

Course Outline MATH 406 2020

Variational and Approximate Methods in Applied Mathematics

Prerequisites: One of MATH 307, CPSC 302 and either MATH 400 or 80% in M256, 257, 316, 358, MECH 358, PHYS 312

Credits: 3 Credits. Math M406 is credit excluded with MATH 401 and 405.

Learning Objectives: This course introduces fundamental tools of scientific computing such as interpolation, numerical integration, and schemes for solving initial value ODEs. We construct Green's functions for ODEs and PDEs and discuss the approximate solution of these equations by the Boundary Integral Method. We discuss Variational formulations of ODE and PDE boundary value problems and approximate methods based on these variational formulations such as the Finite Element Method.

Instructor: Anthony Peirce

Course Canvas Page: <https://canvas.ubc.ca/courses/55325>

Lectures: Lectures will be delivered live via Zoom MWF at 2:00 pm PST. Recordings of the Zoom lectures will be posted on Canvas. The link for the Zoom Lectures will be posted on the course Canvas page.

Office Hours: Mondays 3:30-4:30 pm PST. Office Hours are drop-in and optional. They will not be recorded.

Piazza forum: We will be using Piazza for class discussion. The system is set up to get you help efficiently from classmates and the TA. Rather than emailing questions, I encourage you to post your questions on Piazza. A link to register for the class Piazza group appears on the Course Canvas Page.

Assessment: The final grade will be based entirely on regularly assigned homework or projects that will be posted on Canvas. These will typically involve a significant MATLAB component. You should submit your solutions to Canvas in a legible .pdf file. Should the legibility become an issue, I will require you to typeset your answers in LaTeX and submit your solutions in a .pdf file generated by the latex editor. If you don't know how to use LaTeX is very easy to learn and it will be useful in your future studies and work. I suggest that you consider using the online system Overleaf. <https://www.overleaf.com/>

Missing assignment and project deadlines: No late assignments can be accepted. There are no make-up assignments in this course. If you miss any of the assessment deadlines for a valid reason, the weight of that assessment will be transferred to the other assessments. Any student who misses an assessment must present to me within 72 hours the completed Department of Mathematics self declaration form (available on the Canvas page).

Texts and topics covered

Notes: A comprehensive set of written lecture notes is posted on the Canvas Page.

Useful Texts:

There is no one textbook that covers all the topics treated in this course. However, the following lists some classic textbooks that treat the various topics covered in the course:

1. Burden and Faires, Numerical Analysis, 10 th Edition, Brooks Cole (2015).
2. Zauderer, Partial Differential Equations of Applied Math., Wiley-Interscience, 3 Ed. (2006).
3. Stakgold and Holst, Green's functions and Boundary value problems, Wiley, 3 Ed. (2011).
4. Crouch, S.L. and Starfield, A.M., Boundary Element Methods in Solid Mechanics, George Allen and Unwin, London, 1983.
5. Courant and Hilbert, Methods of Math. Physics Vol. 1 & 2.
6. Hildebrand, Methods of Applied Mathematics, Dover Books on Math., 1992.

Topics:

1. Introduction to numerical methods
 - 1.1 Interpolation (5 lectures)
 - 1.2 Integration (5 lectures)
2. Boundary Value Problems for Ordinary Differential Equations
 - 2.1. Green's Functions for Boundary Value Problems (8 lectures)
 - 2.2. Variational methods and the Finite Element method (5 lectures)
3. Partial Differential Equations
 - 3.1 Elliptic Boundary Value problems
 - 3.1.1 The Finite Element Formulation for the Poisson Problem with triangular tessellation of arbitrary regions (4 lectures)
 - 3.1.2 Green's functions and Boundary Integral formulations of Elliptic PDE (7 lectures)
4. Numerical solution of evolution equations (3 lectures)

Tips for success:

Make your own notes: When watching the lectures make your own comprehensive notes. It has been demonstrated that the note-taking process is a powerful tool in mastering new concepts. With the recorded lectures you have the added benefit of being able to review a point you may not have understood on the first viewing.

Put in the time and effort: Math is not a spectator sport: you learn by doing, and the more you do, the more accomplished you become.

Keep up: For six days a week, schedule some time to work on this course. Don't fall behind. If you are struggling with some material, make sure to seek help, either from your classmates and TA via Piazza or by coming to the online office hours.

Zoom Etiquette:

- Please try to keep your video on for the duration of online class meetings. Think about video this way: if we were in a classroom together, we would be able to see each other for the whole time;
- Keep your audio muted, except when you want to speak, to minimize background noise when others are speaking;
- You can use a virtual background if you want, as long as it doesn't use too much of your bandwidth and interfere with your audio/video quality;
- Close all applications on your computer/tablet that aren't necessary for the course;
- Temporarily disable notifications so they don't distract you. Turn off your phone (or put it on Do Not Disturb).
- Try to find a place where you won't be interrupted or distracted by pets, curious family members, etc;
- Food? Eat if you need to eat and can't have a meal before or after class. Try to minimize any distraction from eating during class. (Use the same judgment you would for an in-person class meeting.);
- Please use the "raise hand" function to contribute to discussion, or raise your hand physically if you are having trouble with the "raise hand" function.

Academic Misconduct:

1. UBC takes cheating incidents very seriously. After due investigation, students found guilty of cheating are usually given a final grade of 0 in the course and suspended from UBC for one year.
2. While students are encouraged to study together, they should be aware that blatant copying of another student's work is a serious breach of academic integrity. Please discuss with your instructors their expectations for acceptable collaboration on any assigned coursework. Cases of suspected cheating will be investigated thoroughly.
3. Note that academic misconduct includes misrepresenting a medical excuse or other personal situation for the purposes of postponing an examination or quiz or otherwise obtaining an academic concession.

Statement on UBC's Policies and Resources to Support Student Success

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available at:

<https://senate.ubc.ca/policies-resources-support-student-success>