Course Syllabus Jesse Wilson

Logout Close your browser to end your session. (http://www.acns.colostate.edu/single-sign-on-using-shibboleth/#1471272725675-6603b487-ebab)

BIOM/ECE 537 Biomedical Signal Processing

Spring 2022

Lectures: MWF, 10AM-10:50AM, **Engineering B2**

Instructor: Jesse Wilson
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Skype Messaging: jessew@colostate.edu (mailto:jessew@colostate.edu)
Phone: 970-491-3706

Office Hours: Wednesdays 12--2PM, Scott Building 324 or by appointment

MATLAB Grader Designer: Saurabh Gupta

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

COVID/Pandemic considerations

Important information for students:

Masks are required inside university buildings. You must also meet university vaccine or exemption requirements.

All students are expected and required to report to the COVID Reporter (https://covid.colostate.edu/reporter/ (https://covid.colostate.edu/reporter/)) when:

- You suspect you have symptoms of COVID, regardless of whether or not you are vaccinated and even if your symptoms are mild
- You have tested positive for COVID through a non-CSU testing site, such as home test or test at a pharmacy
- You believe you may have been exposed to COVID go to the COVID Reporter and follow the guidance under "I believe I have been in close contact with someone who has COVID-19." This guidance will depend upon your individual circumstances

You will not be penalized in any way for reporting symptoms or concerns.

Do not ask me as your instructor to report for you. It is your responsibility to report through the COVID Reporter promptly.

As your instructor I may not ask you about vaccination status or if you have COVID but you may freely volunteer to send me information from a public health official if you have been asked to isolate or quarantine.

When you complete the COVID Reporter, the CSU Public Health office is notified. Once notified, that office will contact you and, depending upon each situation, will conduct contact tracing, initiate any necessary public health requirements and notify you if you need to take any steps.

If you do not have internet access to fill out the online COVID-19 Reporter, please call (970) 491-4600.

For the latest information about the University's COVID resources and information, including FAQs about the spring semester, please visit the **CSU COVID-19 site** https://covid.colostate.edu/ (https://covid.colostate.edu/) .

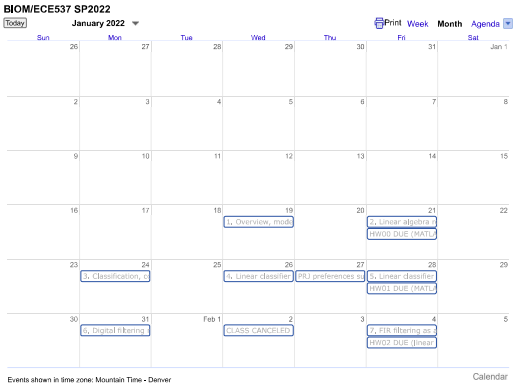
OVERVIEW: An in-depth course on modeling and classification of biosignals (e.g. EEG, ECG, EMG), covering adaptive filtering, wavelets, neural networks, and handling problems with overfitting of noisy data.

PREREQUISITES: MATH340 or ECE311 or STAT303

LEARNING OBJECTIVES: At the end of this course, successful students will be able to:

- Choose an appropriate model for biomedical signals
- Evaluate model fitting results and recognize overfitting
- Classify signals using fitted model parameters
- Predict future samples of a time series and estimate narrowband frequency components using autoregression.

CALENDAR



REQUIRED TEXTBOOK:

- *Biosignal and Medical Image Processing*, 3rd ed. by J. Semmlow & B. Griffel, CRC Press Taylor & Francis Group, 2014. (Available at CSU bookstore)

OTHER REQUIRED MATERIALS:

- *The Elements of Statistical Learning*, 2nd, by Hastie, Tibshirani, and Friedman. Accessible online through https://web.stanford.edu/~hastie/ElemStatLearn/ (https://web.stanford.edu/~hastie/ElemStatLearn/) .
- *Fundamentals of Adaptive Signal Processing*, by Aurelio Uncini. Accessible online through CSU's library subscription at: https://link.springer.com/book/10.1007%2F978-3-319-02807-1. (https://link.springer.com/book/10.1007%2F978-3-319-02807-1)
- MATLAB software. Available on any ENS lab computer, or remotely through the ENS Virtual Classroom (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 1-2	Intro to signal modeling & classification, model complexity, and overfitting.
Week 3-4	Optimal and adaptive filtering.
Week 5	Fourier series, basis expansions, intro to inverse problems and regu
Week 6	Review and exam
Week 7-8	Spectrograms, Wavelets: continuous, discrete, applications for denoising and feature extraction.
Week 9	Review and exam.
Weeks 10-11	Principal and independent component analysis. Dimension reduction.
Week 12-14	Exam on PCA/ICA. Neural networks and applications.
Week 15	Convolutional and deep neural networks.
Week 16	Final

GRADING [draft; to be finalized in the first week of classes]:

Quizzes (online): 20%. Lowest 3 scores will be dropped.

Homework assignments: 40%. Lowest 1 scores will be dropped.

Exams Exam: 20%

Final Project: 20%

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

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/).

HOMEWORK:

Homework will be due one week after it is assigned, , but check the website for updates. Links to the homework can be found on Canvas. **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.

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.

ABSENCES, LATE ASSIGNMENTS: Students are expected to attend all lectures and complete all assignments on time. Late assignments will receive at most half credit. Extensions will be considered only for family/personal/medical emergencies, or official university business.

Course Summary:

Date	Details	Due
Thu Jan 20, 2022	Lecture 01 Summary (Overview) -- Optional (https://colostate.instructure.com/courses/141562/assignments/1725445)	due by 11:59pm
Fri Jan 21, 2022	HW00: MATLAB Warm-up (https://colostate.instructure.com/courses/141562/assignments/1745510)	due by 11:59pm
Sat Jan 22, 2022	Lecture 02 summary (Linear algebra) (https://colostate.instructure.com/courses/141562/assignments/1725446)	due by 11:59pm
Mon Jan 24, 2022	Reading 03: Correlation, covariance, and classification (https://colostate.instructure.com/courses/141562/assignments/1725423)	due by 10am
Tue Jan 25, 2022	Lecture 03 summary (classification overview) (https://colostate.instructure.com/courses/141562/assignments/1725447)	due by 11:59pm
Wed Jan 26, 2022	Reading 04: Linear classifiers (https://colostate.instructure.com/courses/141562/assignments/1725475)	due by 10am
Thu Jan 27, 2022	Lecture 04 summary (classification formalism) (https://colostate.instructure.com/courses/141562/assignments/1725449)	due by 11:59pm
	Project preferences (https://colostate.instructure.com/courses/141562/assignments/1725483)	due by 11:59pm
Fri Jan 28, 2022	HW01: Getting Started (https://colostate.instructure.com/courses/141562/assignments/1725433)	due by 11:59pm
Sat Jan 29, 2022	Lecture 05 summary (classification demo) (https://colostate.instructure.com/courses/141562/assignments/1725448)	due by 11:59pm
Mon Jan 31, 2022	Reading 06: Digital filters (https://colostate.instructure.com/courses/141562/assignments/1725424)	due by 10am
Wed Feb 2, 2022	Convolution matrices (https://colostate.instructure.com/courses/141562/assignments/1725422)	due by 11:59pm
Fri Feb 4, 2022	HW02: Linear classification (https://colostate.instructure.com/courses/141562/assignments/1725434)	due by 11:59pm
	Optimal Filtering (https://colostate.instructure.com/courses/141562/assignments/1725479)	due by 11:59pm
Sat Feb 5, 2022	Lecture 07 summary (FIR filtering as a matrix product) (https://colostate.instructure.com/courses/141562/assignments/1725452)	due by 11:59pm
Mon Feb 7, 2022	Adaptive filtering (https://colostate.instructure.com/courses/141562/assignments/1725420)	due by 11:59pm
Tue Feb 8, 2022	Lecture 06 summary (https://colostate.instructure.com/courses/141562/assignments/1725451)	due by 11:59pm
	Lecture 08 summary (Wiener filtering) (https://colostate.instructure.com/courses/141562/assignments/1803966)	due by 11:59pm
	Preliminary plan (https://colostate.instructure.com/courses/141562/assignments/1725481)	due by 11:59pm
Wed Feb 9, 2022	Fourier series (https://colostate.instructure.com/courses/141562/assignments/1725432)	due by 11:59pm
Thu Feb 10, 2022	Lecture 10 summary (https://colostate.instructure.com/courses/141562/assignments/1725455)	due by 11:59pm
	Lecture 09 summary (Adaptive filtering) (https://colostate.instructure.com/courses/141562/assignments/1803967)	due by 11:59pm
	Preliminary plan peer review (https://colostate.instructure.com/courses/141562/assignments/1725482)	due by 11:59pm
Fri Feb 11, 2022	Regularization (https://colostate.instructure.com/courses/141562/assignments/1725484)	due by 11:59pm
	HW03: FIR filtering as convolution and matrix product (https://colostate.instructure.com/courses/141562/assignments/1725435)	due by 11:59pm
Sat Feb 12, 2022	Lecture 11 summary (https://colostate.instructure.com/courses/141562/assignments/1725456)	due by 11:59pm

Date	Details	Due
	Lecture 10 summary (Fourier Transform / Matrix) (https://colostate.instructure.com/courses/141562/assignments/1805139)	due by 11:59pm
Mon Feb 14, 2022	Reading: Non-orthogonal basis dictionaries (https://colostate.instructure.com/courses/141562/assignments/1804710)	due by 11:59pm
Tue Feb 15, 2022	Lecture 11/12 summary (Nonorthogonal bases and inverse problems) (https://colostate.instructure.com/courses/141562/assignments/1805140)	due by 11:59pm
Fri Feb 18, 2022	Exam 1 (https://colostate.instructure.com/courses/141562/assignments/1725425)	due by 11am
	HW04: Weiner optimal filtering (https://colostate.instructure.com/courses/141562/assignments/1725436)	due by 11:59pm
Mon Feb 21, 2022	Reading: Spectrograms (https://colostate.instructure.com/courses/141562/assignments/1725485)	due by 11:59pm
Tue Feb 22, 2022	Lecture 13 summary (https://colostate.instructure.com/courses/141562/assignments/1725457)	due by 11:59pm
Wed Feb 23, 2022	Reading: Wavelets intro (https://colostate.instructure.com/courses/141562/assignments/1725486)	due by 11:59pm
Fri Feb 25, 2022	HW05: Adaptive filtering (https://colostate.instructure.com/courses/141562/assignments/1725437)	due by 11:59pm
	Wavelets 2 (https://colostate.instructure.com/courses/141562/assignments/1725487)	due by 11:59pm
Sat Feb 26, 2022	Lecture 15 summary (https://colostate.instructure.com/courses/141562/assignments/1725459)	due by 11:59pm
	Lecture 14 summary (https://colostate.instructure.com/courses/141562/assignments/1725458)	due by 11:59pm
Tue Mar 1, 2022	Lecture 16 summary (https://colostate.instructure.com/courses/141562/assignments/1725460)	due by 11:59pm
Thu Mar 3, 2022	Lecture 17 summary (https://colostate.instructure.com/courses/141562/assignments/1725461)	due by 11:59pm
Fri Mar 4, 2022	HW06: Regularized Wiener filter (https://colostate.instructure.com/courses/141562/assignments/1725438)	due by 11:59pm
Sat Mar 5, 2022	Lecture 18 summary (https://colostate.instructure.com/courses/141562/assignments/1814198)	due by 11:59pm
Tue Mar 8, 2022	Mid-semester progress report and proposal (https://colostate.instructure.com/courses/141562/assignments/1725476)	due by 11:59pm
Thu Mar 10, 2022	Mid-semester progress report and proposal peer review, (https://colostate.instructure.com/courses/141562/assignments/1725477)	due by 11:59pm
Fri Mar 11, 2022	HW07: Continuous Wavelets (https://colostate.instructure.com/courses/141562/assignments/1725439)	due by 11:59pm
Tue Mar 15, 2022	PCA (https://colostate.instructure.com/courses/141562/assignments/1725480)	due by 11:59pm
Sat Mar 19, 2022	Lecture 19 summary (https://colostate.instructure.com/courses/141562/assignments/1725462)	due by 11:59pm
Mon Mar 21, 2022	Exam 2 (https://colostate.instructure.com/courses/141562/assignments/1725426)	due by 11:59pm
	Exam 2 (Online) (https://colostate.instructure.com/courses/141562/assignments/1725413)	due by 11:59pm
Tue Mar 22, 2022	Lecture 23 summary (https://colostate.instructure.com/courses/141562/assignments/1725465)	due by 11:59pm
Wed Mar 23, 2022	Independent Component Analysis (https://colostate.instructure.com/courses/141562/assignments/1725444)	due by 11:59pm
Thu Mar 24, 2022	Lecture 20 summary (https://colostate.instructure.com/courses/141562/assignments/1725463)	due by 11:59pm
	Lecture 24 summary (https://colostate.instructure.com/courses/141562/assignments/1725466)	due by 11:59pm
Fri Mar 25, 2022	HW08: Wavelet denoising (https://colostate.instructure.com/courses/141562/assignments/1725440)	due by 11:45pm
	Neural networks (https://colostate.instructure.com/courses/141562/assignments/1725478)	due by 11:59pm
Sat Mar 26, 2022	Lecture 21 summary (https://colostate.instructure.com/courses/141562/assignments/1725464)	due by 11:59pm
	Lecture 25 summary (https://colostate.instructure.com/courses/141562/assignments/1725467)	due by 11:59pm
Tue Mar 29, 2022	Lecture 26 summary (https://colostate.instructure.com/courses/141562/assignments/1725468)	due by 11:59pm
Thu Mar 31, 2022	Lecture 27 summary (https://colostate.instructure.com/courses/141562/assignments/1725469)	due by 11:59pm
Fri Apr 1, 2022	HW09: Principal Component Analysis (https://colostate.instructure.com/courses/141562/assignments/1725441)	due by 11:45pm
Mon Apr 4, 2022	Exam 3 (https://colostate.instructure.com/courses/141562/assignments/1725427)	due by 11:59pm
	Exam 3 (Online) (https://colostate.instructure.com/courses/141562/assignments/1725416)	due by 11:59pm
Fri Apr 8, 2022	HW10: ICA (https://colostate.instructure.com/courses/141562/assignments/1725442)	due by 11:45pm
Sat Apr 9, 2022	Lecture 28 summary (https://colostate.instructure.com/courses/141562/assignments/1725470)	due by 11:59pm
Tue Apr 12, 2022	Lecture 29 summary (https://colostate.instructure.com/courses/141562/assignments/1725471)	due by 11:59pm
Thu Apr 14, 2022	Lecture 30 summary (https://colostate.instructure.com/courses/141562/assignments/1725472)	due by 11:59pm
Fri Apr 15, 2022	Convolutional networks (https://colostate.instructure.com/courses/141562/assignments/1725421)	due by 11:59pm
Sat Apr 16, 2022	Lecture 31 summary (https://colostate.instructure.com/courses/141562/assignments/1725473)	due by 11:59pm
Tue Apr 19, 2022	Lecture 32 summary (https://colostate.instructure.com/courses/141562/assignments/1725474)	due by 11:59pm
Sun Apr 24, 2022	Exam 4 (online) (https://colostate.instructure.com/courses/141562/assignments/1725417)	due by 11:59pm

Date	Details	Due
Tue Apr 26, 2022	Final project paper (https://colostate.instructure.com/courses/141562/assignments/1725429)	due by 11:59pm
Wed Apr 27, 2022	Final project team self-evaluations (https://colostate.instructure.com/courses/141562/assignments/1725431)	due by 11:59pm
Thu Apr 28, 2022	Final project peer review (https://colostate.instructure.com/courses/141562/assignments/1725430)	due by 11:59pm
Fri Apr 29, 2022	HW11: Neural net classifier (https://colostate.instructure.com/courses/141562/assignments/1725443)	due by 11:45pm
	Exam 1 (Online) (https://colostate.instructure.com/courses/141562/assignments/1725415)	
	Roll Call Attendance (https://colostate.instructure.com/courses/141562/assignments/1799460)	