Earth Sciences 2222B Data Analysis and Signal Processing in the Sciences
January - April 2018

Lecturer: Dr. Sheri Molnar
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If you are contacting your instructor or TA, please use your Western email address.

(Course material courtesy Prof. Gail Atkinson and Dr. Hadi Ghofrani)

DESCRIPTION: An introduction to data analysis and visualization techniques, including: data types and transformation, statistical methods to characterize uni-, bi- and multi-variate data, spatial data and interpolative mapping, time series and Fourier transformation, and signal processing. Earth Science applications will be emphasized. Includes MATLAB basics for data and time-series analysis and visualization.

Prerequisites: Applied Mathematics 1413 (1.0 course and no other prerequisite required); or 0.5 course from Calculus 1000A/B, 1500A/B, the former Calculus 1100A/B, Mathematics 1225A/B.
Pre- or Corequisites: 0.5 course from Applied Mathematics 1201A/B, 1411A/B, Calculus 1301A/B, 1501A/B, Mathematics 1228A/B, 1229A/B, 1600A/B, Statistical Sciences 1023A/B, 1024A/B, or permission of the department.
Antirequisites: Computer Science 2034A/B, 2035A/B
Unless you have either the requisites 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.

2 lecture hours, 3 laboratory hours, 0.5 course.
LECTURES: Monday & Wednesday 10:30am – 11:30pm, PAB 150
LAB: Tuesdays 6:00 – 9:00 pm, BGS-0184

This course involves programming with **MATLAB** and **COPLOT**. Some start-up instruction in the use of MATLAB and COPLOT will be given. One lab assignment may be accomplished using **ArcGIS** this 2017 year (subject to change).

TUTORIAL HELP: Ample time is available during each three-hour lab. Labs are focused on answering questions and working on assignments. The lab period is the course tutorial. Office hours are not provided outside of lab time.

METHOD OF ASSIGNING FINAL GRADE: There will be 5 Lab Assignments, 2 Term Quizzes, and an Independent Project (oral and written presentation and peer assessment). All assignments are due ~2-3 weeks after the assignment is given <u>at the beginning of a Wednesday lecture</u>. The ability to express ideas in a coherent and logical manner is an important factor in evaluation of assignments and tests.
Term Test I: mid-Feb;   **Term Test II:** end of March;   **Project Presentations:** early April.
Final Grade: Assignments --- 50%, Term tests --- 25%, Project --- 15%, Participation --- 10%

TEXTBOOK: *MATLAB Recipes for Earth Sciences* (3rd edition, 2010) – Martin Trauth. Springer.
Available for download through Springer when connected to Western internet:
3rd Edition http://link.springer.com/book/10.1007/978-3-540-72749-1
4th Edition http://link.springer.com/book/10.1007%2F978-3-662-46244-7

Additional References
The following texts are recommended for additional reading and supplement to the lectures, but not required:
- *Matlab Design Recipes for Earth Sciences by M. Trauth and E. Sillmann. Available through Springer at http://www.springer.com/us/book/9783642325434*
- *Data Reduction and Error Analysis for the Physical Sciences* – Philip R. Bevington (and D. Keith Robinson). A classic text, well written, clear, and not too much math.
- *Time Series Analysis: A comprehensive introduction for the Social Scientists*. J. M. Gottman Camb.U.Press, 1984. A very good introductory text aimed at social sciences, but with insights for all fields.

LONG DESCRIPTION OF COURSE CONTENT:

Weeks 1 & 2 – Introduction and Data Analysis Tools
Purpose and scope of course
Course expectations and evaluation
Overview of data types and data analysis methods and tools
MATLAB basics – Syntax, data input/output, scripts/functions, plotting, etc.

Week 3 – Univariate Statistical Problems and Distributions
Empirical distributions
Theoretical distributions
Distribution tests

Week 4 – Bivariate/Multivariate Problems
Trends and Correlations
Regression Analysis
Residual Analysis

Week 5 – COPLOT for Graphically-Based Statistical Analysis/Regression

Week 6 – Review
Quiz 1 (Feb. 14)

Reading Week (Feb. 19)

Week 7 – Spatial Data and Mapping

Week 8 – Time Series Analysis
Generating and analyzing time series data

Week 9 & 10 – Signal Processing

Week 11 – Review
Quiz 2 (March 28)

Weeks 12 & 13 – Class Projects
Draft and final oral presentations
Project written report
Peer review assessment

EVALUATION AND DUE DATES (Subject to change):

- Lab Assignment 1 (4%) – Jan. 24
- Lab Assignment 2 (15%) – Feb. 7
- Quiz 1 (10%) – Feb. 14 (lecture time)
- Lab Assignment 3 (9%) – Feb. 14
- Lab Assignment 4 (9%) – March 7
- Lab Assignment 5 (15%) – March 22
- Quiz 2 (15%) – March 28 (lecture time)
- Final project oral presentation (5%) – April 3 (lecture time)
- Project written report (10%) – April 3 (beginning of lab)
- Peer review assessment (4%) – April 4 (beginning of scheduled lecture)
- Written response to peer review assessment and/or project revisions (4%) – April 11

Timetable

	Lecture 1 (Monday)	Lab (Tuesday)	Lecture 2 (Wednesday)
W1: Jan 8-10	Course Introduction	Learning MATLAB	Overview of Data Analysis and Types
W2: Jan 15-17	Introduction to MATLAB – Part 1	Lab 1 [Matlab]	Introduction to MATLAB – Part 2
W3: Jan 22-24	Univariate Data – Part 1	Lab 2 [Matlab]	Univariate Data – Part 2 **[Lab 1 due]**
W4: Jan 29-31	Bivariate Data – Part 1	Lab 2 continues	Bivariate Data – Part 2
W5: Feb 5-7	Coplot – Part 1	Lab 3 [Coplot]	Coplot – Part 2 **[Lab 2 due]**
W6: Feb 12- **Feb 14**	REVIEW	Lab 3 continues	Quiz 1 **[Lab 3 due]**
(Feb 19-23)	Reading Week		
W7: Feb 26-28	Spatial data & mapping	Lab 4 [Matlab, ArcGIS]	Feedback, Quiz 1, Projects
W8: Mar 5-7	PDAC (No Lecture)	PDAC (No Lab)	Time Series Analysis - Part 1 **[Lab 4 due]**
W9: Mar 12-14	Time Series Analysis - Part 2	Lab 5 [Matlab]	Signal Processing – Part 1 Project topics and datasets reviewed*
W10: Mar 19- **Mar 22**	Signal Processing – Part 2	Lab 5 continues	REVIEW I **[Lab 5 due]**
W11: Mar 26-28	REVIEW II	Project Lab	Quiz 2
W12: **Apr 2-4**	**Final project oral presentations**	**Project reports (due)** Peer Review Lab	**Peer review assessments (due)**
W13: Apr 9-11	Receive Peer Review Feedback (no lecture)	**Report Revisions Lab**	**Response to peer review and revised reports (due)**

POLICY STATEMENTS:
No electronic devices may be in your possession during quizzes.

It is Faculty of Science policy that a student who chooses to write a test or exam deems themselves fit enough to do so, and the student must accept the mark obtained. Claims of medical, physical, or emotional distress after the fact will not be considered.

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/scholoff.pdf

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see:
http://www.uwo.ca/univsec/handbook/appeals/medical.pdf

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Dean's Office) for visits to Student Health Services. The form can be found here:
https://studentservices.uwo.ca/secure/medical_document.pdf

Accessibility Statement: *Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.*

Support Services: *Learning-skills counsellors at the Student Development Centre are ready to help you improve your learning skills (http://www.sdc.uwo.ca). They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.*

Students who are in emotional/mental distress should refer to Mental Health@Western (http://www.health.uwo.ca/mental_health) for a complete list of options about how to obtain help.

Additional student-run support services are offered by the USC, http://westernusc.ca/services.

The website for Registrarial Services is http://www.registrar.uwo.ca.