

CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C-6 GEODETIC POSITIONING

March 2011

Although programmable calculators may be used, candidates must show all formulae used, the substitution of values into them, and any intermediate values to 2 more significant figures than warranted for the answer. Otherwise, full marks may not be awarded even though the answer is numerically correct.

Note: This examination consists of 4 questions on 2 pages.

| <u>Q. No</u> | <u>Time: 3 hours</u> | <u>Marks</u> | |
|--|--|--------------|---------------|
| | | <u>Value</u> | <u>Earned</u> |
| 1. | a) What does TAI stand for? Explain how this time reference is realized nowadays. | 5 | |
| | b) Define UT1 and explain how it is obtained nowadays. | 5 | |
| | c) What does UTC stand for? Explain the relationship between UTC and TAI as well as between UTC and UT1. | 5 | |
| 2. | The Canadian Vertical Geodetic Datum is called CGVD28. There are plans to replace it in the 'near' future by a new vertical datum. | | |
| | a) Which type of height is used in the CGVD28 and on which type of observations do the heights rely upon? Enumerate briefly the main characteristics of CGVD28. | 10 | |
| | b) Explain how the new datum will be established and on which components it will rely. Which type of height will be used? | 8 | |
| 3. | c) Why is the CGVD28 no longer adequate, or in other terms, what will be the advantages of this modernization? | 7 | |
| | You are in charge of checking the fitness for use of the coordinates of about 100 sites, established several years ago by terrestrial means. The requested relative accuracy between all sites is 5 cm horizontally and 2 cm vertically. You decide to measure by GPS a control sample. You pick out 15 sites which are well distributed over the area of 10 x 10 km and suited for GPS. | | |
| | a) Which procedure do you suggest in order to satisfy the accuracy requirements choice of receivers, schedule of site occupation, observation techniques, and strategy of data analysis? | 15 | |
| | The old coordinates of the sites you are checking are given as UTM coordinates with respect to NAD83 together with their orthometric heights. The GPS coordinates are Cartesian geocentric coordinates with respect to NAD83(CSRS). | | |
| b) What do NAD83 and NAD83(CSRS) stand for? What are the major differences between the realization of NAD83 and NAD83(CSRS)? | 10 | | |
| c) Explain in detail the procedure you are applying in order to check the quality of the old coordinates horizontally. | 7 | | |
| d) Explain in detail the procedure you are applying in order to check the quality of the old coordinates vertically | 8 | | |

| | | | |
|----|--|-----|--|
| 4. | <p>The geodetic coordinates of marker A are:</p> <p style="text-align: center;">A N45° 57' 02.3453" W71°43' 21.3478" h_{ell} = 54.543 m</p> <p>The geocentric Cartesian coordinates of marker B are:</p> <p style="text-align: center;">B 1393413.466 m -4218873.685 m 4560786.811 m</p> <p>All coordinates are with respect to NAD83(CSRS) which uses the GRS80 ellipsoid.</p> <p>a) Calculate the spatial distance between A and B with a resolution of 1 cm. <i>(just giving a numerical result without commenting on how you got it will not be accepted).</i></p> <p>b) Outline briefly (<u>without</u> giving numerical values) how you get the corresponding distance on the ellipsoid.</p> | 15 | |
| | Total Marks: | 100 | |

Some formulas which may be helpful or not :

$$ds^2 = R_M^2 d\varphi^2 + R_N^2 \cos^2 \varphi d\lambda^2$$

$$R_N = \frac{a}{(1 - e^2 \sin^2 \varphi)^{1/2}} \quad \text{and} \quad R_M = \frac{a(1 - e^2)}{(1 - e^2 \sin^2 \varphi)^{3/2}}$$

$$x = (R_N + h) \cos \varphi \cos \lambda$$

$$y = (R_N + h) \cos \varphi \sin \lambda$$

$$z = (R_N(1 - e^2) + h) \sin \varphi$$

GRS80 ellipsoid : a = 6378137 m f = 1/298.257222101

$$(e^2 = 2f - f^2)$$