CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

SCHEDULE II / ITEM 1 **March 2010**
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**

Q. No	Time: 3 hours	Value	Earned
1.	a) What does NAD83(CSRS) stand for? How has it been realized? What is the level of accuracy related to this datum?	10	
	b) Explain ***with formulas*** the concept of a Helmert transformation (also called a seven-parameter transformation or sometimes a similarity transformation).	10	
	The ITRF96 to NAD83(SCRS) transformation parameters at epoch 1997.0 and their rate of change are : **Translation and their rate of change** (in metres and metres per year respectively) **Tx = 0.9910 m Ty = −1.9072 m Tz = −0.5129 m** **dTx = 0.0000 m/y dTy = 0.0000 m/y dTz = 0.0000 m/y** **Rotation and their rate of change** (in milliarcseconds and milliarcseconds per year, respectively) **Rx = −25.790 mas Ry = −9.650 mas Rz = −11.660 mas** **dRx = −0.053 mas/y dRy = 0.742 mas/y dRz = 0.032 mas/y** **Scale and its rate of change** **DS = 0 dDS = 0** (scale and its rate of change are zero)		
	c) As can be seen, the translation affects the coordinates by about 1-2 m. By how much does the rotation affect the coordinates? (You may neglect the rate of change in evaluating the order of magnitude).	5	
	d) The rates of change of all parameters are zero with the exception of those related to the rotations (**dRx dRy dRz**). Why? What do they account for?	5	
2.	You are in charge of installing a reference network on Canada Lands in a remote northern location. It consists of 10 markers spread over an area of 20 x 10 km. The nearest CBN marker is more than 1000 km away. An absolute accuracy of better than 5 cm with respect to NAD83(CSRS) and a relative accuracy better than 1 cm are requested. A field trip of one week with 3 GPS receivers is scheduled. The final data analysis may be done after the field trip but you are not supposed to return to the area. a) Which procedure do you suggest to satisfy the accuracy requirements and to guarantee a high level of confidence: choice of receivers, schedule of site occupation, observation techniques, and strategy of data analysis?	20	
	b) Let us now suppose that the task has been carried out successfully and that you got the geocentric Cartesian coordinates of all markers with respect to NAD83 (CSRS). However, you also need their orthometric heights. How can you obtain them?	5	

3.	a) What does RTK stand for? Explain its basic functional principle and comment on the requirements for the equipment (type of receivers, additional equipment). What are the characteristics of RTK in terms of distance between reference and rover, the time it takes to get a solution, and the achievable accuracy? b) Why does RTK not work over long distances?	15 5	

4.	The coordinates of point A with respect to NAD 83(CSRS) are:
	
	`latitude = N46° 50' 51.71361"  longitude = W71° 15' 41,22904"`
	`UTM-y = 5 190 722.517 m  UTM-x = 327 586.657 m`
	
	a) Define geodetic latitude and longitude. **(<u>*Add a sketch*</u>).**
	
	b) Point B is located 500.000 m south of point A (distance on the ellipsoid). Calculate latitude and longitude of point B. *(just giving a numerical result without commenting on how you got it will not be sufficient).*
	
	c) Point C is located 500.000 m west of point A (distance on the ellipsoid). Calculate latitude and longitude of point C. *(just giving a numerical result without commenting on how you got it will not be sufficient).*
	
	d) Explain with formulas how you find the UTM coordinates of B and C with a resolution of 1 mm (<u>***no numerical results needed***</u>).
		6
		
		7
		
		7
		
		5	

		100	

Some formulas which may be helpful or not :

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

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

NAD83(CSRS) is using the GRS80 ellipsoid with : a = 6378137 m f = 1/298.257222101

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