

Introduction to Biophysics for Mechanical Engineers

EML 4930/6934 Sections XXXX

Class Periods: MWF, 3rd Period, 9:35am

Location: Virtual

Academic Term: Fall 2020

Instructor:

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352-392-6438

Office Hours: TBA (495 Wertheim).

Teaching Assistants:

- NA

Course Description

In this course we will cover the molecular components of cells, statistical mechanics and thermodynamics in biological contexts, and mechanical properties of biomolecules. (3 credit hours)

Course Pre-Requisites / Co-Requisites

None

Course Objectives

Upon completion of this course, students will demonstrate:

1. understanding of the classes and functions of biological molecules;
2. the ability to use advanced mathematics to describe and investigate the statistical mechanics and thermodynamics of biological materials and systems;
3. an understanding of how entropic driving forces generate macromolecular elasticity; and
4. familiarity with classical models of transport, biological statistical mechanics, and experimental approaches.

Materials and Supply Fees

NA

Professional Component (ABET):

4A. EML 4930/6934 supports the following program outcomes as listed in the Mission Statement of the Department of Mechanical and Aerospace Engineering:

(M1) apply knowledge of chemistry and calculus based physics with depth in at least one of them;

(M2) apply knowledge of advanced mathematics through multivariate calculus and differential equations;

(M3) be familiar with statistics and linear algebra; and

4B. Mathematical sciences (33%), physical sciences (34%), engineering sciences (33%).

Relation to Program Outcomes (ABET):

Outcome	Coverage*
a. Apply knowledge of mathematics, science, and engineering	High
b. Design and conduct experiments, as well as analyze and interpret data	Low
c. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	Low
d. Function on multidisciplinary teams	Low
e. Identify, formulate, and solve engineering problems	High
f. Understand professional and ethical responsibilities	Low
g. Communicate effectively	Medium
h. Understand the impact of engineering solutions in a global, economic, environmental, and societal context	High
i. Recognize the need for and be able to engage in lifelong learning	Medium

j. Understand contemporary issues	High
k. Use the techniques, skills, and modern engineering tools necessary for engineering practice	High

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

Required Textbooks and Software

Biological Physics: Energy, Information, Life (Student Edition), Philip Nelson

Recommended Materials

Course Schedule

See accompanying document

Attendance Policy, Class Expectations, and Make-Up Policy

Class policies

- Cheating or any other dishonesty will result in failure and prosecution according to university policies. ASME has a website dedicated to engineering ethics, <http://www.asme.org/ethics/>.
- Students are responsible for all announcements, assignments, etc. made during lectures, including changes in the scheduling of lecture topics and exams. Please make appropriate arrangements with a classmate if you need to miss a class.
- **Attendance is required.**
- The course grade is based partially on class participation, making attendance necessary for graded evaluation.
- Students will be required to lead the class in discussions about homework problems. The number of discussions students must lead will be determined based on course enrollment level.
- Students are expected to conduct themselves in the virtual classroom in a manner which does not interfere with the other students' learning.
- Any changes in the schedule or assignments will be communicated to the class via email using your Gatorlink (@ufl.edu) email address and using the course web site. You are responsible for monitoring this mailbox and the web site regularly for any class notices.

Exam policies

- All exams will be "take-home" format. Exams I-III will be sent to students electronically and collected one week later. Students will submit their completed exams in PDF format.
- It is the students' responsibility to communicate their knowledge on the exams. In order to be able to grade your work, it must be neat, legible, and follow in logical steps with all work shown. *Partial credit* may be given for work which can be followed and the nature and magnitude of the mistake identified. *No credit* will be given for incorrect answers with insufficient indication of how they were obtained.

Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Evaluation of Grades

Exams I-III, Final 60% (lowest score will be dropped, 3·20% = 60%)
Homework Discussions 40%

Grading Policy

Percent	Grade	Grade Points
94 - 100	A	4.00
90.0 - 93.9	A-	3.67
87 - 89.9	B+	3.33
83 - 86.9	B	3.00

80.0 - 82.9	B-	2.67
77 - 79.9	C+	2.33
73 - 76.9	C	2.00
70.0 - 72.9	C-	1.67
67 - 69.9	D+	1.33
63 - 66.9	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:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>

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 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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

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

date	meeting #	topic	reading assignment
Part I: Introduction and Background Material			
8/31/2020	1	Motivation, Background, and Perspective	1.1, 1.2
9/2/2020	2	Motivation, Background, and Perspective	1.3, 1.4, 1.5
9/4/2020	3	The important biomolecules and their properties	2.1, 2.2
9/7/2020		holiday	
9/9/2020	4	The important biomolecules and their properties	2.3
9/11/2020	5	Review Day	
Part II: Diffusion, Dissipation, and Drive			
9/14/2020	6	Important statistics in biophysics	3.1
9/16/2020	7	Important statistics in biophysics	3.2
9/18/2020	8	Statistics of genetics & heredity: historical example	3.3
9/21/2020	9	Random walks, friction, and diffusion	4.1, 4.2
9/23/2020	10	Polymers as random walks and continuum diffusion	4.3, 4.4
9/25/2020	11	Biological applications of diffusion	4.5, 4.6
9/28/2020	12	Review Day	
9/30/2020	13	Friction in Fluids	5.1
10/2/2020		homecoming	
10/5/2020	14	Low Reynolds Numbers	5.2
10/7/2020	15	Biological Applications: life at low Reynolds Number	5.3
10/9/2020	16	Review Day	5.4
10/12/2020	17	Disorder and Entropy	6.1, 6.2
10/14/2020	18	Temperature and the 2nd Law of Thermodyn.	6.3, 6.4
10/16/2020	19	Open systems	6.5
10/19/2020	20	Microscopic Systems	6.6
10/21/2020	21	RNA folding	6.7
10/23/2020	22	Review Day	
10/26/2020	23	Entropic forces and osmotic pressure	7.1, 7.2
10/28/2020	24	Osmotic Flow	7.3
10/30/2020	25	Wet electrostatics	7.4
11/2/2020	26	The Special Properties of Water	7.5
11/4/2020	27	Review Day	
11/6/2020	28	Chemical Potential	8.1
11/9/2020	29	Chemical Reactions	8.2
11/11/2020		Veteran's Day	
11/13/2020	30	Molecular Dissociation	8.3
11/16/2020	31	Self Assembly of Amphiphiles	8.4
11/18/2020	32	Self Assembly in Cells	8.5, 8.6
11/20/2020	33	Review Day	
Part III: Molecules, Machines, Mechanisms			
11/23/2020	34	Elasticity Models of Polymers	9.1
11/25/2020		Thanksgiving break	
11/27/2020		Thanksgiving break	

11/30/2020	35	Stretching Macromolecules	9.2
12/2/2020	36	Eigenvalue Problems and the Transfer Matrix	9.3, 9.4
12/4/2020	37	Thermal, Chemical, and Mechanical Switching	9.5
12/7/2020	38	Allostery	9.6
12/9/2020	39	Review Day	
12/16/2020	40	Final Exam Due	