SELECTED TOPICS In Aerospace Engineering

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IIUM Press

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

ISBN: 978-967-418-145-1

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed by :
IIUM PRINTING SDN.BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan
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A linear model

10.1. Introduction

This chapter presents a development of linear model for aircraft based on first-principle approach. The linearization is based on the small disturbance theory by retaining only linier terms of the Taylor series expansion form of all variables in the aircraft of motion. The small disturbance theory will be reviewed earlier, and then continued by expression of the Taylor series in term of the perturbation variables.

10.2. The Small-Disturbance Theory

The equations of motion obtained previously are frequently linearized for use in stability and control analysis. It is assumed that the motion of the airplane consists of small deviations from a reference condition of steady flight. The use of small disturbance theory predicts with satisfactory precision the stability of unaccelerated flight, and can be used for response calculations where the disturbances are not infinitesimal. However, the theory is not suitable for solutions of problems in which large disturbances occur, for example, $\Phi = \pi/2$.

All variables in the equations (9.59) and (9.60) are replaced by a reference value plus a disturbance:

$$\begin{array}{lll} X = X_0 + \Delta X & Y = Y_0 + \Delta Y & Z = Z_0 + \Delta Z \\ M = M_0 + \Delta M & N = N_0 + \Delta N & L = L_0 + \Delta L \\ \theta = \theta_0 + \Delta\theta & \phi = \phi_0 + \Delta\phi & \\ u = u_0 + \Delta u & v = v_0 + \Delta v & w = w_0 + \Delta w \\ p = p_0 + \Delta p & q = q_0 + \Delta q & r = r_0 + \Delta r \end{array} \qquad (10.1)$$