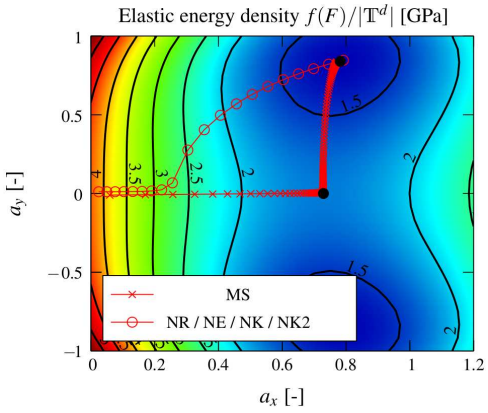
Announcement for the course
Solving Nonlinear Equations



Comparing different numerical methods for solving a nonlinear optimization problem[a]

[a] from: Kabel, M., Böhlke, T., Schneider, M.: Efficient fixed point and Newton-Krylov solvers for FFT-based homogenization of elasticity at large deformations. Comp. Mech., 54(6), 1497-1514 (2014).

Topics

Engineering problems lead, in general, to a set of equations whose solution is sought. To solve these numerically, the most popular technique among engineers appears to be Newton's method. Unfortunately, when applied naively, more often than not such an approach fails admirably, for instance for strongly nonlinear or nondifferentiable equations. The goal of this course is to provide a deeper understanding on when Newton's method works and to provide powerful alternatives to the working engineer. For this purpose, we study the concept of monotone operators, a vectorial generalization of the notion of a monotonic function in one spatial dimension, and develop the associated theory. With this central notion at hand, we study applications to linear and nonlinear elasticity, thermodynamics of inelastic materials, and convergence of discretization schemes.
The exercise sessions concerns implementing dedicated solution methods, and starts with an introduction to the scripting language Python.
The course will be offered in a purely digital format, supported by ILIAS . The lecture notes will be provided beforehand, and the students are given specific parts of the notes to read before a specific date. On a weekly basis, we will get together via MS Teams , and discuss the relevant topics. After the course work (takes 30-45 min), the exercise sessions take place in the same time slot.

Literature

[1] Schneider, M.: Lecture Notes. 2021

Schedules and exams

Courses & Exercises	Thursdays, 10:00-11:30
Location	Online Q/A-sessions via MS Teams
Start of lecture	15th April
Exams	Oral
Volume	C 2 SWS, E 2 SWS, 6 LP
Lecture notes	Available on ILIAS , join April 1st 2021
Course language	German or English if preferred
Contact	JProf M. Schneider, MSc F. Ernesti

Target audience

This course addresses bachelor and master students with an engineering, mathematical or more general scientific background with an interest in the mechanics of materials. This course is complementary to other events offered at the Institute of Engineering mechanics.

Prerequisites

You should have some familiarity with mathematics as taught in the basic engineering classes. All further relevant results will be developed during the course.

Content

- Fixed-point methods and monotone operators:

  Banach spaces and Banach's fixed-point method; Hilbert spaces and Riesz' representation theorem; Anderson acceleration; Strongly monotone operators

- Applications of monotone operators:

  Linear elasticity; Generalized standard materials; Nonlinear small-strain elasticity; Galerkin discretizations

- Newton methods:

  Differentiation; Newton's method; Semismooth Newton methods