EOSC352 — Continuum Dynamics

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Office hours: Wednesdays, 2-3 pm,
Contact me in advance if you have a class at this time but would like to see me outside of class
Course website: https://www.eoas.ubc.ca/academics/courses/eosc352

TA: Luke Brown lbrown@eoas.ubc.ca

Course outline: At the end of the course, you will be able to use vector and tensor calculus to model geophysical continuum problems involving conservation of mass, momentum and energy. By continuum, we mean a medium in which physical quantities like mass, momentum and energy are not concentrated at points ('particles', billiard balls, ...), but distributed spatially. The models we derive are usually partial differential equations, and you will also be able to solve these using a number of methods, and interpret your results physically.

- Basic concepts of continuum physics, fields and fluxes
- Mathematical tools: vector calculus, volume and surface integrals, the divergence theorem
- Conservation laws: mass and energy in continua
- Transport by advection and conduction
- Constitutive relations for conductive transport of heat
- Differential equation models
- Solution by separation of variables, similarity solutions, Fourier modes
- Scaling: non-dimensionalization
- Continuum mechanics: conservation of momentum and angular momentum
- Extending the idea of a flux to conservation of vectorial quantities: tensors
- Subscript notation for vectors and tensors
- Tensor calculus: extending volume and surface integrals, the divergence theorem

- Conservation of momentum in tensor notation, advection and conduction of momentum, the stress tensor
- Conservation of angular momentum: constraints on the stress tensor
- Constitutive relations: viscous flow
- Examples of viscous flow: flow in pipes, inertial boundary layers, porous media
- Scaling, Reynolds numbers: Stokes and inviscid flows
- Convection: stability analysis and Fourier series
- Time permitting: principal stress components and yield stresses

Grading: Contributions to your final grade in this course will be allocated as follows:
Assignments 40 %
Mid-term exam (open book, timed) 10 %
Final exam 40 %
Contribution in class, quizzes, reading homework 10 %.
I plan to run the class based around advance readings of course materials posted on the couse website, with short homework problems to go with some of them. These short problems are not the assignments that make up the 45 % above, but will count to towards the 10 % contribution in class, quizzes, reading homework contribution to your grade. I will be looking for effort put into these, rather than getting the right answer. The first, math background homework will be graded for credit, but only at 2 % of the final grade (this goes into the 10 % for quizzes etc.

Assignments: There will be between 5 or 6 assignments. Assignments are due after class on the date given on the course website. Subject to the UBC rules around self-assessing for medical issues etc, please submit assignments on time. We will use the assignment functionality of canvas for submissions, which you will need to convert to a single PDF file. By way of warning, I (or the TA) will not try to infer meaning in what you write: if I or the TA can't decipher it, you will get no marks. Aim for a clear, linear presentation of your work. The usual rules regarding plagiarism also apply to this course. You can exchange ideas, but what you hand in has to be your own work. You cannot copy someone else's work. No marks for a plagiarized assignment, and there may be more severe consequences. I have sadly had some experience with this.

Course materials: An extensive set of class notes are posted on the course website, and these are the basis for the course. Schaum's outlines 'Continuum Mechanics' by G. Mase and 'Geodynamics' by D. Turcotte and G. Schubert are useful textbooks. You do not need to get them, but I these texts are a useful resource. The book by Mase covers the fundamentals in detail with a lot of exercises. Turcotte and Schubert is a nice introduction to how these fundamentals relate to real Earth Science problems. Some of the material in Turcotte and Schubert is more advanced than what we will cover in the course. 'Mechanics in the Earth and Environmental Sciences' by G. Middleton and P. Wilcox has some useful material on scaling

and is less mathematical. You may also find standard texts on multivariable calculus (e.g., Stewart, or 'div, grad, curl and all that' by H. Schey) and on differential equations (e.g., Boyce & DiPrima) useful. In addition, I will draw on the lecture notes for EOSC 250, posted at: http://www.eoas.ubc.ca/academics/courses/eosc250
Assignments and any other course materials will be posted on the course website:
https://www.eoas.ubc.ca/academics/courses/eosc352
The website will be updated regularly.