

# GG/OCN 312: Geomathematics

Fall 2009

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## Introduction

The goal of this course is to introduce you to a number of mathematical subjects that are crucial in science and engineering with applications to the Earth and Ocean Sciences. By the end of the course, it is expected that you will have the mathematical foundation necessary to carry you through scientific research such as fluid dynamics, ecosystems, computer modeling, etc. You will also learn the basic skills of using a numerical package such as Matlab™.

## Administrative

The class meets MWF 9:30–10:20am in POST 703. The goal of the lectures is to introduce each mathematical concept and present the methods. Attendance is highly recommended. The final exam is scheduled for Friday, Dec. 18 from 9:45–11:45am. This is the UH scheduled exam time, and it will not be given early. Do not plan to leave beforehand.

All announcements will be made in class. It is your responsibility to discuss with your fellow students or come see me or the TA if you miss a class. Exceptions will not be made if you miss an announcement in class.

## Additional Hours

We will hold three, one-hour recitation sessions per week to answer questions on the homework or other problems in the class. These sessions are crucial for helping you to understand the material if you find yourself falling behind. They are not required, but are for your help and benefit.

**Office hours** with Dr. Powell are available by appointment. The recitation sessions are available to help you with the course material, but if you would like to discuss your grade, the course, etc. in private, please schedule an appointment with me.

**Recitation Sessions** will be determined on the first day of class to best meet the schedules of the class.

**Email** me or the TA at any time; however, I often check email in batches and may take time to respond.

## Text

Required Text: *Advanced Engineering Mathematics 2nd Ed.* by Michael Greenberg, 1998, which is available in the bookstore or online.

## Grading

**50%** Homework: Due in instructor's office by 3pm of due date.

Homework is the primary method for you to learn the material. You must solve a number of problems in order to understand the mathematical concepts covered. For this reason, the homework is required and much of the course support is provided for you to understand and solve the homework problems. If you do understand and solve the homework sets, the exams will not be difficult for you. You are encouraged to work with others on the homework assignments, but you must

turn in your own work. Some homework will be computer problems that make use of a numerical package such as Matlab™ or Python. Every student must write their own program.

### 20% Mid-Term Exam

The mid-term exam will cover the Maths Review and Ordinary Differential Equations. All exams will be given in-class. You will be allowed to bring a single  $8.5 \times 11$ -inch sheet of paper with notes on it to the exam. You must hand in your note sheet with your exam.

### 30% Final Exam

Friday, Dec. 18: 9:45–11:45am. The final is comprehensive and will test all of the material covered during the semester with an emphasis on the second half of the course. You will be allowed to bring two,  $8.5 \times 11$ -inch sheets of paper with notes to the exam. You must hand in your note sheets with your exam.

## Holidays

Class or Recitation will not be held on: Sept. 7, Oct. 16, Nov. 11, or Nov. 26-27.

## Computing

Some of the homework assignments require the use of a numerical package, such as Matlab™, Octave, or Python. Matlab™ is available in the computing labs or the student version for purchase. Octave is a free clone of matlab available on the web. Scientific Python is also available for free on the web. For many of the GES students looking for a senior project, your advisor will most probably use Matlab™, and for this reason, we will be working with it in class. You are free to use the language of your choice.

## Course Topics

### 1. Introduction and Review [~2 weeks]

- Calculus: derivatives and integrals
- Elementary Functions: logs, exponentials, trigonometric
- Taylor Series §13.5
- Multivariate Functions: Partial Derivatives §13.3
- Complex Plane: Complex numbers, exponentials §21.1-3
- Coordinate Systems: Cartesian, Polar, Cylindrical, and Spherical

### 2. Ordinary Differential Equations (ODEs) [~4 weeks]

- First-order ODEs Ch 1-2
- Numerical Methods Ch 6
- Second-order ODEs §3.1-8
- Systems of Coupled ODEs §3.9
- Applications

### 3. Linear Algebra [~4 weeks]

- Systems of Linear Equations Ch 8
- Matrix Algebra Ch 10
- Matrix Inversion and Solutions to Linear Systems Ch 8
- Eigenvalue Problem Ch 11
- Applications

### 4. Vector Calculus [~3 weeks]

- Vectors and Unit Normals Ch 9
- Scalar and Vector products §14.1-5
- Coordinate Transforms §14.6
- Gradient, Divergence, and Curl §16.1-5
- Multivariate Integrals Ch 15
- Integral Theorems §16.8-9
- Conservation Laws: Mass and Momentum