وزارة التعليم العالي والبحث العلمي

الجامعة التقنية الجنوبية

المعهد التقني العمارة

قسم تقنيات المساحة

Advance Surveying/1

Surveying Department

Second Stage

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الأسبوع	تفاصيل المفردات النظرية
1	مراجعة تصنيف أجهزة الثيودولايت والتعرف على أجزاءه الرئيسية ووظيفة كل جزء، تعلم كيفية قراءة الدوائر الأفقية والرأسية وتسجيلها في دفتر الحقل لأجهزة مختلفة
2	تعلم الطالب على طرق رصد الزوايا الأفقية.
3	كيفية قراءة وحساب الزوايا الرأسية والخطأ الهامشي (خطأ الاستدلال أو المؤشر) وتوضيح المواقع التي يستفاد منها وكذلك مصادر الأخطاء في قياس الدوائر (الزوايا) الرأسية.
4	تعلم أنواع الشمال وكيفية رصد الشمال الحقيقي والمغناطيسي والافتراضي وحساب اتجاهات الأضلاع من خلال الزوايا المرصودة في الحقل.
5	أنواع المضلعات واستخدامها ودرجاتها (تصنيفها) مع الأعمال الحقلية الخاصة بالتضليع وأنواع الزوايا المستخدمة في المضلعات الدائرية المغلقة. (Closed Loop Trav., Closed Connected Trav.).
6	إجراء التصحيحات للزوايا بمختلف أنواعها في المضلعات الدائرية المغلقة وحساب الاتجاهات الصحيحة من خلالها.
7	حساب المركبات الأفقية والرأسية في المضلعات الدائرية المغلقة وطرق تصحيحها (بالبوصلة والعبور) (Compass Rule & Transit Rule).
8	حساب الإحداثيات (مواقع النقاط) باستخدام المركبات الأفقية والرأسية المصححة وتصحيح الإحداثيات باستخدام المركبات الأفقية والرأسية التي تحتوي على خطأ قفل (Closure error) بطريقتي البوصلة والعبور.
9	الحسابات الأمامية والحسابات العكسية لمواقع النقاط.
10	تعلم الطالب كيفية انتخاب نقاط مضلع رابط مغلق (Connected Traverse) ورصد كافة الزوايا (باتجاه اليمين وزوايا الانحراف) وكيفية تصحيحها (Deflection angle – angle to the right) .
11	تعلم الطالب كيفية إجراء حسابات المضلع الرابط المغلق (المركبات الأفقية والرأسية) وحساب الإحداثيات وإجراء التصحيحات بطريقتي البوصلة والعبور، وكيفية التغلب على (تصحيح) خطأ القفل.
12	تعريف المساحة التاكيومترية وأغراضها واستخدامها وشرح الطرق الممكن أيجاد المسافات والمناسيب للاضلاع والنقاط بالطرق التاكيومترية .
13	استخدام جهاز الثيودولايت والمسطرة الاعتيادية لإيجاد المسافات وفرق الارتفاعات بطريقة الظلال (Tangential Method) .
14	استخدام جهاز الثيودولايت والمسطرة الاعتيادية لإيجاد المسافات وفرق الارتفاعات بطريقة الستديا

	.(Stadia Method)
15	الأسس النظرية في استخدام الأجهزة الالكترونية (T.S , EDM) أنواعها ، دقتها، مدياتها، استخداماتها .

-الفئة المستهدفة

طلبة المرحلة الثانية في قسم تقنيات المساحة.

اهداف المقرر :ان يكون الطالب بعد دراسته للمقرر قادرا على

أولاً: التعرف على علم المساحة

ثانياً: تعلم كافة الحسابات الهندسية التي نحتاجها في تنفيذ الاعمال المساحية.

ثالثاً: اتقان اعمال التضليع وشبكات التثليث

رابعا: التعرف على الاجهزة المساحية القديمة والحديثة كالمحطة المتكاملة.

Lecture (1) and (2)

Theodolite

The Theodolite is an instrument used for measuring horizontal and vertical angles and it used in all works surveying high accuracy

جهاز الثيودولايت يستخدم لقياس الزوايا الأفقية والعمودية ويستخدم في أعمال المساحة عالية الدقة

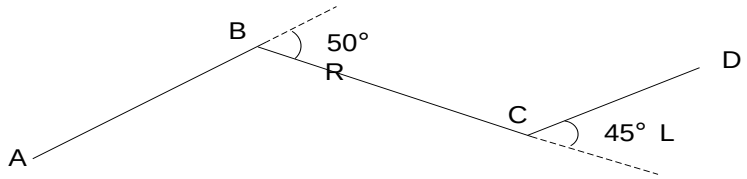
أجزاء جهاز المزواة الحديث Parts of Theodolite :

1- المنظار Telescope .
2- الدائرة الأفقيةو الرأسية Horizontal and vertical circle .
3- لولب لتوضيح الصورة داخل المنظار .
Focusing Knob or screw
4- لولب توضيح حامل الشعيرات Eyepiceming or screw .
5-لولب تطبيق مايكروميتر قراءة الزوايا .
Micrometer Drummer Screw
6- لولب (أو عتلة) قفل الحركة الأفقية السريعة للجهاز .
Horizontal clamp screw or lever
7- لولب التماس الحركة الأفقية البطيئة للجهاز .
Horizontal slow motion (Tangent) screw
8- لولب (أو عتلة) قفل الحركة الرأسية السريعة للجهاز .
Vertical clamp screw or lever
9-لولب التماس الحركة الرأسية البطيئة للجهاز .
Vertical slow motion (Tanget) screw
10-مرآة (أو مرآتان) عاكسة للضوء لزيادة مجال الرؤية داخل منظار قراءة الزوايا (لكل من الدائرة الأفقية والرأسية) .
Horizontal and vertical reflecting mirrors
11- موشور التسامت (أو الشاقول البصري) او قضيب التسامت لإجراء عملية تمركز الجهاز فوق النقطة .
. Optical plummet or centering rod
12- لوالب التسوية الثلاثة لضبط أفقية الجهاز .
. Three leveling head screw
13-فقاعة دائرية وأخرى طولية لضبط أفقية الجهاز .
. Circular and Tubular bubbles
14- لولب تثبيت الجهاز فوق الحامل .
. Fixing screw for instrument (in tripod head)
15- لولب خط فقاعة التطابق للدائرة الرأسية على شكل (U) او المعوض البصري او الميكانيكي الذاتي .
Automatic optical or mechanical compensator vertical circle V-Bubble .
16- الركيزة الثلاثية الأرجل لتركيب الجهاز فوقها .

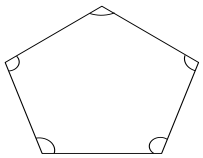
. Three – leg Tripod

Measurement of angles

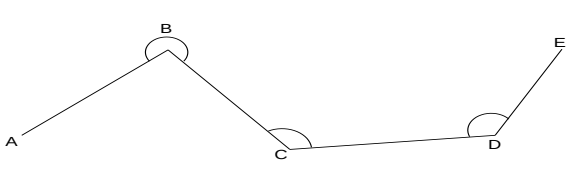
Deflection angle :- The angle between aline and prolongation of the preceding line . It recorded as right or left .

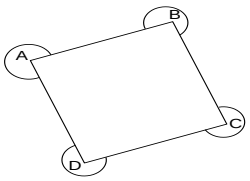


Interior angles :- In closed polygon the angle inside the figure between adjacent lines .



Angles to the Right:- The angle between aline and the preceding line in clock wise direction .





Observation of Horizontal and Vertical Angles

Angles observed in surveying are classified as either ***horizontal*** or ***vertical***, depending on the plane in which they are measured. Horizontal angles are the basic observations needed for determining bearings and azimuths. Vertical angles are used in trigonometric leveling and for the reduction of distances to horizontal.

Horizontal angle:- is the angle formed in ahorizontal plane by two intersecting vertical planes.The theodolite is an instrument used for measuring horizontal and vertical angles .

Two classes of instrument are used to measure horizontal angles . These are :-

a- Repeating theodolite .

b- Direction theodolite .

Measuring ahorizontal angle :-There are two methods.

1-Direction method :-

a- Set up the theodolite at station B.

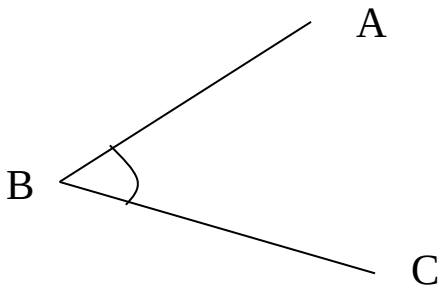
b- Set the vernier to read 0° or take initial reading.

c- Set the telescope to bisect station A.

d- Loosen the upper plat and turn telescope in clockwise direction until the line of sight is set approximately on the right hand sight C .

e- Tighten the upper clamp bisect point C exactly and take reading .which gives the angle ABC if the initially reading = zero.

f- Change the face of the instrument and repeat the whole process. The mean of the two readings gives the value of the angle ABC .



Double Sighting:- measuring the angle once with the telescope in the direct position and once with the telescope in the reversed position .

EX./ A direction theodolite is used to measure angle at Q from P to R , the following observation taken .find the angle PQR .

Ins. station	Station bisected	Circle reading Face Left(L)	Horizontal angle	Circle reading Face Right(R)	Horizontal angle
Q	P	10º 37' 00"	34º 38' 40"	190º 37' 40"	34º 38' 06"
	R	45º 15' 40"		225º 15' 46"	

< PQR = $\frac{34º\ 38'\ 40'' + 34º\ 38'\ 06''}{2}$ = 34º 38' 23"

EX./ Comput the angle SRT from the following observation

Ins. station	Station bisected	Telescope face	Circle reading	Horizontal angle
R	S	L	00º 00' 40"	
	T	L	170º 30' 20"	170º 29' 40"
	T	R	350º 30' 00"	170º 29' 20"

$< SRT = \frac{170°\ 29`\ 40``+170°\ 29`\ 20``}{2} = 170°\ 29`\ 30``$

F.L = F.R – 180

2- Repetition Method:-

To improve upon the accuracy for measuring a single horizontal angle , the method of repeat ion is used .

For reading angle BOC :-

1- The instrument is set up O , make vernier zero or take initial reading .

2-The lower clamp is loosened , bisect station B , the adjustment of bisection is done by the lower tangent screw .

3- The upper clamp is loosened and the station B bisected any adjustment required in bisection is done by upper clamp , take reading .

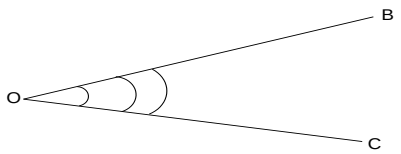
4-The first station B bisected again by loosening the lower clamp , and by loosening the upper clamp dissect C .

5-Repeat the process for example 3 time (No. of repetitions) .

6-The final reading dividing by 3 (No. of repetitions) gives the angle .

7-The same process is repeated on the other face .

8-Mean of two faces is taken as correct horizontal angle .



Examples

Ex. / An angle is measured by repetition . The initial mean reading is 32° 12` 20``. After first repetition the reading is 49° 13` 40`` , after sixth repetition the reading is 134° 19` 20`` .Compute the value of the angle .

Sol /

The approximate angle = 49° 13` 40`` - 32° 12` 20`` = 17° 01` 20``

The angle after repetition = last reading - initial reading

No. of repetitions

$$= \frac{134°19`20``-32°12`20``}{6} = 17°01'10''$$

Ex. / Compute the value of angle if initial reading = 136° 01` 50`` and the first reading = 216° 21` 00`` , reading after 6 repetition = 257° 57` 50`` .

(Ans.= 80° 19` 20``)

Sol. /

The approximate angle =216° 21` 00`` - 136° 01` 50`` = 80° 19` 10``

The approximate reading = 80° 19` 10`` × 6 = 481° 55` 00``

∴ Last reading =257° 57` 50`` + 360° = 617° 57` 50``

H. angle $= \frac{617°57`50``-136°01`50``}{6} = 80°19`20``$

Ex. / Compute the horizontal angle .

Station Inst.	Station bisected	No. of Rep.	face	Circle reading
F	E	0	L	70° 10` 30``
	G	1	L	170° 30` 30``
	G	6	L	312° 11` 00``
	G	6	R	312° 12` 00``

Sol. /

The approximate angle =170° 30` 30`` - 70° 10` 30`` = 100° 20` 00``

The approximate reading = 100° 20` 00`` × 6 = 602°

∴ Last reading =312° 11` 00`` + 360° = 672° 11` 00``

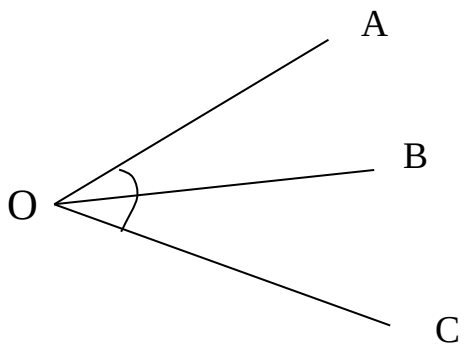
$$\text{L.Angle} = \frac{672°11`00``-70°10`30``}{6} = 100°20`05``$$

$$\text{R.Angle} = \frac{672°12`00``-70°10`30``}{6} = 100°20`15``$$

$$\text{Mean angle} = \frac{F.L + F.R}{2} = 100°20`10``$$

H.W. / Compute the angles AOB , BOC from the following observation at O.

Station Inst.	Circle reading(F.L)	Circle reading(F.R)
A	13° 37` 00``	193° 37` 40``
B	48° 15` 40``	228° 15` 45``
C	101° 19` 45``	281° 19` 00``



Lecture (3)

Vertical Angle

A vertical angle is an angle measured in a vertical plane from horizontal line upward or downward to give negative or positive value .

Sometimes referred to elevation or depression .

vertical angle lies between 0° and $\pm 90^{\circ}$.

Zenith angle :- is an angle measured in a vertical plane downward from an upward direction vertical line through the instrument .it is thus between 0° and 180° .

(الزاوية العمودية:- هي الزاوية الحاصلة من رصد نقطتين بأرتفاعين مختلفين عن سطح الارض وتكون اما موجبة (زاوية ارتفاع) او سالبة (زاوية انخفاض)).

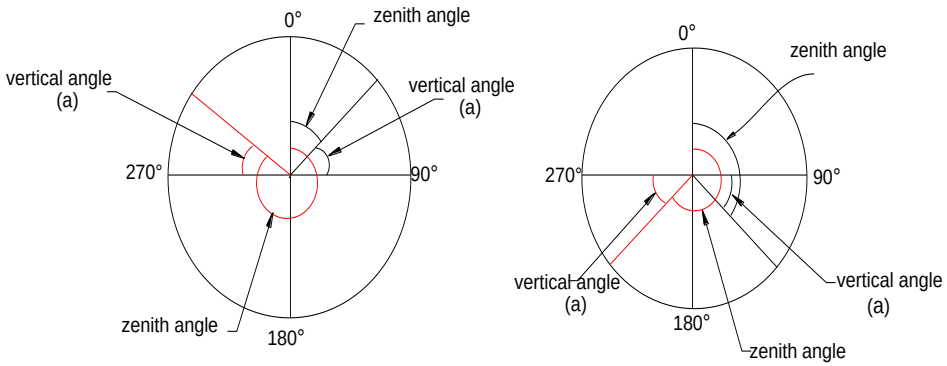
* معظم الاجهزة تكون قراءة دائرتها الرأسية (صفرا) عندما يكون المنظار متجها الى الاعلى . لذلك عندما يكون المنظار افقيا تكون القراءة 90° اذا كان وضع المنظار متياسر (F.L) ، او 270° اذا كان وضع المنظار متيامن (F.R) ويمكن ايجاد قيمة واشارة الزاوية العمودية :- $\alpha = 0^{\circ} - 90^{\circ}$

(وضع المنظار متياسر) $\alpha = 90^{\circ} - Z(F.L)$

(وضع المنظار متيامن) $\alpha = Z(F.R) - 270^{\circ}$

α = vertical angle

Z= Zenith angle



a bove horizontal

Below horizontal

Examples :-

A zenith angle observed on a theodolite as follow:-

(F.L) $85^\circ\ 10`\ 45``$ ⟶ vertical angle(α)= $90^\circ$ - $85^\circ\ 10`\ 45``$=+$4^\circ 49`15``$

(زاوية ارتفاع)

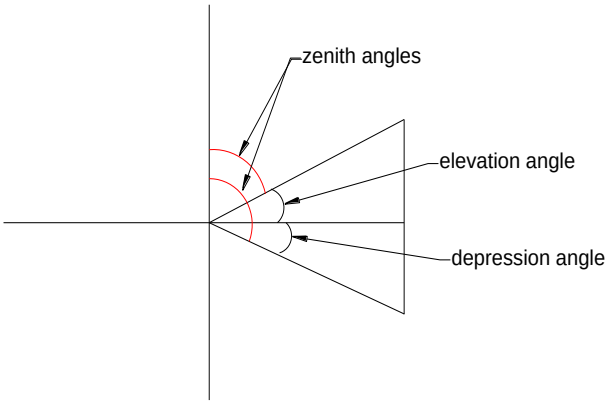
(F.L) $94^\circ\ 12`\ 44``$ ⟶ vertical angle(α)=$90^\circ$ - $94^\circ\ 12`\ 44``$= - $4^\circ\ 12`44``$

(زاوية انخفاض)

(F.R) $274^\circ 49`\ 15``$ ⟶ $\alpha = 274^\circ 49`\ 15`` - 270^\circ = +\ 4^\circ\ 49`15``$

(F.R) $265^\circ\ 47`\ 16``$ ⟶ $\alpha = 265^\circ\ 47`\ 16`` - 270^\circ = -\ 4^\circ\ 12`44``$

F.L =360° - F.R



Ex./ A vertical angle is measured to target on top of hill with telescope in direct position (F.L) , the circle reads ($67^\circ\ 23`\ 50``$), with the telescope in the reversed (F.R) position the circle reads ($292^\circ\ 36`\ 16``$) compute the vertical angle .

$$\alpha = 90^\circ - F.L(F.R - 270^\circ)$$

$$\alpha = 90^\circ - 67^\circ 23`50`` = +22^\circ 36`10``$$

Sol/ $\alpha = 292^\circ 36`16`` - 270^\circ = +22^\circ 36`16``$

$$\alpha = \frac{22^\circ 36`10`` + 22^\circ 36`16``}{2} = 22^\circ 36`13``$$

Ex./ To measure the vertical angle of a point (P) ,the theodolite was set up and leveled at station point (Q).The vertical verniers was set at zero.The final reading of the verniers were as follows :-

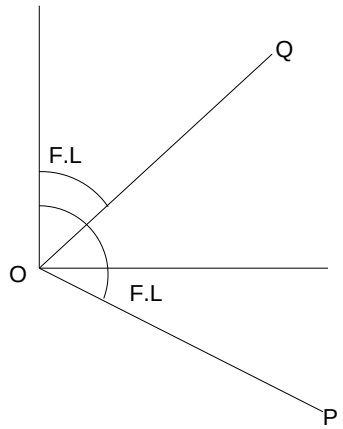
station	Face	V. circle reading	V. angle(α)	Mean V. angle
P	F.L	93° 40` 30``	-3° 40` 30``	
P	F.R	266° 10` 50``	-3° 49` 10``	-3° 44` 50``

* must be the value of (F.L & F.R) negative or positive for the same angle .

*(يجب ان تكون قيمة F.L & F.R موجبة او سالبة لزاوية واحدة) .

H.w./ A surveyor wants to find out the vertical angle between two points P &Q(at different elev.) P being below .The two values of angles are as follow, calculate the vertical angle POQ.

Station Inst.	Station bisected	Face	V. circle reading
	P	F.L	103° 20` 12``
O	P	F.R	256° 39` 40``
	Q	F.L	46° 39` 30``
	Q	F.R	313° 20` 10``



Lecture (4)

Directions

The directions of the lines:- are fixed by measuring the angle between the lines and fixed line of reference .

This angle is called ((bearing)) of the line .

The reference line is called ((Meridian)) and it may be one of the following :-

a- True Meridian :- The line connected the earths poles it is fixed .

الاتجاه الحقيقي :- هو الخط المار بالقطبين الجغرافيين الشمالي والجنوبي للكرة الارضية ويسمى احيانا بالهجير الجغرافي وهو ثابت لايتغير ويعين بواسطة الارصاد الفلكية .

b- Magnetic Meridian:- is the direction which is indicated by freely suspended magnetic needle at specific time .It varies from time to time .

c- Assumed Meridian;- Any line of survey may be assumed to be meridian .

d- Grid Meridian:- A line through one point of survey has been adopted as areference meridian .

e- Azimuths, and Bearings

Determining the locations of points and orientations of lines frequently depends on the observation of angles and directions. In surveying, directions are given by **azimuths** and **bearings**

Systems of Directions (bearing) .

The bearing are designated by the following system:-

1- Whole circle Bearing (W.C.B) or Azimuth :-

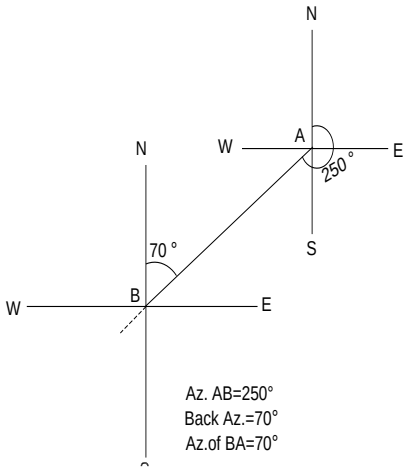
It is the bearings measured from north point towards the line in clock wise direction.(AZ. is measured from N only).

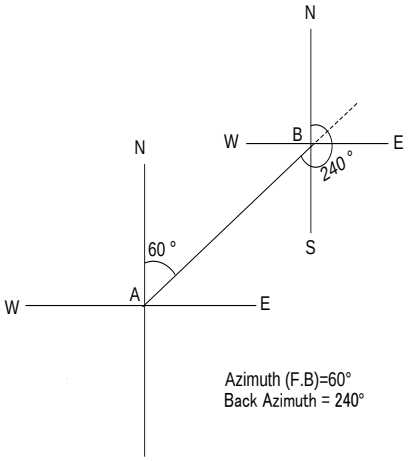
Back Bearing is an opposite direction .

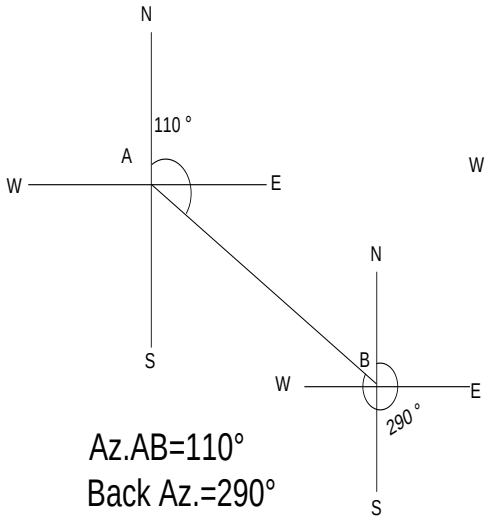
Back Bearing = Bearing $\pm 180^{\circ}$

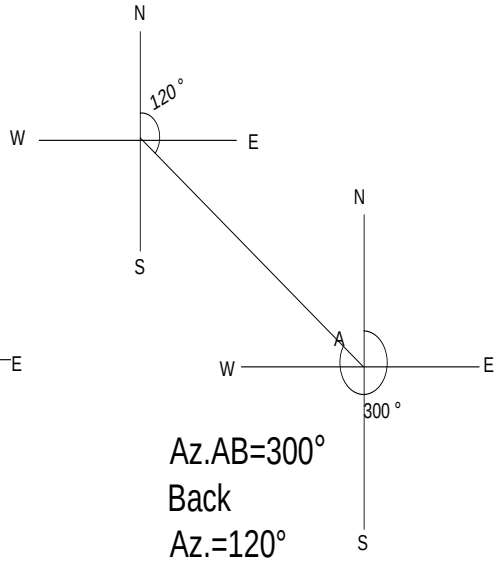
Use (+) if bearing less than 180°

Use (-) if bearing more than 180°





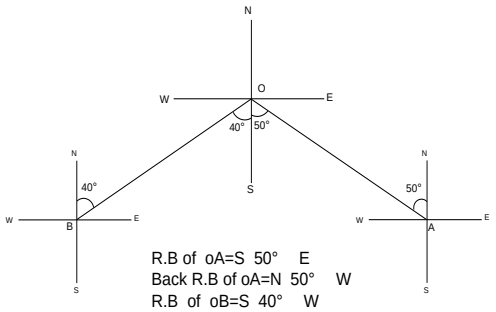




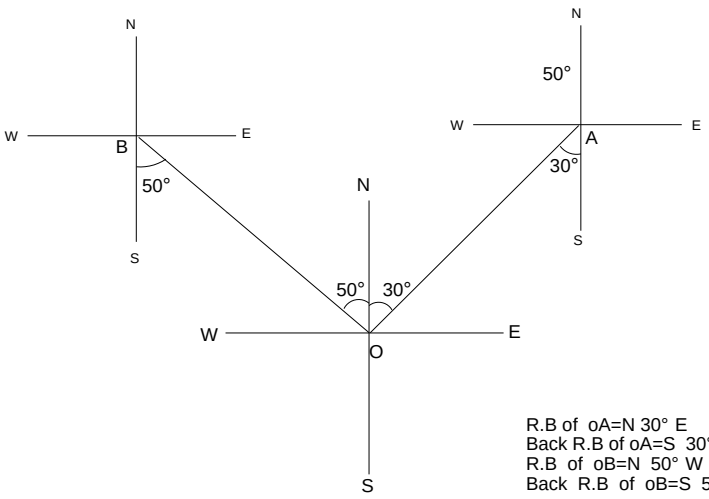
2- Reduced Bearing (R.B):-

Bearings are another system for designating directions of lines. The bearing of a line is defined as the acute horizontal angle between a reference meridian and the line. The angle is observed from either the north or south toward the east or west, clock wise direction or un clock wise direction. to give a reading smaller

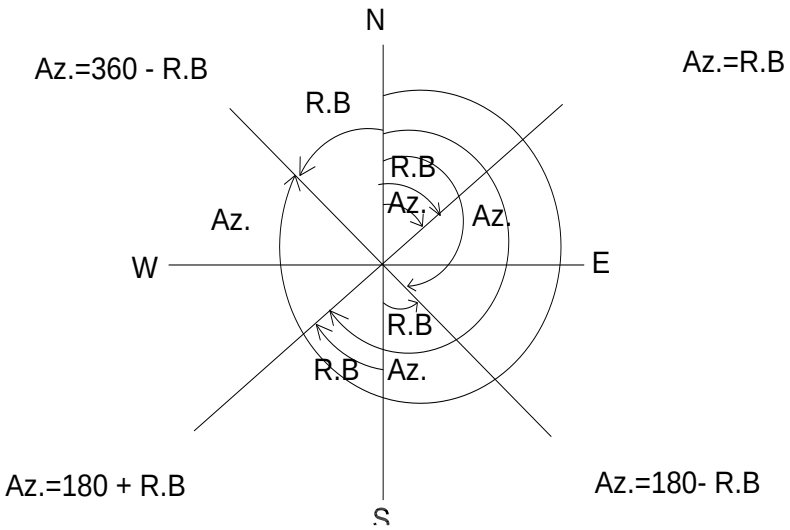
than 90°. The letter N or S preceding the angle, and E or W following it shows the proper quadrant. Thus, a properly expressed bearing includes quadrant letters and an angular value



R.B of oA=S 50° E
Back R.B of oA=N 50° W
R.B of oB=S 40° W
Back R.B of oB=N 40° E



R.B of oA=N 30° E
Back R.B of oA=S 30° W
R.B of oB=N 50° W
Back R.B of oB=S 50° E



Examples:-

W.C.B of line (Az.) = 50° 40́ R.B=N 50° 40́ E

W.C.B of line (Az.) = 130° 20́ R.B= S 49° 40́ E

W.C.B of line (Az.) = 210° 30́ R.B= S 30° 30́ W

W.C.B of line (Az.) = 310° 10́ R.B=N 49° 50́ W

R.B= S 30° 40́ E (Az.) = 149° 20́

R.B= S 50° 30́ W (Az.) = 230° 30́

R.B=N 60° 10́ E (Az.) = 60° 10́

R.B=N 70° 50́ W (Az.) = 289° 10́

H.W Convert the Azimuth of lines to R.B.

76° 20` 00``, 90° 00` 00``, 245° 30` 15`` , 108° 32` 20`` , 320° 00` 42`` ,

286° 55` 25``, 164° 00` 00``

Lecture (5)

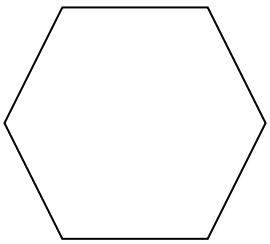
Traversing

Traverse :- A polygon consisting of series of straight lines related to one another by known angles .

.

The traverse may be classified as :-

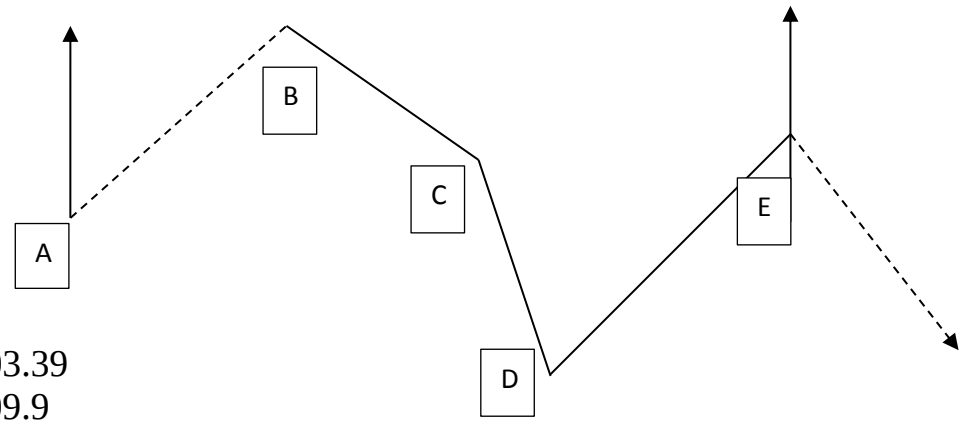
1- Closed traverse :- if the last point closes on the starting point .



2-Open traverse :- if the last point terminates at any point which except the starting .

Connected Traverse

Ex1 :



XB = 5603.39
YB = 5709.9

XE = 6174.80

AZ 1 = AZ 2 + B – n X 180 . YE = 5440.15
= 48 20 + 820 15 – 720 = 148 35
Error = AZ 2 – AZ = 148 35 – 148 30 = 05

Traverse field work:-

1-choose position for stations as close at to the objects to be located .

2- Mark the stations by stone or concrete monument.

3-Make angles and length measurements.

4-Place signales at each station .

5-A sketch of traverse .

Angles of the traverse may be measured by observing :-

1-Interior angles.

2-Deflection angles.

3-Angles to the right.

Lecture (6)

Balancing a traverse

1-Interior angles الزوايا الداخلية

The sum of the included angles =(n-2)×180

n =number of the angles .

The error should not exceed $=(3-5)a\sqrt{n}$ use $3a\sqrt{n}$ (allowable error)الخطأ المسموح.

a =least count of instrument قراءة للجهاز اقل .

(اذا كان الخطأ اقل من الخطأ المسموح به فيوزع على الزوايا, اما اذا كان الخطأ اكثر من المسموح به فيعاد العمل).

EX./ The clockwise interior angles in a traverse which beginning and closes at point A are at follows ,compute the adjusted angles .

Station	interior angles	correction	Adjusted angles
A	78° 22` 30``	+18``	78° 22` 48``
B	110° 28` 00``	+18``	110° 28` 18``
C	153° 29` 00``	+18``	153° 29` 18``
D	58° 20` 30``	+18``	58° 20` 48``
E	139° 18` 30``	+18``	139° 18` 48``
SUM measured	539° 58` 30``	+ 1` 30``	540° 00` 00``

∑ Theoretical=(n-2)180

Error = ∑theoretical - ∑measured

Error = 540° 00` 00`` - 539° 58` 30`` = + 1` 30``

Total correction = + 1` 30``

$$\text{Correction for each angle} = \frac{\text{total correction}}{\text{No. of angles}} = \frac{+1`30``}{5} = 18``$$

Or

Error(closure) = ∑measured - ∑theoretical

Error =539° 58` 30`` - 540° 00` 00`` = - 1` 30``

Total correction = + 1` 30``

$$\text{Correction for each angle} = \frac{-\text{ total correction}}{\text{No. of angles}} = \frac{+1`30``}{5} = 18``$$

2-Exterior angles زوايا خارجية

EX./ Adjusted the following traverse's angles

Station	Angles to the right	correction	Adjusted angles
A	254° 30` 00``	+15`	254° 45` 00``
B	248° 15` 00``	+15`	248° 30` 00``
C	276° 30` 00``	+15`	276° 45` 00``
D	299° 45` 00``	+15`	300° 00` 00``
SUM measured	1079° 00` 00``	+ 1°	1080° 00` 00``

The sum of angle to the right should be =(n+2)180

The sum =(4+2)180 = 1080°

Error = ∑theoretical - ∑measured

Error =1080° 00` 00`` - 1079° 00` 00`` = + 1°

Total correction = + 1°

Correction angle = $\frac{+1°}{4} = \frac{60`}{4} = +15`$

3-Deflection angles

The sum of right deflection angle - The sum of left deflection angle = 360°

∑ R - ∑L = 360°

(R)زاوية الانحراف الى اليمين تأخذ اشارة موجبة .

(L)زاوية الانحراف لليسار وتأخذ اشارة سالبة .

لذلك المجموع الجبري لزوايا الانحراف = 360°

EX./ The following deflection angles were measured in a traverse that beginning and closes at station A what are the adjusted deflection angles .

Station	Deflection angles	correction	Adjusted angles
A	113° 39` 00`` L	- 30``	113° 38` 30`` L
B	98° 15` 30`` L	- 30``	98° 15` 00`` L
C	88° 19` 30`` L	- 30``	88° 19` 00`` L
D	117° 43` 00`` L	- 30``	117° 42` 30`` L
E	57° 54` 30`` R	+ 30``	57° 55` 00`` R
SUM			∑L =417° 55` 00`` ∑R= 57° 55` 00`` = 360° 00` 00``

Angles to the left =417° 55` 00`` L

Angles to the right =57° 55` 00`` R

=57° 55` 00`` - 417° 55` 00`` = - 360° 02` 30``(تهمل الاشارة السالبة)

Error = 360° 02` 30`` - 360° = + 02` 30``

Correction angles $= \frac{2`30``}{5} = 30``$

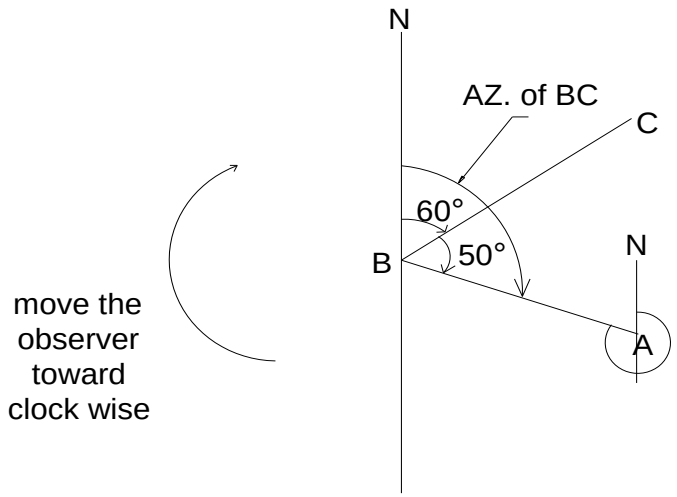
H.W./ Adjust the following deflection angles.

Station	Def. angles
A	30° 26` 00`` L
B	66° 02` 30`` L
C	119° 32` 00`` L
D	57° 28` 00`` R
E	109° 15` 30`` L
F	17° 52` 00`` R
H	110° 00` 30`` L

Computing Directions f or traverse

1-Interior angles الزوايا الداخلية

لايجاد اتجاه اضلاع المضلع يجب معرفة او فرض اتجاه احد الاضلاع(وبمعرفة الزاوية الداخلية)



اذا فرض ان اتجاه BC معلوم $AZ._{BC} = 60^{\circ}$

B angle $= 50^{\circ}$

AZ. For BA$=60^{\circ} + 50^{\circ} + 110^{\circ}$

AZ. For AB$= 110^{\circ} + 180^{\circ} = 290^{\circ}$

(back $AZ._{AB} + 180^{\circ}) = 290^{\circ}$

اما اذا كان الاتجاه الدائري للضلع AB معلوم $= 290^{\circ}$

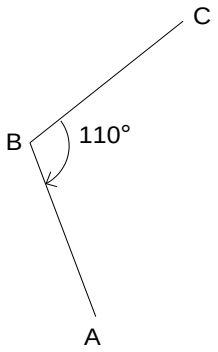
AZ. For BC = AZ. For BA $- 50^{\circ}$

$= 290^{\circ} - 180^{\circ} - 50^{\circ} = 60^{\circ}$

اي بعبارة اخرى اذا كانت حركة الراصد بأتجاه عقرب الساعة فأن الاتجاه الدائري للضلع =الاتجاه الخلفي للضلع السابق – الزاوية الداخلية .

اما اذا كانت حركة الراصد عكس عقرب الساعة فأن الاتجاه الدائري للضلع السابق = الاتجاه الخلفي -الزاوية

الداخلية



if AZ. of AB =340°
AZ. of BC=Back AZ.

of AB- <B
=
(340°-180°)-110°=50°

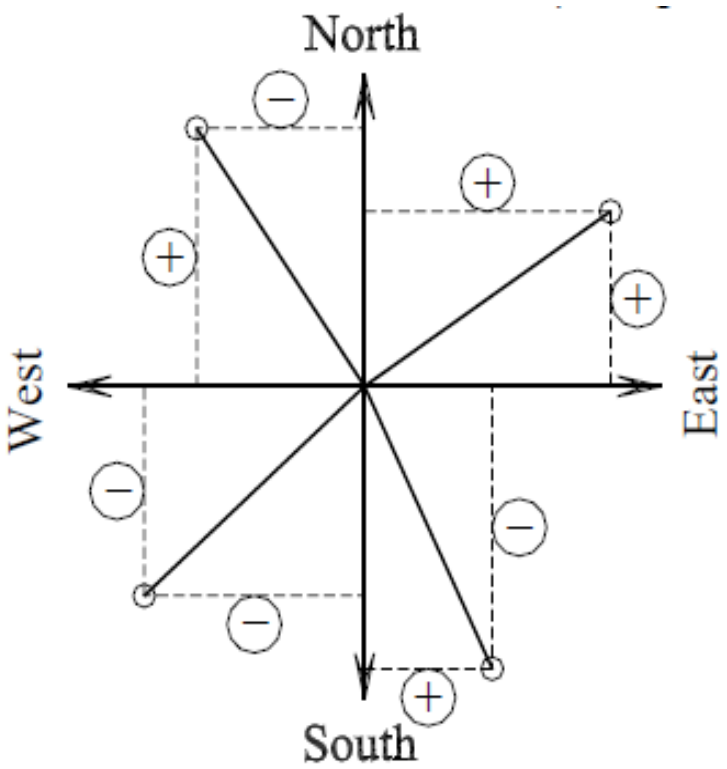
نحدد الإنحراف المختصر لكل ضلع، وبالتالى نعرف موقعه لحساب الاتجاهات:

N-E (North-East) the Vertical component is (+) and Horizontal component is (+)

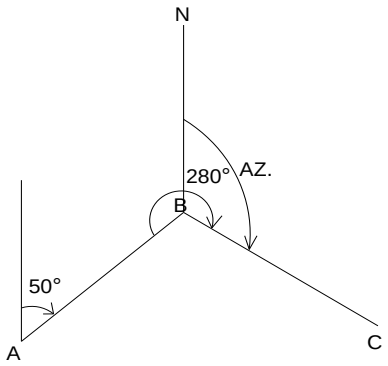
N-W (North-West) the Vertical component is (+) and Horizontal component is (-)

S-E (South-East) the Vertical component is (-) and Horizontal component is (+)

S-W (South-West) the Vertical component is (-) and Horizontal component is (-)

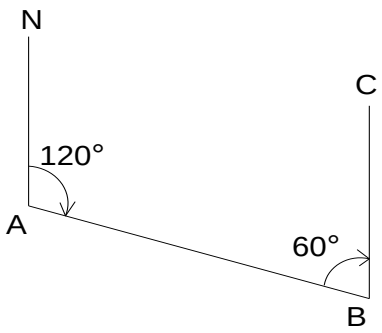


2-Angle to right

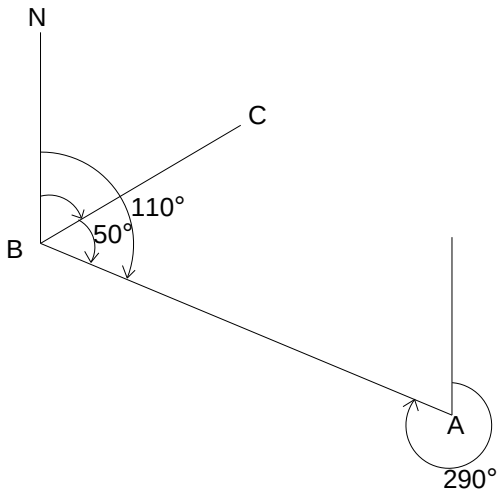


Angle to the right =280°

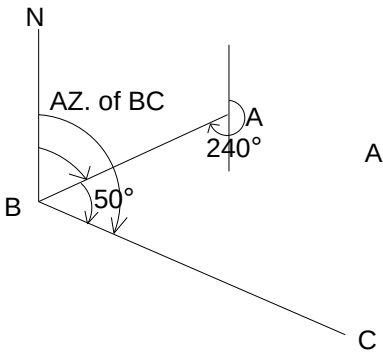
AZ. of AB=50°
AZ. of BC=AZ. of BA+Angle to right
AZ. of BC=(50°+180°)+280°=510°
510°-360° =150°



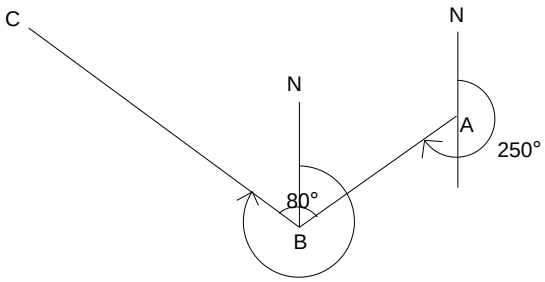
AZ. of AB=120°
AZ. of BC=Back AZ. of AB+Angle to right
=(120° +180°)+60° =360 °-360°= 0°
BC due N



AZ. of AB =290°
Back AZ. of AB=AZ. ± 180°
=290° - 180° =110°
AZ. of BC =Back AZ. of AB - <B
=110°- 50° =60°



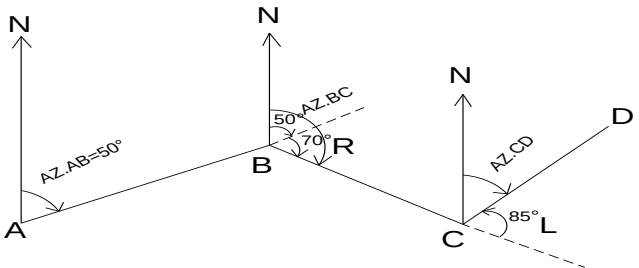
AZ. BC=Back AZ. AB+<B
=(240°-180°)+50°=110°



AZ. of BC =Back
AZ. of AB-C

=(250°-180°) -80°
=350°

3-Deflection Angle

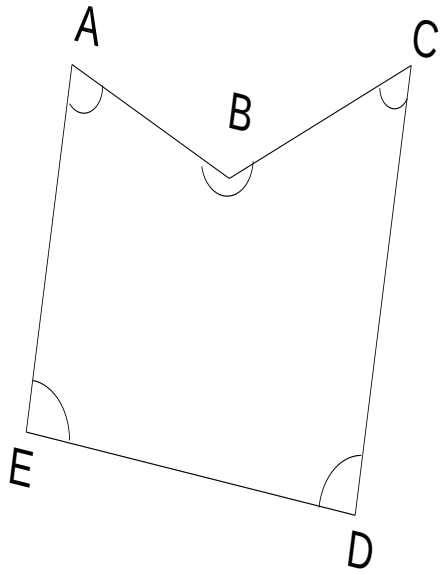


AZ.of AB=50°
AZ.of BC=AZ. of AB+70°
=50°+70°=120°
AZ.of CD=AZ. of BC - 85°
=120° - 85° =35°

AZ. of BC=AZ. of AB+< R
AZ. of CD=AZ. of BC - < L

1-Interior angles

EX./ Compute the Azimuth of each side for the traverse ABCDE , if AZ_{AB} =109° 09` 20`` .



station	Internal Angles	correction	Corrected angle
A	75° 45` 52``	-03``	75° 45` 49``
B	220° 10` 10``	-03``	220° 10` 07``
C	50° 40` 30``	-03``	50° 40` 27``
D	93° 58` 48``	-03``	93° 58` 45``
E	99 24` 55``	-03``	99° 24` 52``
Sum	540° 00` 15``		540° 00` 00``

side	Azimuth
AB	109° 09` 20`` +180° -220° 10` 07`` _____
BC	68° 59` 13`` +180° -50° 40` 27``
CD	198° 18` 46`` -180° -93° 58` 45`` _____
DE	-75° 39` 59`` +360° _____ 284° 20` 01`` -180°
EA	99 24` 52`` _____ 04° 55` 00`` +180° -75° 25` 49`` _____
AB	109° 09` 20``

Lecture (7) and(8)

Departure and latitude

The vertical component (Lat.) = L * cos AZ.

The horizontal component (Dep.) = L * sin AZ.

Where AZ. is the Azimuth.

- Correction Departure & latitude

طرق تصحيح المركبات أو الإحداثيات أو الأطوال للمضلع أو حساب التصحيح :

Methods of correction peps and Lat. or coordinates or lengths .

أ – طريقة أو قاعدة البوصلة أو القياس أو طريقة باودج :

-Compass rule or method or Bowditch method

$$\text{Correction for a dep.} = \frac{-\Sigma \text{Dep.}}{\Sigma \text{Length}} \times \text{length of side}$$

$$\text{التصحيح للمركبة الأفقية للضلع} = \frac{\text{التصحيح الكلي للمركبات الأفقية}}{\text{مجموع أطوال الأضلاع}} \times \text{طول الضلع}$$

$$\text{Correction for a Lat.} = \frac{-\Sigma \text{Lat.}}{\Sigma \text{Length}} \times \text{length}$$

$$\text{التصحيح للمركبة الرأسية للضلع} = \frac{\text{التصحيح الكلي للمركبات الرأسية}}{\text{مجموع أطوال الأضلاع}} \times \text{طول الضلع}$$

ب – طريقة أو قاعدة الترانسيت Transit Rule or Method

$$\text{Correction for a Dep. of a side} = \frac{-\Sigma \text{ Dep.}}{\Sigma \text{ Dep.}} \times \text{Dep. of side}$$

$$\text{التصحيح للمركبة الأفقية للضلع} = \frac{\text{التصحيح الكلي للمركبات الأفقية}}{\text{المجموع المطلق للمركبات الأفقية للمضلع}} \times \text{القيمة المطلقة للمركبة الأفقية}$$

$$\text{Correction for a Lat.} = \frac{-\Sigma \text{ Lat.}}{\Sigma \text{ Lat.}} \times \text{Lat. of side}$$

$$\text{التصحيح للمركبة الرأسية للضلع} = \frac{\text{التصحيح الكلي للمركبات الرأسية}}{\text{المجموع المطلق للمركبات الرأسية للمضلع}} \times \text{القيمة المطلقة للمركبة الرأسية}$$

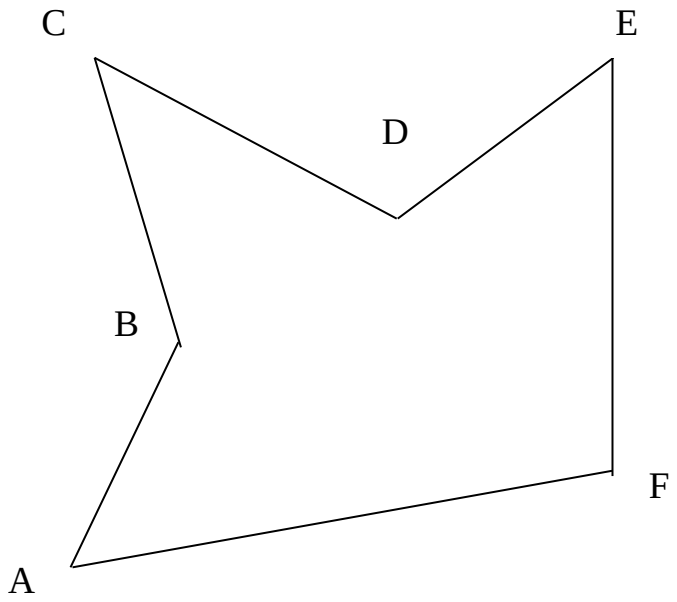
Lat + Dep –	Lat + Dep +
Lat – Dep –	Lat – Dep +

.- Find the coordinates

$E_2 = E_1 + \text{Corrected Dep}$. يأخذ مع الإشارة

$N_2 = N_1 + \text{Corrected Lat}$. يأخذ مع الإشارة

EX/Find the coordinates of traverseABCDEF



Side	Bearing	Length	AZ
AB	N 47 28 00 E	483.52	47 28 00
BC	S 8 27 28 W	392.28	188 27 28
CD	S 56 27 00 W	886.04	236 27 00
DE	N 26 16 30 E	452.66	26 16 30
EF	N 39 18 00 W	279.33	320 42 00
FA	S 80 20 30 E	421.90	99 39 30

Side	Dep	Lat
AB	356.30	326.87
BC	- 57.70	- 388.01
CD	- 738.43	- 489.68
DE	200.38	405.89
EF	- 176.92	216.16
FA	+ 415.92	- 70.78

-Correction Dep. &Lat.

Side	Dep	Lat	Length(m)
AB	356.30	326.87	483.52
BC	- 57.70	- 388.01	392.28
CD	- 738.43	- 489.68	886.04
DE	200.38	405.89	452.66
EF	- 176.92	216.16	279.33
FA	+ 415.92	- 70.78	421.90
	∑ = -0.45	∑ =0.45	∑ =2852.73

1- Compass method

Side	Corr. Dep.	Corr. Lat.	Corrected Dep.	Corrected Lat.	Point	X	Y
AB	+ 0.07	- 0.07	356.37	326.80	A	500	500
BC	+ 0.06	- 0.06	- 57.64	- 388.07	B	856.37	826.80
CD	+ 0.14	- 0.14	- 738.29	- 489.82	C	598.73	438.73
DE	+ 0.07	- 0.07	200.45	405.82	D	60.44	51.09
EF	+ 0.04	- 0.04	- 176.88	216.12	E	260.89	354.73
FA	+ 0.07	- 0.07	415.99	- 70.85	F	84.01	570.85
					A	500	500

2- Transit method

Side	Corr. Dep.	Corr. Lat.	Corrected Dep.	Corrected Lat.	Point	X	Y
AB	+ 0.08	- 0.08	356.38	326.79	A	500	500
BC	+ 0.01	- 0.09	- 57.69	- 388.10	B	856.38	826.79
CD	+ 0.17	- 0.12	- 738.26	- 489.80	C	798.69	438.69
DE	+ 0.05	- 0.10	200.43	405.79	D	60.43	51.11
EF	+ 0.04	- 0.05	- 176.88	216.11	E	260.86	354.69
FA	+ 0.10	- 0.10	416.02	- 70.79	F	83.98	570.79
					A	500	500
			∑= 0	∑ =0			

Lecture(9)

- Inverse Computation الحسابات العكسية لمواقع النقاط

EX./ Compute the missing data from the following table

Line	AZ	Distance (M)	Lat	Dep
AB	—	—	+ 355.36	- 103.04
BC	—	—	+ 20.450	+ 539.61

$$Brg. = \tan^{-1}\left| \frac{Dep.(\Delta X)}{Lat.(\Delta Y)} \right|$$

$$Length = \sqrt{(Dep.)2 + (Lat.)2}$$

$$Dep. = X_2 - X_1 = E_2 - E_1$$
$$Lat. = Y_2 - Y_1 = N_2 - N_1$$

$$Brg. = \tan^{-1}\left|\frac{Dep.}{Lat.}\right|$$

$$Brg.AB = \tan^{-1}\left|\frac{-103.04}{355.36}\right| = 16.17001735^{\circ}$$

$$Brg.AB = N16^{o}10'12.06''W$$
$$AZ.AB = 343^{\circ}49'48''$$

$$Length_{AB} = \sqrt{(-103.04)2 + (355.36)2} = 369.997m$$

$$Brg._{BC} = \tan^{-1}\left|\frac{+539.61}{+20.450}\right| = N87^{\circ}49'46.77''E$$

$$AZ._{BC} = 87^{\circ}49'46.77''$$

$$Length = \sqrt{(539.61)2 + (20.45)2}$$

$$Length = 539.997m$$

Ex.1/Find the missing data from the following table.

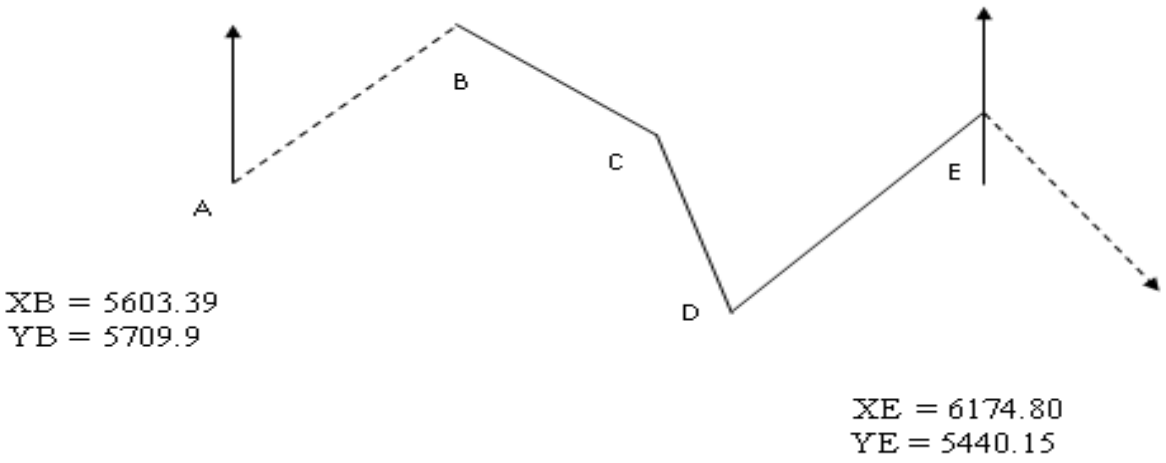
Point	AZ	Distance (M)	Lat	Dep	E	N
K L	?	?	?	?	1000 1162.99	1000 1422
الحل	21° 07 05	452.382	422	162.99		
M N	?	?	?	?	471.89 449.32	867.69 476.04
الحل	183° 17 53	392.2997	- 391.65	- 22.57		

H.W /

Point	AZ	Distance (M)	Lat	Dep	E	N
A B C D	? ?	? ?	? ?	? ?	0.00 193.82 112.53 93.44	0.000 115.19 207.97 158.26

Lecture(10) and(11)

- Link(connected) Traverse



$$AZ1 = AZ2 + \sum \beta - (n * 180)$$

.

= 48 20 + 820 15 – 720 = 148 35

Error = AZ 2 – AZ = 148 35 – 148 30 = 05`

Point	Angle	Corr.	Correct angle	Side	AZ	
B C D E	240° 11´ 215° 36´ 109° 26´ 255° 02´	- 1´ - 1´ - 1´ - 2´	240° 10´ 215° 35´ 109° 25´ 255° 00´	AB BC CD DE EF	48° 20´ 108° 30´ 144° 05´ 73° 30´ 148° 30´	حساب AZ نفس طريقة المضلع المغلق وكذلك DEpو Lat

48 20	108 30	144 05	73 30
+ 180	180	+ 180	+180
228 20	288 30	324 05	253 30
+240 10	215 35	+ 109 25	+ 255
468 30	504 05	433 30	508 30
- 360 00	- 360	360	- 360
108° 30´	144° 05´	73° 30 ´	148° 30´

Dep.	Lat .	Side	Length	AZ.
271.32	- 90.78	BC	286.1	108° 30´
159.67	- 220.45	CD	272.2	144° 05´
140.37	41.58	DE	146.4	73° 30´
571.36	- 269.65		704.7	

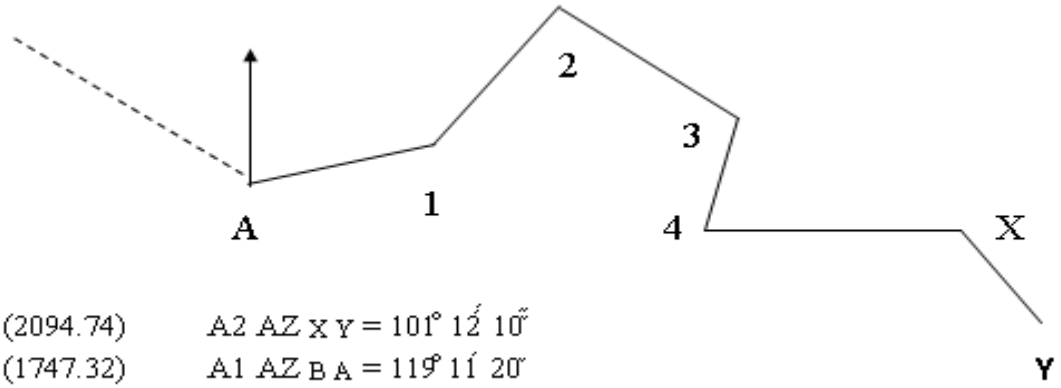
T.C Dep = T.C Dep = X - Dep التصحيح Dep.
X = X 2 – X 1

T.C Lat = T Lat = Y - Lat التصحيح Lat.
Y = Y 2 – Y 1
Dep = 271.36
X = 6174.8 – 5603.39 = 571.41
T.C Dep = 571.41 – 571.36 = 0.05
Y = 5440.15 – 5709.9 = - 269.75
T.C Lat = - 269.75 – (- 269.65) = - 0.10

حساب التصحيحات Dep و Lat **نفس طرق المضلع المغلق .**

Side	Corr Dep .	Corr Lat .	Corrected Dep.	Corrected Lat.	Point	X	Y
BC	+ 0.02	- 0.04	271.34	- 90.82	B	5603.39	5709.9
CD	+ 0.02	- 0.04	159.69	- 220.49	C	5874.73	5619.08
DE	+ 0.01	- 0.02	140.38	41.56	D	6034.42	5398.59
					E	6174.80	5440.15
	0.05	0.10	571.41	269.75			

H.W



A (1769.11) (2094.74) A2 AZ X Y = 101° 12′ 10″
X (2334.71) (1747.32) A1 AZ B A = 119° 11′ 20″

Side	AZ	Length
BA	119 11 20	
A1	54 48 30	208.26
1-2	43 07 50	193.47
2-3	144 20 40	326.71
3-4	207 14 30	309.15
4-x	107 41 00	224.79
x-y	101 12 10	
		1262.3

Lecture(12)and(13)

Tacheometry

The term tachometry means speed measurement distance indirect method .

عبارة التاكيومتري تعني سرعة القياس(القياس السريع) بطريقة غير مباشرة .

Tacheometry Objectives

1- Measuring vertical distances
2- Measuring horizontal distances
3- Measuring the difference between the elevations of two points
4- Reducing time and extensive work required for measurements

Instrument used in Tacheometry :

الأجهزة المستخدمة في المسح التاكيومتري :

1. Subtense bar and the theodolite .
2. level and the leveling rod or staff .
3. Theodolite and the leveling rod .
4. tacheometer and the tacheometer rod or leveling rod .
5. Reducing tachometers and the tachometer rod or leveling rod .

Uses of tacheometry :

(1) For obtaining the horizontal and vertical distances and determination of elevation .
لأجل الحصول على المسافة الأفقية والعمودية وتحديد المناسيب للنقاط .

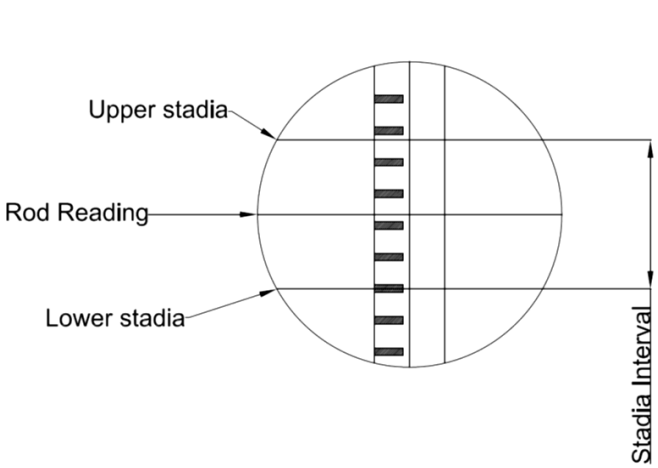
(2) For location surveys of rods or railroads or canals .
لأجل المسح الموقعي للطرق وسكك الحديد والقنوات .

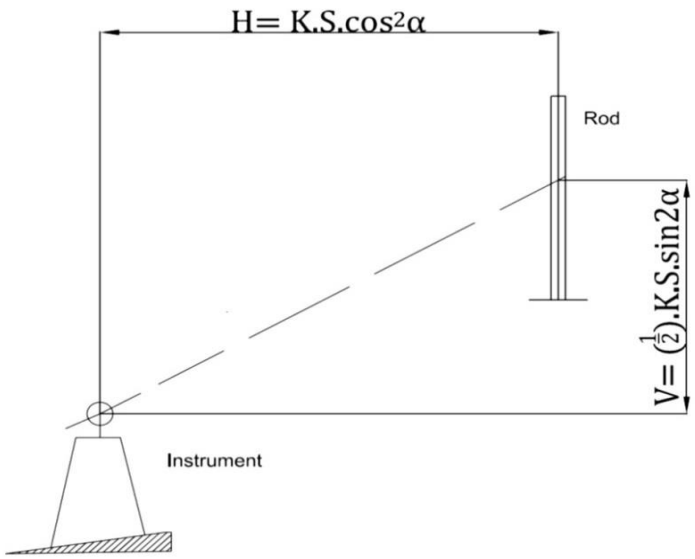
(3) For conduction hydrographic surveying and land surveying and contour map .
لأجل توقيع المساحة المائية والمساحة الأرضية والخرائط الكنتورية .

(4) For conducting traversing difficulty terrain don't able to use tape .
لأجل توقيع المضلعات في التضاريس الأرضية الصعبة غير قادر على استخدام الشريط .

Tacheometry using theodolite and the leveling rod

1- **Stadia method** Used the method of measuring the distances horizontal and vertical are measured by using the optical properties of the telescope of theodolite or Stadia hairs which taken on the rod reading .





تستخدم هذه الطريقة لقياس المسافة الأفقية والعمودية وتقاس بواسطة استخدام الخواص العينية لمنظار الثيودولايت او منظومة الشعيرات المتقاطعة التي تؤخذ القراءات على المسطرة .

Horizontal sight : التسديد او النظر الأفقي

Horizontal sight to measure the horizontal distance from center of instrument to rod by level or theodolite .

التسديد الأفقي لقياس المسافة الأفقية من مركز الجهاز الى المسطرة بواسطة اللفل او الثيودولايت .

$H = K \times S \times \cos^2\alpha$

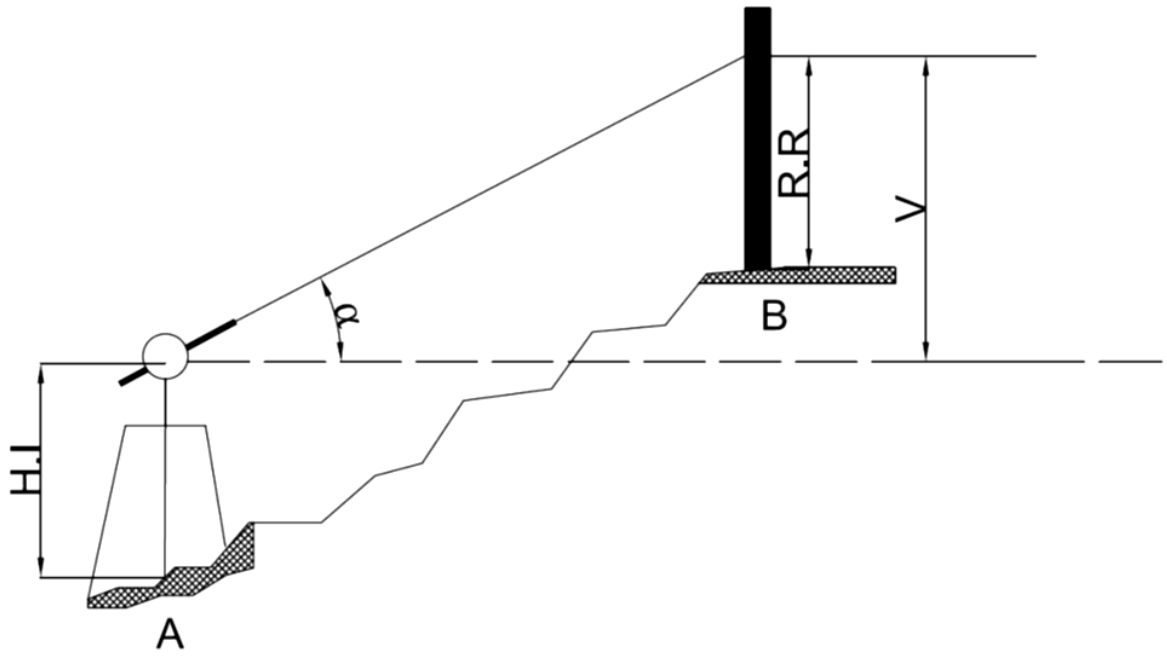
$V = \frac{1}{2} K \times S \times \sin 2\alpha$

(Stadia Interval (S) = Upper Stadia – Lower Stadia)

H: Horizontal distance .
V: Vertical distance.
K: stadia interval factor = 100
S: Stadia interval (the difference between upper stadia reading and lower stadia reading).

α: Zenith angle.

Measuring The Difference Between Two Points Elevations



If **α** is positive:

Elev. (B) – Elev. (A) = H.I + V – R.R

If **α** is negative:

Elev. (B) – Elev. (A) = H.I – V – R.R

Elev. (B): elevation of point B

Elev. (A): elevation of point A
H.I: Height of instrument
V: Vertical distance
R.R: rod reading of the middle stadia hair

Example :

If the height of instrument above point (A) is 1.55 m and the zenith angle is (-7° 15') and the readings of the three hairs are (1.00, 1.32 and 1.64) estimate the elevation of point (B) and the horizontal distance between the two points knowing that point (A) elevation is 42.65 m.

Solution:

R.R = 1.32 m
S= 1.64-1.00 = 0.64 m
V= $12 \times K \times S \times sin2\alpha$
= $50 \times 0.64 \times \sin(14°30')$
= 8.01 m
Since α is negative:
Elev (B) – Elev (A) = H.I – V –R.R
Elev (B) = 42.65+1.55-8.01-1.32
=34.87 m
H= $k \times s \times \cos^2 \alpha$
= $100 \times 0.64 \times \cos 2(7°15')$
=62.98 m.

Example :

Find the elve. Of k from the following observation and distance ok , pk

Inst.sta	Staff.sta	H.I	Staff reading	R.L of inst. Sta	V angle
O	K	1.5	0.63 1.46 2.2	157.75	2 30
P	K	1.6	0.25 1.27 2.3	177.68	- 3 45

$H_{OK} = K.\ S\ COS^2\ \alpha$

$100 \times (2.2 - 0.63) \times COS^2\ 2°\ 30' = 100 \times 1.57 \times 0.9980973$

$H_{OK} = 156.70\ m$

$H_{PK} = K.S.\ COS^2\ \alpha$

$= 100 \times (2.3 - 0.25) \times COS^2\ 3°\ 46' = 100 \times 2.05 \times 0.995724$

$= 204.12\ m$

$V_{OK} = \frac{1}{2}\ K.S.\ Sin\ 2\alpha$

$= \frac{1}{2} \times 100 (2.2 - 0.63) \times Sin\ 2 (2°\ 30')$

$= \frac{1}{2} \times 100 \times 1.57 \times 0.0871 = 6.8417\ m$

Or

$V_{OK} = H \times \tan \alpha$

$= 156.70 \times \tan 2°\ 30' = 156.70 \times \tan 2\ 30$

$= 6.841\ m\ .$

$E_X = E_O + H.I + V - MR$

$= 157.75 + 1.5 + 6.841 - 1.46 = 164.631$

$V_{PK} = \frac{1}{2} \times K.S \times Sin\ 2\ \alpha$

$= \frac{1}{2} \times 100 \times 2.05 \times Sin\ 2 (3\ 45) = 13.378\ m$

$E_K = E_P + H.I - V - MR$

$177.98 + 1.6 - 13.378 - 1.27$

$= 164.631\ m\ .$

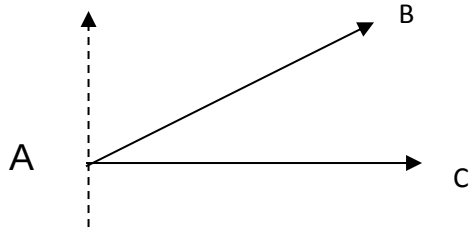
Example :

Theodolite was set up at (A) to observe the staff at B , C the data obtained were as follows :

From	To	V.reading	S (m)	Azimuth
A	B	+ 82° 35□	0.95	30° 20□
	C	+ 80° 35□	0.80	89° 14□

Find the following :

1. the area of triangle (ABC) .
2. If B , C were on the same elevation and the middle reading on staff (C) = 1.45m what will be the stadia readings at staff (B) .



Area (ABC) = $\frac{1}{2}$ x AB x AC x Sin α

H_{AB} = K. S. COS^2 α

α= 90° – 82° 35□= 07° 25□

H_{AB} = 100 x 0.95 x COS^2 07° 25□= 93.417 m .

H_{AC} = K. S. COS^2 α

90 – 80 35 = 09° 25□

= 100 x 0.80 x COS^2 09° 25□= 77.8584 m .

H_{AC} = K. S. COS^2 α

$\alpha = AZ_{AC} - AZ_{BA} = 89° 14' - 30° 20' = 58° 54'$

$Area = \frac{1}{2} \times AB \times BC \times \sin 58° 54'$

$= \frac{1}{2} \times 93.417 \times 77.8584 \times \sin 58° 54'$

$= 3113.9429\ M^2$

$V_{AB} = \frac{1}{2} \times 100 \times 0.95 \times \sin 2\alpha = 50 \times 0.95 \times \sin(2\times 07° 25')$

$= 12.1603$ m .

$V_{AC} = \frac{1}{2} \times 100 \times S \times \sin 09\ 25 = 50 \times 0.80 \times \sin 09\ 25$

$= 12.9126$ m .

بما ان ElevC = Elev.B **لأنها في نفس المنسوب :**

$EB = EC = EA + H.I + V_{AB} - MR_B = EA + H.I + V_{AC} - MR_C$

$EA + H.I + V_{AB} - MR_B - EA + H.I - V_{AC} + MR_C$

$MR_B = V_{AB} - V_{AC} + MR_C$

$MR_B = 12.1603 - 12.9126 + 1.45 = 0.698$

نستخرج L , U الفرق بين القراءتين (S)يقسم على 2 ثم يضاف الى قراءة الشعرة الوسطية نحصل على (U) وكذلك يطرح نحصل على (L) .

$S\ (m) = \frac{0.95}{2} = 0.475$

$U_B = 0.698 + 0.475 = 1.173m$

$L_B = 0.698 – 0.475 = 0.223m$.

H.W A theodolite was set up at point (A) to observe the staff at B , C the data obtained were as follows :

From	To	v. angle	S (m)
A	B	+ 5° 00□	2.50
	C	+ 5° 15□	2.30

Find the following :

1. The area of ABC if BC = 150 m .
2. If B , C are on the same elevation and the middle reading on staff (C) = 1.250 m what will be the stadia readings at staff (B) .

Lecture(14)

2-Tangential method طريقة الظلال

نضع التلسكوب في وضع أفقي ثم توجه أعلى المسطرة نحصل على θ_1 .

نضع التلسكوب في وضع أفقي ثم توجه أسفل المسطرة نحصل على θ_2 .

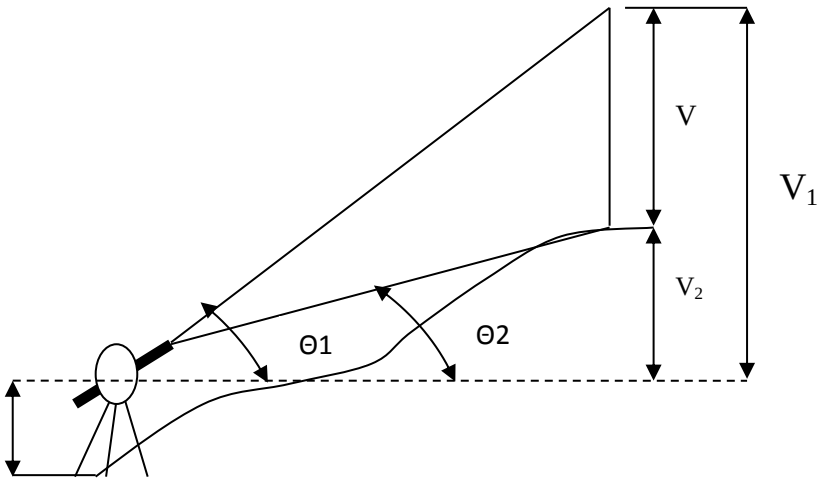
$$\tan\theta_1 = \frac{V_1}{H} \Rightarrow V_1 = H \times \tan\theta_1$$

$$\tan\theta_2 = \frac{V_2}{H} \Rightarrow V_2 = H \times \tan\theta_2$$

$$V_1 - V_2 = H \times \tan\theta_1 - H \times \tan\theta_2$$

$$V_1 - V_2 = H(\tan\theta_1 - \tan\theta_2)$$

$$H = \frac{V_1 - V_2}{\tan\theta - \tan\theta_{21}}$$



بما ان $V_1 - V_2$ يمثل ارتفاع المسطرة نضع طول المسطرة المستخدمة.

ولأيجاد منسوب النقاط نطبق القانون التالي:

$$E_B = E_A + H.I + V_2$$

Example no1:

Find the horizontal distance between A&B and elevatin for station B, if Elev.$_B$ =130m.

$\theta_1 = 3° 58' 33''$, $\theta_2 = 3° 10' 00''$, H.I=1.5m

Sol.

$$H = \frac{2}{\tan\theta_1 - \tan\theta_2}$$

$$H = \frac{2}{\tan 3^{o}58\ 33\ - \tan 3^{o}10\ 00} = 141.06m$$

$$V_1 = H \times \tan\theta_1$$

$$V_1 = 141.06 \times \tan 3^{o}58\ 33\ = 9.80m$$

$$V_2 = 141.06 \times \tan 3^{o}10\ 00\ = 7.80m$$

$$E_B = E_A + H.I + V_2$$

$$E_B = 130 + 1.5 + 7.80$$

$$E_B = 139.30m$$

Lecture(15)

Total Station Instruments
اجهزة المحطة الشاملة

Introduction

In the past, transits and theodolites were the most commonly used surveying instruments for making angle observations. These two devices were fundamentally equivalent and could accomplish basically the same tasks. Today, the total station instrument has replaced transits and theodolites. Total station instruments can accomplish all of the tasks that could be done with transits and theodolites, and do them much more efficiently. In addition, they can also observe distances accurately and quickly and, can be connected to survey controllers.

- ➢ The Total station is designed for measuring of slant distances, horizontal and vertical angles and elevations in topographic and geodetic works, tachometric surveys, as well as for solution of application geodetic tasks. The measurement results can be recorded into the internal memory and transferred to a personal computer interface.
- ➢ The basic properties are unsurpassed range, speed and accuracy of measurements. Total stations are developed in view of the maximal convenience of work of the user. High-efficiency electronic tachometers are intended for the decision It has the broad audience for sole of industrial problems.
- ➢ Angles and distances are measured from the total station to points under survey, and

the coordinates (X, Y, and Z or northing, easting and elevation) of surveyed points relative to the total station position are calculated using trigonometry and triangulation.

- ➢ Data can be downloaded from the total station to a computer and application software used to compute results and generate a map of the surveyed area.
- ➢ A **total station** is an electronic/optical instrument used in modern surveying. It is also used by archaeologists to record excavations as well as by police, crime scene

investigators, private accident Re- constructionists and insurance companies to take measurements of scenes. The total station is an electronic theodolite (transit) integrated with an electronic distance meter (EDM), plus internal data storage and/or external data collector.

- ➢ The purpose of any survey is to prepare maps, control points formed a basic requirement for the preparation of these maps.
- ➢ There are several numbers of methods like traverse, triangulation etc., to provide these control points.
- ➢ Whatever the method the provision of control points, includes the measurement of two entities (Distance and Angle).

➢+9

Linear Tap, Gunter's chain (20m and 30m), Steel band(20m and 30m), Inver tap. Hunter Short Base (80m), Electronic Distance Measurement Instruments, Total station and GPS.

➢ Angle can be measured by using a THEODOLITE.

➢ Once distance and angular measurement is over computation is performed to provide the control points. A combination of all the three results in a powerful instrument called TOTAL STATION.Hence, the TOTAL STATION is an instrument which consists of the following:

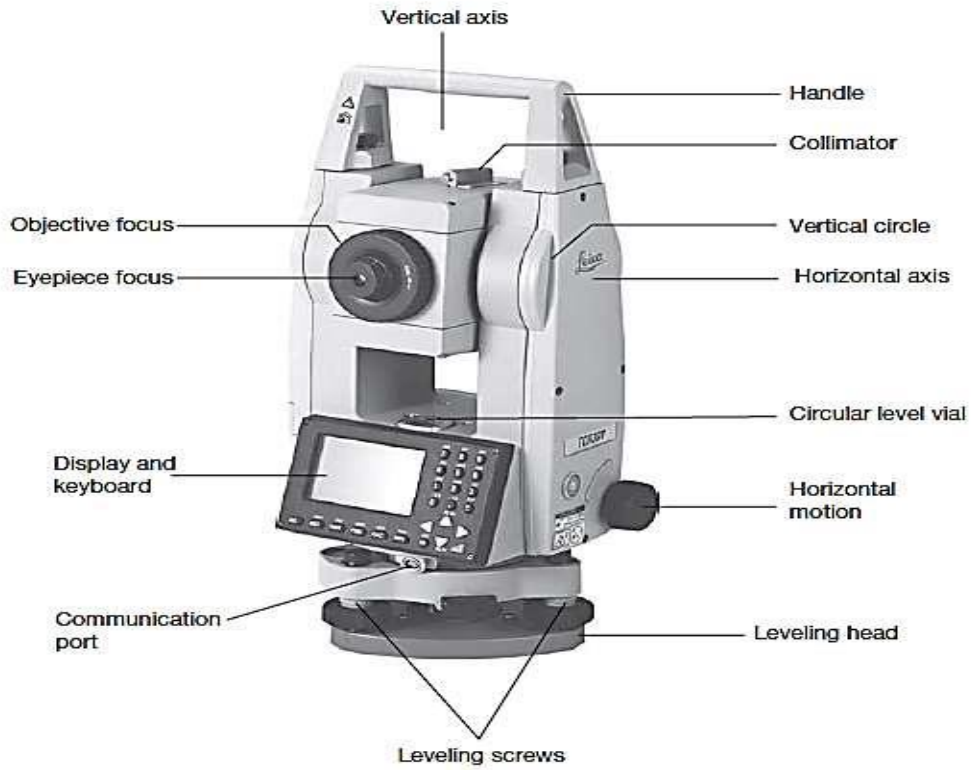
i) Distance measuring instrument (EDM).

ii) An angle measuring instrument (Theodolite).

iii) A simple microprocessor.

Instrumentation:

It consists of an EDM, Theodolite, Microprocessor combined into one. It also has a memory card to store the data. It also consists of battery socket which houses the battery. A fully charged battery works for about 3 to 5 hrs continuously.



Parts of a total station instrument, with view of eyepiece end of telescope. (Courtesy Leica Geosystems AG.)

Different Parts of Total Station

Accuracy of a Total Station:

Accuracy depending upon the instrument and varies from instrument to instrument

1.The angular accuracy varies from1″ to 20 ″.

2.Distance accuracy depends upon two factors.

Instrumental error which ranges from

+ / – 10mm to + / – 2mm.

b) Error due to the length of measurement.It can be from + / – 10mm to + / – 2mm per kilometre.1 prism, 2.5–2.7 km ,2 prisms 5-7 km, 3 prisms 10-12 km

NIKON One second+ / – 2mm/km or 2ppmTriple the number of prisms double the distance. LEICA One second SOKKIA One second.

Accuracy & Precision

• Precision is the reproducibility of the measurement.

• Accuracy is how close the measured position is to the actual location.

The important features of total station are

1. Keyboard-control – all the functions are controlled by operating key board.

2. Digital panel – the panel displays the values of distance, angle, height and the Coordinates of the observed point, where the reflector (target) is kept.

3. Remote height object – the heights of some inaccessible objects such as towers can be read directly. The microprocessor provided in the instrument applies the correction for earth's curvature and mean refraction, automatically.

4. Traversing program – the coordinates of the reflector and the angle or bearing on the reflector can be stored and can be recalled for next set up of instrument

5.Setting out for distance direction and height -whenever a particular direction and horizontal distance is to be entered for the purpose of locating the point on the ground using a target, then the instrument displays the angle through which the theodolite has to be turned and the distance by which the reflector should move.

References

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-Surveying for Engineers: 2th Edition Uren ,W,S, 1999.

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