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Aerospace autonomous systems

Academic Year: (2017 / 2018) **Review date: 21-04-2017**

Department assigned to the subject: Bioengineering and Aeroespace Engineering Department

Coordinating teacher: SOLER ARNEDO, MANUEL FERNANDO

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

OBJECTIVES

Skills

Acquire knowledge to create the foundations for future originality in the development and application of ideas, often in a research and innovation context.

Learn how to apply knowledge and the capacity to solve problems in new, multidisciplinary environments related with the area of study (in this case aerospace autonomous system)

Acquire capacity to integrate knowledge and face the complexity of judging given information that is incomplete and might include subjective reflexions on social responsibility and ethics.

Acquire capacity to communicate extracted conclusions, supporting them in a clear and unambiguous manner.

Acquire abilities to further continue studying the topics in a self and autonomous way.

Acquire capacity to project, build, inspect and certify autonomous aerospace vehicles and its subsystems.

Acquire capacity to technically manage research, development and innovation projects both in companies and centers of research in aerospace.

Aquire capacity to integrate complex aerospace system and work in multidisciplinary teams.

Acquire capacity to analyze and establish correction measures for environmental impact of the developed technical solutions.

Acquire capacity for the analysis and resolutions of aerospace problems in new environments.

Acquire knowledge and comprehension on the legislation that applies in the use of autonomous vehicles.

Apply knowledge acquired on avionics, embedded software, and control to aerospace autonomous systems framed into the system of air navigation.

Apply knowledge acquired on Air Navigation (including routes; communication, navigation, and surveillance systems; regulations) to understand the integration of autonomous vehicles in a non-segregated airspace.

LEARNING OUTCOMES

By successfully completing this course, the student should be able to:

1) Understand the technologies that apply to aerospace autonomous systems, including legislation, economical and industrial frameworks, and vehicle design.

2) Understand the mathematical foundations of some of the fundamental systems used of autonomous navigation, including the dynamics of quad-rotors, and the principles of inertial measurement units and Kalman Filters.
3) Understand how these systems can be simulated aided by computers
4) Understand how these knowledge can be incorporated into state of the art hardware.
5) Understand the different elements that compose a quad-rotors, including hardware and software, learn how to ensemble them, calibrate the vehicles, and finally fly it in an autonomous way.

DESCRIPTION OF CONTENTS: PROGRAMME

Block I: Technology that applies to autonomous vehicles

Legislation
Socio-economical Aspects
Applications
Industry
Types of vehicles
Design particularities

Block II: Autonomous Navigation.

Quadcopter dynamics
IMU: accelerometers and gyroscopes
Estimation: Kalman filter

Block III: Quad-rotor ensambly lab.

Introduction to Arducopter;
IMU Integration;
Quad-rotor ensambly;
Controllers calibration;
Flight Testing.

LEARNING ACTIVITIES AND METHODOLOGY

TEACHING ACTIVITES

Theoretical sessions

Practical sessions (exercises)

Labs in computer room

Hands-on labs

Individual work by the student

Group work

TEACHING METHODOLOGY

Class exposition with the aid of computers and audiovisuals, and on the blackboard. Development of concepts and analysis of the bibliographic material

Critical lecture of different material: technical reports, papers, manuals.

Resolution of exercises posed by the Professor.

Elaboration of reports and oral communications by the student

ASSESSMENT SYSTEM

Continuous Evaluation: 40%

a) Quadcopter dynamics lab (report)
b) Quadcopter ensembly/flight test lab (oral communication)

Exam: 60%

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

Minimun 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