

Faculty of Engineering
Civil Engineering Department

Surveying lab
ENCE316

Experiment no. 1
Mapping using ties & offsets

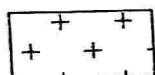
Done By Group (A, B, C, D):
student names Students no.

Date:

Units :

Scale:

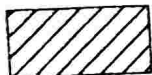
Legend:



Soil



Concrete



Building



concrete wall



stone wall



Manhole



electric pole



Tree

Birzeit University
Faculty of Engineering and Technology
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SURVEYING Lab ENCE316

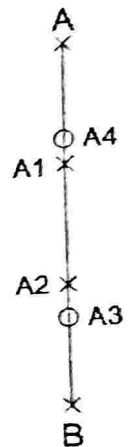
Experiment no. 1: Tapping and Mapping using ties & offsets
Prepared by: Eng. Shuroq Jamal

❖ Part 1 : Tapping

Data Arrangement:

Forward

Segment	Distance (m)
A A1	√
A1 A2	√
A2 B	√
Σ	Sum 1



Backward

Segment	Distance (m)
B A3	√
A3 A4	√
A4 A	√
Σ	Sum 2

Calculations:

$$AB \text{ avg} = \frac{\text{Sum1} + \text{sum2}}{2}$$

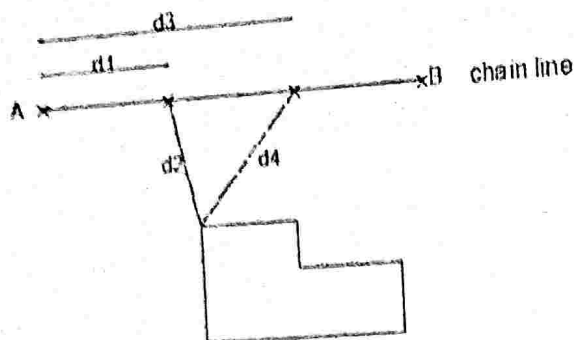
$$\text{Error (e)} = |\text{measured distance} - \text{known distance}|$$

$$RP = \frac{1}{\text{measured distance} / |e|} \approx \frac{1}{3000}$$

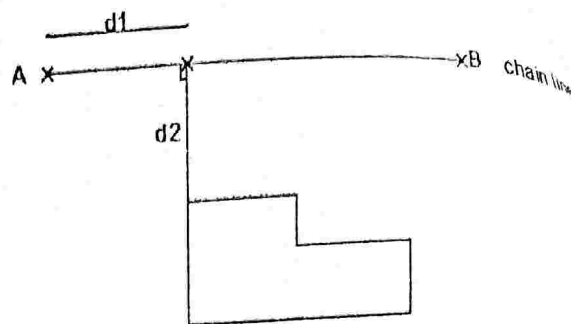
Part 2: Mapping using ties & offsets

Data Arrangement:

You have to submit 1- Data & Calculations
2- Tabulated data collection
3- Sketch for mapping
4- Map



Ties method



Offset method

Point	Ties Method				Offset Method		Notes
	d_1^*	d_2	d_3^*	d_4	d_1^*	d_2	
P1							
P2							
P3							
.							
.							
.							

Note: d_1^* and d_3^* measured on chain line.

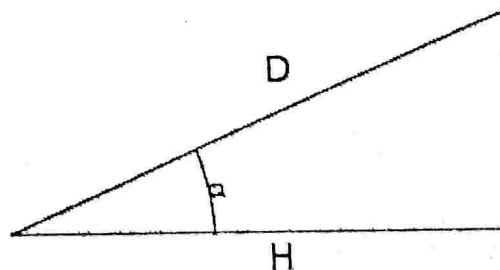
Calculations:

You have to check if it necessary to correct the distances measured on chain line.

$$H = D \cos \alpha ,$$

Where α is angle of inclination of chain line measured using Abney level.

D is the largest distance measured on chain line.



If $H = D \pm 0.05$ m then no need for any correction and α can be neglected (means α has small value)

If not, then you have to correct d_1^* and d_3^* before drawing.

→ Known: H.B.M
→ measured :



$r_1, r_2, r_3 \rightarrow$ to the B.M
 $r_1, r_2, r_3 \rightarrow$ point B

You have to submit the following:

- 1- Data & Calculations for tapping part.
- 2- Tabulated data collected for mapping exercise.
- 3- Sketch for mapping area.
- 4- Map on A3 paper for ties & offsets exercise as attached.

Experiment no.4: Closed Loop Levelling (longitudinal and transverse profiles)

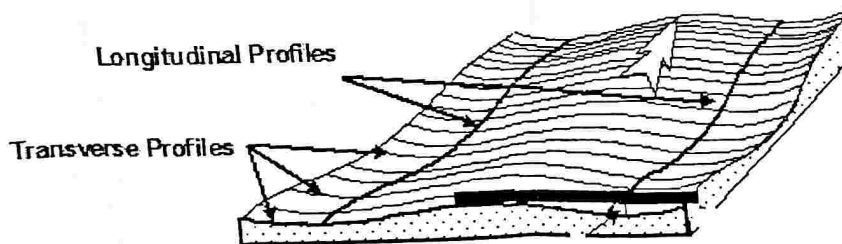
Prepared by: Eng. Shuroq Jamal

❖ Closed Loop (Polygon) Levelling

Closed Leveling is the process of determining the height of points with respect to certain level (MSL) by starting and ending at the same point.

The purpose of this exercise is drawing longitudinal and transverse profiles. Since Profiling is a way of graphically representing changes of ground topography in a sectional view, with a horizontal scale and a vertical scale (Usually horizontal scales are smaller than vertical scales). There are two types of profiling:

- Longitudinal profiles: If profiling is taken along the centre line.
- Transverse profiles (Cross section): If profiling is taken orthogonal to the centre line.



Cross Sections



Long. Section

by for profiles working elevations of points must be taken at constant intervals (5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180, 185, 190, 195, 200, 205, 210, 215, 220, 225, 230, 235, 240, 245, 250, 255, 260, 265, 270, 275, 280, 285, 290, 295, 300, 305, 310, 315, 320, 325, 330, 335, 340, 345, 350, 355, 360, 365, 370, 375, 380, 385, 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440, 445, 450, 455, 460, 465, 470, 475, 480, 485, 490, 495, 500, 505, 510, 515, 520, 525, 530, 535, 540, 545, 550, 555, 560, 565, 570, 575, 580, 585, 590, 595, 600, 605, 610, 615, 620, 625, 630, 635, 640, 645, 650, 655, 660, 665, 670, 675, 680, 685, 690, 695, 700, 705, 710, 715, 720, 725, 730, 735, 740, 745, 750, 755, 760, 765, 770, 775, 780, 785, 790, 795, 800, 805, 810, 815, 820, 825, 830, 835, 840, 845, 850, 855, 860, 865, 870, 875, 880, 885, 890, 895, 900, 905, 910, 915, 920, 925, 930, 935, 940, 945, 950, 955, 960, 965, 970, 975, 980, 985, 990, 995, 1000, 1005, 1010, 1015, 1020, 1025, 1030, 1035, 1040, 1045, 1050, 1055, 1060, 1065, 1070, 1075, 1080, 1085, 1090, 1095, 1100, 1105, 1110, 1115, 1120, 1125, 1130, 1135, 1140, 1145, 1150, 1155, 1160, 1165, 1170, 1175, 1180, 1185, 1190, 1195, 1200, 1205, 1210, 1215, 1220, 1225, 1230, 1235, 1240, 1245, 1250, 1255, 1260, 1265, 1270, 1275, 1280, 1285, 1290, 1295, 1300, 1305, 1310, 1315, 1320, 1325, 1330, 1335, 1340, 1345, 1350, 1355, 1360, 1365, 1370, 1375, 1380, 1385, 1390, 1395, 1400, 1405, 1410, 1415, 1420, 1425, 1430, 1435, 1440, 1445, 1450, 1455, 1460, 1465, 1470, 1475, 1480, 1485, 1490, 1495, 1500, 1505, 1510, 1515, 1520, 1525, 1530, 1535, 1540, 1545, 1550, 1555, 1560, 1565, 1570, 1575, 1580, 1585, 1590, 1595, 1600, 1605, 1610, 1615, 1620, 1625, 1630, 1635, 1640, 1645, 1650, 1655, 1660, 1665, 1670, 1675, 1680, 1685, 1690, 1695, 1700, 1705, 1710, 1715, 1720, 1725, 1730, 1735, 1740, 1745, 1750, 1755, 1760, 1765, 1770, 1775, 1780, 1785, 1790, 1795, 1800, 1805, 1810, 1815, 1820, 1825, 1830, 1835, 1840, 1845, 1850, 1855, 1860, 1865, 1870, 1875, 1880, 1885, 1890, 1895, 1900, 1905, 1910, 1915, 1920, 1925, 1930, 1935, 1940, 1945, 1950, 1955, 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2015, 2020, 2025, 2030, 2035, 2040, 2045, 2050, 2055, 2060, 2065, 2070, 2075, 2080, 2085, 2090, 2095, 2100, 2105, 2110, 2115, 2120, 2125, 2130, 2135, 2140, 2145, 2150, 2155, 2160, 2165, 2170, 2175, 2180, 2185, 2190, 2195, 2200, 2205, 2210, 2215, 2220, 2225, 2230, 2235, 2240, 2245, 2250, 2255, 2260, 2265, 2270, 2275, 2280, 2285, 2290, 2295, 2300, 2305, 2310, 2315, 2320, 2325, 2330, 2335, 2340, 2345, 2350, 2355, 2360, 2365, 2370, 2375, 2380, 2385, 2390, 2395, 2400, 2405, 2410, 2415, 2420, 2425, 2430, 2435, 2440, 2445, 2450, 2455, 2460, 2465, 2470, 2475, 2480, 2485, 2490, 2495, 2500, 2505, 2510, 2515, 2520, 2525, 2530, 2535, 2540, 2545, 2550, 2555, 2560, 2565, 2570, 2575, 2580, 2585, 2590, 2595, 2600, 2605, 2610, 2615, 2620, 2625, 2630, 2635, 2640, 2645, 2650, 2655, 2660, 2665, 2670, 2675, 2680, 2685, 2690, 2695, 2700, 2705, 2710, 2715, 2720, 2725, 2730, 2735, 2740, 2745, 2750, 2755, 2760, 2765, 2770, 2775, 2780, 2785, 2790, 2795, 2800, 2805, 2810, 2815, 2820, 2825, 2830, 2835, 2840, 2845, 2850, 2855, 2860, 2865, 2870, 2875, 2880, 2885, 2890, 2895, 2900, 2905, 2910, 2915, 2920, 2925, 2930, 2935, 2940, 2945, 2950, 2955, 2960, 2965, 2970, 2975, 2980, 2985, 2990, 2995, 3000, 3005, 3010, 3015, 3020, 3025, 3030, 3035, 3040, 3045, 3050, 3055, 3060, 3065, 3070, 3075, 3080, 3085, 3090, 3095, 3100, 3105, 3110, 3115, 3120, 3125, 3130, 3135, 3140, 3145, 3150, 3155, 3160, 3165, 3170, 3175, 3180, 3185, 3190, 3195, 3200, 3205, 3210, 3215, 3220, 3225, 3230, 3235, 3240, 3245, 3250, 3255, 3260, 3265, 3270, 3275, 3280, 3285, 3290, 3295, 3300, 3305, 3310, 3315, 3320, 3325, 3330, 3335, 3340, 3345, 3350, 3355, 3360, 3365, 3370, 3375, 3380, 3385, 3390, 3395, 3400, 3405, 3410, 3415, 3420, 3425, 3430, 3435, 3440, 3445, 3450, 3455, 3460, 3465, 3470, 3475, 3480, 3485, 3490, 3495, 3500, 3505, 3510, 3515, 3520, 3525, 3530, 3535, 3540, 3545, 3550, 3555, 3560, 3565, 3570, 3575, 3580, 35

at experiment 10 m intervals will be used. Where (P1, P2, P3, P4, P5 & P6) called

	B.S	I.S	F.S	HI (m)	H(m)	Correction	H corrected (m)	Remark
1	✓				767.174	---		
		✓				C ₁		
		✓				C ₁		
	✓		✓			C ₁		T.P
		✓				C ₂		
		✓				C ₂		
		✓				C ₂		
		✓				C ₂		
		✓				C ₂		
		✓				C ₂		
P ₅	✓		✓			C ₂		T.P
P ₆		✓				C ₃		
A	✓		✓			C ₃		T.P
B	✓		✓			C ₄		T.P
C	✓		✓			C ₅		T.P
BM1			✓			C ₆		
Σ	Σ B.S	Σ I.S	Σ F.S		Σ H			

staff reading at each point (r_2)

NOTE:

• Measure (r_1, r_2, r_3) for both benchmark BM 1.

Since $\frac{r_1 + r_2 + r_3}{3} = r_2$ with difference = 2 mm

- a, b, c, d & f : are points taking transverse profile, and their readings recorded as I.S also they must be taken in consideration while doing levelling calculations.
- A, B & C : are points taking just to close the loop at BM1 (Not a part of longitudinal profile) and their readings recorded as B.S and F.S in the table above.

But it must be taken in consideration while doing levelling calculations.

❖ Levelling calculations

H for all points determined using ordinary levelling calculations with the required checks, as followed:

1. No. of setups = No. of T.P. + 1
2. No. of B.S = No. of F.S
3. $\sum B.S - \sum F.S = \text{Elev. of the last point} - \text{Elev. of the first point}$
4. $\sum \text{Elev. for all points} - \text{Elev. Of BM}_1 = [\sum (HI_i * (\# \text{ of IS} + \# \text{ of FS}))] - \sum IS - \sum FS$

Misclosure error (ϵ) = BM computed elevation (from leveling) – known elevation for BM

Tolerance error (mm) = $C \sqrt{K}$ where $\rightarrow C$: constant

K: loop length (Km)

Correction (C_i) = $-\epsilon * \frac{\text{No. of level setups up to the point}}{\text{total No. of setups}}$

H corrected = H calculated + correction

using

You have to submit the following:

1. Copy of your data
2. Full levelling calculations (Calculate corrected elevation at each point).
3. Longitudinal profile on A3 paper
4. Transverse profile on A4.

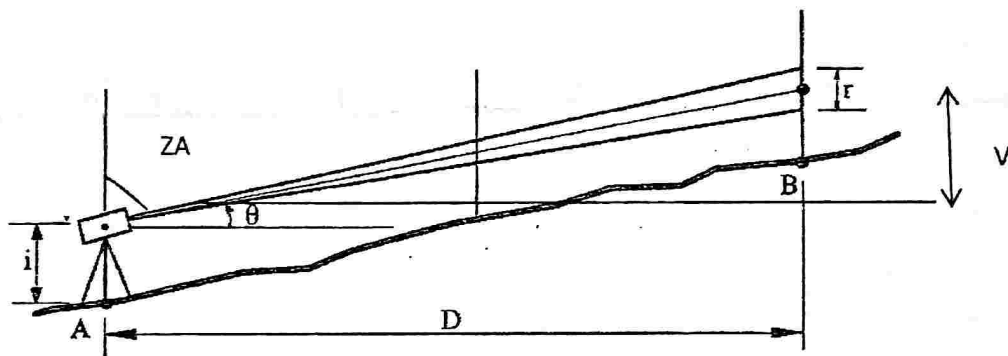
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Experiment no. 6 : Measuring Height of object using Stadia Method

Prepared by: Eng. Shuroq Jamal

The Stadia is a method of measuring distances and height of points with theodolite when there is no possibility to take any staff readings at those points such as building corner or tower.

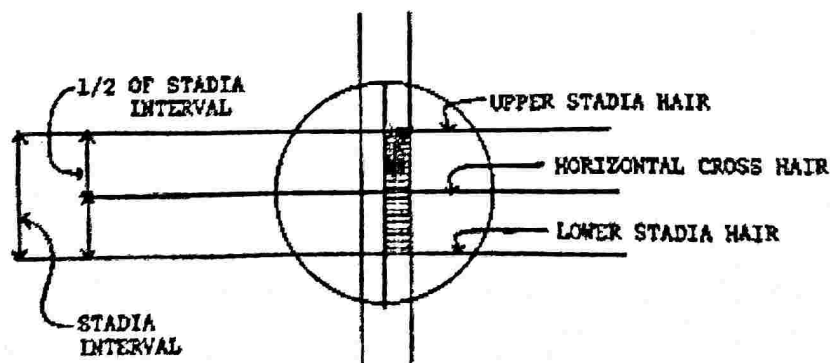


$$\text{Vertical distance } V = \frac{1}{2} K r \sin(2 Z.A)$$

$$\text{Horizontal distance } D = K r \sin^2 Z.A$$

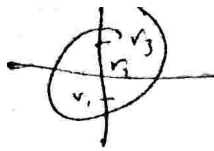
Where K is stadia constant

r is stadia interval = $r_1 - r_3$



Purpose: to find the height of tower (or point C)

20



Group B

Required Data :

Station	Point	HCR	Staff reading			ZA	HI
			r ₁	r ₂	r ₃		
A	BM	-----	✓ 1.186	✓ 1.387	✓ 1.579	89°58'25"	✓ 1.45m
A	B	0°0'0"	✓ 1.225	✓ 1.620	✓ 1.992	91°08'38"	✓
	C	HCR ₁ 56°51'36"	-----	-----	-----	75°58'04"	✓
B	C	0°0'0"	-----	-----	-----	-----	-----
	A	HCR ₂ 92°05'18"	-----	-----	-----	-----	-----

Where:

HCR: Horizontal circle reading

ZA: Zenith Angle

HI : Height of instrument

BM: Bench Mark

----- : No need to be measured

✓ : Record measurement.

Calculations:

Use $K = 100$, $(F+C=0)$ for all equations.

- H_{BM} : Known
- Find H_A

$$H_{BM} = H_A + HI_A + V_{A,BM} - r_2 \text{ BM} \quad \text{where : } V_{A,BM} = \frac{1}{2} K r \sin(2 Z.A)$$

$$r = r_1 - r_3$$

- $\angle a = HCR_1 - 0^\circ 0' 0''$
- $\angle b = HCR_2 - 0^\circ 0' 0''$
- $\angle c = 180^\circ - \angle a - \angle b$

- $DAB = K r \sin^2 Z.A$ where : $r = r_1 - r_3$
- Find DAC from sine law

$$\frac{DAC}{\sin b} = \frac{DAB}{\sin c}$$

- Find H_c

$$H_c = H_A + HI_A + \frac{DAC}{\tan ZA}$$

