MAE 142
Dynamics and Control of Aerospace Vehicles

Designation: Required Course

Catalog Data:
MAE 142 Dynamics and Control of Aerospace Vehicles (4)

The dynamics of vehicles in space or air are derived for analysis of the stability properties of spacecraft and aircraft. The theory of flight, lift, drag, dutch roll and phugoid modes of aircraft are discussed. Optimal state space control theory for the design of analog and digital controllers (autopilots). Optimal state estimation to predict and estimate trajectories of aircraft, spacecraft, and rockets.

Prerequisites: Admission to the engineering major and grades of C- or better in MAE 104 and MAE143B.

Textbook, Required Materials: Stevens and Lewis, Aircraft Control and Simulation Williamson and Skelton, Vehicle Dynamics and Control

Prerequisites by Topic: Dynamics, aerodynamics, and control theory.

Class/Laboratory Schedule: 4 lecture hours per week

Course Topics:
1. Kinematics: Direction cosines, Euler angles, quaternions, velocity.
2. Dynamics: Rigid bodies in translation, rotation.
3. Forcing functions: gravity-gradient torques, airfoils, aerodynamic forces, magnetic torques.
4. Linearization: Taylor series, state-space models.
5. Linear systems: Controllability, observability, state estimation, attitude estimation, pole assignment
6. Optimal state feedback control
7. Optimal state estimators
8. Optimal log control
9. Design of autopilots for linearized models of lateral and longitudinal aircraft motion
10. Design of attitude control for spacecraft

Course Objectives:
(Numbers in parenthesis refer to AE Program Outcomes)

Objective 1: To review the modeling of the dynamics of rigid bodies in 3-dimensional space. (1a)

Objective 2: To enable students to extend such models to aerospace systems such as aircraft, spacecraft, helicopters, and rockets, and to learn how to estimate the unknown state variables based on sensor measurements (1a, 5e, AE12, AE13)

Objective 3: To introduce the tools of state-space control theory, and to apply such tools to the simple problems in the control of aerospace vehicles. (1a, AE12, AE13)

Methods of Evaluation:

1. Biweekly graded homework assignments.
2. Midterm exam.
3. Final project.

Performance Criteria:

Objective 1
1.1 Students will display proficient understanding of rigid body dynamics. (1,2)

Objective 2
2.1 Students will analyze case studies from the textbook and demonstrate how to extend the abstract concepts of rigid-body dynamics to model real physical systems. (1,2)

Objective 3
3.1 Homeworks early in the quarter will focus on spacecraft attitude and rocket launch control. Students will complete a final project in which they design an autopilot which controls the longitudinal and roll characteristics of an aircraft. (1,2,3)

CONTRIBUTION OF COURSE TO PROFESSIONAL COMPONENT:
Engineering Science

PREPARED BY:
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Revised, June 2007.