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Christopher G. Cooley, Robert G. Parker

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Eigenvalue Sensitivity and Veering in Gyroscopic Systems with Application to High-Speed Planetary Gears

Christopher G. Cooley[a,*], Robert G. Parker[b]

[a]*Department of Mechanical Engineering and Energy Processes, Southern Illinois University Carbondale, Carbondale, IL 62901, USA*
[b]*Department of Mechanical Engineering, Virginia Tech, Blacksburg, VA 24061, USA*

Abstract

This study investigates eigenvalue sensitivity to model parameters and veering in gyroscopic systems. The eigenvalue perturbation approach is formulated such that the results apply to discrete, continuous, and hybrid discrete-continuous gyroscopic systems. Third-order perturbation approximations for distinct eigenvalues are determined. Perturbations through second-order are derived for degenerate eigenvalues. The perturbation results are applied to a high-speed planetary gear model, where the results are shown to be accurate over a wide range of rotation speeds. The sensitivity of the eigenvalues to model parameters are written in terms of modal kinetic and potential energies. From the second-order perturbation approximation an eigenvalue veering parameter is defined and used to analyze veering in high-speed planetary gears, which is prominent in planetary gears that have disrupted cyclic symmetry.

Keywords: eigenvalue perturbation, eigenvalue veering, gyroscopic systems, planetary gears

*Corresponding author
Email addresses: chris.cooley@siu.edu (Christopher G. Cooley), r.parker@vt.edu (Robert G. Parker)