

Canadian Board of Examiners for Professional Surveyors
Core Syllabus Item
E 5: ADVANCED PHOTOGRAMMETRY

Syllabus Topics:

Quality Assurance (QA) and Quality Control (QC) of photogrammetric mapping: flight configuration, camera calibration, system calibration, precision, and accuracy;

Modern digital imaging systems: frame cameras, multi-head frame cameras, and bush-broom scanners;

Sensor modeling: physical and replacement sensor models;

Image geo-referencing: indirect geo-referencing, direct geo-referencing, integrated sensor orientation, accuracy analysis;

Image matching: cross correlation and least-squares matching;

Epipolar geometry;

Ortho-rectification: polynomial rectification, differential rectification, and true orthophoto generation;

LiDAR mapping: laser principles, system specifications, error sources (random and systematic errors), Quality Assurance and Quality Control (QA/QC), and classification and segmentation of LiDAR data

Recommended Prior Knowledge and Skills:

Item C1: Mathematics

Item C2: Least-Squares Estimation and Data Analysis

Item C3: Advanced Surveying

Item C4: Coordinate Systems and Map Projections

Item C5: Geospatial Information Systems

Item C6: Geodetic Positioning

Item C7: Remote Sensing and Photogrammetry

Learning Outcomes:

In order to fulfill the requirements of this syllabus item, candidates should be able to:

1. Identify the pre-mission factors that might affect the quality of photogrammetric products and post-mission measures for evaluating the quality of the delivered product. (*See Essential Reference Material ENGO 431 Chapters 1 – 8; ENGO 531, Chapters 1, 3, 4, and 5; ENGO 667, Chapters 1 and 2*)
2. Differentiate between the mechanisms and the sensor modeling alternatives of photogrammetric data acquisition modalities (e.g., frame, multi-head frame, and line cameras). (*See Essential Reference Material ENGO 431, Chapter 4; ENGO 435, Chapter 1 and 3; ENGO 531, Chapter 2*)
3. Explain the conceptual basis and the implementation details of the various mathematical models for relating image and ground coordinates. (*See Essential Reference Material ENGO*

431, Chapters 7 and 8; ENGO 435, Chapter 5; ENGO 531, Chapters 1 and 2; ENGO 667, Chapters 1 and 2)

4. Explain the differences between the various image geo-referencing techniques and their impact on the quality of the final product (e.g., indirect geo-referencing, direct geo-referencing, and integrated sensor orientation). (See *Essential Reference Material ENGO 431, Chapter 8; ENGO 531, Chapters 1, 2, and 3*)
5. Explain the conceptual basics and implementation of image matching techniques (e.g., cross correlation, least squares matching, and epipolar geometry). (See *Essential Reference Material ENGO 435, Chapters 4 and 5; ENGO 531, Chapter 3; ENGO 667, Chapter 4*)
6. Differentiate between image ortho-rectification techniques (e.g., polynomial rectification, differential rectification, and true orthophoto generation). (See *Essential Reference Material ENGO 435, Chapter 5; ENGO 531, Chapter 5; ENGO 667, Chapter 4*)
7. Explain the principles of LiDAR mapping (e.g., laser principles, error sources and their impact, and data processing). (See *Essential Reference Material ENGO 435, Chapter 3; ENGO 531 Chapters 4 and 5; ENGO 667, Chapter 4*)

Essential Reference Material:

Study notes from the University of Calgary:

ENGO 431: Principles of Photogrammetry

<http://dprg.geomatics.ucalgary.ca/Courses/ENGO431>

ENGO 435: Introduction to remote sensing

<http://dprg.geomatics.ucalgary.ca/Courses/ENGO435>

ENGO 531: Advanced Photogrammetric and Ranging Techniques

<http://dprg.geomatics.ucalgary.ca/Courses/ENGO531>

ENGO 667: Advanced Photogrammetric and Ranging Techniques

<http://dprg.geomatics.ucalgary.ca/Courses/ENGO667>

Supplementary Reference Material:

Krauss, K., [1993]. *Photogrammetry, Volume 1: Fundamentals and Standard Processes*, 4th Edition, Dummler/Bonn. ISBN 3-427-78684-6

Provides an overview of the photogrammetric principles and their application for object space reconstruction from imagery.

Krauss, K., [1997]. *Photogrammetry, Volume 2: Advanced Methods and Applications*, 4th Edition, Dummler/Bonn. ISBN 3-427-78694-3

Provides an overview of the photogrammetric principles and their application for object space reconstruction from imagery.

Mikhail, E., Bethel, J. and McGlone, J., [2001]. *Introduction to Modern Photogrammetry*, John Wiley & Sons, Inc. ISBN 0-471-30924-9

Provides an overview of the impact of modern photogrammetric and remote sensing systems on photogrammetric mapping.

Schenk, T., [1999]. *Digital Photogrammetry (Volume I): Background, Fundamentals, Automatic Orientation Procedures*, TerraScience. ISBN 0-9677653-1-5

Provides a comprehensive coverage of photogrammetric mapping in a digital environment.

Shan, J. and Toth, C. (editors), [2009]. *Topographic Laser Ranging and Scanning: Principles and Processing*, CRC Press, Taylor & Francis Group. ISBN 1-4200-5142-3

Provides a collection of chapters that explain the basic principles, data manipulation, and application of LiDAR mapping.