

CIVIL-449

**Nonlinear analysis of structures**

Beyer Katrin, Lignos Dimitrios, Saloustros Savvas

<b>Cursus</b>	<b>Sem.</b>	<b>Type</b>
Civil Engineering	MA1, MA3	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Written
Workload	180h
Weeks	14
<b>Hours</b>	<b>5 weekly</b>
Courses	3 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

This course provides an introduction to the nonlinear modelling of civil engineering structures.

**Content**

The course is based on assignments in which students either implement the nonlinear analysis from scratch (for models with truss elements) or use an open-source software (for models with beam elements). The topics that are covered are the following:

- Truss models: Hand calculations and finite element calculations of truss models with material and geometric nonlinearity; Nonlinear material laws: Plasticity
- Beam element formulations: Total and incremental compatibility and equilibrium relations of beams, accounting for large displacements. Differential equations for Euler-Bernoulli and Timoshenko beams. Sectional analysis of RC sections. Beam formulations with concentrated and distributed plasticity approaches (force-based and displacement-based).
- Nonlinear analyses: Solution methods for nonlinear static and dynamic analysis. Damping models.
- Review of past blind prediction tests and comparison between numerical and experimental results.
- Use of nonlinear simulations in civil engineering practice.

**Learning Prerequisites****Required courses**

CIVIL-321 Numerical modelling of solids and structures (or similar)  
Courses on structural mechanics

**Learning Outcomes**

By the end of the course, the student must be able to:

- Implement nonlinear finite element approaches for truss elements
- Assess / Evaluate the consequences of modelling hypotheses on analysis results
- Choose appropriate finite element formulations for nonlinear structural analysis problems
- Develop models that represent the essentials of the nonlinear response of structures

**Assessment methods**

Assignments

Project during the semester  
Final exam

## Resources

### Ressources en bibliothèque

- [Finite element analysis for building assessment / Lourenço & Gaetani](#)

### Moodle Link

- <https://go.epfl.ch/CIVIL-449>