CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING   March 2023

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

Q. No	Time: 3 hours	Value	Earned
1.	Surveyors are always involved in working with local and global (geocentric) coordinate systems. In addition, they will be performing several required coordinate transformations. This mainly depends on the used equipment, obtained measurements, and related applications.		
	a) Define each of the following 3D coordinate systems: local astronomical, local geodetic, global (geocentric) astronomical, and global (geocentric) geodetic. Include figures in your answer.	8	
	b) Consider the following scenario: it is required to establish a new geodetic control station in the area (station J) and obtain its Ellipsoidal coordinates (φ_J, λ_J, h_J) in NAD83 (CSRS). However, you don't have access to any GNSS equipment, only a total station. You occupied a nearby control station (station T) with known ellipsoidal coordinates (φ_T, λ_T, h_T) and obtained the slope distance S_{TJ}, vertical angle θ_J, and azimuth α_{TJ}. Describe in detail the procedure with equations how to compute (φ_J, λ_J, h_J). Assume the deflection of the vertical components are very small in the area and can be neglected.	13	
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?	8	
	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.	5	
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?	5	

4.		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.	9	
	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?	3	
	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.	8	
5.		With the evolution of GPS as the most used GNSS, surveyors have been using it on a daily basis with implementing different techniques. In addition, other GNSSs have been developed and used worldwide.		
	a)	Compare between the DGPS and RTK techniques. Include what the acronyms stand for, observations, tools, obtained accuracy, advantages, disadvantages, and possible applications.	10	
	b)	In some of the RTK applications, a virtual reference station (VRS) is created. Explain this concept and how it is implemented.	4	
	c)	What other GNSSs are currently available with GPS?	3	
	d)	What is meant by WADGPS, LADGPS, and WAAS? How are they implemented and what are their main applications?	4	
		Total Marks:	100	