

**Course offered for the PhD program
in Civil, Chemical and Environmental Engineering
Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials
a.a. 2016/2017 (XXXI ciclo)**

(course is open for participation of students from other PhD cycles or programs)

1. Title

Perspectives on multi-scale modeling of biological and small-scale materials and structures

2. Course Description

Modern topics in biological and small-scale materials/ structures, including: (1) state of the art experimentation at the micro and nano scales (2) assessment of multi-scale models through comparisons with experimental results (3) concomitant introduction of fundamental concepts in fracture mechanics, plasticity and viscoelasticity, with focus on size effects.

1. Fundamentals of mechanics of materials, including elasticity, plasticity, viscoelasticity, and fracture mechanics.
2. A review of superior properties of natural structures, via performance indices and illustrative examples.
3. Reverse engineering of specific structures; the strength and fracture toughness of the shells of *Lobatus gigas* (Queen Conch) and *Haliotis* (Abalone). Determination of the roles played by architectural design, constituent properties, and hierarchy.
4. Mechanical testing at multiple scales, with focus on measuring properties at the micro and nano scales using microelectromechanical systems (MEMS) platforms. Focus on the critical role of experimentation in the development and assessment of multi-scale models. This will include the assessment of molecular dynamics predictions of the mechanical properties of collagenous structures and silicon nanostructures.
5. Self-healing in natural structures and methods being developed to achieve this phenomenon in man-made structures. Examples from polymeric and cementitious composites.

3. Course Organization

The course is provided via lectures.

4. Teacher

Roberto Ballarini, Thomas and Laura Hsu Professor and Chair, University of Houston

5. Duration and credits

8 hours, 2 credits

6. Activation mode and teaching period

Early May 2016

7. Deadline for registration

8. Final exam

Individual or group research report that applies the insights gained by the student(s) to a specific technological problem in materials and/or structural engineering.