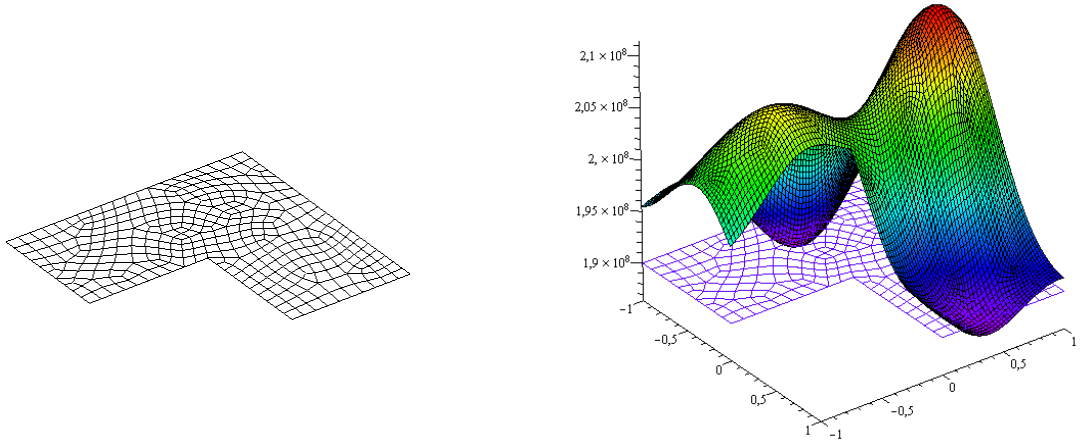
Stochastic finite elements for plane elasticity problems

Several finite element (FE) applications necessitate the consideration of the uncertain nature of input parameters, such as material properties, load and geometry. These uncertainties may be represented by a set of stochastic variables defined using probability distributions and spatial correlations, such that random realizations describing a possible parameter state may be produced. The following figure depicts a realization of a stochastically distributed Young's modulus in a 2D L-shaped domain.



(a) L-shaped FE mesh (b) Random realization of E [kPa]

Fig: Random realization of Young's modulus E in a 2D FE mesh

The FE solution may no longer be deterministic, since the stochastic variables are involved in the FE solution process. Instead, the FE method may be employed for the determination of a probability structure which relates possible solution states with corresponding probabilities of occurrence. Such a solution is obtained by the stochastic FE method [1, 2].

In this software lab project, the students will become acquainted with the theory behind the stochastic FE method and will subsequently implement a stochastic FE C/C++ program for 2D plane stress/strain problems.

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References

[1] R.G. Ghanem, P.D. Spanos, "Stochastic Finite Elements: A Spectral Approach", Springer, New York, 1991.

[2] B. Sudret, A. Der Kiureghian, “Stochastic Finite Elements and Reliability: A State-of-the-Art Report”, University of California, Berkeley, 2000 – Technical Report no UCB/SEMM-2000/08