

SIO 125: Biomechanics of Marine Life

Spring 2014

Lecture Syllabus

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Office Hours: After class, Mondays 3:00-4:00, or by appointment

Lectures: Monday/Wednesday/Friday 2:00-2:50, Vaughan 100

Objectives:

The main goal of this course is to develop an understanding of the fundamental connection between the physical and biological worlds. This course explores how the physical principles of solids and fluids underlay the functional morphology, ecology, and adaptations of all living things, with emphasis on marine organisms. Specifically, this course explores the forces on organisms such as the mechanical forces from flows, hydrostatic pressures, impacts, and gravity, and how the shapes, habits, and materials of organisms reflect these forces.

By the end of this course, you should be able to:

- Describe the properties of biological materials
- Explain how organism body parts respond to external forces
- Explain how structural support systems of organisms work
- Describe the laws of static and flowing fluids
- Explain how the physics of fluids govern support in organisms
- Explain how animals move through fluids

Textbook:

Required: Vogel, S. 2013. *Comparative Biomechanics: Life's Physical World*. Second Edition, Princeton University Press, 580 pp.

Course Requirements:

Field trips: There will be 3 required class field trips during the quarter, each with an assignment. Please note the dates in the schedule below. Two of these trips are within SIO and will take place during the scheduled lecture time, while the other is a day-long cruise to the San Diego Trough aboard the Scripps research vessel *New Horizon*. This cruise will take place on Sunday, April 20 and will be all day, from 6:00 am to 10:00pm. Detailed information will be provided at a later date.

- *San Diego Trough, New Horizon cruise*
 - Explore the morphology of animals collected from deep sea and pelagic environments, while gaining at-sea experience and learning the instrumentation used to study animals from these environments.
- *Scripps tidepools and sandy beach*
 - Explore the physical aspects of these environments and the mechanical adaptations of organisms that live there.

- *Taylor laboratory*
 - Learn how a mechanical testing machine can be used to characterize animal materials through a hands-on activity.

Exams: There will one mid-term exam covering solid mechanics and one non-comprehensive final exam covering fluid mechanics. Exam format includes problem solving and short answer questions. The exams will be “open-book”, as they are designed to test your application of concepts and not memorization of facts and formulas.

There are no make-up examinations. Individual circumstances will be evaluated at instructor's discretion only.

Problems Sets: Throughout the quarter you will be given 4 problem sets to complete as homework. Each problem set will consist of several questions that require you to apply the concepts covered in lecture and will include calculations and written answers. You will have 1 week to complete each problem set and they must be turned in at the beginning of lecture on the due date. The problem sets are not a group activity. You must complete them independently, without any discussion among your classmates. If you fail to abide by this rule, you will not receive credit for the homework.

Attendance: It is to your advantage to attend lecture on a regular basis. There will be no powerpoints or lecture notes available, and lecture content will be the main source of material for exams and problem sets. Also, we will likely deviate from the schedule provided below, so being in lecture will help you follow what exactly we are working on.

Grading:

Exams	2 x 100 Points	200
Problem Sets	4 x 25 Points	100
Field Trip Activities	3 x 20 Points	60
Total		360 Points

Grading Scale:

≥ 97 %, 93-96, 90-92	A+, A, A-
87-89, 83-86, 80-82	B+, B, B-
77-79, 73-76, 70-72	C+, C, C-
67-69, 63-66, 60-62	D+, D, D-
≤ 59	F

Lecture Schedule:

Date		Lecture Topic	Chapter
Mar 31	M	Introduction, dimensions, units, and scaling	Appx 1
Part I: Solid Mechanics			
Apr 2	W	Solids – properties of materials	15
4	F	Cont.	“
7	M	Biological materials	16
9	W	Cont.	“
11	F	Complex materials - composites <i>Problem Set 1</i>	17
14	M	Cont.	“
16	W	Complex materials - viscoelasticity	18
18	F	Cont. <i>Problem Set 1 Due</i>	“
20	Su	Field Trip 1: New Horizon Cruise	
21	M	Structures – beams and columns	19
23	W	Con.	“
25	F	Field Trip 2: Taylor lab, mechanical testing <i>Problem Set 2</i>	
28	M	Structures - complex	20
30	W	Structures – hydrostatic	21
May 2	F	Structural systems – adhesion <i>Problem Set 2 Due</i>	22
Part II: Fluid Mechanics			
5	M	Fluids – at rest	4
7	W	Air-water interface	5
9	F	Exam 1 (Solids)	
12	M	Field Trip 3: Beach/tidepools	
14	W	Flowing fluids	6
16	F	Cont. <i>Problem Set 3</i>	“
19	M	Forces of flow	7
21	W	Cont.	“
23	F	Boundary layers <i>Problem Set 3 Due</i>	8
26	M	Memorial Day, NO CLASS	
28	W	Low Reynolds numbers <i>Problem Set 4</i>	11
30	F	Moving in fluids – lift	12
Jun 2	M	Cont.	“
4	W	Moving in fluids – Thrust <i>Problem Set 4 Due</i>	13
6	F	Environmental Biomechanics	
Jun 13	F	Exam 2 (Final Exam, Fluids) 3:00 – 6:00 pm	