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NASA TECH BRIEF

Ames Research Center

Prediction of Ducted Fan Performance

The problem:

To determine the performance of a ducted fan in terms of axial flow and angle of attack by making improvements and adding to an existing program.

The solution:

A computer program was developed to determine the performance of a ducted fan in axial flow and at a specified angle of attack. Improvements to an already existing program consist of adding a capability for angle of attack flow, computing duct surface pressure distributions, adding a centerbody model, and removing certain restrictions on advance ratio and nonlinear blade lift characteristics.

How it's done:

The program is used to predict the performance at a specified advance ratio and angle of attack of a given fan-duct combination, which is specified by the radial distributions of blade pitch, chord, and thickness; the duct chord, diameter, camber, and thickness distribution; the fan location; and the centerbody geometry.

The information obtained from the program includes duct and fan thrust, ducted fan normal force, pitching moment coefficient, radial distributions of fan inflow velocity, and blade angle of attack. The duct surface pressure distribution at any specified azimuthal angle is also calculated.

The computation proceeds as follows. An initial knowledge of the fan inflow velocity profile is required in order to compute blade performance, from which all other computations are made. Since the inflow is affected by the, as yet undetermined, duct-bound vorticity, an iterative procedure is used. An initial uniform inflow of 2V is assumed, and the blade element calculations are made to determine the fan performance and wake characteristics. The flow tangency condition on the duct reference cylinder is then applied to determine the duct-bound vorticity distribution. With all the singularity distributions known, the fan inflow is calculated. This is compared with the initially assumed inflow. If the two do not agree, a new inflow equal to the average between the initial and computer inflow is determined. The fan and duct-bound vorticity calculations are repeated to obtain a new inflow. The process continues until the inflow velocity in each annulus has converged to within the desired value. When convergence is obtained for all annuli, the program continues to calculate the force and moment coefficients and duct surface pressure coefficients, if desired.

Notes:

1. This program is written in FORTRAN IV to be utilized on the IBM-7094 computer.
2. Inquiries concerning this program should be directed to:

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