CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C-6 GEODETIC POSITIONING

October 2010

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.

Time: 3 hours

Q. No		Marks Value	Marks Earned
1.	a) Define ellipsoidal latitude, longitude, and height. Add a sketch. b) Define 3D Cartesian geocentric coordinates and explain how the ellipsoidal latitude, longitude, and height are related to the 3D Cartesian geocentric coordinates *(with formulas)*.	10 10	
2.	a) Define a modern terrestrial reference system like ITRF2005 (its origin and the orientation of its axes) and comment on its realization. b) The transformation between NAD83(CSRS) and ITRF2005 is based on a 14 parameter transformation. Which type of coordinates is used in this transformation? Explain how a 14 parameter transformation works *(with formulas)*. Explain the signification of the individual parameters. c) Why is a 7 parameter transformation not sufficient?	10 15 5	
3.	You are responsible for a local survey in a rural region somewhere in Ontario. The network consists of 50 points distributed homogeneously over an area of 10 km x 10 km. Your task is to determine the UTM coordinates of all 50 points with an accuracy of 2 cm. At your disposition are 5 dual frequency receivers capable of RTK. a) Explain briefly how RTK works. Why are dual frequency measurements of enormous benefit compared to single frequency measurements? b) Why does RTK not work over long distances? c) Explain your strategy for solving this task and meeting the required accuracy in terms of number of reference stations used, occupation plan with rovers, ties to NAD83(CSRS), and your estimation of the total duration in days. d) The results you got from your survey are 3D Cartesian coordinates of all points with respect to NAD83 (CSRS). Explain what UTM stands for and outline briefly how you transform the 3D Cartesian coordinates to UTM (no formulas required). e) Supposing that all instrumental heights of the GPS sensors have been recorded during the survey, can you determine the orthometric heights from your result? If yes, explain how you proceed and give an estimation of the accuracy you get.	 5 5 10 5 5	

4.	The geodetic coordinates of marker A with respect to the GRS80 ellipsoid are: Point-A N45º 57' 02.3453” W71º43' 21.3478” a) A marker B is located 500.000 m to the south and 100.000 m to the east of marker A. Calculate latitude and longitude of marker B. You may assume that the values refer to distances on the ellipsoid. *(Just giving a numerical result without commenting on how you got it will not be sufficient).* b) Calculate the distance between A and B on the ellipsoid. What type of correction do you have to apply in order to get the distance on a UTM map? Which parameters does this correction depend on? What is the maximal amount of this correction one may expect for a distance of 1 km anywhere in a UTM projection and where does it occur?	15 5	
	Total Marks:	100	

Some formulas which may be helpful or not :

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

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

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

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