Assignments

Modeling Flight Dynamics with Tensors

Lecture 11

Problem 1 Pitching Moment Taylor Series Expansion

Slide 6 gives the compact form of the aerodynamic Taylor series development $y_i = d_i(z_j)$ with $y_i = \{X, Y, Z, L, M, N\}; i = 1,2,...,6$ and $z_j = \{u, v, w, p, q, r, \dot{u}, \dot{v}, \dot{w}, \delta p, \delta q, \delta r\}$, $j = 1,2,...,12$.

Expand the aerodynamic pitching moment *M* up to second order of the Taylor series and present it in matrix form.

Problem 2 Replacing Tabular Dependency by Polynomial

Slide 4 depicts the aerodynamic model for the F16. The pitching moment is expanded into a mixture of tables and derivatives:

$$C_m = C_{m_o}(M, \alpha, \delta e) + \underline{\frac{c}{2V} C_{m_q}(M, \alpha) q} + \frac{C_Z}{c}(x_{cg_R} - x_{cg})$$

The pitch damping derivative is itself a tabular function of Mach and angle-of-attack. You want to reduce that two-dimensional table to a one-dimensional table of Mach only, while expanding the angle-of-attack dependency into a Taylor series of up to third order. Show the process and determine whether all these derivatives exist based on the mirror symmetry of the aircraft.

Problem 3 Aero Derivative Table for Missiles

You are to build a derivative map up to second order for a missile with tetragonal symmetry, with particular emphasis on roll rate and roll control coupling, using the chart on Slide 11. Forces and moments are in body axes: Y, Z, M, N, L. Eliminate all those derivatives that do not exist because of tetragonal symmetry.