SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babeş-Bolyai University
1.2 Faculty	Faculty of Mathematics and Computer Science
1.3 Department	Department of Computer Science
1.4 Field of study	Computer Science
1.5 Study cycle	Bachelor
1.6 Study programme / Qualification	Computer Science

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			Audio-video Data Processing				
2.2 Course coordinator			Lect. PhD. Sterca Adrian				
2.3 Seminar coordinator			Lect. PhD. Sterca Adrian				
2.4. Year of study	**3**	2.5 Semester	**5**	2.6. Type of evaluation	**C**	2.7 Type of discipline	**Optional**
2.8 Code of the discipline		MLE8117					

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	5	Of which: 3.2 course	2	3.3 seminar/laboratory	1lab +2pr
3.4 Total hours in the curriculum	70	Of which: 3.5 course	28	3.6 seminar/laboratory	42
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					6
Additional documentation (in libraries, on electronic platforms, field documentation)					6
Preparation for seminars/labs, homework, papers, portfolios and essays					8
Tutorship					6
Evaluations					4
Other activities:					0

3.7 Total individual study hours	30
3.8 Total hours per semester	100
3.9 Number of ECTS credits	4

4. Prerequisites (if necessary)

4.1. curriculum	• Computer Networks, Distributed Operating Systems, Databases, Data Structures and Algorithms, Object Oriented, Programming
4.2. competencies	• Strong knowledge in computer networks, very good knowledge on data structures and algorithms, programming languages, object-oriented programming.

5. Conditions (if necessary)

5.1. for the course	• Class room with a video projector device
5.2. for the seminar /lab activities	•

6. Specific competencies acquired

Professional competencies	Identification of concepts and models from the field of multimedia, networking (multimedia streaming) and computer vison (image/video/sound feature extraction)
Transversal competencies	Applying rules for an organized and efficient work, responsible attitude towards the didactic-scientific field for creative capitalization of one's own potential, complying to the principles and professional ethics norms. Utilizing efficient methods and techniques for learning, knowing, research and development of knowledge capitalization capacities, adapting to the requirements of a dynamic society and the communication in Romanian or an international language.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Getting the student acquainted with concepts and technologies used in multimedia processing and audio-video communication in digital networks, satellite or terrestrial, and most importantly in digital "best-effort" networks based on IP (e.g. the Internet). The course is meant to be on an intermediate-to-advanced level in the field of multimedia
7.2 Specific objective of the discipline	• Understanding audio-video codecs and digital audio-video formats, audio-video streaming fundamentals in the Internet (signaling and streaming protocols, rate/congestion control) and the basics of audio-video satellite broadcasting. • Being able to perform digital sound processing (like applying sound filters or voice/speech recognition) and video processing (like edge detection and blurring in video frames, object recognition and tracking in videos). • The course has also a strong applicative part meaning that students must implement specific applications/projects on the processing, transmission and playback of digital audio-video signal.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction to multimedia. Analog representation of audio and video signals. Digital representation of audio and video signals. The JPEG compression standard.	Exposure:description, explanation, examples,discussion of case studies	JPEG and JPEG2000 compression standards are the most used image compression standards in Internet and on digital cameras and capture devices
2. Audio-video formats (containers) and codecs.	Exposure:description,	

Basics of video encoding. The structure of a general video encoder/decoder. AV encoding standards. AV containers: .avi, .ogg, .mp4, .vob, .3gp, .mkv etc.	explanation, examples,discussion of case studies	
3. Audio-video formats (containers) and codecs. The MPEG-1 and MPEG-2 standards.	Exposure:description, explanation, examples,discussion of case studies	
4. Audio-video formats (containers) and codecs. The H.264/MPEG-4 AVC standard. H.264/MPEG-4 SVC	Exposure:description, explanation, examples,discussion of case studies	H.264/MPEG-4 AVC is one of the most commonly used formats for high definition video in Internet and satellite/terrestrial television networks
5. Audio-video formats (containers) and codecs. The H.265/HEVC standard. VP9 codec.	Exposure:description, explanation, examples,discussion of case studies	
6. Multimedia streaming protocols. RTP and RTCP. Multimedia signaling protocols. RTSP, SDP, SIP.	Exposure:description, explanation, examples,discussion of case studies	Explains how skype or google hangouts function
7. Audio-video streaming over HTTP. DASH	Exposure:description, explanation, examples,discussion of case studies	Explains how youtube, Vimeo work
8. Congestion control algorithms for audio-video applications in best-effort networks. TCP AIMD, DCCP, TFRC and UTFRC	Exposure:description, explanation, examples,discussion of case studies	
9. Voice over IP. Speech coding. Voice and Speech recognition.	Exposure:description, explanation, examples,discussion of case studies	Explains the basic technologies behind sound recognition software like Google Voice Search on Windows/Android and Siri and Shazzam on iOS
10. Audio-video communication in satellite networks. Basics of satellite communication and DBS (Direct Broadcast Satellite)	Exposure:description, explanation, examples,discussion of case studies	
11. Audio-video communication in satellite networks. Video broadcasting and DVB standards: DVB-S, DVB-T and DVB-C	Exposure:description, explanation, examples,discussion of case studies	Presents the protocols used by current TV content providers.
12. Audio-video libraries and applications. FFMPEG, VideoLan, OpenCV	Exposure:description, explanation, examples,discussion of case studies	FFMPEG and VideoLan are the most used free, open-source libraries for audio-video encoding/decoding and

		processing and OpenCV is a powerful library used in computer vision (object recognition in video)
13. Multimedia QoS in Internet. P2P video streaming and Internet Television.	Exposure:description, explanation, examples,discussion of case studies	
14. Object recognition in video.	Exposure:description, explanation, examples,discussion of case studies	The basic techniques for object recognition and tracking in videos

Bibliography

1.Al Bovik, The Essential Guide to Video Processing, Academic Press, Elsevier, 2009.
2.L. Hanzo, P. Cherriman, J. Streit, Video Compression and Communications. From Basics to H.261, H.263, H.264, MPEG4 for DVB and HSDPA-Style Adaptive Turbo-Transceivers, Wiley & IEEE Press, 2007.
3.A. Sterca, Congestion Control for Streaming Protocols, PhD Thesis, 2008.
4.Iain Richardson, Video Codec Design, Wiley, 2002.
5.Iain Richardson, H.264 and MPEG-4 Video Compression, Wiley, 2003.
6.Colin Perkins, RTP - Audio and Video for the Internet, Addison-Wesley, 2003.
7.Tokunbo Ogunfunmi, Madihally Narasimha, Principles of Speech Coding, CRC Press, 2010
8.Frank Y. Shih, Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley-IEEE Press, 2010.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Presentation of project themes. Students must choose a project theme and must develop that project by the end of the semester. Examples of project themes for the current year are at http://www.cs.ubbcluj.ro/~forest/pdav/projects.html	Dialogue, debate, case studies, examples	The laboratory is structured as 2 hours classes, one lab every two weeks
2. Image processing. JPEG encoder in java. Simple examples (in C/C++) using the SDL library (displaying a BMP/YUV image on a SDL surface)	Dialogue, debate, case studies, examples	
3. Getting acquainted with the FFMPEG library. A simple audio-video player based on FFMPEG and SDL (written in C); synchronizing audio with video, saving frames as images, filters. Youtube downloader using FFMPEG. WebRTC demo.	Dialogue, debate, case studies, examples	
4. Sound processing in Java and C. Creating digital effects for an electric-acoustic guitar (delay, distortion, chorus, echo etc.) – demonstration using a Yamaha FX370C electro-acoustic guitar.	Dialogue, debate, case studies, examples	
5. Getting input from a digital camera, internal or using a video capture device (TV tuner), in java and C/++; demonstration using a Sony HDR-TD10 Full HD 3D video camera and an internal Acer notebook camera. 3D movie rendering on a regular LCD display using anaglyph glasses – demo.	Dialogue, debate, case studies, examples	
6. Object Recognition in videos - simple applications in C/C++ using the OpenCV library.	Dialogue, debate, case studies, examples	
7. Presentation of student projects	Dialogue, case	

	studies	

Bibliography
1. The FFMPEG code
2. The VideoLan VLC code
3. Al Bovik, The Essential Guide to Video Processing, Academic Press, Elsevier, 2009.
4. Iain Richardson, Video Codec Design, Wiley, 2002.
5. David Salomon, Data Compression: The Complete Reference, Springer, 3rd edition, 2004

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course respects the IEEE and ACM Curriculla Recommendations for Computer Science studies;
- The course exists in the studying programs of all major universities in Romania and abroad;
- The content of the course is considered by software companies as important for average programming skills

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowing the theoretical issues discussed during the course. Being able to design and understand a multimedia streaming system.	**1) Project**: Students should develop a project related to audio-video data processing either individually or in small teams of 2 persons. Students must choose the project theme in the beginning of the semester and they must present the project at the end of the semester. During the semester, they must also show work progress and intermediate versions of the project at the labs. **The possible grades a student can receive on the project are: 10, 9 and 4. No other grades are possible.** Examples of project ideas are here: List of possible projects (in romanian). **2) Labs + Quiz test**: Students must complete 4 laboratory tasks (i.e. 4 labs) during the semester and at the end of the semester they must take a quiz test. The lab tasks require the students to build a part of a video codec and are detailed here:Laboratorytasks. The final grade is formed like this: averageLabGrade*0.8 + quizGrade*0.2 **3) Quiz test**: If the student does not get an average lab grade of at least 6 and he/she does not do a project, he/she must take the quiz test and the grade he/she receives for this quiz test is the final grade. This grade can not be greater than 7.	
10.5 Seminar/lab activities	Applying the knowledge received from the course, the ability to implement from scratch a multimedia system (without any help from a multimedia framework, using only operating system's drivers and tools).		

10.6 Minimum performance standards			
➢ In order to successfully pass this class, students must get at least 5 at either the project presentation (preferable) or at the written exam. ➢ The course requirements are described at: http://www.cs.ubbcluj.ro/~forest/pdav			

Date	Signature of course coordinator	Signature of seminar coordinator
.....	Lect.PhD. Adrian Sterca	Lect.PhD. Adrian Sterca

Date of approval	Signature of the head of department
.....	Prof. PhD. Anca Andreica