NASA TECH BRIEF
Lewis Research Center

Computer Program for Flexible Rotor Dynamics Analysis

A digital computer program has been developed to analyze the general nonaxisymmetric and nonsynchronous transient and steady-state rotor dynamic performance of a bending- and shear-wise flexible rotor-bearing system under various operating conditions.

The computer program can serve as a useful tool in predicting the dynamic performance of a rotor-bearing system under various operating conditions. The drive and dissipation torque effects on an accelerating or decelerating rotor can be analyzed with this program. In addition, the causes and effects of non-synchronous whirl rotor motion may also be studied by applying appropriate out-of-phase stiffness and positive or negative damping excitations. The program can be used as an analytical study tool for a general transient spin-speed and/or non-axisymmetric rotor motion.

The computer program simulates many important dynamic properties of a real rotor-bearing system. Included in the program are the effects of:

1. Rotor slope coordinates.
2. Rotor material mechanical hysteresis in transverse shear and in bending and torsional shear using viscous and/or Coulomb friction hysteresis coefficients.
3. Rotor torsional flexibility.
4. Rotor transverse effects due to torsional and axial loading.
5. Bearing in-phase and out-of-phase anisotropic stiffness and damping force and moment coefficients.
6. Bearing mass.
7. Bearing transverse mass moment of inertia.
8. Mounting in-phase anisotropic stiffness and damping moment coefficients.

Input and output can be in either U.S. customary or SI (metric) units.

The computer program is written to simulate a continuous rotor mass distribution by a discrete-mass rotor model with an appropriate massless elastic shaft. The minimum number of discrete masses used should be such that the desired rotor dynamic mode shape can be sustained. In general, to obtain good accuracy, several times the minimum number of mass requirements are used. Since rotor motion is influenced by mass eccentricity and the damping and stiffness of bearings and supports, the mode shape in a critical speed range may be substantially modified from that of a pure critical speed mode shape. Judgment must be exercised in selecting the number of discrete masses to adequately represent a rotor configuration.

The rotor to be studied is first divided into consecutively numbered stations. The total number of stations may vary from 3 to 15, inclusively; this number may be increased, if necessary, by altering the program's DIMENSION statements.

A namelist input procedure is used as the basic input format due to its flexibility in selecting input parameters and the liberal use of built-in input data when appropriate. For preliminary analysis, by making use of built-in data, the input data volume, particularly for a large number of rotor stations, can be drastically reduced.

The program output is in the form of printed output and graphic (CRT) plots.

The printed output includes the following:

1. Input Data Write-Out.
2. Input Rotor Mass Data. Includes rotor local masses, transverse and polar mass moments of inertia, total rotor mass and polar mass moment of inertia, and location of the rotor mass center.
3. Rotor Dynamic Startup Configuration. Includes deflections and loads for all rotor and bearing components.
4. Computation Results Write-Out. The printout time interval can be approximately specified by the product of the values DP and IPRINT in seconds.
5. Graphic (CRT) Output. A total of eight types of CRT graphs are provided where each presents a pictorial summary of certain rotor dynamic performance in supplementing the printed output.

Notes:

1. This program is written in FORTRAN IV for use on an IBM 360/370.
2. Inquiries concerning the program should be directed to:

(continued overleaf)

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under contract to
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(LEW-12153)