COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**ECE_TEL851**	**SEMESTER**	**8**
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**
Lectures		2	
Seminars / Practice exercises		1	
Laboratory		1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).		4	5
COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Special Background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://www.ece.uop.gr/		

(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*

The aim of the course is to familiarize students with the principles, concepts and applications of information theory. Information Theory is the fundamental scope of study of signal transmission and compression, which is related to the quantification of data with the aim of making as much data as possible to be reliably stored on a medium or transmitted through a communication channel. The average number of bits required for storage or communication usually expresses the information measure, also known as information entropy.

Keywords: information, entropy, information channel, information flow on the bus, information channel capacity, characteristic information channels, source encoding, lossless compression, Huffman codes, Fano.

Learning Outcomes

Upon successful completion of the course, students will be able to:

At the level of Knowledge:

1. Understand the basic definitions and concepts of probabilities.
2. Describe the concepts of entropy, information and redundancy.
3. To study discrete and continuous sources of information with memory and without memory.
4. Describe the encoding algorithms Shannon, Huffman, Fano, Shannon-Fano-Elias and Lempel-Ziv.
5. Describe the concept of noise-free channel capacity and aWG noise.
6. Describe block codes, bar codes and channel syntax codes.

7. Describe the decoding of a loose decision.
8. Describe non-lossy zip encoding standards, bzip, pkzip, gzip, 7zip
9. Describe the patterns of lossy encoding JPEG, MPEG, H.26X

At Skill Level:

1. Calculate the entropy of sources with memory and without memory.
2. Apply to specific problems the encoding algorithms Shannon, Huffman, Fano, Shannon-Fano-Elias and Lempel-Ziv.
3. Evaluate the effects of noise presence on the channel.
4. Evaluate wave form coding algorithms
5. Calculate block codes for given problem.
6. Compare structural differences between error detection and correction codes.
7. Compare linear and circular codes.
8. Calculate synergistic codes for a given problem.

At Skill Level:

1. Apply to specific problems the encoding algorithms Shannon, Huffman, Fano, Shannon-Fano-Elias and Lempel-Ziv.
2. Compare and evaluate source-encoding methods without memory and with memory.
3. Design and evaluate block codes for given problem.
4. Apply the Viterbi algorithm to a given problem
5. Design block codes, interleaving codes and Reed-Solomon codes.
6. Drawing trellis diagrams
7. Design combined source, channel and configuration encoding systems as a whole.

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	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Search, analysis and synthesis of data and information using the necessary technologies.
- Working independently
- Team work
- Working in an international environment
- Production of free, creative and inductive thinking

(3) SYLLABUS

Summary

Definitions, Gausian random variables, Sequences of random variables, Spectral power density, Addition of random gaussian noise to a signal, Definition of the measure of information according to Shannon, Properties of the average amount of information, Combined and Reciprocal Information, Conditional amount of information, Mutual amount of information, Discrete source of information without memory, Source encoding methods (Fano, Shannon, Huffman), Discrete sources of information with memory, Markoff processes, Discrete communication channels, Basic channel encoding concepts, Block codes, Mathematical background (birther table, hamming distance, etc.), Bar code block example, Circular block codes, Mathematical background (polynomial birther, etc.), Example of circular block code, Gain encoding Channel, Interleaving, Reed-Solomon Codes, Reed-Solomon Code Representation (Trellis Diagrams, Status Diagrams), Syntic Code Example, Viterbi Algorithm, Loose Decision Decoding, Comparison Between Loose and Strict Decision Decoding, Turbo Codes , The Channel Capacity Theorem (Shannon Limit), Channel Code Applications in Recording and Data Transmission, CD/DVD, Modem, DSL, 3G, DVB, WiFi, WiMAX, Rate-Distortion Theory, Source

Encoding with Distortion, Applications in JPEG, MPEG, H.26X.

Theoretical Part

1. **Basic Principles of Probability Theory:** Total theory elements, Probability theory principles, Random variables, Discrete probability distributions, Cumulative distribution function, Probability density function

2. **Stochastic Signals:** Mean value and random variable dispersion, Gaussian probability density, Error function, Rayleigh probability density, Central borderline theorem

3. **Basic Principles of Information Theory:** Definition of the shannon information measure, Properties of the average quantity of information, Combined and Mutual Information, Conditional quantity of information, Reciprocal quantity of information

4. **Discrete information source without memory:** Discrete source of information without memory, Amount of source information, Source encoding, Source encoding algorithms (Fano, Shannon, Huffman)

5. **Discrete source of information with memory:** Discrete sources of information with memory, Markoff processes, Entropy of Markoff sources, Coding issues of Markoff sources

6. **Communication channels:** Discrete communication channels (channel capacity, encoding theorem, discrete channels with memory), Continuous communication channels (channel capacity, encoding theorem, continuous channels with memory)

7. **Channel Encoding with Block Bar Codes:** Basic channel encoding concepts, Block codes, Mathematical background (birther table, hamming distance, etc.), Example barcode block (encoding, decoding)

8. **Channel Encoding with Circular Block Codes:** Circular block codes, Mathematical background (polynomial birther, etc.), Example of circular block code (Encoding, Decoding), Channel encoding gain

9. **Advanced Block Encoding:** Interleaving, Reed-Solomon Codes

10. **Channel Encoding with Convolutional Codes:** Historical background, Mathematical background, Representation of synlic codes (Trellis diagrams, Status diagrams), Synliccode example (Encoding, Decoding), Viterbi Algorithm

11. **Channel Encoding with Convolutional Codes:** Loose decision decoding, Comparison between loose decoding and strict decision

12. **Channel Encoding with Turbo Codes:** Turbo Codes, The Channel Capacity Theorem (Shannon Limit)

13. **Code Applications:** Channel code applications in recording and transmitting data, CD/DVD, modem, DSL, 3G, DVB, WiFi, WiMAX, Rate-distortion theory, Source encoding with distortion, Applications in JPEG, MPEG, H.26X

Laboratory Part

The laboratory part of the course includes practical exercises aimed at applying and consolidating the knowledge of theory and concerning the design of the techniques of source coding and channel coding with block and convolutional codes that have been presented in theory, in the Octave programming environment.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY
Face-to-face, Distance learning, etc.

USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students

- Slides for the lectures of the theoretical part, which have been posted since the beginning of the semester in e-Class.
- Laboratory guides for the laboratory part (one for each laboratory exercise), which have been posted since the beginning of the semester in e-Class.
- Solutions of laboratory exercises (suspended after each laboratory exercise).
- Support of a learning process through the e-Class platform (for notification of the course operation regulation, for the distribution of slides, complementary material, announcements, links and bibliography, for the conduct of the intermediate and final examination of the laboratory part, etc.).
- Specialized Octave mathematical calculation software for the laboratory arm freely available to each student.

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

Activity	***Semester workload***
Lectures	26 (=13x2)
Seminars	13 (=13x1)
Laboratory Exercises (in Lab)	12 (=6x2)
Projects (homework)	18 hours
Lecture & bibliography study (at home)	23 hours
Preparing for Final Exam	30 hours
Course Total	***125 hours (5 ECTS)***

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.

A. Evaluation of the Theoretical Part:
I. Mid-term review (progress) (30%) which includes:
  a. Resolution of exercises
  b. Multiple choice questions

II. Written final examination comprising:
  a. Resolution of exercises
  b. Multiple choice questions
  c. Benchmarking of theory elements

B. Evaluation of laboratory part:
I. Oral examination during laboratory exercises (30%)
II. Mid-term review (progress) (30%) which includes:
  a. Resolution of exercises
  b. Multiple choice questions
III. Written final examination (40%) which includes:
  a. Resolution of exercises
  b. Multiple choice questions

Exams II and III are implemented through e-Class.

Comments:
- The final grade results from the weighting of the degrees of theory and laboratory with gravity factors of 60% and 40%, respectively.

	• The evaluation is carried out in Greek or In English for Erasmus students • The evaluation process and evaluation criteria are published on the course's website in e-Class.

(5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:
- Related academic journals:

1. Thomas M. Cover - Joy A. Thomas, Elements of Information Theory, Publisher: FORTH, University Publications of Crete
2. N. Alexandris, V. Chrysikopoulos, K. Patsakis, Introduction to Information Theory, Codes and Cryptography, Publisher Markella I. Varvarigou
3. F. Afati, Introduction to information theory, Publisher S.Athanasopoulos
4. V. Zorkandis, Information and coding theory, Hellenic Open University, 2002.
5. Voukalis Dimitris, Information Theory - Codes, Publisher S. Parikou
6. K. Sam Shammungen: Digital and Analog Communication Systems, Translation – edited by K. Karoubalou, Athens, Ed. C. Spiritual, English-language version of John Wiley & Sons, 1979.
7. J. G. Proakis and M. Salehi, Telecommunications Systems, NGO, Athens, 2002
8. S. Roman, "Introduction to Coding and Information Theory", Springer Verlag, 1996.
9. G. A. Jones, J. M. Jones, "Information and Coding Theory", Springer Verlag, 2000.
10. J. C. A. van der Lubbe: Information Theory, Cambridge University Press, 1997.