



COURSE OUTLINE

1. **Course:** GOPH 619, Advanced Computational Methods for Geophysicists - Winter 2023

Lecture 01 : TR 08:00 - 09:15 in ENG 201

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

Calendar Description:

Review of important mathematical models in geophysics (Poisson equation, acoustic wave equation, elastic wave equation) and typical boundary conditions for elliptic and parabolic partial differential equations. Numerical solutions using finite difference, finite volume and finite element approaches. Algorithms for nonlinear constitutive behaviour and introduction to nonlinear optimization/inversion algorithms. Course includes an independent term project.

Learning Objectives:

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

1. *Explain* and *implement* numerical solution algorithms for ODEs/PDEs, applied within a geophysics context.
2. *Explain* and *apply* appropriate boundary conditions for a problem of interest; *implement* a consistent boundary condition within a numerical solution scheme.
3. *Perform* error analyses of approximate numerical solutions and *discuss* whether the solutions are acceptable.
4. *Explain* the advantages and limitations of the numerical techniques examined in the course.
5. *Distinguish* between and select the most applicable of available numerical techniques for an analysis task in geophysics.
6. *Use* software packages (spreadsheet tools such as MS Excel and/or programming languages such as Python) to *compute* numerical solutions.
7. *Communicate* the results of numerical analysis to peers in the scientific community and *critically evaluate* the work of peers.

To account for any necessary transition to remote learning for the current semester, courses with in-person lectures, labs, or tutorials may be shifted to remote delivery for a certain period of time. In addition, adjustments may be made to the modality and format of assessments and deadlines, as well as to other course components and/or requirements, so that all coursework tasks are in line with the necessary and evolving health precautions for all involved (students and staff).

In Person Delivery Details:

Lecture periods (TuTh 8:00-9:15 in ENG 201) will be in-person. Students are expected to attend these sessions to participate in class discussions.

Re-Entry Protocol for Labs and Classrooms:

To limit the spread of COVID-19 on campus, the University of Calgary has implemented safety measures to ensure the campus is a safe and welcoming space for students, faculty and staff. The most current safety information for campus can be found [here](#). **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.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor's permission.

Lab periods (W 8:00-10:45) will be online synchronous. Zoom links will be provided via the course D2L page. Students are expected to attend these sessions to participate in examples/demonstrations and for student presentations that will occur throughout the term.

Lab assignments will be online asynchronous with completion and submission instructions provided via the course

D2L page.

Course Site:

D2L: GOPH 619 L01-(Winter 2023)-Advanced Computational Methods for Geophysicists

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

Equity Diversity & Inclusion:

The University of Calgary is committed to creating an equitable, diverse and inclusive campus, and condemns harm and discrimination of any form. We value all persons regardless of their race, gender, ethnicity, age, LGBTQIA2S+ identity and expression, disability, religion, spirituality, and socioeconomic status. The Faculty of Science strives to extend these values in every aspect of our courses, research, and teachings to better promote academic excellence and foster belonging for all.

2. Requisites:

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

Prerequisite(s):

Admission to a graduate-level Geoscience program or consent of the Department.

Antirequisite(s):

Credit for Geophysics 619 and Geophysics 699.09 will not be allowed.

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:

Course Component	Weight	Due Date (duration for exams)	Modality for exams	Location for exams
Lab Assignments	20%	Ongoing		
Paper Reviews/Presentations	20%	Ongoing		
Project Proposal	10%	Feb 10 2023		
Project Presentation	15%	Apr 05 2023		
Project Report	35%	Apr 12 2023		

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 %	67 %	63%	60%	55 %	50 %

Lab assignments will be given as homework assignments throughout the term at the completion of each major topic to help students build understanding and experience with the mathematical techniques and computer implementation of algorithms. There will be approximately 3-4 of these over the course of the semester. They will be evaluated based on a lab assignment rubric that will be posted on the course D2L page. At the end of the semester, the lowest assignment grade will be dropped in evaluating this grade component and the average percentage grade of the remaining assignments will be taken as the overall grade for this component.

Students will also be responsible for leading the class through two paper reviews/discussions of about 30 minutes each. These will take place during the lab period. The paper topics should be related to the course topics (error, approximation, ODE solvers, finite differences, finite elements) and applied to some problem in geoscience/geophysics/physics. One of your papers should be a technical paper and one should be a literature review. Your paper selection should be sent to the course instructor for approval at least 2 weeks prior to the lab in which you will lead the discussion. Your presentation/discussion will be evaluated using a rubric posted on D2L.

Students will also complete a term project involving application of the course topics to a problem of interest, ideally related to your research project (for thesis-based M.Sc. and Ph.D. students). You are encouraged to discuss potential topics with the course instructor and your research supervisor early in the term, as they should

be able to support you in arriving at a topic and scope that are appropriate. Evaluation will be divided into three components: a brief proposal (due early Feb), a project report (due at the end of classes in April) and a presentation (completed in the second last lab in early April). All of these will be evaluated using rubrics posted on D2L.

There will be no midterm or final exam for this course.

At the end of the semester, your weighted grade will be rounded to the nearest integer percentage point and converted to a letter according to the table above.

The University of Calgary offers a [flexible grade option](#), Credit Granted (CG) to support student's breadth of learning and student wellness. Faculty units may have additional requirements or restrictions for the use of the CG grade at the faculty, degree or program level. To see the full list of Faculty of Science courses where CG is not eligible, please visit the following website: <https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade>

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, one possible arrangement is that the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course. This option is at the discretion of the coordinator and may not be a viable option based on the design of this course.

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

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

6. **Course Materials:**

Recommended Textbook(s):

Steven Chapra and Raymond Canale, *Numerical Methods for Engineers, 7th Ed. (5th or 6th are also OK)* McGraw-Hill.

Olek Zienkiewicz Robert Taylor J.Z. Zhu, *The Finite Element Method: Its Basis and Fundamentals 7th Edition (5th or 6th also OK)*: Elsevier, Butterworth-Heinemann.

There are no required texts for this course. Students are encouraged to discuss recommended texts and/or papers with the course instructor. The instructor will post supplemental notes on D2L (<https://d2l.ucalgary.ca/login.asp>), as applicable. You will be expected to stay up-to-date with the online content of the course on a weekly basis.

To keep up with in-class code examples and lab assignments, you will also require a working version of **Python 3.8** or higher, the **git** version control program, and a **text editor / IDE** suitable for Python code development. Detailed installation instructions (for Windows, Mac, or Linux machines) will be provided via the course D2L page and during the first lab session.

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 lab quizzes/assignments are open book/notes with web access and use of any calculator (including Excel and Python) permitted and 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 Services:** For more information, see their [website](#) 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 [here](#).
- d. **Student Ombuds Office:** A safe place for all students of the University of Calgary to discuss student related issues, interpersonal conflict, academic and non-academic concerns, and many other problems.
- e. **Student Union Information:** [SU contact](#), Email your SU Science Reps: science1@su.ucalgary.ca, science2@su.ucalgary.ca, science3@su.ucalgary.ca,
- f. **Academic Accommodation Policy:**

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf>.

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate

degree, based on a Protected Ground other than Disability, should communicate this need, by filling out the [Request for Academic Accommodation Form](#) and sending it to Brandon Karchewski by email brandon.karchewski@ucalgary.ca preferably 10 business days before the due date of an assessment or scheduled absence.

- g. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional [Code of Conduct](#) and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

[Student Handbook on Academic Integrity](#)
Student Academic Misconduct [Policy](#) and [Procedure](#)
[Faculty of Science Academic Misconduct Process](#)
[Research Integrity Policy](#)

Additional information is available on the [Student Success Centre Academic Integrity page](#)

- h. **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.
- i. **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.
- j. **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.

Electronically Approved - Jan 04 2023 10:22

Department Approval