Surveying Engineering

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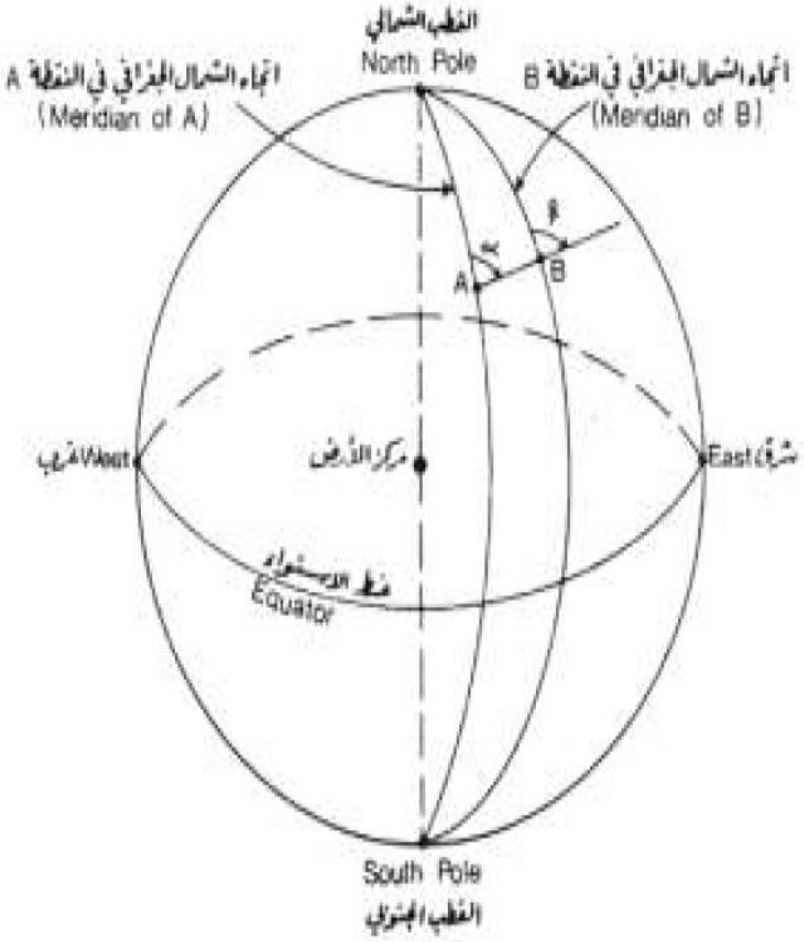
Directions

- It’s a necessary process and an important step in surveying works. Directions are considered as the first step in coordinates calculations of the of points on the land surface. The direction of the line represents the enclosed rang of this line to a specific reference line.
- The reference line may be one of the following forms which are different in direction and accuracy :

1-True Meridian.

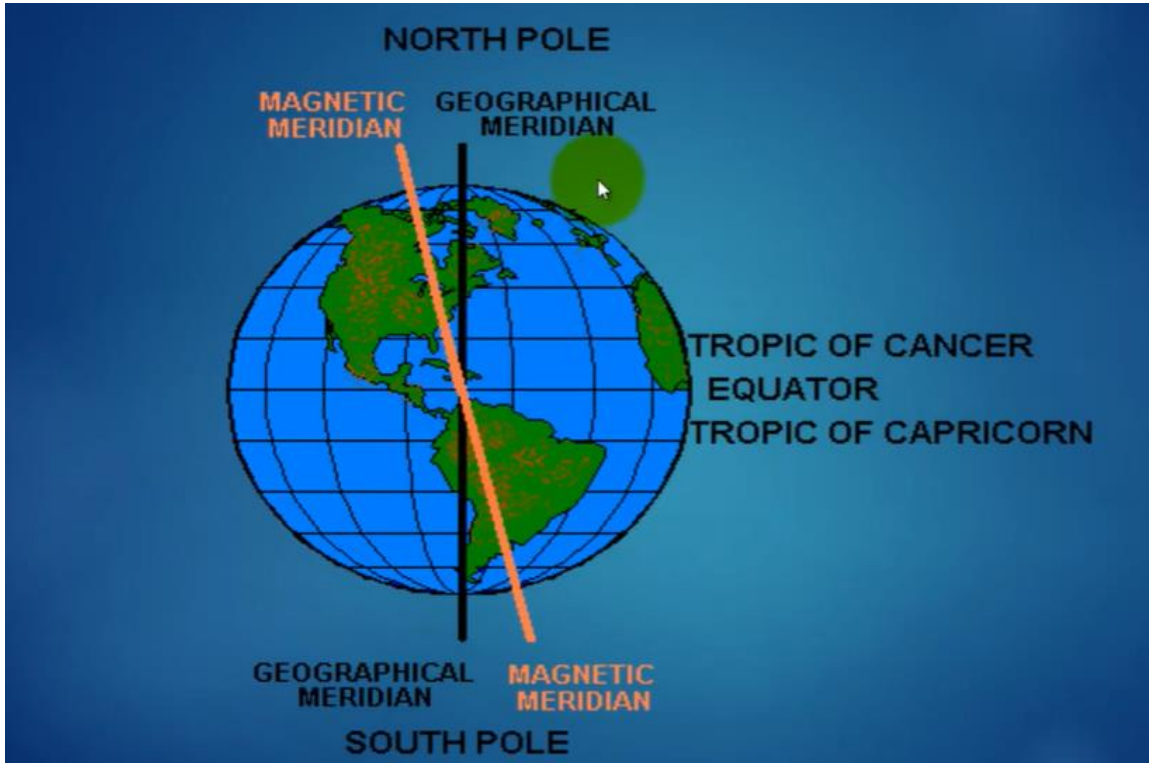
2- Magnetic north.

3- Grid north.



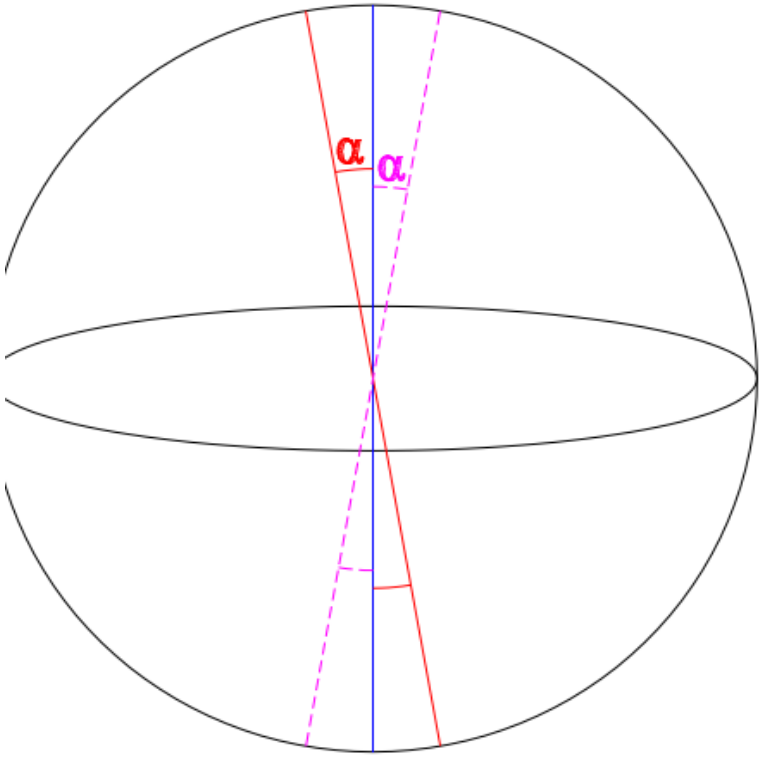
True Meridian

It represents the longitude lines that located on the globe which their meeting point is at the geographical north of the globe. This method is considered one of the most accurate methods for determining the deviation of a line from the north, but the biggest problem is that it needs to a special type of monitoring by using the polar star whose deviation from the true north is very small and with a calculated and known value in advance, or by using satellites, by sending a Specific waves showing the direction of longitude. This type of directions is used in large cadastral works such as cites and country surveys and other international surveys.



Magnetic North

Magnetic North :It is known that the axis of rotation of the globe points to the true north of the globe, but there is another axis that deviates somewhat from it, which is the axis connecting the magnetic poles, as the magnetic north pole does not apply to the true geographical north pole. This magnetic property is used in the compass work, as the magnetic needle of the compass, when it is free to move, is fully balanced and not under any local magnetic influence, it always points to the north. The correction between true and magnetic north is done by knowing the angle of magnetic declination (α).



Grid North

- Grid North : If a broad survey of a particular area is required; The survey process requires drawings and maps of the area; In order to draw the map, the north must be set in the center of the region, and it is considered true north. Therefore, the true north line is drawn in the center of the map, then lines parallel to this line are set arithmetic or imaginary; These parallel lines represent and indicate the Grid direction, and the benefit of it is to calculate the coordinates of the points located on or between the lines. It is also used when it is intended to correct the direction of a particular line relative to the true north.

Directions systems in engineering surveying

1. Quadrant bearing (QB) : It is the range enclosed by (the horizontal angle between magnetic north or south and the line whose direction is to be found, whichever is closer to the line.

2. Whole-circle or Azimuth: It is the enclosed range (horizontal angle) measured from north always clockwise towards the line whose direction is to be found.

Quadrant Bearings

Sometimes it is possible to measure from east or west when the direction of the line is close to east or west. The characteristics of this system are:

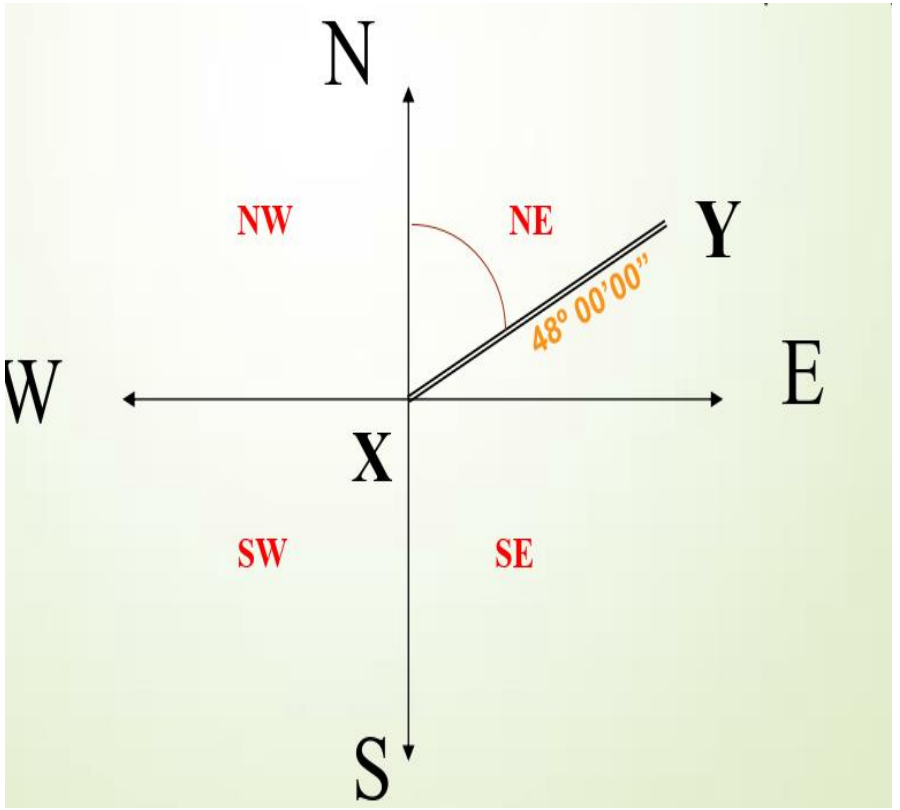
1. The value of the measured angle ranges from 0° to 90, so it is called the quadrilateral system.

2. There is no limitation in movement with a clockwise or counterclockwise direction, but the general designation of the direction of any line is as follows:

The general name of direction ⟶ the started observation direction ⟶ the angle value ⟶ the end of observation direction .

- A QB cannot be greater than 90°.

- A QB is measured in relation to the north or south end of the meridian – NE, NW, SE or SW.

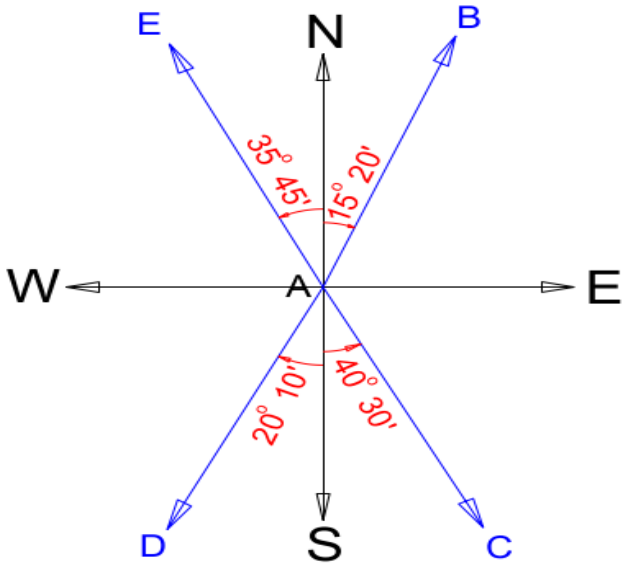


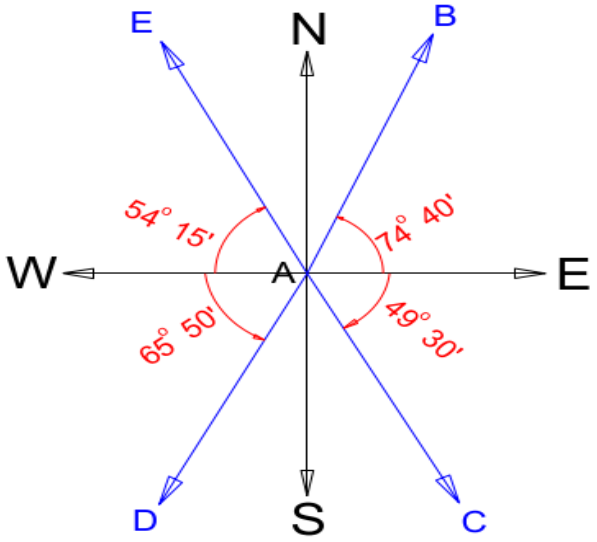
Direction Symbols

الشمال: N = North　　الجنوب: S = South

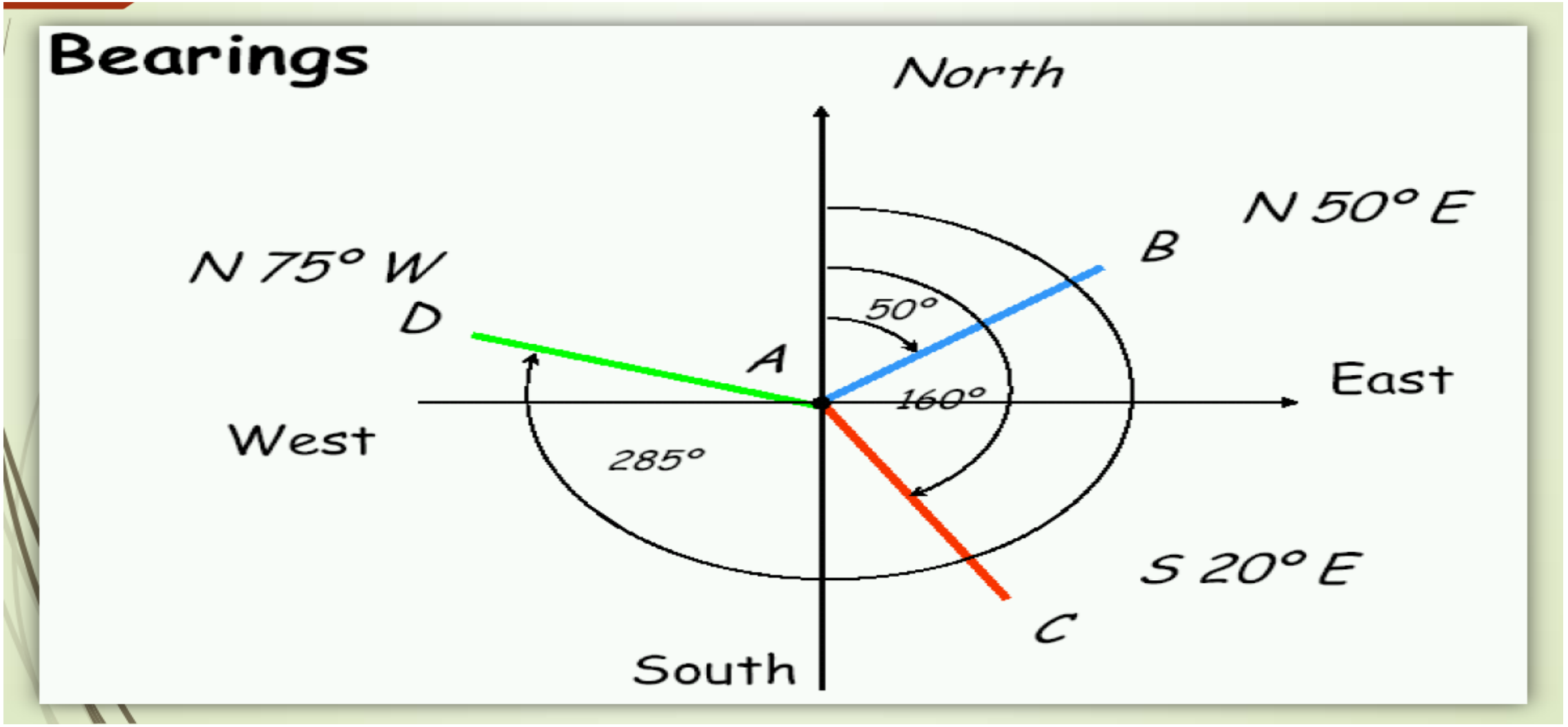
الشرق: E = East　　الغرب: W = West

عندما يتم القياس من الشمال أو الجنوب Bearing	عندما يتم القياس من الشرق أو الغرب Bearing
AB = N 15° 20' E	AB = E 74° 40' N
AC = S 40° 30' E	AC = E 49° 30' S
AD = S 20° 10' W	AD = W 65° 50' S
AE = N 35° 45' W	AE = W 54° 15' N





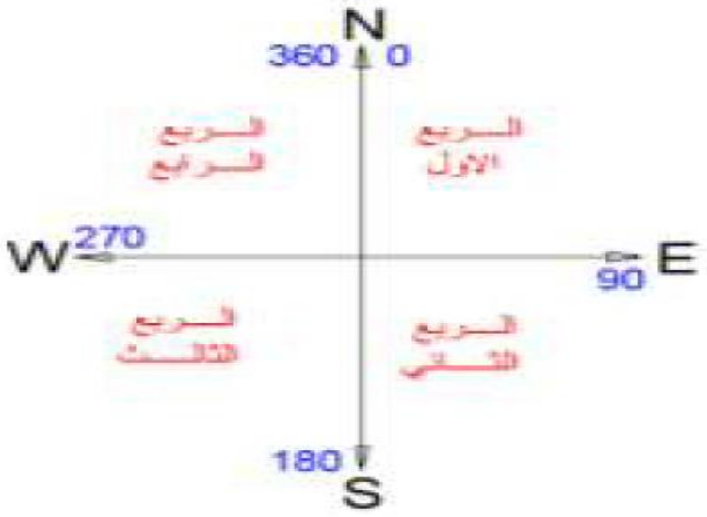
Quadrant Bearings (QB)



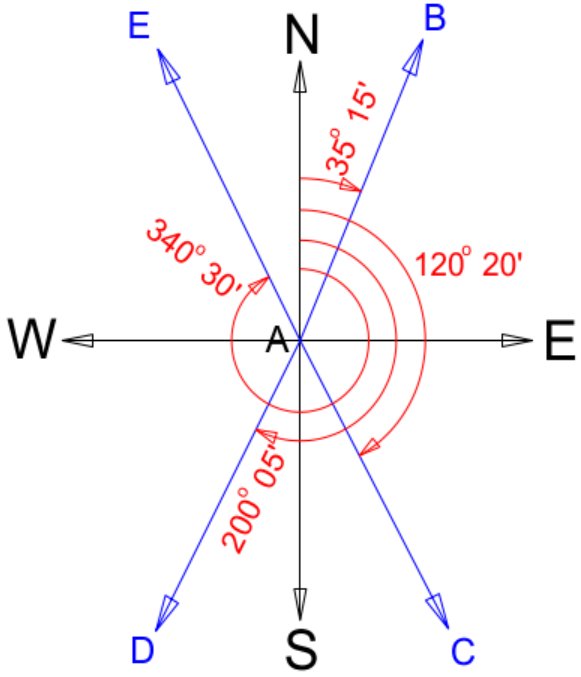
Azimuth whole circle system

- Azimuth consider as the general system that used to represent the four directions, and is preferred over QB system often. The specifications of this system are:
- 1. The value of the angle ranges from (0° - 360), but if any direction crosses 360°, this means that the direction has entered a new circular cycle (the second, third,..) after it has completed the first cycle.
- 2. The movement must be determined in this system, because the measurement process for this system is from the north always with the clockwise. The system works on the basis of the usual quadrants, as shown below:

Whole Circle system Azimuth

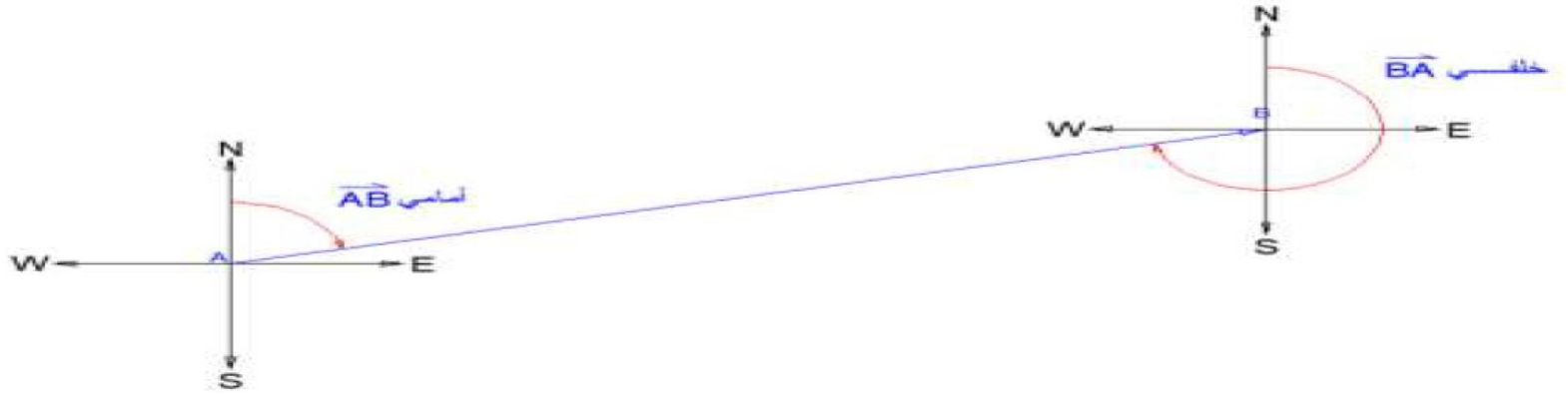


Azimuth	
AB = 35° 15′	الربع الأول
AC = 120° 20′	الربع الثاني
AD = 200° 05′	الربع الثالث
AE = 340° 30′	الربع الرابع



Azimuth

- Forward Azimuth : it is the range (horizontal angle) enclosed between the starting point of observation and the guidance point so that the guidance point is located in front of the starting point of observation .
- Backward Azimuth: it is the range (horizontal angle) enclosed between the starting point of observation and the guidance point so that the guidance point is located behind the starting point of observation .
- Note :when the foreword Azimuth < 180° ⟶ add 180°.
- when the foreword Azimuth > 180° ⟶ subtract 180°.



$$\text{Backward} = \text{Forward} \pm 180$$

Azimuth VS QB

Azimuths	Bearings
Vary from 0 to 360°	Vary from 0 to 90°
Require only a numerical value	Require two letters and a numerical value
Are measured clockwise only	Are measured clockwise and counterclockwise
Are measured either from north only, or from south only on a particular survey	Are measured from north and south

Quadrant	Formulas for computing bearing angles from azimuths
I (NE)	Bearing = Azimuth
II (SE)	Bearing = 180° − Azimuth
III (SW)	Bearing = Azimuth − 180°
IV (NW)	Bearing = 360° − Azimuth

Example directions for lines in the four quadrants (azimuths from north)

Azimuth	Bearing
54°	N54°E
112°	S68°E
231°	S51°W
345°	N15°W

Direction : it is the range that measured from the north to any other line which its direction required. This range is measured clockwise from the north .

Horizontal angle :is the range which enclosed between two specific directions that are measured clockwise from the north at the same point of observation.

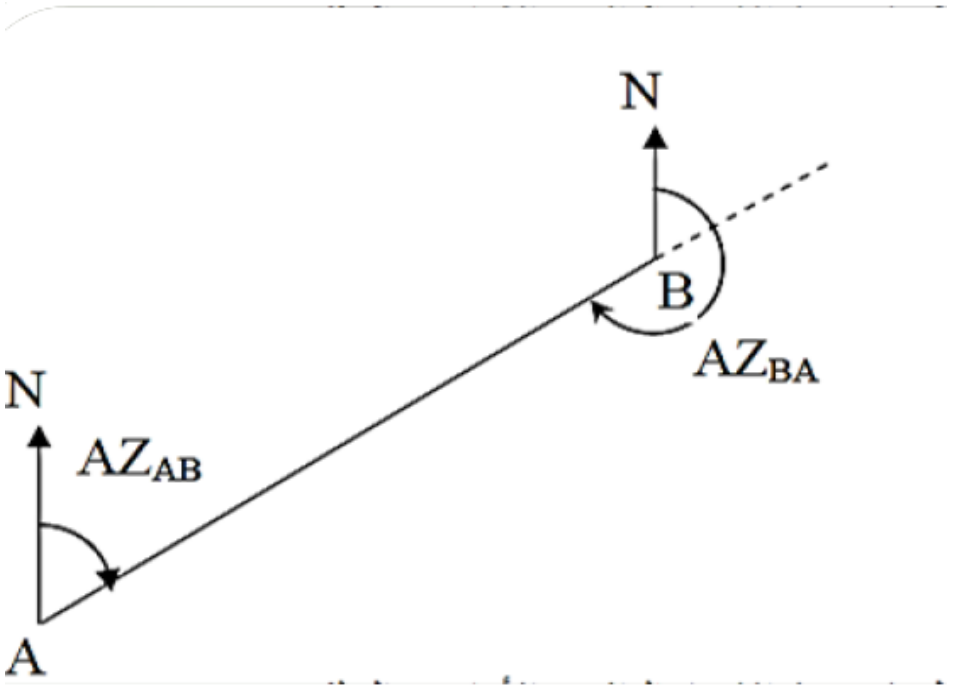
Type of horizontal angles :

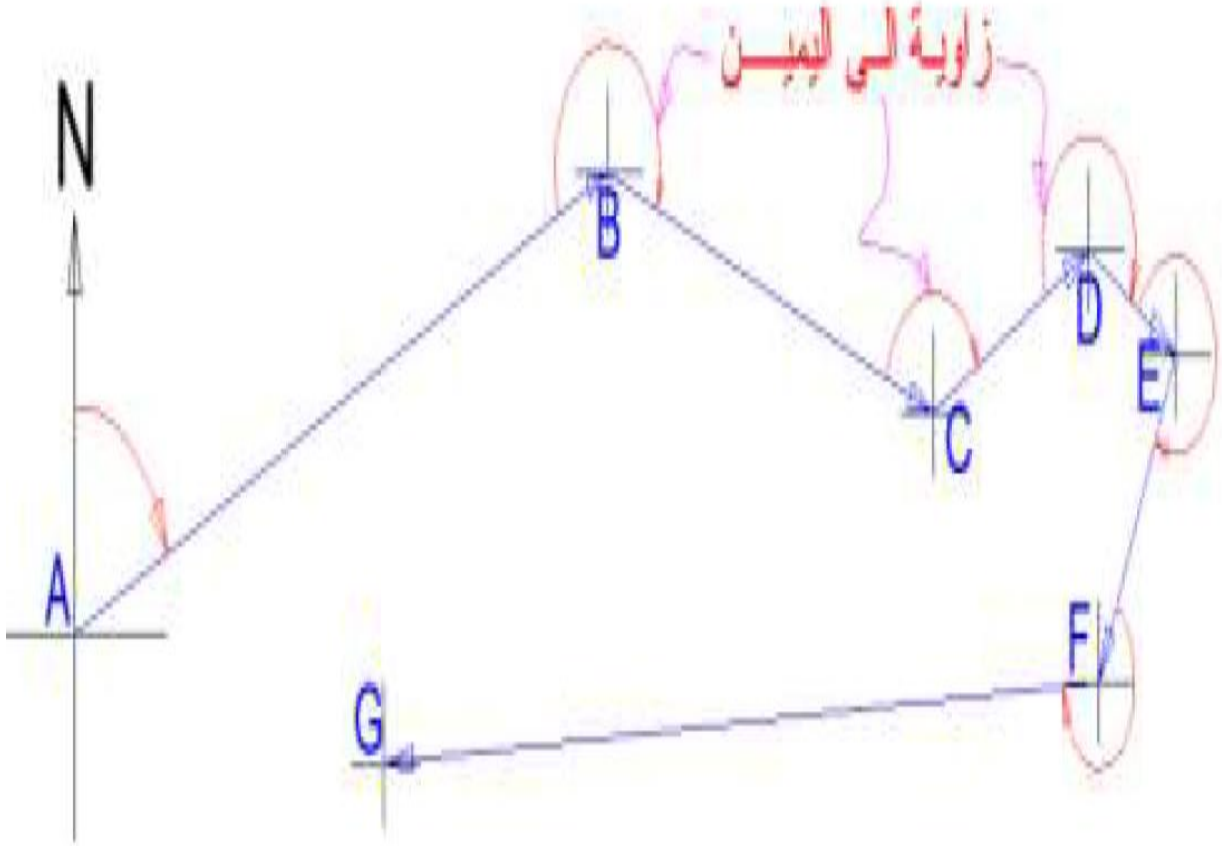
1- right angle : it is the angle that measured from the previous line to the next line with clockwise always, may be an internal or external angles between two lines with certain direction. Angles to the right can be either interior or exterior angles of a closed polygon traverse.

$$\text{Forward Azimuth} = \text{Backward Azimuth} + \text{Angle to the right}$$

Every line consists two direction:
Forward and Reverse directions

- Forward AB = 48º 00’00”
- Backward BA = 48° 00’00” + 180°



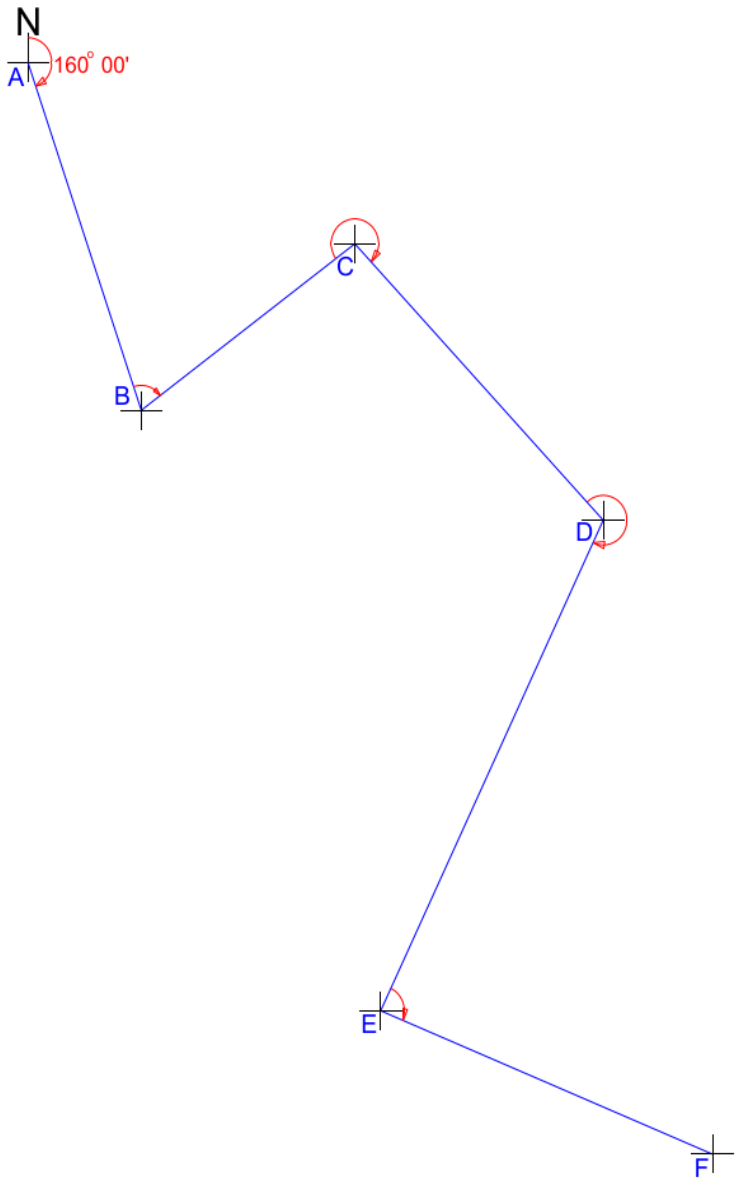


Example 1 : in the tranvers below the angles was measured in the right angle method as shown below :

ABC = 88° 20', BCD = 250° 15',

CDE = 265° 25', DEF = 82° 10’

If the direction of the line AB 160° 00" . Find the directions of other lines?



Solution :

أمامي $AB = 160^{\circ} \rightarrow BA = 160 + 180 = 340^{\circ}$

$BC = BA + \text{Angle to the right}$

$BC = 340^{\circ} + 88^{\circ}\ 20' = 428^{\circ}\ 20'$

$BC = 428^{\circ}\ 20' - 360^{\circ} = 68^{\circ}\ 20'$

$\rightarrow CB = 68^{\circ}\ 20' + 180 = 248^{\circ}\ 20'$

$CD = CB + \text{Angle to the right} = 248^{\circ}\ 20' + 250^{\circ}\ 15' = 498^{\circ}\ 35'$

$\therefore CD = 498^{\circ}\ 35' - 360 = 138^{\circ}\ 35' \rightarrow DC = 138^{\circ}\ 35' + 180 = 318^{\circ}\ 35'$

$DE = DC + \text{Angle to the right} = 318^{\circ}\ 35' +$

$265^{o}\ 25' = 584^{o}\ 00'$

$\therefore$ DE $= 584^{o}\ 00' - 360 = 224^{o}\ 00$ ➔ ED $= 224^{o}\ 00 - 180 = 44^{o}\ 00'$

EF = ED + Angle to the right $= 44^{o}\ 00' + 82^{o}\ 10' = 126^{o}\ 10'$

$\therefore$ اتجاهات الأضلاع هي:

AB $= 160^{o}\ 00'$, BC $= 68^{o}\ 20'$, CD $= 138^{o}\ 35'$, DE $= 224^{o}\ 00'$, EF $= 126^{o}\ 10'$

Example 2 : in the tranvers below the angles was measured in the right angle method as shown below :

ABC $= 136^{o}\ 14'\ 20''$, BCD $= 172^{o}\ 16'\ 40''$, CDE $= 96^{o}\ 37'\ 10''$,

DEF $= 217^{o}\ 54'\ 30''$, EFG $= 81^{o}\ 10'\ 20''$, FGH $= 168^{o}\ 46'\ 50''$,

If the direction of the line "AB = 327° 18' 40. Find the following:

1- draw an approximate line for the tranverse on which directions are indicated for each line, and angles between these lines.

2- find the line GH .

AB = 327 ° 18' 40"

BA = 327 ° 18' 40" – 180

Solution :

$\therefore$ BA = 147° 18' 40"

BC = BA + Angle to the right

BC = 147° 18' 40" + 136° 14' 20" = 283° 33' 00"

$\therefore$ CB = 283° 33' 00" – 180 = 103° 33' 00"

CD = 103° 33' 00" + Angle to the right = 103° 33' 00" + 172° 16' 40"

CD = 275° 49' 40" ➔ DC = 275° 49' 40" – 180 = 95° 49' 40"

DE = DC + Angle to the right = 95° 49' 40" + 96° 37' 10" = 192° 26' 50"

$\therefore$ ED = 192° 26' 50" – 180 = 12° 26' 50"

EF = ED + Angle to the right = 12° 26' 50" + 217° 54' 30" = 230° 21' 20"

FE = 230° 21' 20" – 180 = 50° 21' 20"

FG = EF + Angle to the right = 50° 21' 20" + 81° 10' 20" = 131° 31' 40"

GF = 131° 31' 40" + 180 = 311° 31' 40"

GH = GF + Angle to the right = 311° 31' 40" + 168° 46' 50" = 480° 18' 30"

$\therefore$ GH = 480° 18' 30" – 360 = 120° 18' 30" ➔ الاتجاه المطلوب