Potential-Field and Gamma-Ray Spectrometry Methods

Cross-listed as an undergraduate (GEOL 4826) and a graduate course (GEOL 5826)

Winter (January 8 – May 4) 2024

Harquail School of Earth Sciences (HES)

Laurentian University

Course Description: This course covers gravity, magnetic and gamma-ray spectrometry methods, including a discussion of the relevant physical properties, the background theory, instrumentation and procedures to collect the data using ground, airborne and drill-hole equipment. Students will learn methods for processing the data (e.g. filtering, gridding, continuation, reduction to the pole) and how to interpret the data using qualitative methods and forward and inverse modelling methods. Case history examples will be discussed.

Prerequisites: Completion of 30 university credits which include GEOL 1006; PHYS 1006 /1007; MATH 1036 or 1912. Recommended MATH 2037. Students cannot retain credits for both GEOL 4826 and GEOL 5826. (lec 3, lab 3) cr 3.

Course Instructor: *Dr Richard Smith* (Harquail School of Earth Sciences/MERC), Willet Green Miller Building, Room B8018, (705) 675 1151 ext 2364. Email: rssmith@laurentian.ca. **Office hours: Wednesday 8**:30 to 11:20 am Wednesday**.** Appointments can be made via email.

Course Format: lectures Tuesday 4:00 – 6:50pm, B8030, laboratory practicals/exercises Wednesday 1:00 – 3:50 pm, B8030. (remote and asynchronous participation can also be accommodated)

Course Credit: 3 credits towards an undergraduate or graduate degree. Successful completion of the course can be counted toward continuing education and continuing professional development requirements for professional registration. A participation certificate will be issued on request with hours listed.

Assessment:

Assessment Type	Number	Overall Weight (%)
On line quizzes	7	15
Laboratories	7	20
Class discussion documents	8	20
Presentation on chapter	1	20
Summative exercise (in lieu of exam)	1	25

The on-line quizzes are completed at the end of each chapter of the student authored textbook to test your understanding of the material. The laboratory exercises are computer exercises that are intended to be completed in the allotted 3-hour lab period(s). The class discussion documents are completed as each student reads each of the 7 chapters *and* during the class discussion time. In the discussion, students highlight inadequacies in the material (errors, poor explanations, missing material, etc) and then the class suggests how to rectify the defects. The summative exercise involves each student revising one (or part of one) of the chapters, following the suggested modifications that have been contributed to the class discussion document. The presentation is given during the final weeks of class on the chapter (or part thereof) that the student will be revising. Remote and asynchronous participation will be possible in this course as all material (lectures, discussion documents, textbooks, quizzes) are available at any time. **Due dates**: One line quizzes and contributions to the discussion documents should be completed at the end of the week that the discussion of the relevant chapter is completed, for example, for the introductory chapter, this is Sunday January 21 at 11:59 pm.

Chapter Discussions: A set of chapters from a student-authored textbook will be provided. The students are to discuss this chapter, indicating errors, outlining topics that are missing from the chapter or concepts or text they do not understand. This discussion will take place by editing a document on Google Drive using Google Docs. Students will then be expected to find explanations for what they or other students do not understand and insert this in the relevant Google Doc. For grading, students are to upload their contributions to a Dropbox on D2L or if they do not have access to D2L email it to the TA and instructor.

Summative exercise: Prepare and/or revise the chapter selected from the student-authored textbook. The revisions will be based on the discussion documents the class have prepared as part of the chapter discussions. One case history of the method being applied to an example should be taken from the open-source literature, the journals Geophysics, Interpretation or the Leading Edge and added to the chapter. A guide to writing the chapter is provided. Some of the Chapters are incomplete (in italic fonts in the table below). For these chapters, in the discussion document, the students will suggest figures or slides from the lectures or textbooks that have been supplied that could be added to the chapter. It will be easier to get good grades revising these chapters in italics, as the marking rubric rewards adding new material and it is easier to add material to these chapters. Students should spend about 24 hours on this task. The revised chapter is due at a date and time set by the Registrar, during the exam period.

Website: Course materials and announcements will be posted on D2L (Desire 2 Learn) and/or the Google Drive for the course. Announcements will be emailed to participants without access to D2L. It is the student's responsibility to check the D2L page or their email account for course information throughout the semester.

Course Costs for Enrolled students: Undergraduate and graduate students from Laurentian can enroll using the usual channels. Graduate students enrolled in other Ontario universities will not pay fees directly to Laurentian, but their home institution, as they can enroll through the Ontario Visiting Graduate Student program. Undergraduate students outside Laurentian or graduate students from outside Ontario will need to obtain a *letter of permission* from their home institution to enroll in Laurentian and then they will pay fees to Laurentian. Students or professionals who are not taking the course for credit, but as professional development can enroll using the registration form for the course (see the registration section immediately below for how to request a registration form). Those *not* taking the course for credit are expected to take part in the discussions, but are not required to hand in material for assessment, although they can if they wish. Students not formally enrolled for credit will not be able to do the on-line quizzes.

Course Costs for Professional participants: 1) In person attendance: CDN $2750.00 (CDN) + 13% GST. 2) Remote (zoom) attendance: CDN $1200 + 13% HST. Registration includes all digital course notes. Professionals working for MERC members get a discount in registration fees. **Registration:** Ms. Roxane Mehes**,** Harquail School of Earth Sciences**,** Laurentian University, 935 Ramsey Lake Road, Sudbury, ON P3E 2C6 Canada, Tel: +1 (705) 673-6575, Fax. +1 (705) 675-4898, e-mail: rmehes@laurentian.ca

Course textbooks and notes: Digital textbooks and lecture notes will be provided free of charge.

Further information about MERC courses may be found at: http://hes.laurentian.ca/ *under* Modular Courses. *For other information about the course please contact:* rssmith@laurentian.ca

Course Learning Outcomes.

Upon completion of this course students will be able to:

1. Understand the basic theory relevant to potential-field and gamma-ray spectrometry methods.
2. Describe the strengths and weaknesses of potential-field and gamma-ray spectrometry methods and the strengths and weaknesses of the equipment used in potential-field and gamma-ray spectrometry surveys.
3. Design potential-field and gamma-ray spectrometry surveys and know how to acquire, process, model and interpret the data to investigate the subsurface geological material.

4. Present the results of potential-field and gamma-ray spectrometry surveys by displaying the results graphically and communicating the results in written documents and oral presentations.
5. Describe case histories where potential-field and gamma-ray spectrometry data are used to solve real-world problems in areas such as geology, planetary science, mineral exploration, environmental studies, archaeology, forensic science, agriculture and engineering.
6. Apply potential-field and gamma-ray spectrometry methods when working as a geoscientist in industry, government or academia.

Tentative schedule

Potential-field and gamma-ray spectrometry methods
GEOL 4826 and 5826 Winter 2024

Week starting Monday	**Chapter topic or lecture**	**Discussion**	**Laboratory**	**TA**
Jan 8	*Intro and physical properties lecture*	Introduction to discussion documents	gravity data acquistion	
Jan 15	*Potential field theory, gridding, filtering, RTP, continuation.*	Discussion of Introduction chapter	Magnetic data acquisition	
Jan 22	Gravity instruments, acquisition and reduction.	Discussion of Potential-Field Theory chapter	Gridding exercise (Freeware or QCTool)	
Jan 29	Magnetic instruments, acquisition and reduction	Discussion of Gravity chapter	Gravity data reduction exercise	
Feb 5	Magnetics continued	Discussion of Magnetic chapter	Python reduction to pole exercise (RTPVP software)	
Feb 12	*Modelling forward and inverse.*	Discussion of Magnetic chapter	Fatiando a Terra exercise or PYGMY	
Feb 19	*Study Break*	*Study Break*	Study Break	
Feb 26	Gamma-Ray spectrometry	Discussion of Modelling chapter	Inversion exercise gravity (SimPEG) John Weiss tool.	
Mar 4	PDAC 3-6 March	No classes	No Lab	
Mar 11	*Borehole methods*	Discussion of Gamma-Ray Spectrometry chapter	Inversion exercise magnetics (SimPEG)	
Mar 18	*Qualitative interpretation*	Discussion of Borehole Logging chapter focusing on potential-field and gamma-ray methods.	Interpretation exercise QGIS	
Mar 25	*Case Histories*	Discussion of Integrated Interpretation chapter	Interpretation exercise continues	
April 1	Review	Complete all discussions	Final presentations	
Tues April 9	*Final Day of classes*	*Monday is a make up for missed Good Friday class; Tuesday make-up for Easter Monday.*		

Land Acknowledgment

We would like to acknowledge the Robinson-Huron Treaty of 1850. We also further recognize that Laurentian University is located on the traditional lands of the Atikameksheng Anishnawbek and that the City of Greater Sudbury, also includes the traditional lands of the Wahnapitae First Nation. We extend our deepest respect to Indigenous peoples - as a sign of our continued relationship we will support Laurentian University's Truth and Reconciliation Task Force Recommendations. Miigwech.

Student Conduct:

Students will be expected to abide by the Laurentian University Code of Conduct.
LU Code of Student Rights and Responsibilities

Academic integrity and Grade Appeals policy

In this course, students are expected to submit their own individual work for academic credit, properly cite the work of others, and to follow the rules for examinations. Academic misconduct, plagiarism, and cheating will not be tolerated. Copying of assignments and lab reports is considered academic misconduct. Students are responsible for understanding and following the Laurentian University Policy on Academic Integrity.
https://intranet.laurentian.ca/policies/2017.09.19%20-%20Policy%20and%20Procedures%20on%20Academic%20Integrity%20-%20EN.pdf

Course policy on Artificial intelligence. It is permitted to use artificial intelligence like ChatGPT, Bing AI (and co-pilot), Bard, etc. on assignments; however, you are required to submit copies of all your questions and responses, so please keep these and submit them separately as an appendix with your assignment(s).

Laurentian Grade Appeal Policy and Procedure, see
https://intranet.laurentian.ca/policies/2017.09.19%20Grade%20Appeal%20Policy%20-%20EN.pdf

Equity, Diversity and Inclusion: I seek to engender a class environment where equity, diversity and inclusion are embraced. Feedback on any of these matters is welcome and encouraged.