ENSIETA- Universitat Politècnica de Catalunya (UPC)	
Module Title: ACOUSTIC SIGNAL PROCESSING	
Module Organiser: Prof Cédric Gervaise	*Module Staff:* Cédric Gervaise, Mike van der Schaar, Carine Simon

Module Aim:

The goal of this module is to focus on digital signal processing tools dedicated to acoustic underwater data analysis and to apply them to real world data

Module Objectives:

Of principal interest is the design of algorithms to extract from the acoustic measurements its main features such as:

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- frequency content to separate useful signal from noise,
- time-frequency content to asses kinetic of sources by Doppler effect,
- measurement digital invariant linear filtering,
- modulation & demodulation
- detection of active signal, estimation of time of arrival and signal magnitude to asses geometric properties of underwater channel and to asses emission level and target strength

Learning Outcomes:

On successful completion of this module students will be able to:

- design basic algorithms based on Digital Signal Processing to understand the contents of measurements produce by hydrophones and to filter them to suppress nuisance components,
- design algorithms to estimate major features (time delay, target strength, signal bandwidth, direction of arrival, detection) from measurements produce by a underwater acoustic system,
- be aware of accuracies and robustness of these algorithms,
- link the quantities to be estimated with some needs of underwater channel characterization (bathymetry, tomography…),
- apply theses tools to real data and develop criticism analysis of performances.

Universitat Politècnica de Catalunya (UPC)	
Module Title: BIOACOUSTICS	
Module Organiser: Prof. Michel André	*Module Staff:* M. André, Eric Delory, M. van der Schaar

Module Aim: Part I: To understand how marine mammals sense and perceive the marine environment (sensory systems including sound production and reception)

Part II: a.) Optimality of biosonar signals and b.) auditory computation

Module Objectives: The part I includes 5 components which involve the study of:

1. Marine mammal morpho-physiological adaptations to the marine environment: A comparative approach.
2. Marine mammal sound production. The phonation apparatus and sound characteristics
3. Marine mammal sound reception. Cetacean acoustic pathways and processing
4. Biosonar and communication function of acoustic signals: theoretical and experimental approach
5. Acoustic signal capture and interpretation. Effect of noise pollution: modelling a virtual ocean.

The part II presents two objectives:

a.) Provides an introduction to the current knowledge on how marine vertebrates modulate their acoustic signals in order to efficiently sense their environment. Basics of information theory applied to cetacean signals time-frequency characteristics are presented and the students will learn about the natural time-frequency trade-offs that animals are faced with in their search for preys and in long-range communication.

b.) Provides an introduction to the computational approach for understanding auditory information processing. Psychoacoustic results will be introduced for cetaceans and compared to humans, accounting for the adaptation to the aquatic medium.

Learning Outcomes:

On successful completion of this module, the student should have:

- Understanding of the marine environment perception from a non-human perspective
- General knowledge of cetacean sound repertoire and functions
- Ability to predict the effects of noise pollution in the marine environment under simple scenarios
- Understanding of biosonar signals specificity in terms of environmental sensing and information extraction
- Ability to provide quantitative time-frequency cues of modulated pulsed signals
- Ability to apply basic mathematical and physical principles to extract relevant information from an emitted acoustic signal
- Understanding of the basics of mammalian auditory computation
- Understanding of the neural bioprocesses involved in hearing
- Model simple hearing systems, from monoaural to binaural
- Decompose an auditory scene analysis problem and implement basic auditory biomimetic tasks with a computer

Universitat Politècnica de Catalunya (UPC)-ENSIETA	
Module Title: STATE OF THE ART	
Module Organiser: Prof. Michel André	*Module Staff:* All professors
Module Aim: Bibliography research on specific topics to be developed in final projects	
Module Objectives: During the second semester, the students will choose their specific final project. In parallel with the taught units in the second semester, students undertake a review of the literature on their selected research topic, chosen in consultation with the teaching staff. The Review should consist of a critical appraisal of published work and should be structured and produced to a professional standard. The content should be summarized concisely in an abstract; there should be an introduction to define the context of the topic; and there should be a concluding section to emphasize important points and to indicate possible areas where future work (including the student's own research) should be directed. The length should be about 5000-8000 words, and the completed work should be handed in with a deadline to be specified.	
Learning Outcomes: On successful completion of this module, the student should have: • ability to access and create data base (endnotes software) • critical review of published work • ability to synthesize data base research results	

Universitat Politècnica de Catalunya (UPC)-ENSIETA	
Module Title: FINAL RESEARCH PROJECT	
Module Organiser: All professors	*Module Staff:* All professors
Module Aim: Students will devote themselves entirely to their individual project during the last weeks of the course.	
Module Objectives: The subject of the research should be agreed as early as possible with the staff supervisor and will normally be related to that chosen for the literature review (state of the art). Students' own ideas for research topics are welcome, and where appropriate, students are encouraged to select topics relevant to the work they have been or expect to be doing in their home institute. The possibility of incorporating projects actually being undertaken in the students' institute will be considered. Supervisors will in any case offer several possible topics that make use of the wide range of modern equipment available in the different institutions laboratories. Ideally, discussions on the outline of the project should be completed by the end of the first semester, in order to assemble any necessary equipment, and define the literature review subject appropriately. Particular urgency for early planning exists for projects involving work on research vessels. The pattern of research projects varies widely, with opportunities to acquire a variety of skills in using the many research tools available. In addition, students are required to pursue programming courses given Information Services in preparation for the data reduction phase of their projects. The dissertation, submitted at the end of the project, should contain a clear and concise account of the experimental programme as well as a full discussion of the results and their relation to existing knowledge. The assessment of the written account (together in some cases, with a viva voce examination) constitutes 33% of the total for the course. Students are advised to give the fullest attention to its preparation and presentation.	