Last update: 30-05-2018

300321 - UAS-OA - Unmanned Aircraft Systems

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering

Teaching unit: 701 - AC - Department of Computer Architecture
748 - FIS - Department of Physics

Academic year: 2018

Degree: BACHELOR'S DEGREE IN AIRPORT ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN AIR NAVIGATION ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN AEROSPACE SYSTEMS ENGINEERING (Syllabus 2015). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

Prior skills

- To know basics of OOP.
- Learn to program in a programming language.
- Programming in Matlab.

Degree competences to which the subject contributes

Specific:

1. CE 9 AERO. Comprender la globalidad del sistema de navegación aérea y la complejidad del tráfico aéreo. (CIN/308/2009, BOE 18.2.2009)
7. CE 1 AERO. Capacidad para la resolución de los problemas matemáticos que puedan plantearse en la ingeniería. Aptitud para aplicar los conocimientos sobre: álgebra lineal; geometría; geometría diferencial; cálculo diferencial e integral; ecuaciones diferenciales y en derivadas parciales; métodos numéricos; algorítmica numérica; estadística y optimización. (CIN/308/2009, BOE 18.2.2009)
8. CE 14 AERO. Comprender el sistema de transporte aéreo y la coordinación con otros modos de transporte. (CIN/308/2009, BOE 18.2.2009)

Transversal:

4. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
14. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
11. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
10. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

Teaching methodology

The course combines the following teaching methods:

- Third language, because the course materials will be in English.
- Self study, because students will work self-learning materials at home.
- Cooperative learning, because students are organized in small groups to perform some course tasks.
- Project-based learning, because students will develop a project in groups during the course.
- Class presentations by teachers.

Learning objectives of the subject

After the subject of Unmanned Aircraft Systems the student should be able to:

· Identify Unmanned Aircraft System (UAS) segments, its historical development, UAS uses and applications.
· To know basics of UAS Flight Control System, Flight Plan, Communications and Payload.
· Use simulation environments for UAS.
· Understand the existing regulatory framework for UAS.
· To know existing ground control stations for UAS.
· Understand the previous theoretical issues to Kalman filtering.
· Design and implement a Kalman filter to solve a simple problem.
· Design and implement a Kalman filter to improve the navigation of an unmanned system.

Study load

Total learning time: 150h	Hours large group:	32h 30m	21.67%
	Hours small group:	32h 30m	21.67%
	Guided activities:	1h	0.67%
	Self study:	84h	56.00%

Content

(ENG)- Introduction to Unmanned Aircraft Systems (UAS)	Learning time: 58h 30m Theory classes: 10h Laboratory classes: 17h 30m Guided activities: 1h Self study : 30h

Description:
1.1 Historical Evolution
1.2 Definition (UAS vs RPAS)
1.3 UAS Components
1.4 UAS Uses and Applications
1.5 Current Situation
1.6 UAS Autopilot
1.7 UAS Flight Plan, Mission and Payload Management.
1.8 UAS Ground Control Stations (GCS)
1.9 Simulation Environment.

Related activities:
A1, E1 and E2

(ENG) - Control and Navigation in Unmanned Aircraft Systems (I): Probability and Random Variables. Stochastic Estimation	Learning time: 14h Theory classes: 5h Self study : 9h

Description:
2.1 Probability
2.2 Random Variables
2.3 Mean and variance
2.4 Normal Distribution (Gaussian)
2.5 Stochastic Estimation
2.6 Continuous Independence and conditional probability
2.7 Signal characteristics: spatial vs. spectral
2.8 Continuous Linear Systems
2.9 Discrete Linear Systems

Related activities:
A2, E1 and E2

(ENG) - Control and Navigation in Unmanned Aircraft Systems (II): KALMAN FILTER	Learning time: 30h Theory classes: 5h Laboratory classes: 10h Self study : 15h

Description:
3.1 Discrete Kalman Filter
3.2 Extended Kalman Filter
3.3 Practice I: Modeling error in positioning systems
3.4 Practice II: Implementation of Kalman filters for simple problems
3.5 Practice III: Implementation of Kalman filters for UAS navigation (I)
3.6 Practice IV: Implementation of Kalman filters for UAS navigation (II)

Related activities:
A2, E1 and E2

(ENG) - UAS Integration in non segregated airspace.	Learning time: 27h 30m Theory classes: 7h 30m Laboratory classes: 5h Self study : 15h

Description:
4.1 Current Regulation
4.2 Management of contingencies: in-flight and lost link.
4.2 Sense and Avoid: Self separation & Collision avoidance
4.3 Architectures for integrating UAS

Related activities:
A2, E1 and E2

(ENG) - UAS Real Examples.	Learning time: 20h Theory classes: 5h Self study : 15h

Description:
5.1 NASA UAS: Ikhana and GlobalHawk
5.2 Research Activities
5.3 Market in Europe

Related activities:
E1, E2

Planning of activities

(ENG) A1: SIMULATION PROJECT	Hours: 52h 30m Laboratory classes: 22h 30m Guided activities: 1h Self study: 29h

Description:

In this activity students will have to do a project in groups. Methodology of project-based learning, so that students have to learn autonomously topics needed to achieve the project objectives. Directed and independent learning activities consist primarily of :

· Study of self-learning materials.
· Carry out individual tasks projected
· Group meetings for project tasks.
· Completing the design and planning of the different prototypes of the project.

The activities that will be made to the class sessions :

· Resolution of doubts weekly working in small groups.
· Resolution of the most frequent questions from the professor.
· Some theoretical sessions on key issues.
· Individual and small group exercises.
· Conducting individual project tasks.
· Group meetings for project tasks.

In this activity, special attention will be devoted to the written and oral presentation of the work performed by the teams.

Support materials:

· Self-learning material to the contents of the subject.
· Statements of individual and group exercises.
· Detailed plan of activities and deliveries.

All material will be available through Atenea

Descriptions of the assignments due and their relation to the assessment:

The activity is assigned a series of individual and group deliverable (at least one deliverable per week). Based on these deliveries relevant feedback processes are articulated.

The completion of at least 80% of the deliverables of the course will be required to pass the course.

Specific objectives:

At the end of this activity, students will be able to:

· Acquire knowledge about UAS simulators.
· Know the different UAS navigation modes.
· Understand the peculiarities when performing a real UAS mission.
· Design and implement a flight plan for a UAS mission.
· Design and implement contingency flight plans.
· Development of a mission in the simulation environment from scratch.
· Explain and defend their solutions in presentations and reports.
· Use resources of Web 2.0 as a tool for communication and presentation of results

(ENG) A2: FILTROS DE KALMAN	Hours: 25h Laboratory classes: 10h Self study: 15h

Description:

In this activity students will have to do design and implement a Kalman filter in groups. Methodology of project-based learning, so that students have to learn autonomously topics needed to achieve the project objectives. Directed and independent learning activities consist primarily of :

· Study of self-learning materials.
· Carry out individual tasks projected
· Group meetings for project tasks.
· Completing the design and planning of the different prototypes of the project.

The activities that will be made to the class sessions :

· Resolution of doubts weekly working in small groups.
· Resolution of the most frequent questions from the professor.
· Some theoretical sessions on key issues.
· Individual and small group exercises.
· Conducting individual project tasks.
· Group meetings for project tasks.

In this activity, special attention will be devoted to the written and oral presentation of the work performed by the teams.

Support materials:

· Self-learning material to the contents of the subject.
· Statements of individual and group exercises.
· Detailed plan of activities and deliveries.

All material will be available through Athena

Descriptions of the assignments due and their relation to the assessment:
The activity is assigned a series of individual and group deliverable (at least one deliverable per week). Based on these deliveries relevant feedback processes are articulated.

The completion of at least 80% of the deliverables of the course will be required to pass the course.

Specific objectives:
At the end of this activity, students will be able to:
· Acquire knowledge of modeling error navigation systems.
· Acquire knowledge of the design and implementation of Kalman filters for simple problems.
· Understand how different parameters affect the design of a Kalman filter.
· Design and implement a Kalman filter to improve the UAS navigation.

(ENG) E1	Hours: 20h Self study: 20h

Description:
Exam 1: Answering questions on the syllabus seen so far

Support materials:
Bibliography and class' slides

Descriptions of the assignments due and their relation to the assessment:
20%

Specific objectives:
Validation of knowledge

(ENG) E2	Hours: 20h Self study: 20h

Description:
Exam 2: Answering questions on the syllabus seen so far

Support materials:
Bibliography and class' slides.

Descriptions of the assignments due and their relation to the assessment:
20%

Specific objectives:
Validation of knowledge

Qualification system

Exercises and controls (10%)
Exams (40%)
Practices and project (40%)
Attitude and participation (10%)

Regulations for carrying out activities

To bring personal computer to the laboratory classes.

Bibliography

Basic:

Angelov, Plamen P. Sense and avoid in UAS : research and applications. Chichester: Wiley, cop. 2012. ISBN 9780470979754.

Grewal, Mohinder S.; Andrews, Angus P. Kalman filtering : theory and practice : using MATLAB [on line]. 2nd ed. New York [etc.]: John Wiley & Sons, 2001Available on: <http://onlinelibrary.wiley.com/book/10.1002/9780470377819>. ISBN 0471392545.

Gundlach, Jay. Designing unmanned aircraft systems : a comprehensive approach. Reston, VA: American Institute of Aeronautics and Astronautics, 2012. ISBN 9781600868436.

Grewal, Mohinder S; Andrews, Angus P; Bartone, Chris. Global navigation satellite systems, inertial navigation, and integration [on line]. 3rd ed. Hoboken: John Wiley & Sons, 2013 [Consultation: 18/04/2018]. Available on: <http://lib.myilibrary.com/Open.aspx?id=445876>. ISBN 9781118447000.

Fahlstrom, Paul Gerin; Gleason, Thomas J. Introduction to UAV systems [Recurs electrònic] [on line]. 4th ed. Chichester: Wiley, 2012Available on: <http://onlinelibrary.wiley.com/book/10.1002/9781118396780>. ISBN 9781118396780.

Complementary:

Troelsen, Andrew. Pro C# 5.0 and the .NET 4.5 framework. 6th ed. [New York]: Apress, cop. 2012. ISBN 9781430242338.

Others resources:

Hyperlink

Aroca, J.M. Probabilitat i processos estocàstics. Notes de classe.