# Introduction to Physical Oceanography

AOS 660

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| Instructor | Prof. Galen McKinley,<br>AOS&S 1511, 262-4817, galen@aos.wisc.edu |
| Office hours | Wednesday 2-3:30, or by appointment |
| Time and Location | 9:30-10:45 TR<br>room 1411 AO&SS Bldg |
| Credits | 3 |
| Course website | Learn@UW https://uwmad.courses.wisconsin.edu/ |
| Prerequisites | Physics 208, Math 234 & cons inst. Or permission of instructor. |

Required Texts:

1. Stewart, R.H. 2007. Introduction to Physical Oceanography, 353pp.
   http://oceanworld.tamu.edu/home/course_book.htm
2. Knauss, J.A. 1997. Introduction to Physical Oceanography, Prentice Hall. **Ch 7.**
3. Open Univeristy, 2001. Ocean Circulation, Pergamon Press, **Section 5.3, Ch 6.3-6.5**.

For the required reading, a **course reader** can be purchased at Printex (627 State St.)

- If you choose not to purchase the reader, printing of the Stewart text should be done at home, not on AOS Department printers.

Other Recommended References:

1. Pickard, G.L. and J.W. Emery, 1992. Descriptive Physical Oceanography, An Introduction (5th Edition), , Butterworth-Heinemann, 320pp.
2. Pond S. and G.L. Pickard. 1982. Introductory Dynamical Oceanography, Butterworth-Heinemann, 329pp.
3. Thurman, H.V. and E.A. Burton. 2001. Introductory Oceanography, Prentice Hall, 554p.
4. Cushman-Roisin, B. 1994. Intro. to Geophysical Fluid Dynamics, Prentice Hall. (Appendix A will be included in the reader for a review of wave kinematics.)

All books, except Stewart, have been requested for reserve in the Schwerdfeger Library.

Course Description:

This course offers the student an introduction to the physical structure and dynamical processes governing the ocean. We will begin with the ocean's structure and the forcings on it, then discuss the dynamics determining its currents and water masses, and conclude with a discussion of the ocean role in the climate system. A rotating tank apparatus will be used to illustrate basic phenomena in geophysical fluids. Grading will be determined based on several homeworks, a mid-term and final exam, discussion of research papers, and a short-write up on a rotating tank experiment.

Grading:

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| 1. Exams (2) | 45% (20% mid-term, 25% final) |
| 2. Homeworks (4) | 40%, each equally weighted |
| 3. Research paper discussion | 10% |
| 4. Write-up on rotating tank experiment | 5% |

Exams:
The mid-term exam will focus on description of the ocean and its forcings. The final exam will be cumulative. Please note that calculations performed in lecture and on in-class exercises will be important to the quantitative questions posed on the exams.

Homeworks:
Homeworks will focus on analysis of oceanographic and relevant atmospheric data. You will have several weeks to complete these. You are encouraged to discuss your work with your peers, but each student must execute their own analysis and develop their own written explanations.

Research paper discussions:
Every few lectures, we will take about 30 minutes to have a discussion of a recent research paper. Students will work in pairs to lead these discussions. Grading will be based both on your leading of a discussion and your contribution to the discussion of other papers. Please come prepared each time!

Write-up on rotating tank experiment:
In the Dynamics section of the course, we will use a rotating tank apparatus to perform geophysical fluid dynamics experiments. In groups of 2 or 3, students will select one experiment to do on their own time in the rotating tank lab (room 1518). This should take about 2 hours. You will need to coordinate with Professor McKinley to gain access to the tank lab.

A short write-up (5-6 pages, double spaced) on your experiment should be turned in no later than December 11. Your write-up should include a succinct discussion of the motivation for the experiment, the experiment design and execution (max 1 page), discussion of the relevant equations and a description of how they are expressed in the experiment, and connection to real flows in the ocean. Each individual will submit their own write-up.

Please see the schedule for the day-by-day course plan, including reading and homework assignments.

Daily Schedule
AOS 660 - Fall 2007

| Week | Date | | Topic | Reading, *Assignment Due* |
|---|---|---|---|---|
| 1 | 4-Sep | 1 | Introduction (Past, Present and Future of Oceanography) | |
| | 6-Sep | 2 | Observations for Oceanography | Stewart Ch 1-3 |
| 2 | 11-Sep | 3 | Lake Mendota Field Trip | |
| | 13-Sep | 4 | Forcing the Ocean (Global Energy Balance, Heat Fluxes) | Stewart Ch 4-5 |
| 3 | 18-Sep | 5 | Forcing the Ocean (Wind Stress) | |
| | 20-Sep | 6 | Forcing the Ocean, Paper discussion 1 | P1 |
| 4 | 25-Sep | 7 | Descriptive PO (Temperature, Salinity, Density) | Stewart Ch 6, *HW1* |
| | 27-Sep | 8 | Descriptive PO (Stratification and Mixing) | |
| 5 | 2-Oct | 9 | Descriptive PO (Major Currents) | Knauss Ch 7 |
| | 4-Oct | 10 | Descriptive PO (Water Masses) | Open Ch 6.3-6.5 |
| 6 | 9-Oct | 11 | Dynamics (Basic Equations), Paper discussion 2 | Stewart Ch 7, P2 |
| | 11-Oct | 12 | Dynamics (Basic Equations) | *HW2* |
| 7 | 16-Oct | 13 | Dynamics (Viscosity), Paper discussion 3 | Stewart Ch 8, P3 |
| | 18-Oct | 14 | **Mid-term Exam** | |
| 8 | 23-Oct | 15 | Return to Lake Mendota | |
| | 25-Oct | 16 | Dynamics (Ekman Processes)<br>Return to Lake Mendota, rain date | Stewart Ch 9 |
| 9 | 30-Oct | 17 | Dynamics (Balanced Flow) | Stewart Ch 10 |
| | 1-Nov | 18 | Dynamics (Balanced Flow) | |
| 10 | 6-Nov | 19 | Dynamics (Wind-driven Circulation) | Stewart Ch 11 |
| | 8-Nov | 20 | Dynamics (Wind-driven), Paper discussion 4 | P4, *HW3* |
| 11 | 13-Nov | 21 | Dynamics (Vorticity, Western Boundary Currents) | Stewart Ch 12 |
| | 15-Nov | 22 | Dynamics (Abyssal Circulation) | Stewart Ch 13 |
| 12 | 20-Nov | 23 | Dynamics (Equatorial Processes), Paper discussion 5 | Stewart Ch 14, Open 5.3, P5 |
| | 22-Nov | | *Thanksgiving* | |
| 13 | 27-Nov | 24 | Dynamics (Waves & Tides) | Stewart Ch 16, CR A |
| | 29-Nov | 25 | Dynamics (Waves & Tides), Paper discussion 6 | P6, *HW4* |
| 14 | 4-Dec | 26 | Dynamics (Waves & Tides) | Stewart Ch 17 |
| | 6-Dec | 27 | Oceans and Climate, Paper discussion 7 | P7 |
| 15 | 11-Dec | 28 | Oceans and Climate | Stewart Ch 15, *Tank Write Up* |
| | 13-Dec | 29 | Oceans and Climate, Paper discussion 8 | P8 |
| | 19-Dec | | **Final Exam, 5:05-7:05pm** | |