

GEOG*3420 REMOTE SENSING OF THE ENVIRONMENT

The University of Guelph, Department of Geography, Environment and Geomatics
Winter 2025, 0.5 Credits

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Office Hours: Fridays 10:00-11:00

Prerequisite 10.00 credits, including GEOG*2420

Course Description

This course provides students with the concepts and technical expertise used to analyze satellite imagery in the field of remote sensing. Students will gain hand-on experience processing multispectral, thermal, and radar images and LiDAR 3D point clouds using advanced analytical software to study environmental processes and systems. In particular, students will learn about image transformations and techniques used in image classification and change detection applications, including supervised and unsupervised machine learning based methods. The integration of remote sensing and Geographical Information Systems (GIS) is stressed.

This course is part of the geomatics sequence of courses offered by the Geography Department. The required prerequisite course (10.00 credits including GEOG*2420) laid the foundations with an introduction to the processes necessary for an understanding of the physical basis for remote sensing (i.e., energy and the atmosphere). The second-year course (GEOG*2420) introduced basic concepts in earth imaging, focusing more on image interpretation, aerial photography, and photogrammetry. This course (GEOG*3420) provides a more detailed overview of remote sensing, focusing on the processing of satellite imagery and their applications. The final course in the sequence in the geomatics sequence of courses is GEOG*4480 Applied Geomatic, which allows students to further refine their geomatics (GIS and remote sensing) skill through a student-led project.

By the end of this course, each student should have gained:

- An understanding of remote sensing fundamental concepts, such as electromagnetic radiation, and systems, including common platforms.
- A working knowledge of remote sensing data and related digital image processing techniques.
- The ability to utilize advanced remote sensing techniques for applications such as land-use change detection.

Textbook

We will use a digital version of:

Mather, PM and Koch, M, 2011. Computer Processing of Remotely-Sensed Images, 4th Ed. Wiley-Blackwell.

A PDF of this version is available through the Guelph library and therefore **is free and does not require purchasing**.

Method of Evaluation

Laboratory exercises (5 x 8%):	40%
Mid-term examination (Wed. Feb 26):	30%
Final examination (online, April 9-10):	30%

The mid-term will be held in class (in person) Wednesday Feb 26 and will be closed book. The final exam will be an online CourseLink based Quiz that will be available to write over a two-day period. **The final exam is NOT cumulative and will only cover topics after the cut-off point (given in lecture) for the mid-term exam.**

Course Schedule

The course involves lectures and weekly hands-on computer exercises. The practical exercises provide an applied context to demonstrate the theory and concepts developed in lecture. This course will be delivered in-person, with face-to-face lectures and in-person examinations. In addition to lectures, each student **must attend an in-person two-hour lab**, which will also have an option for students who require a remote learning environment due to the pandemic. Lab sessions will be held for each of the five lab assignments, roughly every second week starting in week 2 (see schedule below).

Lecture Times:

Mondays/Wednesdays/Fridays 1:30 PM - 2:20 PM in MACS 121

Lab Times:

Section 101 Friday 02:30 PM - 04:20 PM

Section 102 Thursday 02:30PM – 04:20PM

You may not change your lab period without the permission of the instructor. The following is a preliminary schedule of lectures/labs and is subject to change.

Week	Date	Topic ¹	Lab Schedule ²
Block 1: Introduction and Review			
1-M	Jan 6	Introduction	
1-W	Jan 8	Electromagnetic radiation	
1-F	Jan 10	Electromagnetic radiation	
2-M	Jan 13	Remote sensing systems and platforms	Lab 1 assigned
2-W	Jan 15	Remote sensing systems and platforms	
2-F	Jan 17	Remote sensing systems and platforms	
Block 2: Digital Data for Remote Sensing			
3-M	Jan 20	Digital imagery: rasters, multi/hyper spectral data, file formats	

3-W	Jan 22	Digital imagery: rasters, multi/hyper spectral data, file formats	
3-F	Jan 24	Point cloud data: LiDAR data	
		Block 3: Digital Image Processing	
4-M	Jan 27	Image pre-processing: missing data, geometric corrections, registration, atmospheric corrections	Lab 2 assigned
4-W	Jan 29	Image pre-processing: missing data, geometric corrections, registration, atmospheric corrections	
4-F	Jan 31	Image pre-processing: missing data, geometric corrections, registration, atmospheric corrections	
5-M	Feb 3	Enhancement: contrast enhancement, histogram matching	
5-W	Feb 5	Enhancement: contrast enhancement, histogram matching	
5-F	Feb 7	Image transforms: algebraic operations, vegetation indices, principal components analysis, Fourier transform, wavelet transform, RGB-IHS, image fusion	
6-M	Feb 10	Image transforms: vegetation indices, principal components analysis, Fourier transform, wavelet transform, RGB-IHS	Lab 3 assigned
6-W	Feb 12	Image transforms: vegetation indices, principal components analysis, Fourier transform, wavelet transform, RGB-IHS	
6-F	Feb 14	Image transforms: vegetation indices, principal components analysis, Fourier transform, wavelet transform, RGB-IHS	
	Feb 17	Winter Break—No class	
	Feb 19	Winter Break—No class	
	Feb 21	Winter Break—No class	
7-M	Feb 24	Image filtering techniques	
7-W	Feb 26	Mid-term exam	
7-F	Feb 28	Image filtering techniques	
8-M	Mar 3	Image classification: supervised, unsupervised, segmentation, ML	Lab 4 assigned
8-W	Mar 5	Image classification: supervised, unsupervised, segmentation, ML	
8-F	Mar 7	Image classification: supervised, unsupervised, segmentation, ML	
9-M	Mar 10	Image classification: supervised, unsupervised, segmentation, ML	

9-W	Mar 12	Image classification: supervised, unsupervised, segmentation, ML	
9-F	Mar 14	Change detection	
10-M	Mar 17	Change detection	Lab 5 assigned
10-W	Mar 19	Change detection	
10-F	Mar 21	Accuracy assessment	
11-M	Mar 24	Accuracy assessment	
		Block 4: Point Cloud Processing	
11-W	Mar 26	LiDAR point cloud analysis	
11-F	Mar 28	No class (holiday—Easter)	
12-M	March 31	LiDAR point cloud analysis	
12-W	Apr 2	Wrap-up	
12-F	Apr 4	Wrap-up	
Exam	April 9-10	Final Exam on CourseLink	

Notes: ¹ The sequence and topics of lectures is subject to change depending on progression. ² All labs are assigned and due on the day of the week during which your regularly scheduled lab occurs.

Lab Topics

Lab 1: The Whitebox Workflows for Python library

Lab 2: Image pre-processing and enhancement

Lab 3: Image filtering and transformations

Lab 4: Image classification

Lab 5: Change detection

Please consult your TA regarding lab due dates and times; however, generally labs are due when a new lab is assigned.

Laboratory Exercises

The labs are designed to facilitate the application of digital image processing techniques to practical real-world problems. It would be advisable to use a USB pen drive for additional storage, mobility, and back-up needs. All labs require that students submit their own independent work. Students must supply their media for file back-up. Labs begin in the second week of the semester. Note: Material from all lab exercises will be covered on the final exam.

Office Hours

If you are having difficulties with the lab, please contact the course TA. TA office hours are to be scheduled and will be announced upon first meeting. For any other matters, please feel free to visit me during my office hours or e-mail me.

Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic of-

fences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-misconduct/>) is outlined in the Undergraduate Calendar.

Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability. Use of the SAS Exam Centre requires students to make a booking at least 10 days in advance, and no later than the first business day in November, March or July as appropriate for the semester. Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time. For students at the Guelph campus, information can be found on the SAS website. (<https://www.uoguelph.ca/sas/>)

Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements.

See the Academic calendar for information on regulations and procedures for Academic Accommodations of Religious Obligations (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-accommodation-religious-obligations/>).

Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all undergraduate students except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course

registration are available in the Undergraduate Calendar - Dropping Courses (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/dropping-courses/>).

Email Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Health and Wellbeing

The University of Guelph provides a wide range of health and wellbeing services at the Vaccarino Centre for Student Wellness (<https://wellness.uoguelph.ca/>). If you are concerned about your mental health and not sure where to start, connect with a Student Wellness Navigator (<https://wellness.uoguelph.ca/navigation/>) who can help develop a plan to manage and support your mental health or check out our mental wellbeing resources (<https://wellness.uoguelph.ca/shine-this-year/>). The Student Wellness team are here to help and welcome the opportunity to connect with you.

Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g., final exam or major assignment).

Recording of Materials

Presentations that are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars (<http://www.uoguelph.ca/registrar/calendars/?index>) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration. (<https://calendar.uoguelph.ca/undergraduate-calendar/undergraduate-degree-regulations-procedures/academic-consideration-appeals-petitions/>)