

University of California, Berkeley
College of Engineering
Department of Bioengineering

BioE 121: BioMEMS and Medical Devices (4 units)
BioE 221: Advanced BioMEMS and Bionanotechnology (4 units)

Lecture: Tu & Th 12:30-2:00 PM, 241 Cory Hall
Discussion Section S101 (M 1-2 PM, 285 Cory Hall)
Prerequisites: Physics 7A & 7B, Chemistry 3A
Professor Luke P. Lee
408C Stanley Hall; Email: lpLee@berkeley.edu
Office Hour: Thursday (3:30-5:30 PM) @ 408C Stanley Hall

Brief Description:

Biophysical and chemical principles of biomedical devices, bionanotechnology, bionanophotonics, and biomedical microelectromechanical systems (BioMEMS). Topics include basics of nano- & microfabrication, soft-lithography, DNA arrays, protein arrays, electrokinetics, electrochemical transducers, microfluidic devices, biosensor, point of care diagnostics, lab-on-a-chip, drug delivery microsystems, clinical lab-on-a-chip, advanced biomolecular probes, biomolecular spectroscopy, neural interfaces, implantable devices, microsurgical tools, and nano- & microstructure devices for tissue engineering.

Teaching Assistant:

Office Hour: Wednesday (3-4 PM) @ 421 Stanley Hall

Required Textbooks:

Introduction to BioMEMS by Albert Folch (AF)
Fundamentals of BioMEMS and Medical Microdevices by Steven Saliterman (SS)

Reference Books:

Introduction to Microfluids and BioMEMS by Li & Gray (LG) *Practical MEMS* by Ville Vilekaajakari (VV)
Theoretical Microfluidics by Henrik Bruus (HB) *Introduction to Microelectronic Fabrication* by Richard Jaeger (RJ)
Introduction to Microfabrication by Sami Franssila (SF) *Biophysical Chemistry* by Alan G. Marchsall (AM)

Objectives:

Bionanotechnology, biomedical microelectromechanical systems (BioMEMS), and nanomedicine have been developed for a wide range of applications from quantitative systems biology to clinical applications. In particular, molecular diagnostics on chip will provide a solution for preventive, predictive, and personalized medicine. It intersects micro & nanofabrication technology, solid-state transducers, soft lithography, microfluidics, high throughput screening of bioassays or drugs, drug delivery microsystems, point of care microsystems, neural prosthesis, neural probes, genomics, proteomics, cellomics, systems biology, synthetic biology, and quantitative biology. Biomolecular nanopores such as fluorescent probes, quantum dots, and nanoplasmonic devices enable to detect specific components of living cells with exquisite sensitivity and selectivity. Advanced development of bionanotechnology and BioMEMS for biological applications requires basic foundations from biophysics, biochemistry, solid-state transducers, soft-state matters, and polymer sciences & engineering.

First objective of this course is to build basic foundation for understanding of mechanisms on electrical, mechanical, chemical, and optical transducers in the context of biomedical applications. Second objective is to teach critical thinking in nano- & microengineering design issues, biomaterial compatibility, working in biofluidic circuits, cellular interaction at the interface, and other biological considerations. Third objective is to review current medical devices along with the examination of the viability of nano-scale devices and BioMEMS technology in a particular biomedical application. Fourth objective is to teach practical designs of integrated molecular diagnostic systems (iMDx) and nano- & microscale medical devices.

Grading Policy:

Critical Review Paper I (10%)
Homework (Undergraduate Students) or Proposal (Graduate Students) (10%)
Midterm Exams (30%)
Design Project (20%)
Final Exam (30%)

**Course Outline for BioE 121/221
BioMEMS and Medical Devices
Advanced BioMEMS and Bionanotechnology**

Week 1 (1/20, 1/22)	L#1/L#2 Introduction to Bionanoscience & BioMEMS <i>HW #1: Chapter 1 (SS) Review questions: 2, 3, 4, 5 (Due 1/27) & Review Paper (due 2/24)</i>	Chap. 1(AF)/1(SS)
Week 2 (1/27, 1/29)	L#3/L#4 Microfabrication: Lithography & Etching <i>HW #2: Chapter 2 (SS) Review questions: 2-9 (Due 9/12) & Team Meeting Report for Final Project (2/3)</i>	Chap. 1(AF)/2(SS)
Week 3 (2/3, 2/5)	L#5/L#6 Microfabrication: Deposition & Surface Micromachining <i>HW #3: Chapter 2 (SS) Review questions: 10-15, 17, 18 (Due 2/10)</i>	Chap. 1(AF)/2(SS)
Week 4 (2/10, 2/12)	L#7/L#8 Soft Matter Microfabrication & Soft Electronics <i>HW #4: Chapter 3 (SS) Review questions: 2-6, 8-14 & Team Meeting Report for Final Project (Due 2/17)</i>	Chap. 1 (AF)/3(SS)
Week 5 (2/17, 2/19)	L#9 Polymer Medical Devices & Midterm (I) <i>HW #5 : Chapter 4 (SS) Review questions : 1-15 (Due 2/24)</i>	Chap. 1 & 2 (AF)/4(SS)
Week 6 (2/24, 2/26)	L#10/L#11 Nanolithography/Biointerface & Microfluidics (I) <i>HW #6: Chapter 5 (SS) Review questions: 6, 8, 10, 12-16, 20-22, 24, 25 (Due 3/3)</i>	Chap. 2 & 3 (AF)/5(SS)
Week 7 (3/3, 3/5)	L#12/L#13 Microfluidics (II) & Basics of Biosensors (I) <i>HW #7: Chapter 6 (SS) Review questions: 5-7, 8, 11, 12, 16, 17, 20-25 (Due 3/10)</i>	Chap. 3 (AF)/6(SS)
Week 8 (3/10, 3/12)	L#14/L#15 Basics of Biosensors & Basics of Biosensors (III) <i>Team Meeting for Final Project & Submit 1 page Project Proposal with an Abstract (Due 3/17)</i>	Chap. 6 (SS)
Week 9 (3/17, 3/19)	L#16/L#17 Plasmonic Optical Biosensors & Microactuators <i>HW #8: Chapter 7 (SS) Review questions: 3, 5, 8, 9 (Due 3/31)</i>	Handout & Chap. 7 (SS)
Week 10 (3/23-27)	Spring Recess (Reading Advanced BioMEMS Papers for Graduate Students & Write Review Article)	
Week 11 (3/31, 4/2)	L#18/L#19 Drug Delivery & Clinical Laboratory Medicine <i>HW #9: Chapter 8 (SS) Review questions: 5-22 & Team Meeting Report for Final Project (Due 4/7)</i>	Chap. 7 & Chap. 8 (SS)
Week 12 (4/7, 4/9)	L #20/L#21 Micro TAS & Detection and Measurement Methods <i>HW #10: Chapter 9 (SS) Review questions: 1-14 & Team Meeting Report for Final Project (Due 4/14)</i>	Chap. 3 (AF)/9 & 10 (SS)
Week 13 (4/14, 4/16)	L#22/L#23 Genomics & DNA Biochip <i>HW #11: Chapter 10 (SS) Review questions: 1-6, 9-12 & Team Meeting Report for Final Project (Due 4/21)</i>	Chap. 4 (AF)/11 (SS)
Week 14 (4/21, 4/23)	L#24 Proteomics & Protein Microarrays & Midterm (II) <i>HW #12: Chapter 11 (SS) Review questions: 2-14 & Chapter 12: 6, 8-11 (Due 4/28)</i>	Chap. 4 (AF)/12 (SS)
Week 15 (4/28, 4/30)	L#25 Membrane Biophysics & L#26 Neural Interfaces	Chap. 5 & 6 (AF)
Week 16 (5/5, 5/7)	Final Project Presentation <i>Final Project Report (due 12/15)</i>	Chap. 8 (AF)/13 (SS)
Final Exam (Group 15) Thursday, 5/14 3-6 AM		