STUDENTS' PERFORMANCE ASSESSMENT

Form ٠٨

CADASTRAL SURVEY – THIRD STAGE

Instructor: Abed Tuama Jasim

Table ١, Plan of whole year assessments

Program Outcomes	Course Learning Objectives	Strategies for Achieving Outcomes	Assessment Method (results table after performing)
١. Developing the mapping process using modern science and equipment and survey programs such as GIS, ATCAD ERDAS and others ٢. Designing and developing cadastral maps by scientific and technical methods. ٣. Calculate areas and volumes using methods and mathematical calculations ٤. Calculating areas using scientific programs such as the server, GIS and others ٥. Division of lands and fixing borders by old and modern methods	١. Definition of **CADASTRAL SURVEY** . **٢. Types of travers (closed travers, open travers).** **٣. Close errors.** **٤. Type pf bearing.** **٥. Forward computations and invers computations** **٦. Definition of intersection and resection and land division**	٧. Learning and training on the use of modern and old survey equipment Eliminate bad habits ٨. Training in manual mapping without using programs ٩. Training in the use of software and the production of maps by collecting data through ground survey and mapping, or by producing a map through a satellite or aerial photo	١. In-class and online quizzes ٢. Homework ٣. Peer feedback activities ٤. Practice exams

Table ٢, Assessment Rubrics

Rubric	٤- Exceeds	٣- Meets	٢-Progressing	١-Below Average
Engineering Knowledge	students can draw a cadastral map using primitive methods in the first stage of the lectures	The student will just be able to understand the concepts of basic science and basic mathematics to solve engineering problems	The student will just be able to remember the concepts of basic science and basic mathematics to growing maps	the student does not have an engineering and technical sense in choosing the appropriate colors for the topography
Problem Analysis	The student can establish the boundaries of any plot of land, separate them, and calculate the area of each part separately by mathematical methods	The student is just able to have a grasp of a problem statement and its constraints and can understand problem definition and the requirements for a given problem which are suitable for its solution.	Students need assistance to have a grasp of the problem statement and its constraints and can understand problem definition and the requirements for a given problem which are suitable for its solution.	The student is not able to recognize the basics of problem analysis and using the global symbols
Design and Developme nt of Solutions	The student can fix the boundaries of any plot of land, separate them, and calculate the area of each part separately using modern survey programs such as GIS and AUTOCAD	The student can understand and apply the engineering knowledge for the design of functional and realistic system consisting of multiple components or processes.	The student will need help and application of engineering knowledge to design and produce a map of any engineering project	The student does not have the imagination to design an engineering part

Table ٣, Students Works Rating

Students Outcome	Max Score
	High : ١٠٠
	Low : ٥٠
	Mean :٧٥
	SD : ٢,٥

Table ٤, Student and Faculty Evaluations of Learning Outcomes

Students Outcomes	Students Rating	Instructor Rating	Instructor Comments
Not yet achieved	**Not yet achieved**	**Not yet achieved**	**Not yet achieved**

Table ٥, Changes/Improvements

Assessment of Changes/Improvements Made this year	
Changes/Improvements That Will Be Made Next Time the Course is Offered	

Table ٦, Final Evaluation

Outcome	Average	Notes
Not yet achieved	**Not yet achieved**	**Not yet achieved**

Appendices:

Materials: (Course notes should be here)

Faculty Curriculum Vitae:

Abed Tuama Jasim
Master in Remote Sensing and Surveying
Cell# ٠٠٩٦٤٧٧٠٨٥٧٨١٩٣
abedtuama@ntu.edu.iq
Google Scholar: https://scholar.google.com/citations?user=O٣٣XfJgAAAAJ

Education

Ural Federal State University - Russian Federation - Yektran Borg
Master of Surveying Engineering - Assistant Lecturer (٢٠١٥)
Dissertation title: "I STUDY OF DYNAMIC EVOLUTION
EARTH REMOTE SENSING SATELLITES IN SOLAR-SYNCHRONOUS ORBITS"

Appointments

- **Technical trainer at the Technical Education Authority - Kirkuk Technical College - Survey Technology Engineering Department (٠٥-١٤-٢٠٠٦).**
- **Department Associate for Evening Studies (٢٠١٨-٢٠١٩).**
- **Department Chairman (١/١٠/٢٠١٩– Present) ,surveying Department ,Technical College –Kirkuk, Kirkuk, Iraq.**
- **Faculty member (master) and lecturer (٧/٢٠١٥ - Present) Technical College –Kirkuk, Kirkuk, Iraq.**
- **Member of an examination committee from ٢٠١٨ until now.**
- **Member of the Educational Guidance Committee in the Survey Department.**
- **Member of a technical committee for the purpose of determining the lands owned by the college.**

Academic Honors and Awards

- **A letter of thanks and appreciation from His Excellency the Minister of Education and Higher Education.**
- **A letter of thanks and appreciation from the President of the Northern Technical University.**
- **A letter of thanks and appreciation from the Assistant President of the Northern Technical University.**

Miscellaneous
Computer Skills:

- Matlab/Simulink/GUI
- Arc Map GIS
- SQL Multiphysics
- Visual Basic
- AUTOCAD (٢D/٣D)
- AutoCADCivil ٣D
- Microsoft Office
- Erdas and ENVI and Surfer programs

Languages: Arabic– native language
English – Fluency in speaking, reading, and writing.
Russian – Fluency in speaking, reading, and writing.

Publications

Research published and accepted for publication and its journals

An AHP-based GIS for a New Hospital Site Selection in the Kirkuk Governorate
QM Ajaj, MA Shareef, AT Jasim, SF Hasan, AM Noori, ND Hassan
٢٠١٩ ٢nd International Conference on Electrical, Communication, Computer …

On the long-period evolution of the sun-synchronous orbits
ED Kuznetsov, AT Jasim
Solar System Research ٥٠ (٣), ١٩٧-٢٠٣
Comparative in urban growth among various local jurisdiction of Kirkuk city from ٢٠١٤ to ٢٠١٦ in hawija and dibis
ALAT Jasim
Solid State Technology, ٤٦٧-٤٨٥

Analytical Study of Earth Tides on Low Orbits Satellites
AK Izzet, MJ Hamwdi, AT Jasim
Iraqi Journal of Science, ٤٥٣-٤٦١

PHOTOGRAMMETRY
TJ Abed
Аграрная наука Северо-Кавказскому Федеральному округу, ٢٠٩-٢١٢

Moon and Sunperturbations effectson the orbital elementsof earth satellitesorbits
Ahmed K. Izzet,AbedT. Jasi,m Mayada J. Hamwdi,Qayssar M. Ajaj
Acceptance of publishing ٢٠١٩

Ministry of Higher Education and Scientific Research
The Northern Technical University
College Of Technology
Kirkuk
Surveying Technical

CADSTRAL SURVEY - THIRD STAGE

CADASTRAL SURVEY – THIRD STAGE

Lecturer Abed tuama jasim

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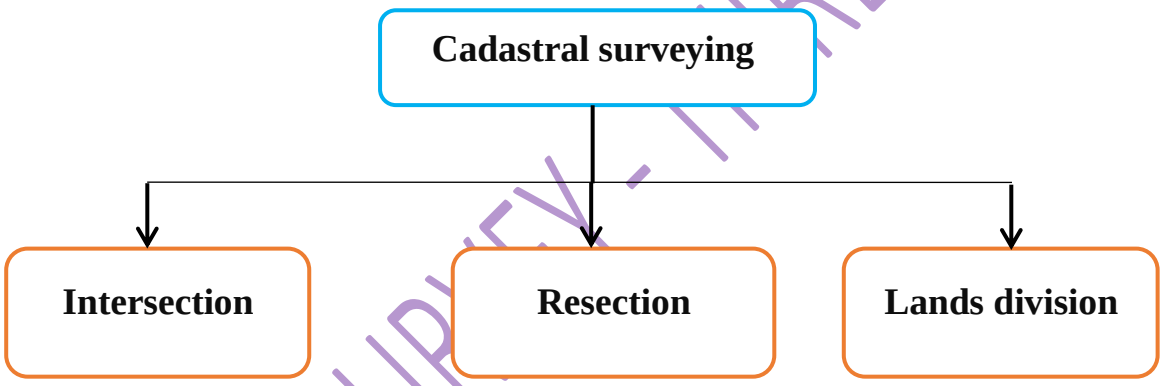
Cadastral Survey

Cadastral surveying is the discipline of land surveying relating to the laws of land ownership and the definition of property boundaries. It involves interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property. Such information is recorded for use on plans, maps and other legal documents. It also involves the physical delineation of property boundaries and determination of dimensions, area, and certain rights associated with properties, whether they are on land, water or defined by natural or artificial features.



Intersection: there are three types of intersection based on the unknown elements, which are

a) Intersection I : Two lengths of two sides are unknown

b) Intersection II: One length and one direction of sides are known.

c) Intersection III: Two directions of two sides are unknown

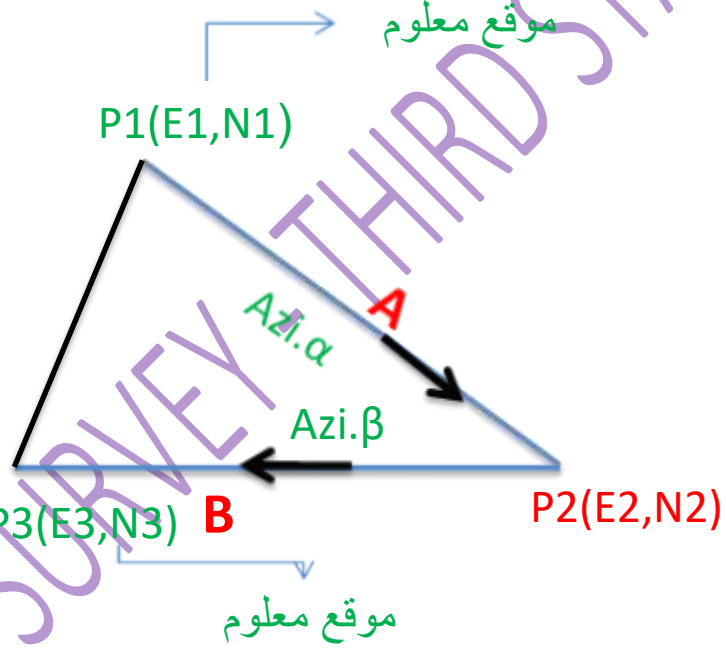
1-Intersection I

Two lengths of two sides are unknown

Known:- P1(E1,N1); P3(E3,N3) ; Azi.α ; Azi.β

Required:- P2(E2,N2) ; The length of A= P1P2 ;

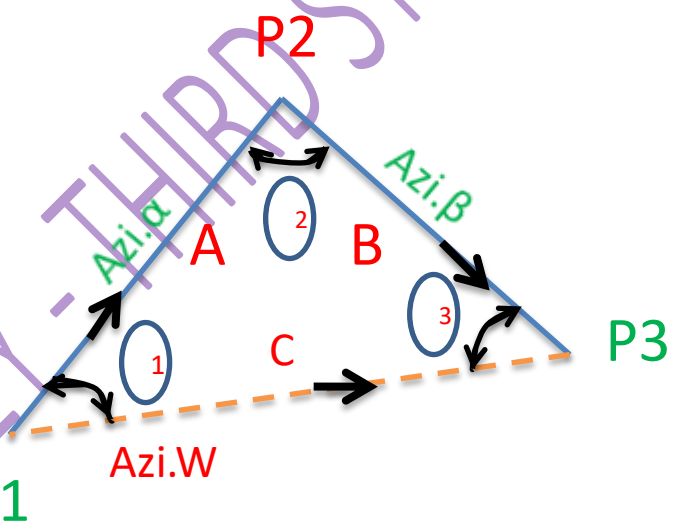
The length of B= P2P3



Method of solving For intersection -1:

1- find length C and Azi. W

$$Azi.w = \tan^{-1}\left(\frac{E3-E1}{N3-N1}\right).....1$$



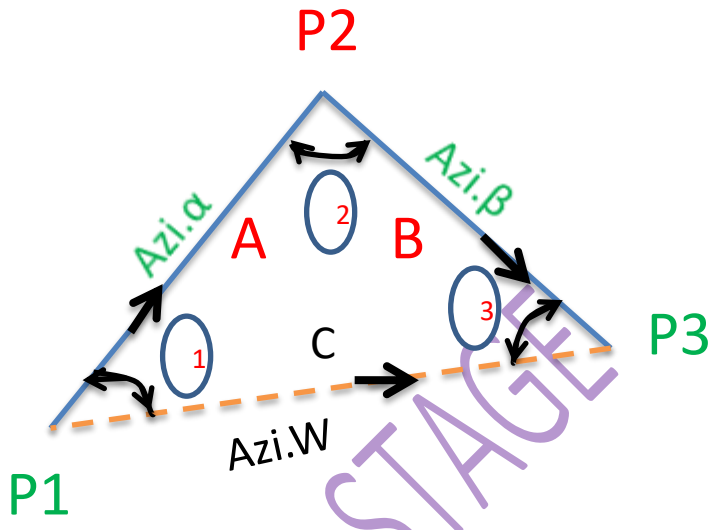
$$Length\ c = \left(\frac{E3-E1}{Sin\ Azi.W}\right) = \left(\frac{N3-N1}{Cos\ Azi.w}\right).....2$$

2- find length Angle (1) ; Angle (2) and (3)

Using Azi.α and Azi.w →find angle (1)

Using Azi.α and Azi.β →find angle (2)

Using Azi.β and Azi.w →find angle (3)



3- find length A and B Using sines low.

$$\frac{C}{\sin\angle 2}=\frac{A}{Sin\angle 3}\Rightarrow A=\frac{C}{Sin\angle 2}Sin\angle 3.....3$$

$$\frac{C}{\sin\angle 2}=\frac{B}{Sin\angle 1}\Rightarrow B=\frac{C}{Sin\angle 2}Sin\angle 1.....4$$

4- find Coordinate of P2 (E2,N2) Using forward computations.

$$E2=E1+A.Sin\alpha .....5$$

$$N2=N1+A.Cos\alpha .....6$$

2- Intersection –II التقاطع الثاني

A length o side and direction of anther side are unknown

Known:-

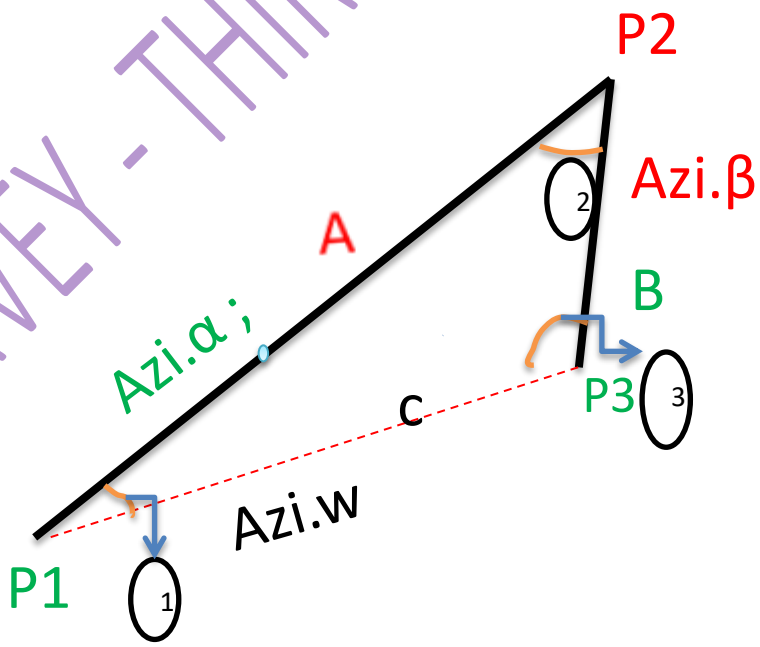
P1(E1,N1); P3(E3,N3) ; Azi.α ; B.

Required:- P2(E2,N2) ; Azi.β , A

1-Find length C and Azi.w by using forward computations

$$Azi.W = \tan^{-1}\left(\frac{E3-E1}{N3-N1}\right)$$

$$Length\ C = \left(\frac{E3-E1}{\sin w}\right)$$



2- Find angle 1 using Azi.α and Azi.w

<1= Azi.w- Azi.α

3- Find angle 2 using sines low.

$$\frac{B}{\sin\angle 1} = \frac{C}{\sin\angle 2}$$

$$\Rightarrow \sin\angle 2 = \frac{C}{B}\sin\angle 1$$

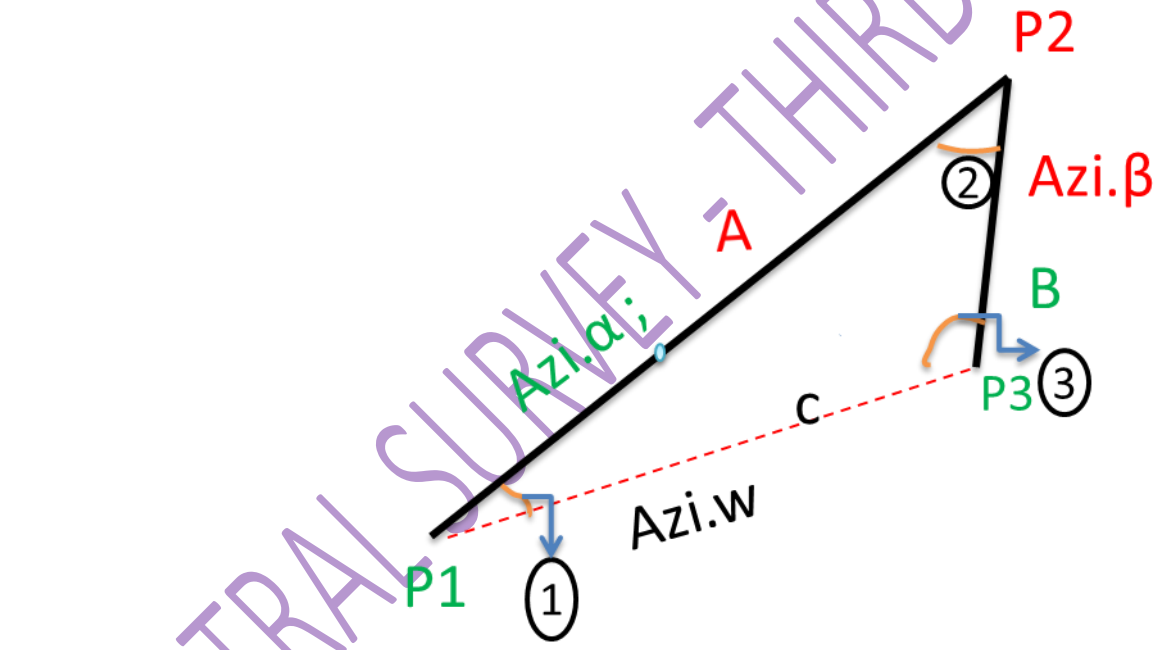
$$\therefore \angle 2 = \sin^{-1}\left[\frac{C}{B}\sin\angle 1\right]$$

4- Find angle 3

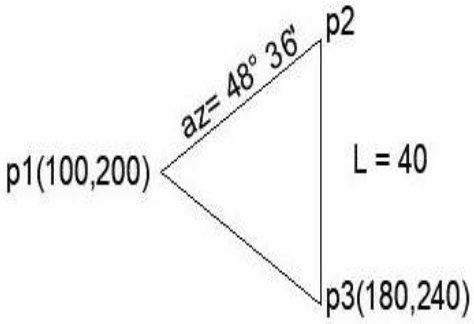
$$\angle 3 = 180 - (\angle 1 + \angle 2)$$

5- Find Azi.β.

$$Azi.\beta = Back\ Azi.\alpha - \angle 2$$



EX/ if the direction of P_1P_2 is 48° 36' and the length of P_2P_3 is 40m the coordinate of P_1 (100,200) , P_3(180,240) compute the unknown length of P_1P_2 and the direction of P_2P_3 ?



Sol/

Az. P_1P_2 = 48° 36'

Length P_2P_3 = 40m

P_1= (100,200), P_3= (180,240)

L of P_1P_2 =?

Az. of P_2P_3 = ?

L of P_1P_3 = $\sqrt{(\Delta E)^2 + (\Delta N)^2}$

= $\sqrt{(180-100)^2 + (240-200)^2}$

= 89.442m

Az of P_1P_3 = $\tan^{-1}$ ΔE / ΔN

= $\tan^{-1}$ (180-100) / (240-200)

= 63° 26' 5.82"

<P1 = Az of P_1P_3 _ Az of P_1P_2

= 63° 26' 5.82" _ 48° 36'

= 14° 50' 5.82 "

By sin rule

$$\frac{P2P3}{SinP1} = \frac{P1P3}{SinP2}$$

$$\frac{40}{Sin\ 14°\ 50'\ 5.82"} = \frac{89.442}{SinP2}$$

$<P_2 = 34°\ 55'\ 31.11"$

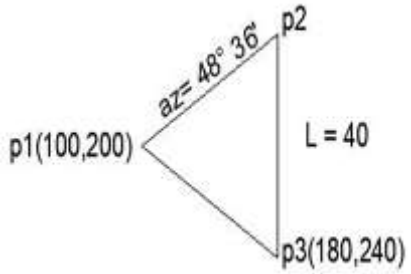
$<P3 = 180\_ (<P1+<P2)$

$= 130°\ 14'\ 23"$

Az of P_2P_3 = Az of P_2P_1 _ $<P2$

$= (48°\ 36"+ 180)$ _ $(34°\ 55'\ 31.11")$

$= 193°\ 40'\ 28.8"$



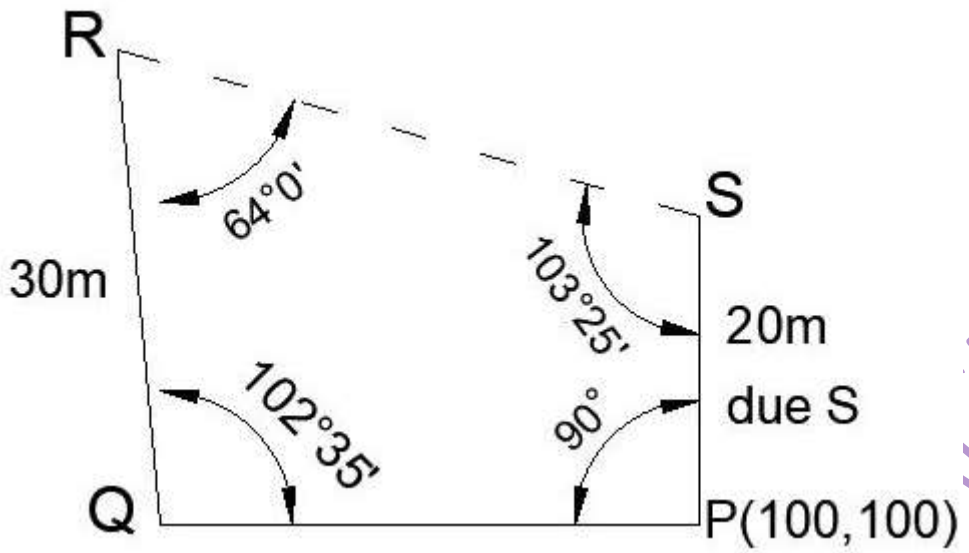
By sin rule

$$\frac{P1P2}{SinP3} = \frac{P2P3}{SinP1}$$

$$\frac{P1P2}{\sin\ 130°\ 14'\ 23"} = \frac{40}{Sin\ 14°\ 50'\ 5.82"}$$

$P_1P_2 = 119.256m$

Ex / compute the coordinate of Q, R ?



Sol /

Az SP = 180° , Az PS = 360°

Az PQ = Az PS _ < P

= 270°

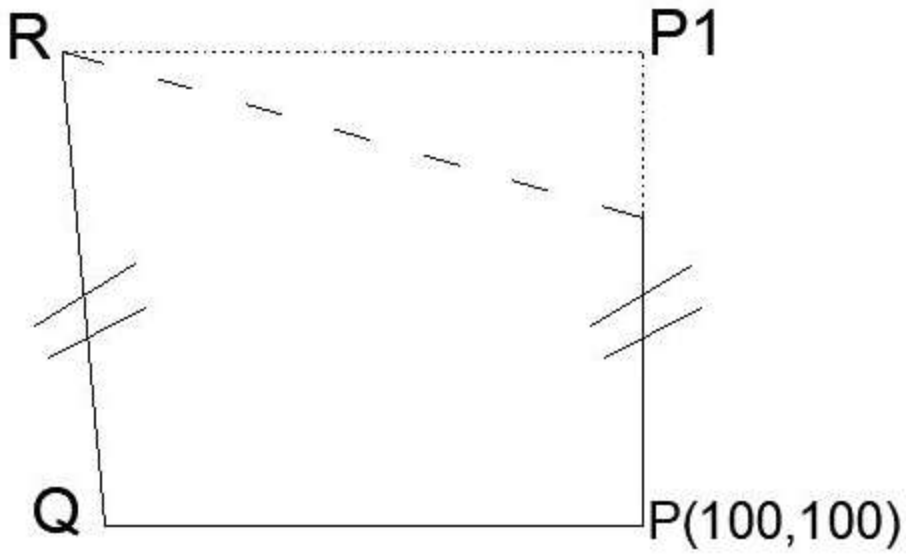
Az SR = Az SP + < S

= 283° 25 "

Az RQ = Az RS + < R

=167° 25" , Az QR = 347° 25"

PP1 ∥ QR



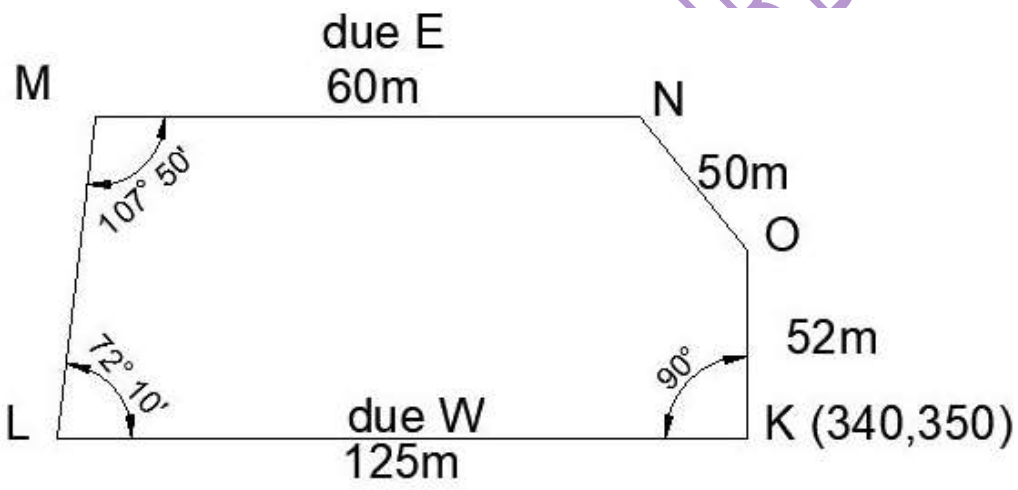
EP1 = EP + 30Sin Az QR

= 93.46m

NP1 = NP + 30Cos Az QR

= 129.27m

Ex / compute all unknown coordinate for travers MNOKL ?



Sol/

$E_L = E_K + L_{KL} * \text{Sin Az}_{KL}$

= 215m

$N_L = N_K + L_{KL} * \text{Cos Az}_{KL}$

= 340m

< K = AZ. KO – AZ KL

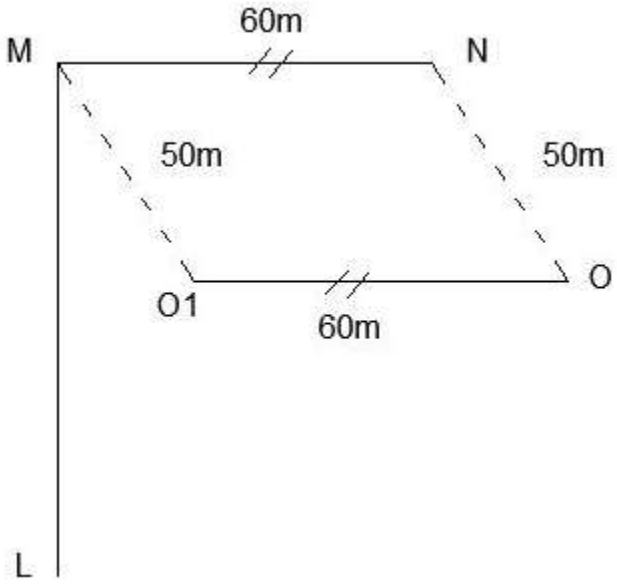
AZ.KO = AZ.KL+ < K = 360

$E_O = E_K + L_{KO} * \text{Sin Az}_{KO}$

340m

$N_O = N_K + L_{KO} \text{ Cos Az}_{KO}$

= 402m



L(215,340)

O(340,402)

AZ KL = 270°

AZ LM = AZ LK _ < L

= (270°_180°)_ 72° 10'

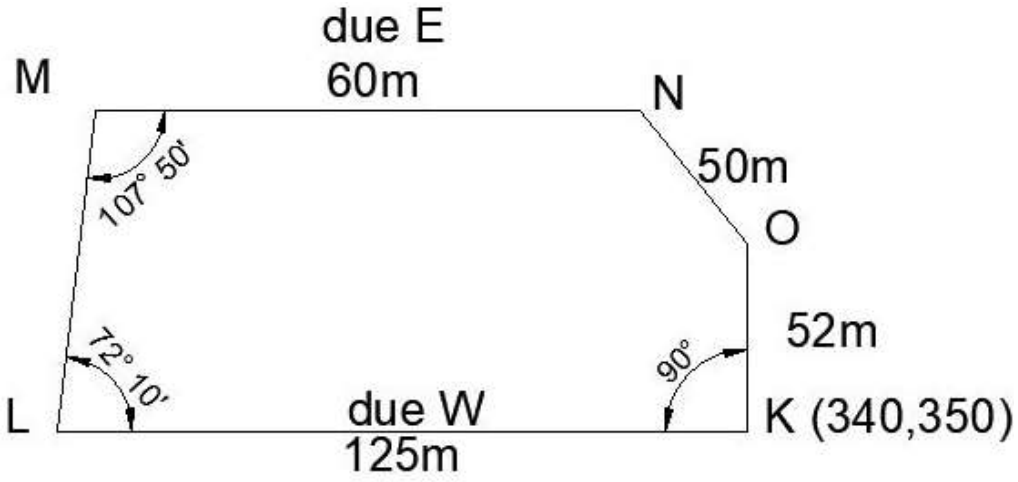
= 17° 50'

AZ MN = AZ ML _ <M

= (17° 50'+ 180°) _ 107° 50'

= 90°

AZ KO = AZ KL + < K



= 270° + 90°

= 360°

AZ $_{NO}$ = AZ $_{MO1}$ = ?

$E_{O1} = E_O + L_{OO1}$ Sin Az $_{OO1}$

= 280m

$N_{O1} = N_O + L_{OO1}$ Cos Az $_{OO1}$

= 402m

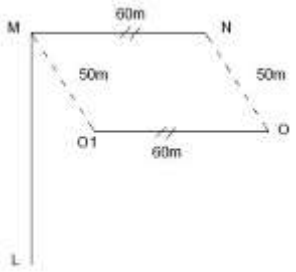
$L_{LO1} = \sqrt{(280-215)^2 + (402-350)^2}$

= 83.24m

Az $_{LO1}$ = $\tan^{-1}$ ΔE / ΔN

= 51° 20' 24.69"

<L = Az $_{LO1}$ _ Az $_{LM}$



= 33° 30' 24.69"

By sin rule

$\frac{MO1}{SinL} = \frac{LO1}{SinM}$

M = 66° 47' 5.31"

<O1 = 180 _ (<M+<L)

<O1 = 79° 42' 30"

By sin rule

$$\frac{MO1}{SinL} = \frac{ML}{SinO1}$$

ML = 89.116m

Az $_{MO1}$ = AZ $_{ML}$ _<M

= 131° 2' 54.62"

$E_M = E_L + L_{LM}$ Sin Az $_{LM}$

= 242.29m

$N_M = N_L + L_{LM}$ Cos Az $_{LM}$

= 434.83m

$E_N = E_M + L_{MN}$ Sin AZ $_{MN}$

= 302.29m

$N_N = N_M + L_{MN}$ Cos AZ $_{MN}$

= 434.93m

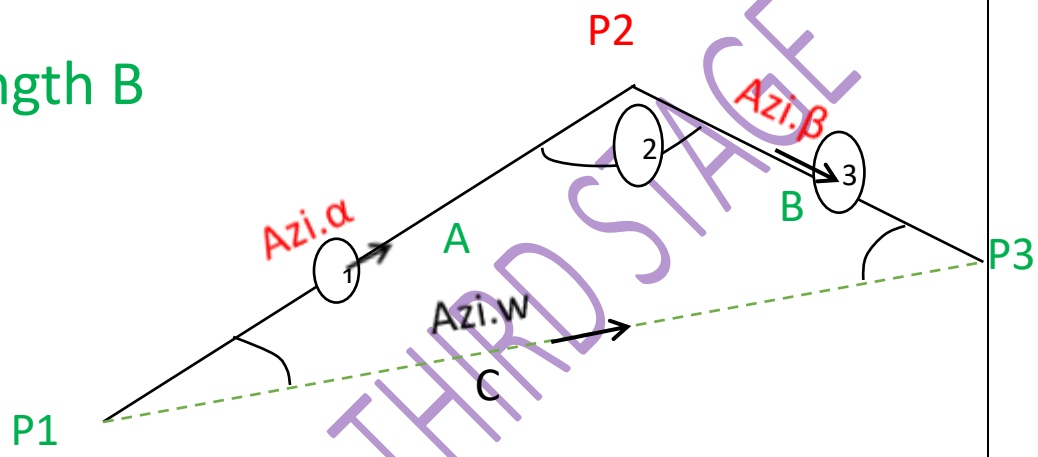
3-Intersection III-two direction are unknown التقاطع الثالث

Known:-

1-P1(E1,N1)

2-P3(E3,N3)

3-Length A & Length B



Required:-

1-P2(E2,N2)

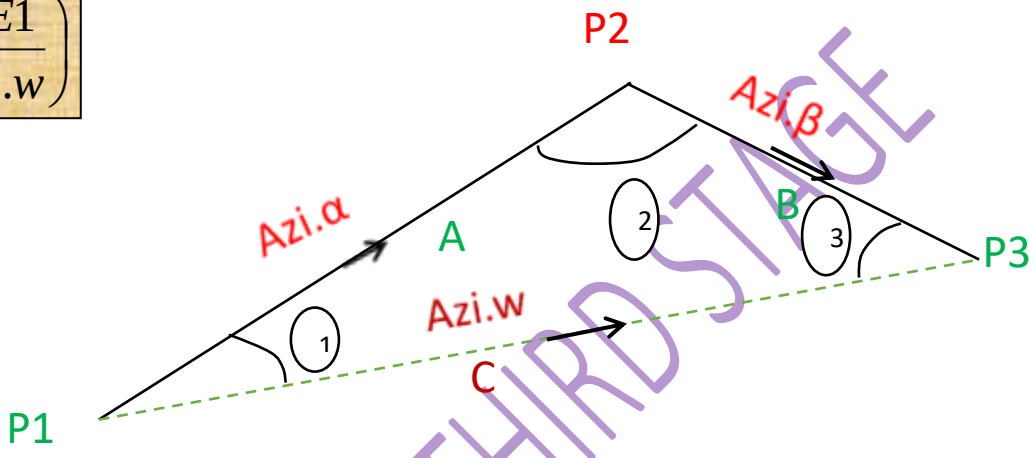
2-Azi.α

3-Azi.β

1- Find Azi.w and length c

$$Azi.w = \tan^{-1}\left(\frac{E3-E1}{N3-N1}\right)$$

$$Length\,C = \left(\frac{E3-E1}{\sin Azi.w}\right)$$



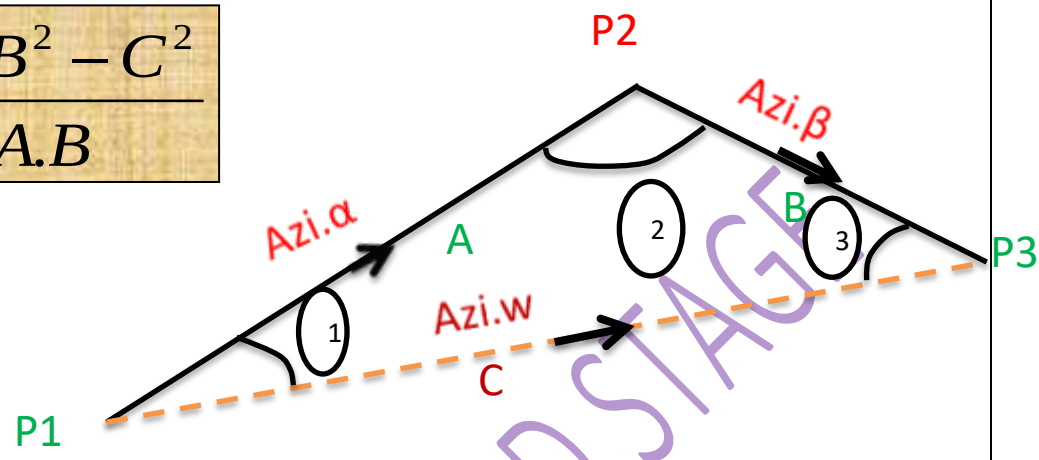
2- Find angle 1 , 2 & 3

Using cosines rule

$$B^2 = A^2 + C^2 - 2AC\,Cos\angle 1$$

$$\Rightarrow Cos\angle 1 = \frac{A^2 + C^2 - B^2}{2A.C}$$

$$Cos\angle 2 = \frac{A^2 + B^2 - C^2}{2A.B}$$



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

3- Find Azi.α and Azi.β

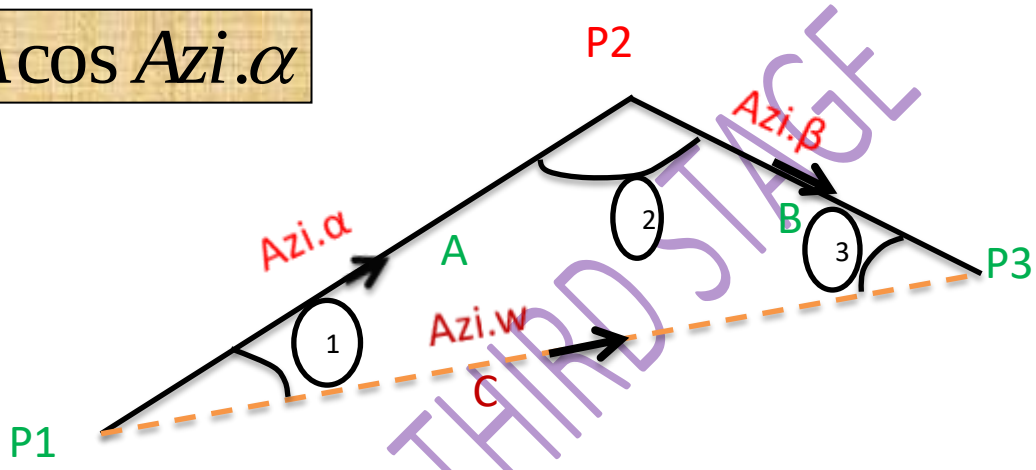
$$Azi.\alpha = Azi.w - \angle 1$$

$$Azi.\beta = Back\ Azi.\alpha - \angle 2$$

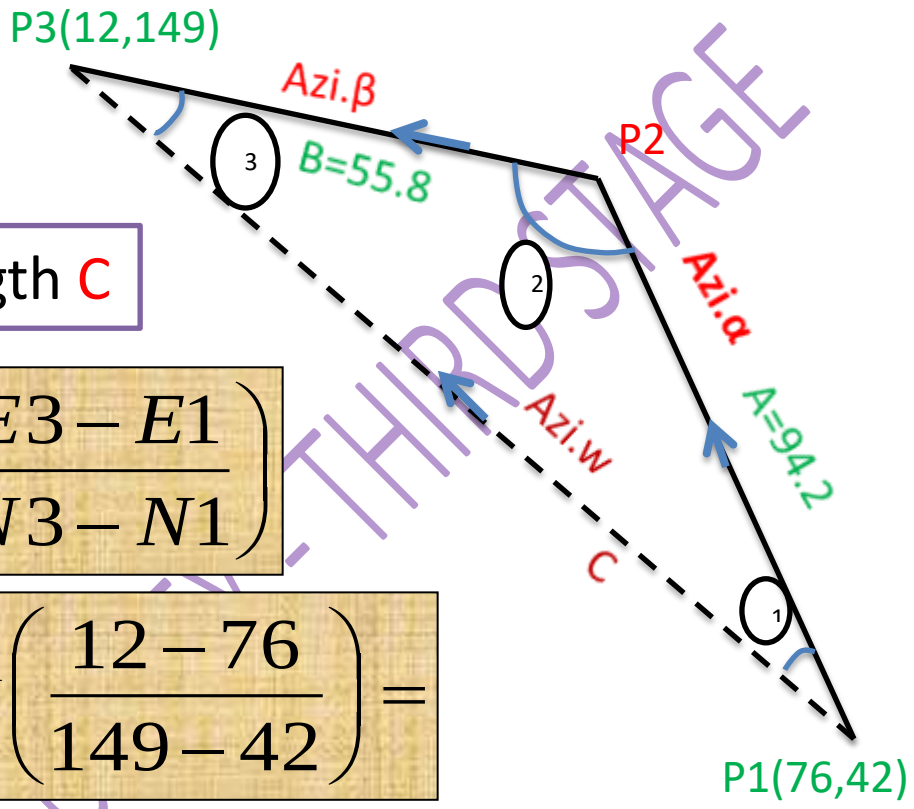
5- Find P2(E2,N2) Using forward computations

$$E2 = E1 + A\sin Azi.\alpha$$

$$N2 = N1 + A\cos Azi.\alpha$$



EXAMPLE:- Find the two directions for each side shown below and coordinate of p2 ,if you know the P1(76,42); P3(12,149); A=94.2m, B=55.8m



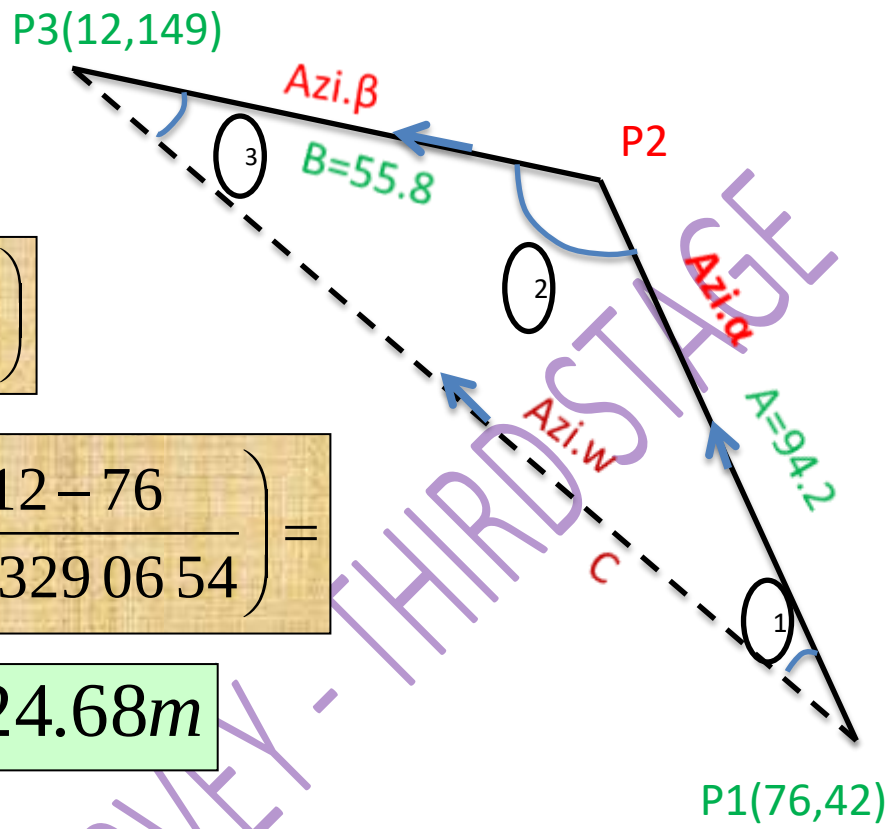
Solution:-

1- find Azi.w & length C

$$Azi.w = \tan^{-1}\left(\frac{E3-E1}{N3-N1}\right)$$

$$\Rightarrow Azi.w = \tan^{-1}\left(\frac{12-76}{149-42}\right) =$$

$$\therefore Azi.w = 329^\circ\ 06'\ 54''$$



$$Length\ C = \left(\frac{E3 - E1}{\sin Azi.w} \right)$$

$$\Rightarrow Length\ C = \left(\frac{12 - 76}{\sin 329\,06\,54} \right) =$$

$$\therefore Length\ C = 124.68m$$

2- Find angle 1 , 2 & 3

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

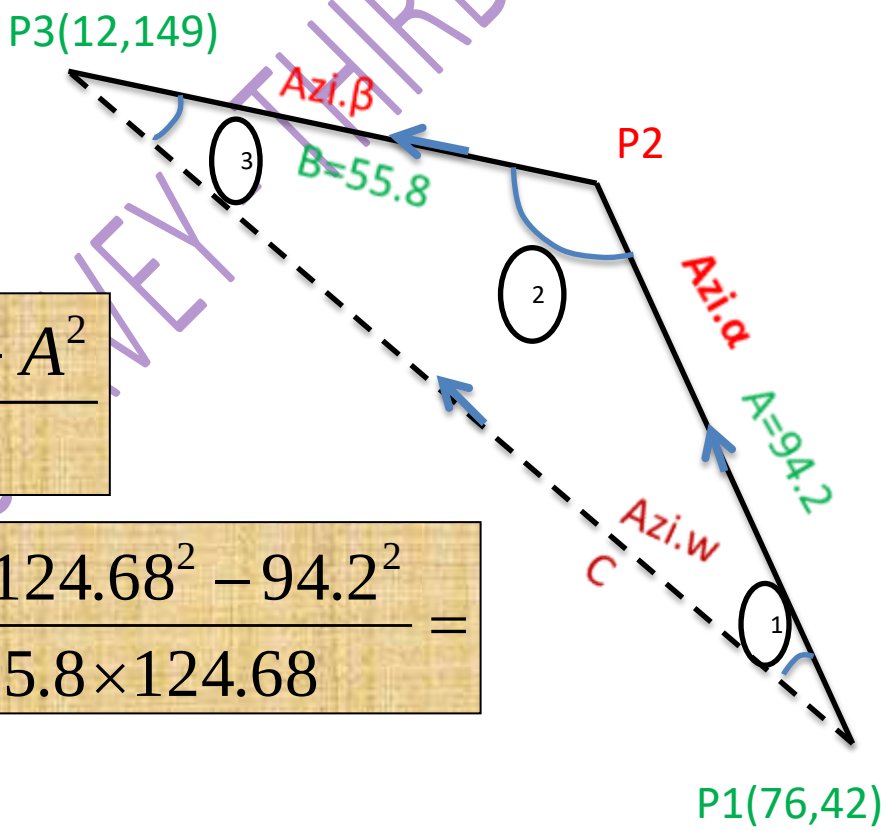
$$\Rightarrow Cos\angle 1 = \frac{94.2^2 + 124.68^2 - 55.8^2}{2 \times 94.2 \times 55.8} =$$

$$\therefore Cos\angle 1 = 24^\circ\ 54'\ 23''$$

$$Cos\angle 2 = \frac{A^2 + B^2 - C^2}{2A.B}$$

$$\Rightarrow Cos\angle 2 = \frac{94.2^2 + 55.8^2 - 124.68^2}{2 \times 94.2 \times 55.8} =$$

$$\therefore Cos\angle 2 = 109^\circ\ 18'\ 52''$$



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

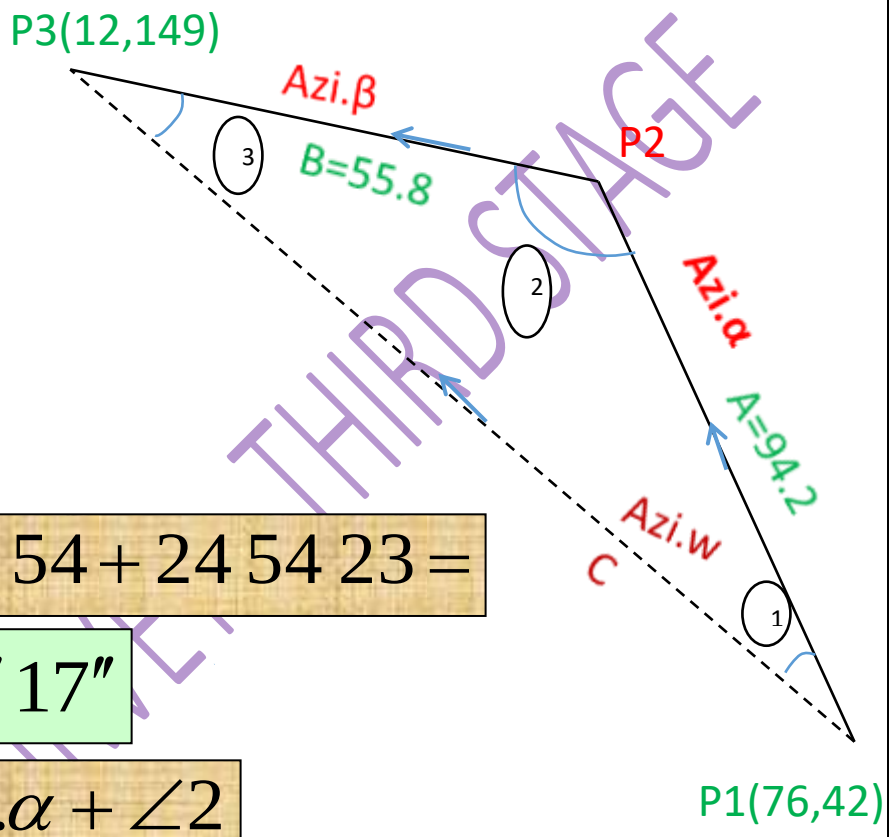
$$\Rightarrow Cos\angle 3 = \frac{55.8^2 + 124.68^2 - 94.2^2}{2 \times 55.8 \times 124.68} =$$

$$\therefore \angle 3 = 45^\circ\ 18'\ 45''$$

For check $\sum \angle 1 + \angle 2 + \angle 3 = 180^\circ$

3- Find Azi.α & Azi.β

$$Azi.\alpha = Azi.w + \angle 1$$



$$\Rightarrow Azi.\alpha = 329\,06\,54 + 24\,54\,23 =$$

$$\therefore Azi.\alpha = 354^\circ\ 01'\ 17''$$

$$Azi.\beta = Back\ Azi.\alpha + \angle 2$$

$$\Rightarrow Azi.\beta = (354\,0117 - 180) + 109\,46\,52 =$$

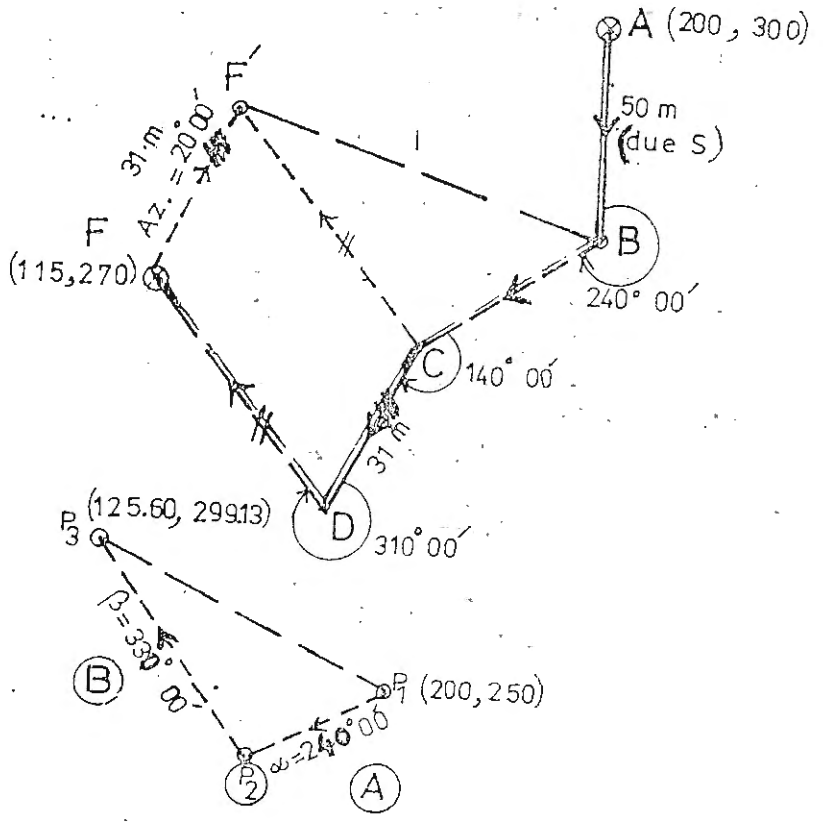
$$\therefore Azi.\beta = 283^\circ\ 46'\ 52''$$

9.5 القياسات المجهولة في المضلعات الدائرية والرابطة وأعمال التثليث وغيرها

تستخدم هذه التقاطعات التي ذكرت في الفقرات السابقة لأغراض حساب القياسات المجهولة في المضلعات الدائرية والرابطة وفي أعمال التثليث الثانوية وفي أعمال تقسيم الاراضي وعند تقاطع حدود مستقيمة مع خطوط تقسيم مستقيمة أو منحنية أو عند تقاطع منحنيين مع بعضهما ، حيث يمكن بوساطة هذه التقاطعات حساب الاطوال والأتجاهات المجهولة للاضلاع وحساب مواقع نقاط التقاطع للخطوط المستقيمة أو مع الخطوط المنحنية . وطرق الحسابات التي ذكرت للتقاطعات هي عند وجود ضلعين مجهولين متجاورين ومتقاطعين في نقطة ، فاذا كان الضلعان المجهولان غير متجاورين فيجب رسم متوازي اضلاع (فيه ضلع موازٍ للضلع المجهول وآخر موازٍ للضلع المعلوم) أو عدة متوازيات أضلاع حتى يصبح الضلعان المجهولان متجاورين لغرض الحل بموجب الطرق المذكورة سابقاً . وسوف يتم حل أمثلة لاحقاً للقياسات المجهولة في المضلعات وهناك تمارين لغرض الحل ولمختلف الاعمال الخاصة بالمسح .

مثال 9.5

إحسب إحداثيات نقاط المضلع الرابط A B C D F المجهول فيه طولا الضلعين BC و DF . (باستخدام التقاطع الأول) .



الشكل 9.22

الحل

حتى يصبح الضلعان المجهولا الطولين متجاورين لغرض الحل ، يُرسم من C الخط CF' موازياً للضلع DF والخط FF' موازياً للضلع DC .

ثم تحسب إتجاهات الاضلاع كالآتي :

$$\text{AZ. of BC} = 240°00'$$

$$\text{AZ. of CD} = (240° - 180°) + 140° = 200°00'$$

$$\text{AZ. of DF} = (200° - 180°) + 310° = 330°00'$$

ويُحسب بعد ذلك موقعا النقطتين B و F' كالآتي :

$$E_B = E_A + AB.\ \text{Sin}\ 180 = 200 + 50 \times 0 = 200{\cdot}00$$

$$N_B = N_A + AB.\ \text{Cos}\ 180 = 300 - 50 \times 1 = 250{\cdot}00$$

$$E_{F'} = E_F + FF'.\ \text{Sin}\ 20° = 115 + 31 \times 0{\cdot}342020 = 125{\cdot}60$$

$$N_{F'} = N_F + FF'.\ \text{Cos}\ 20° = 270 + 31 \times 0{\cdot}939693 = 299{\cdot}13$$

وهكذا يصبح المثلث B C F' هو المطلوب حلّه حيث أن: B تعدّ P_1 و C تعدّ P_2 و F' تعدّ P_3 والضلع BC هو P_1P_2 والضلع CF' هو P_2P_3 . وبالتالي يمكن حساب طولي الضلعين P_1P_2 و P_2P_3 باستخدام طريقة المثلثات (قانون الجيوب بعد حساب طول واتجاه P_1P_3 وزوايا المثلث الثلاث).

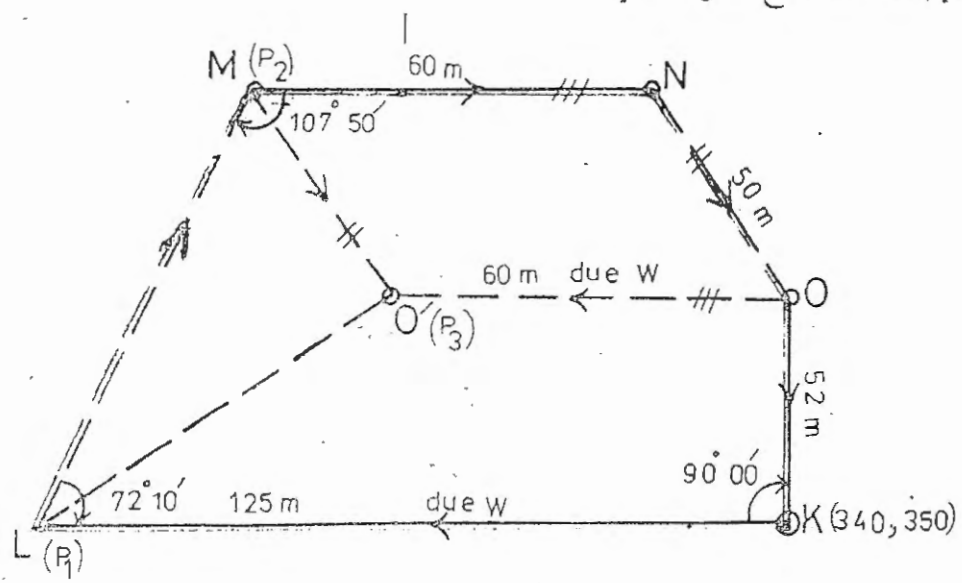
كما يمكن حل المثلث بطريقة الهندسة التحليلية حيث يحسب موقع P_2 أولاً باستخدام قانوني N_2 و E_2 . ثم يحسب طولا الضلعين بالحسابات المعكوسة .

مثال 9.6 .

إحسب إحداثيات نقاط المضلع المغلق K L M N O المجهول فيه طول الضلع LM واتجاه الضلع NO . (باستخدام التقاطع الثاني) .

الحل

حتى يصبح الضلع المجهول الطول مجاوراً للضلع المجهول الاتجاه لغرض الحل ، يُرسم من M الخط M0′ موازياً للضلع NO ومن O الخط 00′ موازياً للضلع MN . وبذلك يصبح المثلث LMO′ هو المطلوب حلّه .
فتحسب إتجاهات الاضلاع المعلومة كالآتي :



الشكل 9.23

$$\text{AZ. of LM} = 90° - 72°10' = 17°50'$$

$$\text{AZ. of MN} = 197°50' - 107°50' = 90°00'$$

$$\text{AZ. of OK} = 360° - 180° = 180°00'$$

وتُحسب مواقع النقاط المطلوبة للحل وهي :

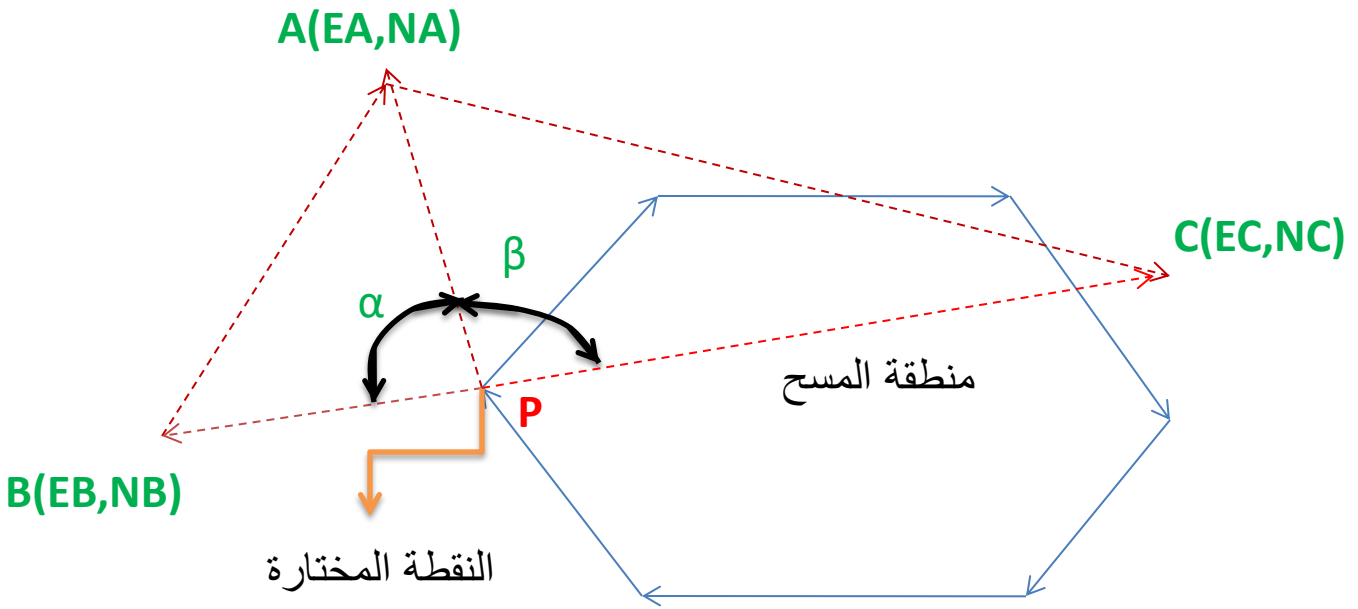
$$P_1 : (E_L = 340 + 125 \cdot \text{Sin } 270 = 215 \ , \ N_L = 350 + 125 . \text{Cos } 270 = 350)$$

$$E_O = 340 + 52 . \text{Sin } 0°00' = 340 \ , \ N_O = 350 + 52 \cdot \text{Cos } 0°00' = 402$$

$$P_3 : (E_{O'} = 340 + 60 \cdot \text{Sin } 270 = 280 \ , \ N_{O'} = 402 + 60 \cdot \text{Cos } 270 = 402)$$

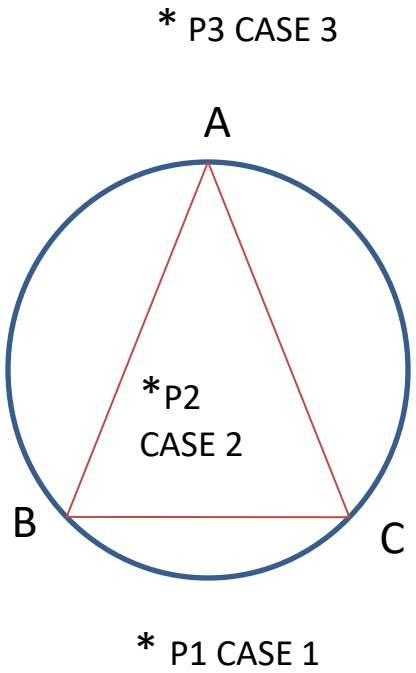
التقاطع الخلفي او العكسي Resection

هو عملية المسح التي يتم فيها حساب موقع نقطة مختارة (نقطة يتم نصب الجهاز فوقها) عن طريق رصد ثلاث نقاط معلومة الموقع (الاحداثيات) وحساب زاويتيين باتجاه هذه النقاط الثلاث من النقطة المختارة .



الدائرة الخطرة Danger circle

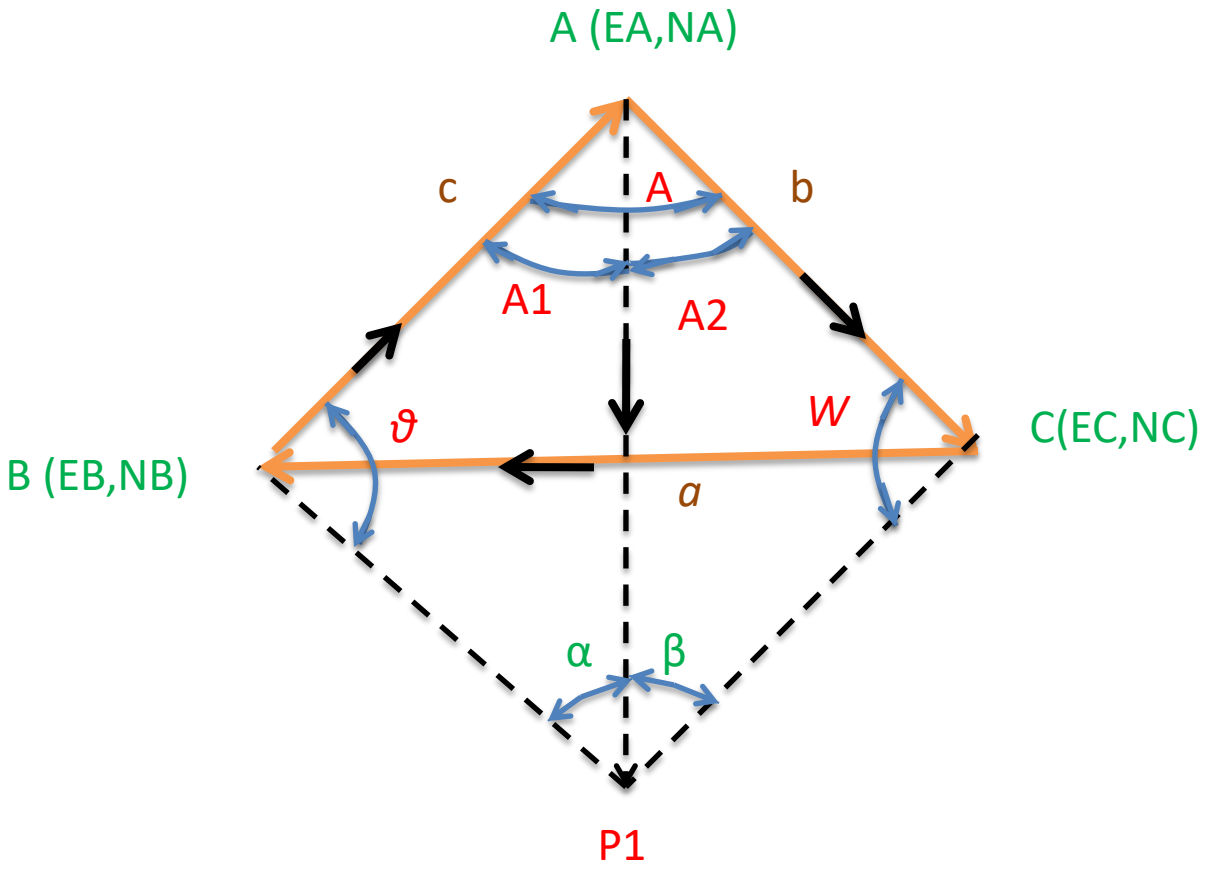
وهي الدائرة التي تمر بالمواقع الثلاثة المعلومة وان اي نقطة تقع على محيط هذه الدائرة لايمكن تعيين موقعها لانة يمكن فيه رصد نفس الزاويتين المعينتين بالقيميتين نفسهما.



Case -1. When p1 is front of the head of triangle at the opposite side.

Known: coordinate of A,B,C and angle α , β

Required : Angle ϑ and Angle w and coordinate of p1



Procedure or steps :

1- find the length and direction of AB,BC,CA (*a*,b,c) using inverse computations .

2-from directions or azimuths find angle A

$$\angle A = Back\ Azimuth\ BA - Azi.AC \ldots\ldots\ldots 1$$

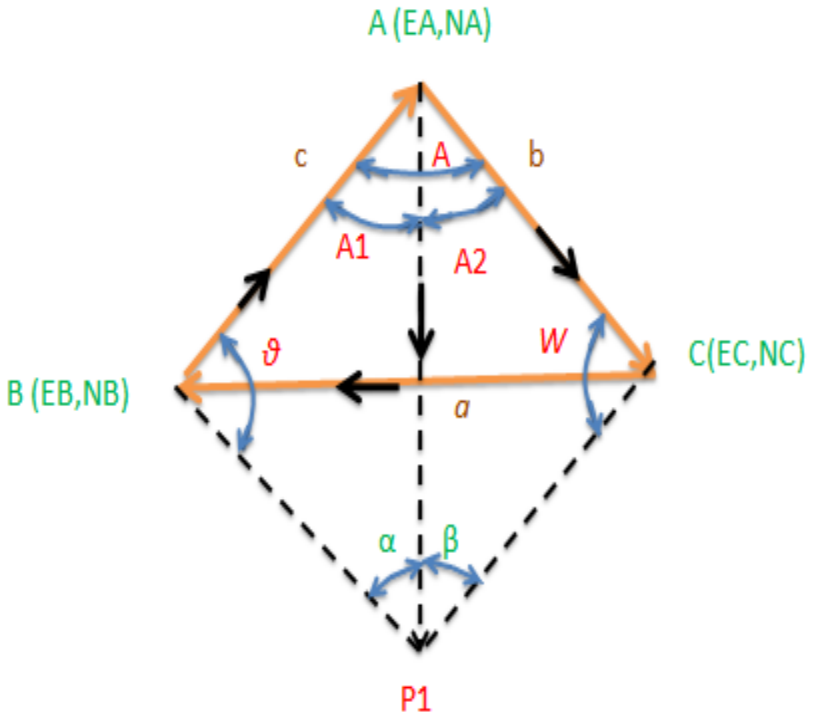
3- Compute angle S

$$\angle S = (\vartheta + w) = 360 - (\alpha + \beta + A)$$

$$4 - Compute\ \phi = \frac{Sin\angle w}{Sin\angle \vartheta}.as\ followe:$$

In Δ ABP1 → *Sines* lows →

$$\frac{AP1}{Sin\,\vartheta} = \frac{c}{Sin\,\alpha} \ldots\ldots 2$$



In Δ ACP1 → *Sines* lows →

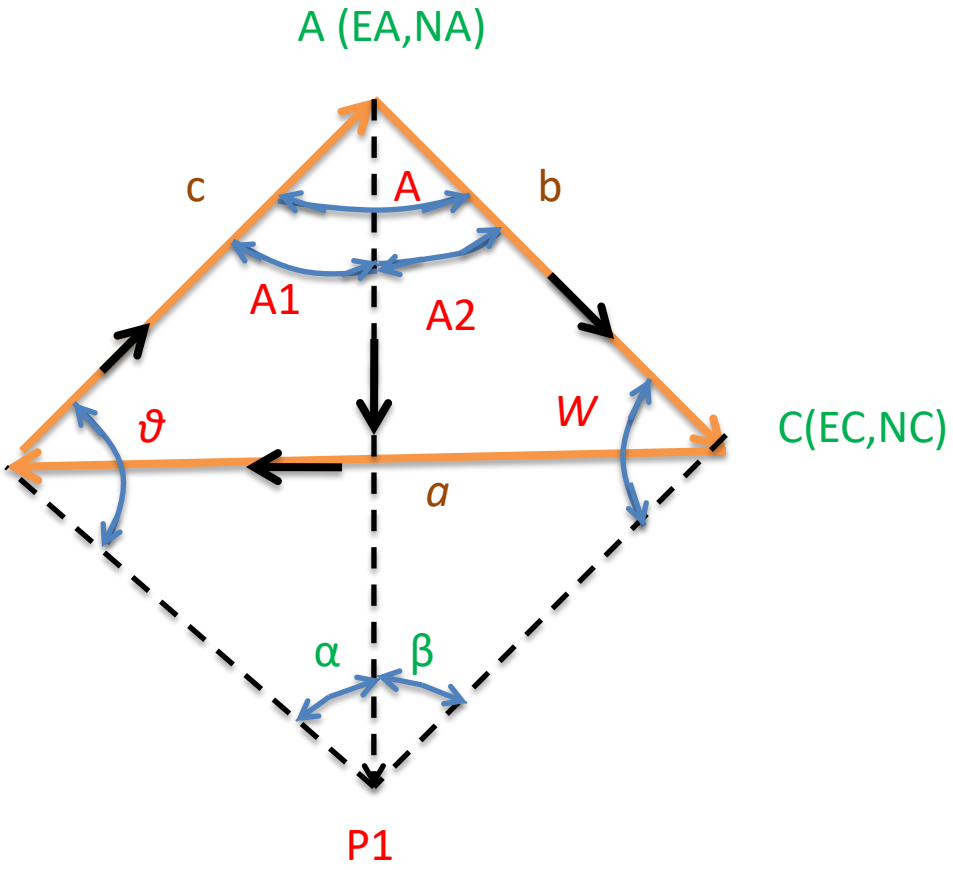
$$\frac{AP1}{Sin W} = \frac{b}{Sin\,\beta} \ldots\ldots 3$$

Dividing (2) by (3) →

$$\frac{\frac{AP1}{Sin\,\vartheta}}{\frac{AP1}{Sin\,w}} = \frac{\frac{c}{Sin\alpha}}{\frac{b}{Sin\beta}} \rightarrow$$

$$\frac{\sin w}{\sin\vartheta} = \frac{\sin\beta}{b} \times \frac{c}{\sin\alpha} = \tan\phi$$

$$\therefore \tan\phi = \frac{\sin w}{\sin\vartheta} = \frac{c.\sin\beta}{b.\sin\alpha} \ldots\ldots\ldots 4$$



$$\rightarrow \angle\phi = \tan^{-1}\left(\frac{c.\sin\beta}{b.\sin\alpha}\right)$$

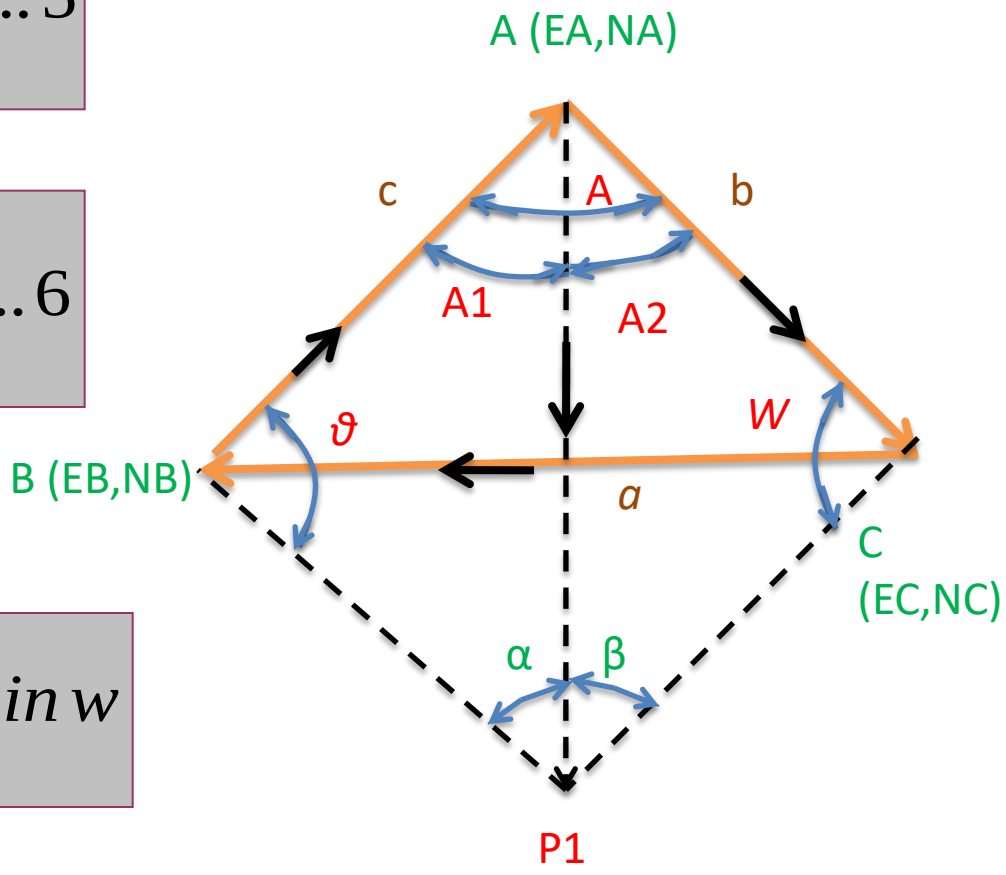
5- compute angle ϑ *and* w

$$\angle\vartheta = \tan^{-1}\left(\frac{\sin s}{\tan\phi + \cos s}\right) \ldots\ldots\ldots 5$$

$$\angle w = \tan^{-1}\left(\frac{\sin s}{\cot\phi + \cos s}\right) \ldots\ldots\ldots 6$$

6- Find length *AP1*

$$AP1 = \frac{C}{\sin\alpha} \bullet Sin\,\vartheta = \frac{b}{\sin\beta} \bullet Sin\,w$$



7- Compute Angle *A1,A2*

$$\angle A1 = 180 - (\vartheta + \alpha)$$

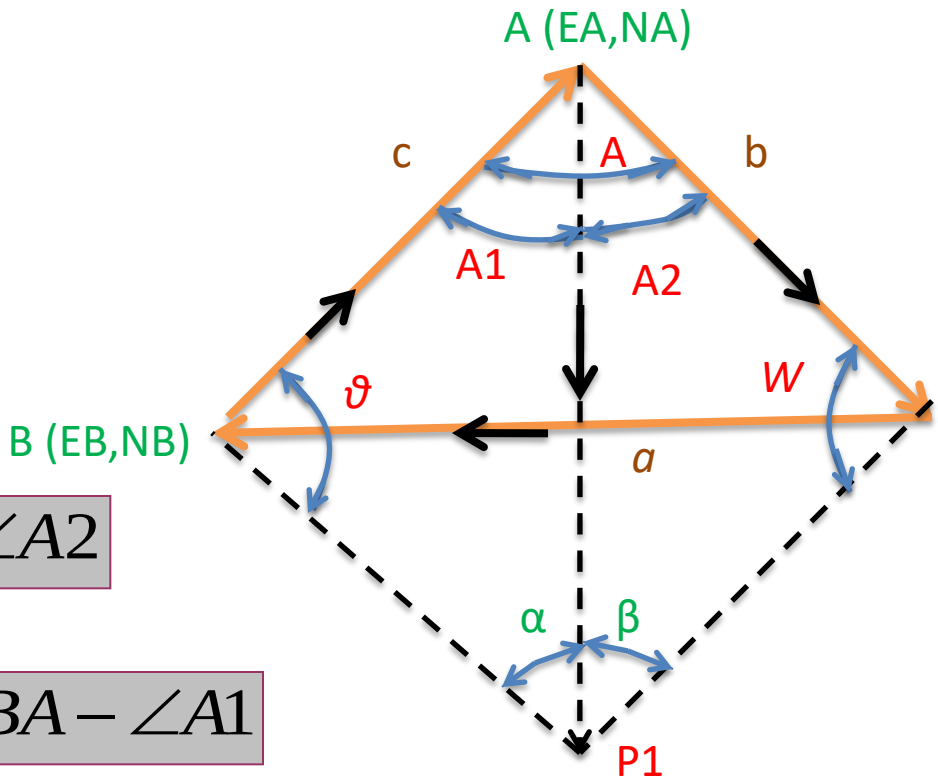
$$\angle A2 = 180 - (W + \beta)$$

8- Find direction of *AP1*

$$Azimuth\ AP1 = Azimuth\ AC + \angle A2$$

OR

$$Azimuth\ AP1 = Back\ \ Azimuth\ BA - \angle A1$$



9- Find Position of *P1* *by using point A(EA,NA) and Azi. AP1 and length of AP1 by forward computations*

$$EP1 = EA + AP1\,Sin(Azi.AP1)$$

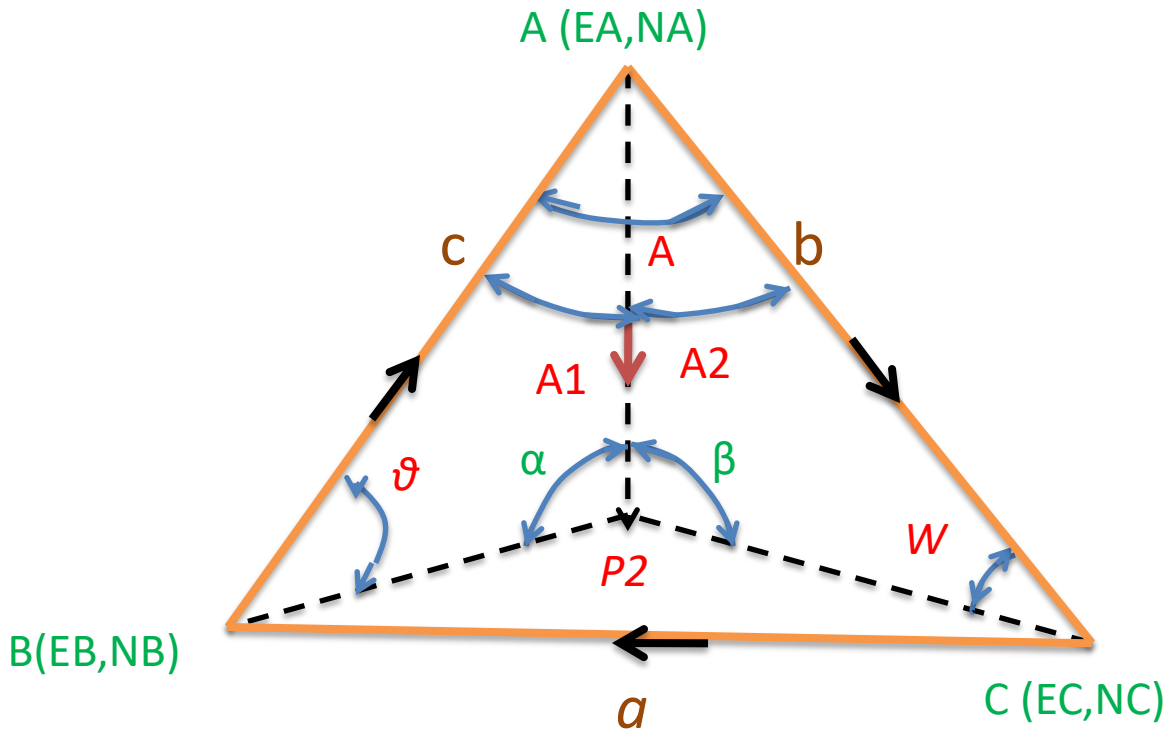
$$NP1 = NA + AP1\,Cos(Azi.AP1)$$

او تحسب من موقع B او ال C وبنفس الاسلوب بعد حساب الاتجاهات والاطوال الازمة للحسابات الامامية

Case -2. When p2 is inside of the triangle .

Known: coordinate of A,B,C and angle α , β

Required : Angle ϑ and Angle w and coordinate of p2



Procedure or steps :

1- find the length and direction of AB,BC,CA (*a*,b,c) using inverse computations .

2-from directions or azimuths find angle A

$$\angle A = Back\ Azimuth\ BA - Azi.AC \ldots 1$$

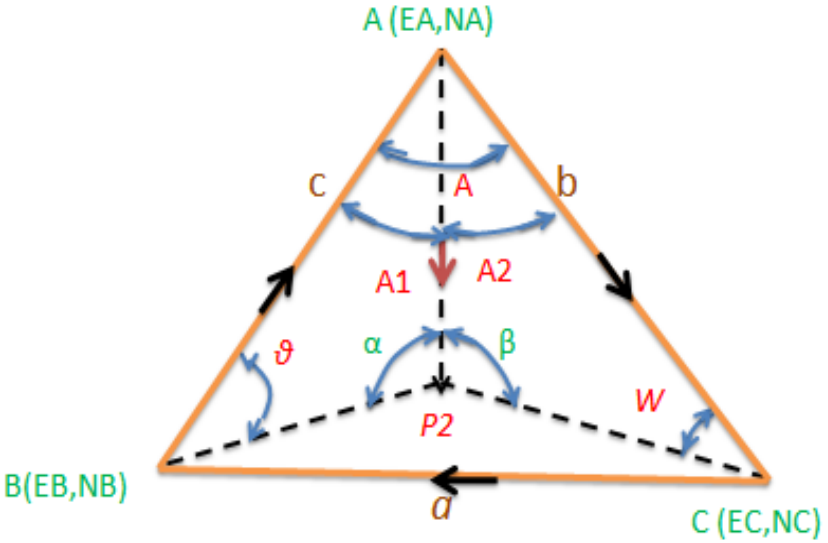
3- Compute angle S.

$$\angle S = (\vartheta + w) = 360 - (\alpha + \beta + A)$$

$$4 - Compute\ \phi = \frac{Sin\angle w}{Sin\angle \vartheta}.as\ followe:$$

In Δ ABP2 → *Sines* lows →

$$\frac{AP2}{Sin\,\vartheta} = \frac{c}{Sin\,\alpha} \ldots\ldots 2$$



In Δ ACP2 → *Sines* lows →

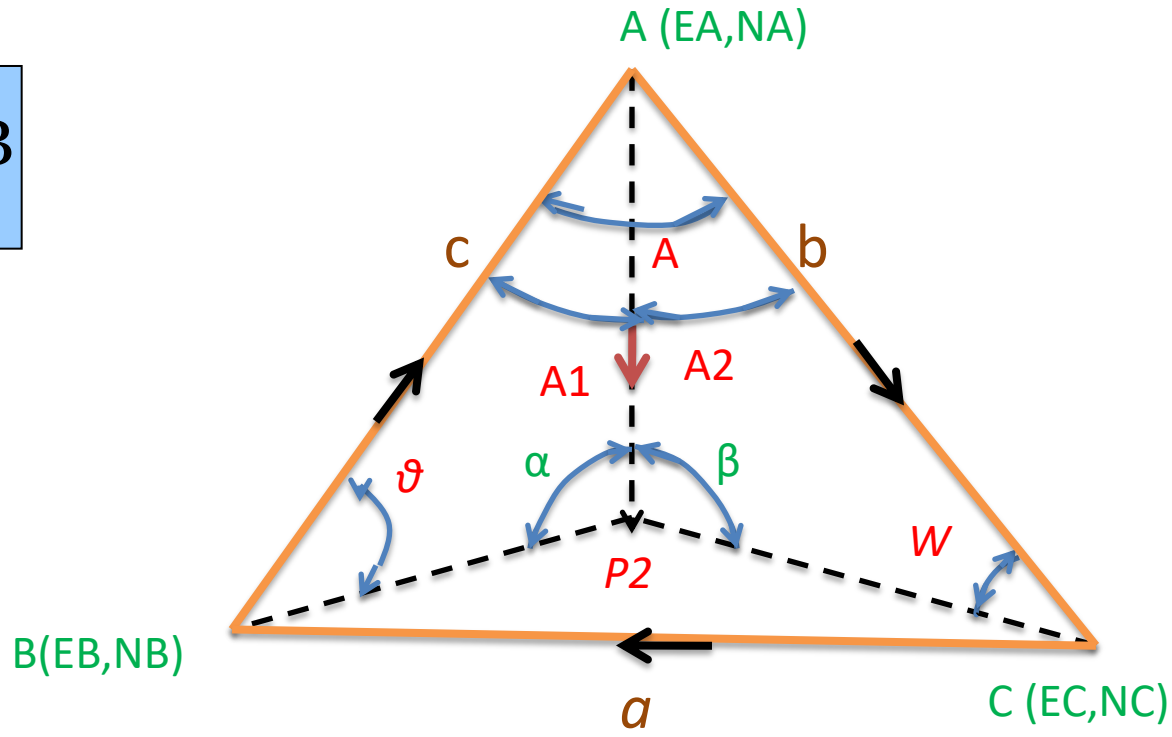
$$\frac{AP2}{Sin W} = \frac{b}{Sin\,\beta} \ldots\ldots 3$$

Dividing (2) by (3) →

$$\frac{\frac{AP2}{Sin\vartheta}}{\frac{AP2}{Sin w}} = \frac{\frac{c}{Sin\alpha}}{\frac{b}{Sin\beta}} \rightarrow$$

$$\frac{\sin w}{\sin\vartheta} = \frac{\sin\beta}{b} \times \frac{c}{\sin\alpha} = \tan\phi$$

$$\therefore \tan\phi = \frac{\sin w}{\sin\vartheta} = \frac{c.\sin\beta}{b.\sin\alpha} \ldots\ldots\ldots 4$$

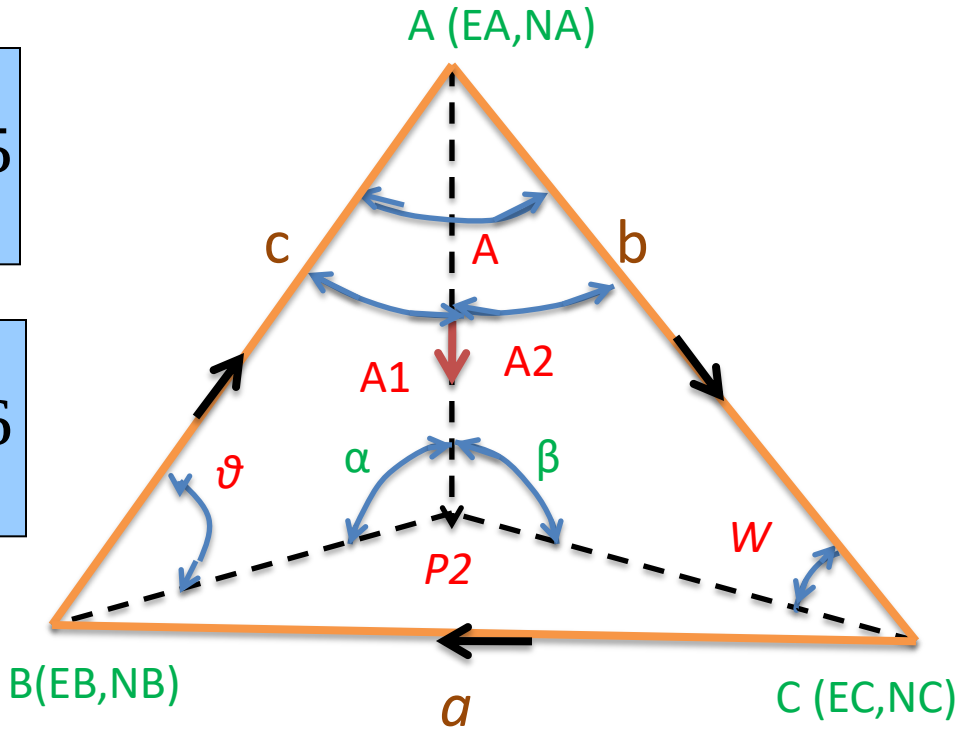


$$\rightarrow \angle\phi = \tan^{-1}\left(\frac{c.\sin\beta}{b.\sin\alpha}\right)$$

5- compute angle ϑ *and* w

$$\angle\vartheta = \tan^{-1}\left(\frac{\sin s}{\tan\phi + \cos s}\right) \ldots\ldots\ldots 5$$

$$\angle w = \tan^{-1}\left(\frac{\sin s}{\cot\phi + \cos s}\right) \ldots\ldots\ldots 6$$



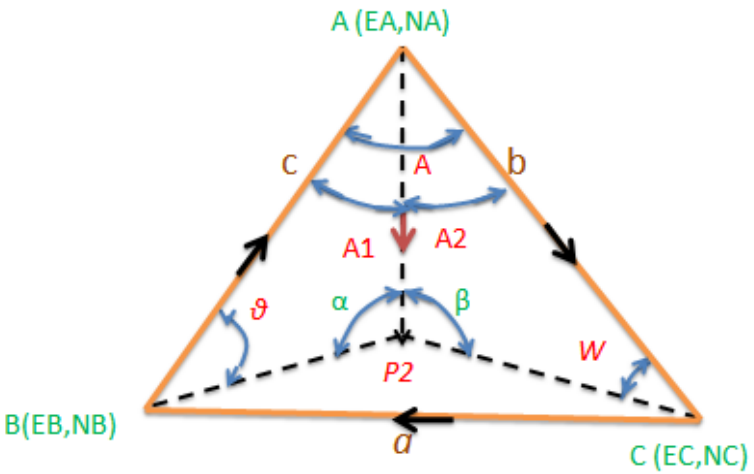
6- Find length *AP2*

$$Length\ AP2 = \frac{C}{\sin\alpha} \bullet Sin\,\vartheta = \frac{b}{\sin\beta} \bullet Sin\,w$$

7- Compute Angle *A1,A2*

$$\angle A1 = 180 - (\vartheta + \alpha)$$

$$\angle A2 = 180 - (W + \beta)$$



8- Find direction of *AP2*

$$Azimuth\ AP2 = Azimuth\ AC + \angle A2$$

9- Find Position of *P2* by using point *A(EA,NA)* and *Azi. AP2* and *length of AP2* by forward computations

$$EP2 = EA + AP2\,Sin(Azi.AP2)$$

$$NP2 = NA + AP2\,Cos(Azi.AP2)$$

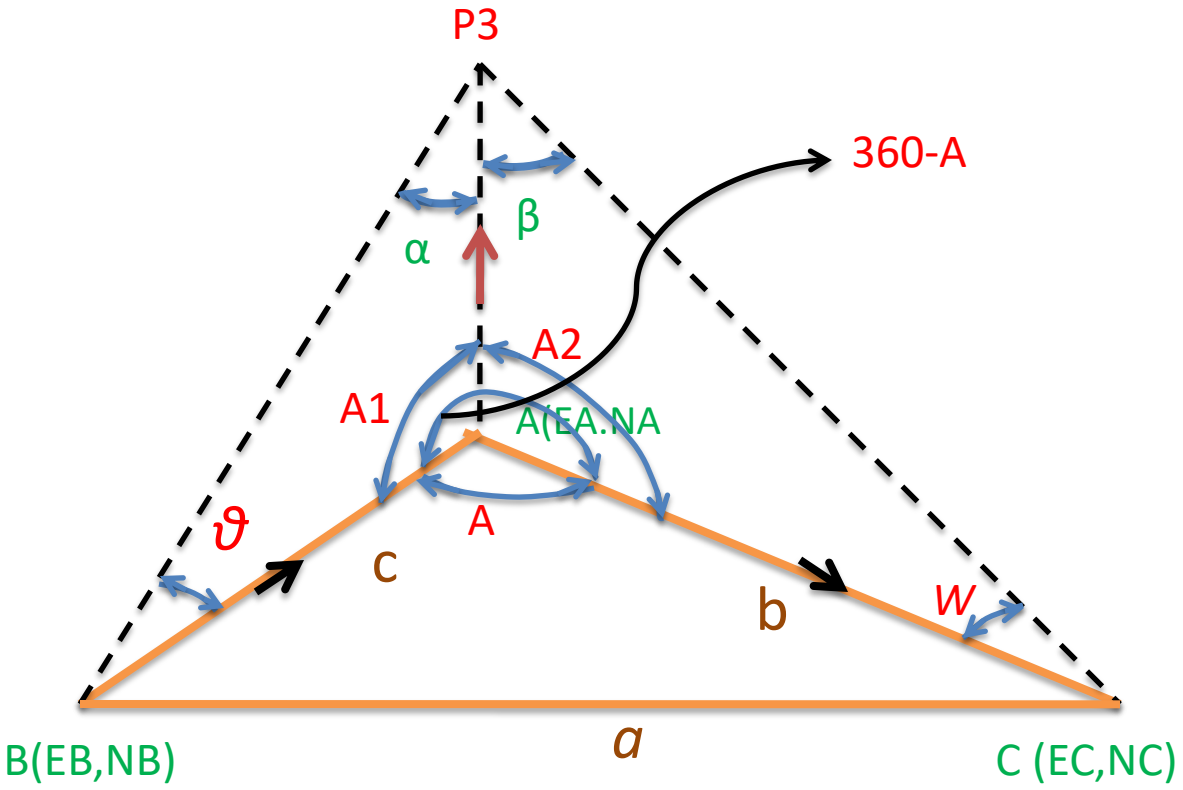
او تحسب من موقع B او ال C وبنفس الاسلوب بعد حساب الاتجاهات والاطوال الازمة للحسابات الامامية.

او تحسب بواسطة التقاطع الاول بعد حساب الاتجاهين BP2,CP2.

Case -3. When p3 is behind of the triangle .

- Required : Angle ϑ and Angle w and coordinate of p3

  Known: coordinate of A,B,C and angle α , β



Procedure or steps :

1- find the length and direction of AB,BC,CA (*a*,b,c) using inverse computations .

2-from directions or azimuths find angle A

$$\angle A = Back\ Azimuth\ BA - Azi.AC \ldots 1$$

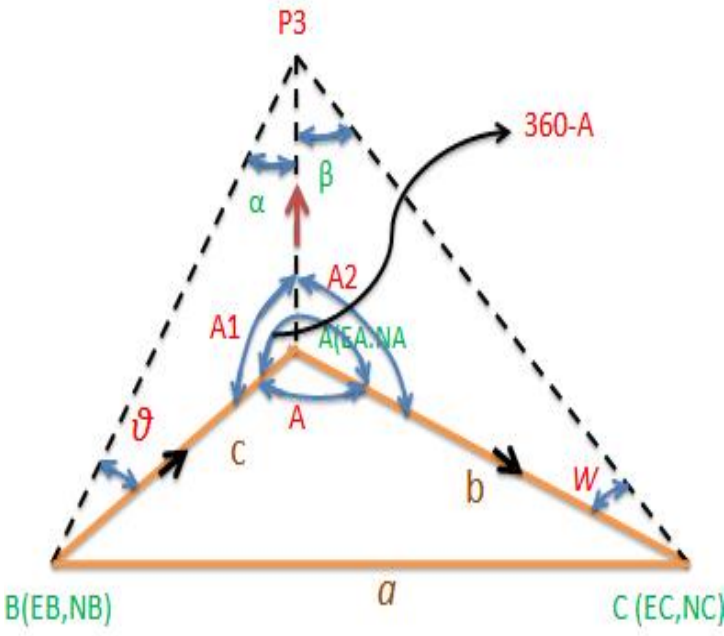
3- Compute angle S.

$$\angle S^{-} = (\vartheta + w) = 360 - (\alpha + \beta + 360 - A)$$

OR

$$\angle S^{-} = (A - \alpha - \beta)$$

$$4 - Compute\ \phi = \frac{Sin \angle w}{Sin \angle \vartheta}.as\ followe:$$



In Δ ABP3 → *Sines* lows →

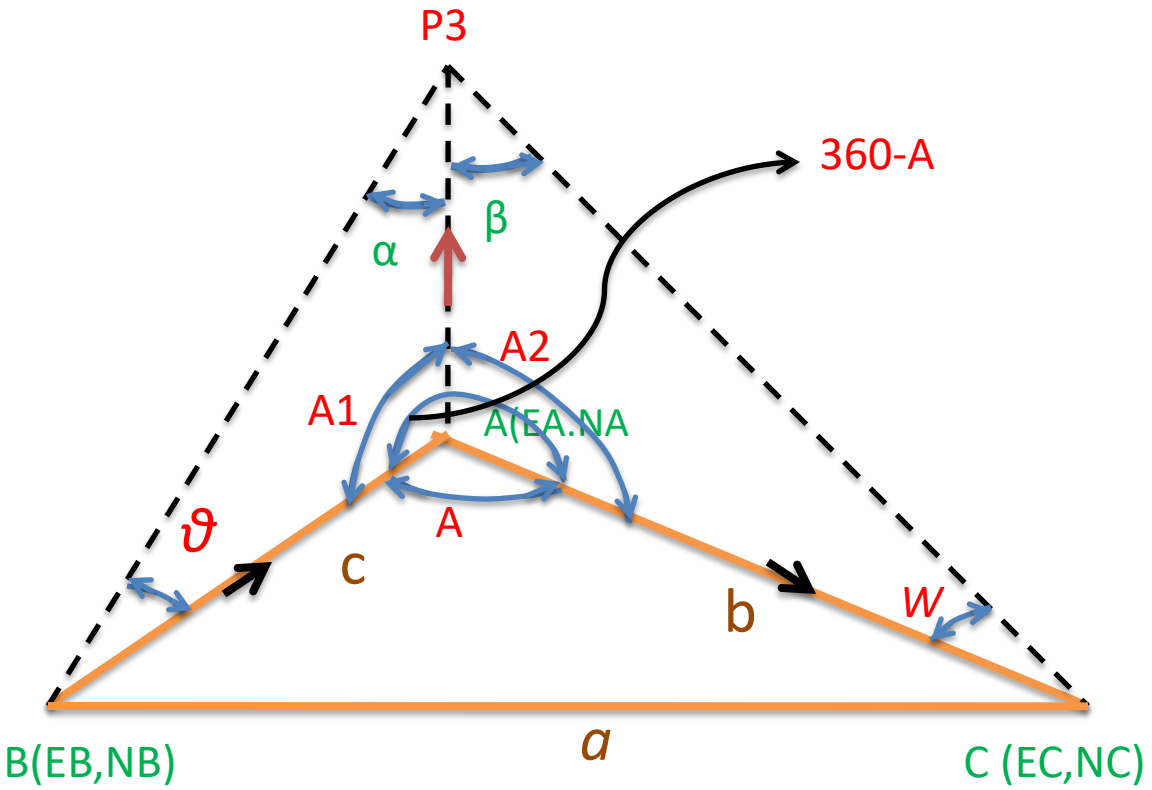
$$\frac{AP3}{Sin\vartheta} = \frac{c}{Sin\alpha} \ldots\ldots 2$$

In Δ ACP3 → *Sines* lows →

$$\frac{AP3}{SinW} = \frac{b}{Sin\beta} \ldots\ldots 3$$

Dividing (2) by (3) →

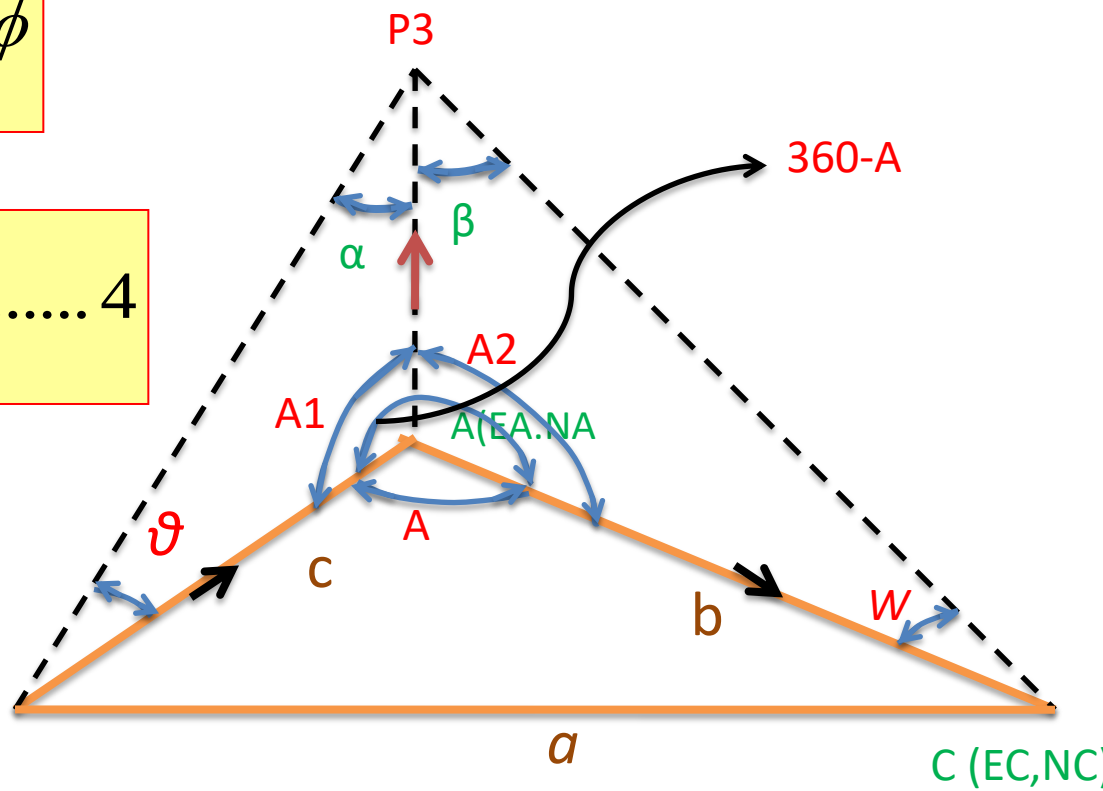
$$\frac{\frac{AP3}{Sin\vartheta}}{\frac{AP3}{Sinw}} = \frac{\frac{c}{Sin\alpha}}{\frac{b}{Sin\beta}} \rightarrow$$



$$\frac{\sin w}{\sin \vartheta} = \frac{\sin \beta}{b} \times \frac{c}{\sin \alpha} = \tan \phi$$

$$\therefore \tan \phi = \frac{\sin w}{\sin \vartheta} = \frac{c.\sin \beta}{b.\sin \alpha} \ldots\ldots\ldots 4$$

$$\rightarrow \angle \phi = \tan^{-1}\left(\frac{c.\sin \beta}{b.\sin \alpha}\right)$$



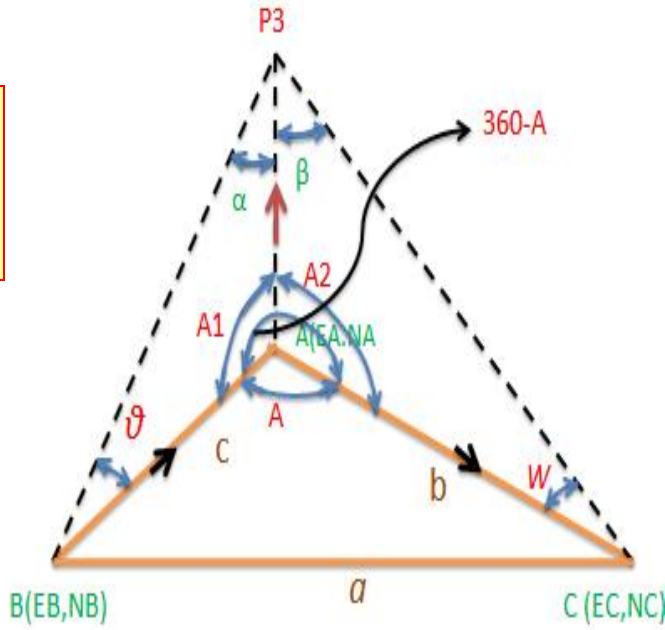
5- compute angle ϑ *and* w

$$\angle \vartheta = \tan^{-1}\left(\frac{\sin s^{-}}{\tan \phi + \cos s}\right) \ldots\ldots\ldots 5$$

$$\angle w = \tan^{-1}\left(\frac{\sin s^{-}}{\cot \phi + \cos s^{-}}\right) \ldots\ldots\ldots 6$$

6- Find length *AP3*

$$Length\ AP3 = \frac{C}{\sin\alpha} \bullet Sin\,\vartheta = \frac{b}{\sin\beta} \bullet Sin\,w$$



7- Compute Angle *A1,A2*

$$\angle A1 = 180 - (\vartheta + \alpha)$$

$$\angle A2 = 180 - (W + \beta)$$

9- Find Position of *P3* *by using point A(EA,NA) and Azi. AP3and length of AP3 by forward computations*

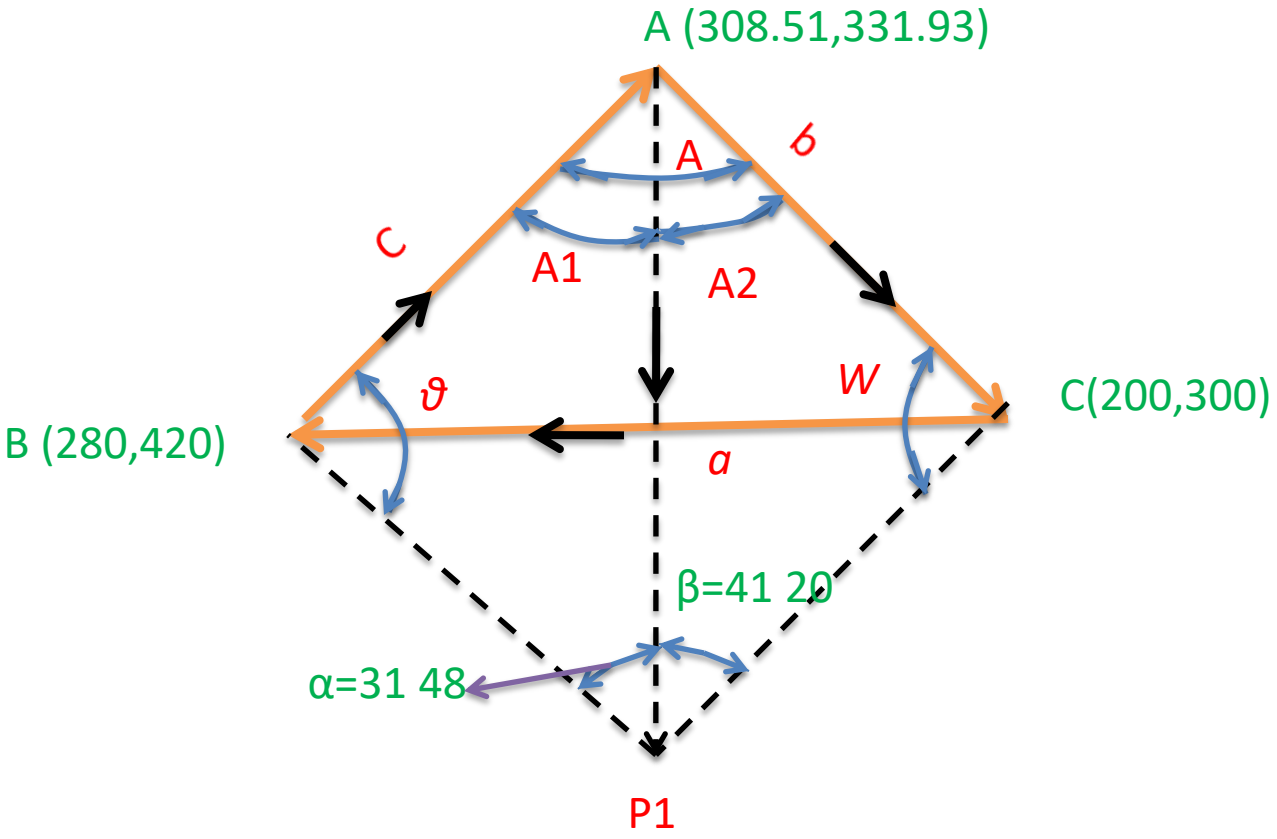
$$EP3 = EA + AP3\,Sin(Azi.AP3)$$

$$NP3 = NA + AP3\,Cos(Azi.AP3)$$

او تحسب من موقع B او ال C وبنفس الاسلوب بعد حساب الاتجاهات والاطوال الازمة للحسابات الامامية.

او تحسب بواسطة التقاطع الاول بعد حساب الاتجاهين BP3,CP3.

Example 1: Its required to find the coordinate of P1 for the figure shown below?



1-Find b,c angle A

$$Azimuth\ CA = Tan^{-1}\left(\frac{\Delta ECA}{\Delta NCA}\right) = \left(\frac{308.51-200}{331.93-300}\right) = 73^{\circ}\ 36'\ 11''$$

$$\Rightarrow Length\ CA(b) = Tan^{-1}\left(\frac{\Delta ECA}{Sin\ Azi.CA}\right) = \left(\frac{308.51-200}{Sin\ 73^{\circ}\ 36'11''}\right) =$$

$$Length\ CA(b) = 113.11m$$

$$Azimuth\ AB = Tan^{-1}\left(\frac{\Delta EAB}{\Delta NAB}\right) = \left(\frac{280-308.51}{420-331.93}\right) = 342^{\circ}\ 03'\ 44''$$

$$Length\ AB(c) = Tan^{-1}\left(\frac{\Delta EAB}{Sin\ Azi.AB}\right) = \left(\frac{280-308.51}{Sin\ 342^{\circ}\ 03'\ 44''}\right) =$$

$$Length\ AB(c) = 92.57m$$

$$\angle A = Back\ Azimuth\ AB - Azi.CA = 342\ 03\ 44 - (73\ 36\ 11 + 180) =$$

$$\angle A = 88^{\circ}\ 27\ 33$$

2-Find angle S And angle ϕ.

$$\angle S = (\vartheta + w) = 360 - (\alpha + \beta + A)$$
$$= 360 - (31\ 48 + 41\ 20 + 88\ 27\ 33)$$

$$\angle S\ = 198^{\circ}\ 24'$$

$$\angle \phi = \tan^{-1}\left(\frac{c.\sin\beta}{b.\sin\alpha}\right) = Tan^{-1}\left(\frac{92.57\ Sin\ 41\ 20}{113.11\ Sin\ 31\ 48}\right) =$$

$$\angle \phi = 45^{\circ}\ 44'$$

3-Find angle w And angle ϑ.

$$\angle \vartheta = \tan^{-1}\left(\frac{\sin s}{\tan\phi + \cos s}\right) = \left(\frac{Sin198\,24}{\tan 45\;44 + cas198\,24}\right)$$

$$\angle \vartheta = 103^{\circ}\;41'$$

$$\angle w = \tan^{-1}\left(\frac{\sin s}{\cot\phi + \cos s}\right) = \left(\frac{Sin198\,24}{\cot 45\;44 + cas198\,24}\right) =$$

$$\angle w = 94^{\circ}\;34'$$

$$AP1 = \frac{C}{\sin\alpha}\,\sin\vartheta = \frac{92.57}{\sin 31\,48}\sin 103\,41 =$$

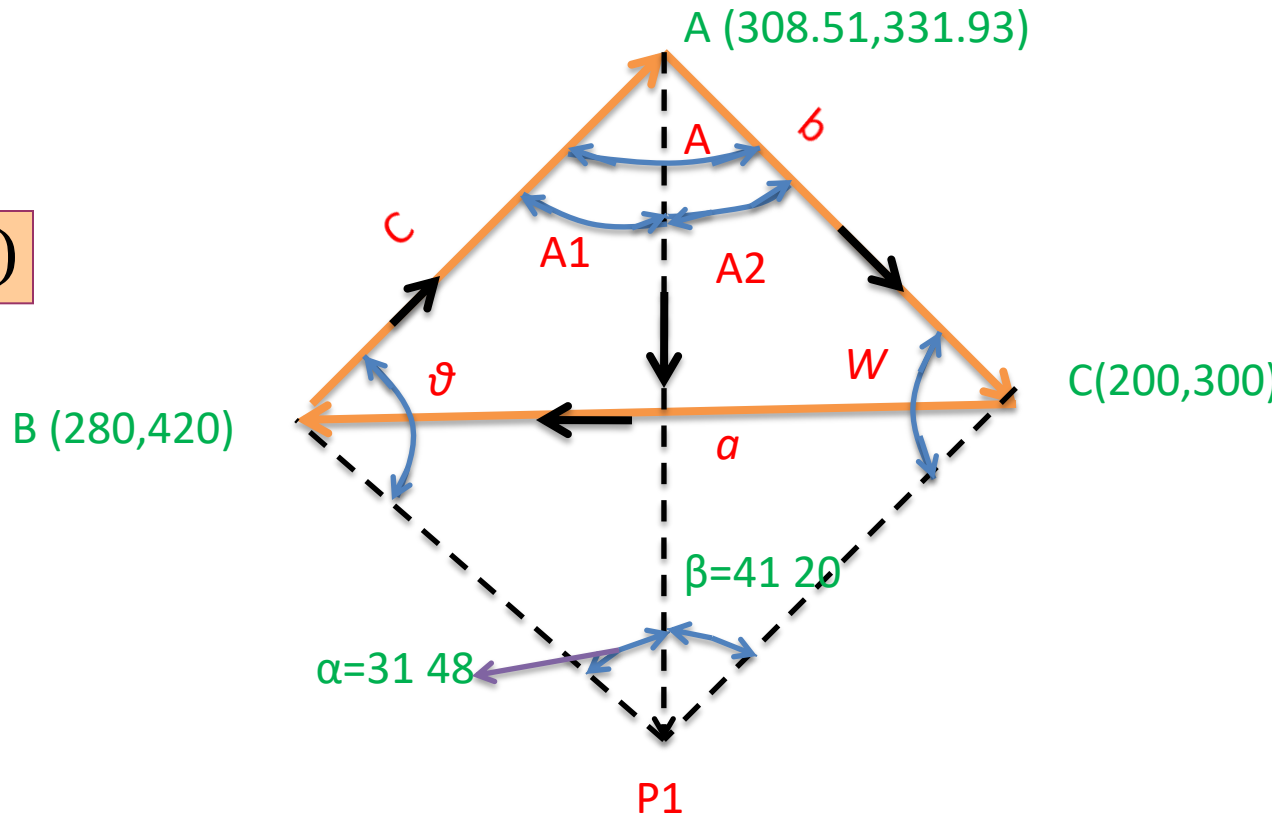
$$AP1 = 170.69m$$

$$\angle A1 = 180 - (\vartheta + \alpha) = 180 - (31\,48 + 103\,41)$$

$$\angle A1 = 44^\circ\ 31'$$

$$\angle A2 = 180 - (W + \beta)$$

$$\angle A2 = 43^\circ\ 57'$$



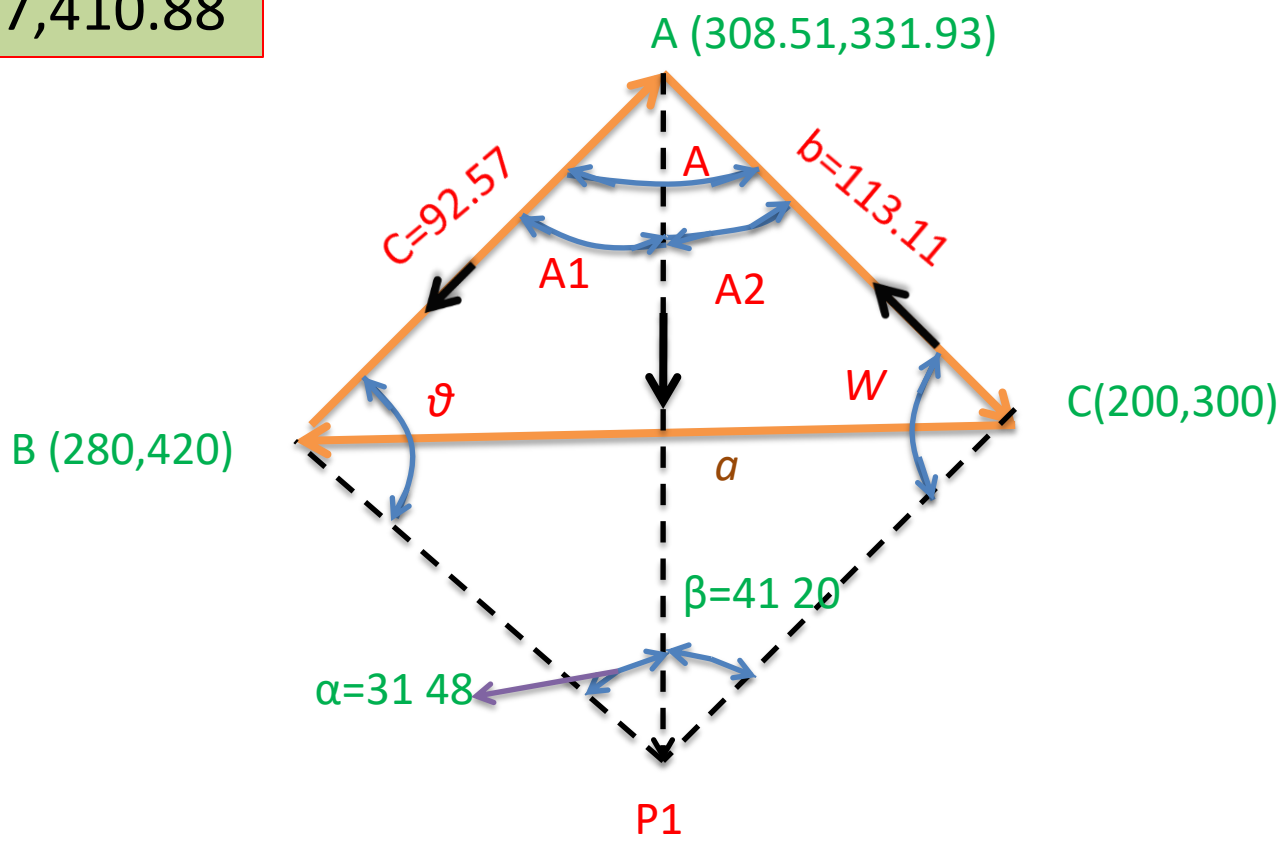
$$Azimuth\ AP1 = Azimuth\ AB - \angle A1 = 342\,03\,44 - 44\,31 =$$

$$Azimuth\ AP1 = 297^\circ\ 32'\ 44''$$

$$EP1 = EA + AP1\,Sin\,(Azi.AP1)$$
$$= 308.51 + 170.69 \sin 297\ 32\ 44 = 157.17$$

$$NP1 = NA + AP1\,Cos\,(Azi.AP1)$$
$$= 331.93 + 170.69 \cos 297\ 32\ 44 = 410.88$$

P1(157.17,410.88



Example 2: Given b = 6883.4 m ; c = 6605 m and angle A = 102 45 20 , α = 89 15 30 ; β = 128 20 10 ; Azi. AC = 106 14 40 ; EA = 3000 ; ; NA = 4000 . Find coordinate of P2?

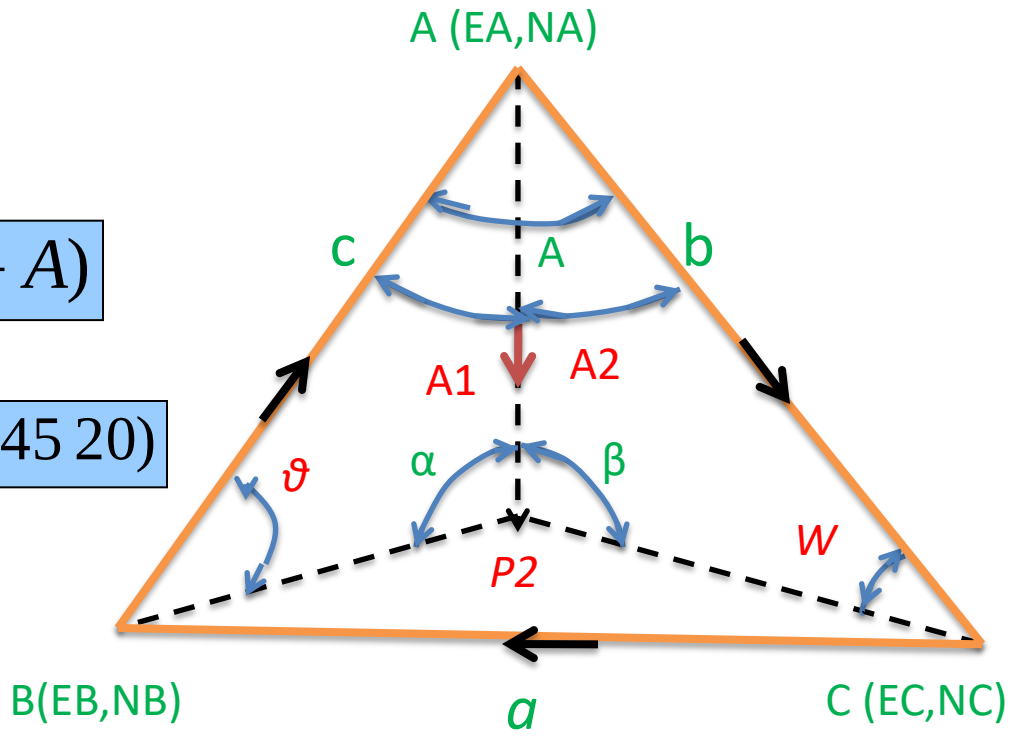
Solution:

1-Find angle S & ϕ

$$\angle S = (\vartheta + w) = 360 - (\alpha + \beta + A)$$

$$= 360 - (89\,15\,30 + 128\,20\,10 + 102\,45\,20)$$

$$\angle S = 39^\circ\ 39'\ 09''$$



$$\angle\phi = \tan^{-1}\left(\frac{c.\sin\beta}{b.\sin\alpha}\right)$$

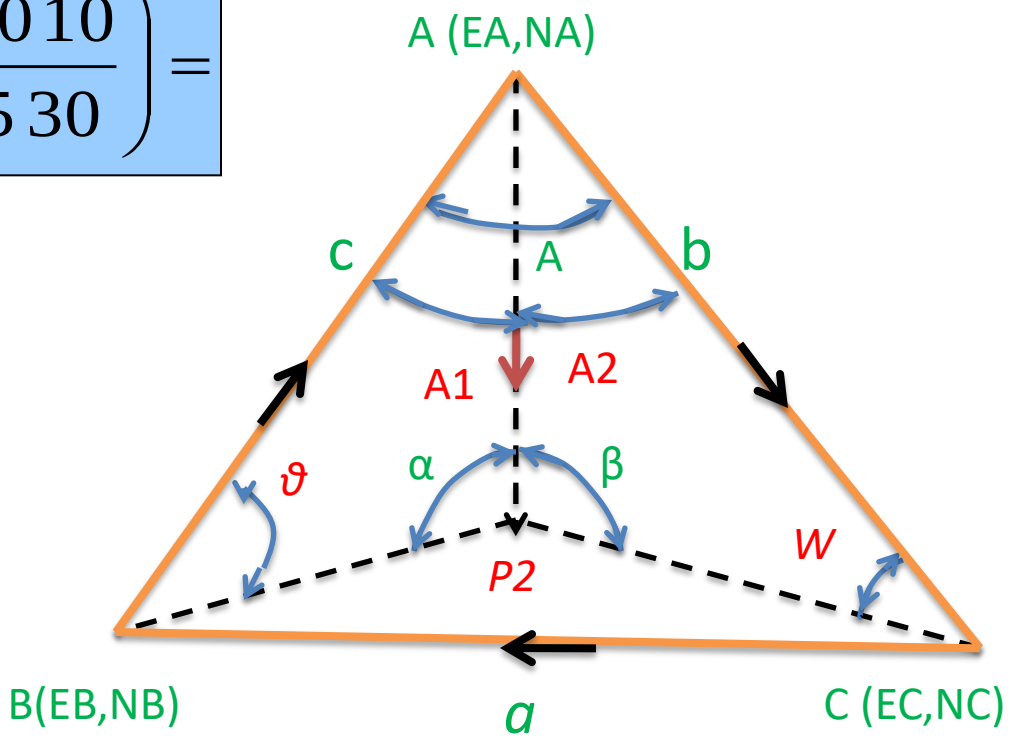
$$\angle\phi = \tan^{-1}\left(\frac{c.\sin\beta}{b.\sin\alpha}\right)$$

$$\angle\phi = \tan^{-1}\left(\frac{6605.3\sin 128\,20\,10}{6883.3\sin 89\,15\,30}\right) =$$

$$\angle\phi = 36^\circ\ 58'\ 15''$$

2-Find angle W & ϑ

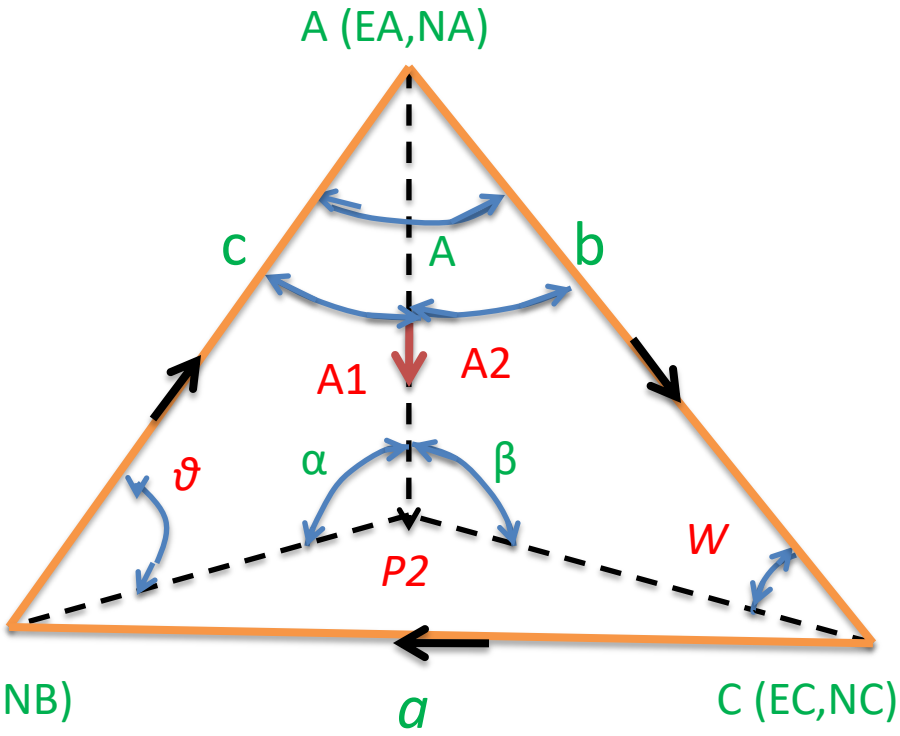
$$\angle\vartheta = \tan^{-1}\left(\frac{\sin s}{\tan\phi + \cos s}\right)$$



$$\Rightarrow \angle \vartheta = \tan^{-1}\left(\frac{\sin 39\,39\,09}{\tan 36\,58\,15 + \cos 39\,39\,09}\right) =$$

$$\angle \vartheta = t\,21^\circ\ 11'\ 08''$$

$$\angle w = \tan^{-1}\left(\frac{\sin s}{\cot \phi + \cos s}\right)$$



$$\Rightarrow \angle w = \tan^{-1}\left(\frac{\sin 39\,39\,09}{\cot 36\,58\,15 + \cos 39\,39\,09}\right) =$$

$$\angle w = 15^\circ\ 47'\ 08''$$

3-Find angle A2

$$\angle A2 = 180 - (W + \beta)$$

$$\Rightarrow \angle A2 = 180 - (128\,20\,10 + 15\,47\,08) =$$

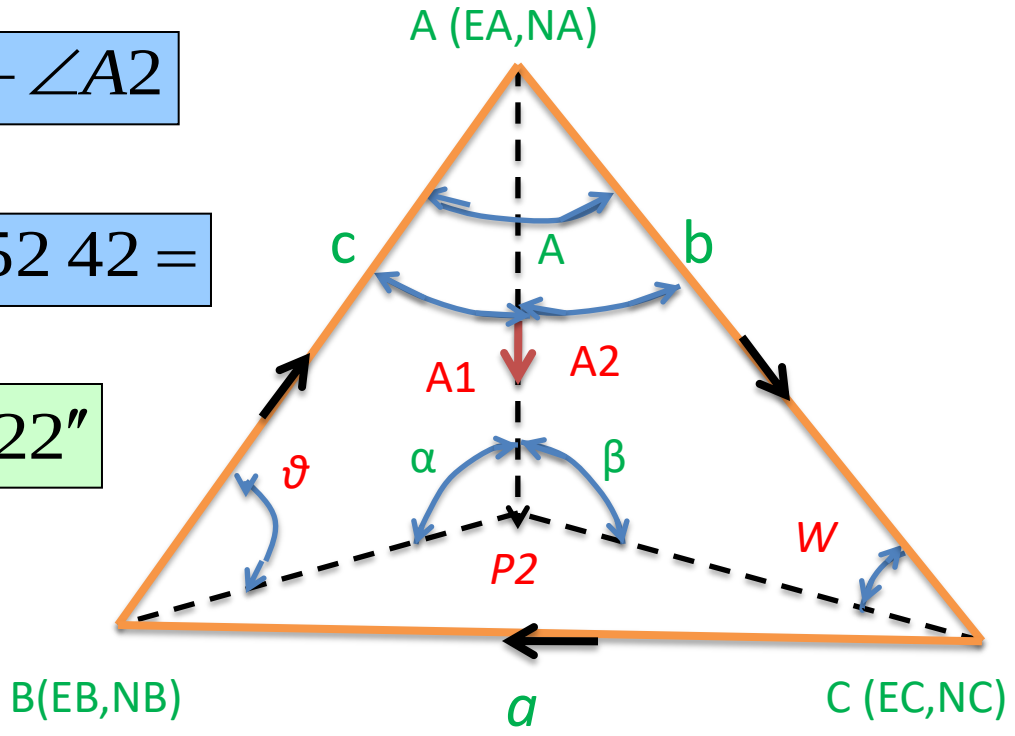
$$\angle A2 = 35^\circ\ 52'\ 42''$$

$$Azimuth\ AP2 = Azimuth\ AC + \angle A2$$

$$\Rightarrow Azi.AP2 = 106\,14\,40 + 35\,52\,42 =$$

$$Azi.AP2 = 142^\circ\ 07'\ 22''$$

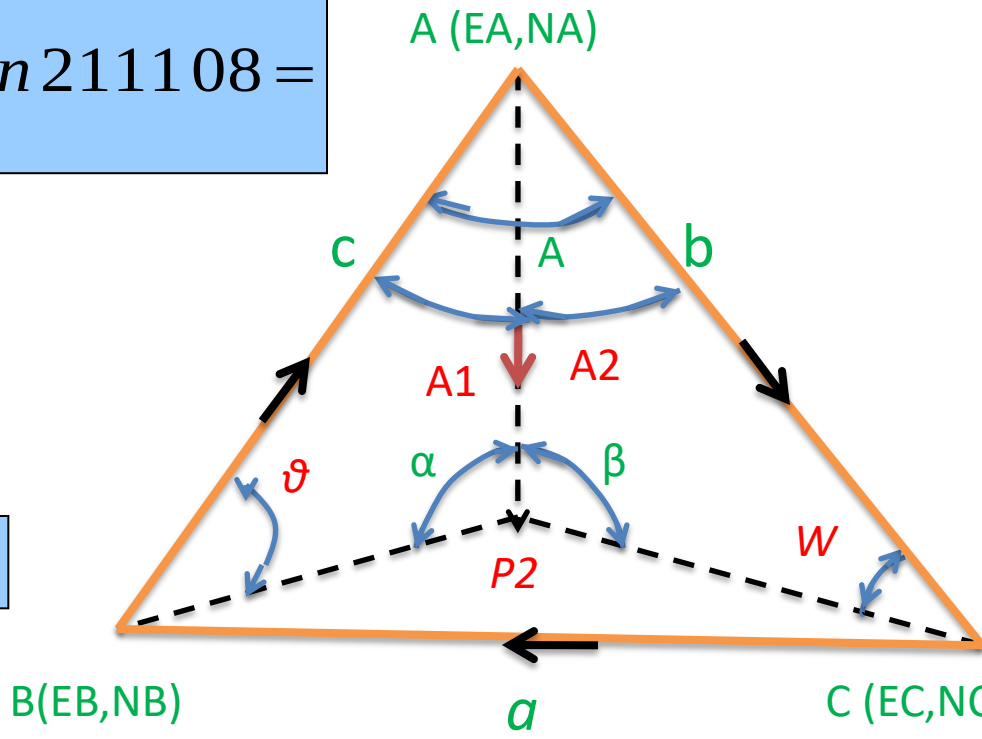
$$Length\ AP2 = \frac{C}{\sin\alpha}\ Sin\vartheta$$



$$\Rightarrow Length\ AP2 = \frac{6605.3}{\sin 89\,15\,30} Sin\,211\,08 =$$

$$Length\ AP2 = 2387.28m$$

$$EP2 = EA + AP2\,Sin(Azi.AP2)$$



$$EP2 = 3000 + 2387.28\,Sin(142\,07\,22) = 4465.7$$

$$NP2 = NA + AP2\,Cos(Azi.AP2)$$

$$NP2 = 4000 + 2387.28\,Cos(142\,07\,22) = 2115.64$$

$$P2 = (4465.7, 211.64)$$

H.W: Given Angle A = 152 23 22 and Angle α = 26 34 50 ; β = 44 15 15 ; b = 12481.7 m ; c = 6672.5 m , EA = 45000 ; NA = 65000 ; Azi. AB = 211 20 45

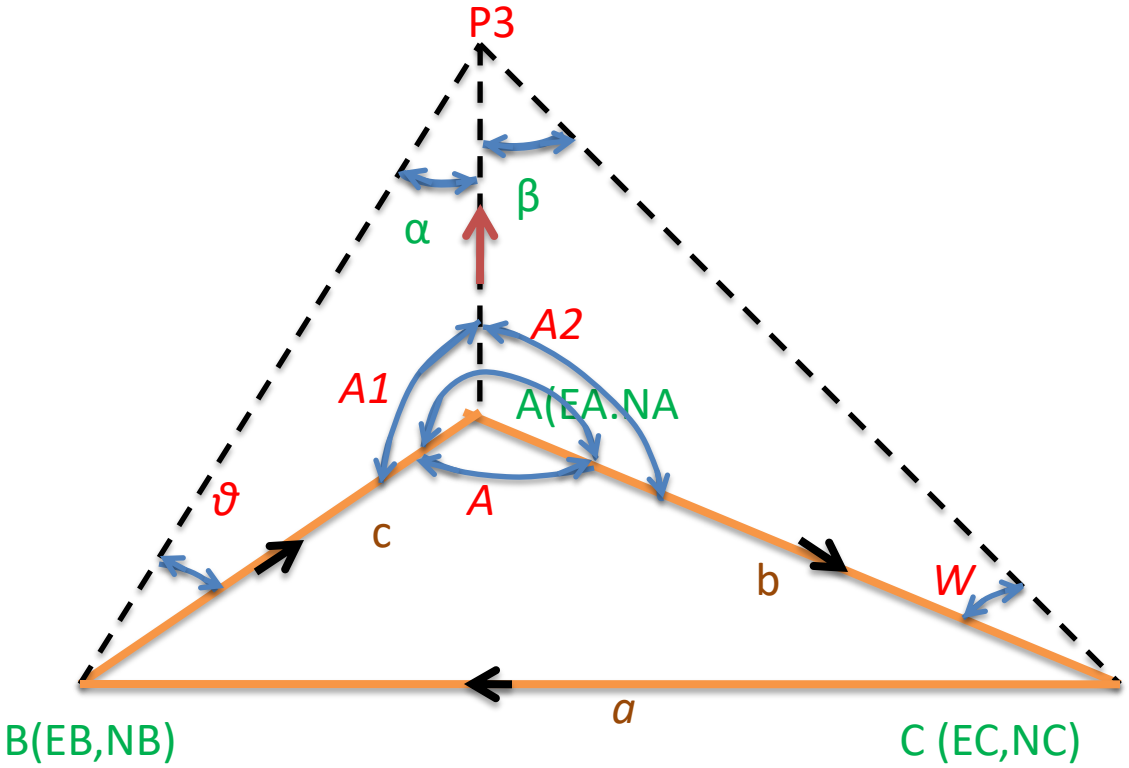
Required : EP3;NP3

Solution:

$1-Find\ \angle S^{-}\ \&\ \angle\phi$

$$\angle S^{-}=(\vartheta+w)$$

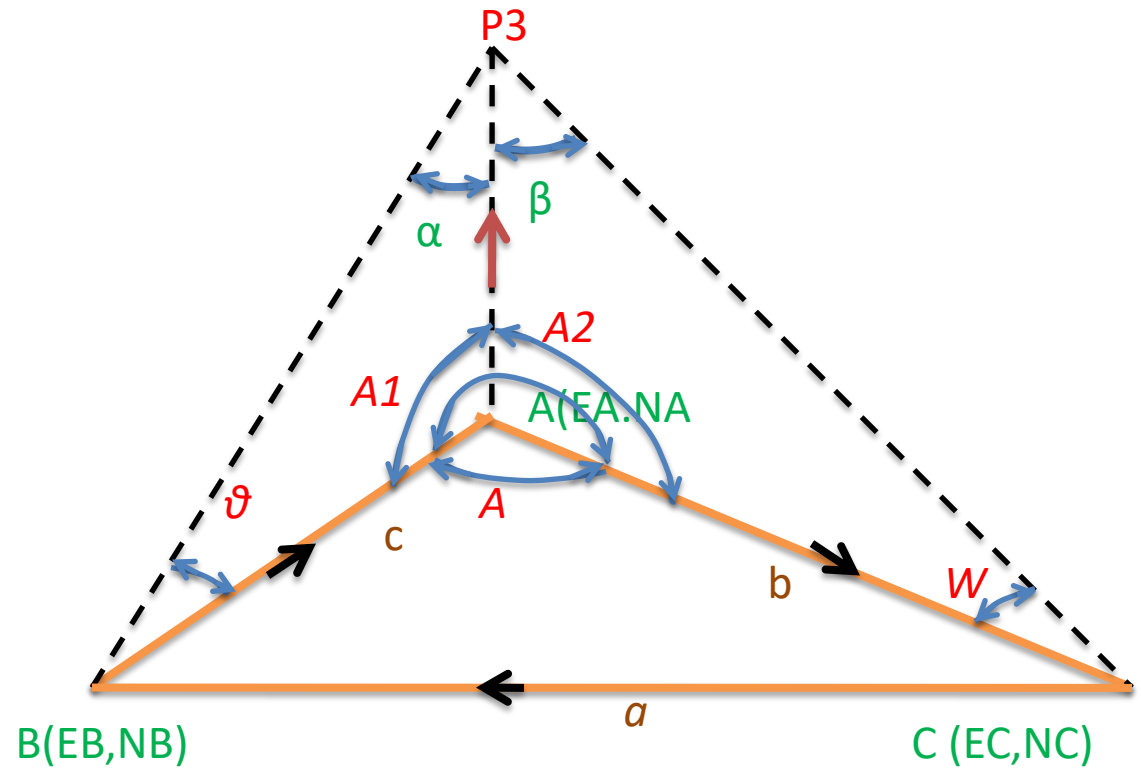
$$\Rightarrow \angle S^{-}=360-(\alpha+\beta+360-A)$$



$$\Rightarrow \angle S^{-} = 360 - (26\,34\,50 + 44\,15\,15 + 360 - 152\,23\,22) =$$

$$\angle S^{-} = 81^{\circ}\ 33'\ 17''$$

$$\angle \phi = \tan^{-1}\left(\frac{c.\sin\beta}{b.\sin\alpha}\right)$$



$$\Rightarrow \angle \phi = \tan^{-1}\left(\frac{6672.5.Sin\ 44\,15\,15}{12481.7.\sin 26\,34\,50}\right) =$$

$$\angle \phi = 39^{\circ}\ 49'\ 08''$$

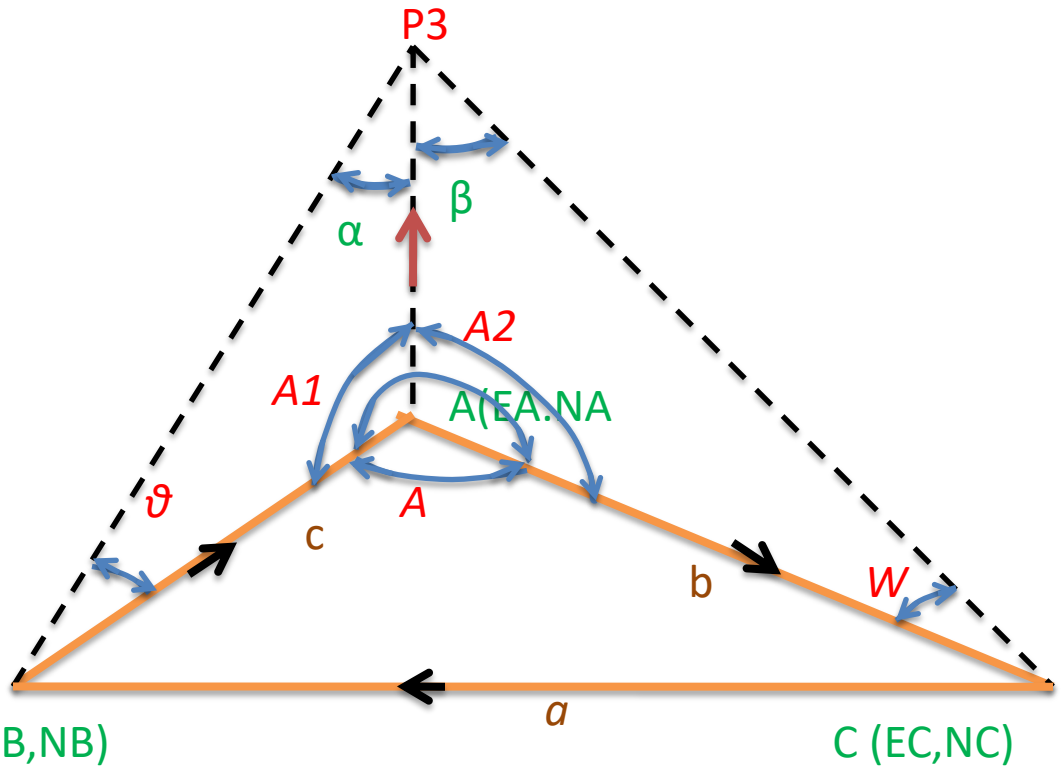
2 – Find $\angle\vartheta$ & $\angle w$

$$\angle\vartheta = \tan^{-1}\left(\frac{\sin s^{-}}{\tan\phi + \cos s}\right)$$

$$\Rightarrow \angle\vartheta = \tan^{-1}\left(\frac{\sin 81\,33\,17}{\tan 39\,49\,08 + \cos 81\,33\,17}\right) =$$

$$\angle\vartheta = 45^{\circ}\ 14'\ 57''$$

$$\angle w = \tan^{-1}\left(\frac{\sin s^{-}}{\cot\phi + \cos s^{-}}\right)$$

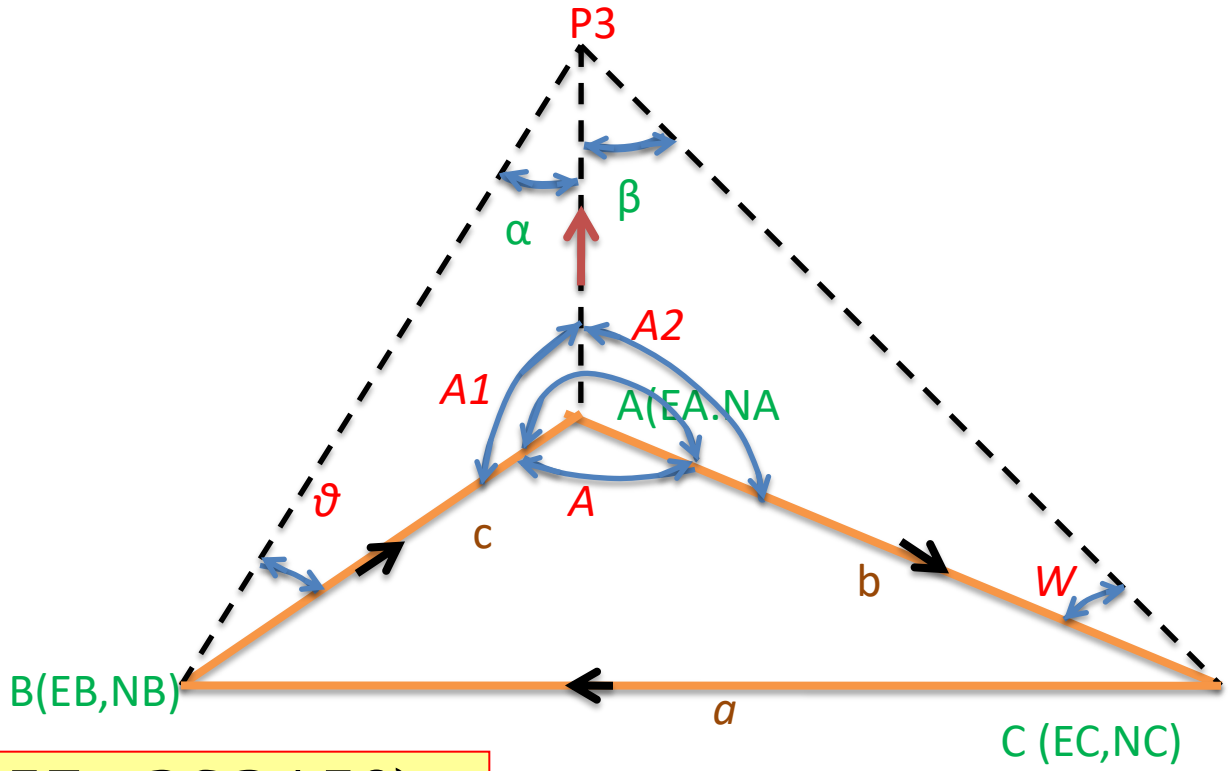


$$\Rightarrow \angle w = \tan^{-1}\left(\frac{\sin 81\,33\,17}{\frac{1}{\tan 39\,49\,08} + \cos 81\,33\,17}\right) =$$

$$\angle w = 36^\circ\ 18'\ 20''$$

$$3 - Find\ \angle A1$$

$$\angle A1 = 180 - (\vartheta + \alpha)$$



$$\Rightarrow \angle A1 = 180 - (45\,14\,57 + 26\,34\,50) =$$

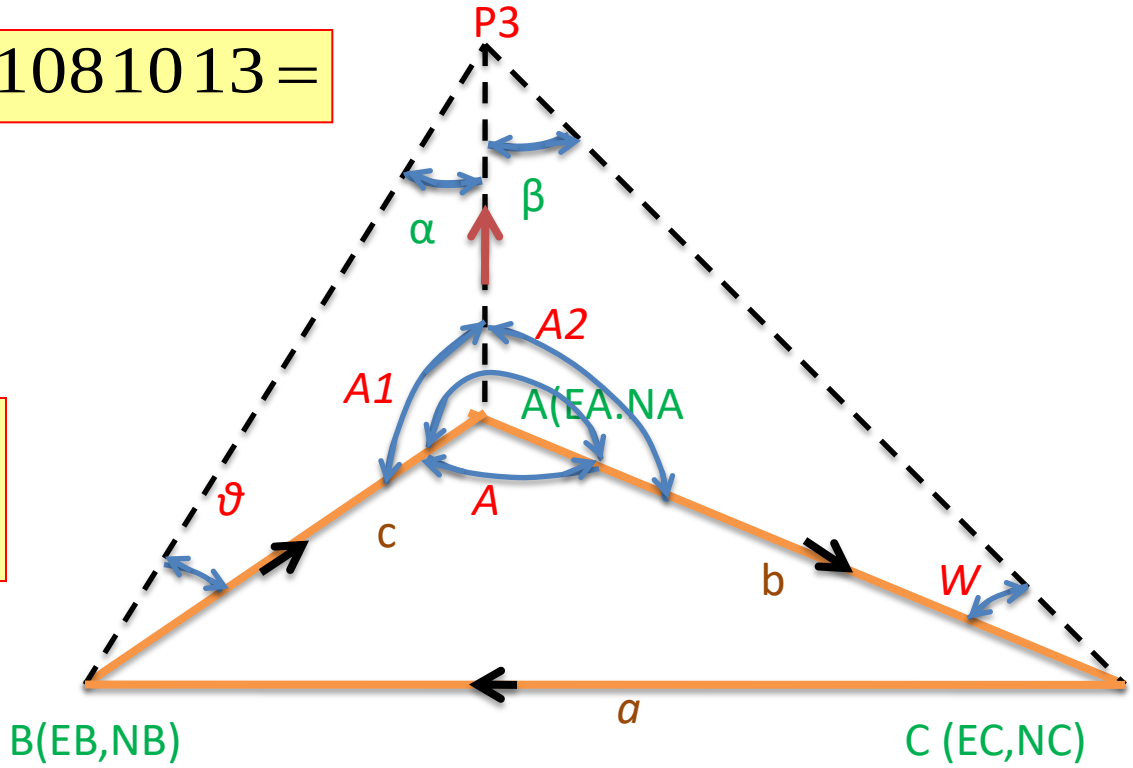
$$\angle A1 = 108^\circ\ 10'\ 13''$$

$$Azi.AP3 = Azi.AB + \angle A$$

$$\Rightarrow Azi.AP3 = 211\,20\,45 + 108\,10\,13 =$$

$$Azi.AP3 = 319^{\circ}\ 30'\ 58''$$

$$Length\ AP3 = \frac{C}{\sin\alpha} \bullet Sin\,\vartheta$$



$$\Rightarrow Length\ AP3 = \frac{6672.5}{\sin 26\,34\,50} \bullet Sin\,45\,14\,58 =$$

$$Length\ AP3 = 10590.2m$$

4 – *Find coordinate P3*

$$EP3 = EA + AP3\,Sin(Azi.AP3)$$

$$\Rightarrow EP3 = 45000 + 10590.2\,Sin(319\,30\,58) =$$

$$EP3 = 38124.48$$

$$NP3 = NA + AP3\,Cos(Azi.AP3)$$

$$\Rightarrow NP3 = 65000 + 10590.2\,Cos(319\,30\,58) =$$

$$NP3 = 73054.78$$