



University of Zambia
School of Engineering
Department of Geomatic Engineering

1.02
2.136
2.137

GE481 Semester Test - 13th May 2004

Answer all questions

1. A levelling trajectory was carried out at a construction site near the University of Cape Town. The circuit began and closed at TBM1 with RL 1284.263. Results arising from that level survey are given in the table below.

LEVELLING

PNT	UPPER/ LOWER	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL
		BS	IS	FS	BS	FS	RISE	FALL	
BMI	1.368/0.904	1.135							1284.263
	2.303/1.857			2.887			0.946		1283.317
1	2.415/1.855	2.887		1.682			0.522		1283.850
	1.801/1.406								
2	2.005/1.754	1.881							
	-1.873/-1.621		-1.746				0.526		1284.376
	-1.821/-1.528		2.277				0.072		1284.304
	-2.405/-1.904						0.480		1284.784
	2.414/2.140			2.277				1.083	1283.701
3	2.512/2.095	2.304							
	1.877/1.531		1.704				0.600		1284.054
	2.198/1.790			1.993				0.289	1283.765
4	1.951/1.459	1.705							
	1.811/1.303		1.558				0.147		1283.618
	2.115/1.908		2.298				0.453		1284.071
	2.675/2.601		2.638				-0.627		1283.444
	1.258/0.907			1.084			1.554		1284.998
S BMT	2.301/1.867	2.083							
Bm1	2.413/1.986			2.899			0.116		1284.27
	Σ	11.244		11.237			6.941	6.934	1284.270
									-1284.263
									0.000007

2.135
1.604
1.136
2.080

$-1.818 + \pi = 0.460$ $1.818 + \pi = 0.460$

- a) Fill in the missing readings and complete the levelling booking form. Carry out all necessary checks. Use the booking form provided at the end of question paper. [8 Marks]

- b) Compute allowable and actual misclosure. State whether the latter is acceptable (assume $\sigma = 30\text{mm}$). [3 Marks]

$2.136 - \pi =$ $-2.298 - 2.277$ 1283.7

$-1.706 + \pi = 0.072$

$\pi = 1.818$

$-1.818 + \pi = 0.460$ $1.818 + \pi = 0.460$ $1.558 - \pi = 0.946$

$\pi =$ $1.135 - 0.945$

$1.558 - \pi = 0.453$ $\pi =$ $1.705 - \pi = 0.147$

- c) Calculate the adjusted levels of all the points in this levelling loop. [5 Marks]
- d) The BS and FS distances appear to be almost equal. What technique of levelling was being applied here and what advantages does it offer in terms of error mitigation or elimination? [2 + 3 Marks]
- e) Discuss, with the aid of a clearly labelled diagram, any of the three types of levelling instruments. [4 Marks]

2. The four corners A, B, C and D of a rectangular building were set out by intersection from two control points G and H. After the setting out had been completed, the reduced levels of A, B, C and D were taken and the lengths of the diagonals were measured with a steel tape of length 29.995m. The setting out and measurement data are given in table 1.

Calculate:

- i) The bearings required to establish points A and B from both control points
- ii) The error between the designed value and the set out value of the horizontal length of each diagonal. Assume that the ground slope along each diagonal was uniform.

Table 1.

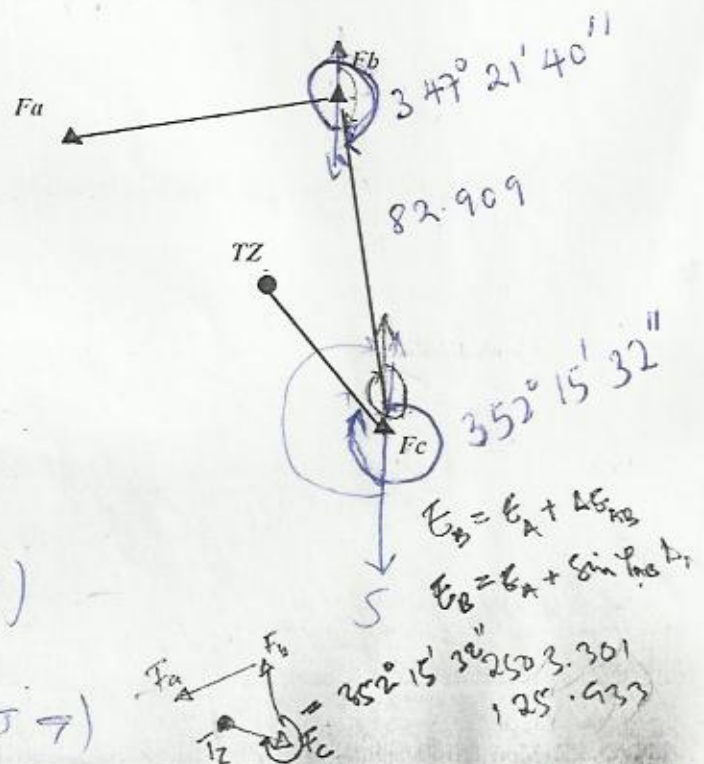
Point	Coordinates		RL (m)
	m E	m N	
A	641.710	513.110	27.120
B	677.065	548.465	28.715
C	705.349	520.181	25.050
D	669.994	484.826	30.475
G	601.520	525.730	
H	720.660	540.125	

Slope length along diagonal AC = 64.075m
Slope length along diagonal BD = 64.080m

[8 + 17 Marks]

3. During a survey to effect a subdivision of a property in Kabulonga, a minute theodolite was correctly mounted above point Fc in order to determine the plane coordinates of point TZ. The distance Fc - TZ was measured thrice along the slope with a tape as 64.467m, 64.466m and 64.465m. The known coordinates of Fa and Fb are:

Fa	3749.497m	987.879m
Fb	3699.464m	976.657m



$$C_{\text{SLOPE}} = -L(1 - \cos \theta)$$

$$D = L \cos \theta$$

$$E_{F_c} = E_{F_b} + \sin \phi_{F_b F_c} (82.909)$$

$$N_{F_c} = N_{F_b} + \cos \phi_{F_b F_c} (82.909)$$

$$E_{TZ} = E_{F_c} + 250 \sin 352^\circ 15' 32''$$

$$E_{TZ} = 125.933$$

$$N_{TZ} = N_{F_c} + 250 \cos 352^\circ 15' 32''$$

$$N_{TZ} = 2503.301$$

On further observation with the Theodolite at station F_c , the clockwise angle $F_b - F_c - TZ$ was determined as $352^{\circ}15'32''$ while the vertical angle to TZ was observed as $05^{\circ}12'01''$.

- (a) Compute the co-ordinates of points F_c and TZ , given that the bearing and horizontal distance of F_c from F_b are $347^{\circ}21'40''$ and 82.909m respectively

[12 Marks]

- (b) Describe the following terms using illustrations where necessary. Your description of the various terms must however be limited to a maximum of 10 lines.

- i) Photogrammetry
- ii) Cadastral Surveys
- iii) The Zambian L0 coordinate system
- iv) Contrast Level and Horizontal lines

[2 + 2 + 4 + 5 Marks]

-
4. Define Geomatics and discuss all its disciplines as well as four classifications. Furthermore, state how Geomatic Engineering would be helpful in your profession as a Civil or Agricultural engineer or indeed as Geologists or Soil Scientists?

[2 + 10 + 8 + 5 Marks]

The end

Good Luck



University of Zambia

School of Engineering
Department of Geomatic Engineering

GE481 Semester Test – 23rd August 2010

DOUG DEE!!

Answer all questions

ONE MORE BY KINAKO!!

Question 1 (16 + 14 Marks)

The four corners **A**, **B**, **C** and **D** of a rectangular building were set out by intersection from two control points **G** and **H**. After the setting out had been completed, the reduced levels of **A**, **B**, **C** and **D** were taken and the lengths of the diagonals were measured with a steel tape of length 29.995m. The setting out and measurement data are given in table 1.

Calculate:

- i.) The bearings required to establish points **A** and **B** from both control points
- ii.) The error between the designed value and the set out value of the horizontal length of each diagonal. Assume that the ground slope along each diagonal was uniform.

Table 1.

Point	Coordinates		
	m E	m N	RL (m)
A	641.710	513.110	27.120
B	677.065	548.465	28.715
C	705.349	520.181	25.050
D	669.994	484.826	30.475
G	601.520	525.730	
H	720.660	540.125	

Slope length along diagonal **AC** = 64.075m
Slope length along diagonal **BD** = 64.080m

Question 2 (15+15 Marks)

In order to determine the horizontal distance between two points A and B set on the floor of a tunnel, measuring heads were set up over those points. A new 30 m steel tape, standardized on the flat under a pull of 49 N at 20°C, is suspended in catenary between the measuring heads, and a pull of 150 N is applied. The mean tape readings at the measuring heads are observed to be 0.422 m and 29.872 m, and the difference in level between the heads is found to be 0.078 m. Determine the corrected horizontal distance AB.

The mean tape temperature during the observations was 26°C, the cross-sectional area of the tape was 0.406 cm². Mass of the tape was 0.27 g/cm, while the coefficient of linear expansion of steel is given as $1.15 \times 10^{-5} / ^\circ\text{C}$. The modulus of elasticity of steel is given as 207 000 N/mm²

Question 3 (5 + 10 + 10 + 10 + 5 Marks)

Describe the following terms using illustrations where necessary. Your description of the various terms must however be limited to a maximum of 10 lines.

- i.) Photogrammetry
- ii.) Engineering Surveys
- iii.) The Zambian **UTM** coordinate system
- iv.) The two ways of carrying out survey operations
- v.) Hydrographic surveys

The end

Good Luck

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2004 / 9 / 2003

University of Zambia
School of Engineering
Department of Geomatic Engineering

GE481 Assignment 2

Introduction to Levelling

1. The following is a page from a levelling field book. Fill in the missing readings and calculate the reduced levels of all the points.

LEVELLING BOOKING FORM

POINT	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS	RISE	FALL		
BM1	1.863			49.6				1225.535	11.4
1	1.880		1.663	46.8	49.1		0.600	1224.935	CP 11.4
2		2.250					0.370	1224.565	2.8
3	2.525		1.920	38.3	47.4	0.330		1224.895	CP 2.8
4		2.540					0.015	1224.88	4.2
5		1.84				1.000		1225.88	4.2
6	1.361		2.115	30.1	38.2		0.675	1225.305	CP 4.2
7		1.624					0.264	1225.041	5.6
8		1.155				0.470		1225.510	5.6
9	2.005		1.895	45.6	30.7		0.740	1224.770	CP 5.6
BM2			1.255		45.1	0.750		1225.521	7
Σ	8.835		8.948	210.4	210.5	2.550	2.564	1225.521	
	-8.848					-2.564		1225.535	
	-0.014					-0.014		-0.014	

- Compute the allowable and actual misclosures. State whether the latter is acceptable (assume $\sigma = 25\text{mm}$) if the published Reduced Level of BM2 is 1225.528.
- Calculate the adjusted levels of all the points in this levelling loop.
- The BS and FS distances appear to be almost equal. What technique of levelling was being applied here and what advantages does it offer in terms of error mitigation or elimination?
- With the aid of diagrams and formulas, describe how the level and horizontal lines relate to each other over shorter and longer distances.

$$E_{all} = \pm 25 \sqrt{16} = \pm 100$$

$$= \pm 16.22 - E$$

$$E_{act} = 0.014 - (-0.007) = +0.027m + 7mm$$

$$Corr = 7/5$$

$$1.361 - x = -0.264$$

$$y = 1.255$$

$$x = 0.575$$

2. The following is raw data for a level circuit. Arrange the data into the levelling field book provided given that the Reduced Level (RL) of *BMI* is 1264.854m.

BS on *BMI* 1.146, FS on *TP1* 1.219, BS on *TP1* 2.478, FS on *TP rock* 0.902, BS on *TP rock* 2.954, FS on *TP2* 1.494, BS on *TP2* 0.195, FS on *TP3* 0.674, BS on *TP3* 2.393, FS on *TP4* 1.558, BS on *TP4* 3.069, FS on *TP5* 3.444, BS on *TP5* 1.405, FS on *TP6* 3.636, BS on *TP6* 1.792, FS on *TP7* 1.437, BS on *TP7* 0.765, FS on *BMI* 1.844.

LEVELLING BOOKING FORM

POINT	READINGS			DISTANCE		HEIGHT OF COLLIMATION	REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS			
				49.1				
				46.8	49.6			
				38.2	47.4			
				30.7	38.3			
				45.4	30.6			
				46.7	45.1			
				50.2	46.3			
				38.7	49.8			
				42.0	38.8			
					41.8			
Σ								

- a) Compute the allowable and actual misclosures given that the distances in the table correspond to the instrument to station distances (for instance 49.1m is the distance from the instrument to *BMI*). State whether the latter is acceptable (assume $\sigma = 25\text{mm}$).
 - b) Calculate the adjusted levels of all the points in this levelling loop.
 - c) Describe at least three applications of levelling and when does it become necessary to use inverted staff readings?
 - d) With the aid of diagrams, describe the three types of levelling instruments.
 - e) Explain the principle of obtaining height difference between two points
 - f) Describe the errors and error sources affecting levelling in general and levelling instruments in particular.
3. A level survey is carried out around a particular area for vertical control works. Points 1, 2, 3, 4 and 5 are pegs for which the Reduced levels are determined. Point 4 is a centreline point on a road at which a cross-section has to be made. This is done in the same survey. The cross-section

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Department of Geomatic Engineering

GE481 Assignment 2
Introduction to Levelling

1. A levelling trajectory was carried out at a construction site near the University of Cape Town. The circuit began and closed at TBM1 with RL 1284.263. Results arising from that level survey are given in the table below.

LEVELLING

PNT	UPPER/ LOWER	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL
		BS	IS	FS	BS	FS	RISE	FALL	
BM1	1.368/0.904	1.135			46.7				1284.263
	2.303/1.857			2.081	44.6	44.6	0.948		1283.317
1	2.415/1.855	2.136			56				
	1.801/1.406			1.853	39.5		0.533		1283.850
2	2.005/1.754	1.881			25.1				
	-1.873/-1.621		-1.746				3.024		1287.477
	-1.821/-1.528		-1.874	0.127			0.072		1287.465
	-2.405/-1.904		-1.338	2.154			0.480		1287.885
	2.414/2.140			2.277	24.4				1283.454
3	2.512/2.095	2.304			41.7				
	1.877/1.531		1.704				0.600		1284.054
	2.198/1.790			1.993	40.8		0.289		1283.765
4	1.951/1.459	1.705			49.2				
	1.811/1.303		1.858				0.147		1283.912
	2.115/1.908		2.011				0.453		1283.459
	2.675/2.601		2.638				0.627		1282.832
	1.258/0.907			1.084	35.1		0.554		1284.386
5	2.301/1.867	2.083			43.4				
BM1	2.413/1.986			2.099	42.7		0.116		1284.270
	Σ	11.244		11.237	261.8	230.1	6.941	6.934	

- a) Fill in the missing readings and complete the levelling booking form. Carry out all necessary checks. Use the booking form provided at the end of question paper. [10 Marks]
- b) Compute allowable and actual misclosure. State whether the latter is acceptable (assume $\sigma = 30\text{mm}$). [5 Marks]

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c) Calculate the adjusted levels of all the points in this levelling loop. [8 Marks]

d) The BS and FS distances appear to be almost equal. What technique of levelling was being applied here and what advantages does it offer in terms of error mitigation or elimination? [2 + 6 Marks]

e) Discuss, with the aid of a clearly labelled diagram, any of the three types of levelling instruments. [4 Marks]

2. The following is raw data for a level circuit. Arrange the data into the levelling field book provided given that the Reduced Level (RL) of *BMI* is 1264.854m.

BS on *BMI* 1.146, FS on *TP1* 1.219, BS on *TP1* 2.478, FS on *TP rock* 0.902, BS on *TP rock* 2.954, FS on *TP2* 1.494, BS on *TP2* 0.195, FS on *TP3* 0.674, BS on *TP3* 2.393, FS on *TP4* 1.558, BS on *TP4* 3.069, FS on *TP5* 3.444, BS on *TP5* 1.405, FS on *TP6* 3.636, BS on *TP6* 1.792, FS on *TP7* 1.437, BS on *TP7* 0.765, FS on *BMI* 1.844.

LEVELLING BOOKING FORM

POINT	READINGS			DISTANCE		HEIGHT OF COLLIMATION	REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS			
BMI	1.146			49.1		1266.000	1264.854	BMI
1	2.478		1.219	46.8	49.6	1267.259	1264.781	CP
rock	2.954		0.902	38.2	47.4	1269.311	1266.357	CP
2	0.195		1.494	30.7	38.3	1268.012	1267.817	CP
3	2.393		0.674	45.4	30.6	1269.731	1267.338	CP
4	3.069		1.558	46.7	45.1	1271.242	1268.193	CP
5	1.405		3.444	50.2	46.3	1269.203	1267.798	CP
6	1.792		3.636	38.7	49.8	1267.359	1265.567	CP
7	0.765		1.437	42.0	38.8	1266.687	1265.922	CP
BMI			1.844		41.8		1264.843	BMI
Σ	16.192		16.208	387.8	387.7		1264.843	
							- 1264.854	
							- 0.011	

a) Compute the allowable and actual misclosures given that the distances in the table correspond to the instrument to station distances (for instance 49.1m is the distance from the instrument to *BMI*). State whether the latter is acceptable (assume $\sigma = 25\text{mm}$). [10 Marks]

b) Calculate the adjusted levels of all the points in this levelling loop. [5 Marks]

c) Describe at least one applications of levelling and when does it become necessary to use inverted staff readings? [10 Marks]

d) Explain the principle of obtaining height difference between two points [5 Marks]

e) Describe the errors, error sources affecting levelling in general, and levelling instruments in particular. [10 Marks]

$$E_{\text{allow}} = \pm \sigma \sqrt{A(\text{km})}$$

$$= \pm 25 \sqrt{0.7755}$$

$$= \pm 22.015 \text{ mm}$$

$$= \pm 22.015 \text{ mm} \approx \pm 22 \text{ mm}$$

$$E_{\text{actual}} = A_0 \text{ RL} - K_{\text{inst}} \text{ RL}$$

$$= (-0.011) - 1264.854 - 1264.843$$

$$D = (387.8 + 387.7) \times 10^{-3}$$

$$= 0.7755 \text{ km}$$

$$\text{corr} = - (E_{\text{actual}}) / n$$

$$= - (-0.011) / 8$$

$$= + 0.001375$$

3. In order to determine the minimum clearance between a road running generally in a north south direction and the underside of a bridge, a series of levels were taken as shown in Table 1. All the readings are in metres.

Levelling booking form

POINT	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS	RISE	FALL		
1	0.150			49.6				1259.617	BM1
2	0.219		3.152	46.8	49.1	2.802		1256.615	CP
3		3.127				2.908		1253.707	
4		-0.862				2.999		1257.696	
4a		2.858				2.920		1253.976	
4b		-0.868				2.976		1257.702	
4c		2.872				2.940		1253.962	
4d		-0.802				2.674		1259.636	
5	3.566		0.478	65.6	47.4	1.180		1256.356	CP
1			0.305		65.1	2.261		1259.617	BM1
		3.925	2.925			14.65	14.65	1259.617	
								-1259.617	
		0				0		0	

- a) Complete the booking form. [5 Marks]
- b) Compute the allowable and actual misclosure in the loop and state whether the latter is acceptable or otherwise (assume $\sigma = 25\text{mm}$). [5 Marks]
- c) Calculate the adjusted RL's of all the points in this level loop. [5 Marks]
- d) With the aid of diagrams and formulas, describe how the level and horizontal lines relate to each other over shorter and longer distances. How does the curvature of the earth affect this relationship? [15 Marks]

Point RL Corr ABL PE

The end

Robert Zimba Room SR2 New Eng. Building

KAS



The University of Zambia
School of engineering
Department of Geomatic Engineering
University Examinations – Semester I

GE 481: Introduction to Surveying

August 2003

Instructions

Time: Three (3) hours.

Answer four (4) questions in total

Three (3) from section A for all students. Use tables provided at the back

One (1) question from section B for Engineering and Agricultural Science Students

One (1) question from section C for Geology Students.

PLEASE! Answer different sections on separate answer Booklet(s). DO NOT tie them together.

Section A: Answer any three (3) questions from this section

1. The four corners *A*, *B*, *C* and *D* of a rectangular building were set out by intersection from two control points *G* and *H*. After the setting out had been completed, the reduced levels of *A*, *B*, *C* and *D* were taken and the lengths of the diagonals were measured with a steel tape of length 29.995m. The setting out and measurement data are given in table 1.

Calculate:

- i) The bearings required to establish points *A* and *B* from both control points
- ii) The error between the designed value and the set out value of the horizontal length of each diagonal. Assume that the ground slope along each diagonal was uniform.

Table 1.

Point	Coordinates		RL (m)
	m E	m N	
A	641.710	513.110	27.120
B	677.065	548.465	28.715
C	705.349	520.181	25.050
D	669.994	484.826	30.475
G	601.520	525.730	
H	720.660	546.125	

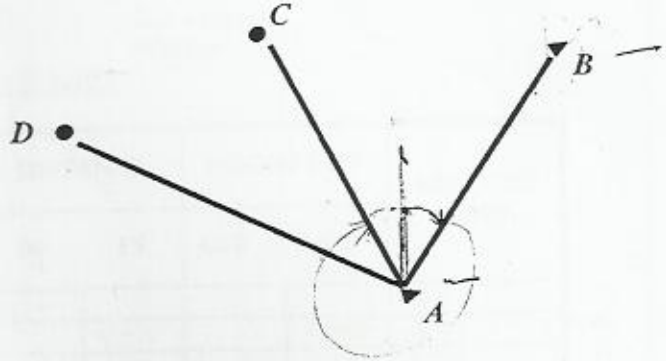
Slope length along diagonal AC = 64.075m
Slope length along diagonal BD = 64.080m

Corrected
Set out - Design

[16 + 9 Marks]

2. In order to determine the plane coordinates of points *C* and *D*, a minute Theodolite was correctly mounted above point *A*. The distances *AC* and *AD* were measured twice along the slope with a tape as 160.936m and 272.155m. The known coordinates of *A* and *B* are:

A 38853.807mE 11276.044mN
B 38941.835mE 11280.506mN



The horizontal angles from point *A* are observed in two rounds and for the vertical angle only one FL and FR reading are taken.

Horizontal angles (^{degrees} grades)

Pnt	Readings		Simple Mean	Reduced Mean	Remarks
	FL	FR			
<i>B</i>	254 52 52	74 52 48	254° 52' 50"	00° 00' 00"	RO
<i>C</i>	211 27 31	31 27 27	211° 27' 29"	-43° 25' 21"	
<i>D</i>	180 10 06	00 10 04	180° 10' 05"	-74° 42' 45"	
<i>B</i>	344 50 05	164 50 01	344° 50' 30"	00° 00' 00"	RO
<i>C</i>	301 24 40	121 24 39	301° 24' 39.5"	-43° 25' 24"	
<i>D</i>	270 07 21	90 07 17	270° 07' 19"	-74° 43' 14"	

Mean: 00° 00' 00"

Vertical angles

Pnt	Readings		Reduced FL	Reduced FR	Mean
	FL	FR			
<i>C</i>	88 39 49	271 20 16	1° 20' 11"	01° 20' 16"	01° 20' 14"
<i>D</i>	84 45 17	275 14 47	05° 14' 43"	05° 14' 43"	05° 14' 45"

- ✓ a) Complete the booking forms. [7 Marks]
- b) Calculate the co-ordinates of points *C* and *D*. [12 Marks]
- ✓ c) In order to measure angles with a relatively high order of accuracy, so that the effects of certain systematic and random errors are minimised as much as possible, we use the so-called Bessel -rounds. Describe the rules that must be followed by this approach. [6 Marks]

$$90 - FC = FL$$

3. A leveling trajectory was carried out at a construction site near the University of Cape Town. The circuit began and closed at TBM1 with RL 1284.263. Results arising from that level survey are given in the table below.

Name:
Date:

Instrument:
Weather:

LEVELLING

PNT	UPPER/ LOWER	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL
		BS	IS	FS	BS	FS	RISE	FALL	
BM1	1.368/0.904	1.135							
	2.303/1.857			X				0.946	1284.263
1	2.415/1.855	X							
	1.801/1.406			X					1283.850
2	2.005/1.754	1.881							
	1.873/1.621		1.746				0.135		
	1.821/1.528		X				0.072		
	2.405/1.904		X					0.480	
	2.414/2.140			2.277					
3	2.512/2.095	2.304							
	1.877/1.531		1.704						
	2.198/1.790			1.993					
4	1.951/1.459	1.705							
	1.811/1.303		X				0.147		
	2.115/1.908		X					0.453	
	2.675/2.601		2.638						
	1.258/0.907			1.084					
BM1	2.301/1.867	2.083							
	2.413/1.986			X					
Σ		11.244		11.237			3.041	3.034	

- ✓ a) Fill in the missing readings and complete the leveling booking for n. Carry out all necessary checks. [10 Marks]
- ✓ b) Compute the allowable and actual misclosures. State whether the latter is acceptable (assume $\sigma = 30\text{mm}$). [5 Marks]
- ✓ c) Calculate the adjusted levels of all the points in this levelling loop. [6 Marks]
- ✓ d) Describe at least two other methods of levelling. [4 Marks]

4. The Theodolite is said to be the most important instrument in Surveying. From the determination of angles between points to heighting in Mountainous terrain. Describe its various parts with the aid of a clearly labelled diagram. Furthermore, explain what Transitting of the Theodolite is and why it's necessary.

[15 + 10 Marks]

Transiting

When the theodolite is used to measure angles between points, it is necessary to ensure that the instrument is perfectly level and that the line of sight is horizontal. This is done by a process called transiting. The theodolite is first levelled and then the telescope is rotated about its horizontal axis until the bubble level is centred. This ensures that the line of sight is horizontal. The process of transiting is necessary to ensure that the measurements are accurate and that the instrument is not affected by any tilt or rotation.

Leveling

Leveling is the process of determining the height of a point above a datum. It is done by using a level and a staff. The level is a long, narrow tube containing a bubble level. The staff is a vertical rod with a scale on it. The level is held horizontally and the staff is held vertically. The bubble level is used to ensure that the line of sight is horizontal. The height of the point is then determined by reading the staff. Leveling is necessary to determine the height of a point above a datum and to ensure that the measurements are accurate.

End of Section A