Introduction to Physical Oceanography

(ENV 170/298.89, EOS 170)

Instructor: Jim Hench
Office: Room 309, Bookhout Research Lab
jim.hench@duke.edu

Meets: MTWH 10:00-12:00 (lecture; Repass classroom), ~1:30-2:30 (lab; location varies)
Office hrs: MTW 2:30-3:30

Texts:
Knauss, J. A., Introduction to Physical Oceanography (2nd ed.), Prentice Hall, 2005.
Stewart, R. H., Introduction to Physical Oceanography, 2008.
See: *http://oceanworld.tamu.edu/resources/ocng_textbook/PDF_files/book_pdf_files.html*

Grading: 40% Homework (roughly weekly)
10% Lab write-ups
10% Paper presentations
15% Mid-term
25% Final exam (cumulative)

a) if Final exam grade > Mid-term exam grade,
then Mid-term grade = Final exam grade
b) >90%=A, >80%=B, >70%=C
c) Final grade may be curved upward, but not downward

Honor code:
See http://www.nicholas.duke.edu/people/students/advising/honorcode.html

Alternative references for this class:
Marshall, J., and R. A. Plumb. Atmosphere, Ocean, and Climate Dynamics, Academic Press, 2008.
Mellor, G. L., Introduction to Physical Oceanography. Springer, 1996.
Open University, Ocean Circulation (2nd ed.), Pergamon Press, 2004.
Pickard, G.L. and W.J. Emery, Descriptive Physical Oceanography (5th ed.), Pergamon Press, 1990.
Pond, S. and G.L. Pickard, Introductory Dynamical Oceanography (2nd ed.), Pergamon Press, 1983.

Some other useful oceanography books:
Cushman-Roisin, B., Introduction to Geophysical Fluid Dynamics, Prentice Hall, 1994.
Dean, R. G., and R. A. Dalrymple, Water Wave Mechanics for Scientists and Engineers, World Scientific Publishing, 1991.
Denny, M., Biology and the Mechanics of the Wave-Swept Environment, Princeton University Press, 1988.
Gill, A. E., Atmosphere-Ocean Dynamics, Academic Press 1982.
Kundu, P. K., and I. M. Cohen, Fluid Dynamics (4th ed.), Academic Press, 2010.

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Open University, Waves, Tides, and Shallow Water Processes, Pergamon Press, 2000.
Philander, S.G., El Niño, La Niña, and the Southern Oscillation, Academic Press, 1990
Pedlosky, J., Geophysical Fluid Dynamics, 1992.
Thorpe, S.A., An Introduction to Ocean Turbulence, Cambridge Press, 2007.
Tomczak, M. and J. S. Godfrey Regional Oceanography: An Introduction, Oxford Press, 1994.

Primary sources for physical oceanography (most are available as e-journals at Duke) Continental Shelf Research, Deep Sea Research, Dynamics of Atmospheres and Oceans, EOS (newspaper), Estuaries and Coasts, Estuarine Coastal and Shelf Science, Geophysical Research Letters, Journal of Atmospheric and Oceanic Technology, Journal of Geophysical Research (Oceans), Journal of Marine Research, Journal of Marine Systems, Journal of Physical Oceanography, Limnology & Oceanography, Ocean Dynamics, Ocean Modeling, Progress in Oceanography

List of weekly journal articles (each student will lead the group on one article)

Barth, JA, Menge, BA, Lubchenco, J, Chan, F, Bane, JM, Kirincich, AR, McManus, MA, Nielsen, KJ, Pierce, SD, Washburn, L (2007) Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current. *Proc National Acad Science*, 104(10): 3719-3724.

Lozier, SM (2010) Deconstructing the conveyor belt. *Science*, 328: 1507-1511.

McCabe, RM, MacCready, P, Hickey, BM (2009) Ebb-tide dynamics and spreading of a large river plume. *Journal of Physical Oceanography*, 39(11): 2839-2856.

Mitarai, S, Siegel, DA, Winters, KB (2008) A numerical study of stochastic larval settlement in the California Current system. *Journal of Marine Systems*, 69: 295-309.

Shearman, RK, Lentz, SJ (2010) Long-term sea surface variability along the U.S. East Coast. *Journal of Physical Oceanography*, 40(5): 1004-1017.

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Syllabus (updated 19-Feb-2012)

	Date	Topic	Location	Assignments
wed	08-Feb	Lect01: Course info, overview, introduction Lect02: math review *Lab A: matlab tutorial*	Lab: BRL computer room	
thu	09-Feb	Lect03: Properties of seawater Lect04: T/S distribution, water masses, stratif. *Lab B: density measurements*	Lab: BRL309	
mon	13-Feb	Lect05: Conservation equations, heat budget *Lab C: oceanographic instrumentation*	Lab: BRL309	
tue	14-Feb	Lect06: Equations of motion (ΣF=ma), pt. 1 Lect07: ΣF=ma, pt. 2, Coriolis (rotation effects) *Lab D: journal article (Shearman & Lentz 2010)*	Lab: BRL309	HW1 due Lab B due
wed	15-Feb	Lect08: ΣF=ma, pt. 3, Pressure gradients *Lab E: gravity currents and stratified flow* *Lab F: Review HW1*	Lab: BRL309	
thu	16-Feb	Lect09: ΣF=ma, pt. 4, Friction *Lab G: boundary layers in seawater flume* *Lab Gb: review for mid-term*	Lab: BRL309	
fri	17-Feb	Mid-term exam (10-11AM)		
sun	19-Feb	Office hours (4-6PM)		
mon	20-Feb	Lect10: Scaling, tour of large scale circulation Lect11: Computer modeling ocean circ. *Lab H: journal article (Lozier 2010)*	Lab: BRL309	
tue	21-Feb	Lect12: Geostrophic balance Lect13: Thermal wind balance	Lab: BRL 309	HW2 due Lab G due
wed	22-Feb	Lect14: Inertial, cyclostrophic balances Lect15: Ekman balance *Lab I: journal article (Mitarai et al. 2008)*	Lab: BRL309	
thu	23-Feb	Lect16: Ekman balance (cont.) Lect16b: Settlement velocity of particles Lab J: HW3 help	Lab: BRL309	
sun	26-Feb	Office hours (TBD)		
mon	27-Feb	Lect17: Ekman transport, upwelling/pumping *Lab K: Ekman pumping in rotating tank* *Lab L: journal article (Barth et al. 2007)*	Lab: BRL309	HW3 due
tue	28-Feb	Lect18: Sverdrup balance, Sverdrup transport Lect19: Stommel & Munk gyre models, β effect Lab M: HW 4 help	Lab: BRL309	
wed	29-Feb	Lect20: Coastally trapped (long) waves, tides Lect21: Dr. Brian White seminar (12:30-1:30PM) *Lab N: journal article (McCabe et al. 2008)*	Lab: BRL309	HW4 due Lab K due
thu	01-Mar	Lect22: Course review and look ahead *Lab O: extended office hours (1-6PM)*	Lab: BRL309	
fri	02-Mar	Final exam (9AM-12PM)	Repass	