Dynamic response of mechanical systems to impulse process stochastic excitations: Markov approach.

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Abstract

Methods for determination of the response of mechanical dynamic systems to impulse process stochastic excitations are presented. The considered classes of impulse processes are: Poisson process and two renewal processes: an Erlang process and a generalized Erlang process. Stochastic differential and integro-differential equations of motion are introduced. For systems driven by Poisson impulse process the theory of non-diffusive Markov processes is applied. In particular, the generalized Ito's differential rule and its use to obtain the equations for response moments is discussed. The integro-differential Kolmogorov-Feller equation governing the probability density of the response to Poisson impulse process is shown to be derived from the forward integro-differential Chapman-Kolmogorov equation. For systems driven by non-Poisson impulse processes two methods of exact conversion of the original non-Markov problem into a Markov one are covered. The first method is based on the augmentation of the state vector by auxiliary pure jump stochastic processes regarded as extra state variables. The second method is based on the appended Markov chain corresponding to the auxiliary pure jump stochastic process. The derivation of the set of integro-differential equations for response probability density and also an alternative moment equations technique are based on the forward integro-differential Chapman-Kolmogorov equation and on the appended Markov chain.