AE 4723 — Aircraft Dynamics and Control
B-Term Fall 2015, MTWRF 1:00 PM – 1:50 PM

Instructor: Prof. R. V. Cowlagi,
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Instructor Office Hours: Mondays and Thursdays 3:30 PM – 5:00 PM, otherwise by appointment via email.

Teaching Assistant: Ms. Lakshmy Krishnamoorthy, HL 310
TA Office Hours: N/A

Recommended Background: A background in ordinary differential equations (MA 2051) and familiarity with vectors and matrices (MA 2071) are required. A background in 3D kinematics (AE 4733) is required. A background in introductory control theory (AE/ME 3703, ES 3011) is recommended. Familiarity with MATLAB® is recommended.

Course Summary: The goal of this course is for students to develop, analyze, and utilize models of aircraft dynamics, and to study various aircraft control systems. Topics include: longitudinal and lateral flight dynamics, simulation methodologies, natural modes of motion, static and dynamic aircraft stability; and aircraft control systems (such as autopilot design, flight path control, and automatic landing).

Course Objectives: The instructional goal of this course is to apply control theoretic tools to aircraft motion. Specifically, the students will:

1. Define static and dynamic stability, and identify conditions for the same.
2. Review aircraft rigid body equations, and analyze these equations via linearization.
3. Recognize lateral and longitudinal modes of aircraft motion.
4. Develop numerical simulation models of aircraft motion.
5. Review open-loop control response characteristics, review linear control systems theory, and apply this theory to design aircraft control systems.
6. Review handling quality requirements, and evaluate closed-loop control response characteristics to meet these requirements.

Course Outline:
- Elements of aircraft performance: basic forces and aircraft maneuvers.
- Aircraft dynamical equations of motion.
  - Review of 3D kinematics and rigid body dynamics.
  - Physics-based equations of motion.
  - Longitudinal and lateral aerodynamic forces.
  - Numerical simulation.
- Static stability: definitions and conditions of longitudinal and lateral static stability.
- Dynamic stability.
  - Linearization of equations of motion about trim conditions.
  - Longitudinal and lateral modes.
  - Open-loop response to control inputs.
- Application of linear control theory.
  - Handling qualities.
  - Linear Quadratic Regulation (LQR).

Textbook:

This textbook is recommended for purchase. Additional reading material will be provided as appropriate.
Additional recommended reading:


These textbooks are excellent references. However, students are not required to purchase these textbooks.

Performance Evaluation:

Homeworks (20 pts), Quizzes (40 pts), Midterm exam (20 pts), Final exam (20 pts)

- Homeworks will be assigned approximately once per week.
- Short quizzes will be administered approximately once per week. A midterm exam and a final exam will be administered.
- The following rubric will be used for grading each problem in all assignments and exams:
  - 0%: Solution missing.
  - 20%: Minimal progress made towards solution.
  - 40%: Moderate progress towards solution, but incorrect approach or incomplete answer.
  - 60%: Significant progress towards solution and all work shown, but incomplete answer.
  - 80%: All work shown, correct approach, minor errors.
  - 100%: All work shown, correct approach, correct answer.

- The course grade for each student will be assigned based on the weighted sum of points received by that student in each assignment (homework, quizzes, midterm exam, final exam).

Policies and Guidelines:

- Students are expected to attend all class lectures and tutorial sessions. Whereas lecture notes and slides will be provided, students are encouraged to make their own notes in class.
- Students are expected to return all assignments (homework assignments and any take-home exams) by the due dates and times. Late submissions will be penalized according to the following rubric:
  - Late by up to 24 hours after due: 20% penalty.
  - Later than 24 hours, up to 48 hours after due: 30% penalty.
  - Later than 48 hours after due: assignment will not be accepted, and all points for that will be forfeited.
- Illegible and/or untidy homeworks and exams will not be accepted or graded, and the students will forfeit points unless the work is entirely resubmitted. For these resubmissions, lateness penalties as described above will apply. The determination of “illegibility” and “untidiness” is solely based on the subjective judgment of the instructor and/or the TA.
- Cheating and plagiarism on any assigned homework, exam, or project will result in forfeiture of all points associated with that assignment. Students are strongly encouraged to study the WPI policies on academic honesty, which may be found at http://www.wpi.edu/offices/policies/honesty/policy.html.
- When possible, the students are required to inform the instructor of potential difficulties in advance. Most problems can be handled over email. Students should individually inform the instructor, by September 2, 2015, of any long-standing commitments (i.e. religious observances, varsity team athletic events, etc) that may affect their ability to meet the class requirements, for alternative arrangements to be considered.
- Students in need of course accommodations because of a disability should make an appointment with the instructor as soon as possible. Additionally, students are encouraged to contact the Office of Disability Services (ODS), as soon as possible to ensure that such accommodations are implemented in a timely manner. The ODS is located at 157 West Street, (508) 831-4908, DisabilityServices@wpi.edu.