**CANADIAN BOARD OF EXAMINERS FOR PROFESSIONAL SURVEYORS**

## C7 – REMOTE SENSING & PHOTOGRAMMETRY — March 2017

**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

| Q. No | | Value | Earned |
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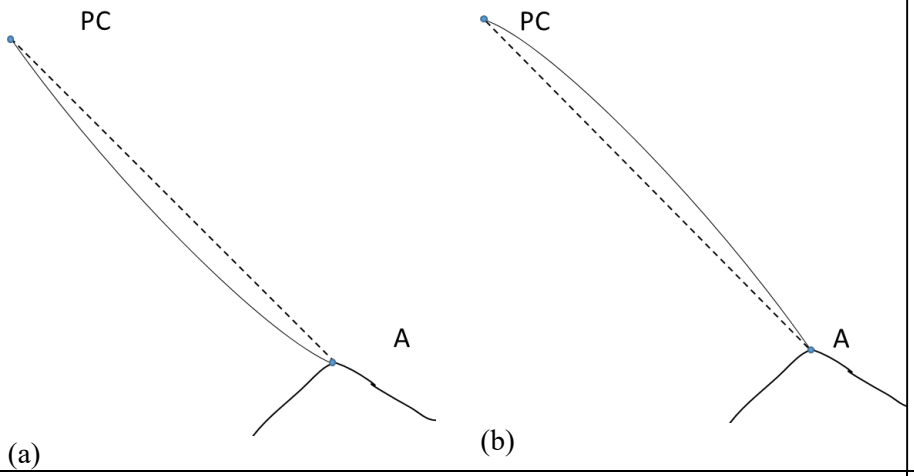
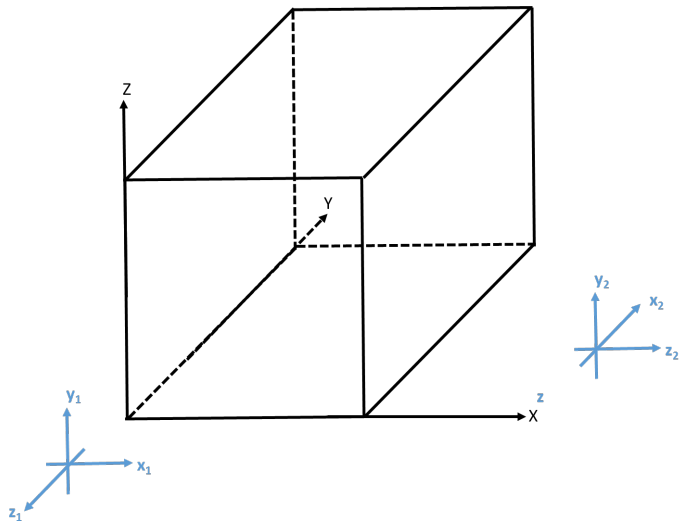
| 1. | Of the following two figures, which one correctly describes the atmospheric refraction pattern for a light ray traveling from the object point (A) to the perspective center (PC)? Why?<br>  <br> | 8 | |
| 2. | The Figure below shows a 3D schematic diagram of a building and the associated ground coordinate system (in black – upper case *XYZ*) as well as the image 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?<br>  <br> | 12 | |

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| 3. | What is the minimum number and optimal distribution of ground control points that are needed for (justify your answer):<br>• Relative orientation of a stereo-pair,<br>• Single photo resection,<br>• Indirect geo-referencing of an image stereo-pair, and<br>• Indirect geo-referencing of an image block with 60% overlap and 60% side lap? | 8 | |
| 4. | a) Satellite remote sensing systems avoid detecting and recording wavelengths in the ultraviolet portion of the spectrum. Why?<br>b) What is the maximum number of independent rotation angles needed to define a two-dimensional rotation matrix? Why?<br>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. | 2<br>2<br>6 | |
| 5. | a) List the required input and the necessary steps required to produce an orthophoto using differential rectification.<br>b) What are the main characteristics/differences between supervised and unsupervised classification strategies? Tabulate your answer. | 4<br>4 | |
| 6. | a) Describe the conceptual basis and necessary steps of image smoothing in the frequency domain.<br>b) Describe the conceptual basis and necessary steps of image sharpening (enhancement) in the frequency domain.<br>c) You are given a stereo-pair with identified twenty-nine 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?<br>d) What are the alternative methodologies for establishing the exterior orientation parameters of an imaging system? | 2<br>2<br>3<br>3 | |
| 7. | a) Explain how you can use the spectral reflectance curve to identify the moisture content in vegetation and soil.<br>b) One can argue that digital cameras can see through shadow. Do you agree with this statement? Why?<br>c) What is the maximum number of independent rotation angles needed to define a three-dimensional rotation matrix? Why?<br>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)? | 2<br>2<br>2<br>6 | |
| 8. | a) How is the perspective center defined for the lens assembly for a digital camera system?<br>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.<br>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? | 2<br>3<br>3 | |

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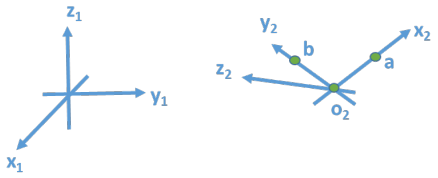
| 9. | a) What is the EM radiation waveband used in LiDAR remote sensing systems? Are they active or passive systems?<br>b) What are the advantages of LiDAR remote sensing systems?<br>c) What are the quantities measured by a GPS/INS system onboard an imaging platform? What are the main requirements for relating these measurements to the exterior orientation parameters of the exposure stations?<br>d) What are the main differences between the scene acquisition procedures for frame and line cameras? | 2<br>2<br>4<br>2 | |
| 10. | 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* $r_{o_2 b}^{x_1 y_1 x_1} = [-3 \quad -4 \quad 5]^T$? Briefly explain how you derived such a rotation matrix.<br>  | 14 | |
| | **Total Marks:** | 100 | |