RELIABILITY-BASED DESIGN OPTIMIZATION IN RANDOM VIBRATIONS AND AERODYNAMICS

[1]Santosh Patil*, [1]Dimitrios Papadimitriou, [2]Zissimos Mourelatos, [1]John Skarakis, [1]Vishal Naidu
[1]BETA CAE Systems USA Inc., USA
[2]Oakland University, USA

KEYWORDS –
RBDO, Random Vibrations, Aerodynamics, TDRBDO

ABSTRACT –
This presentation is concerned with the application of novel reliability-based design optimization algorithms to design large-scale vibratory systems under random loads, and with the aerodynamic shape optimization of aerodynamic bodies under uncertainties. For the random vibrations part, a mass-related objective function is minimized, constrained by the time-dependent probability of failure being less than a given value. The probability of failure expresses the probability the maximum stress to exceed a user defined threshold. It is computed using joint up-crossing rates. A sparse-grid methodology is incorporated into the total probability theorem, to account for uncertainties in random variables (e.g. stiffness components of structure), and a novel reanalysis method is applied to reduce the computational cost of the structural analysis. The methodology is applied to the reliability-based design optimization of a vehicle frame under stationary loading. In the case of computational fluid dynamics, the optimal shape of an aerodynamic body is sought, considering geometrical and flow-related uncertainties. The robust drag of the aerodynamic shape is minimized under the condition the probability the lift exceeding a specified limit, is greater than a given value. The adjoint approach and a novel saddlepoint approximation method are combined with optimal design of experiments algorithms to efficiently take into account the uncertainties in the computation and minimization of an objective function under reliability constraints.