ABET Course Syllabus

ENAE 403 Aircraft Flight Dynamics

Credits & Contact Hours: 3 credits (3 hours of lecture)

Course Status: Required

Schedule: Offered every Fall semester

Course Description: Study of motion of aircraft, equations of motion, aerodynamic force representation, longitudinal and lateral motions, response to controls and to atmospheric disturbances, handling qualities criteria and other figures of merit.

Pre-Requisites: ENAE 432 and ENAE 414

Co-Requisites: None

Textbooks: (1) R. Nelson. Flight Stability and Automatic Control. McGraw Hill, second edition, 1998 (recommended).
(2) T. Yechout. Introduction to Aircraft Flight Mechanics. AIAA Education Series, 2003 (recommended).
(3) B. Pamadi. Performance, Stability, Dynamics, and Control of Airplanes. AIAA Education Series, second edition, 2004 (recommended).
(4) B. Stevens and F. Lewis. Aircraft Control and Simulation. John Wiley and Sons, second edition, 2003.

Other Required Material: Course lecture notes and handouts

Course Oversight: Dynamics and Control Committee

Syllabus Prepared By/Date: Dr. Sean Humbert, June 13, 2011

Course Objectives/Student Learning Outcomes:

1. Analyze a given aircraft configuration to determine its stability and control characteristics based on standard formulations of the six degree of freedom linearized equations of motion.
2. Formulate the nonlinear 6 DOF kinematics and dynamics equations for fixed wing aircraft.
3. Use perturbation methods to reduce nonlinear aircraft dynamics to linearized equations of motion.
4. Determine aircraft response to initial conditions and control inputs; analyze the dependence of the dynamic response on reference altitude and airspeed.
5. Understand the role of flight mechanics in the design cycle of flight vehicles

Topics Covered:

1. Introduction: Review of vector/matrix analysis
2. Kinematics
    a. Coordinate systems
    b. Rotation matrices
    c. General 3-D motion with rotating reference frames
    d. Euler angles
    e. Quaternions

3. Dynamics
    a. Linear and angular momentum
    b. Transport theorem
    c. 6-DOF translational and rotational equations of motion
    d. Aircraft geometry and inertia
    e. Aerodynamic force representation
4. Linear analysis
    a. Equilibrium solutions and trim conditions
    b. Small perturbation analysis and linear model derivation
    c. Stability derivatives
5. State space
    a. State & observation equations
    b. Dyadic expansions
    c. Modal participation factors
    d. Natural and forced response
    e. Controllability
    f. Observability
    g. Pole Placement
6. Aircraft Response
    a. Longitudinal and lateral dynamics and modes
    b. Stick-fixed and input response
    c. Handling qualities
    d. Stability augmentation systems (SAS)

Relationship of Course Objectives to Program Outcomes
This course addresses program outcomes: 1, 2, 3, 5, 9