GLY 5457: Geophysical Data Analysis
Department of Earth Sciences
Fall 2011
MW 5:00-6:15 PM; PC 326A

Syllabus (8/22/2011)

Instructor:
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Office Hours: M/Tu 2:00-4:30 or by appointment

Course Description:
This course explores computer analysis and modeling of geophysical data and digital images. Topics include statistical description of data, linear inverse theory, digital signal and image processing. Computer exercises with MATLAB.

Prerequisites:
Differential and Integral Calculus. Physics and Statistics are recommended.

Course Materials
Required Text:
Bevington, P. H., and D. K. Robinson, Data Reduction and Error Analysis for the Physical Sciences, Third Ed., McGraw Hill, 2003.

Recommended Text/Program (buy on your own):
MATLAB Student Version – available through the bookstore or from the Mathworks web site: http://www.mathworks.com/products/studentversion/

- MATLAB is installed in various computers in the department including PC 324. However, you may want to purchase the student version at a much discounted price (~$100) for installation on your own personal computer. This version is available to registered students and is good for 4 years.

Free Electronic Texts from the internet and on provided CD:
- Press, W., B. Flannery, S. A. Teukolsky, W. T. Vetterling, *Numerical Recipes, 3nd Edition*, Cambridge University Press, 1997
  - 3rd Ed. Can be purchased from http://www.nr.com
  - 2nd Ed. Available Free at http://www.nr.com/oldverswitcher.html
    - (selected chapters on CD)
- From *Samizdat Press* http://samizdat.mines.edu/
  Scales J., Smith, M., and Trietel, Introductory Geophysical Inverse Theory, Samizdat Press, 2001, 193 pp.
  Snieder, R., and Trampert, J., Inverse Problems in Geophysics,1999
- From Stanford University http://sepwww.stanford.edu/sep/prof/index.html
  Claerbout, J., Fundamentals of Geophysical Data Processing (FGDP) 1976.
  Claerbout, J., Fourier Transforms and Waves in four lectures, 1999

Books on reserve in PC 324:
Gubbins, D., Time Series Analysis and Inverse Theory for Geophysicists, Cambridge University Press, 2004.

Menke, W., Geophysical Data Analysis: Discrete Inverse Theory, Academic Press, 1989.
Middleton, G. V., Data Analysis in the Earth Sciences Using Matlab, Prentice Hall, 2000.
Kanasewich, E., Time Sequence Analysis in Geophysics, University of Alberta Press, 1981.

Grading:
Problem sets and projects: 50%; Midterm 25%; Final Exam 25%

Homework Assignments:
Homework assignments will consist of MATLAB based exercises and will be assigned approximately every 1-2 weeks. Normally you will have 1 week to complete the assignment. Assignments will normally be due at the beginning of class. Homework assignments received after that time will be considered late and marked off at a rate of 25% per week.

Exams
Exams will be closed book 75 minute exams. Exams will cover all material in the assigned readings, lectures, and exercises, and will generally consist of short essays and problems. The midterm exam will cover material from the first section of the course and the final exam will cover material for the second part of the course.

University Policy on Academic Misconduct
Florida International University is a community dedicated to generating and imparting knowledge through excellent teaching and research, the rigorous and respectful exchange of ideas, and community service. All students should respect the right of others to have an equitable opportunity to learn and honestly to demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the Student Handbook.

Tentative Course Outline (9/22/2011):

Week 1:	Introduction: models, formulating forward and inverse problems Introduction to MATLAB;
Week 2 :	Statistics, errors, probabilities, and distributions. Random variables. Propagation of Errors Quantification of errors.
Exercise 1:	Introduction to MATLAB. The Distribution of Error and the Central Limit Theory
Week 3:	Review of linear algebra: matrices, vectors and linear systems
Exercise 2:	Using MATLAB to do linear algebra and least squares problems
Week 4:	Linear Inverse theory. The method of least squares, weighted least squares.
Exercise 3:	Over determined linear and non-linear inverse problems
Week 5:	Solving underdetermined or mixed determined problems. The generalized inverse. Covariance, resolution, and information matrices. The Singular value decomposition
Exercise 4:	Solving underdetermined linear inverse problems
Week 6:	Modeling Surfaces. Geostatistics and Kriging.
Exercise 5:	Variograms and Kriging in MATLAB
Week 7 & 8	Solving nonlinear problems: linearization and parameter search techniques. Solving Large Systems. Iterative techniques. Applications: acoustic tomography, earthquake location.

Midterm: Inverse Theory

Week 8 & 9:	Introduction to digital signal/image analysis and processing. Review of complex variables. Fourier's theorem. Sine and Cosine Series; Complex Fourier Series, spectral description of data. The Fourier Transform, properties; The DFT, FFT
Exercise 7:	Spectral Analysis with the Fast Fourier transform
Week 10 & 11:	Convolution and Filtering, Moving averages, FIR and IIR filters. Sampling Theorem, Aliasing. Subaveraging
Exercise 6:	Digital Filtering I: Time (*space*) Domain
Week 12 & 13:	Filtering in the frequency domain; impulse response and transfer function; windowing considerations and ringing; tapering
Exercise 8:	Digital Filtering II, frequency domain
Week 14 & 15:	Application of spatial and the 2-D Fourier transform to digital images. Smoothing, edge enhancement, directional filtering, reduction to the pole, f-k filtering
Exercise 9:	2-D filtering applications, image processing:
FWS	**Final Exam**