Ge263: Computational Geophysics

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Instructors:

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Meeting Place/time:

TTh 1-2:30 PM, South Mudd 162a

Grading:

Homework, 100%

Prerequisites: an introductory class in geophysics, class in partial differential equations, ability to program in some language.

Description:

Finite-difference, finite-element and spectral-element methods will be presented and applied to a number of geophysical problems including heat flow, deformation and wave propagation. Students will program simple versions of the methods.

Syllabus

1) Finite-Difference Methods

a) approximating 1st and 2nd derivatives

b) combining approximations to solve a
partial differential eqn. - centering

c) stability analysis

d) initial (source) and boundary conditions

e) application to the heat-flow (diffusion) equation
(Crank-Nicholson method)
programming example

f) application to the acoustic wave equation
programming example

g) staggered-grid 4th order elastic wave equation

2) Finite-Element Methods

a) Weak and strong forms of governing equations,
boundary conditions, sources

b) Mesh design, quadrilateral elements

c) Integration over an element

d) Discretization of the weak form

e) Assembly

f) Heat-flow equation
programming example

g) Advection-Dffusion equation
programming example

h) Incompressible viscous flow equation

3) Discrete Element Method

a) Family of discrete methods (cellular automata, SPH)

b) Applications to tectonics and collisions

4) Spectral-Element Methods

a) Weak and strong forms of governing equations,
boundary conditions, sources

b) Mesh design, quadrilateral and hexahedral elements

c) Interpolation over an element

d) Integration over an element

e) Discretization of the weak form

f) Dispersion and stability analysis.

g) Time marching

h) Heat-flow equation

    programming example

i) Acoustic wave equation

    programming example