Bispectrum and Bicorrelation: a higher order stochastic approach tonon-Gaussian Dynamic WindLoading

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The main objective of this Thesis is to provide a more efficient and faster alternative to classic dynamic analysis. Classically, dynamic analysis is performed by means of Fourier Analysis, in which time series of the loading are analysed, then brought into the frequency domain (by Fourier Transform), applied to the specific structure (characterised by its Transfer Function, which depend on structural parameters only) to get response in the frequency domain, then Inverse Fourier Transform is applied to recover response in time domain.

As it can be clearly understood, this process become very heavy when dealing with (real) structures having many degrees of freedom - because this double transformation has to be done for each degree of freedom to be able to reconstruct the entire structural response (supposing to perform analysis in the Modal Base, which is almost always the case since with nowadays F.E.M. software, recovering the Modal Matrix is no more time spending as it could have been some years ago).

Therefore, specially for the pre-design stage of a project, an alternative method, faster as well as precise, able to compute or characterise structural response is needed. In this context, this Thesis takes its place.

It has been shown and proved in many previous works an alternative dynamic analysis method based on the Background and Resonant responses, under the assumption of stationary Gaussian loading. It is basically based on the decomposition of the response in its two major components, which are by their own computed based on main statistical quantities of the loading (mean value and Power Spectral Density Function or, equally, variance). This way, the previous Double time-frequency transformation is avoided: once loading is known (i.e. measured or simulated), response can be reconstructed by statistical analysis.

However, this decomposition is no more valid when the loading has non-Gaussian distribution. Therefore, the aim of this Thesis is to finally validate an extension of the previous approach to more general cases in which loading is non-Gaussian. Still, the response will be decomposed in its Background and Bi-resonant components in the frequency space, where they will be connected to higher order statistical quantities of the loading.

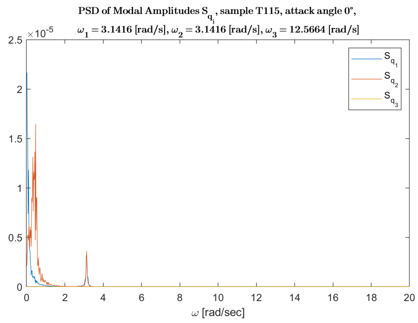

Figure 1: Power Spectral Density Functions.

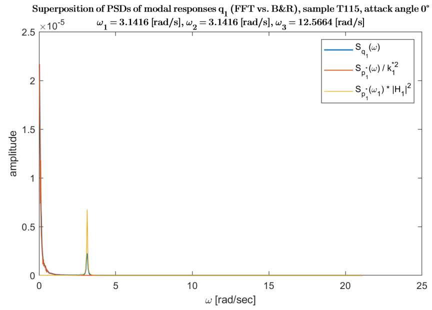

Figure 2: Background and Resonant responses.

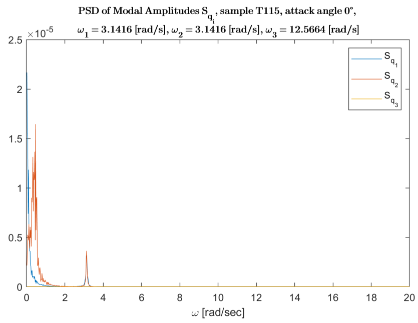

Figure 3: Power Spectral Density Functions.

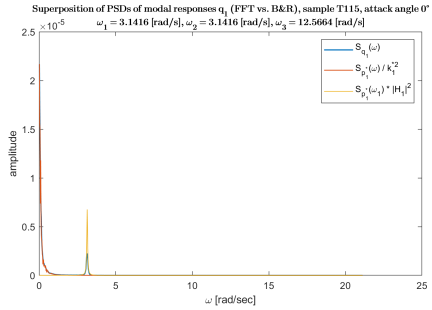

Figure 4: Background and Resonant responses.

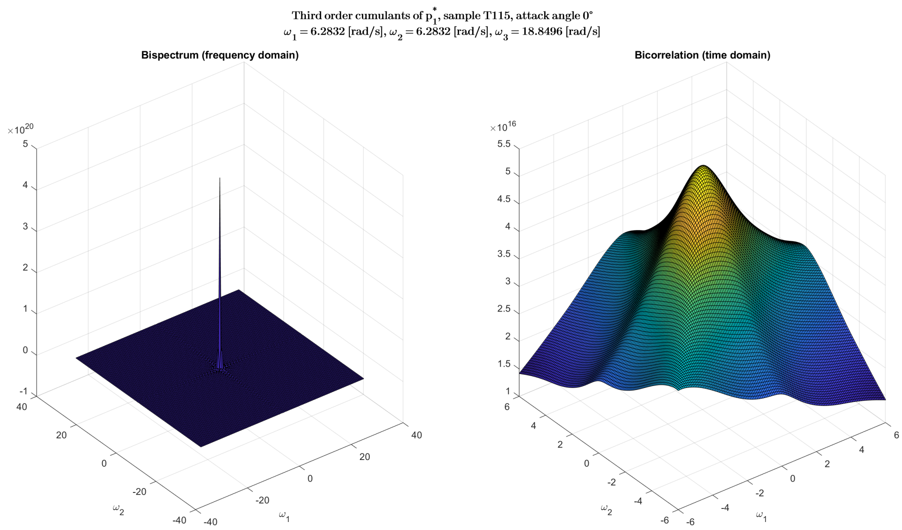

Figure 5: Bispectrum and Bicorrelation.