

$$C_{D,0} = C_{fx} \frac{S_{wet}}{S_{ref}} \quad (1)$$

Where C_{fx} is the equivalent skin friction drag coefficient, S_{wet} is the total wetted area, and S_{ref} is the planform area of the wing. The values of these parameters for F-16 fighter aircraft are obtained from various resources as $C_{fx} = 0.0035$ [2], $S_{wet} = 1542.2 \text{ ft}^2$ [2], and $S_{ref} = 300 \text{ ft}^2$ [4]. The resulting $C_{D,0}$ from these parameters is:

$$C_{D,0} = 0.018 \quad (2)$$

As for the lift-induced drag, it is calculated as [1]:

$$C_{D,i} = KC_L^2 \quad (3)$$

$$K = k_1 + k_2 + k_3 \quad (4)$$

Where k_3 is estimated from Oswald Span Efficiency Method [3]:

$$k_3 = \frac{1}{\pi e AR} \quad (5)$$

$$e = 4.61(1 - 0.045 AR^{0.60})(\cos \Lambda_{LE})^{0.15} - 3.1(6)$$

The value of k_1 is calculated as $k_1 = \frac{R_1}{3}$ [1], and the wave drag is ignored in our calculations which makes $k_2 = 0$ [1]. With these calculations, the value of K comes out to be 0.1489.

The NACA 64A204 airfoil was chosen for the F-16 design [1]. The lift-coefficient at zero angle of attack ($C_{L,0}$) and lift-curve slope ($C_{L,\alpha}$) were taken 0.2 and 5.73 per radian respectively [8]. The data collected was then analyzed to determine the aircraft's behavior under straight and level flight conditions.

B. Analytical Calculations (MATLAB)

MATLAB, a high-level numerical computing software, was used to perform analytical calculations of the performance parameters. The MATLAB environment was chosen due to its versatility and powerful mathematical processing capabilities. The analytical calculations were performed using mathematical models and equations using [1] that took into consideration the impact of factors such as altitude, weight, and other relevant variables on the aircraft's performance. However, the basic calculations are carried out at cruise conditions with maximum takeoff weight for the F-16 fighter aircraft. The results of the data collection process formed the basis for the analytical calculations performed to evaluate the aircraft's key performance parameters, such as zero-lift and lift-induced drags, lift-to-drag ratio, thrust-to-weight ratio, thrust required, service ceiling, absolute ceiling, minimum time to climb, rate of climb, maximum climb angle, and glide performance.

C. Software Validation (OpenVSP)

In this research paper, low-fidelity simulation software OpenVSP was utilized to perform a software analysis of the performance parameters of the F-16 fighter aircraft. OpenVSP is an open-source parametric aircraft design and analysis software, and its low-fidelity nature made it suitable for this study. The geometry of the aircraft was

analyzed using VSPAero tool, a potential flow solver developed by NASA Ames. A low-fidelity 3D model was made according to the best knowledge acquired, and the results of the software analysis were compared with those obtained from analytical calculations to validate the accuracy of the results and provide a more comprehensive understanding of the aircraft's behavior in straight and level flight. The four view and one isometric view of the 3D model is shown below:



Fig. 2. Four-view of the VSPAero 3D model for the F-16

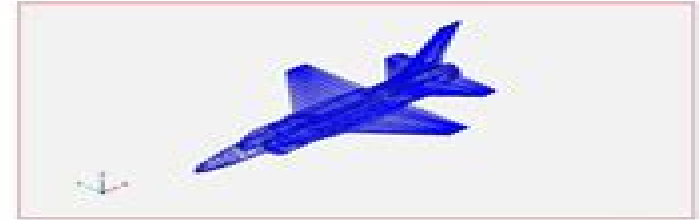


Fig. 3. Isometric view of the VSPAero 3D model for the F-16

III. ASSUMPTIONS

Several assumptions were made in order to perform the analysis of the F-16 fighter aircraft's performance parameters. These assumptions were based on the best available knowledge and experience, and they aimed to simplify the analysis while still providing accurate results. Some of the most significant assumptions are listed below:

- A steady and non-accelerating flight of the aircraft.
- A straight and level flight except in case of climbing and gliding flight.
- Aircraft flying at cruise conditions of 846 feet per second velocity [9] and 30000 feet altitude [7].
- The weight of aircraft remains constant during flight and is considered to be maximum takeoff weight [4].
- The thrust available from the engine remains constant with velocity.
- The occurrence of drag divergence at sonic speed was not taken into consideration which makes $k_2 = 0$ in (4).
- The climb angle is very small in climbing flight [1].

Aircraft Performance And Aerodynamic Control Solution Manual

DP Hallahan



Aircraft Performance And Aerodynamic Control Solution Manual:

Catalogue for the Academic Year Naval Postgraduate School (U.S.),1955 *Scientific and Technical Aerospace Reports*,1971 **STAR** ,1973 **Principles of Helicopter Aerodynamics with CD Extra** Gordon J. Leishman,2006-04-24 Written by an internationally recognized teacher and researcher this book provides a thorough modern treatment of the aerodynamic principles of helicopters and other rotating wing vertical lift aircraft such as tilt rotors and autogiros The text begins with a unique technical history of helicopter flight and then covers basic methods of rotor aerodynamic analysis and related issues associated with the performance of the helicopter and its aerodynamic design It goes on to cover more advanced topics in helicopter aerodynamics including airfoil flows unsteady aerodynamics dynamic stall and rotor wakes and rotor airframe aerodynamic interactions with final chapters on autogiros and advanced methods of helicopter aerodynamic analysis Extensively illustrated throughout each chapter includes a set of homework problems Advanced undergraduate and graduate students practising engineers and researchers will welcome this thoroughly revised and updated text on rotating wing aerodynamics **AIAA Journal** American Institute of Aeronautics and Astronautics,2007 *Aircraft Accident Report* ,1972 **Applied Mechanics Reviews** ,1995 *Journal of Guidance, Control, and Dynamics* ,2007 *Hearings, Reports and Prints of the Senate Select Committee on Small Business* United States. Congress. Senate. Select Committee on Small Business,1975 **Journal of Thermophysics and Heat Transfer** ,2007 This journal is devoted to the advancement of the science and technology of thermophysics and heat transfer through the dissemination of original research papers disclosing new technical knowledge and exploratory developments and applications based on new knowledge It publishes papers that deal with the properties and mechanisms involved in thermal energy transfer and storage in gases liquids and solids or combinations thereof These studies include conductive convective and radiative modes alone or in combination and the effects of the environment

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