



FACULTY OF EXPLORATION AND EARTH SCIENCES
BACHELOR OF ENGINEERING DEGREE IN GEOMATICS AND SURVEYING

PHYSICAL GEODESY
MODULE CODE: ESG 2108
FINAL EXAMINATIONS: JUNE 2024

DURATION : 3 HOURS
TOTAL MARKS : 100
EXAMINER : O. MUROMO

INSTRUCTIONS

1. Answer **ALL** questions
2. Scientific calculators may be used
3. Modified Clarke 1880 Constants:

Semi- Major axis,	$a = 6378\,249.145326\text{m}$
Semi- Minor axis,	$b = 6356\,514.966721\text{m}$
Flattening $f = (a-b)/a$,	$f = 1/293.466307656$
First Numerical eccentricity $e^2 = (a^2 - b^2)/a^2$,	$e^2 = 0.006803481018883$
Second numerical eccentricity $e'^2 = (a^2 - b^2)/b^2$,	$e'^2 = 0.006850085445147$

1			HISTORY OF GEODESY (25MARKS)	
	a)		State the major functions of geodesy.	5
	b)		Explain the three basic observation techniques that are used in Geodesy	7
	c)		Outline the historical developments and the major contributors in the determination of the size and shape of the earth up-to the present day	13
2			GEODETIC REFERENCE SYSTEMS (25MARKS)	
	a)	(i)	On an ellipse described by the following parameters: a: semi-major, b: semi - minor axis, g: linear eccentricity, f: flattening	5
		(ii)	Using a well labelled diagram, describe the different types of latitudes encountered in Geodesy	13
	b)		Derive the following relationships	
		(i)	$e^2 = \frac{e'^2}{1 + e'^2}$	3
		(ii)	$e'^2 = \frac{2f - f^2}{(1 - f)^2}$	4
3			TYPES OF LATITUDES (TOTAL 25 MARKS)	
	a)		Given that the geodetic latitude of a station ROCK is 21°35'44,3" on the Clarke 1880 Ellipsoid, compute the geocentric latitude of the same point, after deriving the expression relating the geodetic to the geocentric latitude.	10
	b)		Using the data given below, compute good approximate coordinates for 161/P and the reverse azimuth using the Gauss Mid latitude formula. 160/P $\phi = 17^\circ 36' 37''$ $\lambda = 31^\circ 10' 25''$ 160/P- 161/P $\alpha = 222^\circ 31' 56''$ $s = 13547.934\text{m}$ Use Modified Clarke 1880 ellipsoid constants	15
4			COORDINATE SYSTEMS AND COORDINATE TRANSFORMATIONS (25 MARKS)	
	a)		With the aid of well annotated diagrams describe the following coordinate systems:	
		(i)	Topocentric coordinate systems	3
		(ii)	Earth-Fixed coordinate systems	3
	b)		Explain in detail how the following affect coordinate systems:	
		(i)	Annual parallax	3
		(ii)	Precession	3

		(iii)	Nutation	3
	c)		Find the geocentric coordinates for a point with the following geodetic coordinates: $\varphi = 43^{\circ} 15' 46.2890''$, $\lambda = 89^{\circ} 59' 42.1640''$ and $h = 1382.618$. Use Modified Clarke 1880 ellipsoid constants	10

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