PSYC 315 – Introduction to the Analysis of Psychological Signals – Winter 2025

Objectives

The objectives of this course are to (1) introduce the student to basic techniques for the quantitative analysis of time-varying signals and (2) teach the student how to apply these techniques using MATLAB, the most commonly used high-level computing language used in science and engineering. Emphasis will be placed on methods appropriate to the psychological research environment. The theoretical background for each technique will be presented briefly, but the major stress will be on the application to practical problems. This will be achieved partially by the demonstration of typical analysis procedures. More importantly, students will be required to undertake assignments involving the analysis of simulated and actual psychological data. Expertise in MATLAB or signal processing is not required. Note that we will integrate AI tools (e.g., ChatGPT, CoPilot) into the course, using them both to write and evaluate MATLAB code.

Schedule

Week	Lecture	Date	Labs	Dates
Week 1	Introduction	Jan 6	MATLAB basics	Jan 6, Jan 8
Week 2	1st MATLAB lecture	Jan 13	MATLAB Assignment 1 (Due Jan 20)	Jan 13, Jan 15
Week 3	2nd MATLAB Lecture	Jan 20	MATLAB Assignment 2 (Due Jan 27)	Jan 20, Jan 25
Week 4	Basic Statistical Tools MATLAB Quiz 1	Jan 27	Basic Statistical Tools Assignment 3 (Due Feb 3)	Jan 27, Jan 29
Week 5	Amplitude Structure of Signals	Feb 3	Amplitude Structure of Signals Assignment 4 (Due Feb 12)	Feb 3, Feb 5
Week 6	Frequency Representation of Signals	Feb 10	Frequency Representation of Signals Assignment 5 (Due Feb 24)	Feb 10, Feb 12

Reading Week				
Week 7	Filtering	Feb 24	Filtering Assignment 6 (Due Mar 3)	Feb 24, Feb 26
Week 8	Sampling Considerations MATLAB Quiz 2	Mar 3	Sampling Considerations Assignment 7 (Due Mar 10)	Mar 3, Mar 5
Week 9	Correlation functions	Mar 10	Correlation Functions Assignment 8 (Due Mar 17)	Mar 10, Mar 12
Week 10	Data Collection for Analysis Project	Mar 17	Analysis Project (Due Apr 7)	Mar 17, Mar 19
Week 11	MATLAB Quiz 3	Mar 31	Analysis Project	Mar 31, Apr 2

Course Outline

MATLAB Basics

Basic of the MATLAB programming language; programming environment; scalars, vectors and matrices; matrix operations and relational operators; program control and flow.

Basic Statistical Tools and Concepts

Deterministic and random variables; probability distributions; realizations; range and domain; stationarity, nonstationarity, ergodicity; expected values; moments; standard deviation, coefficient of variation; median, minimum, and maximum values.

Amplitude Structure of Signals

Probability distributions, probability densities, joint probability distributions; statistical independence; Gaussian distribution and its properties; rectangular, exponential, Poisson, and chi-square distributions; amplitude histograms; identification of distributions.

Frequency Domain Representation of Signals

Periodic signals; Fourier series; discrete Fourier spectra; the Fourier transform; power spectra.

Filtering

Types of noise; low-pass, band-pass, high-pass and band-reject filters; Bode plots; cut-off frequency and roll-off; analog filters; digital filters: frequency domain implementations, FIR filters, recursive filters.

Sampling Considerations

Digitization, sampling, and quantization; Shannon-Nyquist sampling theorem; aliasing; Nyquist frequency; quantization theorem; analog-digital converters; digital to analog converters.

Correlation Functions

Auto-correlation, auto-covariance, and auto-correlation coefficient functions; cross-correlation, cross-covariance, and cross-correlation coefficient functions; estimation of correlation functions; relation between correlation functions and spectral densities; practical applications.

Teaching Techniques

This course consists of a single **lecture** each week and two **labs**. The lecture is on Monday at 2:30 and the labs are on Monday at 4:00 and Wednesday at 2:30.

The **lectures** will cover the topic for the *current* week and will include a handout summarizing the material. The assignment from the previous week is due on the Monday of the current week.

The **labs** will go over the MATLAB functions and tools required to complete the assignments. Most of the time will be spent working on the assignment due at the start of the next week.

The assignments are used to stress and develop further the points made in the lectures, demonstrate the applicability, strengths and weaknesses of particular methods, and test for understanding of the material. In the assignments, students will be provided with data sets that they will analyze and report (using plots, tables and text as appropriate).

There will be three MATLAB quizzes during the term, which will involve writing and evaluating code with and without AI tools.

In addition to the assignments, each student will complete a final **project** that will involve the collection, analysis, and evaluation of data using techniques they have learned in the course.

Evaluation

Evaluation will be based on assignments and projects. The 8 assignments will be graded out of 10 and will be worth a total of 65% of the grade. The MATLAB quizzes will be worth a total of 15% of the grade (5% each) The final project will be worth 20% of the grade.