Department of Music Technology & Acoustics
School of Music & Optoacoustic Technologies
https://mta.hmu.gr/

(B.Sc) courses offered in English

WINTER SEMESTER									
Module Code	X	Module Title	Number of teaching hours/week				ECTS	Semester	Responsbile
			Θ	A	E	Total			
0807.3.004.1	Y	Programming Environments for Sound & Music	2	2		4	7	3rd	S. Paschalidou pashalidou@hmu.gr
0807.5.003.1	Y	Sound Design	2	2		4	6	5th	K. Tzedaki tzed@hmu.gr
0807.5.006.1	EY	Audio Software Development	2	2		4	7	5th	M. Kaliakatsos maximoskp@hmu.gr
0807.7.012.1	EY	Acoustic Ecology and Sound Arts	2	2		4	6	7th	K. Tzedaki tzed@hmu.gr
Total Winter Semester courses offered in English (Y & EY)			**8**	**8**		**16**	**26**		

SPRING SEMESTER									
Module Code	X	Module Title	Number of teaching hours/week				ECTS	Semester	Responsbile
			Θ	A	E	Total			
0807.2.004.1	Y	Structured Programming	2	2		4	7	2nd	C. Alexandraki chrisoula@hmu.gr
0807.6.007.1	EY	Electronic Musical Instruments	2	2		4	6	6th	K. Tzedaki tzed@hmu.gr
0807.8.002.1	EY	Selected Topics in Acoustics	2	2		4	6	8th	S. Kouzoupis skouzo@hmu.gr
0807.8.004.1	EY	Applied Machine Learning	2	2		4	6	8th	M. Kaliakatsos maximoskp@hmu.gr
Total Spring Semester courses offered in English (Y & EY)			**8**	**8**		**16**	**25**		

Abbreviations:

Θ: Theory, **A:** Practical sessions, **E:** Lab.

Course type (X): Y: Compulsory, **EY:** Compulsory with options, **Π:** Elective

Course Description

COURSE TITLE	*Programming Environments for Sound & Music*		
COURSE CODE	0807.3.004.1	**SEMESTER**	3rd / Winter
COURSE PROMOTER	Dr. Stella Paschalidou		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	7

TYPE OF COURSE	Compulsory
PREREQUISITE COURSES	No
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

The course aims at getting students acquainted with audio programming environments and providing them with the basic understanding and skills of audio programming. This can be considered as an introductory course in digital audio synthesis, as it covers rudimentary knowledge on digital sound and computer music. No prior computer programming skills are required.
More specifically, the course offers fundamental knowledge on the following subjects:
- computer music
- digital sound
- digital sound synthesis
- GUIs and audio interactive systems.

LEARNING OUTCOMES

By completion of this course, students will be familiar with the theoretical background required for understanding basic sonic algorithmic processes and will have gained skills to develop their first computer music synthesis and sonic interaction algorithms in (mainly, but not exclusively) graphical audio programming environments.

COURSE CONTENT

- Introduction to audio programming environments and languages (graphical/modular versus textual)
- Bridging analog to digital sound
- Digital sound: sampling & quantization
- The concepts of Oscillators, Unit Generators, Wavetables and Signal flowcharts
- Interpolation functions over time for sound control (amplitude envelopes, glissandi)
- Stereo imaging and panning
- Additive synthesis (example: Bell by Jean-Claude Risset)
- LFOs for tremolo and vibrato
- Real-time sound control and interaction (mouse and MIDI controllers)
- Overview and comparison of audio programming environments

Indicative audio programming environments used during practical sessions: MaxMsp / PureData, Supercollider.

RECOMMENDED LITERATURE

[1] Online course material and hand-outs ('E-class' online platform)
[2] Διαμαντόπουλος Τ., Η μουσική των υπολογιστών
[3] Λώτης Θ., Διαμαντόπουλος Τ., Μουσική πληροφορική και μουσική με υπολογιστές
[4] Roads C., The Computer Music Tutorial
[5] Dodge C., Jerse T., Computer Music: Synthesis, Composition, and Performance
[6] Collins N. & d'Escrivan J., The Cambridge Companion to Electronic Music
[7] Wilson S., Cottle D, Collins N., The Supercollider book

COURSE TITLE	*Sound Design*		
COURSE CODE	0807.5.003.1	**SEMESTER**	5th / Winter
COURSE PROMOTER	Dr. Katerina Tzedaki		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	6

TYPE OF COURSE	Compulsory
PREREQUISITE COURSES	0807.2.005.1 [Morphology of Sound]
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

The aim of the course is to introduce the theoretical and practical issues of sound design.

COURSE CONTENT

The thematic modules of the course include:
Basic concepts and terminology in the sound arts.
Sound arts and the music of sounds.
Areas of application of sound design.
Methodologies for collecting, classifying and categorizing audio material.
Basic techniques of transforming sounds with mechanical, analogue and digital means.
Listening and analysis of selected musical and audio-visual artistic works.
Functional categories of sound and music in their coexistence with moving image
Final Assignment: Independent individual work of creating an original sound composition or sound overlay.

COURSE TITLE	*Audio Software Development*		
COURSE CODE	0807.5.006.1	**SEMESTER**	5th / Winter
COURSE PROMOTER	Dr. Maximos Kaliakatsos		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	7

TYPE OF COURSE	Compulsory with options
PREREQUISITE COURSES	No
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

Developing software that processes audio, especially in real-time, presents challenges that are related to advanced subjects in digital signal processing, computer science, software engineering and mathematics. This course presents the principles that are necessary for audio software development within each of these subjects. Even though it is assumed that the student already has some basic understanding of the basics the aforementioned disciplines, the course starts from the fundamentals and takes the shortest route toward developing close to product-level synthesisers and audio effects, in the form of standalone applications (Mac, Windows, Linux), smart devices (iOS, Android) and VST-plugins. The course starts with python but transits to C++ using JUCE, a framework that facilitates rapid product-level development.
Aim of this course is to provide the necessary components of digital signal processing and mathematics as well as the computational background in computer science and software engineering to enable students to develop software that processes audio, mainly in real time.

LEARNING OUTCOMES

On completion of this course, students will be able to:
- Understand the basic workflow and fundamental difficulties of real-time audio processing software development.
- Identify and debug common theoretical (e.g. aliasing) and technical (e.g. buffer overflow) issues that arise when developing audio software applications.
- Develop basic software that implements basic effects and sound visualisations.
- Export the software they develop for computer devices (Mac, Windows, Linux and VST-plugins) and smart devices (iOS and Android).
- Use git to store, distribute and showcase their work.

COURSE CONTENT

The course starts with fundamental issues on digital signal processing in python, along with an introduction of some python libraries that facilitate and enable real-time audio processing. From the beginning, all code is provided through GitHub and, therefore, the philosophy and basic manipulation of GitHub is discussed. After an introduction to real-time audio processing in Python, object oriented programming is introduced, which leads to an introduction in C++. The JUCE framework is presented and simple software is developed for synthesisers and sound effects.

RECOMMENDED LITERATURE
[1] Géron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. " O'Reilly Media, Inc.". [2] Foster, D. (2022). Generative deep learning. " O'Reilly Media, Inc.".

COURSE TITLE	*Acoustic Ecology and Sound Arts*		
COURSE CODE	0807.7.012.1	**SEMESTER**	7th / Winter
COURSE PROMOTER	Dr. Katerina Tzedaki		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	6

TYPE OF COURSE	Compulsory with options
PREREQUISITE COURSES	No
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

This course aims to introduce students to the issues and practices of Acoustic Ecology and their application to Sound Arts.

LEARNING OUTCOMES

Upon successful completion of the course, the student will be able to:
To understand and use the terminology of Acoustic Ecology (AE).
To apply research methodologies of AE (sound maps, categorization of sound sources and events, soundwalking, field recordings) to the study and analysis of any sound environment.
To create sound environments and/or soundscape compositions

COURSE CONTENT

What is Acoustic Ecology? – Basic Terminology. - Related areas and terminology.
Historical Isuues and Current Trends of Acoustic Ecology. -
Sound Arts – An intoduction - Terminology
Soundscape Research – Field work- Practices- Soundscape Analysis
Soundwalking and Soundscape composition.
Acoustic Ecology and Sound Arts- Issues and Applications.

Assignments:
Soundscape Recording, Reasearch and Analysis (40%)
Soundscape Composition (40%)
Field work (participation) (20%)

COURSE TITLE	*Structured Programming*		
COURSE CODE	0807.2.004.1	**SEMESTER**	2nd / Spring
COURSE PROMOTER	Dr. Chrisoula Alexandraki		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	7

TYPE OF COURSE	Compulsory
PREREQUISITE COURSES	No
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

This course focuses on algorithmic problem solving and algorithm implementation, thus aiming at the development of general reasoning and problem solving skills to fluently interpret and design structured procedures and rule systems.

LEARNING OUTCOMES

Specific objectives of the course focus on developing skills for:

a) Algorithmic thinking, i.e. how to analyse the solution to a given problem in a finite number of well-defined steps.
b) Algorithm implementation, i.e. how to transform an algorithm to a computer program and what are the best practices in coding, documentation and effective use of computer memory and processing power.
c) C Programming Language, i.e. acquaint students with one of the most fundamental programming languages. The course emphasizes on different concepts including variables, numerical operations, control structures, procedures, pointers, data structures and memory management.

COURSE CONTENT

Following are the titles of weekly lectures:

1. Introduction: Algorithms and Programs
2. Variable types, operands, program input/output
3. Flow Control Structures: sequence, selection, repetition
4. Arrays
5. Pointers, pointer operations, array-pointer relationship
6. Functions, call-by-reference, call-by-value, variable scope
7. Strings and string operations
8. Dynamic Memory Allocation
9. Data Structures
10. File operations

RECOMMENDED LITERATURE

[1] Programming in C. C, Kernighan B., Ritchie D., Pearson; 2nd edition, 1988.
[2] Programming in ANSI C. E. Balagurusamy, MC GRAW HILL INDIA; 8th edition, 2019.

COURSE TITLE	*Electronic Musical Instruments*		
COURSE CODE	0807.6.007.1	**SEMESTER**	6th / Spring
COURSE PROMOTER	Dr. Katerina Tzedaki		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	6

TYPE OF COURSE	Compulsory with options
PREREQUISITE COURSES	0807.3.004.1 [Programming Environments for Sound & Music]
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

The course aims to familiarize students with topics related to the structure, function, design and practice of new musical instruments.

LEARNING OUTCOMES

Upon successful completion of the course, the student will be able to:
To analyse the structure, functions and practice of a musical instrument.
To experiment with ideas on the design of new musical instruments.
The thematic modules of the course include:
Electronic Musical Instruments: Types, Operation, History.
Musical instruments as interactive systems.
Similarities and Differences of acoustic and electronic musical instruments.
Anatomy of a musical instrument. Generalised Model.
Typology of New Musical Instruments..
Sound design issues
Design and Evaluation Issues.
Current and Future Trends in Research and Design.

COURSE CONTENT

An introduction to the history, design, operation and functions of electronic, digital, experimental, hybrid and interactive musical instruments.

COURSE TITLE	*Selected Topics in Acoustics*		
COURSE CODE	0807.8.002.1	**SEMESTER**	8th / Spring
COURSE PROMOTER	Dr. Spyros Kouzoupis		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	6

TYPE OF COURSE	Elective
PREREQUISITE COURSES	0807.4.001.1, 0807.4.002.1 [Digital Signal Processing, Room Acoustics]
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

Acquiring a good understanding of a certain acoustics branch. Typical acoustics areas could be: Musical acoustics, structural acoustics, room acoustics, bioacoustics, numerical acoustics e.t.c.

LEARNING OUTCOMES

Basic theoretical knowledge and experimental or numerical skills concerning a certain Acoustics topic.

COURSE CONTENT

This is a project oriented course. Students will pick a topic from a list of topics and write up a report, introducing the selected field, perform basic bibliographical survey and depending on the subject selected, engage in some simple experimental or numerical work.

RECOMMENDED LITERATURE

Depends on the topic selected.

COURSE TITLE	*Applied Machine Learning*		
COURSE CODE	0807.8.004.1	**SEMESTER**	8th / Spring
COURSE PROMOTER	Dr. Maximos Kaliakatsos		

TEACHING ACTIVITIES	**HOURS PER WEEK**	**ECTS**
LECTURES	2	
PRACTICAL SESSIONS	2	
TOTAL	4	6

TYPE OF COURSE	Compulsory with options
PREREQUISITE COURSES	0807.4.001.1 0807.5.006.1 [Digital Signal Processing, Audio Software Development]
TEACHING LANGUAGE	Greek/English
OFFERED TO ERASMUS STUDENTS	Yes

AIMS & OBJECTIVES

Machine learning has become a fundamental part of many research and commercial applications. Modern frameworks like Keras/Tensorflow and Scikit-learn have made it easy to write programs that implement sophisticated machine learning algorithms that can be readily applied to text, image and audio data. This course offers an introduction to the fundamentals of machine learning and quickly scales to applications that include data from image and text to audio and music. The student is expected to obtain a clear understanding of the basic mathematical principles and working knowledge on developing end-to-end research implementations, i.e., from data curation to proper presentation of results. All programming is in Python using the Keras framework, while the course offers material from books, slides and GitHub code.
Aim of this course is to provide a clear understanding of the basic principles that underly modern machine learning algorithms, while enabling end-to-end implementation of basic versions of modern machine learning systems.

LEARNING OUTCOMES

On completion of this course, students will be able to:
- Identify the correct class of algorithms for solving specific problems.
- Prepare data in optimal representations for specific tasks.
- Follow steps to mitigate common obstacles concerning overfit and error stagnation.
- Present results in a scientifically rigorous manner.

COURSE CONTENT

The course starts with basic ideas around data dimensionality, dimensionality reduction and linear regression. This study leads to a straightforward understanding of artificial neural networks (ANNs). The MNIST digits dataset is employed for introducing basic supervised learning with feedforward ANNs and towards the introduction of convolutional layers. 1D convolutional layers are introduced for waveforms and 2D for spectrograms. Autoencoders are then implemented which lead to Variational Autoencoders and Generative Adversarial Networks, initially with the MNIST dataset and then for audio. Recurrent Neural Networks (LSTM and GRU) are also examined for sequence learning and sequence-to-sequence translation, along with Temporal Convolutional Networks (TCNs). This study leads to Transformer encoder-decoder architectures (under the hood of ChatGPT), which are understood deeply and developed with ready-made implementations of KerasNLP.

RECOMMENDED LITERATURE
[1] Géron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. " O'Reilly Media, Inc.". [2] Foster, D. (2022). Generative deep learning. " O'Reilly Media, Inc.".