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Fourier Analysis of Lowest Normal-Mode Functions for Beams and Plates: Implication for Graphene W. EUGENE COLLINS, Fisk University, RONALD E. MICKENS, Clark Atlanta University — The mechanical properties of grapheme sheets and tubes can be modeled by a very nonlinear, integral-partial differential equation. For one (effective) space dimension, the solution u(x,t) is generally written as a product of the mode shape, ϕ(x), and a mode amplitude, ϕ(t), i.e., u(x,t)= ϕ(x)ψ(t), where ϕ(x) is taken to be ϕ(x)=sin(πx/L). This ansatz allows the determination of an ordinary differential equation for ψ(t), which turns out to be the Duffing equation. However, the (constant) coefficients appearing in the Duffing equation depend on exactly which specific function is selected for ϕ(x). Since these coefficients are used to calculate various mechanical features, it follows that the use of different ϕ(x) can produce different estimates for the related mechanical properties. We consider the case of a rigidly clamped beam, defined by the conditions

$$\phi(0) = \phi(L) = 0, \phi'(0) = \phi'(L) = 0, \tag{1}$$

and compare its Fourier series representations to the functions

$$\phi 1(x) = \sin(\pi x/L), \phi\_\{^2\}g(x) = x(L - x). \tag{2}$$

An example of a mode function satisfying Eq.(1) is

$$\phi 3(x) = x^2(L - x)^2. \tag{3}$$

Background information on these issues is given in I. Kovavic and M. J. Brennan: The Duffing Equation (Wiley, 2011), sections 2.8 – 2.10.

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