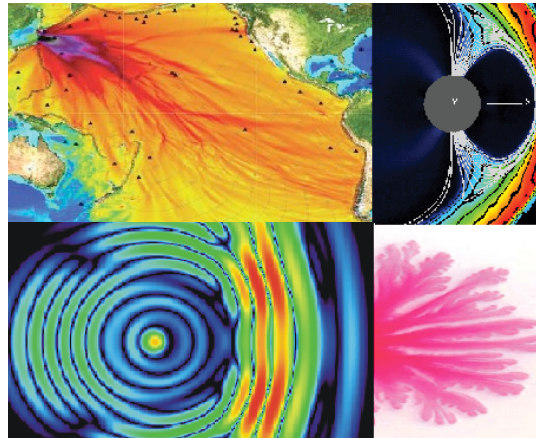


ERTH 630 – Numerical Modeling of Physical Systems



Instructor: Dr. Robert Dunn POST 808 email: dunnr@hawaii.edu
Meeting Times and Location: T/Th 10:30-11:45 POST 708
Credits: 3

A broad variety of physical phenomena are considered by the fields of geology and geophysics and these phenomena, whether in fluid dynamics, electricity, magnetism, wave mechanics, heat flow, chemical diffusion, or phase transformations, can be described by mathematical models. These models are then solved via numerical methods, which involve simplified versions of the original equations that are solved on a computer. This is an introductory course for graduate students who (1) are not necessarily focusing on modeling as part of their graduate work, but would like to learn how to model some physical system(s) or (2) are modelers who are just starting out. The course predominantly deals with Finite Difference Methods, which are easy to understand and implement, and are the workhorse of numerical modeling – including being integral parts of other techniques, such as the time step of finite element techniques. Since no two problems are ever solved in the same way, we focus on the building blocks of numerical modeling and issues of convergence, accuracy, and stability. The building blocks are put together in different ways to solve different types of problems, which are categorized by the type of equation(s) solved. Throughout the semester, working through example problems during class, as a group activity, is an important part of this course.

Expected Background: Experience with MATLAB or other programming language. A basic understanding of differential equations is useful.

SHORT SYLLABUS

Introduction
Mathematics Review
Building Blocks for the Finite Difference Approach
Ordinary Differential Equations (ODEs)
 1-D Initial Value Problems
 1-D Boundary Value Problems
Partial-Differential Equations (PDEs)
 Boundary Value Problems
 Initial Value Problems
The so-called Elliptic, Parabolic, and Hyperbolic PDEs

Grading: 80% homework, project and in-class participation. 20% quizzes and tests. Reading is assigned in advance; each class hour we review the reading and work through problems as a group.

Reference Text: Numerical Methods for Engineers and Scientists, Joe D. Hoffman, 2nd edition, Marcel Dekker, Inc., 2001.

Some other useful resources for the Computational Geoscientist:

Div, grad, curl, and all that, HM Shey, Norton, 1992.

Partial Differential Equations for Scientists and Engineers, SJ Farlow, Dover Publications, NY, 1993.

Introduction to Numerical Geodynamic Modelling, 2nd edition, Taras Gerya, 2019.

The Department of Earth Sciences defines five learning objectives for the graduate degree program: the acquisition of technical knowledge, expertise in a sub-discipline, implementation of the scientific method, developing oral and written skills, and ability to contribute to the advancement of science. The course objectives for EARTH 630 encompass all five categories, by introducing fundamental technical knowledge that supports sub-disciplines; by developing communications skills with regards to problem solving; by gaining proficiency in the application of math, physics, and chemistry, computer applications, critical problem analysis, and problem solving; and by providing a foundation for future hypothesis-driven research.

The University of Hawai'i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the **confidential resources available here**:

<http://www.manoa.hawaii.edu/titleix/resources.html#confidential>

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact: Dee Uwono Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.

Disability Access: If you have a disability and related access needs the Department will make every effort to assist and support you. For confidential services students are encouraged to contact the Office for Students with Disabilities (known as "Kokua") located on the ground floor (Room 013) of the Queen Lili'uokalani Center for Student Services: KOKUA Program; 2600 Campus Road; Honolulu, Hawaii 96822. Voice: 956-7511; Email: kokua@hawaii.edu; URL: www.hawaii.edu/kokua