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TITLE: Combination of Statistical Linearization and Harmonic Balance for non-stationary random vibration analyses.

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Abstract

Non-stationary nonlinear random vibrations involving polynomial kind of stiffness and damping nonlinearities of dynamic systems are investigated. Attention is focused on assessing the performance of two linearization schemes [1] for estimating the system response statistics. The first one relates to traditional Statistical Linearization, in which effective stiffness and effective damping are determined as functions of the response statistics. The second one introduces a prior first step of Harmonic Balancing in deriving response-amplitude dependent equivalent stiffness and damping. Then, the expected values of these parameters are considered, in proceeding to formulate a Statistical Linearization solution approach. In this context the expected values of the equivalent stiffness and damping, which depend on the statistics of the amplitude, are determined as functions of the variance of the system response itself. The solution procedure is completed by integrating in time the Lyapunov equation associated with the derived equivalent linear system.

It is pointed out that the Harmonic Balancing is associated with the assumption of lightly damped nonlinear systems. This limitation, however, must be juxtaposed versus the option of using the pre-Harmonic Balancing for applying Statistical Linearization on hysteretic systems [2, 3] or systems with fractional derivatives [4]. This can be done without resorting to traditional representations, such as the classical Bouc-Wen model, which involve augmentation of the dimension of the requisite equivalent linear system.

The two approaches are compared for a variety of nonlinear systems; a series of germane Monte Carlo studies are used to elucidate salient features of the two approximations.

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