# Politehnica University of Bucharest

# Faculty of Electronics, Telecommunications and Information Technology

**COURSE DESCRIPTION**

**1. Program identification information**

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| 1.1 Higher education institution | Politehnica University of Bucharest |
| 1.2 Faculty | Electronics, Telecommunications and Information Technology |
| 1.3 Department | Applied Electronics and Information Engineering |
| 1.4 Domain of studies | Computers and Information Engineering |
| 1.5 Cycle of studies | Bachelor |
| 1.6 Program of studies/Qualification | Information Engineering |

**2. Course identification information**

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| 2.1 Name of the course | | | | Information Transmission Theory (IIA) | | | |
| 2.2 Lecturer | | | | Prof. dr. Dan Alexandru Stoichescu | | | |
| 2.3 Instructor for practical activities | | | | Assistant drd. Anamaria Rădoi | | | |
| 2.4 Year of studies | II | 2.5 Semester | I | 2.6 Evaluation type | Examination | 2.7 Course choice type |  |

**3. Total estimated time** (hours per semester for academic activities)

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| 3.1 Number of hours per week, out of which | 5 | | 3.2 course | 3 | 3.3 practical activities | | 2 |
| 3.4 Total hours in the curricula, out of which | 70 | | 3.5 course | 42 | 3.6 practical activities | | 28 |
| Distribution of time | | | | | | | hours |
| Study according to the manual, course support, bibliography and hand notes | | | | | | | 50 |
| Supplemental documentation (library, electronic access resources, in the field, etc) | | | | | | | 4 |
| Preparation for practical activities, homeworks, essays, portfolios, etc. | | | | | | | 4 |
| Tutoring | | | | | | | 0 |
| Examinations | | | | | | | 2 |
| Other activities | | | | | | | 0 |
| 3.7 Total hours of individual study | | 60 | | | |  |  |
| 3.9 Total hours per semester | | 130 | | | |  |  |
| 3. 10 Number of ECTS credit points | | 5 | | | |  |  |

**4. Prerequisites (if applicable)**

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| 4.1 curricular | Mathematical analysis 1 and 2; Algebra and Geometry; Foreign Language 1 and 2. |
| 4.2 competence-based |  |

**5. Requisites (if applicable)**

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| 5.1 for running the course | None |
| 5.2 for running of the applications | The students have to be present during practical activities hours according to the PUB regulations. |

**6. Specific competences**

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| Professional competences | The students must be able :  **C1 –** to usescientific, engineering and informatics fundamental elements:  **C1.2 –** to use specific theory and instruments (algorithms, schemata, models, protocols etc,) for explaining the structure and function of hardware, software and communication systems.  **C2 –** to design hardware, software and communication system components:  **C2.1 –** to describe the structure and function of hardware, software and communication system components;  **C2.2 -** to explainthe role and interaction of hardware, software and communication systems.  **C3 –** to solve the encountered problems by means of computer science:  **C3.4 –** to evaluate coparatively (inclusively, by experiments) different solutions in order to optimize performance.  **C6 –** to apply, in typical specific situations, the basic signal acquisition and processing methods:  **C6.1. –** to define signal mathematical expressions in time and frequency fields;  **C6.4 –** to use specific methods and instruments for signal analysis. |
| Transversal  competences |  |

**7. Course objectives (as implied by the grid of specific competences)**

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| 7.1 General objective of the course | The thorough knowledge and understanding of the fundamentals and applications of the quantity of information, source and channel information entropies, source coding for noiseless and noisy channels. |
| 7.2 Specific objectives | -understanding of the concept of information and ability to calculate the quantity of information;  - knowledge of definitions and mathematical methods concerning source and channel information entropies;  -knowledge of source encoding for noiseless channels fundamentals: encoding by means of Shanon-Fano and Huffman procedures;  - understanding of error detection and error correction philosophy; encoding and decoding of group, cyclic and recurrent codes methods; analysis and design of shift registers for encodind and decoding;  - general knowledge of digital cryptography. |

**8. Content**

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| 8.1 Lectures | | Teaching techniques | Remarks |
| **1.Generals:** information and quantity of information; fundamental concepts in information transmission theory; fidelity criteria. | | The blackboard and the videoprojector , when necessary, are mostly used in classroom. For oral communication, the exposure, concept understanding by solving problems and conversation methods are used. For learning, the students have, at their disposal, note courses and the recommen- ded books. | 2 hours |
| 2. **Information Mesurement in Discrete Signals**: quantity of information units. | | 2 hours |
| **3. Information Sources -**discrete information sources;-entropy, rate of information, redundancy and efficiency of discrete information sources; example;- Markov sources. | | 5 hours |
| **4. Information Communication Channels -** discrete memoryless channels;- discrete channel characteristic entropies; - mutual information, discrete channel capacity, redundancy and efficiency; example. - information transmission continuous channel; continuous channel capacity. | | 5 hours |
| **5. Discrete information sources encoding for noiseless channels -** uniquely decodable codes, instantaneous codes: definitions, examples;- mean length of a code word, efficiency and redundancy of codes; - absolutely optimal codes; - noiseless channel coding theorem; -symbol by symbol encoding: Shannon-Fano technique, binary encoding procedure of Huffman. | |  | 6 hours |
| **6. Discrete information sources encoding for noisy channels (Error correcting and error detecting codes)** - error detection and correction; - error correcting and error detecting code classification; - characteristic features of block codes; - noisy channel Shannon theorem. | |  | 1 hour |
| **7. Group codes** - code words specification; code words as elements of cosets; - Hamming distance, minimum distance decision, decision regions; - error detection and correction algorithm: error word, parity check matrix; -group code encoding and decoding with the check matrix H; relations between the columns of an e errors detecting or e errors correcting code; - the generator matrix G; group code encoding and decoding with the generator matrix; - the Hamming group codes; - the iterated codes. | |  | 5 hours |
| **8. Cyclic codes -** polynomial residue classes;- code words specification; - cyclic code encoding and decoding with the generator polynomial;- G and H matrices of a cyclic code; - cyclic codes encoding and decoding for error detection with dividing shift registers; - cyclic codes encoding and decoding for error correction with feedback shift registers; - cyclic Hamming codes; -multiple errors correcting codes: cyclic codes specification in terms of the roots of the generator polynomial; Bose Chaudhuri Hocquenghem codes and Golay codes. | |  | 10 hours |
| **9. Recurrent codes -** recurrent codes structure; - recurrent code encoding with the check matrix H; - recurrent codes decoding by means of the majority logic method. | |  | 4 hours |
| **10. Cryptographic systems**  **-** encrypting with random key; - encrypting with pseudorandom key. | |  | 2 hours |
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| |  |  | | --- | --- | | |  | | --- | |  |  1. Al. Spătaru, Teoria Transmisiunii Informaţiei, Editura Didactică şi Pedagogică, Bucureşti, 1983. 2. A.T. Murgan, Principiile Teoriei Informaţiei în Ingineria Informaţiei şi a Comunicaţiilor, Editura Academiei Romane, Bucureşti, 1998. 3. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory 2nd Edition, Wiley-Interscience, 2006 4. Rodica Stoian, Lucian Andrei Perişoară, Teoria Informaţiei şi a Codurilor – Aplicaţii, Editura Politehnica Press, 2010 | | | | |
| 8.2 Practical applications | Teaching techniques | | Remarks |
| 1 Discrete first order Markov information sources | * Computer applications * Matlab applications for efficient computation of specific performance parameters * Examples of practical applications * Team work (2 students) * Filling application reports by students for each laboratory   Handouts containing the homework after each laboratory class | | 2 hours |
| 2. Discrete and continuous channels | 2 hours |
| 3. Compact codes using Huffman method | 2 hours |
| 4. Hamming group codes | 2 hours |
| 5 Hamming cyclic codes | 2 hours |
| 6. Convolutional codes | 2 hours |
| 7. Final laboratory verification | 2 hours |
| Bibliography   1. Al. Spătaru, Teoria Transmisiunii Informaţiei, Editura Didactică şi Pedagogică, Bucureşti, 1983. 2. A.T. Murgan, Principiile Teoriei Informaţiei în Ingineria Informaţiei şi a Comunicaţiilor, Editura Academiei Romane, Bucureşti, 1998. 3. R. Rădescu, Rodica Stoian, Teoria Informaţiei şi a Codurilor - îndrumar de laborator, Ed. Printech, 1998. 4. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory 2nd Edition, Wiley-Interscience, 2006 5. Rodica Stoian, Lucian Andrei Perişoară, Teoria Informaţiei şi a Codurilor – Aplicaţii, Editura Politehnica Press, 2010 | | | |

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| 8.3 Seminary | Teaching techniques | Remarks |
| 1. Elements of probability theory and information theory | * Brief presentation of the theoretical aspects regarding the exercise session * Solving exercises under each studied topic   Individual handin evaluation at each 2 – 3 exercise sessions | 2 hours |
| 2. Memoryless discrete sources. Discrete first order Markov information sources | 2 hours |
| 3. Discrete channels | 2 hours |
| 4. Compact codes using Shannon-Fano and Huffman methods | 2hours |
| 5.Hamming group codes | 2hours |
| 6.Hamming cyclic codes |  | 2 hours |
| 7.Convolutional codes |  | 2 hours |
| Bibliography   1. Al. Spătaru, Teoria Transmisiunii Informaţiei, Editura Didactică şi Pedagogică, Bucureşti, 1983. 2. A.T. Murgan, Principiile Teoriei Informaţiei în Ingineria Informaţiei şi a Comunicaţiilor, Editura Academiei Romane, Bucureşti, 1998. 3. Thomas M. Cover, Joy A. Thomas, Elements of Information Theory 2nd Edition, Wiley-Interscience, 2006 4. Rodica Stoian, Lucian Andrei Perişoară, Teoria Informaţiei şi a Codurilor – Aplicaţii, Editura Politehnica Press, 2010 | | |

**9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program**

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| The information considered a measurable item is an essential concept, necessary to any specialist in signal processing, signal transmission and informatics. Information sources and transmission channels evaluation by means of statistical variables is necessary to communication specialists. The recent increasing demand for reliable digital data systems asks thorough knowlwdges in the field of error detecting and correcting codes. The former remarks are undeniable arguments for the study of this discipline, the concepts taught being expected by employers and the epistemic community representatives. |

**10. Evaluation**

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| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Weight in the final mark |
| 10.4 Lectures | - thorough knowledge  of the fundamental concepts of the discipline and of the methods to operate with these concepts;  -ability to solve problems concerning the sources and transmission channels, source encoding for noiseless and noisy channels;  - capacity to select the optimum solutions in applications. | - a test during the semester | 30% |
|  | -oral examination at the end of the semester | 30% |
| 10.5Practical applications | - understanding the experiments performed including sofware;  - correct interpretation of experimental results according to the theory | -examination at the end of the semester | 20% |
| 10.6 Seminary | - ability to solve ITT problems | -examination during the semester | 20% |
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| 10.7 Minimal performance standard | | | |
| -Knowledge and correct interpretation of fundamental concepts definitions in the fields of discrete information sources and transmission channels, noiseless and noisy channels codes;  -development of optimal solutions for problems in the fields of information sources and channel statistics, source encoding for noiseless channels and error detecting and error correcting codes (in this case, the mathematical solutions have to be implemented with shift registers, too). | | | |

Date Lecturer Instructor for practical activities

.27.09.2013 ............................................. .............................................

Date of department approval Director of Department,

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