Updated on September 10, 2019

Introduction to Physical Oceanography

(JP 12.808; SAW WH.441)

Fall semester, 2019

https://stellar.mit.edu/S/course/12/fa19/12.808/

Instructors:
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Meeting Times:
Tuesdays, 1:00 PM– 2:30 PM, WHOI Clark 331 & **MIT 54-827**
Thursdays, 1:00 PM– 2:30 PM, WHOI Clark 331 & **MIT 54-823**

Teaching Assistant:
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Course Overview:
This course is an introduction to the fundamental processes that control the circulation of the world's oceans and the methods and techniques researchers use to observe the ocean's physical structure and variability. Physical oceanography is a rapidly developing field, in response to the pressing societal need to understand how the physical state of the oceans might be changing as part of a changing climate. Are the oceans warming? Is the ocean circulation slowing? Rapid development on these and other questions is made possible by new technology, e.g., satellite measurement systems and autonomous floats and gliders that enable more efficient and more comprehensive observation of the ocean. Topics are organized around concepts and processes, rather than geography, and the approach will be quantitative rather than merely descriptive. Emphasis will be on large-scale distributions and processes that are central to the ocean's role in Earth's climate and biosphere. The course goal is to understand how the oceans contribute to Earth's climate and biosphere by storing and transporting properties and materials, e.g., heat (energy) and nutrients. Four specific objectives are to: (1) Become familiar with the large-scale distributions of the ocean's physical properties, e.g., temperature, salinity and currents, and how these are observed, (2) Understand the basic principles of ocean physics, e.g., equation of state of sea water, consequences of stratification, effects of Earth's rotation, transport by mean and fluctuating ocean currents, (3) Learn how to estimate ocean processes from the observations, e.g., meridional heat transport by geostrophic and Ekman layer currents or changes in mixed layer depth due to surface heating or winter storms, (4) Foster interdisciplinary understanding and interaction from the diverse background of course participants.

Required Texts:
Descriptive Physical Oceanography, An Introduction, 6th Edition. by Talley et al., 2011, Academic Press. ISBN: 978-0-750-64552-2. Supplementary chapters and the other additional materials are available from http://www.elsevierdirect.com/companions/9780750645522.

Introduction to Physical Oceanography, Second Edition, by John A. Knauss, 2005.

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Course Schedule:

L01 Sep. 5: Intro to Physical Oceanography Seo/Toole
Motivations, goals, and logistics

L02 Sep. 10: Physical properties of sea water 1 Seo
Pressure, Temperature, and Salinity

L03 Sep. 12: Argo and Physical properties of sea water 2 Seo
(40 min) Intro to Argo and WHOI Argo Program (Susan Wijffels, Senior Scientist)
Enthalpy and thermodynamics

L04 Sep. 17: Heat fluxes and Earth radiation balance Seo

L05 Sep. 19: Heat transport, evaporation, precipitation, and freshwater transport Seo
Project Part 1 Due

L06 Sep. 24: Wind, wind stress, and bulk formula Seo

L07 Sep. 26: Physical properties of sea water 3 Seo
Density, equation of state, the 2nd law, potential temperature and density

L08 Oct. 1: Physical properties of sea water 4 Seo
Static stability, buoyancy frequency, and speed of sound

L09 Oct. 3: Physical properties of sea water 5 Seo
Stirring and mixing, advection and diffusion
Review for Midterm
Project Part 2 Due

L10 Oct. 8 In-class Midterm Exam

L11 Oct. 10: Overview of oceanographic instruments and methods Toole

Oct. 15: No class, Long Columbus Day Weekend

L12 Oct. 17: Midterm Review and Ocean Phenomena and Dynamics 1 Toole
Momentum, frictional stresses, Navier-Stokes eq., Coriolis effect

L13 Oct. 22: Ocean Phenomena and Dynamics 2 Toole
Hydrostatic, Geostrophic & Thermal Wind Balances

L14 Oct. 24: Ocean Phenomena and Dynamics 3 Toole
Friction, Eddy Viscosity & Ekman balance
Project Part 3 Due

L15 Oct. 29: Ocean Phenomena and Dynamics 4 Toole

Vorticity, Sverdrup Balance, Western Intensification

L16 Oct. 31: Ocean Phenomena and Dynamics 5 Toole
Energy budgets and balances (kinetic, potential)
Buoyancy forcing, Ventilation, Abyssal Circulation

L17 Nov. 5: Ocean Phenomena and Dynamics 6 Toole
Planetary Waves, Mesoscale Eddies, Eddy Diffusivity

L18 Nov. 7: Ocean Phenomena and Dynamics 7 Toole
Waves, continued: gravity waves, tides
Project Part 4 Due

L19 Nov. 12: Ocean Phenomena and Dynamics 8 Toole
Internal waves, energy cascades, turbulence, mixing, intrusions

L20 Nov. 14: Ocean basin presentations 1 Toole/Seo

L21 Nov. 19: Ocean basin presentations 2 Toole/Seo

L22 Nov. 21: Ocean basin presentations 3 Toole/Seo

L23 Nov. 26: Climate connection 1: Tropics Seo

Nov. 28 Thanksgiving Break, No class

L24 Dec. 3: Climate connection 2: Extratropics Seo

L25 Dec. 5: Review for Final Exam & Course Evaluation Toole/Seo

L26 Dec. 10: In class Final Exam Hyodae is away