

**ΟΙΚΟΝΟΜΙΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ
ΑΘΗΝΩΝ**



**ATHENS UNIVERSITY
OF ECONOMICS
AND BUSINESS**

SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

DEPARTMENT OF STATISTICS

**UNDERGRADUATE STUDIES GUIDE
2017-2018**

ATHENS, SEPTEMBER 2017

A. PART A: INFORMATION ABOUT THE INSTITUTION

A1. Name, Address and contact info

Athens University of Economics and Business (AUEB)

76 Patision str, Athens, 104 34

Call Centre +30 (210) 8203911

webmaster@aueb.gr

<http://aueb.gr>

A.2 Academic Calendar

- **Fall Semester:** October 2nd 2017 to January 12 2018
- **Christmas Holidays:** December 23rd 2017 to January 7 2018
- **Fall Semester Exam Period:** January 15th 2018 to February 9 2018
- **Spring Semester:** February 12th 2018 to May 25 2018
- **Easter Holiday :** April 2nd 2018 to April 15 2018
- **Spring Semester Exam Period:** May 29 2018 to June 22 2018

- **Official Holidays**
 - November 17th (Athens Polytechnic Uprising Day)
 - January 30 (The Three Patron Saints of Education Day)
 - February 19 (Clean Monday)
 - May 1st (Labor Day)
 - May 28 (Holy Spirit Day)

A3. Academic authorities

The organization and operation of the Foundation is governed by the applicable law N.4485/2017 (FEK 114/ 4-8-2017). The Athens University of Economics and Business is under the supervision of the Ministry of Education, Research and Religious Affairs.

SENATE

The **Senate** consists of:

- The Rector,
- The Vice Rectors (until the elections for Rector take place, they do not participate or hold a voting right in the Senate),
- The Deans ,
- The Heads of Departments,
- A representative of the undergraduate students, one of the postgraduate students and one of the doctoral candidates,
- One representative per staff category, EEP, EDIP, ETEP and Administrative staff

THE RECTORATE

The University's Rectorate consist of the Rector and the Vice Rectors, as described below:

The Rector

Professor Emmanouil Giakoumakis

The Vice Rectors

Vice Rector of Student and Administrative Affairs

Professor Dimitrios Bourantonis

Vice Rector of Research

Professor Dimitrios Gritzalis

Vice Rector of Financial Planning and Development

Associate Professor Georgios Ksilomenos

THE SCHOOLS

The Athens University of Economics and Business consists of **three Schools**:

1. **SCHOOL OF ECONOMICS:** Oversees and coordinates the operation of the Department of International and European Economic Studies and the Department of Economics.
2. **SCHOOL OF BUSINESS:** Oversees and coordinates the operation of the Department of Management Science and Technology, the Department of Business Administration, the Department of Accounting and Finance and the Department of Marketing and Communication.
3. **SCHOOL OF INFORMATICS:** Oversees and coordinates the operation of the Department of Informatics and the Department of Statistics.

According to Law 4485/2017 (FEK 114/ 4-8-2017), the Institutions of the School are: a) the General Assembly, b) the Deanship, and c) the Dean

THE DEPARTMENTS

The Department is the Foundation's main educational and academic unit. It promotes science, technology or arts in the relevant scientific field, organizes teaching within the curriculum and ensures the continuous learning improvement. The Department consists of members of Academic Staff, members of the Special Educational Staff (EEP), members of the Laboratory Teaching Staff (EDIP) and members of the Special Technical Laboratory Staff (ETEP).

The Departments of the University are:

1. International and European Economic Studies
2. Economics
3. Management Science and Technology
4. Business Administration
5. Accounting and Finance
6. Marketing and Communication
7. Informatics
8. Statistics

According to Law 4485/2017 (FEK 114/ 4-8-2017), the Institutions of the Department are: a) the General Assembly, b) the Board of Directors and c) the Head of the Department

UNIVERSITY STAFF

University's staff consists of the following categories:

➤ **TEACHING STAFF:**

- Academic Faculty: Teaching and Research faculty, which consist of: (a) Professors, (b) Associate Professors, (c) Assistant Professors and (d) Lecturers.
- Special Teaching Staff (Ε.Ε.Π.).
- Special Teaching Laboratorial Staff (Ε.ΔΙ.Π).
- Special Technical Laboratorial Staff (Ε.Τ.Ε.Π.).
- Assistant Teaching Personnel (ΕΔΠ).
- Academic Scholars
- Adjunct instructors

➤ **ADMINISTRATIVE STAFF**

SERVICES

The Athens University of Economics and Business provides both administrative and other services (catering, housing, library, sports, etc.) to cater its students as well as the administrative and teaching staff. More information on the organization and operation of the University's services can be found at the website (<http://www.aueb.gr>).

A4. General Description of the University

The Athens University of Economics and Business (AUEB), as a Higher Educational Institution, is a legal entity governed by public law and supervised by the Ministry of Education, Research and Religious Affairs.

AUEB is, in order of seniority, the third Higher Education Institution of the country and the first in the field of Economics and Business Administration. The scientific fields of Informatics and Statistics were added later. Since its foundation in 1920 up to today, AUEB has a rich history of significant scientific achievements that characterize presence and set excellent prospects for the future.

The Athens University of Economics and Business (AUEB) has been historically established in the collective consciousness of the academic community - Greek students and society - as a leading University in its core areas of expertise. At an international level, the University's unwavering strategic goal is to actively participate in the global academic environment, to develop high-profile international collaborations, and to generally enhance its international impact and recognition through excellence in research and education.

Its reputation reflects, on the one hand, the high level of the scientific staff, the quality of its research and teaching work and the contemporary curricula and, on the other, the high

scientific training of its graduates, which enables them to be professionally employed successfully, both in Greece and abroad.

A5. List of offered curricula leading to an academic title

The following programs, leading to an academic title, are offered at the Athens University of Economics and Business:

A/A	DEPARTMENT'S STUDY PROGRAM	CYCLES(*)
1.	Department of International and European Economic Studies	1. International Economics and Finance 2. International and European Political Economy
2.	Department of Economics	1. Economic Theory and Policy 2. Business Economics and Finance 3. International and European Economics
3.	Department of Management Science and Technology	1. Operations Research and Business Analytics 2. Operations and Supply Chain Management 3. Software and Data Analysis Technologies 4. Information Systems and Electronic Business 5. Strategy, Entrepreneurship and Human Resources
4.	Department of Business Administration	1. Management 2. Information Systems Management 3. Accounting and Financial Management 4. Marketing
5.	Department of Accounting and Finance	1. Accounting 2. Finance
6.	Department of Marketing and Communication	1. International Management, Innovation and Entrepreneurship 2. Human Resource Management 3. Business Analytics 4. Digital Marketing
7.	Department of Informatics (*)	1. Theoretical Computer Science 2. Computer Systems and Networks 3. Information Systems and Information Security 4. Databases and Knowledge Management 5. Operational Research and Economics

		of Information Technology 6. Computational Mathematics and Scientific Calculations
8.	Department of Statistics	

More detailed information is provided at the corresponding course guides and the departments' websites.

Undergraduate studies at the Departments of the Athens University of Economics and Business are conducted on the basis of the system of six-month courses and according to the Undergraduate Studies Program prepared by the Assembly of each Department. The academic year starts on September 1st and ends on August 31st of the following year. The educational work of each academic year is structured in two semesters, the winter and the spring semester. The duration of undergraduate studies is four years (eight semesters).

The courses of each semester last 13 weeks and are interrupted during the Christmas and Easter periods. At the end of each semester, the exam period lasts four weeks.

After completion of the June exam period and until the end of the academic year, there are no courses.

In the last week of August begins the exam period of September (repetitive examination period), which lasts four weeks and ends before the start of the winter semester.

The exact starting and ending dates for the semesters and exams periods are proposed by the Department of Education of the Directorate for Education, approved by the Senate and announced in the academic journal of the University.

A6. Admission and Registration Procedures

Admission to the department takes place through the Pan-Hellenic exams. Registration of the students that succeeded at the Pan-Hellenic Exams, at the Universities, and thus at AUEB, takes place every September through the system of compulsory electronic registration, according to the instructions of the Ministry of Education, Research and Religious Affairs.

A7. Basic Regulations of the University (including academic recognition procedures)

The basic regulations of the University include, among others:

- ✓ The University's Internal Rules of Operation
- ✓ Administrative Services Regulation
- ✓ The Rule of Operation for the Postgraduate and Doctoral Programs
- ✓ The Internal Rule for conducting post – Doctoral Research
- ✓ The Exams Guide

A8. The ECTS Coordinator of the Foundation

The University's ECTS Coordinator is the Chairman of the Quality Assurance Unit, who ensures compliance with the principles and rules of the European accumulation and transfer credit system, supervises the compliance and implementation and is responsible for the full acknowledgment and transfer of credit units.

B. PART TWO: INFORMATION ABOUT COURSE PROGRAMS LEADING TO AN ACADEMIC TITLE AQUISITION

A) General Description

✓ **Academic Title offered:**

Degree in Statistics

✓ **Admission Requirements**

Students are admitted by the Department through the Pan-Hellenic Exam system and the rules defined regarding special student categories.

✓ **Educational and Professional aims**

The aim of the Department is to promote and transmit knowledge in the field of statistical science and its related subjects, theoretical and applied, through research and education, by preparing graduate scientists with the ability to implement appropriate methods of statistical analysis in various fields of activity (eg. economic, social, business, administrative, research, educational, etc.).

✓ **Access to further studies**

Department graduates have access to postgraduate studies in a wide range of programs, both in Greece and abroad, with a comparative advantage their solid mathematical and statistical background of quantitative and computational methods of analysis, which, combined with the ability to choose courses from other departments, gives them access to a wide range of subjects and their orientation in their postgraduate studies.

✓ **Course Curriculum with credits
(60 per year)**

The general structure of the course program is displayed in the below table:

A' Semester	B' Semester
<ul style="list-style-type: none"> • Probability I (C) • Calculus I (C) • Linear Algebra I (C) • Introduction to Programming with R (C) 	<ul style="list-style-type: none"> • Probability II (C) • Calculus II (C) • Linear Algebra II (C) • Introduction to Probability and Statistics with R (C)
C' Semester	D' Semester
<ul style="list-style-type: none"> • Estimation and Hypothesis Testing (C) • Stochastic Processes I (C) • Introduction to Mathematical Analysis • Demographic Statistics • Introduction to Economic Theory • Introduction to Computerized Accounting and Finance 	<ul style="list-style-type: none"> • Linear Models (C) • Time Series Analysis (C) • Sampling • Mathematical Methods • Actuarial Science I • Numerical Methods in Statistics
E' Semester	F' Semester
<ul style="list-style-type: none"> • Generalized Linear Models (C) • Bayesian Statistics • Statistical Quality Control • Econometrics 	<ul style="list-style-type: none"> • Data Analysis (C) • Simulation • Multivariate Statistical Analysis • Non Parametric Statistics

• Theoretical Statistics	• Biostatistics I
G' Semester	H' Semester
<ul style="list-style-type: none"> • Applied Linear Models • Probability Theory • Statistical Learning • Biostatistics II • Introduction to Operational Research • Stochastic Processes II • Actuarial Science II • Research Methodology • Special Topics in Probability and Statistics • Bachelor Thesis • Practical Training 	<ul style="list-style-type: none"> • Categorical Data Analysis • Advanced Sampling Methods • Statistical Methods for the environment and ecology • Official Statistics • Bayesian Inference Methods • Special Topics in Probability and Statistics • Bachelor Thesis • Practical Training

(C) : compulsory courses

The student can choose from a list of courses offered by other departments.

✓ **Final Exam**

Exams take place at the end of each semester, as well as in the repetitive exams period in September. The department does not support any extra exam periods.

✓ **Exams and Evaluation/ Grading Rules**

As defined by the University regulations.

✓ **Departments ECTS Coordinator**

The Department's ECTS Coordinators are Professor D. Karlis with Associate Professor A. Livada.

B) Individual Course Description

1° YEAR

A' Semester

Probability I (code: 6001)

Course type: Compulsory

Course level: First studies cycle

Instructor: Professor E. Kyriakidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course the students should be able to understand the different ways to calculate probabilities of events, solve problems by using the laws of probability, revise probabilities by using Bayes' rule, use random variables with realistic applications, and choose the appropriate probability model.

Prerequisites: none

Syllabus: Sample space, events, Definition of Probability, elementary combinational analysis. Properties of probabilities, independent events, Conditional Probabilities, Law of Total Probability, Bayes theorem. Discrete random variables, Joint distribution of random

variables. Independence. Mean value, Variance, Markov and Chebyshev inequalities. Uniform, binomial, geometric and hypergeometric distributions, Poisson distribution.

Continuous distributions. Distribution function and probability density function. Mean, variance. Uniform, exponential and normal distribution. Gamma and Beta distributions. Moment generating functions.

Recommended Reading

- Κούτρας Μ., Εισαγωγή στη Θεωρία Πιθανοτήτων και Εφαρμογές, Εκδόσεις ΤΣΟΤΡΑΣ ΑΝ ΑΘΑΝΑΣΙΟΣ, 2016.
- Feller, W. (1968). An Introduction to Probability Theory and its Applications. Wiley, N.Y.
- Hoel P., Port S., Stone C., Εισαγωγή στη Θεωρία Πιθανοτήτων, ΙΤΕ Παν/κές Εκδόσεις Κρήτης, 2009.
- Hogg, R. and Graig, A. (1970). Introduction to Mathematical Statistics, Third Ed., The Macmillan Co., New York.
- Hogg,R.V. and Tanis,E.A. (2000). Probability and Statistical Inference. Prentice Hall.
- Mendenhall, W., Beavec R.J. & Beaver, B.M. (1999): Introduction to Probability & Statistics (10th edition), Duxbury Press.
- Mood, A., Graybill, F. and Boes, D. (1974). Introduction of the Theory of Statistics. McGraw-Hill.
- Ross, S. (1976). A First Course in Probability. Collier, Macmillan, New York.
- Ross, S. (1983). Introduction to Probability Models. 2nd Ed. Academic Press, New York.
- Roussas, G.G. (2003). An introduction to Probability and Statistical Inference. Academic Press.
- Ε.Ξεκαλάκη, Ι.Πανάρετος (1998) Probability και Στοιχεία Στοχαστικών Ανεξίξεων.

Teaching Method: Face to Face

Teaching includes: Class lectures. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek

Calculus I (code: 6041)

Course type: Compulsory

Course level: First studies cycle

Instructor: Assistant Professor ΑΙ. Zymbidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Fundamental concepts of Differential and Infinite Calculus that are basic prerequisites for the Statistical Science.

Prerequisites: none

Syllabus: Axiomatic foundation of the system of real numbers. Axioms of domain and order, axiom of the least upper bound and the Archimedean property. Monotonic and bounded functions, continuity of a function, Bolzano's theorem, Mean-value theorem, extreme value theorem and uniform continuity. Elements of set theory. Derivative of a function, calculus of derivatives and derivatives of higher order, theorems of Rolle, Mean-Value and L'Hospital, local extremes. Riemann' s integral, properties of the integral (additivity, triangular inequality, linearity), continuity and differentiability of the integral function, integrability of

continuous functions, Mean-value theorem for integrals, indefinite integral of a function, Fundamental theorem of Infinitesimal Calculus. Techniques of integration (change of variable, integration by parts, etc.), logarithm and the exponential function, generalized integrals, examples and applications. Subsets of \mathbb{R} , points of accumulation, sequences of real numbers, monotonic sequences, subsequences and the Cauchy criterion of convergence, Bolzano-Weierstrass theorem, theorems of sequence convergence. Series of real numbers, series with positive terms, criteria of convergence and absolute convergence of series. Taylor's theorem and Taylor series.

Recommended Reading

- Αθανασιάδης Χ.Ε, Γιαννακούλιας Ε., Γιωτόπουλος Σ.Χ. (2009). Γενικά Μαθηματικά, Απειροστικός Λογισμός, Τόμος 1, Εκδόσεις Συμμετρία.
- Σπινάκ, Μ. (2010). Διαφορικός και Ολοκληρωτικός Λογισμός, 2η έκδοση, ΙΤΕ Πανεπιστημιακές Εκδόσεις Κρήτης.
- Finney R.L., Weir M.D., and Giordano F.R. (2004). Απειροστικός Λογισμός, τόμος Ι, Πανεπιστημιακές Εκδόσεις Κρήτης.
- Apostol, T. M. (1967). Calculus, Vol.1, 2nd edition, Wiley.

Teaching Method: Face to Face.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek

Linear Algebra I (code: 6051)

Course type: Compulsory

Course level: First studies cycle

Instructor: Assistant Professor E. Ioannidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: : In depth understanding of the concepts introduced in the course, so that the students are able to answer questions demonstrating this understanding, obtaining a geometric insight in concepts such as projection, and finally, applying this knowledge to solving exercises such as: obtaining the LDU factorization of a matrix, inverting a matrix and calculating a projection matrix.

Prerequisites: none

Syllabus: Elements and calculus in \mathbb{R}^n , lines and planes in \mathbb{R}^n . Matrices and matrix multiplication, Elementary matrices. Linear systems: The Gauss algorithm and the factorization $PA=LDU$. Inverse and transposed matrices, the algorithm Gauss-Jordan. Symmetric matrices and the Cholesky factorization. Vector spaces and subspaces. Linear systems: the solution of m equations with n unknowns and the rank of a matrix. Linear independence, bases and dimension. The four fundamental subspaces of a matrix. The fundamental theorem of Linear Algebra. Linear transformations of \mathbb{R}^n and matrices. Orthogonal subspaces, and orthogonal complement of a subspace. Projections and least squares approximations. Orthogonal matrices.

Recommended Reading

- Gilbert Strang (1999), Γραμμική Άλγεβρα και Εφαρμογές, Πανεπιστημιακές Εκδόσεις Κρήτης.
- Lipschutz, S., Lipson Marc Lars, Γραμμική Άλγεβρα, 5η Έκδοση, Εκδόσεις Τζιόλα, 2013.
- Ε. Ξεκαλάκη & Ι. Πανάρετος (1993), Γραμμική Άλγεβρα για Στατιστικές Εφαρμογές, Αθήνα.
- Η. Φλυτζάνης (1999), Γραμμική Άλγεβρα & Εφαρμογές, Τεύχος Α: Γραμμική Άλγεβρα, Το Οικονομικό.
- Γ. Δονάτος-Μ. Αδάμ (2008), Γραμμική Άλγεβρα Θεωρία και Εφαρμογές, Gutenberg.
- Graybill, F. A. (1969), Introduction to Matrices with Applications in Statistics, Wadsworth, Belmont, CA.
- Harville, D. A. (1997), Matrix Algebra from a Statistician's perspective, Springer.
- Healy, M.J.R. (1995), Matrices for Statistics, Oxford University Press.
- Searle, S. R. (1982), Matrix Algebra Useful for Statistics, Wiley.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Home Assignment.

Teaching Language: Greek

Introduction to Programming with R (code: 6122)

Course type: Compulsory

Course level: First studies cycle

Instructor: Professor I. Ntzoufras, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course students should be able to manage and import data to R, perform basic R operations, create and analyze simple functions in R.

Prerequisites: none

Syllabus: Introduction to computers. Basic principles of programming. Introduction to R: basic elements of R; command and window environment. Arithmetic operations. Graphs and figures, multiple graphs.

Objects and object types. Loop Commands and Syntax (for, while, repeat). Creating Scripts and Programs. Simple Functions & Functions with multiple output. Lists of results. Special functions and commands.

Recommended Reading

- Ντζούφρας Ι., Καρλής Δ., Εισαγωγή στον Προγραμματισμό και στη Στατιστική Ανάλυση με R, Εκδόσεις Ελληνικά Ακαδημαϊκά Συγγράμματα και Βοηθήματα-Αποθετήριο "Κάλλιπος", 2016.
- Δ. Φουσκάκης (2013). Ανάλυση Δεδομένων με Χρήση της R . Εκδόσεις Τσότρας. Αθήνα.
- Crawley, M. (2014) Εισαγωγή στη στατιστική ανάλυση με την R (ελληνική μετάφραση). Εκδόσεις Broken Hill.

- Field, A., Miles, J and Field, Z. (2012). Discovering Statistics Using R. Sage publications Ltd.

Teaching Method: Face to Face

Teaching includes: Class lectures. Lab exercises. Tutorial. Assignments.

Student Assessment Method: Written exam at the end of the semester (80%). Written assignments (20%). Lab exercises (extra small bonus).

Teaching Language: Greek

B' Semester

Probability II (code: 6142)

Course type: Compulsory

Course level: First studies cycle

Instructors: Professor M. Zazanis – Professor P. Dellaportas, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course, students will have a fuller and deeper understanding of the concepts learned in the introductory probability course. They will have understood the basic concepts underlying multidimensional probability distributions and obtained the necessary mathematical skills in order to use them in the context of statistical problems.

Prerequisites: Introduction to Probability.

Syllabus: Joint distributions of discrete random variables, marginal and conditional distributions. The multinomial and the multi-hypergeometric distribution. Joint distributions of continuous random variables. Joint, marginal, and conditional densities. Transformations of multidimensional random variables. The χ^2 , t, and F distributions. Order Statistics. The multivariate normal distribution. Convergence in distribution. The Central Limit Theorem.

Recommended Reading

- Ross, S., Βασικές Αρχές θεωρίας πιθανοτήτων, Εκδόσεις Κλειδαριθμός ΕΠΕ, 2011.
- Κούτρας Μ., Εισαγωγή στη θεωρία Πιθανοτήτων και Εφαρμογές, Εκδόσεις Τσότρας, 2016.
- Παπαϊωάννου Τ., Θεωρία Πιθανοτήτων και Στατιστικής, Εκδόσεις Σταμούλης Α.Ε., 1997.
- Feller, W. (1968). An Introduction to Probability Theory and its Applications. Wiley, N.Y.
- Hoel P., Port S., Stone C., «Εισαγωγή στη Θεωρία Πιθανοτήτων», ΙΤΕ Παν/κές Εκδόσεις Κρήτης, 2009.
- Hogg, R. and Graig, A. (1970). Introduction to Mathematical Statistics, Third Ed., The Macmillan Co., New York.
- Hogg,R.V. and Tanis,E.A. (2000). Probability and Statistical Inference. Prentice Hall.
- Mendenhall, W., Beavec R.J. & Beaver, B.M. (1999): Introduction to Probability & Statistics (10th edition), Duxbury Press.
- Mood, A., Graybill, F. and Boes, D. (1974). Introduction of the Theory of Statistics. McGraw-Hill.
- Ross, S. (1976). "A First Course in Probability". Collier, Macmillan, New York.
- Ross, S. (1983). "Introduction to Probability Models". 2nd Ed. Academic Press, New York.
- Gut, Alan. (2009). A Second Course in Probability, 2nd ed. Springer Verlag.

Teaching Method: Face to Face.
Teaching includes: Class lectures. Tutorial. Assignments. Self Study.
Student Assessment Method: Written exam at the end of the semester.
Teaching Language: Greek

Calculus II (code: 6042)

Course type: Compulsory

Course level: First studies cycle

Instructor: Professor A. Yannacopoulos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course, students will be able to understand and use basic concepts related (a) series of functions and (b) function of more than one variables (partial derivatives, optimization with or without constraints, including techniques such as Lagrange multipliers or the Kuhn-Tucker conditions, multiple integrals, etc.). The course emphasizes on future application of these concepts to statistics, probability, computer science and various fields of study related to economic or management sciences.

Prerequisites: none

Syllabus: Series of functions (power series, Taylor series, Fourier series) and applications. Pointwise and uniform convergence and applications. Geometry of R^n . Functions of more than one variables. Limits and continuity. Derivatives of functions on R^n . Integration of functions on R^n . Transformations and Jacobian. Optimization, Lagrange multipliers and applications.

Recommended Reading

- Marsden and Tromba (2007) Διανυσματικός Λογισμός (ελληνική μετάφραση). Παν. Εκδ. Κρήτης.
- Thomas and Finney, Weir and Giordano (2001) Απειροστικός Λογισμός, Παν. Εκδ. Κρήτης.
- Αθανασιάδης Χ.Ε, Γιαννακούλιας Ε., Γιωτόπουλος Α. (2010) Γενικά Μαθηματικά, Απειροστικός Λογισμός, Τόμος 1, Εκδόσεις Συμμετρία.
- Κατερίνης, Φλυτζάνης, (2010) Ανώτερα Μαθηματικά, Εκδ. Μπένου

Teaching Method: Face to Face.
Teaching includes: Class lectures. Tutorial. Assignments. Self Study.
Student Assessment Method: Written exam at the end of the semester. Midterms. Home assignment. Teaching Language: Greek.

Linear Algebra II (code: 6082)

Course type: Compulsory

Course level: First studies cycle

Instructors: Academic Scholar D. Pappas, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: In-depth understanding of the concepts of the course so that students be able to answer questions demonstrating this understanding. The acquisition of a geometric oversight of concepts such as projection, determinant, eigenvalues and eigenvectors. Finally, applying this knowledge to solving exercises, such as calculating a projection matrix, solving a function interpolation problem with least squares, matrix diagonalization, calculating the square type contour lines. Applications of eigenvalues/eigenvectors also include an introduction to the Principal Component Analysis method and Dynamical systems.

Prerequisites: none

Syllabus: Rectangular matrices, the Gramm-Schmidt rectangularization and $A = QR$ factorization. Determinants. Eigenvalues and characteristic polynomial, eigenvectors and eigenspaces. The minimal polynomial. Matrix powers and spectral theorem for symmetric matrices. Basis coordinates and similar matrices. Quadratic forms in symmetrical matrices: positive, Rayleigh quotient, ellipsoids in $n -$ dimensions. The Jordan canonical form. The Principal Component Analysis (PCA). The Singular values decomposition (SVD). The Polar decomposition. Complex and hermitian matrices. The generalized inverse (Moore-Penrose inverse) and its applications in linear regression and projection matrices.

Recommended Reading

- Gilbert Strang (1999), *Γραμμική Άλγεβρα και Εφαρμογές*, Πανεπιστημιακές Εκδόσεις Κρήτης.
- Ε. Ξεκαλάκη & Ι. Πανάρετος (1993), *Γραμμική Άλγεβρα για Στατιστικές Εφαρμογές*, Αθήνα.
- Η. Φλυτζάνης (1999), *Γραμμική Άλγεβρα & Εφαρμογές, Τεύχος Α: Γραμμική Άλγεβρα*, Το Οικονομικό.
- Γ. Δονάτος-Μ. Αδάμ (2008), *Γραμμική Άλγεβρα Θεωρία και Εφαρμογές*, Gutenberg.
- D. C. Lay, (2012), *Linear Algebra and Applications*, Addison-Wesley.
- Harville, D. A. (1997), *Matrix Algebra from a Statistician's perspective*, Springer.
- Healy, M.J.R. (1995), *Matrices for Statistics*, Oxford University Press.
- Searle, S. R. (1982), *Matrix Algebra Useful for Statistics*, Wiley.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Introduction to Probability and Statistics with R (code: 6031)

Course type: Compulsory

Course level: First studies cycle

Instructor: Professor D. Karlis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: The student will be able to understand and make use of basic concepts about statistics and probability. They will be able to have sufficient knowledge of R program, as to be capable to implement basic programs in order to perform basic statistical methods, to create and understand basic descriptive visualization, to manage data of certain complexity and to extract them from large datasets. they will be also able to comprehend basic characteristics of real data. and communicate them efficiently

Prerequisites: none

Syllabus: This course aims to introduce students to basic principles of statistics and probability using R. These tasks include: Data collection. Reading and organizing data. Data management. The basic idea of simulation. Probability games using computer and R. Law of large numbers and other probability results. Introduction and comparison of distributions. Basic principles of descriptive statistics. Describing data using the appropriate graphs and measures. Tabulating and presenting the data. Introduction to linear regression. Statistical terminology and the media, probabilities, inference. Case studies. Examples from everyday life.

Recommended Reading

- Αγγελής Β., Δημάκη Α., Στατιστική Τόμος Α, Εκδόσεις “σοφία”, 2010.
- Δαμιανού Χ., Κούτρας Μ., Εισαγωγή στη Στατιστική Μέρος Ι, Εκδόσεις Συμμετρία, 2003.
- Verzani J., Εισαγωγή στη Στατιστική με την R, Εκδόσεις Κλειδάριθμος ΕΠΕ, 2016.
- Gelman, A. Nolan, D. (2002) Teaching Statistics: A bag of tricks. Oxford University Press
- Dalgaard, P. (2008) Introductory Statistics with R. Springer
- Kerns, J. (2011) Introduction to Probability and Statistics Using R. Available at <http://cran.r-project.org/web/packages/IPSUR/vignettes/IPSUR.pdf>
- Horgan, J. (2008) Probability with R: An Introduction with Computer Science Applications. Wiley
- Crawley, M.J. (2014) Statistics: An Introduction Using R, 2nd Edition, Wiley
- Δ. Φουσκάκης (2013). Ανάλυση Δεδομένων με Χρήση της R . Εκδόσεις Τσότρας, Αθήνα.
- Crawley, M. J. (2014) Εισαγωγή στη στατιστική ανάλυση με την R (ελληνική μετάφραση). Εκδόσεις Broken Hill.
- Πετράκος, Γ. (2016) Εφαρμογές της Θεωρίας Πιθανοτήτων με τη χρήση της R. Εκδόσεις Τσότρας.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Bibliography studying and analyzing. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Home assignment. Written exam (Project).

Teaching Language: Greek.

2^o YEAR

C' Semester

Estimation and Hypothesis Testing (code: 6012)

Course type: Compulsory

Course level: First studies cycle

Instructors: Professor A. Kostaki, Professor St. Psarakis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course, students will be able to estimate unknown parameters using the appropriate methodology, to build confidence

intervals that contain the unknown parameters with the desired probability and to carry out statistical tests regarding the specific problems.

Prerequisites: none

Syllabus: Point estimation, properties of point estimators (consistency, unbiasedness, efficiency, sufficiency), point estimation methods (moment method, least squares, maximum likelihood). Sampling and sampling . Confidence intervals for means, rates, variances and their differences for normal and non normal populations.

Hypothesis testing, statistical hypotheses, hypothesis testing for parameters such as mean values, variations, comparing parameters in two different samples, statistical significance level, p-value, power of a test, sample size calculation.

Recommended Reading

- Robert V. Hogg, Elliot Tanis, Dale Zimmerman, Probability and Statistical Inference, 9th edition .
- G. A. Young ,R. L. Smith. Essentials of Statistical Inference. Cambridge Series in Statistical and Probabilistic Mathematics.
- Tore Schweder and Nils Lid Hjort. Confidence, Likelihood, Probability: Statistical Inference with Confidence Distributions. Cambridge Series in Statistical and Probabilistic Mathematics.

Teaching Method: Face to Face.

Teaching includes: Class lectures, Studying and analyzing bibliography, Tutorial: Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Stochastic Processes I (code: 6126)

Course type: Compulsory

Course level: First studies cycle

Instructor: Assistant Professor H. Pavlopoulos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course, students should be able to: classify stochastic processes according to the state space and the parameterization set, determine whether a stochastic process is stationary or non-stationary, know the basic properties of a simple random walk process on the integers, Poisson and Wiener processes in continuous time, Markov chains in discrete time, renewal and branching processes.

Prerequisites: Probability I, Probability II, Linear Algebra I, Calculus I.

Syllabus: Discrete probability spaces, probability generating functions, binomial models and Poisson limit theorems. Simple random walk, gambler's ruin, game length, ballot theorems, arc-sine law. Markov chains, matrix of transition probabilities, classification of states. Asymptotic behavior, stationary distribution, stability equations. Time reversibility, Kolmogorov's criterion, random walks on graphs. Speed of convergence to stationary

distribution, potential matrices. Perfect simulation and the Propp-Wilson algorithm. Branching processes and probability of extinction. Poisson process, Markov chains in continuous time, Kolomogorov's differential equations, birth - death - migration process.

Recommended Reading

- Χρυσάφινου Ουρανία (2008) Εισαγωγή στις Στοχαστικές Ανελίξεις. Εκδόσεις Σοφία.
- Καλπαζίδου Σ., Στοιχεία θεωρίας στοχαστικών ανελιξεων, Εκδόσεις Ζήτη, 1991.
- Cox, D.R. and Miller, H.D. (1965). Theory of Stochastic Process, Methuen, London.
- Ross, S. M. (2002). Introduction to Probability Models, 8th edition, Academic Press.
- Karlin S. and H. Taylor (1975). A First Course in Stochastic Processes, Academic Press.
- Grimmett, G.R. and D.R. Stirzaker (2001). Probability and Random Processes. Oxford University Press.
- Norris, J.R. (1998). Markov Chains, Cambridge University Press.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Self Study.

Student Assessment Method: Written exam at the end of the semester. Problem solving.

Teaching Language: Greek.

Linear Models (code: 6023)

Course type: Compulsory

Course level: First studies cycle

Instructor: Associate Professor P. Tsiamirtzis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing this course, students will be able to handle topics concerning: correlation coefficient, bivariate and multivariate normal distribution, simple and multiple linear regression, statistical inference in linear regression, hypothesis testing and diagnostic tests, transformations, general linear model, algorithmic methods of choosing the optimal (sub)model, multilinearity and dummy variables, one and two way, with(out) interaction, ANOVA.

Prerequisites: Estimation and hypothesis testing (code: 6012)

Syllabus: Introduction to regression, fitting, estimating the coefficients. Coefficient estimator properties, mean value, variance, confidence intervals,. Predicted values, ANOVA, R^2 , F test (definition via SS_{Regr} and SS_{error}).

Introduction to multivariate normal distribution, quadratic forms, quadratic forms mean, distributions, independence. Multiple Regression definition and examples. Design matrix, introduction to dummy variables, linear model general form, LS estimations and properties. Unbiased variance estimation. Predicted values estimation, error estimation, properties, maximum likelihood estimation, LRT, general linear hypothesis, examples. Multiple correlation coefficient, ANOVA, partial F-tests. Examples. Simple residuals, standardized residuals, studentized residuals, normality test, Q-Q plots, basic model hypothesis testing graphs, added variable plot, other diagrams and model hypotheses testing. Simple transformations, influence statistics, the concept of multilinearity, diagnostic tests. One way analysis of variance. Sum to zero parameterization, corner point parameterization, design matrix, estimated coefficients, model ANOVA.

Two way analysis of variance, saturated and cumulative model. Parameterization explanation, design matrix, estimated ANOVA model parameters. Choosing the optimal regression model, forward, backward, stepwise methods, all possible regressions.

Recommended Reading

- Draper N.R. and Smith, H. (1997). Εφαρμοσμένη Ανάλυση Παλινδρόμησης, Παπαζήσης
- Κούτρας, Μ. Και Ευαγγελάρας, Χ. (2010). Ανάλυση Παλινδρόμησης: Θεωρία και Εφαρμογές, Σταμούλης
- Montgomery, D.C., Peck, E.A. and Vining, G.G. (2012). Introduction to Linear Regression Analysis, Wiley.
- Weisberg, S. (2014). Applied Linear Regression, Wiley

Teaching Method: Face to Face.

Teaching includes: Class lectures. Studying and analyzing bibliography. Tutorial. Assignments.

Student Assessment Method: Written exam at the end of the semester. Home assignment.

Teaching Language: Greek.

Introduction to Mathematical Analysis (code: 6133)

Course type: Optional

Course level: First studies cycle

Instructor: Professor A. Yannacopoulos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course students will be familiar and able to use in concrete applications the basic concepts of mathematical analysis focusing on the future applications of these concepts in statistics, probability, and computer science as well as their applications in various fields of study related to economic sciences.

Prerequisites: none

Syllabus: Introduction to Real Analysis. Fundamental concepts from set theory. The set of real numbers. Sequences and series of real numbers. Real functions, continuous, uniformly continuous, monotone and convex functions. Stieltjes integral and functions of bounded variation. Metric spaces and continuous functions in metric spaces. Uniform convergence of sequences and series of functions. Linear spaces with norm and inner product spaces (Banach and Hilbert spaces). Short introduction to Lebesgue measure and integration. Applications of these concepts in probability, statistics and scientific computation.

Recommended Reading

- K. Saxe, Beginning Functional Analysis, Springer Series on Undergraduate Mathematics, 2002
- A.N. Yannacopoulos, Introduction to Mathematical Analysis, Lecture Notes (2016)
- Johnsonbaugh, R. and W. Pfaffenberger (1981). Foundations of mathematical analysis. M. Dekker (New York, NY).
- Labarre, A. E. (2008). Intermediate mathematical analysis. Dover Publications
- Bobrowski, A. (2005). Functional analysis for probability and stochastic processes: an introduction. Cambridge University Press.

- Rudin, W. (1964). Principles of mathematical analysis, Volume 3. McGraw-Hill New York.
- Severini, T. A. (2005). Elements of distribution theory, Volume 17. Cambridge University Press.
- Jacod, J. and P. E. Protter (2003). Probability essentials. Springer.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Home assignment.

Teaching Language: Greek.

Demographic Statistics (code: 6134)

Course type: Optional

Course level: First studies cycle

Instructor: Professor A. Kostaki, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Knowledge of statistical techniques for analyzing demographic data and their applications.

Prerequisites: none

Syllabus: Basic concepts: Introduction to demographics, demographic events, types of demographic data, sources of demographic data, demographic data publications, basic demographic measures, ratios, indices or coefficients, population evolution – basic equation. Mortality, mortality per cause of death, mortality measures, mortality probability, mortality comparisons – standardization methods, direct and indirect standardization. Life tables: building a life table, the life table as a stationary population, mortality rate, stochastic approach to life table functions. Modeling mortality by age. Multiple decrement tables: building a multiple decrement table, summary of functions of the multiple decrement table. Fertility: Fertility measures, reproduction factors, modeling fertility. Nuptiality: nuptiality measures, nuptiality tables. Estimations, projections and population projections: projection techniques.

Recommended Reading

- Keyfitz, Nathan, Caswell, Hal (2010). Applied Mathematical Demography (Statistics for Biology and Health). Springer.
- Preston, S., Heuveline, P., Guillot, M. (2000). “Demography: Measuring and Modeling Population processes” Blackwell publishing.
- Shiva S. Halli, K. Vaninadha Rao (1992). Advanced Techniques of Population Analysis, Plenum Pub Corp.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Self Study and assignment.

Student Assessment Method: Written exam (70% of the final grade) and assignment using the presented techniques (30% of the final grade).

Teaching Language: Greek.

Introduction to Economic Theory (code: 6112)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor A. Livada, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course, students will be able to understand the basic concepts of economic science focused on micro and macro analysis, as well as economic policy tools.

Prerequisites: none

Syllabus: Introductory knowledge regarding the way microeconomics and macroeconomics operate, as well as the main problems they face. Also, introductory knowledge regarding basic concepts and scales of the economy and how to measure and define them. Introduction: the Circular flow of income. The Scarcity problem. Institutional Framework.

Microeconomics theory: Supply and Demand, Balance and elasticity. Consumer behavior theory. Utility method and Indifference curves. Production and cost theory. Market structures forms: Perfect competition, Monopoly, Monopolistic competition, Oligopoly, other forms. General Economic Balance and Economics of Prosperity.

Macroeconomics theory: National product and National income. Consumption. Saving. Investment. Multiplier. Production. Employment, Salaries. Defining income and employment. Money markets. Fiscal and Monetary policy. International trade and macroeconomics. About inflation and unemployment. Economic growth. The State's role in solving macroeconomic problems.

Recommended Reading

- Mankiw N., Taylor P. Mark, Οικονομική 3^η Έκδοση, Εκδόσεις Τζιόλα, 2016.
- McConell C., Flynn S., Brue S., Εισαγωγή στην Οικονομική Επιστήμη, Εκδοτικός Οίκος Rosili, 2016.
- G. Mankiw, M. Taylor (2011) «Αρχες Οικονομικής Θεωρίας» - Gutenberg Γιώργος & Κώστας Δαρδανός
- D. Begg, S. Fischer, R. Dornbusch (2006) “Εισαγωγή Στην Οικονομική” Εκδοσεις Κριτική
- Δημέλη Σ. (2010) «Μακροοικονομικά Μεγέθη και ανάπτυξη της Ελληνικής Οικονομίας»

Teaching Method: Face to Face

Teaching includes: Class lectures. Seminars. Field exercises. Studying and analyzing bibliography. Interactive teaching. Educational visits.. Assignments. Devising a study. Self Study. Scientists lectures.

Student Assessment Method: Written exam at the end of the semester. Elaboration questions. Problem solving. Home assignment. Written exam (Project). Presentation. Practical exercises.

Teaching Language: Greek

Introduction to Computerized Accounting and Finance (code: 6163)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor G. Siougle, Department of Accounting and Finance

E.C.T.S.: 6

Desired Learning Outcomes: Introducing the basic framework of Financial Accounting and Reporting. Analyzing the components of an Accounting Information System (AIS).

Prerequisites: none

Syllabus:

Introducing the basic framework of Financial Accounting and Reporting. Presentation and preparation of Financial Statements in accordance with International Financial Reporting Standards (Statement of Financial Position, Income Statement, Comprehensive Income Statement, Statement of Changes in Equity, disclosures). Presenting accounting cycle steps and basic accounting records (general ledger), analyzing economic events, accrual accounting concepts, the accounting equation, posting journal entries, adjustment entries, closing entries. Introduction to an accounting information system (AIS).

Recommended Reading

- Γκίκας, Δ. και Παπαδάκη Α. (2012) Χρηματοοικονομική Λογιστική, 4η έκδοση, Εκδόσεις Μπένου.
- Μπάλλας Α. και Χέβας Δ. (2010) Εφαρμοσμένες Χρηματοοικονομικής Λογιστικής, Εκδόσεις Μπένου.
- Jerry J. Weygandt, Donald E. Kieso, Paul D. Kimmel (2013) Financial Accounting, 7th edition, Wiley publications
- An Accounting Information System (AIS)

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Devising a study.

Student Assessment Method: Written exam at the end of the semester. Written exam (Project).

Teaching Language: Greek.

D' Semester

Linear Models (code: 6023)

Course type: Compulsory

Course level: First studies cycle

Instructor: Professor A. Kostaki, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing this course, students will be able to handle topics concerning: correlation coefficient, bivariate and multivariate normal distribution, simple and multiple linear regression, statistical inference in linear regression, hypothesis testing and diagnostic tests, transformations, general linear model, algorithmic methods of choosing the optimal (sub)model, multilinearity and dummy variables.

Prerequisites: Estimation and hypothesis testing (code: 6012)

Syllabus: Introduction to regression, straight line fitting, coefficients estimators. Coefficient estimators properties, mean value, variance, confidence intervals, estimating data variance. Predicted values, straight line ANOVA, R^2 , F test (definition via SS_{Regr} and SS_{error}).

Introduction to multivariate normal distribution, quadratic forms, quadratic forms mean, distributions, independence. Multiple Regression definition, examples. Design matrix, introduction to dummy variables, linear model general form, LS estimations, Estimator properties. Unbiased variance estimation. Predicted values estimation, error estimation, properties, maximum likelihood estimation, LRT, general linear hypothesis, $R\beta=r$, examples. Multiple correlation coefficient, ANOVA, partial F-tests. Examples. Simple residuals, standardized residuals, studentized residuals, normality test, Q-Q plots, basic model hypothesis testing graphs, added variable plot, other diagrams and model hypotheses testing. Simple transformations, influence statistics, the concept of multilinearity, diagnostic tests. One factor analysis of variance. Sum to zero parameterization, corner point parameterization, design matrix, estimated coefficients, model ANOVA.

Two way analysis of variance, saturated and cumulative model. Parameterization explanation, design matrix, estimated ANOVA model parameters. Choosing the optimal regression model, forward, backward, stepwise methods, all possible regressions.

Recommended Reading

- Draper N.R. and Smith, H. (1997). Εφαρμοσμένη Ανάλυση Παλινδρόμησης, Παπαζήσης
- Κούτρας, Μ. Και Ευαγγελάρας, Χ. (2010). Ανάλυση Παλινδρόμησης: Θεωρία και Εφαρμογές, Σταμούλης
- Montgomery, D.C., Peck, E.A. and Vining, G.G. (2012). Introduction to Linear Regression Analysis, Wiley.
- Weisberg, S. (2014). Applied Linear Regression, Wiley

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Tutorial. Assignments.

Student Assessment Method: Written exam at the end of the semester. Home assignment.

Teaching Language: Greek.

Time Series Analysis (code: 6145)

Course type: Compulsory

Course level: First studies cycle

Instructor: Associate Professor I. Vrontos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes:

Prerequisites: none

Syllabus: Introduction with examples of time series data. Concepts of stationarity. Autocorrelation function of stationary time series. The additive model with deterministic components (trend, seasonality). Parametric and nonparametric methods of estimating and eliminating deterministic components. Box Cox transformations for eliminating heteroscedasticity. Classical tests for randomness and normality of the stochastic component. Linear filters of stationary time series. Stationary series representation as linear filters of uncorrelated noise and Wold's theorem. Autoregressive moving average model (ARMA), conditions for the existence of causality - reversibility of stationary linear solutions.

Calculating the auto-covariance function of causal stationary solutions in the general ARMA(p,q) model. Bartlett's theorem and asymptotic statistical inference for autocorrelations. Predicting the minimum mean squared error. Algorithms for calculating optimal linear predictions functions (Durbin-Levinson, innovations) and its applications in predicting causal stationary ARMA models solutions. Partial autocorrelation function and its estimation.

Fitting causal stationary ARMA models:

a) preliminary estimators for autoregressive AR(p) models (Yule-Walker, least squares), moving average MA(q) models (innovations algorithm), mixed ARMA(p,q) models, (generalized Yule-Walker method), innovations algorithm).

b) maximum likelihood estimation and asymptotic inference. Diagnostic tests and criteria for choosing ARMA models rank (AIC, BIC).

Introduction to ARIMA and SARIMA models for non stationary time series with a unit root, Dickey - Fuller test.

Recommended Reading

- Μπόρα-Σέντα Ε., Μωυσουάδης Χ.Θ., Εφαρμοσμένη Στατιστική, Εκδόσεις Ζήτη, 1990.
- Zivot, Eric.Wang, Jiahui, Modeling Financial Time Series with S-PLUS, Springer Science and Business Media Inc., 2006.
- Shumway, Robert H., Stoffer, David S., Time Series Analysis and its Applications, Springer Science and Business Media LLC, 2006.
- Gilgen, Hans, Univariate Time Series in Geosciences, Springer-Verlag Berlin Heidelberg, 2006.
- Kirchgassner, Gebhard, Wolters, Jurgen, Introduction to Modern time Series Analysis, Springer-Verlag Berlin Heidelberg, 2007.
- Δαμιανού Χαράλαμπος Χ., ΜΕΘΟΔΟΛΟΓΙΑ ΔΕΙΓΜΑΤΟΛΗΨΙΑΣ, Εκδόσεις “σοφία”, 2007.
- Brockwell, P.J. and R.A. Davis (2002, 2nd Edition): Introduction to Time Series and Forecasting, Springer Verlag.
- Brockwell, P.J. and R.A. Davis (1991, 2nd Edition): Time Series: Theory and Methods, Springer Verlag.
- Cryer, J.D. and K.S. Chan (2008): Time Series Analysis With Applications in R, Springer-Verlag.
- Δημέλη Σ. (2003, 3^η Έκδοση): Σύγχρονες Μέθοδοι Ανάλυσης Χρονολογικών Σειρών, Εκδόσεις ΚΡΙΤΙΚΗ, Αθήνα.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Studying and analyzing bibliography. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Estimation and Hypothesis Testing (code: 6012)

Course type: Compulsory

Course level: First studies cycle

Instructor: Associate Professor E. Kandilorou, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course, students will be able to estimate unknown parameters using the appropriate methodology, to build confidence intervals that contain the unknown parameters with the desired probability and to carry out statistical tests regarding the specific problems.

Prerequisites: none

Syllabus: Point estimation, properties of point estimators (consistency, unbiasedness, efficiency, sufficiency), point estimation methods (moment method, least squares, maximum likelihood). Sampling and sampling distributions. Confidence intervals for means, rates, variances and their differences in the case of normal and non normal populations.

Hypothesis testing, statistical hypotheses, hypothesis testing for parameters such as mean values, variations, comparing parameters in two different samples, statistical significance level, p -value, power of a test, sample size calculation.

Recommended Reading

- Αγγελής Β., Δημάκη Α., Στατιστική Τόμος Α, Εκδόσεις “σοφία”, 2012.
- Δαμιανού Χ., Κούτρας Μ., Εισαγωγή στη Στατιστική ΜΕΡΟΣ Ι, Εκδόσεις Συμμετρία, 2003.
- Πανάρετου Ι, Ξεκαλάκη Ε. Εισαγωγή στη Στατιστική Σκέψη Τόμος ΙΙ.
- Newbold, P., Carlson, W. and Thorne, B. 'Statistics for Business and Economics'.
- Berry, D. and Lindgren, B. 'Statistics Theory and Methods'.
- Freund, J. 'Mathematical Statistics with applications'.
- Walpole, R., Myers, R. and Myers, S. 'Probability and Statistics'.
- Wonnacott, T. H. and Wonnacott, R. J. Introductory Statistics. 4th edition, J. Wiley & Sons.
- Alder, H. L. and Roessler, E. B. Introduction to Probability and Statistics. 6th edition, W. H. Freeman & Company.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Studying and analyzing bibliography. Tutorial. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Sampling (code: 6033)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor E. Kandilorou, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After the completion of the course the students should ideally be able to:

- Implement the standard sampling designs and a combination of these, from the sampling theory to select the sample from a finite population.
- Choose the appropriate method depending on the target population, in order to achieve best performance for the derived estimates.
- Find estimates and their standard errors, confidence intervals, and general statistical inference that is in accordance with the sampling procedure that has been followed.

- Identify the sampling and non-sampling errors that may occur in a sampling survey and implement techniques that can minimize them.
- Construct a questionnaire.

Prerequisites: none

Syllabus: Introductory concepts and definitions. Finite populations, subpopulations, variables. Census survey, sampling survey. Random and non random sampling. Probability of selecting population units. Finite population parameters, parameter estimation, properties. Sampling frame. Sampling techniques. Simple random sampling. Mean, ratio and proportion estimation. Confidence intervals . Estimating required sample size. Stratified sampling. Parameter estimation. Distributing a sample in strata. Comparing simple random to stratified sampling. Quota sampling. Systematic sampling. Estimating parameters and comparison to other sampling techniques. Probability proportional to size ('PPS') sampling. Cluster sampling. Single stage cluster sampling. Equal and non equal probability sampling. Two stage cluster sampling. Conducting a sampling research. Sampling frame, questionnaire and methods of data collection. Sampling research errors. Methods of avoiding or minimizing errors and correction methods. Non response errors, adjustment and imputation techniques.

Recommended Reading

- Παπαγεωργίου Ι., Θεωρία Δειγματοληψίας, 2016.
- Sarndal, C-E., Swensson, B., Wretman, J. (1992) Model assisted survey sampling. Springer.
- Lohr, S. (2010) Sampling: Design and Analysis. 2nd Edition. Brooks/Cole. Sengage learning.
- Kish, L. (1965). Sampling Surveys. John Wiley & Sons. New York.
- Barnett, V. (1974). Elements of Sampling Theory. The English Universities Press Ltd.
- Pascal Ardilly, Yves Tillé. Sampling Methods: Exercises and Solutions.
- Δαμianού, Χ. (2006) Μεθοδολογία της Δειγματοληψίας. Τεχνικές και εφαρμογές. Εκδόσεις Σοφία.
- Ξεκαλάκη Ε. (1995) Τεχνικές Δειγματοληψίας. Σημειώσεις, Οικονομικό Πανεπιστήμιο Αθηνών.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Mathematical Methods (code: 6143)
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Course type: Optional

Course level: First studies cycle

Instructor: Professor M. Zazanis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course, the students will have a good working understanding of the mathematical techniques described in the syllabus.

Prerequisites: Calculus I and II, Linear Algebra I and II.

Syllabus: Linear recursive relations. Linear differential equations with constant coefficients. Matrix differential equations, the exponential matrix. Orthogonal polynomials. Combinatorial Analysis. Permutations, orders, combinations. Enumeration techniques, binomial coefficients, probability generating functions, partitions. Elements of the graph theory. Optimization under Constraints, Introduction to Convex Analysis.

Recommended Reading

- Lipschutz S., Lipson Marc Lars, Γραμμική Άλγεβρα, 5^η έκδοση, Εκδόσεις Τζιόλα, 2013.
- Slomson A. (1991). An introduction to combinatorics, Chapman and Hall.
- Arrowsmith D. K. and Place C. M. Ordinary differential equations. Chapman and Hall.
- Τσουμπελής, Δ. (2008). Συνήθεις Διαφορικές Εξισώσεις, Πανεπιστήμιο Πατρών.
- Χαραλαμπίδης, Χ. (2010). Συνδυαστική Ανάλυση. Εκδόσεις Συμμετρία.
- Bellman, R. (1987). Matrix Analysis. Classics in Applied Mathematics, SIAM Publishing.
- Liu, C.L. (1968). Introduction to Combinatorial Mathematics. McGraw-Hill.
- Strang, G. (1986). Introduction to Applied Mathematics. Wellesley-Cambridge Press.
- Logan, D.J. (2010). Εφαρμοσμένα Μαθηματικά. Πανεπιστημιακές Εκδόσεις Κρήτης.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Actuarial I (code: 6135)

Course type: Optional

Course level: First studies cycle

Instructor: Assistant Professor A. Zymbidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the lectures, the students are able to deal with the basic problems of pricing, reserving and reinsurance in a general insurance company.

Prerequisites: none

Syllabus: Individual and collective risk models, damage or loss distributions and compensation distributions and their estimation. Application in non analog risk coverage, asymptotic estimations in the distributions right end, estimating upper limits of stop loss premiums, stop loss and inflation, Pricing. Models of insurance against damage: evolution of one use payments or one insurance year use, Reserve for outstanding losses and allocated and non allocated settlement expenses, loss reserving methods, total and structural, triangular methods of compensation progress (chain ladder etc.), expected loss ratio, the Bornhuetter-Ferguson method, separate frequency and severity modeling, parametric methods (use of damage functions). Reinsurance schemes: Quota Share, Excess of Loss, Stop Loss, Markov chains and Bonus-Malus insurance systems.

Recommended Reading

- Ζυμπίδης, Α. (2008) Αναλογιστικά Μαθηματικά Γενικών ασφαλίσεων. Εκδόσεις ΟΠΑ.
- Ζυμπίδης, Α. (2008) Θεωρία Κινδύνων,, Εκδόσεις ΟΠΑ.
- Robert L. Brown, Leon R. Gottlieb (2007) Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance, ACTEX Publications.
- Kaas, R., Goovaerts, M., Dhaene, J., Denuit, M. (2008) Modern Actuarial Risk Theory, Springer, 2nd ed.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

3^o YEAR

E' Semester

Generalized Linear Models (code: 6176)

Course type: Compulsory

Course level: First studies cycle

Instructors: Associate Professor I. Vrontos – Assistant Professor E. Ioannidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Understanding generalized linear models, the statistical analysis techniques implied and their properties, as well as the ability to apply these methods in data analysis. These models include in particular logistic models for binary data as well as Poisson-log-linear models for contingency tables, including the interpretation of their results, and in some depth understanding of the theoretical issues that arise. In addition, the ability to construct design matrices with different parameterizations and to identify the presence of interactions from diagrams of the fitted values of a model.

Prerequisites: Linear Algebra, Estimation – Hypothesis Testing, Linear models.

Syllabus: GLM Theory: Covariance matrix and the Wald test. Maximum likelihood estimation: scores and their distribution, asymptotic distribution of the maximum likelihood estimators and the likelihood ratio. The exponential distributions family. Generalized linear model likelihood analysis, maximum likelihood estimation in the generalized linear model: the scores, the Fisher information and the Newton-Raphson algorithm. Relation to weighted least squares. Inference for coefficients. Deviance from the saturated model. Models with an unknown scale parameter. Residuals.

Applications, examples: binomial data: Link functions, coefficients interpretation, inference, overdispersion. One factor analysis (categorical or continuous), two or more factors analysis, with or without interactions: parameterizations, design matrices, coefficients interpretation. Probit and clog-log models examples.

Poisson and log-linear models. Contingency tables, odds ratio and log-linear parameters. Multinomial and multinomial product, equivalency with log-linear, log-linear and logistic regression. Independence, group independence, conditional independence, uniform dependence. Overdispersion, overdispersion test and dispersion index, the negative binomial model and other alternatives.

Recommended Reading

- Agresti, A. (2015), Foundations of Linear and Generalized Linear Models, Wiley Series in Probability and Statistics
- Agresti, A. (2012), Categorical Data Analysis, 3rd edition, Wiley Series in Probability and Statistics
- Dobson & Barnett (2008), An Introduction to Generalized Linear Models, Taylor & Francis.
- Fox (2008), Applied Regression Analysis and Generalized Linear Models, Kindle
- Hosmer, D.W. and Lemeshow, S. (1989, 2000), Applied Logistic Regression. New York: Wiley.
- McGullagh, P and Nelder, J.A. (1989), Generalized Linear Models, London: Chapman and Hall.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Written exam (Project). Exams on computers at the end of the semester.

Teaching Language: Greek.

Bayesian Statistics (code: 6106)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor P. Tsiamyrtzis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successful completion of the course, students will be able to handle issues regarding: objective and subjective probability, features in the Bayes approach, the likelihood principle, a-priori distribution and how to choose one (conjugate, non-informative, improper, Jeffreys, a-priori mixtures), Sufficiency and sequential updating, Multivariate Bayesian statistics, Statistical inference: (decision theory, Bayes risk, Bayes rule, MINIMAX rule, point estimate, interval estimation, hypothesis testing), predictive distribution.

Prerequisites: none

Syllabus: The aim of this course is to introduce students to the Bayesian approach to statistics and to compare the Bayesian with the classic (frequentist) approach to statistics. During this course are taught: objective and subjective probability, features in the Bayes approach, the likelihood principle. A-priori distribution and how to choose one (conjugate,

non-informative, improper, Jeffreys, a-priori mixtures). Sufficiency and sequential updating. Multivariate Bayesian statistics. Statistical inference: decision theory, Bayes risk, Bayes rule and MINIMAX. Point estimate, interval estimation, hypothesis testing. Predictive Distribution. Asymptotic theory.

Recommended Reading

- Δελλαπόρτας Π & Τσιαμυρτζής Π (2012) "Στατιστική κατά Bayes". Πανεπιστημιακές Σημειώσεις;
- Bernardo J. M. & Smith A. F. M., (1994). Bayesian Theory, Wiley, London.
- Carlin B.P. & Louis T.A. (2000). Bayes and Empirical Bayes Methods for Data Analysis, Chapman and Hall/CRC.
- O' Hagan A. and Forster J. (2004). Kendall's advanced Theory of Statistics, Volume 2b: Bayesian Inference, Edward Arnold, London.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Studying and analyzing bibliography. Tutorial. Assignments.

Student Assessment Method: Written exam at the end of the semester. Home assignment.

Optional quizzes.

Teaching Language: Greek.

Statistical Quality Control (code: 6123)

Course type: Optional

Course level: First studies cycle

Instructor: Professor St. Psarakis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After the course the student will have the skills needed to deal with improving the quality of products or services using statistical methods.

Prerequisites: none

Syllabus: Basic concepts of quality control and statistical quality control. Cause and effect charts. Pareto charts. Control charts for variables (R,S). Attributes control charts (p,np,c,u). CUSUM and EWMA control charts. Capability indices. Introduction to multivariate control charts. The six sigma methodology. Acceptance sampling. Basic experimental design using principals of repetition and blocking.

Recommended Reading

- Montgomery D (2012) Introduction to Statistical Quality Control, 7th Edition Wiley.
- Ταγαράς Γιώργος (2001) Στατιστικός Έλεγχος Ποιότητας. Εκδόσεις ΖΗΤΗ.

Teaching Method: Face to Face.

Teaching includes: Class lectures, Lab exercise, Studying and analyzing bibliography, Tutorial
Assignments: Self Study.

Student Assessment Method: Written exam at the end of the semester + Project.

Teaching Language: Greek.

Econometrics (code: 6175)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor A. Livada, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course students will be able to: know, identify, control and suggest ways to deal with violations of classical hypotheses of the multivariate regression model: autocorrelation - heteroscedasticity and multilinearity, know how and where the dummy variable is used instead of a qualitative variable in multivariate regression analysis. Know what the Seemingly Unrelated Regression Equation Systems are. Know the formation of models with structural equations, what conditions should be met to be able to estimate them and the methods used, as well as everything about the model multipliers.

Prerequisites: linear algebra, regression analysis

Syllabus: Interdependent variables systems, recursive-reduced models, financial systems multipliers, concept - interpretation, estimation, the consequences of ignoring explanatory variables endogeneity, identification problems, estimating correction coefficients using various methods. SURE - Seemingly Unrelated Regression Equations, estimation, inference, panel models and applications. ARCH and GARCH models and other models for financial data.

Recommended Reading

- Τζαβαλής Η., (2008). «Οικονομετρία», Εκδόσεις Οικονομικού Πανεπιστημίου Αθηνών.
- Johnston J., Dinardo J., Οικονομετρικές Μέθοδοι, Εκδόσεις Κλειδάριθμος ΕΠΕ, 2005.
- Δριτσακη Ν. Χαϊδω, Δριτσακη Ν. Μελίνα (2013) "Εισαγωγή στην Οικονομετρία με τη Χρήση του Λογισμικού EViews" Εκδ. Κλειδαριθμος.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Studying and analyzing bibliography. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Theoretical Statistics (code: 6144)

Course type: Optional

Course level: First studies cycle

Instructor: Assistant Professor I. Papageorgiou, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After completing the course the students ideally should be able to: Implement the standard methods to derive estimates for unknown parameters of a population with a known distribution. Evaluate and compare estimates with respect to standard criteria. Construct confidence intervals for the unknown parameters.

Construct statistical tests for hypothesis testing about unknown parameters.

Prerequisites: none

Syllabus: Terminology and definition of basic introductory concepts of parametric statistical inference (random sample, sampling space, parametric space, sample distribution, estimating statistical function). Point estimation in decision making theory (loss function, risk function). Criteria for estimator evaluation: Unbiasedness, Minimum Variance, Sufficiency, completeness, maximum Likelihood, efficiency. Methods of finding unbiased estimators of uniformly minimum variance. Fisher information, Cramer-Rao-Frechet inequality. The exponential family of distributions. Lehmann-Scheffe theorem. Maximum Likelihood Estimators (MLE). Invariance and asymptotic properties of the MLE. The concept of estimating parameters with confidence intervals. Methods of constructing confidence intervals. Pivotal quantity and the general method. Optimal confidence intervals. Asymptotic confidence intervals. Introduction to theory of parametric statistical hypothesis testing (defining the parametric hypothesis, types of errors, control function, power function). Evaluating statistical tests based on the power function. The Neyman-Pearson lemma and its applications in finding a uniformly powerful statistical test of simple hypotheses. Composite hypothesis testing. Likelihood Ratio test (LRT) and asymptotic LRT.

Recommended Reading

- Φερεντίνος Κ. και Παπαϊωάννου Τ. (2000) Μαθηματική Στατιστική, 2^η Έκδοση, Εκδόσεις Σταμούλη, Αθήνα.
- Κολυβά-Μαχαίρα Φ., Μαθηματική Στατιστική, Εκδόσεις Ζήτη, 1998.
- Φουσκάκης Δ., Ανάλυση Δεδομένων με τη Χρήση της R., Εκδόσεις Τσότρας, 2013.
- Crawley M.J., Στατιστική Ανάλυση με το R., Broken Hill Publishers, 2013.
- Ρούσσας Γ. (1994) Στατιστική Συμπερασματολογία, Τόμος Ι - Εκτιμητική, 2^η Έκδοση, Εκδόσεις Ζήτη, Θεσσαλονίκη.
- Ρούσσας Γ. (1994) Στατιστική Συμπερασματολογία, Τόμος ΙΙ – Έλεγχοι Υποθέσεων, 2^η Έκδοση, Εκδόσεις Ζήτη, Θεσσαλονίκη.
- Bickel P.J. and Doksum K.A. (2007): Mathematical Statistics, vol.I, 2nd Edition – Updated Printing, Pearson Prentice Hall.
- Casella G. and Berger R. (2002): Statistical Inference, 2nd Edition, Duxbury.
- Mood A.M., Graybill F.A. and Boes D.C. (1974): Introduction to the Theory of Statistics, 3rd Edition, McGraw-Hill Book Company.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Home assignment.

Teaching Language: Greek.

F' Semester

Data Analysis (code: 6005)

Course type: Compulsory

Course level: First studies cycle

Instructor: Professor I. Ntzoufras, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successful completion of the course, the students should be able to:

1. Manage real life problems and analyze data in R,
2. Perform basic hypothesis testing,
3. Construct and interpret regression models, and
4. Write statistical reports in a professional manner.

Prerequisites: Linear Models (code: 6023)

Syllabus: Statistical methods in simple problems using statistical packages (emphasis on R and secondary on other statistical packages): Descriptive statistics, visualization, simulating random numbers from theoretical distributions, confidence intervals, hypothesis testing for one and two independent samples, hypothesis testing for two dependent samples, contingency tables, simple and multiple regression analysis, AnCoVa models and analysis for one and two factors (and one continuous explanatory). Case studies and analysis real data sets from various scientific fields (economics, marketing, social sciences, sports, medicine, psychology etc.). Basic principles for writing professional and scientific reports.

Recommended Reading

- Ντζούφρας Ι., Καρλής Δ., Εισαγωγή στον Προγραμματισμό και στη Στατιστική Ανάλυση με R, Εκδόσεις Ελληνικά Ακαδημαϊκά Ηλεκτρονικά Συγγράμματα και Βοηθήματα-Αποθετήριο “Κάλλιπος”, 2016.
- Φουσκάκης Δ. (2013). Ανάλυση Δεδομένων με Χρήση της R. Εκδόσεις Τσότρας. Αθήνα.
- Marques de Sa, Joaquim P., Applied Statistics Using SPSS, STATISTICA, MATLAB and R, Editions Springer-Verlag, 2008.
- Chatterjee S., Handcock M.S., Simonoff J.S. (1995). A Casebook for a First Course in Statistics and Data Analysis. John Wiley & Sons.
- Faraway J.J. (2002). Practical Regression and Anova using R. Free electronic book available at <http://cran.r-project.org/doc/contrib/Faraway-PRA.pdf>.
- Fox J. & Weisberg H.S. (2011). An R Companion to Applied Regression. 2nd edition. SAGE Publications Inc.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercises. Studying and analyzing bibliography.

Tutorial. Assignments.

Student Assessment Method: Written exam at the end of the semester (50%). Assignment and oral examination/presentation (50%). Lab exercises (small extra bonus).

Teaching Language: Greek.

Simulation (code: 6125)

Course type: Optional

Course level: First studies cycle

Instructor: Professor P. Dellaportas, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: The students after successfully completing the course will be able to understand elements of stochastic simulation and implement it on pc.

Prerequisites: none

Syllabus: Generating uniform random variables, reductive generators, random number tests, methods of generating random numbers. The inversion method, the rejection method,

component method, other methods. Methods for specific distributions. Dispersion reduction techniques and the Monte Carlo integration: Monte Carlo simulation, significance sampling, opposite random variables, control random variables. Generating dependent random variables: ranked sample, exponential spaces, multivariate normal distribution, Poisson process, Markov chains, random Markov fields, Gibbs sampler, Particle filtering.

Recommended Reading

- Δελλαπόρτας, Π. (1994). Στοχαστικά Μοντέλα και Προσομοίωση. Σημειώσεις παραδόσεων, τμήμα Στατιστικής, Οικονομικό Πανεπιστήμιο Αθηνών. Διαθέσιμες στη διεύθυνση <http://www.stat-athens.aueb.gr/~ptd/simulation.ps>.
- Devroye, L. (1986). Non-Uniform Random Variable Generation, Springer-Verlag, New York.
- Ripley, Brian D. (1987). Stochastic Simulation, John Wiley, New York.
- Robinson, S. (2004). Simulation: The Practice of Model Development and Use, Wiley, Chichester, UK.
- Robert, C., Casella, G. (2010). Introducing Monte Carlo Methods with R. Springer

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Tutorial. Research assignment. Assignments.

Student Assessment Method: Home assignment. Written exam (Project).

Teaching Language: Greek.

Multivariate Statistical Analysis (code: 6136)

Course type: Optional

Course level: First studies cycle

Instructor: Professor D. Karlis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon completion of the course, the student will be able to: produce graphs and comprehend relations in his data, apply basic methods of multivariate data analysis, infer on multivariate data, use methods of dimension reduction.

Prerequisites: none

Syllabus: Multivariate data, multivariate descriptive measures, covariance matrix, generalized variance. Plots for multivariate data. Multivariate distributions, basic properties. Multivariate normal distribution, properties and estimation. Distributions arising from the multivariate normal distribution. Principal components analysis, choosing the number of principal components, principal components interpretation. Principal components analysis in sampling data. Factor analysis, the orthogonal factor model. Estimation. Model rotation, results interpretation, applications. The multivariate linear model, multivariate regression, multivariate analysis of variance. The concept of distance and its use for grouping. Structural Equation Modeling.

Recommended Reading

- Bartholomew David J., Steele F., Moustaki I., Galbraith J.I., Ανάλυση Πολυμεταβλητών Τεχνικών στις Κοινωνικές Επιστήμες, Εκδόσεις ΚΛΕΙΔΑΡΙΘΜΟΣ ΕΠΕ, 2011.
- Σιάρδος Γ., Μέθοδοι Πολυμεταβλητής Στατιστικής Ανάλυσης, Εκδόσεις Σταμούλη Α.Ε., 2005.

- Everitt, Sidney B., Casella, Fienberg G., Olkin S., Ingram, An R and S-PLUS Companion to Multivariate Analysis, Springer-Verlag London Limited, 2005.
- Anderson, T. W. (1984). An Introduction to Multivariate Statistical Analysis, John Wiley & Sons, New York, 2nd edition.
- Bartholomew, D.J., Steele, F., Moustaki, I., Galbraith, J. (2011) Ανάλυση πολυμεταβλητών τεχνικών στις κοινωνικές επιστήμες, Εκδόσεις ΚΛΕΙΔΑΡΙΘΜΟΣ
- Basilevski, A. (1994). Statistical Factor Analysis and Related Methods. Theory and Applications. John Wiley & Sons.
- Chatfield, C. and Collins, A.J. (1992). Introduction to Multivariate Analysis.
- Jackson, J. (1991). A User's Guide to Principal Components, John Wiley & Sons, Inc., New York, NY.
- Krzanowski, W. J. (1988). Principles of Multivariate Analysis. Oxford University Press.
- Mardia, K. V., Kent, J. T. & Bibby, J. M. (1979). Multivariate Analysis. London: Academic Press.
- Καρλής, Δ. (2005). Πολυμεταβλητή Στατιστική Ανάλυση. Εκδόσεις Σταμούλη.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Research Assignment. Self Study.

Student Assessment Method: Written exam at the end of the semester. Written exam (Project).

Teaching Language: Greek.

Non Parametric Statistics (code: 6113)

Course type: Optional

Course level: First studies cycle

Instructor: Assistant Professor E. Ioannidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the course the student will be able to: a) Understand the non parametric methods described and their properties: Bootstrap, non parametric density estimation, non parametric regression, generalized additive models and rank tests. b) Implement these methods in real data analysis and correctly interpret the results.

Prerequisites: Linear algebra, Estimation and testing statistical hypothesis, Linear models.

Syllabus: Non parametric density estimation, histograms, Nadaraya-Watson estimator: bias, variance, tradeoff between them and bandwidth choice: plug in and cross-validation methods. Non parametric regression: smoothing techniques. Estimator based on kernels (Nadaraya-Watson), asymptotic development of bias and variance, bandwidth choice, local polynomial regression and splines, variance estimation and confidence intervals. Generalized additive models (and regression trees). Empirical distribution function, empirical process, Kolmogorov –Smirnov and similar tests. Statistics based on functional of the empirical distribution. Jackknife and Bootstrap: general principles, examples, parametric bootstrap, estimating parameter variance and bootstrap confidence intervals. Non parametric tests based on ranks and concepts of robustness and asymptotic relative efficiency.

Recommended Reading

- Efron and Tibshirani (1998), An Introduction to the Bootstrap. Chapman & Hall.
- Fan, J. and Gijbels, I. (1996). Local polynomial modelling and its applications. Chapman & Hall.

- Fox, J. (2000). Nonparametric Simple Regression: Smoothing Scatterplots. Sage Publications.
- Hajek, J. (1969). A Course in Nonparametric Statistics. Holden Day.
- Hastie, T. J. and Tibshirani, R. J. (1990). Generalized Additive Models. Chapman and Hall.
- Hettmansperger, T. and McKean, J. (2011). Robust nonparametric Statistical Methods. Boca Ration : CRC/Taylor & Francis.
- Higgins, J. J. (2004). Introduction to Modern Nonparametric Statistics. Thomson/Brooks/Cole, New York.
- Hollander, M. and Wolfe, D. A., (1999). Nonparametric Statistical Method. Wiley.
- Shao and Tu (1995), The Jackknife and the Bootstrap, Springer.
- Sidak, Z., Sen, P. K. and Hajek, J. (1999). Theory of Rank Tests. Academic Press.
- Silverman, B.W.(1986). Density Estimation for Statistics and Data Analysis. Chapman and Hall.
- Wand, M. P. and Jones, M. C. (1994). Kernel Smoothing. Chapman and Hall.
- Wasserman, L. (2006). All of Nonparametric Statistics. Springer.
- Wood, Generalized Additive Models.Chapman and Hall.
- Ξεκαλάκη , E. (2001). Μη παραμετρική στατιστική.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Tutorial. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Written exam (Project).

Teaching Language: Greek.

Biostatistics I (code: 6246)

Course type: Optional

Course level: First studies cycle

Instructor: Assistant Professor N. Demiris, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the course the student will: Be familiar with the basic types of medical research. Be able to read a medical study and the corresponding scientific publication. Be able to perform basic analysis of medical data. The course motivates students to continue their studies in Biostatistics and to engage in the field.

Prerequisites: none

Syllabus: Basic principles of epidemiology, morbidity and risk measures, odds ratio, diagnostic tests (Mantel-Hanzel, ROC curves, sensitivity – specificity), case control studies, introduction to clinical trials, sample size estimation, principles of epidemic models, Infectious disease control.

Recommended Reading

- Pagano M. και Gauvreau, K. (2000). Αρχές Βιοστατιστικής. (μτφ. Ρ.Δαφνή) Εκδόσεις ΕΛΛΗΝ Περιστέρι.
- Ιωαννίδης, Ι (2000) Αρχές Αποδεικτικής Ιατρικής: Επιδημιολογία, Δημόσια Υγιεινή, Μέθοδοι Έρευνας, Εκδόσεις Λίτσας, Αθήνα.

- Ντζούφρας Ι. (2010). Εισαγωγή στη Βιοστατιστική και την Επιδημιολογία. Διδακτικές Σημειώσεις. Τμήμα Στατιστικής, Οικονομικό Πανεπιστήμιο Αθηνών [διαθέσιμες μέσω <http://eclass.aueb.gr>]
- Δεμίρης Ν. (2012). Εισαγωγή στα Επιδημικά Μοντέλα. Διδακτικές Σημειώσεις. Τμήμα Στατιστικής, Οικονομικό Πανεπιστήμιο Αθηνών [διαθέσιμες μέσω <http://eclass.aueb.gr>]
- Rosner, B. (2010). Fundamentals of Biostatistics. 7th International edition, Brooks/Cole – Νέα έκδοση προσεχώς.
- Diekmann O., Heesterbeek, J.A.P. and Britton, T. (2012). Mathematical tools for understanding infectious disease dynamics. First edition, Princeton University Press.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Tutorial. Assignments. Self Study. Screenings of films relative to the course and exercises/ tasks based on them. Sometimes we also have guest graduates to talk about their career and about problems and methodologies they face in their work.

Student Assessment Method: Written exam at the end of the semester. Open questions.

Problem Solving. Home assignment. Lab exercises. Practical exercises.

Teaching Language: Greek.

4^ο YEAR

Z' Semester

Applied Linear Models * (code: 6225)

** This course is not offered in the academic year 2017-18*

Course type: Optional

Course level: First studies cycle

Instructor: Professor V. Vasdekis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Students are expected to know the fundamental theory behind the simple and multiple linear regression models, weighted regression, non-linear regression, random effects models and to become familiar with their practical applications. The students study the conditions for applications and the use for analysis under different data types.

Prerequisites: Linear Algebra, Linear Models

Syllabus: Linear models for normal data using matrices. Statistical inference. Maximum likelihood and least squares. Quadratic forms. Confidence interval construction and prediction. Goodness-of-fit, plots. ANCOVA and their applications, weighted regression, variance modeling, sensitivity analysis, non-linear regression with independent data. Design of experiments. Factorial experiments with one, two or more factors. Applications of multiple comparisons. Blocking and confounding in factorial experiments. Fractional factorial experiments. Random effects models and split-plot experiments.

Recommended Reading

- Chatterjee, S. and Hadi, A.S. (2012). Regression analysis by example, Wiley.

- Draper N.R. and Smith, H. (1997). Εφαρμοσμένη Ανάλυση Παλινδρόμησης, Παπαζήσης
- Montgomery, D.C., Peck, E.A. and Vining, G.G. (2012). Introduction to Linear Regression Analysis, Wiley.
 - Montgomery, D.C. (2012). Design and analysis of experiments, Wiley.
 - Ryan, T.P. (2008). Modern regression methods, Wiley.
 - Weisberg, S. (2014). Applied Linear Regression, Wiley

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Assignments.

Student Assessment Method: Written exam at the end of the semester. Written exam (Project).

Teaching Language: Greek.

Probability theory (code: 6116)
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Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor H. Pavlopoulos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course, students should be able to: determine the probability space of a random experiment with uncountable sample space according to the Lebesgue - Caratheodory extension theorem, to apply advanced probability calculus according to Kolmogorov's axioms, manage random variables as measurable mappings of a given probability space to the Borel line, determine the type of a random variable according to its probability distribution induced on the Borel line (discrete, continuous, mixed), calculate its expected (or mean) value as a Lebesgue integral on the Borel line, to distinguish and verify modes of stochastic convergence of a given sequence of random variables, to apply the laws of large numbers and the central limit theorem.

Prerequisites: Probability I, Probability II, Calculus I, Calculus II, Introduction to Mathematical Analysis.

Syllabus: Uncountable sets and the necessity for axiomatic foundation of probability spaces (σ -algebra of events, Kolmogorov's axioms, properties of probability measure). The Lebesgue-Caratheodory extension theorem for construction of probability spaces (summary, applications). Definition of random variables and Borel measurability. Stochastic independence, Borel-Cantelli lemmas, tail events and Kolmogorov's 0-1 law. Expectation of random variables with respect to a probability measure as Lebesgue integral with respect to their probability distributions induced on the Borel line, properties of expected values. Modes of convergence for sequences of random variables (almost certain, in p -th order mean, in probability, in distribution). Limit theorems (monotone convergence, Fatou's lemma, dominated/bounded convergence theorem, uniform integrability, weak and strong laws of large numbers, central limit theorem). Lebesgue's decomposition of a probability distribution on the Borel line to its components (discrete, absolutely continuous, singular continuous), characterization of absolute continuity by the Radon-Nikodym theorem. Conditional expectation, conditional probability and their properties.

Recommended Reading:

- Athreya, Krishna B., Lahiri, Soumendra N., Measure Theory and Probability Theory, Springer Science and Business Media, LLC, 2006.
- Billingsley, P. (1995): Probability and Measure, 3rd Edition, John Wiley & Sons.
- Bhattacharya, Rabi. Waymire, Edward C., A Basic Course on Probability Theory, Springer Science and Business Media, Inc., 2007.
- Rosenthal, J. S. (2006): A First Look at Rigorous Probability Theory, Second Edition, World Scientific.
- Roussas, G.G. (2005): An Introduction to Measure-Theoretic Probability, Elsevier Academic Press.
- Skorokhod, A.V., Prokhorov, Yu.V., Basic Principles and Applications of Probability Theory, Springer-Verlag Berlin Heidelberg, 2005.
- SpringerLink (Online service), Gut A., Probability: A graduate Course, Springer Science and Business Media, Inc., 2005.
- Ρούσσας, Γ. Γ. (1992): Θεωρία Πιθανοτήτων, Εκδόσεις ΖΗΤΗ, Θεσσαλονίκη.
- Καλπαζίδου, Σ. (2002): Στοιχεία Μετροθεωρίας Πιθανοτήτων, Εκδόσεις ΖΗΤΗ, Θεσσαλονίκη.

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Statistical Learning (code: 6127)

Course type: Optional

Course level: First studies cycle

Instructor:

E.C.T.S.: 8

Desired Learning Outcomes: Upon completion of the course the students will be able to: chart and understand relationships in the data, find groups of observations, create classification rules, apply methods and work with large data sets. At the end of the course, the student will be able to construct graphs and understand relationships between data, identify observation clusters in the data, be able to build classification rules, apply methods and work with large data sets.

Prerequisites: None.

Syllabus: Statistical Data mining methods, Hierarchical and Partitioning methods for clustering. Advanced clustering methods, Model based clustering, clustering large data sets. Classification methods, the nearest neighbor methods, decision trees, linear and non linear separation methods, non parametric methods using kernels. Measures of good classification evaluation. Dimension reduction methods. Regularization, LASSO, etc. Big data problems and methods.

Recommended Reading

- Bartholomew D.J., Steele F., Moustaki I., Galbraith J.I., Ανάλυση Πολυμεταβλητών Τεχνικών στις Κοινωνικές Επιστήμες, Εκδόσεις Κλειδάριθμος ΕΠΕ, 2011.
- Ιωαννίδης Δ., Αθανασιάδης Ι., Στατιστική και Μηχανική Μάθηση με την R, Εκδόσεις Τζιόλα, 2017.
- Rajaraman A., Ullman D.J., Εξόρυξη από Μεγάλα Σύνολα Δεδομένων, Εκδόσεις Νέων Τεχνολογιών, 2014.

- Sidney B., Everitt, Casella G., Fienberg, S., Ingram O., An R and S-PLUS Companion to Multivariate Analysis, Springer-Verlag London Limited, 2005.
- Hastie, Tibshirani and Friedman (2009) Elements of Statistical Learning, 2nd edition Springer
- James, Witten, Hastie and Tibshirani (2011) Introduction to Statistical Learning with applications in R, Springer
- B. S. Everitt, S. Landau, M. Leese, and D. Stahl (2011) Cluster Analysis, Fifth Edition, Wiley

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Studying and analyzing bibliography. Tutorial. Assignments.

Student Assessment Method: Written exam at the end of the semester. Oral exam . Written exam (Project).

Teaching Language: Greek.

Biostatistics II (code: 6118)

Course type: Optional

Course level: First studies cycle

Instructor: University Scholar A. Sahlas, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes:

Upon successful completion of the course, the students will: Know and understand Survival Analysis. Acquire knowledge about theory and methods. Practical skills for survival data analysis. Basic and transferable skills for Medical Statistics and Biostatistics.

Prerequisites: none

Syllabus: Survival data and their properties. Survival time functions (survival function, risk function, average residual life) and their interrelationships. Survival time parametric models examples: Exponential , Weibull, Log-logistic etc). Non parametric survival analysis, estimating functions methods: : Product-Limit (Kaplan-Meier) and Nelson-Aalen estimators. Standard errors, types of confidence intervals (plain, log, cloglog) and inference. Methods of comparing survival function: Logrank test and generalizations. Extension to more than two samples.

Parametric survival analysis: Distribution fitting with the maximum likelihood method. Hypothesis testing, asymptotic theory, types of confidence intervals and inference. Generalization for two samples. Survival analysis with instrumental variables: Cox's model of analog risks, partial likelihood and inference. Accelerated Failure Time model. Model interpretation through Bayesian examples. Survival analysis and frailty. Introduction to clinical trials. Designs (parallel, crossover, cross-sectional, etc.). Sample size and power. Treatment allocation randomization, adjustable designs. Meta analysis.

Recommended Reading

- Μπερσίμης Σ., Σαχλάς Α., Εφαρμοσμένη Στατιστική με έμφαση στις Επιστήμες Υγείας, Εκδόσεις Τζιόλα, 2016.

- Μπερσίμης Σ., Σαχλάς Α., Εφαρμοσμένη Στατιστική με χρήση του IBM SPSS Statistics 23, Εκδόσεις Τζιόλα, 2016.
- Petrie A., Sabin C., Ιατρική Στατιστική με μια ματιά, Εκδόσεις Παρισιάνου Α.Ε., 2015.
- Pagano M., Gauvreau K., Αρχές Βιοστατιστικής, Εκδόσεις Έλλην, 2002.
- Ιωαννίδης Ι., Αρχές Αποδεικτικής Ιατρικής, Ιατρικές Εκδόσεις Λίτσας, 2000.
- Μπεσμπέας (2015) Ανάλυση Επιβίωσης. Σύγγραμμα (150 σελ.).
- Rosner, B. (2010). Fundamentals of Biostatistics. 7th International edition, Brooks/Cole – Νέα έκδοση θα βγει σύντομα.
- Armitage, P., Berry, G. and Mathews JNS (2002). Statistical Methods in Medical Research. 4th Edition. Blackwell Science.
- Hosmer, D. W., Lemeshow, S. and May S. (2008). Applied Survival Analysis: Regression Modeling of Time to Event Data, Second Edition, Wiley-Blackwell.
- Friedman L.M., Furberg C.D. and DeMets, D.L. (2010). Fundamentals of Clinical Trials. 4th edition, Springer.
- Collett D. (2003). Modelling survival data in medical research, Second edition. Chapman and Hall.
- J.F. Lawless (2002). Statistical Models and Methods for Lifetime Data, Second Edition. Wiley.
- D.R. Cox and D. Oakes (1984). Analysis of survival data. Chapman and Hall.
- S. Piantadosi (2005). Clinical Trials: A Methodological Perspective Second Edition. Wiley.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Tutorial. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Introduction to Operations Research (code: 6153)

Course type: Optional

Course level: First studies cycle

Instructor: Professor E. Kyriakidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully attending the course, the students will be able to solve linear programming problems graphically, with algebraic methods, with the Simplex method and with Excel. They will also be able to find the optimal policy that minimizes the total expected cost for finite-time horizon problems using the method of dynamic programming. They will also be able to find optimal replenishment policies for inventory problems.

Prerequisites: none

Syllabus: The linear programming problem, realistic examples, solution by graphical method, canonical form, properties of solutions, The Simplex algorithm, the M-method, the dual problem of linear programming, sensitivity analysis, the transition problem, the integer programming problem, the dynamic programming problem, the machine maintenance problem, the replacement problem, the Secretary problem. An introduction to inventory control.

Recommended Reading

- Δ. Φακίνος, Α. Οικονόμου, «Εισαγωγή στην Επιχειρησιακή Έρευνα», Εκδόσεις Συμμετρία, 2003.
- Hillier F., S., Lieberman G.J., Εισαγωγή στην Επιχειρησιακή Έρευνα, Τόμος Α', Τεύχος Α', Εκδόσεις Παπαζήσης, 1985.
- F. S. Hillier, G. J. Lieberman, "Introduction to Operations Research", McGraw-Hill, 2005.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Studying and analyzing bibliography. Assignments.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Stochastic Procedures II (code: 6057)

Course type: Optional

Course level: First studies cycle

Instructor: Professor A. Yannacopoulos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course, students will be familiar with the basic concepts of stochastic processes in continuous time and continuous state space including their simulation focusing on applications in probability, statistics, computer science and finance.

Prerequisites: none

Syllabus: Martingales in discrete time, stopping times, filtrations (intuitive). Optional Stopping Theorem. Applications of martingales in statistics, statistical learning and finance. Stochastic processes in continuous time. Brownian motion and its properties. Geometric Brown motion and the Ornstein-Uhlenbeck process. Gaussian processes. Introduction to the stochastic integral.

Simulation of stochastic processes. Applications of Brownian motion and stochastic integration in finance.

Recommended Reading

- Karlin S., Taylor H. M. (1981). A second course in stochastic processes, Academic Press.
- Rogers L. C., Williams D. (2000). Diffusions, Markov processes and Martingales: Volume I, Foundations. Cambridge University press.
- Revuz D., Yor M. (2004). Στοιχηματικές στοχαστικές διαδικασίες συνεχούς χρόνου και κίνηση Brown (ελληνική μετάφραση), Leaders Books.
- Χρυσ αφίνου Ουρανία (2008) Εισαγωγή στις Στοχαστικές Ανελίξεις. Εκδόσεις Σοφία.
- Karlin S. and H. Taylor (1975). A First Course in Stochastic Processes, Academic Press.
- Grimmett, G.R. and D.R. Stirzaker (2001). Probability and Random Processes. Oxford University Press.
- Steele, M.J. (2001). Stochastic Calculus and Financial Applications. Springer.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Studying and analyzing bibliography. Self Study. Simulation lab session.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Actuarial II (code: 6124)

Course type: Optional

Course level: First studies cycle

Instructor: Assistant Professor A. Zymbidis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the course, students can deal with the main problems of pricing and storage of life insurance policies.

Prerequisites: none

Syllabus: Simple mortality matrix and relative functions. Force of mortality, classic mortality laws, actuarial tables and commutation functions, stochastic approach to life insurance. Types of personal insurance, actuarial present values, present values variances and covariances. Types of annuities, actuarial present values and annuities variances, relations between annuities and insurance policies. Insurance (annual, united, payable in installments), approximate relationships between different types of insurance. Recursive and differential relationships for insurances and annuities. Mathematical stocks of all types, differential equations and approximate relations, alternative reserving methods (stochastic and non stochastic), Joint life and death probability, “multiple head” insurance and annuities, common insurance for Gompertz and Makeham cases, as well as under the assumption for uniform distribution of deaths (UDD). Matrices with multiple output causes, multiple situations standards, disability standards and Markov methods. Retirement models.

Recommended Reading

- Ζυμπίδης Α. (2009), Αναλογιστικά Μαθηματικά Ασφαλίσεων Ζωής
- Ζυμπίδης Α. (2008) Συνταξιοδοτικά Ταμεία & Αναλογιστικές Μελέτες
- Neil A. (1986), «Life Contingencies» Heinemann Professional Publishing
- Etienne De Vylder (1997), “Life insurance : Actuarial Perspectives”, Kluwer Academic Print
- David C. M. Dickson, Mary Hardy, Mary R. Hardy, Howard R. Water. (2013) Actuarial Mathematics for Life Contingent Risks. Cambridge University Press, 2013
- Arthur W. Anderson (2006) Pension Mathematics for Actuaries, ACTEX Publications

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Introduction to Measurement Theory with regard to Probability and Statistics (code: 6256)

Course type: Optional

Course level: First studies cycle

Instructor: Academic Scholar G. Papagiannis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully attending the course students will become familiar with the basic concepts of measure theory and integration and will be able to use some of its basic tools. Thus, they will be able to approach the techniques used in the probabilities and statistics from a point of view of measurement theory, as well as the techniques of statistical/ mechanical learning.

Prerequisites: none

Syllabus: Sets and functions. Algebra and σ -algebra of sets. Open, closed and solid subsets of the real numbers. Constructing the Lebesgue measure in real numbers. Measurable sets according to Borel and Lebesgue. The Cantor set and the Cantor function. Non-measurable sets according to Lebesgue.

Measurable functions according to Lebesgue. Borel Functions. Random variables. Sequences of functions and random variables and convergence concepts (almost certain, in measure).

The Lebesgue integral, construction and properties. Basic convergence theorems, (the Fatou Lemma, monotonous convergence theorem, dominated convergence theorem). Expected price. Convergence in distribution and applications in statistics (estimation, simulation, etc).

Lebesgue spaces of integrable functions and random variables and their structure as metric spaces. Holder and Minkowski inequities, the Beppo-Levi theorem and completeness. Convergence in Lebesgue spaces and applications. The case of L^2 , its structure as a Hilbert space, the projection theorem and its relation to conditional mean value, bases and expansions (eg Karhunen-Loeve transform, etc.).

Product measure, construction and properties and relation to independence. Integration and product measure, Fubini theorem.

Absolute continuity and measure singularity. Hahn-Jordan decomposition. Radon-Nikodym derivation. Measure space as an extension of the functions. Applications in statistics (the conditional average value under a new prism, likelihood, extreme event simulation, consistency) in finance.

Measure space as a metric space and applications. Total change distance, Helinger distance, Kuhlback-Leibler distance (entropy), transportation distance. Applications in model selection statistical and mechanical learning, etc.

Recommended Reading

- Athreya, Krishna B., and Soumendra N. Lahiri. Measure theory and probability theory. Springer Science & Business Media, 2006.
- Billingsley, P. 2008. Probability and measure. John Wiley & Sons.
- Capinski, M., & Kopp, E., (2003). Measure, Integral and Probability. Springer-Verlag.
- Jacod, J., & Protter, P. E. (2003). Probability essentials. Springer Science & Business Media.
- Καλπαζίδου, Σ. (2002). Στοιχεία μετροθεωρίας πιθανοτήτων. Εκδόσεις ΖΗΤΗ.

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Assignments. Written exam at the end of the semester and/ or assignment.

Teaching Language: Greek.

Research Methodology *

* This lesson is not offered during the academic year 2017-18

Course type: Optional

Course level: First studies cycle

E.C.T.S.: 8

Desired Learning Outcomes: Upon completion of the course, the students should be able to:

- Read scientific announcements and understand the results as well as their validity
- Be able to find information about data and methodologies needed for their analyses
- Accurately designing surveys and all their individual features
- Understand survey's validity and reliability
- Be able to distinguish problematic from accurately designed surveys
- Be able to correctly choose and apply statistical methodologies to address a research problem
- Be able to grasp morality issues in research.

Prerequisites:

Syllabus: Data collecting methods: contemporary methods, advantages and disadvantages. Error types. Questionnaire design. Building scales, scale types. Reliability indices. Examples of misuse of statistics, discussions on specific publications, building a questionnaire, research issues (introducing bias, etc), report writing and presenting.

Recommended Reading

- Norman M. Bradburn, Seymour Sudman, Brian Wansink (2004) Asking Questions: The Definitive Guide to Questionnaire Design.
- Paul P. Biemer (2004) Measurement Errors in Surveys. Wiley.

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

H' Semester

Categorical Data Analysis (code: 6108)

Course type: Optional

Course level: First studies cycle

Instructors: Professor V. Vasdekis – Associate Professor P. Merkouris, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the course, students are expected to know how to quantify different dependency forms between two or more categorical data (knowledge), to control which form of dependency appears to apply to a particular set of data (aptitude), to fit logistic regression models and to interpret the results of their data fit (capability).

Prerequisites: none

Syllabus: Types of categorical data. Contingency tables, joint, marginal and conditional probabilities, independence, comparison of proportions in 2x2 contingency tables (difference of proportions, relative risk, odds ratio), types of observational studies (retrospective, cross-sectional, prospective), odds ratio and other measures of correlation in LxJ tables. χ^2 test of independence, exact tests, partition of the statistical function χ^2 , test of independence for ordinal data, tests of linear trend for 2xL tables. Correlated data pairs, comparison of correlated proportions, Mc Nemar test for comparison of marginal proportions, measures of raters' agreement, odds ratio for agreement, kappa measure of agreement. Correlation in multidimensional contingency tables, conditional and marginal odds ratios, Simpson's paradox, partial-conditional independence, homogeneity, collapsibility, Cochran-Mantel-Haenszel tests. Logistic regression, interpretation of model parameters, inference in logistic regression, the case of categorical predictive variables, multiple logistic regression, model selection, test of goodness of fit. Models of logistic regression for polytomous variables.

Recommended Reading

- Agresti A., (2013). Categorical data analysis, Wiley
- Agresti A., (2007). An Introduction to Categorical Data Analysis, Wiley.
- Hosmer, D., Lemeshow, S. and Sturdivant, R. (2013) Applied Logistic Regression, Wiley
- Kateri, M. (2014). Contingency Table Analysis, Springer.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Studying and analyzing bibliography. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Advanced Sampling Methods (code: 6128)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor P. Merkouris, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: Upon successful completion of the course, students will be able to recognize the type of statistical problems in real-time sample surveys as well as to select and apply the appropriate by case methodology. They will also have the ability to evaluate the quality of the results of the selected method.

Prerequisites: none

Syllabus: Statistical theory of finite populations: populations, sub-populations, variables, parameters. Random sampling, probabilities of selection of units. Sampling with unequal probabilities, sampling weights, selfweighting and nonselfweighting sampling. Randomization in finite populations, estimation of finite population parameters and calculation of estimators' variances. Design effect. Estimation for sub-populations. Estimation of the distribution function. Graphics for survey data. Estimation for population size and rare populations.

Use of auxiliary information in estimation: Method of generalized regression (ratio estimator, regression estimator, poststratified estimator). Optimal regression estimator. Calibration.

Variance estimation in complex surveys. Resampling methods (random groups, jackknife, bootstrap).

Treatment of non-sampling errors. Methods of adjustment for non-response. Imputation.

Recommended Reading

- Lohr, S. (2010) Sampling: Design and Analysis. 2nd Edition. Brooks/Cole. Sengage learning.
- Sarndal, C-E., Swensson , B., Wretman , J. (1992) Model assisted survey sampling. Springer.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Lab exercise. Studying and analyzing bibliography. Assignments. Self Study.

Student Assessment Method: Written exam at the end of the semester. Open questions. Short answer questions. Home assignment.

Teaching Language: Greek.

Numerical Methods in Statistics (code: 6115)

Course type: Optional

Course level: First studies cycle

Instructor: Academic Scholar G. Papagiannis, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the course the student should be able to: use a pc to perform statistical inference. Write basic programs in R to apply statistical inference. Analyze data using computational methods and approaches.

Prerequisites: None

Syllabus: General principles of arithmetic calculations and basic tools in estimating accuracy of said calculations. Arithmetical solving of one variable functions. Bisection methods. Point method. Newton method. Secant method, False position method. Function approximation. Function approximation using least squares. Interpolation and multinomial function approach. Orthogonal polynomials and applications. Curve fit. Spline functions. Approximation using kernels. Arithmetical linear algebra. Direct methods. Linear systems stability. Matrices factorization, special matrices. LU decomposition, the Cholesky decomposition. Iterative methods of solving linear systems. The Jacobi method, the Gauss-Seidel method and its variants, general iterative method. Special linear systems. Numerical solving of non linear systems. Point method for multiple variable functions, Newton method in the multidimensional case. Numerical integration and differentiation methods. Taylor series approach. Monte Carlo integration. Numerical differentiation. Calculating derivatives using interpolation polynomials. Numerical optimization methods. Typical optimization problems, using LaGrange method of multipliers in optimization theory and the Karush–Kuhn–Tucker conditions (KKT). The Steepest Descent method, the Newton method for solving optimization problems with or without equality constraints. Interior point methods –

central path method and using bounded functions for solving optimization problems with mixed constraints. Principles of simulation and random search algorithms. Basic idea of global optimization methods. Simulated Annealing algorithmic method. The EM algorithm and its variations.

Recommended Reading

Προτεινόμενη Βιβλιογραφία

- Burden, R., Faires, J., (2010). Numerical Analysis. Cengage Learning.
- Chapra, S., Canale, R. (2016). Αριθμητικές Μέθοδοι για Μηχανικούς. Εκδόσεις Τζιόλα.
- Gentle, J. (2009). Στοιχεία Υπολογιστικής Στατιστικής. Εκδόσεις Παν. Μακεδονίας.
- Lange, K. (2010). Numerical Analysis for Statisticians. Springer.
- Monahan, J. F. (2011). Numerical methods of statistics. Cambridge University Press.

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Statistical Methods for the Environment and Ecology (code: 6058)

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor H. Pavlopoulos, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course, students should be able to: distinguish between deterministic and statistical criteria for weighing/ evaluating environmental contamination, apply contamination weighing criteria in stochastic models of enumerating violations of contamination threshold, compare the compatibility between keeping the statistical criterion and probability of violating the corresponding contamination threshold, determine the (spatial and temporal) distribution of pollutants concentration (produced at a constant rate at a constant source) based on a stochastic model of molecular diffusion – transmission of the pollutant to the environmental medium, determine probability distribution for pollutant concentration in a fixed point in space based on the theory of consecutive stochastic diffusions, apply stochastic models of population dynamics in estimating the population size based on sampling data with various methods (inventory, survival, distance, retrieval)

Prerequisites: Probability I, Probability II, Stochastic Procedures I

Syllabus: General overview of topics and problems of interest in environmental statistics and ecology. Criteria of weighing environmental pollutants. Applications of stochastic models in checking the keeping or violation of weighing criteria. Statistical analysis and modeling of extreme values (for example, exceeding the pollutant concentration threshold). Natural process of pollutant diffusion and dilution, and the Plume model of spatial and time distribution of pollutant concentration. The theory of stochastic dilution and asymptotic lognormal diffusion processes for modeling point concentration of pollutants. Introduction to spatial statistics methods, models and estimating the function of spatial scatter (variogram) and the Kriging regression.

Data types from studies of biological organizations and examples. Preliminary analysis of characteristic data sets. Special characteristics of sample distributions and the appropriate models, such as truncated, inflated, mixed. Overdispersion, underdispersion and appropriate models. Individual heterogeneity models. Model fit using maximum likelihood through arithmetic methods and the use of statistical packages (R). Estimating population size and variance. Methods of census and distance sampling. Capture – Recapture methodologies for closed and open populations. Ecological time series and their characteristics. Stochastic models of population dynamics: state – space models and models for simultaneous analyses of survival and census. Examples and applications.

Recommended Reading

- Ott, W. R. (1995): Environmental Statistics and Data Analysis, CRC Press, Inc.
- Barnett, V. (2004): Environmental Statistics: Methods and Applications, Wiley.
- Le, N.D. and Zidek, J.V. (2006): Statistical Analysis of Environmental Space-Time Processes, Springer.
- Williams, K., Nichols, J. and Conroy, M. J. (2002): Analysis and Management of Animal Populations. Academic Press, San Diego, California.
- Μπεσμπέας, Π. (2010): Στατιστικές Μέθοδοι στην Οικολογία, Πανεπιστημιακές Σημειώσεις
- Καρανδεινός Γ. Μ. (2007): Ποσοτικές Οικολογικές Μέθοδοι, Πανεπιστημιακές Εκδόσεις Κρήτης
- Σαϊτάνης Κ., Καρανδεινός Γ.Κ. (2010): Πληθυσμιακή οικολογία - δυναμική πληθυσμών. Έμβρυο.

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Course type: Optional

Course level: First studies cycle

Instructor: Associate Professor A. Livada, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: After successfully completing the course, students will be able to understand the basic concepts and principles of each country's Official Statistics. They will also be able to know the basic concepts and principles of constructing, assessing and using index numbers.

Prerequisites: none

Syllabus: Introduction, use of index numbers, estimation of simple and composite index numbers, evaluation criteria, how we define and choose the base, base change, chain index, issues of weights for composite indices, sampling errors, heterogeneity, concentration indices, indices' applications especially in Greece – Europe .

Family budget surveys, Metadata, basic Eurostat surveys and issues of statistical nomenclature. Describing basic surveys (SILC, HBS, steady panels, INTRASTAT etc) and the problems and challenges they face.

Recommended Reading

- Τζωρτζόπουλος Π., Α Λειβαδά (2011) «Αριθμοδείκτες Και Επίσημες Στατιστικές», Οικονομικό Πανεπιστήμιο Αθηνών, Αθήνα.
- OECD (2008) “Handbook on Constructing Composite Indicators – Methodology And User Guide.

Teaching Method: Face to Face.

Teaching includes: Class lectures. Seminars. Field exercise. Bibliography study and analysis. Interactive teaching. Scientists lectures. Educational Visits. Conducting a study. Assignments. Self study.

Student Assessment Method: Written exam with open notes at the end of the semester. Open questions. Problem solving. Project and project presentation. Practical exercises.

Teaching Language: Greek.

Statistics – Erasmus Course*

* This lesson is not offered during the academic year 2017-18

Course type: Optional

Course level: First studies cycle

E.C.T.S.: 8

Desired Learning Outcomes: After successful completion of the course the students should be able to:

- Understand basic statistics and how they are interconnected
- Be able to understand lectures in English
- Know the English terminology about statistical concepts
- Be able to write assignments with statistical content in English
- Use english bibliography for statistical science

Prerequisites:

Syllabus: This course is taught in English and contains subjects of introduction to probability, descriptive statistics, statistical inference and hypothesis testing as a service course. It is addressed to Erasmus students and the students of the department can attend it and have their exams in English. The curriculum covers: Overview of Statistics, Summarizing Data, Tables and Plots, Introduction to Probability, Discrete Probability Distributions, Continuous Probability Distributions, Sampling. Hypothesis testing and confidence intervals, Correlation and regression.

Recommended Reading

- De Veaux, Velleman and Bock (2012) Stats: Data and Models, 3rd edition. Pearson.
- F. J Gravetter and L. B. Wallnau (2013) Essentials of Statistics for the Behavioral Sciences, 8th Edition Wadsworth

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek/ English.

Methods of Bayesian Inference *

* This lesson is not offered during the academic year 2017-18

Course type: Optional

Course level: First studies cycle

E.C.T.S.: 8

Desired Learning Outcomes: After successful completion of the course the students should be able to:

- Understand the differences between classic and Bayesian approach
- Know the basic principles of the Bayesian approach
- Apply contemporary Bayesian analysis methods to real problems
- Know the tools that will assist them in implementing these analyses

Prerequisites:

Syllabus: Repetition of the basic principles of Bayesian inference. Markov chain, Monte Carlo and its use in Bayesian Statistics. Variations of this method and extensions. Building algorithms MCMC in R. Bayesian regression. Bayesian models using R and WinBUGS. Deviance information criterion and model complexity. Hierarchical models. Basic principles of Bayesian hypothesis testing, comparing and weighing models.

Recommended Reading

- Ntzoufras, I. (2009). Bayesian Modeling Using WinBUGS. Wiley. Hoboken. USA.
- Carlin B. and Louis T. (2008), Bayes and Empirical Bayes Methods for Data Analysis. 3rd Edition, London: Chapman and Hall.
- Gelman A., Carlin J.B., Stern H.S., Dunson, D.B., Vehtari, A. and Rubin D.B. (2013). Bayesian Data Analysis. Third Edition. Chapman and Hall/CRC.

Teaching Method: Face to Face.

Teaching includes: Class lectures.

Student Assessment Method: Written exam at the end of the semester.

Teaching Language: Greek.

Bachelor Thesis (code: 6907)

Course type: Optional

Course level: First studies cycle

Coordinator: Assistant Professor N. Demiris, Department of Statistics

E.C.T.S.: 8

Desired Learning Outcomes: At the end of the thesis the student will have extensive experience in using interdisciplinary knowledge in a particular area and will have improved his/her understanding of a research question or problem, the analysis and processing of the relevant evidence and other problem solving techniques as appropriate

Prerequisites:

Syllabus: It can only take place in the 4th year of studies, or later. In order for a student to be able to conduct a thesis he/ she must have passed all compulsory courses and hold an average grade of at least 7. The work lasts one Semester. A supervising Professor is assigned, as well as two other faculty members as examiners. The thesis is presented on a specific day

and time specified for all theses within (or shortly before) the corresponding exam. The thesis corresponds to 8 PM.

Practical Training (code: 6801)

Course type: Optional

Course level: First studies cycle

Coordinator: Professor D. Karlis – Associate Professor A. Livada, Department of Statistics

E.C.T.S.: 6-14

Desired Learning Outcomes: Upon completion of the practical training the student will be able to:

- Know how they can deal with a statistical problem with real data
- Be able to understand, explore and formulate a real problem of statistical content in the sense of statistical analysis.
- Know the role of a statistician in a company and the way of interacting with colleagues and function within a group.
- Understand time allocation when working on a project.
- Learn to handle various types of data, coming from different sources.
- Learn how to compile reports on the results of statistical analyses.
- Transfer theoretical knowledge to practical aspects
- Acquire work experience and work skills while discovering the working environment.
- Learn how to write a CV and choose prospective employers/ work environment

Prerequisites:

- Student must have completed the 5th semester.
- Not have participated again in practical training
- Have accumulated at least 80 ECTS's
- Have successfully completed at least 8 compulsory courses
- Participate in a relevant informative session/ seminar of the Practical Training office.

Syllabus: The Practical Training can take place only once and it refers to the application of statistical methods in a workplace of the Public or Private Sector. To start with the practical training, everyone interested should obtain the assent of a Department Professor who will act as a supervisor, and the approval of the Department's coordinator, and then fill out the forms available on the Department's website. The start of the Practical training can take place after the 5th Semester. The student must have registered at least 80 ECTS, passed a minimum of 8 compulsory courses and attended a relevant seminar. Depending on the subject and its duration, it can yield from 6 to 14 ECTS. The number of ECTS is determined by the Practice Exercise Coordinator at the suggestion of the supervisor faculty member. URL: <http://internship.aueb.gr/>.

C. PART THREE: GENERAL INFORMATION FOR THE STUDENTS

C: General Information for the students

The Athens University of Economics and Business emphasizes not only in providing high quality education, but also high quality services. The issue of PD 387/83 and the Law 1404/83, defines the operation, organization and administration of Student Clubs in the Universities, which aim at improving the living conditions of the students, their entertainment and the promotion of their social and intellectual education with processes and initiatives to participate in socialization.

Fulfillment of this objective is pursued by ensuring the necessary infrastructure for accommodation, feeding, training of students, with the operation of a restaurant, a canteen, a reading room, a library, organizing lectures, concerts, theater productions and excursions locally and abroad, developing international student relations, teaching of foreign languages and computer science as well as Modern Greek as a foreign language for foreign and expatriate students and the provision of any other means.

C1. Cost of Living

The cost of living is determined by the current housing and feeding prices. This cost is reduced if students qualify for free housing and meals.

C2. Housing

The Student Club of the Athens University of Economics and Business is responsible for providing free accommodation to its students under certain conditions, which are available on the Student Club's website

(<https://www.aueb.gr/el/content/%CF%86%CE%BF%CE%B9%CF%84%CE%B7%CF%84%CE%B9%CE%BA%CE%AE-%CE%BB%CE%AD%CF%83%CF%87%CE%B7>). At the same time, the Student Club of the University also has a Housing Finding Office, which collects ads for renting apartments.

C3. Feeding

In the main building of the University operates a restaurant where all members of the academic community can eat free or for a fee. Free meals are granted to those that meet the necessary conditions, which they can be informed about by the Student Club office.

C4. Medical Services, Insurance/ Healthcare

The undergraduate, postgraduate and doctoral candidates of the University that have no other medical and hospital care are entitled to full care in the National Health System, with expenses covered by the National Health Services Provider (EOPYY). The university's infirmary is housed in the main building and operates on some working days. The Psychiatric Counseling Service also operates at the University, where a physician specializing in the psychodynamic treatment of mental health issues is employed.

C5. Services for students with special needs

The University ensures the facilitation of students with special needs through the design, implementation and application of adaptations to the university's environment for access to

university buildings. More specifically, in the main building there are specially designed lifting equipment, ramps and lifts.

There are also specific exam rules for students with special needs.

The Study-Room of the Library is accessible by anyone who uses a wheelchair or has other problems with mobility. A lift for mobility-disabled people is available in the staircase of central building that leads to the entrance of Study-Room. It is suggested that you should use Antoniadou or Derigni entrances to enter the Building.

Electronic access in the Library for students with sight disabilities:

There is the possibility of electronic access to the proposed Greek literature from students of AUEB that face impaired sight problems which cannot be corrected using eye lenses to a degree that would be sufficient for reading and generally students who because of disabilities are unable to read a printed text in a conventional manner or understand the content of a work using their natural senses.

For this purpose, within the framework of the Hellenic Association of Academic Libraries Link (HEAL-Link), it has been developed a multimodal electronic library called AMELib, accessible to students who face serious sight-problems. To enter the service, user authentication is required.

C6. Financial Support for Students

Undergraduate students of Higher Education Institutions and Higher Ecclesiastical Academies, Greek nationals or nationals of other European Union countries, are entitled to annual housing allowance in accordance with the terms and conditions set out in Joint Ministerial Decision 140832 / G1 / 25-8-2017 (FEK 2993 B / 31-8-2017).

Also, the State Scholarship Foundation (IKY) grants annual scholarships and scholarships and grant loans to students who have exceeded the examinations: a) six-month courses and b) admission to universities. The Secretariats of the respective Departments shall notify the names of the Candidate Scholars by announcing them and will set the deadlines for submitting their supporting documents.

In addition, at the University operates the "George Halkiopoulos Foundation", which grants scholarships depending on the educational performance and the financial status of the candidates. In October of each academic year, the Foundation (Public Relations Department, ground floor building) announces the scholarship amount, as well as the manner and timing of submission of interested parties' applications.

Finally, other awards are granted occasionally by various Institutions, Organizations and Businesses. Information is provided by the Department of Education Department of Student Welfare (ground floor of the main building) and by the Secretariats of the Departments, as well as on the central AUEB website.

C7. Office of Student Affairs – Student Counselors

Each Department is appointed a Professor Consultant, appointed by the Assembly of the Department, responsible to direct and advise students on their studies. The Professors - Consultants (faculty members and EDIP) accept the students for questions and advice regarding the educational process in the office hours announced outside the Professors office.

C8. Study Centers – Reading Rooms – Libraries

The Library & Information Center (BCC) of the Athens University of Economics and Business was established in 1920 and is located on the first and second floor of the University's central building. It is a part of the Hellenic Academic Libraries Association (Heal-LINK), the European Documentation Centers Europe Direct and the Economic Libraries Cooperation Network (DIOB).

At the Library there are also three (3) Documentation Centers:

- The European Documentation Center (KET) since 1992,
- The Organization for Economic Cooperation and Development (OECD) Documentation Center since 1997
- The Delegation Center of the World Tourism Organization (WHO) publications since 2004.

The Library contributes decisively both to meeting the academic community's needs for scientific information as well as to support the teaching and research work. This objective is achieved through the unified organization of collections and the coordination of the services provided. The Library provides access to:

- the printed collection of books and scientific journals,
- courses textbooks,
- the collection of electronic scientific journals
- e-books collection
- the postgraduate theses and doctoral theses produced in AUEB and deposited in digital form at the PYXIDA institutional repository
- sectoral studies
- statistical series by national and international organizations
- audiovisual material
- information material (encyclopedias, dictionaries)
- Collection of official governmental publications of the European Union, the OECD and the WCO
- databases on the issues cultivated by the University
- printed collections of other academic libraries.

The Library is lending to its members, in all its printed collections, except for magazines and statistical series, according to its internal rule of operation. The Library has a reading room, computer workstations for visitors, photocopiers and printing machines, and provides the opportunity to interlibrary loan books and magazine articles from other academic libraries that are members of the networks in which it participates.

C9. International programs and practical information regarding international student mobility

AUEB is actively involved in the Erasmus+ Program by promoting cooperation with universities, businesses and international organizations of the European Union (EU) as well as the mobility of students, teaching and administrative staff. Within the framework of the above Program, the University collaborates with more than 220 European Institutions on the subjects that concern its Departments. More than 7000 students have participated so far in the Erasmus Program at AUEB. From 1989 up to now approximately 4000 students have

attended courses at EU partner institutions while approx. 3000 were welcomed to our university and took courses in English for one semester or one full academic year. In addition, the Foundation co-ordinates the Erasmus+ Practical Training Group with partners from the National Technical University of Athens and the Universities of Crete, Ioannina and Macedonia, offering the possibility of practical training for students of these five (5) Universities as well as the ability to further educate and train the staff. Finally, the University, acting in accordance to the internationalization and extroversion strategy, has been successfully participating in the International Credit Mobility Program with the aim of developing international collaborations in education and research with Partner Universities in countries outside the EU. through: a) student mobility; b) the mobility of teaching staff for short-term teaching; and c) the mobility of teaching and administrative staff for training. The Program is being implemented in the University from the academic year 2015-2016 and to date there have been 52 students and staff members moving from and to 8 Partner Institutions in countries outside the EU. (USA, Canada, Singapore, Russia, South Korea, Armenia). More information can be found on the Foundation's homepage (<https://www.aueb.gr/el/content/πρόγραμμα-έραςμος>).

C10. Language lessons

Knowledge of foreign languages, as a universally accepted educational value, is a necessary resource for effective participation of the individual in the complex work and social reality. The Student Club, understanding this modern educational necessity, offers the opportunity to every university and technical university student, as well as to all those who are interested, in attending relevant seminars. Seminars are held in English, French, German, Spanish, Italian and Russian, and new language seminars are available if there is a similar interest.

C11. Practical Training

The mission of the Central Office of Practical Training is to promote in the best possible way the linking of theory to practice and the transition of students from student to working life. Practical Training is an integral part of education at the Athens University of Economics and Business, as all Departments have instituted and included it in their curriculum. It lasts 2 to 4 months and is mainly implemented in three periods (winter semester, spring semester and summer season). Prepare seminars are carried out before each internship. Information: 13 Elpidos street, 3rd floor.

C12. Sports Facilities

The Athens University of Economics and Business organizes a variety of sports activities. It has a long history in sports with a multitude of distinctions, medals, cups, prizes in national and international competitions. In order to continue to provide complete education to its students, the Athens University of Economics and Business collaborates with the City of Athens Cultural, Sports and Youth Organization and uses its sports facilities, located at 10 Pasov Street, Grava, Ano Patissia (indoor swimming pool, indoor basketball and volleyball court, open athletics course at the junction of Ermonassis & Pityountos - Thermis (5x5 open soccer field) and at the junction Street Mitsakis & Polyly - Ano Patissia (Open tennis tennis) court.

The teaching of the courses in the Department of Physical Education of AUEB follows the curriculum for the teaching of academic subjects. It begins with the beginning of the winter semester and ends with the end of the spring semester courses. It is worth noting that students have the right to attend Physical Education courses up to six months after receiving their Diploma. The Department of Physical Education of the Athens University of Economics and Business is staffed by well-trained Physical Education Teachers and by temporary specialized teaching staff.

C13. Student Clubs

Various Student Organizations and Clubs are active and developing in the academic community of the Athens University of Economics and Business. More information can be found on the main website of the OPA

<https://www.aueb.gr/el/content/%CF%83%CF%8D%CE%BB%CE%BB%CE%BF%CE%B3%CE%BF%CE%B9-%CF%86%CE%BF%CE%B9%CF%84%CE%B7%CF%84%CF%8E%CE%BD>