CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C6 – GEODETIC POSITIONING

October 2020

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 page.

Time: 3 hours

Q. No		Marks Value	Marks Earned
1.	You are in charge of installing a GPS network on Canada Lands in a remote northern location. It consists of 15 markers spread over an area of 10 x 10 km. The nearest CBN marker is more than 1000 km away. An absolute accuracy of better than 10 cm with respect to NAD83(CSRS) and a relative accuracy better than 1 cm are requested. A field trip of 4 days 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? b) Your primary result are 3D Cartesian coordinates of all sites. Subsequently you need UTM coordinates and orthometric heights. Explain what UTM coordinates and orthometric heights are. How do you obtain them?	15 10	
2.	In GPS positioning, DOPs are used as accuracy indicators. a) What do the acronyms DOP, PDOP, HDOP, and VDOP stand for? Which values do you consider as a good, an acceptable, and a bad PDOP? b) Explain in detail (with formulas) how PDOP is obtained. c) Which pieces of information are needed to calculate a PDOP?	10 8 7	

3.	The geodetic coordinates of 2 markers are: Marker A N45º 57' 03."6753 W71º43' 35."3138 Marker B N45º 55' 55."4788 W71º43' 43."6734 Ellipsoid parameters: $\boldsymbol{a}$ = 6378137 m (semi-major axis) and $\boldsymbol{f}$ = 1/298.257222101 (flattening) Evaluate the **distance** (on the ellipsoid) between the 2 markers with a resolution of better than 1 m. Evaluate the **azimuth** from marker A to marker B (on the ellipsoid) with a resolution of 1'. *(just giving a numerical result without commenting on how you got it will not be accepted).* Some formulae that may be helpful or not depending on the approach you opt for. $R_N = \frac{a}{\left(1-e^2\sin^2\varphi\right)^{1/2}}$ $R_M = \frac{a\left(1-e^2\right)}{\left(1-e^2\sin^2\varphi\right)^{3/2}}$ $e^2 = 2f - f^2$	20	
4.	In the last decade, PPP has become a more and more powerful tool in GNSS positioning. What does PPP stands for? Explain the principles of PPP and comment on its advantages and disadvantages compared to RTK. Describe in detail one application where you would prefer a PPP solution.	15	
5.	Two important modern space geodetic techniques are VLBI and SLR. Choose one of them and explain the acronym, its functional principle, and its contribution to the determination of the Earth rotation parameters. ***Start your answer by identifying your choice***.	10	
6.	Which other GNSS (Global Navigation Satellite Systems) exists or are presently under development? What do you think will be there impact on surveying in the future?	5	
	Total Marks:	100	