

Guia docent

300078 - UA - Aeronaus No Tripulades

Última modificació: 09/06/2023

Unitat responsable: Escola d'Enginyeria de Telecomunicació i Aeroespacial de Castelldefels
Unitat que imparteix: 710 - EEL - Departament d'Enginyeria Electrònica.
739 - TSC - Departament de Teoria del Senyal i Comunicacions.

Titulació: MÀSTER UNIVERSITARI EN APLICACIONS I TECNOLOGIES PER ALS SISTEMES AERIS NO TRIPULATS (DRONS) (Pla 2017). (Assignatura obligatòria).

Curs: 2020 **Crèdits ECTS:** 4.5 **Idiomes:** Anglès

PROFESSORAT

Professorat responsable: Casas Piedrafita, Jaime Oscar

Altres: Parès Calaf, M. Eulàlia; García Lozano, Mario; Ruiz Boqué, Sílvia

CAPACITATS PRÈVIES

DC and AC circuit analysis, linear system theory, analysis and design of basic analog, digital and mixed-signal electronic circuits using passive and active electronic components. Basic concepts of communications systems. Mathematical basic skills.

COMPETÈNCIES DE LA TITULACIÓ A LES QUALS CONTRIBUEIX L'ASSIGNATURA

Específiques:

CE1 DRONS. (CAT) (ENG) CE1 DRONS Analizar los requisitos de la misión, seleccionar la plataforma dron más adecuada de acuerdo a los requisitos (tipo de aeronave y sistemas energéticos, de propulsión, de posicionamiento, de navegación, de guiado, de telecomunicación, de seguridad y de emergencia) y realizar la verificación del sistema.

Genèriques:

CG1 DRONS. (CAT) (ENG) CG1 DRONS Proyectar e implantar soluciones viables y rentables utilizando sistemas basados en aeronaves no tripuladas (drones) en entornos nuevos o poco conocidos dentro de contextos más amplios y multidisciplinares.

CG2 DRONS. (CAT) (ENG) CG2 DRONS Integrarse de manera eficaz en equipos interdisciplinares, asumiendo el liderazgo en las aportaciones relativas al uso de las tecnologías relacionadas con los drones.

Transversals:

CT3. TREBALL EN EQUIP: Ser capaç de treballar com a membre d'un equip interdisciplinari, ja sigui com un membre més o duent a terme tasques de direcció, amb la finalitat de contribuir a desenvolupar projectes amb pragmatisme i sentit de la responsabilitat, tot assumint compromisos considerant els recursos disponibles.

CT4. ÚS SOLVENT DELS RECURSOS D'INFORMACIÓ: Gestionar l'adquisició, l'estructuració, l'anàlisi i la visualització de dades i informació de l'àmbit d'especialitat, i valorar de forma crítica els resultats d'aquesta gestió.

CT5. TERCERA LLENGUA: Conèixer una tercera llengua, preferentment l'anglès, amb un nivell adequat oral i escrit i en consonància amb les necessitats que tindran els titulats i titulades.

Bàsiques:

CB7. Que els estudiants sàpiguin aplicar els coneixements adquirits i la seva capacitat de resolució de problemes en entorns nous o poc coneguts dins de contextos més amplis (o multidisciplinaris) relacionats amb la seva àrea d'estudi.

CB8. Que els estudiants siguin capaços d'integrar coneixements i enfrontar-se a la complexitat de formular judicis a partir d'una informació que, tot i ser incompleta o limitada, inclogui reflexions sobre les responsabilitats socials i ètiques vinculades a l'aplicació dels seus coneixements i judicis.

CB10. Que els estudiants tinguin les habilitats d'aprenentatge que els permetin seguir estudiant d'una manera que haurà de ser en gran mesura autodirigida o autònoma.

METODOLOGIES DOCENTS

The professors of this matter recognise that the learning and teaching strategy should reflect the different requirements of the students. In order to achieve this professors have agreed the following strategy:

1. To ensure that the teaching methods adopted for classroom and related activity are planned to ensure that tutors use a range of examples, reflecting the diversity of experiences when explaining the application of theory to practise.
2. To ensure that group discussions, case study / problem solving activity relate to and reflect the different aspects of practice represented within the classroom.
3. Where guest lecturers are used, they will be briefed by the module tutor to ensure that they are aware of the student profile and that the proposed presentation accommodates this.
4. Students will be supported by tutorial discussions between the tutor and student to ensure that the proposed learning reflects the practice needs of the student.
5. To ensure that the assessment strategy and methods of assessment are sufficiently flexible to enable students to apply and demonstrate their learning in a context which is relevant to them.

The learning and teaching methods adopted reflect the Drone Master's degree characteristics descriptors in the following ways:

- a) Lectures are used to impart key information and show case new ways of working which will enable students to develop a sound understanding of the principles of their field of study as well as identifying new ways of working.
- b) Case studies, role plays and group working will be used to facilitate application of the principles more widely. They will also be used to prompt discussion and Practise problem solving skills. This will also allow students to evaluate the appropriateness of different approaches to solving problems.
- c) Assessments are used to facilitate learning as well as providing an indication of student achievement.

OBJECTIUS D'APRENTATGE DE L'ASSIGNATURA

The central element of the drone-based system is the aircraft itself. In this subject the several existing aircraft types will be studied, including but not limited to their characteristics, feeding and propulsion systems, actuators, autopilots, sensors and communication systems, etc...The subject gives the student the adequate criteria for the accurate selection of the aircraft and its components based on the requested mission. At the end of the course the student should be able to:

- a) Understand the global vision, aircraft providers and fabricants.
- b) Understand the Unmanned aircraft definition and its components.
- c) Describe and design Propulsion and energy systems in unmanned aircrafts.
- d) Analyse and design sensors systems and actuators
- e) Analyse and design stability, navigation and guide systems.
- f) Analyse and design communication systems in unmanned aircrafts.

HORES TOTS DE DEDICACIÓ DE L'ESTUDIANTAT

Tipus	Hores	Percentatge
Hores aprenentatge autònom	85,5	76.00
Hores grup petit	27,0	24.00

Dedicació total: 112.5 h

CONTINGUTS

1. Introduction to UAVs

Descripció:

The first portion of the session reviews the history of UAV systems from the earliest and crudest “flying objects” through the events of the last decade, which has been a momentous period for UAV systems. The second portion of the session describes the subsystems that comprise a complete UAV system configuration to provide a framework for the subsequent treatment of the various individual technologies that contribute to a complete UAS. The air vehicle itself is a complicated system including structures, aerodynamic elements (wings and control surfaces), propulsion systems, and control systems. The complete system includes, in addition, sensors and other payloads, communication packages, and launch and recovery subsystems.

1.1 UAV definition.

1.2 Terminologies of UAV

1.3 History of UAV

1.4 Classifications of UAV

1.5 UAV components: Controller and computing. Power supply. Sensors systems. Actuators. Flight controls and Communications

1.6 UAV applications

Activitats vinculades:

Lectures, homework: questionnaires and exercises.

Dedicació: 9h 20m

Grup petit/Laboratori: 3h

Aprenentatge autònom: 6h 20m

2. Propulsion and energy systems

Descripció:

Two aspects of propulsion are addressed in this topic. The first is the aerodynamics of generating thrust or what is called “powered lift,” which is lift that is directly generated by a rotor or fan and is very similar to upward thrust. The second aspect of propulsion is the source of the power to produce the thrust or lift, which is the engine or motor that moves a propeller or rotor or fan. Finally, the energy sources and the power conditioning circuits are presented.

2.1 Overview

2.2 Thrust Generation

2.3 Powered Lift

2.4 Sources of Power. Motor and propeller models. Electronic controls and drivers

2.5 Power supply systems. Batteries Linear and switching regulators. Efficiency.

Activitats vinculades:

Lectures of complementary material about Motors and switching regulators

Homework: problems about motor models and control (8 %)

Practical homework about motor control or sensor acquisition (8 %)

Dedicació: 17h 50m

Grup petit/Laboratori: 5h

Aprenentatge autònom: 12h 50m

3. Sensor, inertial and navigation systems

Descripció:

In this topic the electronic models of the sensor systems that can be used in a drone will be presented, as well as their basic conditioning. Emphasis will be placed on inertial systems and navigation systems, their models and errors, which are fundamental to the design of drones. Possible causes of interference, their models and reduction from the point of view of optimal drone design will also be presented.

3.1 Sensor systems. Types and electronic conditioning.

3.2 Introduction to stabilisation, guidance and navigation systems

3.3 Inertial systems. Uncertainties factors. Interferences and electromagnetic compatibility. Calibrations methods.

3.4 Satellite navigation systems: GPS, EGNOS, GBAS

Activitats vinculades:

Lectures of complementary material about inertial systems

Homework: problems about sensor acquisition (8%) and navigation and inertial sensors (8 %)

Practical homework about motor control or sensor acquisition (8 %)

Dedicació: 32h

Grup petit/Laboratori: 9h

Aprenentatge autònom: 23h

4. Communication systems. Data link

Descripció:

This topic provides a general description of the functions and attributes of the data-link subsystem of a UAS and describes how the attributes of the data link interact with the mission and design of the UAV. The data link provides a communications link between the UAV and its ground station, and is a critical part of the complete UAV. It is very important for the designers to realize that the characteristics of the data link must be taken into account in the design of the total system, with numerous tradeoffs between the mission, control, and design of the UAV and the design of the data link.

4.1 Overview of UAV communication systems. Features and design

4.2 Data link functions and attributes

4.3 Data link margin. Transmitter Power. Antenna Gain. Processing Gain. Losses. Obstruction of the Propagation Path

4.4 Data-Link Signal-to-Noise Budget

4.5 UAV telemetry and communication examples

Activitats vinculades:

Homework: problems and theoretical questions about communication systems in drones (8 %)

Dedicació: 20h 10m

Grup petit/Laboratori: 6h

Aprenentatge autònom: 14h 10m

5. UAV simulation and control

Descripció:

The matter of this topic is approximate the performance of any DC motor or propeller from empirical data mathematically. Understand and harness the Physics of a Drone. Convert physical motion (throttle, roll, pitch, yaw) to voltage signals. Derive, understand and model the rotational dynamics of a drone (pitch, roll and yaw motion). Implement mathematical functions in Matlab and Simulink. Create and test an engineering model in Simulink. Design, tune and implement automated PID algorithms (altitude control and rotational dynamics).

5.1 Physics model of a drone. Rotational dynamics of a drone

5.2 Drone simulation. Matlab and simulink

5.3 Drone control. Design and tune PID algorithms

Activitats vinculades:

Theoretical questions and simulations with matlab about control systems in drones. As it is the last topic of the course, the practical work is optionally extended with the realization of the research project in this topic

Dedicació: 20h 40m

Grup petit/Laboratori: 4h

Aprenentatge autònom: 16h 40m

6. Research project

Descripció:

Application and extension of the knowledge acquired on an assigned topic from a list of proposals made by teachers. Each proposal clearly defines the objective of the project and the expected results. The results of the research project will be documented in the form of a research paper. The main topics dealt with in relation to this subject will be: models, simulation and control of drones, since they are topics that require a timeframe in their development that the hours adjusted to the subject do not allow to cover in depth.

Activitats vinculades:

Preliminary version of the research paper

Evaluation of the preliminary version of at least two classmates

Final version of the research paper. (20%)

Dedicació: 12h 30m

Aprenentatge autònom: 12h 30m

SISTEMA DE QUALIFICACIÓ

Assessment:

a) Unseen final written exam: 40 %

b) Problem-solving exercises, design exercises: 40 %

c) Research project: 20 %

NORMES PER A LA REALITZACIÓ DE LES PROVES.

The final exam will be three hours long and will consist of problems and theoretical issues. Students have a second opportunity (in May) to take the final exam

Examination Policies and Best Practices:

- a) Check student IDs when they enter the classroom and check them off of a class list or ask students to sign the list as the ID card is checked.
- b) Make sure to give each student only one exam form and that at the end of the exam only one is submitted by each student.
- c) Create multiple forms of one exam, if it is necessary (Extraordinary non-presential examinations due to the Covid-19 pandemic). Use different questions or the same questions scrambled. Warn students that the exams differ and that misconduct will be apparent when the exam is graded.
- d) Tell students about the Code of Academic Honesty and remind them about the importance of academic integrity and the consequences of misconduct.

BIBLIOGRAFIA

Bàsica:

- Fahlstrom, Paul Gerin; Gleason, Thomas J. Introduction to UAV systems [Recurs electrònic] [en línia]. 4th ed. Chichester: Wiley, 2012 [Consulta: 06/11/2020]. Disponible a: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781118396780>. ISBN 9781118396780.
- Valavanis, Kimon P. Advances in Unmanned Aerial Vehicles [Recurs electrònic] : State of the Art and the Road to Autonomy [en línia]. Dordrecht: Springer Netherlands, 2007 [Consulta: 06/11/2020]. Disponible a: <http://dx.doi.org/10.1007/978-1-4020-6114-1>. ISBN 9781402061134.
- Sadraey, Mohammad H. Design of unmanned aerial systems. Hoboken, NJ: Wiley, 2020. ISBN 9781119508700.