2024/2025 – M1 IMDEA Course Plan
Semester 1

Teaching Unit	Lecture	Contents	Hours	ECTS
Acoustics fundamentals	Acoustics I	Plane wave in rectangular and cylindrical waveguide Reflection, transmission in a waveguide Scattering of plane wave with an interface. Plane wave in rectangular and cylindrical waveguide Reflection, transmission in a waveguide Scattering of plane wave with an interface	60	6
Acoustic Engineering	Room acoustics I	Physical phenomena involved in the sound propagation in a room. Control of room acoustics by passive (materials). Measurements of room characteristics in different environnements, Simulation principle of room acoustics. Introduction to CATT Acoustics. Limits of room acoustics simulation.	34	3
	Vibrations I	One Degree of Freedom (DOF) System : free and forced vibrations. Two Degree of Freedom (DOF) System : free and forced vibrations with and without damping. N Degree of Freedom System. From discrete to continuous systems, elementary model for the longitudinal vibrations of a bar Transverse vibrations of strings, transverse vibrations of membranes	20	2
Electroacoustics	Loudspeaker system	Model and measure usual loudspeaker systems (sealed enclosure, vented enclosure, electrical filters). Mini project on a loudspeaker system (measurement of loudspeaker characteristics, modelling & measuring the system response, discuss the validity of the model).	40	4
	Transducers basics	Experimental characterisation of different elementary systems : electroacoustic chain, mechanical and acoustical systems, Thiele & Small estimation of a loudspeaker. Lectures on equivalent networks for mechanical, acoustical systems and transducers. Tutorials on mechanical, acoustical systems and loudspeaker mounted in infinite baffle * Analyze a mechanical system and represent the equivalent electrical diagram. Calculate analytically the response of a mechanical system. * Analyze an acoustic system and represent the equivalent electrical diagram. Calculate analytically the response of an acoustic system. * Represent the equivalent network to the usual couplings (electromechanical, electroacoustic). * Represent the equivalent network to an electrodynamic transducer. Calculate analytically the response (efficiency, sensitivity) of an electrodynamic transducer	42	4
Maths	Maths for acoustics I	Projection techniques on orthogonal bases. Advanced matrix operations (Projections, LU, QR, Householder, Decomposition in Singular Values). Practical applications of the Hilbertian theory. Approximation by least mean square polynomial or with exponential. Solving a given physical problem through adapted development (orthogonal polynomials).	30	3
Signal & Instrumentation	Electronics basics	Electronic circuit theory, diodes, impulse response, resonant circuits, active filters, transistor… Practical work on electronic systems	24	2,5
	Signal I	4 to 6 projects in Python dedicated to : - Discrete time signals, Fourier transform - Basics on digital filtering, basics on time frequency transform, basics on beamforming	20	2
	Instrumentation basics	The aim is to discover the basics in instrumentation for acoustics & vibrations. - signal analysis (oscilloscope, analyzer, …) - system analysis (FRF measurement) - Uncertainties, application to electrical impedance measurement	10	1
	Python for Audio	This course aims at discovering and practicing Python langage. Some examples about Audio applications are included. Time domain computing : Python basics and manipulation of sound waves, sound envelopes and synchronous detection. Frequency domain: Spectral analysis, direct and inverse Fourier transforms, frequency resolution, windowing, spectrograms. Musical sounds: analysis & Synthesis of musical sounds Mini Project: simulation of a microphone pair recording and writing of flanging effect function.	24	2,5
TOTAL			**304**	**30**