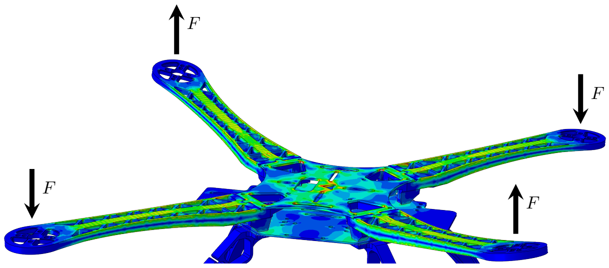
Information to the Course
Computational Elasticity



FEM analysis of local von-Mises stresses within a drone housing [Gajek, S., Schneider, M. & Böhlke, T.: An FE-DMN method for the multiscale analysis of short fiber reinforced plastic components. (2021)]

Contents of the lecture

The lecture provides an introduction into the principles and numerical aspects of computational elasticity. In the beginning, direct and iterative solution methods for linear systems are discussed. Basics of linear elasticity as well as the boundary value problem of linear elasticity are treated afterwards. For solving problems of linear elasticity the finite element method will be developed in detail focusing on numerical implementation. In the last part, an introduction into finite elasticity is given and implementation issues in specific examples are discussed. In tutorials, example problems will be solved and coded in the programming language python which is widespread in academics and industry. An introduction to python will be provided in the beginning. Additionally, the commercial FE software ABAQUS is used.

Dates, Credits, Contact

Lecture	Tue, 11:30 - 13:00, Engesser lecture hall, bldg 10.81
First Lecture	Tue, Oct 28th, 11:30 - 13:00, Engesser lecture hall, bldg 10.81
Tutorial	to be defined during first lecture
First Tutorial	to be defined during first lecture
SWS / Credits / Exam	2+2 SWS, 5+1 CP / oral examination
Language	English / German (depending on the audience)
Contact	Prof. T. Böhlke, Dr.-Ing. T.-A. Langhoff

Literature

[1] G. H. Golub & C. F. Van Loan: Matrix Computations. The John Hopkins University Press, 2013.

[2] M. G. Larson & F. Bengzon: The Finite Element Method: Theory, Implementation, and Applications, Springer, 2013. Fulltext available via KIT library

[3] T. J. R. Hughes: The Finite Element Method - Linear Static and Dynamic Finite Element Analysis. Prentice Hall, 1987.

Recommendation

This course on MSc level is suitable for students with a high interest and good background in engineering mechanics, especially in elasticity. The students should be familiar with tensor calculus. Basic knowledge of the linear static finite element method and of a commercial FE software package like ABAQUS is highly recommended. Also basics in numerical mathematics and numerical algebra are assumed. Experience in coding is recommended, but special knowlege in Python is not required.

Contents of Lecture

- **Numerical solution of linear systems**
  vector norms, matrix norms; properties of matrices; spatial discretizations; condition number; direct solution methods, LR and Cholesky decomposition; iterative solution methods; conjugate gradient method
- **Basics and boundary value problem of linear elasticity**
  kinematics of deformation; balance equations; compatibiliy; constitutive equations for homogeneous elastic materials; material symmetries; boundary value problem of linear elasticity; functional spaces; notion of functionals and variations; strong and weak form of linear elastostatics,
- **Finite element technology for linear elastostatics**
  Galerkin formulation, stiffness matrix and load vector, linear and non-linear shape functions, numerical integration, isoparametric concept, convergence and conditioning, setup of a user material routine (UMAT) in ABAQUS
- **Basics of geometrically nonlinear elasticity**
  Kinematics of finite deformations, Eulerian and Lagrangian description of fields, material time derivative, deformation gradient, transformation of line, area and volume elements, polar decomposition of the deformation gradient, generalized strain measures