CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING **March 2024**

Note: This examination consists of 5 questions on 2 pages. **Marks**

Q. No	Time: 3 hours	Value	Earned
1.	Astronomic observations are important in geodetic positioning and the related highly accurate applications. This is especially true for azimuth determination and the establishment of geodetic networks. Accurate time measurements are also implemented.		
	a) Discuss the procedure of the observation and computation of astronomic azimuth using Polaris and the Sun. Explain the differences between observing Polaris and the Sun. Give the equation and explain its parameters. Indicate which parameters are known, observed, or unknown.	10	
	b) What is the typical accuracy of the astronomic azimuth determination using the method you used in a) above? What are the main factors affecting such value and how can you improve it?	4	
	c) Differentiate between Sidereal Time, Solar Time, GMST, GAST, UT, UT1, TAI, and UTC, including what the acronyms stand for and how the UTC is obtained.	6	
2.	Geodetic positioning is extremely affected by the gravity, gravity potential, and the corresponding Earth's gravity field.		
	a) Explain the relationship between the gravity vector and the gravity potential.	3	
	b) Discuss the components that constitute the Earth's gravity vector, what causes each one, and which one is the largest. What are the locations on the surface of the Earth where each component has its smallest and largest value?	6	
	c) Define a level surface and discuss its properties in detail. Give examples of known level surfaces used in geodetic positioning and how each one was/is obtained.	4	
	d) What is the geopotential number? Discuss how geopotential numbers are used to obtain different types of heights. Explain these heights and the main factor affecting their obtained type.	6	
3.	Earth rotation around its spinning axis is one of the most important phenomena that affects geodetic positioning. However, Earth rotation involves other phenomena such as Earth precession, nutation, and wobble.		
	a) Explain in detail Earth precession, nutation, and wobble. Use a figure to show your answer. What causes each one of them?	8	
	b) Differentiate between ICRS, ITRS, ITRF, and NAD83(CSRS) including what the acronyms stand for and how realizations are obtained.	5	
	c) What are the required parameters to transform between ICRS and ITRS? How are these parameters obtained? What is the name of the organization (name and acronym) that coordinates and provides these parameters?	6	

4.	GPS has become a standard tool in several applications in geodetic positioning. In its implementation, different techniques and modes of operation are applied. Worldwide, other GNSSs have been developed and used.		
	a) Compare between the DGPS and RTK techniques. Include what the acronyms stand for, observations, tools, obtained accuracy, advantages, disadvantages, and possible applications.	9	
	b) In some of the RTK applications, a virtual reference station (VRS) is created. Explain this concept and how it is implemented.	3	
	c) What other GNSSs are currently available? List the major differences between them and the GPS.	5	
	d) What is meant by WADGPS, LADGPS, and WAAS? How are they implemented and what are their main applications?	4	
5.	With several applications in geodetic positioning requiring different observations and utilizing different equipment, it is inevitable to work with different coordinate systems including local and global ones. This also involves performing different coordinate transformations among these systems.		
	a) What is meant by local and global geodetic coordinate systems? In your explanation, include the origin, axes, associated coordinates and the relationship between the two systems.	5	
	b) List common local and global geodetic coordinate systems used by surveyors.	4	
	c) To establish a geodetic baseline in an area that has only one available control station (station S) with known geodetic coordinates (φ_S, λ_S, h_S), a surveyor was tasked with the establishment of a new geodetic control station (station P) and to obtain its geodetic coordinates (φ_P, λ_P, h_P) in NAD83 (CSRS). With no access to GPS equipment, only a total station, the surveyor occupied station S with the total station and obtained the following: - zenith angle θ_P - slope distance d_{SP} - geodetic azimuth α_{SP}. Describe the detailed approach with equations how to compute the coordinates (φ_P, λ_P, h_P). In your approach, you can neglect the effect of the deflections of the vertical.	12	
	Total Marks:	100	