

| |
|------------|
| Name _____ |
| ID _____ |

GGE 2012
Advanced Surveying
Winter Term 2009-2010
Geodesy and Geomatics Engineering, University of New Brunswick

FINAL EXAMINATION

3 hours, closed book

14 April 2010

This exam is worth 50% of your final mark in this course. It is composed of two parts. Part A is worth 30% and Part B is worth 70% in the calculation of the mark for this exam. Answer ALL questions of Part A on the question sheets by circling the correct answer. There is only one correct answer per question. All questions in Part A carry equal weight. It is recommended that **you do not guess, as 1/3 of a mark will be deducted for incorrect answers.** Enter your ID number on the front of the exam and sign your name. Answer Part B in the booklet provided.

A correct answer to a question in Part A scores 1 mark, an incorrect answer $-1/3$ of a mark. Part A will be assessed out of 20 marks.

Part A

Choose the correct answer. Only **one** answer is permitted for multiple choice questions.

1) Which of the following **wrongly** describes plane surveying?

- a) It references to a flat plane without considering curvature of the Earth.
- b) It ignores the actual shape of the Earth and allows use of plane geometry and trigonometry.
- c) It is performed on the surface of the Earth.
- d) It considers the size and shape of the Earth.

2) Which of the following errors are usually significantly larger when compared to the spread of the measured observations?

- a) Gross errors.
- b) Systematic errors.
- c) Random errors.
- d) None of the above.

Name _____
ID _____

3) The Earth's radius is assumed to be 6,378 km ($=R$), and you are to determine the distance between two points, 50 km apart on Earth. When your survey is carried out using plane surveying, what is your expected distance error? (Note: $\Delta l/l = l^2/12R^2$)

- a) 0.257m. b) 2.572m. c) 0.129m. d) 1.285m.

4) Which of the following methods is the most precise and longest distance measuring technique?

- a) EDM. b) VLBI. c) SLR. d) GNSS.

5) Which of the following errors can **not** be eliminated by ensuring that backsights and foresights are of equal distance?

- a) Reading error of a rod. b) Collimation error.
c) Error due to the Earth's curvature. d) Error due to the refraction of the rays.

6) EDM is the terrestrial-based electronic distance measurement unit which is an indirect way of using an infrared signal or laser pulse. It determines the distance from the phase delays between transmitted and received signals. GNSS is a state-of-the-art space-based positioning method. Comparing GNSS with EDM, both of them fundamentally face the same issue in order to determine the distance of an object. To solve this issue as simple as possible, EDM uses multiple signals but this can **not** be applied to longer distances; it is limited to a few kilometres only. What is the cause of this problem?

- a) Correlating timing issue. b) Error mitigation techniques.
c) Integer number of cycles. d) Refraction of the rays.

7) Which of the following is **not** a systematic error in levelling?

- a) Sinking of rod. b) Scale error of rod graduation.
c) Offset error of rod graduation. d) None of the above.

8) Which of the following statements is **incorrect** regarding the resection method?

- a) Three directions are measured to determine an unknown point.
b) It does necessary to physically occupy the known points.

| |
|------------|
| Name _____ |
| ID _____ |

- c) Accuracy depends upon the precision of instrument used.
- d) Minimum requirement of this method is three known points. Other redundant points whose coordinate are already known can be used as a check.

9) Which of the following statements is **incorrect** regarding the collimation error in levelling?

- a) This error is created because the optical line of sight is not perfectly perpendicular to the direction of gravity.
- b) The effect can be minimized by setup the levelling instrument midway between the staffs.
- c) Kukkamaki or Peg test can be performed to determine the size of the error.
- d) 3-wire level can be used to minimize the collimation error.

10) In order to decrease refraction errors in levelling:

- a) Double scale rods should be used.
- b) Instrument should be set up on a solid ground.
- c) Line of sight should be at least 0.5 m above ground.
- d) Parallel plate micrometers should be used.

11) Which of the following statements is **incorrect** regarding a total station (TS)?

- a) An up-to-date “integrated” TS with GNSS instrument can provide automatic data recording with coordinates including height of the instrument. This can be possible because GNSS can automatically determine the height.
- b) TS can record the horizontal, vertical, and slant distance data if it has a memory function.
- c) The data recorded can be post-processed with a computer to make, for example, a topographic plan.
- d) All of the above.

12) Which of the following traversing methods provides checks for systematic errors in distances and directions?

- a) Link traverse.
- b) Loop traverse.
- c) Open traverse.
- d) All of the above.

| |
|------------|
| Name _____ |
| ID _____ |

13) Which of the following methods provides the most precise height?

- a) Differential levelling with a parallel plate micrometer.
- b) Trigonometric heighting from a benchmark.
- c) GNSS heighting using precise point positioning using multiple frequencies.
- d) Differential GNSS heighting using multiple frequencies.

14) Which of the following statements **correctly** describes the primary purpose of simultaneous reciprocal levelling?

- a) This method is primarily used to minimize the Earth's curvature effect.
- b) The primary purpose of it is to minimize the collimation error, but both refraction effect and curvature effect can be also minimized as it reads at the same time at both ends.
- c) This method is primarily used for determining the height of the water on river.
- d) This method is used for eliminating the collimation error only.

15) When using GPS, what type of height is the raw GPS height?

- a) Orthometric height
- b) Geoidal height
- c) Ellipsoidal height
- d) None of the above

16) To set a "horizontal" control point by GNSS surveying method and a "vertical" control point by other methods, which of the following is the best processing methodology for achieving the most efficient and precise 3-D coordinates **for a short-baseline less than 10 km, e.g. a local project at UNB Fredericton campus?** (Note: PPM denotes Parallel Plate Micrometer)

- a) Differential GNSS with L1 frequency + differential levelling with a PPM.
- b) Differential GNSS with a combination of both L1 and L2 frequency + differential levelling with a PPM.
- c) Differential GNSS with L1 frequency + trigonometric heighting.
- d) Differential GNSS with a combination of both L1 and L2 frequency + trigonometric heighting.

17) In GNSS surveying, lowering the elevation mask angle has many disadvantages. However, lowering the angle to approximately 5° is especially useful to have a better estimate of the coordinate component of height. What is the most prominent error source, when lowering the elevation mask angle? (Note: we assume that there are no trees nearby and the survey area is performed in the Fredericton campus.)

- a) Multipath.
- b) Tropospheric effect.
- c) Cycle slips.
- d) Ionospheric effect.

| |
|------------|
| Name _____ |
| ID _____ |

18) In GNSS, which “difference” **eliminates** both satellite and receiver clock errors, and **possibly eliminates** the impact of refraction as well? (*Note: this is the most commonly used differencing techniques in GNSS.*)

- a) Single. b) Double. c) Triple. d) None of the above.

19) Regarding correctly drawn contours, which of the following statements is **not** correct?

- a) Contours do not form closed loops. b) Contours can cross each other.
c) Contours are not continuous. d) All of the above.

20) In GNSS, it is crucial to input the correct antenna height to determine 3D coordinates. Observers must carefully measure and check the height, and record and describe all measurements and antenna constants. Basically, where is the physical point on an antenna that receives the GNSS signals? (*Note: some software can automatically correct your slant height to this physical point, but some can not. Therefore, to minimize any possible mistake, it may be useful to calculate it by hand at first.*)

- a) APC (antenna phase center). b) ARP (antenna reference point).
c) Bottom of notch. d) Top of notch.

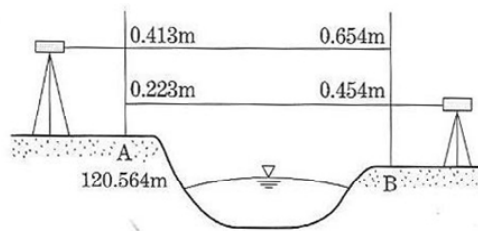
Name _____
ID _____

Part B

Answer the following questions. Write your answers in complete, coherent sentences, *and ensuring they are clearly readable*. Poor English may not enable your answers to be *fully understood*. You may supplement your answers with diagrams if you think it would be helpful. **1) to 3) are mandatory**. You can **not get more than 100%** for Part B including bonus quiz.

1) Discuss the following terms and carry out the calculation (25%):

- Hierarchy of modern geodetic control in Canada [5 %].
- NAD83 (CSRS) and CGVD28 [5 %].
- Integer Ambiguity in GNSS [5 %].
- GPS height and orthometric height [5 %].
- Based on simultaneous reciprocal heighting, the following values are achieved. When the elevation of the point A is 120.564m, what is the elevation of the point B? [5 %].



2) You have been asked to prepare a topographic plan for a town (50%).

a) For this project, **GPS relative positioning** is deemed suitable to establish control. Baseline length between two receivers is less than 10 km. The required horizontal accuracy is less than 1 cm. The points will later be used as control points for a terrestrial traverse. Especially, you are asked to achieve the best GPS height you can. Describe and justify the field and office procedures (from field reconnaissance to the final report) you are going to adopt to achieve the control project requirements (25%).

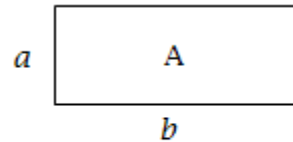
b) You are also required to carry out the topographic survey with a horizontal and a vertical precision to the cm level. Describe the field and office procedures needed to produce the topographic plan from the survey. In particular, describe the field and office procedures needed to ensure that the contours depict the terrain accurately (25%).

| |
|------------|
| Name _____ |
| ID _____ |

3) Calculate the following (25%).

The following data are given.

$$\begin{array}{l}
 \text{: Given } \left\{ \begin{array}{l}
 x = A(\text{area}) \\
 L = [a, b] \\
 \bar{a} = 30m, \sigma_{\bar{a}} = 0.1m \\
 \bar{b} = 40m, \sigma_{\bar{b}} = 0.2m
 \end{array} \right. \\
 \text{Then, solve for } \hat{A} \text{ and } \sigma_{\hat{A}}
 \end{array}$$



You are supposed to determine the area of **A** based on the measurements **a** and **b**. The mean value of vertical **a** is 30m, and standard deviation of the mean is 0.1m. The mean of horizontal **b** is 40 m, and the standard deviation of the mean is 0.2m. Solve for the best estimate of A and standard deviation of the mean using the error propagation law.

[NOTE] Please write all necessary mathematical formulation of the error propagation, and be careful of the units. If any of them are wrong, you can not earn any marks for this question.

4) [Bonus] (5%)

A few of the highlights on the course were the following distance measuring and coordinate determination techniques: EDM, 3-D terrestrial laser scanners, terrestrial DEM concepts, and GNSS. These techniques are only for terrestrial surveying purposes. However, with space geodetic techniques such as VLBI, SLR, LLR, etc, we can currently determine the distance up to the boundary of the universe; 137×10^{21} m from the Sun. Therefore, at such a distance an object does not seem to be moving from us, and it can be used as a fixed point on the sky. Why is this distance object important to us, and how is it related on our surveying in general?