Universitatea Națională de Știință și Tehnologie Politehnica București

Facultatea de Electronică, Telecomunicații și Tehnologia Informației

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	Masters
1.6 Programme of studies	Advanced Wireless Communications

2. Date despre disciplină

2.1 Course name (ro) (en)				Prelucrarea semnalelor video și multimedia Digital Video and Multimedia Processing			
2.2 Course Lecturer				Conf. Dr. Cristina Oprea			
2.3 Instructor for practical activities				Conf. Dr. Cristina Oprea			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M2.O.21-10		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	2.5	Out of which: 3.2 course	1.50	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	35.00	Out of which: 3.5 course	21	3.6 seminary/laboratory	14
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.					27
Tutoring					3
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	40.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Not the case.
4.2 Results of learning	General knowledge in image processing, video signals.

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

5.1 Course	The course will take place online or in a room equipped with a video projector and computer.
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a specially equipped room, which must include computers, video projector and appropriate furniture.

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)*

This discipline is studied within the field of "Electronic Engineering, Telecommunications and Information Technologies", the Master's degree program "Advanced wireless communications" (AWC) and aims to familiarize students with the main approaches, techniques and explanatory theories of the field of analysis and digital processing of video signals in the context of wireless transmissions. Implications for solving practical applications in fields using multimedia content and video signals are presented.

The discipline addresses the following basic notions, concepts and principles as a specific topic: video formation, perception and representation, sampling and conversion between video signal sampling structures. Video signal analysis techniques as well as modern compression methods will be briefly described. Advanced elements that will be presented in the course are: multimedia content distribution, adaptive video streaming and Content Delivery Networks.

All of this contributes to providing students with an overview of the functional milestones related to the field of video and multimedia signal processing for wireless transmissions.

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	Demonstrates basic knowledge of digital video signal analysis and processing in the context of wireless transmissions. • Analyzes video information at an advanced level for: video signal processing, compression and distribution of multimedia content. • Explaining the phenomena related to the processing and transmission of video signals, coding/decoding. • Comparative evaluation of the solutions of some problems related to the processing of video signals in order to optimally transmit the information. • The use of simulation environments for the acquisition and digital processing of video signals. • Apply standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identify solutions. • Argue and analyze coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and the specific methodology

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. • Respects the principles of academic ethics: correctly cites the bibliographic sources used in the documentation activity. • Identifying the need for continuous training and the effective use of information sources and communication resources and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.).

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 main methods and mechanisms of digital processing of video signals in the context of wireless transmissions; • Defines the basic notions specific to the field of video compression; • Describes the most important modern video signal modeling and analysis techniques; • Develops the ability to expand and use the knowledge acquired in the course for applications involving video processing, analysis and compression; • Identifies the main problems related to the adaptive transmission of video signals; • Acquire the basic skills necessary to find practical solutions for problems that arise in the field of multimedia content distribution.
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 develop computational models. • Work productively in a team. • Elaborate a scientific text. • Experimentally verifies identified solutions. • Solve practical applications. • Adequately interpret causal relationships. • Analyze and compare the methods and techniques that can be used to solve a given practical problem. • Identifies solutions and develops resolution plans. • Formulates conclusions to the experiments carried out. • Argue the identified solutions and ways of solving them

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 • 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)

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 exploration direct and indirect of reality (experiment, demonstration, modelling), but also on action-based methods, such as exercise, practical activities and solving tasks in simulation environments.

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.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	The human visual system and visual perception. Digital images. Video formats.	3
2	Signal compression – general notions. Lossy and lossless compression.	4
3	Image compression standards. JPEG and JPEG2000.	4
4	Compression of video signals - general notions. H.264 AVC and H.265 HEVC compression standards. Feature extraction. Metadata. Organization of multimedia information. Program and transport flows. Perceptual evaluation of video quality	5

5	Transmission of multimedia streams. Transmission through variable bit rate channels. MPEG DASH, Microsoft Smooth Streaming, Adobe Dynamic Streaming, and Apple HTTP Live Streaming (HLS).	3
6	Multimedia information delivery architectures. Content Delivery Networks – content delivery networks	2
	Total:	21

Bibliography:

1. C. Oprea, „ Prelucrarea semnalelor video și multimedia”, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9459
2. C. C. Oprea, R. O. Preda, Fundamentals of Image Processing and Computer Vision – Theory and Applications, Politehnica Press, ISBN 978-606-9608-03-6, Bucharest, 2022.
3. Pirnog, R.O. Preda, R.M. Udrea, Analiza şi Prelucrarea Digitală a Semnalelor Video: îndrumar de laborator, Politehnica Press, ISBN 978-606-515-487-2, Bucureşti, 2013.
4. A. Murat Tekalp, Digital Video Processing (2nd Edition), Prentice Hall, ISBN: 978-0133991000, 2015.
5. F. H. P. Fitzek, F. Granelli, P. Seeling, ” Computing in Communication Networks. From Theory to Practice”. Academic Press - Elsevier, ISBN: 978-0-12-820488-7, 2020.
6. M. S. Mushtaq, A. Mellouk, ” Quality of Experience Paradigm in Multimedia Services”, iSTE Press Elsevier, ISBN 978-1-78548-109-3, 2017

PROJECT

Crt. no.	Content	No. hours
1	The use of the Matlab environment in the processing of video sequences. Simple processing operations.	2
2	Low-level video feature extraction. Metadata.	2
3	Video coding techniques. H.264 AVC video stream formation	2
4	Video compression for high resolution. H.265 HEVC video stream	2
5	Methods for estimating the perceptual quality of video sequences	2
6	QoS measurements for multimedia streams transmitted over wireless channels	2
7	MPEG DASH efficiency. Building a scenario with variable channel parameters during the transmission of a multimedia stream. Evaluation of MPEG DASH's ability to adapt to QoS parameter variations	2
	Total:	14

Bibliography:

1. C. Oprea, „ Prelucrarea semnalelor video și multimedia”, suport de curs electronic, https://curs.upb.ro/2021/course/view.php?id=9459
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4. A. Murat Tekalp, Digital Video Processing (2nd Edition), Prentice Hall, ISBN: 978-0133991000, 2015.
5. F. H. P. Fitzek, F. Granelli, P. Seeling, ” Computing in Communication Networks. From Theory to Practice”. Academic Press - Elsevier, ISBN: 978-0-12-820488-7, 2020.
6. M. S. Mushtaq, A. Mellouk, ” Quality of Experience Paradigm in Multimedia Services”, iSTE Press Elsevier, ISBN 978-1-78548-109-3, 2017

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Criteria 1	Midterm quizz	10%
	Criteria 2	Final exam	40%
11.5 Seminary/laboratory/project	Project criteria	Project assignments	50%
11.6 Passing conditions			
Obtaining 50% of the total score.			

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)

The processing of video and multimedia signals is an important branch of the engineering market in the fields of electronics and telecommunications, but also for medicine, military-type applications, the IT industry. The industry relies on solutions developed by engineers with solid knowledge of image and video signal processing for modern multimedia systems. Most of the modern technologies based on operating systems, the most widespread being "smart-phone" type mobile terminals, widely use audio and video signals for new software applications. Knowing the fundamentals specific to video processing makes it possible to move easily to new applications and even multimedia experiences.

The course curriculum responds concretely to these current development and evolution requirements, subscribed to the European economy of services in the field of Telecommunications. Graduates are provided with adequate competences with the needs of current qualifications and a modern, quality and competitive scientific and technical training, which will allow them to be quickly employed after graduation, being perfectly framed in the policy of the Polytechnic University of Bucharest, both from the point of view of content and structure , as well as from the point of view of the skills and international openness offered to students.

Date	Course lecturer	Instructor(s) for practical activities
	Conf. Dr. Cristina Oprea	Conf. Dr. Cristina Oprea

Date of department approval	Head of department
27.10.2024	Conf. Dr. Serban Georgica Obreja

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Date of approval in the Faculty Council	Dean
25.10.2024	Prof. Dr. Mihnea Udrea