

CADASTRE SURVEY (SBEU 3313)

WEEK 9 & 10 – AMALAN PEJABAT

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ISI KANDUNGAN

- Hitungan (Latit, Dipat, Tikaian Lurus)
- Persediaan dan format untuk jilid kira
- Hitungan Koordinat
- Hitungan keluasan
- Hitungan aras laras

HITUNGAN (LATIT, DIPAT, TIKAIAN LURUS)

Hitungan Latit dan Dipat

Latit - Perbezaan pada Koordinat Utara / Selatan

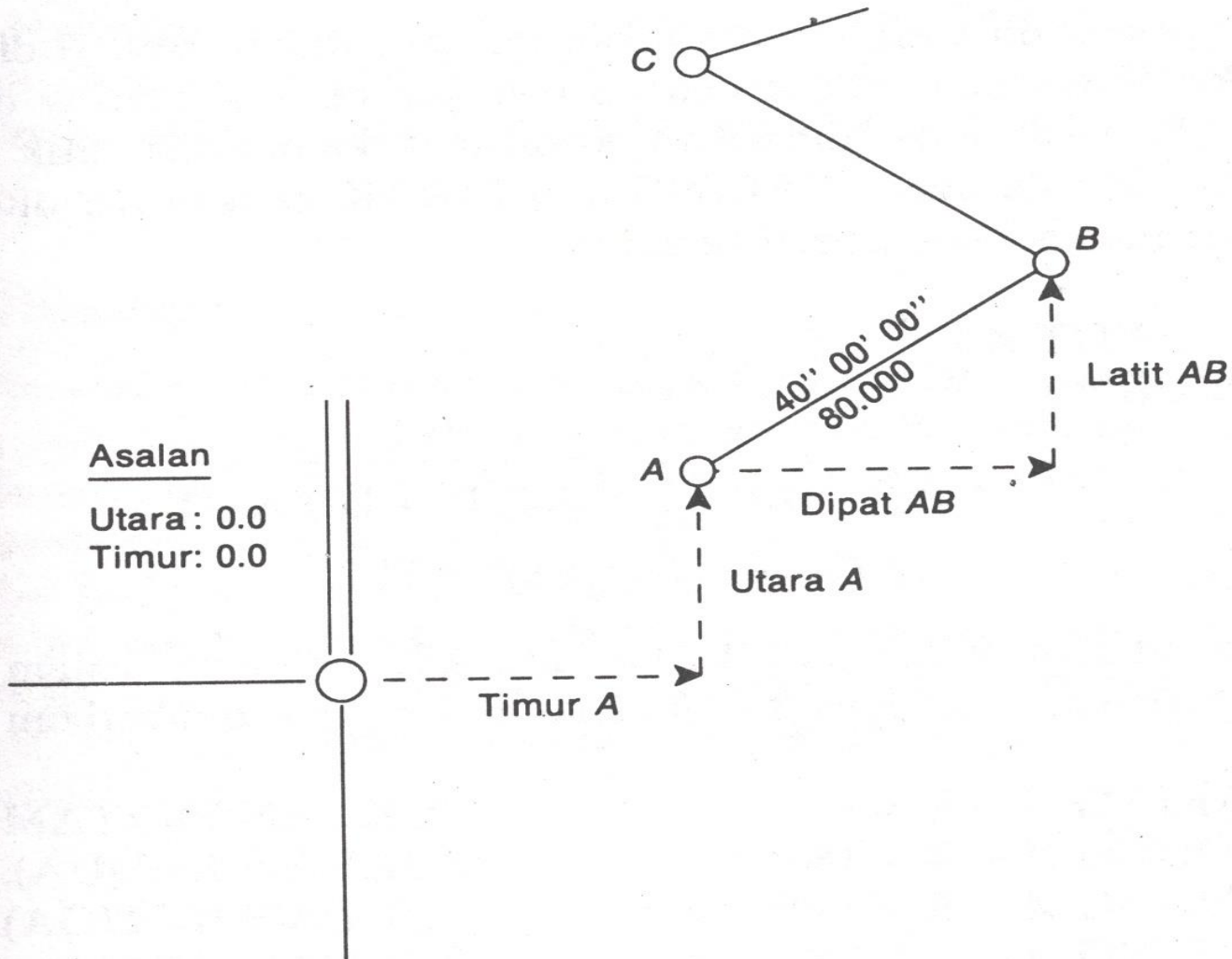
➤ Tanda positif menunjukkan utara dan negatif menunjukkan selatan

Dipat - Perbezaan pada Koordinat Timur / Barat

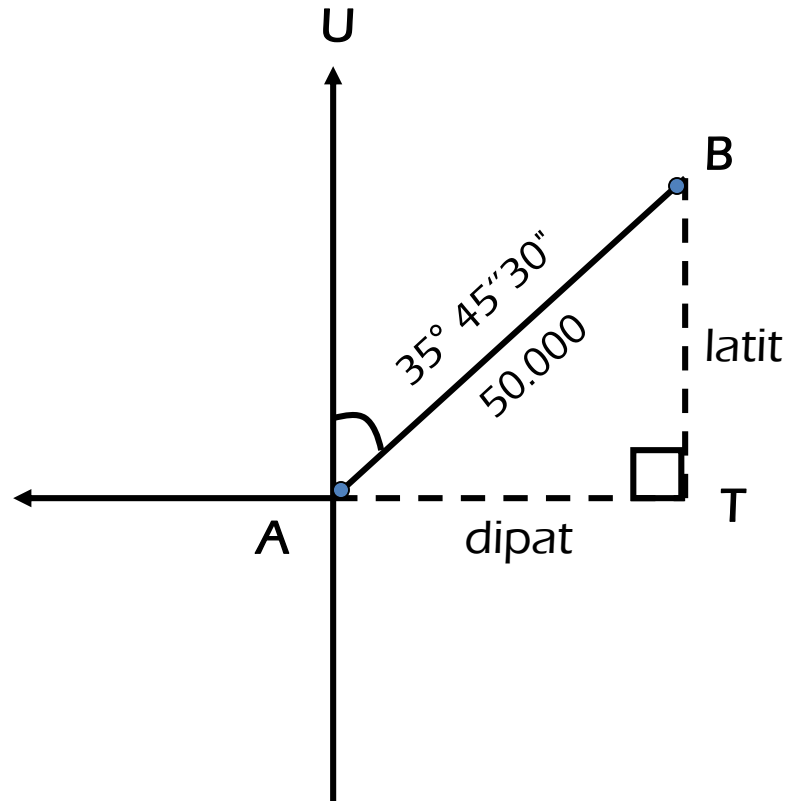
➤ Tanda positif menunjukkan timur dan negatif menunjukkan barat

☐ **Bering** dan **jarak** yang telah dilaras digunakan untuk menghitung latit dan dipat.

Rajah Latit dan Dipat



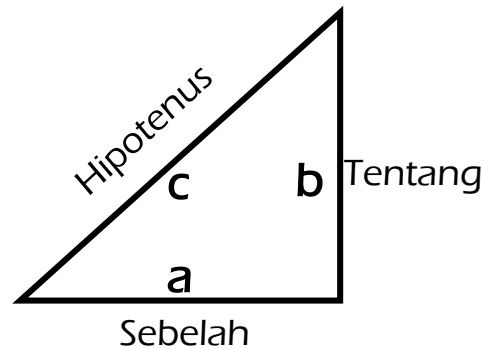
Rajah Latit dan Dipat



Formula Menghitung Latit/Dipat

$$\text{Latit} = J \cos \theta$$

$$\text{Dipat} = J \sin \theta$$



$$\sin A = \frac{\text{Tentang}}{\text{Hipotenus}}$$

$$\cos A = \frac{\text{Sebelah}}{\text{Hipotenus}}$$

$$\tan A = \frac{\text{Tentang}}{\text{Sebelah}}$$

Di mana :

J adalah Jarak yang telah dilaras

θ adalah Bering yang telah dilaras

Contoh Hitungan Latit/Dipat

Latit

$$\begin{aligned}\text{Latit} &= 37.938 \times \text{Cos } 345^{\circ}30'40'' \\ &= 36.731\end{aligned}$$

Dipat

$$\begin{aligned}\text{Dipat} &= 37.938 \times \text{Sin } 345^{\circ}30'40'' \\ &= -9.492\end{aligned}$$

Contoh Pembukan Hitungan Latit/Dipat

Stn	Bering	Jarak	Latit (L)		Dipat (D)	
			U	S	T	B
2						
3	26 10 10	57.348	51.469		25.292	
4	104 35 00	122.807		30.921	118.850	
5	195 30 10	144.940		139.667		38.740
6	358 18 10	40.843	40.825			1.210
1	320 28 40	68.021	52.470			43.287
2	292 59 00	66.124	25.819			60.875
	Σ	500.083	170.583	170.588	144.142	144.112
				σ = 0.005	σ = 0.030	

$$\begin{aligned} \sigma_{\text{Latit}} &= 170.583 - 170.588 \\ &= - 0.005 \\ &(- \text{ tulis di tempat } \mathbf{S}) \end{aligned}$$

$$\Sigma L = 341.171$$

$$\Sigma D = 288.254$$

$$\begin{aligned} \sigma_{\text{Dipat}} &= 144.142 - 144.112 \\ &= + 0.030 \\ &(+ \text{ tulis di tempat } \mathbf{T}) \end{aligned}$$

Hitungan Tikaian Lurus

- Bertujuan mendapatkan kejituan dalam ukuran
- Had yang dibenarkan mengikut PUK 2002 mestilah tidak kurang **1 : 8000** untuk ukuran baru dan tidak kurang **1 : 4000** untuk ukuran minima.
- Formula menghitung Tikaian Lurus

$$\begin{aligned}\text{Tikaian Lurus} &= \frac{1 : \text{Jumlah Jarak}}{\sqrt{\sigma_{\text{Latit}}^2 + \sigma_{\text{Dipat}}^2}} \\ &= \frac{1 : \underline{500.083}}{\sqrt{0.005^2 + 0.030^2}} \\ &= 1 : 16,443\end{aligned}$$

Pelarasan Latit/Dipat

Terdapat dua kaedah yang digunakan iaitu :

- **Kaedah Transit**
- **Kaedah Bowditch**

Latit dan Dipat

Tikaian lurus terabas adalah daripada kiraan latit dan dipat garisan-garisan da;am terabas tersebut.

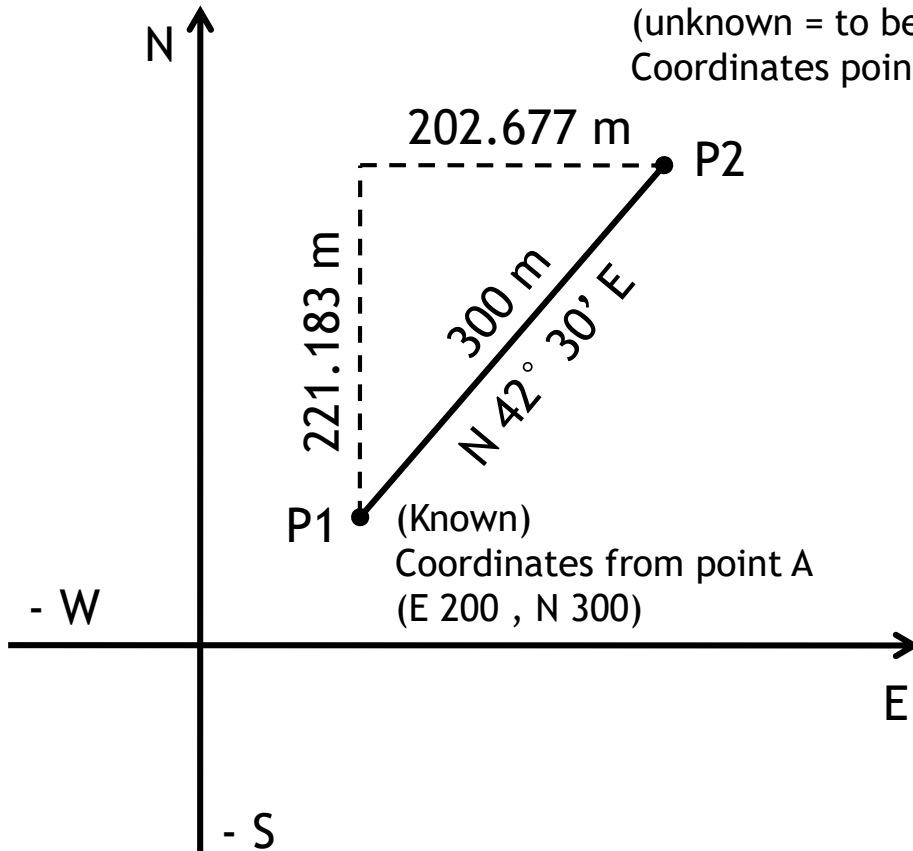
- Latit merupakan paksi utara-selatan dalam pengukuran.
- Latit merupakan komponen N bagi satu garisan dalam system grid.
- Dipat merupakan paksi timur-barat dalam pengukuran.
- Latit merupakan komponen E bagi satu garisan dalam system grid.

Latit dan Dipat

- Dalam kiraan terabas, latit dan dipat boleh dalam negetif (-) atau positif (+).
- Latit Utara dan Dipat Timur adalah positif (+).
- Latit Selatan dan Dipat Barat adalah negetif (-).

Latit dan Dipat

Dalam contoh ini, Panjang AB ialah 300 m dan bering ditunjukkan seperti di bawah. Tentukan koordinat titik 2.



$$\text{Latit} = (300) \cos (42^\circ 30') \\ = 221.183 \text{ m}$$

$$\text{Dipat} = (300) \sin (42^\circ 30') \\ = 202.677 \text{ m}$$

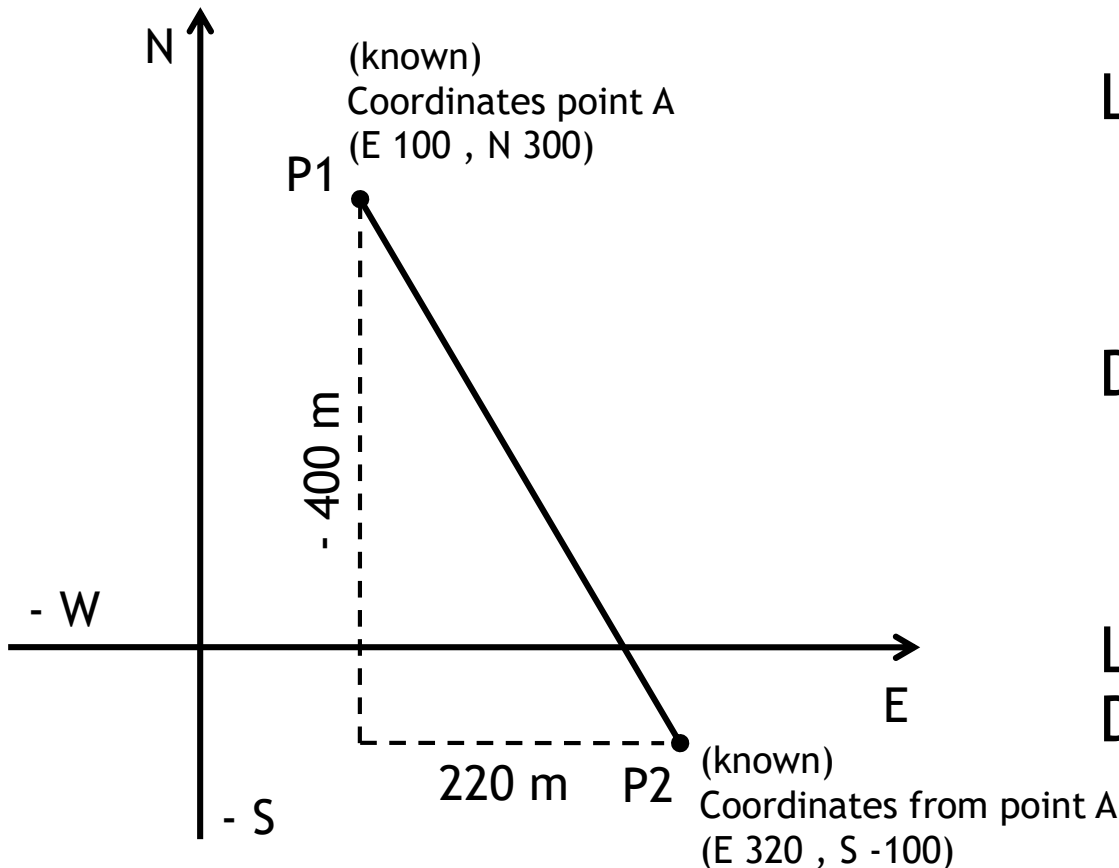
$$E_{P2} = 200 + 202.677 = 402.667 \text{ m}$$

$$N_{P2} = 300 + 221.183 = 521.183 \text{ m}$$

Latit = Utara/Selatan
Dipat = Timur/Barat

Latit dan Dipat

Dalam contoh ini, titik 1 dan 2 adalah diketahui koordinat dan dikehendaki untuk mengira latit dan dipat garisan AB.



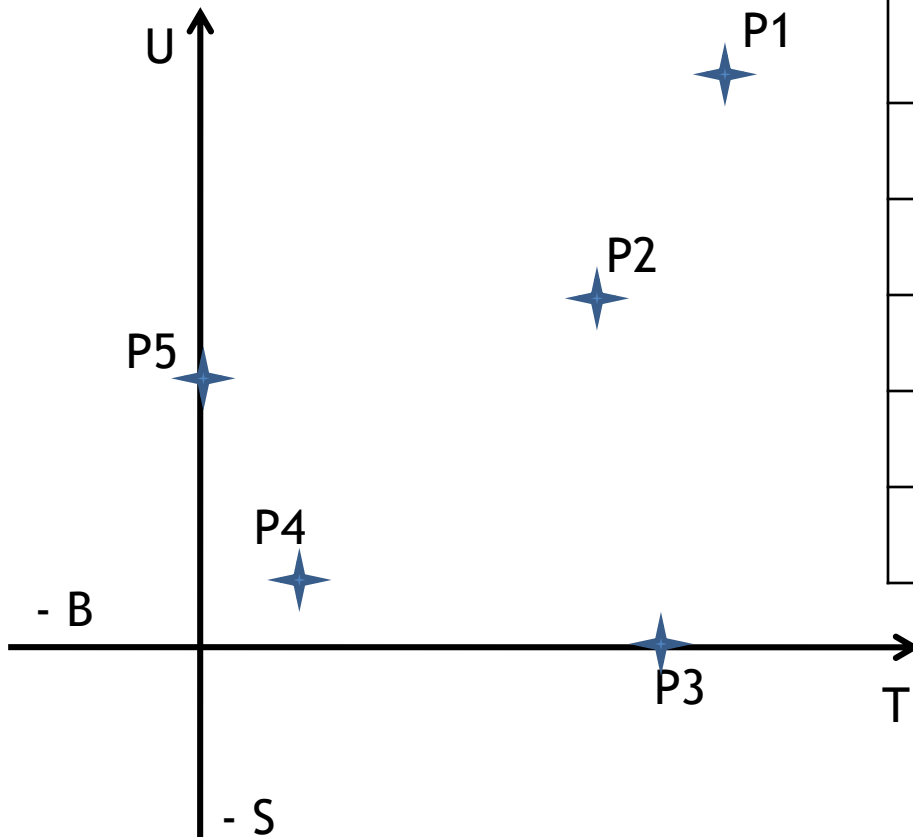
$$\begin{aligned}\text{Latit} &= N_{P2} - N_{P1} \\ &= -100 - (300) \\ &= -400 \text{ m}\end{aligned}$$

$$\begin{aligned}\text{Dipat} &= E_{P2} - E_{P1} \\ &= 320 - (100) \\ &= 220 \text{ m}\end{aligned}$$

Latit = Utara/Selatan
Dipat = Timur/Barat

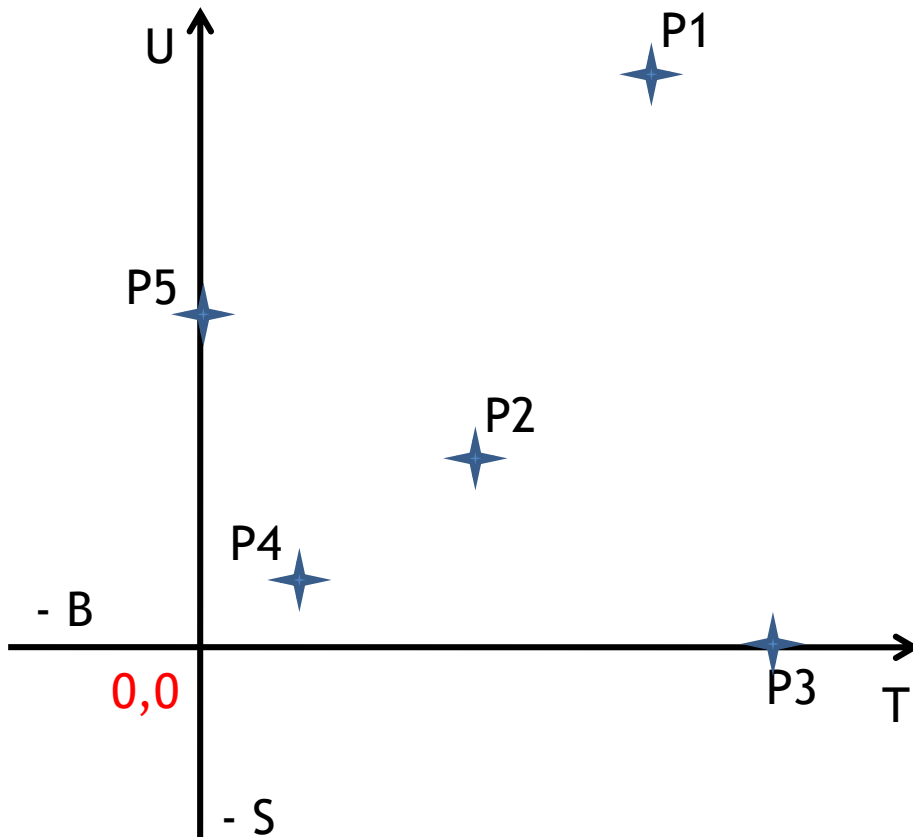
Latit dan Dipat

Carikan nilai koordinat dalam T dan U setiap titik.



Garis	Nilai	
	Latit	Dipat
P1-P2	- 188.388	- 20.601
P2-P3	- 152.252	86.648
P3-P4	29.933	- 195.470
P4-P5	139.080	- 30.551
P5-P1	171.627	159.974

Latit dan Dipat

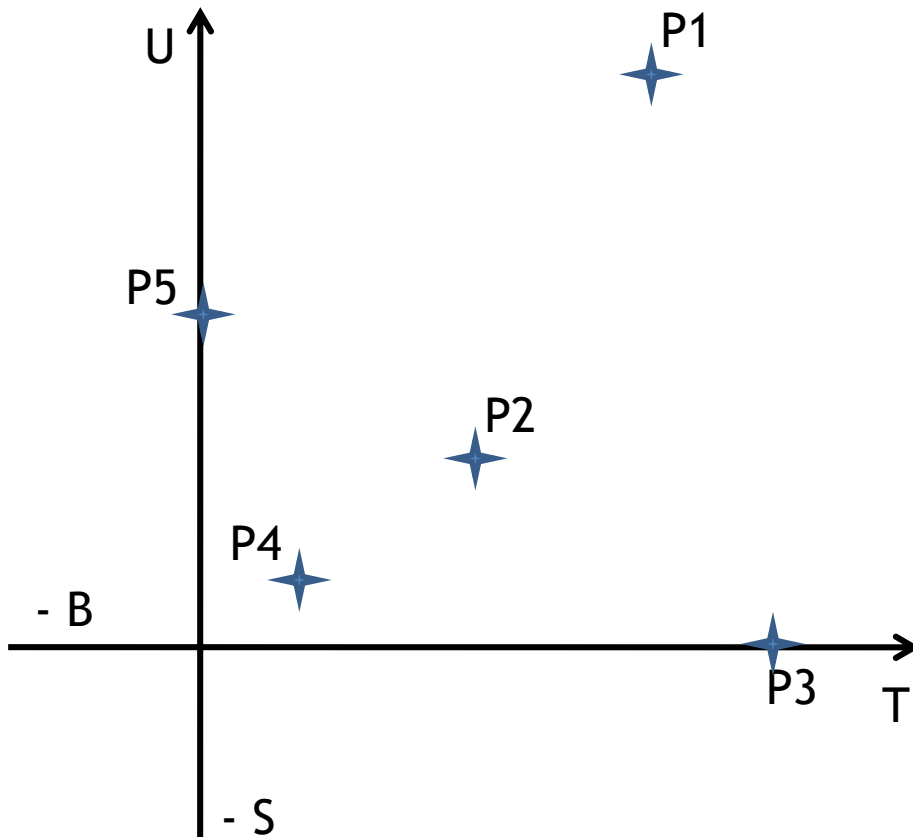


Garis	Nilai	
	Latit	Dipat
P1-P2	- 188.388	
P2-P3	- 152.252	
P3-P4	29.933	
P4-P5	139.080	
P5-p1	171.627	

Koordinat U

- P3 = 0 m
- P4 = P3 + 29.933 = 29.933 m
- P5 = P4 + 139.080 = 169.013 m
- P1 = P5 + 171.627 = 340.640 m
- P2 = P1 + (- 188.388) = 152.252 m
- P3 = P2 + (- 152.252) = 0 m

Latit dan Dipat



Garis	Nilai	
	Latit	Dipat
P1-P2		- 20.601
P2-P3		86.648
P3-P4		- 195.470
P4-P5		- 30.551
P5-P1		159.974

Koordinat T

$$P5 = 0 \text{ m}$$

$$P1 = P5 + 159.974 = 159.974 \text{ m}$$

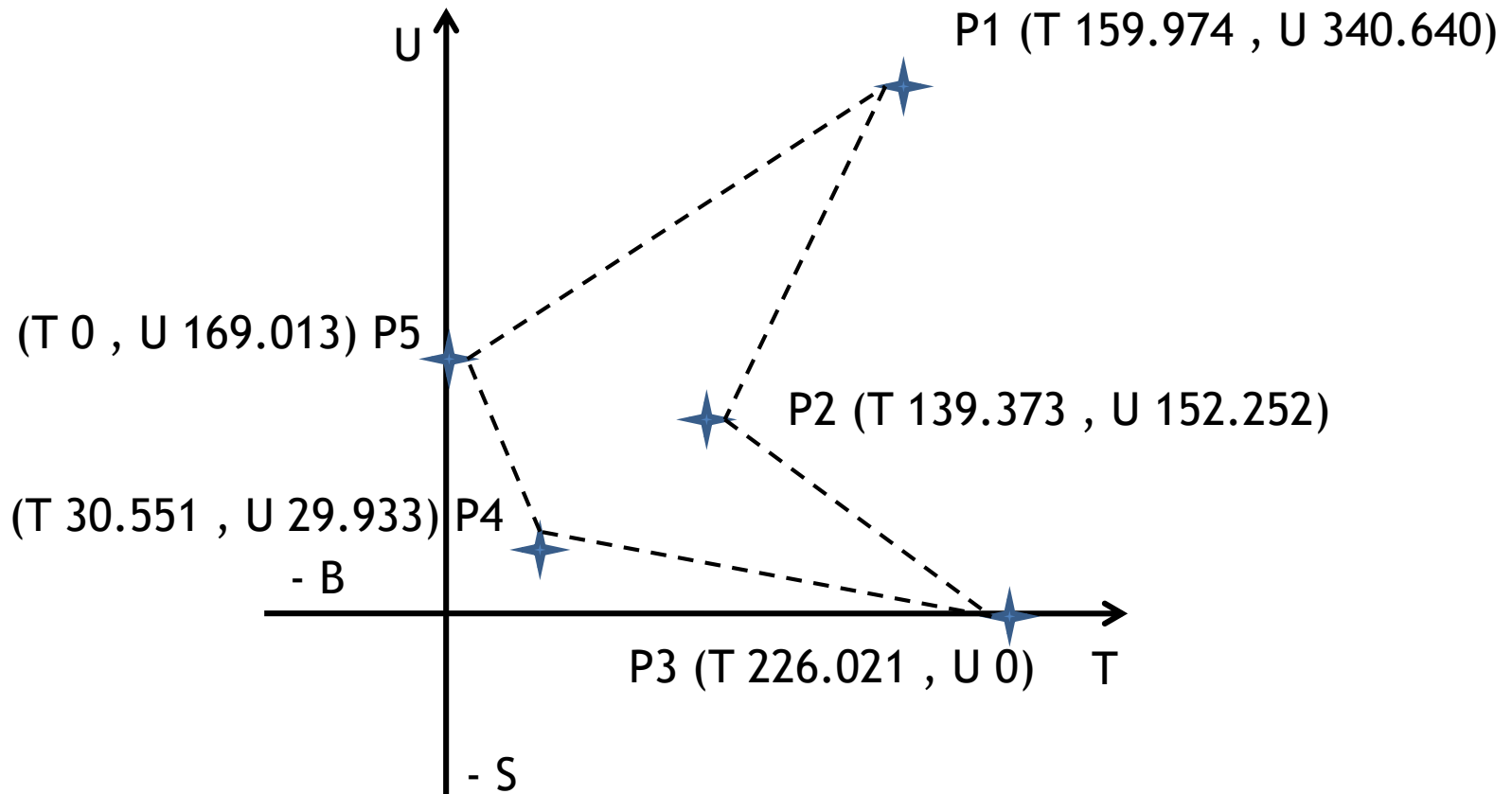
$$P2 = P1 + (- 20.601) = 139.373 \text{ m}$$

$$P3 = P2 + 86.648 = 226.021 \text{ m}$$

$$P4 = P3 + (- 195.470) = 30.551 \text{ m}$$

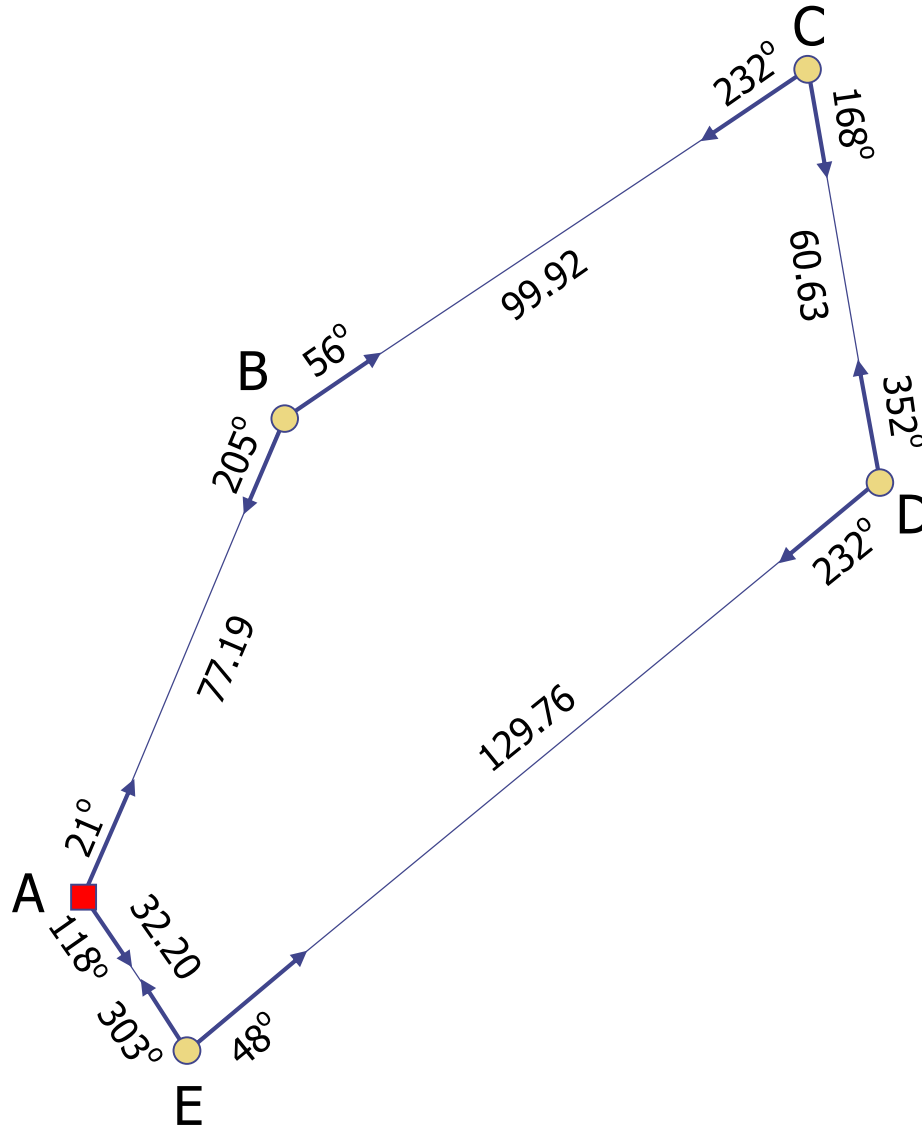
$$P5 = P4 + (- 30.551) = 0 \text{ m}$$

Latit dan Dipat



PERSEDIAAN DAN FORMAT UNTUK JILID KIRA

Susunan Pengukuran



Susunan Pengiraan

1. Kiraan tikaian sudut
2. Pelarasan tikaian sudut
3. Kiraan bering terlaras
4. Kiraan jarak cerun dll
5. Kiraan (ΔT , ΔU) setiap terabas
6. Kiraan tikaian lurus
7. Kiraan kejitudan
8. Pelarasan tikaian linear

Kiraan Sudut Dalaman

Point	Foresight Azimuth	Backsight Azimuth	Internal Angle	Adjusted Angle
A	21°	118°	97°	
B	56°	205°	149°	
C	168°			
D	232°			
E	303°			
$\Sigma = (n-2)*180$				
Misclose				
Adjustment				

At each point :

- Measure foresight azimuth
- Measure backsight azimuth
- Calculate internal angle (back-fore)

For example, at B :

- Azimuth to C = 56°
- Azimuth to A = 205°
- Angle at B = 205° - 56° = 149°

Kiraan Tikaian Sudut

Point	Foresight Azimuth	Backsight Azimuth	Internal Angle	Adjusted Angle
A	21°	118°	97°	
B	56°	205°	149°	
C	168°	232°	64°	
D	232°	352°	120°	
E	303°	48°	105°	
$\Sigma = (n-2)*180$			535°	
Misclose			-5°	
Adjustment			-1°	

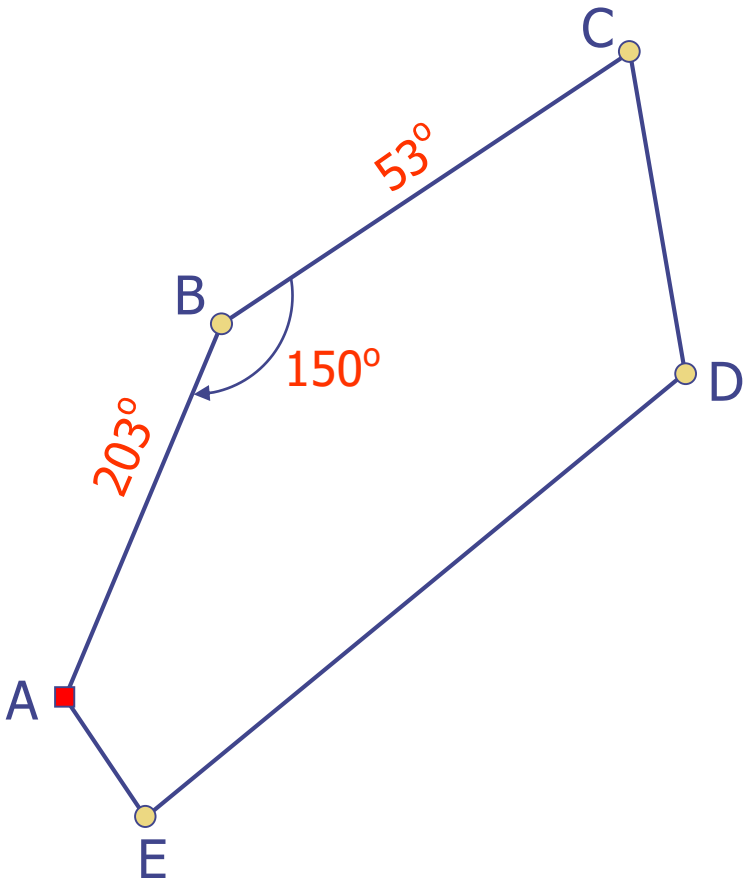
Kiraan Sudut Terlaras

Point	Foresight Azimuth	Backsight Azimuth	Internal Angle	Adjusted Angle
A	21°	118°	97°	98°
B	56°	205°	149°	150°
C	168°	232°	64°	65°
D	232°	352°	120°	121°
E	303°	48°	105°	106°
$\Sigma = (n-2)*180$			535°	540°
Misclose			-5°	
Adjustment			-1°	

Hitungan Azimut Terlaras

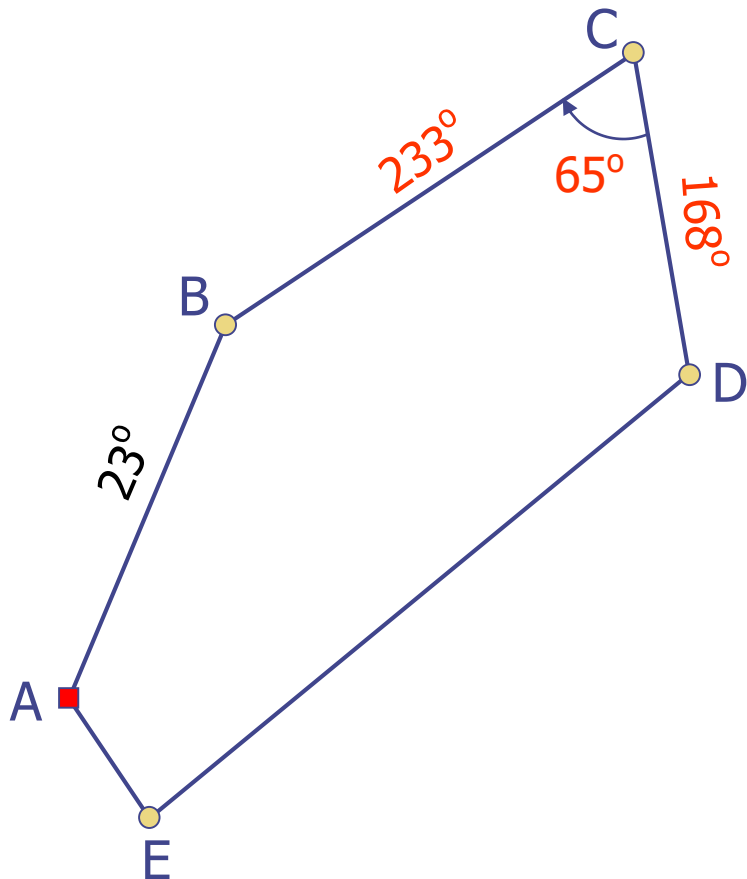
- Adopt a starting azimuth
- Then, working clockwise around the traverse :
 - Calculate reverse azimuth to backsight (forward azimuth $\mp 180^\circ$)
 - Subtract (clockwise) internal adjusted angle
 - Gives azimuth of foresight
- For example (azimuth of line BC)
 - Adopt azimuth of AB **23°**
 - Reverse azimuth BA ($=23^\circ+180^\circ$) **203°**
 - Internal adjusted angle at B **150°**
 - Forward azimuth BC ($=203^\circ-150^\circ$) **53°**

Hitungan Azimut Terlaras



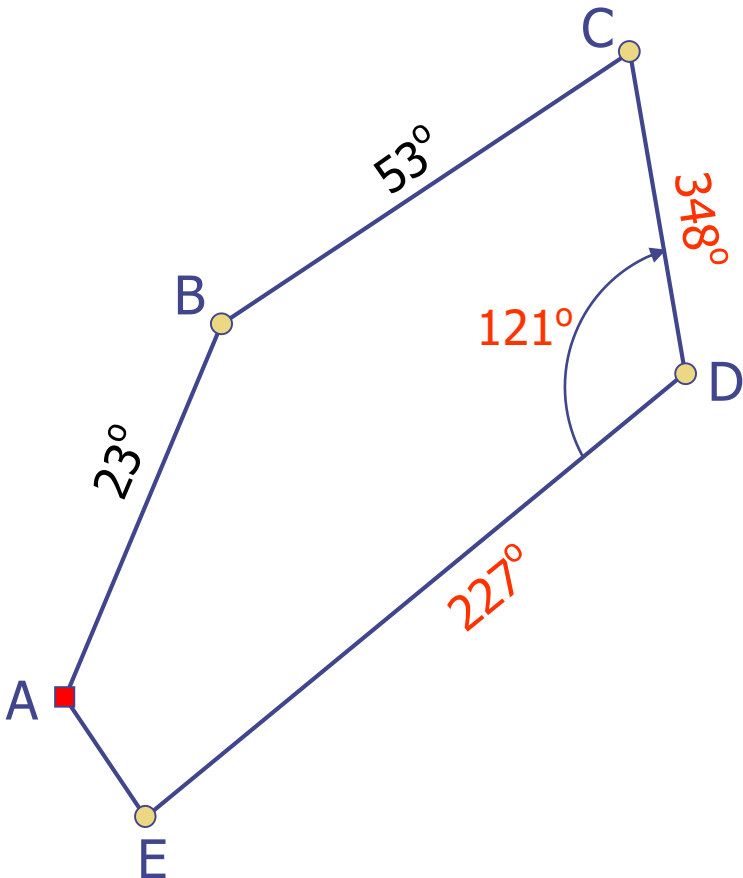
Line	Forward Azimuth	Reverse Azimuth	Internal Angle
AB	23°	203°	150°
BC	53°		
CD			
DE			
EA			
AB			

Hitungan Azimut Terlaras



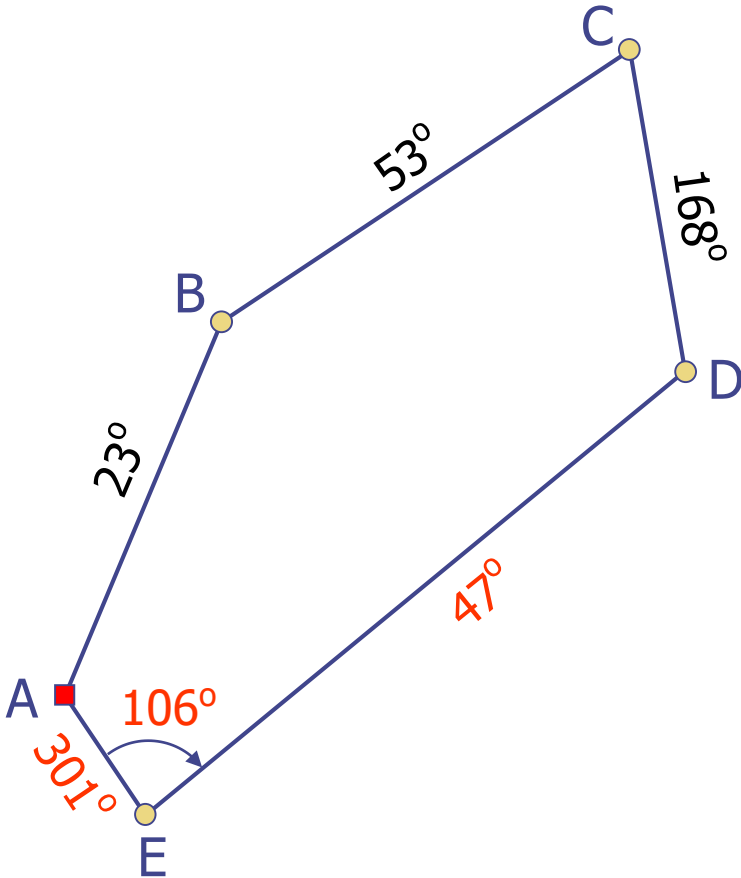
Line	Forward Azimuth	Reverse Azimuth	Internal Angle
AB	23°	203°	150°
BC	53°	233°	65°
CD	168°		
DE			
EA			
AB			

Hitungan Azimut Terlaras



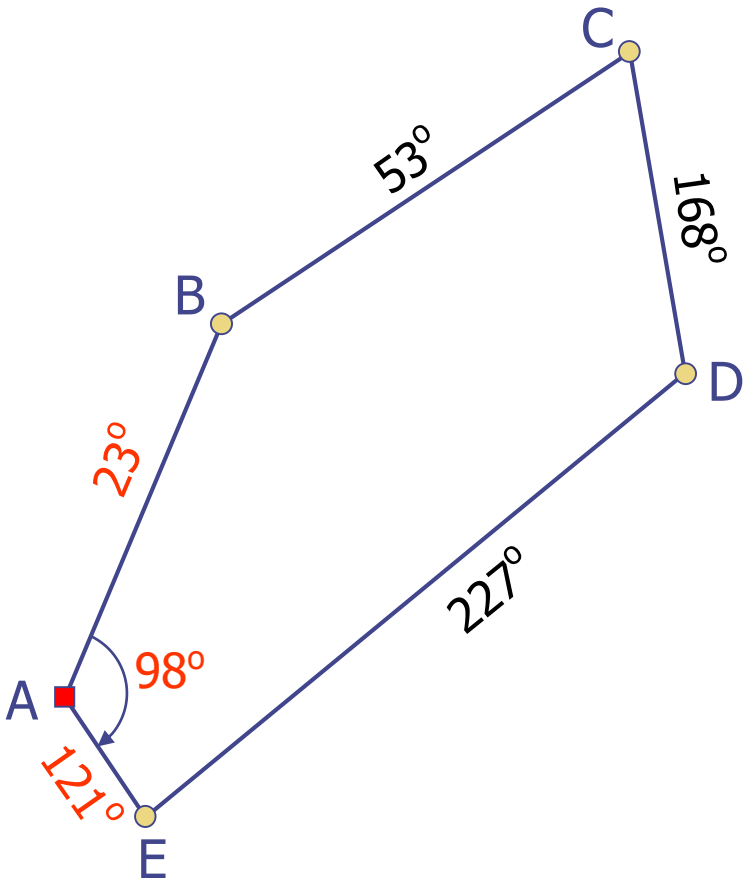
Line	Forward Azimuth	Reverse Azimuth	Internal Angle
AB	23°	203°	150°
BC	53°	233°	65°
CD	168°	348°	121°
DE	227°		
EA			
AB			

Hitungan Azimut Terlaras



Line	Forward Azimuth	Reverse Azimuth	Internal Angle
AB	23°	203°	150°
BC	53°	233°	65°
CD	168°	348°	121°
DE	227°	47°	106°
EA	-59° 301°		
AB			

Hitungan Azimut Terlaras



Line	Forward Azimuth	Reverse Azimuth	Internal Angle
AB	23°	203°	150°
BC	53°	233°	65°
CD	168°	348°	121°
DE	227°	47°	106°
EA	301°	121°	98°
AB	23° (check)		

$(\Delta T, \Delta Y)$ Setiap Garisan

- The rectangular components for each line are computed from the polar coordinates (β, d)

$$\Delta E(D) = d \sin \beta$$

$$\Delta N(L) = d \cos \beta$$

Where

N(L) = Latitude

E(D) = Departure

- Note that these formula apply regardless of the quadrant so long as whole circle bearings are used

Komponen Vektor

Line	Azimuth	Distance	$\Delta N(L)$	$\Delta E(D)$
AB	23°	77.19	71.05	30.16
BC	53°	99.92	60.13	79.80
CD	168°	60.63	-59.31	12.61
DE	227°	129.76	-88.50	-94.90
EA	301°	32.20	16.58	-27.60
			147.76 147.81	122.57 122.50
Σ		(399.70)	(-0.05)	(0.07)

Tikaian Lurus dan Kejituan

- Convert the rectangular misclosure components to polar coordinates

$$\beta = \tan^{-1} \left(\frac{\Delta E(D)}{\Delta N(L)} \right)$$
$$d = \sqrt{\Delta N(L)^2 + \Delta E(D)^2}$$

Beware of quadrant when calculating β using \tan^{-1}

- Accuracy is given by
 $1 : (\text{traverse length} / \text{linear misclosure})$

Contoh

- Misclosure ($\Delta N(L)$, $\Delta E(D)$)
 - $(-0.05, 0.07)$
- Convert to polar (Δ, d)
 - $\Delta = -54.46^\circ$ (2nd quadrant) = 125.53°
 - $d = 0.09$ m
- Accuracy
 - $1:(399.70 / 0.09) = 1:4441$

Contoh

- East Misclose 0.07 M
- North Misclose -0.05 M
- Side AB 77.19 M
- Side BC 99.92 M
- Side CD 60.63 M
- Side DE 129.76 M
- Side EA 32.20 M
- Total Perimeter 399.70 M

Komponen Vektor

(Pre-adjustment)

Side	$\Delta N(L)$	$\Delta E(D)$	$d\Delta N(L)$	$d\Delta E(D)$	$\Delta N(L)_{adj}$	$\Delta E(D)_{adj}$
AB	71.05	30.16				
BC	60.13	79.80				
CD	-59.31	12.61				
DE	-88.50	-94.90				
EA	16.58	-27.60				
	147.76	147.81	122.57	122.50		
Misc	(-0.050)	(0.070)				

Pelajaran Bowditch

- The adjustment to the *easting* component of any traverse side is given by:

$$d\Delta E/W(D) = (\Delta E/W(D)_{\text{misc}} * \text{side length}) / \text{total perimeter}$$

- The adjustment to the *northing* component of any traverse side is given by:

$$d\Delta N/S(L) = (\Delta N/S(L)_{\text{misc}} * \text{side length}) / \text{total perimeter}$$

Pelajaran Bowditch

- The **adjustment** to the *easting* component of any traverse side is given by:

$$\Delta E/W(D)_{adj} = \Delta E/W(D) +/- d\Delta E/W(D)$$

You need to "Plus" if misc is "-",
You need to "Minus" if misc is "+"

- The **adjustment** to the *northing* component of any traverse side is given by:

$$\Delta N/S(L)_{adj} = \Delta N/S(L) +/- d\Delta N/S(L)$$

You need to "Plus" if misc is "-",
You need to "Minus" if misc is "+"

Komponen Vektor

(Pre-adjustment)

Side	$\Delta N(L)$	$\Delta E(D)$	$d\Delta N(L)$	$d\Delta E(D)$	$\Delta N(L)_{adj}$	$\Delta E(D)_{adj}$
AB	71.05	30.16	-0.010	0.014		
BC	60.13	79.80	-0.012	0.016		
CD	-59.31	12.61	-0.008	0.011		
DE	-88.50	-94.90	-0.016	0.023		
EA	16.58	-27.60	-0.004	0.006		
	147.76	147.81	122.57	122.50		
Misc	(-0.050)	(0.070)	(-0.050)	(0.070)		

Komponen Vektor

(Pre-adjustment)

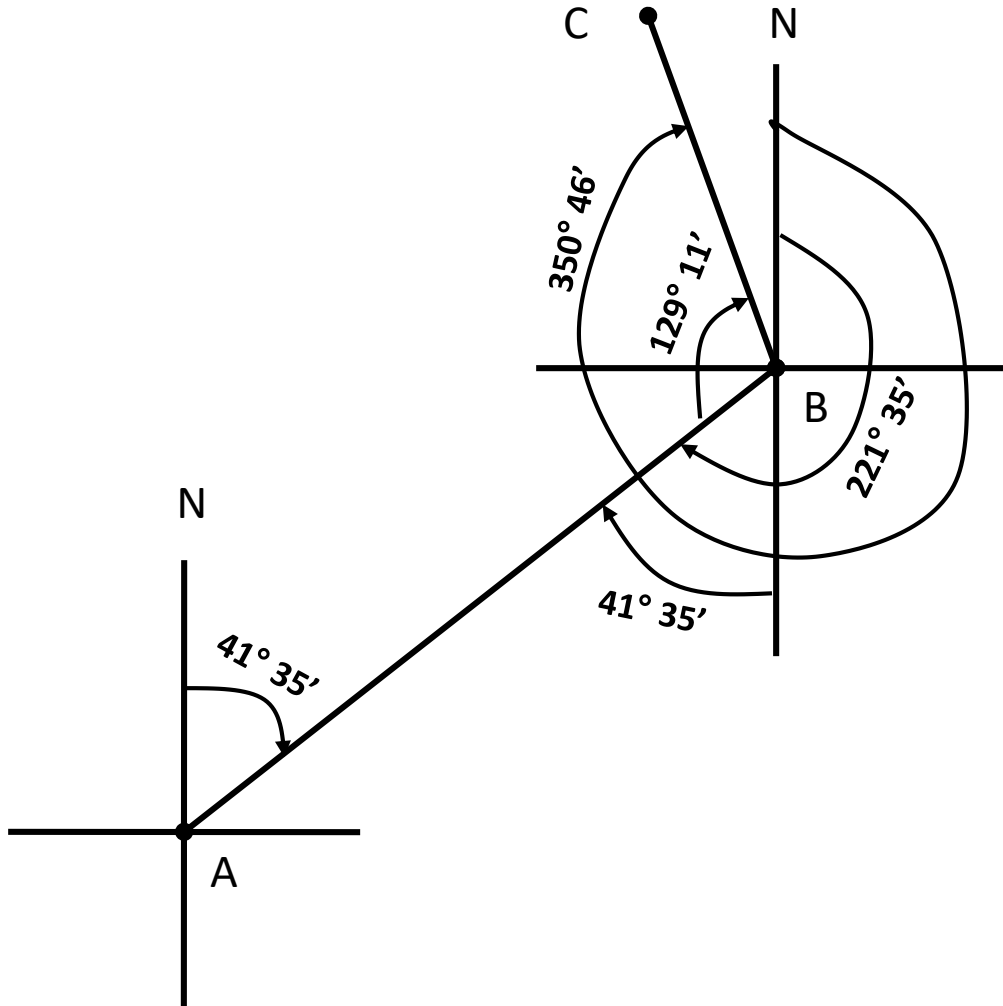
Side	$\Delta N(L)$	$\Delta E(D)$	$d\Delta N(L)$	$d\Delta E(D)$	$\Delta N(L)_{adj}$	$\Delta E(D)_{adj}$
AB	71.05	30.16	-0.010	+0.014	71.060	30.146
BC	60.13	79.80	-0.012	+0.016	60.142	79.784
CD	-59.31	12.61	-0.008	+0.011	-59.302	12.599
DE	-88.50	-94.90	-0.016	+0.023	-88.484	-94.923
EA	16.58	-27.60	-0.004	+0.006	16.584	-27.606
Misc	(-0.050)	(0.070)	(-0.050)	(0.070)	(0.000)	(0.000)

You need to "Plus" if misc is "-"

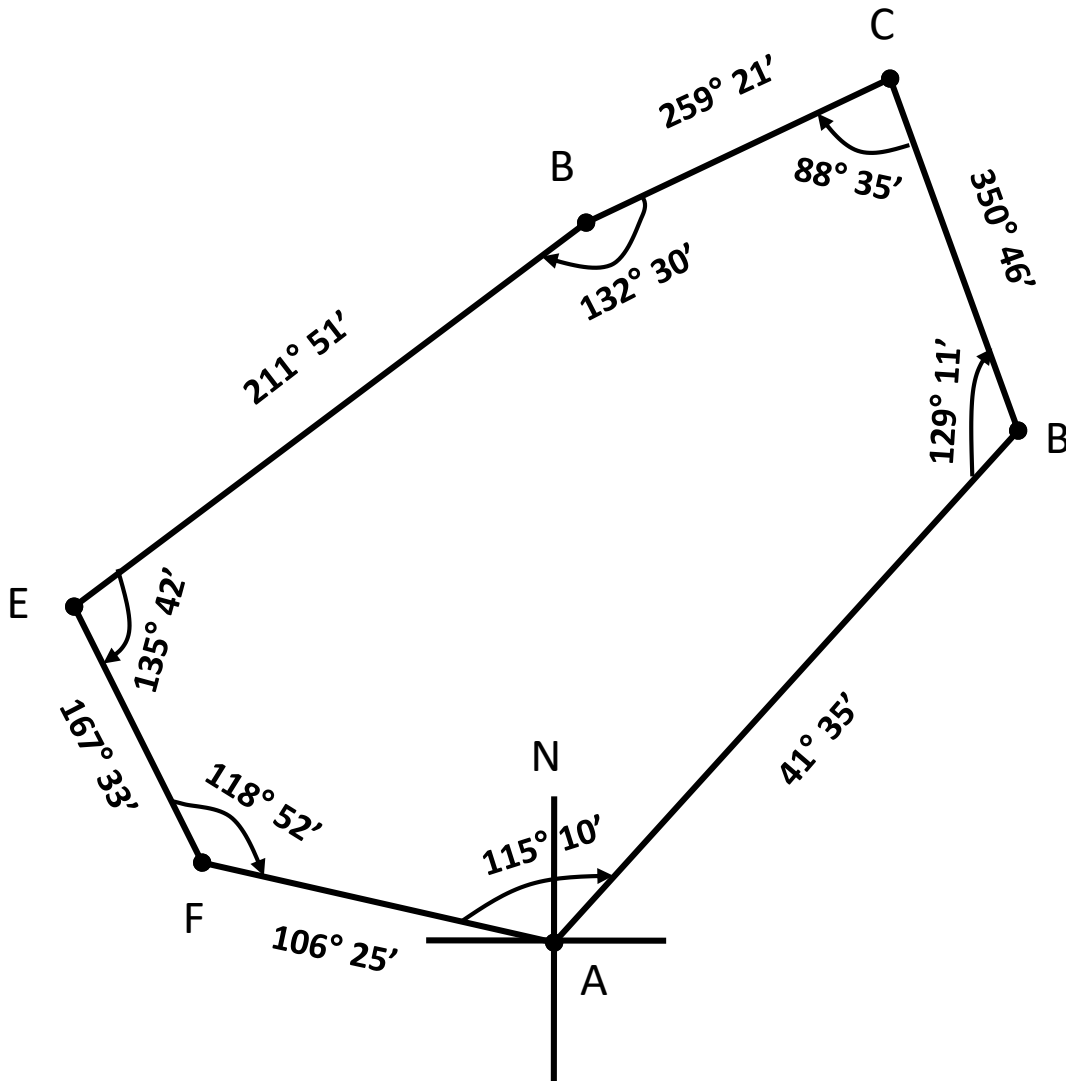
You need to "Minus" if misc is "+"

147.76 147.81 122.57 122.50

Kiraan Bering Belakang dan Hadapan Dengan Satu Garisan Tetap



Kiraan Bering Belakang dan Hadapan Dengan Satu Garisan Tetap



Kiraan Bering Belakang dan Hadapan Dengan Satu Garisan Tetap

Line	Forward Azimuth	Backward Azimuth	Internal Angle
AB	41° 35' (Known)	221° 35'	129° 11'
BC	350° 46'	170° 46'	88° 35'
CD	259° 21'	79° 21'	132° 30'
DE	211° 51'	31° 51'	135° 42'
EF	167° 33'	347° 33'	118° 52'
FA	106° 25'	286° 25'	115° 10'
AB	41° 35' (Check)		

Kiraan Bering Belakang dan Hadapan Dengan Satu Garisan Tetap

$$\begin{array}{r}
 41^{\circ} 35' = \mathbf{AB} \\
 + 180^{\circ} 00' \\
 \hline
 221^{\circ} 35' = \mathbf{BA} \\
 + 129^{\circ} 11' \\
 \hline
 350^{\circ} 46' = \mathbf{BC} \\
 - 180^{\circ} 00' \\
 \hline
 170^{\circ} 46' = \mathbf{CB} \\
 + 88^{\circ} 35' \\
 \hline
 259^{\circ} 21' = \mathbf{CD} \\
 - 180^{\circ} 00' \\
 \hline
 79^{\circ} 21' = \mathbf{DC} \\
 + 132^{\circ} 30' \\
 \hline
 211^{\circ} 51' = \mathbf{DE}
 \end{array}$$

$$\begin{array}{r}
 211^{\circ} 51' = \mathbf{DE} \\
 - 180^{\circ} 00' \\
 \hline
 31^{\circ} 51' = \mathbf{ED} \\
 + 135^{\circ} 42' \\
 \hline
 167^{\circ} 33' = \mathbf{EF} \\
 + 180^{\circ} 00' \\
 \hline
 347^{\circ} 33' = \mathbf{FE} \\
 + 118^{\circ} 52' \\
 \hline
 466^{\circ} 25' - 360^{\circ} \\
 = 106^{\circ} 25' = \mathbf{FA} \\
 + 180^{\circ} 00' \\
 \hline
 286^{\circ} 25' = \mathbf{AF} \\
 + 115^{\circ} 10' \\
 \hline
 401^{\circ} 35' - 360^{\circ} \\
 = 41^{\circ} 35' = \mathbf{AB}
 \end{array}$$

When a computed azimuth exceeds 360° , the correct azimuth is obtained by merely subtracting 360°

Pelarasan Sudut Dalam

- ✓ Sebelum kiraan keluasan sekeping tanah, adalah baik mempunyai satu terabas tutup yang baik.
- ✓ Sudut dalam untuk terabas tertutup adalah:
 - $\Sigma = (n - 2) * 180$
 - Jumlah pembetulan = Σ - jumlah sudut dalam terabas
 - Pembetulan setiap garisan = Jumlah pembetulan / Jumlah sisi
 - Di mana, n = bilangan sisi dalam terabas

Pelarasan Sudut Dalam

Site	Measured Interior Angle	Correction	Adjusted Angle
AB	100° 45' 37"	- 2"	100° 45' 35"
BC	231° 23' 43"	- 2"	231° 23' 41"
CD	17° 12' 59"	- 2"	17° 12' 57"
DE	89° 03' 28"	- 2"	89° 03' 26"
EA	101° 34' 23"	- 2"	101° 34' 21"
	540° 00' 10'	-10"	540° 00' 00

$$\Sigma = (n - 2) * 180 = (5 - 2) * 180 = 540^\circ$$

$$\begin{aligned} \text{Total correction} &= \Sigma - \text{Total angles of traverse} = 540^\circ - 540^\circ 00' 10' \\ &= - 00^\circ 00' 10' \end{aligned}$$

$$\begin{aligned} \text{Each line correction} &= \text{Total correction} / \text{Number of sides} = \\ &= - 00^\circ 00' 10' / 5 = - 00^\circ 00' 02'' \end{aligned}$$

Kesilapan Dalam Latit dan Dipat

- ✓ Apabila latit ditambah bersama, ralat yang terhasil dipanggil ralat dalam latit
- ✓ Apabila dipat ditambah bersama, ralat yang terhasil dipanggil ralat dalam dipat
- ✓ Oleh kerana ada ralat dalam latit dan dipat, azimut dan jarak ada ralat, dengan itu terabas tidak dapat tutupan yang baik.

Tikaian Dalam Latit dan Dipat

Kerana kesilapan dalam cerapan terabas dan jarak. Ralat linear misclosure (e) mewakili jarak dari lokasi sebenar titik 1 ke lokasi pengiraan titik 1.

$$e = \sqrt{(\text{Latitude misclosure})^2 + (\text{Depature misclosure})^2}$$

$$e = \sqrt{(\sum N(L))^2 + (\sum E(D))^2}$$

Tikaian Dalam Latit dan Dipat

- ✓ Ketepatan relatif terabas dinyatakan oleh pecahan yang mempunyai tikaian linear, atau
- ✓ Relative precision = linear misclosure / traverse length
- ✓ Fractional Linear Misclosure (FLM) = $1 \text{ in } D/e$,
Where, D = total distance of survey
 e = linear misclosure

Tikaian Dalam Latit dan Dipat

Site	Azimuth			Length (m)	Uncorrected Departure $\Delta E(D)$	Uncorrected Latitude $\Delta N(L)$
	Degree	Minute	Second			
AB	00°	00'	00''	638.57	0.000	638.570
BC	306°	12'	51''	1576.10	- 1271.620	931.168
CD	195°	54'	06''	3824.10	- 1047.754	- 3677.764
DA	47°	44'	33''	3133.72	2319.361	2107.313
				9172.49	$\Sigma E = - 0.013$	$\Sigma N = - 0.713$

$$e = \sqrt{(\Sigma N(L))^2 + (\Sigma E(D))^2}$$

$$e = \sqrt{(-0.713)^2 + (-0.013)^2}$$

$$e = 0.713 \text{ m}$$

Fractional Linear Misclosure (FLM) = 1 in D/e

FLM = 1 in 9172.49/0.713

FLM = 1 in 12865

$$\Delta E(D) = d \sin \beta$$

$$\Delta N(L) = d \cos \beta$$

Kaedah Perlarasan Terabas

- ✓ Terdapat dua jenis perlarasan terabas:
 - Kaedah Transit
 - Kaedah Bowditch

Pelajaran Transit

- ✓ The adjustment to northing (L) component of any traverse side is given by:

$$N(L)_{adj} = [\text{Misclosure } (\sum N(L)_{misc}) * \text{latitude line (P12)}] / \text{total latitude}$$

- ✓ The adjustment to easting (D) component of any traverse side is given by:

$$E(D)_{adj} = [\text{Misclosure } (\sum E(D)_{misc}) * \text{departure line (P12)}] / \text{total departure}$$

Pelarasan Latit / Dipat

Terdapat 2 kaedah yang digunakan:

Transit Method

- Digunakan untuk terabas di mana kaedah pengukuran sudut mempunyai kejituan yang lebih tinggi daripada kaedah pengukuran jarak.
- Pembetulan adalah berdasarkan nilai latit dan dipat. Correction is based on latitude and departure value. Semakin tinggi nilai latit / dipat, semakin besar nilai pelarasan.

Formula Kaedah Transit

$$\text{Adjustment latitude}_{1-2} = \frac{[\pm \sigma_{\text{Latitude}} \times \text{Latitude Line}_{1-2}]}{\text{Sum of all latitude}}$$

$$\text{Adjustment Departure}_{1-2} = \frac{[\pm \sigma_{\text{Departure}} \times \text{Departure Line}_{1-2}]}{\text{Sum of all departure}}$$

Contoh Kiraan Pelarasan Latit / Dipat (Transit)

Stn	Latit		Dipat		Latit Terlaras	Dipat Terlaras
	U	S	T	B		
3	51.469 +0.001		25.292 -0.003		51.470	25.289
4		30.921 0.000	118.850 -0.012		-30.921	118.838
5		139.667 -0.002		38.740 +0.004	-139.665	-38.744
6	40.825 +0.001			1.210 0.000	40.826	-1.210
1	52.470 +0.001			43.287 +0.005	52.471	-43.292
2	25.819 0.000	0.005		60.875 +0.006	25.819	-60.881
	170.583 +0.003	341.171 -0.002	170.588 -0.015	144.142 +0.015	288.254	144.112
	170.586	170.586	144.127	144.127	0	0

Contoh Pelarasan Latit dan Dipat Menggunakan Kaedah Transit

Pelarasan Latit

$$\begin{aligned}\text{Latit}_1 &= (0.005 \times 51.469) \div 341.171 \\ &= 0.001 \text{ (N less, need to +)}\end{aligned}$$

$$\begin{aligned}\text{Latit}_2 &= (0.005 \times 30.921) \div 341.171 \\ &= -0.000 \text{ (S more, need to -)}\end{aligned}$$

Pelarasan Dipat

$$\begin{aligned}\text{Dipat}_1 &= (0.030 \times 25.292) \div 288.254 \\ &= -0.003 \text{ (E more, need to -)}\end{aligned}$$

$$\begin{aligned}\text{Dipat}_2 &= (0.030 \times 118.850) \div 288.254 \\ &= -0.012 \text{ (W less, need to +)}\end{aligned}$$

Pelarsan Transit

Site	Length (m)	Uncorrected Latitude	Uncorrected Departure	Adjustment Latitude	Adjustment Departure
AB	638.57	638.570	0.000	+0.062	+0.000
BC	1576.10	931.168	-1271.620	+0.090	-0.004
CD	3824.10	-3677.764	-1047.754	-0.357	-0.003
DA	3133.72	2107.313	2319.361	+0.204	+0.006
	9172.49	3677.051	2319.361	0.356	0.006
		-3677.764	-2319.374	-0.357	-0.007
		7354.815	4638.735	3677.406	2319.367
		$\Sigma N = -0.713$	$\Sigma E = -0.013$	-3677.407	-2319.367

$$\text{Adjustment latitude AB} = [-0.713 * 638.570] / 7354.815$$

$$= + 0.062$$

You need to "Plus" if the total N is less than total S,
 You need to "Minus" if the total S is more than total N
 or in the other way.

$$\text{Adjustment departure AB} = [-0.013 * 0] / 4638.735$$

$$= + 0.000$$

Because of the uncorrected latitude N are less than S, so, the adjustment must plus (+) or in the other way.

Pelajaran Bowditch

- ✓ The adjustment to northing component of any traverse side is given by:

$$N(L)_{adj} = [\text{Misclosure } (\sum N(L)_{misc}) * \text{length of line}] / \text{total traverse length}]$$

- ✓ The adjustment to easting component of any traverse side is given by:

$$E(D)_{adj} = [\text{Misclosure } (\sum E(D)_{misc}) * \text{length of line}] / \text{total traverse length}]$$

Pelajaran Bowditch

- The adjustment to the *easting* component of any traverse side is given by:

$$d\Delta E/W(D) = (\Delta E/W(D)_{\text{misc}} * \text{side length}) / \text{total perimeter}$$

- The adjustment to the *northing* component of any traverse side is given by:

$$d\Delta N/S(L) = (\Delta N/S(L)_{\text{misc}} * \text{side length}) / \text{total perimeter}$$

Pelajaran Bowditch

- The **adjustment** to the *easting* component of any traverse side is given by:

$$\Delta E/W(D)_{adj} = \Delta E/W(D) +/- d\Delta E/W(D)$$

You need to "Plus" if misc is "-",
You need to "Minus" if misc is "+"

- The **adjustment** to the *northing* component of any traverse side is given by:

$$\Delta N/S(L)_{adj} = \Delta N/S(L) +/- d\Delta N/S(L)$$

You need to "Plus" if misc is "-",
You need to "Minus" if misc is "+"

Pelarsan Bowditch

Site	Length (m)	Uncorrected Latitude	Uncorrected Departure	Adjustment Latitude	Adjustment Departure
AB	638.57	638.570	0.000	+0.050	+ 0.001
BC	1576.10	931.168	-1271.620	+0.123	-0.002
CD	3824.10	-3677.764	-1047.754	-0.297	-0.005
DA	3133.72	2107.313	2319.361	+0.244	+ 0.004
	9172.49	3677.051	2319.361	0.417	0.005
		-3677.764	-2319.374	-0.297	-0.007
		7354.815	4638.735	3677.468	2319.366
		$\Sigma N = -0.713$	$\Sigma E = -0.013$	-3677.467	-2319.367

Adjustment latitude AB = $[-0.713 * 638.57] / 9172.49$

= + 0.050

You need to "Plus" if the total N is less than total S,
 You need to "Minus" if the total S is more than total N
 or in the other way.

Adjustment departure AB = $[-0.013 * 638.57] / 9172.49$

= + 0.001

Because of the uncorrected latitude N are less than S, so, the adjustment must plus (+) or in the other way.

Pelarsan Bowditch

Site	Uncorrected Latitude	Uncorrected Departure	Adjustment Latitude	Adjustment Departure	Corrected Latitude	Corrected Departure
AB	638.570	0.000	+0.050	+0.001	638.620	0.001
BC	931.168	-1271.620	+0.123	-0.002	931.291	-1271.618
CD	-3677.764	-1047.754	-0.297	-0.005	-3677.467	-1047.749
DA	2107.313	2319.361	+0.244	+0.004	2107.557	2319.365
	$\sum N = -0.713$	$\sum E = -0.013$	+0.417 -0.297	+0.005 -0.007	0.001	0.001

Pelarasan Latit / Dipat

Bowditch Method

- Digunakan untuk terabas di mana kaedah pengukuran sudut hampir sama dengan kaedah pengukuran jarak.
- Pembetulan adalah berdasarkan panjang garisan. Semakin panjang garisan, semakin besar nilai pelarasan

Formula Kaedah Bowditch

$$\text{Adjustment latitude}_{1-2} = \frac{[\pm \sigma_{\text{Latitude}} \times \text{Distance Line}_{1-2}]}{\text{Total Distance}}$$

$$\text{Adjustment Departure}_{1-2} = \frac{[\pm \sigma_{\text{Departure}} \times \text{Distance Line}_{1-2}]}{\text{Total Distance}}$$

Contoh Kiraan Pelarasan Latit / Dipat (Bowditch)

Stn	Latit		Dipat		Latit Terlaras	Dipat Terlaras
	U	S	T	B		
3	51.469 +0.001		25.292 -0.003		51.470	25.289
4		30.921 -0.001	118.850 -0.007		-30.920	118.843
5		139.667 -0.001		38.740 +0.009	-139.666	-38.749
6	40.825 0.000			1.210 +0.003	40.825	-1.213
1	52.470 +0.001			43.287 +0.004	52.471	-43.291
2	25.819 +0.001			60.875 +0.004	25.820	-60.879
	170.583 +0.003	341.171 -0.002	170.588 -0.010	144.142 +0.020	288.254	144.112
	170.586	170.586	144.132	144.132	0	0

Contoh Pelarasan Latit dan Dipat Menggunakan Kaedah Bowditch

Pelarasan Latit

$$\text{Latit}_1 = [0.005 \times 57.348] \div 500.083 \\ = + 0.001 \text{ (N less, need to +)}$$

$$\text{Latit}_2 = [0.005 \times 122.807] \div 500.083 \\ = - 0.001 \text{ (S more, need to -)}$$

Pelarasan Dipat

$$\text{Dipat}_1 = [0.030 \times 57.348] \div 500.083 \\ = - 0.003 \text{ (E more, need to -)}$$

$$\text{Dipat}_2 = [0.030 \times 122.807] \div 500.083 \\ = - 0.007 \text{ (W less, need to +)}$$

Langkah Ketiga

Sebelum pengiraan seterusnya dilakukan, pelarasan terhadap latit dan dipat perlu dibuat. Ada dua kaedah yang boleh digunakan iaitu,

- Kaedah Bowditch
- Kaedah Transit

1. Kaedah Bowditch

$$\text{Pembetulan Latit} = + (\text{Selisih Latit} \times \text{Jarak Garisan}) \div \text{Jumlah jarak}$$

$$\text{Pembetulan Dipat} = + (\text{Selisih Dipat} \times \text{Jarak Garisan}) \div \text{Jumlah jarak}$$

2. Kaedah Transit

$$\text{Pembetulan Latit} = + (\text{Selisih Latit} \times \text{Latit Garisan}) \div \text{Jumlah Latit}$$

$$\text{Pembetulan Dipat} = + (\text{Selisih Dipat} \times \text{Dipat Garisan}) \div \text{Jumlah Dipat}$$

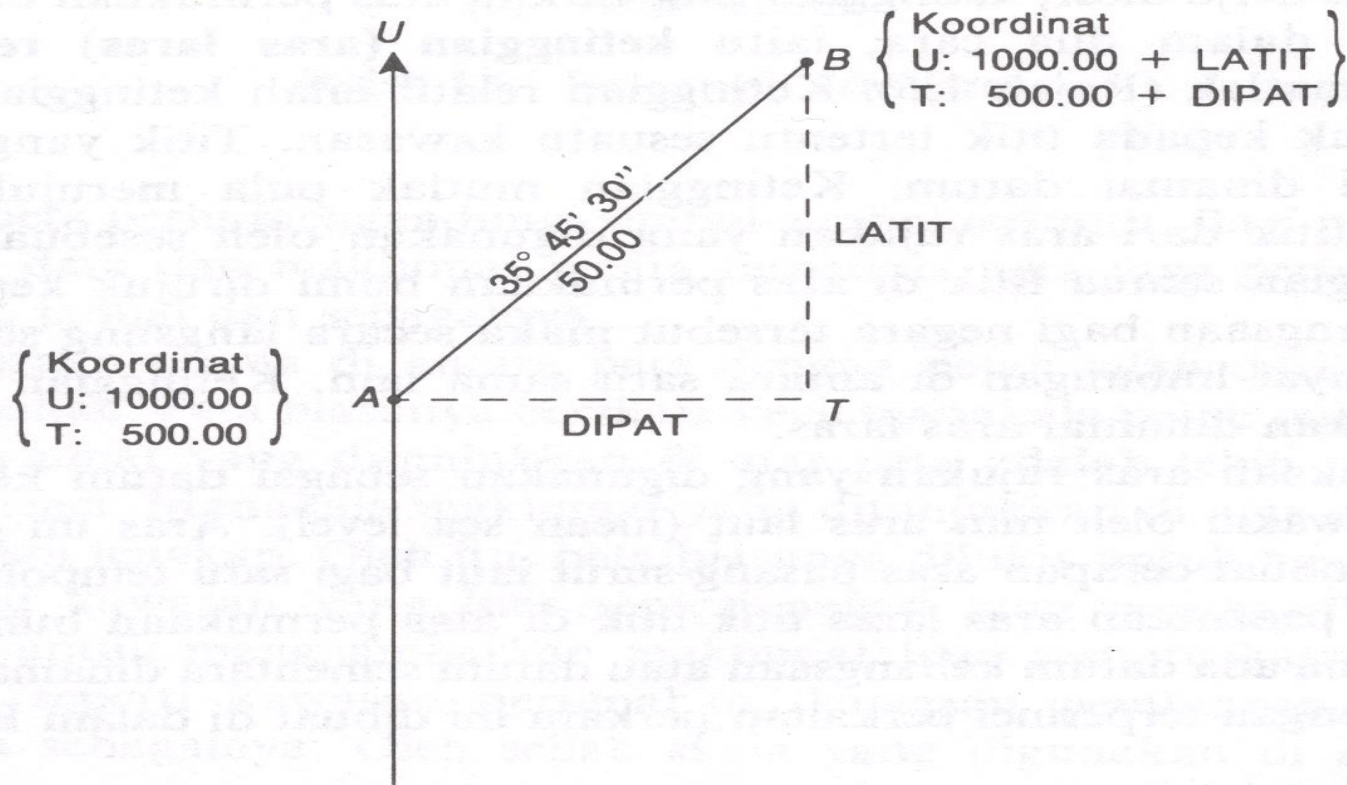
Untuk menentukan samada nilai pembetulan negatif atau positif, rujuk jadual dibawah.

Perkara	Pembetulan Latit		Pembetulan Dipat	
	Utara	Selatan	Timur	Barat
J.L.U > J.L.S	-ve	+ve		
J.L.S > J.L.U	+ve	-ve		
J.D.T > J.D.B			-ve	+ve
J.D.B > J.D.T			+ve	-ve

Hitungan Koordinat

- Koordinat sesuatu titik dapat ditentukan jika titik tersebut mempunyai hubungan bering dan jarak dengan titik lain yang mempunyai koordinat.
- Dengan mengetahui nilai latit dan dipat di antara dua titik tersebut, koordinat titik kedua dapat ditentukan.
- Sekiranya koordinat titik 1 (U_1, T_1) diketahui, maka ;
 - Utara₂ = Utara₁ + Latit₁₋₂ , Timur₂ = Timur₁ + Dipat₁₋₂
 - Utara₃ = Utara₂ + Latit₂₋₃ , Timur₃ = Timur₂ + Dipat₂₋₃

Hitungan Koordinat



Dengan mengetahui Koordinat stesen A dan bearing serta jarak garisan A – B diketahui maka koordinat stesen B boleh ditentukan apabila nilai latit dan dipat dihitung bagi garisan tersebut.

BORANG HITUNGAN

Pengiraan Tikaian Lurus dan Hitungan Koordinat



Stn	Bering	Jarak	Rujukan	Latit		Dipat		2 Kali Latit	2 Kali Dipat	Koordinat	
				U (+)	S (-)	T (+)	B (-)			U/S	T/B
A										1000	500
B	35 45 30	50.000		40.574		29.218				1040.574	529.218

Contoh Pembukuan Hitungan Koordinat

Stn	Latit Dilaras	Dipat Dilaras	Koordinat	
			U / S	T / B
2			500.000	700.000
3	51.470	25.289	551.470	725.289
4	-30.920	118.843	520.550	844.132
5	-139.666	-38.749	380.884	805.383
6	40.825	-1.213	421.709	804.170
1	52.471	-43.291	474.180	760.879
2	25.820	-60.879	500.000	700.000

$$\begin{aligned}
 U_3 &= 500.000 + 51.470 \\
 &= \mathbf{551.470} \\
 T_3 &= 700 + 25.289 \\
 &= \mathbf{725.289}
 \end{aligned}$$

HITUNGAN KELUASAN

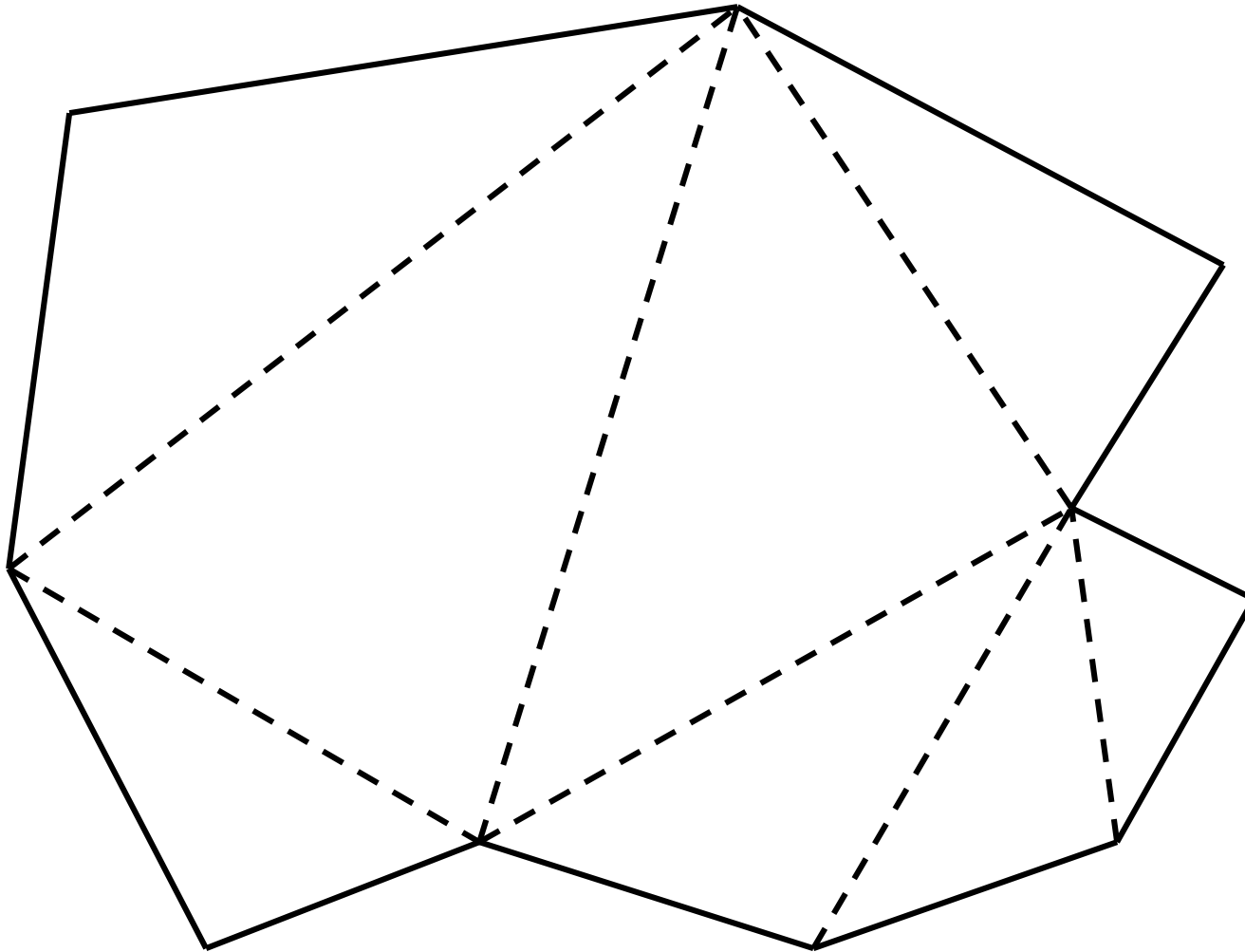
Kepentingan Penentuan Keluasan

- Menentukan Kawasan dalam hakmilik
- Menentukan Kawasan berkepentingan
- Menentukan keluasan untuk anggaran bahan keperluan

Kaedah Pengiraan Keluasan

- Bahagikan Keluasan tersebut ke dalam triangles, rectangles and trapezoids yang ringkas.
- Ofset daripada garis lurus.
- Double meridian distances
- Rectangular coordinates

Gambaran Ringkas



Pengiraan Keluasan Dengan Triangulation

Jika diketahui ketiga-tiga Panjang sisi

□ $\text{Area} = \sqrt{s(s - a)(s - b)(s - c)}$

□ di mana:

a, b dan c = sisi segitiga dan

$$S = \frac{1}{2} (a + b + c)$$

Pengiraan Keluasan Dengan Triangulation

Jika diketahui panjang dua sisi dan sudut di antara dua sisi tersebut

□ $\text{Area} = \frac{1}{2} ab \sin C$

□ di mana:

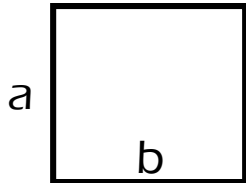
C = sudut antara sisi a dan sisi b

Pengiraan Keluasan Dengan Triangulation

- Boleh menggunakan campuran pelbagai kaedah untuk mendapatkan keluasan.
- Dengan terabas, boleh dapat perimeter dan sudut dalaman.
- Boleh mengambil ukuran sudut tambahan atau ukuran jarak tambahan semasa berada di lapangan untuk memudahkan pengiraan

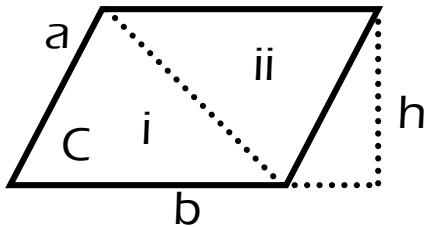
Hitungan Keluasan

Segi Empat Mudah



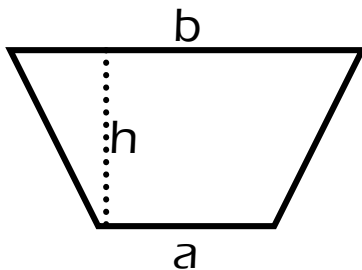
Segi Empat Tepat

$$\begin{aligned}\text{Luas, } A &= \text{Panjang} \times \text{Lebar} \\ &= a \times b\end{aligned}$$



Segi Empat Selari → Dipecah kepada 2 segitiga

$$\begin{aligned}\Delta i &= \frac{1}{2} ab \sin C \\ \Delta ii &= \frac{1}{2} ab \sin C \\ \text{Luas, } A &= \Delta i + \Delta ii \\ &= ab \sin C\end{aligned}$$



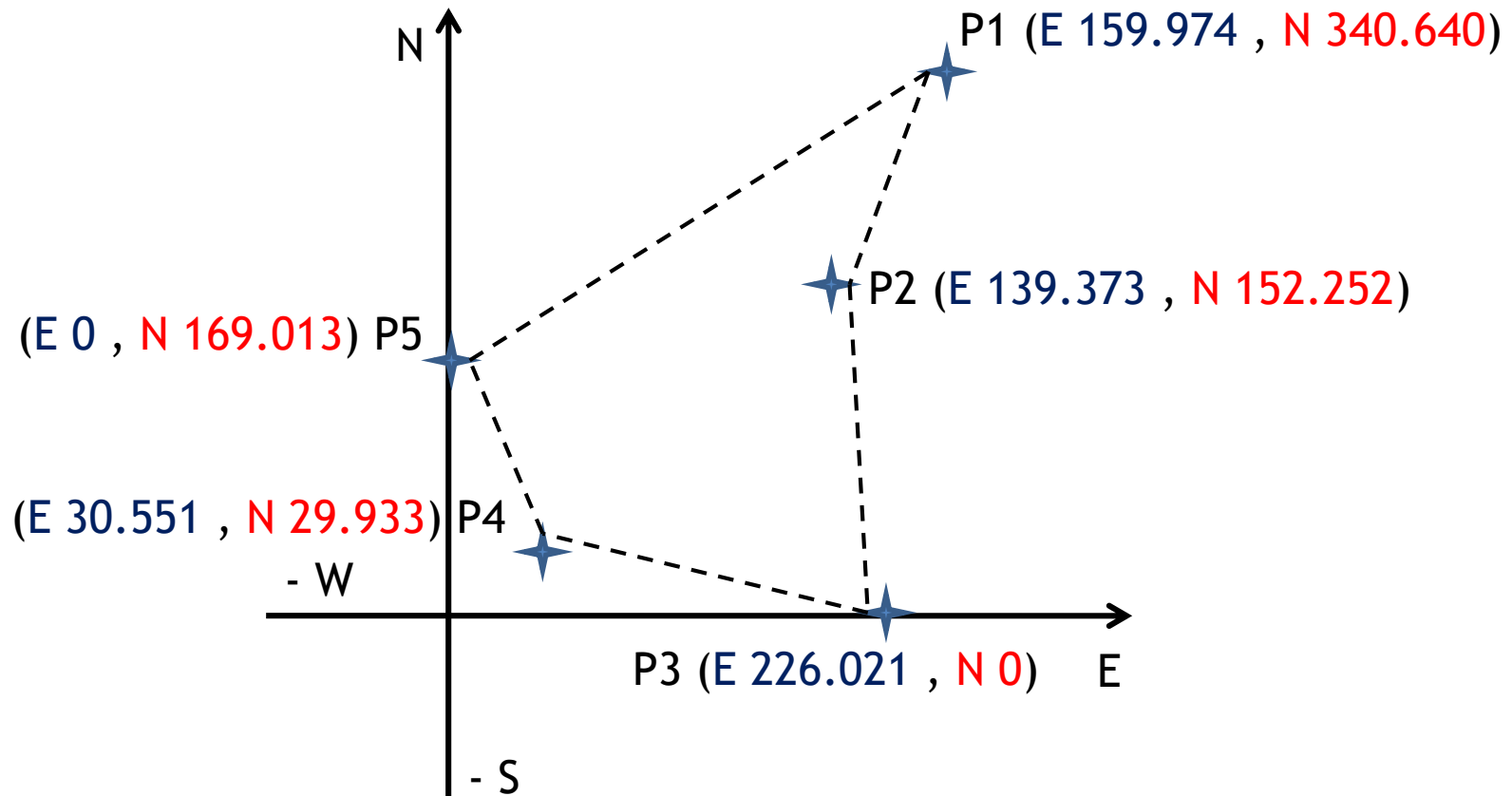
Trapezium

$$\text{Luas, } A = \frac{1}{2} \times (a + b) \times h$$

Hitungan Keluasan Dengan Koordinat

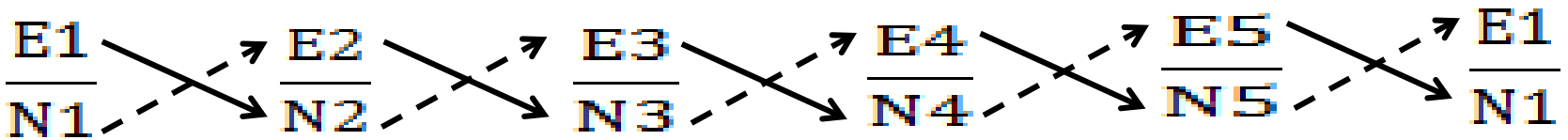
Luas tutupan terabas boleh dikira dengan mengambil setiap koordinat N dikali dengan perbezaan dalam dua koordinat E bersebelahan (menggunakan konvensyen + untuk sisi sebelah dan – untuk sisi terakhir).

Hitungan Keluasan Dengan Koordinat



Hitungan Keluasan Dengan Koordinat

□ Terdapat variasi mudah kaedah koordinat untuk pengiraan luas.



$$\text{Sum 1} = E_1N_2 + E_2N_3 + E_3N_4 + E_4N_5 + E_5N_1$$

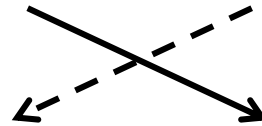
$$\text{Sum 2} = N_1E_2 + N_2E_3 + N_3E_4 + N_4E_5 + N_5E_1$$

Hitungan Keluasan Dengan Koordinat

- ❑ Senarai T dan U dalam 2 baris.
- ❑ Ulangi kiraan secara bersilang sehingga akhir.
- ❑ Sum the products designated by arrows
 - Left to right (minus sign)
 - Right to left (plus sign)
 - Difference between the two sums = twice the area
 - Careful with the W & S.....must consider the '-ve' in the value.

Hitungan Keluasan Dengan Koordinat

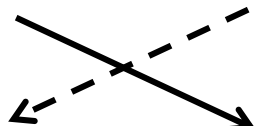
P1 (E 159.974 , N 340.640)



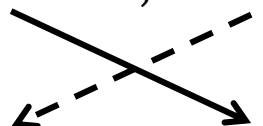
P2 (E 139.373 , N 152.253)



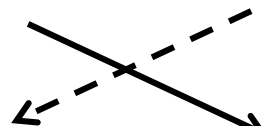
P3 (E 226.021 , N 0)



P4 (E 30.551 , N 29.933)



P5 (E 0 , N 169.013)



P1 (E 159.974 , N 340.640)

Hitungan Keluasan Dengan Koordinat

$$\text{Sum 1} = 159.974 (152.253) + 139.373 (0) + 226.021 (29.933) + 30.551 (169.013) + 0 (340.640) = 36285.364$$

$$\text{Sum 2} = 340.640 (139.373) + 152.252 (226.021) + 0 (30.551) + 29.933 (0) + 169.013 (159.974) = 108925.854$$

Subtract the smaller sum from the larger sum (since it doesn't make any sense to have a negative area)

So:

$$\begin{aligned} 2 \text{ (Area)} &= \text{Sum 1} - \text{Sum 2} \text{ or } \text{Sum 2} - \text{Sum 1} \\ &= 108925.854 - 36285.364 = 72640.490 \end{aligned}$$

Remember that this is equal to **twice** the area, so divide this number by 2

$$72640.490 / 2 = 36320.245 \text{ m}^2$$

Hitungan Keluasan dengan Dua Kali Latit x Dipat atau Dua Kali Dipat x Latit

Penggunaan Maklumat Terabas

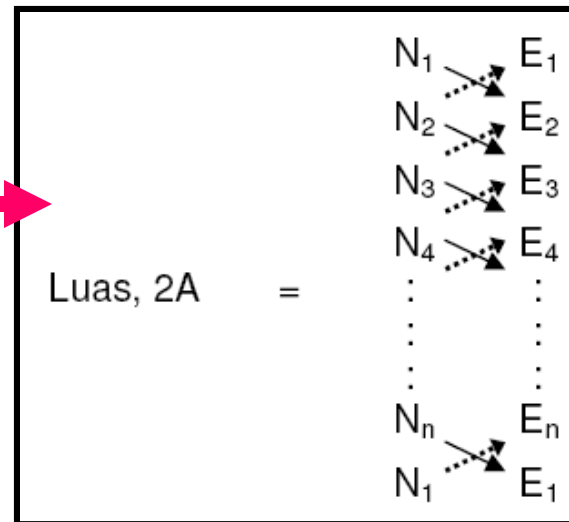
- Latit, Dipat & Koordinat
- Terdapat 2 kaedah:-
 - Kaedah Koordinat
 - Kaedah Latit dan Dipat
 - Kaedah Jumlah Latit & Jumlah Dipat
 - Kaedah Dua Kali Latit x Dipat @ Dua Kali Dipat x Latit

Hitungan Keluasan dengan Dua Kali Latit x Dipat atau Dua Kali Dipat x Latit

Kaedah Koordinat

- Latit, ΔN = Perbezaan Koordinat Utara/Selatan
= Jarak x cos bering
- Dipat, ΔE = Perbezaan Koordinat Timur/Barat
= Jarak x sin bering
- Andaikan Koordinat titik 1 diketahui, $N_1 E_1$

$$\begin{array}{l}
 N_2 = N_1 + \text{Latit}_1 \\
 E_2 = E_1 + \text{Dipat}_1 \\
 N_3 = N_2 + \text{Latit}_2 \\
 E_3 = E_2 + \text{Dipat}_2 \\
 N_4 = N_3 + \text{Latit}_3 \\
 E_4 = E_3 + \text{Dipat}_3 \\
 \vdots \quad \quad \quad \vdots \\
 \vdots \quad \quad \quad \vdots \\
 N_n = N_{n-1} + \text{Latit}_n \\
 E_n = E_{n-1} + \text{Dipat}_n
 \end{array}$$



$$2A = (N_1 E_2 + N_2 E_3 + N_3 E_4 \dots + N_n E_1) - (N_2 E_1 + N_3 E_2 + N_4 E_3 \dots + N_1 E_n)$$

$$\text{Keluasan, } A = \frac{1}{2} [(N_1 E_2 + N_2 E_3 + N_3 E_4 \dots + N_n E_1) - (N_2 E_1 + N_3 E_2 + N_4 E_3 \dots + N_1 E_n)]$$

Hitungan Keluasan dengan (Dua Kali Latit Kali Dipat atau Dua Kali Dipat Kali Latit)

- Kaedah hitungan luas yang biasa digunakan oleh JUPEM adalah Dua Kali Latit x Dipat atau Dua Kali Dipat x Latit.
- Cara hitungan (menggunakan Dua Kali Latit x Dipat) ;
 - **Dua Kali Latit 1** = Latit 1
 - **Dua Kali Latit 2** = **Dua Kali Latit 1** + Latit 1 + Latit 2
 - **Dua Kali Latit 3** = **Dua Kali Latit 2** + Latit 2 + Latit 3
- Setelah selesai, Dua Kali Latit setiap garisan tersebut dikalikan (x) dengan Dipat bagi garisan tersebut.

...Sambungan

- Kemudian jumlahkan dan dibahagikan dengan 2

$$\text{Luas} = \frac{\text{Jumlah (Dua Kali Latit x Dipat)}}{2}$$

- Semakan perlu dibuat kerana sebarang kesilapan akan memberi kesan kepada hitungan.
- Nilai Dua Kali Latit x Dipat yang terakhir mestilah sama dengan nilai Dua Kali Dipat x Latit titik tersebut tetapi berlawanan tanda.
- $\sum \text{Dua Kali Latit x Dipat} = \sum \text{Dua Kali Dipat x Latit}$

Contoh Pembukuan Hitungan Keluasan

Stn	Latit Dilaraskan	Dipat Dilaraskan	Dua Kali Latit	Dua Kali Dipat	Dua Kali Latit x Dipat	Dua Kali Dipat x Latit
2						
3	51.470	25.289	51.470	25.289	1301.6248	1301.6248
4	-30.920	118.843	72.020	169.421	8559.0729	-5238.4973
5	-139.666	-38.749	-98.566	249.515	3819.3340	-34848.7620
6	40.825	-1.213	-197.407	209.553	239.4547	8555.0012
1	52.471	-43.291	-104.111	165.049	4507.0693	8660.2861
2	25.820	-60.879	-25.820	60.879	1571.8958	1571.8958
					19998.4515	-19998.4515
				/2	9999.2257	-9999.2257

Luas = $9999.2257m^2$ atau 2.471 ekar

Borang Latit/Dipat

Dr - Ke	Bering	Jarak	Latit		Dipat		2 x Latit	2 x Dipat	Kodinit	
			Utara	Selatan	Timur	Barat			U / S	T / B

Lat = L Cos θ Atau: Shift (-) (Rec L, θ) =
Dip = L Sin θ Atau: Alpha Tan =

Unit Pengukuran (Jarak & Keluasan)

Table 20

CONVERSION FACTORS and other constants

km = kilometres ; m = metres ; cm = centimetres .

1 mile = 1.609341 km	1 m = 0.000914401 mile
1 chain = 20.116665 m	1 km = 0.621372 mile
1 link = 0.201168 m	1 km = 49.709781 chains
1 yard = 0.914398 m	1 m = 1.093615 yards
1 foot = 0.304799 m	1 m = 3.280845 feet
1 inch = 2.539996 cm	1 m = 39.370147 inches (a)
	1 m = 4.970975 links
	1 cm = 0.393701 inch

(a) Determined by Sears, Johnson & Jolly in 1927.

1 mile = 80 chains = 5280 feet
 1 link = 7.92 inches (very accurate)
 1 kilogram = 2.204622 pounds
 1 pound = 0.453592 kilogram

1 acre = 4840 sq. yds. = 43560 sq. ft. = 10 sq. chs.
 1 sq. ch. = 484 sq. yds. = 4356 sq. ft.
 1 sq. link = 0.4356 sq. ft. = 62.7264 sq. inches
 1 acre = 1 ch. x 10 chs. = 2 chs. x 5 chs. = 3 chs. x 3.3333 chs.
 1 acre = 208.71 ft. x 208.71 ft.
 1/2 acre = 147.581 ft. x 147.581 ft.
 1/4 acre = 104.355 ft. x 104.355 ft.

π = 3.1415926536

Sin 1" = 0.0000048481

Log Sin 1" = 4.6855748668

Earth,	Equatorial Radius = 3963.35 miles
"	Polar Radius = 3950.01 "
"	Mean Radius = 3958.90 "

1 acre = 0.40469 hectare (»0.4 hectare)
 1 acre = 4046.86 meter sq
 1 acre = 43560 ft sq
 1 hectare = 2.471 acres (»2.5 acres)
 2/5 hectare = 0.988 acres (»1 acre)
 1 hectare = 9999.7976 meter sq
 1 feet sq = 0.092903 meter sq
 1 feet sq = 2.29568430602 acres
 6300 feet sq = 0.1446 acre
 1 meter sq = 10.7639 feet sq
 1 square centimetre = 0.1550 square inches
 1 square metre = 1.1960 square yards
 1 hectare = 2.4711 acres
 1 square kilometre = 0.3861 square miles
 1 square inch = 6.4516 square centimetres
 1 square foot = 0.0929 square metres
 1 square yard = 0.8361 square metres
 1 acre = 4046.9 square metres
 1 inch = 2.54 centimetres (cm)
 1 foot (ft) = 12 inches (in) = 0.3048 metre (m)
 1 yard (yd) = 3 ft = 0.9144 m
 1 mile = 1,760 yd = 1.60934 kilometres (km)
 1 int nautical mile = 2025.4 yd = 1852 m
 1 centimetre (cm) = 10 millimetres (mm) = 0.3937 in
 1 m = 100 cm = 1.0936 yd / 3.38 ft / 39.37 in
 1 kilometre (km) = 1000 m = 0.62137 mile / 5/8ths of a mile
 1 in² = 645.16 mm²
 1 yd² = 9 ft² = 0.8361 m²
 1 acre = 4,840 yd² = 4046.86 m² / 0.405 hectare
 1 mile² = 640 acres = 2.590 km²
 1 cm² = 100 mm² = 0.1550 in²
 1 metre² square = 10,000 cm² = 1.1960 yd²
 1 hectare (ha) = 10,000 m² = 2.471 acres
 1 km² = 100 ha = 0.3861 mile²

Handwritten notes:
 1 ac = 4 rods = 160 paces
 1 rod = 40 paces
 1 chain = 20.1168 m

Unit Pengukuran (Jarak & Keluasan)

1 link	=	0.201168 metres
1 metre	=	4.9709695 links
1 metre	=	3.2808399 feet
1 sq.m	=	24.710538 sq.links
1 sq.m	=	10.763910 sq.feet
1 Ha	=	2.471054 ekar
1 ekar	=	0.404686 hectar
1 ekar	=	4046.86 sq.metre
1 ekar	=	43560 sq.feet
1 metre	=	39.37 inches
1 inch	=	2.54 cm
1 km	=	0.62 miles
1 miles	=	1.609344 km
1 sq.ft	=	0.092903 sq.metre
1 R	=	0.101171 Ha
1 P	=	272.25 sq.ft
1 P	=	0.002529 Ha
Conversion		3A 2R 35P
35r/40	=	0.875
0.875+2	=	2.875
2.875/40	=	0.71875
0.71875+3	=	3.71875
OR		
3.71875-3	=	0.71875
0.71875x4	=	2.875
2.875-2	=	0.875
0.875x40	=	35

HITUNGAN ARAS LARAS

Hitungan Aras Laras

- Aras sesuatu titik dapat ditentukan jika titik di tempat alat total station didirikan mempunyai nilai aras yang diketahui.
- Tinggi alat total station dan tinggi target (prizam) perlu dicatatkan
- Bacaan jarak tegak perlu dicatat atau dikira
- Contoh formula :
$$AL \text{ titik} = AL \text{ stesen} + HI \pm v - s$$

Di mana,
AL = aras laras
HI = tinggi alat (total station)
v = jarak tegak
s = tinggi target (prizam)

Contoh Hitungan Aras Laras

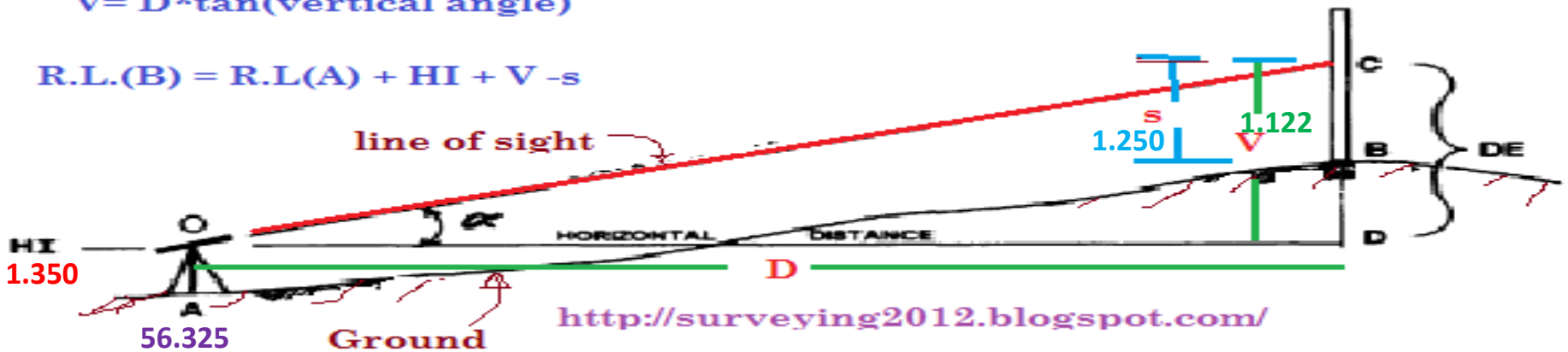
Formula:

$$\text{AL titik} = \text{AL stesen} + \text{HI} \pm v - s$$

$$\begin{aligned} \text{AL titik} &= 56.325 + 1.350 + 1.122 - 1.250 \\ &= 57.547 \end{aligned}$$

$$V = D \cdot \tan(\text{vertical angle})$$

$$\text{R.L.}(B) = \text{R.L.}(A) + \text{HI} + V - s$$



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Figure. Trigonometric leveling

THANK YOU