



INSTITUTE OF SPACE TECHNOLOGY

COURSE SYLLABUS

Program: MS in RS & GISc
Department: Space Science (SS)
Course Code: RG-754
Course Name: Data Analysis for the Earth Sciences
Credits: CR 3-0
Instructors: Dr. Waqas A. Qazi
Email: waqas.qazi@grel.ist.edu.pk
Office: Room 226 - Block II
Phone: 051-9075583

Prerequisites:

The required prerequisite for taking this elective course is RG 701 Advanced Research Methods

Strong background in mathematics and understanding of the basics of statistics are required as a necessary pre-requisite for this course. Students are expected to know or learn programming on MATLAB, and gain relevant expertise on MATLAB during the course. Consent from instructor is required for each student before registration of this course.

Course Description:

This is an extensive graduate-level course on data analysis methods and techniques for datasets related to earth sciences, remote sensing, and geographical information science. It gives exposure to students on a variety of traditional and modern quantitative mathematical / statistical methods for analyzing data. The course will require extensive use of MATLAB as a programming and data analysis tool. Regular assignments will be given, and will form an integral part of the course learning.

A course project will let students apply the data analysis methods learnt in class on real datasets of their own choice. The output of the class project will be in the form of a presentation and report. More details about the project will be provided during the course.

COURSE PLAN

Week	Topics	Reading Material
1	<ul style="list-style-type: none">- Intro to the Course- Intro to MATLAB	<ul style="list-style-type: none">- MATLAB Resources- Trauth_Ch2
2	<ul style="list-style-type: none">- Intro to MATLAB:<ul style="list-style-type: none">- m-files- functions- Data Types- Intro to data analysis techniques- Uncertainties in measurements	<ul style="list-style-type: none">- MATLAB Resources- Trauth_Ch1- Trauth_Ch2



Week	Topics	Reading Material
3	<ul style="list-style-type: none">- Sampling, Sampling Interval and Sampling Duration- Nyquist Sampling Theorem- Random variables and probability- PMF and PDF- CDF	<ul style="list-style-type: none">- Trauth2007, p. 30-31- ThomsonEmery2014, Sec. 3.3
4	<ul style="list-style-type: none">- Descriptive statistics- Degrees of Freedom- Theoretical Probability distributions- Statistical hypothesis testing<ul style="list-style-type: none">- t-test- F-test- Chi-square test	
5	<ul style="list-style-type: none">- Correlation- Regression<ul style="list-style-type: none">- Linear regression- Ordinary Least Squares (OLS)- OLS Minimization for linear regression- Standard Error for regression	
6	<ul style="list-style-type: none">- Regression<ul style="list-style-type: none">- The Random Error variable and its distribution- Curvilinear / polynomial regression- Multi-linear regression- Non-linear regression- Confidence Intervals for linear regression- MATLAB functions for regression- Analysis of residuals- Bootstrapping & Jackknifing	
7	<p>*** MIDTERM EXAM ***</p> <ul style="list-style-type: none">- Time Series Analysis<ul style="list-style-type: none">- Intro to time series- Fourier series & Fouriter transform- Time domain and frequency domain	
8	<ul style="list-style-type: none">- Time-series analysis<ul style="list-style-type: none">- Fourier transform properties- Important Fourier transforms- The DFT- MATLAB FFT function	
9	<ul style="list-style-type: none">- Time-series analysis<ul style="list-style-type: none">- Finite time series and DFT- Spectral analysis- Wiener-Kinchin Theorem- Parseval Theorem- Windowing	
10	<ul style="list-style-type: none">- Time-series analysis<ul style="list-style-type: none">- Autospectrum- Plotting spectra- Blackman-Tukey spectrum- Linear trend analysis	



Week	Topics	Reading Material
11	<ul style="list-style-type: none">- Time-series analysis- Windowing- Cross-spectrum- Coherence- Cross-spectrum phase analysis- Intro to Mapping Toolbox- Plotting directional data	
12	<ul style="list-style-type: none">- Analyzing and plotting directional data- Intro to Image Processing Toolbox	
13	<ul style="list-style-type: none">- Data Filtering- Principal component analysis	
14	<ul style="list-style-type: none">- Objective analysis (OI)	
15	<ul style="list-style-type: none">- Application Examples / Seminar	
16	Class Project Presentations	
17	***Final Exam***	

Reading/Reference Materials:

Recommended Textbooks:

- William J. Emery & Richard E. Thompson (2004), Data Analysis Methods in Physical Oceanography
- Martin H. Trauth (2007), MATLAB Recipes for the Earth Sciences, 2nd Ed.

Supporting & Reference Books and Readings:

- To be assigned by instructor
-

TEACHING METHODOLOGY

The course will be taught using lectures, in-class discussions, homework assignments, and individual research projects.

ASSESSMENT:

The general grading distribution is as follows (subject to change):

Assignments	30%
Course Project	15%
Mid-term Exam	25%
Final Exam	30%
<hr/>	
Total	100%



GENERAL COURSE POLICIES:

- The Course Grading percentage distribution may be changed by the end of the course. Students will be notified if such changes take place.
- The classroom environment shall preferably be active and open discussions are very much favored, but please try to stick to the topic under discussion.
- In assignments, any/all references must be PROPERLY quoted and cited and this must be STRICTLY followed. Marks will be deducted if this strict rule is not attended to.
- All graded work must be the original effort of the student. Plagiarism (either copying from another student or writing text without proper referencing) will NOT be tolerated. Severe grading loss may result, so please be careful. A quick search on Google will show you what plagiarism is and how to avoid it. It is your responsibility to avoid plagiarism.
- Do NOT take assignment deadlines lightly. If you have a problem, come to the instructor before the deadline, not after it. Deadlines will not be relaxed unless in case of an emergency. Marks will be deducted, as deemed suitable, for late submissions.