

CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING

March 2025

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

Marks

<u>Q. No</u>	<u>Time: 3 hours</u>	<u>Value</u>	<u>Earned</u>
1.	Natural coordinates are considered a major type of coordinates used in geodetic positioning that involve several coordinates transformations as well. a) Define natural coordinates and explain what they depend on including their main datum. 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. 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. Discuss also the importance of evaluating this relationship in Geodetic Positioning.	6 8 6	
2.	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. b) List common local and global geodetic coordinate systems used by surveyors. c) To establish a geodetic baseline in an area that has only one available control station (station S) with known geodetic coordinates ($\varphi_S, \lambda_S, h_S$), a surveyor was tasked with the establishment of a new geodetic control station (station P) and obtain its geodetic coordinates ($\varphi_P, \lambda_P, h_P$) 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: i. zenith angle θ_P ii. slope distance d_{SP} iii. geodetic azimuth α_{SP}. Describe the detailed approach with equations how to compute the coordinates ($\varphi_P, \lambda_P, h_P$). In your approach, you can neglect the effect of the deflections of the vertical.	5 5 14	

3.	Geodetic positioning is extremely affected by the gravity, gravity potential, and the corresponding Earth's gravity field. a) 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. b) What is the geopotential number? Discuss how geopotential numbers are used to obtain different types of heights. Explain these heights in detail and the main factor affecting their categorization.	7	
4.	Spatial reference systems, vertical datums, and geoid models constitute the core of geodetic positioning. For more accurate and reliable positioning data, several systems and datums have been adopted over the years. a) Differentiate between ICRS, ITRS, ITRF, NAD27, NAD83 (Original), NAD83(CSRS), and NATRF2022 including what the acronyms stand for and how realizations are obtained for each. b) Discuss the following: CGVD28, CGVD2013, GSD95, and CGG2013. In your discussion, include what the acronyms stand for and how realizations are obtained for each. 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?	10 8 4	
5.	With the evolution of GPS as the most used GNSS, surveyors have been using it on a daily basis, implemented with different techniques. In addition, other GNSSs have been developed and used worldwide. a) Compare between the DGPS, PPP, and RTK techniques. Include what the acronyms stand for, observations, tools, obtained accuracy, advantages, disadvantages, and possible applications. b) In some of the RTK applications, a virtual reference station (VRS) is created. Explain this concept and how it is implemented. c) What is meant by WADGPS, LADGPS, and WAAS? How are they implemented and what are their main applications?	13 3 4	
	Total Marks:	100	