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

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.

Course Structure: This is a 3-credit course including a lab. The entire course (lecture and labs) will be delivered online (but see below).

Lecture: Lectures will be given on most Mondays and Friday as synchronous Zoom sessions from 2-3pm. Certain lectures will have asynchronous 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. Given that lectures for this course are both interactive and discussion heavy, these lectures will NOT be recorded.

Labs: A single synchronous lab session will be held on Wednesdays from 2-5 pm. These will involve a mix of guided activities and digital exercises to help students become familiar with biomechanical techniques and technologies. Three of the labs during the first half of the course will lead to graded lab reports. As the term progresses, the instructor will gauge the classes interest in attempting some face-to-face labs either held outside or done as smaller groups. However, these latter options are at the discretion of the instructors who wish to ensure all students are comfortable.

Work Days: Certain MF sessions will be devoted to graded problem sets. These days will be work days, allowing students to work together and gain assistance from instructors on the problems. 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.

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
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:
Hannah Darcy hdarcy2@illinois.edu
Hannah is a graduate student in the School of Integrative Biology. She will assist during lectures and labs as well as help grade problem sets and lab reports.

Textbook:
Pennycuick 1988. Conversion Factors. University of Chicago Press (Required)

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

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

Communication Plan
Communication between instructors and students will primarily occur through the Moodle website. As an enrolled student, you will have access to the course 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
- Links to synchronous Zoom lectures
- Pre-lecture materials including readings and pre-lecture videos.
- Materials for Lab
- Updates from the instructors and TAs.
- Resources, lecture notes and handouts.
- Course gradebook

Announcements will be updated every week on the site and will be made visible on the main page. All schedules and deadlines will be posted both on the announcements page when they are approaching and on the weekly pages at all times. Announcements will also be made live during synchronous lecture sessions, but everything announced there will also be posted on the site.

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 is a professional and kind manner when interacting with both each other and with instructors. A full description on netiquette is listed below.

Time and Place
On your computer!

Class Format

Lectures: Every Monday and Friday will be a one-hour lecture sessions on Zoom. During the first 7-9 weeks of the semester, these lectures will focus on fundamental principles in biomechanics and functional morphology. Examples include lectures on 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 terrestrial locomotion, flight mechanics in birds and insects and flow through circulatory systems. The specific topics covered will be partly determined by class interests.

Discussions: Some MF sessions will be one-hour 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 functional morphology and particularly how the fundamental principles they are learning in lecture 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.

Labs: During the first eight weeks of the course, the 3-hour lab sessions on Wednesdays will involve directed laboratory activities designed to give the students hands-on experience with theoretical 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.

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. Due to the online nature of the course this Spring, these projects will likely have to have a more theoretical/modeling bent to them. There is potential for more hands-on projects, but these will have to be discussed with the instructors. Regardless, 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. While this is often easier in a face-to-face setting, I want to try and keep that atmosphere online as well. My lectures are not as formal as you may be used to and will utilize Zoom's whiteboard feature extensively. I will also often ask you to take time to discuss ideas amongst yourselves using breakout rooms. 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.

Tentative Course Calendar (Spring 2021) (subject to change)

Week	Date	Day	Activity
1	1/25	Monday	Introduction to the course
	1/27	Wednesday	Introduction and Stress/Strain
	1/29	Friday	Materials
2	2/1	Monday	Materials/Structures
	2/3	Wednesday	Crocodylomorph Snout bending
	2/5	Friday	Structures

3	2/8	Monday	Failure
	2/10	Wednesday	FEBio tutorial
	2/12	Friday	Discussion: Endoskeleton Vs Exoskeleton
4	2/15	Monday	Problem Set 1
	2/17	Wednesday	Non Instructional Day
	2/19	Friday	Movement
5	2/22	Monday	Biological Engines
	2/24	Wednesday	FEBio analysis
	2/26	Friday	Molecular engines
6	3/1	Monday	Discussion: Could T-Rex Run?
	3/3	Wednesday	Linkages
	3/5	Friday	Problem set 2
7	3/8	Monday	Flow 1
	3/10	Wednesday	Videography and Kinematics
	3/12	Friday	Flow 2
8	3/15	Monday	Flow 3
	3/17	Wednesday	TBD
	3/19	Friday	Discussion: Life in Low Re
9	3/22	Monday	Problem Set 3
	3/24	Wednesday	Non Instructional Day
	3/26	Friday	Discussion: Biomech and Diversity
10	3/29	Monday	TBD
	3/31	Wednesday	Project Work
	4/2	Friday	Student Led Discussion
11	4/5	Monday	TBD
	4/7	Wednesday	Project Work
	4/9	Friday	Student Led Discussion
12	4/12	Monday	TBD
	4/14	Wednesday	Project Work
	4/16	Friday	Student Led Discussion
13	4/19	Monday	TBD
	4/21	Wednesday	Project Work
	4/23	Friday	Student Led Discussion
14	4/26	Monday	TBD
	4/28	Wednesday	Project Work
	4/30	Friday	Student Led Discussion
15	5/3	Monday	Presentations
	5/5	Wednesday	Presentations

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

Attendance Policies:

ATTENDANCE AT LECTURE IS REQUIRED. This course is 100% synchronous as the lectures, labs and discussions are all interactive with 20% of the course grade coming from in class participation. Therefore, there is no substitute for regular zoom lecture 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.

Netiquette Statement: In any social interaction, certain rules of etiquette are expected and contribute to more enjoyable and productive communication. The following are tips for interacting online via e-mail or discussion board messages, adapted from guidelines originally compiled by ChuqVon Rospach and Gene Spafford (1995):

- Remember that the person receiving your message is someone like you, deserving and appreciating courtesy and respect
- Avoid typing whole sentences or phrases in Caps Lock
- Be brief; succinct, thoughtful messages have the greatest effect
- Your messages reflect on you personally; take time to make sure that you are proud of their form and content
- Use descriptive subject headings in your e-mails
- Think about your audience and the relevance of your messages
- Be careful when you use humor and sarcasm; absent the voice inflections and body language that aid face-to-face communication, Internet messages are easy to misinterpret
- When making follow-up comments, summarize the parts of the message to which you are responding
- Avoid repeating what has already been said; needless repetition is ineffective communication
- Cite appropriate references whenever using someone else's ideas, thoughts, or words

Students will be expected to interact maturely and responsibly with their course instructor and fellow classmates. Students who fail to adhere to this expectation will be removed from discussion and will not receive credit for participation.

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: 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

Everything on this site and within University of Illinois courses is copyrighted. The copyrights of all non-student work are owned by the University of Illinois Board of Trustees, except in approved cases where the original creator retains copyright of the material. Copyrights to external links are owned by or are the responsibility of those external sites. Students are free to view and print material from this site so long as

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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.