Doctoral school SPIM - science course 2015-2016

Acronym : SPIM-MRLP	***MODES AND RESONANCES IN LINEAR PHYSICS***
Required prior knowledge	Theory of optical waveguide and fiber ; Optic Electromagnetics ; Theory of acoustic and hydrodynamic wave ; linear algebra (matricial computing ; eigenvalues and eigenvectors)
Form of examinaton	Reports on practical works
Keywords	Homogenenous problem ; mode ; resonance; free and forced oscillations ; complex resonance wavelength ; quality factor ; resonator ; waveguide ; mode coupling
Learning outcomes	What are the differences between modes and resonances, free and forced oscillations ? Is there a general formalism to describe them, via Tranfert –matrix as an example ? What does solving a homogeneous problem mean? Why are resonance frequencies complex? What is the rigourous expression of the resonance quality factor ? Etc... The aim of the course is to give a general and multi-physic overview of elementary knowledge about modes and resonances in linear Physics. For different domains of Physics, these fundamental and ubiquitous notions are often independently learned (electric resonators, optical waveguides, acoustic and hydrodynamic waves, intrinsic formulation of quantum mechanics,...). So, the vocabulary will be clarified, and a global formalism highlighted by various examples and numerical applications will be exposed. This course works will be illustrated by 3 practical works.
Content	**I. HOMOGENENOUS PROBLEMS AND THEIR SOLUTIONS (P. Boyer 5h)** I.1. Formulation of fundamental laws in linear Physics. Geometrical properties of systems. Writing Physic problems in a transfert or scatteringmatrix form via sources and system responses. Definitions of free and forced oscillations. Ex: Mechanic oscillators (elastic pendulum), diffraction theories,... I.2. Modes and resonances. Definitions as eigensolutions of an homogenenous problem (pole searching of transfert matrix). Difference and relationship between modes and resonances: When modes become resonances. Vocabulary and physical meaning: constant propagations and resonance frequencies. Various kinds of modes and resoanances. Ex: Optical waveguides, Fabry-Perot, Bragg and Nano-antenna resonators, Photonic Crystals, Fano resonances, Bloch modes,... I.3. Losses. Physical interpretations of imaginary part of resonance frequencies. Rigourous and approximate definitions of quality factor. Ex: electrical resonators as basic RLC circuit, optical metallic sieves **II. SOLVING PROBLEMS IN PHYSICS WITH COMBINATIONS OF MODES (K. Phan Huy 3h)** II.1. Canonical solutions of laws as base for general solutions. Most laws in Physics only describe evolution and propagation of pre-existing solutions (Maxwell equations, laws in classical Mechanics, Quantum Mechanics,...). In consequence, sources terms in theoretical formalisms are often described as canonical solutions of laws. Ex: Planewaves, plane wawe expansion, molecular orbitals, electric harmonic regime and Fourier transformation,... II.2. Coupled mode theory. Overview of coupled mode theory from the above general formalism point of view. Ex: Mode excitation, mode degeneracy, critical and strong coupling,... **III. PRACTICAL WORK** III.1. Optical modes and resonances in planar optical waveguides (N. Courjal 3h) III.2. Mimicking a 1D photonic crystal resonances and modes with electric coaxial cables (J. Salvi 3h)
Instructor(s)	BOYER Philippe, PhanHuy Kien, COURJAL Nadège, Jérôme Salvi (FEMTO-ST Optique)
Number of participants	Beetwen 8 and 28 participants
Hours	14h (Lecture cours: 8h + Pract. Work, TP:6h)
Calendar number of sessions, dates and times	1 session in 2015-2016 : jeudi 19/05/2016 8:00-12:00 and 14:00-18:00 vendredi 20/05/2016 8:00-12:00 and 14:00-16:00
Location (room, building, adress, city)	Besançon (room to be confirm later)
Registration Procedures	by email to formations.doctorales@univ-fcomte.fr Your message MUST specify your Full name, graduate school, research team, the style of training and / the sessions you wish to register. If you are outside the UFC also indicate your year of thesis, the name of your manager and your home university. Registrations will be taken into account until three weeks before the date of formation within the limits of available seats. You will receive an acknowledgment of your request, then a notice by email approximately one week prior to training. WARNING: The courses are expensive, by registering, you agree to participate. If you are exceptionally ultimately unable to participate, be sure to inform as soon as possible.
Comments	Participants who have validated this course (registration at each session and validation rules as above) and who have completed the online survey will receive a certificate via email in the days / weeks following the training. This training is open to doctoral students from other graduate schools. This course will be taught in English or French (depending on age) with course materials in English