

## EARTH SCIENCES 4420A (GP 9505A)

### Geophysical Forward and Inverse Modelling Methods

**Course Instructor:** Gerhard Pratt, BGS 1028 (Email: gpratt2@uwo.ca)

**Teaching Assistant:** Sebastian Braganza (Email: sbragan@uwo.ca)

**Office hours:** by appointment

**Lectures:** Tues and Thurs 9:30-10:30, CHB 9

**Labs:** Wed 2:30-5:30, BGS 0184

**PREREQUISITES:** Calculus 2303A/B or 2503A/B.

**NOTE:** Unless you have either the prerequisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

### CALENDAR DESCRIPTION

An introduction to potential theory and methods of interpreting geophysical data through the construction of forward models, optimization of misfit surfaces, and inversion.

### COURSE SYLLABUS:

This course will review the underlying theory and guiding principles of understanding digital geophysical data, and processing fundamentals. Topics include discrete and continuous Fourier and sampling theory; filtering and signal shaping, least-squares and prediction filters; causality implications. The course focusses on waveform seismic data, but applications to processing of potential field map data are also covered.

The course moves beyond time series analysis and reviews the theory and practice of geophysical inversion, culminating in the design and construction of optimized quantitative Earth models. Topics for this section of the course include discrete linear problems, maximum likelihood methods, Lanczos (Singular Value) decomposition, uniqueness and accuracy. The course finishes with an introduction to non-linear problems, with case studies from seismic imaging.

### COURSE MATERIALS:

#### Primary text:

Pratt, R.G 2015 **Time Series Analysis and Inverse Theory Course Notes** (Available to ES 4420A students in PDF format). Course notes will be modified and updated during the term – students should check frequently for these updates.

#### Suggested textbook:

Gubbins, David, 2004. **Time Series Analysis and Inverse Theory for Geophysicists**, Gubbins (2004), Cambridge university Press.. David Gubbins is a professor of geophysics at Leeds University, UK. His major contributions have been in earthquake seismology and in geomagnetism; he specializes in global inverse problems. This recent book is a superb summary of the techniques that practicing geophysicists rely on.

#### Other recommended textbooks:

A number of other excellent books on Time Series Analysis and Inverse methods are recommended. A detailed list will be provided in the course notes.

**Electronic Devices:**

Non-programmable electronic calculator is strongly recommended for labs, tests and examinations. Cameras or any recording devices are not allowed in the class.

**MARK DISTRIBUTION:**

**For ES 4420:**

Assignments (8-10 in total): 40%  
Midterm Exam: 10%  
Final Exam: 45%  
Quizzes, class participations: 5%

**For GP 9505**

Assignments (8-10 in total): 30%  
Midterm Exam: 10%  
Final Exam: 35%  
Quizzes, class participations: 5%  
Final project: 20%

**Assignments:** Assignments consist of a number of problems for solution either as written exercises, or through Matlab coding, or both. Assignments will be distributed during the lectures, and the lab periods are intended to provide you with the help you need to solve these problems. Assignments will be due at the beginning of the following lab session.

**Quizzes:** Quizzes consist of one-two theoretical questions and/or simple calculations and will require no more than five minutes to complete.

**Labs:** Labs are computer based assignments. Lab reports are due the week after the lab, at the beginning of the next lab period.

**Midterm Exam:** will be scheduled during regular lecture time, tentatively at the week of October 19th.

The Midterm and Final examinations will be mixed format. They are intended to test for comprehension of the material, not memorization of definitions and formulas (a formula sheet will be provided). Students are permitted to bring a non programmable calculator into both the midterm and final exams. Questions will focus on explaining concepts or making simple calculations.

**Academic Honesty Statements:**

*Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: [http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf)*

*Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence).*

*All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing*

agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Computer-marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

### **Missed Course Components:**

*If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or supporting documentation to the Academic Counselling Office of your home faculty as soon as possible.*

*If you are a Science student, the Academic Counselling Office of the Faculty of Science is located in WSC 140, and can be contacted at 519-661-3040 or [scibmsac@uwo.ca](mailto:scibmsac@uwo.ca). Their website is [http://www.uwo.ca/sci/undergrad/academic\\_counselling/index.html](http://www.uwo.ca/sci/undergrad/academic_counselling/index.html).*

*A student requiring academic accommodation due to illness must use the Student Medical Certificate ([https://studentservices.uwo.ca/secure/medical\\_document.pdf](https://studentservices.uwo.ca/secure/medical_document.pdf)) when visiting an off-campus medical facility.*

*For further information, please consult the university's medical illness policy at [http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf)*

*If you miss the Final Exam, please contact your faculty's Academic Counselling Office as soon as you are able to do so. They will assess your eligibility to write the Special Exam (the name given by the university to a makeup Final Exam).*

*You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (see [http://www.registrar.uwo.ca/examinations/exam\\_schedule.html](http://www.registrar.uwo.ca/examinations/exam_schedule.html)).*

### **Accessibility Statement**

*Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 ext. 82147 if you have questions regarding accommodation.*