ERTH/OCN 312: Advanced Mathematics I
Lecture: MWF 9:30–10:20am HST
Recitation: TBD

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COVID-19

Due to the ongoing pandemic, the course this semester will be entirely online. No student will need to be physically present for this course during the semester. If the situation improves, then we may allow students who want to physically attend some of the online lectures and recitations if they choose; however, that will not be allowed until mid-October at the earliest and depends on the situation. You will be expected to attend each online lecture, download and submit your assignments via laulima, and take your exams in laulima.

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 HST in Zoom.

Recitation sessions will meet: Th 4:00–6:00pm HST and F 10:30–12:30 HST in Zoom.

The TA will hold two, 2-hour recitation sessions per week to answer questions on the homework or other problems in the class. The time will be determined on the first day of the class, and this will be updated. 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.

Online Tools and Communication

As mentioned, lectures and recitations will be conducted via Zoom; however, due to the nature of writing mathematics, this adds some complications to the way we have to conduct the semester. All

announcements will be made via laulima. If you miss a class, it is your responsibility to obtain the material you missed by reaching out to your fellow students.

For lectures and recitations, we will be sharing a tablet screen to present our writing to you as we lecture in addition to the camera. Before each lecture, lecture notes will be made available for you to review. These are my lecture notes that I lecture from, but I have tried to make them in a somewhat readable form for you during this online semester. You are expected to review the notes prior to the lecture so that you can be prepared for questions and be able to take your own specific notes during the lecture to help you. The goal of the lectures is to go over each mathematical concept and present the methods. Attendance to the lecture Zoom is expected and comprises a portion of your grade.

For lectures, we will keep your microphones and video muted. Questions are strongly encouraged, and you can ask a question by unmuting and asking your question, or making a quick post in the chat. If you post in the chat, the TA will interrupt to alert for a question, and you will then be able to ask.

For help during recitations, we will utilize Slack. During the first week of class, you will receive an invitation to join: `https://erthocn312.slack.com`. From the email, when you click to join, you want to click on "Continue with Google" and then log in with your `hawaii.edu` account. We will automatically add your `hawaii.edu` email accounts to have access to the Slack channel, ERTH/OCN 312. Once you have that working, you are encouraged to install the slack app on your phone. This will allow you to instantly post an image to the slack channel during recitations for help on your work with the TA. The picture will allow the TA to examine and focus on your work without you having to hold it to a camera. During the recitations, you are encouraged to listen to other questions students have to help in your own understanding.

Additional Hours

Virtual Office hours with Dr. Powell are available by appointment and will be conducted over Zoom. 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. You can also utilize the Slack channel to ask questions of your classmates.

Textbook and Resources

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

Course Materials: All notes, homework assignments, exams, etc. will be made available via laulima.

Supplemental Videos: Prof. Garrett Apuzen-Ito from Earth Sciences has made a series of video lectures for ERTH/OCN 312 that are available on YouTube. These may be helpful to provide a different lecture for the material that I provide. We will be covering slightly different material, but if you are confused another presentation may help to see material in another light.

If you have difficulty or require assistance in reading or hearing the materials posted in this class, please contact myself or the TA, and we can provide alternate methods. In addition, the *Kokua* program may be able to provide assistance.

Grading

- **Participation (10%)**: 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 and questions are encouraged during the lectures. You are expected to read the lecture materials before class so that you can be prepared with questions for you to better understand the material. The TA will take an accounting of attendance for each lecture. Every student is allowed five absences. After that, points are lost.

- **Homework (40%)**: Uploaded to Laulima by the posted time on the due-date. Late homework will be accepted, but after the time for submission has passed, 20% will be deducted, and each 24 hours after that another 20% will be deducted. Homework submitted more than 5 days after it was due will not be accepted. 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. Every student must write their own program. See section below about submitting homework solutions electronically.

- **Exams (50%)**: Four exams will be given via laulima. There will **not** be a cumulative final exam. Once you begin, you will have a fixed number of minutes to complete the exam. In laulima, you may not "go back" to a previous problem, so you must work through the exam linearly. There will be a several hour window available for you to take the exam that fits with your schedule; however, once you start, you will have the fixed time to complete it. For each question, you will be prompted with the question. You will then need to solve it on a piece of paper, take a picture of your work and upload it via the "Add Attachment" button on laulima. This is a similar process as the homework but only needs a picture since it will be a single page. Each exam will be given on the honor code (Student Conduct Code). You must work on it alone and without help. You **are** allowed to use your class notes during the exam. You are **not** allowed to use software, web services, your homework, etc. Violations will be reported for UH disciplinary action. If we find that an individual or individuals are not abiding by these rules, we will change the remaining exams for all students to be during the class time over zoom.

    - Exam 1: Math and Calculus Review
    - Exam 2: Ordinary Differential Equations and Numerical Methods.
    - Exam 3: Linear Algebra and Numerical Methods.
    - Exam 4: Vector Calculus.

Homework

This semester, homework will need to be uploaded via laulima by the due date. By its nature, mathematical homework solutions are handwritten. You could type up your solutions, but it may take as

long to enter as it does to solve them. As such, you are going to need to use your phone to put together your homework solutions to turn in. You will need to leave enough time to put together your homework electronically to upload to laulima on time.

To submit, you **must** upload a single PDF file with all of your homework solutions via laulima. There are numerous <u>free</u> document scanner apps for both iOS and Android phones. These scanner programs allow you to take pictures of numerous pages, and it cleans the photos and puts them together into a single PDF. You can then upload the PDF to laulima via "Add Attachment" when you submit the assignment.

A list of some document scanner apps for phones is below. **Note:** we have only tested the Adobe Scan. The list below is not comprehensive, and if you have one you prefer, feel free to use it.

iOS (Apple App Store)

- Adobe Scan
- Scanner Pro
- Prizmo
- JotNot Scanner App

Android (Google Play Store)

- Adobe Scan
- Genius Scan
- Mobile Doc Scanner Lite
- Fast Scan
- TurboScan
- CamScanner

Calendar

Neither Class or Recitation will be held on the holidays: Sept. 7, Nov. 11, or Nov 27.

The last day of class is Dec. 9 and it will be the date of Exam 4. No final will be held, so you do not need to be present during the scheduled Final period for this class.

Computing

We will be learning about numerical solutions to mathematical problems during the semester, and some of the homework assignments require the use of a numerical language. You are allowed to choose the language, such as Python, Julia, Matlab, Octave, R, or even Excel. Python, Julia, Octave, and R are free software (you can modify it, give it away, etc.) and are available from the following:

- Python

- Julia

- Octave (freely available Matlab clone)

- R-language

Matlab is popular in engineering, but it is non-free software. As a UH student, you may install Matlab on your computer as part of the UH site-license program. Likewise, Excel is cumbersome to use, but it is viable for solving simple numerical problems. It is also non-free software.

You are free to any computer language of your choice in this course. I will provide examples for in Python and possibly Matlab or Julia.

Course Topics

The following topics will be covered in this order for the semester. Due to the online nature of this semester, we don't know the date of each lecture and exam, we will see how fast we get through the material.

1. Introduction and Review [$\sim$2 weeks]

    - Calculus: derivatives and integrals
    - Elementary Functions: logs, exponentials, trigonometric
    - 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) [$\sim$3 weeks]

    - General Linear Differential Equations (§3.1)
    - Constant Coefficients of varying order, homogeneous and inhomogeneous (§3.2-8)
    - Systems of Coupled ODEs (§3.9)
    - Applications of ODEs

3. Numerical Methods (Ch 6) [~2 weeks]

    - Taylor Series (§13.5)
    - Basic Scientific Computing
    - Solving higher ODEs with Change of Variables
    - Applications

4. Linear Algebra [$\sim$3 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

5. 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

Student/Instructor Contract

By remaining enrolled in this online class, you agree to:

- Be responsible for keeping on-time with the course and attending lectures;
- Do all assignments (unless stated otherwise) on your own to be prepared for the exams;
- Finish all lessons (including the assignments and quizzes) by the deadline;
- Not request time extensions except in cases of emergency;
- Abide by the rules for each exam;
- Check the announcements in laulima to stay up-to-date on the class and expectations;
- Abide by the University of Hawai'i Student Conduct Code.

The instructor and TA agree to:

- Respond within a day to inquires;
- Be excited and passionate about the course materials;
- Provide regular recitations to help students work through their homework;
- Grade exercises and exams in a timely manner;
- Adjust course materials and schedules as needed by the COVID-19 and online situation;
- Be open to feedback on the course delivery and content.

Learning Outcomes

Course Learning Outcomes

On successful completion of the semester, students should be able to ...

- state the definition of a derivative, explain its physical meaning, and apply it to a wide a variety of formulas.

- explain the use of the Taylor series and apply it to approximate functions.

- transform problems into cartesian, polar, or spherical coordinate systems.

- understand and apply the general solution of linear, constant-coefficient differential equations

- understand and apply numerical tools to solve differential equations

- explain when to utilize numerical solutions and apply them to a number of problems.

- transform systems into linear algebra, explain the reasoning, and compute the solution.

- state the definitions of divergence, gradient, and curl, explain their physical meaning, and apply each operation to any vector field.

Program Student Learning Outcomes

On successful completion of the semester, students should meet the student learning outcomes of the following programs:

Global Environmental Science:

- Define and explain the basic principles and concepts of chemistry, physics, biology, calculus, geology, geophysics, meteorology, and oceanography.

- 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.

- Employ the scientific approach to problem solving, and hypothesis formation and testing.

Earth Science:

- 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.

- Students use the scientific method to define, critically analyze, and solve a problem in earth science.

Civil Engineering:

- 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

Class Learning Outcomes

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

- explain the objective of the course and its relevance to your field.

- explain the course grading policy and rank the importance of various categories.

- identify what is required for the class participation grade.

- list when the weekly course recitation times are and identify at least one that you can attend.

University Policies and Procedures

The University of Hawai'i is an equal opportunity/affirmative action institution. It is committed to a policy of nondiscrimination on the basis of race, sex, victims of domestic or sexual violence, gender identity and expression, age, religion, color, national origin, ancestry, citizenship, disability, genetic information, marital status, breastfeeding, income assignment for child support, arrest and court record (except as permissible under State law), sexual orientation, national guard absence, or status as a covered veteran. For additional details, visit the UH Systemwide Policies and Procedures Information System (PPIS) site.

Student Conduct

It is a privilege to be a member of the University of Hawai'i at Mānoa community. This privilege provides students with the opportunity to learn and to participate in the many programs that are offered on campus. Along with this privilege, students are expected to be responsible in relationships with others and to respect the interests of the institution. These interests are fully set forth in the UH Systemwide Student Conduct Code (EP 7.208).

Faculty members are encouraged to respond to behaviors which are disruptive to the academic environment. Students may be referred to the Office of Judicial Affairs for possible disciplinary action including suspension, dismissal or expulsion and/or the Department of Public Safety summoned in serious cases of disruptive behavior.

Academic Honesty

Cheating, plagiarism, or other forms of academic dishonesty are not permitted within this course and are prohibited within the Systemwide Student Conduct Code (EP 7.208). Examples include: fabrication, facilitation, cheating, plagiarism, and use of improper materials. Any incident of suspected academic dishonesty will be reported to the Office of Judicial Affairs for review and possible adjudication. Additionally, the instructor may take action in regards to the grade for the deliverable or course as they see fit.

Acts of dishonesty, including but not limited to the following:

1. Cheating is an act of academic dishonesty and includes, but is not limited to:

   - use of any unauthorized assistance in taking quizzes, tests, or examinations;
   - use of sources beyond those authorized by the instructor in writing papers, preparing reports, solving problems, or carrying out other assignments;
   - the acquisition, without permission, of tests or other academic material belonging to a member of the UH faculty, staff or student body; and
   - engaging in any behavior specifically prohibited by a faculty member in the course syllabus or class discussion.

2. Plagiarism is also an act of academic dishonesty and includes, but is not limited to:

   - the use, by paraphrase or direct quotation, of the published or unpublished work of another person without full and clear acknowledgement.
   - It also includes the unacknowledged use of materials prepared by another person or agency engaged in the selling of term papers or other academic materials.
   - Furnishing false information to any UH official, faculty member, or office.

3. Forgery, alteration, or misuse of any UH document, record, or form of identification.

UH 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 (UH Title IX). 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.

If you would like to report incidents of sex discrimination or gender based violence, contact your campus Title IX Coordinator or submit the online reporting form. If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, contact your campus' confidential resource.

Accommodation Statement

The University of Hawai'i is committed to a barrier-free campus and provides accommodations to ensure students with disabilities equal access to education. We agree to make academic adjustments to ensure non-discrimination of students with disabilities. This commitment is in accordance with applicable state and federal laws, including the Americans with Disabilities Act, and Sections 504 and 508 of the Rehabilitation Act.

Under the Americans with Disabilities Act (Title II) and the Rehabilitation act of 1973-section 504 and 508, individuals with disabilities have protections against discrimination and are assured access to programs, services and activities. For more information see "Americans with Disabilities Act" and "Rehabilitation Act of 1973 – Section 504 or Section 508".

Students must self-identify to UH Mānoa KOKUA and complete the intake process before receiving reasonable accommodations. To ensure the prompt and effective provision of accommodations, students should contact the Disability Services Office as early as possible. KOKUA can also be reached at (808) 956-7511 or (808) 956-7612, email: kokua@hawaii.edu.

Student Support

Academic Advising Bookstore Career Services Counseling Services Registration

- Academic Advising

- Bookstore

- Career Services

- Counseling Services

- Registration

Financial Aid Statement

If students do not begin attendance in a course or stop participating in a course, Title IV funds must be returned according to Federal Return of Title IV funds regulations (34 CFR 668.21(a)). This means you may be required to return some (or all) of the financial aid you have received. It is very important to remember that colleges are required to take steps necessary to ensure that students are academically engaged in order to justify the disbursement of Federal Title IV student aid funds. If at any time your plans change and you no longer plan to participate in the courses in which you enrolled, you must contact the financial aid office to minimize any possible negative financial impact.

For more information on financial assistance for your education, please contact Manoa Financial Aid Office. Financial assistance may include grants, scholarships, and other resources to help you pay for the cost of college. A financial aid adviser will be able to help you navigate this process to determine your eligibility for these funds.