UNIVERSITY OF CALGARY
FACULTY OF SCIENCE

Department of Geoscience
ES 118
403 220-5841
geoscience@ucalgary.ca

COURSE OUTLINE

1. **Course:** GOPH 517, Time Series Analysis and 1D Data Processing - Fall 2020

   Lecture 01: TR 11:00 - 12:15 - Online

Instructor	Email	Phone	Office	Hours
Dr Brandon Karchewski	brandon.karchewski@ucalgary.ca	403 220-6678	ES 108	By Appointment

   Teaching Assistant:
   Meghan Sharp, *Email:* meghan.sharp@ucalgary.ca

   Online Delivery Details:

   Some aspects of this course are being offered in real-time via scheduled meeting times. For those aspects you are required to be online at the same time.

   Lectures: The lectures will be *online synchronous* at the registrar-scheduled time (TuTh 11:00AM - 12:15PM Mountain/Calgary Time) via Zoom (links available via course D2L page). These will also be recorded and available on the course D2L page (usually within 24 hours after the class) in case you are unable to attend class at the scheduled time for any reason. You are encouraged to attend the online synchronous class sessions as they will involve interaction/discussion about the content.

   Labs: The labs will be *online asynchronous*. You do not need to attend live lab sessions at a regularly scheduled time each week. The lab descriptions/exercises/assignments will be uploaded to D2L for you to work through at your own pace. As you work through the labs, you are welcome to ask questions of the instructor and/or TA via email or schedule an online Zoom meeting to discuss.

   Assessments: All course assessments will be *online asynchronous*. Lab assignments will be submitted electronically via the Dropbox on D2L (see course schedule on D2L page for due dates). Quizzes will be posted to D2L throughout the term and you will typically have one week to complete multiple attempts of each quiz. The "final exam" will be posted at the beginning of the final exam period as a series of D2L quizzes covering similar topics to the term quizzes; again, you will be given one week to complete multiple attempts of each quiz.

   Course Site:

   D2L: GOPH 517 L01-(Fall 2020)-Time Series Analysis and 1D Data Processing

   Note: Students must use their U of C account for all course correspondence.

2. **Requisites:**

   See section 3.5.C in the Faculty of Science section of the online Calendar.

   Prerequisite(s):
   Geophysics 355, Mathematics 211 and 415.

   Calendar Description:
   Analysis of geophysical time series, especially real and synthetic seismic signals, is introduced using theoretical concepts and their practical application in a computational lab using commercial computational software.

   Course Learning Objectives:
   By the end of this course, students should be able to:

   1. ***Explain the concepts and equations*** associated with continuous and discrete geophysical signals and time series analysis (e.g. convolution, correlation, Fourier transforms, frequency spectra, Nyquist frequency, sampling, aliasing, frequency filters, minimum-phase wavelets, inverse filters, deconvolution)
   2. ***Calculate results*** using appropriate equations associated with 1D discrete and continuous signals.
   3. ***Use the equations and formulae*** from basic time series analysis and 1D data processing, and

the related mathematics, to solve problems and derive other equations and formulae.
4. ***Implement computer programs*** and ***use commercial mathematical and computational software*** to perform the calculations associated with CLOs 1 and 2 above.
5. ***Communicate*** the results of 1D data processing to peers in the geophysics/scientific community and ***critically evaluate*** the work of peers.

3. **Grading:**

The University policy on grading and related matters is described in F.1 and F.2 of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

Component(s)	Weighting %	Date
Quizzes	30%	See Schedule, posted on D2L
Lab Assignments/Reports	35%	See Schedule, to D2L Dropbox
Final Exam Quizzes	35%	Posted on D2L at beginning of final exam period

The course is divided into 7 modules or topics (see course schedule on D2L). Each module will consist of two to three lectures introducing the module content, one class period for completing practice problems and one quiz. The quiz will be posted on D2L and you will have one week to complete multiple attempts (highest attempt score will count as your quiz mark). This modular format is designed to give students appropriate background and practice with each of the course topics. There will also be three (3) lab assignments (approx. every 2-3 modules), which will include significant computation and a written report. The lab assignment topics will be as follows: 1) Wave propagation, convolution and synthetic seismograms, 2) Fourier transforms, frequency spectra and filtering and 3) Correlation, minimum phase, attenuation and deconvolution. There will be no scheduled lab sessions, but you are encouraged to seek guidance from the course instructor and/or TA while working through the lab assignments either via email or by scheduling a Zoom meeting to discuss.

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum % Required	95 %	90 %	85 %	80%	75%	70 %	65 %	62%	60%	55 %	50 %

4. **Missed Components Of Term Work:**

The university has suspended the requirement for students to provide evidence for absences. Please do not attend medical clinics for medical notes or Commissioners for Oaths for statutory declarations.

In the event that a student legitimately fails to submit any online assessment on time (e.g. due to illness etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date. Absences not reported within 48 hours will not be accommodated. If an excused absence is approved, then the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course.

5. **Scheduled Out-of-Class Activities:**

There are no scheduled out of class activities for this course.

6. **Course Materials:**

Recommended Textbook(s):

W.M. Telford, L.P. Geldart, R.E. Sheriff,*Applied Geophysics, 2nd Ed*: Cambridge University Press, 1990.
A.B. Downey, *Think DSP - Digital Signal Processing in Python* Green Tea Press.
A.B. Downey, *Think Python 2e - How to Think Like a Computer Scientist* Green Tea Press.

This course will focus on processing time series data relevant to geophysics. As such, background in geophysical theory is expected. Good references are Applied Geophysics, 2nd ed by Telford et al. and your course notes from 300-level and 400-level GOPH courses.

The course will also use both Matlab and Python to demonstrate signal processing techniques. You can obtain a license for a current version of Matlab through the UofC IT Software page (https://iac01.ucalgary.ca/SDSWeb/). Python 3 (and matplotlib, NumPy, SciPy, and other packages) are free, open-source, and available from a variety of sources. A recommended distribution is the Anaconda Individual Edition (https://www.anaconda.com/products/individual), which includes Python 3 with many useful packages for scientific computing pre-loaded and a package manage built-in for installing other Python packages. The Anaconda distribution also includes multiple development environment (IDE) options. We will mostly use Jupyter notebooks for in-class demonstrations and you are welcome to submit your assignments as Jupyter notebook (.ipynb) files. Anaconda also includes the Spyder development environment, which has a similar "look-and-feel" to the Matlab environment and you can submit your assignments as .py files developed using Spyder (or any other IDE of your choice) if you prefer.

Information, examples, and tutorials for both Matlab and Python will be provided in-class. You can find additional information about Matlab functions (including more examples) via the Mathworks website and you are encouraged to use this resource regularly to get in the habit of understanding the tools you are using. You should already have some background with Python 3 from your introductory computer science course (CPSC 217 or equivalent), but if you need a refresher the text Think Python 2e by A.B. Downey provides a concise and clear overview of Python for general scientific computing. Best of all, it can be downloaded for free in PDF format from the author/publisher's webpage (https://greenteapress.com/wp/think-python-2e/). A related textbook more specific to signal processing is Think DSP - Digital Signal Processing in Python also by A.B. Downey. This text can also be downloaded for free in PDF format (https://greenteapress.com/wp/think-dsp/). These are "recommended" texts and are not strictly required for the course, but they provide additional descriptions, examples, and exercises to help you develop greater proficiency with Python and signal processing.

The course D2L site will contain all of the handouts for labs, as well as other resource material. In addition to course notes provided by the instructor, the following text and course notes are available on the CREWES website (https://www.crewes.org/ResearchLinks/FreeSoftware/) as supplementary material:

Margrave, G.F. (2003). *Numerical Methods of Exploration Seismology*, University of Calgary.
Margrave, G.F. (2005). *Methods of Seismic Data Processing*, University of Calgary.

Reading the course D2L page is not a substitute for attendance at lectures. In addition to explanations of the course text/notes, the lecture time will include team-based active learning exercises where students will have the opportunity to practice course material and discuss with their peers and the instructor.

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC ELearning online website.

7. **Examination Policy:**

All exams and quizzes are “open book”. During an exam or quiz, you may consult any course materials including notes and previous exams or quizzes *which you have made yourself.* You may not consult exams or quizzes from previous years. You *may* access the internet during an examination, but *may not* use email or other forms of communication (written, verbal, electronic) except to communicate with the course instructor or TAs. The use of calculators or computers for computation is encouraged.

Students should also read the Calendar, Section G, on Examinations.

8. **Approved Mandatory And Optional Course Supplemental Fees:**

   There are no mandatory or optional course supplemental fees for this course.

9. **Writing Across The Curriculum Statement:**

   For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section E.2 of the University Calendar.

10. **Human Studies Statement:**

    Students will not participate as subjects or researchers in human studies.

    See also Section E.5 of the University Calendar.

11. **Reappraisal Of Grades:**

    A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See Section I.3 of the University Calendar.

    a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work form to the department in which the course is offered within 2 business days of receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections I.1 and I.2 of the University Calendar

    b. **Final Exam:**The student shall submit the request to Enrolment Services. See Section I.3 of the University Calendar.

12. **Other Important Information For Students:**

    a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, Mental Health Services Website) and the Campus Mental Health Strategy website (Mental Health).

    b. **SU Wellness Center:** For more information, see www.ucalgary.ca/wellnesscentre or call 403-210-9355.

    c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email (svsa@ucalgary.ca) or phone at 403-220-2208. The complete University of Calgary policy on sexual violence can be viewed at (https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf)

    d. **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties. Examples of academic misconduct may include: submitting or presenting work as if it were the student's own work when it is not; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; collaborating in whole or in part without prior agreement of the instructor; borrowing experimental values from others without the instructor's approval; falsification/ fabrication of experimental values in a report. **These are only examples**.

    e. **Academic Accommodation Policy:** Students needing an accommodation because of a disability or medical condition should contact Student Accessibility Services in accordance with the procedure for accommodations for students with disabilities available at procedure-for-accommodations-for-students-with-disabilities.pdf.

       Students needing an accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Teaching Professor of the Department of Geoscience, Jennifer Cuthbertson by email

cuthberj@ucalgary.ca or phone 403-220-4709. Religious accommodation requests relating to class, test or exam scheduling or absences must be submitted no later than **14 days** prior to the date in question. See Section E.4 of the University Calendar.

f. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see Legal Services website.

g. **Student Union Information:** VP Academic, Phone: 403-220-3911 Email: suvpaca@ucalgary.ca. SU Faculty Rep., Phone: 403-220-3913 Email: sciencerep@su.ucalgary.ca. Student Ombudsman, Email: ombuds@ucalgary.ca.

h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction (USRI) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

i. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or non-academic misconduct, in addition to any other remedies available at law.

Course Outcomes:

- Explain the various concepts and equations associated with continuous and discrete geophysical signals and time series analysis, e.g., convolution, correlation, the convolutional model of a seismic trace, Fourier transforms and frequency spectra, Z-transforms, the Nyquist frequency, sampling, aliasing, frequency filters, minimum-phase wavelets, inverse filters, deconvolution, predictive deconvoution, least-squares filters, and the discrete linear inverse method
- Mathematically calculate various quantities associated with 1D discrete and continuous signals, such as Fourier transforms, convolutions, correlations, Z-transforms, and filter components.
- Use the equations and formulas from basic time series analysis and 1D data processing, and the related mathematics, to solve problems and derive other equations and formulas.
- Write computer programs and use commerical mathematical and computational software to calculate various quantities, such as Fast Fourier transforms, convolutions, correlations, filter components, 1D synthetic seismograms from well logs, deconvolutions, and to solve problems in time series analysis and 1D geophysical data processing.

Electronically Approved - Aug 25 2020 23:02

Department Approval

Electronically Approved - Aug 26 2020 14:34

Associate Dean's Approval for...

1. A non-registrar scheduled final examination.