearing of AB is N 35° E
- ĹBAC 95° ĹCAD 110° ĹDAF 75°

R .Bearing of AB= 35°

R .Bearing of AC= (35° + 95°) = 140°

R .Bearing of AD= ?

R. Bearing of AE= ?



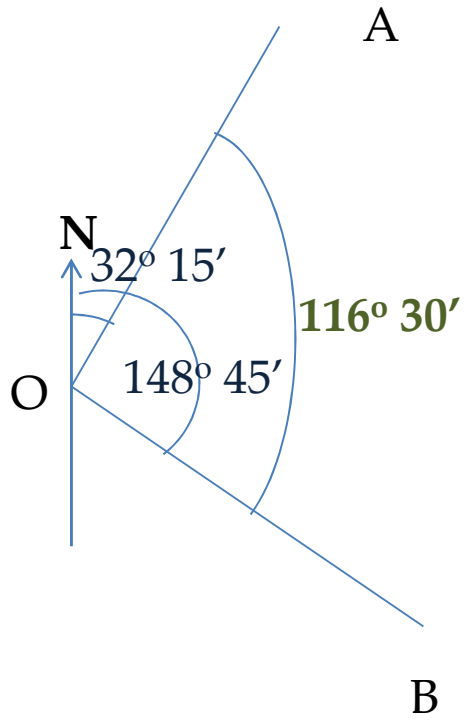
Examples

- **Example : 1**
- Find angle between the line OA and OB, if their respective bearings are (a) 32° 15’ and 148° 45’
- **Solution:**
- LAOB = bearing of OB – Bearing of OA

  = 148° 45’ - 32° 15’

  = 116° 30’

If greater than 180° then it will be Exterior angle, to find interior angle, subtract from 360°.



Examples

- **Example : 2**
- Find angle between the line AB and BC, if their respective bearings are 146° 12’ and 68° 24’,

- **Solution:**

Bearing of AB = 146° 12’

Bearing of BA = 180° + 146° 12’

= 326° 12’

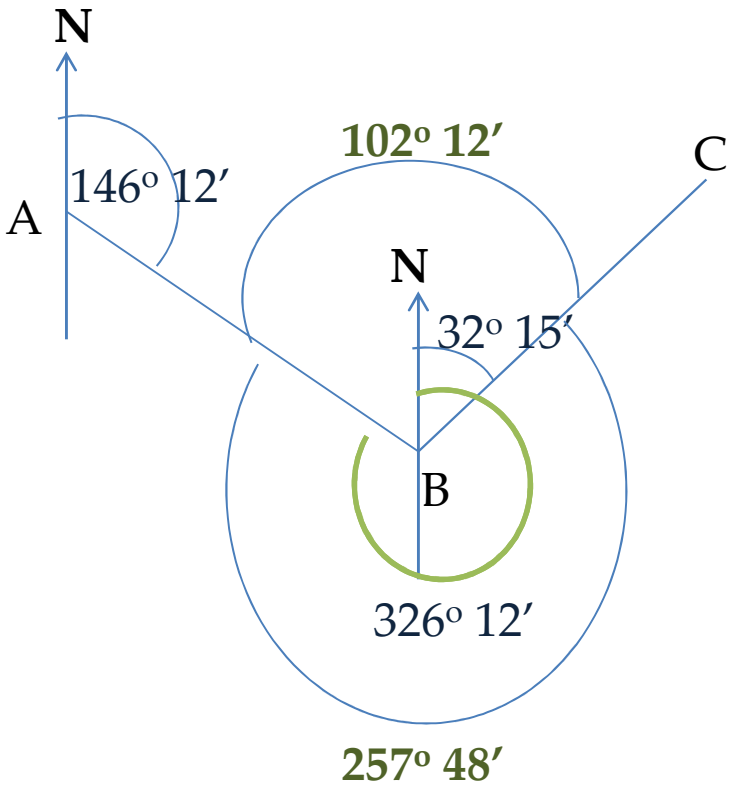
Bearing of BC = 68° 24’

Difference between the two bearing =

326° 12’ - 68° 24’ = 257° 48’ (Exterior angle)

Interior angle = 360° 0’ - 257° 48’

= 102° 12’



Examples

- **Example : 3**
- The bearings of sides of Traverse ABCDE are

SIDE	Fore Bearing	Back Bearing
AB	107° 15’	287° 15’
BC	22° 0’	202° 0’
CD	231° 30’	101° 30’
DE	189° 15’	9° 15’
EA	124° 45’	304° 45’

- Find the interior angle of the traverse.
- **Solution:**

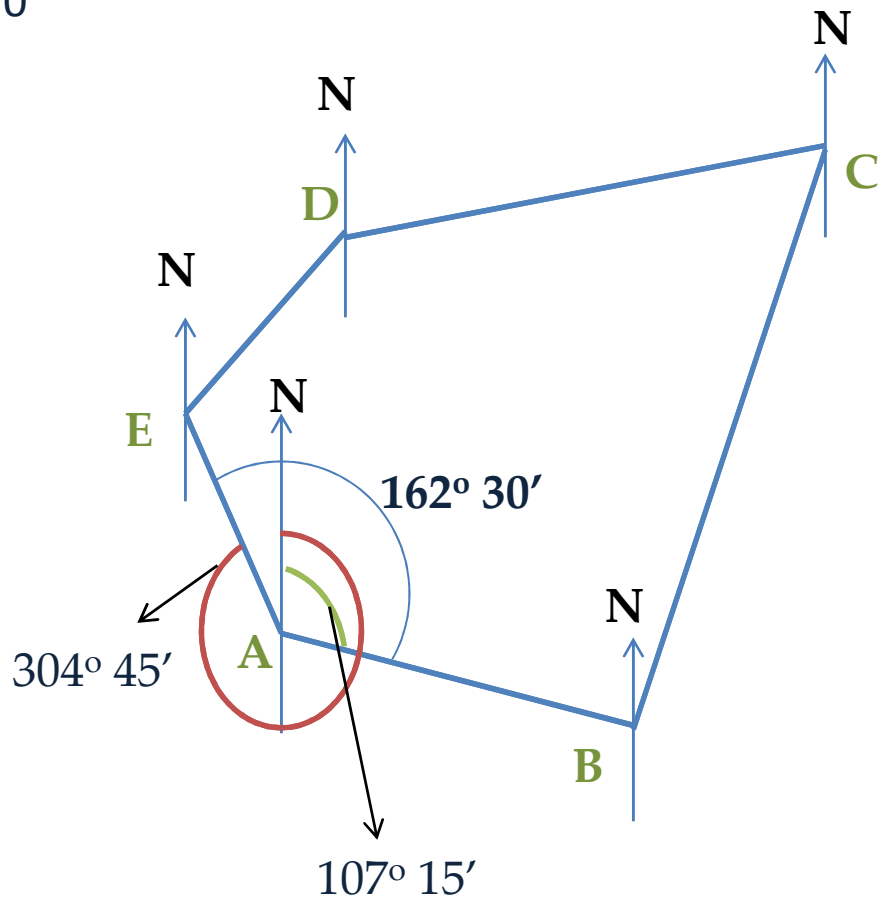
Bearing of AE= B.B of EA= 304° 45’

= F.B of AB = 107° 15’

Difference = 197° 30’ (Exterior angle)

LA = LEAB = 360° 0’ - 197° 30’

= 162° 30’



- **Assignment**

(A) Examples on bearings 1, 2, 3, 4 (Part 1 ,page 141)

(B) Examples on computation of included angle

1, 2, 3, 4, 5, 6, 7 (Part 1 ,page 146)

Local Attraction

- The effect of any source which will disturb the true direction of magnetic needle of a compass is called Local Attraction.

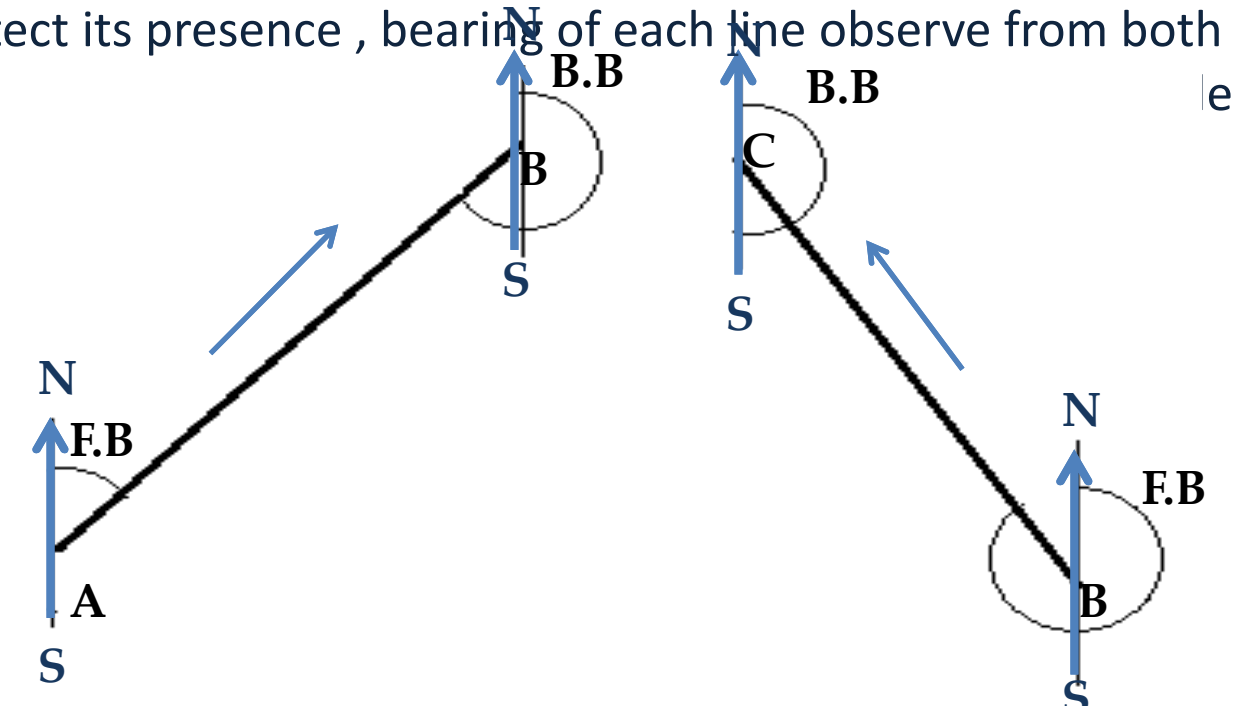
- The deflection of the magnetic needle from its original position due to some disturbance is known as Local Attraction.

- Iron ores, rails, steel structure, electric cable. Iron pipes etc cause this type of disturbance.
- This is much greater in Cities than the countries.

Local Attraction

- The reading taken from the help of compasses are not very mush reliable until means are taken to predict the presence of local attraction.

- To detect its presence , bearing of each line observe from both ends. If the F.B ar ed no instru



HOW to detect the Error.

- If the error is with in the permissible limit then use approximate method (Mean).

E.g: Observed **FB= 90°0' BB=276°30' .**

From observed BB, FB=276°30' - 180°0'=96°30' (calculated FB)

Mean of calculated and observed FB = (96°30'+ 96°0')/2

96°15'(which is the corrected F.B).

- If the error is not within the limit then there are two possibilities:
  1. There is some observational error in taking FB and BB.
  2. There is Local attraction.

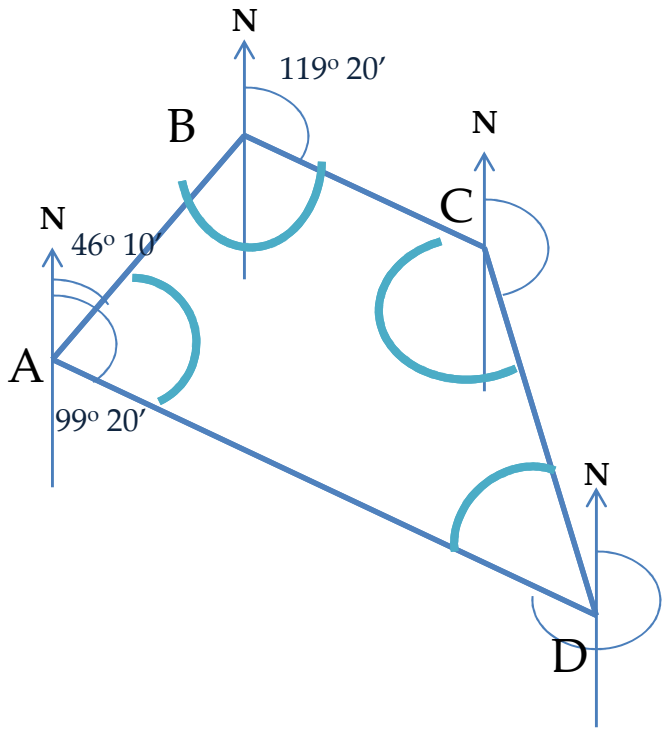
- **There are Two methods of correcting the observed bearings of lines.**

1) In this method the **Included angle** at the affected stations are calculated and then starting from the correct line , the corrected bearings are calculated.

Example:

The observed bearings of lines AB,BC,CD,DA.

Line	FB	BB
AB	46° 10’	226° 10’
BC	119° 20’	298° 40’
CD	169° 30’	351° 10’
DA	230° 20’	99° 20’



Example:

The observed bearings of lines AB,BC,CD,DA

Line	FB	BB	Difference
AB	46° 10′	226° 10′	**180° 0′**
BC	119° 20′	298° 40′	**179° 20′**
CD	169° 30′	351° 10′	**181° 40′**
DA	280° 20′	99° 20′	**181° 0′**

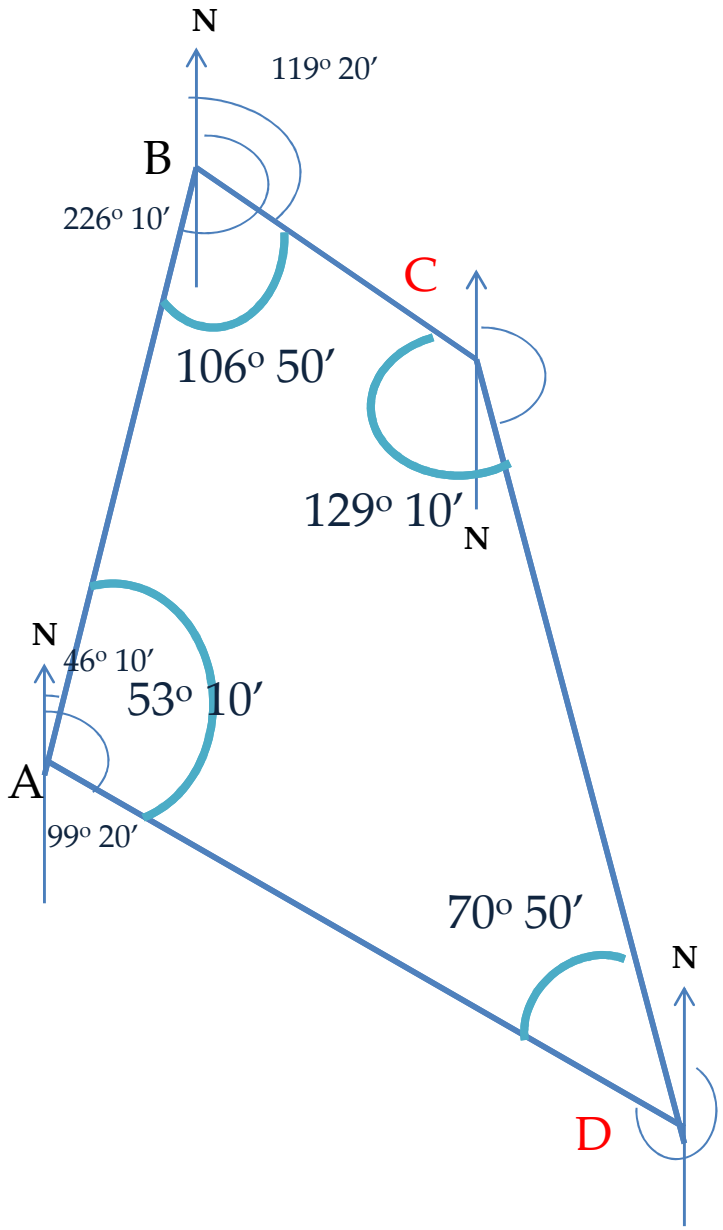
- Station A and B are there fore Free from local attraction, so observed bearing of AB are correct.
- Compute the true included angle from the observed bearings.

LA = 53° 10′

LB = 106° 50′

LC = 129° 10′

LD = 70° 50′



Example:

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CD	169° 30′	351° 10′	**181° 40′**
DA	280° 20′	99° 20′	**181° 0′**

- Starting from unaffected line AB, the correct bearings of others lines may be computed

BB of AB = 226° 10′ FB of CD = 170°10′

minus LB =106° 50′ add 180° = 180°

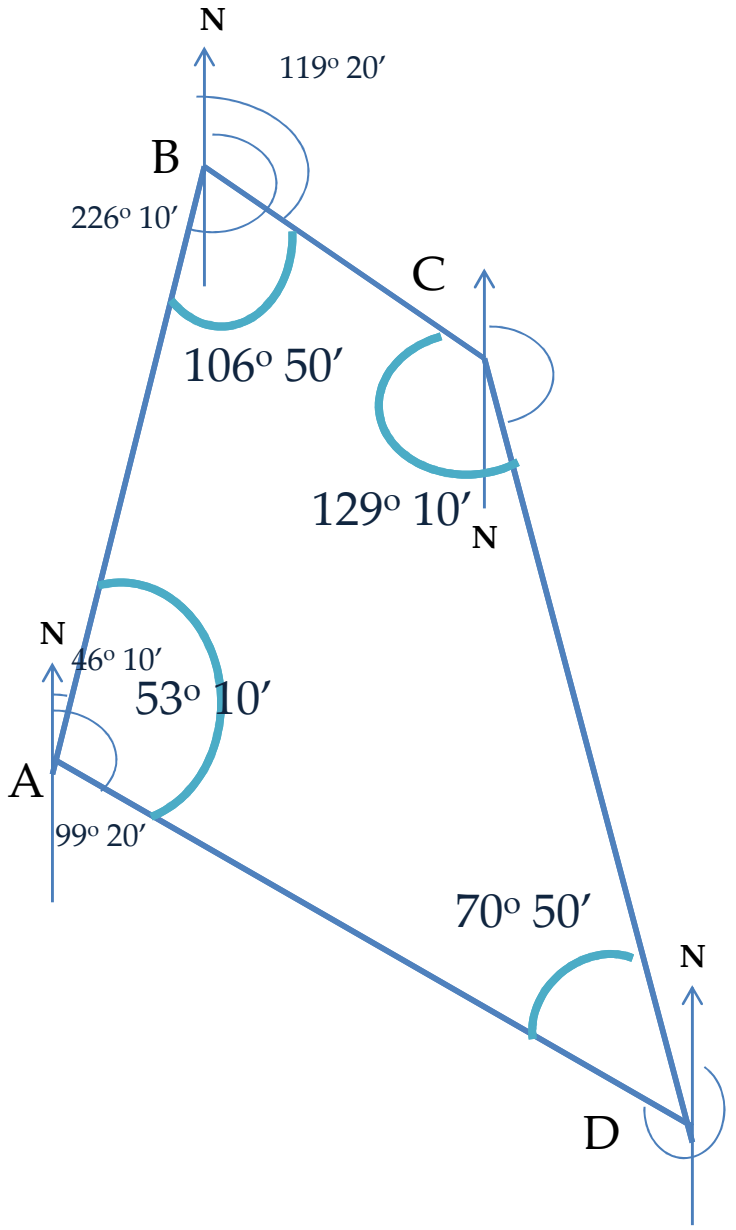
F.B of BC =119° 20′ BB of CD = 350° 10′

add 180°=180° 10′ minus LD = 70° 50′

BB of BC =299° 20′ FB of DA = 279° 20′

minus LC =129° 10′ minus180°= 180°

FB of CD =170° 10′ BB of DA = 99° 20′



Check= BB of DA - 53° 10′ = 46° 10′

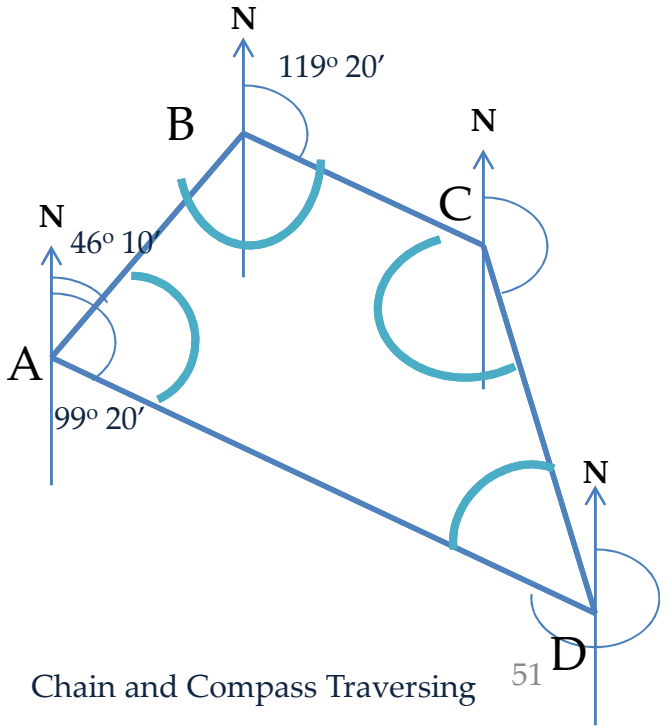
2) Second method most communally used in which the included angle are not computed but the amount and direction of the error due to local attraction at each station is found.

- Starting from a bearing of unaffected by local attraction, the bearings of successive lines are adjusted by applying the correction of the observed bearings.

Example:

The observed bearings of lines AB,BC,CD,DA.

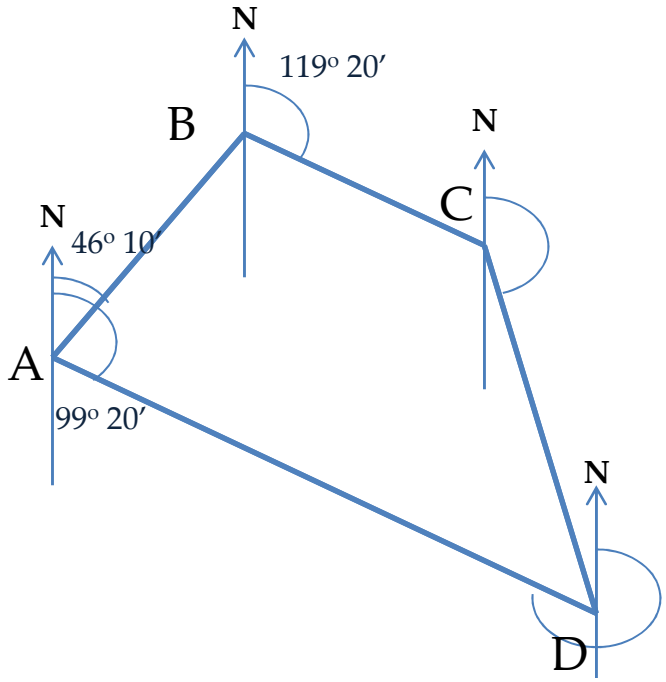
Line	FB	BB
AB	46° 10’	226° 10’
BC	119° 20’	298° 40’
CD	169° 30’	351° 10’
DA	280° 20’	99° 20’



Example:

The observed bearings of lines AB,BC,CD,DA

	Observe Bearings			Corrected Bearings			
Line	**FB**	**BB**	**Difference**	**Correction**	**FB**	**BB**	**Remarks**
AB	46° 10′	226° 10′	**180° 0′**	0 at A	**46° 10′**	**226° 10′**	Station C and D are affected by Local Attraction.
BC	119° 20′	298° 40′	**179° 20′**	0 at B	**119° 20′**	299° 20′	
CD	169° 30′	351° 10′	**181° 40′**	+0°40′at C	170°10′	350°10′	
DA	280° 20′	99° 20′	**181° 0′**	-1° at D	279° 20′	**99° 20′**	



Example No 2:

Line	Observed bearings
AB	44° 40’
BA	225° 20’
BC	96° 20’
CB	274° 18’
CD	30° 40’
DC	212° 2’
DE	320 12’
ED	140° 12’

At which station do you suspect local attrition?

Find the corrected bearings of lines

Example:

The observed bearings of lines AB,BC,CD,DA.

	Observe Bearings			Corrected Bearings			
Line	**FB**	**BB**	**Difference**	**Correction**	**FB**	**BB**	**Remarks**
AB	44° 40	225° 20’	**180° 40’**	0 at A	**44° 40’**	224° 40’	Station B and C are affected by Local Attraction.
BC	96° 20’	274° 18’	**177° 58’**	-0°40’ at B	95° 40’	275° 40’	
CD	30° 40’	212° 2’	**181° 22’**	+1°22’at C	32°2’	**212° 2’**	
DE	320 12’	140° 12’	**181° 0’**	0 at D	**320 12’**	**140° 12’**	

- Assignment

Example on page 153, 155, 156, 157 (Part 1)

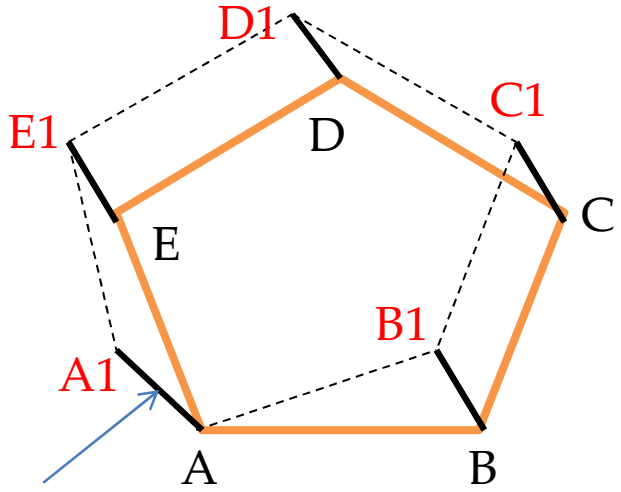
Problem 17,18 on page 176.

Graphical adjustment of closing error in a closed Traverse.

- The closing error or error of closure, is the actual distance by which a traverse fails to close.
- If the error is large, indicate that error in chaining and lines required to be measured.
- If it is small it may be eliminated and the traverse is made to close.
- **Bowditch's Rule:**

A traverse $AB_1C_1D_1E_1A_1$.

Line AA1 represent closing error of traverse.



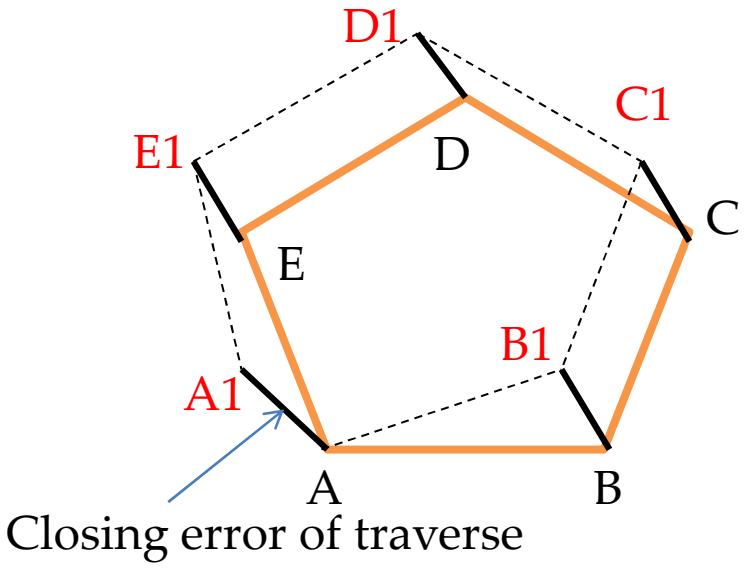
Closing error of traverse

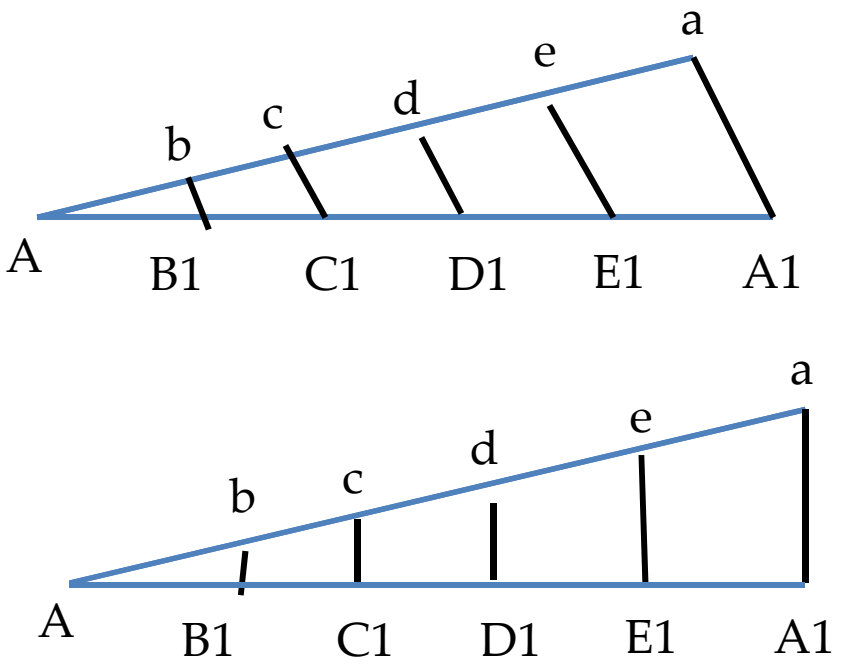
- **Bowditch's Rule:**

To Adjust:

AA1 = perimeter of traverse

aA1 equal and parallel to A1A(closing error)





Assignment No 3

(A) Difference between Prismatic and Surveyor compass

(B) Examples on bearings 1, 2, 3, 4 (Part 1 ,page 141)

(C) Examples on computation of included angle
1, 2, 3, 4, 5, 6, 7 (Part 1 ,page 146)

(D) Examples on Local attraction
On page 153, 155, 156, 157 (Part 1))
Problem 17,18 on page 176.

(E) Bowditch's Rule

References

- Surveying & Leveling (part 1) by T P Kanetkar & S V Kulkarni (Part 1)