NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

DEPARTMENT OF LAND AND SPATIAL SCIENCES

QUALIFICATIONS: BACHELOR OF GEOMATICS	
QUALIFICATIONS CODES: 07BGEO	**QUALIFICATION LEVEL:** Level 7 - 07BGEO
COURSE CODE: ODC721S	**COURSE NAME:** Geodesy
DATE: November 2025	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
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MODERATOR:	**Dr K. Owolabi**

INSTRUCTIONS

1. Answer all questions.
2. Write clearly and neatly.
3. Marks will be deducted for poor writing, spelling and grammatical errors.
4. Number the answers clearly.
5. Make sure your Student Number is on the EXAMINATION BOOK(s).

THIS QUESTION PAPER CONSISTS OF 5 PAGES (Including this front page)

PERMISSIBLE MATERIAL

Calculator

QUESTION 1

1.1 The terrestrial coordinate system is an essential mapping frame for representing point positions on Earth. Discuss this in the light of its various realizations. (10)

1.2 The curvilinear coordinates of a point in Windhoek are as given below. Compute the ECEF coordinates of the point. (10)

Given that;

$\varphi = -22.56°, \lambda = 17.065°$, h = 1650m.

Semi-major axis: $a = 6378137.0\ \mathrm{m}$
Flattening: $f = 1/298.257223563$
Eccentricity squared: $e^2 = 2f - f^2 \approx 0.00669437999014$

Hint:

$$X = (N + h)\cos\varphi\cos\lambda$$
$$Y = (N + h)\cos\varphi\sin\lambda$$
$$Z = [N\,(1 - e^2) + h]\sin\varphi$$
$$N = \frac{a}{(1 - e^2\sin^2\varphi)^{1/2}}$$

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QUESTION 2

2.1 Discuss the application of Geodesy to: (10)

(i) Drought surveillance.

(ii) Earthquake monitoring & plate tectonics assessment.

2.2 Using relevant diagrams, define the following Geodetic terminologies: (10)

(i) Geodetic latitude.

(ii) Parametric latitude.

(iii) Geocentric Latitude.

(iv) Astronomic Latitude.

(v) Vernal equinox

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QUESTION 3

3.1 It is required to determine the altitude and azimuth of a Western star (Formalhaut) at NUST, Windhoek, on Friday, 5th September 2025. To do this, the following information was obtained from the star almanac:

Time (UTC)	Star	SHA	Dec	GHA
19:30 hrs	Formalhaut	$15^\circ\ 13.7'$	$-29^\circ\ 29.0'$	$-262^\circ\ 43.0'$

If the approximate $\varphi = 22^\circ\ 33.9'\text{S}$, $\lambda = 17^\circ\ 4.6'E$,

Calculate the azimuth and altitude of the star. (10)

Hint:

$\tan A = \frac{\sin HA}{\cos HA\ .\ \sin HA - \tan\delta \cos\varphi}$; $\sin a = \sin\varphi \sin\delta + \cos\varphi \cos\delta \cos HA$

3.2 In order to determine the azimuth of K-19 to FTSM-24, astronomic observation was carried out on the 5th of September, 2025, to α – Tauri. Given the field notes below, compute the azimuth of the line. (10)

Face	HCR	Horizontal Angle	VCR	Vertical angle	Bubble displacement	L std time
L	$79^\circ\ 50'\ 32''$		$91^\circ\ 05'\ 45''$			
L	$157^\circ\ 21'\ 10''$		$79^\circ\ 00'\ 42''$		2 - 3	20: 28: 23
R	$337^\circ\ 10'\ 00''$		$281^\circ\ 28'\ 10''$		2 - 3	20: 31: 37
R	$259^\circ\ 50'\ 38''$		$91^\circ\ 05'\ 45''$			

Hint:

bubble division = 10''

Star declination (from star almanac) = $45^\circ\ 16'\ 12.0''$

Star's RA = 9hr 34mins 27secs

$\cos Z = \frac{\cos P - \cos w.\cos z}{\sin w\ .\sin z}$

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QUESTION 4

Given the following gravity observations taken with a Scrintrex CG5 gravimeter, compute the following at each station:

4.1 Drift rate.

4.2 Latitude.

4.3 Free-air corrections.

Consequently, determine the final absolute gravity value for each station. (20)

Table 1.1: Gravity field notes

Sta_ID	Lat (φ)	Long (λ)	Height (m)	Dial Reading	Time of Observation	Absolute Gravity (*mgals*)
YT1/24	6.5085	3.3751	28.20	1580.8086	3/25/2017- 09:06	978119.857
GP01	6.5143	3.3769	30.7	1581.7569	3/25/2017- 09:23	
GP02	6.5251	3.3684	18.1	1582.9931	3/25/2017- 09:29	
GP03	6.5298	3.3683	18.8	1582.2448	3/25/2017- 09:37	
GP04	6.5251	3.3681	19.2	1582.3104	3/25/2017- 09:52	
GP05	6.5185	3.3169	30.65	1581.6923	3/25/2017- 10:04	
YT1/24	6.5085	3.3751	28.20	1580.8617	3/25/2017- 10:35	

Hints:

$FA_{corr} = 0.3086h$ mgals

$Lat_{corr} = 0.000812 \times \sin(2\varphi)$ mgals/m

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QUESTION 5

You have recorded the following observations from FTSM-24 to a point K-19 on the NUST campus, using a theodolite and an EDM.

Geodetic Azimuth = $341°\ 45'\ 32.09''$

Horizontal distance = 3612.666 m (International metre)

Calculate the necessary corrections that must be applied to these observations in order to calculate the Lo2217 coordinates of Point A. Invariably, calculate the final distance and direction that will be used for the polar calculation, but you do not have to calculate the coordinates of Point A. (20)

Coordinates of the points

Station	Locality	Projected coordinates			Geodetic coordinates (GNSS)		
		Y	X	Z	phi	lambda	h
FTSM-24	Eros-Park	-9279.121	59133.914	1708.012	22.5344618	17.0893873	1650
K-19	NUST	-8146.061	62564.646	1669.541			

Hints:

$e'^2 = \frac{(a^2 - b^2)}{b^2}$

a = 6, 377, 397. 155m

b = 6, 356, 078. 9628m

$$\gamma \approx \ell.sin\phi + \frac{\ell^3}{3}.sin\phi.cos^2\phi.(1 + 3\eta^2) - \cdot$$

where:

γ = Meridian Convergence (radians!)

$\ell = \lambda_0 - \lambda$ (longitude difference, in radians);

$\eta^2 = e'^2.cos^2\phi$;

$$(t - T)_1 = \rho.\frac{x_1 - x_2}{2R^2}.y_m$$ (With ρ=206265, (t−T) will be in seconds)

Where y_m is mean y-ordinate of the two points concerned, and R can be taken as 6371000m.

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