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Course title: Uncertainty Quantification & Structural Reliability.

This course starts with a demonstration and interpretation of the basic probabilistic moments and characteristics, different types of uncertainty in engineering problems resulting from both engineering laboratory experiments and inherent in mathematical models and numerical simulations. Continuous and discrete definitions of positional statistics, and also a listing of different probability density functions is delivered. Mathematical issues inherent in probabilistic integrals are demonstrated using the computer algebra system MAPLE. The basic algorithm of the Monte-Carlo simulation is demonstrated in this system and also with the use of Python programming environment. Probabilistic convergence of the basic statistics in some specific engineering problems is demonstrated numerically; short overview of some numerical accelerators is attached. These issues are contrasted with the basic methodology typical for a family of the perturbation methods of the first, second and general order. The role of the perturbation order and convergence of the method is discussed, especially in the context of both linearization and iterative approach to the basic moments calculation. Some engineering examples for all these three methods are attached and discussed in detail. Next, a definition of the First and the Second Order Reliability Methods (FORM and SORM) would be provided together with some engineering illustrations. This apparatus would be enriched with the definitions and interpretation of probabilistic entropy and distance. Different mathematical models would be recalled and their engineering applications, i.e. in beam, plates, shells and spatial structures will be demonstrated. Application and usefulness of the probabilistic distance to the reliability assessment will be shown for linear, nonlinear and coupled multi-physics problems of computational mechanics and physics (including fire risk and safety analysis). This course would be completed with random time series approximations of the ageing processes of certain engineering materials and structures. Some numerical simulations will display an impact of the experimentally-driven ageing processes on popular engineering structures.