COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Telecommunications**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Technologies and Telecommunications Systems

2. Date despre disciplină

2.1 Course name (ro) (en)				Multimedia Coding - Techniques and Applications			
2.2 Course Lecturer				S.l./Lect. Dr. Victor Popa			
2.3 Instructor for practical activities				S.l./Lect. Dr. Victor Popa			
2.4 Year of studies	4	2.5 Semester	II	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		S	2.9 Course code	04.S.08.O.612		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3.5	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	49.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	21
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					61
Tutoring					9
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	76.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	The following subjects: Signals and Systems; Digital Signal Processing

4.2 Results of learning	Basic knowledge regarding the theory of signals and systems, as well as basic knowledge on Matlab programming enviroment

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	Course room with projector
5.2 Seminary/ Laboratory/Project	Compulsory attendance at laboratories (in accordance with the regulations for license university studies in UNSTPB) Room with computers and Matlab software

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The course encompasses a unitary presentation of the main audio/video compression and coding techniques. In this context, the most used compression methods of still images, video sequences and audio signals, whether vocal, musical, narrowband or wideband, are reviewed. The presented compression techniques are later aggregated in complex audio/video applications, both in the field of storage or distribution of multimedia content and in the category of communications.
Within the applications, we want to highlight the performances and application areas for the main current solutions regarding high-performance compression of audio/video signals. Software applications will be made on general purpose hardware.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	• Learning the general principles that underlie the specific algorithms for processing voice/audio/video signals (optimal filtering, predictive linear analysis, predictive coding, adaptive coding, motion estimation); • Understanding of the simplified model of vocal signal production; • Mastering the coding solutions of the main types of voice coders presented (LPC, RELP); • Recognition of artifacts specific to the various presented audio/video encoders; • Acquiring coding standards for images and video; • Conception, implementation and operation of data, voice, video, multimedia services, based on the understanding and application of fundamental notions in the field of communications and information transmission.

Transversal (General) Competences	• Works in a team and communicates effectively, coordinating efforts with others to solve problem situations of medium complexity; • Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions; • Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis; • Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity; • Puts elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • Lists the most important methods of encoding audio and video signals; • Defines domain-specific notions; • Describes/classifies concepts/processes/phenomena/structures of audio/video coding; • Highlights consequences and relationships.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Selects and groups relevant information in a given context; • Reasonably uses specific principles in order to analyze audio and video signals; • Work productively in a team; • Experimentally verifies identified solutions; • Solves practical applications of coding audio and video signals; • Adequately interpret causal relationships; • Analyzes and compares various algorithms for coding audio and video signals; • Formulates conclusions to the experiments carried out; • Argue the identified solutions/solutions.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Select appropriate bibliographic sources and analyze them; • Respect the principles of academic ethics, correctly citing the bibliographic sources used; • Demonstrates responsiveness to new learning contexts; • Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities; • Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved; • Demonstrates social responsibility through active involvement in student social life/involvement in academic community events; • Promotes/contributes through new solutions related to the specialized field to improve the quality of social life; • Realizes the value of his contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility); • Apply principles of professional ethics/deontology in the analysis of the technological impact of the proposed solutions in the specialized field on the environment; • Analyzes and capitalizes on business/entrepreneurial development opportunities in the specialized field; • Demonstrates real-life situation management skills (collaborative vs. conflict time management)

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct exploration and indirect of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and problem solving.
In the teaching activity, lectures will be used, based on Power Point presentations or different videos that will be made available to the students. Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.
Presentations use images and diagrams so that the information presented is easy to understand and assimilate.
This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.
It will be considered the practice of active listening and assertive communication skills, as well as feedback construction mechanisms, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.
Teamwork skills will be practiced to solve different learning tasks.
The course materials are: course notes and presentations, collections of proposed problems (theoretical and solved on the computer). All materials are available in electronic format.

10. Contents

COURSE

Chapter	Content	No. hours
1	Introduction 1.1 Image and sound – representations, characteristics, models, fundamental notions 1.2 Multimedia signal compression – principle, classifications, architecture	2
2	Optimal Filtering in stationary environment – Wiener Filters 2.1 Optimal Filtering 2.2. Mean Square Filters 2.3 Wiener Filters 2.4 Classes of Applications	2
3	Linear Prediction 3.1 Forward Linear Prediction. Forward Error Prediction Filter 3.2 Transversal Structure for FIR Error Prediction Filters 3.3 Recommendations on how to use Linear Prediction in Compression Systems	2
4	Waveform Coding 4.1 Pulse Code Modulation. μ-Law. A-Law 4.2 Predictive Coding for FIR filters 4.2.1 Differential Pulse Code Modulation 4.2.2 Delta Modulation 4.3 Predictive Coding for IIR Filters 4.4 Adaptive Coding Based on Signal's Power Evolution 4.4.1 Adaptive Pulse Code Modulation 4.4.2 Adaptive Delta Modulation	2
5	Speech Model 5.1 The Phonatory Apparatus 5.2 The Acoustic Speech Model 5.3 Temporal and Spectral Speech Signal Characteristics 5.4 The Real Model of Speech	2
6	Parametric Speech Coding. Vocoders 6.1 Representation by synthesis parameters and error signal. Parametric Speech Coding 6.2 Speech Synthesis Models 6.3 Linear Predictive Vocoder. 6.3.1 USFS 1015 LPC10e Vocoder. 6.4 Residual Excited Linear Prediction Vocoder	3
7	MPEG-1 Layer III (MP3) 7.1 Definitions. Clasification 7.2 Bitrate and channel modes 7.3. Anatomy of a MP3 file 7.4. Frame structure 7.5. ID3 7.6. MP3 coding. Filter banks. The Modified Discrete Cosine Transform 7.7. Huffman coding	3

8	Principles for image and video compression 8.1. Definitions. Classifications 8.2. The Statistic Model of the Source 8.3. Transformed Domain Encoding 8.4. Predictor and Motion Compensation 8.5. Color Systems and Formats 8.6. Color Depth 8.7. Biparametric Transformations 8.8. Discrete Cosine Transform 8.9. JPEG	5
9	Perceptual video compression – Specific Instruments for Video Encoding 9.1. Video Encoders. 9.2. Video Predictive Coding based on Motion Compensation 9.3. Motion Estimation 9.4. Predictive Coding based on Motion Estimation	3
10	10. Perceptual video compression – International Standardized Video Encoders 10.1. H261 Video Encoder. 10.2. MPEG1 Video Encoder. 102.3. MPEG2 Video Encoder	4
	Total:	28

Bibliography:

- C. Negrescu, “Experimente numerice fundamentale privind analiza și prelucrarea semnalelor vocale”, Editura Printech, ISBN 973-652-918-5, București, 2004
- R. M. Udrea, D. N. Vizireanu, M. Răducanu, R. O. Preda, “Comunicații multimedia – Îndrumar de laborator”, Electronica 2000, 2004
- M. Răducanu, R. O. Preda, R. M. Udrea, “Sisteme și aplicații multimedia – Îndrumar de laborator”, Editura Electronica 2000, 2004
- C . Negrescu, “Algoritmi de optimizare și sisteme adaptive – Îndrumar de laborator”, Editura Printech, ISBN 973-9475-49-1, București, 1999
- C. Negrescu, — “Codarea semnalului vocal”, a 2-a ediție, Ed. Printech, București, 2005.
- M. Răducanu, —Sisteme și aplicații multimedia – Transformări biparametrice utilizate în analiza imaginilor‖, Ed. Electronica 2000, București, 2004.
- M. Răducanu. —Sisteme și aplicații multimedia – Algoritmi de compresie pentru semnale video‖ Ed. MatrixRom, București, 2004.

LABORATORY

Crt. no.	Content	No. hours
1	Wiener Filters	3
2	Forward Linear Prediction	3
3	Predictive Coding Techniques	3
4	Image filtering	3
5	The Discrete Cosine Transform. JPEG compression	3
6	Video compression MPEG2, H261, H263	3
7	Video motion vectors. Lab test	3

	Total:	21

Bibliography:

- C. Negrescu, “Experimente numerice fundamentale privind analiza și prelucrarea semnalelor vocale”, Editura Printech, ISBN 973-652-918-5, București, 2004
- R. M. Udrea, D. N. Vizireanu, M. Răducanu, R. O. Preda, “Comunicații multimedia – Îndrumar de laborator”, Electronica 2000, 2004
- M. Răducanu, R. O. Preda, R. M. Udrea, “Sisteme și aplicații multimedia – Îndrumar de laborator”, Editura Electronica 2000, 2004

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	To be able to reproduce theoretical fundamental notions To be able to apply theoretical notions on specific problems To be able to perform a differential analysis on different methods and techniques	2 written test papers.	70%
11.5 Seminary/laboratory/project	- to be able to implement (in a minimal form) the algorithms studied for Wiener filtering, linear prediction, predictive coding. - to be able to recognize and apply compression methods for both audio and video signals. - to be able to understand and use the functionalities of basic audio/video codecs.	Lab homework and a practical test	30%
11.6 Passing conditions			
50% of the lab allocated points 50% of the total points of the tests			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

Multimedia applications and systems have experienced explosive development in recent years, and today they are an integral part of our lives. Together with telecommunications, they have become the core of the development of modern society. In this context, knowing the techniques and algorithms used in audio/video signal compression becomes an important objective. Currently in the industry there is a significant demand for qualified engineers with specializations in telecommunications who possess a solid foundation in electronics, systems and information technology, so that the pace of development of the field can be maintained.

In this manner, the graduates are provided with the appropriate skills for the current qualification needs and with modern scientific and technical competitive training, enabling them quick employment after graduation, which is perfectly framed with the UNSTPB policy, both in terms of content and structure and in terms of skills and international openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
	S.l./Lect. Dr. Victor Popa	S.l./Lect. Dr. Victor Popa

Date of department approval	Head of department
	Conf. dr. ing. Șerban Obreja

Date of approval in the Faculty Council	Dean
	Prof. dr. ing. Radu Mihnea Udrea