COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

# Yuchen LI

for the degree of Doctor of Philosophy (Ph.D.)

## "Some topics related to the vibrations of deterministic and non-deterministic metamaterial structures"

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777 Glades Road
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Ocean and Mechanical Engineering.

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ABSTRACT OF DISSERTATION

Some topics related to the vibrations of deterministic and non-deterministic metamaterial structures
This thesis deals with some questions about the vibration of structures composed of metamaterials, especially acoustic metamaterials. In this thesis, we will explore different kinds of metamaterial or architectural structural problems, including structures composed of heterogeneous media with bi periodic sub-structures, discrete structures with sub-elements or continuous structures with discrete attached sub-elements. The thesis is composed of seven parts. After having introduced the specificities of metamaterial mechanics, the second chapter is devoted to the vibration of discrete beam problems called Hencky bar-chain model in a stochastic framework. It is shown that the lattice beam behaves as a nonlocal continuous beam problem, both in the deterministic and the non-deterministic analyses. The third chapter deals with the vibration of continuous beams with the introduction of shear effects, with attached periodically oscillators. A discussion on beam modelling, for example Timoshenko beam models or truncated Timoshenko beam models is included. It is shown that the bandgap phenomenon observed for metamaterial beams can be accurately captured by a truncated Timoshenko beam model. The next work presents results on mass in-mass lattices called Kelvin lattice, which possess two branches, the acoustical and the optical branches in the dispersion wave phenomenon. It is shown that the effective mass and the effective stiffness of this mass in-mass lattice depend on the branches of eigenfrequencies. The fourth work gives analytical results for the static deflection of biperiodic beams (beams composed of repetitive continuous cells with two alternative materials). Exact solutions are derived for such heterogeneous structures composed of periodic elements. The fifth work generalizes the previous one restricted to the static analysis to a dynamical framework. The eigenfrequencies of the simply supported biperiodic beam are calculated and compared to a Finite Element Beam model. The last chapter demonstrates that the metamaterial layer has the property to change the eigenfrequencies of a system composed of a layer and a cavity full of air.

BIOGRAPHICAL SKETCH
Born in China
B.S., Huazhong University of Science and Technology, Wuhan, China, 2011
M.S., Ecole des Ponts ParisTech, Marne-la-Vallée, France, 2018
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CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

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**Published Papers:**

**Li, Y., Elishakoff, I. and Challamel, N., 2023. Analytical Calculation of Static Deflection of Biperiodic Stepped Euler–Bernoulli Beam. International Journal of Structural Stability and Dynamics, p.2340009.**

**Li, Y., Challamel, N. and Elishakoff, I., 2023. Effective mass and effective stiffness of finite and infinite metamaterial lattices. Archive of Applied Mechanics, 93(1), pp.301-321.**

**Elishakoff, I., Li, Y., Challamel, N. and Reddy, J.N., 2022. Simplified Timoshenko–Ehrenfest beam equation to analyze metamaterials. Journal of Applied Physics, 131(10).**

**Li, Y., Challamel, N. and Elishakoff, I., 2021. Stochastic analysis of lattice, nonlocal continuous beams in vibration. Vietnam Journal of Mechanics, 43(2), pp.139-170.**