Overview

The purpose of this course is to help students acquire some basic knowledge of what the ocean looks like, and some understanding of how it works. For the former we will use up-to-date observations and data products, and for the latter we will learn about how rotation, stratification, and the shape of the earth, together with the basic physics of water in motion, lead to the rich variety of structures and phenomena that we observe.

This is not strictly a lecture course. Class time may include quick quizzes, discussions, question and answer sessions, brief student presentations, and experiments.

Topics

The following is a rough outline of themes and topics that we expect to encounter; it is not a schedule. All themes and many topics will come up repeatedly and in different contexts during the course.

Themes and concepts

1. Scales
2. Approximation
3. The interplay of rotation and stratification
4. Waves as conveyors of information
5. Linear versus nonlinear behavior
6. Instability

Ocean structures and phenomena

1. Large-scale distribution of T, S, tracers
2. General circulation and named currents
3. Mesoscale eddies
4. Waves
5. Fine structure and microstructure

Building blocks of dynamics

1. Hydrostatic balance
2. Rotation: Coriolis and centrifugal forces
3. Geostrophic balance
4. Ekman layer balance
5. Potential vorticity
6. Forcing: fluxes of momentum and buoyancy

Readings

The central resource for the course is the class website: https://currents.soest.hawaii.edu/ocn620/. It includes lecture notes prepared over the years primarily by Eric Firing. Additional information in various forms is also available, and more will be added as the course progresses.

We do not have an assigned textbook for the course. You might find the following free texts useful; both can be downloaded from links in https://currents.soest.hawaii.edu/ocn620/other_courses.html.

Introduction to Physical Oceanography by Robert H. Stewart.

Regional Oceanography: an Introduction by Tomczak and Godfrey is a good source of primarily descriptive information.

Other texts that you might find helpful include:

Descriptive Physical Oceanography, 6th Edition by Talley et al. is packed with up-to-date PO information.
**Ocean Dynamics and the Carbon Cycle** by Williams and Follows gives a concise and modern introduction to PO and its relation to ocean biology and chemistry.

**Atmosphere, Ocean and Climate Dynamics** by John Marshall and Alan Plumb introduces geophysical fluid dynamics as applied equally to the atmosphere and the ocean. It uses rotating tank experiments—some of which we will do in this class—to demonstrate how rotation affects fluid dynamics.

**Atmosphere-Ocean Dynamics** by Adrian Gill is an old but highly respected text and reference. Although as a whole it is too advanced to be used as a primary text for this course, parts may be helpful, particularly to those who continue their studies of physical oceanography or meteorology.

**Grading**

The weighting for the final grade will be 25% for the midterm, 45% for the final, and 30% for class participation, quizzes, and homework.

**Mathematics**

An important part of the language of physical oceanography (and aspects of biological and chemical oceanography) is vector calculus, with which some of you may not yet be familiar. We cannot provide a full course in vector calculus, and we will not require you to learn it well enough to solve complex problems. But we will introduce the basic concepts and symbols, and we will expect you to learn them well enough to understand their physical meaning and perform some simple calculations.

Experience has shown that a strong mathematical background is not essential for doing well in this course; but a student with such a background should be able to get more out of the course than one without.

**Physics**

Physical oceanography is largely the physics of the ocean; although students in this course have often complained about the mathematics, it is our experience that the real problem is more often lack of a sound background in **basic physics**.

**Student Learning Outcomes**

By the end of this course, we expect all students to be familiar with the main features of the world ocean circulation and hydrography, with the main classes of ocean waves, with other important processes such as mixing, and with the dynamic balances that govern these phenomena and processes. We recognize that we will be covering a broad area and introducing many new and sometimes unintuitive concepts. Just do your best, and rest assured that your exposure to these concepts, and the effort you put into understanding them, will be worthwhile so long as you pursue your interest in oceanography.

In addition to learning facts and concepts, you should gain some skills such as the following:

- Calculate Ekman transport and estimate velocity in an Ekman layer.
- Estimate geostrophic currents from a sea-surface topography map or from a CTD section.
- Interpret a current meter record or a sea level record in terms of the types of motion that contribute to the variability at different frequencies.
- Predict wave arrival times from a storm or an earthquake.
- Estimate how a pollutant or other tracer might spread in a given area.
- Explain the basic dynamics of the wind-driven ocean circulation.
- Discuss how a storm might affect a plankton population.
- Read and understand a paper in the modern PO literature.

In other words, the goal is not just to know some things, but to be able to do something with what you know.

One more goal: have fun!