# Syllabus: SIOC 221A, Analysis of Physical Oceanographic Data

Sarah Gille
*Class Meetings:* Monday and Wednesday, 9:30-10:50
*Discussion:* Friday, 9:30-10:20 or 10:00-10:50

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*Course website:* http://pordlabs.ucsd.edu/sgille/sioc221a
*Grading:* letter or S/U

*Course Description:* Fundamental elements of analysis of geophysical and oceanographic time series, including sampling problems, least-squares techniques, spectral analysis, interpretation of series, design of experiments.

*Course Objectives:* During this class you will learn (or refresh your knowledge of) basic statistics, Fourier transforms, time-series analysis methods including least-squares fitting and spectral analysis. Along the way, you should develop your programming skills so that you are able to put the methods that we discuss in class into practice.

*Course requirements:* Complete weekly problem sets (by due dates). You may work on most of the problem sets collaboratively, but you need to work through the problems yourself and write up your own work. If you work in a group, please identify your collaborators. (Science is collaborative, and we always acknowledge our sources and our collaborators.) A mid-term problem set will have about the same scope as the regular problem sets, but you will complete it independently, and you will be asked to sign a statement indicating that the work you submit is your own. The final problem set will be a project based on data that you choose and will also be completed independently. Each problem set will contribute approximately equally to your final grade.

In lieu of a final exam, you will prepare and present a final project based on a data set of your choosing. This will take place during the final exam time slot (Wednesday 16 December, 8:00-11:00). The final exam will count as two problem sets: one grade for the oral presentation and a second for the write up.

Participation also matters, and you have multiple ways to participate and to demonstrate your engagement in the class. Mini-lectures will be posted in advance of class for you to view on your own schedule. I will also post course notes and small segments of textbook reading, which will be available in electronic form. You should review this material in advance of class, post questions/reflections on the course discussion board on Canvas. Feel free to identify topics that need clarification on the course discussion board. Themese that emerge on the discussion board will help determine how we use our in-class time. The general plan is to focus class time on discussion, group learning, and questions/answers/work time for problem sets. Please come to class ready to ask questions and to interact. (If you aren't able to attend class, you can catch up through the asynchronous recording.) Bonus points may be awarded for exemplary class participation in any form.

By the end of the term you should aim to understand time series analysis, including Fourier transforms, spectra, and coherence, and you should be have the programming skills needed to analyze data using these techniques. Everyone starts this class with a different background, and your goal is to advance your own skills—not to compete against your classmates. Please set learning goals for yourself (e.g. to learn Matlab, learn python, develop skills in latex) that reflect your own starting point. And please support each other, and help everyone to learn.

*Topics:*

— Introduction: statistics, probability density functions, mean, standard deviation, skewness, kurtosis

— Error propagation

— Least-squares fitting

— The Fourier transform

— Spectra, spectral uncertainties, using Monte Carlo methods (and fake data) to evaluate formal uncertainties

— Windowing and filtering

— Cross-spectra, coherence, uncertainties of coherence

— Multi-dimensional spectral analysis

— Alternative approaches for computing spectra: multitaper and maximum entropy methods

*Time permitting, we might get to:*

— Rotary spectra

— Filter design

**Texts on reserve for SIOC 221A**

*Electronic resources (available on line and in hard copy):*

Bendat, J. S. and A. G. Piersol, 2010: *Random Data: Analysis and Measurement Procedures*. John Wiley & Sons, 4th edition.

Koopmans, L. H., 1995: *The spectral analysis of time series*, Academic Press.

Thomson, R. E. and W. J. Emery, 2014: *Data Analysis Methods in Physical Oceanography*, 3rd edition, Elsevier.

von Storch, H. and F. W. Zwiers, 1984: *Statistical Analysis in Climate Research*, Cambridge University Press.