ROSE Master of Science

Civil Engineering for Mitigation of Risk from Natural Hazards

Computational Mechanics

Lecturer: **S. Morganti - L. Greco**
Date: 28/09/2026 – 23/12/2026
Credits: 6 ECTS (CFU)

Course Description

The course is organized in theoretical lectures and computer exercises. Theoretical lectures will be primarily held at the blackboard and complemented by tutorials (aiming at the practical implementation in Matlab of the methods considered during the lectures).

Topics

Review of beam theory and of standard displacement-based methods for planar frames. Basic concepts of the finite element method (from strong form to weak form and approximation) and development of a finite element scheme for Bernoulli-Euler beams, starting from the elastica differential equation. Solution of frames including concentrated and distributed loads, prescribed displacements, concentrated stiffness, internal constraints. Development of a finite element scheme for (shear deformable) Timoshenko beams starting from the total potential energy. Shear locking issues and possible solution techniques. Review of linear elasticity. Finite elements for linear elasticity in 1D and 2D. Development of triangular and isoparametric quadrilateral finite elements. Numerical integration. Volumetric locking issues and possible solution techniques. Review of advanced Computational Mechanics methods.

Learning Outcomes

Students will be able to formulate, implement, and critically evaluate finite element models for planar frames and 2D linear elastic structures. They will possess the critical judgment required to select appropriate element formulations, verify numerical convergence, understand and solve possible issues (e.g., locking) and bridge classical finite element procedures with advanced computational mechanics frameworks.

Suggested reading material/Reference textbooks (if applicable)

In addition to specific papers and handouts indicated/delivered during classes, the following general textbooks are recommended:

- Course notes.
- T.J.R. Hughes (2000), The Finite Element Method: Linear Static and Dynamic Finite Element Analysis. Dover.
- O.C. Zienkiewicz, and R.L. Taylor (2005), The finite element method for solid and structural mechanics. Elsevier.

Assessment Methods

Assignments will be handed over during the course. The final examination will consist of two parts:

1) Implementation exercises to be solved in the computer lab.
2) Oral examination discussing assignments and theoretical aspects.

Schedule and classroom:

See the calendar here