211A, Ocean Waves
Winter Quarter 2024
Professor Matthew Alford
malford@ucsd.edu

Class meets T/Th from 9-10:20 in Spiess 330.
The goal of this introduction to Waves class is to give a broad introduction to a variety of waves in the ocean. We will methodically go through the appropriate derivations for each, but also strive to understand each one in physically sensible and intuitive ways. Classes will primarily be lecture format, but with regularly interspersed active learning activities when possible. I don't give out lecture notes, because I think you learn more when you write down notes in your own words.

Most of the class is concerned with linear wave theory as it applies to the ocean. The emphasis is on gravity waves of various types, but other waves will also be discussed. We will start with the shallow water equations to develop our understanding of the wave equation and its solutions for one and then multiple stratification layers, phase and group velocity, energetics, and wave propagation/evolution through inhomogeneous media. Subsequently the same analysis tools will be applied to other waves, including surface and internal gravity waves in a fully stratified ocean, Rossby waves, and Kelvin waves.

Pre-requisite: a basic fluid dynamics class at the senior undergraduate or graduate (e.g. SIO 214) level. We will start with the Navier-Stokes equations (assuming you are all familiar) and move onwards from there.

Textbooks:
Homework and exams will be based only on material covered in class. Useful additional information can be found in several textbooks, which have been placed on Canvas.

Grading:

We will have a daily quiz at the beginning of most classes, which will be graded on a pass/fail basis. You can miss up to 2 quizzes with no consequence. The purpose of the quiz is primarily as feedback for me, to know what was clear in the previous class, and what was unclear (so we can go over it again).

There will be homework due roughly every week. Homework will involve a combination of traditional analytical assignments, reading/analysis of relevant journal articles, and some hands-on calculations from datasets that will be made available. You are encouraged to work in groups, but please write up your own assignment. Just as we do with professional science, please acknowledge those you have worked with on the homework. Homework may be hand-written or typed, as you prefer.

There will also be a mid-term exam in week 5, and at quarter's end, a final exam, and a final project. Each student will read a few papers about some type of ocean wave of their choice (I'm happy to suggest some possibilities), and give an AGU-style (10-min) presentation with slides to the class.

The final grade will determined as follows: daily quizzes (10%), homework (25%), paper presentation (15%), mid-term (25%), final exam (25%).

Daily Schedule: (subject to evolve as we go along)

Lecture 1: Introduction, springs as simple oscillators, start to shallow water equations (SWE)

Lecture 2: Shallow water equations continued, wave-like solutions

Lecture 3: SWE continued, phase velocity, kinematics

Lecture 4: SWE continued, group velocity

Lecture 5: SWE: energetics, energy flux, reflection at walls

Lecture 6: Reflection at boundaries continued

Lecture 7: Surface gravity waves, the complicated version

Lecture 8: Introduction to 2-layer SWE waves

Lecture 9: Continued 2-layer wave solutions

- Mid-term, in class -

Lecture 10: Adding rotation to surface and internal waves - changes to dispersion relation, kinematics, propagation

Lecture 11: Continuous stratification part I, internal waves

Lecture 12: Continuous stratification part II: vertically propagating and vertical mode solutions

Lecture 13: Internal waves around the world.

Lecture 14: Geostrophy and Kelvin wave introduction

Lecture 15: Kelvin waves and Tides

Lecture 16: Potential vorticity, Rossby waves

Last week: In-class project presentations

Final exam: during finals week.

Classroom Philosophy:

A respectful and inclusive classroom environment is essential both for learning within our classroom, and creating the community of science as we want it to be. Everyone in our class approaches the material and our discussions with different backgrounds, senses of self, histories, identities, and learning styles. I recognize that many identities have been historically excluded from science and academia, and many facets of racism, sexism, homophobia and ableism, amongst others, still permeate our community.   As a teacher, I strive to acknowledge my own biases while while also committing to the work of building and sustaining a campus community that increasingly embraces the core value of inclusion. Feel free to reach out any time if there are things that can be changed to make the environment a more supportive and productive one.