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	Audio-video Communication in High-speed Networks						
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	**6**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Optional**

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

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	36	Of which: 3.5 course	24	3.6 seminar/laboratory	12

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	20
Additional documentation (in libraries, on electronic platforms, field documentation)	20
Preparation for seminars/labs, homework, papers, portfolios and essays	30
Tutorship	15
Evaluations	4
Other activities:	0

3.7 Total individual study hours	89
3.8 Total hours per semester	125
3.9 Number of ECTS credits	5

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	▪ Good programming skills in high-level languages ▪ Ability to work independently and/or in a team in order to solve problems in defined professional contexts. ▪ Ability to permanently learn, understand and apply the most recent scientific results in the field of Computer Science.
Transversal competencies	▪ Understanding the main concepts and techniques in the field of multimedia processing ▪ Ability to analyze and digital process audio and video signals ▪ Ability to design and build an audio-video playback system and an audio-video streaming system over the Internet

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 audio-video communication in analog 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. Basics of video encoding. The structure of a general video encoder/decoder. AV encoding standards. AV	Exposure:description, explanation,examples, discussion of case studies	

containers: .avi, .ogg, .mp4, .vob, .3gp, .mkv etc.		
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. Multimedia streaming protocols. RTP and RTCP. Multimedia signaling protocols. RTSP, SDP, SIP. Audio-video streaming over HTTP.	Exposure:description, explanation,examples, discussion of case studies	Explains how youtube, vimeo, skype or google hangouts function
6. 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	
7. 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
8. Audio-video communication in satellite networks. Basics of satellite communication and DBS (Direct Broadcast Satellite)	Exposure:description, explanation,examples, discussion of case studies	
9. 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.
10. 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)
11. Multimedia QoS in Internet. P2P video streaming and Internet Television.	Exposure:description, explanation,examples, discussion of case studies	
12. 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/cav/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. Youtube downloader using FFMPEG.	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. Object Recognition in videos - simple applications in C/C++ using the OpenCV library.	Dialogue, debate, case studies, examples	
6. Public 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	10.2 Evaluation methods	10.3 Share in

	criteria		the grade (%)
10.4 Course	Knowing the theoretical issues discussed during the course. Being able to design and understand a multimedia streaming system.	During the semester, students will have to implement a medium-complexity software project from the multimedia (audio-video) field based on the FFMPEG library. E.g.: audio-video player enhanced with several output filters and surfaces, simple audio or video codec, video surveillance system etc. For a list of potential project ideas for this year see: http://www.cs.ubbcluj.ro/~forest/cav/projects.html As an alternative, the final grade can also be obtained by taking a written exam (without developing a semester project), but in this case, the maximum obtainable final grade is 7.	100 %
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/cav			

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. Bazil Parv