Aerospace autonomous systems

Academic Year: (2022 / 2023) **Review date: 04-11-2022**

Department assigned to the subject: Aerospace Engineering Department

Coordinating teacher: MARCOS ESTEBAN, ANDRES

Type: Compulsory ECTS Credits : 3.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Air Navigation Systems
Elements of Critical Software
Advanced Flight Mechanics

OBJECTIVES

This course aims at preparing the students to work in the field of unmanned aerial vehicles (also known as drones and/or UAVs). As part of this preparation, lectures will be given covering the legislative/economic/business framework, as well as lectures focused on the technical knowledge necessary to understand, design, and operate this type of vehicles. The technical topics include advanced concepts in dynamics, estimation, control, guidance, and navigation. The course also has an important practical component, both in computer simulation as well as flight tests, with drones (quadcopters).
This combination of theory and practice allows the student to gain a complete understanding of UAV systems.

DESCRIPTION OF CONTENTS: PROGRAMME

Block I: Technology that applies to autonomous vehicles

Types of vehicles and design particularities
Distingueshed aspects of the air navigation, certification, and legislation of UAVs
Socio-economical Aspects and air traffic management of UAVs.
Applications and industry
Communication, navigation and surveillance (CNS) sensors for UAVs

Block II: Autonomous guidance, navigation, and control

Arquitecture, methodologies, and decision-making in UAVs.
IMU: accelerometers and gyroscopes
State estimation. Extended Kalman filter
Nonlinear dynamics and control strategies for UAVs.

Block III: Quad-rotor lab.

Introducction to Matlab/Simulink simulator.
Introduction to the onboard software (Arducopter). Concepts, principles, and methods of computational systems in real time .
Controllers calibration and Flight Testing.
Data analysis and comparison.

LEARNING ACTIVITIES AND METHODOLOGY

TRAINING ACTIVITIES
AF1 (Theoretical classes) and AF2 (Practical classes),
AF3 (Practices in computer classroom) and AF4 (Laboratory practices),
AF5 (Individual student work) as well as group work
TEACHING METHODOLOGIES
MD1 (Presentations in the teacher's class with support of computer and audiovisual media).
MD2 (Critical reading of texts recommended by the teacher of the subject).

MD3 (Resolution of practical cases raised by the teacher individually or in groups)
MD5 (Preparation of papers and reports individually or in groups)

ASSESSMENT SYSTEM

Continuous Evaluation: 40%

a) Homeworks.
b) Quadcopter simulation/flight test lab (oral communication)

Exam: 60%

Theory Block I, Theory Block II, Problems Block II and Questions about the labs.

Minimum final exam mark is 4 (out of 10) in order to go for the continuous evaluation.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- Donald Norris Build Your Own Quadcopter: Power Up Your Designs with the Parallax Elev-8, McGraw-Hill/TAB Electronics, 2014
- Kenneth Robert Britting Inertial Navigation Systems Analysis, Artech House, 2010
- Robert M. Rogers Applied Mathematics in Integrated Navigation Systems, American Institute of Aeronautics and Astronautics, 2007
- Valavanis, Kimon P., Vachtsevanos, George J. (Eds.) Hanbook of Unmanned Aerial Vehicles., Springer, 2015

ADDITIONAL BIBLIOGRAPHY

- Herbert Goldstein Classical mechanics, Addison-Wesley Pub. Co, 1980
- Kenzo Nonami Ph.D., Farid Kendoul Ph.D., Satoshi Suzuki Ph.D., Wei Wang Ph.D., Daisuke Nakazawa Ph.D. (auth.) Autonomous Flying Robots: Unmanned Aerial Vehicles and Micro Aerial Vehicles, Springer, Tokio, 2010
- Paul Zarchan, Howard Musoff, Frank K. Lu Fundamentals of Kalman Filtering:: A Practical Approach, AIAA (American Institute of Aeronautics & Astronautics), 2009
- Mohinder S. Grewal, Angus P. Andrews Kalman Filtering: Theory and Practice with MATLAB, Wiley, 2015 (4th edition)
- Donald Norris Build Your Own Quadcopter: Power Up Your Designs with the Parallax Elev-8, McGraw-Hill/TAB Electronics, 2014
- Guowei Cai, Ben M. Chen, Tong Heng Lee (auth.) Unmanned Rotorcraft Systems, Springer-Verlag London, 2011
- Michael Margolis Arduino Cookbook, O'Reilly, 2012
- Norris Build Your Own Quadcopter: Power Up Your Designs with the Parallax Elev-8, Mc Grawhill, 2014
- Reg Austin Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Wiley, 2010

BASIC ELECTRONIC RESOURCES

- Mathwoorks . Mathworks: https://ch.mathworks.com/