

# Computational Phase-field Modelling

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## Abstract

*Course description:* Computational phase-field modelling is a thriving paradigm in computational mechanics. Phase-field modelling refers to the mathematical description of physical systems with different phases separated by an evolving diffuse interface. Prime examples include the interface evolution in a single material, such as crack propagation, as well as between two, or more, distinct states arising in mixtures and multi-phase systems, such as in binary alloys, two-phase flows, solidification, grain and crystal growth, and the growth of cancerous tumors.

Course objective: The objective of the short-course is to give an accessible introduction to computational phase-field modelling, focusing on the questions:

- What are the phase-field models?
- Why do they work, and how do you solve them?
- Where do phase-field models come from, and how are they derived?

*Course contents:*

- Examples: Phase-field fracture, the Navier-Stokes-Cahn-Hilliard system, phase-field solidification mechano-biological mixtures
- Principles: Free-energy dissipation, phase separation, phase transition, coarsening
- Computational methods: Energy-stable time-stepping algorithms
- Foundations: Truesdell's continuum theory of mixtures, Gurtin-Coleman-Noll phase-field theory

## Bio

Dr Kris van der Zee is an Associate Professor in the School of Mathematical Sciences at the University of Nottingham. Previously he was an Assistant Professor at Eindhoven University of Technology, a Postdoctoral researcher at the Oden Institute for Computational Engineering and Sciences at The University of Texas at Austin, and a Cum Laude PhD Graduate in Aerospace Engineering at Delft University of Technology. His research specializes in computational mechanics of interfacial phenomena, the mathematics of finite element methods, and more recently, the development and analysis of deep-learning algorithms within scientific computation.

He held a UK Royal Society International Exchange Fellowship, he was awarded a "Veni" Early Career Grant by the Netherlands Organisation for Scientific Research, and he was awarded a UK Royal Society Newton International Fellowship. He is Associate Editor of the Journal Engineering with Computers.