

**Course offered for the PhD program
in Civil, Chemical and Environmental Engineering a.a. 2025/2026**

**Curriculum in Fluid Dynamics and Environmental Engineering
Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials
Curriculum in Wind Science and Engineering**

(possibility of participation for students in other PhD cycles or other PhD courses)

1. Title

Perturbation Methods 2

2. Course description

In smooth continuity with the companion course (Perturbation Methods 1), the course titled Perturbation Methods 2 deals with conceptual, methodological and applicative aspects concerned with the employment of asymptotic techniques. The perturbation-based solutions of algebraic and differential problems are presented by means of traditional and advanced tools (such as fractional power series or multiparameter expansions). Different mathematical issues recurring in the fields of Mathematical Engineering and Mechanics are faced, including eigenproblems, dimension reductions, static/dynamic bifurcations, self-excited and forced oscillations and parametrically excited systems.

3. Course Organization

The course consists of lectures and exercises. Softwares for symbolic computation are introduced.

4. Teachers

Marco Lepidi, Giuseppe Piccardo

5. Duration and credits

The course consists of 10 hours of lessons (2 credits)

6. Activation mode and teaching period

The course is scheduled every two years, free of charge. For the academic year 2025-26 the course will be held in February 2026, in series with Perturbation Methods 1. The minimum number of participants to activate the course is 5. The option of online participation will be activated on request.

7. Deadline for registration

The deadline for applications is 31th January 2026. Confirmation can be sent by e-mail to Marco Lepidi (Marco.Lepidi@unige.it) or Giuseppe Piccardo (Giuseppe.Piccardo@unige.it).

8. Final exam

Written examination (solution of one or more simple problems) at the end of the course

9. References

- Lepidi, M. (2013), Multi-parameter perturbation methods for the eigensolution sensitivity analysis of nearly-resonant non-defective multi-degree-of-freedom systems. J. Sound and Vibration, 332(4), 1011-1032.
- Lepidi, M. (2024), Free vibrations of shallow inextensible cables: a perturbation approach. Nonlinear Dynamics, in press. Doi: <https://doi.org/10.1007/s11071-024-10536-8>
- Luongo A., Paolone A. (1997), Perturbation methods for bifurcation analysis from multiple nonresonant complex eigenvalues. Nonlinear Dynamics, 14(3), 193-210.
- Luongo, A. (2017) On the use of the multiple scale method in solving 'difficult' bifurcation problems. Mathematics and Mechanics of Solids 22(5) pp.988-1004.
- Luongo, A., Zulli, D., D'Annibale, F., Ferretti, M. (2024). Perturbation Methods and Nonlinear Phenomena. Springer.
- Nayfeh A.H. (1993), Introduction to Perturbation Techniques. John Wiley & Sons
- Nayfeh, A.H., Mook, D.T. (2008). Nonlinear oscillations. John Wiley & Sons
- Seyranian A, Mailybaev A. (2003), Multiparameter stability theory with mechanical applications. World Scientific.