GEOM 4001 – Selected Topics in Geomatics
Winter 2025 – Remote Sensing with Synthetic Aperture Radar (SAR)

Department of Geography and Environmental Studies

Brightspace course page link: https://brightspace.carleton.ca/d2l/home/284538

Instructor: **Scott Mitchell** scott.mitchell@carleton.ca

Office hour Mondays 10-11 in Loeb A301B; for other contact times, arrange appointments by email, or drop-ins are always welcome if my office door is open.

1. Course Description

Sentinel-1 and more recently the RADARSAT Constellation Mission have highly increased the use of SAR data in operational remote sensing applications, and more missions are coming online soon. That means it is now more important for remote sensing users to learn how to process, analyze and use SAR data. However, using data from SAR satellites to monitor the state and changing conditions of land can be mystifying, even for those experienced in analysis of optical satellite data. In this course, the students will learn from basic to advanced topics in SAR in a way that they will not only learn the theory of the SAR remote sensing but also will be equipped with hands-on experience processing and analysis of SAR data. The course interweaves lectures with hands-on labs. The following are some topics that will be covered in this course:

- Basics of SAR
- Matrix Algebra for Geographers
- SAR Polarimetry
- SAR Sensors and SAR System Characteristics
- Effects of Targets on Microwave Signals
- Common Applications of SAR
- Interferometric SAR

2. Learning Outcomes

Students completing this course will gain an understanding of the principles of active remote sensing using microwave / synthetic aperture radar sensors, and how these differ from other common remote sensing techniques in earth observation. They will develop and demonstrate their ability to interpret imagery from these sensors to produce information about the targeted regions and applications. Technical proficiency in common tools used in the field will be developed. Students will gain understanding of current areas of research in the field and demonstrate critical analysis of the strengths and weaknesses of the current capabilities.

3. Texts & Course Materials

Students are not required to purchase textbooks or other learning materials for this course. All required software or readings are either freely available or provided through licenses applicable to all Carleton students.

4. Course Calendar

As this is the first time Scott has taught this course, there is some uncertainty in the exact details of how much time it will take to cover each topic, but this is the initial plan:

Week	Topic
1	Introduction to course, and to SAR ("Teaser" and SAR Basics)
2	Where are the data?
3	Speckle and pre-processing
4	Matrix algebra for geographers; SAR polarimetry
5	SAR Systems
6	Polarimetric decomposition, and Radarsat 2
7	The importance of targets
8	Interferometic SAR
9	InSAR II, and decomposition of Sentinel imagery
10	Classification with SAR
11	Water and soil moisture
12	Machine learning and SAR

Timing of evaluations:

- There will be six lab assignments spread through the term. The first two labs will be combined, leading to 5 due dates spread from week 3 to week 11 (Lab 1 + 2 due week 3, then another due date every 2 weeks leading to week 11).
- There will be 3 quizzes spread through the term, to be completed in class, using Brightspace. The first will cover weeks 1-3, the second will cover weeks 4-6, and the third will cover weeks 7-9. The anticipated timing of these quizzes will be in weeks 4, 7, and 10, but if there are any complications they may be delayed into later classes.
- There will be a final project, which will include a practical component which is due on the last day of term (April 8)
- There will be a take-home exam, in which you will answer questions about the above project, due on the last day of the exam period (April 26).

5. Evaluation

The following outlines the course components which will be evaluated in this course:

- **Lab exercises** (40% of final grade) graded using a rubric which will be available in Brightspace
- **Quizzes** (10% of final grade) with multiple choice or short answer questions, in Brightspace
- **Final project** (25% of final grade for each of the practical component and the take-home exam report) graded using a rubric which will be available in Brightspace.

All work will be submitted on Brightspace, possibly in combination with other online platforms as indicated in individual assignments. By default, all work should be submitted as is on the due date – there is no possibility of handing something in late for a penalty, because you need to move on to the next assignment. However, individual extensions or special considerations will be made for special circumstances; please contact the instructor as soon as possible if problems arise that are going to impact your ability to finish an assignment on time. If illness or other mutually-agreed-upon emergency situations develop, we will help you find a plan to keep up.

You will be responsible for completing lab assignments on your own time in addition to formally scheduled time in the lab. You will have access to our lab spaces to do this, any time a class is not using that space.

Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

6. Statement on Academic Integrity

Unless otherwise specified on individual assignments, all work is to be completed individually. It is assumed that you will discuss the assignments and share knowledge / tips / observations with your classmates and that is encouraged. However, everyone needs to individually accomplish the practical tasks to gain the skills and knowledge we are pursuing, and you must write your reports on your own, reporting your own perspectives and knowledge gained.

Unless explicitly permitted for a specific assignment, any use of generative AI tools to produce assessed content is considered a violation of academic integrity standards.

The University Academic Integrity Policy defines plagiarism as "*presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own.*" This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source. Examples of sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, artworks, laboratory reports, research results, calculations and the results of calculations, diagrams, constructions, computer reports, computer code/software, material on the internet and/or conversations.

Examples of plagiarism include, but are not limited to:

- any submission prepared in whole or in part, by someone else, including the unauthorized use of generative AI tools (e.g., ChatGPT)
- using ideas or direct, verbatim quotations, paraphrased material, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment
- using another's data or research findings without appropriate acknowledgement
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own
- failing to acknowledge sources with proper citations when using another's work and/or failing to use quotations marks.

Plagiarism is a serious offence that cannot be resolved directly by the course's instructor.

The Associate Dean of the Faculty follows a rigorous process for academic integrity allegations, including reviewing documents and interviewing the student, when an instructor suspects a violation has been committed. Penalties for violations may include a final grade of "F" for the course.

7. Statement on Student Mental Health

As a student you may experience a range of mental health challenges that significantly impact your academic success and overall well-being. If you need help, please speak to someone. There are numerous resources available both on- and off-campus to support you. For more information, please consult https://wellness.carleton.ca/

Emergency Resources (on and off campus)

- Suicide Crisis Helpline: call or text 9-8-8, 24 hours a day, 7 days a week.
- For immediate danger or urgent medical support: call 9-1-1

Carleton Resources

- Mental Health and Wellbeing: https://carleton.ca/wellness/
- Health & Counselling Services: https://carleton.ca/health/
- Paul Menton Centre: https://carleton.ca/pmc/
- Academic Advising Centre (AAC): https://carleton.ca/academicadvising/
- Centre for Student Academic Support (CSAS): https://carleton.ca/csas/
- Equity & Inclusivity Communities: https://carleton.ca/equity/

Off Campus Resources

- Distress Centre of Ottawa and Region: call 613-238-3311, text 343-306-5550, or connect online at https://www.dcottawa.on.ca/
- Mental Health Crisis Service: call 613-722-6914 or toll-free 1-866-996-0991, or connect online at http://www.crisisline.ca/
- Empower Me Counselling Service: call 1-844-741-6389 or connect online at https://students.carleton.ca/services/empower-me-counselling-services/

- Good2Talk: call 1-866-925-5454 or connect online at https://good2talk.ca/
- The Walk-In Counselling Clinic: for online or on-site service https://walkincounselling.com

8. Requests for Academic Accommodations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the *Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances*, are outlined on the Academic Accommodations website (students.carleton.ca/course-outline).