

APPL 490
Bioelectronic Materials
Fall Semester, 2021

<p>Introduction</p>	<p>Developing electronic systems that can seamlessly integrate with biological systems represents a pivotal foundation for building a smart healthcare platform, advanced clinical technology, and beyond. This course will explore and discuss: i) electronic materials, mechanisms, and designs at the biotic-abiotic interface, ii) their impacts for a wide range of applications ranging from medicine, robotics, to human augmentation, and iii) the associated ethics that aim to harmonize the development pathways. Through multiple hands-on activities, this class will highlight a multifaceted understanding of materials and their integration strategies that not only improve intrinsic functionalities (sensing, stimulation, or others) of the fabricated devices, but also and more importantly innovate the ways electronics can interact with the biological counterparts at multiscale.</p>
<p>Methods</p>	<p>The class will consist of lectures, discussions with hands-on activities, biweekly assignments, and a final group/individual presentation that focuses on one of the three following aspects:</p> <ul style="list-style-type: none"> i) A current leading-edge research topic in bioelectronics. ii) A comprehensive discussion on an ethical topic related to the developments of bioelectronics. iii) An innovative idea that might advance the field of bioelectronics. <p>We will utilize the platform provided by BeAM makerspace for implementing our hands-on activities.</p>
<p>Results</p>	<p>By the end of the course, students will be able to:</p> <ul style="list-style-type: none"> • Establish a foundational understanding of physical principles underlying electrical, optical, and magnetic approaches to design bioelectronic devices. • Develop basic skills in materials design and fabrication of passive and active components for sensitive, multimodal, and robust wearable and implantable devices. • Implement holistic considerations ranging from technical aspect, safety aspect, to ethical aspect, when designing bioelectronic devices.
<p>Discussion</p>	<p>Our goal in this course is to broaden our perspectives on electronics systems with a vision towards bio-inspired designs and human-centered developments. The course also aims to demonstrate, with several paradigms, how engineering principles converge applied sciences from multiple disciplines to build integrated systems for addressing societal challenges.</p>
<p>Engineering Student Outcomes</p>	<p>On completion of this course, students will gain experience in the following engineering student outcomes:</p> <ul style="list-style-type: none"> • An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Demonstrate constant curiosity about our changing world.
- Explore a contrarian view of accepted solutions.
- Identify unexpected opportunities to create extraordinary value

Class Essentials

➤ CONTACT INFORMATION

Dr. Wubin Bai

Teaching assistants


 **Office Location**
Kenan Lab, Room A700

(Names and contact information about TAs or mark “not applicable”)


 **Email**
wbai@unc.edu

 **Phone**
(Insert phone)

➤ LOGISTICS

 **Class meeting times**
(Insert days/times)

 **Class meeting location**
(Insert location)

 **Office Hours**
(Insert days/times) or by appointment

 **Required Texts & Software**

- TBD

 **Pre-requisites**

- BMME 209 or
- APPL 260, or
- CHEM 102, PHYS 115/119, and permission of the instructor
- Core engineering concepts and basic understandings of biomaterials or physiology would be helpful.

Course content

➤ COURSE TOPICS

- Biochemical/bioanalyte sensing
- Biophysical sensing
- Electrophysiological sensing
- Impedance monitoring
- Stimulation/Electroceuticals

- Microfabrication and advanced manufacturing
- Immune response and signal transduction
- Bioresorbable electronics
- Neural interface
- Applications in wearables/rehabilitation
- Optogenetics
- Bioethics and regulatory, policy and security concerns

➤ COURSE SCHEDULE

The current course calendar is available in Sakai under Resources.

To help you succeed

➤ COURSE EXPECTATIONS AND POLICIES

- (Insert course expectations and policies)

Example expectations and policies:

- Watch all online lectures and do all reading assignments before coming to class (in-class quizzes will help to encourage you to do this).
- Participate in class discussions and problem-solving activities.
- During class time, do not use your phone or computer for something unrelated to class; research shows that this is distracting to other students in the class. If there is an urgent situation, then you can leave the classroom to use your phone or computer.
- Come to every scheduled class and lab session and let me know ahead of time if you cannot attend.
- Turn in assignments on time; if an assignment is up to 24 hours late, there is a 25% deduction, and if an assignment is beyond 24 hours late, you will get a zero. If you need an extension, you must ask at least 24 hours before the time that the assignment is due (you can avoid a grade deduction this way).

➤ STUDENT RESOURCES

SEE, SAY, DO SOMETHING

We're happy you are here and eager to learn. Despite our best intentions to follow a plan, life may throw us a curve ball.

CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: <https://caps.unc.edu/> or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more. (source: *Student Safety and Wellness Proposal for EPC, Sep 2018*)

ACCESSIBILITY RESOURCES

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities.

Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Website for contact information: <https://ars.unc.edu> or email ars@unc.edu.

<p>If you or someone you know is experiencing some distress or you are concerned about the well-being of a student, please report it here: https://deanofstudents.unc.edu/carereport. It is important to support one another. If you see something, say, and do something.</p>	
<p>Title IX Resources Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison – Adrienne.allison@unc.edu), Report and Response Coordinators in the Equal Opportunity and Compliance Office (reportandresponse@unc.edu), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (gvsc@unc.edu; confidential) to discuss your specific needs. Additional resources are available at safe.unc.edu.</p>	<p>Community Standards in Our Course and Mask Use. This semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community — your classmates and me – as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the Office of Student Conduct. At that point you will be disenrolled from this course for the protection of our educational community. An exemption to the mask wearing community standard will not typically be considered to be a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask must seek alternative accommodations through the Accessibility Resources and Service. For additional information, see Carolina Together.</p>

Assignments & Evaluation

➤ YOUR COURSE GRADE	
40%: Homework and quizzes	Biweekly assignments, readings
20%: Individual projects	Reports on hands-on projects
40%: Final projects	Final group/individual presentation
100%: total	

➤ GRADE INTERPRETATION & HONOR CODE	
Your final course grade will be determined from a standard scale:	ACADEMIC HONESTY There will be clear communication if assignments are individual or group. For individual assignments, while I encourage collaboration, it is a violation of the honor code if a student duplicates work or obtains solutions from another student and submits it on their own. Please reference the honor code: http://honor.unc.edu .
A 93+	
A- 90.0 - 92.9	
B+ 87.0 - 89.9	
B 83.0 - 86.9	
B- 80.0 - 82.9	
C+ 77 - 79.9	
C 73 - 76.9	

C-	70 - 72.9	
D+	67 - 69.9	
D	60 - 66.9	
F	<60	

➤ MAJOR COURSE DUE DATES	
Exam 1	(Date)
Exam 2	(Date)
Final Project	(Date)

I reserve to right to make changes to the syllabus, including project due dates and test dates (excluding the officially scheduled final examination), when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.