SYLLABUS: ELEMENTS OF MODERN OCEANOGRAPHY, WH401

WHOI SAW Program, Fall 2019 (tentative syllabus: 12 July 2019)

INSTRUCTORS:	**SAMUEL LANEY**	**MAGDALENA ANDRES**
Hours: MW 11:30-1:00	Redfield 1-36 (WHOI)	Clark 311A (WHOI)
Lectures: MIT (54-823) & WHOI (Clark 331)	slaney@whoi.edu	mandres@whoi.edu
http://stellar.mit.edu/S/course/12/fa19/12.702/	508-289-3647 (office)	508-289-2660 (office)
TA: TBD	Recitations TBD	

COURSE OVERVIEW

WH401 *Elements of Modern Oceanography* examines a series of crosscutting topics that exemplify current directions in interdisciplinary oceanography. This WHOI SAW course meets concurrently with the MIT-WHOI Joint Program course 12.702 and MIT 12.372. Refer to the main course syllabus (website link above) for complete information about general course format, policies, and expectations.

SAW-ONLY POLICIES AND GRADING

WHOI SAW students enroll in this course for 3 WHOI credits and are expected to be directing substantial effort into their SAW research projects during the term, so there are some separate policies for WH401:

Problem Sets: Students taking *Elements of Modern Oceanography* as WH401 for 3 WHOI credits are not required to complete the same full suite of problem sets and assignments as the students enrolled for 12 Joint Program credits are. Generally, SAW students will be given the same problem sets as the rest of the class but only need to complete a subset of the problems, with the remainder serving as extra-credit opportunities.

Research Project Report: WH401 students will already be conducting independent SAW research projects in their sponsors' labs during term, and so a research project report will take the place of the independent self-study assignment.

A short summary (1 page) introducing the topic and describing the project's hypothesis and proposed approach will be due early in the term. In mid-October, each student will give a short oral presentation introducing the topic, describing their project hypotheses/objectives and proposed approach, ideally along with some preliminary analyses or summaries of data if available.

SAW students will then begin writing a term paper on their research. Due to the likely offset in when the independent research projects will be completed and the term project paper deadlines, papers for SAW students will focus on the introduction and methods, with the option of also including any preliminary data as available and a rough outline of the likely discussion points. The paper should not exceed 15 pages, double-spaced and including any figures and tables (but not including references).

Four weeks before the final project reports are due, SAW students will exchange drafts for peer review. Reviewers will have one week to provide comments. These reviews should aim to be substantive, focusing on both the content (approach, methods, interpretations) and writing (organization, structure, etc.). Instructors will also provide input (playing the role of journal editor). On the final due date, submit the reviewer's marked copy of the initial draft with comments, along with the final revised report. Short oral presentations on the findings and what was learned will be given in the penultimate week of the term.

As credit for the SAW research itself is being received elsewhere, grading of SAW student project reports will be based 5% for the initial topic description; 30% for the mid-term presentation; 20% for effective peer review of a classmate's report; 15% for responding to the peer review; and 30% for the final presentation.

Exam: WH401 students will take the same final exam as the rest of the class, but WH401 exams will be graded on a separate curve comprising only the enrolled SAW cohort.

Course grades for WH401 will be based on the following elements:

Problem Sets	50%
Research Project Report	25%
Final Exam	25%

EXPECTATIONS: SAW STUDENTS

Graduate-level courses: For many SAW students WH401 will be your first exposure to graduate-level coursework. Be aware that class dynamics and tempo may be different than you have experienced in prior undergraduate courses. The TA and instructors are available for advice and guidance on this.

Participation: SAW students will be required to attend all lectures, complete all assigned readings, and participate in class discussions the same as all other students in *Elements*. Absences due to any SAW fieldwork must be arranged in advance with the instructors.

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COURSE OVERVIEW

Elements of Modern Oceanography examines a series of crosscutting topics that exemplify current directions in interdisciplinary oceanography.

GOALS AND OBJECTIVES

This course helps early-stage graduate students in ocean science obtain a solid grasp of ocean structure, dynamics, and key processes. This course begins with an intensive module in fundamentals of ocean and planetary science, followed by two in-depth and crosscutting modules that more deeply examine ocean basins and the coastal ocean. Students will become knowledgeable in core concepts of the various oceanographic disciplines (physical, chemical, biological, and marine geology) and will be able to then apply this knowledge correctly in explaining the oceans' role in societally relevant issues such as climate change, eutrophication, and ocean acidification. This course will complement and prepare students more thoroughly for subsequent core classes required by each of the individual Joint Program disciplines.

PREREQUISITES

This course is targeted at doctoral students in their first or second year in the MIT-WHOI Joint Program. MIT graduate students in other programs and upper-division undergraduates with adequate preparation are welcome, pending prior permission of the instructors. The course does not assume any previous coursework in oceanography but it does assume competency with basic undergraduate calculus, physics, and chemistry. Students unsure about their level of preparation should consult the disciplinary summaries for expected undergraduate preparation for the MIT-WHOI Joint Program[1] and contact the instructors if any concerns are noted. The course will require use of Matlab and prior skill with coding will be useful for taking better advantage of the problem sets and other exercises, but this is not a formal prerequisite.

The 12-credit graduate level course (12.702) meets concurrently with the 12-credit undergraduate level course (12.372) and with the WHOI 3-credit SAW course (WH401). SAW participants please refer to the extended WH401/SAW syllabus for additional information on assignment, grading, and expectations.

COURSE REQUIREMENTS

The course grade will be based on the following elements:

Problem Sets	40%
Independent Self-Study Exercise	30%
Final Exam	30%

[1] http://mit.whoi.edu/undergrad

Problem Sets: Problem sets will be assigned roughly weekly throughout the term. These will be posted on the course website along with their due dates, to be submitted via Stellar. Students expecting to be away for fieldwork or conferences for longer than one week should consult with the instructors early in the semester to arrange a schedule for completing missed assignments. Problem sets may include discussion questions, quantitative problem sets, preparation for in-class discussion exercises, preparation of peer tutorials, and data analyses requiring programming in Matlab.

Independent Self-Study Assignment: Over these 14 weeks each student will design and complete an independent self-study assignment aimed at developing greater depth of knowledge in a fundamental topic of modern oceanography. Students will consult with the instructors early in the semester to identify an area or topic that involves foundational ocean knowledge for that student's chosen subdiscipline that is relevant to the course material but not already expected to be covered by the student's future research training or required coursework. The student will then identify specific learning goals within this chosen topical area and then devise an independent plan of study aimed at developing a credible, Master's-level understanding of this topic. This is not to be a simple literature review on some aspect of oceanography; rather, by the end of the project we expect the student to be able to demonstrate substantial in-depth learning on this aspect of oceanography and be able to clearly and correctly explain how it relates to their own chosen oceanographic subdiscipline.

Time for this assignment will be interspersed among problem sets throughout the semester. Topic choices must be approved by the instructors early in the term. This will involve a short summary (2-3 paragraphs) introducing the topic and describing the learning goals and proposed course of study for the student. In mid-October, pending enrollment numbers, each student will give a short oral presentation to the class that introduces the topic, describes its relevance, outlines the student's learning goals and proposed approach, and demonstrates some preliminary progress in developing new understanding. Instructors will provide formal graded feedback on this presentation.

The remainder of this assignment involves writing a monograph on the topic as if for publication, following guidelines provided by the instructors. Pending enrollment numbers, students will be asked to provide short final oral presentations (mini-lectures) in the penultimate week of class.

Exam: The final exam will include an initial, 48-hour take-home part and a later, 90-minute in-class part.

EXPECTATIONS: STUDENTS

Course communications: Check the class web site regularly for assignments and updates. In using the course online forum, be thoughtful and civil to classmates and the instructors. Student are responsible for bringing technical glitches in the Stellar system to the attention of the instructors or TA.

Participation: We will expect students to arrive in class having completed any assigned readings or pre-class assignments and prepared to contribute knowledgably to discussions or questions. Discussions of papers drawn from the primary literature will be held weekly. These discussions and this course more broadly requires active participation by all enrollees and so listener status will not be allowed.

Attendance: The course will be videolinked between WHOI and MIT and each lecture will be recorded and available for viewing through the Stellar site. This is intended for students who are away for fieldwork or other comparable reasons; otherwise, routine attendance in class is expected. Students who expect to miss class meetings due to fieldwork or conferences should inform the instructors well in advance.

Matlab: Use of computers to analyze ocean data is central to modern oceanography and problem sets will explore published oceanographic models and data sets using Matlab. All students should obtain an MIT site license[2] and have Matlab installed on their computer by the end of the first week of classes. It is expected that students who have little prior experience with programming or with Matlab will need to spend additional time at the beginning of the semester, coming up to speed on Matlab basics. The TA will host an introductory session on using Matlab at the first recitation.

[2] https://ist.mit.edu/matlab/all

TEXTS

Readings will be drawn from textbooks and the primary literature. Electronic copies of required reading assignments will be posted to the course website. In addition to the formal readings, general oceanography and introductory-level disciplinary textbooks include:

- *Ocean Studies: Introduction to Oceanography* (Moran)
- *Descriptive Physical Oceanography* (Talley, Pickard, Emery & Smith)
- *Chemical Oceanography and the Marine Carbon Cycle* (Emerson & Hedges)
- *Biological Oceanography* (Miller & Wheeler)
- *Regional Oceanography: An Introduction* (Tomczak and Godfrey)
- *Dynamics of Marine Ecosystems* (Mann and Lazier)
- *Introduction to Marine Biogeochemistry* (Libes)

The Open University textbooks are a little out of date but provide valuable introductory material:

- *Seawater: Its Composition, Properties & Behaviour*
- *Ocean Circulation*
- *Biological Oceanography: An Introduction*
- *The Ocean Basins: Their Structure & Evolution*
- *Waves, Tides and Shallow-Water Processes*
- *Ocean Chemistry and Deep-Sea Sediments*
- *Case Studies in Oceanography and Marine Affairs*

GENERAL POLICIES

ACADEMIC INTEGRITY & MISCONDUCT

All students are expected to follow MIT guidelines for academic integrity[3].

WRITTEN WORK POLICY

All written assignments for this course are to be submitted via Stellar. Emailed assignments will not be accepted. Furthermore, you are responsible for any work lost due to technical problems, etc.

Except when specified we expect that submitted materials reflect a student's own individual work, but students are welcome to work in pairs or in groups on most assignments.

Assignments are always due immediately before class on the day designated. Assignments submitted late without prior accommodations will be docked 10% for each day that they are late. Any extensions must be discussed with the instructors and arranged in advance.

GRADING POLICY

Graduate students should expect to dedicate 12 hours per week to the course, commensurate with the 12 credit hours awarded per MIT grading guidelines. We expect most 12.702 students (i.e., MIT/WHOI JP students pursuing doctoral degrees in ocean science) will earn grades of B or better although Cs will be awarded for commensurate performance. The MIT Graduate Policy and Procedures[4] provides some guidance as to how students can expect their performance to be reflected in terms of a letter grade:

> A: Exceptionally good performance demonstrating a superior understanding of the subject matter, a foundation of extensive knowledge, and a skillful use of concepts and/or materials.
>
> B: Good performance demonstrating capacity to use the appropriate concepts, a good understanding of the subject matter, and an ability to handle the problems and materials encountered in the subject.
>
> C: Minimally acceptable performance for graduate work, demonstrating partial familiarity with the subject matter and some capacity to deal with relatively simple problems, but also demonstrating deficiencies serious enough to make it inadvisable to proceed further in the field without additional work.

[3] https://integrity.mit.edu
[4] http://catalog.mit.edu/mit/procedures/academic-performance-grades/#gradestext

ASSIGNMENT SCHEDULE (Tentative)

Week	Lec#	Date	Day	Lecture	Lead	Assigned / *Due*	Readings (due on this date)
1	1	9/4	W	What is Oceanography?	Laney	PS1	
2	2	9/9	M	Seawater and the Life Within: Constituents of Seawater	Andres		OU Seawater CH1.1,2-5,6.1-6.2
	3	9/11	W	Seawater and the Life Within: Constituents of Seawater	Andres	PS2 / *PS1*	Stommel 1963, Dickey & Bidigare 2005
3	4	9/16	M	Seawater and the Life Within: Motion of the Ocean	Andres		OU OceanCirc CH2, CH3
	5	9/18	W	Seawater and the Life Within: Motion of the Ocean	Andres	SS prospectus / *PS2*	
4	6	9/23	M	Seawater and the Life Within: Effects of the Solid Earth	Laney		OU MarGeol CH1,2.1-2.5,3
	7	9/25	W	Seawater and the Life Within: Effects of the Solid Earth	Laney	PS3 / *SS Prospectus*	OC MarGeol CH5, Shanks 1995
5	8	9/30	M	Seawater and the Life Within: Chemistry and Biology	Laney		L&P CH3
	9	10/2	W	Seawater and the Life Within: Biogeochemistry and Ecology	Laney	PS3	L&P CH5.5; Strong et al. 2009
6		10/7	M	Topic Presentations	Andres	PS4 / *PS3*	
	10	10/9	W	Oceans on the Basin Scale: Physics of the Atlantic/Pacific	Andres		OU OceanCirc CH6
7		10/14	M	No Class: Columbus Day			
	11	10/16	W	Oceans on the Basin Scale: BGC of the Atlantic/Pacific	Laney	PS5 / *PS4*	
8	12	10/21	M	Seasonal & Annual Dynamics: Physics and Weather	Andres		
	13	10/23	W	Seasonal & Annual Dynamics: Blooms and Export	Laney	No recitation / *PS5*	
9	14	10/28	M	Long Term Trends: ENSO, Decadal Scales, & Teleconnections	Andres		
	15	10/30	W	Long Term Trends: Arctic Amplification & Change	Laney	PS6	
10	16	11/4	M	Coastal: Dynamics of NW Atlantic & GoMaine	Laney		Greene et al. 2013
	17	11/6	W	Coastal: Dynamics of GoMexico	Laney	*PS6*	Rabalais et al. 2014
11		11/11	M	No Class: Veterans Day			
	18	11/13	W	Coastal: Physical Oceanography of Boundary Waters	Andres		
12	19	11/18	M	Coastal: Modeling Coastal Ocean Ecosystems	Laney	PS7	Song et al. 2017
	20	11/20	W	Coastal: Nearshore Physical Processes	Andres		
13	21	11/25	M	Coastal: Terrestrial and Anthropogenic Effects	Andres		
	22	11/27	W	Coastal: Terrestrial and Anthropogenic Effects	Laney	No recitation / *PS7*	
14	23	12/2	M	Summary lecture	Andres /Laney	Pre-Exam	
		12/4	W	Exam	Laney/ Andres	*Pre-exam*	
15		12/9	M	Project Presentations	Laney/ Andres	*SS Final Report*	
		12/11	W	Project Presentations	Laney/ Andres		