

CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING

October 2022

Note: This examination consists of 6 questions on 2 pages.

Marks

<u>Q. No</u>	<u>Time: 3 hours</u>	<u>Value</u>	<u>Earned</u>
1.	<p>Earth’s rotation around its spinning axis is one of the most important factors in physical and geometric geodesy. This rotation involves other phenomena such as Earth precession, nutation, and wobble.</p> <p>a) Explain Earth precession, nutation, and wobble. Use a figure to show your answer. What causes each one of them?</p> <p>b) Differentiate between ICRS, ITRS, ITRF, and NAD83(CSRS) including what the acronyms stand for and how realizations are obtained.</p> <p>c) What are the required parameters to transform between ITRF and NAD83(CSRS)?</p> <p>d) Identify the parameters required to transform between ICRS and ITRS. Explain how these parameters are obtained. What is the name of the organization (name and acronym) that coordinates and provides these parameters?</p>	6 4 3 5	
2.	<p>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.</p> <p>a) Discuss in detail the RTK technique. Include what the acronym stands for, when it should be used, observations, tools, obtained accuracy, advantages, disadvantages, and possible applications.</p> <p>b) In some of the RTK applications, a virtual reference station (VRS) is created. Explain this concept and how it is implemented.</p> <p>c) Name the other GNSSs that are currently available in addition to GPS.</p> <p>d) Explain the terms WADGPS, LADGPS, and WAAS. Discuss how they are implemented and their main applications.</p>	6 3 4 4	
3.	<p>Natural coordinates are considered a major type of coordinates used in geodetic positioning that involve several coordinates transformations as well.</p> <p>a) Define natural coordinates and explain what they depend on including their main datum.</p> <p>b) What are the two main coordinate frames that are based on natural coordinates? For each coordinate frame, discuss the used abbreviation, define the axes, explain the implemented coordinates, and plot a figure showing all the previously mentioned elements.</p> <p>c) State the main relationship between the two coordinate frames discussed in part b) above. Use a single figure showing both coordinate frames to illustrate such relationship.</p>	5 8 5	

4.	<p>Geodetic positioning is extremely affected by the gravity, gravity potential, and the corresponding Earth's gravity field.</p> <p>a) Explain the relationship between the gravity vector and the gravity potential.</p> <p>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?</p> <p>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.</p> <p>d) What is the geopotential number? Explain how geopotential numbers are used in obtaining different types of heights and discuss which quantity is the main factor affecting the type of obtained height.</p>	2 8 4 4	
5.	<p>Time and time systems are major components in geodetic positioning since all space borne techniques depend on very accurate time measurements. In addition, realizations of modern geodetic reference systems are obtained using several time varying parameters.</p> <p>a) Differentiate between Sidereal Time, Solar Time, GMST, GAST, UT, UT1, TAI, and UTC, including what the acronyms stand for.</p> <p>b) Explain how the TAI is realized in practice and what is meant by the term "leap seconds".</p>	8 3	
6.	<p>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.</p> <p>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.</p> <p>b) 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 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:</p> <ul style="list-style-type: none"> - zenith angle θ_P - slope distance d_{SP} - geodetic azimuth α_{SP}. <p>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.</p>	5 13	
Total Marks:		100	