GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND ENVIRONMENT

DEPARTMENT OF GEOMATICS AND SURVEYING

ADJUSTMENT COMPUTATIONS II

ESG 3209

Examination Paper

April 2025

This examination paper consists of 4 pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: **Mr A Sibanda**

INSTRUCTIONS

1. Answer ALL 4 questions
2. Each question carries 25 marks
3. Use of calculators is permissible, but programmable calculators are not allowed in the exam
4. Statistical tables

QUESTION 1

Statistical Analysis			Marks
1	**a**	An angle is measured 10 times. Each measurement is independent and made with the same precision. The sample mean is 42 12 14.6 and the sample standard deviation is 3.7″. Answer the following	
		i. Test at a significance level of 5% the hypothesis that the population standard deviation σ of the measurements is 2.0″ against the alternative that σ is not 2.0″	**3**
		ii. Test at a significance level of 5% the hypothesis that the population mean of the measurements is 42 12 16.0 against the alternative that it is not 42. 1.2 16.0″.	**3**
		iii. With regard to information provided in questions (a) and (b), if one of the sample measurements is 42. 12. 10.5″ , perform out-of-context test to determine if this measurement is an outlier at 99% confidence level, assuming the population mean and standard deviation are both known	**4**
	b	The standard deviation of measuring a 1000.000 m long baseline with the Leica TPS 1203 equipment is 1.8 mm (according to the manufacturer's specification). After calibrating the equipment on the 1000.000 m long baseline, the calculated standard deviation was 2.5 mm based on 15 measurements of the baseline. Determine, statistically at 95% confidence level, if the equipment is performing according to the manufacturer's specification.	**5**
	c	To check the precision of a theodolite measurement, 32 direction readings of a single line were measured. The mean (seconds' portion only) of the readings was 25.2″, and the standard deviation of the mean measurement is ±0.4″. Answer the following.	
		i. Determine the 95% confidence interval for the population mean.	**5**
		ii. Compute the 99% confidence range for the population variance.	**5**

Conditional Least Squares Adjustment			
2		Consider a scenario where a control point C (x, y, z) is to be established from two fixed points A and B (referring to Figure 1.0) using GPS survey. The coordinates of the fixed points are given in three-dimensional GNSS system as: A (x = 402 351 m, y = -4 652 995 301 m, z = 4 349 760 778 m) B (x = 8086 032 m, y = -4 642 712 847 m, z= 4 360 439 083 m). The measured GPS baseline vectors are shown in Table 3.0, assuming the standard deviation of each observation is 0.010 m.	

Table 1.0

From	To	dx(m)	dy(m)	dz(m)
C	A	- 1116.452	- 4569.161	- 4355.906
C	B	6567.231	5686.293	6322.392
B	C	- 6567.231	- 5686.303	- 6322.381

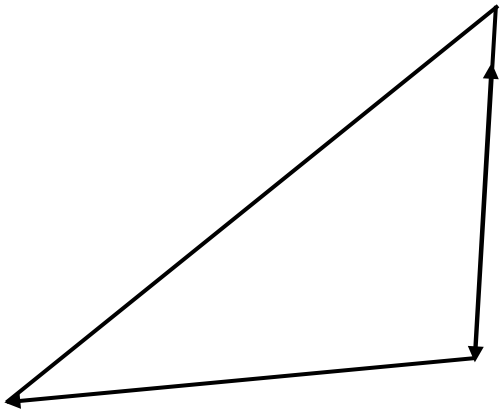

Figure 1.0

	a	Compute the least squares adjusted coordinates of point C using the condition equations method.	**13**
	b	Compute the standard deviations of the vector of the adjusted observations.	**12**

		Similarity transformation	
3	**a**	Define the three terms Scaling, Rotation and Translations in terms of two-dimensional conformal coordinate transformation	**5**
	b	Show the development of the transformation equation shown below; $X = (S\ cos\ \theta)x - (S\ sin\ \theta)y + T_X$ $Y = (S\ sin\ \theta)x + (S\ cos\theta)y + T_Y$	**5**
	c	Points A and B have their coordinates known in both an EN system and a XY system. Points C and D have their coordinates known only in the XY system. These coordinates are shown in the table below. Using a two dimensional conformal coordinate transformation Determine:	

Point	E	N	X	Y
A	194 683.50	99 760.22	2848.28	2319.94
B	196 412.80	102 367.61	5720.05	3561.68
C			3541.72	897.03
D			6160.31	1941.26

		i.	The transformation parameters	**5**
		ii.	The most probable coordinates in the XY coordinate system.	**5**
		iii.	The rotation angle and scale factor.	**5**

Statistics and Least Squares			
4	**a**	In your own words, discuss when it is appropriate to use:	
		i. a t test. ii. a $\chi 2$ test. iii. an F test	**9**
		Explain the differences between mathematical, Functional and stochastic models.	**6**
		Solve the following nonlinear equations using the least squares method. Use initial approximations of $x_0 = 9$ and $y_0 = 4$. $x^2 + 3y = 115$ $5x + y^2 = 75$	**6**
		Define posterior statistical analysis? [4]	**4**

Critical Values Z_α	Level of significance (α)			
	1%	2%	5%	10%
Two-tailed test	$\lvert Z_\alpha \rvert = 2.58$	$\lvert Z_\alpha \rvert = 2.33$	$\lvert Z_\alpha \rvert = 1.96$	$\lvert Z_\alpha \rvert = 1.645$
Right tailed test	$Z_\alpha = 2.33$	$Z_\alpha = 2.055$	$Z_\alpha = 1.645$	$Z_\alpha = 1.28$
Left tailed test	$Z_\alpha = -2.33$	$Z_\alpha = -2.055$	$Z_\alpha = -1.645$	$Z_\alpha = -1.28$