MAST-811 Time Series Analysis (Fall 2016)

Instructor: Andreas Münchow (muenchow@udel.edu)
Web-Site: http://muenchow.cms.udel.edu/classes/MAST811
Time: Tuesday and Thursday 17:00-18:15
Location: 203 Robinson Hall

Goal: Provide each student with a set of tools to confidently handle common data analysis task in both the time (space) and frequency (wave number) domains.

Synopsis: The class is applied and focused on students to develop their own computer programs in the analysis of time series drawn from real problems. Topics to be discussed include the nature of time series, stationarity, auto and cross covariance functions, power and cross spectra and the analysis of linear time-invariant relationships between pairs of series. The class consist of lectures, but most learning takes place via a set of computer-based projects that translates lecture materials into tested codes to apply

(1) Auto-spectral analysis,
(2) Digital filters,
(3) Linear systems.
(4) Least-squares function fitting,
(5) Empirical orthogonal functions, and
(6) Grid interpolation techniques

to data with known signal to noise properties and the uncertainties associated with these.

Pre-requisites: Fourier transforms, programming in a compiled language (C, Fortran, etc.)

Grades: 80% analysis projects, 10% homework problems, 10% in-class participation

Text: The class has been developed over the years from extensive notes that Prof. Wong developed at the University of Delaware and the current instructor at Rutgers University, but the following books are relevant (alphabetical order):

1. Bendat, J.S. and A. G. Piersol, 1986. Random Data: Analysis and Measurement Procedures, 2nd ed., John Wiley, New York, NY, 566 pp.

2. Emery, W.J. and R.E. Thompson, 2001. Data analysis methods in physical oceanography, 2nd ed., Elsevier Science, Amsterdam, Netherlands, 658 pp.

3. Press, W.H. et al., 2007. Numerical Recipes 3d edition: The Art of Scientific Computing. Cambridge University Press, Cambridge, UK, 1256 pp.

MAST-811: Time Series Analysis (Fall 2016)

Instructor:	Andreas Muenchow	muenchow@udel.edu
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Grading: 80% computer exercises on
(a) Fourier transforms
(b) Linear systems
(c) Filtering, harmonic analysis
(d) Empirical orthogonal functions

10% home work exercises
10% final oral presentation

Text Books:	Bendat and Piersol (1986)	Random Data: Analysis and measurement …
	Emery and Thompson (1997)	Data analysis methods in physical oceanography
	Press et al. (1992)	Numerical recipes: The art of scientific computing

Course Outline (numbers indicate approximiate number of weeks per topic)

A. Introduction (1)
Definitions, data types, sources, and their sampling
Review of basic concepts (Fourier series and transforms)

B. Sampling (2)
Sampling theorem
Discret Fourier transform, Fast Fourier Transform

C. Digital Filters (1)
Non-recursive filters (Godin, raised-cosine, Lanczos)
Recursive filters (Butterworth filter)

D. Auto-spectral Analysis (2)
Probability density functions, central limit theorem
Auto-correlation, Periodigram, Confidence limits

E. Linear Systems (2)
One input – one output system (coherence and phase)
Multiple input – one output system (partial and multiple coherence)

F. Harmonic Analysis (1)
Tidal Analysis (time domain)
Least squares function fitting (time and space domain)

G. Empirical Orthogonal Function (Principal Component) Analysis (2)
Scalar and vector fields in time/space domain
Scalars in frequency/wave number domain

H. Grid Interpolation (2)
Objective Analysis, Kriging
Minimum curvature and biharmonic splines