

# ERTH 4804 – Exploration Geophysics

Geophysics, in part, is the measurement of contrasts in the physical properties of materials beneath the surface of the Earth and the attempt to deduce the nature and distribution of the materials responsible for these observations. These contrasts in physical properties then permit the explorationist to map in detail bedrock topography that is present at depths. These techniques can result in extracting the form and distribution of alluvial sand and gravel deposits or to trace a buried river channel, to find the buried stone walls of an ancient city, or define guidelines for groundwater use based on the results of geophysical surveys, etc.

This course gives an ongoing look into exploration of the Earth's subsurface. When subsurface information is needed, and is difficult to obtain directly from observation, we acquire physical measurements on the surface and use various techniques to deduce the subsurface geology. The tools discussed in this course are applicable to the collection of data in the field, or to the interpretation of data collected and applied to numerous important targets: identifying sources for much-needed resources, protecting water supplies, providing safe building sites, locating areas for safe disposal of certain wastes, or simply furthering our understanding of the Earth.

In particular, we focus on methods and approaches that are appropriate for the shallow target, including data processing techniques, magnetic, gravitational, and electromagnetic surveying methods. The main objective is to cover the fundamental principles of common methods of exploration geophysics, examining some case examples and applying these ideas to practical examples.

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**Office hours:** By appointment, if you have any questions please reach out to me and we can set up a time to zoom.

**Teaching Assistant:** Fateme Hormozzade Ghalati  
[fatemehormozzadeghal@cmail.carleton.ca](mailto:fatemehormozzadeghal@cmail.carleton.ca)  
Office Hours: By appointment.

## **Course Texts (Optional):**

Introduction to Applied Geophysics – Exploring the shallow subsurface  
H. Robert Burger, Anne F. Sheehan and Craig H. Jones, 1992

An Introduction to Geophysical Exploration  
P. Kearey, M. Brooks, I. Hill, 2002

Books available at the bookstore and the library.

### Course Topics (Tentative order):

- Introduction
- Geophysical data processing
- Gravity; exploration using gravity surveying
- Magnetism; basic theory, rock magnetism, Earth's magnetic field
- Exploration using the magnetic method
- Electromagnetic waves and surveying
- Forward and inverse models

### Learning Outcomes

By the end of this course, students will be able to:

- Explain the physical principles behind different geophysical surveying techniques
- Describe applications and limitations of various geophysical surveying methods
- Process, analyze and interpret gravitational, magnetic and electromagnetic surveying data
- Examine and discuss exploration survey results
- Understand different forward and inverse modelling techniques after data collection and reduction methods have been applied

### Grading scheme:

Laboratory attendance and assignments	20%
Final paper and presentation	20%
Exam 1 (Feb 25 <sup>th</sup> )	25%
Exam 2	30%
Participation	5%

The labs are a mixture of theoretical problems, to ensure a firm understanding of the fundamentals of each technique, and computer-based analytical problems to practice data reduction and interpretation techniques. Students will use geophysical software in their labs, and other computer programs such as excel or Matlab. All Carleton students can download Matlab to their own computers for free by following the instructions at this website:

<https://carleton.ca/its/all-services/computers/site-licensed-software/matlab-students/>

Due to COVID-19 and the entirely online winter 2021 semester, the labs will take place on BigBlueButton. This is of course not ideal, but between the Teaching Assistant and myself, it will still be interactive, collaborative hands-on learning.

The laboratory assignments should be completed within the scheduled laboratory time, but if extra time is needed then they will be due by the following Monday. I encourage you to discuss the problems with your classmates, but it is absolutely imperative that any work you submit is your own. This means you must very clearly attribute any quotations or copied figures (citing name + year + publication of any sources). You should always mention any classmates with whom you have collaborated (a brief marginal note will suffice), and it is not EVER permitted to copy another student's work. If you are found to be in violation of this policy, there are very

serious consequences. The instructor *is required* to report all incidents (or suspected incidents) of plagiarism to the Dean.

Exam 1 will be a take-home exam and will consist of long answer questions. Exam 2 will be in the formally scheduled exam time, is also a take-home exam, and will also be long answer.

For all labs and exams *always* show your full working for mathematical problems. As well as making it much easier to judge where/if you made any errors, I will not award full marks if the logic and work-flow of the answer is not clear. Make sure to properly highlight your final answer to each problem. Answers should be mathematically *correct*, i.e. if you write an “equals sign”, both things on either side of it must be equal. This sounds totally obvious, but it is often not done, leading to avoidable errors and marks deducted. **Get in the practice of being meticulous with your mathematics!**

Some class time will be allotted to the discussion of some important research in exploration geophysics, and some interesting case examples. All literature will be posted to CuLearn, so make sure to check for it, and is expected to be read by all students prior to class. Participation in the class discussion will be noted and counts for 5%. Participation has nothing to do with being the most correct, or the most profound. It’s really about encouraging students to ask questions, to make comments, and to think out loud about what they are reading and learning.

Finally, each student will pick a geophysical exploration topic/technique and write a paper investigating the method. The last class of the semester will then be reserved for presentations and a general discussion of the chosen topics. More information will be given out during the semester, with several lab periods reserved for preparation time.

### **Course Requirements:**

- Attendance in class is mandatory. It is required that you email the instructor to advise of absences due to illness or emergencies.
- The final exam must be passed in order to pass the course.
- Labs must be handed in on time. Late labs will be accepted in the instance of illness, with a medical note, or in the instance of emergencies, by consultation with your TA and instructor.
- It is the student’s responsibility to come to classes and labs prepared. Reading assignments are mandatory.
- It is your responsibility to refer regularly to the course website for lecture topics, reading assignments, laboratory topics and pre-lab review or homework.
- Regularly log onto the CU Learn course website to check for announcements, course information, laboratory assignments and lecture material.
- Lab exercises will be posted on CU Learn.

**Tentative Schedule** (note: it is subject to change):

<b>Week</b>	<b>Class Date</b>	<b>Topic</b>	<b>Lab</b>
1	Jan. 11	Introduction	NO lab
2	Jan. 18	Geophysical data processing	Lab 1 – data processing
3	Jan. 25	Gravity Surveying theory	Lab 2 – gravity theory
4	Feb. 1	Gravity Surveying	Lab 3 – gravity surveying
5	Feb. 8	Magnetic Surveying theory	Lab 4 – magnetic theory
6	Feb. 15	<b>WINTER BREAK</b>	
7	Feb. 22	Magnetic Surveying	<b><i>Midterm Posted</i></b>
8	Mar. 1	Gravity & Magnetic Surveying activity	Lab 5 – magnetic surveying
9	Mar. 8	Electromagnetic Surveying theory	Lab 6 – electromagnetic theory
10	Mar. 15	Electromagnetic surveying	Lab 7 – EM surveying
11	Mar. 22	Electromagnetic surveying activity	Lab 8 – Paper and presentation prep
12	Mar. 29	Forward and inverse models	Lab 9 – Paper and presentation prep
13	Apr. 5	Presentations	No Lab
14	Apr. 12	Presentations	No Lab
15	Apr. 16 - 27	<b>Final exam period</b>	

## **ACADEMIC INTEGRITY**

**It is your responsibility to review Carleton’s policy on Academic Integrity** - Section 14 of the Calendar.

<http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/acadregsuniv14/>

### **Plagiarism**

*The instructor is required to report all incidents (or suspected incidents) of plagiarism to the Dean. All work handed in must be your own.* Plagiarism and cheating are viewed as being particularly serious and the sanctions imposed are accordingly severe. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students. Plagiarism and cheating – presenting another’s ideas, arguments, words or images as your own, using unauthorized material, misrepresentation, fabricating or misrepresenting research data, unauthorized co-operation or collaboration or completing work for another student – weaken the quality of the graduate degree. Academic dishonesty in any form will not be tolerated. Students who infringe the Policy may be subject to one of several penalties including: expulsion; suspension from all

studies at Carleton; suspension from full-time studies; a refusal of permission to continue or to register in a specific degree program; academic probation; or a grade of Failure in the course.

## **REQUESTS FOR ACADEMIC ACCOMMODATION**

**Please review the Carleton's Student Guide to Academic Accommodations at**

<http://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf>, and the websites therein.

### **For Students with Disabilities:**

“The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your ***Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation.*** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website ([www.carleton.ca/pmc](http://www.carleton.ca/pmc)) for the deadline to request accommodations for the formally-scheduled exam . “

### **For Religious Observance:**

1. *As soon as you receive your course syllabus*, identify any potential conflicts between your religious obligations and course requirements. 2. Make a formal written request to your instructor indicating the nature of the religious obligation and suggest possible alternative dates and/or means of satisfying the academic requirements. *NOTE: Such request should be made during the first two weeks of the term*, or as soon as possible after a need for accommodation is known to exist, but in no case later than the second last week of classes for that term. For detailed information on Religious Obligations please visit our website at: [carleton.ca/equity/accommodation/academic](http://carleton.ca/equity/accommodation/academic).

### **For Pregnancy:**

**A.** For final exams. Identify and discuss your needs for final examinations with your professors. When an agreement is reached fill out and submit the online **Pregnancy Accommodation Final Exam Request Form** at: [carleton.ca/equity/accommodation](http://carleton.ca/equity/accommodation). Equity Services will forward the request to Exam Services to coordinate the accommodation. **B.** For in-class accommodations ONLY. If you anticipate you will only require in-class accommodations, discuss them directly with your course instructor. This request should be made in the first two weeks of the academic term. For detailed information on pregnancy and parental leave policies please visit the website at: [carleton.ca/equity/accommodation/academic/](http://carleton.ca/equity/accommodation/academic/)

### **Equity and PMC Contact information:**

- Department of Equity and Inclusive Communities  
613-520-5622  
3800 Carleton Technology & Training Centre

[equity@carleton.ca](mailto:equity@carleton.ca)

Website: [carleton.ca/equity](http://carleton.ca/equity)

- Paul Menton Centre for Students with Disabilities  
613-520-6608

[pmc@carleton.ca](mailto:pmc@carleton.ca)

500 University Centre

Website: [carleton.ca/pmc](http://carleton.ca/pmc)