CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

E5 - ADVANCED PHOTOGRAMMETRY　　　　　October 2016

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 three pages.　　　**Marks**

Q. No		Time: 3 hours	Value	Earned
1.	a)	What are the parameters defining the Interior Orientation of a given camera?	3	
	b)	What are the alternative methodologies for estimating the Interior Orientation Parameters of a given camera? Which methodology would you prefer? Why?	4	
	c)	How would you classify the following cameras in terms of being normal, wide, or super-wide angle cameras (show the calculations that support your answer): • 9" × 9" format size with 30 cm focal length, • 9" × 9" format size with 15 cm focal length, and • 9" × 9" format size with 8 cm focal length.	3	
2.	a)	Discuss the differences between 2D and 3D rotation matrices in terms of number of elements in the matrix, number of independent parameters required to describe the corresponding rotation matrix, and number of orthogonality conditions that should be satisfied.	3	
	b)	What are the main differences between the photogrammetric collinearity equations and the Rational Polynomial Coefficient (RPC) model?	4	
	c)	What are the differences between direct and indirect transformation during image rectification? Tabulate the advantages and disadvantages of each method.	3	
3.	a)	What is the objective of image matching?	2	
	b)	What is the conceptual basis of the cross-correlation image matching?	3	
	c)	What is meant by image resampling according to epipolar geometry? How would this process facilitate the image matching procedure?	3	
	d)	How would you compare the intensity image generated from a LiDAR system to an optical image?	2	
4.	a)	What is meant by the double mapping problem when generating orthophotos from large scale imagery over urban areas? Use a sketch to illustrate your answer.	3	
	b)	Explain the conceptual basis of the z-buffer method for true orthophoto generation.	3	
	c)	What are the main components of an airborne LiDAR mapping system?	2	
	d)	What are the main factors affecting the size of the laser footprint of a LiDAR system?	2	
5.	a)	What is the conceptual basis of the photogrammetric Direct Linear Transformation (DLT)? How is it different from the collinearity Equations?	3	
	b)	What is the conceptual basis of the photogrammetric Projective Transformation? How is it different from the DLT?	3	
	c)	What are the main advantages of a photogrammetric system when compared to LiDAR?	3	
	d)	What are the characteristics of an orthophoto?	1	

6.	a) What are the main limitations of the Z-buffer method for true orthophoto generation?	2	
	b) For orthophoto generation, it is recommended to use wide-angle camera for DEM generation while using narrow-angle camera for the rectification process. Do you agree with this statement? Why?	4	
	c) Explain what is meant by beam divergence angle of a LiDAR system.	2	
	d) What are the advantages of a digital frame camera when compared with an analogue one?	2	
7.	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	
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 impact of biases in the Interior Orientation Parameters (IOP) on the reconstruction outcome from photogrammetric triangulation aided by GNSS/INS observations or GCP? Why?	3
	b)	What would you expect from a GNSS/INS-controlled triangulation and intersection procedures in terms of the quality of the reconstructed object space? Why?	3

	c)	What would be the contribution magnitude (i.e., significant versus insignificant) of an INS in the following situations (explain why):
		    i. GNSS/INS-controlled photogrammetric triangulation of an image block captured by wide-angle frame camera?
		    ii. GNSS/INS-controlled photogrammetric triangulation of an image block captured by a narrow-angle line camera?
			4

10.	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?	3
	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?	3
	c)	Can you carry out a photogrammetric reconstruction of a GNSS-aided photogrammetric triangulation of a single flight line without any ground control points? Why?	2
	d)	What is the role of the geo-referencing in the photogrammetric reconstruction procedure?	2
		Total Marks:	100