CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 - GEODETIC POSITIONING

October 2014

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 6 questions on 2 pages.

Time: 3 hours

Q. No		Marks Value	Marks Earned
1.	a) Define the ITRS (its origin and the orientation of its axes) and comment on its different realizations.	10	
	b) Define ellipsoidal latitude, longitude, and height (*add a sketch*). How are they related to the 3D Cartesian geocentric coordinates *(with formulas)*?	10	
2.	Natural Resources Canada has released the Canadian Geodetic Vertical Datum of 2013 (CGVD2013), which is now the new reference standard for heights across Canada. This new height reference system is replacing the Canadian Geodetic Vertical Datum of 1928 (CGVD28), which was adopted officially by an Order in Council in 1935 *(http://webapp.geod.nrcan.gc.ca/geod)*.		
	a) Explain in detail how the new CGVD2013 is defined, realized and maintained. What is its link to the NAD83 (CSRS)?	10	
	b) What are the advantages of the new vertical datum? Do you see any disadvantages?	5	
3.	For calculating a GPS solution the satellites' positions are needed. Two different source of information are available: broadcast and precise ephemerides.		
	a) ***Broadcast Ephemeris:*** How does the user access broadcast ephemeris? What is the format of it? Who is responsible for its determination and how is it achieved? What is its accuracy?	10	
	b) ***Precise Ephemeris:*** How does the user access precise ephemeris? What is the format of it? Who is responsible for its determination and how is it achieved? Comment on the different products available and their accuracy.	10	
	c) Enumerate two applications where you would use broadcast ephemeris and two applications where you would use precise ephemeris. Give brief justifications.	5	

4.	The geodetic coordinates of two points with respect to the GRS80 ellipsoid are: Marker -A N45º 57' 02."3453 W71º43' 21."3478 Marker -B N45º 55' 54."4557 W71º43' 43."6788 a) Calculate an approximate value for the ***geodetic azimuth from A to B*** with a resolution of 1'. *(just giving a numerical result without commenting on how you got it will not be accepted).* $R_N = \frac{a}{\left(1-e^2 \sin^2 \varphi\right)^{1/2}}$ and $R_M = \frac{a\left(1-e^2\right)}{\left(1-e^2 \sin^2 \varphi\right)^{3/2}}$ GRS80-values : a = 6378137 m f = 1/298.257222101 $(e^2 = 2f - f^2)$	10	
5.	You are the responsible surveyor involved in the construction of a new bridge connecting an island to the mainland. The length of the bridge is about 8 km. a) Your task is to establish a reference network of a total of eight markers at both ends of the planned bridge (four markers on the mainland and four markers on the island) using GPS. A relative accuracy of better than 1 cm horizontally and vertically should be achieved. Based on these requirements, which procedure do you suggest: choice of receivers, schedule of site occupation, observation techniques, and strategy of data analysis, reference system used? b) For the height control you need the orthometric heights of all markers. How do you obtain them? Comment on their accuracy.	15 5	
6.	What does a gravimeter measure? Give the unit of this measurement. The FG5 is the most frequently used absolute gravimeter today. Explain the underlying principle of its operating mode. What is the obtainable accuracy with this instrument? Give two applications in which gravimeter measurements are used.	10	
	Total Marks:	100	

Radii of curvature of an ellipsoid:

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

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