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:

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:
  - 3rd Ed. Can be purchased from http://www.nr.com
    • (selected chapters on CD)
- From Samizdat Press http://samizdat.mines.edu/
  Snieder, R., and Trampert, J., Inverse Problems in Geophysics, 1999
- From Stanford University http://sepwww.stanford.edu/sep/prof/index.html
  Claerbout, J., Fourier Transforms and Waves in four lectures, 1999

Books on reserve in PC 324:

**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;

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

Exercise 5: Variograms and Kriging in MATLAB

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