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.
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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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 32h 30m</th>
<th>21.67%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group: 32h 30m</td>
<td>21.67%</td>
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<tr>
<td></td>
<td>Guided activities: 1h</td>
<td>0.67%</td>
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<td></td>
<td>Self study: 84h</td>
<td>56.00%</td>
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<tr>
<td><strong>(ENG)- Introduction to Unmanned Aircraft Systems (UAS)</strong></td>
<td><strong>Learning time:</strong> 58h 30m</td>
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<td>----------------------------------------------------------</td>
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<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 10h</td>
<td></td>
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<tr>
<td>1.1 Historical Evolution</td>
<td>Laboratory classes: 17h 30m</td>
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<td>1.2 Definition (UAS vs RPAS)</td>
<td>Guided activities: 1h</td>
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<td>1.3 UAS Components</td>
<td>Self study: 30h</td>
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<td>1.4 UAS Uses and Applications</td>
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<td>1.5 Current Situation</td>
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<td>1.6 UAS Autopilot</td>
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<td>1.7 UAS Flight Plan, Mission and Payload Management.</td>
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<td>1.8 UAS Ground Control Stations (GCS)</td>
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<tr>
<td>1.9 Simulation Environment</td>
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<tr>
<td><strong>Related activities:</strong></td>
<td></td>
<td></td>
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<tr>
<td>A1, E1 and E2</td>
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<tr>
<th><strong>(ENG) - Control and Navigation in Unmanned Aircraft Systems (I): Probability and Random Variables. Stochastic Estimation</strong></th>
<th><strong>Learning time:</strong> 14h</th>
</tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 5h</td>
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<tr>
<td>2.1 Probability</td>
<td>Self study: 9h</td>
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<tr>
<td>2.2 Random Variables</td>
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<td>2.3 Mean and variance</td>
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<tr>
<td>2.4 Normal Distribution (Gaussian)</td>
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<tr>
<td>2.5 Stochastic Estimation</td>
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<td>2.6 Continuous Independence and conditional probability</td>
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<td>2.7 Signal characteristics: spatial vs. spectral</td>
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<td>2.8 Continuous Linear Systems</td>
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<td>2.9 Discrete Linear Systems</td>
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<tr>
<td><strong>Related activities:</strong></td>
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<tr>
<td>A2, E1 and E2</td>
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**300321 - UAS-OA - Unmanned Aircraft Systems**

### (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

<table>
<thead>
<tr>
<th><strong>(ENG) A1: SIMULATION PROJECT</strong></th>
<th><strong>Hours:</strong> 52h 30m</th>
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<tbody>
<tr>
<td></td>
<td>Laboratory classes: 22h 30m</td>
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<td>Guided activities: 1h</td>
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<td>Self study: 29h</td>
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**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

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

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

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
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**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:**


**Complementary:**


**Others resources:**

**Hyperlink**

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