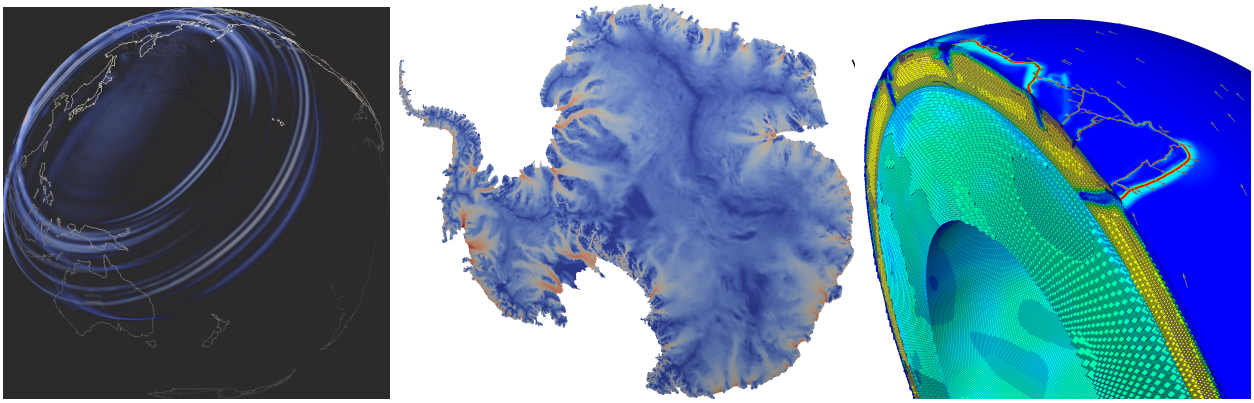
GEO 384F: Finite Element Method in Geophysics
Fall 2018



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Lectures: 9-11am Mondays/Wednesday, GDC 2.210

Description: This course covers numerical methods for the solution of partial differential equations (PDEs) arising in continuum geophysics. Our focus is on the finite element method (FEM), for its generality, adaptivity, and accuracy. The FEM is applicable to a broad spectrum of geophysical and environmental models including those arising in seismology, geodynamics, subsurface flow and transport, geomechanics, ocean dynamics, atmospheric sciences, and glaciology. We will begin by developing the core ingredients of the FEM—weak formulation, Galerkin approximation, piecewise polynomial basis functions, numerical quadrature, isoparametric elements, assembly—with reference to model 1D and 2D diffusion problems. In this portion of the course, students will use MATLAB for implementation to enhance understanding of the machinery of finite element methods. We will then study finite element approximations of fundamental continuum mechanics and continuum physics PDEs that underlie a spectrum of geophysical problems, including elasticity, wave propagation, viscous flow (Stokes and Navier Stokes), and porous media flow and transport. To implement the FEM for these problems, we will employ the powerful finite element toolkit `FEniCS`, which abstracts away low level implementation details, allowing student to focus on high level issues that are critical for finite element solution.

Prerequisites: Graduate standing or consent of instructor. The background required is just the vector calculus, linear algebra, and differential equations included in the curriculum of a standard undergraduate science or engineering degree. However, the required mathematical and computational background will be covered as needed, and thus the course will be relatively self-contained. Auditors are welcome.

Required work: Course grades will be based on 5–6 assignments.

Text: E.B. Becker, G.F. Carey, and J.T. Oden, *Finite Elements: An Introduction* (Volume 1 of Texas Finite Element Series), Prentice Hall, 1981. (Will be made available to students for purchase).