namibia university
of science and technology
FACULTY OF NATURAL RESOURCES AND SPATIAL SCIENCES

DEPARTMENT OF GEO-SPATIAL SCIENCES AND TECHNOLOGY

QUALIFICATIONS : DIPLOMA IN GEOMATICS BACHELOR OF GEOMATICS	
QUALIFICATIONS CODES: 06DGEM 07BGEM	COURSE LEVEL: Level 5
COURSE CODE: BSV521S	COURSE NAME: Basic Surveying
SESSION: November 2019	PAPER: Theory
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER:	Mr F. J. Louw
MODERATOR:	Mr S. E. Sinvula

INSTRUCTIONS
1. You **MUST** answer **Question 1 in SECTION A** and **ANY THREE QUESTIONS in SECTION B**
2. Write clearly and neatly.
3. Number the answers clearly.
4. Make sure your Student Number is on the EXAMINATION BOOK(s).
5. Make sure your Student Number is on all the Data Sheets and that you submit them with your EXAMINATION BOOK(s).

PERMISSIBLE MATERIALS
1. Calculator, ruler, pencil and eraser.

THIS QUESTION PAPER CONSISTS OF 10 PAGES (Including this front page and 2 Data Sheets)

SECTION A - YOU MUST ANSWER ALL QUESTIONS

Question 1

1.1. Answer the following questions by selecting the correct statement for each:

   1.1.1. Making measurements of the relative positions of natural and man-made features on, above or beneath the earth's surface, and the presentation of this information either graphically or numerically is called:

   A   Surveying

   B   Levelling

   C   Measuring

   D   Contouring

   1.1.2. The type of surveying in which the true shape of the earth is taken into account is:

   A   Photogrammetry

   B   Geodetic Surveying

   C   Cartography

   D   Plane Surveying

   1.1.3. What type of survey are performed by a registered Land Surveyor or under his/her supervision in Namibia, concerned with the measurement of land for the preparation of plans and diagrams, drawn to scale, showing and defining legal property boundaries in order that ownership may be registered in the Deeds Office?

   A   Topographic Surveying

   B   Hydrographic Surveying

   C   Cadastral Surveying

   D   Engineering Surveying

1.1.4.   Which of the following methods of levelling makes use of the phenomenon that difference in elevation between two points is proportional to the difference in atmospheric pressures at these points?

A   Barometric levelling

B   Trigonometric levelling

C   Spirit levelling

D   Traverse levelling

1.1.5.   Which among the following is one of the principles of surveying?

A   Taking measurements

B   Covering entire area

C   Determining the elevation differences

D   Working from whole to part

1.1.6.   Parallax can be eliminated by focusing the eye piece and objective.

A   True

B   False

C   May be

D   None of these

1.1.7.   Close contours of decreasing values towards their centre, represents a

A   Hill

B   Depression

C   Saddle

D   River bed

1.1.8.   Contours of different elevations may cross each other only in the case of a

A   Over hanging cliff

B   Vertical cliff

C   Pass

D   Valley

1.1.9. The Reference object in angular observations must fulfil the following requirements:

    A   It must be a well-defined point

    B   It must not be to close or too far

    C   It does not have to have co-ordinates

    D   All the above

1.1.10. A permanent reference point or mark, of known height above a datum, is called

    A   Reference point

    B   Bench mark

    C   Datum point

    D   Witness mark

(1 x 10)

1.2. Distinguish between "Zero south orientation" and "True orientation".   (4)

1.3. Differentiate between a Measurement and an Observation.   (4)

1.4. Measured survey data can be described according to accuracy and precision. Fully describe "Accurate and Precise Observations".   (2)

1.5. Write short notes to explain what Systematic Errors are.   (2)

1.6. Are Systematic Errors controllable or uncontrollable?   (1)

1.7. Give an example of a Systematic Error.   (1)

1.8. Explain collimation line.   (1)

[25]

# SECTION B - YOU MUST ANSWER ANY 3 QUESTIONS

Question 2

2.1. Use the levelling observations given on the levelling field sheet below to determine the final heights using any method which provides a full arithmetic check. All usual checks must be done, and any mis-closures need to be distributed.   (12)

Levelling field sheet

Point	B.S.	I.S.	F.S.	Final Heights
K2	1.451			1669.125
A		1.463		
B		0.730		
C	1.996		0.782	
D		1.754		
E		-1.139		
F	-0.990		-1.145	
G		-0.995		
H		1.376		
I	0.555		1.539	
J		0.896		
K		-0.589		
L		-2.489		
K2			1.839	1669.125

2.2. Points A, B, C and D were placed around a dam for the survey of a proposed water right. As neither A to C, nor B to D were intervisible, the distances AB, BC, CD and DA, and the angles at A, B, C and D were measured. Unfortunately, it was discovered that only the recorded value of angle C was correct. From the information given in the sketch on the next page, calculate the values of angles A, B and D. Please perform all possible checks.

(13)
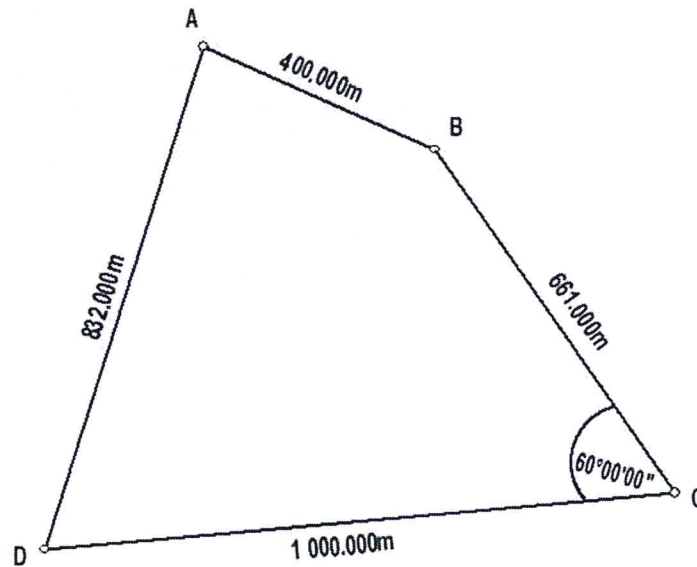
[25]

Question 3

3.1. Calculate oriented directions for the traverse by completing the direction sheet on Data Sheet 1. Use the said Data Sheet for all your calculations.   (10)

3.2. Calculate the traverse on Data Sheet 2. Use the said Data Sheet for all your calculations. Use the Bowditch Rule to adjust the traverse. Please note that the directions are oriented, and the distances are final.   (10)

3.3. Differentiate between a Closed Traverse and an Open Traverse.   (2)

3.4. List THREE application of Levelling.   (3)

[25]

Question 4

4.1. Use the information below to calculate the co-ordinates of point **RP100**.   (11)

Please note:

- The Atmospheric Correction, the Conversion to German Legal Metre, Prism constant, instrument correction and the Combined Sea level & Scale Enlargement Scale Factor correction are already applied to all measured distances.

- The directions are **FINAL OBSERVED DIRECTIONS**.

Co-ordinates

Point	Y	X	Description
Δ Eros	-10 489.688	+60 272.255	Standard Concrete Pillar
K2	- 8 166.864	+62 580.799	16mm iron peg in paving.

@ RP100   Height of Instrument = 1.715m

Point/Station	Final Observed Direction	Final Horizontal Distance
Δ Eros	242° 03' 23"	
K2	324° 14' 10"	26.339m

4.2. Calculate the mean co-ordinates of point **INT100** using the information below.   (14)

Co-ordinates

Point	Y	X	Description
ΔP2	- 8 183.882	+62 681.985	Concrete Pillar
K3	- 8 136.154	+62 628.497	Hole in concrete

The Final Oriented Direction from ΔP2 to INT100 is 60° 38' 05"

The Final Horizontal Distance from K1 to INT100 is 203.065m

                                                                                                        [25]

Question 5

5.1. What is the alternative method to calculate a resection?   (1)

5.2. Briefly explain the FOUR important aspects of a resection.   (4)

5.3. During your survey project practical, you have done the observation to three trigonometrical beacons at point **R**. Use this information below to calculate the co-ordinates for point **R** by using Collins Q-point method.   (20)

Co-ordinates

Name	Y	X	Z
ΔKleine	-10 567.964	+70 190.852	
ΔSWP	- 4 680.105	+62 348.557	
ΔEros	-10 489.688	+60 272.255	

@ R	Height of Instrument = 1.678	
Name	Fin. Observed Dir.	
Δ SWP	111° 03' 51"	
ΔEros	223° 12' 37"	Long Leg
Δ Kleine	334° 10' 16"	

[25]

Student Number: _____   Data Sheet 1

Question 3.1

Direction Sheet

1	2	3	4	5	6	7
Station	Final Observed Direction	Incoming/ Back Direction	Prov. Correction	Outgoing/ Forward Direction	Final Correction	Final Direction (Join Direction / Final Oriented Direction)
@ K1						
ΔCC	285° 56' 10"					**285° 56' 31"**
ΔMun	309° 39' 50"					**309° 40' 12"**
ST1	81° 42' 05"					
@ ST1						
K1	261° 42' 20"					
ST2	87° 48' 08"					
@ST2						
ST1	267° 47' 50"					
H1	61° 47' 34"					
@H1						
ΔWin5	236° 15' 40"					**236° 15' 26"**
ST2	241° 48' 00"					
ΔWin3	78° 32' 48"					**78° 32' 28"**

Student Number: _____   Data Sheet 2

Question 3.2

Bowditch Rule - Adjustment Sheet

Note: All answers must be rounded off to 3 decimal places

DIRECTION & DISTANCE	JOINS	DIFFERENCES		STATION	FINAL	COORDINATES
		ΔY	ΔX		Y	X
				Hotel	-7 554.223	62 655.709
241° 47' 54"						
160.935m						
	Do NOT Calculate Joins			TR1		
267° 48' 18"						
203.515m						
				TR2		
261° 42' 31"						
205.118m						
				Kerb	-8102.407	62542.287

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FIRST OPPORTUNITY EXAMINATION MEMORANDUM	
EXAMINER:	**Mr F. J. Louw**
MODERATOR:	**Mr S. E. Sinvula**

INSTRUCTIONS
1. The model answers are used as guidance only.
2. The information presented by the students will be evaluated on merit.

THIS MEMORANDUM CONSISTS OF 17 PAGES (Including this front page and 2 Data Sheets)

1.1.4.   Which of the following methods of levelling makes use of the phenomenon that difference in elevation between two points is proportional to the difference in atmospheric pressures at these points?

A   ***Barometric levelling***

B   Trigonometric levelling

C   Spirit levelling

D   Traverse levelling

1.1.5.   Which among the following is one of the principles of surveying?

A   Taking measurements

B   Covering entire area

C   Determining the elevation differences

D   ***Working from whole to part***

1.1.6.   Parallax can be eliminated by focusing the eye piece and objective.

A   ***True***

B   False

C   May be

D   None of these

1.1.7.   Close contours of decreasing values towards their centre, represents a

A   Hill

B   ***Depression***

C   Saddle

D   River bed

1.1.8.   Contours of different elevations may cross each other only in the case of a

A   ***Over hanging cliff***

B   Vertical cliff

C   Pass

D   Valley

1.4. Measured survey data can be described according to accuracy and precision. Fully describe "Accurate and Precise Observations". (2)

Accurate and Precise Observations - All observations are closely grouped and the measurement (average value) is accurate.
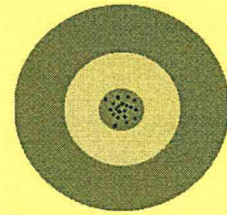
1.5. Write short notes to explain what Systematic Errors are. (2)

Systematics errors are caused by a faulty system. These errors are dependent on: The observer, the instrument, physical and/or environmental conditions(these errors follow a defined pattern under similar conditions)

1.6. Are Systematic Errors controllable or uncontrollable? (1)

Controllable

1.7. Give an example of a Systematic Error. (1)

- *The observer – Errors caused by limitations of the observer's natural senses (e.g. vision & hearing).*
- *Instrument errors – These include collimation & index errors as well as those caused by instrument being out of adjustment.*
- *Environmental conditions – Temperature, humidity, barometric pressure and visibility.*

ANY ONE

1.8. Explain collimation line. (1)

This is the imaginary line passing through the optical centre of the object lens, through the telescope, through the eyepiece and enters the eye.

[25]

2.2. Points A, B, C and D were placed around a dam for the survey of a proposed water right. As neither A to C, nor B to D were intervisible, the distances AB, BC, CD and DA, and the angles at A, B, C and D were measured. Unfortunately, it was discovered that only the recorded value of angle C was correct. From the information given in the sketch on the next page, calculate the values of angles A, B and D. Please perform all possible checks.

(13)
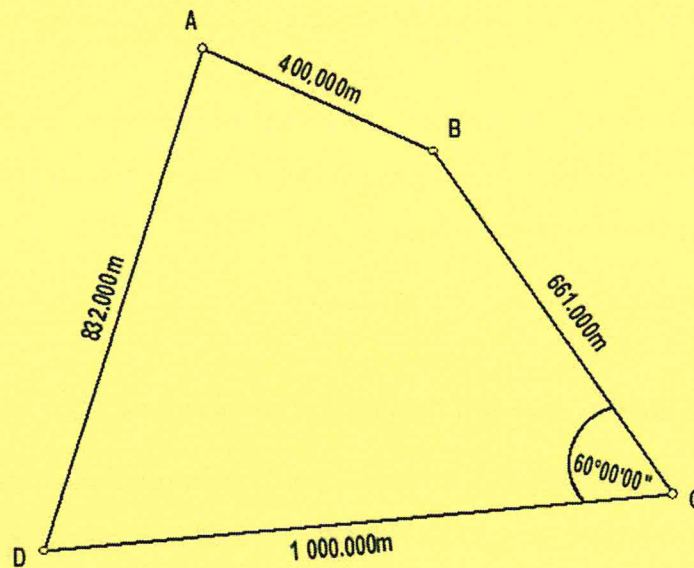
In Triangle BCD
Distance BD	**=**	**880.864m**
Angle CBD	**=**	**79° 28' 07"**
Angle BDC	**=**	**40° 31' 53"**
Angle BCD	**=**	**60° 00' 00"**
∑ of Angles	**=**	**180° 00' 00"**

In Triangle ABD
Angle BAD	**=**	**83° 25' 02"**
Angle ABD	**=**	**69° 46'05"**
Angle ADB	**=**	**26° 48' 53"**
∑ of Angles	**=**	**180° 00' 00"**

Question 4

4.1. Use the information below to calculate the co-ordinates of point **RP100**.   (11)

Please note:

- The Atmospheric Correction, the Conversion to German Legal Metre, Prism constant, instrument correction and the Combined Sea level & Scale Enlargement Scale Factor correction are already applied to all measured distances.

- The directions are **FINAL OBSERVED DIRECTIONS**.

Co-ordinates

Point	Y	X	Description
Δ Eros	-10 489.688	+60 272.255	Standard Concrete Pillar
K2	- 8 166.864	+62 580.799	16mm iron peg in paving.

@ RP100   Height of Instrument = 1.715m

Point/Station	Final Observed Direction	Final Horizontal Distance
Δ Eros	242° 03' 23"	
K2	324° 14' 10"	26.339m

Join K2 to Δ Eros

Δ Eros	Y-10 489.688	X+60 272.255	Direction. = 225° 10' 36"
K2	Y -8 166.864	X+62 580.799	Distance = 3 274.887m
ΔY =	-2 322.824	ΔX = -2 308.544	

Measured Angle @ RP100   = 82° 10' 47"

Angle @ ΔEros   = 0° 27' 24"

Angle @ K2   = 97° 21' 49"

Direction K2 to RP100   = 127° 48' 47"

Polar K2 to RP100
Direction = 127° 48' 47"   K2   Y-8 166.864   X+62 580.799
Distance= 26.339m   ΔY =   +20.808   ΔX =   -16.148
                          RP100   Y-8 146.056   X+62 564.651

Question 5

5.1.   What is the alternative method to calculate a resection?   (1)

   Blunt's Method

5.2.   Briefly explain the FOUR important aspects of a resection.   (4)

   If three known points are visible and correctly identified from an unknown point, by measuring three directions to these known points, the orientation correction and subsequently the co-ordinates of the unknown point can be determined.
   A minimum of four existing known points is usually recommended to allow for checks.
   The existing control points should be evenly distributed around the point.
   The existing control points observed should be identified in the field using a map. To merely sight unidentified control points on the horizon is to invite trouble.

5.3.   During your survey project practical, you have done the observation to three trigonometrical beacons at point **R**. Use this information below to calculate the co-ordinates for point **R** by using Collins Q-point method.   (20)

   Co-ordinates

Name	Y	X	Z
ΔKleine	-10 567.964	+70 190.852	
ΔSWP	- 4 680.105	+62 348.557	
ΔEros	-10 489.688	+60 272.255	
@ R	Height of Instrument = 1.678		
Name	Fin. Observed Dir.		
Δ SWP	111° 03' 51"		
ΔEros	223° 12' 37"	Long Leg	
Δ Kleine	334° 10' 16"		

   Angle α1   *= 102° 08' 46"*
   Angle ß1   *= 110° 57' 39"*
   Angle α   *= 67° 51' 14"*
   Angle ß   *= 69° 02' 21"*
   ∑ of Angles   *= 360° 00' 00"*

Direction =154° 58' 36"	ΔKleine	-10 567.964	+70 190.852
Distance = 7 440.701m		ΔY = +3 147.322	ΔX = - 6 742.284
	R	Y - 7 420.642	X +63 448.568

R   Y - 7 420.644   X +63 448.566

[25]

Rise and Fall Levelling Sheet

NOTE: The **BOLD** and <u>Underlined</u> values are the Inverted Staff Readings.							
Rounded off to the nearest 3 (0.000) decimal places.							
POINT	BACK SIGHT	INTER. SIGHT	FORE SIGHT	RISE	FALL	REDUDED LEVELS	CORRECTION	FINAL LEVELS

POINT	BACK SIGHT	INTER. SIGHT	FORE SIGHT	RISE	FALL	REDUDED LEVELS	CORRECTION	FINAL LEVELS
K2	1.451					1669.125	0.000	1669.125
A		1.463			*0.012*	*1669.113*	*0.001*	*1669.114*
B		0.730		*0.733*		*1669.846*	*0.001*	*1669.847*
C	1.996		0.782		*0.052*	*1669.794*	*0.001*	*1669.795*
D		1.754		*0.242*		*1670.036*	*0.001*	*1670.038*
E		**-1.139**		*2.893*		*1672.929*	*0.001*	*1672.931*
F	**-0.990**		**-1.145**	*0.006*		*1672.935*	*0.001*	*1672.937*
G		**-0.995**		*0.005*		*1672.940*	*0.002*	*1672.942*
H		1.376			*2.371*	*1670.569*	*0.002*	*1670.571*
I	0.555		1.539		*0.163*	*1670.406*	*0.002*	*1670.408*
J		0.896			*0.341*	*1670.065*	*0.003*	*1670.068*
K		**-0.589**		*1.485*		*1671.550*	*0.003*	*1671.553*
L		**-2.489**		*1.900*		*1673.450*	*0.003*	*1673.453*
K2			1.839		*4.328*	*1669.122*	*0.003*	1669.125
	3.012	*1.007*	*3.015*	*7.264*	*7.267*			
	3.015			*7.267*				
	-0.003			*-0.003*		*-0.003*		
						error =	*-0.003*	
						correction =	*0.003*	

Student Number: _____

Question 3.2

Bowditch Rule - Adjustment Sheet

Note: All answers must be rounded off to 3 decimal places

DIRECTION & DISTANCE	JOINS	DIFFERENCES		STATION	FINAL	COORDINATES
		ΔY	ΔX		Y	X
				Hotel	**-7 554.223**	**62 655.709**
241° 47' 54"		-141.830	-76.054			
160.935m		-0.004	0.002			
				TR1	-7696.057	62579.657
267° 48' 18"		-203.366	-7.795			
203.515m	Do NOT Calculate Joins	-0.005	0.002			
				TR2	-7899.428	62571.864
261° 42' 31"		-202.974	-29.580			
205.118m		-0.005	0.002		-8102.407	62542.287
				Kerb	**-8102.407**	**62542.287**
S=		-548.170	-113.428		-548.184	-113.422
569.568m		-0.014	0.006			

Linear Mis-closure = 0.015
Accuracy = 1/38 000
Class A = 0.059
Traverse is a Class A