CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 - GEODETIC POSITIONING — March 2012

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 5 questions on 2 pages **Marks**

Q. No Time: 3 hours Value Earned

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1.	The ITRF96 to NAD83(CSRS) transformation parameters at epoch 1997.0 and their rate of change are : **Translation and their rate of change** (in meter, and meter 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 milliarcsecond, and milliarcsecond 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) a) Explain ***with formulas*** how this transformation (a so-called 14 parameter transformation) works. b) The rate of change of all parameters is zero with the exception of those related to the rotations (**dRx dRy dRz**). Why? What do they account for? c) What does NAD83(CSRS) stand for? How has it been realized? What is the level of accuracy related to this datum?	12 5 8	
2.	Explain in details how a standalone ***low-cost*** GPS receiver calculates its position. - On which observations does it rely? Which unknowns are determined? Give the observation equation (formula required). - Which additional information is needed and how does the receiver get this information?	15	
3.	a) What are the characteristics, the applications and attainable accuracy of: - Dual-frequency Real Time Kinematic (RTK)? - Precise Point Positioning (PPP)? - Single frequency Differential GPS (DGPS)? b) How does the ***tropospheric*** delay of the GPS signal impact the solution obtained with the above mentioned methods i.e.: RTK, PPP, DGPS? c) How does the ***ionospheric*** delay of the GPS signal impact the solution obtained with the above mentioned methods i.e.: RTK, PPP, DGPS?	9 3 3	

4.	Traditionally a vertical datum is established by using spirit leveling and gravity measurements. a) What is the reference surface used in such a vertical datum? Why does it differ from an ellipsoid and by how much with respect to an ITRF-GRS80 ellipsoid? b) 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? c) 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 5 5	

5.	The geodetic coordinates of point A and B with respect to the GRS80 ellipsoid are:
	`Point-A  N45° 57' 02."3453  W71°43' 21."3478`
	`Point-B  N45° 55' 54."4557  W71°43' 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)*
	b) Explain the difference between an astronomical and a geodetic azimuth.
	c) Explain the difference between a geodetic azimuth and a grid bearing with respect to a cartographic projection.
	d) What is the maximum difference between a geodetic azimuth and a grid bearing in the UTM projection at a mid-latitude and its influence on the coordinates over a distance of 1 km?
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		5
		5	

		100	

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

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