

Biological Physics for Engineers

EML 6934 (24562) Section XT25

Class Periods: MWF 10:40 am – 11:30 am (EST)

Location: Zoom links via Canvas (<https://elearning.ufl.edu/>)

Academic Term: Spring 2025

Instructor:

Xin Tang, Ph. D.

xin.tang@ufl.edu

Office Phone Number: 352-294-1194

Office Hours: MWF 11:30 am – 12:30 pm, Zoom via Canvas (Please email the instructor to schedule)

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

NA

Course Description

Course catalogue, “Frontiers in biological physics, including quantitative molecular and cell biology, advanced optical imaging and instrumentation, biomechanics, bio-nanotechnology, statistical physics and chemistry, intermolecular and cellular forces, thermodynamics, and quantum physics in life science.” (Credits 3)

Course Pre-Requisites / Co-Requisites

Students will learn all necessary knowledge in the class. Both undergraduate and graduate students are eligible. No prior biology or engineering background required.

Course Objectives

Emerging physical concepts and innovative tools have transformed the way many life science problems are addressed today. This interdisciplinary course will explore the physics and mechanics underpinning of life processes, such as the interactions of molecules, macromolecular structures, and cells in warm, wet, squishy environments. Statistical analyses and numerical simulations of important biological processes will be covered throughout the course. We aim to foster the next generation of leading engineers and scientists to approach scientific inquiry in a way that crosses conventional academic disciplines.

Required Textbooks and Software

Various handout materials will be provided digitally by professor. MATLAB programming (all tutorials will be provided) is needed to complete homework and projects. Microsoft Word and PowerPoint are needed to complete proposal/reports and capstone presentation.

Recommended Materials

These books are not required to purchase. Relevant chapters and articles will be provided by professor.

- Phillips, Kondev, Theriot, *Physical Biology of the Cell*, 2009.
- Ken Dill, *Molecular driving forces: statistical thermodynamics in biology, chemistry, physics, and nanoscience*, 2003.
- James Pawley, *Handbook of Biological Confocal Microscopy*, 2008.
- Lakowicz, *Principles of Fluorescence Spectroscopy*, 2006.
- Douglas Murphy, *Fundamental of Light Microscopy and Electronic Imaging*, 2001.
- Philip Nelson, *From Photon to Neuron: Light, Imaging, Vision*, 2017.

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- Gonzalez, Woods, *Digital Image Processing*, 2007.
- Uri Alon, *An Introduction to Systems Biology: Design Principles of Biological Circuits*, 2020.
- Leah Edelstein-Keshet, *Mathematical Models in Biology*, 2005.
- Terrell Hill, *Free Energy Transduction and Biochemical Cycle Kinetics*, 2004.
- John Kuriyan et al., *The Molecules of Life: Physical and Chemical Principles*, 2013

Course Schedule (the content may adjust slightly according to students' preferences)

Week 1:	Introduction. Role of physics (and physicist) in biology. Examples of biological problems amenable to physical solution and engineering innovation
Week 2:	Quantitative basis of molecular and cell biology
Week 3:	Quantitative basis of nature-inspired designs and tissue engineering
Week 4:	Statistical distributions in biology, such as Brownian Motion and cardio-vasculature function
Week 5:	Diffusion equation and its impacts. Diffusion in a potential
Week 6:	First passage problems and implication in biology, such as cancer. Diffusion-limited reaction rates.
Week 7:	Applications of Brownian motion: Chemotaxis in <i>E. coli</i> ; limits on size of organisms; tumor growth
Week 8:	Correlation function and power spectra. Fluorescence correlation spectroscopy (FCS)
Week 9:	Application of advanced optical microscopy in research. Super-resolution and two-photon
Week 10:	<i>in vivo</i> deep imaging, PET, fMRI, CT, EEG, MEG, ECG, Ultrasound, Photoacoustic imaging
Week 11:	Mechanics in biomolecules, ion channels, transporters, and pumps. Electrogenic transporters
Week 12:	Bio-electricity in life science. Membrane potential and Nernst equation. Voltage imaging
Week 13:	Intermolecular forces, Coulomb, van der Waals, Keesom, and their impacts on living systems
Week 14:	Continuum/quantum mechanics of DNA, cytoskeleton, and membrane. Bending, twisting, buckling
Week 15:	Future challenges and opportunities in biophysics; Capstone presentation by students

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy, Class Expectations, and Make-Up Policy

- It is expected that students attend class.
- Required statement by the University of Florida: Excused absences must be in compliance with university policies in the Graduate Catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.
- The student is responsible for their education. The professor is the guide to their understanding of the field.
- In class students (does not apply to online students) - Cell phones, laptops, etc.: Under no circumstances will devices be used in the classroom. Students are expected to take handwritten notes.
- Late submission of class material is not accepted. If a tragedy has occurred then instructor notifications are required. See <https://care.dso.ufl.edu/instructor-notifications> for details. Note that, "Professors have the right

to accept or reject the notification.” Additional information can be found here:
<https://gradcatalog.ufl.edu/graduate/regulations/>

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (4)	100 each	20%
Quizzes (4)	100 each	10%
Midterm Exam (2)	100 each	30%
Final Projects	100	30%
Proposal / Reports	100	10%
		100%

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 - 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 - 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

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In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Policy on Ethics and Cheating

Any kind of cheating, lying, dishonesty, or honor code violations results in a failing grade of the entire course.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu

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- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Excused and Unexcused Absences

Students may only participate in classes if they are registered officially or approved to audit with evidence of having paid audit fees. The Office of the University Registrar provides official class rolls to instructors. Students are responsible for satisfying all academic objectives as defined by the instructor. Absences count from the first-class meeting. Acceptable reasons for absence from or failure to engage in class include illness; Title IX-related situations; serious accidents or emergencies affecting the student, their roommates, or their family; special curricular requirements (e.g., judging trips, field trips, professional conferences); military obligation; severe weather conditions that prevent class participation; religious holidays; participation in official university activities (e.g., music performances, athletic competition, debate); and court-imposed legal obligations (e.g., jury duty or subpoena). Other reasons (e.g., a job interview or club activity) may be deemed acceptable if approved by the instructor. For all planned absences, a student in a situation that allows an excused absence from a class, or any required class activity must inform the instructor as early as possible prior to the class. For all unplanned absences because of accidents or emergency situations, students should contact their instructor as soon as conditions permit. Students shall be permitted a reasonable amount of time to make up the material or activities covered during absence from class or inability to engage in class activities because of the reasons outlined above.

If a student does not participate in at least one of the first two class meetings of a course or laboratory in which they are registered, and they have not contacted the department to indicate their intent, the student can be dropped from the course. Students must not assume that they will be dropped, however. The department will notify students if they have been dropped from a course or laboratory. The university recognizes the right of the instructor to make attendance mandatory and require documentation for absences (except for religious holidays), missed work, or inability to fully engage in class. After due warning, an instructor can prohibit further attendance and subsequently assign a failing grade for excessive absences.

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and

weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.