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, ecological research, computer modeling, etc. You will also learn the basic skills of solving problems numerically using a computing package.

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 mandatory. The final exam is scheduled for Monday, Dec. 10 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. Anyone not taking the final will receive an ‘F’ for the class.

All announcements will be made in class. If you miss a class, it is your responsibility to obtain the material you missed by discussion with your fellow students, the instructor, or the TA. Exceptions will not be made if you miss an announcement in class.

Additional Hours

We will hold two, 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 have particular questions or 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.

Course Materials: All reading assignments, individual class learning outcomes, homework assignments, etc. will be made available via laulima. If you have any difficulty or require assistance to read the materials posted on laulima, please contact myself or the TA, and we can provide alternate methods. In addition, the Kokua program may be able to provide assistance.

Grading

15% Participation: This course covers a great deal of material. As such, you are going to have to play an integral role in the course material. You will need to be present and participating in each lecture. Discussion is
encouraged during the lectures. Every student is **required** to ask at least two thoughtful questions during class over the course of the semester (this is tracked). The reading and student learning outcomes for each class will be posted on laulima. The student learning outcomes should help each student to identify and understand what they need to know from each class. There will be 10–12 pop quizzes throughout the semester that cover the reading material before it has been lectured on. The pop quiz will be judged on how you reason through the problem (if you did the reading, it will be easy). The TA will take an accounting of attendance for each lecture. Every student is allowed two absences (including if it happens on the day of a pop quiz). After two, points will be deducted.

**35%** 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 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.

**15%** Exam 1
The first exam will cover the Calculus Review and Ordinary Differential Equations. All exams will be given in-class. You will be allowed to bring a single 8.5 × 11-inch sheet of paper with notes on it to the exam. You must hand in your note sheet with your exam.

**15%** Exam 2
The second exam will cover Linear Algebra. All exams will be given in-class. You will be allowed to bring a single 8.5 × 11-inch sheet of paper with notes on it to the exam. You must hand in your note sheet with your exam.

**20%** Final Exam
Monday, Dec. 10: 9:45–11:45am. The final is comprehensive but will be skewed towards the Vector Calculus portion of the class. You will be allowed to bring two, 8.5 × 11-inch sheets of paper with notes to the exam. You must hand in your note sheets with your exam.

**Holidays**
Neither Class or Recitation will not be held on: Sept. 3, Nov. 6, Nov. 12, or Nov. 22–23.

**Computing**
Some of the homework assignments require the use of a numerical package, such as Python, Matlab, Octave, R, or Excel. Python, Octave, and R are freely available from the following:

- Python: [https://www.anaconda.com/download](https://www.anaconda.com/download)
- Octave: [https://www.gnu.org/software/octave/](https://www.gnu.org/software/octave/)
- R: [https://www.r-project.org](https://www.r-project.org)

A University-wide site license for Matlab is available for students. Information can be found at: [https://www.hawaii.edu/sitelic/matlab/matlab.html](https://www.hawaii.edu/sitelic/matlab/matlab.html).
You are free to use the language of your choice in this course.
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

Course Learning Outcomes

By the end of the semester, students should be able to ...

1. state the definition of a derivative, explain its physical meaning, and apply it to a wide a variety of formulas.
2. explain the use of the Taylor series and apply it to approximate functions.
3. transform problems into cartesian, polar, or spherical coordinate systems.
4. identify the various forms of differential equations and apply a proper solution methodology.
5. explain when to utilize numerical solutions and apply them to a number of problems.
6. transform systems into linear algebra, explain the reasoning, and compute the solution.
7. state the definitions of divergence, gradient, and curl, explain their physical meaning, and apply each operation to any vector field.

Class Learning Outcomes

By the end of today's class, students should be able to ...

1. explain the objective of the course and its relevance to your field.
2. explain the course grading policy and rank the importance of various categories.
3. identify what is required for the class participation grade.
4. list when the weekly course recitation times are and identify at least one that you can attend.