224.4043 –Time series analysis Semester B

Time: [Sunday] [12:00-14:00], Room [Terrace Building #2013]

Instructor: [Prof.] [Boris] [Katsnelson],

Office Hours: [Thursday] [12:00-14:00], Room [258], [046647985]

Teaching Assistants & Office Hours:

[Boris] [Katsnelson] – [Monday] [10:00-12:00], Room [258],
[bkatsnels@univ.haifa.ac.il]

Course Type : Lecture/Computational Lab

Course Level : MSc/ PhD

Pre-Requisites: Advanced topics in mathematics and physics for Marine sciences

Course Overview:

The course is designed to introduce students to the Fourier analysis, methods of the signal processing, including practical skills within the framework of MATLAB tools. Program of the course includes forward and inverse Fourier transform (fft and ifft in MATLAB), analysis of spectrum of the signal, windowed Fourier transform, construction and analysis of spectrogram, methods and tools of filtering. Analysis of selection of desired signal on the noise background, estimation of the signal to noise ratio (SNR). Main attention is paid on practical skills using MATLAB tools.

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Topics:

1. ***Introduction***. Goal of the course. Main concepts, signal, noise, desired signal. Physical examples. Probability density function (PDF)
2. ***Mathematical background***. Vectors and vector space. Basis. Functional space, orthogonal and normalized basis. Correlation.
3. Fourier series, decomposition, correlation coefficient. Cross correlation function. Auto-correlation function.
4. Decomposition of different functions into Fourier series. Spectral coefficients (Fourier components).
5. Complex Fourier series. Parseval's theorem.
6. Fourier integral. Forward and inverse Fourier transform. Spectrum and its properties. Examples of decomposition. Amplitude and phase spectra.
7. ***Application***. MATLAB tools for Fourier analysis. fft and ifft programs. Examples of applications.
8. Dirac delta function. Idea of filtering. Windowed Fourier transform, spectrogram. Wavelet.
9. Convolution and deconvolution, Fourier transform of convolved signals, theoretical background of filtering. MATLAB tools.
10. Filtering of the desired signal on the noise background. Practical examples using MATLAB.
11. Practical calculations of spectrograms, convolution, spectra and filtering using MATLAB

At the end of the course students will be able to: [Learning Outcomes]

1. Have basics knowledge about Fourier analysis, decomposition of signal, spectrum and spectrogram

2. Have the skills on application of MATLAB tools

3. Carry out basic data processing: to get spectrum of signal, spectrogram, to carry out filtering and to improve SNR

Requirements: Attendance, **Exam**, **Homework assignments**

Grading:

Passed, if final grade is 65-100,

Website: [http://marsci.haifa.ac.il/en/academics/marine-geosciences/marine-geosciences-courses]

Reading List:

R.Bracewell. The Fourier analysis and its application. McGraw Hill, 2003.

Chu E. Discrete and continuous Fourier transforms. Analysis, applications and fast algorithms. CRS press, 2008