COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF SCIENCE		
ACADEMIC UNIT	INFORMATICS AND TELECOMMUNICATIONS		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**K35**	**SEMESTER**	**6th**
COURSE TITLE	INFORMATION THEORY		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
	4	6 ECTS
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).		

COURSE TYPE *general background, special background, specialised general, knowledge, skills development*	Track Compulsory
PREREQUISITE COURSES:	K13 Probability and Statistics (Recommended)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek/English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/DI663/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

To train students in the basic concepts and methodologies of information theory as well as in the application of its basic tools in representative applications of emerging technologies. Upon successful completion of the course, the student will be able to:

- **Describe** and **explain** basic principles and concepts of information theory.

- **Develop** the various measures of information quantification.
- **Define** the Shannon measure of information quantity.
- **Analyze** the statistical behavior of Markovian sources.
- **Explain** the principle of coding theory.
- **Develop** procedures for encoding and decoding linear codes.
- **Implement** coding algorithms and **form** codes based on them.
- **Calculate** the capacity or upper bound of the capacity of contiguous channels without memory.
- **Formulate** the coding theorem for continuous communication channels.
- **Calculate** the amount of information of random variables.
- **Apply** fundamental inequalities of statistics and information theory (e.g. Hoeffding inequality).

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology. Decision-making. Production of new research ideas. Production of free, creative and inductive thinking.

(3) SYLLABUS

Section 1: C. E. Shannon: His life, work, and influence on modern communications.
Section 2: Information measures and basic properties: Eetropy, mutual information, Kullback-Leibler divergence, convexity.
Section 3: Typicality and the asymptotic equipartition property.
Section 4: Stationary (ergodic) sources and entropy rate.
Section 5: Lossless source compression, prefix codes, fundamental compression limits based on entropy rate, Shannon and Huffman codes.
Section 6: Channel capacity examples (binary symmetric channel, erasure channel) and properties, statement and proof of the channel coding theorem for discrete memoryless channels, achievability, joint typicality.
Section 7: Fano's inequality and the converse theorem, feedback capacity.
Section 8: Continuous-time sources and channels, differential entropy, mutual information and properties, entropy of a Gaussian random vector.
Section 9: Additive Gaussian channel and its capacity, typicality, coding theorem, bandlimited channel capacity.
Section 10: Parallel Gaussian channels, the colored noise channel, power allocation for rate maximization, water-filling method.
Section 11: Source coding with stream codes, arithmetic coding, and Lempel-Ziv coding.
Section 12: Introduction to rate-distortion theory and lossy compression.
Section 13: Linear codes, description and encoding, Hamming codes.
Section 14: Introduction to statistical signal processing and the Wald test.
Section 15: Fundamental information-theoretic inequalities and applications to communication networks.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>In class (face-to-face) and live transmission of lectures (if needed)</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Learning process supported by the eclass platform; more specifically: Course Description, Material Supply, Announcements, Calendar, Assignment and Submission of Exercises, Discussion on Exercises, Questionnaires, External Links)
• e-mail communication
• Live transmission of lectures (if needed)
• Ability to follow recorded lectures (if needed)</td></tr>
<tr><td>TEACHING METHODS

The manner and methods of teaching are described in detail.

Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.

The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>39</td></tr><tr><td>Teaching aid</td><td>26</td></tr><tr><td>Solving exercises</td><td>40</td></tr><tr><td>Self-study</td><td>45</td></tr><tr><td>Course total</td><td>150</td></tr></table>The course's lectures and seminars are given through slide show presentations in the amphitheater; representative applications of the mathematical approaches are demonstrated. The lectures' presentations are made available to the students in the course's eclass.</td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION

Description of the evaluation procedure

Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other

Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>Written Exam: 100%</td></tr>
</table>

(5) ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*

T. M. Cover, J. A. Thomas, *Elements of Information Theory,* Wiley-Interscience, 2nd edition, 2006. (Available free hardcopy)
Y. Polyanskiy, Y. Wu, *Information Theory: From Coding to Learning*, Cambridge University Press, 2025.

- *Related academic journals:*

IEEE Transactions on Information Theory
IEEE Journal on Selected Areas in Information Theory
IEEE BITS
IEEE Transactions on Information Forensics and Security
Annals of Statistics