

# BENG 186B PRINCIPLES OF BIOINSTRUMENTATION DESIGN

Winter 2023

Class lectures Tue and Thu 2:00-3:20pm, Warren Lecture Hall 2205,  
Zoom: <https://ucsd.zoom.us/j/94265053050>  
Discussions Fri 1pm-1:50pm, Zoom: <https://ucsd.zoom.us/j/94265053050>

Web site: <http://isn.ucsd.edu/courses/beng186b>

## Instructor:

Prof. Gert Cauwenberghs  
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Office hours: see web site

## TAs:

Adyant Balaji, [abalaji@ucsd.edu](mailto:abalaji@ucsd.edu)  
Vikrant Jaltare, [vjaltare@ucsd.edu](mailto:vjaltare@ucsd.edu)  
Samira Sebt, [sasebt@ucsd.edu](mailto:sasebt@ucsd.edu)  
Consultations: see web site

**Overview:** This course will provide an overview of instrumentation systems used in clinical medicine and biomedical research. We will review some circuit theory, and its application to bioinstrumentation. Systems for measuring biologic signals will be discussed including biopotentials, stress and strain, pressure, temperature, and optical properties. Electrical hazards, safety, measuring instruments and techniques will be discussed. There will be applications to engineering design including transducer systems and sensing and driving circuits. There will also be practical design experience working in groups, and discussion of ethical and regulatory issues related to bioinstrumentation.

The Tuesday and Thursday 2:00-3:20pm lectures will be formal presentations of course and book material. The Friday 1:00-1:50pm discussions will be for review sessions with exercises and practice homework/quizzes. All lectures and discussion sessions will be recorded and posted on Canvas (Media Gallery). Recordings of the lectures will also be available on Podcast (<https://podcast.ucsd.edu/>).

**Textbook:** Webster JG. Medical Instrumentation: Application and Design, 4th ed. 2010 John Wiley & Sons: New York.

**Homework:** There will be 6 homework assignments as indicated in the course outline. They are posted on the class web page and are due over Canvas on the due date. Homework assignments are the best way to learn engineering. You are expected to complete every homework problem on your own but are encouraged to consult with classmates before completing a problem. Please turn in your homework on time; late assignments will not be accepted. Each homework will have some form of a design problem. Solutions will be made available on Canvas.

**Quizzes:** There will be three online quizzes. During the extended time to complete each quiz, no communication is allowed with anyone except for questions to the instructor and TAs. Several practice quizzes with solutions are available on the class web site.

**Final project:** In lieu of a final exam, students in groups of their choice will conduct a final design project, formulating and solving a biomedical instrumentation problem of their choice. Each group will present their project in-class (or online, or pre-recorded) and submit a final report.

**Grades:** Final letter grades will be based on a combination of homework (40%), quizzes (30%), and final projects (30%). The quizzes cover all material up to the previous week.

**Reviews:** The TAs conduct review sessions and take questions about grading. Consultation hours are posted on the web.

## Course Outline—Winter 2023

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<u>Week of</u>	<u>Topics</u>
Jan 10	Intro to course & bioinstrumentation. Instrumentation systems, operational modes, measurement characteristics. Circuit analysis review. <i>Reading:</i> Chap. 1 (Sec. 1.2, 1.3, 1.5, 1.8-1.10) <b>HW#1, Due Fri 1/20</b>
Jan 17	Switches, relays and potentiometers. Transducers and sensors. <i>Reading:</i> Chap. 2 (Sec. 2.1-2.9) <b>HW #2, Due Fri 2/3</b>
Jan 24	Circuit analysis and design. Power supplies. Amplifiers and op amps. Active filtering. Impedance matching. Timing and digital circuits. <i>Reading:</i> Chap. 3 (Sec. 3.1-3.5, 3.10-3.12, 3.14, 3.16) <b>Quiz #1: Due Fri 1/27</b>
Jan 31	Origin of biopotentials. <i>Reading:</i> Chap. 4 (Sec. 4.1-4.8) <b>HW #3, Due Fri 2/10</b>
Feb 7	Biopotential electrodes. <i>Reading:</i> Chap. 5 (Sec. 5.1-5.11) <b>HW #4, Due Fri 2/24</b>
Feb 14	Electrocardiogram, common-mode suppression, active shielding. <i>Reading:</i> Chap. 6 (Sec. 6.1-6.6) <b>Quiz #2: Due Fri 2/17</b>
Feb 21	Instrumentation for cardiovascular measurements. <i>Reading:</i> Chapters 7 & 8 (Sec. 7.1-7.4, 7.14-7.14, 8.1-8.4) <b>HW #5, Due Fri 3/3</b>
Feb 28	Chemical biosensors. <i>Reading:</i> Chap. 10 (Sec. 10.1-10.6) <b>HW #6, Due Fri 3/17</b>
Mar 7	Distribution of electrical power, safety in bioinstrumentation, electrical hazards. <i>Reading:</i> Chap. 14 (Sec. 14.1-14.9) <b>Quiz #3: Due Fri 3/10</b>
Mar 14	<b>Final project presentations</b>
Mar 23	<b>Final project reports due, Thu 3/23</b>