BIOEN 4101, BioSystems Analysis
Fall Semesters
MWF, 12:55–1:45 & one lab section:
M, 8:35–11:35, 2:00–5:00
T, 9:10–12:10, 2:00–5:00

Instructor: Chuck Dorval
Email: chuck.dorval@utah.edu
Open Instructor Hours: M 10:35–11:35, M 4:00–5:00, T 11:10–12:10, T 4:00–5:00
Open Instructor Location: MEB 2560

Contact Preferences
Questions regarding course material should be asked as a discussion in Canvas. Questions about personal matters should be emailed to the instructor.

Course Materials
Strongly Recommended (2nd ed. preferred, but 3rd ed. acceptable)

Helpfully Supplemental (3rd ed. preferred, but 2nd ed. acceptable)

Course Description
The goals of this course are to solidify the techniques developed in BioSignals Analysis (BIOEN 3101) in the context of complete systems, including biomedical instrumentation design with a focus on discrete-time implementations. The course will explore basic modeling approaches to medical and physiological systems while those same systems are examined concurrently in the corequisite, Physiology for Engineers (BIOEN 3202). The activities of the course couple example systems with hands-on experience through laboratory exercises. Students are expected to perform a substantial amount of programming in LabVIEW and MATLAB. The course relies on one textbook that students should already have from BioSignals Analysis (BIOEN 3101), and a second text.

Course Outcomes
If you pass this course, you will be able to perform the following tasks.
1. Express exact solutions to ordinary, linear differential equations of fairly reasonable order.
2. Explain steady-state frequency responses of continuous linear systems of less reasonable order.
3. Expound on the complete response of discrete-time linear systems of quite unreasonable order.
4. Formulate continuous time, mathematical models of both biological and manufactured systems that may include translationally and rotationally mechanical, thermal, hydraulic, and electrical domains.
5. Build and analyze electrical circuits to coordinate with sensing material to safely collect physiological data across a host of domains from living organisms, including humans.
6. Develop and evaluate software to filter, identify, and categorize discrete-time physiological signals in an even larger host of domains, independent of the sensors with which the signals were acquired.

**Teaching and Learning Methods**
I teach. You learn. Homework includes daily readings and ~1 problem set per week. There is ~1 in class assessment per week: either a quiz or an exam. There are ~9 labs throughout the course; some labs require substantial extra time to prepare lab reports.

**University Policies**
1. *Americans with Disabilities Act.* The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.
2. *Addressing Sexual Misconduct.* Title IX makes it clear that violence and harassment based on sex and gender — including sexual orientation and gender expression — is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).
3. *Students’ Preferred Addressing.* Class rosters are provided to the instructor with the student’s legal name as well as their preferred first name, if it was previously entered into the student profile section of their CIS account. We aim to honor you by referring to you with the name and pronoun that feels best for you in class. Please advise us of any name or pronoun changes so that we can help create a learning environment in which you, your name, and your pronoun will be respected. If you need assistance getting your preferred name on your UIDcard, please visit the LGBT Resource Center Room 409 in the Olpin Union Building, or email bpeacock@sa.utah.edu to schedule a meeting. The LGBT Resource Center hours are M-F 8am-5pm, and 8am-6pm on Tuesdays.
4. *Academic Code of Conduct.* Academic misconduct — including but not limited to cheating, misrepresenting one's work, inappropriately collaborating, plagiarizing, and
fabricating or falsifying information — shall not be tolerated. You may read the Student Code, Policy 6-400 for details. We do employ a plagiarism detection service, the details of which you will not be informed. If you are unclear whether any particular action violates this policy within the context of BioSystems, ask an instructor for clarification. Perceived misconduct will be reported to the Department of Biomedical Engineering for investigation and record keeping. Any verified misconduct will result in a negative grade (i.e., less than zero) on the assignment in question, for all students involved.

5. **Grading Appeals.** Scores on all course deliverables must be made in writing, on paper, within a week of receiving the grade. Emails will be ignored. If you approach an instructor to argue a grade, you will have waived your right to appeal to the course instructors. If you believe that an academic action made by the instructor or a teaching assistant is arbitrary or capricious, you should discuss the action with Dr. Dorval and attempt to resolve the issue. If we are unable to reach a resolution, you may appeal the action in accordance with the following: deliver a written appeal to the chair of the Department of Biomedical Engineering within 40 business days. The chair must notify you of a decision within 15 days; if you disagree with his decision, you may appeal to the Academic Appeals Committee (see [http://www.coe.utah.edu/current-undergrad/appeal.php](http://www.coe.utah.edu/current-undergrad/appeal.php) for members of committee). See II Section D, Code of Student Rights and Responsibilities for details.

**Course Policies**

**Attendance** for lecture is optional; attendance for laboratory sessions is mandatory. Students are not generally allowed to make up work (e.g., quizzes) missed due to absences.

**Labs** will be performed in groups of two, where possible. Each group will demonstrate their lab project working to an instructor — including answering questions about the lab — before they turn in the associated lab report. Each pair will submit a single lab report for each lab which must be unique to the group; do not use data taken from another group. Lab reports are due prior to lecture on the listed days, and must be uploaded to Canvas before class begins. You will not use one laboratory period to finish the lab or lab report from the previous session. You may not enter MEB 2560 to finish an incomplete or future lab during another section's lab time without permission of the supervising instructor. Permission will not be granted in the first two hours of a lab section; if the supervising instructor feels that the prevailing environment of the day can accommodate additional lab groups in the third hour, they may allow you to work on unfinished labs. You can always work in the lab during scheduled open lab hours. Lab groups will change with each unit.

**Problem sets** are due at the beginning of class. Assignments turned in even 1 second after the beginning of class will yield greatly reduced or zero credit. You are encouraged to discuss labs and homework problems with your classmates. However, either directly copying a classmate’s work or allowing a classmate to copy your work is not allowed. Instructors will not provide help on homework assignments due within 24 hours.

**Quizzes** will be neither rescheduled nor made up. They will require you recall knowledge attained in previous, prerequisite courses. They will require you recall knowledge attained throughout the semester, including during the previous lecture. They will require you recall knowledge attained in the assigned readings for that day.

**Exams** will not be rescheduled unless they conflict with other courses. Exams missed due to illness will be considered unexcused unless the instructor is notified of the situation ahead of time and a signed excuse from your physician on his or her letterhead is presented at the
next opportunity. The zeroth exam will count one-third of the other midterm exams, cover prerequisite material, and should indicate to you whether or not you are prepared for this class. The final exam will be comprehensive.

Electronic devices are allowed in class. Students are encouraged to take notes on tablets or laptops, and may record lectures with phones or other personal device assistants. However, no electronic devices are allowed during quizzes or exams. In other words, phones and calculators are expressly forbidden during quizzes and exams.

**Grading Policy**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
<th>Grade Requirements</th>
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<tbody>
<tr>
<td>Participation (~lab)</td>
<td>5-10%</td>
<td>A ≥ (\frac{280}{3}) %</td>
</tr>
<tr>
<td>Quizzes (~12)</td>
<td>5-10%</td>
<td>A- ≥ (\frac{270}{3}) %</td>
</tr>
<tr>
<td>Problem Sets (~12)</td>
<td>15-20%</td>
<td>B+ ≥ (\frac{260}{3}) %</td>
</tr>
<tr>
<td>Labs (~9)</td>
<td>15-20%</td>
<td>B ≥ (\frac{250}{3}) %</td>
</tr>
<tr>
<td>Exams (3-4)</td>
<td>40-60%</td>
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**Curving may occur, or not**

**Course Schedule**

**Unit 1: Finite Responses & Mechanical Systems**

1. Mechanical Systems
   - Intro to LabView
   - Prerequisite Exam
2. Discrete LTI Systems
   - Digital Interfacing
   - Quiz
3. Convolution
   - Quiz
4. Frequency Responses
   - Quiz
5. Frequency Spaces
   - Quiz

**Unit 2: Filters & Circuit-Based Systems**

6. Electrical Systems
   - Quiz
7. Operational Amplifiers
   - Electrical Circuits
   - Quiz
8. Hydraulic Systems
   - Hydraulic Circuits
   - Quiz
9. z-Transforms
   - Filter Design
   - Quiz
10. Infinite Time Responses
    - Second Exam

**Unit 3: Instrumentation & System Design**

11. Bridge Design
    - Quiz
12. Discrete Time Stability
    - Sensor Design
    - Quiz
13. Amplifier Design
    - Sensor Integration
    - Quiz
14. Systems Engineering
    - Feedback Controls
    - Quiz
15. Systems Integration
    - Final Exam

**Note:** This syllabus is meant to serve as an outline and guide for our course. Please note that the instructor may modify it with reasonable notice to you. A more detailed syllabus will be made available at the start of the course, and any changes to that syllabus will be announced.