The problem of eigen value and the mode of aircraft rotating element motion.

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For the dynamic analysis of spatial elements of machine-building constructions, new approaches are needed which will take into account such peculiarities of their behavior as the high angular speed of rotation and the significant initial stress caused by temperature gradients, centrifugal loads and element interfacing. The linearized equations of motion were derived by applying the variation principle. The developed equations describe the influence of the pre-stress state on the dynamic characteristics of elastic systems. The use of three-dimensional relationships essentially improves the accuracy of the results obtained by the theory of plates. Besides, the proposed approach allows us to determine vibration eigen modes corresponding to the disk motion in the in-plane direction. Numerical results demonstrate that the pre-stress state has a strong effect on the natural vibration frequencies of the system. For real angular speed of rotation, the centrifugal effects lead to an increase (by a factor of 1.5-2) in natural vibration frequencies compared to the steady-state frequency. More complex effects are observed when taking into account the non-uniform temperature field, though its effect on eigenfrequencies is of less significance.

This study presents an algorithm based on the finite element method for the numerical solution of the problem on free and forced vibrations of rotating dynamically symmetric bodies. To obtain all the information on «the dynamic passport of a system», in addition to the problem on free and forced vibrations of rotating elastic bodies it is necessary to consider the non-conservative elastic stability problem. Judging from the character of the found eigen values, the conclusion can be drawn regarding the stability of the system, for instance in the framework of Lyapunov's theorems on stability in a first approximation. It is proposed to seek the eigen modes of the non-conservative problem in the form of an expansion in eigen modes of the conservative problem, which reduces the dimensionality of matrices and allows us to solve the complex eigen value problem using the developed and verified schemes. The amplitude-frequency characteristics of the non-conservative system are constructed for different values of the angular velocity parameter referred to stable and unstable modes.