CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS

C7 – REMOTE SENSING & PHOTOGRAMMETRY October 2018

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 10 questions on 3 pages.   **Marks**

Q. No	Time: 3 hours	Value	Earned
1.	a) Do we need Fiducial marks for metric digital cameras? Why?	2	
	b) Briefly explain the following terms: 1) Registration, 2) Geo-coding, and 3) Ortho-rectification.	6	
	c) Where in the image is there no relief displacement? Why?	2	
2.	The Figure below shows a 3D schematic diagram of a building and the associated ground coordinate system (in black – upper case *XYZ*) as well as the image/camera coordinate systems for two images (in grey – lower case *xyz*) that have been captured around the building. What will be the approximate values you would use for the rotation angles (ω, φ, and κ) for these images in a bundle adjustment procedure? Why? Would you expect any problem in the estimation of these rotation angles in the bundle adjustment procedure? Why? 	10	
3.	What is the rotation matrix that relates the coordinate systems in the figure below – given that $r_{o_2 a}^{x_1 y_1 x_1} = [3 \quad 4 \quad 5]^T$ and $r_{o_2 b}^{x_1 y_1 x_1} = [-6 \quad -8 \quad 10]^T$? Briefly explain how you derived such a rotation matrix. 	14	

4.	What is the minimum number and optimal distribution of ground control points that are needed for (justify your answer):
	  • Independent relative orientation of a stereo-pair,
	  • Dependent relative orientation of a stereo-pair
	  • Single photo resection,
	  • Indirect geo-referencing of an image stereo-pair, and
	  • Indirect geo-referencing of an image block with 60% overlap and 60% side lap?
			8	

5.	a) Explain how you can use the spectral reflectance curve to identify the moisture content in vegetation and soil.		2	
	b) One can argue that digital cameras can see through shadow. Do you agree with this statement? Why?		2	
	c) What is the maximum number of independent rotation angles needed to define a three-dimensional rotation matrix? Why?		2	
	d) What are the parameters that are solved for in the following photogrammetric problems: 1) Single photo resection; 2) Photogrammetric intersection; 3) Bundle adjustment; 4) Bundle adjustment with self-calibration; 5) Dependent relative orientation for a stereo-pair; and 6) Independent relative orientation for a stereo-pair?		6	
6.	a) Satellite remote sensing systems avoid detecting and recording wavelengths in the ultraviolet portion of the spectrum. Why?		2	
	b) The dimensions of a square in the center of a pre-marked panel on a photo are required to be 0.045 mm x 0.045 mm. If the focal length of the camera is 6" and the flight height is 6500′ above the datum, what should be the dimensions of the square on the ground that is 350′ above the datum?		2	
	c) Explain the conceptual basis of the Collinearity Equations, Direct Linear Transformation, Projective Transformation, and Rational Functional Models for relating corresponding scene and object coordinates.		6	
7.	a) List the required input and the necessary steps required to produce an orthophoto using differential rectification.		4	
	b) What are the main characteristics/differences between supervised and unsupervised classification strategies? Tabulate your answer.		4	
8.	a) Describe the conceptual basis and necessary steps of image smoothing in the frequency domain.		2	
	b) How many tie points are needed to establish the relative orientation between the images of a stereo-pair? Why?		2	
	c) You are given a stereo-pair with identified thirty-five tie points. List the balance between the observables and the unknown parameters in a bundle adjustment procedure to solve for the exterior orientation parameters as well as the ground coordinates of tie points. Can you estimate the involved unknown parameters? Why?		3	
	d) What are the alternative methodologies for establishing the exterior orientation parameters of an imaging system?		3	

9.	a)	How is the perspective center defined for the lens assembly for a digital camera system?	2	
	b)	Give a brief definition of the following entities: Nadir point, principal point, principal distance, focal length, principal planes, as well as optical axis of a lens system.	3	
	c)	What are the alternative methodologies for deriving the Interior Orientation Parameters (IOP) of a photogrammetric camera? Which one would you prefer to adopt? Why?	3	
10.	a)	What is the EM radiation waveband used in LiDAR remote sensing systems? Are they active or passive systems?	2	
	b)	What are the advantages of RADAR remote sensing systems?	2	
	c)	What are the quantities measured by a GPS/INS system onboard an imaging platform? What are the main requirements for relating these measurements to the exterior orientation parameters of the exposure stations?	4	
	d)	What are the main characteristics of a metric digital camera?	2	
		Total Marks:	100	