"Nonlinear Structural Mechanics with Application to Composite and Smart Structures"

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Short description of the lecture (up to 10 sentences):

This lecture focuses on nonlinear statics and dynamics of thin-walled structures and its application to composite and piezoelectric smart structures. The lecture firstly introduces the basic mathematical preliminaries required for arbitrarily shaped beams, plates and shells. Then, various plate/shell hypotheses will be discussed, which include the classical plate/shell hypothesis, first- and higher-order shear deformation hypothesis. Geometrically nonlinear strain-displacement relations will be discussed for structures undergoing small strains but moderate or unrestricted finite rotations. For simplicity the first-order shear deformation von Kármán type nonlinear plate/shell theory will be used to demonstrate the derivation of internal stress resultants, equilibrium equations, equations of motion and finite element formulations via the principle of virtual work. Finally, the aforementioned theories will be extended to composite and piezoelectric smart structures, including the basics of piezoelectricity, the constitutive equations of piezoelectric materials, and electro-mechanically coupled modeling. Numerous finite element simulation results will be presented for statics, stability and dynamics of thin-walled composite and smart piezolaminated structures including shape and vibration control.

Syllabus of the lecture subjects (enlisted):

1. Introduction. Structural Nonlinearity, Kinematical Hypotheses
2. Mathematical preliminaries
3. Geometry of the initial and deformed configuration
4. Finite deformations
5. Stress and strain tensors for geometrically nonlinear analysis
6. Geometrically nonlinear first-order transverse shear deformation theories, von Kármán type nonlinearity

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7. Strain-displacement relations for tangential, transverse shear and transverse normal strains
8. Principle of virtual displacements, internal and external virtual work
9. Equilibrium equations and equations of motion
10. Constitutive equations for isotropic and composite laminated structures
11. Finite element formulation
12. Direct and converse piezoelectric effect
13. Introduction into the theory of piezoelectricity
14. Piezolaminated smart structures for shape and vibration control
15. Nonlinear simulation results for statics, stability and dynamics of isotropic, composite and smart structures

Terminy wykładów			
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