CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

SCHEDULE II / ITEM 1 — October 2009
GEODETIC POSITIONING

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 **Marks**

Time: 3 hours

Q. No		Value	Earned
1.	a) The acronym ITRS stands for International Terrestrial Reference System. Explain the concept, the type of coordinates used, and the realization of such a datum. Enumerate and briefly comment on the different space techniques involved in maintaining the ITRS.	15	
	b) What does NAD83(CSRS) stand for ?	5	
	c) How are plate tectonic movements accounted for in ITRF2005 and in NAD83(CSRS) and what is the drawback concerning the transformation between 3D Cartesian coordinates related to ITRF2005 and NAD83(CSRS) ? Which coordinates are more affected by plate tectonics?	10	
2.	Geopotential numbers play an important role in the definition and establishment of a vertical datum.		
	a) Define orthometric heights and identify their reference surface.	5	
	b) How can geopotential numbers be converted to orthometric heights ? *(Give formulas)*	10	
	c) In Canada this traditional approach will be replaced in the future by a new modern one. How will the vertical datum then be defined, realized and maintained?	5	
	d) Nowadays GPS is widely used for positioning purposes. The height obtained from GPS is basically a height above the ellipsoid. Would it not therefore be more suitable to drop the geoid as a reference surface completely and to switch to the ellipsoid as vertical datum using ellipsoidal heights only? Argue.	5	
3.	a) What are the characteristics, the applications and attainable accuracy of the following GPS solutions : i - Dual-frequency Real Time Kinematic (RTK)? ii - Precise Point Positioning (PPP)?	10	
	b) RTK and PPP are both relying on dual frequency phase measurements. Explain their benefit by answering the question : how well would RTK and PPP work with L1 phase-measurements only?	10	

4.	The geodetic coordinates of point A and B with respect to the GRS80 ellipsoid are: Point-A N45º 57' 02."3453 W71º43' 21."3478 Point-B N45º 55' 54."4557 W71º43' 43."6788 a) Estimate the distance between point A and B with a coarse resolution of 1 m. Explain your approach step by step. b) Let us now suppose that point A and B are at a mean height of roughly 500 m above the ellipsoid. Calculate the difference between the horizontal distance at this height and the horizontal distance at height zero. In other words by how much does the horizontal distance change when reducing it from a height of 500 m to the ellipsoid ?	15 10	
		100	

Question 4a): Some formulae which may be helpful or not depending on the approach you opt for:

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

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

GRS80-values : a = 6378137 m f = 1/298.257222101

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