وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الجنوبية
المعهد التقني العمارة
قسم تقنيات المساحة

Cadastral Surveying

Stage: 2nd .Surveying/ Second semester

Assistant Lecturer: Athraa abbas kadhim

المفردات النظرية	
الاسبوع	**تفاصيل المفردات**
الأول	حسابات التضليع : أنواع الزوايا والاتجاهات وطرق تصحيحها وحساباتها للمضلع الدائري المغلق والمضلع الرابط وحساب الإحداثيات لأركان المضلع وتصحيحها (بطريقة البوصلة) ،حساب الأطوال والاتجاهات المصححة (الحسابات المعكوسة للأضلاع) .
الثاني	التقاطعات أو القياسات المجهولة في عملية التضليع والتثليث وتشمل : التقاطع الأول (لإيجاد طولين مجهولين) باستخدام طريقتي المثلثات وقوانين التضليع
الثالث	باستخدام طريقتي الهندسة التحليلية ودوران الإحداثيات ، تطبيقات في تقاطعات الطرق وتقسيم الأراضي .
الرابع	التقاطع الثاني . (لإيجاد طول ضلع واتجاه ضلع أخر) باستخدام طريقة المثلثات .
الخامس	باستخدام قوانين التضليع ، الهندسة التحليلية ، تطبيقاتها في تقاطعات الطرق وتقسيم الأراضي.
السادس	التقاطع الثالث . (لإيجاد اتجاهي الضلعين المجهولين) باستخدام طريقة المثلثات .
السابع	باستخدام طريقة الهندسي التحليلية ، تطبيقاتها في تقاطعات الطرق وتقسيم الأراضي .
الثامن	أيجاد القياسات المجهولة (أطوال واتجاهات) في المضلعات الدائرية والرابطة باستخدام التقاطعات المختلفة مع الأمثلة للانواع الانف ذكرها.
التاسع	التقاطع الخلفي أو العكسي: لإيجاد موقع نقطة مختارة بالرصد نحو ثلاث نقاط معلومة المواقع الأفقية ولثلاث حالات مختلفة (أو محتملة) .
العاشر	كيفية أعداد جدول بالخطوات المنطقية لإيجاد القياسات المجهولة لمسائل متنوعة باستخدام التقاطعات الثلاثة والحسابات الأمامية والمعكوسة والتقاطع الخلفي .
الحادي عشر	تقسيم الأراضي : تقسيم المضلعات : تقسيم المضلع الى جزئين بواسطة خط ذي نهايتين معلومتي الموقعين . تقسيم المضلع الى جزئين بواسطة خط ذي اتجاه معلوم ويبدأ من نقطة معلومة الموقع (وبعرض معين في حالة طريق أو قناة للري) وحساب مساحات الأجزاء والمواقع الغير محسوبة ، تطبيقات عملية في تقسيم الأراضي لحالات متعددة .
الثاني عشر	تقسيم المضلع الى جزئين متساويين في المساحة بواسطة خط يبدأ من نقطة معلومة الموقع ، تقسيم المضلع الى جزئين متساويين في المساحة بواسطة خط ذي اتجاه معلوم ، تطبيقات عملية في تقسيم الأراضي لحالات متعددة عمليا.
الثالث عشر	مشروع صغير لتقسيم الأراضي الكبيرة باستخدام الحسابات والتقاطعات المختلفة وبموجب مواصفات معينة للمساحات وابعاد الشوارع وأنصاف أقطارها
الرابع عشر	تكملة حسابات المشروع ورسم المخطط الأفقي له
الخامس عشر	رسم المقطع الطولي له ، وأجراء المناقشات حول النتائج النهائية للتقسيم قطعة الارض

Course Objective

After studying this course the student should be able to

1- Known the types of angles and traverses
2- Compute the coordinates of points
3. calculate the unknown measurement
4.divsion and subdivision of lands.

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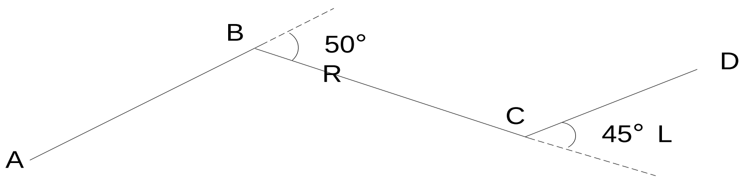
Target Audience: 2nd .Surveying student

Course Description: 2hr Theoretical ,2hr Application

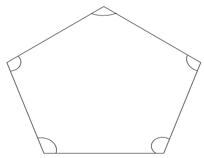
Lecture (1)

Measurement of angles

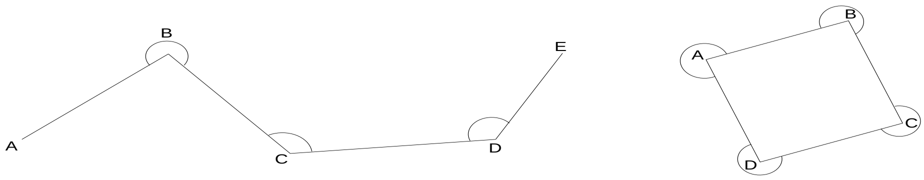
Deflection angle :- The angle between aline and prolongation of the preceding line . It recorded as right or left .



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	10° 37' 00"	34° 38' 40"	190° 37' 40"	34° 38' 06"
	R	45° 15' 40"		225° 15' 46"	

$\angle PQR = \frac{34^\circ\ 38'\ 40'' + 34^\circ\ 38'\ 06''}{} = 34^\circ\ 38'\ 23''$

EX./ Comput the angle SRT from the following observation

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

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

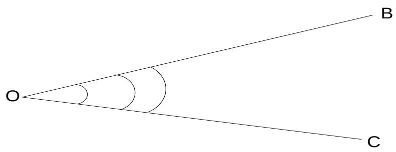
F.L = F.R – 180

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 = $\dfrac{\text{last reading - initial reading}}{\text{No. of repetitions}}$

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

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 $= \dfrac{617°57`50`` - 136°01`50``}{6} = 80°19`20``$

Ex. / Compute the horizontal angle .

Station Inst.	Station bisected	No. of Rep.	face	Circle reading
	E	0	L	$70^\circ\ 10'\ 30''$
	G	1	L	$170^\circ\ 30'\ 30''$
F	G	6	L	$312^\circ\ 11'\ 00''$
	G	6	R	$312^\circ\ 12'\ 00''$

Sol. /

The approximate angle $=170^\circ\ 30'\ 30'' - 70^\circ\ 10'\ 30'' = 100^\circ\ 20'\ 00''$

The approximate reading $= 100^\circ\ 20'\ 00'' \times 6 = 602^\circ$

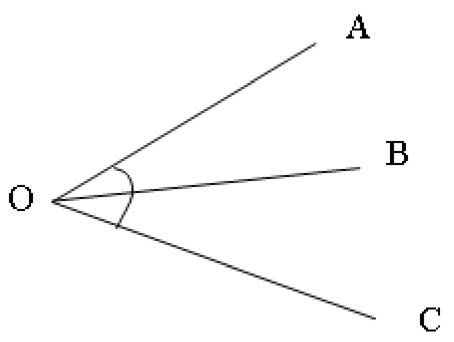
$\therefore$ Last reading $=312^\circ\ 11'\ 00'' + 360^\circ = 672^\circ\ 11'\ 00''$

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

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

$$\text{Mean angle} = \frac{F.L + F.R}{2} = 100^\circ 20' 10''$$

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

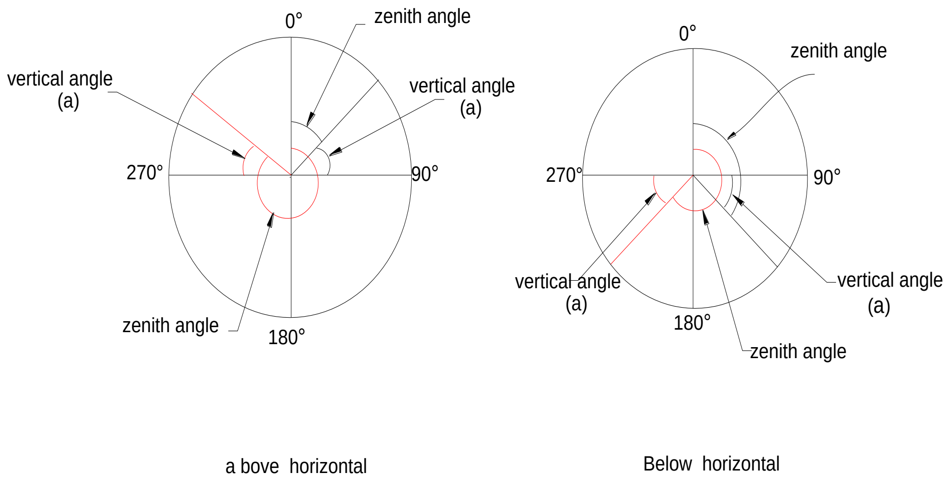


Vertical Angle

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°

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



Ex./ A vertical angle is measured to target on top of hill with telescope in direct position (F.L) , the circle reads (67° 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/ $\alpha = 292^\circ 36`16`` - 270^\circ = +22^\circ 36`16``$

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

Traversing

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

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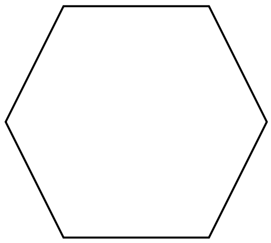
The traverse may be classified as :-

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 .

Angles of the traverse may be measured by observing :-

1-Interior angles.

2-Deflection angles.

3-Angles to the right.

Balancing a traverse

1-Interior angles الزوايا الداخلية

The sum of the included angles $=(n-2)\times 180$

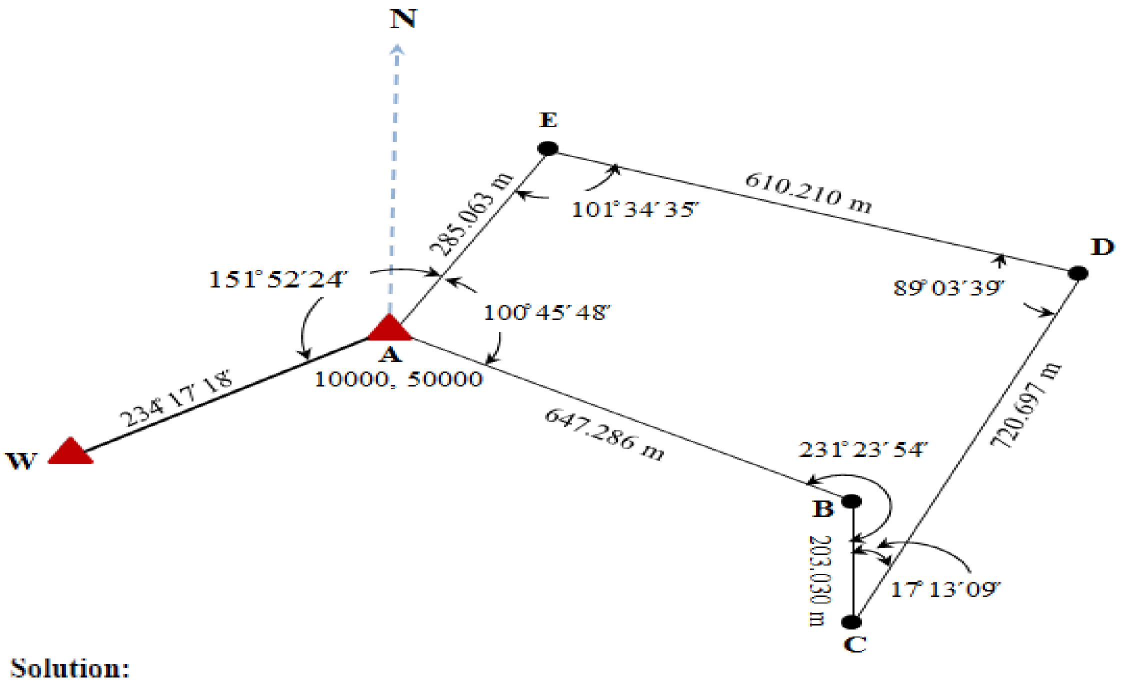
n =number of the angles .

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).

<u>EX</u>:Compute the coordinates points for the following traverse if ,
Az.AW=234° 17′ 18″,XA=10000, YA=5000



Solution:

Σ Theoretical Interior Angles = (n -2) * 180°

Σ Theoretical Interior Angles = (5 -2) * 180° = 540°00′00″

Σ measured angles = 540°01′05″

e = 540°00′00″ - 540°01′05″ = 00°01′05″

$c = \pm k.\ \sqrt{n}$

$c = \pm 00°00'30'' \sqrt{5}$

c = ± 00°01′07″

$$\text{Correction / angle} = \frac{\text{T.C.for Interior angles}}{n}$$

$$\text{Correction / angle} = \frac{00°01'05''}{5} = 00°00'13''$$

Point	Int. angle	Corr.	Corrected Int. angle
A	100°45′48″	-13″	100°45′35″
B	231°23′54″	-13″	231°23′41″
C	17°13′09″	-13″	17°12′56″
D	89°03′39″	-13″	89°03′26″
E	101°34′35″	-13″	101°34′22″
Σ	**540° 01′05″**	**-1′05″**	**540°00′00″**

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**

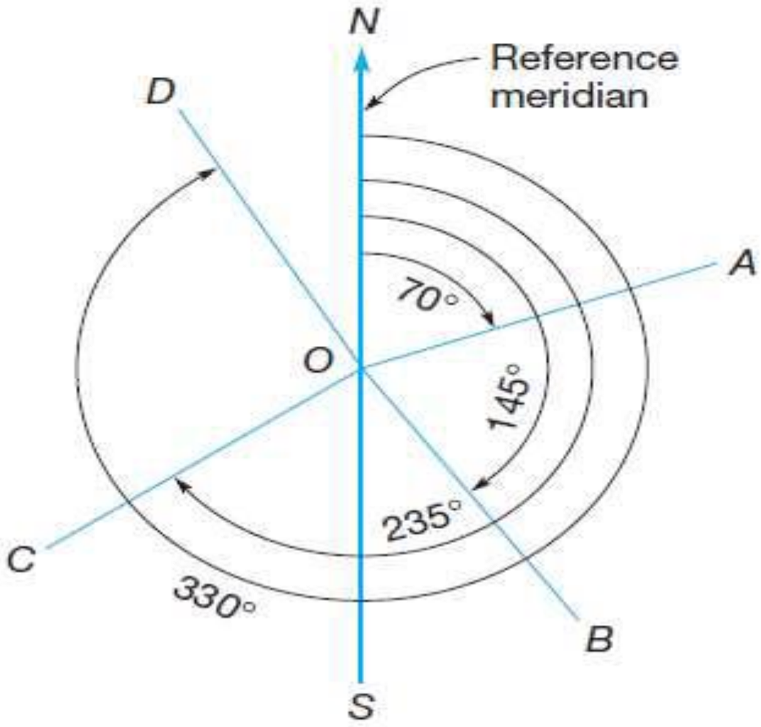
Systems of Directions (bearing) .

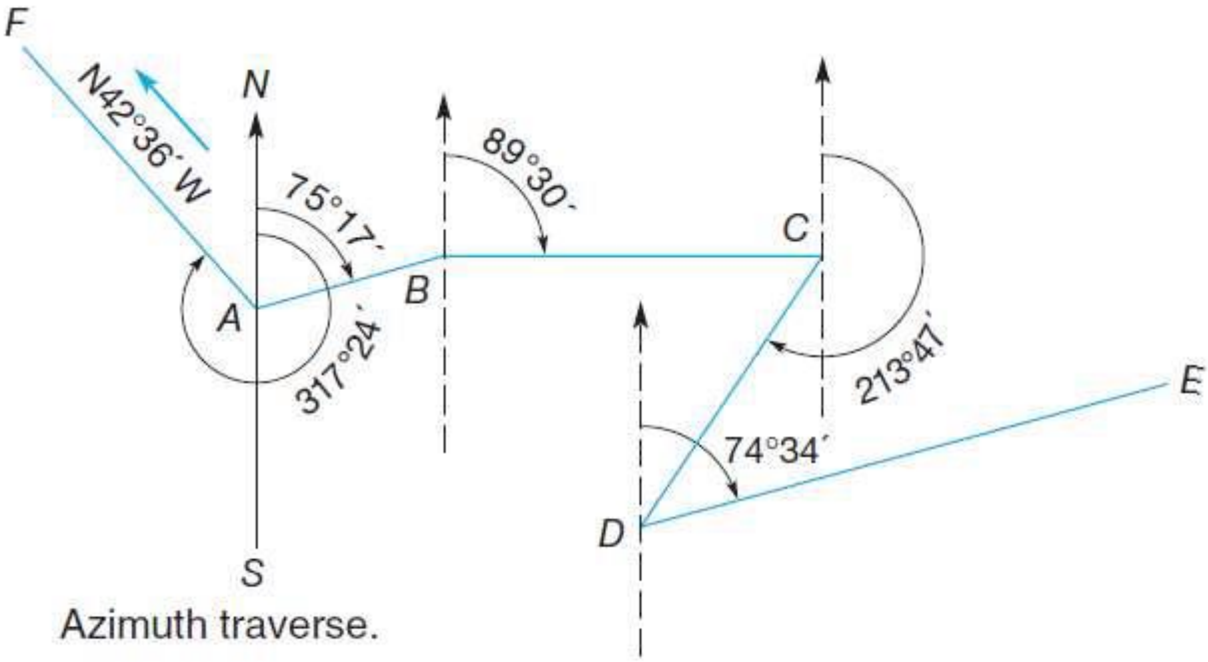
bearing are designated by the following system:-

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

Azimuths

Azimuths *are* ***horizontal angles*** *observed* ***clockwise*** *from any reference meridian*. In plane surveying,azimuths are generally observed from ***north*** as shownin figure below**,** but astronomers and the military have used south as the reference direction

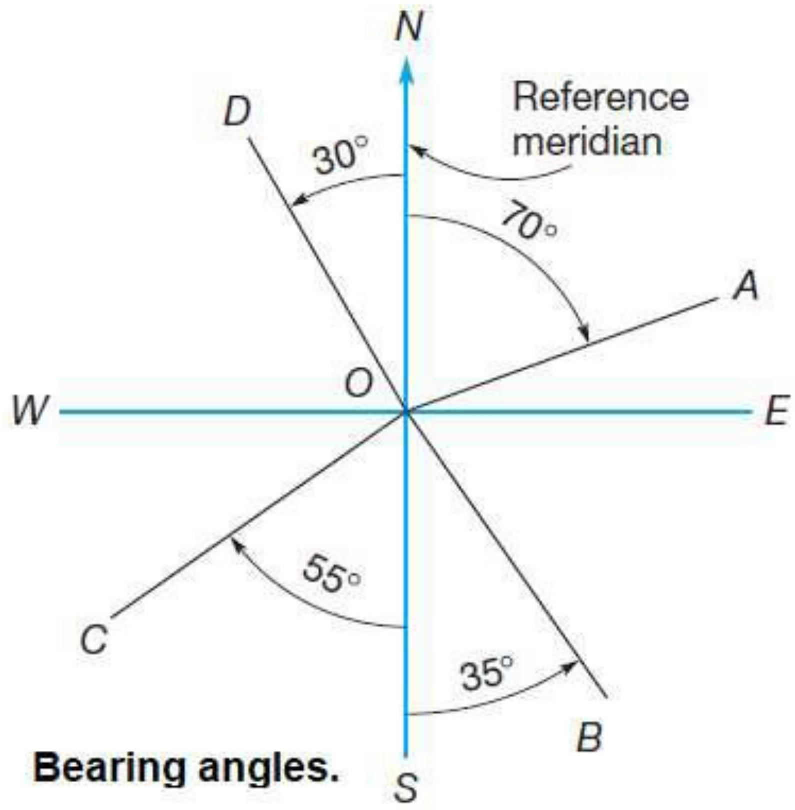




Azimuth traverse.

Bearings

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, 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.



Bearing angles.

Directions computation

Side	Azimuth computation equation	Azimuth
AB	< WAE – (360- Az.AW) + <EAB	126°55′17″
BC	< ABC – (360° - Az. BA	178°18′58″
CD	< BCD – (360- Az.CB)	15°31′54″
DE	Az.DC + < CDE	284°35′20″
EA	Az.ED + < DEA	206°09′42″
Checking AB	**Az.AE + < EAB**	**126°55′17″**

المركبة الافقية للضلع

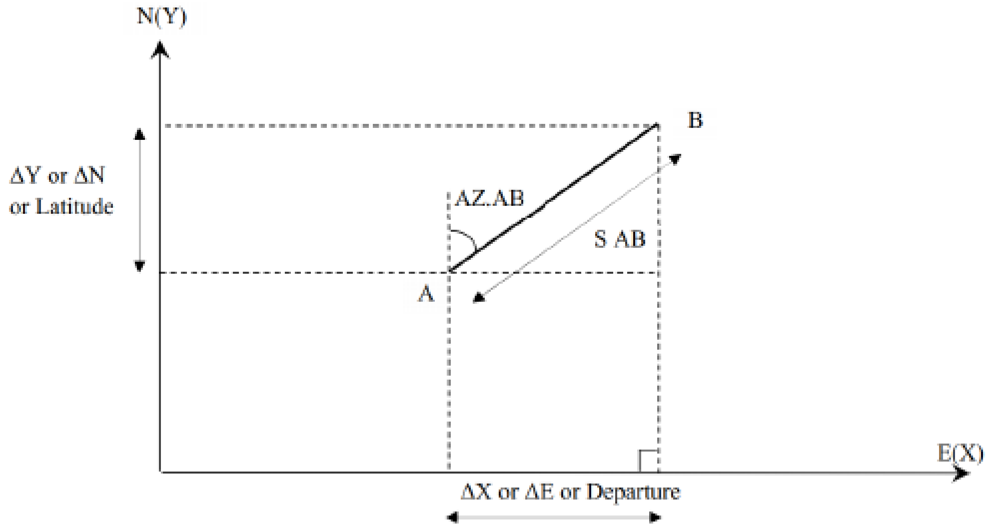
Dep. or ΔE = Length of side * sin (Az. of side)

$\Delta E = S * \sin Az.$

المركبة الراسية للضلع

Lat. or ΔN = Length of side * cos (Az. of side)

$\Delta N = S * \cos Az.$



Side	Length(m)	Direction	Dep.(Δ Easting)	Lat. (ΔNorthing)
AB	647.286	126°55′17″	517.480	-388.837
BC	203.030	178°18′58″	5.966	-202.942
CD	720.697	15°31′54″	192.982	694.379
DE	610.210	284°35′20″	-590.536	153.701
EA	285.063	206°09′42″	-125.686	-255.895
Σ	**2466.286**		**ΣΔE= 0.206**	**ΣΔN=0.442**

Linear misclosure خطأ القفل المضلع

يعرف خط غلق المضلع بانه طول الخط الذي يغلق المضلع من الناحية النظرية والذي يساوي حسابيا محصلة التصحيح الكلي.

Linear misclosure $= \sqrt{\Sigma\Delta E^2 + \Sigma\Delta N^2}$

$= \sqrt{0.206^2 + 0.442^2}$

= 0.487 m.

$$\text{Correction for Departure} = -\frac{\text{Total Departure misclosure}}{\text{Total length Rraversr}} \times \text{Length of side}$$

$$\text{Correction for Latitude} = -\frac{\text{Total Latitude misclosure}}{\text{Total length Rraversr}} \times \text{Length of side}$$

$$\text{Correction for Departure} = -\left(\frac{0.206}{2466.286}\right) 647.286$$

Correction for Departure = - 0.054 m.

$$\text{Correction for Latitude} = -\left(\frac{0.442}{2466.286}\right) \times 647.286$$

Correction for Latitude = - 0.116m.

Side	Length (m)	Computed (m)		Correction (m)		Corrected (m)	
		Dep.	Lat.	Dep.	Lat.	Dep.	Lat.
AB	647.286	517.480	-388.837	- 0.054	- 0.116	517.426	-388.953
BC	203.030	5.966	-202.942	- 0.017	- 0.036	5.949	-202.978
CD	720.697	192.982	694.379	- 0.060	- 0.129	192.922	694.250
DE	610.210	-590.536	153.701	- 0.051	- 0.109	-590.587	153.692
EA	285.063	-125.686	-255.895	- 0.024	- 0.051	-125.710	-255.910
Σ	**2466.286**	**0.206**	**0.442**	**- 0.206**	**- 0.442**	**0.000**	**0.000**

Coordinates Computation

لحساب احداثي التشريق

$X_B = X_A + Dep._{AB} (\Delta X._{AB})$

Or

$E_B = E_A + Dep._{AB} (\Delta E._{AB})$

$E_B = E_A + S._{AB} * \text{Sin} (Az._{AB})$

اما لحساب احداثي التشميل

$Y_B = Y_A + Lap._{AB} (\Delta Y._{AB})$

Or

$N_B = N_A + Lap._{AB} (\Delta N._{AB})$

$N_B = N_A + S._{AB} * \text{Cos} (Az._{AB})$

وبالتالي يمكن الحصول على جميع الاحداثيات باتباع الاسلوب ذاته، ففي المضلعات المغلقة polygon يتم حساب احداثيات المحطة الاولى مرة اخرى بالاعتماد على المحطة الاخيرة في المضلع لغرض التحقق من حسابات المضلع.

Point	X (m)	Y (m)
A	10000	5000
B	10517.426	4611.047
C	10523.375	4408.069
D	10716.297	5102.319
E	10125.710	5255.011
A′	10000	5000.1

2-Exterior angles

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 $= \frac{+1^\circ}{4} = \frac{60`}{4} = +15`$

3-Deflection angles

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

$\sum R - \sum L = 360°$

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``

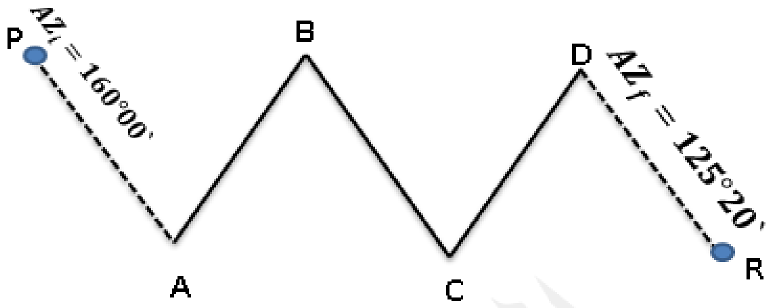
Correction angles $= \frac{2`30``}{5} = 30``$

H.W: In the closed traverse ABCD. compute the Azimuth for each side $AZ_{AB} = 31°33`$

point	Deflection angle
A	+143°16`R
B	-51°16` L
C	+150°34`R
D	+116°52`R

2- connected traverse (Link)

EX:



Sol :

point	Angle to the Right	correction	Cor.angle
A	82°34`	-00°04`	82°30`
B	237°14`	-00°04`	237°10`
C	119°44`	-00°04`	119°40`
D	246°04`	-00°04`	246°00`
	$\Sigma = 685°36`$		685°20`

$\Sigma theory = AZ_F = AZ_i + \Sigma \mathbf{Angles}(B) - (n * 180°)$

$AZ_F = 160°00` + \Sigma 685°36` - (4 * 180°)$

$AZ_F = 125°36`$

نطرح من الازيموث المعطى لاستخراج مقدار التصحيح

Error=$AZ_F - AZ_F \Rightarrow 125°36` - 125°20` = 00°16`$

T.C=$-00°16`$

Correction=$\frac{T.C}{n} = \frac{-00°16`}{4} = -00°04`$

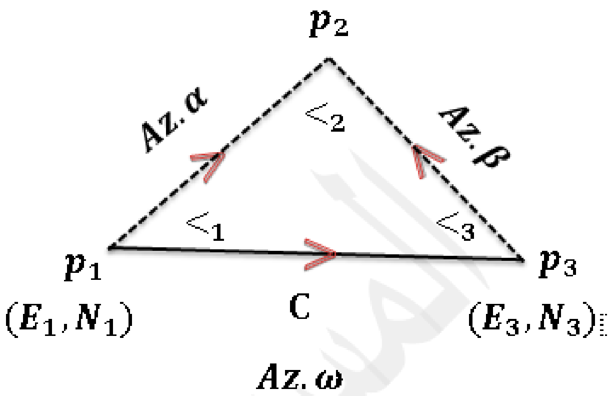
$AZ_F = 160°00` + 685°36` - 720°00` = 125°20`$

Lecture (2) and(3)

Intersection or Omitted measurements

التقاطعات او القياسات المجهولة

Intersection: two lengths side are unknown (التقاطع الاول (طول الضلعين المجهولان



Trigonometric method:

1. compute, Az.ω , C

$$R.B = \tan^{-1}\frac{\Delta E}{\Delta N} \quad , R.B \rightarrow Az.\omega$$

C= $\sqrt{(\Delta E)^2 + (\Delta N)^2}$

2- Comput angles: $< 1 , < 2 , < 3$

$$< 1 = Az.w - Az,\alpha$$

$$< 2 = B.Az.\alpha - Az,\beta$$

$$< 3 = Az.w - Az,\beta \quad or \quad < 3 = 180^\circ - (< 1 + < 2)$$

2- Comput A and B by using(sins Law)

$$A = \frac{c * \sin < 3}{\sin < 2} \quad , \quad B = \frac{c * \sin < 1}{\sin < 2}$$

2- traverse Equation method

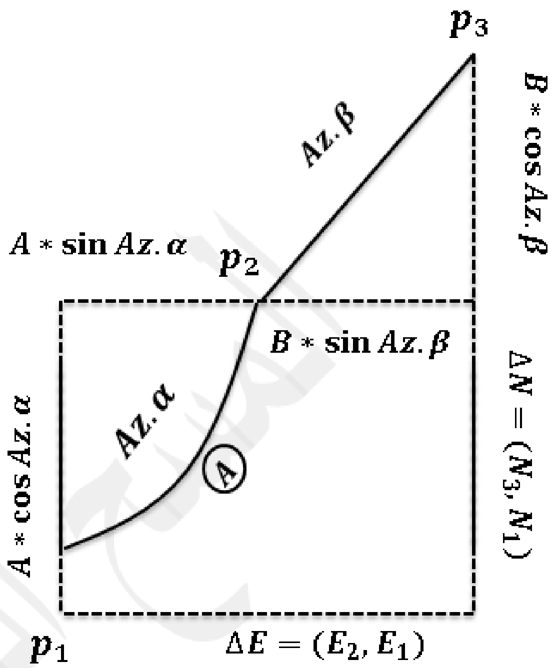
$\sum Dep = \Delta E = (E_2 - E_1)$

$\sum lat = \Delta N = (N_2 - N_1)$

or

$\Delta E = A * \sin Az.\alpha + B * \sin Az.\beta$

$\Delta E = A * \cos Az.\alpha + B * \cos Az.\beta$



(p_1, p_3)

$$A = \frac{\Delta E * \cos\beta - \Delta N * \sin\beta}{\sin AZ.(\alpha - \beta)} \quad , \quad B = \frac{\Delta E * \cos\alpha - \Delta N * \sin\alpha}{\sin AZ.(\alpha - \beta)}$$

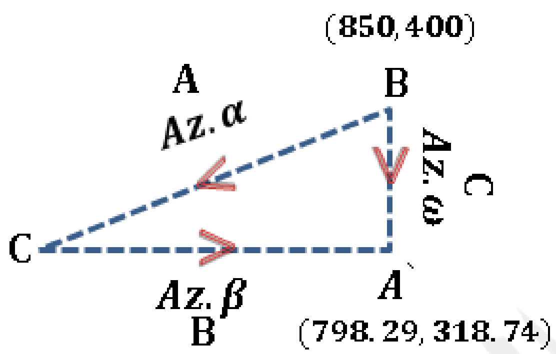
$EP_2 = EP_1 \pm (A * \sin AZ.\alpha)$

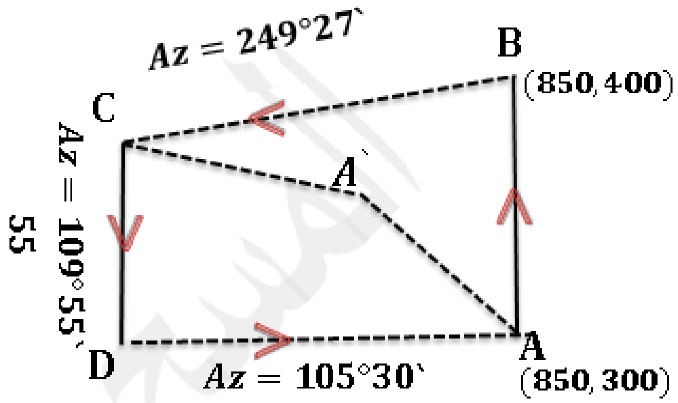
$NP_2 = NP_1 + (A * \cos AZ.\alpha)$

$EP_3 = EP_2 + (B * \sin AZ.\beta)$

$NP_3 = NP_2 + (B * \cos AZ.\beta)$

EX: Compute the coordinates of the traverse A, B,C,D if A A=(850,300) ,B=(850,400) by using trigonometric method and check solution by using traverse method





$$\Delta E = 850(55 \sin 249°27`) = 798.29$$

$$\Delta N = 300(55 \cos 249°27`) = 318.74$$

$$R.B = \tan^{-1}\left|\frac{\Delta E}{\Delta N}\right| = \tan^{-1}\frac{798.29-850}{318.74-400} = S32°28`15″w$$

$$AZ.W = 180° + 32°28`15″ = 212°48`\,15″$$

$$C=\sqrt{(\Delta E)^2 + (\Delta N)^2} \implies \sqrt{(798.29-850)^2+(318.74-400)^2} = 96.32\ m$$

2- Comput $< 1, < 2, < 3$

$$< 1 = Az,\alpha - Az.w = 249°27` - 212°48`\,15″ = 36°58`\,45″$$

$$< 2 = Az,\beta - B.Az.\alpha = 105°30` - (249°27` - 180°) = 36°03`\,00″$$

$$< 3 = 180° - (< 1 + < 2) = 180° - (36°58`\,45″ + 36°54`\,00″ = 106°58`\,15″$$

$total\ angle: < 1, < 2, < 3$

$$36°58`\,45″ + 36°03`\,00″ + 106°58`\,15″ = 180°$$

$$\frac{A}{\sin < 3} = \frac{c}{\sin < 2} \implies A = \frac{c * \sin < 3}{\sin < 2}$$

$$A = \frac{c * \sin < 3}{\sin < 2} = \frac{96.32 * \sin 106°58`\,15″}{\sin 36°03`\,00″} = 156.55\ m$$

$$\frac{B}{\sin < 1} = \frac{c}{\sin < 2} \implies B = \frac{c * \sin < 1}{\sin < 2}$$

$$B = \frac{c * \sin < 1}{\sin < 2} = \frac{96.32 * \sin 36°58`\,45″}{\sin 36°03`\,00″} = 98.45\ m$$

Coords. Of p_2

$EP_2 = EP_1` \pm (A * \sin AZ.\alpha)$

$= 850 \pm (156.55 * \sin 249°27`) = 798.29$

$NP_2 = NP_1` \pm (A * \cos AZ.\alpha)$

$= 120 \pm (156.55 * \sin 249°27`) = 318.74$

$\therefore P_2, \quad E = 798.29 \;, N = 318.74$

Check:

$EP_3 = EP_2 + (B * \sin AZ.\beta)$

$= 798,29 + (98.45 * \sin 105°30`) = 798.28$

$NP_3 = NP_2 + (B * \cos AZ.\beta)$

$= 318,74 + (98.45 * \cos 105°30`) = 318.74$

2- check by using traverse method

$\Delta E = 798.29 - 850 = -51.71$

$\Delta N = 318.74 - 400 = -81.26$

$$A = \frac{\Delta E * \cos\beta - \Delta N * \sin\beta}{\sin AZ.(\alpha - \beta)} \quad , \quad B = \frac{\Delta E * \cos\alpha - \Delta N * \sin\alpha}{\sin AZ.(\alpha - \beta)}$$

$$A = \frac{\Delta E * \cos\beta - \Delta N * \sin\beta}{\sin AZ.(\alpha - \beta)}$$

$$= \frac{(-51.71) * \cos 105°30` - (-81.26) * \sin 105°30`}{\sin AZ.(249°27` - 105°30`)} = 156.54\ m$$

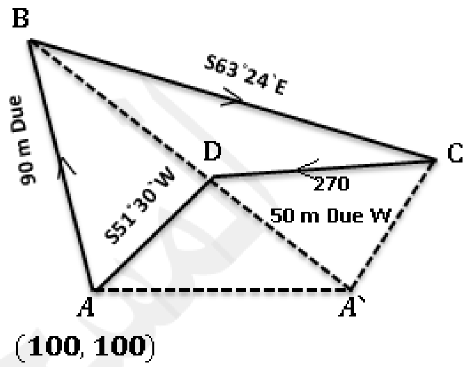
$$B = \frac{\Delta E * \cos\alpha - \Delta N * \sin\alpha}{\sin AZ.(\alpha - \beta)}$$

$$= \frac{(-51.71) * \cos 249°27` - (-81.26) * \sin 249°27`}{\sin AZ.(249°27` - 105°30`)} = 98.45\ m$$

EX: compute the missing Lengths and coords. of travers shown below

$E_B = 100 \ , E_{A`} = 150$

$N_B = 190 \ , N_{A`} = 100$



$$R.B = \tan^{-1}\left|\frac{\Delta E}{\Delta N}\right| = \tan^{-1}\left|\frac{150-100}{100-190}\right| = 29°03`$$

$$AZ.W = 180° - 29°03` = 150°57`$$

$$C = \sqrt{(\Delta E)^2 + (\Delta N)^2} \implies \sqrt{(150-100)^2 + (100-190)^2} = 102.90\ m$$

2- Comput $< 1, < 2, < 3$

$$< 1 = Az.w - Az.\alpha = 150°57` - (180° - 63˚24`) = 34°21`$$

$$< 2 = B.Az.\alpha - Az.\beta = (360° - 63˚24`) - (180° - 51°30`) = 65°06`$$

$$< 3 = 360° - (B.Az.w - Az.\beta) = 360° - (180° + 150°57` - 51°30`) = 80°33`$$

$$A = \frac{c * \sin < 3}{\sin < 2} = \frac{102.90 * \sin 80°33`}{\sin 65°06`} = 111.97\ m$$

$$B = \frac{c * \sin < 1}{\sin < 2} = \frac{102.90 * \sin 34°21`}{\sin 65°06`} = 64.05\ m$$

Coords. Of p_2

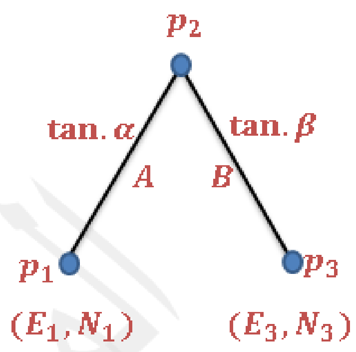
$EP_2 = EP_{1`} \pm (A * \sin AZ.\alpha)$
$= 100 \pm (111.97 * \sin 116°36`) = 200.12$ m

$NP_2 = NP_{1`} \pm (A * \cos AZ.\alpha)$
$= 190 \pm (111.97 * \cos 116°36`) = 139.86$ m

Check:

$EP_3 = EP_2 + (B * \sin AZ.\beta)$
$= 187,63 + (64.05 * \sin 231°30`) = 150$ m

$NP_3 = NP_2 + (B * \cos AZ.\beta)$
$= 120,30 + (64.05 * \cos 231°30`) = 100$ m



3- Analytic Geometry method

$$\tan.\alpha = \frac{E_2 - E_1}{N_2 - N_1}$$

$$\tan.\beta = \frac{E_3 - E_2}{N_3 - N_2}$$

$$N_2 = \frac{E_3 - E_1 + N_1 * \tan.\alpha - N_3 * \tan.\beta}{\tan.\alpha - \tan.\beta}$$

$$E_2 = E_1 + (N_2 - N_1) * \tan.\alpha$$
$$= E_3 - (N_3 - N_2) * \tan.\beta$$

Comput A and B

$$A = \frac{\Delta E}{\sin.AZ.\alpha} \Rightarrow \frac{E_2 - E_1}{\sin.AZ.\alpha}$$

$$B = \frac{\Delta N}{\cos.AZ.\beta} \Rightarrow \frac{N_3 - N_2}{\cos.AZ.\beta}$$

Solution:

1- Comput $p_2(E_2, N_2)$

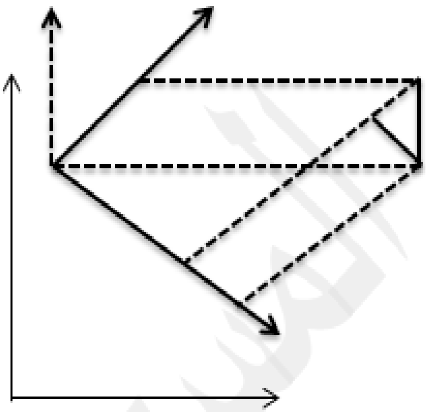
2- Comput A and B

3- Comput p_2 and check on p_3

من القوانين الاتية

$$EP_2 = EP_1 \pm (A * \sin AZ.\alpha)$$
$$NP_2 = NP_1 + (A * \cos AZ.\alpha)$$
$$EP_3 = EP_2 + (B * \sin AZ.\beta)$$
$$NP_3 = NP_2 + (B * \cos AZ.\beta)$$

4- Rotation of Coordinates Method



$\theta =$ Rotation angle

$\emptyset = (AZ.\beta - AZ.\alpha)$

Comput: $\Delta E^{`}, \Delta N^{`}$

$\Delta E^{`} = \Delta E * \cos\theta\alpha - \Delta N * \sin\theta\beta$

$\Delta N^{`} = \Delta E * \sin\theta\alpha - \Delta N * \cos\theta\beta$

$$B = \frac{\Delta E * \cos\alpha - \Delta N * \sin\alpha}{\sin(\beta - \alpha)}$$

$A = \Delta E * \sin\alpha - \Delta N * \cos\beta - B\cos(\beta - \alpha)$

ملاحظة : يتم حساب (B) قبل حساب (A)

$EP_2 = EP_1 \pm (A * \sin AZ.\alpha)$

$NP_2 = NP_1 + (A * \cos AZ.\alpha)$

$EP_3 = EP_2 + (B * \sin AZ.\beta)$

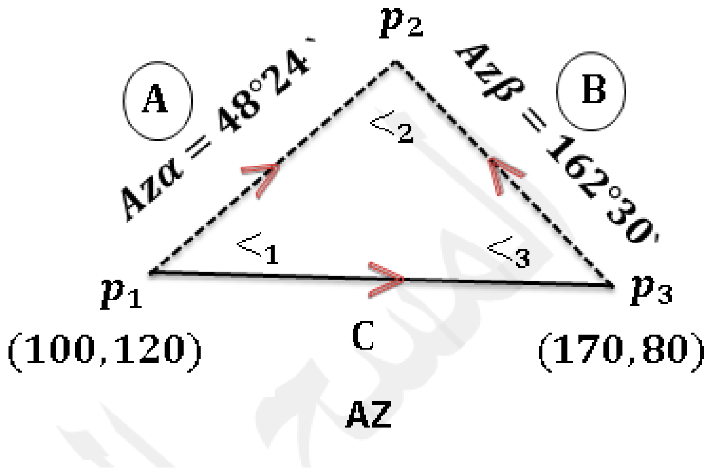
$NP_3 = NP_2 + (B * \cos AZ.\beta)$

Solution:

1- Comput A and B

2- Comput p_2 and check on p_3

H.W: Find the lengths (A,B) and the coords. of Point (P2) From the figure below.

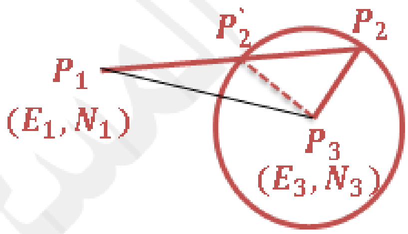


Lecture (4) and(5)

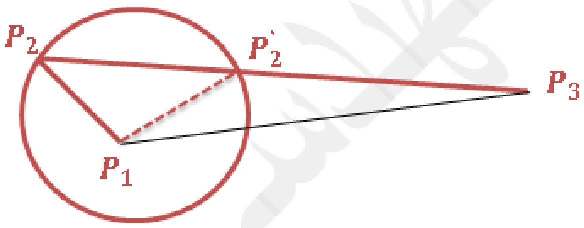
Intersection (II)

Two lengths of side and Azimuth on other are unknown

<u>الحالة الاولى:</u> يكون اتجاه الضلع الاول وطول الضلع الثاني معلومات



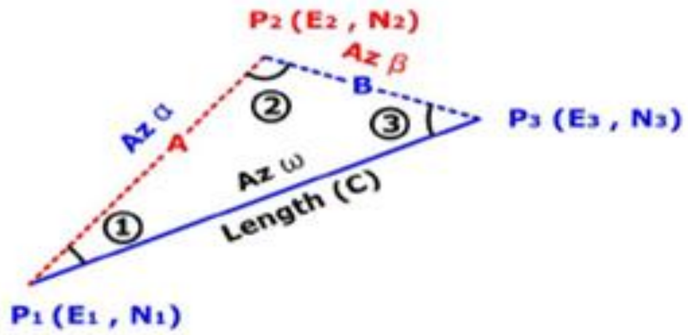
<u>الحالة الثانية:</u> اذا كان طول الضلع الاول واتجاه الضلع الثاني معلومات



- التقاطع الثاني (Intersection (II :

يمثل هذا التقاطع هندسيا بتقاطع خط مستقيم ودائرة أحدهما معلوم الطول والثاني معلوم الاتجاه ، وبالتالي فإنه بمعلومية ميل أحدهما وطول الاخر يمكن تحديد نقطة تقاطعهما المجهولة (P_2) .

ولتبسيط هذا النوع من التقاطعات ، في حال عدم تجاور الاضلاع الحاوية على المجاهيل (كما في الاشكال الرباعية والخماسية والسداسية .. وغيرها) يتم رسم موازيات بحسب الحالة المتوفرة بهدف تكوين حالة التقاطع الثاني ، بحيث يكون الضلعين الحاويين على تلك المجاهيل متجاوران وتشكل نقطتي بدايتيهما خطاً معلوما بالاسم (P_1 , P_3) ويتقاطعان من طرفهما الاخر في النقطة المجهولة (P_2) . وكما في الشكل التالي :



Known :

Position of (P_1) : (E_1 , N_1)

Position of (P_3) : (E_3 , N_3)

Dirdction of (P_1 >>> P_2) : Az α

Length (P_2 >>> P_3) : B

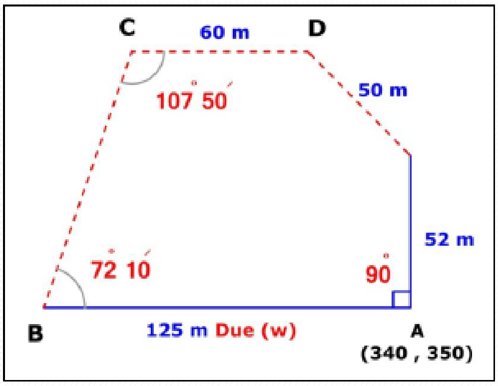
Required :

Position of (P_2) : (E_2 , N_2)

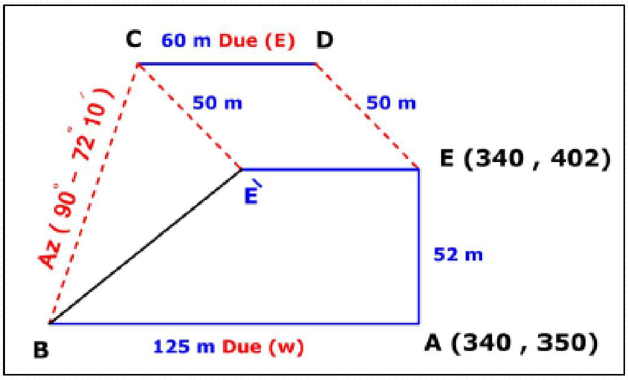
Length (P_1 >>> P_2) : A

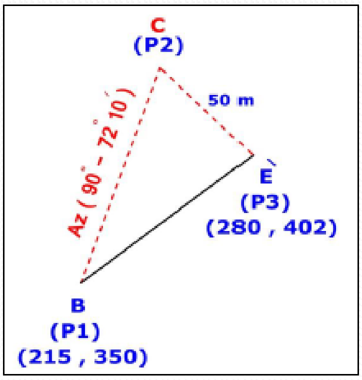
Dirdction of (P_2 >>> P_3) : Az β

Ex : Compute the Coords of a Traverse (A,B,C,D,E) :

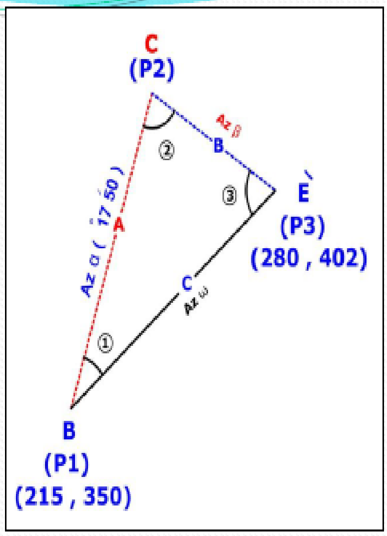


Sol :





(Intersections II)



$Az_{BC} = 90^o - 72^o\ 10' = 17^o\ 50'$

$Az_{CD} = (17^o\ 50' + 180^o) - 107^o\ 50' = 90^o$

Coords. Of (B) : (215 , 350)

Coords. Of (E) : (340 , 402)

Coords. Of (E′) : (280 , 402)

$Az\ \omega = \tan^{-1}\left(\frac{E_3 - E_1}{N_3 - N_1}\right) \rightarrow \tan^{-1}\left(\frac{280 - 215}{402 - 350}\right) = 51^o\ 20'$

$C = \sqrt{(280 - 215)^2 + (402 - 350)^2} = 83.24\ m$

$< 1 = Az\ \omega - Az\ \alpha \rightarrow 51^o\ 20' - 17^o\ 50' = 33^o\ 30'$

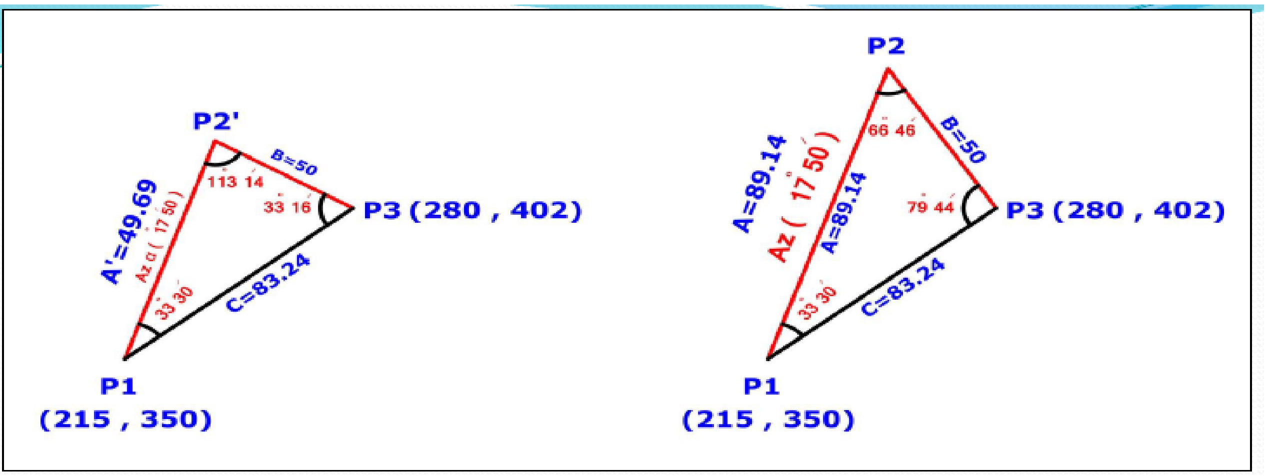
By Sin Law :

$\frac{B}{Sin < 1} = \frac{C}{Sin < 2} \rightarrow \frac{50}{Sin\ 33^o\ 30'} = \frac{83.24}{Sin < 2} \rightarrow Sin < 2 = 0.92 \rightarrow < 2 = 66^o\ 46'$

$< 3 = 180^o - (< 1 + < 2) \rightarrow 180^o - (33^o\ 30' + 66^o\ 46') = 79^o\ 44'$

$\frac{50}{Sin\ 33^o\ 30'} = \frac{A}{Sin\ 79^o\ 44'} = 89.14\ m$

$Az\ \beta = Back\ Az\ \alpha - < 2 \rightarrow (17^o\ 50' + 180^o) - 66^o\ 46' = 131^o\ 04'$



$< 2' = 180^o - < 2 \rightarrow 180^o - 66^o\, 46' = 113^o\, 14'$

$< 3' = 180^o - (< 1 + < 2') \rightarrow 180^o - (33^o\, 30' + 113^o\, 14') = 33^o\, 16'$

$\frac{50}{Sin\, 33^o\, 30'} = \frac{A'}{33^o\, 16'} = 49.69\ m$

$Az\ \beta' = Back\ Az\ \alpha - < 2' \rightarrow (17^o\, 50' + 180^o) - 131^o\, 04' = 84^o\, 36'$

Coords. Of P_2 :

$E_{P_2} = E_{P_1} + A\,.Sin\ Az\ \alpha \rightarrow 215 + 89.41\ Sin\ 17^o\, 50' = 242.30\ m$

$N_{P_2} = N_{P_1} + A\,.Cos\ Az\ \alpha \rightarrow 350 + 89.41\ Cos\ 17^o\, 50' = 434.86\ m$

Check P_3 From P_2 :

$E_{P_3} = E_{P_2} + B\,.Sin\ Az\ \beta \rightarrow 242.30 + 50\ Sin\ 131^o\, 04' = 280\ m$

$N_{P_3} = N_{P_2} + B\,.Cos\ Az\ \beta \rightarrow 434.86 + 50\ Cos\ 131^o\, 04' = 402\ m$

...... Checked ......

Coords. Of P_2' :

$E_{P_2}' = E_{P_1} + A'.Sin\ Az\ \alpha \rightarrow 215 + 49.69\ Sin\ 17^o\, 50' = 230.22\ m$

$N_{P_2}' = N_{P_1} + A'.Cos\ Az\ \alpha \rightarrow 350 + 49.69\ Cos\ 17^o\, 50' = 397.30\ m$

Check P_3 From P_2':

$E_{P_3} = E_{P_2}' + B\,.Sin\ Az\ \beta' \rightarrow 230.22 + 50\ Sin\ 84^o\, 36' = 280\ m$

$N_{P_3} = N_{P_2}' + B\,.Cos\ Az\ \beta' \rightarrow 397.30 + 50\ Cos\ 84^o\, 36' = 402\ m$

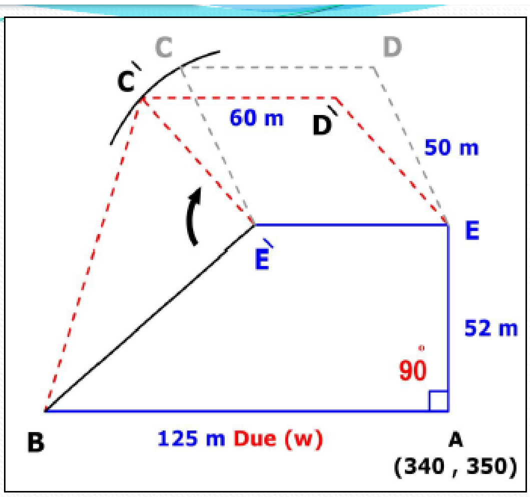
...... Checked ......

Coords. Of (C) (P2) : (242.30 , 434.86)

Coords. Of (C ') (P2') : (230.22 , 397.30)

Coords. Of (D) From (C) : (302.30 , 434.86)

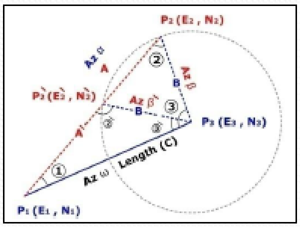
Coords. Of (D') From (C ') : (290.22 , 397.30)



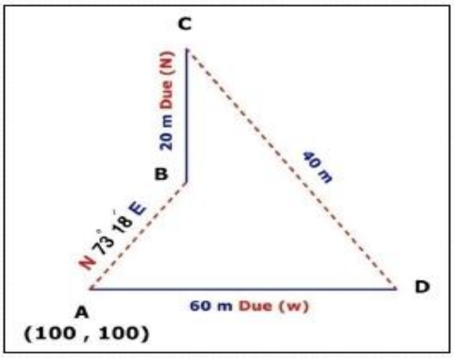
ength of DE :

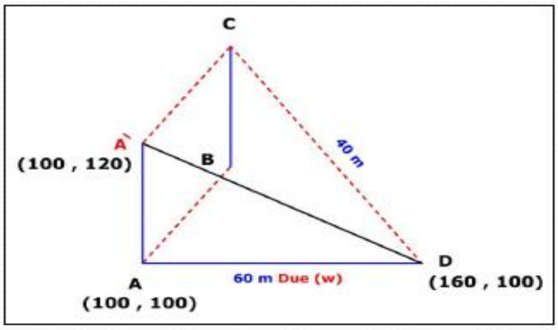
$$D-E=\sqrt{(340-302.3)^2+(402-434.86)^2}\ =\ 50.01\ m$$

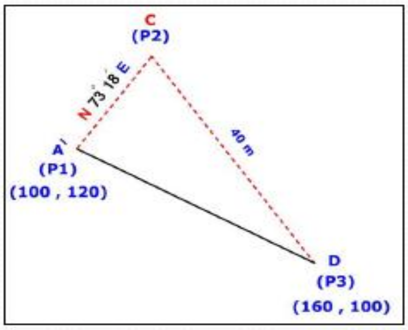
$$D'-E=\sqrt{(340-290.22)^2+(402-397.3)^2}\ =\ 50.00\ m$$



Home work : Find the Coords. of the following TraversePoints by a triagnometric method :





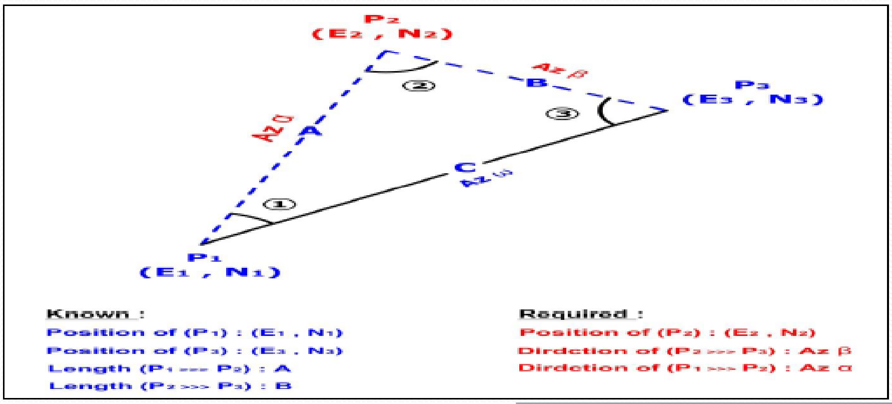


Lecture (6) to (8)

- التقاطع الثالث (III) Intersection :

يمثل هذا التقاطع هندسيا بتقاطع خطين مستقيمين معلومي الطول ومجهولي الاتجاه ، وبالتالي فإنه بمعلومية طوليهما يمكن تحديد نقطة تقاطعهما المجهولة (P_2) .

ولتبسيط هذا النوع من التقاطعات ، في حال عدم تجاور الاضلاع الحاوية على المجاهيل (كما في الاشكال الرباعية والخماسية والسداسية .. وغيرها) يتم رسم موازيات بحسب الحالة المتوفرة بهدف تكوين حالة التقاطع الثالث ، بحيث يكون الضلعين الحاويين على تلك المجاهيل متجاوران وتشكل نقطتي بدايتيهما خطاً معلوما بالاسم (P_1 , P_3) ويتقاطعان من طرفهما الاخر في النقطة المجهولة (P_2) . وكما في الشكل التالي :



هنالك طريقتين لحساب المجاهيل في هذا النوع من التقاطعات :

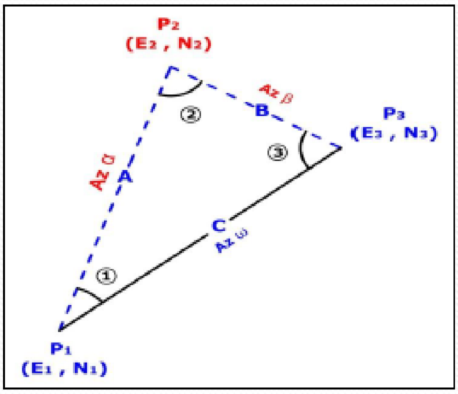
أولاهما (وهي الطريقة المهمة) : طريقة المثلثات (Triagnometric Method) :

يستخدم في هذه الطريقة قانون جيب التمام (Cos Law) . وكما يلي :

١- يحسب إتجاه الضلع $(P_1 \rightarrow P_3)$ $(Az\ \omega)$ وطوله (C) بالعلاقتين التاليتين :

$$Az\ \omega = \tan^{-1}\left(\frac{E_3 - E_1}{N_3 - N_1}\right)$$

$$Length\ (C) = \left(\frac{E_3 - E_1}{Sin\ Az\ \omega}\right) = \left(\frac{N_3 - N_1}{Cos\ Az\ \omega}\right)$$



٢- تحسب الزوايا الداخلية للمثلث (3> , 2> , 1 >) بإستخدام قانون جيب التمام .

$$B^2 = A^2 + C^2 - 2A.C.Cos < 1$$

$$Cos < 1 = \frac{A^2 + C^2 - B^2}{2A.C} \qquad Cos < 2 = \frac{A^2 + B^2 - C^2}{2A.B} \qquad Cos < 3 = \frac{B^2 + C^2 - A^2}{2B.C}$$

٣- يحسب الاتجاهان المجهولان (Az β , Az α) من الزوايا الداخلية التي تم حسابها في الخطوة السابقة ، والاتجاه (Az ω) .

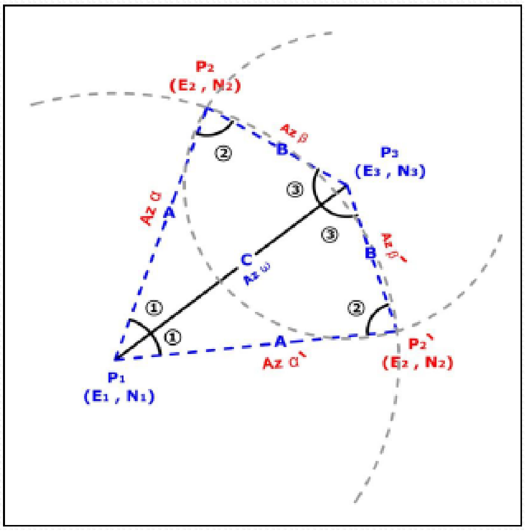
$Az\ \alpha = Az\ \omega \pm <1$

$Az\ \beta = Back\ Az\ \alpha \pm <2$

٤- يحسب الاتجاهان المحتملان (Az β′ , Az α′) وهما نفس الزوايا السابقة ، لكن بالاتجاه المعاكس لخط القاعدة ، وكما في الشكل التالي .

$Az\ \alpha' = Az\ \omega \pm <1$

$Az\ \beta' = Back\ Az\ \alpha' \pm <2\ ...(or)...\ Back\ Az\ \omega \pm <3$



٥- يحسب الموقع (P2) من خلال (P1 , A , Az α).

ويتم التحقق من (P3) بواسطة (P2 , B , Az β) .

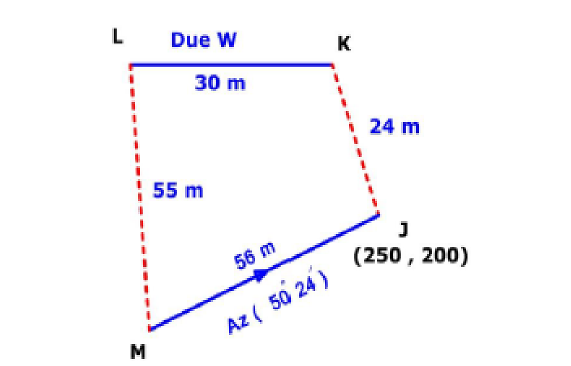
٦- يحسب الموقع المحتمل (P2′) من خلال (P1 , A , Az α′)

ويتم التحقق من (P3) بواسطة (P2′ , B , Az β′) .

٧- يتم إختيار أحد الاحتمالين إما بالاعتماد على الرسم أو الواقع .

Ex : Find the coords. of the traverse (J , K , L , M) by using triagnometric method .

Sol : **Coords. Of (M) :**



$E_M = E_J + L_{(J\to M)} Sin\ Az_{(J\to M)}$

$E_M = 250 + 56\ Sin\ (50^o\ 24^o + 180^o) = 206.85\ m$

$N_M = N_J + L_{(J\to M)} Cos\ Az_{(J\to M)}$

$N_M = 200 + 56\ Cos\ (50^o\ 24' + 180^o) = 164.30\ m$

Coords. Of (J ′) : (220 , 200)

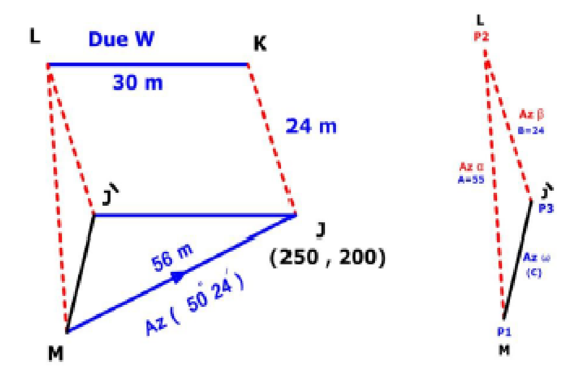
$length_{(C)} = \sqrt{(220 - 206.85)^2 + (200 - 164.30)^2} = 38.05\ m$

$Az_{\omega} = tan^{-1} \dfrac{(220 - 206.85)}{(200 - 164.30)} = 20^o\ 13'$

$Cos <1 = \dfrac{A^2 + C^2 - B^2}{2A.C} \to \dfrac{55^2 + 38.05^2 - 24^2}{2 \times 55 \times 38.05} = 21^o\ 24'$

$Cos <2 = \dfrac{A^2 + B^2 - C^2}{2A.B} \to \dfrac{55^2 + 24^2 - 38.05^2}{2 \times 55 \times 24} = 35^o\ 21'$

$Cos <3 = \dfrac{B^2 + C^2 - A^2}{2B.C} \to \dfrac{24^2 + 38.05^2 - 55^2}{2 \times 24 \times 38.05} = 123^o\ 15'$

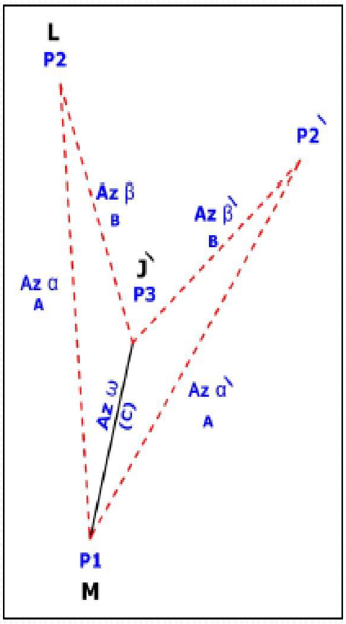


$Az_{\alpha} = Az_{\omega} - \angle 1$

$Az_{\alpha} = 20^{o}\,13' - 21^{o}\,24' \rightarrow -1^{o}\,11' + 360^{o} = \mathbf{358^{o}\,49'}$

$Az\,\beta = Back\ Az\,\alpha - \angle 2$

$Az_{\beta} = (358^{o}\,49' - 180^{o}) - 35^{o}\,21' = \mathbf{143^{o}\,28'}$



Coords. Of (P2) From (P1) :

$E_{P2} = E_{P1} + A.Sin\ Az_{\alpha} \rightarrow 206.85 + 55\ Sin\ 358^{o}\,49' = \mathbf{205.71\ m}$

$N_{P2} = N_{P1} + A.Cos\ Az_{\alpha} \rightarrow 164.30 + 55\ Cos\ 358^{o}\,49' = \mathbf{219.29\ m}$

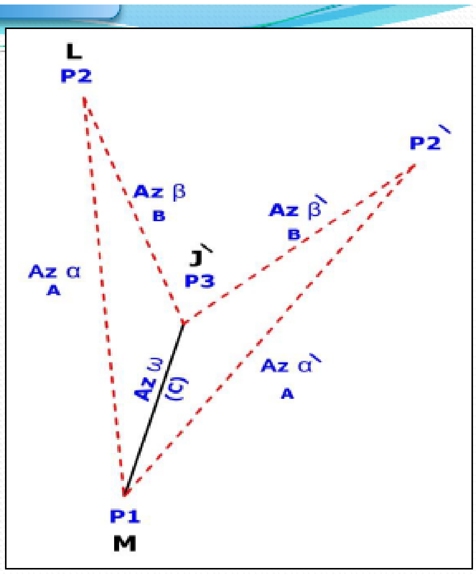
Check Of (P 3) From (P2) :

$E_{P3} = E_{P2} + B.Sin\ Az_{\beta} \rightarrow 205.71 + 24\ Sin\ 143^{o}\,28' = \mathbf{220\ m}$

$N_{P3} = N_{P2} + B.Cos\ Az_{\beta} \rightarrow 219.29 + 24\ Cos\ 143^{o}\,28' = \mathbf{200\ m}$

(((Checked)))

(((الاحتمال الثاني)))



$Az_{\alpha}' = Az_{\omega} + \angle 1$

$Az_{\alpha}' = 20^{o}\,13' + 21^{o}\,24' = \mathbf{41^{o}\,37'}$

$Az_{\beta}' = Back\ Az_{\omega} - \angle 3$

$Az_{\beta}' = (20^{o}\,13' - 180^{o}) - 123^{o}\,15' = \mathbf{76^{o}\,58'}$

$(or)\ Az_{\beta}' = Back\ Az_{\alpha}' + \angle 2 - 180^{o}$

$Az_{\beta}' = (41^{o}\,37' + 180^{o}) + 35^{o}\,21' - 180^{o} = \mathbf{76^{o}\,58'}$

Coords. Of (P2 ') From (P1) :

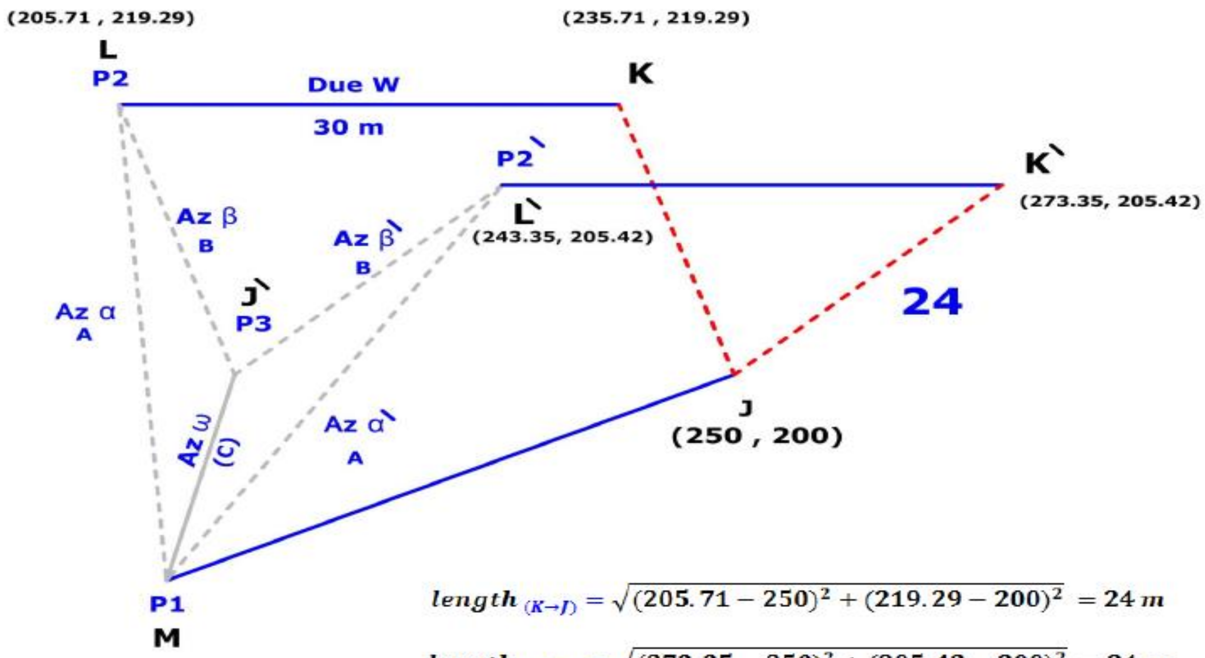
$E_{P2}' = E_{P1} + A.Sin\ Az_{\alpha}' \rightarrow 206.85 + 55\ Sin\ 41^{o}\,37' = \mathbf{243.38\ m}$

$N_{P2}' = N_{P1} + A.Cos\ Az_{\alpha}' \rightarrow 164.30 + 55\ Cos\ 41^{o}\,37' = \mathbf{205.42\ m}$

Check Of (P3) From (P2 ') :

$E_{P3} = E_{P2}' + B.Sin\ Az_{\beta}' \rightarrow 243.38 + 24\ Sin\ (76^{o}\,58' + 180^{o}) = \mathbf{220\ m}$

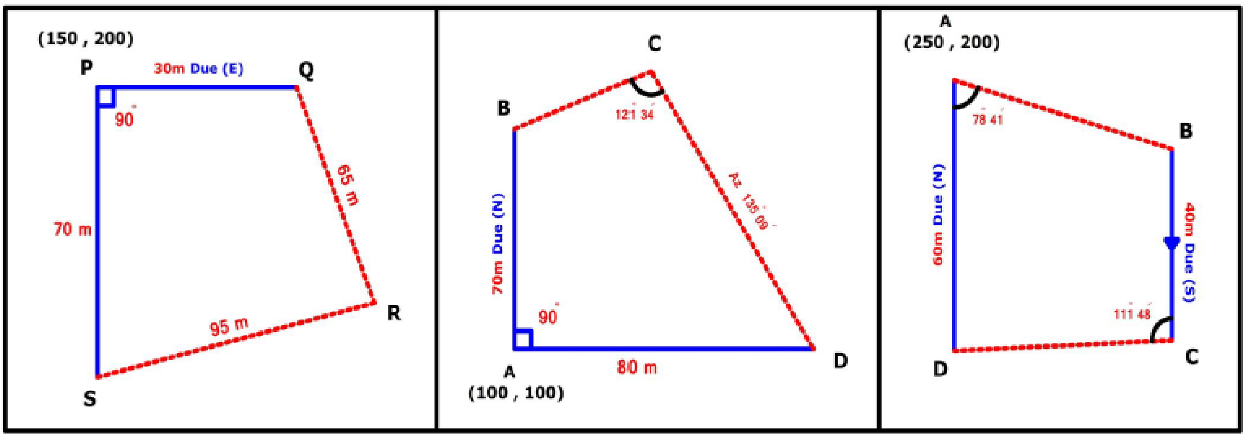
$N_{P3} = N_{P2}' + B.Cos\ Az_{\beta}' \rightarrow 205.42 + 24\ Cos\ (76^{o}\,58' + 180^{o}) = \mathbf{200\ m}$



$$length_{(K\rightarrow J)} = \sqrt{(205.71-250)^2+(219.29-200)^2} = 24\,m$$

$$length_{(K'\rightarrow J)} = \sqrt{(273.35-250)^2+(205.42-200)^2} = 24\,m$$

__Examples__ : Find the solving triangle of the traverses .



Lecture (9) to (15)

(Resections)

يقصد بـ (Resection) التقاطع العكسي عملية حساب موقع نقطة معينة يمكن نصب الجهاز عليها (إحتلالها) وإيجاد إحداثيتها من خلال ثلاث نقاط معلومة الاحداثيات ، والزاويتين (α ، β) الناتجتين من رصد النقاط الثلاث.

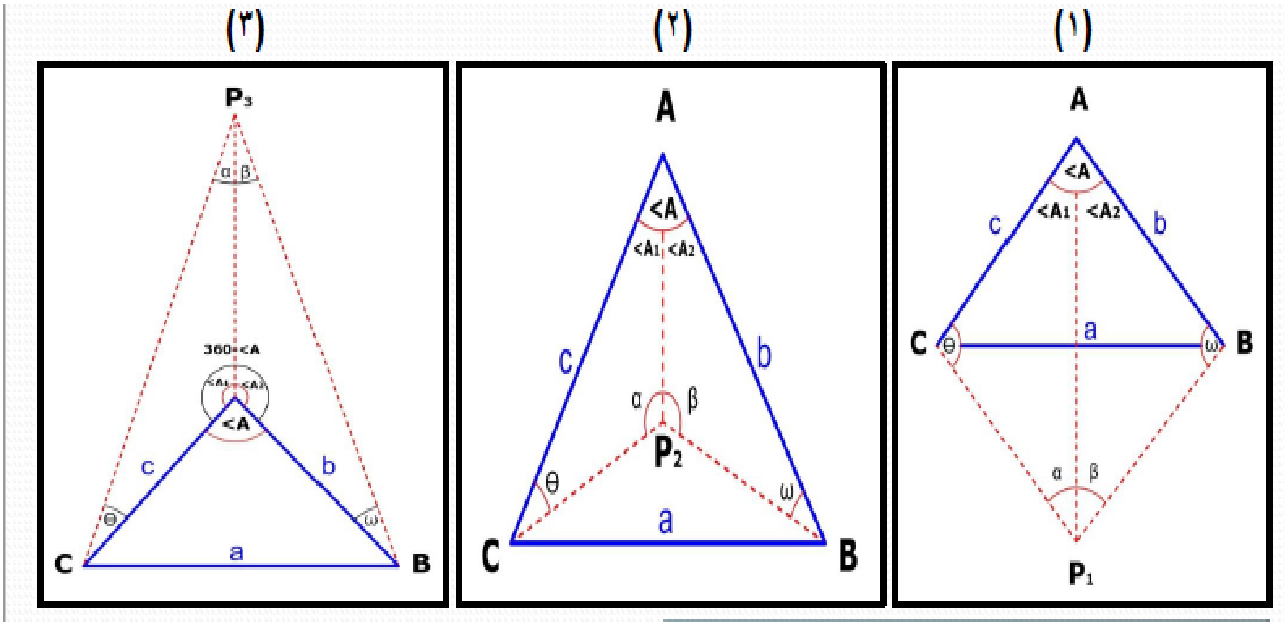
ويستخدم التقاطع الخلفي عادة لربط احداثيات منطقة حديثة الانشاء بمدينة قائمة ، أو للبدئ بمشروع معين من خلال نقاط معلومة الاحداثيات محيطة بالموقع .

هنالك ثلاثة حالات للتقاطع العكسي بالاعتماد على النقطة المطلوب حساب احداثياتها ، وهي كما موضحة في الاشكال التالية :

١- النقطة المطلوبة (P_1) خارج المثلث بإتجاه القاعدة.

٢- النقطة المطلوبة (P_2) داخل حدود المثلث .

٣- النقطة المطلوبة (P_3) خارج حدود المثلث بإتجاه الرأس



Resection Case (1)

١- طريقة كاستنر : KAESTNER METHOD

المعطيات : (احداثيات A,B,C) والزاويتان (α ، β) .

المطلوب : الزاويتان (ω, θ) والموقع (P) .

(((خطوات الحل في الحالة (١) طريقة كاستنر / النقطة المطلوبة اسفل قاعدة المثلث)))

١- من احداثيات اركان المثلث نحسب الاطوال (a , b , c) . والاتجاهات لاضلاع المثلث ثم الزوايا الداخلية للمثلث .

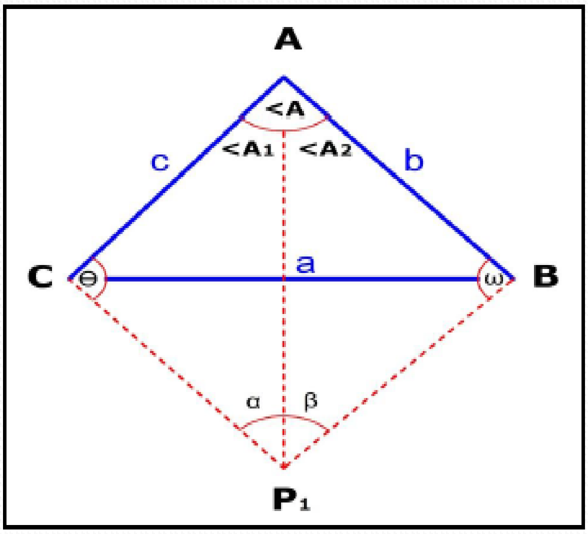
٢- لحساب الزاويتين (ω, θ) يجب حساب (tan ϕ , < S). ويتم ذلك من خلال :

$$< S = \theta + \omega = 360 - (\alpha + \beta + < A) \quad .. (1)$$

$$\tan \phi = \frac{\sin \omega}{\sin \alpha} = \frac{c . \sin \beta}{b . \sin \alpha} \quad ....(2)$$

$$\tan \theta = \frac{\sin < S}{\tan \phi + \cos < S} \quad ....(3)$$

$$\tan \omega = \frac{\sin < S}{\cot \phi + \cos < S} \quad ....(4)$$



٣- يحسب طول الضلع (AP1) بإستخدام قانون الجيوب .

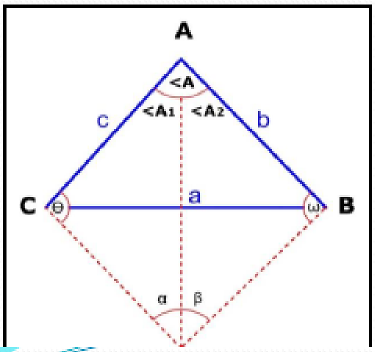
للمثلث الايسر $\frac{AP_1}{Sin\,\theta} = \frac{c}{Sin\,\alpha}$ or $\frac{AP_1}{Sin\,\omega} = \frac{b}{Sin\,\beta}$ للمثلث الايمن

٤- يحسب إتجاه الضلع AP1 من الاتجاه (AZ_{AC} والزاوية A1) أو (AZ_{AB} والزاوية A2) .

$$< A1 = 180 - (\theta + \alpha) \quad , \quad < A2 = 180 - (\omega + \beta)$$

$$AZ_{AP1} = AZ_{AC} \pm < A1 \quad , \quad AZ_{AP1} = AZ_{AB} \pm < A2$$

٥- تحسب احداثيات (P1) من الاتجاه AZ_{AP1} والطول AP_1 واحداثيات A .



$$EP1 = EA + (AP1)\ Sin\ AZ_{AP1}$$

$$NP1 = NA + (AP1)\ Cos\ AZ_{AP1}$$

Ex : For the fig. below , find the coords. of point (P1) .

Sol. : 1- Calculating (Length , Azimuth of a triangle Sides) :

$$a = \sqrt{(722.178 - 240.983)^2 + (454.913 - 502.233)^2} = 483.516 \text{ m}$$

$$b = \sqrt{(722.178 - 500)^2 + (454.913 - 750)^2} = 369.377 \text{ m}$$

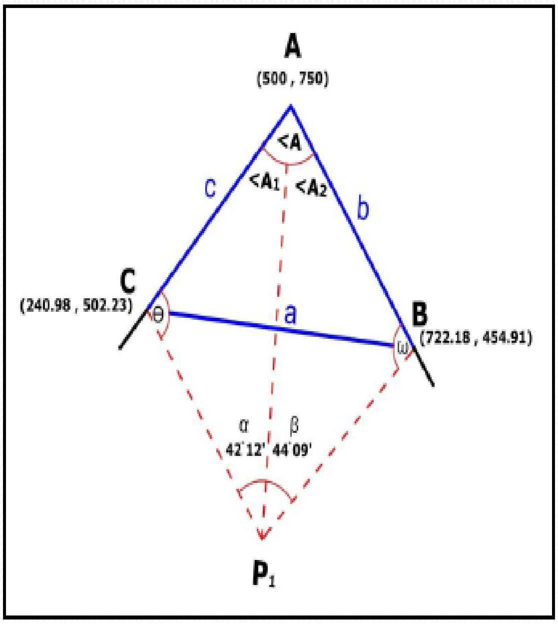
$$c = \sqrt{(500 - 240.983)^2 + (750 - 502.233)^2} = 358.439 \text{ m}$$

$$Az_{CA} = tan^{-1}[\frac{(500-240.983)}{(750-502.233)}] = 46^\circ\ 16'\ 18''$$

$$Az_{AB} = tan^{-1}[\frac{(722.178-500)}{(454.913-750)}] = 180^\circ - 36^\circ\ 58'\ 37'' = 143^\circ\ 01'\ 22''$$

Compute < A from Az_{CA} & Az_{AB}

$$< A = (46^\circ\ 16'\ 18'' + 180^\circ) - 143^\circ\ 01'22'' = 83^\circ\ 14'\ 56''$$



2- The angles (θ & ω):

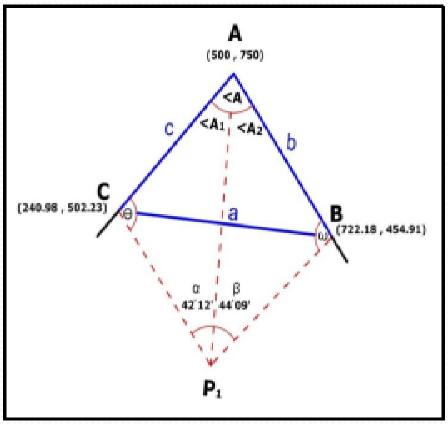
$$< S = \theta + \omega = 360 - (\alpha + \beta + < A) \quad ..(1)$$

$< S = 360° - (42° 12' 17" + 44° 09' 09" + 83° 14' 56") = 190° 23' 38"$

$$\tan \phi = \frac{\sin \omega}{\sin \alpha} = \frac{c . \sin \beta}{b . \sin \alpha} \quad ....(2)$$

$$\tan \varphi = \frac{358.439 * \sin 44°09'09"}{369.377 * \sin 42°12'17"} \rightarrow \tan \varphi = 1.006 \rightarrow \varphi = 45°10'37"$$

$$\tan \theta = \frac{\sin < S}{\tan \phi + \cos < S} \quad ....(3)$$



$$\tan \theta = \frac{\sin 190°23'38"}{1.006 + \cos 190°23'38"} \rightarrow \theta = -82°55'10"$$

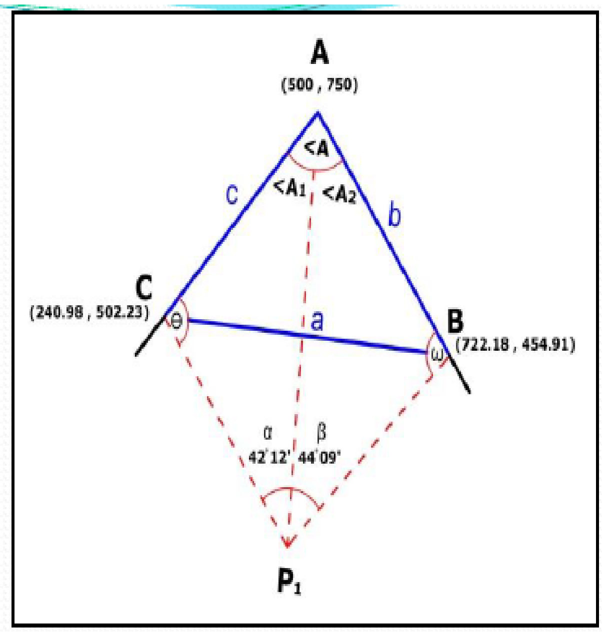
$\theta = 180° - 82° 55' 10" \rightarrow \theta = 97° 04' 50"$

$$\tan \omega = \frac{\sin < S}{\cot \phi + \cos < S} \quad ....(4)$$

$$\tan \omega = \frac{\sin 190°23'38"}{\frac{1}{1.006} + \cos 190°23'38"} \rightarrow \omega = -86°41'52"$$

$\omega = 180° - 86° 41' 52" \rightarrow \omega = 93° 18' 08"$

3- The length (AP_1) by Sin Law :



(المثلث الايسر) $\frac{AP_1}{\sin \theta} = \frac{c}{\sin \alpha}$

$$AP_1 = \frac{358.439 * \sin 97° 04' 50"}{\sin 42° 12' 17"} \rightarrow AP_1 = 529.496\ m$$

(Or) (المثلث الايمن) $\frac{AP_1}{\sin \omega} = \frac{b}{\sin \beta}$

$$AP_1 = \frac{369.377 * \sin 93° 18' 08"}{\sin 44° 09' 09"} \rightarrow AP_1 = 529.399\ m$$

Avg. of AP1 = 529.448 m

4- The direction (AP1) :

$< A1 = 180 - (\theta + \alpha)$, $< A2 = 180 - (\omega + \beta)$

$AZ_{AP1} = AZ_{AC} \pm < A1$, $AZ_{AP1} = AZ_{AB} \pm < A2$

$< A_1 = 180° - (42° 12' 17" + 97° 04' 50") \rightarrow < A_1 = 40° 42' 53"$

$Az_{AP1} = (46° 16' 18" + 180°) - 40° 42' 53" \rightarrow Az_{AP1} = 185° 33' 25"$

5- Coordinate of point (P1) :

$EP_1 = EA + (AP_1) \sin AZ_{AP1}$, $NP_1 = NA + (AP_1) \cos AZ_{AP1}$

$EP_1 = 500 + 529.448 \sin 185° 33' 25" \rightarrow EP_1 = 448.731\ m$

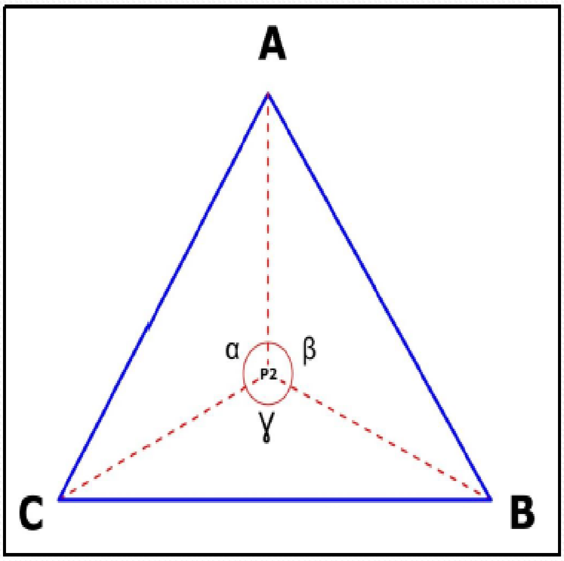
$NP_1 = 750 + 529.448 \cos 185° 33' 25" \rightarrow NP_1 = 223.04\ m$

Resection Case (2)

طريقة تينستر (TIENSTRA'S METHOD)

المعطيات : (احداثيات A,B,C) والزوايا (α ، β , γ) .

المطلوب : الموقع (P2) .. وخطوات الاجابة كما يلي :



$$a = tan^{-1}[\frac{E_C - E_A}{N_C - N_A}] - tan^{-1}[\frac{E_B - E_A}{N_B - N_A}]$$

$$b = tan^{-1}[\frac{E_A - E_B}{N_A - N_B}] - tan^{-1}[\frac{E_C - E_B}{N_C - N_B}]$$

$$C = tan^{-1}[\frac{E_B - E_C}{N_B - N_C}] - tan^{-1}[\frac{E_A - E_C}{N_A - N_C}]$$

$$K_1 = \frac{1}{Cot\,a - Cot\,\gamma} \quad , \quad K_2 = \frac{1}{Cot\,b - Cot\,\alpha} \quad , \quad K_3 = \frac{1}{Cot\,c - Cot\,\beta}$$

$$E_{P3} = \frac{K_1 * E_A + K_2 * E_B + K_3 * E_C}{K_1 + K_2 + K_3} \quad , \quad N_{P3} = \frac{K_1 * N_A + K_2 * N_B + K_3 * N_C}{K_1 + K_2 + K_3}$$

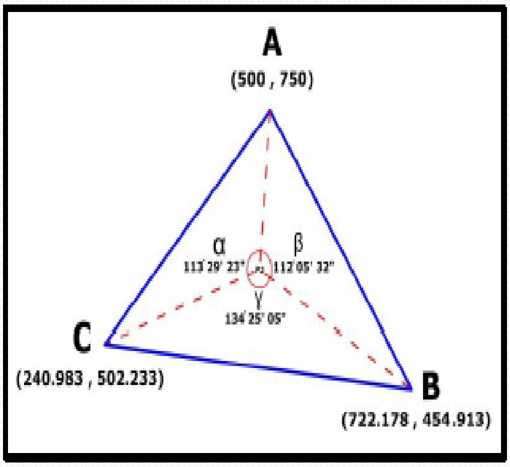
Ex : For the fig. below , find the coords. of point (P2) .

Sol . :

$$a = tan^{-1}\left[\frac{E_C - E_A}{N_C - N_A}\right] - tan^{-1}\left[\frac{E_B - E_A}{N_B - N_A}\right] \rightarrow a = tan^{-1}[\frac{240.983 - 500}{502.233 - 750}] - tan^{-1}[\frac{722.178 - 500}{454.913 - 750}] = 83.249$$

$$b = tan^{-1}\left[\frac{E_A - E_B}{N_A - N_B}\right] - tan^{-1}\left[\frac{E_C - E_B}{N_C - N_B}\right] \rightarrow b = tan^{-1}[\frac{500 - 722.178}{750 - 454.913}] - tan^{-1}[\frac{240.983 - 722.178}{502.233 - 454.913}] = 47.407$$

$$C = tan^{-1}\left[\frac{E_B - E_C}{N_B - N_C}\right] - tan^{-1}\left[\frac{E_A - E_C}{N_A - N_C}\right] \rightarrow c = tan^{-1}[\frac{722.178 - 240.983}{454.913 - 502.233}] - tan^{-1}[\frac{500 - 240.983}{750 - 502.233}] = -130.655$$



$$K_1 = \frac{1}{Cot\ a - Cot\ \gamma} \rightarrow K_1 = \frac{1}{Cot\ 83.249 - Cot\ 143^o\ 25'\ 05''} = 0.912$$

$$K_2 = \frac{1}{Cot\ b - Cot\ \alpha} \rightarrow K_2 = \frac{1}{Cot\ 47.407 - Cot\ 113^o\ 29'\ 23''} = 0.739$$

$$K_3 = \frac{1}{Cot\ c - Cot\ \beta} \rightarrow K_3 = \frac{1}{Cot\ 130.655 - Cot\ 112^o\ 05'\ 32''} = 0.791$$

$$E_{P3} = \frac{K_1 * E_A + K_2 * E_B + K_3 * E_C}{K_1 + K_2 + K_3} \rightarrow E_{P3} = \frac{0.912 * 500 + 0.739 * 722.178 + 0.791 * 240.983}{0.912 + 0.739 + 0.791} = 483.336\ m$$

$$N_{P3} = \frac{K_1 * N_A + K_2 * N_B + K_3 * N_C}{K_1 + K_2 + K_3} \rightarrow N_{P3} = \frac{0.912 * 750 + 0.739 * 454.913 + 0.791 * 502.223}{0.912 + 0.739 + 0.791} = 580.445\ m$$

Resection Case (3)

المعطيات : (احداثيات A,B,C) والزاويتان (α ، β) .

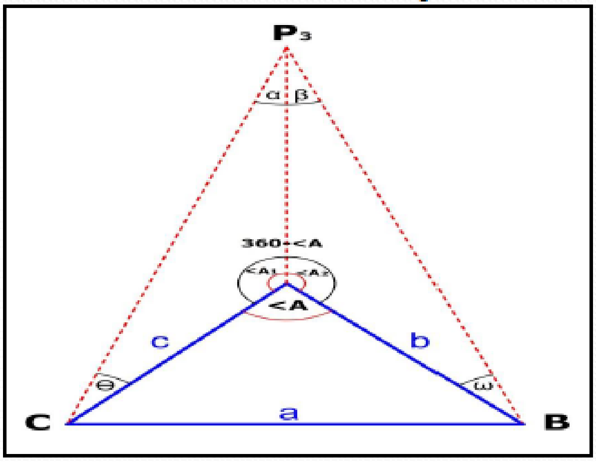
المطلوب : (ω, θ) والموقع (P) .

(((خطوات الحل في الحالة (٣) / النقطة المطلوبة داخل المثلث)))

*** الخطوات مطابقة لخطوات الحالة الاولى ، الاختلاف فقط في قيمة (< S) وهي كما يلي :**

$$< S = \theta + \omega = 360 - (\alpha + \beta + 360 + < A)$$

$$< S = < A - \alpha - \beta$$



Ex : For the fig. below , find the coords. of point (P3) .

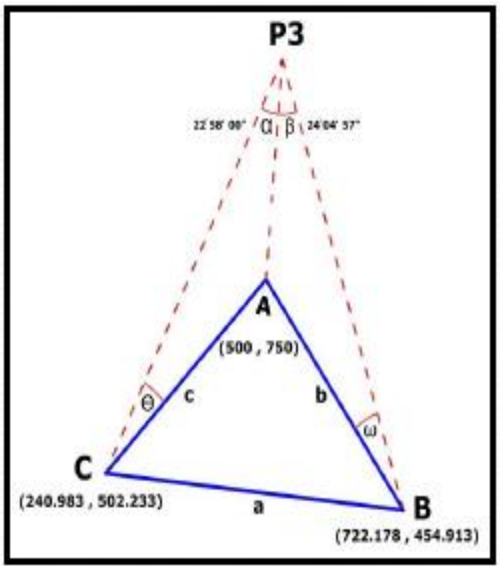
Sol : from the Coords. we find the requirement of point (1) in solution steps , as follow :

$c = 358.44$ m .

$b = 369.38$ m .

$Az_{CA} = 46^o\ 16'$

$<A = 83^o\ 15'$



(2) Compute the value of $(\theta + \omega)$:-

$\measuredangle_s = \theta + \omega = 360 - (\alpha + \beta + 360 + \measuredangle A) \Rightarrow \measuredangle_s = \measuredangle_A - \alpha - \beta$

$\measuredangle_s = 83^\circ\, 14'\, 55'' - 22^\circ\, 58' - 24^\circ\, 4'\, 57'' = 36^\circ\, 11'\, 58''$

$\tan\phi = \frac{c \cdot \sin\beta}{b \cdot \sin\alpha} = \frac{358.42 \sin 24^\circ\, 4'\, 57''}{369.377 \sin 22^\circ\, 58'} \Rightarrow \tan\phi = 1.0156 \quad \phi = 45^\circ\, 25'\, 9''$

$\tan\theta = \frac{\sin \measuredangle s}{\tan\phi + \cos \measuredangle s} = \frac{\sin 36^\circ\, 11'\, 58''}{1.015 + \cos 36^\circ\, 11'\, 58''} \Rightarrow \quad \theta = 17^\circ\, 57'\, 37''$

$\tan\omega = \frac{\sin \measuredangle s}{\cot\phi + \cos \measuredangle s} = \frac{\sin 36^\circ\, 11'\, 58''}{\frac{1}{1.015} + \cos 36^\circ\, 11'\, 58''} \Rightarrow \quad \omega = 18^\circ\, 14'\, 21''$

(3) Compute the length AP_1 by Sin law :-

$\frac{AP_3}{\sin\theta} = \frac{c}{\sin\alpha} \Rightarrow AP_3 = \frac{\sin 17^\circ\, 57'\, 37'' * 358.42}{\sin 22^\circ\, 58'} \Rightarrow AP_3 = 283.247\ m$

or

$\frac{AP_3}{\sin\omega} = \frac{b}{\sin\beta} \Rightarrow AP_3 = \frac{\sin 18^\circ\, 14'\, 21'' * 369.377}{\sin 24^\circ\, 04'\, 57''} \Rightarrow AP_3 = 283.32\ m$

$Avg._{AP_3} = 283.284\ m$

(4)

$\measuredangle A_1 = 180^\circ - (\alpha + \theta) \Rightarrow 180^\circ - (22^\circ\, 58' + 17^\circ\, 57'\, 37'') \Rightarrow \measuredangle_{A_1} = 139^\circ\, 4'\, 23''$

$Az_{AP_3} = Az_{AC} + \measuredangle A_1 \Rightarrow (180^\circ + 46^\circ\, 16'\, 18'') + 139^\circ\, 4'\, 23'' = 365^\circ\, 20'\, 41''$

$Az_{AP_3} = 365^\circ\, 20'\, 41'' - 360^\circ = 5^\circ\, 20'\, 41''$

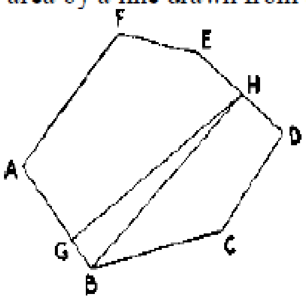
(5)

$E_{P_3} = E_A + AP_3 \sin Az_{AP_3} \Rightarrow 500 + 283.284 \sin 5^\circ\, 20'\, 41'' = 526.387\ m$

$N_{P_3} = N_A + AP_3 \cos Az_{AP_3} \Rightarrow 750 + 283.284 \cos 5^\circ\, 20'\, 41'' = 1032.052\ m$

. Subdivision of an Area into Given Parts from a Point on Boundary.

Let ABCDEFA (Fig. 202) be a plot of land, and let be required to cut off a definite area by a line drawn from the H on the boundary.



Calculate the area of the figure ABCDEFA from the coordinates and also plot the figure on a fairly large scale. By inspectic or by trial and error on the plotted plan, find the station B so th the area bounded on one side by the line HB is nearer in value u» the given area than that bounded by a line from H to any other I

The length and bearing of the line BH have been computed from the coordinates of H and B and, since the bearing of BG is known, **the** angle HBG is known. Consequently, BG can be computed and the coordinates of G found.

406. Subdivision of an Area into Given Parts by a Line of Given Bearing. Let it be required to divide the area ABCDEFGA (Fig. 203) into two parts by a line whose bearing is given.

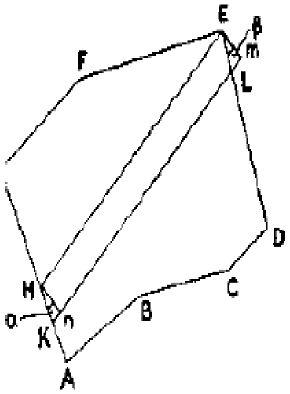


FIG. 203.

Calculate the area of the figure from the coordinates and plot it on a fairly large scale. Draw the line EH from one station E, and in the given direction, so that it cuts off an area HEFGH approximately equal to *A,* the area required. Calculate the bearing and distance of GE. Then, since the bearings of the lines GE, EH, and HG are known, the three angles of the triangle GEH are known and, from these and the computed distance GE, the lengths HE and GH can be calculated. Hence, the coordinates of H can be found. Using these coordinates, and those of the points E, F, and G, calculate the area of the figure HEFGH. Let *A'* be this area. Then, if LK is the line needed to cut off the area *A,* we must have:

$$A - A' = \text{Area of figure HKLEH.}$$

From E draw Em perpendicular to EH to meet KL in m, and from H draw Hn perpendicular to KL. Let Em = Hn = *x* and angle

KHn = a, and *ELm* = /?, these angles being known bearings of the different lines are known. Then, lengtfc HE — *x* . tan /? + *x* . tan *a.* Hence,

Area of figure HKLEH = ^(HE + KL)

= |(2HE + x(tan *a* - tan 01 j

2

= x . HE + y{tana-tan/?).

Hence,.

A-A'=

y(tana-tan£).

This is a quadratic equation which can be solved for x. having found *x,* we have:

EL = x . sec /?; HK = x . sec a. Hence, the coordinates of K and L

can be found.

سؤال:11.10/قطعة ارض على شكل مضلع مغلق JKLMفي الشكل ادناه ، تمر خلالها قناة الرأي عرضها 6م باتجاه : N 70° W وابتداءاً من نقطة K . اريد تقسيم الجزء الواقع الى جنوب تلك القناة . الى مساحتين متساويتين من نقطة P الذي تقع في منتصف KH والمطلوب حساب : أ) مساحات اجزاء JGF وGKHF و KLMH .
ب) طول واتجاه الخط PR وموقع نقطة R .

J(100,100)

Ek=100+40*Sin 180°=100 m

Nk=100+40*Cos 180°=60 m

EL=100+50*Sin 126° 45'=140.063 m

NL=60+50*Cos 126° 45'=30.083 m

EM=140.063+100*Sin 270°=40.063 m

NM=30.083+100*Cos 270°=30.083 m

EJ=40.063+92*Sin 40° 35'=99.914 m

NJ=30.083+92*Cos 40° 35'=99.953 m

Point	Sild	Length	AZ.	Dep.	Lat	X	Y
J						100	100
	JK	40	180°	0	-40		
K						100	60
	KL	50	126° 45'	40.063	-29.916		
L						140.063	30.084
	LM	100	270°	-100	0		
M						40.063	30.084
	MJ	92	40° 35'	59.851	69.870		
J						99.914	99.954
		282		-0.086	-0.046		

Corr. Dep.	Corr. Lat.	Corrected Dep.	Corrected Lat.	X	Y
				100	100
0.012	0.006	0.013	-39.994		
				100.013	60.006
0.015	0.008	40.078	-29.908		
				140.091	30.098

References

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-Web sites.