GGR 337	**Environmental Remote Sensing**
Instructor:	**Dr. Holly Croft**
Office:	**Room 5027A, 100 St. George St.**
E-Mail:	holly.croft@utoronto.ca
Teaching Assistants:	**Dr. Rong Wang and Dr. Ting Zheng**
	Room 5027B, 100 St. George St.
	wangr@geog.utoronto.ca and
	zhengt@geog.utoronto.ca

Lectures

Monday 10 am -12 noon, AB 107

Consultations

Instructor: Monday 13.00-15.00 pm, Room 5027A, 100 St. George St.
TAs: Thursday 13:00-14:00 pm and Friday 15:00-16:00 pm, Room 5027B, 100 St. George St.

Lab. Tutorials

Practical 0101 - Tuesday 1-3 pm and Practical 0201 - Wednesday 1-3 pm, Room SS 561, Sydney Smith. There are five tutorials in total (two times each in the same week). Dates of these tutorials are given in the schedule below. Students should be available for one of the two time slots. A sign-up sheet will be available in the first class and thereafter on my office door. Space is restricted so sign up early if you prefer a specific day.

Prerequisite

GGR100H1/JEG100H1/GGR272H1 (The requirement is flexible and can be discussed with the instructor)

Outline

Environmental remote sensing has been an exciting subject as many satellite sensors have been launched in the past few decades and many are still forthcoming. The unprecedented abundance of earth observation data will allow us to address many pressing environmental issues. This course will cover the basics of using remote sensing data for environmental studies. In addition to learning the basic concepts, terminology, and theories of remote sensing science and applications, students will have the opportunity to acquire hands-on experience in digital image processing using ArcGIS. A series of laboratory assignments are designed with detailed instructions to lead the students through the key steps in processing satellite images and in extracting quantitative information about the Earth's surface.

Evaluation

5 Lab assignments_____ 45%
Mid-term exam _____ 15%
Final exam _____ 40%

Late lab reports will be penalized at 10% of the portion of the lab for each day of delay, i.e., a multiplying factor of 0.9 will be used for 1-day delay, and 0.8 for 2-day delay, etc.

Text Book

Lillesand, T. M., R. W. Kiefer, and J. W. Chipman, 2015. *Remote Sensing and Image Interpretation*. seventh edition. ISBN 978-1-118-34328-9

Other References (in order of importance)

Campbell, J. B. 2011. *Introduction to Remote Sensing*. Guilford Press, fifth edition, ISBN: 978-1-59385-319-8.
Verbyla, D. L., 1995. *Satellite Remote Sensing of Natural Resources*. Lewis Publishers, New York. ISBN:1-56670-107-4

Additional readings

To be provided in class.

Course Objectives

After successfully completing GGR337H1F, students will be able to:

- Understand fundamental principles of electromagnetic radiation as applied to remote sensing;

- Appropriately use basic concepts related to remote sensing observations;

- Acquire the basic knowledge on the characteristics of the main existing spaceborne and airborne remote sensing systems;

- Have the ability to conduct applications of remote sensing techniques to real-world environmental issues;

- Use an image processing tool to implement basic operations with remote sensing images and conduct quantitative analysis;

Note: If you are having difficulties in keeping up with class assignments or in understanding the material we are covering, please see me as soon as possible!

Lecture Schedule

Week	Date	Subject	Reading	Labs. Due
1	Sept 11	Introduction to remote sensing principles and course introduction	JC: Chapter 1 LKC: Chapter 2.1-2.2	
2	Sept 18 Sept 19/20	Electromagnetic radiation and Radiation terminology **Tutorial for Lab. 1 (5%)** ***not a computer lab.**	LKC: Chapter1.1-1.43 JC: Chapter 2	
3	Sept 25	Spectral characteristics	LKC: Chapter 1.4-1.5	
4	Oct 2 Oct 03/04	Satellite orbits and sensors **Tutorial for Lab. 2 (10%)**	LKC: Chapters 4, 5 and 6 JC: Chapters 6 and 7	**Lab. 1 report due Oct 2**
No class	Oct 9	Thanksgiving holiday		
5	Oct 16 Oct 17/18	Image processing and geometric correction Image enhancement techniques Color display techniques **Tutorial for Lab. 3 (10%)**	LKC: Chapters 1.7, 4.6-4.7 JC: Chapter 4 (Image proc.) LKC: Chapter 7.3-7.5 JC: Chapter 5 (Image enh.) LKC: Chapters 2.4-2.5 and 7.6 (Color display).	**Lab. 2 report due Oct 16**
6	Oct 23	RADAR principles and applications	LKC: Chapter 6	
7	Oct 30	UAV technology **Mid-term exam (15%)**		
No class	Nov 6	Reading week		
8	Nov 13 Nov 7/8	Radiometric corrections **Tutorial for Lab. 4 (10%)**	LKC: Chapters 1.4 and 7.2 (Radiometric Cor.)	**Lab. 3 report due Nov 13**
9	Nov 20	Multispectral transformations of image data and vegetation indices	LKC: Chapter 7.6 JC: Chapter 17	
10	Nov 27 Nov 28/29	Clustering and unsupervised classification Supervised classification techniques **Tutorial for Lab. 5 (10%)**	LKC: 7.11, JC: Chapter 12 LKC: 7.8, JC: Chapter 12	**Lab. 4 report due Nov 27**
11	Dec 4	LiDAR principles and application	LKC: Chapter 6.23-6.25	
12	Dec 7	Remote sensing applications: Agriculture, forestry, climate change	JC: Chapters 17, 19-21	**Lab. 5 report due Dec 7**

Note: JC is the reference book of James Campbell, and LKC is the textbook of Lillesand, Kiefer and Chipman

Academic Integrity

It is your responsibility as a student at the University of Toronto to familiarize yourself with, and adhere to, both the Code of Student Conduct and the Code of Behaviour on Academic Matters.

This means, first and foremost, that you should read them carefully.

- The Code of Student Conduct is available from the U of T website:
  http://www.governingcouncil.utoronto.ca/policies/studentc.htm
- The Code of Behaviour on Academic Matters is available from the U of T website:
  http://www.governingcouncil.utoronto.ca/policies/behaveac.htm

See also the University's website on Academic integrity: www.utoronto.ca/academicintegrity.

Accessibility Services

The University of Toronto is committed to accessibility. If you require accommodations or have any accessibility concerns, please visit Accessibility Services at http://www.accessibility.utoronto.ca/ as soon as possible. For more information please contact Accessibility Services at:

Robarts Library, 1st Floor (ground entrance off St. George St.), 130 St. George St, Toronto, M5S 3H1
Voice: 416-978-8060
Fax: 416-978-8246
TTY: 416-978-1902
Email: accessibility.services@utoronto.ca
Web: www.accessibility.utoronto.ca

Policies

Assignments: Assignments should be submitted either before or after the class on the due date**.** *Please do not put your assignments in my mail box at Sydney Smith Hall.* Late assignments will be subject to a late penalty of 10% per day (including weekends) of the total marks for the assignment. Assignments submitted five calendar days beyond the due date will be assigned a grade of zero. *Electronic submissions will not be accepted*. All late assignments must be turned into the drop box located outside of the Geography main office (Sidney Smith Hall, Room 5047). You can only turn in a late assignment during business hours, normally between 9am and 5pm, Monday – Friday. They will be time stamped at 5pm on the day submitted.

Missed assignments and mid-term test: There will be no re-writes or make-ups for missing the assignments and the mid-term test for University-accepted, verifiable reasons. Instead the total marks of the final exam will be increased by the marks of the missed assignments and test.

Informing Your Instructor and Submitting Appropriate Documentation: Students must submit an original University-accepted documentation (e.g., signed U of T medical certificate) within **one week** of a missed assignment due date or test date. Failure to submit appropriate documentation will result in a grade of zero.

Geography Math Help Centre

A resource for this course is the department's Math Help Centre. Geography TAs will be available to help refresh and explain math concepts and techniques that may come up in your Geography courses. This includes working with formulas, graphing data, completing calculations, and so forth. It does not matter how basic your questions are! No appointment is required, just drop by. There will also be table space available in the room, allowing students to get math help as they work through assignments. Details on location and TA times will be posted here:
http://geography.utoronto.ca/undergraduate/math-help/