Canadian Board of Examiners for Professional Surveyors
Core Syllabus Item
C 7: REMOTE SENSING AND PHOTOGRAMMETRY

Syllabus Topics:

Principles of modern quantitative remote sensing using optical, infrared, and microwave radiation: basic characteristics of electromagnetic radiation, interaction between radiation and terrestrial materials and atmospheric constituents, and characteristics of sensor systems and their measurements (e.g., passive and active sensors); Sensor models: resolution, spectral, and spatial response; Spatial transform: convolution; Corrections and calibration: noise reduction, radiometric calibration, geometric corrections; Classification: principles, supervised/unsupervised classification, accuracy evaluation.

Data acquisition systems employed in aerial and close-range photogrammetry: analogue versus digital cameras, metric versus non-metric cameras, and frame versus line cameras; Stereo-coverage: objective, overlap, and side lap; Project planning; Mathematical relationship between image and object space: collinearity and coplanarity conditions; Orientation procedures: Interior, Exterior, Relative, and Absolute orientation; Measurement and correction of image coordinates; Aerial triangulation: strip triangulation, block adjustment of independent models, and bundle adjustment; Quality Assurance (QA) and Quality Control (QC) of photogrammetric mapping: camera calibration, system calibration, precision, and accuracy

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

Learning Outcomes:

In order to satisfy the requirements of this syllabus item, candidates should have, at an introductory level:

- the ability to explain and illustrate the role of remote sensing and photogrammetry in mapping applications (image acquisition, image measurement, object reconstruction, and information retrieval), *(see Essential Reference Materials ENGO 431, Chapters 1 – 8; ENGO 435, Chapters 1 – 6; Elements of Photogrammetry (with Applications in GIS), Chapters 11 and 17; Remote Sensing of the Environment: An Earth Resource Perspective, Chapters 1 and 6)*;
- the ability to work in a basic fashion with remote sensing imagery (optical, infrared, and microwave radiation), spatial transform (convolution), corrections and calibration (noise reduction, radiometric calibration, and geometric corrections), geometric manipulation (registration, geo-coding, and ortho-rectification), and thematic classification (supervised/unsupervised classification and accuracy evaluation), *(see Essential Reference Materials ENGO 431, Chapters 1 – 8; ENGO 435, Chapters 1 – 6; Elements*

of Photogrammetry (with Applications in GIS), Chapters 13 and 14; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 6); and

- the ability to apply concepts and principles of determining spatial positions using photogrammetric techniques (e.g., machine-to-image coordinate transformation, space intersection, and space resection), *(see Essential Reference Materials ENGO 431, Chapters 5 – 8; Elements of Photogrammetry (with Applications in GIS), Chapters 11 and 17)*.

In addition, candidates should have, at an introductory level, the ability to:

- perform mission planning for airborne sensing operations, *(see Essential Reference Materials ENGO 431, Chapters 7 and 8; Elements of Photogrammetry (with Applications in GIS), Chapter 18; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 4)*;
- assess geo-referencing data acquired with tools such as GPS and inertial technologies, and control requirements in photogrammetric networks, *(see Essential Reference Materials ENGO 431, Chapters 7 and 8; Elements of Photogrammetry (with Applications in GIS), Chapters 16 and 17)*;
- assess the quality of different rectification methodologies (e.g. ortho-rectification, polynomial rectification), *(see Essential Reference Materials ENGO 435, Chapter 5; Elements of Photogrammetry (with Applications in GIS), Chapter 13; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 6)*;
- discuss the concept of electromagnetic radiation and how it interacts with matter, particularly land surface, oceans, and atmosphere, *(see Essential Reference Materials ENGO 435, Chapter 4; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 2)*;
- infer valid information from remote observations (e.g., electromagnetic spectra), *(see Essential Reference Materials ENGO 435, Chapters 1 – 4; Remote Sensing of the Environment: An Earth Resource Perspective, Chapters 10 – 13)*;
- apply the principles, techniques, and practice of the quantitative analysis of digital imagery, *(see Essential Reference Materials ENGO 431, Chapter 5 – 8; Elements of Photogrammetry (with Applications in GIS), Chapters 11, 14, 15 and 17)*;
- demonstrate an understanding of remote sensing technologies and their spatial and temporal sampling characteristics, *(see Essential Reference Materials ENGO 435, Chapters 1 – 4; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 12)*;
- relate observations to models (mathematical, computational, and conceptual) of photogrammetric data, *(see Essential Reference Materials ENGO 431, Chapter 5 – 8; Elements of Photogrammetry (with Applications in GIS), Chapters 11 and 17; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 6)*; and
- apply the concepts and principles of determining spatial positions using photogrammetric techniques, *(see Essential Reference Materials ENGO 431, Chapter 5 – 8; Elements of Photogrammetry (with Applications in GIS), Chapters 11 and 17; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 6)*.

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

Jensen, John R. [2000]. *Remote Sensing of the Environment: An Earth Resource Perspective*. Prentice Hall. ISBN 0-13-489733-1

Wolf, P. R. and Dewitt, B. A. [2000]. *Elements of Photogrammetry (with Applications in GIS)*. 3rd Edition, McGraw-Hill. ISBN 0-07-292454-3

Supplementary Reference Material:

1. Schowengerdt, Robert A. [1997]. *Remote Sensing: Models and Methods for Image Processing*. 2nd, Academic Press. ISBN 0-12-628981-6
2. Jensen, John R. [1995]. *Introductory Digital Image Processing: A Remote Sensing Perspective*. 2nd, Prentice Hall. ISBN 0-13-205840-5
3. Jia X. and Richards, J. [1999]. *Remote Sensing Digital Image Analysis: An Introduction*. 3rd, Springer Verlag. ISBN 3-540-64860-7
4. Congalton, R. and Green, K. [1998]. *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices.* CRC Press. ISBN 0-87-371986-7
5. Atkinson, K.B. [1996]. *Close range photogrammetry and machine vision*. Whittles Publishing. ISBN 1-87-032546-X
6. Slama, C. S. (Editor) [1980]. *Manual of Photogrammetry*. 4th. American Society of Photogrammetry and Remote Sensing, Falls Church, VA ISBN 0-937-294-01-2
7. Krauss, K. [1993]. *Photogrammetry, Volume 1: Fundamentals and Standard Processes*. 4th. Dummler/Bonn. ISBN 3-427-78684-6
8. Krauss, K. [1997]. *Photogrammetry, Volume 2: Advanced Methods and Applications*. 4th. Dummler/Bonn. ISBN 3-427-78694-3
9. Mikhail, E., Bethel, J. and McGlone, J. [2001]. *Introduction to Modern Photogrammetry*. John Wiley & Sons, Inc. ISBN 0-471-30924-9

Supplementary references 1 – 4 deal with remote sensing and image processing principles and their applications. Supplementary references 5 – 9 deal with the necessary photogrammetric principles for object space reconstruction from imagery.