ON THE DETERMINATION OF THE POWER SPECTRUM OF RANDOMLY EXCITED OSCILLATORS VIA STOCHASTIC AVERAGING: AN ALTERNATIVE PERSPECTIVE

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ABSTRACT

An approximate formula which utilizes the concept of conditional power spectral density (PSD) has often been employed to determine the response PSD of stochastically excited nonlinear systems. Although this expression has been used in numerous applications, its derivation has been so far treated in a rather heuristic, even "unnatural" manner. Indeed, the formula is based on the notion of the conditional PSD, and its mathematical legitimacy has been based on somewhat "arm-waving" arguments. In this paper, a perspective on the legitimacy of this formula is provided by utilizing spectral representations both of the excitation and of the response processes of the nonlinear system. The orthogonality properties of the sinusoidal functions which are involved in the representations are utilized. Furthermore, not only stationarity but ergodicity of the system response is invoked. In this context, the nonlinear response PSD can be construed as a superposition of the PSDs which correspond to equivalent response amplitude dependent linear systems. Next, relying on classical excitation-response PSD relationships for these linear systems leads, readily, to the derivation of the formula for the determination of the PSD of the nonlinear system.

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