San José State University
Department of Aerospace Engineering

AE173, Uncrewed Air Vehicle Design, 01, Fall, 2022

Course and Contact Information

Instructor(s): Nick Cramer
Office Location: Online
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Office Hours: TuTh 4:30-5:30 PM AE162
Class Days/Time: TuTh 6:00-7:15PM
Classroom: Engineering Building 340
Prerequisites: AE 30.

Course Description

Introduction of unmanned aircraft systems (UAS) and relevant design and operation considerations. Vehicle dynamics and flight controls. UAS flight path planning and optimization. Computer simulations.

Faculty Web Page and MYSJSU Messaging

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on my faculty web page at https://www.sjsu.edu/ae/faculty_staff/part-time/nickcramer.phpand/or on Canvas Learning Management System course login website. You are responsible for regularly checking with the messaging system through MySJSU on Spartan App Portal (or other communication system as indicated by the instructor) to learn of any updates. For help with using Canvas see Canvas Student Resources page.

Course Goals

The goals of this course are to study:

- Unmanned air vehicle (UAV) design and analysis for flight missions
- UAV models
- Flight control design utilizing successive loop closure
- UAV sensors and actuators
- Advanced UAV configurations

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

1. *Design a UAV mission.*
2. *Design a basic UAV platform.*
3. *Design flight controller and estimator for UAVs*

Required Texts/Readings (Required - Delete the word "Required" in final draft)

Textbook

R.W. Beard, T.W. McLain, *Small Unmanned Aircraft: Theory and Practice,* Princeton University Press, 2012Other Readings

Tischler, Mark B., and Robert K. Remple. *Aircraft and rotorcraft system identification*. Reston, VA: American Institute of Aeronautics and Astronautics, 2012.

Jategaonkar, Ravindra V. *Flight vehicle system identification: a time domain methodology*. American Institute of Aeronautics and Astronautics, 2006.Grant, Barbara Geri. "Getting Started with UAV Imaging Systems: A Practical Guide." SPIE, 2016.

Klein, Lawrence A. *Sensor and data fusion: a tool for information assessment and decision making*. Vol. 138. SPIE press, 2004.

Other technology requirements / equipment / material

MATLAB

Course Requirements and Assignments

The course will have homework assignments every week. Each assignment will normally have 1.5 to 2 weeks for completion. Attendance is not recorded or required but project check-ins during office hours or outside are required on a weekly basis by at least one team member.

"Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus."

Final Examination or Evaluation

The final project will be a group project. The initial proposal process will be the midterm. The midterm and the final will both include presentation and report components that will provide a UAV mission and the UAV design to achieve the specified mission.

Grading Information

Grading is based on the following:

- **Homework: 30%** (due online)
- **Project: 70%**
  - Literature survey: 10%
  - Mid-term reviews: 20%
  - Final presentation/report: 40%

Grade	*Points*	*Percentage*
A plus	*950 to 1000*	*95 to 100%*
A	*900 to 949*	*90 to 94.9%*
A minus	*85. to 899*	*95 to 89.9%*
B plus	*800 to 849*	*80 to 84.9 %*
B	*750 to 799*	*75 to 79.9%*
B minus	*700 to 749*	*70 to 74.9%*
C plus	*650 to 699*	*65 to 69.9%*
C	*600 to 649*	*60 to 64.9%*
C minus	*55. to 599*	*55 to 59.9%*
D plus	*500 to 549*	*50 to 54.9%*
D	*450 to 499*	*45 to 49.9%*
D minus	*400 to 449*	*40 to 44.9%*

Classroom Protocol

GENERAL EXPECTATIONS: Students are expected to work on projects of their choice. In addition, they are encouraged to dovetail their own interests with the class projects.

ONLINE CLASS EXPECTATIONS:

- The lecture period of the classes will be recorded for later watching.
- This is for students who might not be comfortable joining the class or might feel sick. Please do not come to class if you are feeling ill.

University Policies

Per University Policy S16-9 ,relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on Syllabus Information web page (https://www.sjsu.edu/curriculum/courses/syllabus-info.php). Make sure to visit this page to review and be aware of these university policies and resources.

Course Number / Title, Semester, Course Schedule

Course Schedule

Module	Topics, Readings, Assignments, Deadlines
1	Introduction
2	Euler angles and coordinate transformation ▪ Kinematics ▪ Quaterions
3	Derivation of equations of motion ▪ Linear models ▪ Quadcopter dynamics
4	Avionic sensors – Data fusion ▪ IMU/GPS ▪ LIDAR/RADAR
5	Flight control design ▪ Inner-loop ▪ Successive loop closure
6	System identification ▪ Multi-rotor vehicles ▪ Frequency domain
7	**Mid-Term Project Reviews**
8	Guidance control design ▪ Outer-loop ▪ Waypoint following ▪ Trajectory/path planning
9	State-Estimation ▪ Dynamic observer design ▪ Kalman filter
10	State-Estimation ▪ Dynamic observer design

Module	Topics, Readings, Assignments, Deadlines
	▪ Kalman filter
11	Summary & future application
12	Project presentation