Oakland University student develops fatigue reliability and ALT methods for systems under random vibrations

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

Improved Fatigue Reliability and Accelerated Life Testing Methods for Vibratory Systems under Gaussian and Non-Gaussian Excitation

Committee: Zissimos P. Mourelatos, Ph.D. (Chair), Randy Gu, Ph.D., Lianxiang Yang, Ph.D., Dorin Drignei, Ph.D.

Time: **8:30 – 10:30 a.m.**
Date: **Tuesday, March 6, 2018**
Location: **347 EC**

Fatigue life estimation, reliability and durability are important in acquisition, maintenance and operation of vehicle systems. Fatigue is one of the most important failure modes of mechanical systems. Fatigue life is random because of the stochastic load, the inherent variability of material properties and the uncertainty in the definition of the S-N curve. Degradation of the material properties of a system throughout time may cause unexpected fatigue failures that eventually increase the lifecycle costs due to warranty costs, repairs and loss of market share. In this research, fatigue life prediction methods are developed for linear and non-linear systems excited by Gaussian and non-Gaussian loading. For the latter, the statistics of the output process are calculated considering the effects of skewness and kurtosis. The excitation is first characterized using the first four moments and a correlation structure. Then, the first four moments and the correlation structure of the response process are calculated using Polynomial Chaos Expansion (PCE) and Karhunen-Loeve (KL) expansion. Simulated trajectories from the response stochastic metamodel are rainflow counted to obtain realizations of the fatigue life random variable based on Miner's damage model. Finally, the Saddlepoint Approximation (SPA) method provides the PDF and percentiles of the fatigue life. A new Accelerated Life Testing (ALT) methodology has also been developed using Gaussian or non-Gaussian excitations without assuming the type of life distribution or the relationship between life and stress level is also developed. The accuracy of fatigue life prediction at nominal loading conditions is affected by model uncertainty and material uncertainty. To reduce the test duration, the uncertainty of fatigue life prediction is reduced by performing tests at higher loading levels. The new ALT method minimizes the cost of testing while improving the accuracy of fatigue life prediction.