## COURSE OUTLINE

### (1) GENERAL

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|---|---|---|---|
| **SCHOOL** | SCHOOL OF INFORMATION SCIENCES & TECHNOLOGY | | |
| **ACADEMIC UNIT** | DEPARTMENT OF STATISTICS | | |
| **LEVEL OF STUDIES** | 1st Cycle (UNDERGRADUATE) | | |
| **COURSE CODE** | **6116** | **SEMESTER** | **6th** |
| **COURSE TITLE** | **Probability theory** | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **CREDITS** |
|---|---|---|
| Lectures | 4 | 8 |
| Workshops | | |
| Labs | | |
| | | |

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|---|---|
| **COURSE TYPE** | Elective – Scientific Field |
| **PREREQUISITE COURSES:** | |
| **LANGUAGE OF INSTRUCTION and EXAMINATIONS:** | GREEK |
| **IS THE COURSE OFFERED TO ERASMUS STUDENTS** | NO |
| **COURSE WEBSITE (URL)** | https://www.dept.aueb.gr/en/stat/content/probability-theory-8-ects |

### (2) LEARNING OUTCOMES

**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.

**General Competences**

- Search, analysis and synthesis of data and information, using the necessary technologies
- Adaptation to new situations
- Autonomous work
- Promotion of free, creative and inductive thinking

**(3) 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.

Knowledge of Probability I and II, Calculus I and II and Introduction to Mathematical Analysis, will be useful.

## (4) TEACHING and LEARNING METHODS - EVALUATION

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|---|---|
| **DELIVERY**<br>*Face-to-face, Distance learning, etc.* | Face-to-face |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** | In communicating with the students. |
| **TEACHING METHODS** | see below |
| **STUDENT PERFORMANCE EVALUATION** | Written examination at the end of the semester<br><br>Information is available at the Study Guide and the Course Description. |

| *Activity* | *Semester workload* |
|---|---|
| Lectures | 52 |
| Studying and Analyzing Bibliography | 12 |
| Tutorial | 26 |
| Self Study | 110 |
| **Course Total** | **200** |

## (5) ATTACHED BIBLIOGRAPHY


- Ρούσσας Γ. Γ. (1992) *Θεωρία Πιθανοτήτων*, Εκδόσεις ΖΗΤΗ.
- Καλπαζίδου Σ. (2002) *Στοιχεία Μετροθεωρίας Πιθανοτήτων*, Εκδόσεις ΖΗΤΗ.
- Rosenthal J. S. (2006) *A First Look at Rigorous Probability Theory*, 2nd edition, World Scientific.
- Shiryaev A.N. (2016) *Probability*, 3rd Edition, Volume-I, Springer.
- Shiryaev A.N. (2019) *Probability*, 3rd Edition, Volume-II, Springer.
- Billingsley P. (1995): *Probability and Measure*, 3rd edition, Wiley.
- Bhattacharya R., Waymire E. C. (2016) *A Basic Course in Probability Theory*, 2nd edition, Springer.
- Roussas, G.G. (2005): *An Introduction to Measure-Theoretic Probability*, Elsevier-Academic Press.
- Leadbetter R., Cambanis S., Pipiras V. (2014) *A Basic Course in Measure and Probability – Theory for Applications*, Cambrige University Press.
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- Port S.C. (1994): *Theoretical Probability for Applications*, Wiley.
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- Skorokhod, A.V. (2005) *Basic Principles and Applications of Probability Theory*, Springer.
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