CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING

March 2022

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

<u>Marks</u>

| <u>Q. No</u> | Time: 3 hours | <u>Value</u> | Earned |
|--------------|--|--------------|--------|
| 1. | In geodetic positioning, different types and categories of coordinates are used that involve the implementation of 3D, 2D, global, local, curvilinear, Cartesian, and planar coordinates. One type of these coordinates is known as natural coordinates. | | |
| | a) What is meant by natural coordinates? What do they depend on? What is their main datum? | 4 | |
| | b) Define two coordinate frames that are based on natural coordinates. For each frame, state the name and used abbreviation, define the axes and used coordinates, and draw a figure showing the aforementioned elements. | 7 | |
| | c) For the two frames used in b), state the main relationship between them and illustrate this relation in a single figure showing both frames. | 4 | |
| 2. | One of the classic definitions of Geodesy was "Geodesy is the determination of the Earth's gravity field potential function". Another one was "Geodesy is the measurement and representation of the Earth and its gravity field". | | |
| | a) What is the relationship between the gravity potential and the gravity vector? | 3 | |
| | b) What are the components that constitute the Earth's gravity vector? What causes each component? Which component is the largest? What are the locations on the surface of the Earth where each component has its smallest and largest value? | 7 | |
| | 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. | 5 | |
| | d) How is the geopotential number defined? How are geopotential numbers used to obtain different types of heights? Which quantity (or parameter) will govern the obtained height type? | 5 | |
| 3. | With the evolution of GPS as the most common 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) 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. | 7 | |
| | 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 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 | |
|----|--|-------|--|
| | b) How is the TAI realized in practice? What is meant by the term "leap seconds"? | 3 | |
| 6. | Time and time systems are major components in geodetic positioning with all space borne techniques depending on very accurate time measurements, and realizations of modern geodetic reference systems obtained using time varying parameters. a) Explain and differentiate between Sidereal Time, Solar Time, GMST, GAST, UT, UT1, TAL and UTC, including what the acronyms stand for | 9 | |
| 5. | b) Differentiate between ICRS, ITRS, ITRF, and NAD83(CSRS) including what the acronyms stand for and how realizations are obtained. c) What are the required parameters to transform between ITRF and NAD83(CSRS)? d) 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? | 4 3 5 | |
| | One of the most important phenomena that affects geodetic positioning is the Earth rotation around its spinning axis. However, Earth rotation involves other phenomena such as Earth precession, nutation, and wobble.a) Explain Earth precession, nutation, and wobble. Use a figure to show your answer. What causes each one of them? | 6 | |
| 4. | Most surveying projects will involve the use of different tools, equipment, coordinate systems, and coordinate transformations. a) Define local and global geodetic coordinate systems, including origin, axes, associated coordinates and the relationship between the two systems. b) To establish a geodetic baseline in an area that has only one available control station (station P) with known geodetic coordinates (φ_P, λ_P, h_P), a surveyor was tasked with the establishment of a new geodetic control station (station T) and obtain its geodetic coordinates (φ_T, λ_T, h_T) in NAD83 (CSRS). With no access to GPS equipment, only a total station, the surveyor occupied station P with the total station and obtained the following: zenith angle γ_T slope distance S_{PT} geodetic azimuth α_{PT}. Knowing that the area has negligible deflections of the vertical, describe the detailed approach with equations how to compute (φ_T, λ_T, h_T). | 4 | |