2023/2024 – M2 IMDEA Course Plan
Semester 1

Teachning Unit	Lecture	Contents	Hours	ECTS
Acoustics & mechanics	3D sound and sound field synthesis	Spatial perception (how the auditory system localizes sounds), stereophony and multichannel audio. Binaural technology, Holophony and WaveField Synthesis, Ambisonics and Higher Order Ambisonics. Principle of sound zones controls.	20	2
	Numerical Vibroacoustics	Introduction of BEM principles. Introduction to ABEC (Acoustic Boundary Element Calculator). Study of simple cases Simple models of acoustics in closed and opened systems by FEM and/or BEM approaches with Comsol. Computation of vibrations modes for structures and acoustic modes for closed cavities by FEM, vibroacoustic coupling on the solid / fluid interface, Applications to more complex systems.	36	3
Electroacoustics	Materials for Loudspeakers	General concepts about materials : classification of materials, general mechanical properties of materials, elastic and viscoelastic materials, equations of behaviour, experimental characterization techniques (elongation, flexion, Dynamical Mechanical Analysis). Technologies of materials : materials for membranes, materials for motors, materials for suspension, application of materials in loudspeaker design. Examples of design process and measurement techniques. Link between materials and perceptive aspects. Material properties measurement in the laboratory using Chladni patterns, a microphone and REW software, and triangulation laser on beam, and later use of those properties in a Comsol template of a cone with surround for vibroacoustics modelling.	12	1
	Loudspeaker modelling	State space modelling of linear systems (Loudspeaker, loudspeaker in vented box). Introduction to nonlinear systems, main loudspeaker nonlinearities, modelling and measurement techniques, other nonlinearities and effects, nonlinear compensation. Motor design theory and FEMM design application. Suspension design, Comsol model of a spider, DC offset demo, and Klippel SIM comparison with a State space model built by the student. State space modelling of nonlinear loudspeaker. Mini project (model, measure non linearities in a loudspeaker, assess the model performance)	30	2,5
	Microphone modelling	Modelling microphones response taking into account viscothermal effects.	12	1
	Mini & micro transducers	General models of headphones and earphones (lumped elements model of the loudspeaker, model of the ear). Measurement techniques for mini and micro transducers. Mini project on headphone speakers.	10	1
	Radiation of transducers	Introduction to radiation. Elementary electroacoustic sources, principles of arrays, modelling array radiation. Practical (Python simulation) : line array and end-fire array, subwoofer in a room, effect of box diffraction. Introduction to radiation. Loudspeaker arrays in situ. Radiation of horns. Introduction to sound reinforcement (1 & 2). Practical (Matlab simulation): radiation of DML (Distributed Mode Loudspeaker).	35	3,5
	Transducers measurements	Loudspeakers measurement techniques (advanced approaches in measurements using a sound card and a programming platform, advanced approaches in loudspeaker measurements leading to models at higher levels). Klippel Distortion Analyzer and comparison with blocked impedance measurements and prior lectures FEM models results. Practicals on measurement systems, loudspeakers. To be detailed.	27	3
Electronics, Signal processing	Power electronics	Overview of power supplies. Power amplifiers design. Currents converters.	21	2
	Signal III	Introduction to time domain signal processing and to stochastic process. The aim of this course is to master digital signal processing techniques for advanced audio applications (music, telecom, sensors array..): localisation, adaptive signal processing, echo cancellation. Mini project on loudspeaker parameters identification and on active noise control.	40	4
Communication	Tools for Job searching	The aim of this course is to know the different usual tools for job searching and to be able to use them for the Masters' thesis company research.	11	1
Professional	Advanced transducers project	The project aims at studying an electroacoustic system for real life applications or for research applications (literature review, analytical modelling, numerical modelling, experiments).	36	6
	Weekly seminars	Seminars given by engineers, researchers working in the field of electroacoustics	10	
TOTAL			**300**	**30**