Fundamentals of Structural Mechanics:

Structural mechanics" - distinguishing it from continuum mechanics - is the modeling of spatially three-dimensional solid continua by means of certain structures such as trusses, beams, plates as well as shells and the simulation of their mechanical behavior. These structures are fundamentally characterized by restrictive assumptions regarding the kinematics/deformations, which is simultaneously accompanied by a reduction of the spatial dimension of the underlying problem. On the one hand, structural mechanics is used for the calculation of analytical solutions for simple model systems (especially for comparison purposes). On the other hand, structural elements are also frequently used in finite element simulations to reduce the degrees of freedom used and thus the computation times.

The goal of this seminar is to understand the basic assumptions behind relevant theories ourselves and to derive the resulting equations on this basis. We thus go directly on the historical paths and in the footsteps of famous "mechanics" like Bernoulli, Kirchhoff & Co. The errors associated with the respective assumptions are always registered and first qualitatively estimated. Later, these are additionally analyzed and assessed quantitatively by comparison with finite element calculations. This also includes estimates of the range of application of the respective theory.

It is strongly recommended to bring a laptop or similar device on which the programming language Python including common libraries like numpy, scipy, matplotlib and an editor (e.g. Spyder, Jupyter) are installed. The Python codes needed to solve the problems covered in the seminar will be provided.

Variational models for brittle fracture:

In the variational approach to brittle fracture, displacements and crack paths are determined from an energy minimization principle. The central objects are so-called Griffith energies which comprise elastic contributions for the unfractured regions of the body and surface energies comparable to the size of the crack. As crack sets are not preassigned but a critical part of the minimization procedure, such issues are often referred to as a free-discontinuity problems. In this lecture series, we give an overview of classical and more recent existence results for Griffith functionals. In particular, we discuss the underlying framework of functions of bounded variation and deformation.