INSTITUTION	NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS						
SCHOOL	SCHOOL OF SCIENCE						
DEPARTMENT	INFORMATICS AND TELECOMMUNICATIONS						
COURSE LEVEL	UNDERGRADUATE						
COURSE TITLE	**Stochastic Signals**						
COURSE CODE	**C04**		**Semester**	**Spring**	**ECTS**	**6**	
TEACHING HOURS per week	**THEORY**	**3**	**SEMINAR.**	**1**	**LABORATORY**		
URL	https://eclass.uoa.gr/courses/DI461/						

COURSE CONTENT
The course focuses on stochastic signals / random processes covering the basic mathematical tools of their qualitative and quantitative characterization as well as their processing. In the first part of the course, an overview of basic concepts of linear algebra (norms, vector spaces, eigenvalues and eigenvectors of a matrix), probabilities (definitions and properties) and random variables (statistical functions and metrics, transformation of random variables, multiple random variables, correlation, orthogonality, well known distributions, estimators). In the second part of the course, we study random processes (power spectrum, stationarity, ergodicity), their time and frequency analysis (periodogram, filtering, principal component analysis, parametric methods AR, MA, ARMA), Wiener filters, maximum likelihood estimation, Kalman filtering, and the reduced rank minimum variance filter as well as their applications (processing in noisy environments, linear prediction, system identification, multi-antenna systems) and basic adaptive filtering methods (steepest descent method as well as algorithms LMS, NLMS, and RLS). The course's theory and exercises contain example applications of the methods for analyzing and processing stochastic signals in fifth generation (5G) communications systems.

STUDENT LEARNING OBJECTIVES
Upon successful completion of the course the student will be able to: • Define statistical functions and metrics of random variables as well as well-known distributions of a marginal and multiple random variables. • Distinguish the key estimators of the main statistical metrics. • Calculate statistical functions of transformations of random variables. • Define the basic properties of random processes. • Develop methods of stochastic signal analysis: periodogram, filtering, principal component analysis, and parametric methods AR, MA, ARMA. • Implement methods of stochastic signal analysis using embedded functions in well-known software packages for mathematical programming. • Estimate parameters of AR models via the maximum likelihood estimation method. • Design the Wiener and Kalman filters, as well as the reduced rank minimum variance filter. • Develop the basic adaptive filtering methods and recognize the suitability of their use in various applications of stochastic signal processing.

TEACHING AND LEARNING METHODS - ASSESSMENT	
TEACHING METHOD	In Class (Face to Face)

USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

Learning process supported by the e-class platform. More specifically: Course Description, Material Supply, Announcements, Calendar, Assignment and Submission of Exercises, Discussion on Exercises, Questionnaires, External Links)

E-mail communication

Live transmission of lectures

Ability to follow recorded lectures

TEACHING ORGANIZATION

Describe in detail the way and methods of teaching:
Enhanced Lectures,
Online Lectures,
Seminars,
Tutorial,
Laboratory,
Laboratory Exercise,
Study & analysis of literature,
Practice (Positioning),
Interactive teaching,
Developing a project,
Individual / group work
Telework (reference to tools)etc.

Details of the student's study hours for each learning activity and hours of non-guided study are shown to ensure that the total workload at the semester corresponds to the ECTS

Activity	***Student Workload*** *(hours)*
Lectures	39
Seminars	13
Two (2) Personalized Programming Exercises	24+24=48
Independent Study	50
Total Course (25 hours of workload per unit of credit)	***150***

The course's lectures and seminars are given through slide show presentations. Two individual programming exercises (one for each part of the course) are given in order to embed the theory through the programming of taught methods of stochastic signal processing in Matlab or Python mathematical programming software. Support for the exercises is given via discussions in eclass.

ASSESSMENT OF STUDENTS

Description of the assessment process

Assessment Methods, Formative or Concluding, Multiple Choice Test, Quick Response Questions, Test Development Questions, Problem Solving, Written Work, Report / Report, Oral Examination, Public Presentation, Laboratory Work, Other / Other

Fully defined evaluation criteria are mentionedand if and where they are accessible to students.

Students are assessed with two (2) compulsory individual exercises and one (1) final written examination. The written examination covers the theoretical part of the course, while the exercises are based on the programming of applications for understanding the theory. The exercises are evaluated with classified criteria and communicated to the students. Complaints and retrains are allowed.

Assessment methods	***Number***	***Percentage***
Personalized Programming Exercises	2	25%+25%=50%
Final work	1	50%

LITERATURE AND STUDY MATERIALS / READING LIST

1. «Statistical Signal Processing and Learning: Basic Definitions, Algorithms, and Models», D. Ambeliotis, C. Maurokefalidis, K. Berberidis, Kallipos, 2015. **(available online)**
2. «Principles of Communication Networks and Systems», N. Benvenuto and G. Cherubini, University of Patras, 2004. **(available online via eudoxus.gr)**