Spring 2023

Waves and Tides

OEAS 415/515

Lectures: 3 Hours, 3 Credits
Class time: Tuesday, Thursday, 9:15am-10:30am, First Class:1/10/2023
Place: Room 3200, CCPO, 4111 Monarch Way, Res. I Bldg., 3rd Floor

Prerequisites: MATH 211-212 and PHYS 231N-232N (or equivalent or permission from instructor).
Recommended: OEAS 405/505/604 (Physical Oceanography)

Class intended for: Junior/Senior undergrads in Oceanography (with focus on Physical) and graduate students of Oceanography or Coastal Engineering
(Students in other disciplines with good math/physics skills are welcomed too)

Web page for class notes: http://www.ccpo.odu.edu/~tezer/415_515/

Instructor: Tal Ezer (Phone: 683-5631; Email: tezer@odu.edu)
Office: CCPO, 4111 Monarch Way, Room 3217
Office Hours: Monday, 9am-11am (email to schedule other times)

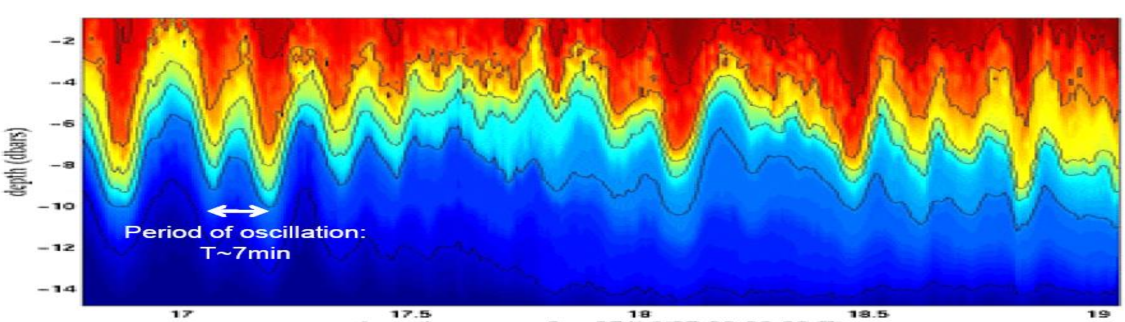
Learning Outcomes:

Students will acquire knowledge on the dynamics of waves and tides in the ocean and how scientists study waves using observations and models. Students will learn about various oceanic waves from the smallest waves (centimeter size) to the longest waves (hundreds and thousands of kilometers) and from wind-waves under a storm to basin-scale waves that impact global climate. Ocean waves will be discussed through mathematical theories, observations, and applications.

Notes:

-Basic calculus is needed, but otherwise the course is self contained. Some math equations as well as basic physical oceanography will be reviewed in class.
-For homework assignments students are expected to be able to make simple plots using Matlab, Excel or other programs of their choice.
-Class notes and assignments will be available on the course web site.

Grading: Homework assignments: 40%, Midterm Exam: 30%, Final Exam: 30%



Textbook:

There is no official textbook, so class material is obtained from various books, journal articles, numerical model simulations and internet resources. Some material will be provided on the class's web site.

Basic texts:

♦The Open University, 1989: Waves, Tides and Shallow-Water Processes.
♦ Stewart, 2006 (web): Introduction to Physical Oceanography, chapters 16-17. (http://oceanworld.tamu.edu/home/course_book.htm)
♦ Mellor, 1996: Introduction to Physical Oceanography, chapter 9-12.
♦ Knauss, 1997: Introduction to Physical Oceanography, chapter 9-10

More Advanced texts:

♦ Kinsman, 1965: Wind Waves, their generation and propagation, Prentice-Hall
♦ Pedlosky, 2003: Waves in the Ocean and Atmosphere, Springer
♦ LeBlond & Mysak, 1978: Waves in the Ocean, Elsevier.
♦ Gill, 1982: Atmosphere-Ocean Dynamics, Academic Press.
♦ Phillips, 1966: Dynamics of the Upper Ocean, Cambridge U. P.

Topics of Course

1. **Introduction**
- Classification of waves
- Observations of waves and energy from waves
- Review of mathematics
- Review of physical oceanography
  - The equations of motion
  - The continuity equation

2. **Linear theory of unbounded surface gravity waves**
- Laplace's and Bernoulli's equations
- Dispersion relation
- Phase velocity and group velocity
- Shallow-Water and Deep-Water solutions
- Particle motion
- Tsunami- an example of a shallow-water wave

3. **Bounded domains and standing gravity waves**
- The shallow-water wave equations
- Open channel steady flow
- Standing waves in closed and open end channels
- Seiches in lakes and harbors

4. **General wave solutions with surface tension & stratification**
- Capillary waves
- Internal waves

5. **Non-linear waves**
- Stokes wave and Trochoids
- Stokes drift
- Breaking waves

6. **The generation of waves by the wind**
- Observations and modeling of wind waves
- Theories of wind wave development and prediction; spectrum models

7. **Interaction of waves with the coast**
- Waves refraction, diffraction and reflection
- Coastal wave breaking types
- Rip currents and storm surge

8. **Large-scale gravity & planetary waves**
- Rossby, Kelvin and Poincare waves
- Coastally trapped and equatorially trapped waves
- Role in basin-scale adjustment and El-Nino dynamics

9. **Astronomical Tides**
- The equilibrium solution
- The dynamic theory of tides
- Observations, analysis and prediction of tides

10. **Basic concepts in numerical models of waves and tides**
- Regional and global models of barotropic tides
- Wave models (e.g., WAM)