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

## Spring 2023

Lectures: MWF 11:00--11:50AM, ENGR B2.

Lectures also available live through MS Teams and recorded online through Echo360.

**Attendance Policy:** Students enrolled in in-person sections (001) are expected to attend all lectures in person. Online enrollments (801) are expected to view lectures within 24 hours of posting.

Lecture livestream link: [https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d)

[NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d)

[context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d)

[367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d) 

[\\_ \(https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d)

[NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d)

[4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d\)](https://teams.microsoft.com/join/19%3a3UGXpDsaDTclAvtqPe8iMOYcQ-NmrM9xEzeOE8g1qfl1%40thread.tacv2/1704486706618?context=%7b%22Tid%22%3a%22afb58802-ff7a-4bb1-ab21-367ff2ecfc8b%22%2c%22Oid%22%3a%22b5d74e13-7c0b-4820-94ee-7f113715f979%22%7d)

Instructor: Jesse Wilson

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

MS Teams: Wilson, Jesse

[\\_ \(mailto:jessew@colostate.edu\)](mailto:jessew@colostate.edu) Phone: 970-491-3706

**Office Hours:** TBD. Fill out when2meet poll ASAP: <https://www.when2meet.com/?22925234-W26nn>

[\\_ \(https://www.when2meet.com/?22925234-W26nn\)](https://www.when2meet.com/?22925234-W26nn)

**MATLAB Grader Assignments Developers:** Saurabh Gupta, Kaitie Wood, Nathan You

**Grader:** Sekar Prasetya ([sekar.prasetya@colostate.edu](mailto:sekar.prasetya@colostate.edu) (<mailto:sekar.prasetya@colostate.edu>))



# COURSE CALENDAR

## BIOM/ECE431 SP2024

Today

January 2024

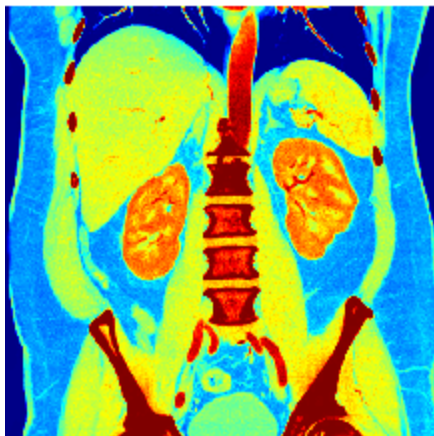
Print Week Month Agenda

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	Jan 1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
		01. Overview			02. Working with	HW00 DUE (MATL
21	22	23	24	25	26	27
	03. Signals		03b. Noise and A	PRJ preferences s	04. Noise and AD	HW01 DUE (MATL
					3:15pm OFFICE HO	
28	29	30	31	Feb 1	2	3
	05. Signal statist		Project Work Day		06. MATLAB Dem	HW02 DUE (Basid
					3:15pm OFFICE HO	

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.

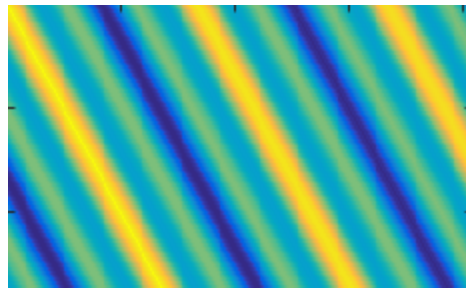


*False color rendering of a computed tomography slice.*

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**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*, 2<sup>nd</sup> 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 1-5	Signal processing toolkit: measurements, noise, spectral analysis, digital filters, MATLAB.
Weeks 6-8	Electrophysiology and electrocardiography (ECG).
Weeks 9-10	Feature extraction, dimension reduction, and classification.
Weeks 11-12	Image processing toolkit: transforms, 2DFFT, and filtering.
(SPRING BREAK)	
Week 13-14	Medical imaging: Microscopy, Computed Tomography, Positron Emission Tomography, Magnetic Resonance Imaging
FINALS	Group project reports due.

**GRADING:**

Category	Percent of final grade	Description	How many	How frequently	Policy
<b>Quizzes</b>	20%	10-minute Canvas quizzes on required reading before lectures	20	Up to 3x per week	Unlimited attempts until deadline. Keep most recent score. Lowest 4 quizzes dropped from final grade.
<b>Homework Assignments</b>	40%	MATLAB Grader online. Automated testbenches.	13	Weekly	Unlimited attempts until deadline. Keep best score. Lowest assignment

					dropped from final grade.
<b>Exams</b>	20%	In-person: written exams. Online: Canvas exams w/ Honorlock.	5	~Monthly	Lowest exam score dropped from final grade.
<b>Group Project</b>	20%	Project proposals, checkpoints, and final paper. Grade also includes peer review of other teams.		Throughout semester	

**All late assignments receive a zero score.** However, I do understand that circumstances may not permit completion of work on time. For this reason, instead of granting deadline extensions, I have a policy of dropping the lowest four quizzes, one homework assignment, and one exam from the final grade. For example, if you are ill and unable to take one of the exams, it will not negatively impact your final grade. If, at any point it appears that extenuating circumstances (e.g. family emergency) will prevent you from earning a passing grade, you have the option to request an Incomplete, provided that documentation of the need is forwarded to the instructor via [CSU Student Case Management](https://studentcasemanagement.colostate.edu/)  (<https://studentcasemanagement.colostate.edu/>).

There is no final exam. Instead, project final reports will be due during Finals Week.



*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%

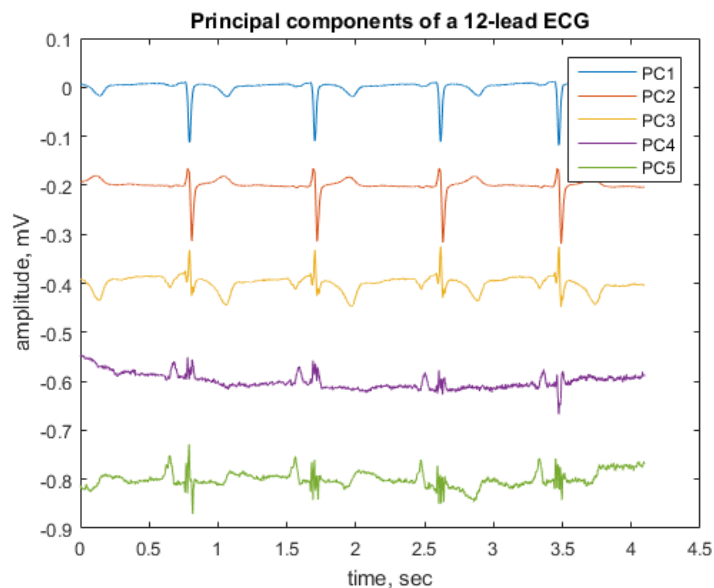
F < 60% to 0%

At the end of the semester, your final grade in Canvas will be the final grade. For incompletes and grade appeals, see [University policy](https://catalog.colostate.edu/general-catalog/academic-standards/grading/) (<https://catalog.colostate.edu/general-catalog/academic-standards/grading/>).

## HOMEWORK:

Homeworks are due typically each Saturday, but check Canvas for updates. **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.



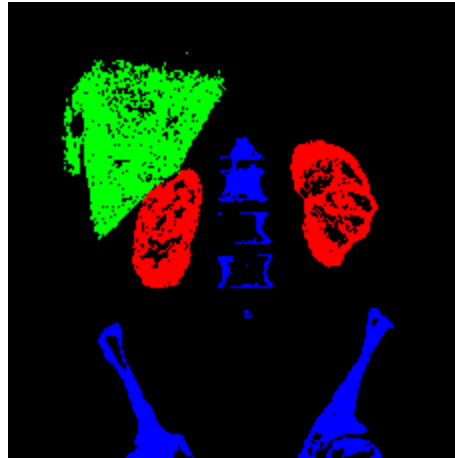
*Principal Component Analysis of electrocardiogram recordings.*

**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) 





([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](http://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	Due
Fri Jan 19, 2024	 <a href="https://colostate.instructure.com/courses/177279/assignments/2276764">Semmlow CH1: Introduction</a> ( <a href="https://colostate.instructure.com/courses/177279/assignments/2276764">https://colostate.instructure.com/courses/177279/assignments/2276764</a> )	due by 10:50am
Sat Jan 20, 2024	 <a href="https://colostate.instructure.com/courses/177279/assignments/2276781">HW00: MATLAB Onramp</a> ( <a href="https://colostate.instructure.com/courses/177279/assignments/2276781">https://colostate.instructure.com/courses/177279/assignments/2276781</a> )	due by 11:59pm
Mon Jan 22, 2024	 <a href="https://colostate.instructure.com/courses/177279/assignments/2276755">Semmlow CH2: Measurement, Noise, and Analysis</a> ( <a href="https://colostate.instructure.com/courses/177279/assignments/2276755">https://colostate.instructure.com/courses/177279/assignments/2276755</a> )	due by 10:50am
Thu Jan 25, 2024	 <a href="https://colostate.instructure.com/courses/177279/assignments/2276803">Team preferences survey</a> ( <a href="https://colostate.instructure.com/courses/177279/assignments/2276803">https://colostate.instructure.com/courses/177279/assignments/2276803</a> )	due by 11:59pm

Date	Details	Due
Sat Jan 27, 2024	 <b><u>HW01: Intro to MATLAB</u></b> <b><u>Grader</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276782">https://colostate.instructure.com/courses/177279/assignments/2276782</a>	due by 11:59pm
Fri Feb 2, 2024	 <b><u>Semmlow CH3: Spectral Analysis</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276757">https://colostate.instructure.com/courses/177279/assignments/2276757</a>	due by 10:50am
Sat Feb 3, 2024	 <b><u>HW02: Basic ECG Analysis</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276783">https://colostate.instructure.com/courses/177279/assignments/2276783</a>	due by 11:59pm
Tue Feb 6, 2024	 <b><u>Feasibility proposal</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276774">https://colostate.instructure.com/courses/177279/assignments/2276774</a>	due by 11:59pm
Wed Feb 7, 2024	 <b><u>Semmlow CH4: Digital Filters</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276752">https://colostate.instructure.com/courses/177279/assignments/2276752</a>	due by 10:50am
Thu Feb 8, 2024	 <b><u>Feasibility proposal peer review</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276775">https://colostate.instructure.com/courses/177279/assignments/2276775</a>	due by 11:59pm
Sat Feb 10, 2024	 <b><u>HW03: Signal and noise</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276784">https://colostate.instructure.com/courses/177279/assignments/2276784</a>	due by 11:59pm
Wed Feb 14, 2024	 <b><u>Steer 2.2.1 Tx line theory</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276765">https://colostate.instructure.com/courses/177279/assignments/2276765</a>	due by 10:50am
Fri Feb 16, 2024	 <b><u>Davis, Cellular Neurophysiology</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276750">https://colostate.instructure.com/courses/177279/assignments/2276750</a>	due by 10:50am
Sat Feb 17, 2024	 <b><u>HW04: ECG Frequency Analysis</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276785">https://colostate.instructure.com/courses/177279/assignments/2276785</a>	due by 11:59pm
Wed Feb 21, 2024	 <b><u>Exam 1 Introduction and DSP review (in-person sections)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276768">https://colostate.instructure.com/courses/177279/assignments/2276768</a> (2024SP-BIOM-431-001)	due by 11:50am
	 <b><u>Exam 1 Introduction and DSP review (in-person sections)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276768">https://colostate.instructure.com/courses/177279/assignments/2276768</a>	due by 11:50am














Date	Details	Due
	(2024SP-ECE-431-001)	
	 <b><u>Exam 1 Introduction and DSP review (online sections) - Requires Respondus LockDown Browser + Webcam</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276758">https://colostate.instructure.com/courses/177279/assignments/2276758</a> (2024SP-ECE-431-801)	due by 11:59pm
	 <b><u>Exam 1 Introduction and DSP review (online sections) - Requires Respondus LockDown Browser + Webcam</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276758">https://colostate.instructure.com/courses/177279/assignments/2276758</a> (2024SP-BIOM-431-801)	due by 11:59pm
Sat Feb 24, 2024	 <b><u>HW05: FIR filter design and application to ECG data</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276786">https://colostate.instructure.com/courses/177279/assignments/2276786</a>	due by 11:59pm
Mon Feb 26, 2024	 <b><u>Foster, Electrocardiography</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276754">https://colostate.instructure.com/courses/177279/assignments/2276754</a>	due by 10:50am
Fri Mar 1, 2024	 <b><u>Foster, Electrocardiography Part II</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276766">https://colostate.instructure.com/courses/177279/assignments/2276766</a>	due by 10:50am
Sat Mar 2, 2024	 <b><u>HW06: Electrophysiology</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276787">https://colostate.instructure.com/courses/177279/assignments/2276787</a>	due by 11:59pm
Mon Mar 4, 2024	 <b><u>Pan-Tompkins</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276763">https://colostate.instructure.com/courses/177279/assignments/2276763</a>	due by 10:50am
Tue Mar 5, 2024	 <b><u>Feasibility Results and Project Proposal</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276776">https://colostate.instructure.com/courses/177279/assignments/2276776</a>	due by 11:59pm
Thu Mar 7, 2024	 <b><u>Feasibility results peer review</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276777">https://colostate.instructure.com/courses/177279/assignments/2276777</a>	due by 11:59pm
Fri Mar 8, 2024	 <b><u>Exam 2 Electrophysiology, ECG, classification (in-person sections)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276769">https://colostate.instructure.com/courses/177279/assignments/2276769</a>	due by 11:50am

Date	Details	Due
	(2024SP-BIOM-431-001)	
	 <b><u>Exam 2 Electrophysiology, ECG, classification (in-person sections)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276769">https://colostate.instructure.com/courses/177279/assignments/2276769</a> (2024SP-ECE-431-001)	due by 11:50am
	 <b><u>Exam 2 Electrophysiology, ECG, classification (online sections) - Requires Respondus LockDown Browser + Webcam</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276759">https://colostate.instructure.com/courses/177279/assignments/2276759</a> (2024SP-ECE-431-801)	due by 11:59pm
	 <b><u>Exam 2 Electrophysiology, ECG, classification (online sections) - Requires Respondus LockDown Browser + Webcam</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276759">https://colostate.instructure.com/courses/177279/assignments/2276759</a> (2024SP-BIOM-431-801)	due by 11:59pm
Sat Mar 9, 2024	 <b><u>HW07: ECG abnormalities</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276788">https://colostate.instructure.com/courses/177279/assignments/2276788</a>	due by 11:59pm
Mon Mar 18, 2024	 <b><u>Semmlow 16.1--16.4 (classification)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276751">https://colostate.instructure.com/courses/177279/assignments/2276751</a>	due by 10:50am
Fri Mar 22, 2024	 <b><u>Semmlow CH17: Neural Nets</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276761">https://colostate.instructure.com/courses/177279/assignments/2276761</a>	due by 10:50am
Fri Mar 29, 2024	 <b><u>Exam 3 Classification and Neural Nets (in-person sections)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276770">https://colostate.instructure.com/courses/177279/assignments/2276770</a> (2024SP-BIOM-431-001)	due by 11:50am
	 <b><u>Exam 3 Classification and Neural Nets (in-person sections)</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276770">https://colostate.instructure.com/courses/177279/assignments/2276770</a> (2024SP-ECE-431-001)	due by 11:50am
	 <b><u>Exam 3 Classification and Neural Nets (online sections) - Requires Respondus LockDown</u></b>	due by 11:59pm

Date	Details	Due
	<b><u>Browser + Webcam</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276762">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276762">https://colostate.instructure.com/courses/177279/assignments/2276762</a>)</a> (2024SP-ECE-431-801)	
	 <b><u>Exam 3 Classification and Neural Nets (online sections) - Requires Respondus LockDown Browser + Webcam</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276762">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276762">https://colostate.instructure.com/courses/177279/assignments/2276762</a>)</a> (2024SP-BIOM-431-801)	due by 11:59pm
Sat Mar 30, 2024	 <b><u>HW08: Classification</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276789">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276789">https://colostate.instructure.com/courses/177279/assignments/2276789</a>)</a>	due by 11:59pm
Mon Apr 1, 2024	 <b><u>Semmlow CH12: Image Processing</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276753">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276753">https://colostate.instructure.com/courses/177279/assignments/2276753</a>)</a>	due by 10:50am
Fri Apr 5, 2024	 <b><u>Semmlow CH13: Image Transforms</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276767">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276767">https://colostate.instructure.com/courses/177279/assignments/2276767</a>)</a>	due by 10:50am
Sat Apr 6, 2024	 <b><u>HW09: Neural networks</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276790">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276790">https://colostate.instructure.com/courses/177279/assignments/2276790</a>)</a>	due by 11:59pm
Tue Apr 9, 2024	 <b><u>Project update</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276797">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276797">https://colostate.instructure.com/courses/177279/assignments/2276797</a>)</a>	due by 11:59pm
Wed Apr 10, 2024	 <b><u>Jahne Ch 2.3 2D Fourier</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276795">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276795">https://colostate.instructure.com/courses/177279/assignments/2276795</a>)</a>	due by 10:50am
Thu Apr 11, 2024	 <b><u>Project update peer review</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276798">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276798">https://colostate.instructure.com/courses/177279/assignments/2276798</a>)</a>	due by 11:59pm
Fri Apr 12, 2024	 <b><u>Michelucci Ch3: Convolutional Networks [EXTRA CREDIT 5 points]</u></b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276796">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276796">https://colostate.instructure.com/courses/177279/assignments/2276796</a>)</a>	due by 10:50am
Sat Apr 13, 2024	 <b><u>HW10: Image processing basics</u></b>	due by 11:59pm

Date	Details	Due
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276791">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276791">https://colostate.instructure.com/courses/177279/assignments/2276791</a>)</a>	
	 <a href="#">Exam 4 Image processing (in-person sections)</a>	due by 11:50am
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276771">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276771">https://colostate.instructure.com/courses/177279/assignments/2276771</a>)</a> (2024SP-BIOM-431-001)	
	 <a href="#">Exam 4 Image processing (in-person sections)</a>	due by 11:50am
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276771">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276771">https://colostate.instructure.com/courses/177279/assignments/2276771</a>)</a> (2024SP-ECE-431-001)	
Wed Apr 17, 2024	 <a href="#">Exam 4 Image Processing (online sections) - Requires Respondus LockDown Browser + Webcam</a>	due by 11:59pm
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276749">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276749">https://colostate.instructure.com/courses/177279/assignments/2276749</a>)</a> (2024SP-ECE-431-801)	
	 <a href="#">Exam 4 Image Processing (online sections) - Requires Respondus LockDown Browser + Webcam</a>	due by 11:59pm
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276749">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276749">https://colostate.instructure.com/courses/177279/assignments/2276749</a>)</a> (2024SP-BIOM-431-801)	
Fri Apr 19, 2024	 <a href="#">Institut Fresnel Fourier plane demonstration</a>	due by 10:50am
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276794">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276794">https://colostate.instructure.com/courses/177279/assignments/2276794</a>)</a>	
Sat Apr 20, 2024	 <a href="#">HW11: Image manipulation and filtering</a>	due by 11:59pm
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276792">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276792">https://colostate.instructure.com/courses/177279/assignments/2276792</a>)</a>	
Mon Apr 22, 2024	 <a href="#">Semmlow 15.2 Tomography</a>	due by 10:50am
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276801">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276801">https://colostate.instructure.com/courses/177279/assignments/2276801</a>)</a>	
Wed Apr 24, 2024	 <a href="#">U. Washington PET Physics Reading</a>	due by 10:50am
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276804">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276804">https://colostate.instructure.com/courses/177279/assignments/2276804</a>)</a>	
Fri Apr 26, 2024	 <a href="#">Semmlow 15.3 Magnetic Resonance Imaging</a>	due by 10:50am
	<a href="https://colostate.instructure.com/courses/177279/assignments/2276802">(<a href="https://colostate.instructure.com/courses/177279/assignments/2276802">https://colostate.instructure.com/courses/177279/assignments/2276802</a>)</a>	

Date	Details	Due
Sat Apr 27, 2024	 <b>HW12: Computed tomography</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276793">https://colostate.instructure.com/courses/177279/assignments/2276793</a>	due by 11:59pm
	 <b>Exam 5 Imaging Technologies (in-person sections)</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276772">https://colostate.instructure.com/courses/177279/assignments/2276772</a> (2024SP-BIOM-431-001)	due by 11:50am
	 <b>Exam 5 Imaging Technologies (in-person sections)</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276772">https://colostate.instructure.com/courses/177279/assignments/2276772</a> (2024SP-ECE-431-001)	due by 11:50am
Fri May 3, 2024	 <b>Exam 5 Imaging Technologies (online sections)</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276756">https://colostate.instructure.com/courses/177279/assignments/2276756</a> (2024SP-ECE-431-801)	due by 11:59pm
	 <b>Exam 5 Imaging Technologies (online sections)</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276756">https://colostate.instructure.com/courses/177279/assignments/2276756</a> (2024SP-BIOM-431-801)	due by 11:59pm
Sat May 4, 2024	 <b>EXTRA CREDIT: Convolutional Nets</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276773">https://colostate.instructure.com/courses/177279/assignments/2276773</a>	due by 11:59pm
Tue May 7, 2024	 <b>Final project paper</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276778">https://colostate.instructure.com/courses/177279/assignments/2276778</a>	due by 11:59pm
Wed May 8, 2024	 <b>Final project team self-evaluations</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276780">https://colostate.instructure.com/courses/177279/assignments/2276780</a>	due by 11:59pm
Thu May 9, 2024	 <b>Final project peer review</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276779">https://colostate.instructure.com/courses/177279/assignments/2276779</a>	due by 11:59pm
	 <b>Roll Call Attendance</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276799">https://colostate.instructure.com/courses/177279/assignments/2276799</a>	
	 <b>Semmlow CH9: multivariate analysis</b> <a href="https://colostate.instructure.com/courses/177279/assignments/2276760">https://colostate.instructure.com/courses/177279/assignments/2276760</a>	