IB 434 - Physical Principles in Biology (3 credits)
Course Syllabus

Course Description: Examines the interaction between biological processes and the fundamental laws of mechanics. Covers general topics, such as structural analyses of anatomy, kinematics of movement, the behavior of organisms in fluids, and the importance of scaling, as well as specific topics, such as bird flight, fluid flow in cardio-vascular systems, and high speed predation. Lab culminates in student-designed, group projects to collect novel biomechanical data to answer questions about the organism of the students' choice.

SLO:

1) Analyze how mechanical principles influence biological form and evolution across vertebrates, invertebrates and plants.
2) Use critical thinking skills and quantitative reasoning to solve biomechanical problems.
3) Apply biomechanical models to natural phenomena.
4) Use the process of scientific inquiry to perform original research.

Prerequisites: IB 202 or consent of instructor. Physics 101 is recommended.

Requirements met: IB major, upper level lab course.

Professor: Dr. Philip Anderson
202A, Shelford Vivarium
One on One support: By appointment
Email: andersps@illinois.edu
I will aim to respond to course-related emails within 24 hours except on weekends. Keep this in mind when emailing questions concerning assignments with deadlines.

Teaching Assistants:
Jules Chabain
Jules is a graduate student in the School of Integrative Biology. He will assist during lectures and labs as well as help grade problem sets and lab reports.

Lecture: Natural History building, Rm 4074. MF, 2:00-2:50pm
Lab: Natural History Building, Rm 4074. W, 2:00-4:50pm

Textbook:
Required: Pennycuick 1988. Conversion factors. University of Chicago Press

Recommended: Vogel 2013. Comparative Biomechanics: Life's Physical World. Princeton University Press

Journal Articles: Readings from the primary literature for lectures and discussions and tutorials for the labs will be made available to students online via the Moodle site.

Course Structure: This is a 3-credit course including a lab.

Lecture: Lectures will be given on most Mondays and Fridays. During the first 7-9 weeks of the semester, these lectures will focus on fundamental principles in biomechanics and

functional morphology. Examples include the material properties of biological tissues, fluid flow around organisms, and the mechanical significance of scaling in biology. The purpose of these lectures is to lay a foundation for understanding how animals function in a physical world. Examples used in lecture will be drawn from vertebrates, invertebrates, plants and microbes. For the latter 5-7 weeks, lectures will focus on more complex mechanical problems drawing upon the knowledge gained from fundamentals. These could include flight in birds/insects, dental mechanics and fluid dynamics at extremely small sizes. Specific topics covered will be partly determined by class interests.

Certain lectures will have materials meant to be reviewed prior to lecture. These may be readings or pre-lecture videos. All such materials will be made available on the Moodle site.

Discussions: Throughout the semester, a set of Mondays and Fridays will be discussion sessions based on the primary literature. The purpose of these sessions is to give the students exposure to a range of topics in biomechanics and how the fundamental principles they are learning can be applied to broader biological questions. For the first half of the semester, these topics will be chosen by the instructor to help reinforce the lecture material. During the latter half of the semester, each project group (see below) will be responsible for leading one such discussion on a manuscript or topic of their choosing, likely related to their specific project. This will give the students opportunities to help each other in trouble-shooting and developing their projects.

Problem Sets: Three specific MF sessions will be devoted to graded problem sets designed to help reinforce the concepts from lectures. These days will be work days, allowing students to work together and gain assistance from instructors on the problems. While working in groups is encouraged, each student will be expected to write-up their own answers.

Labs: A single lab session will be held Wednesdays from 2-5pm. During the first eight weeks of the course, these 3-hour lab sessions will involve directed laboratory activities designed to give the students hands-on experience with experimental techniques. The purpose of these labs is two-fold: 1) to further reinforce the course material through experiential learning and 2) to give the students an introduction to techniques they may wish to utilize for their projects. Three lab sessions will result in brief (3 page) lab write-ups to be graded.

In the latter half of the course, the Wednesday lab time will be given over to work time for the final projects. The instructors will be available during this time period for consultation and other aid.

Expectations: Assessment in this course will include a combination of formative and summative assessments. A full grade breakdown follows:

Grade breakdown:

Project paper	20%
Project presentation	10%
Project milestones	20%
Lab reports (3)	15%
Problem sets (3)	15%
Participation	20%

Problem Sets: These problems sets will include both basic word problems involving materials from lecture, interpretive questions based on graphical data, and larger exercises involving primary data that will be provided to the student. Work can be done in groups, although each student will be expected to write-up their own answers. (each problem set is worth 5% of the final grade)

Labs: Three of the directed labs during the first half of the course will result in brief (3 page) lab write-ups to be graded. The goal of these lab reports is to help students get practice at reporting scientific findings in a clear and concise manner. The content of the reports will vary based on the lab and grading will be partly based on improvement over the course of the term. (each report is worth 5% of the final grade).

Project: The ultimate goal of the course will be group-based projects designed and executed by the students during the second half of the semester. These projects should be accomplishable with the resources available to the class, including materials testing devices, high-speed videography, computer simulations, and other equipment. The projects will be question-based, aiming to address specific hypotheses and accumulate novel data on a system of interest. Each student will write a scientific manuscript of the results at the end of the course and all students will participate in short, group oral presentations to the class.

Participation: 20% of the final grade falls under class participation. This is a small class and is meant to be interactive. My lectures are not as formal as you may be used to and will utilize the whiteboard in the class, as well as audio-visual tools and demonstrations extensively. I will also often ask you to take time to discuss ideas amongst yourselves in small groups. I expect all students to participate in these activities.

Course Grading Philosophy
1) I do not 'curve' individual assignments. Instead, I will assign grade cut off points based on the distribution of student point totals at the end of the semester.

2) I use the standard 90, 80, 70, 60% scores as starting cutoff points for A, B, C, and D grades, respectively. Depending on the distribution of points at the end of the semester I **may** drop the cut off points slightly (e.g., 88% might become the A cut off) but **I will not raise** the cut-offs.

Percentage	**Letter Grade**
94-100	A
90-93.5	A-
87-89.5	B+
84-86.5	B
80-83.5	B-
77-79.5	C+
74-76.5	C
70-73.5	C-
67-69.5	D+
64-66.5	D
60-63.5	D-
Below 59.5	F

Communication Plan

Communication between instructors and students will primarily occur during class. However, as an enrolled student, you will also have access to the course website from your Moodle dashboard. It is also accessible here: https://learn.illinois.edu/course/view.php?id=47820

What you will find on Moodle:

- The syllabi for lecture and lab
- Pre-lecture materials including readings and pre-lecture videos.
- Pre-lab materials including guided activities and equipment documentation
- Updates from the instructors and TAs.
- Resources, lecture notes and handouts.
- Course gradebook

If you have an inquiry, you can use the emails listed for each instructor. Their bio section will also note how fast to expect an answer. If you would like further one-on-one discussion with Dr. Anderson please reach out via email to set-up an appointment. Dr. Anderson can also meet with small groups of students for discussion if you prefer.

As with all communication in a class, the expectation is for students to act in a professional and kind manner when interacting with both each other and with instructors.

Tentative Course Calendar (Spring 2023) (subject to change)

Week	Date	Day	Activity	Due
1	1/18	Wednesday	Introduction to the course and lab	
	1/20	Friday	Materials	
2	1/23	Monday	Materials/Structures	
	1/25	Wednesday	Lab: Materials testing	
	1/27	Friday	Structures	
3	1/30	Monday	Failure	
	2/1	Wednesday	Lab: Materials 2	
	2/3	Friday	Discussion: Endoskeleton Vs Exoskeleton	
4	2/6	Monday	Problem Set 1	
	2/8	Wednesday	Lab: Bending/Buckling	Lab Report 1
	2/10	Friday	Movement	
5	2/13	Monday	Biological Engines	Prob-Set 1
	2/15	Wednesday	Lab: Kinematics/Linkages	
	2/17	Friday	Molecular engines	
6	2/20	Monday	Discussion: Could T-Rex Run?	
	2/22	Wednesday	Lab: Videography	
	2/24	Friday	Problem set 2	
7	2/27	Monday	Flow 1	
	3/1	Wednesday	Lab: Flow 1	Lab Report 2
	3/3	Friday	Flow 2	Prob-Set 2

8	3/6	Monday	Flow 3	
	3/8	Wednesday	Lab: Flow 2	
	3/10	Friday	Discussion: Life in Low Re	Project Idea
9	3/20	Monday	Problem Set 3	
	3/22	Wednesday	Project brainstorming	Lab Report 3
	3/24	Friday	Discussion: Biomech and Diversity	
10	3/27	Monday	TBD	Project Outline
	3/29	Wednesday	Project Work	Prob-Set 3
	3/31	Friday	Student Led Discussion	
11	4/3	Monday	TBD	
	4/5	Wednesday	Project Work	
	4/7	Friday	Student Led Discussion	
12	4/10	Monday	TBD	
	4/12	Wednesday	Project Work	
	4/14	Friday	Student Led Discussion	
13	4/17	Monday	TBD	Methods Draft
	4/19	Wednesday	Project Work	
	4/21	Friday	Student Led Discussion	
14	4/24	Monday	TBD	
	4/26	Wednesday	Project Work	
	4/28	Friday	Student Led Discussion	
15	5/1	Monday	Presentations	
	5/3	Wednesday	Presentations	
Finals	5/10	Wednesday	NA	Project Paper

*Lectures in the second half of the course will vary based on student interest.

Attendance Policies:

ATTENDANCE AT LECTURE IS REQUIRED. This is an interactive course as mentioned above under participation grade. Therefore, there is no substitute for regular attendance so make a note of the dates now. Notify Dr. Anderson prior to lecture or lab if you will have to miss. The only excuse for not informing the instructor prior to missing lecture or lab is personal illness or tragedy in your immediate family. If you have any questions regarding these policies, please see Dr. Anderson.

Late Submission Policy

Lab reports and problem sets turned in late without prior approval of the instructor will be docked 10% of the overall grade for each week that passes after the deadline. Effectively, any assignment turned in late within one week of the deadline will be docked 10% (maximum possible credit is 90%). If the assignment is turned in one week after the deadline (e.g. the following Friday after a Friday deadline) or anytime the following week it will be docked 20%, third week 30% and so on.

Final project: As there are no written exams for this course, there is no formal policy for make-up exams. The written report for the final project is under a stricter version of the guidelines for late work described above (10% per two days late). The final group presentations will be done during the final week of classes; attendance is mandatory without prior approval from the instructor.

Course Policies: All students are assumed to have read and understood the "Code of Policies and Regulations Applying to All Students," University of Illinois, and will be expected to act accordingly.
The Code is available online at: http://www.admin.uiuc.edu/policy/code/index.html

Academic Integrity:

Academic dishonesty will not be tolerated. Examples of academic dishonesty include the following:

- Cheating
- Fabrication
- Facilitating infractions of academic integrity
- Plagiarism
- Bribes, favors, and threats
- Academic interference
- Examination by proxy
- Grade tampering
- Non-original works

Should an incident arise in which a student is thought to have violated academic integrity, the student will be processed under the disciplinary policy set forth in the Illinois Academic Integrity Policy. If you do not understand relevant definitions of academic infractions, contact your instructor for an explanation within the first week of class.

According to the Student Code, `It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.' Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, which can be found here: http://studentcode.illinois.edu/article1_part4_1-401.html

Academic dishonesty may result in a failing grade. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Copyright
Student Content
Participants in University of Illinois courses retain copyright of all assignments and posts they complete; however, all materials may be used for educational purposes within the given course. In group projects, only the portion of the work completed by a particular individual is copyrighted by that individual. The University of Illinois may request that students' materials be shared with future courses, but such sharing will only be done with the students' consent. The information that students submit during a course may, however, be used for the purposes

of administrative data collection and research. No personal information is retained without the students' consent.

Non-Student Content
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These materials may not be mirrored or reproduced on non-University of Illinois websites without the express written permission of the University of Illinois Board of Trustees. To request permission, please contact the academic unit for the program.

Disabilities and Religious Observances: Please contact your instructors or TAs during the first week of classes to make requests for disability accommodations or observation of religious holidays.

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting "Sign-Up for an Academic Screening" at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA) Statement: Any student who has suppressed their directory information pursuant to *Family Educational Rights and Privacy Act* (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Sexual Misconduct Policy and Reporting Statement: The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: https://wecare.illinois.edu/resources/students/#confidential

Other information about resources and reporting is available here: wecare.illinois.edu.

Inclusivity Statement: The effectiveness of this course is dependent upon the creation of an encouraging and safe classroom environment. Exclusionary, offensive or harmful speech (such as racism, sexism, homophobia, transphobia, etc.) will not be tolerated and in some cases subject to University harassment procedures. We are all responsible for creating a positive and safe environment that allows all students equal respect and comfort. I expect each of you to help establish and maintain and environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language.

Support Resources and Supporting Fellow Students in Distress: As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (1-217-333-0050) or online at odos.illinois.edu/community-of-care/referral/. Based upon your report, staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe.

Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Student Assistance Center (SAC) in the Office of the Dean of Students for support and referrals to campus and/or community resources. The SAC has a Dean on Duty available to see students who walk in, call, or email the office during business hours. For mental health emergencies, you can call 911 or contact the Counseling Center.