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Ain Shams University
Faculty of Engineering

Department of Engineering Physics and Mathematics

LINEAR AND NONLINEAR STABILITY ANALYSIS OF ROTTATING DYNAMICAL SYSTEMS WITH ELASTIC AND DAMPED SUPPORTS

By

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A Thesis

Submitted in partial fulfillment of the requirements for the degree of M. Sc. in Engineering Mathematics

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Cairo, 2002

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ABSTRACT

An inclusive historical background and literature review on the subject of rotor-bearing systems modeling and analysis are presented. The dynamics and stability of a uniform rigid spinning shaft with an appendage mounted on two dissimilar 8-coefficient end bearings possessing nonlinear anisotropic and cross coupling stiffness and damping coefficients are analyzed. Lagrange's equations are used to derive the system governing equations of motion in the form of four coupled nonlinear second order differential equations.

A linear stability analysis via Routh-Hurwitz stability criterion is presented for investigating the effects of various end support parameters on the dynamic stability of the translational and rotational modes of whirling motion of the system. Stability boundaries presented graphically as functions of the various end support nondimensionalized parameters afford a comprehensive demonstration of the effects of these parameters on the whirling stability of the system.

A nonlinear stability analysis of the system via Liapunov's direct method is performed. Based on the developed stability criterion of the considered system, the effect of nonlinearity of bearing stiffness and damping parameters on the asymptotic

stability is deduced. System stability regions in terms of the linearized parameters were also presented graphically.

Through the application of Routh-Hurwitz stability criterion and Liapunov direct method, it has been shown quantitatively that the stability of the system can be increased by (1) decreasing the bearing cross-coupling stiffness and damping parameters, (2) increasing the damping isotropy of the two end supports, and (3) increasing the principal stiffness and damping parameters of the two end supports.

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