Types of compass

There are 2 types of compass

(1) Prismatic compass

(2) The Surveyore's compass

(1) Prismatic compass

In this compass the readings are taken with the help of a prism. The following are the essential part of the compass:

(a) Compass box:- The compass box is the Circular material box (The metal should be non-megnatic) of dia of 8 to 10 cm. The pivot Of the sharp point is provided at the center of the box.

(b) Magnetic needle and graduated ring

The magnetic needle is made up of a brodad magnetized ireon. The bare is pointed at both end. The magnetic needle is attached to a graduated aluminium ring.

→ The ring is graduated from 0° to 360° & the graduation is being from the south of the needle Zero degree is marked on the south, 90° west, 180° north, 270° west. The degree is are again subdivided into half degree. The figures are written upside down. The arrangement of the needle & ring contains an aggate cap pivoted on the central pivot point. The reider of the brecss Ore silver coil is provided the needle with the Counter balance is dip.

& 2 Small circular holes, one at the bottom of the prism & other at the side of the observeres eye.

d) Dark glasses

Two dark glasses are provided with a prism. The red glass is meant for sighting luminous object at night & the blue glass for reducing the strain of the observers eye in bright day light.

e) Adjustable mirrors

The mirrors is provided with the side bane the mirrors can be lowered or raised & can also be inclined. If any object is too low or too high w.r.t to the line of the side. The mirrors can be adjusted to observe it through reflection.

f) Break pin:

A break pin is provided just at the side base of the base. If pressed gently, it stops the oscillation of the ring.

g) Lifting pin

A lifting pin is provided just below the side bane, when the side bane folded, it presses the lifting pin. The lifting pin then lift the magnetic needle out of the pivot point to prevent damage to the pivot head.

h) Glass cover

A Glass cover is provided on the top of the box to protect the aluminium ring from dust.

Assignment - 1

Q. A closed traverse is conducted with 5 station A, B, C, D & E taken in anticlockwise order in the form of a regular pentagon. If the FB of AB = 30°0' Find the FB of other side?

Interior angle $= \frac{(2N-4)\times 90}{N}$ $N = 5$

$= \frac{(2\times 5-4)\times 90}{5}$

$= \frac{6\times 90}{5} = 108^\circ$

FB = 30°0' (AB)

BB = FB + 180

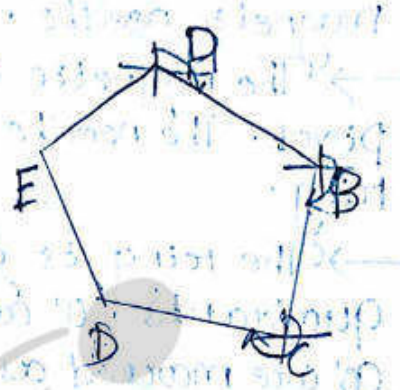
= 30° + 180° = 210°

$\angle A = \angle B = \angle C = \angle D = \angle E = 108$

FB of BC = BB of AB - 108

= 102°.

FB of CD =



The Surveyor's compass

The Surveyor's compass is similar to the Prismatic Compass except for the following point. There is no prism on it. Readings are taken with naked eye. It consists of eye vane (in place of prism with fine slit.

→ A graduated aluminium ring is attached to the circular box. It is not fixed to the magnetic needle.

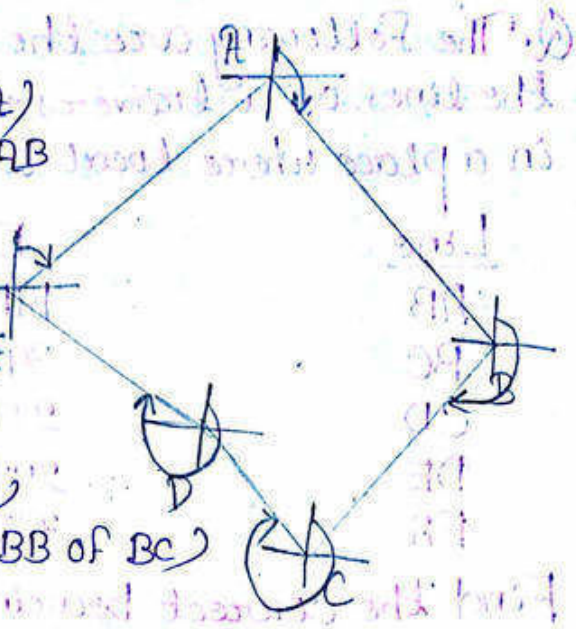
→ The magnetic needle moves freely over the pivot. The needle shows reading in the graduated ring.

→ The ring is graduated from 0° to 90° in 4 quadrants. 0° are marked at the north & south. 90° are marked as east & west. The letters E (East) & W (West) are interchange from their true position. The figures are written right way up no mirror is attached to the object vane.

Q. The following bearings observe in traversing with a compass an area where local attraction are suspected. Calculate the interior angle of traverse & Correct them with necessary.

Line	FB	BB
AB	150°0'	330°0'
BC	230°30'	48°0'
CD	306°15'	127°45'
DE	298°00'	120°00'
EA	49°30'	229°30'

Ans)



$\angle A = 360° - (\text{exterior } \angle A)$

$= BB \text{ of } EA - FB \text{ of } AB$

$= 79°30'$

$\angle B = (\text{exterior } \angle B)$

$= BB \text{ of } AB - FB \text{ of } BC$

$= 99°30'$

$\angle C = 360° - (\text{exterior } \angle C)$

$= 360° - (FB \text{ of } CD - BB \text{ of } BC)$

$= 101°45'$

$\angle D = 360° - (\text{exterior } \angle D)$

$= 360° - (FB \text{ of } DE - BB \text{ of } CD)$

$= 189°45'$

$\angle E = BB \text{ of } DE - FB \text{ of } EA$

$= 70°30'$

$\angle A + \angle B + \angle C + \angle D + \angle E$

$= 541°$

$\text{error} = 541° - 540° = 1°$

Check $= (2N-4) \times 90$

$= 540$

$\text{Correction} = -1° = 60'$

$= \frac{60'}{5} = -12'$

$\angle A = 79°30' - 12' = 79°18'$

$\angle B = 99°18'$

$\angle C = 101°33'$

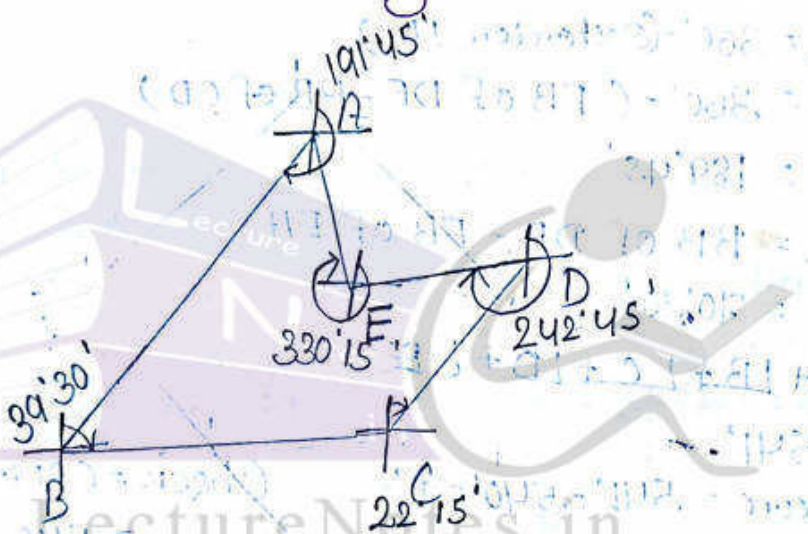
$\angle D = 189°39'$

$\angle E = 70°18'$

Q. The following are the observed bearings of the lines of a traverse ABCDEA with a compass in a place where local attraction are suspected.

Line	FB	BB
AB	191°45'	13°0'
BC	39°30'	222°30'
CD	22°15'	200°30'
DE	242°45'	62°45'
EA	330°15'	147°45'

Find the correct bearing of the lines.



$\angle A$ = FB of AB - BB of EA
= 44°

$\angle B$ = FB of BC - BB of AB + 360°
= 26°30'

$\angle C$ = FB of CD + BB of BC + 360°
= 159°45'

$\angle D$ = FB of DE - BB of CD
= 42°15'

$\angle E$ = FB of EA - BB of DE
= 267°30'

$\angle A + \angle B + \angle C + \angle D + \angle E = 540°$

The correct bearing of the line DE is free from local attraction.

FB of DE = 242°45' (Correct)

FB of EA = 330°15' (Correct)

FB of AB = BB of EA + $\angle A$

= (330°15' − 180°) + 44°

= 150°15' + 44°

= 194°15'

FB of BC = BB of AB + $\angle B$

= (194°15' − 180°) + 26°30'

= 40°45'

FB of CD = BB of BC + ex $\angle C$

= (40°45' + 180°) ~~+159°45'~~ − 200°15'

= 220°45' − 200°15'

= 20°30'

FB of DE = BB of CD + $\angle D$

= (20°30' + 180°) + 42°15'

= 242°45'

FB of EA = BB of DE ∴

→ On verifying the observed bearing it is found that FB & BB of line DE differ by exactly 180° so the station D & E free from local attraction & the observe FB & BB of DE are correct. The observe FB of EA are also correct.

→ The actual BB of EA should be

330°15' − 180°0' = 150°15'

But the observed bearing is 147°15'

So, a correction of (150°15' − 147°45')

42'30' should be applied at A

→ Correct FB of AB = 191°45' + 2'30' = 194°15'

Compass Traversing

In traversing the frame work consist of no of connected line. The lens are measured by chain or tape & the directions are identified by angle measuring instrument i.e compass.
Hence the process is known as compass traversing.

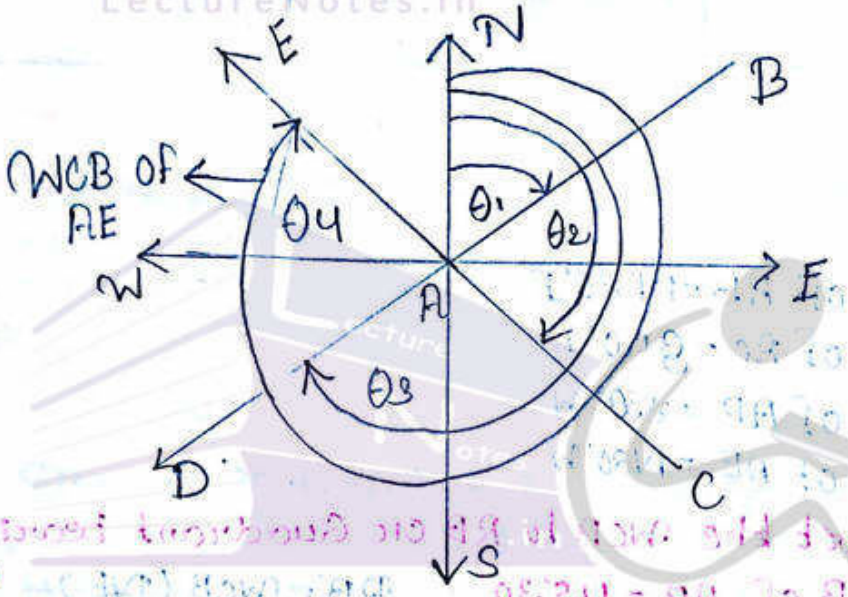
Defination

1) True meridian :- The line or plane passing through the geographical north pole, geographical South pole at any point in surface of the earth is known as true meridian or Geographical meridian.
→ The angle bet^n true meridian & a line is known as true bearing of the line.

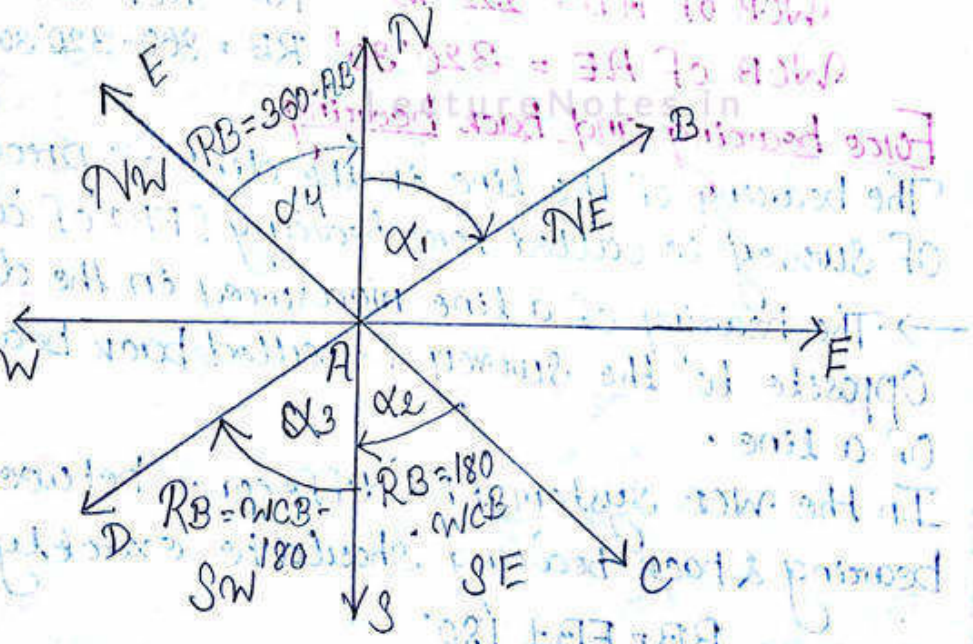
2) Arbitrary meridian
Sometimes for the survey of a small area is convenient dir^n is assumed as a meridian this is known as arbitrary meridian.
→ Sometimes the starting line of a survey is taken as a arbitrary meridian.
→ The angle bet^n the arbitrary meridian and a line is known as arbitrary bearing of a line.

3) Grid meridian
Sometimes for preparing a map some state adgencies assume several line parallel to the true meridian for a particular zone. This lines are termed as grid lines.
→ The central line is known as grid bearing.
→ The bearing of the line w.r.t the grid meridian is known as grid bearing.

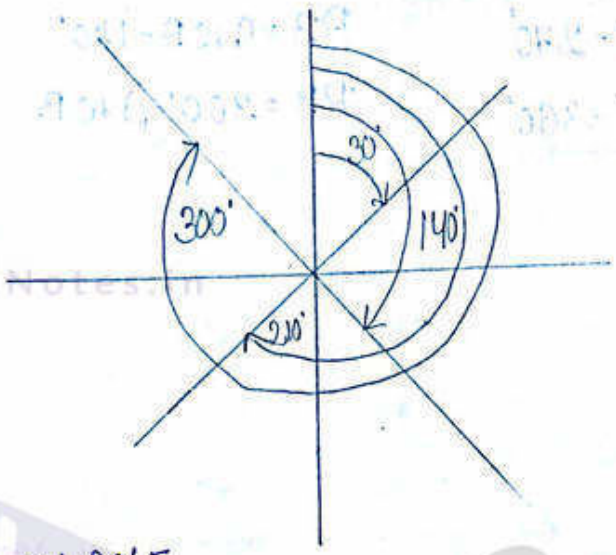
Whole circle bearing	Corresponding reduced bearing	Quadrant
0-90°	RB = WCB	NE
90-180°	RB = 180 - WCB	SE
180-270°	RB = WCB - 180°	SW
270°-360°	RB = 360° - WCB	NW



Q.



Q. WCB of line AB = 30°, AC = 140°, AD = 210°, AE = 300° Convert into reduced bearing (RB)



RB of AB = N 30° E
RB of AC = S 40° E
RB of AD = S 30° W
RB of AE = N 60° W

Q. Convert the WCB to RB or Quadrant bearing

WCB of AB = 45°30'	RB = WCB (NE)
WCB of AC = 125°45'	RB = 180 - 125°45' = 54.25 (SE)
WCB of AD = 222°15'	RB = WCB - 180 = 42.25 (SW)
WCB of AE = 320°30'	RB = 360 - 320°30' = 39.5 (NW)

Force bearing and back bearing

The bearing of the line in the dirⁿ of progress of survey is called fore bearing (FB) of a line.

→ The bearing of a line measured in the dirⁿ opposite to the survey is called back bearing (BB) of a line.

In the WCB system the difference between fore bearing & back bearing should be exactly 180°

BB = FB ± 180°

Q. The fore bearing of the following line are given below. Find the back bearing?

FB of AB = 310°30'
FB of BC = 145°15'
FB of CD = 210°30'
FB of DE = 60°45'

BB = 310°30' + (-180°)
= 130°15'

BB = 145°15' + 180
= 325°25'

BB = 210°30' - 180
= 30°5'

BB = 60°45' + 180
= 240°75'

Q. Convert the following WCB to reduced bearing

a) 56°20' RB = WCB = 56°20'
b) 170°05' RB = 180° - 170°05' = 9°55'
c) 218°30' RB = 218°30' - 180° = 38°30'
d) 272°50' RB = 360° - 272°50' = 87°10'

Magnetic declination

The horizontal angle between the magnetic meridian & true meridian its known as magnetic declination.

Dip of the magnetic needle

If a needle is perfectly balance before magnetization it does not remain in the balance position after it is magnetized. This is due to the magnetic influence to the earth.

→ The needle is found to be inclined towards the pole.

→ The inclination of the needle with the horizontal its known as the deep of the magnetic needle.

Local attraction

A magnetic needle indicates the north dirn when freely supported but if the needle comes near some magnetic substances such as iron ore, steel structures, electric cables etc. It is found to be deflected from its true dirn & does not show the actual north.

→ This disturbing influence of the magnetic substances its known as local attraction.

→ To detect the presence the local attraction fore bearing & back bearing should be taken.

Principle of compass surveying

The preinciple of compass surveying is traversing which involves as a series of connected lines.

→ The magnetic bearings of the line are measured by prismatic compass & the distance

of the line are measured by chain.

→ Compass surveying is recommended when
(1) The area is last to be survey.
(2) The course of a river or a coarsed line is to be surveyed.
(3) If the area is crowded with many details and triangulation is not possible.

Traversing

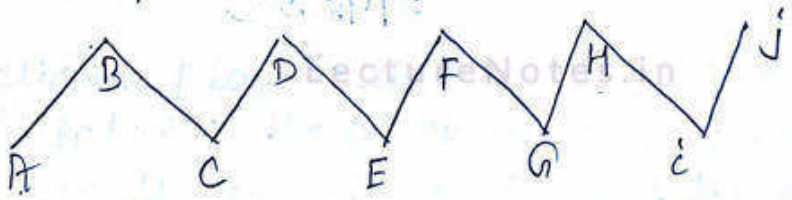
Surveying which involves a series of connected line its known as traversing.

The traversing may be of 2 types
(1) Open traverse
(2) Close traverse

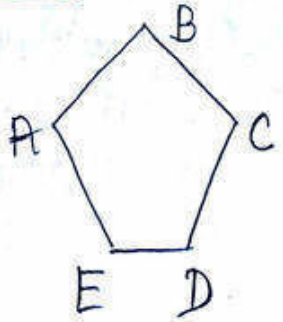
Open traverse

When a sequence of connected line extend along a general dirⁿ & does not return to the starting point its known as open or uncoarsed traverse.

→ Open traverse is suitable for the survey road, river, post line etc.



Close traverse



→ When a sequence of connected lines extend along a direction & return back to the Starting point its known as close traverse.

Q. The magnetic bearing of a line PQ is 124°35' Find its true bearing. If the magnetic declination is '10'10' west.

Ans) True bearing of the line
= Magnetic bearing ± Magnetic declination (E/W)
= 124°35' - 10'10'
= 114°25'

Q. The MB of the line PQ is South 40' east & the magnetic declination is 8°5' east what is the True bearing of the line.

Ans) QB = S40'E
WCB = 180 - 40'
= 140' = MB
MB = 8°5'E

True bearing = MB + magnetic declination
= 140 + 8°5'
= 148°5'

Dt - 19/01/16

Methods of Traversing

Traverse survey may be conducted the following method

(1) Chain traversing
(2) Compass traversing
(3) Theodolite traversing
(4) Plane table traversing

(1) Chain traversing

Chain traversing is mainly conducted when it is not possible for adopt triangulation.

(2) Compass traversing

In this method the fore & back bearing of the traverse legs are measured by a prismatic compass and the sides of the traverse are measured by chain or tape.

(3) Theodolite traversing

In such traversing the horizontal angle betn two traverse legs are measured by theodolite.

→ The length of the legs are measured by chain or by employeeing Stadia method.

→ This method is very accurate.

(4) Plane table traversing

In this method a plane table is set at every traverse station in the clockwise & anticlockwise diren & finally the circuit is closed & the end of the work any closing error which may occur can be adjusted graphically.

Q. Fore bearing of the lines AB, BC, CD & DA are 45°35', 120°15', 200°30' & 280°45' respectively find the angle B, C, D?

BB = FB ± 180°

FB = 45°30'

BB = 45°30' + 180°

= 225°30' (AB)

FB = 120°15'

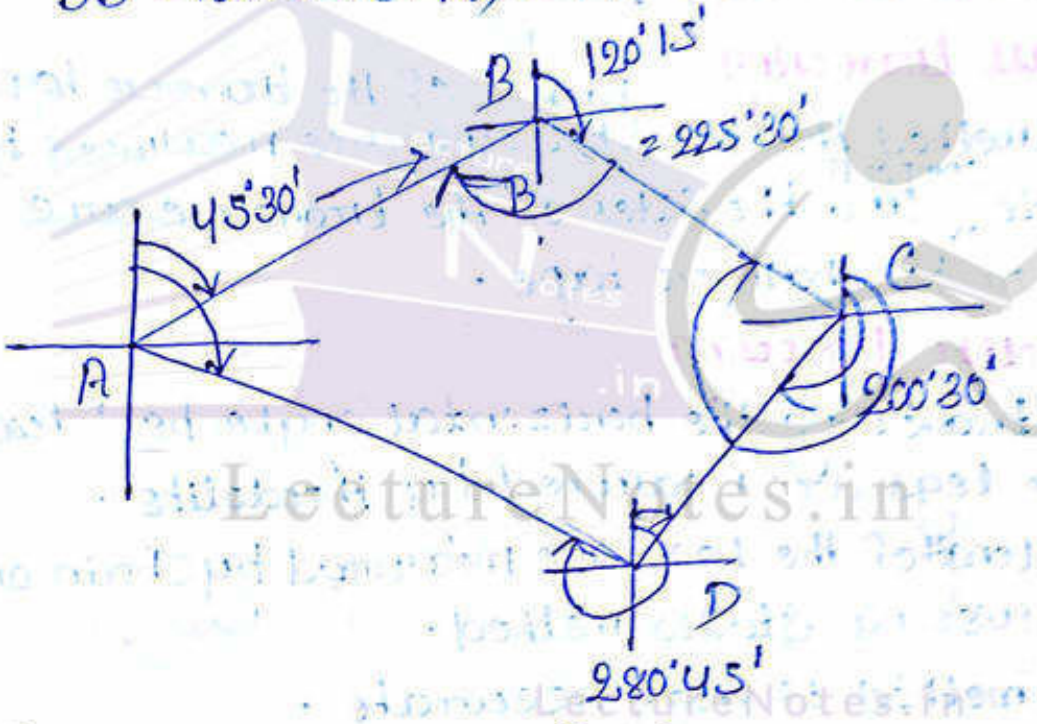
BB = 300°15' (BC)

FB = 210°30'

BB = 20°30' (CD)

FB = 280°45'

BB = 100°45' (DA)



∠B = BB of AB - FB of BC

= 105°15'

∠C = BB of BC - FB of CD

= 99°45'

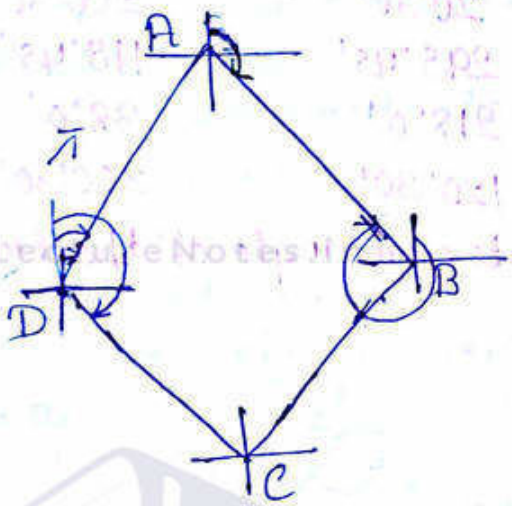
∠D = 360° - (Exterior D)

= 360 - (FB of DA - BB of CD)

= 99°45'

Q. A close traverse ABCDA is made in the form of a square taken in clockwise order. If the bearing of AB is 120°30'. Find the bearing of other sides?

Ans)



FB of AB = 120°30'

BB = 120°30' + 180

= 300°30'

$\angle A = \angle B = \angle C = \angle D = 90°$

FB of BC = BB of AB - 90°

= 300°30' - 90°

= 210°30'

BB = 30°30'

FB of CD = (360° - 90°) + BB of BC

= 300°30'

FB of DA = BB of CD - $\angle D$

= (300°30' - 180°) - 90°0'

= 30°30'

Interior angles

$$\frac{(2N-4)\times 90}{N}$$

N = no of sides

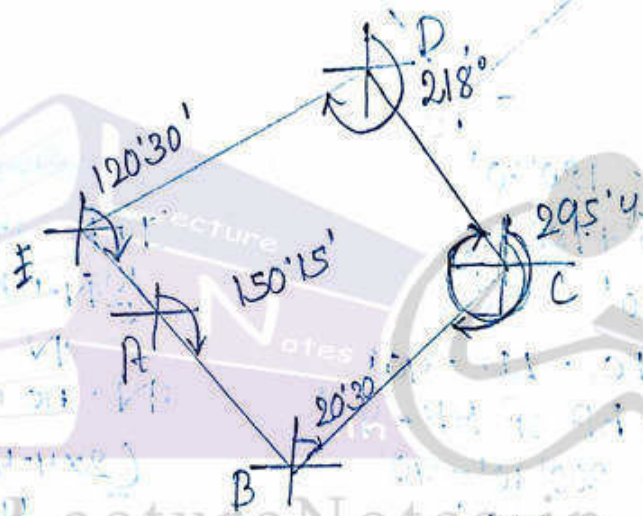
$$\frac{(2\times 4-4)\times 90}{4}$$

$$= \frac{360}{4} = 90°$$

Q. The following are the fore & back bearing of the sides of a close traverse

Side	FB	BB
AB	150°15'	330°15'
BC	20°30'	200°30'
CD	295°45'	115°45'
DE	218°0'	38°0'
EA	120°30'	300°30'

Calculate the interior angle of the traverse.



$\angle A = 360° - (\text{exterior } \angle A)$

$= 360° - (\text{BB of EA} - \text{FB of AB})$

$= 99°45'$

$\angle B = 360° - (\text{Exterior } \angle B)$

$= 360° - (\text{BB of AB} - \text{FB of BC})$

$= 50°15'$

$\angle C = 360° - (\text{exterior } \angle C)$

$= 360° - (\text{BB of BC} + \text{FB of CD})$

$= 95°15'$

$\angle D = \text{FB of DE} - \text{BB of CD}$

$= 102°15'$

$\angle E = \text{FB of EA} - \text{BB of DE} = 82°30'$

Check on Closed traverse

1) Check on angular measurement
2) Check on linear measurement

1) Check on angular measurement

→ The sum of the measured interiore angles should be equal to $(2N-4)\times 90$.

→ The sum of the measured exteriore angles should be equal to $(2N+4)\times 90$.

→ The algebric sum of deflection angle should be equal to 360. Right hand deflection should be considered as +ve, Left hand deflection should be considered as -ve.

2) Check on linear measurement

→ The line should be measured once each on two different days (along opposite dirⁿ) both measurement should be tally.

→ Linear measurement should also be taken by the Stadia method. The measurements by chaining & by the Stadia method should tally.

Check on open traverse

In an open traverse the measurements can not be Check directly. Some field measurement can be taken Check the accuracy of the works.

→ The methods are given below.

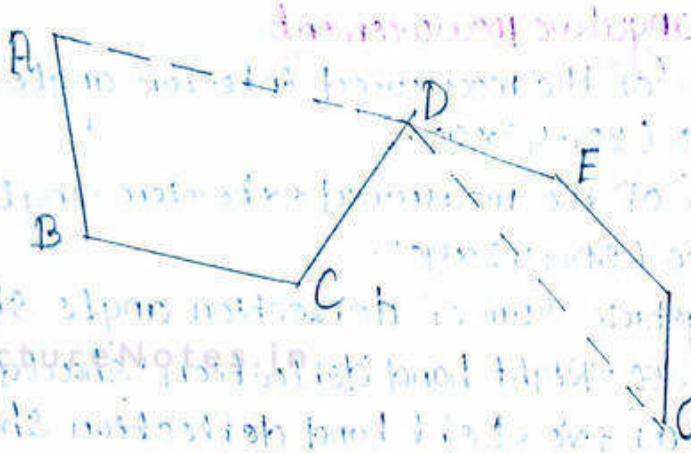
→ Taking cut off line :-

Cut off lines are taken betⁿ some intermediate points or stations of the open traverse. Suppose ABCDEFG represents on open traverse. Let AD & DG be the cut-off lines.

→ The lenghts of the cut-off line are measured accurately.

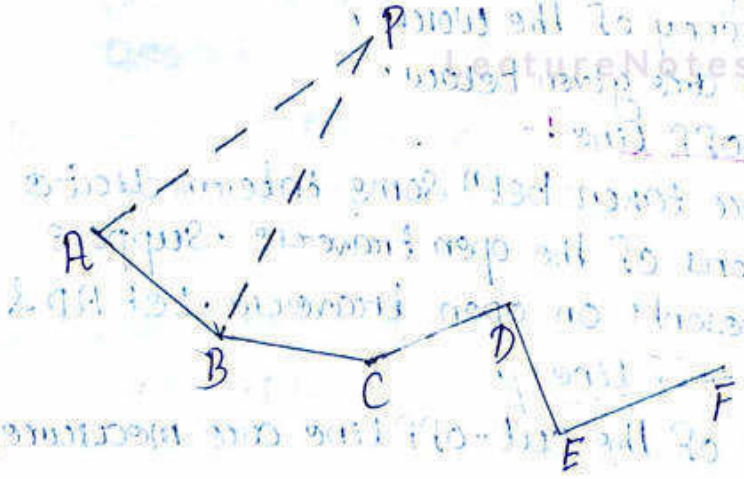
→ After plotting the traverse the distance of the bearing are noted from the map.

→ This distances & the bearing should be tally with the actual records obtained from the field.



2) Taking an auxiliary point

Suppose ABCDEF is an open traverse a permanent point P is selected from one side of it. The magnetic bearing of this point are taken from the traverse station A, B, C, D, E, F. If the survey is carried out accurately & so of the plotting all the measured bearings of 'P' when plotted should be meet at the point P. The permanent point is known as auxiliary point P.



Therefore the actual
BB of AB' = 194°15' - 180° = 14°15'
So, a correction is required
(14°15' - 13°0') = 1°15' at B
⇒ Correct FB of BC = 39°30' + 1°15' = 40°45'
Correct BB of BC = 40°45' + 180°
= 220°45'
But observed = BB of BC = 222°30'
So a correction is
(220°45' - 222°30') = 1°45'
Should be applied.
→ Correct FB of CD = 22°15' - 1°45'
= 20°30'
Which tallies with the observed
BB of CD should be
⇒ 20°30' + 180° = 200°30'
Which tallies with the observed
BB of CD
So D is free from local attraction.

Line	Observed FB	Observed BB	Correction	FB	BB	Remark
AB	191°45'	13°00'	-2°30' at A	194°15'	14°15'	
BC	39°30'	222°30'	+1°15' at B	40°45'	220°45'	
CD	22°15'	200°30'	-1°45' at C	20°30'	200°30'	
DE	242°45'	62°45'	0° at D	242°45'	62°45'	
EA	330°15'	147°45'	0° at E	330°15'	150°15'	

Assignment (Page 100) (Problem 3)

Adjustment of closing error

When a close traverse is plotted, the finishing & starting point may not coinside. The distance by which the traverse fells to close is said to be closing error.

→ Such an error may occur due to mistake made in measurement of lens & bearing because of an error is plotting.

→ If the closing error exceeds a certain permissible limit then the field work should be repeated when the error within the permissible limit then it is adjusted graphically Bowditch's Bowbid rule as explained below.

Representative Factor (RF)

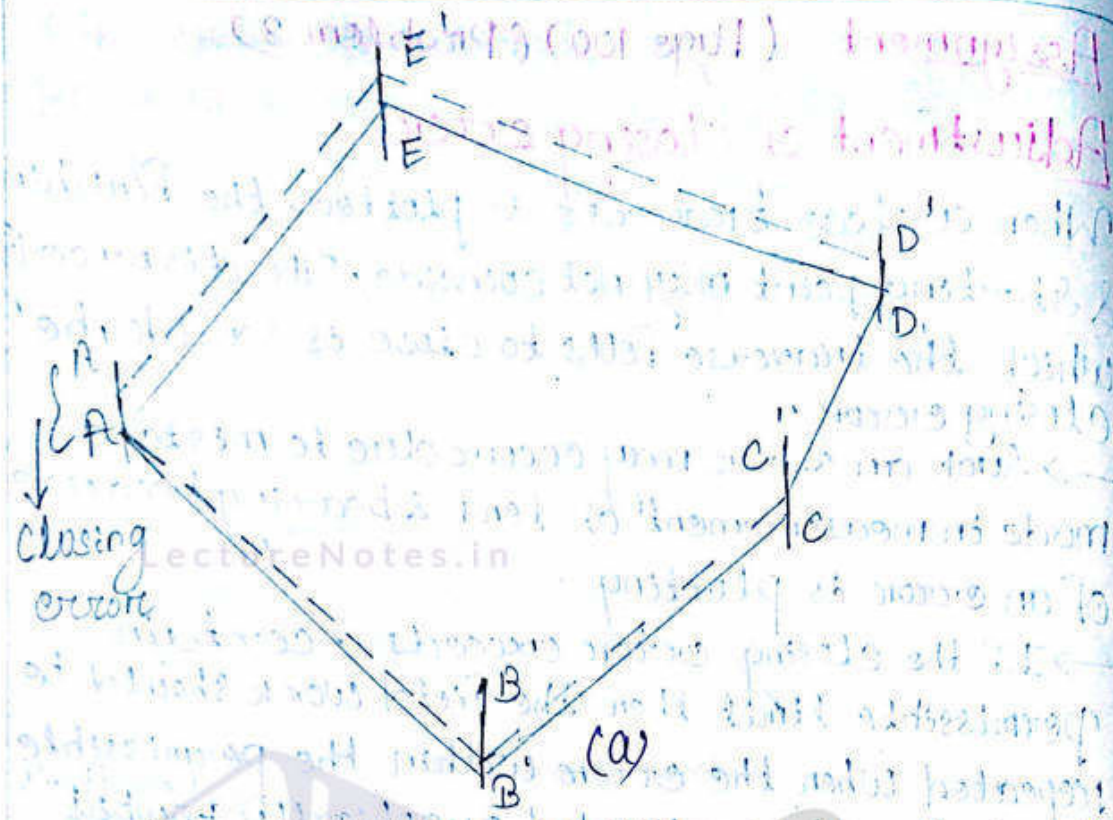
The ratio of the distance on the drawing to the corresponding actual length of the object known as the representative factor.

$$\text{Representative factor (RF)} = \frac{\text{Distance on drawing of object}}{\text{Corresponding actual distance of object}}$$

Ex- of a scale is 1cm = 10 m

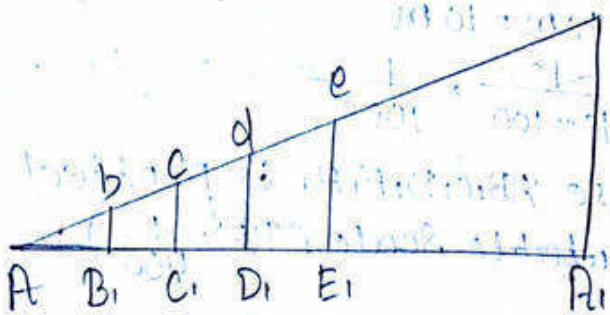
$$\text{then RF} = \frac{1}{10 \times 100} = \frac{1}{1000}$$

→ Suppose a traverse $A B_1 C_1 D_1 E_1 A_1$ is plotted according to any suitable scale ($RF = \frac{1}{400}$).



$RF = \frac{1}{400}(SA')$

In this case the traverse fells to close by a distance A_1A which is the closing error. To adjust this error a horizontal AA_1 is drawn to represent the perimeter of the traverse to another scale ($\frac{1}{2000}$). On this line distances AB_1, B_1C_1, C_1D_1, D_1E_1 are set of according to the corresponding measured length of the traverse legs.



A perpendicular A_1A is drawn equal to the amount of closing error, after which the lin Aa is drawn From the points B_1, C_1, D_1 & E_1 & the lines B_1b, C_1C, D_1d, E_1e are drawn parallal to A_1a. These

intersects represent the amount by which the respective of stations are to be shifted.

In figure a lines are drawn parallel to the closing error through station B, C, D & E then intersect B1b, C1c, D1d & E1e are set of along the parallel lines drawn through the respective stations.

→ In this manner the adjusted traverse ABCDEA is obtained.

Limits of closing error

The angular error of closer should not exceed 15 mins $\sqrt{N}$ where N is the no of sides of the traverse.

Relative closing error =

$$\frac{\text{Amount of closing error}}{\text{Perimeter of traverse}}$$

The value should not exceed $\frac{1}{600}$.

Temporary adjustment of prismatic compass

The following procedure should be adopted while measuring the bearing of prismatic compass.

(1) Fixing the compass with tripod stand:

The tripod stand is placed at the required station with its legs well apart. Then the prismatic compass is held by the left hand & placed over the threaded top of the stand after this the compass box is turned clockwise by the right hand. Thus the threaded base of the compass box is fixed with the threaded top of the stand.

(2) Centering:-

Normally the compass is centered by dropping a piece of stone from the bottom of the compass box. Centering may also be done with the aid of

plumb bod held centrally below the compass box.

3) Leveling

Normally Leveling is done with the help of a ball & Socket arrangement provided on the top of the tripod stand. This arrangement is loasend & box is placed in such a way that the graduated ring rotates freely without touching either the bottom of the box & glass cover at the top.

4) Adjustment of prism:-

The prism is moved up & down till the figures of the graduated ring are seen sharp & clear.

5) Observation of bearing

After centring & Levelling the compass box over the station the ranging rod at the required station is bisected properly by sighting through the slit of the prism & horse haire at sight base.

At this time the graduated ring may rotate rapidly. The breakpin is pressed very gently. To stop this rotation. When the ring comes to rest the box is struck very lightly to verify the horizontality of the ring & the frictional effect on the pivot point. Then the reading is taken from the graduated ring to the whole in the prism. This reading with the magnetic bearing of the line.

Sources of error in compass:

Kinds of error which may occure while taking an Compass.

(1) Instrumentation error :- The needle may not be perfectly Straight & might not be balance properly.

→ The pivot point may be essentric.

→ The graduation of the ring may not be uniform.

→ The ring may not rotate freely on the account of the pivot being blunt.

→ This may occur due to head of the pivot being broken because of the pivot handling.

→ The Sight vane may not be vertically.

→ The horse hair may not be Straight & vertical.

(2) Personal error :-

The centering may not be done perfectly over the Station.

→ The graduated ring may not be levelled.

→ The object might not be bisected properly.

→ The readings may be taken carelessly.

→ The observer may be carrying it magnetic Substances.

(3) Other Soureces of error

→ Theire may be local attraction due to the presence of magnetic substances neare the Station.

→ The magnetic field could vary on account of Some natureal causes.

→ The magnetic declination might varey.

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