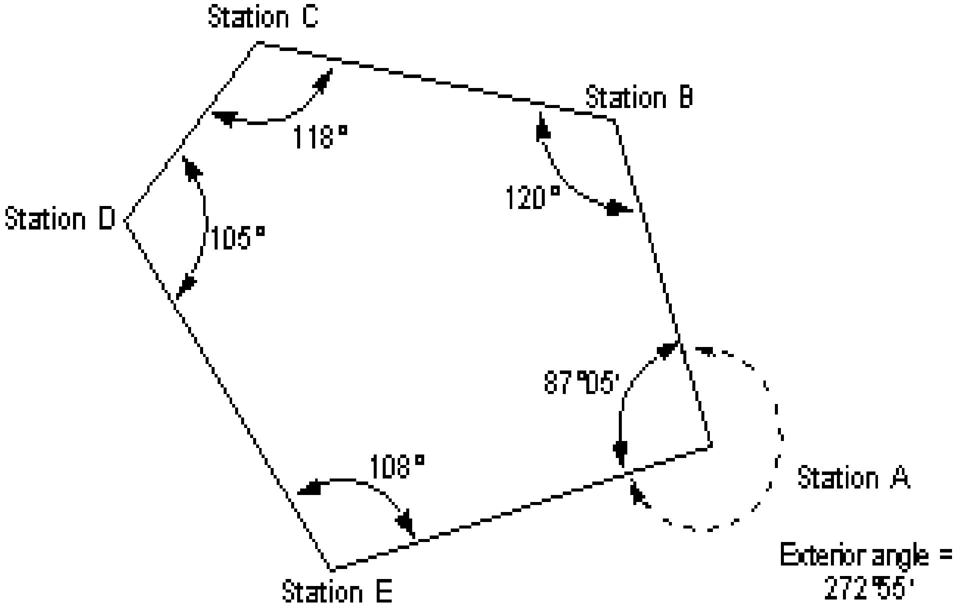
TRAVERSE SURVEY(CONTD…)

Lecture - 3



Fore and Back Bearing:

- Every line has two bearings, one observed at each end of the line. The bearing of the line which is the direction of the progress of survey is called fore or forward bearing (F.B), while its bearing in the opposite direction is known as back or reverse bearing (B.B).
- It may be noted that the fore and back bearings of a line differ exactly by 180^o. In the whole circle bearing system, the back bearing of a line may be obtained from the fore bearing by using the following relation:
- Back Bearing = Fore Bearing $\pm$ 180^o

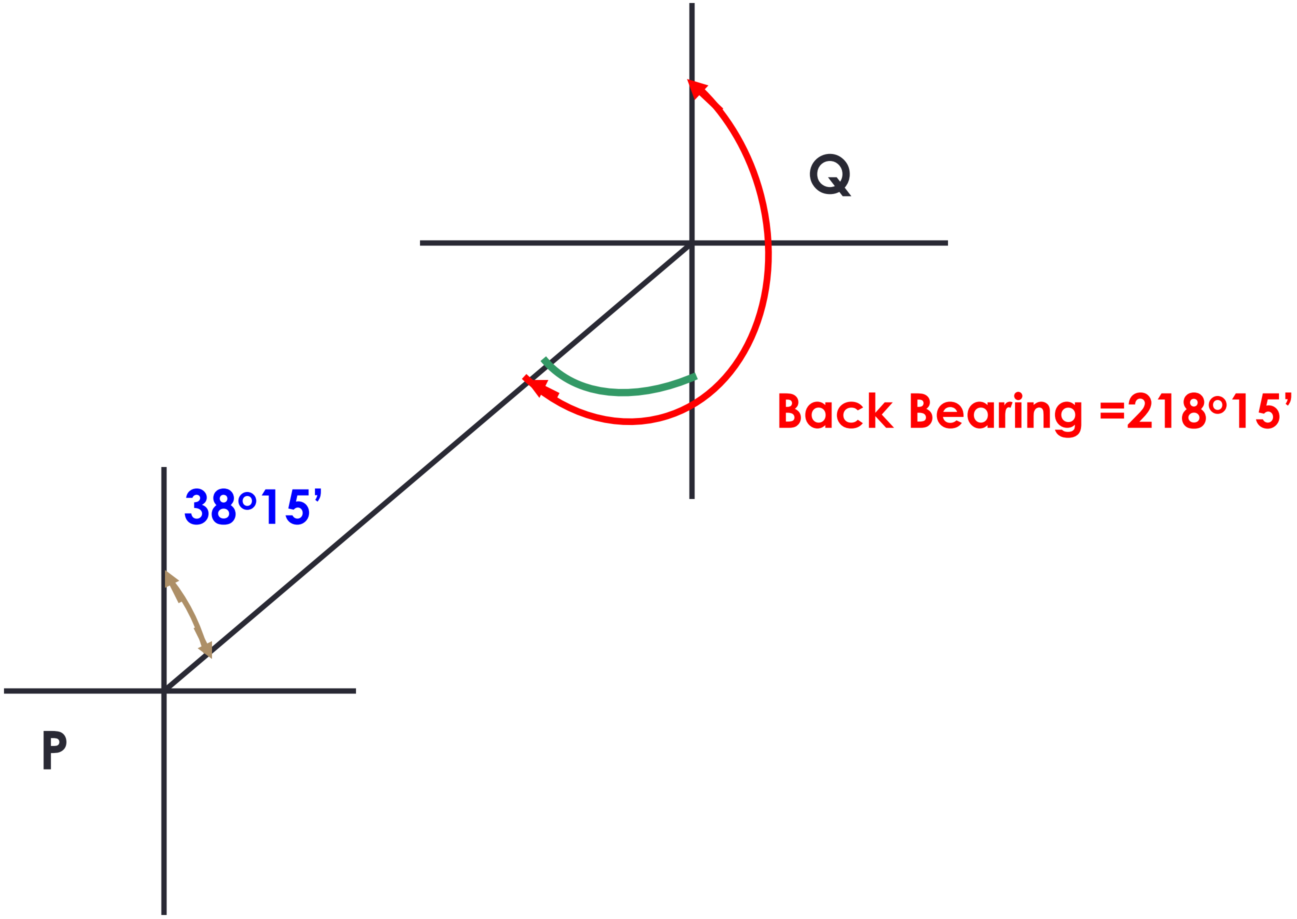
Fore and Back Bearing

- When the fore bearing is less than 180^o, then use plus sign, and if it exceeds 180^o, use minus sign.

- In the quadrantal bearing system, the fore and back bearings are numerically equal but with opposite letters. For example, if the fore bearing of a line is N 40^o 25’ E, then the back bearing of a line is S40^o25’W.

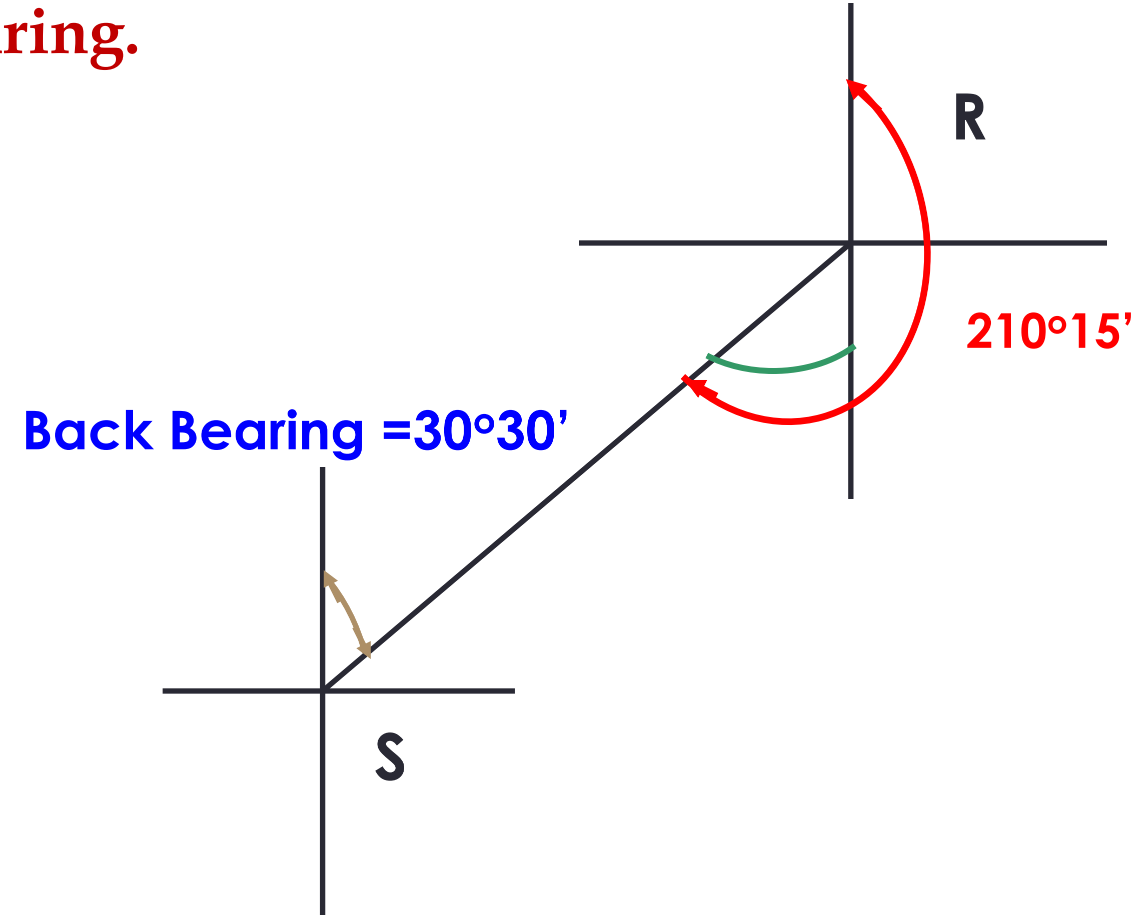
To find Back Bearing from Fore Bearing

- Qn: Fore bearing of Line PQ is 38º15′, find Back bearing.



To find Back Bearing from Fore Bearing

- Qn: Fore bearing of Line RS is 210º15′ find the back bearing.



Conversion of FB to BB:

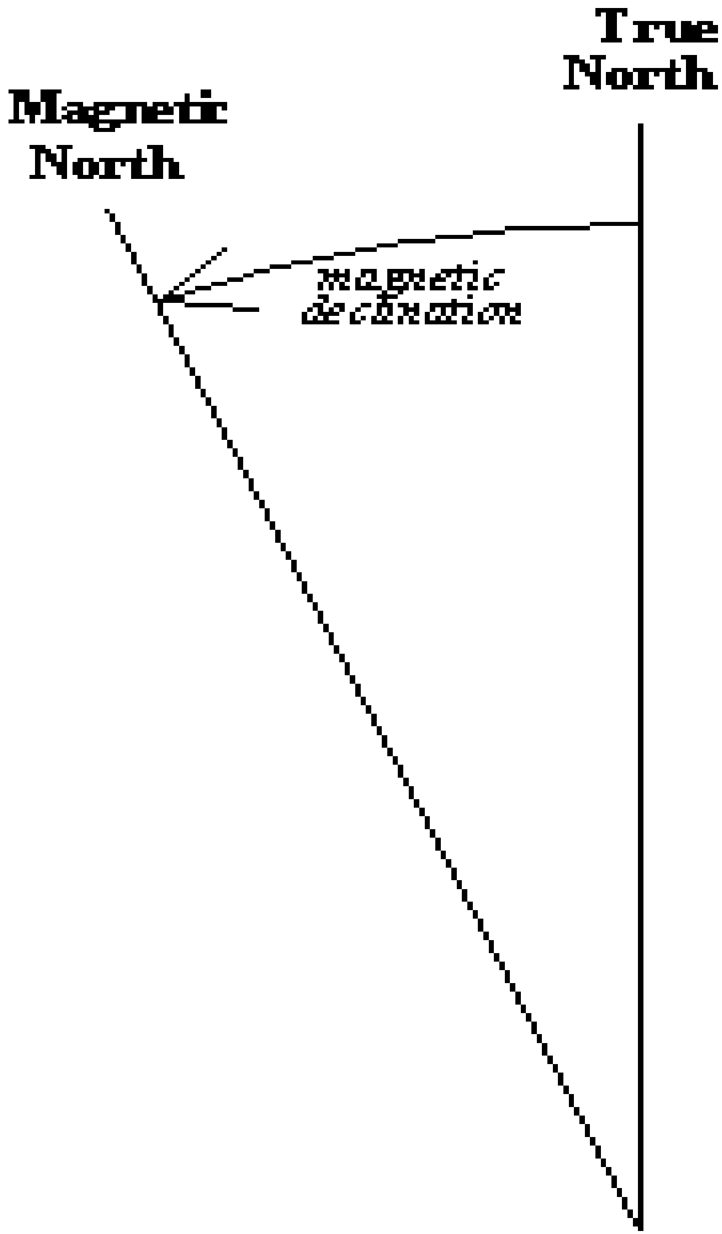
- WCB System
- Quadrantal Bearing System
- Examples
- Problems in Book

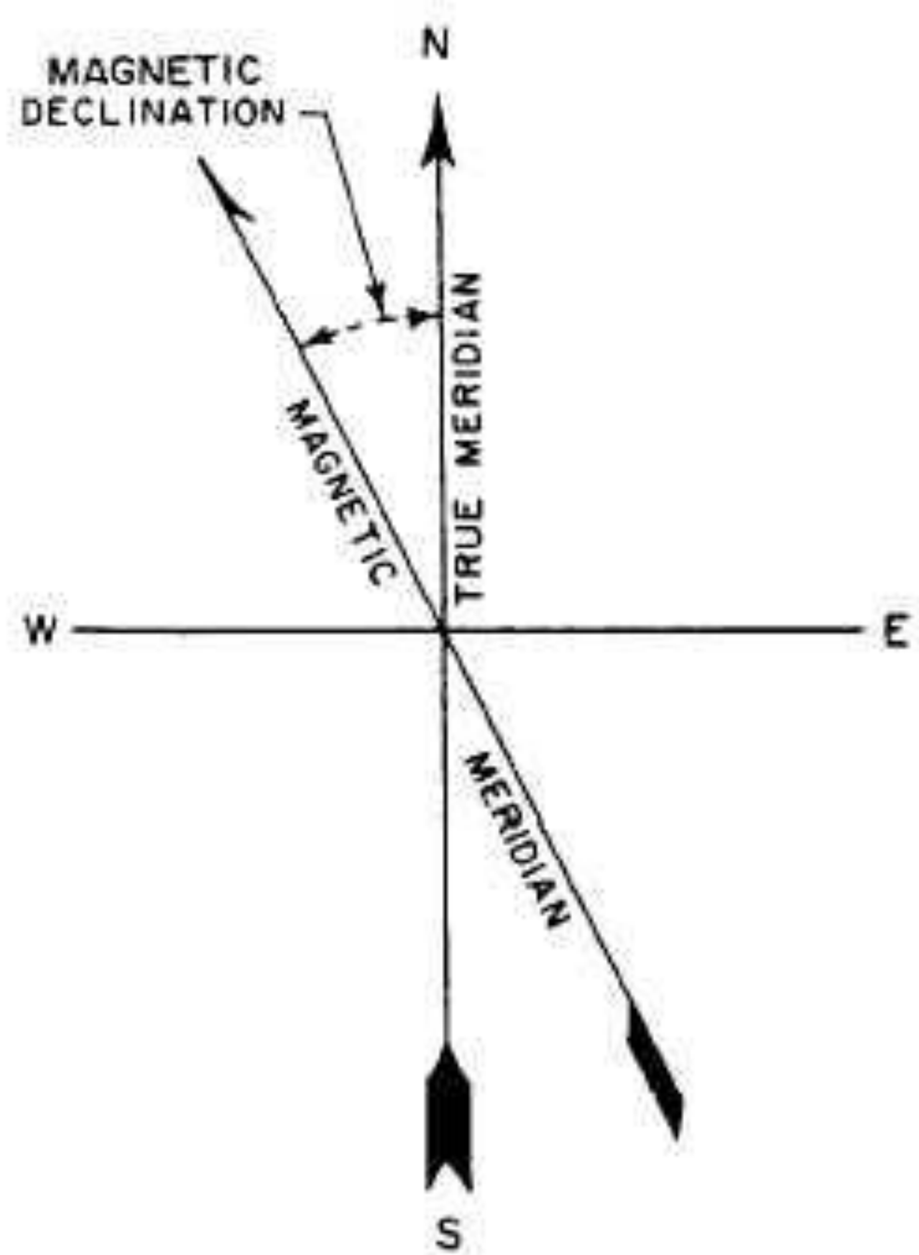
Local Attraction, Dip and Magnetic Declination:

- The magnetic needle is deflected from its normal position when it is under the influence of external attractive forces (called the sources of local attraction). Such a disturbing influence in known as local attraction. The term is also used to denote the amount of deviation of the needle from its normal position.
- If the needle is perfectly balanced before magnetization, it remains in horizontal position. But it will not remain in the same position after it is magnetized, on account of the magnetic influence of the earth. It will be inclined downwards the pole.

Local Attraction, Dip and Magnetic Declination:

- The inclination of the needle with the horizontal is known as dip of the needle. The amount of dip is not constant, but varies in different parts of the earth. It is 0^o at the equator and 90^o at the magnetic poles.
- The magnetic meridian at a place does not coincide with the true meridian at that place except in few places.
- The horizontal angle which the magnetic meridian makes with the true meridian is known as magnetic declination or simply declination.


True North
Magnetic North
magnetic declination


N
MAGNETIC DECLINATION
TRUE MERIDIAN
MAGNETIC
W
E
MERIDIAN
S

Calculation of Angles from Bearings:

- When the bearings are given in WCB
- When given bearings of the two lines are RB
  1. When both the lines lie in the same quadrant
  2. When both the lines are on the same side of different poles
  3. When the lines are on different sides of different poles.
  4. When the lines are lying on different side of same pole.

- Examples

Calculated Bearing:

- Bearings observed in the field with the help of magnetic compass are called observed bearings of that line.

- If we measure the angle between this line and another line at this point of intersection, the bearings of second line can be calculated, which is called the calculated bearing of second line.

Problem:

- A,B,C,D and E are five survey stations of an closed traverse. Following are the interior angles :
- ∟A = 78^o 10' 40''
- ∟B = 165^o 30' 20''
- ∟C = 85^o 10' 20''
- ∟D = 120^o 45' 20''
- ∟E = 90^o 18' 20''
- If the observed bearing of AB is 110^o 20' 40'', then compute the bearings of remaining sides?

Solution

- Since observed bearing of AB is $110^o\ 20'\ 40''$ and we have to find bearings of:

  BC, CD, DE, & EA.

- Bearing of BC = Bearing of BA + angle ABC

  = B.B of BA + angle ABC

  = F.B of AB $\pm\ 180^o$ + angle ABC

  $= 110^o\ 20'\ 40'' + 180^o + 165^o\ 30'\ 20''$

  $= 455^o\ 51' \quad > 360^o$

  $= 95^o\ 51'$ (i.e. $455^o\ 51' - 360^o$)

Solution

- Bearing of CD = Bearing of CB + angle BCD

  = B.B of CB + angle BCD

  = F.B of BC ± 180^o + angle BCD

  = 95^o 51' + 180^o + 85^o 10' 20''

  = 361^o 1' 20''   > 360^o

  = 1^o 1' 20''   (i.e. 361^o 1' 20'' – 360^o)

- Bearing of DE = Bearing of DC + angle CDE

  = B.B of DC + angle CDE

  = F.B of CD ± 180^o + angle CDE

  = 1^o 1' 20'' + 180^o + 120^o 45' 20''

  = 301^o 46' 40''

Solution

- Bearing of EA = Bearing of ED + angle DEA

  = B.B of ED + angle DEA

  = F.B of DE ± 180^o + angle DEA

  = 301^o 46' 40'' – 180^o + 90^o 18' 20''

  = 212^o 5' 0''

Latitude

- It is a projection of a line parallel to the meridian”

OR

- “Latitude of a line is the length of its projection along the meridian”

AB' is the latitude of AB.

$$\textbf{Lat.}_{(ab)} = \textbf{L}\cos\theta$$

Departure

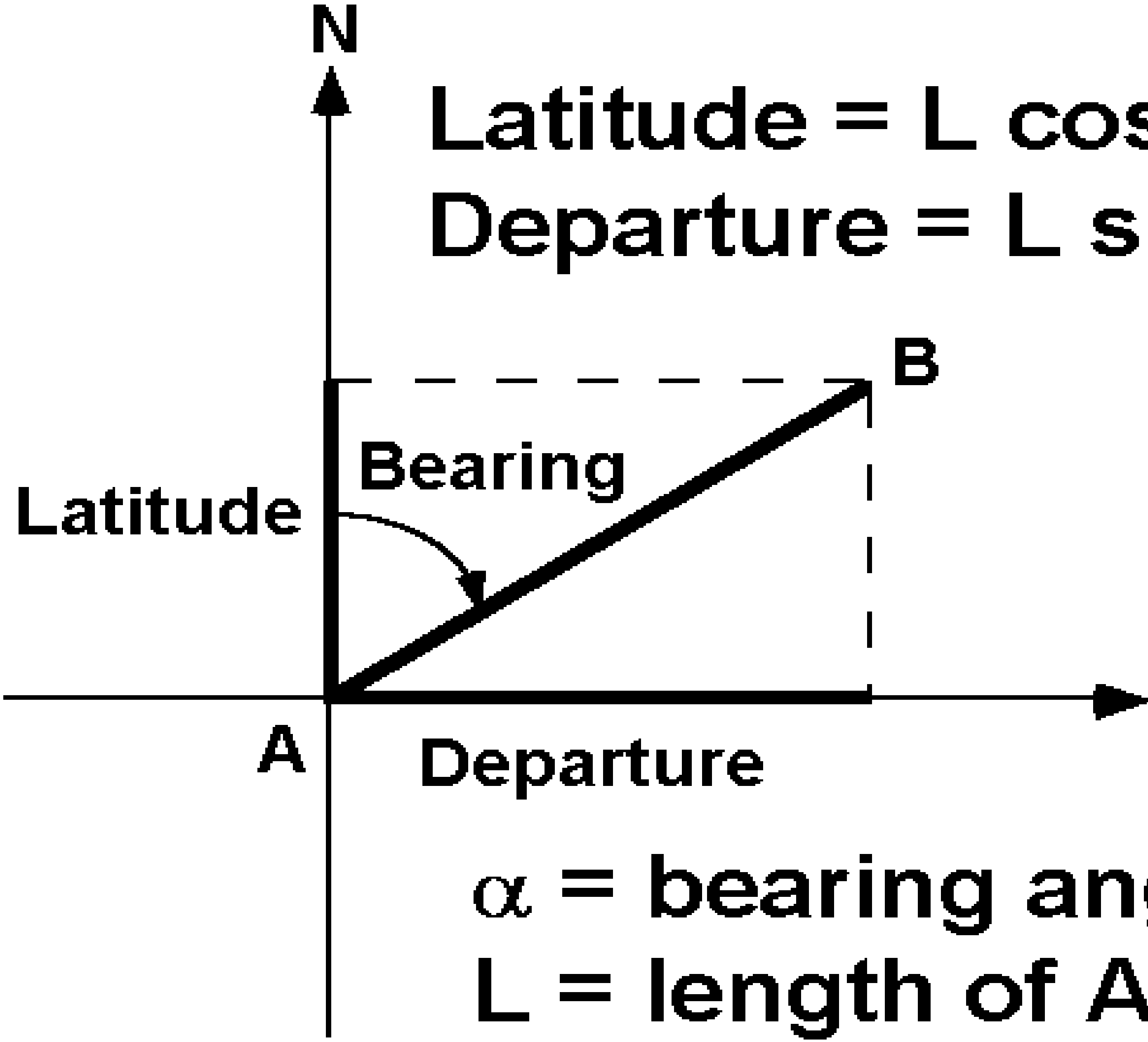
- "Departure of a line is the length of its projection along a line perpendicular to meridian"

AB'' is the departure of AB.

$$\textbf{Dep.}_{(ab)} = L\sin\theta$$

$$\text{Latitude} = L \cos \alpha$$

$$\text{Departure} = L \sin \alpha$$



α = bearing angle

L = length of AB

Problem:

- Calculate the latitude & departure from the following observations?

LINE	LENGTH (L)	BEARINGS (θ)	BEARINGS IN ‘W.C.B’	LATITUDE ‘Lcos θ’	DEPARTURE ‘Lsin θ’
AB	522.1	N 43^{o} 50' E	43^{o} 50'		
BC	560.0	N 35^{o} 20' E	35^{o} 20'		
CD	385.0	N 75^{o} 30' W	284^{o} 30'		
DA	360.0	S 60^{o} 30' W	240^{o} 30'		

Solution

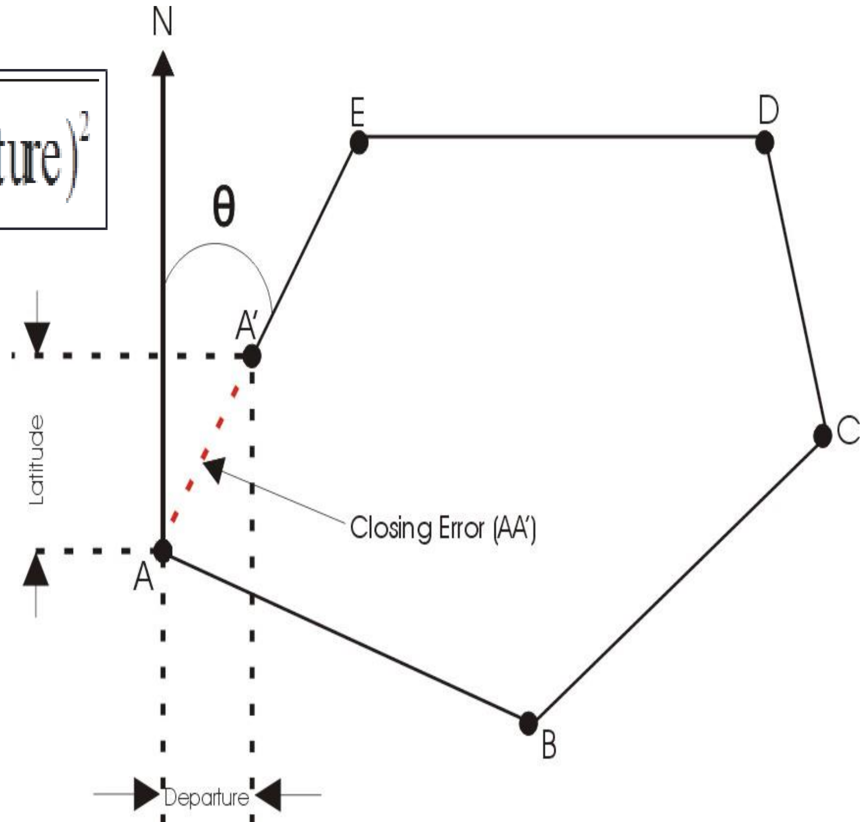
LINE	LENGTH (L)	BEARINGS (θ)	BEARINGS IN ‘W.C.B’	LATITUDE ‘Lcos θ’	DEPARTURE ‘Lsin θ’
AB	522.1	N 43° 50' E	43° 50'	--do--	--do--
BC	560.0	N 35° 20' E	35° 20'	--do--	--do--
CD	385.0	N 75° 30' W	284° 30'	--do--	--do--
DA	360.0	S 60° 30' W	240° 30'	--do--	--do--

CLOSING ERROR OR ERROR OF ENCLOSURE:

- When there is a gap between the starting point of the first line and the finishing point of last line. This gap is called the “error of enclosure”.

$$\text{Length of closing error} = \sqrt{(\Sigma\,\text{latitude})^2 + (\Sigma\,\text{departure})^2}$$

$$\text{Bearing of } AA' = \theta = \tan^{-1}(\Sigma\,\text{dep.} / \Sigma\,\text{lat.})$$



Problem:

- Following data was calculated in connection with a closed traverse PQRS.

LINE	LENGTH (L)	BEARINGS (θ)
PQ	782	$140^{o}12'$
QR	1980	$36^{o}24'$
RS	378	$338^{o}48'$
SP	?	?

Calculate the missing length & bearing of SP?

Solution

LINE	LENGTH (L)	BEARINGS (θ)	LATITUDE 'Lcos θ'	DEPARTURE 'Lsin θ'
PQ	782	$140^o12'$	-600.797	500.565
QR	1980	$36^o24'$	1593.689	1174.969
RS	378	$338^o48'$	352.418	-136.694
SP	?	?	$Lat._{(sp)}$	$Dep._{(sp)}$
			$\Sigma = 1345.31 + Lat._{(sp)}$	$\Sigma = 1538.84 + Dep._{(sp)}$

Now;

$$Lat._{(sp)} = -1345.31$$

& $$Dep._{(sp)} = -1538.84$$

Solution

- Since we know that:
-

$$\text{Length of SP} = \sqrt{(\Sigma\ \text{Lat.})^2 + (\Sigma\ \text{Dep.})^2}$$

OR

$$\text{Length of SP} = \sqrt{(\text{Lat.}_{(sp)})^2 + (\text{Dep.}_{(sp)})^2}$$

- Thus on substituting the values in the above equation, we get;
- Length of SP = 2043.988
- Also;

$\theta = \tan^{-1} (\Sigma \text{ dep.} / \Sigma \text{ Lat.}) = \tan^{-1} (1538.84 / 1345.31)$

* S θ W = $48^o 50' 20''$

Solution

- In W.C.B, we have
- $\theta = 180^o + 48^o50'20''$
- θ = --do--

- ***NOTE:***

- Why we have written “S θ W” and not only “θ”, because value of SP-Latitude is negative and we know that south & west directions are taken as negative.

AREA OF A CLOSED TRAVERSE BY (D.M.D) METHOD:

- “D.M.D” stands for “Double Meridian Distance”

- Area = $\sum$ (longitude $\times$ latitude)

- 2 $\times$ Area = 2 $\times$ $\sum$ (Longitude $\times$ Latitude).

  = $\sum$ (2 $\times$ Longitude $\times$ Latitude).

  = $\sum$ (2 $\times$ M.D $\times$ latitude).

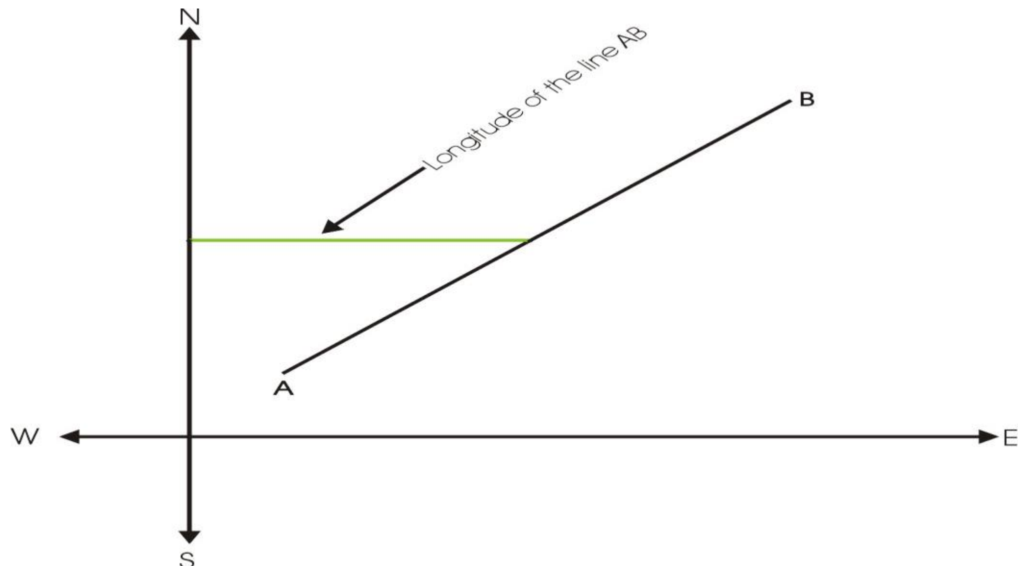
  = $\sum$ (D.M.D $\times$ latitude).

- Area = ½ $\sum$ (D.M.D $\times$ latitude).

Longitude:

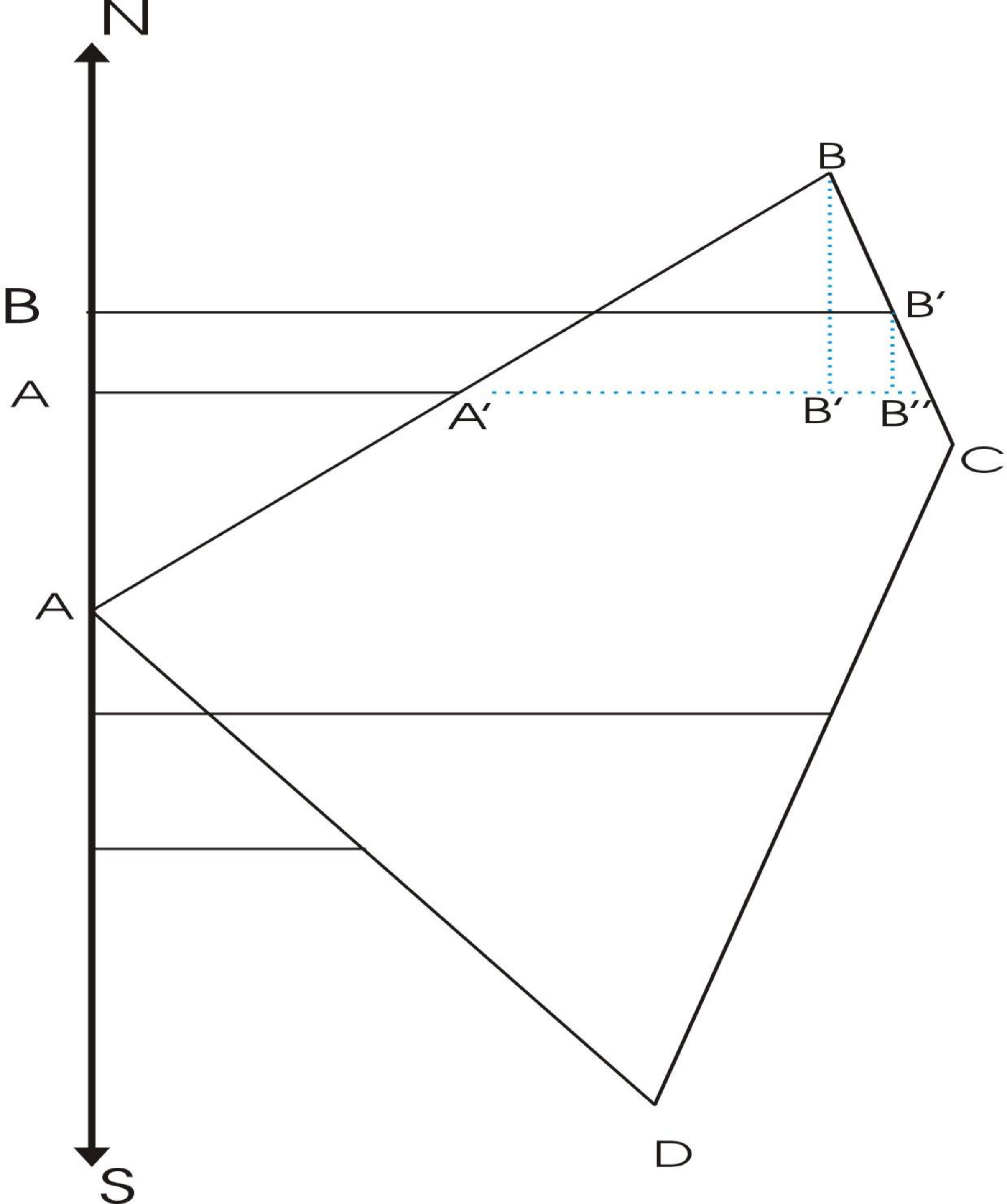
- Longitude (or meridian distance) of a line is the perpendicular distance from a convenient meridian to the center of the line.

- The most convenient meridian for any particular close traverse is the North-South line passing through the most westerly station of the traverse.



AREA OF A CLOSED TRAVERSE BY (D.M.D) METHOD:

- In closed traverse ABCDA, A'_1 and B'_1 are the mid points of sides AB & BC respectively.
- A_1 and B_1 are the foots of perpendicular from A'_1 and B'_1 on the Meridian.
- Meridian distance or longitude of AB = $A_1A'_1$ = ½ (departure of AB).
- D.M.D of AB = Departure of AB
- (M.D) Longitude of BC = $B_1B'_1 = A_1A'_1 + A'_1B' + B'B''_1$
  = M.D of AB + ½ Departure of AB + ½ Departure of BC.


N
B
B′
B
A
A′
B′
B′′
C
A
D
S

AREA OF A CLOSED TRAVERSE BY (D.M.D) METHOD:

- DMD of BC = DMD of AB + Dep. of AB + Dep. of BC
- Similarly, we can prove that:
- DMD of CD = DMD of BC + Dep. of BC + Dep. of CD
- So;
- In general we have:
- DMD of nth line = DMD of (n-1) th line + Dep. of (n-1) th line + Dep. of nth line.
- DMD of last line is equal to the departure of that line but with the opposite sign.
- Area = ½ ∑ (DMD × latitude).

Problem:

Following are the latitudes and departures of a closed Traverse ABCDA. Calculate the area enclosed by DMD method?

Solution:

Line	Latitude	Departure	DMD	DMD × Latitude
AB	-375.98	362.2	362.2	-136179.956
BC	456.82	323.87	1048.27	478870.70
CD	96.40	-372.74	999.4	963421.16
DA	-177.27	-313.33	313.33	-55544.0091

Solution

- Area = $\frac{1}{2} \sum$ (D.M.D × latitude).

  $= \frac{1}{2}$ (383488.8949)

- Area = 191744.4475

- *Hint:

  323.87 + 362.2 + 362.2 = 1048.27