Oakland University student develops methods for efficient time-dependent reliability-based design optimization of large vibratory systems

The Oakland University and School of Engineering and Computer Science communities are invited to attend Santosh Patil's defense of his Ph.D. dissertation. Seating is limited. RSVP with Katie Loodeen at loodeen@oakland.edu.

Time: **10:00 a.m. – 12:00 p.m.**
Date: **Wednesday, March 27, 2019**
Location: **347 EC**

Time-Dependent Reliability-Based Design Optimization of Large Vibratory Systems

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In FEA, a deterministic design optimization (DDO) problem is usually defined by the minimization of an objective function (e.g. weight), such that the values of certain constraints (e.g. maximum stress), do not exceed a specific limit. To consider variability and/or uncertainty in the structure random parameters and loading, one should apply reliability-based design optimization (RBDO). If the problem is time dependent, as in random vibrations, a time-dependent reliability-based design optimization (TD-RBDO) should be applied where the constraints are expressed in terms of a time-dependent probability of failure. However, TD-RBDO of large vibratory system may be computationally very expensive.

In the first part of this research we present two new methods for efficient time-dependent reliability analysis of large vibratory systems. The first method uses a metamodel of output autocorrelation to drastically reduce the number of system simulations required in state-of-the-art methods for time-dependent reliability analysis of non-linear systems under non-Gaussian loading. The metamodel of output autocorrelation method also reduces the time duration of each simulation which further increases the efficiency. The second method uses a combination of a First-Order, Fourth-Moment (FOFM) method and an Extended Karhunen-Loeve (EKL) expansion for time-dependent reliability analysis of vibratory systems. The computational cost of the proposed FOFM-EKL approach is significantly lower than that of other recently developed methodologies which are based on sampling.

An efficient TD-RBDO methodology has also been developed for large vibratory systems where the total probability theorem is used to address the presence of the system random parameters and a sparse grid quadrature method is used to calculate the integral of the total probability theorem efficiently. The Modified Combined Approximations (MCA) reanalysis method is used to reduce the overall computational cost from repeated evaluations of the system frequency response. All new methodologies are demonstrated using representative large scale practical examples from the automotive industry.