# 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** | **6126** | **SEMESTER** | **3rd** |
| **COURSE TITLE** | **Stochastic Processes I** | | |

| **INDEPENDENT TEACHING ACTIVITIES** | **WEEKLY TEACHING HOURS** | **CREDITS** |
|---|---|---|
| Lectures | 4 | 8 |
| Tutorials | 2 | |
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| **COURSE TYPE** | Compulsory |
| **PREREQUISITE COURSES:** | Probability I, Probability II, Linear Algebra I, Calculus I. |
| **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/stochastic-processes-i-8-ects |

## (2) LEARNING OUTCOMES

| **Learning outcomes** |
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| 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, branching and birth - death processes. |
| **General Competences** |
| • Search, analysis and synthesis of data and information, using the necessary technologies<br>• Adaptation to new situations<br>• Autonomous work<br>• Promotion of free, creative and inductive thinking |

**(3) SYLLABUS**

Definition of the concept of a stochastic process on given probability space, along with its parameter space, state space, finite dimensional probability distributions in the space of its sample functions and Kolmogorov's existential theorem. Concepts of stationarity and homogeneity, Gaussian processes, random noises and random walks. Simple random walks, reflection principle, ballot theorem, probability distribution of maximum value reached in finite steps, gambler's ruin probabilities and expected duration of game, arc-sine laws. Continuous time processes with independent increments, the paradigms of Wiener and Poisson (homogeneous, heterogeneous, compound) processes. Point processes, counting processes, renewal and regenerative processes. Markov chains in discrete time, stochastic matrices of (temporally homogeneous) transition probabilities, Chapman-Kolmogorov equations, classification of states according to accessibility-communication-recursiveness, criteria of recursiveness, asymptotic behavior, stationary distribution, equations of equilibrium, ergodicity. Branching processes and probabilities of extinction. Generalization of simple random walks and Poisson processes to birth-death Markov processes, in discrete and continuous time respectively.

**(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** | **YES** |
| **TEACHING METHODS** | |
| **STUDENT PERFORMANCE EVALUATION** | Written examination at the end of the semester (100% of the grade) |

| ***Activity*** | ***Semester workload*** |
|---|---|
| Lectures | 52 |
| Studying and analyzing bibliography | 7 |
| Tutorials | 26 |
| Self Study | 115 |
| **Course total** | 200 |

**(5) ATTACHED BIBLIOGRAPHY**

Recommended Bibliography:


1. Χρυσαφίνου Ουρανία (2012): Εισαγωγή στις Στοχαστικές Ανελίξεις, Β Έκδοση, Εκδόσεις Σοφία, Θεσσαλονίκη. ΕΥΔΟΞΟΣ: 22767997
2. Ζαζάνης Μιχάλης (2025): Στοχαστικά Πρότυπα και Αλυσίδες Markov, Κάλλιπος, Ανοικτές Ακαδημαϊκές Εκδόσεις. https://doi.org/10.57713/kallipos-1082
3. Κάκουλλος Θεόφιλος Ν. (1995): Στοχαστικές Ανελίξεις, Εκδόσεις Συμμετρία, Αθήνα. ΕΥΔΟΞΟΣ: 45438
4. Καλπαζίδου Σοφία (1991): Στοιχεία Θεωρίας Στοχαστικών Ανελίξεων, Εκδόσεις Ζήτη, Θεσσαλονίκη. ΕΥΔΟΞΟΣ: 11376
5. Κωνσταντινίδης Δημήτριος (2009-Μέρος Α, 2010-Μέρος Β): Θεωρία Στοχαστικών Διαδικασιών, Εκδόσεις Σταμούλη, Αθήνα. ΕΥΔΟΞΟΣ: 23122 (Μέρος-Α) & 154812 (Μέρος-Β)

Recommended Supplementary Bibliography:


1. Hoel PG, Port SC, Stone CJ (1972): Introduction to Stochastic Processes, Houghton Miffin Company.
2. Grimmett GR & Stirzaker DR (2001): Probability and Random Processes, Oxford University Press.
3. Ross SM (1996): Stochastic Processes, 2nd edition, John Wiley & Sons.
4. Ross SM (2010): Introduction to Probability Models, 10th edition, Elsevier-Academic Press.
5. Karlin S & Taylor HM (1975): A First Course in Stochastic Processes, Academic Press.
6. Norris JR (1998): Markov Chains, Cambridge University Press.
7. Lawler GF (2006): Introduction to Stochastic Processes, 2nd edition, Chapman & Hall / CRC.
8. Rosenthal JS (2020): A First Look at Stochastic Processes, World Scientific.
9. Rosenthal JS (2006): A First Look at Rigorous Probability Theory, 2nd Edition, World Scientific.
10. Shiryaev, AN (2016): Probability, 3rd Edition, Vol. I, Springer. ΕΥΔΟΞΟΣ: 75491026
11. Bhattacharya R & Waymire EC (2009): Stochastic Processes with Applications, SIAM.
12. Bhattacharya R & Waymire EC (2021): Rand Walk, Brownian Motion, Martingales, Springer.
13. Bhattacharya R & Waymire EC (2022): Stationary Processes and Discrete Parameter Markov Processes, Springer.
14. Bhattacharya R & Waymire EC (2023): Continuous Parameter Markov Processes and Stochastic Differential Equations, Springer.