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ESTIMATION OF ASYMPTOTIC STABILITY REGION OF NONLINEAR ROTOR-BEARING SYSTEM

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ABSTRACT

This study deals with the asymptotic stability analysis of a rigid rotor rotating in two ideal and identical elastic ball bearings. The characteristics of the elastic properties of ball bearings are studied. The dynamics of the system is governed by two coupled nonlinear ordinary differential equations. This nonlinear elastic property of the bearings causes unique phenomena of the self excited vibration type. The nonlinear equations of motion are solved numerically by the fourth order Rung-Kutta method for different combinations of the nondimensional key parameters. The response of the system shows the presence of ' beat '.
As a first approach the stability of the stationary regime is considered. The stability region of the subject stationary regime is obtained in terms of the nondimensional key parameters: Degree of nonlinearity of the elastic bearings, the centrifugal force field intensity and the damping coefficient. The Routh-Hurwitz stability criterion is used to determine the stability zones of the linearized system.

1. INTRODUCTION

Estimation of asymptotic stability regions for nonlinear dynamic systems is one of the most challenging problems in engineering . For the determination of the stability region several methods have been developed for the past few decades [1]. The present day rotating machinery requires uninterrupted service life and economy, for which rolling bearings are now common. However, the three moving elements of the ball bearing namely, the balls, inner race and retainer produce a complex nature of vibration to the entire system leading, in most cases, to instability. A proper analysis of such a system thus becomes necessary in order to determine the instability criterion and the zones, for effective control of vibrations primarily caused by the ball bearings.
With the tendency towards high speed and high pressure in turbo machinery, such as compressors, turbines, etc,the problem of