The numerical determination of Bryan's factor for a non-thin cylindrical shell

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When a vibrating structure is rotated, the vibrating pattern within the structure rotates at a rate proportional to the rate of rotation of the structure. This effect, observed in 1890 by G.H. Bryan [1], is utilised in the vibratory gyroscopes that navigate space shuttles, submarines and commercial jetliners. In a recent articles [2] and [3], expressions were derived for calculating Bryan's factor and vibration frequency in terms of eigenfunctions. These eigenfunctions were analytically derived using Helmholtz potential functions in [2]. In this paper we numerically determine these eigenfunctions for the first few circumferential numbers as well as numerical values for Bryan's factor and the eigenfrequency of vibration of a not necessarily thin cylindrical shell. The numerical routine used here is more robust than "thin shell" theory. Despite this robustness, the routine is easy enough for senior undergraduate students to understand and implement. Analytical solutions to the hyperbolic problems that arise from generalisations of the classical model of vibrating non-thin rods (such as the Midlin-Herrmann model (see [4])) are rare. This routine provides approximate solutions to a number of these models.

References

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