

**Course offered by the PhD program
in Civil, Chemical and Environmental Engineering
Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials
a.y. 2025/2026**

(course is open for participation of students from other PhD cycles or programs)

1. Title

Nonlinear Finite Element Method for Structural Applications

2. Course Description

- Introduction to the Finite Element method
 - Finite element modelling (brush up)
 - The direct stiffness method (bar element) (brush up)
 - Variational formulation (bar element) (brush up)
 - The plane stress problem: plane stress isoparametric elements (brush up)
 - Shape functions, convergence requirements, numerical discretization (brush up)
- Nonlinear analyses:
 - Nonlinear response diagrams: critical points
 - Residual force equations (one parameter)
 - Formulation of the bar element in large displacements
 - Overview of solution methods: predictors, predictor-correctors
 - Linearized Pre-buckling. Geometric nonlinearities. Material nonlinearities
- Applications using ANSYS: linear elastic plate with circular hole (2D problem; solid modelling, meshing, convergence issues); Linearized Pre-Buckling of a portal frame (nonlinear analysis, bifurcation point); Prandtl problem (rigid foundation over an elasto-plastic soil (nonlinear analysis; limit point); Instability of an elasto-plastic beam (nonlinear analysis; geometric and material nonlinearities; unstable post-critical branche); Griffith problem: energy release rate and stress intensity factors in a plate with a crack (fracture mechanics)

3. Course Organization

Frontal lessons and practical classes in the lab.

4. Teacher

Prof. Roberta Massabò

5. Duration and credits

Around 30h+Labs, 5 CFU

6. Activation mode and teaching period

Period: March - June 2026. Frontal Lessons and practical classes with the course "Nonlinear Analysis of Structures" for LM students.

7. Deadline for registration

End of January 2026. Application: email message to the teacher
(roberta.massabo@unige.it)

8. Final exam

Application of Finite Element code ANSYS to solve a nonlinear problem of interest for your research.