

# Physical Oceanography

## Biology 610

### Spring, 2020

Lecture GML 202: T&Th: 08:30-10:30

Laboratory GML 202 and/or 113: T&Th 11:00-14:00

Instructor: Dr. Jack DiTullio: GML, Rm. 204; phone: 953-9196 (ditullioj@cofc.edu)

[Office hours: T&Th 14:00 – 15:00 and by appointment]

This schedule is a general outline of the material that will be discussed each day. Please note, however, we will probably deviate from it somewhat as the course progresses. The outline is simply meant to be an overview of the topics to be discussed in roughly the order they will be covered. Some topics may take more or less time than listed.

	<u>Date</u>	<u>Topic</u>
Jan	09 Th	Introduction, Origin of Universe, Earth & Oceans
	14 T	Marine Geology/Geophysics/ Plate Boundaries
	15 W	Marine Geology/Geophysics/ Plate Boundaries
	21 T	Marine Geology: Deep Sea Sediments
	23 Th	Chemical/Physical Oceanography: Properties of H <sub>2</sub> O, salinity, density
	28 T	Chemical Oceanography: Marine Inorganic & Organic Carbon Cycles
	30 Th	Chemical Oceanography: Marine Nutrient Cycles
Feb	04 T	Meteorology; Gradient and Geostrophic Planetary Wind Systems
	06 Th	Heat Budget, Hydrologic Cycle, Atmospheric-Oceanic Coupling
	11 T	Temperature, Salinity, Density Relations, Water Column Stability
	13 Th	Surface Currents, Circulation & Frontal Boundaries
	18 T	<b>EXAM I</b>
	20 Th	Thermohaline circulation (Deep Ocean Circulation)
	25 T	Equations of motion, Continuity, Coriolis Force
	27 Th	Hydrostatic Equation, Geostrophic Currents, Two-layer Ocean
Mar	03 T	Geostrophic Eddies, Sea Surface Dynamic Topographies
	05 Th	Friction, Viscosity, Wind Stress, Turbulence
	10 T	Ekman Currents, Geostrophic Subtropical Gyres,
	12 Th	Vorticity, Westward Intensification of Boundary Currents
	17 T	Spring Break
	19 Th	Spring Break
	24 T	Mesoscale eddies, Coastal Upwelling
	26 Th	<b>EXAM II</b>
31 T	Progressive Waves, Internal Waves, Tsunamis	

Apr 02	Th	Tides & Tide Generating Forces; Equilibrium & Dynamic Tides
07	T	Estuaries, Coastal Oceanographic Processes
09	Th	Equatorial Pacific Ocean Circulation
14	T	El-Nino Southern Oscillation (ENSO), Planetary Waves
16	Th	Long-term Oceanic Oscillations and Teleconnections
21	T	Oceans and Climate Feedback Loops
23	Th	Reading Day

Apr 24 F **FINAL EXAM**

Texts: There is no specific textbook required for the course as we will cover material from many different sources. A good general physical oceanographic textbook is *Descriptive Physical Oceanography*, Talley et al., 6<sup>th</sup> edition, 2011, ISBN: 978-0-7506-4552-2. In addition, a good general introductory textbook on Oceanography is also recommended such as *Introduction to Ocean Sciences*, 2018, Douglas Segar, 4th edition. This text can be accessed for free at the following link: <http://www.reefimages.com/oceansci.php>. This edition is available for **FREE**. Please note, however, that there is a link for user donations to the author. Please contribute (e.g. a couple of dollars) to help cover the labor and editorial costs that make this resource publicly available for free. I believe Dr. Segar has also updated the link so that you can highlight and make notes on the pdf using Adobe Pro.

Any other general introductory ocean sciences textbook can be substituted for this text as well. While we will cover some basic oceanographic principles in class, because of time constraints you will be expected to cover some of the general oceanographic knowledge found in those introductory textbooks on your own. The Open University (Pergamon Press) also has a very good set of paperback books on various oceanographic topics including *Ocean Circulation*. In addition, another good dynamical PO book that is recommended is *Introduction to Physical Oceanography* by Knauss and Garfield, 2017, ISBN: 978-1-4786-3250-4. Finally, you may also download the on-line text *Introduction to Physical Oceanography* textbook by Robert Stewart at the following link: [http://oceanworld.tamu.edu/home/course\\_book.htm](http://oceanworld.tamu.edu/home/course_book.htm)

Course Objective: To introduce students to multi-disciplinary marine sciences specifically focusing on geological, chemical and physical oceanographic concepts and principles. The main emphasis of the course will be on physical forces in the ocean, especially those forces that drive ocean currents, planetary forces, fluid dynamics and wind-driven and thermohaline circulation. Coastal processes including estuaries, tidal influences, wave dynamics, and coastal upwelling will also be covered.

Student Learning Outcomes:

- Students will learn important principles of both descriptive and dynamic physical oceanographic processes.
- Students will learn how to solve various numerical problems relating to physical oceanography including equations of motion and calculating Ekman and geostrophic current velocities.

- Students will gain an understanding of concepts relating to the Earth's heat budget and atmospheric-oceanic coupling by solving analytical problem sets.
- Students will lead journal discussions from important peer reviewed literature.
- Students will gain field experience by designing and implementing the collection of oceanographic data using a CTD system. Temporal and spatial variability in various physical-chemical parameters will be observed during three field expeditions in Charleston Harbor.
- Students will learn how to analyze seawater for various chemical components including nutrients such as phosphate and silicate and the marine dissolved inorganic carbon system including carbonate and total alkalinity
- Students will demonstrate an ability to collect, assimilate, synthesize and interpret oceanographic datasets from distinct oceanographic regimes using various databases such as OceanDataView and ARGO Float datasets. Class presentations interpreting their regional data will be presented in a power point presentation to the class.

Policies and Requirements: This course will be conducted strictly in accordance with the honor system of the College of Charleston (<http://www.cofc.edu/studentaffairs/HonorBoard.htm>). All work that you turn in for this course (whether for a paper, exam or quiz) must be your own, and have not been used, partially or totally, to fulfill requirements for other classes. Any form of plagiarism (intentional and unintentional), cheating, or presenting someone else's work as one's own will be treated as a serious academic transgression and will be communicated accordingly by the instructor as an honor code violation to the Division of Student Affairs.

All activities performed as part of the BIOL 610 Laboratory in room GML 113 will fall under the College of Charleston Safety Policies and Procedures (Full version has been handed to you with this syllabus, please read them carefully).

According to this college-wide policy: *“Students dismissed from a teaching lab due to violations of the safety procedures will not be allowed to re-enter the laboratory until authorized to do so by their supervisor (instructor). Any course work missed because of a violation of these guidelines cannot be made up at another time (or by an extension of the lab period) and will be treated as an unexcused absence”*

Laboratories: The laboratory portion of the course will include problem sets, chemical lab analyses and some computer analyses. The labs will be held in either the classroom (Rm. #202) or in Rm. # 113. The laboratories will consist of chemical analyses, journal discussions, debates, demonstrations as well as hands-on experiments. Various homework assignments will count toward the lab grade. Problem sets will be assigned for some of the labs and lab write-ups will be required for all. Students will also be required to pass a short course on small boat handling as part of their lab grade. Two harbor samplings on a small boat and a 3 hr harbor cruise aboard the R/V *Silver Crescent* on April 01 and 03, 2019 will be conducted to collect physical and chemical oceanographic data using a CTD (conductivity –temperature-depth) system. Note that all boating operations are weather dependent. More information on cruise specifics will be given the week before the lab. In addition, each student will be required to present a power point-presentation (15 min) on the variability of physical oceanic properties in a certain oceanographic province

using various oceanic databases (e.g. Ocean Data View, ARGOS floats etc.). These presentations will be done on the last week of classes (April 15/17). The ODV program can be found on the computers in the GML computer lab. You can download the program onto your laptops using the following link: <http://odv.awi.de/en/software/download/>

Please note that the topic of your presentation must be submitted before spring break. A written report of the presentation and harbor sampling lab must be submitted on or before April 26<sup>th</sup>.

Grades: Final grades will be determined using the following format:

Exam I-----	15%
Exam II-----	20%
Final Exam-----	25%
Labs-----	20%
Presentations-----	10%
Problem Sets-----	10%

Exams will cover all assigned readings as well as lecture material. Exams will consist of mostly essay type questions and a few problems. The final exam will be a cumulative exam but the emphasis will be on the last third of the semester. Note that class attendance is strongly advised as many lectures will include material taken from various textbooks. Grades will be determined according to the following scale:

A	=	91-100
B+	=	86-90
B	=	80-85
C+	=	75-79
C	=	65-74
F	=	0-64

# Oceanography Lab

## Biology 610, Spring 2020

Teaching Assistant: Julie Loewenstein (loewensteinjm@g.cofc.edu)

Oceanography labs will meet on Tuesdays and Thursdays from 1100 to 1400h in GML Rm #202. On some labs we will go directly to GML Rm. # 113. Some problem sets will be assigned during the course and will contribute to your overall lab grade. Lab reports and problem sets must be turned in the following week unless otherwise noted. Late lab reports will be penalized 10% per day. Individual power point presentations and a write up will be worth a total of 10% of the final grade. More information on the power point presentation will be provided in lab class. A class debate on climate change and geoengineering will be held on Apr 07/09. Further details on the class debate will be provided during one of the first lab periods. Individual regional oceanographic presentations will be done on April 14/16. Charleston Harbor water sampling will be done aboard the R/V *Silver Crescent* (tentatively the last week in March) and periodically aboard one of our smaller boats. The Final Charleston Harbor Lab Report will be due on Tuesday April 21, 2019 (i.e. last day of class) and will contribute the equivalent of 4 individual lab grades.

<u>Date</u>	<u>Topic</u>
Jan	
09	Plate tectonics assignment
14/15	Bathymetry and contouring
21/23	CHS Harbor Sampling
28/30	Plate tectonic presentations + Planet Earth Video + Problem Set #1
Feb	
04/06	Total CO <sub>2</sub> , Alkalinity & the Carbonate Buffering System in Seawater
11/13	Measurement of the Primary Nutrients in Seawater
18/20	Charleston Harbor Sampling + Problem Set #2
25/27	Spectrophotometric and Fluorometric Pigment Analyses
Mar	
03/05	CHS Harbor Water sample analyses + Problem Set # 3
10/12	<i>Weather in a Tank</i> + Problem Set #4
17/19	No Labs --- Spring Break
24/26	Charleston Harbor Cruise aboard R/V <i>Silver Crescent</i>
Apr	
31/02	Charleston Harbor Sample Analyses + Problem Set #5
07/09	Class Climate Debate
14/16	Class Presentations ----- Regional Oceanography Papers Due
21	Charleston Harbor Lab Report Due

### **Honor Code and Academic Integrity:**

Lying, cheating, attempted cheating, and plagiarism are violations of our Honor Code that, when identified, are investigated. Each incident will be examined to determine the degree of deception involved.

Incidents where the instructor determines the student's actions are related more to misunderstanding and confusion will be handled by the instructor. The instructor designs an intervention or assigns a grade reduction to help prevent the student from repeating the error. The response is recorded on a form and signed both by the instructor and the student. It is forwarded to the Office of the Dean of Students and placed in the student's file.

Cases of suspected academic dishonesty will be reported directly by the instructor and/or others having knowledge of the incident to the Dean of Students. A student found responsible by the Honor Board for academic dishonesty will receive a XXF in the course, indicating failure of the course due to academic dishonesty. This status indicator will appear on the student's transcript for two years after which the student may petition for the XX to be expunged. The F is permanent.

Students can find the complete Honor Code and all related processes in the *Student Handbook* at <http://deanofstudents.cofc.edu/honor-system/studenthandbook/index.php>

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### **Disability/Access Statements:**

The College will make reasonable accommodations for persons with documented disabilities. Students should apply for services at the Center for Disability Services/SNAP located on the first floor of the Lightsey Center, Suite 104. Students approved for accommodations are responsible for notifying me as soon as possible and for contacting me one week before accommodation is needed.

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### **Center for Student Learning:**

The Center for Student Learning's (CSL) academic support services provide assistance in study strategies, speaking & writing skills, and course content. Services include tutoring, Supplemental Instruction, study skills appointments, and workshops. Students of all abilities have become more successful using these programs throughout their academic career and the services are available to you at no additional cost. For more information regarding these services please visit the CSL website at <http://csl.cofc.edu> or call (843) 953-5635.

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### **Mental & Physical Wellbeing:**

At the college, we take every students' mental and physical wellbeing seriously. If you find yourself experiencing physical illnesses, please reach out to student health services (843.953.5520). And if you find yourself experiencing any mental health challenges (for example, anxiety, depression, stressful life events, sleep deprivation, and/or loneliness/homesickness) please consider contacting either the Counseling Center (professional counselors at <http://counseling.cofc.edu> or 843.953.5640) or the Students 4 Support (certified volunteers through texting "4support" to 839863 or visit <http://counseling.cofc.edu/cct/index.php>). You can also visit both on campus on the 3rd floor of Robert Scott Small. These services are there for you to help you cope with difficulties you may be experiencing and to maintain optimal physical and mental health.

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## **ATTENDANCE POLICY**

Attendance is not monitored but regular attendance is highly recommended as most of the lecture material is taken from a variety of sources.