

# MSc Computer & Communication Networks (CCN)

---

## Option M32: *Multimedia Engineering*

Coordination: Prof. Françoise PRETEUX

The *Multimedia Engineering* program is proposed as the 3<sup>rd</sup> Semester option M32 of the Computer and Communication Networks (CCN) Master of Science of INT. Managed by the ARTEMIS Project Unit, this program focuses on the processing, storage, delivery, retrieval, exchange and visualization of multimedia content.

### ■ Objectives

The *Multimedia Engineering* program aims at providing students with in-depth knowledge of the state-of-the-art multimedia content technologies and the necessary skills to meet the needs from the IT industry. Designed for graduate students seeking employment in the field of multimedia communications, it provides advanced theoretical and practical training, complemented with state-of-the-art seminars on current research and industrial challenges.

Upon completion of the program, students with different technical backgrounds and aspirations are expected to have acquired:

- ❑ a strong theoretical and practical knowledge in multimedia systems and services;
- ❑ the analytical and technical ability to conduct high-level research and development projects within the rapidly changing IT industry;
- ❑ a deep understanding of current multimedia standards.

### ■ Language of instruction

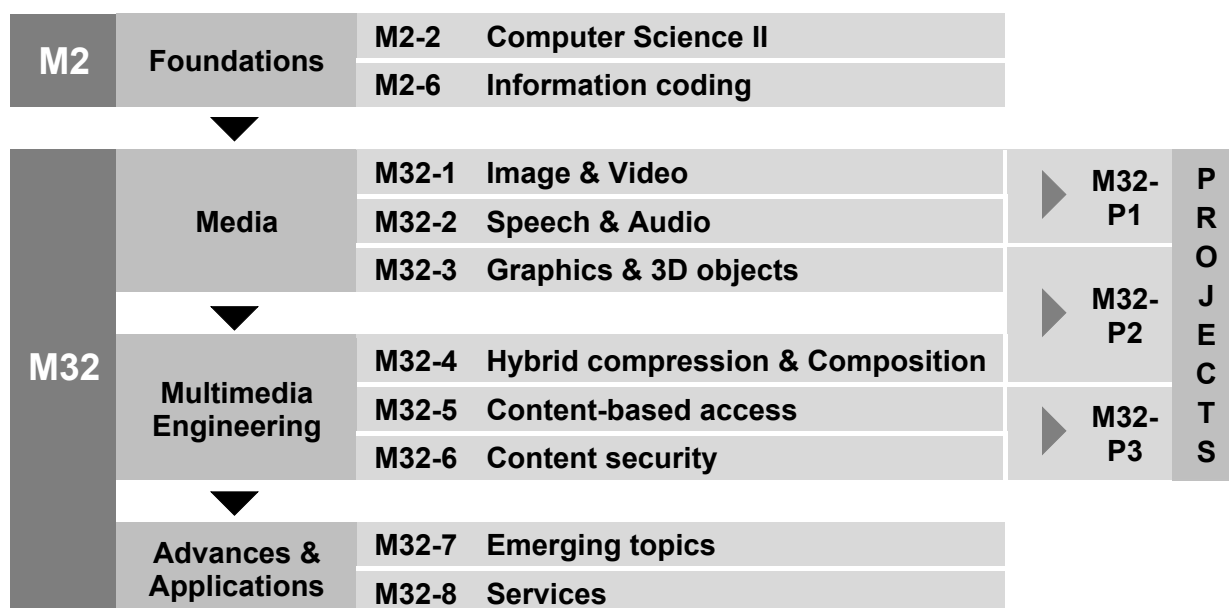
All courses are taught in English.

### ■ Program Structure and Curriculum

The *Multimedia Engineering* program is introduced by the 2<sup>nd</sup> Semester (M2) core courses on *Computer Science II* (M2-2) and *Information Coding* (M2-6). It is structured in 6 courses, 3 projects and 2 seminars, for a total of 30 ETCS.

The first part of the program deals with presenting the various technologies for representing and processing natural and synthetic media (still images & videos, speech & audio, graphics & 3D objects) individually. In a second step, the technologies for composing individual media into multimedia exchangeable scenes, searching and retrieving multimedia content, and enforcing multimedia content security are studied. Mastering the technological basis is strongly reinforced by a project-oriented pedagogy. A third block focuses on current R&D trends in multimedia engineering, viewed both from a research perspective via a seminar on emerging topics, and from an industrial point of view via a conference cycle on state-of-the-art multimedia services.

The program structure is summarized on the following flow-chart:



□ **M2 - Foundation courses (2<sup>nd</sup> Semester)**

Course ID	Title	Duration	ETCS	Coordination
M2-2	Computer Science II	51h	6	François MEUNIER
M2-6	Information Coding	39h	4	Titus ZAHARIA

□ **M32 - Option courses (3<sup>rd</sup> Semester)**

Course ID	Title	Duration	ETCS	Coordination
M32-1	Computer Vision & Image Understanding	30h	3	Catalin FETITA
M32-2	Audio Processing	30h	3	Nicolas ROUGON
M32-3	Computer Graphics	30h	3	Marius PREDA
M32-4	Multimedia Representation & Composition	30h	3	Marius PREDA
M32-5	Information Retrieval & Content-based Access	30h	3	Titus ZAHARIA
M32-6	Multimedia Content Security	30h	3	Catalin FETITA
M32-7	Seminar: Advanced topics in Multimedia Engineering	15h	1.5	Nicolas ROUGON
M32-8	Conference cycle: Multimedia Services	15h	1.5	Françoise PRÉTEUX

The assignment pattern for M32 courses combines coursework and finals with 3 projects related to course topics as follows:


Project ID	Course link	Duration	ETCS	Coordination
M32-P1	M32-1 or M32-2	40h	3	ARTEMIS Project Unit faculty
M32-P2	M32-3 or M32-4	40h	3	
M32-P3	M32-5 or M32-6	40h	3	

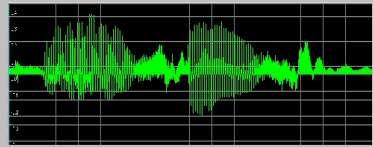
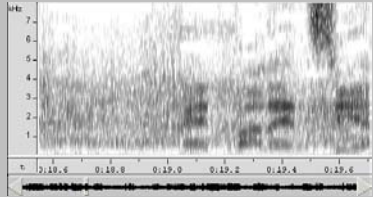
## ■ Faculty

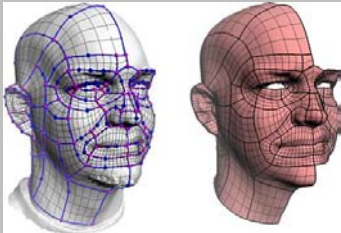
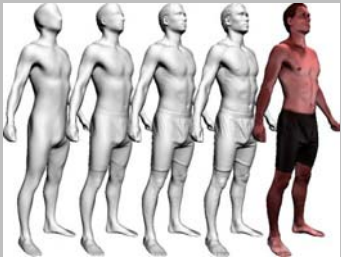
Name	Title (Affiliation)	Room	Phone	Mail
Françoise PRETEUX	Professor (INT / ARTEMIS)	C201	46 57	Francoise.Preteux@int-evry.fr
Catalin FETITA	Associate Professor (INT / ARTEMIS)	D 207	46 68	Catalin.Fetita@int-evry.fr
Marius PREDA	Associate Professor (INT / ARTEMIS)	D207	43 45	Marius.Preda@int-evry.fr
Nicolas ROUGON	Associate Professor (INT / ARTEMIS)	C209-01	46 44	Nicolas.Rougon@int-evry.fr
Titus ZAHARIA	Associate Professor (INT / ARTEMIS)	C205-01	46 74	Titus.Zaharia@int-evry.fr

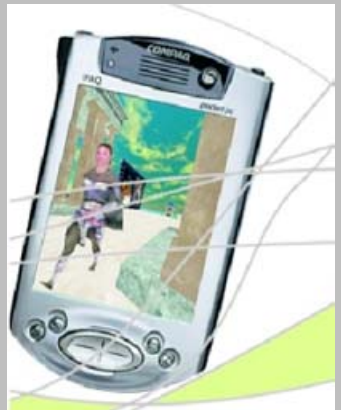
## ■ Course overview


M2-6	Information Coding
<b>Coordination</b>	Françoise PRETEUX
<b>Duration</b>	39h
<b>ETCS</b>	4
<b>Prerequisite</b>	None
<b>Objectives</b>	This course provides a complete overview on digital multimedia compression techniques and standards. Its first part deals with still image compression, leading to the JPEG and JPEG-2000 standards. The focus is then set on video compression for which the MPEG-1/2/4 standards are presented in details. Audio and speech compression are studied in a third part. The course ends up with introducing the currently leading multimedia standards: MPEG-4, DVB, ITU-T H26x.
<b>Content</b>	<p>Coding fundamentals.</p> <p>Quantization.</p> <p>Differential coding.</p> <p>Predictive and transform coding. Wavelet-based coding.</p> <p>Binary coding: variable-length, run-length and dictionary coding.</p> <p>Still image compression: JPEG and JPEG-2000.</p> <p>Motion estimation techniques.</p> <p>Digital video coding: MPEG-1/2.</p> <p>Speech coding.</p> <p>Audio compression.</p> <p>Multimedia standards: MPEG-1/2/4, DVB, ITU-T H26x.</p>
<b>Bibliography</b>	<p>Y.Q. Shi, H . Sun <i>Image and Video compression for multimedia engineering</i> CRC, 2000</p> <p>M. Bosi, R. Golberg <i>Introduction to Digital Audio Coding and Standards</i> Kluwer, 2002</p>
<b>Assignment pattern</b>	<p>Coursework (50%)</p> <p>Software project (50%)</p>


M32-1		Computer Vision & Image Understanding
<b>Coordination</b>	Catalin FETITA	
<b>Duration</b>	30h	
<b>ETCS</b>	3	
<b>Prerequisite</b>	None	
<b>Objectives</b>	This course, which offers a core training in computer vision and image analysis, presents the main issues and techniques related to visual content (static images and videos) processing for multimedia services and systems. After introducing image formation and image models, the main techniques for generating descriptions of static scenes in monocular imaging are presented. More complex problems, including multi-view image analysis, 3D shape reconstruction, dynamic scene analysis and object recognition, are then addressed.	
<b>Content</b>	Image formation and models. Feature extraction, segmentation, grouping. Stereovision. Shape from X. Motion analysis and tracking. Object recognition.	
<b>Bibliography</b>	D.A. Forsyth, J. Ponce <b>Computer Vision : A modern approach</b> Prentice Hall, 2003	
<b>Assignment pattern</b>	Coursework (50%) Software project (50%)	

M32-2		Audio Processing
<b>Coordination</b>	Nicolas ROUGON	
<b>Duration</b>	30h	
<b>ETCS</b>	3	
<b>Prerequisite</b>	None	
<b>Objectives</b>	This course provides a detailed overview of the basic issues, models and methods for processing natural and synthetic audio contents. It covers such aspects as generation, perception, representation, processing, analysis and recognition, illustrated via numerous examples borrowed from operational multimedia systems. The course concludes with presenting the main current audio standards.	
<b>Content</b>	Acoustics foundations. Speech and audio production and perception. Digital speech and audio processing. Speech recognition. Music processing. Synthetic audio. Audio standards.	 
<b>Bibliography</b>	B. Gold, N. Morgan <b>Speech and Audio Signal Processing</b> Wiley, 2002  J.R. Deller, Jr., J.H.L. Hansen, J.G. Proakis <b>Discrete Time Processing of Speech Signals</b> IEEE Press, 2000 (2 <sup>nd</sup> Edition)	
<b>Assignment pattern</b>	Coursework (50%) Software project (50%)	

M32-3		Computer Graphics
<b>Coordination</b>	Marius PREDA	
<b>Duration</b>	30h	
<b>ETCS</b>	3	
<b>Prerequisite</b>	None	
<b>Objectives</b>	This course presents the basic mathematical and algorithmic issues, and software / hardware tools for 3D computer graphics. Geometric modeling, surface and volume rendering, animation techniques, and international graphical standards are covered in details, and enhanced through numerous examples in virtual and augmented reality applications.	
<b>Content</b>	<p>Software and hardware for computer graphics.</p> <p>2D/3D geometric transformations, clipping, perspective and input routines.</p> <p>Geometry representation.</p> <p>Data structures.</p> <p>Hidden surface removal.</p> <p>Color shading techniques.</p> <p>Volume rendering. Image-based rendering.</p> <p>Texturing.</p> <p>Animation.</p> <p>VRML and MPEG standards.</p>	 
<b>Bibliography</b>	<p>J.D. Foley, A. van Dam, S.K. Feiner, J.F. Hughes  <b>Computer Graphics: Principles and Practice in C</b>  Addison Wesley, 1997 (2<sup>nd</sup> Edition)</p>	
<b>Assignment pattern</b>	<p>Coursework (50%)  Software project (50%)</p>	

M32-4		Multimedia Representation & Composition
<b>Coordination</b>	Marius PREDA	
<b>Duration</b>	30h	
<b>ETCS</b>	3	
<b>Prerequisite</b>	M2-6 (Information coding) – M32-3 (Computer graphics)	
<b>Objectives</b>	This course sets up the technological bases for multimedia representation and composition. In the first part, the technologies for media multiplexing and synchronization for interactive multimedia applications (gaming, virtual reality, augmented reality) are presented. State-of-the-art standards (SMIL, VRML, MPEG-4 BIFS) and proprietary solutions (Flash) are then introduced and compared in terms of performance and functions. A special emphasis is set on creating dynamic scenes with programmable interactive contents.	
<b>Content</b>	<p>Multimedia representations: natural and synthetic objects, hybrid scenes.</p> <p>Advanced multimedia compression and scalability.</p> <p>Media multiplex, synchronisation and delivery.</p> <p>Dynamic content: programmability and interactivity.</p> <p>Interoperability: multimedia standards.</p> <p>Composition and rendering.</p>	
<b>Bibliography</b>	<p>T. Ebrahmi, F. Pereira (Editors)  <b>The MPEG-4 Book</b>  Prentice Hall PTR, 2002</p>	
<b>Assignment pattern</b>	<p>Coursework (50%)  Software project (50%)</p>	

M32-5	Information Retrieval & Content-based Access		
<b>Coordination</b>	Titus ZAHARIA		
<b>Duration</b>	30h		
<b>ETCS</b>	3		
<b>Prerequisite</b>	None		
<b>Objectives</b>	This course presents the principles and approaches for metadata-based description and semantic enrichment of multimedia contents for information retrieval purposes. The covered topics comprise multimedia descriptions, their composition by means of description schemes, and the syntactic and semantic integration of the latter into high-level description languages. The course concludes with a detailed overview of the MPEG-7 multimedia standard for content-based access and information retrieval systems.		
<b>Content</b>	<p>From data to metadata.            Multimedia descriptors and similarity metrics.            Multimedia description schemes.            Multimedia description languages.            The MPEG-7 standard.            Content-based information retrieval systems.</p>		
<b>Bibliography</b>	B.S. Manjunath, P. Salembier, T. Sikora <b><i>Introduction to MPEG-7</i></b> Wiley, 2002		
<b>Assignment pattern</b>	Coursework (50%) Software project (50%)		

M32-6	Multimedia Content Protection		
<b>Coordination</b>	Catalin FETITA		
<b>Duration</b>	30h		
<b>ETCS</b>	3		
<b>Prerequisite</b>	Information theory and digital communications basics.		
<b>Objectives</b>	This course presents the main issues and methods for protecting digital multimedia content in data exchange services on communication networks. Its first part deals with modern cryptography. In a second step, multimedia watermarking techniques are presented. The latter provide new solutions for content authentication with predefined quality and security requirements. The emerging MPEG-21 multimedia standard is finally presented.		
<b>Content</b>	<p>Intellectual Property Rights management.            Digital cryptography.            Multimedia watermarking: paradigms and applications.            Watermarking models, error analysis and perceptual quality.            Robust watermarking.            Watermark security: Attacks and counter-attacks.            Content authentication.            The emerging MPEG-21 standard.</p>		
<b>Bibliography</b>	A.J. Menezes, P.C. van Oorschot, S.A. Vanstone <b><i>Handbook of Applied Cryptography</i></b> CRC Press, 2001 (5 <sup>th</sup> Edition)  I.J. Cox, M.L. Miller, J.A. Bloom <b><i>Digital Watermarking</i></b> Morgan Kaufmann Publishers, 2002		
<b>Assignment pattern</b>	Coursework (50%) Software project (50%)		



M32-7	Seminar: Advanced topics in Multimedia Engineering
<b>Coordination</b>	Nicolas ROUGON
<b>Duration</b>	15h
<b>ETCS</b>	1.5
<b>Prerequisite</b>	M32-1-6
<b>Objectives</b>	This research-oriented seminar is targeted towards emerging issues and techniques in the field of multimedia content processing. Organized as a series of one-hour lectures given by recognized researchers, it explores a hot topic related to M32 courses, with the objective of providing students with a first immersion into research.
<b>Content</b>	5 seminars on advanced topics in multimedia content technologies.
<b>Bibliography</b>	None
<b>Assignment pattern</b>	Coursework (50%) Research paper presentation (50%)

M32-8	Conference cycle: Multimedia Services
<b>Coordination</b>	Françoise PRETEUX
<b>Duration</b>	15h
<b>ETCS</b>	1.5
<b>Prerequisite</b>	M32-1-6
<b>Objectives</b>	This conference cycle aims at offering insights into current and emerging industrial challenges in multimedia engineering. The presentations, given by leading industrials of the domain, are focused on issues related to technology integration and deployment in multimedia systems and services.
<b>Content</b>	5 conferences on state-of-the-art multimedia services.
<b>Bibliography</b>	None
<b>Assignment pattern</b>	Coursework (50%) State-of-the art paper (50%)