IASSAR - SC2 on STOCHASTIC DYNAMICS
State-of-Art Review

Abstract for topic 2:
Equivalent Linearization and Monte Carlo Simulation

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The method of equivalent linearization (EQL) is based on the idea, that a nonlinear system, may be replaced by a linear system, i.e. by minimizing the mean square error between the two systems. The most commonly applied and convenient procedure uses Atalik and Utuk's suggestion to estimate the linearization coefficients in context with Wen's introduction of an analytical expression for the restoring force (e.g. from Bouc for Hysteretic systems). Since the procedure requires the assumption of a normally distributed response of the nonlinear system, it has some (in some cases severe) limitations w.r.t. its use for reliability predictions. Hence attempts have been made to extend this method such that the non-Gaussian properties of the response could be captured. This requires, of course, some prior knowledge on the systems behavior. Furthermore, numerical procedures have been developed by which the method of equivalent linearization can be used within a FE environment.

Monte Carlo simulation (MCS) is the most general approach among all available procedures to analyze dynamical systems. No distinction between linear and nonlinear system is required; the procedure and its accuracy remain the same. In contrast to all analytical procedures, the accuracy of MCS is also independent of the dimensionality of the system, while the accuracy depends only on the sample size and the capabilities of the random number generator to produce statistically independent and equally distributed random numbers. The most severe drawback of the MCS approach is the statistical uncertainty in the tails of the distribution of the structural response. Hence direct MCS cannot be easily utilized for reliability investigations e.g. for nonlinear problems, since the required sample size becomes prohibitively large. In order to reduce the sample size, so called weight controlled simulation techniques, such as Russian Roulette and Splitting, Double and Clump, Phase Space Controlled Simulation, etc. have been adapted to and developed for analyzing dynamical systems. All these procedures have in common, that - based on various selection criteria - the samples are guided to the region of interest, e.g. to the expected failure domain.

A recent benchmark study has shown, that currently EQL and (weight controlled) MCS procedures are the only methods by which (strongly) nonlinear dynamical systems of higher dimension can be analyzed.