

# SELECTED TOPICS In Aerospace Engineering

EDITOR

ERWIN SULAEMAN



IIUM Press

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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*AIRCRAFT RIGID-BODY EQUATION OF  
MOTIONS*

*A non linear model*

**8.1. Introduction**

**A**n understanding of the dynamic characteristics of an aircraft is important in assessing its handling or flying qualities and for designing autopilot system as well. In this chapter the relationship of the aircraft motion to aerodynamics characteristics and pilot command will be explained in the non linear differential equations. Before developing the aircraft equation of motion, reviewing the aircraft axis, the rigid-body equation, the orientation and position system will be specified earlier.

**8.2. Definition of Axes and Angles**

The aerodynamic forces and moments on an aircraft are produced by the relative motion with respect to the air and depend on the orientation of the aircraft with respect to the airflow. In a uniform airflow these forces and moments are unchanged after a rotation around the free-stream velocity vector. Therefore, only two orientation angles (with respect to the relative wind) are needed to specify the aerodynamic forces and moments. The angles that are used are the angle of attack ( $\alpha$ ) and the sideslip angle ( $\beta$ ).

Figure 14.2 shows an aircraft with the relative wind on its right side, with three right-handed coordinate systems (forward, starboard, and down) with a common origin at the aircraft center of mass  $cm$ , and with aerodynamic angles  $\alpha$  and  $\beta$ . The body-fixed