

**Canadian Board of Examiners for Professional Surveyors**  
**Core Syllabus Item**  
**E 4: ADVANCED REMOTE SENSING**

**Syllabus Topics:**

Principles of remote sensing: electromagnetic radiation, interaction of electromagnetic radiation with the atmosphere and Earth surface, remote sensing systems/platforms;

Radiometric corrections of remote sensing data: surface reflectance from recorded digital numbers by remote sensing systems;

Geometric corrections of remote sensing data: geo-coding, registration, and ortho-rectification of remote sensing imagery;

Image classification: supervised and unsupervised classification techniques, accuracy evaluation of classification results;

Thermal and multi/hyper-spectral remote sensing: operational principles, temperature mapping, and data processing;

Digital image processing techniques: image enhancement, spatial transform (convolution), and frequency transform (Fourier analysis);

LiDAR mapping: laser principles, system specifications, error sources (random and systematic errors), and classification and segmentation of LiDAR data;

Microwave remote sensing: advantages, operational principles, and geometric characteristics of acquired data;

Information extraction from remotely sensed data to support various applications: vegetation index extraction, water and urban landscape monitoring, and change detection

**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. Explain the physics and principles of remote sensing including EMR interaction with the atmosphere and Earth surface, remote sensing platforms, operational principles of remote sensing systems, and relationship between remote sensing and other mapping sciences. (*See Essential Reference Material ENGO 435, Chapter 2; Remote Sensing of the Environment: An Earth Resource Perspective, Chapters 1 and 2; Introductory Digital Image Processing: A Remote Sensing Perspective, Chapter 2*)

2. Explain the principles and the mathematics of radiometric corrections of remote sensing data to derive the surface reflectance from recorded digital numbers. (*See Essential Reference Material ENGO 435, Chapter 4; Remote Sensing of the Environment: An Earth Resource Perspective, Chapters 1 and 2; Introductory Digital Image Processing: A Remote Sensing Perspective, Chapters 2 and 6*)
3. Explain the principles and the mathematics of geometric corrections to collected imagery including geo-coding, registration, and ortho-rectification. (*See Essential Reference Material ENGO 435, Chapter 5; ENGO 531, Chapters 1, 2, and 5; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 6; Introductory Digital Image Processing: A Remote Sensing Perspective, Chapter 6*)
4. Explain the principles and apply image classification techniques as well as evaluation of the classification results. (*See Essential Reference Material ENGO 435, Chapter 6; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 12; Introductory Digital Image Processing: A Remote Sensing Perspective, Chapter 8*)
5. Explain the principles and data processing techniques of thermal and multi/hyper-spectral scanning. (*See Essential Reference Material Remote Sensing of the Environment: An Earth Resource Perspective, Chapters 7 and 8*)
6. Explain the principles and apply digital imaging processing techniques including image enhancement, spatial transforms, frequency transforms, and texture analysis. (*See Essential Reference Material ENGO 435, Chapter 4; Introductory Digital Image Processing: A Remote Sensing Perspective, Chapter 7*)
7. Explain the principles and operational characteristics of microwave remote sensing. (*See Essential Reference Material ENGO 435, chapter 3; ENGO 531, Chapter 6; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 9*)
8. 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; Remote Sensing of the Environment: An Earth Resource Perspective, Chapter 9*)
9. Explain the application of remote sensing for vegetation, water, and urban landscape monitoring. (*See Essential Reference Material ENGO 435, Chapters 2 and 3; Remote Sensing of the Environment: An Earth Resource Perspective, Chapters 10 – 13*)
10. Use multi-temporal remote sensing data for change detection. (*See Essential Reference Material ENGO 435, Chapters 4 and 6; Introductory Digital Image Processing: A Remote Sensing Perspective, Chapters 8 and 9*)

### **Essential Reference Material:**

Study notes from the University of Calgary:

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>

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

Jensen, John R., [1995]. Introductory Digital Image Processing: A Remote Sensing Perspective, 2<sup>nd</sup> Edition, Prentice Hall. ISBN 0-13-205840-5

**Supplementary Reference Material:**

Schowengerdt, Robert A., [1997]. Remote Sensing: Models and Methods for Image Processing, 2<sup>nd</sup> Edition, Academic Press. ISBN 0-12-628981-6

*Provides a description of remote sensing models, image processing techniques, digital elevation model derivation, and hyper-spectral image analysis.*

Lillesand, Thomas M., Kiefer, Ralph W. and Chipman, Jonathan W. [2007]. Remote Sensing and Image Interpretation, 6<sup>th</sup> edition, Wiley. ISBN: 978-0-470-05245-7

*Covers recent developments in digital image processing, modern imaging satellites, and foundations of remote sensing.*

Richards, John A. and Jia, Xiuping [2006]. Remote Sensing Digital Image Analysis: An Introduction, 4<sup>th</sup> Edition, Springer. ISBN: 978-3-540-25128-6

*Provides a coverage of sources/characteristics of remote sensing data, geometric/radiometric error correction, image registration, and image processing techniques.*

Marther, Paul M., [2004]. Computer Processing of Remotely-Sensed Images: An Introduction, 3<sup>rd</sup> Edition, Wiley. ISBN: 978-0-470-02101-9

*Provides a comprehensive coverage of the mechanics of processing remotely-sensed images.*