

CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

E5 - ADVANCED PHOTOGRAMMETRY

March 2014

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 by the answer. Otherwise, full marks may not be awarded even though the answer is numerically correct.

Note: This examination consists of ten questions on two pages.

<u>Q. No</u>	<u>Time: 3 hours</u>	<u>Marks</u>	
		<u>Value</u>	<u>Earned</u>
1.	a) What is the conceptual basis for evaluating the relative accuracy of LiDAR data? What would be the main challenge in this procedure? How would you mitigate such a challenge?	4	
	b) What is the conceptual basis for evaluating the absolute accuracy of LiDAR data? What would be the main challenge in this procedure? How would you mitigate such a challenge?	4	
	c) Can you carry out a photogrammetric reconstruction of a GPS-aided photogrammetric triangulation of a single flight line without any ground control points? Why?	2	
2.	a) What are the factors that would affect the inter-point spacing for LiDAR data?	2	
	b) What are the factors that would affect the size of the laser beam footprint?	2	
	c) What is the underlying assumption for using a projective transformation to relate the image and object space coordinates?	2	
	d) Briefly explain the conceptual basis for using the Rational Functional Model to relate the image and object space coordinates.	2	
	e) What are the main differences between the collinearity equation and Direct Linear Transformation models?	2	
3.	a) What are the main components of an airborne LiDAR mapping system?	2	
	b) What are the typical unknowns in a photogrammetric bundle adjustment with self-calibration procedure?	2	
	c) What are the main advantages of LiDAR when compared to a photogrammetric system?	2	
	d) What are the main advantages of a photogrammetric system when compared to LiDAR?	2	
	e) How would you compare the intensity image generated from a LiDAR system to an optical image?	2	
4.	a) What is the main limitation of a digital frame camera when compared with an analogue one?	2	
	b) What are the different alternatives for stereo-coverage using line cameras?	3	
	c) How would the stereo-coverage alternatives associated with line cameras affect the Ground Sampling Distance (GSD) in the acquired scenes?	3	
	d) What is meant by Quality Assurance (QA) and Quality Control (QC)?	2	
5.	a) What is the objective of image matching?	2	
	b) What is the conceptual basis of the cross-correlation-based image matching?	2	
	c) What is meant by image resampling according to epipolar geometry? How would this process facilitate the image matching procedure?	2	
	d) What would be the contribution magnitude (i.e., significant versus insignificant) of an INS in the following situations (explain why):	4	
	1) GPS/INS-controlled photogrammetric triangulation of an image block captured by wide-angle frame camera?		
2) GPS/INS-controlled photogrammetric triangulation of an image block captured by a narrow-angle line camera?			

6.	a) What is the impact of biases in the Interior Orientation Parameters (IOP) on the reconstruction outcome from photogrammetric triangulation aided by GPS/INS observations or GCP? Why?	3	
	b) What would you expect from a GPS/INS-controlled triangulation and intersection procedures in terms of the quality of the reconstructed object space? Why?	3	
	c) What are the differences between direct and indirect transformation during image rectification? Tabulate the advantages and disadvantages of each method.	4	
7.	a) What are the necessary input and the processing steps for the generation of an orthophoto through differential rectification?	4	
	b) What is meant by the double mapping problem when generating orthophotos from large scale imagery over urban areas?	3	
	c) Explain the conceptual basis of the z-buffer method for true orthophoto generation.	3	
8.	a) For a photogrammetric system, the horizontal accuracy is superior to the vertical accuracy. Do you agree with this statement? Why?	2	
	b) For a LiDAR system, the vertical accuracy is superior to the horizontal accuracy. Do you agree with this statement? Why?	2	
	c) What are the systematic errors that might be present in a LiDAR system? How can you mitigate the impact of these errors?	3	
	d) What is the conceptual basis for deriving the ground coordinates from a LiDAR mapping system? How is this process different from the image-based photogrammetric mapping?	3	
9.	a) What is the role of the Interior Orientation (IO) in the photogrammetric reconstruction procedure?	2	
	b) What is the role of the geo-referencing in the photogrammetric reconstruction procedure?	2	
	c) What are the factors that should be considered in the QA for a LiDAR mapping mission?	3	
	d) Which one of the following points (i.e., the center of the given windows) can be considered as an interest point? Why? <div style="display: flex; justify-content: space-around; margin-top: 5px;"> 95 94 84 23 94 84 </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> 86 25 96 or 34 26 96 </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> 100 97 87 36 22 25 </div>	3	
10.	a) What are the derived quantities from an integrated GNSS/INS unit onboard an airborne LiDAR mapping system? What are the necessary components for using such quantities for deriving the ground coordinates of the laser beam footprint?	4	
	b) You are working in a company specializing in LiDAR data collection and you have a client that would like to have a point cloud with an average point spacing of 50cm over an urban area. The LiDAR system you have has a maximum pulse repetition rate that would allow you to achieve such point density from a single flight line. Would you recommend a flight configuration with high pulse repetition rate and minimal overlap between neighbouring strips or a flight configuration with less pulse repetition rate and 50% overlap between neighbouring strips? Why?	4	
	c) Is there a difference between scene and image coordinates in imagery captured by a line camera? Why?	2	
Total Marks:		100	