

Preface

Shell-like structures are widely used in engineering as basic structural elements. Such structures are also used in other branches of science as a model of analysis, e.g., in medicine, biology, nanotechnology, etc. New applications are primarily related to new materials—for example, instead of steel or concrete, now one has to analyze laminates, foams, functionally graded materials, shape memory thin films, fullerenes, nanofilms, biological membranes, soft tissues, etc. The new trends in applications demand the improvements of the theoretical foundations of shell theory, since new effects must be taken into account. For example, in the case of small-size shell-like structures (thin films, multi-walled nanotubes), the surface effect plays an important role in the mechanical analysis of these structural elements. On the other hand, the theoretical achievements must be supplemented with the development of consistent numerical tool.

The aim of the CISM course, *Shell-like Structures—Advanced Theories and Applications*, was to present together mathematical aspects of the theory of plates and shells, applications in civil, aerospace and mechanical engineering, as well as other areas. The focus of the course relates to the following problems:

- comprehensive review of the most popular theories of plates and shells;
- relation between 3D and 2D theories;
- presentation of recently developed new refined plates and shells theories such as for example, micropolar theory, or gradient-type theories;
- applications in modeling of complex structures (multi-folded, branching and/or self-intersecting shells, plates and shells made of foams, functionally graded materials, etc.);
- modeling of coupled effects in shells and plates related to electromagnetic and temperature fields, phase transitions, diffusion, etc.;
- applications in modeling of non-classical objects as thin- and nanofilms, nanotubes, and nanoparticles, and biological membranes;
- presentation of actual numerical tools based on finite elements approach.

- During the course the following lectures were presented:
- Holm Altenbach: Thin-walled Structural Elements—Classification, Classical and Advanced Theories, New Applications;
- Victor Eremeyev: Mechanics and Thermodynamics of Micropolar Shells;
- Gennady Mikhasev: Non-Classical Problems on Localized Vibrations and Waves in Thin Shells;
- Paolo Podio-Guidugli: How to Deduce Structure Theories from 3D Elasticity;
- Karam Sab: The Bending-Gradient Theory for Heterogeneous In-Plane Periodic Plates;
- Krzysztof Wisniewski: Selected Topics on Finite Elements for Finite Rotation Shells

In this sense the course was an overview about the theories of plate and shells, the history, and some new developments. In the following chapters the basic material of the course was slightly changed. The chapter names are not always the same like the lecture names.

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