Politehnica University of Bucharest
Facultyof Electronics, Telecommunications andInformation Technology

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	University Politehnica of Bucharest
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Telecommunications
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	License
1.6 Program of studies/Qualification	Technologies and Systems of Telecommunications (TSTeng)

2. Course identification information

2.1 Name of the course				Multimedia Coding - Techniques and Applications			
2.2 Lecturer				Prof.PhD Eng. Cristian Negrescu			
2.3 Instructor for practical activities				Prof.PhD Eng Cristian Negrescu			
2.4 Yearof studies	4	2.5 Semester	8	2.6 Evaluation type	Verification	2.7 Course choice type	Mandatory

3. Total estimated time (hours per semesterfor academic activities)

3.1 Numberofhours perweek,out of which	3.5	3.2 course	2	3.3 practical activities	1.5
3.4 Total hoursin the curricula, out of which	49	3.5 course	28	3.6 practical activities	21

Distributionof time	hours
Studyaccording to the manual, course support, bibliography and hand notes	25
Supplemental documentation(library, electronic access resources, in the field, etc)	8
Preparation for practical activities, homeworks, essays, portfolios, etc.	16
Tutoring	-
Examinations	6
Other activities	-

3.7 Total hoursof individual study	55
3.9 Total hours per semester	104
3. 10 Number of ECTS credit points	4

4. Prerequisites (if applicable)

4.1 curricular	Signals and Systems; Digital Signal Processing
4.2 competence-based	Basic knowledge regarding the theory of signals and systems, as well as basic knowledge on Matlab programming enviroment

5. Requisites (if applicable)

5.1 for running the course	Not applicable
5.2 for running of theapplications	Compulsory attendance at laboratories (in accordance with the regulations for license university studies in UPB)

6. Specific competences

Professionalcompetences	Designing, implementing and operating data, voice, video and multimedia services based on understating and applying the fundamental notions from the field of communication and information transmission
Transversal competences	-

7. Course objectives (as implied by the gridof specific competences)

7.1 General objective of the course	•Course –description of the main compression and coding techniques for audio&video signals –presenting and explaining relevant coding techniques for static image compression, video sequences, audio signals (which include speech, music, wide/narrow band audio) –aggregate the presented techniques in complex audio/video applications pertaining to both multimedia storage and content distribution and communications •Applications –highlight the performances and the domain of application for the main solutions regarding the efficient compression of audio/video signals –generate software applications using general or/and dedicated harware
7.2 Specific objectives	– Understanding and acquiring the main principles which are the basis for classic solutions regarding specific operations involved in audio/video encoding techniques (optimal filtering, linear prediction analysis, predictive coding, adaptive coding, motion estimation, etc.). –Understanding and acquiring the simplified model for speech production mechanism –Understanding and recognizing the coding solutions for the main vocoders (LPC, RELP). –Recognizing specific artifacts introduced by different audio/video coders –Undestanding and acquiring the image and video coding standards

8. Content

8.1 Lectures	Teaching techniques	Remarks
1.Introduction 1.1 Image and sound – representations, characteristics, models, fundamental notions 1.2 Multimedia signal compression – principle, classifications, architecture	Teaching is performed using an overhead projector and classical methods that covers the communication and demonstration activities. The oral communication methods are the expository one and the problem solving method	1 hours
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 hours
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 hours
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		3.5 hours
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 hours
6.Speech Coding 6.1 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		3.5 hours

Vocoder		
7. Principles for image and video compression 7.1. Definitions. Classifications 7.2. The Statistic Model of the Source 7.3. Transformed Domain Encoding 7.4. Predictor and Motion Compensation 7.5. Color Systems and Formats 7.6. Color Depth 7.7. Biparametric Transformations 7.8. Discrete Cosine Transform 7.9. JPEG		4 hours
8. Perceptual video compression – Specific Instruments for Video Encoding 8.1. Video Encoders. 8.2. Video Predictive Coding based on Motion Compensation 8.3. Motion Estimation 8.4. Predictive Coding based on Motion Estimation		4 hours
9. Perceptual video compression – International Standardized Video Encoders 9.1. H261 Video Encoder. 9.2. MPEG1 Video Encoder. 9.3. MPEG2 Video Encoder		6 hours

Bibliography

C. Negrescu, — "Multimedia Coding - Techniques and Applications - Lecture notes", available in electronic format.
C. Negrescu., — "Multimedia Coding - Techniques and Applications -Presentation slides, available in electronic format."
- C. Negrescu, — "Codarea semnalului vocal", 2nd edition, Printech Press, Bucureşti, 2005.
- C. Negrescu., — "Codecuri perceptuale audio multicanal", Printech Press, Bucureşti, 2004.
- M. Răducanu, —Sisteme şi aplicaţii multimedia – Transformări biparametrice utilizate în analiza imaginilorl, Electronica 2000 Press, Bucureşti, 2004.
- M. Răducanu. —Sisteme şi aplicaţii multimedia – Algoritmi de compresie pentru semnale videol MatrixRom Press, Bucureşti, 2004.

8.2 Practical applications	Teaching techniques	Remarks
1. Wiener Filters	Realization of numerical experiments, partial design of analysis/ measurement systems, implementation (in Matlab) of the required functions, handling equipment in the laboratory.	3 hours
2. Forward Linear Prediction		3 hours
3. Predictive Coding Techniques		3 hours
4. JPEG and JPEG2000 compression		3 hours
5. Moving images compression.		3 hours

Motion estimation	Generally, students work individually and sometimes collaborative. The teaching materials are the laboratory platforms (available to students)	
6. Video compression MPEG2, H261, H263		3 hours
7. Laboratory Assessment		3 hours

Bibliography

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

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

After taking this subject the student is expected to understand the specifics of multimedia transmission signals (sound and image component) compared to that of a normal data transmission. By assimilating the material presented, the student will understand and master the basic tools for signal processing, capable of giving the owner the ability to understand the functioning, performance and limitations of the traditional methods and the relatively recent compression methods of speech signals, still images and video sequences integrated in communications system of voice, video or multimedia conference. It is thus expected that graduates should prove useful for the representative market employers or media and communication services..

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 Polytechnic University of Bucharest policy, both in terms of content and structure and in terms of skills and international openness offered to students.

10. Evaluation

Typeof activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	-to be able to reproduce theoretical fundamental notions -to be able to apply theoretical notions on	4 written test papers.	80%

	specific problems -to be able to perform a differential analysis on different methid and techniques		
10.5 Practical applications	- 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.	1 written test paper Oral and practical laboratory assessment at each meeting. Final Colloquium Laboratory, including a theoretical and a practical component. The theoretical component is verified by a test (multiple choice or free answer); practical component is assessed by verifying the student's solving skills of a practical problem (implementation, testing, operation).	20%
10.6 Minimal performance standard			
-to be able to reproduce the fundamental notions on audio/video coding and compression -proven knowledge of the main audio/video formats and codecs -proven knowledge of the main audio/video compression algorithms • submission of solutions to given tasks • scoring 50% out of laboratory assessment; • scoring 50% out of test papers examinations;			

Date Lecturer Instructor for practical activities

05.10.2017 Prof.PhD Eng. Cristian Negrescu Prof.PhD Eng. Cristian Negrescu

Date of department approval Director of Department,

05.10.2017 Assoc. Prof.PhD Eng. Eduard Popovici