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Syllabus

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BIOM/ECE 431 Biomedical Signal and Image Processing (BSIP)

Spring 2020

Lectures: 12:30-1:45 PM Tues/Thurs, Engineering B2.

Lectures available live and recorded online through Echo360.

Instructor: Jesse Wilson

Email: [jesse.wilson@colostate.edu \(mailto:jesse.wilson@colostate.edu\)](mailto:jesse.wilson@colostate.edu)

Skype Messaging: [jessew@colostate.edu \(mailto:jessew@colostate.edu\)](mailto:jessew@colostate.edu)

Phone: 970-491-3706

Office Hours: Mondays 3-4 pm and Fridays 12-1 pm, Scott Building Room 324, or by appointment. See Google calendar for changes.

Teaching Assistant: Sarah Maclean

MATLAB Grader Assignments Developer: Saurabh Gupta

COURSE CALENDAR

BIOM/ECE431 SP2020



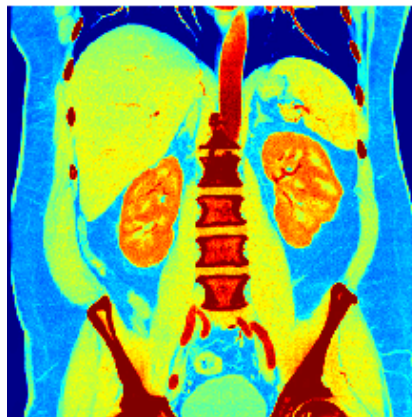
Today Thursday, January 30 ▼ [Print](#) [Week](#) [Month](#) [Agenda](#) ▼

Thursday, January 30
4: Signal measurements
Tuesday, February 4
Project team work (design feasibility study)
Thursday, February 6
5. Demo: correlation, noise reduction
Friday, February 7
12:00pm Office Hours
Monday, February 10
3:00pm Office Hours
Tuesday, February 11
6. Spectral analysis
Thursday, February 13
7. Digital filters
Friday, February 14
12:00pm Office Hours
Monday, February 17
3:00pm Office Hours
Tuesday, February 18
8. Digital filter examples
Thursday, February 20
9. Electrophysiology
Monday, February 24

Events shown in time zone: Mountain Time - Denver

Calendar

Your feedback and input is always welcome! You have the opportunity to help shape this class for future students.

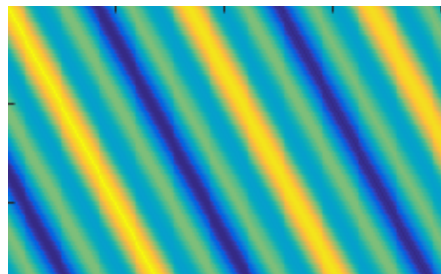


False color rendering of a computed tomography slice.

COURSE OBJECTIVES: Upon completion of this class, students will:



- Define common biomedical signal and image terms including the acronyms ECG, EEG, EMG, MRI, PET and CT.
- Identify the physiological source of common biomedical signals and images.
- Recognize and describe unique primary features of common biomedical signals and images.
- Discuss typical sources of interference and noise and their impact on biomedical signals and images.
- Mathematically transform and filter biomedical signals and images to reduce the impact of interference and noise
- Quantitatively assess the quality of biomedical signals and images before and after processing.
- Employ computer aided engineering software, such as MATLAB, to beneficially process biomedical signals and images.
- Select appropriate signal and image processing methods to apply to example biomedical applications.



Adaptive filter Toeplitz matrix.

PREREQUISITES: PH 142, LIFE 210, ECE 311, ECE 303 (co-requisite)

REQUIRED MATERIALS:

- *Biosignal and Medical Image Processing*, 3rd ed. by J. Semmlow & B. Griffel, CRC Press Taylor & Francis Group, 2014. (Available at CSU bookstore). Data can be downloaded here: <https://www.crcpress.com/Biosignal-and-Medical-Image-Processing-Third-Edition/Semmlow-Griffel/p/book/9781466567368> (<https://www.crcpress.com/Biosignal-and-Medical-Image-Processing-Third-Edition/Semmlow-Griffel/p/book/9781466567368>).
- *The Biomedical Engineering Handbook*, 2nd ed. Edited by J. D. Bronzino, CRC Press, 1999. Accessible online <http://www.crcnetbase.com/doi/book/10.1201/9781420049510> (<http://www.crcnetbase.com/doi/book/10.1201/9781420049510>) from any campus computer through CSU library subscription.
- MATLAB software. Available on any ENS lab computer, or remotely through the [ENS Virtual Classroom](http://www.engr.colostate.edu/ens/tools/virtualclass/) (<http://www.engr.colostate.edu/ens/tools/virtualclass/>).

Canvas: canvas.colostate.edu will have the syllabus, links, homework, course grades and other postings. It is your responsibility to check the calendar under the Index tab each week for new postings.

COURSE TOPICS: The planned topics for this course are:



Weeks 1-4	Signal processing toolkit: measurements, noise, spectral analysis, digital filters, MATLAB.
Weeks 5-6	Electrophysiology and electrocardiography (ECG).
Weeks 7-8	Feature extraction, dimension reduction, and classification.
(Spring Break)	
Week 9	Review and Midterm Exam.
Weeks 10-11	Image processing toolkit: transforms, 2DFFT, and filtering.
Week 12	Computed tomography and backprojection.
Week 13	Ultrasound.
Week 14	Positron emission tomography (PET) and cancer imaging.
Week 15	Magnetic resonance imaging (MRI).
Week 16	Finals week: group project presentations.

GRADING:

Quizzes (online and in-class): 20%

Homework assignments: 40%

Midterm Exam: 20%

Final Project: 20%

The final exam date and location is TBD. Check with your instructor and Canvas for updates.



PET image of glucose uptake in the brain (from

<http://jnm.snmjournals.org/content/45/4/594.abstract> (<http://jnm.snmjournals.org/content/45/4/594.abstract>).



).

Final grades will be determined by the following scale:

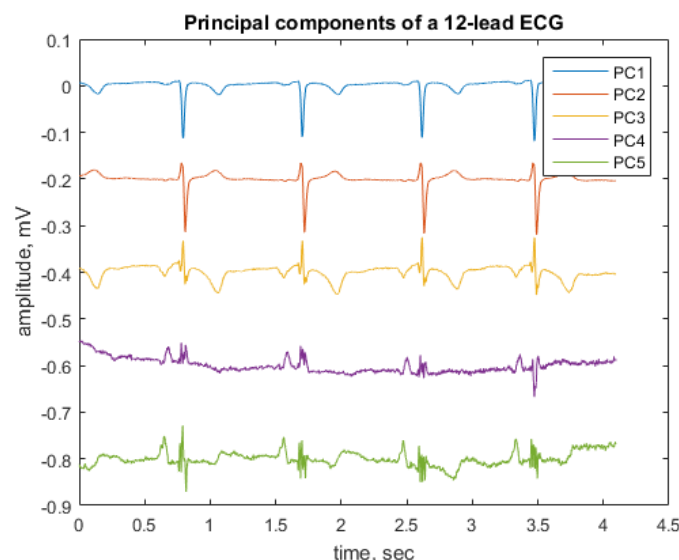
A+	100%	to	96.67%
A	< 96.67%	to	93.33%
A-	< 93.33%	to	90%
B+	< 90%	to	86.67%
B	< 86.67%	to	83.33%
B-	< 83.33%	to	80%
C+	< 80%	to	76.67%
C	< 76.67%	to	70%
D	< 70%	to	60%
F	< 60%	to	0%

HOMEWORK:

Homework will be due at the start of class one week after it is assigned, typically each Thursday, but check the website for updates. Links to the homework can be found on Canvas. I request that you record the time spent on each question on your paper. **All late assignments will receive a zero.**

Unless otherwise indicated, all homeworks for this class are to be completed online in MATLAB Grader (<https://grader.mathworks.com/> (<https://grader.mathworks.com/>)). You will need to sign up for a (free) Mathworks account linked to your CSU email address.

This is the first year for our use of MATLAB Grader. There may be bugs, and some of the tasks may be unclear. Get an early start and ask questions.



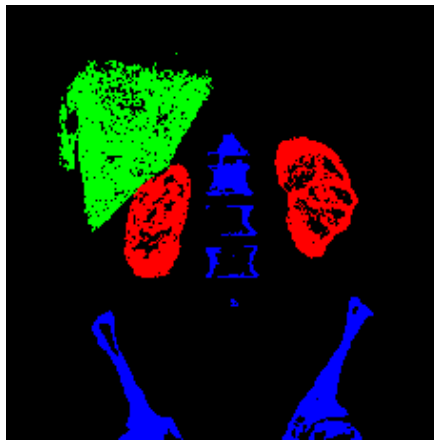
Principal Component Analysis of electrocardiogram recordings.

All submitted homework and code must be your own individual work. Since a large portion of the work will be writing MATLAB code, students are expected to adhere to the Academic Integrity Policies found on the Computer Science Department website:

http://www.cs.colostate.edu/cstop/csacademics/student_info.php






(http://www.cs.colostate.edu/cstop/csacademics/student_info.php)

ACADEMIC INTEGRITY: Students are expected to adhere to the Academic Integrity Policy of Colorado State University, outlined in the CSU General Catalog. Students are also expected to follow the Student Conduct Code which can be found at www.conflictresolution.colostate.edu. Academic dishonesty is not accepted in this course, and any form of cheating (including plagiarism) will be reported. Penalties may include a lowered course grade, loss of course credit, and expulsion from the university.


















Automated segmentation of CT image into liver, kidney, and bone tissue.
















Course Summary:

Date	Details	
Wed Feb 28, 2018	 Semmlow CH9: multivariate analysis (https://colostate.instructure.com/courses/96952/assignments/1106720)	due by 11:30am
Fri Apr 6, 2018	 Background Research (https://colostate.instructure.com/courses/96952/assignments/1106729)	due by 11:59pm
Fri Apr 13, 2018	 Data Exploration (https://colostate.instructure.com/courses/96952/assignments/1106734)	due by 11:59pm
Fri Apr 27, 2018	 Feature Extraction (https://colostate.instructure.com/courses/96952/assignments/1106744)	due by 11:59pm
Fri May 4, 2018	 Classification Methods (https://colostate.instructure.com/courses/96952/assignments/1106731)	due by 11:59pm









Date	Details	due by
Thu May 10, 2018	 Final project paper (extra credit) https://colostate.instructure.com/courses/96952/assignments/1106755	11:59pm
Tue Mar 5, 2019	 Foster, Electrocardiography Part II https://colostate.instructure.com/courses/96952/assignments/1106715	12:30pm
Wed May 15, 2019	 Discussion/participation https://colostate.instructure.com/courses/96952/assignments/1106736	11:59pm
	 Final project team evaluations [REQUIRED] https://colostate.instructure.com/courses/96952/assignments/1106760	11:59pm
Wed Jan 22, 2020	 Semmlow CH1: Introduction https://colostate.instructure.com/courses/96952/assignments/1106717	12:15pm
Thu Jan 30, 2020	 Semmlow CH 2: Measurement, Noise, and Analysis https://colostate.instructure.com/courses/96952/assignments/1106719	12:15pm
Fri Jan 31, 2020	 HW00: MATLAB Onramp https://colostate.instructure.com/courses/96952/assignments/1106823	11:59pm
Fri Feb 7, 2020	 HW01: Basic ECG Analysis https://colostate.instructure.com/courses/96952/assignments/1106763	11:59pm
Tue Feb 11, 2020	 Semmlow CH3: Spectral Analysis https://colostate.instructure.com/courses/96952/assignments/1106722	12:15pm
	 Feasibility proposal https://colostate.instructure.com/courses/96952/assignments/1122595	11:59pm
Thu Feb 13, 2020	 Semmlow CH4: Digital Filters https://colostate.instructure.com/courses/96952/assignments/1106718	12:15pm
Fri Feb 14, 2020	 HW02: Signal and noise https://colostate.instructure.com/courses/96952/assignments/1106767	11:59pm
Thu Feb 20, 2020	 Davis, Cellular Neurophysiology https://colostate.instructure.com/courses/96952/assignments/1106724	12:15pm
Fri Feb 21, 2020	 HW03: ECG Frequency Analysis https://colostate.instructure.com/courses/96952/assignments/1106774	11:59pm
Thu Feb 27, 2020	 Exam 1 -- DSP review https://colostate.instructure.com/courses/96952/assignments/1122539	11:59pm



Date	Details	
Fri Feb 28, 2020	 HW04: FIR filter design and application to ECG data (https://colostate.instructure.com/courses/96952/assignments/1106778)	due by 11:59pm
Tue Mar 3, 2020	 Foster, Electrocardiography (https://colostate.instructure.com/courses/96952/assignments/1106721)	due by 12:15pm
Tue Mar 10, 2020	 Feasibility Results and Project Proposal (https://colostate.instructure.com/courses/96952/assignments/1106829)	due by 11:59pm
Thu Mar 12, 2020	 Semmlow 16.1--16.4 (classification) (https://colostate.instructure.com/courses/96952/assignments/1106725)	due by 12:15pm
Fri Mar 13, 2020	 HW05: ECG abnormalities (https://colostate.instructure.com/courses/96952/assignments/1106786)	due by 11:59pm
Fri Mar 27, 2020	 HW06: Classification (https://colostate.instructure.com/courses/96952/assignments/1106795)	due by 11:59pm
Tue Mar 31, 2020	 Exam 2 -- Electrophysiology, ECG, classification (https://colostate.instructure.com/courses/96952/assignments/1122559)	due by 11:59pm
Thu Apr 2, 2020	 Semmlow CH12: Image Processing (https://colostate.instructure.com/courses/96952/assignments/1106723)	due by 12:15pm
Tue Apr 7, 2020	 Semmlow CH13: Image Transforms (https://colostate.instructure.com/courses/96952/assignments/1106716)	due by 12:15pm
Thu Apr 9, 2020	 Semmlow 13.2 image filtering (https://colostate.instructure.com/courses/96952/assignments/1106831)	due by 12:15pm
Fri Apr 10, 2020	 HW07: Image processing basics (https://colostate.instructure.com/courses/96952/assignments/1106803)	due by 11:59pm
Tue Apr 14, 2020	 Jahne Ch 2.3 2D Fourier (https://colostate.instructure.com/courses/96952/assignments/1106822)	due by 12:15pm
	 Project update (https://colostate.instructure.com/courses/96952/assignments/1106830)	due by 11:59pm
Tue Apr 21, 2020	 Exam 3 -- Image processing (https://colostate.instructure.com/courses/96952/assignments/1122585)	due by 11:59pm
Tue Apr 28, 2020	 Institut Fresnel Fourier plane demonstration (https://colostate.instructure.com/courses/96952/assignments/1106820)	due by 12:15pm



Date	Details	
Thu Apr 30, 2020	 Semmlow 15.2 Tomography (https://colostate.instructure.com/courses/96952/assignments/1106832)	due by 12:15pm
Tue May 5, 2020	 U. Washington PET Physics Reading (https://colostate.instructure.com/courses/96952/assignments/1106837)	due by 12:15pm
Thu May 7, 2020	 Semmlow 15.3 Magnetic Resonance Imaging (https://colostate.instructure.com/courses/96952/assignments/1106833)	due by 12:15pm
Fri May 8, 2020	 HW09: Computed tomography (https://colostate.instructure.com/courses/96952/assignments/1121755)	due by 11:59pm
Fri May 15, 2020	 Final Presentation (https://colostate.instructure.com/courses/96952/assignments/1106746)	due by 11:59pm
Sun May 17, 2020	 HW08: Image manipulation and filtering (https://colostate.instructure.com/courses/96952/assignments/1106807)	due by 11:59pm