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## GEOG 271 – Earth from Space Using Remote Sensing

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Instructor: Claude R. Duguay

Room: TBD

Office hours: Tuesday (12:00-14:00 and by appointment)

MAD staff (office hours): Mike Lackner (by appointment, EV2 1008B)

TAs (office hours): TBD

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### Course Description

This course will provide an introduction to the basic scientific principles involved in remote sensing, and some of the applications to studies of the Earth's surface. This shall include examining the basic physics of electromagnetic radiation and the complex interactions of radiation with the surface and atmosphere (i.e. spectral signatures). The theoretical concepts and examples covered in the lectures will provide the basis for examining various remote sensing applications using data obtained in different parts of the electromagnetic spectrum. The applications will include uses of remote sensing data for mapping and monitoring vegetation, soils and minerals, snow and ice, water resources and quality, and urban landscapes. The laboratory section will include hands-on experience with the Geomatica© image analysis software package, the Sentinel Application Platform (SNAP), various satellite-image data sets, and some basic coding using Python within the Geomatica© environment.

### Course Goal and Student Learning Outcomes

Goal: The goal of this course is to introduce students to the basics of remote sensing with a special focus on the principles, physics, tools, analysis and applications of satellite remote sensing data acquired in different parts of the electromagnetic spectrum.

Student Learning Outcomes: By the end of the course, students should be able to:

- *Relate and use* various radiation laws.
- *Understand* the cause of different spectral responses and the significance of spectral signatures in optical, thermal infrared and microwave remote sensing.
- *Carry out* basic digital processing including spectral ratios, histogram stretching, filtering, supervised and unsupervised classification, and user defined algorithms.
- *Outline* an optimal plan for data acquisition for various environmental applications.

## Class Meetings

### Lecture section:

Tuesday: 14:30-16:20 (STC 0050)

### Lab sections: EV2 1002A (Geddes Lab)

Section 101 – Thursday: 10:30-12:20

Section 102 – Thursday: 16:30-18:20

Section 103 – Friday: 8:30-10:20

Section 104 – Friday: 10:30-12:20

Section 105 – Friday: 13:30-15:20

## Lecture and Lab Schedule

Week	Date	Format	Topic	Reading
1	Jan 8	Lecture	Introduction <b>(No lab this week)</b>	Jensen*, Chap. 1
2	Jan 15	Lecture	Basic Physics of Radiation, Definitions, and Fundamental Laws	Jensen*, Chap. 2
	Jan 17-18	Lab #1	Introduction to PCI <i>Geomatica</i>	PCI documentation
3	Jan 22	Lecture	<u>Visible to Mid-infrared</u> : Spectral Signatures I	Jensen*, Chap. 5
	Jan 24-25	Lab #2	Processing and Interpretation of Visible to Mid-IR Imagery I	Jensen†, Chap. 6
4	Jan 29	Lecture	Visible to Mid-infrared: Spectral Signatures II	Jensen*, Chap. 11-15
	Jan 31-Feb 1	Lab #3	Processing and Interpretation of Visible to Mid-IR Imagery II	Jensen†, Chap. 7
5	Feb 5	Lecture	Visible to Mid-infrared: Sensors and Platforms	Jensen*, Chap. 7
	Feb 7-8	Lab #4	Processing and Interpretation of Visible to Mid-IR Imagery III	Jensen†, Chap. 8

6	Feb 12	Lecture	Visible to Mid-infrared: Applications	Jensen*, Chap. 11-14
	Feb 14-15	Lab #5A	Processing and Interpretation of Visible to Mid-IR Imagery IV	Jensen†, Chap. 9
7	<b>Family Day (Feb 18) and Mid-Term Study Break (Feb 19-22)</b>			
8	Feb 26	Midterm exam & Lecture	<u>Thermal Infrared: Spectral Signatures</u>	Jensen*, Chap. 8
	Feb 28-Mar 1	Lab #5B	Processing and Interpretation of Visible to Mid-IR Imagery IV	Jensen†, Chap. 9
9	Mar 5	Lecture	Thermal Infrared: Sensors, Platforms and Applications	Jensen*, Chap. 8
	Mar 7-8	Lab #6A	Processing and Interpretation of Thermal Infrared Imagery	Jensen†, Chap. 9
10	Mar 12	Lecture	<u>Active Microwave: Spectral Signatures I</u>	Jensen*, Chap. 9
	Mar 14-15	Lab #6B	Processing and Interpretation of Thermal Infrared Imagery	Jensen†, Chap. 8
11	Mar 19	Lecture	<u>Active Microwave: Spectral Signatures II</u>	Jensen*, Chap. 9
	Mar 21-22	Lab #7A	Processing and Interpretation of Active Microwave Imagery	Jensen†, Chap. 9
12	Mar 26	Lecture	Active Microwave: Sensors, Platforms and Applications	Jensen*, Chap. 9

	Mar 28-29	Lab #7B	Processing and Interpretation of Active Microwave Imagery	Jensen†, Chap. 8
13	Apr 2	Lecture	Passive Microwave: Spectral Signatures, Sensors, Platforms and Applications	Jensen*, Chap. 9

## Evaluation

Lab Assignments: 50%

Midterm exam (closed-book; first 45 min of February 26 lecture): 20%

Final exam (closed-book; on-campus exam period April 1-27): 30%

**Note:** Assignments are to be turned in during the lab sections on the specified dates (hard copies and in “Dropbox” folders). No late assignments will be accepted. Consultation and discussion of lecture/lab material with classmates is acceptable BUT all assignments are to be completed individually.

## Assignments

- Access to the computer lab is restricted by code to those enrolled in particular courses including this one. Food and/or drink are NOT permitted in the lab.
- Students are responsible for maintaining their own backups of their work. There are a number of options available for backing up your work, including the N: drive for FE students. It is suggested that you keep two copies of your work in separate locations. Remember that you are only as far ahead as your latest backup!

## Textbooks and Other Resources

### Optional Textbooks

\*Jensen, J.R., 2007. *Remote Sensing of the Environment: An Earth Resource Perspective*. Second Edition, Pearson, NJ, 592 p.

†Jensen, J.R., 2016. *Introductory Digital Image Processing: A Remote Sensing Perspective*. Fourth Edition, Pearson, NJ, 623 p.

These books are expensive at about \$200.00 each. Second hand copies may also be available in the Used Bookstore in the Student Life Centre or via the web. Copies will be placed on reserve at the Dana Porter library. There is also the option of acquiring a digital version (eText) of the Jensen (2016) book for about \$80.00 US.

### Other Textbooks

Campbell, J.B. and R.H. Wynne, 2011. *Introduction to Remote Sensing*. Fifth Edition, Guilford Press, NY, 667 p.

Lillesand, T.M., R.W. Kiefer and J. Chipman, 2015. *Remote Sensing and Image Interpretation*. Seventh Edition, Wiley, NY, 736 p.

Mather, P.M., 2011. *Computer Processing of Remotely-Sensed Images: An Introduction*. Fourth Edition, Wiley, 460 p.

### Lecture Material

PDF Acrobat versions of the Powerpoint presentations will be available through LEARN prior to the lecture.

## **University of Waterloo LEARN Course Environment**

This course uses the LEARN course environment for course material dissemination and information exchange. LEARN is a web-based course management system that enables instructors to manage course materials (posting of lecture notes etc.), interact with their students, and provide feedback. YOU NEED TO ENSURE THAT YOU CAN ACCESS LEARN. Note that lecture slides are posted on LEARN prior to each lecture. Assignment materials are also distributed through LEARN.

### *Logging into LEARN*

Since LEARN is a web-based system, you will need a browser.

Once you have started up your browser, you can access LEARN via:  
<http://learn.uwaterloo.ca>

### *Checking your Userid and Password*

Your password can be checked and reset (if needed) by going to:

<https://watiam.uwaterloo.ca/idm/user/login.jsp>

If you still cannot get on LEARN after checking and resetting your password, please confirm with your instructor that you are on the class roster.

### *Getting Help*

Documentation for LEARN is available at:

<https://uwaterloo.ca/learn-help/students>

## **Academic Integrity**

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. The University's guiding principles on academic integrity can be found here:  
<http://uwaterloo.ca/academicintegrity/>

ENV students are strongly encouraged to review the material provided by the university's Academic Integrity office specifically for students:  
<http://uwaterloo.ca/academicintegrity/Students/index.html>

Students are also expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. Students may also complete the following tutorial: <https://uwaterloo.ca/library/get-assignment-and-research-help/academic-integrity/academic-integrity-tutorial>

When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71 - Student Discipline, <https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-71>

Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Grievance: <https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-70>

**Note for students with disabilities:** AccessAbility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

**Mental Health:** The University of Waterloo, the Faculty of Environment and our Departments consider students' well-being to be extremely important. We recognize that throughout the term students may face health challenges - physical and / or emotional. **Please note that help is available.** Mental health is a serious issue for everyone and can affect your ability to do your best work. Counselling Services <http://www.uwaterloo.ca/counselling-services> is an inclusive, non-judgmental, and confidential space for anyone to seek support. They offer confidential counselling for a variety of areas including anxiety, stress management, depression, grief, substance use, sexuality, relationship issues, and much more.

**Religious Observances:** Student needs to inform the instructor at the beginning of term if special accommodation needs to be made for religious observances that are not otherwise accounted for in the scheduling of classes and assignments.

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. See Policy 70 - Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please contact your Undergraduate Advisor for details.

**Appeals:** decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 – (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm)

**Unclaimed assignments:** Unclaimed assignments will be retained until one month after term grades become official in Quest. After that time, they will be destroyed in compliance with UW's confidential shredding procedures <http://www.adm.uwaterloo.ca/infostor/Confidential%20Shredding%20procedures%202008.htm>

**Communications with Instructor and Teaching Assistants:** All communication with students must be through either the student's University of Waterloo email account or via Learn. If a student emails the instructor or TA from a personal account they will be requested to resend the email using their personal University of Waterloo email account.

**Recording lectures:**

- Use of recording devices during lectures is only allowed with explicit permission of the instructor of the course.
- If allowed, video recordings may only include images of the instructor and not fellow classmates.
- Posting of videos or links to the video to any website, including but not limited to social media sites such as: Facebook, Twitter, etc., is strictly prohibited.

**Co-op interviews and class attendance:** Co-op students are encouraged to try and choose interview time slots that result in the least amount of disruption to class schedules. When this is challenging, or not possible, a student may miss a portion of a class meeting for an interview. Instructors are asked for leniency in these situations; but, a co-op interview does not relieve the student of any requirements associated with that class meeting.

When a co-op interview conflicts with an in-class evaluation mechanism (e.g., test, quiz, presentation, critique), class attendance takes precedence and the onus is on the student to reschedule the interview. CECA provides an interview conflict procedure to manage these situations. Students will be required to provide copies of their interview schedules (they may be printed from JobMine) should there be a need to verify class absence due to co-op interviews.