

# LADISLAV TRNKA | CURRICULUM VITAE

## PERSONAL DETAILS

Gender: Male

Date of birth: 23.6.1999

Place of birth: Havlíčkův Brod, Czech Republic

Citizenship: Czech Republic

✉ Email: [trnka.ladis@gmail.com](mailto:trnka.ladis@gmail.com)

🐙 GitHub: [LadislavTrnka](https://github.com/LadislavTrnka)

🌐 Homepage: [ladislavtrnka.github.io](https://ladislavtrnka.github.io)

## RESEARCH INTERESTS

- Numerical methods for differential equations (spectral collocation method, finite element method)
- Nonlinear dynamical systems and bifurcation analysis
- Elastic solids, Newtonian and non-Newtonian fluids, viscoelastic fluids (numerical simulations, thermodynamics)
- Reduced-order models and machine learning for fluid mechanics

## EDUCATION

- 09/2022-present Charles University, Faculty of Mathematics and Physics  
Master's study programme: **Mathematical Modelling in Physics and Technology**  
Planned graduation: 06/2025  
Thesis title: *Bifurcation analysis of viscoelastic flows using deflation method*  
Supervisor: Doc. Mgr. Vít Průša, Ph.D.
- 09/2019-06/2022 Charles University, Faculty of Mathematics and Physics  
Bachelor degree with honours: **Mathematical Modelling**  
Thesis title: *Spectral collocation methods in solid mechanics*  
Supervisor: Doc. Mgr. Vít Průša, Ph.D.

## PUBLICATIONS

- [1] Vít Průša and **Ladislav Trnka**. Mechanical response of elastic materials with density dependent Young modulus. *Applications in Engineering Science*, 14:100126, 2023. ISSN 2666-4968. doi:10.1016/j.apples.2023.100126

**My contribution:** I performed all numerical computations using **FEniCS** computing platform (see 🐙) and wrote the first draft of the article. CRedIT: formal analysis, investigation, software, writing – original draft.

**In-process**, planned publication date 2025:

- [2] Jan Blechta, Vít Průša, **Ladislav Trnka**, and Karel Tůma. Fast construction of the discrete green operator for a second order ordinary differential equation, 2024. URL <https://arxiv.org/abs/2412.06242>

**My contribution:** I wrote the initial implementation of proposed approach for fast construction of the discrete Green operator. The implementation was done in **MATLAB (chebfun package)**. CRedIT: software, writing – review & editing.

## RESEARCH EXPERIENCE

- 02/2023-03/2025 Team researcher, *Mathematical analysis of partial differential equations describing far-from-equilibrium open systems in continuum thermodynamics*, Czech Science Foundation, EXPRO 20-11027X, Principal investigator Doc. RNDr. Miroslav Bulíček, Ph.D.

**My involvement:** I have studied the bifurcation behaviour of **viscoelastic fluid flows**. In particular, I have investigated steady states of **Giesekus** and **FENE-CR fluid** in a planar sudden expansion channel and in a planar cross-slot geometry. For **bifurcation analysis**, I use the **deflated continuation algorithm** which combines the **deflation techniques** with **continuation methods**. In practice, straightforward discretization of governing equations lead to numerical difficulties during continuation and deflation (**high Weissenberg number problem** [HWNP], the left Cauchy–Green tensor associated with the elastic part of the fluid response loses **positive definiteness**). To alleviate HWNP and preserve positive definiteness of the left Cauchy–Green tensor, I apply two approaches to reformulate the governing equations. The reformulation is based either on the **matrix logarithm transformation** or on the **square root transformation** of the left Cauchy–Green tensor. The problems are solved numerically by finite element method. In addition, I employ **finite element stabilization techniques** (DEVSS-TG, SUPG) used for viscoelastic flows. The numerical methods are implemented using **Firedrake** and **Defcon** libraries. So far, results have been presented at two conferences (see most recent poster 📄) and will be published in 2025.

- 09-11/2022 Principal investigator, *Elastic bodies with density dependent material moduli*, Student Faculty Grants (individual short-term projects for students beyond normal study duties), Charles University, Faculty of Mathematics and Physics, research resulted in publication [1].

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## SCHOLARSHIP

02/2024-12/2024     **UNCE MathMAC** (University Centre for Mathematical Modelling, Applied Analysis and Computational Mathematics at the Faculty of Mathematics and Physics, Charles University), scholarships for excellent PhD and master's students, the scholarship covered my travel costs and conference fees for 2023-2024.

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## TEACHING EXPERIENCE


Winter 2024            Computer Solution of Continuum Physics Problems II (advanced course for master's students), two lectures and two tutorials on the deflation continuation algorithm, Charles University, Prague, Czech Republic.

Winter 2023            Computer Solution of Continuum Physics Problems II (advanced course for master's students), two lectures and two tutorials on the deflation continuation algorithm, Charles University, Prague, Czech Republic.

**My involvement:** I wrote **one section of lecture notes on the deflation continuation algorithm** (algorithm for numerical bifurcation analysis of stationary nonlinear equations) and led **two lectures and two tutorials**.


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## CONFERENCES AND WORKSHOPS

2024                    *Modelling, PDE Analysis and Computational Mathematics in Materials Science*, Faculty of Mathematics and Physics, Charles University, September 22-27, Prague, Czech Republic, on-site participant (**poster** , *Bifurcation analysis of viscoelastic flows using deflation method*)

2024                    *CISM-EUROMECH Advanced Course, Model Reduction and Machine Learning for Solids, Fluids and Controls*, CISM (International Centre for Mechanical Sciences), September 9-13, Udine, Italy, on-site participant

2024                    *The von Karman Institute Lecture Series, Introduction to Quantum Computing in Fluid Dynamics*, the von Karman Institute for Fluid Dynamics, July 8-12, Brussels, Belgium, online participant

2024                    *High Performance Computing in Science and Engineering conference*, IT4Innovations National Supercomputing Center, VSB (Technical University of Ostrava), May 20-23, Karolinka, Czech Republic, on-site participant (**poster** , *Bifurcation analysis of viscoelastic flows using deflation method*)

2024                    *EMS School, Mathematical Aspects of Fluid Flows*, EMS (European Mathematical Society), Faculty of Mathematics and Physics, Charles University, May 12-17, Kácov, Czech Republic, on-site participant (**contributed talk** )

2024                    *The von Karman Institute Lecture Series, Machine Learning for Fluid Mechanics: Analysis, Modeling, Control and Closures*, Université libre de Bruxelles, January 29-February 2, Brussels, Belgium, on-site participant

2023                    *CISM Advanced Course, Machine Learning for Fluid Mechanics*, CISM (International Centre for Mechanical Sciences), July 10-14, Udine, Italy, on-site participant

2023                    *EMS School in Mathematical Modelling, Numerical Analysis and Scientific Computing*, EMS (European Mathematical Society), Faculty of Mathematics and Physics, Charles University, May 28-June 2, Kácov, Czech Republic, on-site participant

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## PROGRAMMING SKILLS

Python (mpi4py basics), C (OpenMP and OpenMPI basics), Firedrake and FEniCS (defcon library), MATLAB (chebfun package), Wolfram Mathematica

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## LANGUAGE SKILLS

English (C1), Czech (native)

### Certificate:

7/12/2024            IELTS Academic test (International English Language Testing System), Overall Band Score **7.5** (CEFR C1)

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## REFERENCES

**Prof. RNDr. Josef Málek, CSc.**  
Email: malek@karlin.mff.cuni.cz  
Mathematical Institute of Charles University  
Sokolovská 83, 186 75 Praha 8  
Czech Republic

**Doc. Mgr. Vít Průša, Ph.D.**  
Email: prusv@karlin.mff.cuni.cz  
Mathematical Institute of Charles University  
Sokolovská 83, 186 75 Praha 8  
Czech Republic

**Prof. Ing. Jan Zeman, Ph.D.**  
Email: jan.zeman@cvut.cz  
Faculty of Civil Engineering  
Czech Technical University in Prague  
Thákurova 7, 166 29 Prague 6  
Czech Republic