

Doctorate Course

Mechanics of Complex Bodies: foundations and perspectives

Professor Paolo Maria Mariano

DICeA, Università di Firenze (Italy)

Escuela de Ingenieros de Caminos, Universidad Politécnica de Madrid,
September 15th-26th, 2008

Programa de Doctorado (con mención de calidad): Estructuras

Motivation of the course:

Stringent technological requirements of sophisticated performances of material and structures and of circumstantial control for micro-devices and other types of machinery at multiple scales can be satisfied often only by resort to or allowance for complex materials. The adjective complex is used to emphasize that the attention is focused on bodies in which changes in their material texture, precisely the substructure at various sub-scales (from nano-to-mesoscopic level), prominently influences the gross behaviour through peculiar interactions generated by substructural changes. Examples can be found in condensed matter physics, in particular soft condensed matter. Their list includes liquid crystals, bodies with dense distributions of microcracks, quasiperiodic alloys, polarizable materials, various types of composites and bodies with strain gradient effects. Even standard structures like beams and shells can be modelled as one-dimensional or two-dimensional complex bodies.

Notwithstanding the variety of special models of complex bodies, a general model building framework for the mechanics of complex bodies exists: basically it is a multifield continuum description involving maps representing the morphology of the material texture on some finite-dimensional manifold (the so-called manifold of substructural shapes). Such a framework unifies popular special models of particular classes of complex bodies and clarifies the physical, intrinsic nature of their structure.

Aim and scope of the course:

The basic aim of the course is an introduction to the mechanics of complex bodies. The attention is focused primarily on the general model-building framework of the mechanics of complex bodies. Then it is shown how such a general framework is specialized to represent the mechanical behaviour of concrete examples. The path toward numerical schemes is also indicated, research perspectives discussed.

The course will be offered in english and for an audience that could be mainly: mathematicians (either pure or applied), engineers (civil, mechanical and materials science) and physicists. The course is though to be for graduate students and researchers in general.

Inscriptions:

No fees are due but registration is mandatory. Please contact Prof. Jaime Planas by e-mail to jaime.planas@upm.es or telephone to the number +34-91.3365374

Location of the activities:

The course will be held in the Department of Materials Science of the ETS de Ingenieros de Caminos at the Universidad Politécnica de Madrid (Avda. profesor Aranguren s/n, 28040 Madrid).

Program:

First week (September 15th-19th from 4 p.m. to 6 p.m.)

Essential elements of the mechanics of complex bodies.

The main topics cover will be the following:

- Representation of material elements.
- Extended notions of observers.
- Geometry of substructural interactions: power and balance.
- Substructural inertia.
- Constitutive structures.
- Examples of complex bodies.
- Identification of constitutive structures from discrete lattices.
- Latent substructures.

Second week (September 22th-26th from 4p.m. to 6p.m.)

Influence of the material substructures on the evolution of defects.

The main topics cover will be the following:

- Lagrangian dynamics of complex bodies, Noether theorem and covariance.
- The principle of relative power.
- Discontinuity surfaces.
- Line and point defects.
- Cracks in complex bodies.
- Examples of applications.
- Research perspectives.