Design Of An Axial Turbine And Thermodynamic Analysis And

Addressing the optimization and design of an axial flow turbine, this volume details a method for selecting the best turbine design, taking into account a range of parameters including size, stress, and number of stages. Topics covered include basic turbine design, stage calculations, thermodynamics and blade shapes, and a design example.
The NASA Technical Reports Server (NTRS) houses half a million publications that are a valuable means of information to researchers, teachers, students, and the general public. These documents are all aerospace related with much scientific and technical information created or funded by NASA. Some types of documents include conference papers, research reports, meeting papers, journal articles and more. This is one of those documents.
Turbine Design and Application
Optimum Design Criteria for an Axial Gas Turbine
Technical Report
A Study on the Design of Axial-flow Gas Turbine Blades
An Enhanced Computational Program for Axial Turbine Design
In this paper, preliminary studies on two turbine engine applications relevant to the tilt-rotor rotary wing aircraft are performed. The first case-study is the application of variable pitch turbine for the turbine performance improvement when operating at a substantially lower shaft speed. The calculations are made on the 75 percent speed and the 50 percent speed of operations. Our results indicate that with the use of the variable pitch turbines, a nominal (3 percent (probable) to 5 percent (hypothetical)) efficiency improvement at the 75 percent speed, and a notable (6 percent (probable) to 12 percent (hypothetical)) efficiency improvement at the 50 percent speed, without sacrificing the turbine power productions, are achievable if the technical difficulty of turning the turbine vanes and blades can be circumvented. The second casestudy is the contingency turbine power generation for the tilt-rotor aircraft in the One Engine Inoperative (OEI) scenario. For this study, calculations are performed on two promising methods: throttle push and steam injection. By isolating the power turbine and limiting its air mass flow rate to be no more than the air flow intake of the take-off operation, while increasing the turbine inlet total temperature (simulating the throttle push) or increasing the air-steam mixture flow rate (simulating the steam injection condition), our results show that an amount of 30 to 45 percent extra power, to the nominal take-off power, can be generated by either of the two methods. The methods of approach, the results, and discussions of these studies are presented in this paper. Chen, Shu-cheng, S. Glenn Research Center NASA/TM-2009-215651/PART2, E-16964-2 AXIAL FLOW TURBINES; RELIABILITY ANALYSIS; ROTARY WING AIRCRAFT; TURBINE ENGINES; DESIGN ANALYSIS; MASS FLOW RATE; TILT ROTOR AIRCRAFT; FLOW VELOCITY; SIMULATION; SHAFTS (MACHINE ELEMENTS); AIR MASSES; VANES
Turbine AerodynamicsAxial-flow and Radial-inflow Turbine Design and AnalysisAmer Society of Mechanical
design of turbine compressor
Design of an Axial-flow Air Compressor for a Gas Turbine Plant
The Aerodynamic Design of a Compressor-drive Turbine for Use in a 75 Kw Automotive Engine
Flow Analysis and Aerodynamics Design
A Guide to Axial-Flow Turbine Off-Design Computer Program Axod2

A Users Guide for the axial flow turbine off-design computer program AXOD2 is composed in this paper. This Users Guide is supplementary to the original Users Manual of AXOD. Three notable contributions of AXOD2 to its predecessor AXOD, both in the context of the Guide or in the functionality of the code, are described and discussed in length. These are: 1) a rational representation of the mathematical principles applied, with concise descriptions of the formulas implemented in the actual coding. Their physical implications are addressed; 2) the creation and documentation of an Addendum Listing of input namelist-parameters unique to AXOD2, that differ from or are in addition to the original input-namelists given in the Manual of AXOD. Their usages are discussed; and 3) the institution of proper stoppages of the code execution, encoding termination messaging and error messages of the execution to AXOD2. These measures are to safe-guard the integrity of the code execution, such that a failure mode encountered during a case-study would not plunge the code execution into indefinite loop, or cause a blow-out of the program execution. Details on these are discussed and illustrated in this paper. Moreover, this computer program has since been reconstructed substantially. Standard FORTRAN Langue was instituted, and the code was formatted in Double Precision (REAL*8). As the result, the code is now suited for use in a local Desktop Computer Environment, is perfectly portable to any Operating System, and can be executed by any FORTRAN compiler equivalent to a FORTRAN 9095 compiler. AXOD2 will be available through NASA Glenn Research Center (GRC) Software Repository. Chen, Shu-Cheng S. Glenn Research Center NASA/TM-2014-218301, E-18884, GRC-E-DAA-TN12340
The second edition of a comprehensive textbook that introduces turbomachinery and gas turbines through design methods and examples. This comprehensive textbook is unique in its design-focused approach to turbomachinery and gas turbines. It offers students and practicing engineers methods for configuring these machines to perform with the highest possible efficiency. Examples and problems are based on the actual design of turbomachinery and turbines. After an introductory chapter that outlines the goals of the book and provides definitions of terms and parts, the book offers a brief review of the basic principles of thermodynamics and efficiency definitions. The rest of the book is devoted to the analysis and design of real turbomachinery configurations and gas turbines, based on a consistent application of thermodynamic theory and a more empirical treatment of fluid dynamics that relies on the extensive use of design charts. Topics include turbine power cycles, diffusion and diffusers, the analysis and design of three-dimensional free-stream flow, and combustion systems and combustion calculations. The second edition updates every chapter, adding material on subjects that include flow correlations, energy transfer in turbomachines, and three-dimensional design. A solutions manual is available for instructors. This new MIT Press edition makes a popular text available again, with corrections and some updates, to a wide audience of students, professors, and professionals.
Axial-flow Compressors
Axial Turbine Aerodynamics for Aero-engines
Analytical Procedure and Computer Program for Determining the Off-design Performance of Axial Flow Turbines

Aircraft Engines and Gas Turbines
A novel humidification dehumidification desalination system was developed at the Rohseneow Kendall Heat Transfer Laboratory. The HDH system runs by having different pressures in the humidifier and dehumidifier. One of the components that will keep the different pressures is an expander. The expander specification is to work with a pressure ratio of 1.2 while having a high efficiency. Two approaches were developed to achieve this result, one was through the design of a turbine and the second was through the selection and testing of a car turbocharger. The design of a turbine is given in detail and follows the process given in "Design of High- Efficiency Turbomachinery and Gas Turbines" by David Wilson. The final design of the turbine blades was sand cast. Due to the sand casting process, cavitation on the blade material was shown and testing of the blades was not pursued for fear of fast fracturing. The second option of selecting a turbocharger is shown and the process which led to its selection is explained. Through such process a K03 turbocharger was selected to be suitable to run at the low pressure ratios with a moderate efficiency. Testing of the K03 was conducted. The static-to-static isentropic efficiency calculated was 53% ± 11% for a pressure ratio of 1.2 while the total-to-total isentropic efficiency 60% ± 14% at a pressure ratio of 1.2. The high error associated with the efficiencies are due to the turbine experiencing small temperature drops in the order of 10°C or less. The K03 turbocharger is meant to run at higher pressure ratios, in the order of 2 with a manufacturer specified efficiency of 70%. Running the K03 at a pressure ratio of 1.2 decreases the efficiency since its not specified to run at those low pressure ratios. If a turbine or a turbocharger is designed for the exact specifications of the desalination syster it can work with low pressure ratios and be highly efficient.
"This report describes a systematic computational design system for two dimensional turbine cascades, including a sequence of calculations in which airfoil profiles are designed from velocity diagram requirements and specified geometric parameters, followed by an inviscid blade-to-blade flow calculation, a transitional boundary layer and wake mixing analysis."--Summary, page ix.
A guide to axial-flow turbine off-design computer program AXOD2
Turbine Aerodynamics
Research and Development of High Performance Axial Flow Turbomachinery
Computer Program for Preliminary Design Analysis of Axial-flow Turbines
Preliminary Axial Flow Turbine Design and Off-Design Performance Analysis Methods for Rotary Wing Aircraft Engines

In this paper, preliminary studies on two turbine engine applications relevant to the tilt-rotor rotary wing aircraft are performed. The first case-study is the application of variable pitch turbine for the turbine performance improvement when operating at a substantially lower shaft speed. The calculations are made on the 75 percent speed and the 50 percent speed of operations. Our results indicate that with the use of the variable pitch turbines, a nominal (3 percent (probable) to 5 percent (hypothetical)) efficiency improvement at the 75 percent speed, and a notable (6 percent (probable) to 12 percent (hypothetical)) efficiency improvement at the 50 percent speed, without sacrificing the turbine power productions, are achievable if the technical difficulty of turning the turbine vanes and blades can be circumvented. The second casestudy is the contingency turbine power generation for the tilt-rotor aircraft in the One Engine Inoperative (OEI) scenario. For this study, calculations are performed on two promising methods: throttle push and steam injection. By isolating the power turbine and limiting its air mass flow rate to be no more than the air flow intake of the take-off operation, while increasing the turbine inlet total temperature (simulating the throttle push) or increasing the air-steam mixture flow rate (simulating the steam injection condition), our results show that an amount of 30 to 45 percent extra power, to the nominal take-off power, can be generated by either of the two methods. The methods of approach, the results, and discussions of these studies are presented in this paper. Chen, Shu-cheng, S. Glenn Research Center
An axial-flow turbine off-design performance computer code used for preliminary studies of gas turbine systems was modified and calibrated based on the experimental performance of large aircraft-type turbines. The flow- and loss-model modifications and calibrations are presented in this report. Comparisons are made between computed performances and experimental data for seven turbines over wide ranges of speed and pressure ratio. This report also serves as the users manual for the revised code, which is named AXOD. Glassman, Arthur J. Unspecified Center NAG3-1165; RTOP 505-69-50...
Analysis of Geometry and Design Point Performance of Axial Flow Turbines. Part 2 - Computer Program
Aerodynamic Design & Performance Predictions of a Single Stage Axial-flow Turbine
Aerodynamic Design of Axial Turbine
Preliminary Design of a Free Vortex Axial Flow Turbine
Users Manual and Modeling Improvements for Axial Turbine Design and Performance Computer Code TD2-2
This book provides a thorough description of actual, working aerodynamic design and analysis systems, for both axial-flow and radial-flow turbines. It describes the basic fluid dynamic and thermodynamic principles, empirical models and numerical methods used for the full range of procedures and analytical tools that an engineer needs for virtually any type of aerodynamic design or analysis activity for both types of turbine. The book includes sufficient detail for readers to implement all or part of the systems. The author provides practical and effective design strategies for applying both turbine types, which are illustrated by design examples. Comparisons with experimental results are included to demonstrate the prediction accuracy to be expected. This book is intended for practicing engineers concerned with the design and development of turbines and related machinery.
This book provides a thorough description of an aerodynamic design and analysis systems for Axial-Flow Compressors. It describes the basic fluid dynamic and thermodynamic principles, empirical models and numerical methods used for the full range of procedures and analytical tools that an engineer needs for virtually any tupe of Axial-Flow Compressor, aerodynamic design or analysis activity. It reviews and evaluates several design strategies that have been recommended in the literature or which have been found to be effective. It gives a complete description of an actual working system, such that readers can implement all or part of the system. Engineers responsible for developing, maintaining of improving design and analysis systems can benefit greatly from this type of reference. The technology has become so complex and the role of computers so pervasive that about the only way this can be done today is to concentrate on a specific design and analysis system. The author provides practical methodology as well as the details needed to implement the suggested procedures.
Design of an Axial Turbine and Thermodynamic Analysis and Testing of a K03 Turbocharger
Axial-flow and Radial-inflow Turbine Design and Analysis
Performance Evaluation of a Two-stage Axial-flow Turbine for Two Values of Tip Clearance
Axial-flow Turbine Cascade Design Procedure and Sample Design Cases
A Guide to Axial-Flow Turbine Off-Design Computer Program AXOD2
Mechanical Engineering Design and Analysis of Axlal and Radial Turbines.
Aircraft Engines and Gas Turbines is widely used as a text in the United States and abroad, and has also become a standard reference for professionals in the aircraft engine industry. Unique in treating the engine as a complete system at increasing levels of sophistication, it covers all types of modern aircraft turbojets, turbofans, and turboprops, and also discusses hypersonic propulsion systems of the future. Performance is described in terms of the fluid dynamic and thermodynamic limits on the behavior of the principal components: inlets, compressors, combustors, turbines, and nozzles. Environmental factors su pollution and noise are treated along with performance.This new edition has been substantially revised to include more complete and up-to-date coverage of compressors, turbines, and combustion systems, and to introduce current research directions. The discussion of high-bypass turbofans has been expan their great commercial importance. Propulsion for civil supersonic transports is taken up in the current context. The chapter on hypersonic air breathing engines has been expanded to reflect interest in the use of scramjets to power the National Aerospace Plane. The discussion of exhaust emissions and noise regulatory structures have been updated and there are many corrections and clarifications.Jack L. Kerrebrock is Richard Cockburn Maclaurin Professor of Aeronautic's and Astronautics at the Massachusetts Institute of Technology.
Turbine Design
Design and Evaluation of a Single Stage Axial Flow Turbine Rotor for a Micro Turbojet Engine
Analysis of Geometry and Design-point Performance of Axial-flow Turbines Using Specified Meridional Velocity Gradients
A Strategy for Aerodynamic Design and Analysis
Users Manual and Modeling Improvements for Axial Turbine Design and Performance Computer Code Td2-2

Computer code TD2 computes design point velocity diagrams and performance for multistage, multishaft, cooled or uncooled, axial flow turbines. This streamline analysis code was recently modified to upgrade modeling related to turbine cooling and to the internal loss correlation. These modifications are presented in this report along with descriptions of the code's expanded input and output. This report serves as the users manual for the upgraded code, which is named TD2-2. Glassman, Arthur J. Unspecified Center NAG3-1165; RTOP 505-69-50...
The program method is based on a mean-diameter flow analysis. Input design requirements include power or pressure ratio, flow, temperature, pressure, and speed. Turbine designs are generated for any specified number of stages and for any of three types of velocity diagrams (symmetrical, zero exit swirl, or impulse). Exit turning vanes can be included in the design. Program output includes inlet and exit annulus dimensions, exit temperature and pressure, total and static efficiencies, blading angles, and last-stage critical velocity ratios. The report presents the analysis method, a description of input and output with sample cases, and the program listing.
Aerodynamic Design of Axial-flow Compressors
Radial, Mixed and Axial Gas Turbine Design and Performance, Wilder, Vermont, 22.8.-26.8.1988
Preliminary Axial Flow Turbine Design and Off-Design Performance Analysis Methods for Rotary Wing Aircraft Engines. Part 2; Applications
The Effect on Axial Flow Turbine Performance of Parameter Variation
The Design of High-Efficiency Turbomachinery and Gas Turbines, second edition, with a new preface
A Users Guide for the axial flow turbine off-design computer program AXOD2 is composed in this paper. This Users Guide is supplementary to the original Users Manual of AXOD. Three notable contributions of AXOD2 to its predecessor AXOD, both in the context of the Guide or in the functionality of the code, are described and discussed in length. These are: 1) a rational representation of the mathematical principles applied, with concise descriptions of the formulas implemented in the actual coding. Their physical implications are addressed; 2) the creation and documentation of an Addendum Listing of input namelist-parameters unique to AXOD2, that differ from or are in addition to the original input-namelists given in the Manual of AXOD. Their usages are discussed; and 3) the institution of proper stoppages of the code execution, encoding termination messaging and error messages of the execution to AXOD2. These measures are to safe-guard the integrity of the code execution, such that a failure mode encountered during a case-study would not plunge the code execution into indefinite loop, or cause a blow-out of the program execution. Details on these are discussed and illustrated in this paper. Moreover, this computer program has since been reconstructed substantially. Standard FORTRAN Langue was instituted, and the code was formatted in Double Precision (REAL*8). As the result, the code is now suited for use in a local Desktop Computer Environment, is perfectly portable to any Operating System, and can be executed by any FORTRAN compiler equivalent to a FORTRAN 9095 compiler. AXOD2 will be available through NASA Glenn Research Center (GRC) Software Repository. Chen, Shu-Cheng S. Glenn Research Center NASA/TM-2014-218301, E-18884, GRC-E-DAA-TN12340 WBS 794072.02.03.05.04 AXIAL FLOW TURBINES; GAS TURBINE ENGINES; USER MANUALS (COMPUTER PROGRAMS); COMPUTER PROGRAMS; FORTRAN; MANUALS; FAILURE MODES
This book is a monograph on aerodynamics of aero-engine gas turbines focusing on the new progresses on flow mechanism and design methods in the recent 20 years. Starting with basic principles in aerodynamics and thermodynamics, this book systematically expounds the recent research on mechanisms of flows in axial gas turbines, including high pressure and low pressure turbines, inter-turbine ducts and turbine rear frame ducts, and introduces the classical and innovative numerical evaluation methods in different dimensions. This book also summarizes the latest research achievements in the field of gas turbine aerodynamic design and flow control, and the multidisciplinary conjugate problems involved with gas turbines. This book should be helpful for scientific and technical staffs, college teachers, graduate students, and senior college students, who are involved in research and design of gas turbines.
Modeling Improvements and Users Manual for Axial-Flow Turbine Off-Design Computer Code Axod
Axial and Radial Turbines
Modeling Improvements and Users Manual for Axial-flow Turbine Off-design Computer Code AXOD
Axial turbine design optimization through aerodynamic performance/mechanical stress trade-off