

ERTH/OCN 312: Advanced Mathematics for Scientists and Engineers I

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TA: TBD

Recommended Textbook: *Advanced Engineering Mathematics 2nd Edition*, by Michael. D. Greenberg

BY TAKING ERTH/OCN 312 STUDENTS WILL...

- Gain confidence and skills in applying mathematical operations commonly used to solve problems in calculus, vector calculus, and differential equations
- Develop familiarity with using computer programs (e.g., Matlab) for solving simple problems, visualization, and applying basic numerical methods
- Gain knowledge needed to solve problems in more advanced coursework leading to careers in Earth Sciences, Ocean Sciences, Biology, and Engineering
- Be able to learn independently, solve problems creatively, and communicate math clearly and accurately

CLASS FORMAT. Course material will be learned through a combination of reading assignments, YouTube lectures, in-class discussions, weekly problem sets, and studying for three exams. This is a “flipped” class so lectures are to be viewed online via YouTube *PRIOR to class* and homework will be started in class.

VIDEO LECTURES: All lectures are on YouTube and are to be viewed prior to class. Optional short video exercises allow you to test your understanding & count as extra credit for class participation (up to 5%).

WEEKLY PROBLEM SETS and READING: Reading will reinforce the lectures and will provide formal background to do the problem sets. Problem sets are due on Fridays at 9:30 a.m. at the beginning of class. Only under unusually extenuating circumstances can a problem set be turned in late; and you must obtain permission prior to the due date.

SOFTWARE: Computer programming literacy is an important part of applied math. Some of the class exercises will provide practice in this. For these I will teach using [Matlab](#), so you should download and install this asap. Alternatively, if you know R or Python, you may use those; although I haven't used those much myself I should be able to help you.

GRADING: 10% class participation, 45% problem sets, 13% midterm 1, 13% midterm 2, 19% final.

INCLUSIVE CLASS CULTURE: Our class culture will be a positive learning environment that is inclusive of sex, age, ethnicity, culture, socio-economic background, scholastic abilities, sexual orientation, gender identity, political viewpoints, spirituality, physical abilities, or any other that makes people who they are. Classroom interactions will promote respect for everyone, as well as support and encouragement for learning.

HONOR CODE: You are encouraged to work together on your problem sets, but all work turned in for grading (including computer programs) must be yours, and yours alone. There will be no collaborations during exams. Cheating or other acts of academic dishonesty will not be tolerated and is prohibited by the [UH Policy 7.208 Student Conduct Code](#). Everyone is responsible for upholding our honor code.

TOPICS COVERED

Introduction and Review

- Class Introduction
- Elementary functions: logarithms, exponentials, trigonometric
- Calculus: derivatives
- Calculus: integrals
- Taylor Series
- Functions of Multiple Variables and Partial derivatives
- Complex numbers and complex plain

Ordinary Differential Equations (ODEs)

- Coordinate Systems
- Introduction to ODEs and First-order ODEs
- Linear first-order ODEs
- Separable Equations
- Exact Equations and Integrating Factors
- Numerical Methods (Euler's method)
- Second-order ODEs
- Solution to Homogeneous Equation
- Application to Harmonic Oscillator
- Solution to Nonhomogeneous Equation

Matrices and Linear Algebra

- System of Linear Equations
- Matrices, Matrix Algebra, and Determinants
- Rank, Linear Dependence, and Solution to $\mathbf{Ax}=\mathbf{c}$
- Inverse Matrix and Cramer's Rule
- Linear Transformations, Change of Basis, Orthogonal Matrices
- Eigenvalue Problem

Vectors, Tensors, and Vector Calculus

- Diagonalization
- Vectors in 3D space
- Divergence
- Gradient, Curl, and combinations of the Grad operator
- Non-Cartesian Coordinates
- Double and triple integrals [§ 15.3]
- Divergence and Stokes theorems

ERTH/OCN 312 ADDRESSES THE FOLLOWING PROGRAMMATIC STUDENT LEARNING OBJECTIVES:

[ERTH student learning objectives](#) emphasized:

2. Students can apply technical knowledge of relevant computer applications, laboratory methods, field methods, and the supporting disciplines (math, physics, chemistry, biology) to solve real-world problems in geology and geophysics.
3. Students use the scientific method to define, critically analyze, and solve a problem in earth science.

[GES student learning outcomes](#) emphasized:

1. Define and explain the basic principles and concepts of chemistry, physics, biology, calculus, geology, geophysics, meteorology, and oceanography.
2. Apply their understanding of the fundamentals of science and mathematics to the description and quantification of the interactions of the atmosphere, hydrosphere, lithosphere, and biosphere, including humans.
3. Employ the scientific approach to problem solving, and hypothesis formation and testing.

[Engineering student learning outcomes](#) emphasized:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to identify, formulate, and solve engineering problems
- An ability to communicate effectively
- A recognition of the need for and an ability to engage in life-long learning

TITLE IX:

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 the Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.