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Nonlinear normal vibration modes and associated problems

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Abstract: Nonlinear normal modes (NNMs) are periodic motions of specific type. In the normal mode a finite- DOF system vibrates like a single-DOF conservative one. The non-localized and localized NNMs, bifurcations of NNMs and global dynamics near NNMs are analyzed in different papers. The Kauderer-Rosenberg concept of NNMs is based on determination of trajectories in configuration space. In general, these trajectories are curvilinear and can be constructed by use of power series. Shaw and Pierre developed alternative concept of NNMs for nonlinear dissipative systems which is based on computation of invariant manifolds in phase space. Generalization of the NNMs concepts to forced, self-exited and parametric vibrations, and to continuous system dynamics is made. NNMs have been used to solve numerous applied problems. In particular, NNMs are applied to analyze free and forced dynamics of rotors, mechanical systems having nonlinear absorbers, elastic systems such as beams, cylindrical shells, arches, shallow shells with complex base et al. Some unexpected kinds of NNMs can be found. Thus, NNMs existing only for finite values of the system amplitude (or energy) and vanishing when the amplitude tends to zero, are determined. NNMs of forced chaotic vibrations exist in elastic systems that have lost stability under external compressive force. In dissipative systems under resonance conditions the transient nonlinear normal modes existing only for some levels of energy, are found. These modes attract other motions near values of time, corresponding to the mentioned energy levels.

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