Course guide
804249 - ADIG - Digital Audio

Last modified: 19/02/2026

Unit in charge: Image Processing and Multimedia Technology Centre
Teaching unit: 804 - CITM - Image Processing and Multimedia Technology Centre.

Degree: BACHELOR'S DEGREE IN VIDEO GAME DESIGN AND DEVELOPMENT (Syllabus 2014). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: Martínez, David

Others: Martínez, David
Buxeda, Martí
Palet, Marc
Boyle, Òscar

TEACHING METHODOLOGY

Class sessions can be of two types:

1. Cooperative problem-based learning:
Students work in small groups on learning activities. This type of learning allows students to develop analysis, synthesis and evaluation skills, as well as encouraging collaboration and teamwork.

2. Expository teaching (lecture):
The teacher presents information to students in an organised manner. This methodology allows students to develop relationship, classification and analysis skills.

These activities are modulated according to the complexity of the exercises and the corresponding content.

LEARNING OBJECTIVES OF THE SUBJECT

- Program interactive 3D elements within a video game scene.

- Create objects, characters, textures, scenes, effects and 2D and 3D animations for inclusion in video game projects.

- Identify the principles of representation of audio signals in digital systems.

- Apply the production and editing tools of audio and musical signals for video games.

STUDY LOAD

Type	Hours	Percentage
Hours large group	18,0	12.00
Hours medium group	32,0	21.33
Guided activities	10,0	6.67
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Physics and Perception of Sound

Description:
Basic principles of sound generation and musical signals. Temporal and frequency representation. Sound perception.
- Nature of sound waves (frequency, amplitude, timbre), propagation and interference.
- Measurement of acoustic power. Concepts of sound intensity, sound pressure levels, decibels and basic units.
- Representations of waves in the time and frequency domains. Spectrogram, dynamic range. Interpretation of the audio signal in the time and frequency domains.
- Sound production, resonance, timbre (spectrum and temporal characteristics).
- Psychoacoustics, perception of loudness. Frequency masking, sequential masking. Critical bands. Pitch perception in harmonic and inharmonic sounds. Pitch resolution and sensitivity. Perception of spatial location (ITD, ILD, HRTF).
- FFT and frequency analysis.

Related activities:
Waveform visualisation and spectrum analysis:
- Familiarisation with Audacity as an example of a wave editor.
- Basic editing (copy, cut, paste).
- Wave exploration: frequency, amplitude and timbre.
- Basic signal generation.
- Temporal and frequency analysis.
- Exploration of sound perception.
- Exploration of FFT parameters.

Full-or-part-time: 21h 40m
Theory classes: 8h
Practical classes: 2h
Self study : 11h 40m

Representation and digital processing of audio signals

Description:
Principles of sampling and signal quantification. Audio formats and representations for different applications. Compression. Signal filtering and processing.
- Digital representation of the audio signal in PCM.
- Digital filters. Concept and types of filters. Stability. Low-pass, band-pass and high-pass filters. Filter concatenation. Equalizers.
- Audio effects: Filtering effects, delay effects, modulation effects, distortion effects.
- Dynamic processors.
- Pitch shift, time shift, spectral processors, noise reduction.
- General principles of data compression applied to digital audio.
- Types of digital audio. Uncompressed audio (PCM, WAV, AIFF). Lossless compression (FLAC). Lossy compression (MP3, AAC, OGG).
- Impact of compression on perceived quality. Data rates. Container formats and their common use in multimedia production.
- Multichannel playback systems and auralisation.
- 3D sound representation. MPEG-H Audio 3D standard. 3D audio representation models. Audio objects. Metadata. 3D audio rendering: Vector Base Amplitude Panning, Binaural, Higher Order Ambisonics & Speaker Decoding.

Related activities:
Digital audio signal processing:
- Adjusting levels, fades and envelopes.
- Exploring filters and equalisation.
- Exploring delay-based processors.
- Exploring modulation-based processors.
- Simulating acoustic environments.
- Exploring dynamics processors.
- Noise reduction.
- Spectral processes, time shift and pitch shift.
- Audio conversion to different formats and exploration of compression.

Full-or-part-time: 25h
Theory classes: 8h
Practical classes: 2h
Self study : 15h

Digital audio engines / Real-time mixing systems

Description:
Operation and signal flow of a digital audio engine
- Basic architecture of a digital audio engine.
- Signal flow and audio graph: Inputs, outputs, tracks, buses, effects, routing. Multi-channel buses, upmix, downmix.
- Signal measurement: Levels, loudness (EBU R128), correlation.
- Real-time processing: input/output latency, buffering, clock synchronisation, processing latency and latency compensation, parallelism and concurrency in processing, latency domains.
- Track-based mixing and object-based mixing.
- Dynamic mixing: automation, real-time control parameters, sidechain.
- Control and automation systems: MIDI, OSC.

Related activities:
Practices developed in part II.

Full-or-part-time: 25h
Theory classes: 8h
Guided activities: 2h
Self study : 15h

Game Audio Design

Description:
Description of the structure and characteristics of the documentation required for the audio section of the Game Design Document and communication with external audio teams.

Specific objectives:
Familiarisation with the different hardware and software techniques that have appeared throughout history in order to understand the current state of technology.

Full-or-part-time: 25h
Theory classes: 5h
Guided activities: 5h
Self study : 15h

Sound Design

Description:
Description of basic recording studio equipment: anechoic chamber, types of cables, microphones, mixers, audio adapters. Foley recording.

Specific objectives:
Learn the basics of studio recording and experiment with creating and recording realistic and acusmatic sounds.

Related activities:
Sound design for a 3D scene using a generic video game engine (Unity or Unreal)
- Searching for and editing assets.
- Importing assets into the engine.
- Introducing static 3D and 2D emitters with looping sounds.
- Configuring sounds synchronised with animations.
- Combined use of triggers and mixers or audio volumes for interior/exterior effects.
- Use of mixers for vertical interactive music changes.
- Configuring asset loading to optimise memory usage.

Full-or-part-time: 26h 40m
Theory classes: 5h
Guided activities: 5h
Self study : 16h 40m

Audio Engines and Middleware

Description:
Theory on advanced audio engines and audio design practices with Wwise.

Specific objectives:
- General concepts shared by all advanced audio engines.
- Specific exercises with Wwise, equivalent to Wwise 101 certification.
- Integrating sound with Wwise. General concepts of audio middleware. Integrating sound with Wwise. Wwise tools for enriching sound. Integration with game state. 2D and 3D spatialisation in Wwise. Audio signal flow to the engine. Mixing. Designing soundscapes. Game Sync.

Related activities:
- Searching for and editing assets.
- Importing assets into the engine.
- Intercepting events from the editing tool.
- Basic use of sound effect settings.
- Configuring audio positioning.
- Integrating game status to shape audio accordingly.
- Optimising hierarchies to improve project structure and efficiency.
- Using mixing and simulation tools from the editing tool.
- Configuring asset loading to optimise memory usage.

Full-or-part-time: 26h 40m
Theory classes: 5h
Guided activities: 5h
Self study : 16h 40m

ACTIVITIES

Waveform display and spectrum analysis

Description:
- Familiarisation with Audacity as an example of a waveform editor.
- Basic editing (copy, cut, paste).
- Waveform exploration: frequency, amplitude and timbre.
- Generation of basic signals.
- Temporal and frequency analysis.
- Exploration of sound perception.
- Exploration of FFT parameters.

Full-or-part-time: 2h
Practical classes: 2h

Digital audio signal processing

Description:
- Adjusting levels, fades, and envelopes.
- Exploring filters and equalisation.
- Exploring delay-based processors.
- Exploring modulation-based processors.
- Simulating acoustic environments.
- Exploring dynamics processors.
- Noise reduction.
- Spectral processes, time shift, and pitch shift.
- Converting audio to different formats and exploring compression.

Full-or-part-time: 2h
Practical classes: 2h

Sound design for a 3D scene using a generic video game engine (Unity or Unreal)

Description:
- Search and edition of assets.
- Import of assets in the engine.
- Introduction of 3D and 2D static emitters with looping sounds.
- Configuration of sounds synchronized with animations.
- Combined use of triggers and mixers or audio volumes for indoor/outdoor effects.
- Use of mixers for vertical interactive music changes.
- Asset load configuration to optimize memory usage.

Full-or-part-time: 2h
Practical classes: 2h

GRADING SYSTEM

Block 1. Digital Audio Foundations (45%):
- Examination: 35%, assessment of the theoretical part.
- Group work: 10%, independent learning.

Block 2. Video Game Production Pipeline (45%):
- Audacity practice: 10%
- Unity practice: 15%
- Wwise practice: 20%

Participation and learning attitude (10%).

Reassessment: Students who have not passed the subject by continuous assessment have the option to be submitted to the reassessment. This will be an exam of 2 hours and the qualification will substitute the mark of the theoretical part of the course. To be eligible, it is required to have presented the process of continuous assessment.

Irregular actions that may lead to a significant variation of the grade of one or more students constitute a fraudulent performance of an evaluation act. This action entails the descriptive grade of failure and a numerical grade of 0 for the ordinary global evaluation of the course, without the right to re-evaluation.

If the lecturers have indications of the use of AI tools not allowed in the evaluation tests, they may summon the students concerned to an oral test or a meeting to verify the authorship.

EXAMINATION RULES.

Practical work:
- Practical exercises begin during class time in the designated period and are completed outside of scheduled class time following the instructions given in the corresponding Practical Work Sheet and the instructions given for this purpose in the corresponding part of the class.
- The solutions to the practical exercises must be submitted using the Atenea campus in the submission space provided for each practical exercise, following the instructions described in the corresponding Practical Exercise Sheet, within the specified deadlines. At the end of the practical exercise, the required files must be submitted. The correct management of the documentation provided is an aspect related to the skills to be acquired and is therefore subject to assessment.
- The assessment of the practical exercises involves not only the completion of the proposed exercises, but also the defence of the results when the student is required to do so at the beginning of the classes.
- Any incident that prevents the practical work from being completed within the specified time frame must be communicated to the relevant teacher via the Virtual Campus; following this communication, the relevance or otherwise of any cause for non-submission of the exercise will be determined and alternatives for completing the assessment will be established if the causes are justified. Causes for non-submission of exercises that are communicated to the teaching staff by the Head of Studies will also be considered justified.

Exams:
- Exams will be taken in the computer lab using an electronic document that the student must complete.
- The questions and problems proposed in the exams refer to both the theoretical content of the subject and the exercises solved in the different practical sessions. The contribution in points to the total exam mark is indicated in the margin of each question or problem.
- Reviews and/or complaints regarding the examinations will be dealt with exclusively on the dates and at the times established in the Academic Calendar.

BIBLIOGRAPHY

Basic:
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- Gold, Bernard [et al.]. Speech and audio signal processing: processing and perception of speech and music. 2a ed. New York [etc.]: John Wiley & Sons, cop. 2011. ISBN 978-0470195369.
- Blackstock, David T. Fundamentals of physical acoustics. New York [etc.]: John Wiley & Sons, cop. 2000. ISBN 9780471319795.
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- Rossing, Thomas D. The Science of sound. 2nd ed. Reading, Mass.: Addison-Wesley Pub. Co, cop. 1990. ISBN 9780201157277.
- Ballou, Glen. Handbook for sound engineers [on line]. 5th edition. Burlington, MA: Focal Press, 2015 [Consultation: 14/07/2025]. Available on: https://doi-org.recursos.biblioteca.upc.edu/10.4324/9780203758281. ISBN 9780240804545.