



Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 2

Part1: Horizontal Tapping Over Uneven or Sloping Ground

Part2: Measuring The Sides & The Diagonals of A Quadrilateral

Name: EYAD MONTHER ASHI

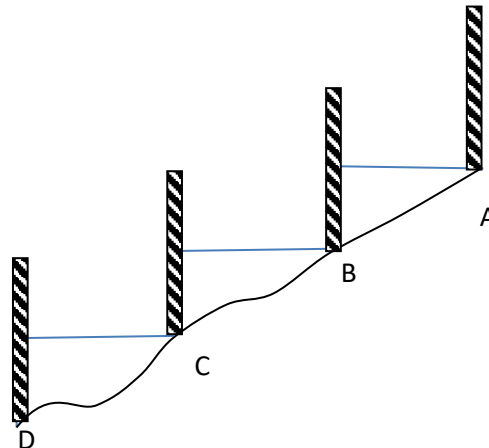
No.: 1430018

Sunday 9/10/2016

Group 2

Part1: Horizontal Tapping Over Uneven Or Sloping Ground

	FWD	BWD
AB	1.60 m	1.59 m
BC	1.59 m	1.58 m
CD	1.20 m	1.21 m



❖ **Total Horizontal Distance:**

- FWD = 4.39 m
- BWD = 4.38 m

❖ **Average Horizontal Distance:**

$$\text{Average Horizontal Distance} = \frac{FWD+BWD}{2} = \frac{(4.39+4.38)}{2} = 4.385 \text{ m}$$

❖ **Error** = | AD – DA | = 4.39 – 4.38 = 0.01

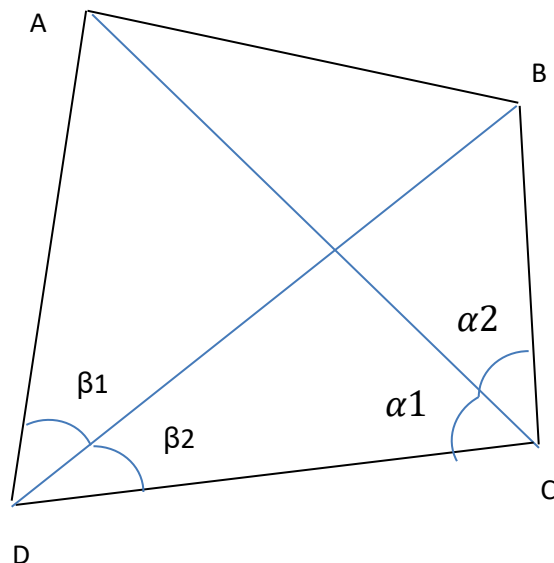
❖ **Accuracy Relative**

$$\text{Accuracy Relative To AD} = \frac{\text{error}}{AD} = \frac{0.01}{4.39} = 1/439$$

$$\text{Accuracy Relative To DA} = \frac{\text{error}}{DA} = \frac{0.01}{4.38} = 1/438$$

Part2 :Measuring The Sides & The Diagonals Of A Quadrilateral

	FWD	BWD	AVG.
AB	2.9m	2.85m	2.875m
BC	2.64m	2.61m	2.625m
CD	2.77m	2.78m	2.775m
DA	3.62m	3.64m	3.63m
AC	3.85m	3.86m	3.855m
BD	4.35m	4.33m	4.34m



❖ α_1 AND α_2 :

$$(DA)^2 = (CD)^2 + (AC)^2 - 2 (CD)(AC) \cos \alpha_1$$

$$(3.63)^2 = (2.775)^2 + (3.855)^2 - 2(2.775)*(3.855)\cos \alpha_1$$

$$\alpha_1 = 63.98$$

$$(AB)^2 = (BC)^2 + (AC)^2 - 2 (BC)(AC) \cos \alpha_2$$

$$(2.875)^2 = (2.625)^2 + (3.855)^2 - 2(2.625)*(3.855)\cos \alpha_2$$

$$\alpha_2 = 48.21$$

❖ β_1 AND β_2 :

$$(AB)^2 = (DA)^2 + (BD)^2 - 2 (DA)(BD) \cos \beta_1$$

$$(2.875)^2 = (3.63)^2 + (4.34)^2 - 2(3.63)*(4.34)\cos \beta_1$$

$$\beta_1 = 40.67$$

$$(BC)^2 = (CD)^2 + (BD)^2 - 2 (DA)(BD) \cos \beta_2$$

$$(2.625)^2 = (2.775)^2 + (4.34)^2 - 2(2.775)*(4.34)\cos \beta_2$$

$$\beta_2 = 35.35$$

❖ Diagonals length ...

$$\alpha_3 = \alpha_1 + \alpha_2 = 112.19$$

$$\beta_3 = \beta_1 + \beta_2 = 76.02$$

$$(AC)^2 = (CD)^2 + (DA)^2 - 2 (CD)(AD) \cos \beta_3$$

$$(AC)^2 = (2.775)^2 + (3.63)^2 - 2(2.775)(3.63)\cos(76.02)$$

$$\underline{AC = 4.00 \text{ m}}$$

$$(BD)^2 = (CD)^2 + (BC)^2 - 2 (DC)(BC) \cos \alpha_3$$

$$(BD)^2 = (2.625)^2 + (2.775)^2 - 2(2.775)(2.625)\cos(112.19)$$

$$\underline{BD = 4.480 \text{ m}}$$

❖ Diagonals Error ...

$$\text{error BD} = |\text{BD}_{\text{exp.}} - \text{BD}_{\text{calc.}}| = |4.34 - 4.480| = 0.14$$

$$\text{error AC} = |\text{AC}_{\text{exp.}} - \text{AC}_{\text{calc.}}| = |3.855 - 4.00| = 0.145$$

❖ Diagonals Accuracy ...

$$\text{accuracy BD} = \frac{\text{error}}{\text{BD}_{\text{calc.}}} = \frac{0.14}{4.480} = \frac{1}{32} = 0.03125$$

$$\text{accuracy AC} = \frac{\text{error}}{\text{AC}_{\text{calc}}} = \frac{0.145}{4.00} = \frac{1}{27.58} = 0.03625$$



Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 3

Horizontal Control for Mapping by Linear Measurements

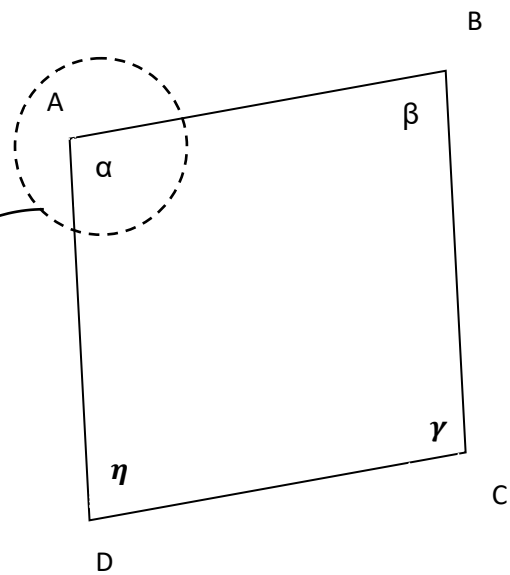
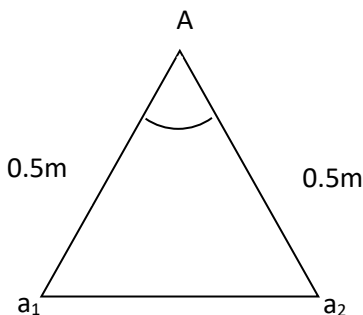
Name: EYAD MONTHER ASHI

No.: 1430018

Sunday 9/10/2016

Group 2

-----	Length (m)
AB	2.9
BC	2.64
CD	2.77
DA	3.62
a_1, a_2	0.7
b_1, b_2	0.78
c_1, c_2	0.85
d_1, d_2	0.60



• **Angles (α, β, γ and η)**

$$\begin{aligned}
 - \sin \frac{\alpha}{2} &= \frac{a_1 a_2}{2L_1} \longrightarrow \sin \frac{\alpha}{2} = \frac{0.7}{2 \times 0.5} \longrightarrow \alpha = 88.85 \\
 - \sin \frac{\beta}{2} &= \frac{b_1 b_2}{2L_1} \longrightarrow \sin \frac{\beta}{2} = \frac{0.78}{2 \times 0.5} \longrightarrow \beta = 102.52 \\
 - \sin \frac{\gamma}{2} &= \frac{c_1 c_2}{2L_1} \longrightarrow \sin \frac{\gamma}{2} = \frac{0.85}{2 \times 0.5} \longrightarrow \gamma = 116.42 \\
 - \sin \frac{\eta}{2} &= \frac{d_1 d_2}{2L_1} \longrightarrow \sin \frac{\eta}{2} = \frac{0.6}{2 \times 0.5} \longrightarrow \eta = 73.73
 \end{aligned}$$

Angular closing error:

$$\begin{aligned}
 \omega &= |360 - \sum \text{Angles}| = \\
 &= |360 - (88.85 + 102.52 + 116.42 + 73.73)| = 21.52
 \end{aligned}$$

• **Traverse to scale (1/100):**

$$\begin{aligned}
 - AB = 2.9\text{m} = 290 \text{ cm} &\longrightarrow \frac{1}{100} = \frac{x}{290} = 2.9\text{cm} \\
 - BC = 2.64\text{m} = 264 \text{ cm} &\longrightarrow \frac{1}{100} = \frac{x}{264} = 2.64\text{cm} \\
 - CD = 2.77\text{m} = 277 \text{ cm} &\longrightarrow \frac{1}{100} = \frac{x}{277} = 2.77\text{cm} \\
 - DA = 3.62\text{m} = 362 \text{ cm} &\longrightarrow \frac{1}{100} = \frac{x}{362} = 3.62\text{cm}
 \end{aligned}$$

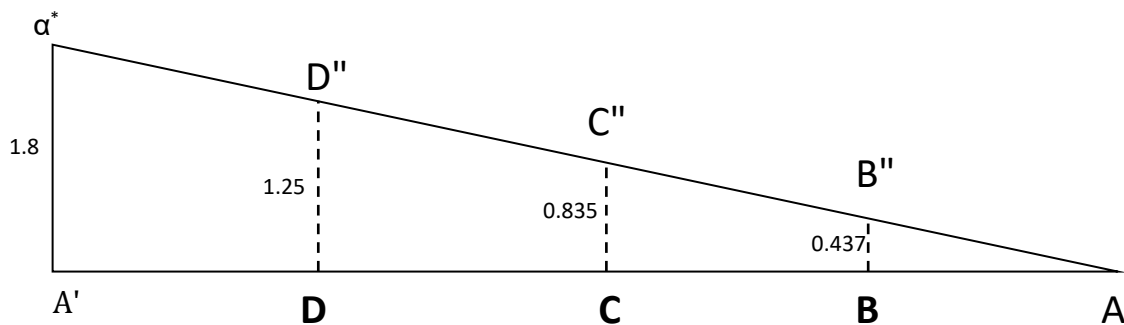
- The Linear Closing Error is :

$$AA' = 0.9\text{cm}_{(\text{at scale } 1:100)} = 0.9 \text{ m}$$

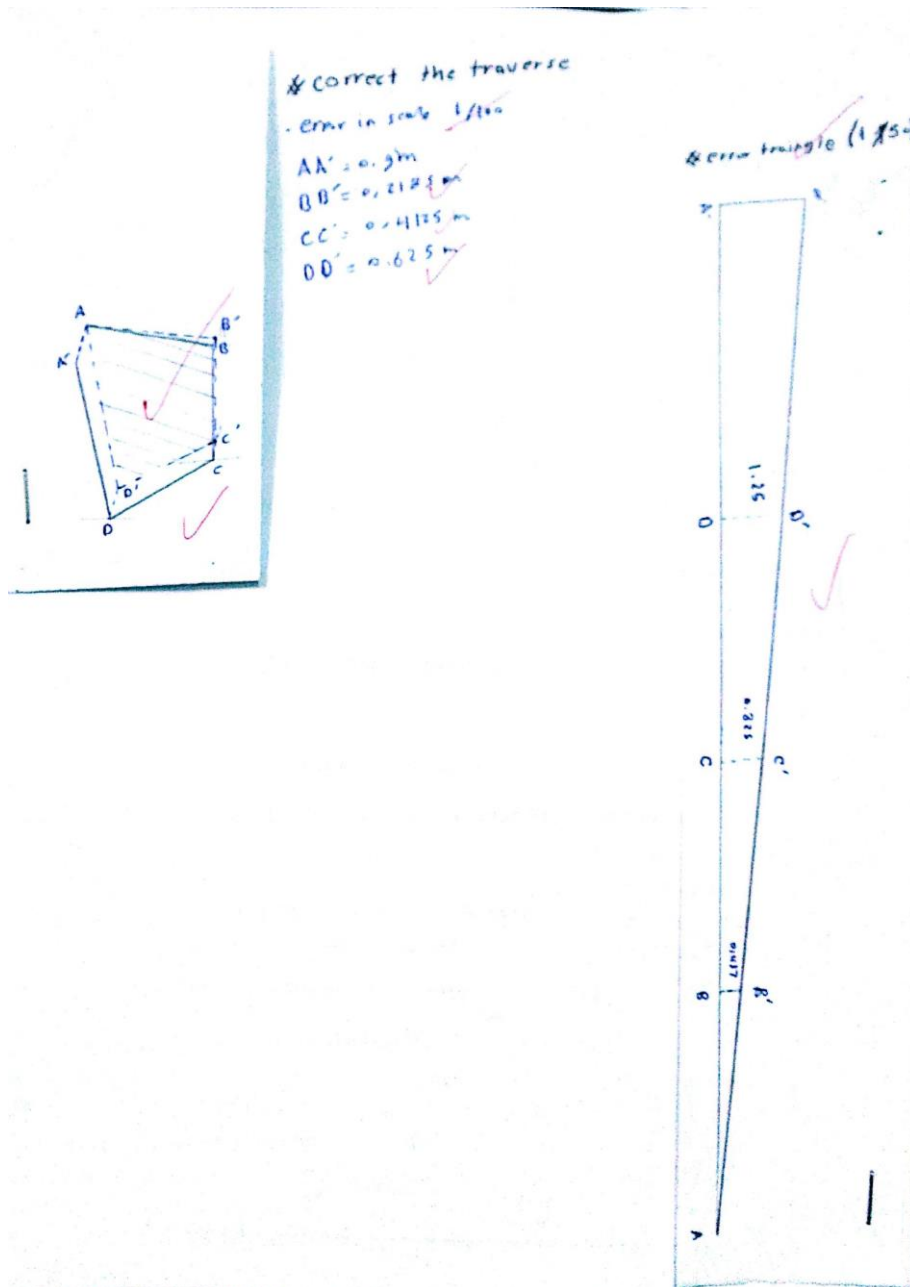
- relative error = $\frac{AA'}{AB+BC+CD+DA} = \frac{0.9}{2.9+2.64+2.77+3.62} = 0.075\text{m}$

- ERROR TRIANGLE IN SCALE (1/50):

- $AB = 2.9\text{m} = 290 \text{ cm} \longrightarrow \frac{1}{50} = \frac{x}{290} = 5.8\text{cm}$
- $BC = 2.64\text{m} = 264 \text{ cm} \longrightarrow \frac{1}{50} = \frac{x}{264} = 5.28\text{cm}$
- $CD = 2.77\text{m} = 277 \text{ cm} \longrightarrow \frac{1}{50} = \frac{x}{277} = 5.54\text{cm}$
- $DA = 3.62\text{m} = 362 \text{ cm} \longrightarrow \frac{1}{50} = \frac{x}{362} = 7.24\text{cm}$
- $AA' = 0.9\text{m} = 90 \text{ cm} \longrightarrow \frac{1}{50} = \frac{x}{90} = 1.8\text{cm}$
- $\overline{AA'} = (AB+BC+CD+DA) = (5.3+5.28+5.54+7.24) = 23.86$



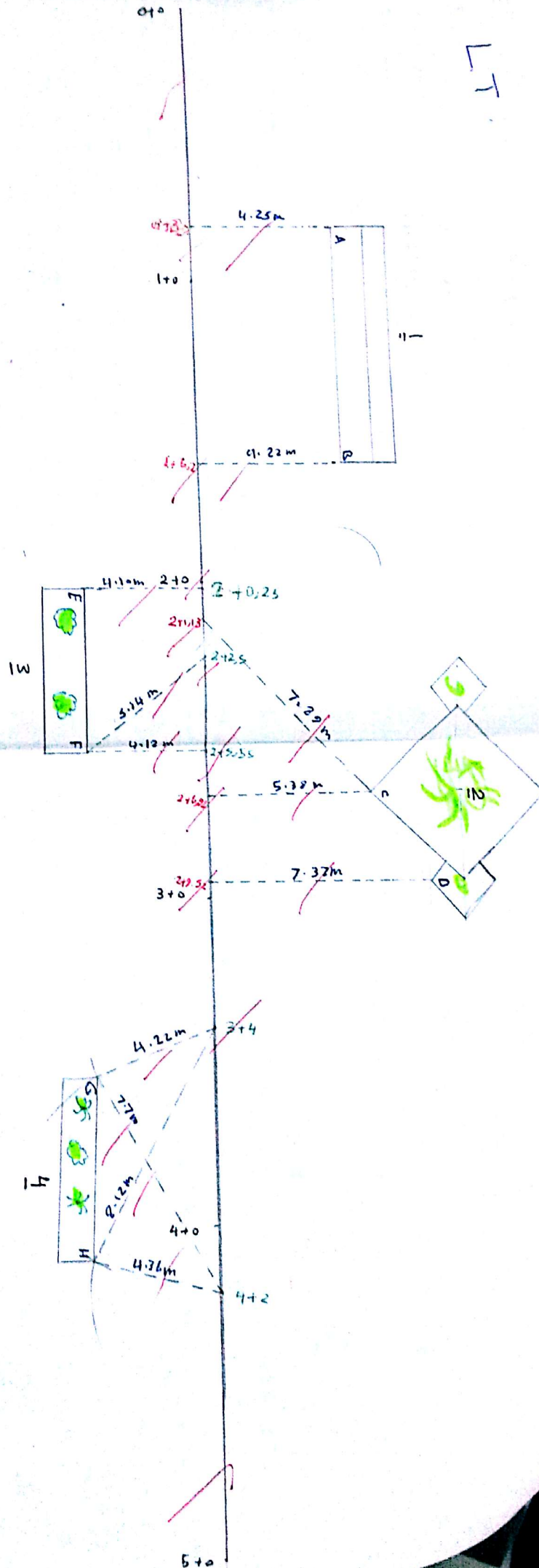
- $DD' = \frac{A\alpha^*}{AA''} = \frac{DD''}{AD} = \frac{1.8}{23.86} = \frac{DD''}{16.62} = 1.25 \text{ cm} \longrightarrow 0.0125 \text{ m}$
- $CC' = \frac{A\alpha^*}{AA''} = \frac{CC''}{AC} = \frac{1.8}{23.86} = \frac{CC''}{11.08} = 0.835 \text{ cm} \longrightarrow 8.35 \times 10^{-3} \text{ m}$
- $BB' = \frac{A\alpha^*}{AA''} = \frac{DD''}{AB} = \frac{1.8}{23.86} = \frac{DD''}{5.8} = 0.437 \text{ cm} \longrightarrow 4.37 \times 10^{-3} \text{ m}$



6

5

RT



Station	L.T	R.T	Method	Remark
0+83	4.25 m	—	offset	Corner A for stairs.
1 1+6.2	4.22 m	—	offset	corner B for stairs.
2+1.13	7.29 m	—	rang Tie	Point C for 
2 2+6.92	5.38 m	—	offset	Point C for 
2+9.52	7.37 m	—	offset	Point D for 
2+0.25	—	4.10 m	offset	Corner E for Basin Planting
3 2+5.55	—	4.12 m	offset	Corner F for Basin Planting
2+2.5	—	5.14 m	check Tie	corner F for Basin planting
3+4	—	4.22 m	Tringle action	corner G for Basin planting
4 3+4	—	8.12 m	"	corner H for Basin planting
4+2	—	4.36 m	"	corner H for Basin planting
4+2	—	7.7 m	"	corner G for Basin planting
			Tringle action	Tringle action
			check Tie	check Tie
			rang Tie	rang Tie
			offset	offset



Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 5

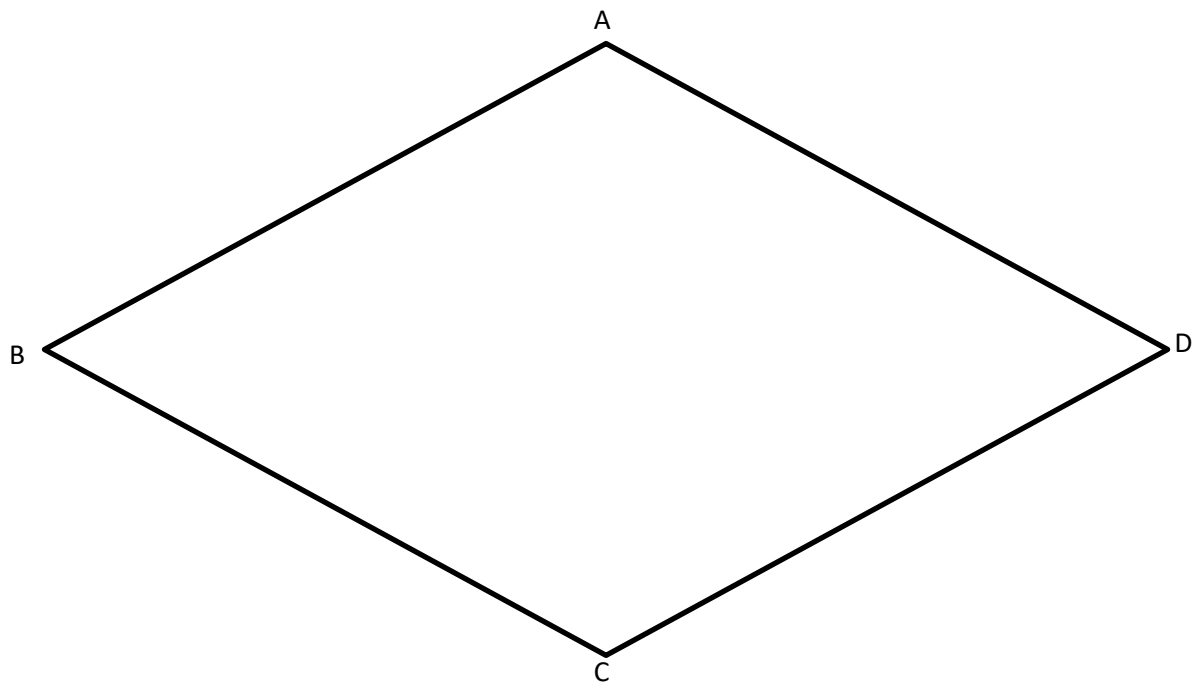
TESTING THE LEVEL AND TRAINING LEVELING

Name: EYAD MONTHER ASHI

No.: 1430018

Sunday 23/10/2016

Group 2



-----	B.S	F.S	CUM.Distance	Point
Upper	1.53			A
Middle	1.503	*****	*****	
lower	1.487	*****	*****	
AVR..	1.507			
Upper	1.493	1.493		B
Middle	1.467	1.463	10	
lower	1.443	1.44		
AVR..	1.467	1.465		
Upper	1.52	1.537		C
Middle	1.503	1.513	20	
lower	1.483	1.487		
AVR..	1.502	1.512		
Upper	1.553	1.565		D
Middle	1.53	1.54	29	
lower	1.517	1.51		
AVR..	1.533	1.538		
Upper		1.507		A
Middle	*****	1.495	37.5	
lower	*****	1.48		
AVR..		1.494		

☒ **ID#1430018 LASR (4#/100) → 00.18**

POINT	BS	HI	FS	ELEVATION	#SET UP
A	1.507	1.687	-----	00.18	0
B	1.467	1.689	1.465	00.222	1
C	1.502	1.679	1.512	00.177	2
D	1.533	1.674	1.538	00.141	3
A	-----	-----	1.494	00.18	4
SUM	6.009	-----	6.009	-----	-----

☒ **CHECK:**

$$\sum BS - \sum FS = LAST\ ELEV - 1^{TH} ELEV$$

$$6.009 - 6.006 = 00.18 - 00.18$$



Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 6

Differential leveling

Name: EYAD MONTHER ASHI

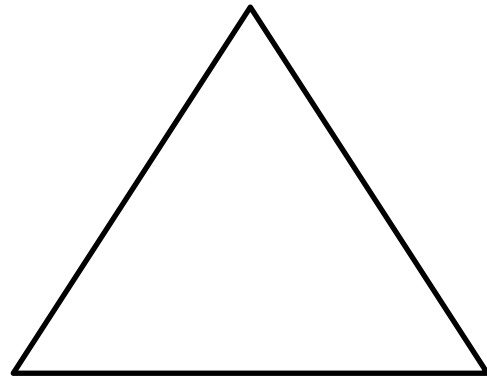
No.: 1430018

Sunday 30/10/2016

Group: 2

☒ DATA and SKETCH:

	BS	FS	CUM DISTAUNCE
A	1.393	-----	-----
B	1.385	1.383	7
C	1.417	1.43	15.20
D	-----	1.385	22.20



☒ ELEVATIONS, (HI's):

POINT	BS	HI	FS	ELEVATION	#SET UP
A	1.393	1.573	-----	00.18	0
B	1.385	1.575	1.383	00.19	1
C	1.417	1.562	1.43	00.145	2
A	-----	-----	1.385	00.177	3
SUM	4.195	-----	4.198	-----	-----

☒ CHECK:

$$\sum BS - \sum FS = LAST\ ELEV - 1^{TH}\ ELEV$$

$$4.195 - 4.198 = 00.177 - 00.18 = -0.003$$

☒ Error in (A):

$$LAST\ ELEV - 1^{TH}\ ELEV = 0.177 - 0.18 = -0.003$$

☒ Allowable error $= m \times \sqrt{K}$

$$= 12 \times 10^{-3} \times \sqrt{K}$$

$$= 12 \times 10^{-3} \times \sqrt{22.20 \times 10^{-3}}$$

$$= 0.00178$$

☒ The error in A is not OK. (17.2mm > 12mm)

☒ **Accuracy:**

$$= \frac{\text{error}}{\text{total distance}} = \frac{-0.003}{22.20} = \frac{-1}{7400} = -1.35 * 10^{-4}$$

☒ **Correction when we use Cumulative distance & corrected elevation:**

$$\begin{aligned} \text{Correction for point A} &= \frac{\text{Cumulative distance}}{\text{total distance}} \times -\text{error} \\ &= \frac{22.20}{22.20} \times 0.003 = 0.003 \end{aligned}$$

$$\begin{aligned} \text{Correction elevation for point A} &= \text{Correction} + \text{elevation} \\ &= 0.003 + 0.177 = 0.18 \end{aligned}$$

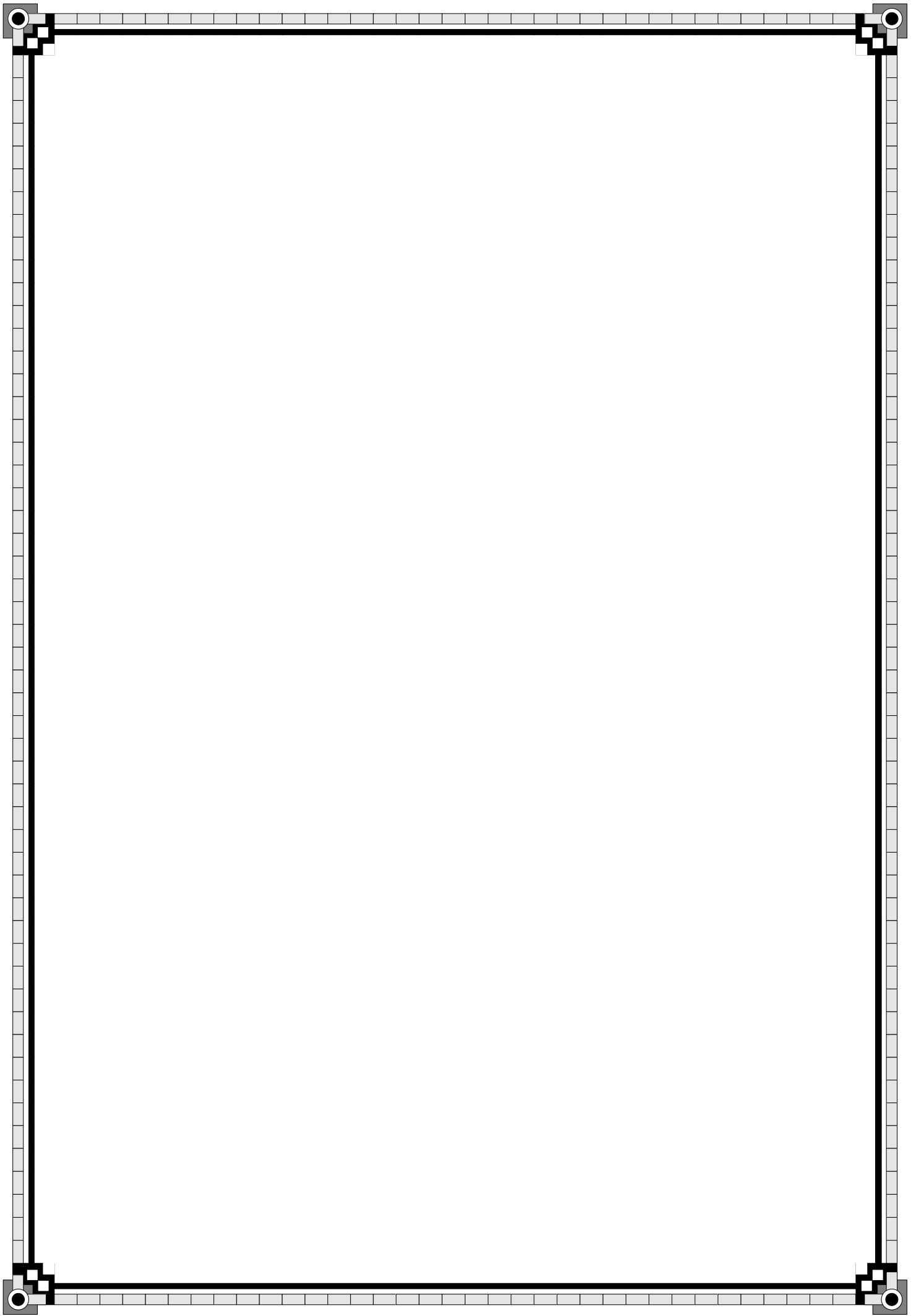
point	Elev.	Cumulative distance	correction	Corrected Elev.
A	0.18	0	$= \frac{0}{22.20} \times 0.003 = 0$	0.18(fixd)
B	0.19	7	$= \frac{7}{22.20} \times 0.003 = 0.0009$	0.1909
C	0.145	15.20	$= \frac{15.20}{22.20} \times 0.003 = 0.002$	0.147
A	0.177	22.20	$= \frac{22.20}{22.20} \times 0.003 = 0.003$	0.18

☒ **Correction when we use # of setup & corrected elevation:**

$$\text{Correction for point A} = \frac{\text{\# of setup}}{\text{total \# of setup}} \times \text{error} = \frac{3}{3} \times 0.003 = 0.003$$

$$\begin{aligned} \text{Correction elevation for point A} &= \text{Correction} + \text{elevation} \\ &= 0.003 + 0.177 = 0.18 \end{aligned}$$

point	Elev.	# of setup	correction	Corrected Elev.
A	0.18	0	$= \frac{0}{3} \times 0.003 = 0$	0.18(fixd)
B	0.19	1	$= \frac{1}{3} \times 0.003 = 0.001$	0.191
C	0.145	2	$= \frac{2}{3} \times 0.003 = 0.002$	0.147
A	0.177	3	$= \frac{3}{3} \times 0.003 = 0.003$	0.18





Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 7

Contouring from grid (spot) elevation

Name: EYAD MONTHER ASHI

No.: 1430018

Sunday 6/11/2016

Group: 2

☒ Data:

Elev. BM(A) = 0018/100 = 00.18 m

B.S reading = 3.987 m

point	BS	HI	FS	Elev
BM	3.987	4.167	-----	00.18
H8	-----	-----	2.853	1.314

point	IS	elevation	point	IS	elevation
A1	3.225	0.942	B1	3.015	1.152
A2	3.123	1.044	B2	2.975	1.192
A3	3.105	1.062	B3	2.965	1.202
A4	2.977	1.19	B4	2.853	1.314
A5	3.017	1.15	B5	2.795	1.372
A6	3.197	0.97	B6	2.777	1.39
A7	3.255	0.912	B7	2.870	1.297
A8	3.345	0.822	B8	3.227	0.94
C1	2.957	1.21	D1	2.913	1.254
C2	2.805	1.362	D2	2.755	1.412
C3	2.577	1.61	D3	2.320	1.847
C4	2.347	1.82	D4	2.200	1.967
C5	2.353	1.814	D5	2.220	1.947
C6	2.597	1.57	D6	2.343	1.824
C7	2.923	1.244	D7	2.855	1.312
C8	3.103	1.064	D8	3.015	1.152
E1	2.853	1.314	F1	2.755	1.412
E2	2.703	1.464	F2	2.665	1.502
E3	2.300	1.867	F3	2.563	1.604
E4	2.223	1.944	F4	2.300	1.867
E5	2.215	1.952	F5	2.315	1.852
E6	2.330	1.837	F6	2.523	1.644
E7	2.575	1.592	F7	2.695	1.472
E8	3.000	1.167	F8	2.985	1.182

G1	2.710	1.457
G2	2.705	1.462
G3	2.585	1.582
G4	2.550	1.617
G5	2.560	1.607
G6	2.623	1.544
G7	2.873	1.294
G8	2.955	1.212

H1	2.693	1.474
H2	2.777	1.39
H3	2.695	1.472
H4	2.713	1.454
H5	2.755	1.412
H6	2.783	1.384
H7	2.793	1.374
H8	-----	1.314

☒ **CHECK:**

$$\sum BS - \sum FS = \text{LAST ELEV} - 1^{\text{TH}} \text{ELEV}$$

$$3.987 - 2.853 = 1.314 - 0.18 = 1.134$$

☒ **Contour interval** = $\frac{\text{max.elevation} - \text{min.elevation}}{\# \text{ of line} + 1}$

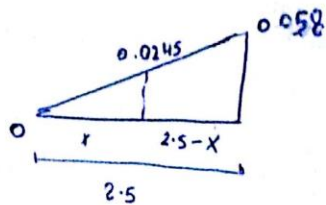
$$= \frac{1.967 - 0.822}{9 + 1}$$

$$= 0.1145$$

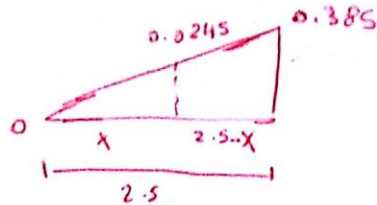
- $CC_1 = \text{min.} + \text{CI} = 0.822 + 0.1145 = 0.9365$
- $CC_2 = CC_1 + \text{CI} = 0.9365 + 0.1145 = 1.051$
- $CC_3 = CC_2 + \text{CI} = 1.051 + 0.1145 = 1.1655$
- $CC_4 = CC_3 + \text{CI} = 1.1655 + 0.1145 = 1.28$
- $CC_5 = CC_4 + \text{CI} = 1.28 + 0.1145 = 1.3945$
- $CC_6 = CC_5 + \text{CI} = 1.3945 + 0.1145 = 1.509$
- $CC_7 = CC_6 + \text{CI} = 1.509 + 0.1145 = 1.6235$
- $CC_8 = CC_7 + \text{CI} = 1.6235 + 0.1145 = 1.738$
- $CC_9 = CC_8 + \text{CI} = 1.738 + 0.1145 = 1.8525$

Use Interpolations:

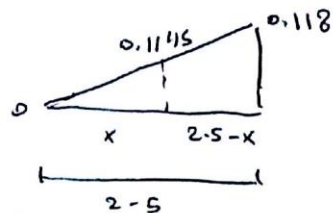
$Cc_1 = 0.9365$



$x = 1.056 \text{ cm}$

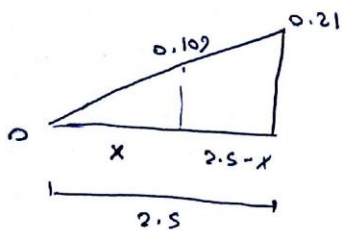


$x = 0.159 \text{ cm}$

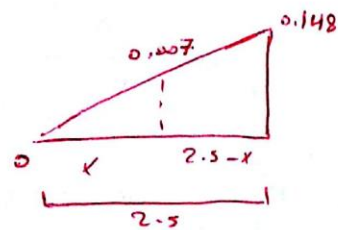


$x = 2.425 \text{ cm}$

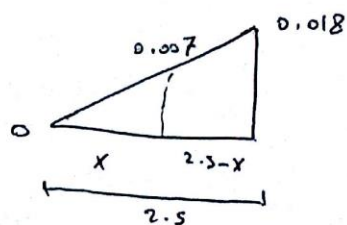
$Cc_2 = 1.051$



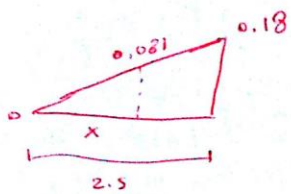
$x = 1.297 \text{ cm}$



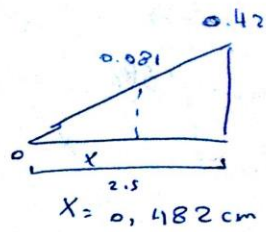
$x = 0.118 \text{ cm}$



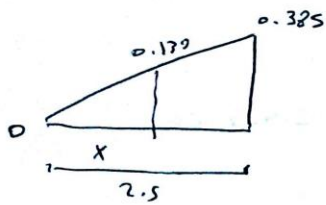
$x = 0.972 \text{ cm}$



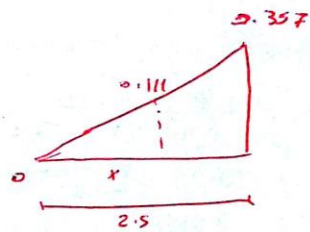
$$x = 1.125 \text{ cm}$$



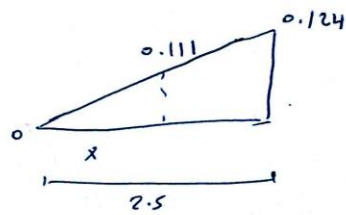
$$x = 0.482 \text{ cm}$$



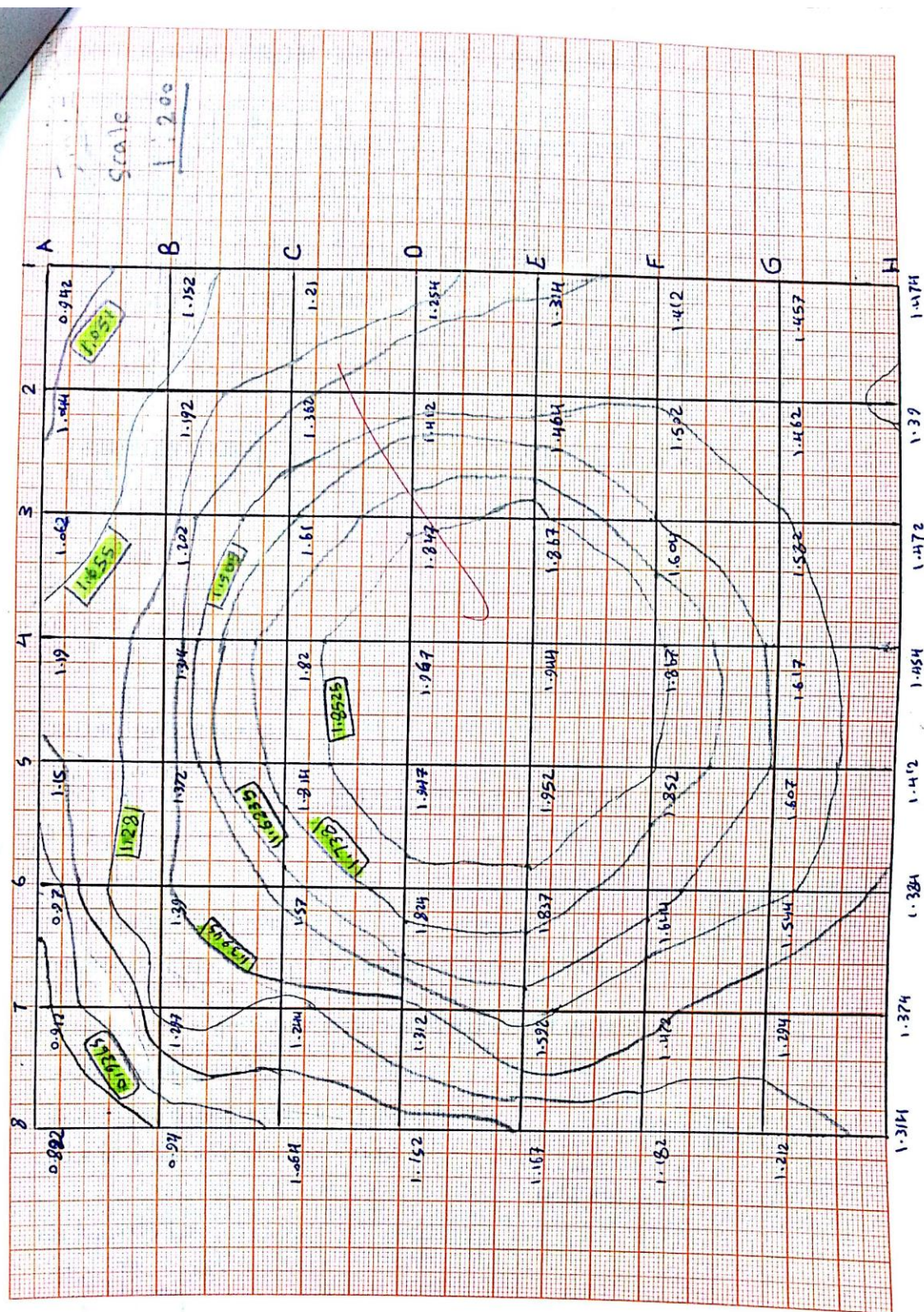
$$x = 0.902 \text{ cm}$$



$$x = 0.777 \text{ cm}$$



$$x = 2.237 \text{ cm}$$





Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 7

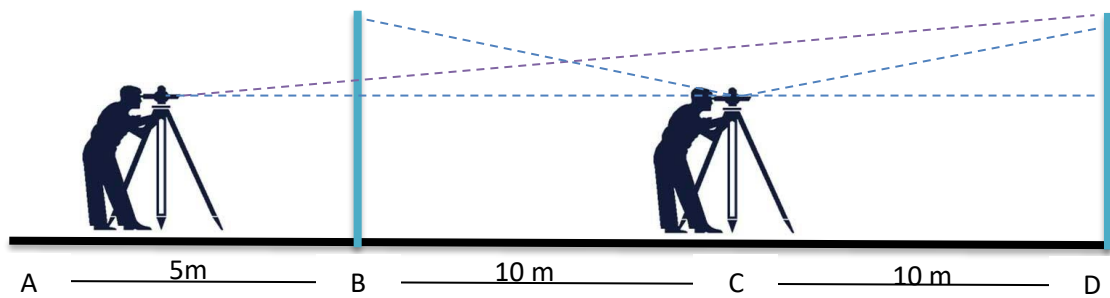
Test the level

Name: EYAD MONTHER ASHI

No.: 1430018

Sunday13/11/2016

Group:2



$$R_{AB} = 1.423 \text{ m}$$

$$R_{CD} = 1.457 \text{ m}$$

$$R_{AD} = 1.52 \text{ m}$$

$$R_{CB} = 1.355 \text{ m}$$

$$\boxed{\times} \Delta H_{\text{true}} = R_{CD} - R_{CB} = 1.455 - 1.347 = 0.102$$

$$\boxed{\times} \Delta H_{\text{true}} = R'_{AD} - R'_{AB}$$

$$R_{CD} - R_{CB} = (R_{AD} - 25\alpha) - (R_{AB} - 5\alpha)$$

$$0.102 = (1.52 - 25\alpha) - (1.423 - 5\alpha)$$

$$\alpha = -0.00025 \text{ m/m} \quad \text{@error is negative, so the error must be added to the read.}$$

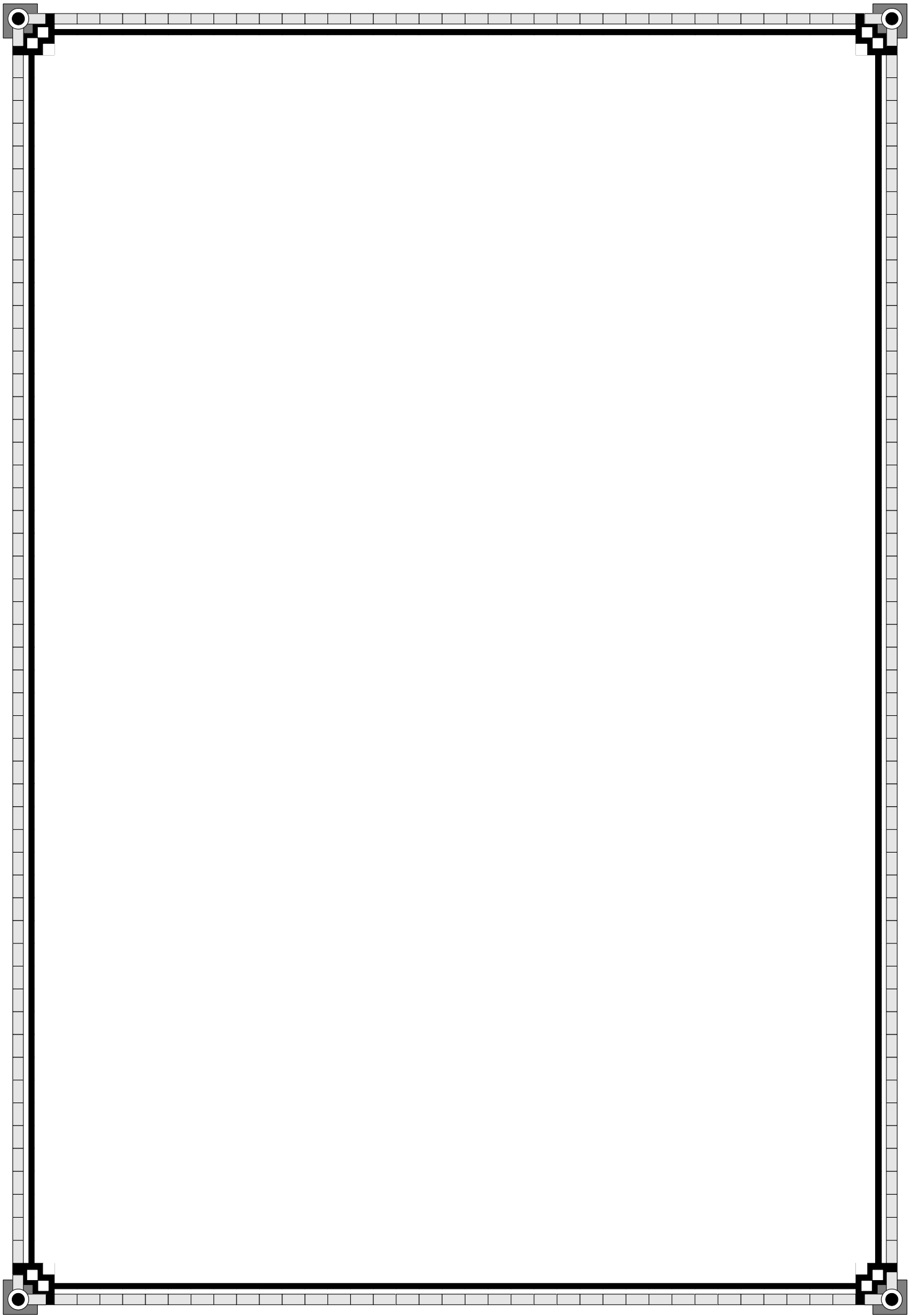
$$\boxed{\times} \text{ collimation error } \alpha \text{ per 5m horizontally:}$$

$$\alpha * 5 = -0.00025 * 5 = -0.00125 \text{ m/5m}$$

$$\boxed{\times} \text{ Correction :}$$

POINT	CORRECTION	
R'_{CD}	$R_{CD} - 10\alpha$	$1.457 - 10 \times (-0.00025) = 1.4595$
R'_{CB}	$R_{CB} - 10\alpha$	$1.355 - 10 \times (-0.00025) = 1.3575$
R'_{AB}	$R_{AB} - 5\alpha$	$1.423 - 5 \times (-0.00025) = 1.42425$
R'_{AD}	$R_{AD} - 25\alpha$	$1.52 - 25 \times (-0.00025) = 1.52625$

Check ... $R_{CD} - R_{CB} = R'_{CD} - R'_{CB} = R'_{AD} - R'_{AB} =$
 $(1.457 - 1.355) = (1.4595 - 1.3575) = (1.52625 - 1.42425)$
 $= 0.102 \text{ it is ok}$





Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 9

Measurement of Horizontal and Vertical Angle

Name: EYAD MONTHER ASHI

No.: 1430018

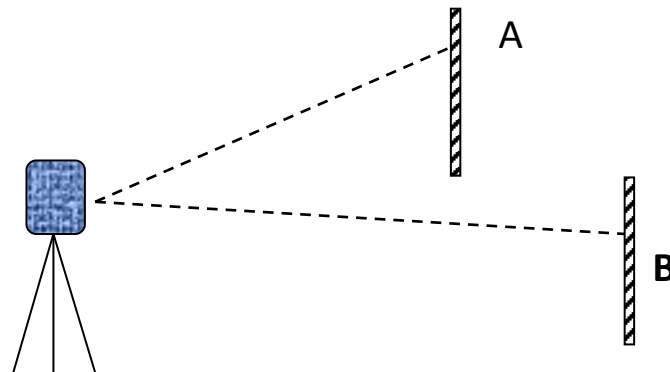
Sunday 23/11/2016

Group: 2

**** تعويض يوم الأربعاء مع مجموعة ١**

☒ Horizontal Angle :

*****	FL	FR
A	250°03'00"	70°03'30"
B	302°51'35"	122°30'30"



☒ Use Difference method :

$$FL < AB = B(I) - A(I) = 302^{\circ}51'35'' - 250^{\circ}03'00'' = 52^{\circ}48'35''$$

$$FR < AB = B(II) - A(II) = 122^{\circ}30'30'' - 70^{\circ}03'30'' = 52^{\circ}27'00''$$

$$AB < = Avg. = \frac{\Delta.I + \Delta.II}{2} = \frac{52^{\circ}48'35'' + 52^{\circ}27'00''}{2} = 52^{\circ}37'47.5''$$

*****	FL	FR	FL < AB	FR < AB	Angle
A	250°03'00"	70°03'30"	52°48'35"	52°27'00"	52°37'47.5"
B	302°51'35"	122°30'30"			

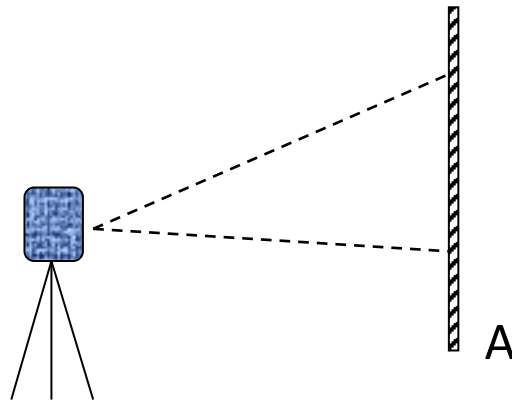
☒ Means method

$$\text{mean A } 250^{\circ}00'00'' + (0^{\circ}03'00'' + 0^{\circ}03'30'') / 2 = 250^{\circ}03'15''$$

$$\text{mean B } = 302^{\circ}00'00'' + (00^{\circ}51'35'' + 00^{\circ}30'30'') / 2 = 302^{\circ}41''2.5''$$

☒ Vertical Angle :

*****	FL	FR
A	8°19'15"	171°38'20"



☒ $AB = FL(I) - FL(I) = 8^{\circ}19'15'' + 171^{\circ}38'20'' = 179^{\circ}57'35''$

- index error = $\frac{|180^{\circ} - 179^{\circ}57'35''|}{2} = 0^{\circ}1'12.5''$
- Correct the I (F.L) = $8^{\circ}19'15'' + 0^{\circ}1'12.5'' = 8^{\circ}20'27.5''$
- Correct the II (F.R) = $171^{\circ}38'20'' + 0^{\circ}1'12.5'' = 171^{\circ}39'32.5''$

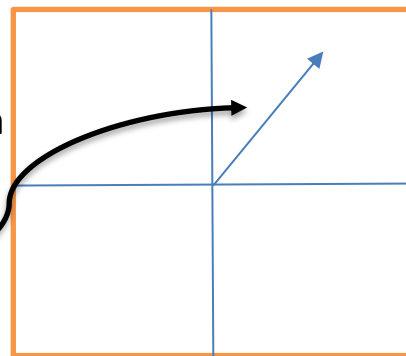
point	I (F.L)	II (F.R)	*sum	index error
A	8°19'15"	171°38'20"	179°57'35"	0°2'25"
A'	8°20'27.5"	171°39'32.5"	180°0'0"	-

☒ Angle of elevation = 8°20'27.5"

zenithal angle = 90° - Angle of elevation

= 90° - 8°20'27.5"

= 81°39'32.5"





Hashemite University
Faculty of Engineering
Civil Engineering Department

Surveying Laboratory

Experiment No. 10

Repetition & error of closure

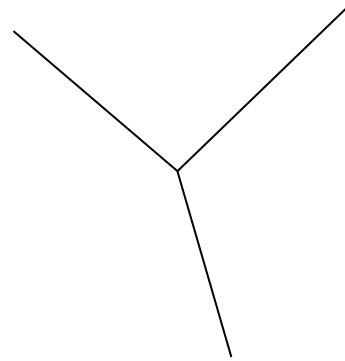
Name: EYAD MONTHER ASHI

No.: 1430018

Sunday 27/11/2016

Group: 2

*****	AOB	BOC	COA
L_0	0°0'0"	340°46'20"	126°44'10"
L_1	85°12'40"	107°33'40"	275°36'30"
L_2	170°21'30"	234°43'50"	64°55'30"
L_3	255°26'30"	1°18'30"	213°40'50"
L_4	340°46'20"	126°44'10"	2°29'40"
m	0	2	2



$$\boxtimes m = \left[\frac{(L_1 - L_0) \times n}{360} \right]$$

$$\begin{aligned} \text{-Mean angle AOB} &= \frac{L_f - L_i}{n} + m \times \frac{360}{n} \\ &= \frac{340^\circ 46' 20'' - 0^\circ 0' 0''}{4} + [0] \times \frac{360}{4} = 85^\circ 11' 35'' \end{aligned}$$

$$\begin{aligned} \text{-Mean angle BOC} &= \frac{L_f - L_i}{n} + m \times \frac{360}{n} \\ &= \frac{126^\circ 44' 10'' - 340^\circ 46' 20''}{4} + [2] \times \frac{360}{4} = 126^\circ 29' 27.5'' \end{aligned}$$

$$\begin{aligned} \text{-Mean angle COA} &= \frac{L_f - L_i}{n} + m \times \frac{360}{n} \\ &= \frac{2^\circ 29' 40'' - 126^\circ 44' 10''}{4} + [2] \times \frac{360}{4} = 148^\circ 56' 22.5'' \end{aligned}$$

$$\begin{aligned} \boxtimes \sum \text{angle } 85^\circ 11' 35'' + 126^\circ 29' 27.5'' + 148^\circ 56' 22.5'' \\ = 360^\circ 37' 25'' \end{aligned}$$

$$\begin{aligned} \boxtimes \text{Error} &= 360 - \sum \text{angle} \\ &= 360 - 360^\circ 37' 25'' = 0^\circ 37' 25'' \end{aligned}$$

$$\begin{aligned} \boxtimes \text{Check error} &= \frac{\text{last reading}}{n} \\ &= \frac{2^\circ 29' 40''}{4} \\ &= 0^\circ 37' 25'' \end{aligned}$$

☒ correction angles: $= \frac{\text{error} * \text{angle}}{360}$

$$\text{corrected angle AOB} = (0^\circ 37' 25'' / 360) \times 85^\circ 11' 35'' \\ = 0^\circ 8' 51.27''$$

$$\text{corrected angle BOC} = (0^\circ 37' 25'' / 360) \times 126^\circ 29' 27.5'' \\ = 0^\circ 13' 8.81''$$

$$\text{corrected angle COA} = (0^\circ 37' 25'' / 360) \times 148^\circ 56' 22.5'' \\ = 0^\circ 15' 28.8''$$

☒ corrected angles: $= (\text{Angle} - \text{correction})$

$$\text{corrected angle AOB} = 85^\circ 11' 35'' - 0^\circ 8' 51.27'' = 85^\circ 2' 43.73''$$

$$\text{corrected angle BOC} = 126^\circ 29' 27.5'' - 0^\circ 13' 8.81'' = 126^\circ 16' 18.69''$$

$$\text{corrected angle COA} = 148^\circ 56' 22.5'' - 0^\circ 15' 28.8'' = 148^\circ 40' 53.7''$$

☒ Check :

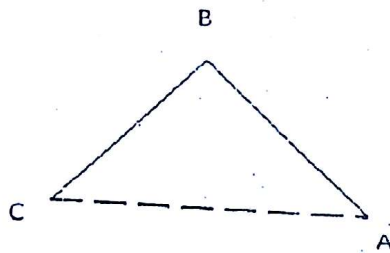
$$85^\circ 2' 43.73'' + 126^\circ 16' 18.69'' + 148^\circ 40' 53.7'' = 359^\circ 59' 56.39''$$

مقياس المساحة
١:٥٠٠٠

(10)

سم: ١:٥٠٠٠
م: ١:٥٠٠٠
الدرجة: ١:٥٠٠٠

Exp. #10: measurement & calculation of open traverse



DATA

Angle ABC:

$L_0 @ A = 0$

$L_1 @ C = 143^\circ 58' 10''$

$L_2 @ C = 281^\circ 42' 25''$

Assume azimuth BC=100

Length: AB... 5 m ... BC... 6 m ...

	Angle	Azimuth	length	Lat. (Δy)	Dep. (Δx)	Bearing
A	$20^\circ 2' 32.63''$					
		$136^\circ 38' 47.5''$	5	-3.636	3.432	$S 47^\circ 21' 12.5'' E$
B	$143^\circ 21' 12.5''$					
		100	6	-1.042	5.908	$S 8^\circ E$
C	$16^\circ 36' 15.47''$					
		$296^\circ 36' 15.47''$	10.45	+4.678	-9.134	$N 63^\circ 28' 44.53'' W$
A						
Σ	$180^\circ 0' 0''$	----	21.45	0	0	---

Hint: ((+): Azimuth counter clockwise, (-): Azimuth clockwise)

$$\uparrow \text{Az. AB} = \text{Az. AC} + \text{angle A}$$

$$\rightarrow \text{Az. BA} = \text{Az. BC} - \text{angle B}$$

$$\text{Az. AB} = \text{Az. BA} \pm 180$$

$$\Sigma \text{lat. must be equal zero} \rightarrow \text{lat. CA} = -(\text{lat. AB} + \text{lat. BC})$$

$$\Sigma \text{dep. must be equal zero} \rightarrow \text{dep. CA} = -(\text{dep. AB} + \text{dep. BC})$$

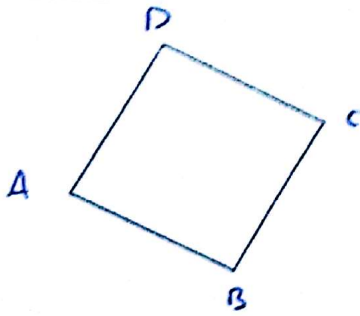
$$\text{Lat.} = \text{length} \cos \text{Az.}$$

$$\text{Dep.} = \text{length} \sin \text{Az.}$$

$$\text{Bearing CA} = \tan^{-1} \frac{\text{dep. CA}}{\text{lat. CA}}, \text{ then you can find the azimuth of BC according to your quarter}$$

EXP. N 10: Closed Traverse

Sketch



Angles

	ABC	BCD	CDA	DAB
L0	0	0	0	0
L1	143° 58' 10"	51° 33' 25"	255° 33' 00"	57° 10' 55"
L2	286° 42' 25"	103° 12' 00"	151° 00' 30"	118° 33' 50"
Mean angle	143° 21' 12.5"	51° 39' 00"	255° 30' 15"	57° 17' 55"

$$\sum \text{ANGLES} = 143^\circ 21' 12.5'' + 51^\circ 39' 00'' + 255^\circ 30' 15'' + 57^\circ 17' 55''$$

$$= 509^\circ 48' 22.5''$$

$$\text{ERROR} = 509^\circ 48' 22.5'' - 360 = 149^\circ 48' 22.5''$$

$$\text{Correction equally for angles} = \text{ERROR} / 4 = 37^\circ 27' 5.63''$$

Angles	Corrected angles
ABC	105° 54' 6.87"
BCD	14° 11' 54.37"
CDA	218° 3' 9.37"
DAB	21° 50' 49.37"
SUM	359° 59' 57.98"

	Angle	Azimuth	length	latitude	departure
A	218° 50' 49.37"	100	5	-0.868	4.924
B	105° 54' 6.87"	25° 54' 6.87"	6	5.39	2.620
C	14° 11' 54.37"	220° 6' 1.24"	7	-5.354	-4.508
D	218° 3' 9.37"	258° 9' 10.61"	6.30	-1.293	-6.165
A	218° 50' 49.37"	---	---	---	---
SUM		----	24.3	-2.125	-3.129

	Correction latitude	Correction departure	Corrected latitude	Corrected departure	Corrected length
A					
	+0.437	0.644	-0.431	5.568	5.585
B					
	+0.524	0.772	5.914	3.392	6.818
C					
	+0.612	0.901	-4.742	-3.607	5.958
D					
	+0.551	0.811	-0.742	-5.354	5.405
A					
SUM	+2.125	+3.129	zero	zero	23.766

	Northing	Easting
1 A	100	100
2 B	99.569	105.568
3 C	105.483	108.96
4 D	100.741	105.353
A	99.999 ≈ 100	99.999 ≈ 100

$$2 \text{ Area} = x_1(y_2 - y_4) + x_2(y_3 - y_1) + x_3(y_4 - y_2) + x_4(y_1 - y_3)$$

$$\text{AREA} = \frac{11.67}{2} = 5.835 \text{ m}^2$$

Draw the traverse according to your coordinate.

