Technologies for Autonomous and Unmanned Systems

Academic Year: (2019 / 2020) **Review date: 21-04-2020**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: GONZALEZ SERRANO, FRANCISCO JAVIER

Type: Electives ECTS Credits : 3.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Digital Communications
Communication Channels and Systems
Electronic Systems

OBJECTIVES

Learning results:
- Know the basic structure of unmanned vehicles.
- Know the typical architecture of the on-board and ground systems, as well as their fundamental components.
- Design the architecture of the systems needed for the fulfillment of a specific mission.

DESCRIPTION OF CONTENTS: PROGRAMME

Unit 1. Introduction to Remotely Piloted Aircraft System (RPAS) and Unmmaned Air Systems (UAS)
- History
- Applications: missions
- Systems: integration
- Normative: operation. Safety of Flight. Human Factors.
- Socio-economic impact
- Types and classification of UAS
- Introduction to UAS Design and Construction

Unit 2. Basic Technologies
- Airframe
  * Materials. 3D Printing & Additive Manufacturing
- Propulsion and Power
  * Battery Management Systems (BMS), Power Systems, Fuel Cells and Propellers. Solar Power Solutions.
- Guidance and Control
  * Autopilots
    + Type of navigation: autonomous (Inertial); non-inertial (e.g., GNSS)
    + Sensors (Barometer, IMU, GPS): measurement attitude and conditions of the aircraft, instrumentation
    + Types of Autopilots, operating principles
    + System control elements, actuators (servos)
- Sensing
  * Cameras, Imaging & Vision Systems
  * Optic (Visible, IR). Range (RADAR, LiDAR, SONAR). Magnetic (MAD)
  * Inertial Sensors: IMU.
- Communication
  * Command and Control
  * Data links
  * Ultra reliable low latency communications. Massive M2M Communications. IoT, 5G.
  * Medium Access Control. Networking. Security

- Processing
  * Data Storage
  * Data Fusion. Information Extraction. Perception.
  * Detection, classification, tracking. Decision Making. Learning.
  * Edge and Fog Computing.
- Ground Control Station
  * GCS software
  * UAV Launch & Recovery Systems

Unit 3. Systems for interaction with the physical world
- Localization, identification and Navigation systems.
  * Collision Avoidance Systems. Traffic Management and Control.

Unit 4. Applications
- Intelligent Transports: ground, air and sea.
- Services, Agriculture and Industry: Aerial photography, filming and mapping, precision agriculture, asset and infrastructure inspection
- Security and defense: surveillance, warfare.

Unit 5. RPAS/UAS operation
- Regulations
- Operational procedures (Flight and Mission planning, Emergency procedures, radio spectrum)
  * Mission control and management software
- Human Factors

LEARNING ACTIVITIES AND METHODOLOGY

Theory Classes: 0.75 ECTS
Practical/Lab. classes: 0.5 ECTS
Group Project: 1 ECTS
- Development of a project of systems integration in a UAV

Individual Project: 0.75 ECTS
The learning activities, methodology and tutoring regime will be organized according to the regulations specified by the university:
https://www.uc3m.es/ss/Satellite/UC3MInstitucional/es/ListadoNormativas/1371206706530/Estudios_de_Grado

ASSESSMENT SYSTEM

% end-of-term-examination:	20
% of continuous assessment (assigments, laboratory, practicals…):	80

End-of-term exam: 20 %
Group Project: 50 %
Individual Project: 30 %

BASIC BIBLIOGRAPHY

- James Aber Irene Marzolff Johannes Ries Susan Aber Small-Format Aerial Photography and UAS Imagery, Academic Press. 2nd Edition., 2019

- Paul Gerin Fahlstrom Introduction to UAV Systems, John Wiley & Sons; 4th Edition, 2012

- Plamen Angelov Sense and Avoid in UAS, Wiley-Blackwell, 2012

- Reg Austin Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Wiley-Blackwell; Edición: 1, 2010

ADDITIONAL BIBLIOGRAPHY

- Brent Terwilliger, David C. Ison, John Robbins Small Unmanned Aircraft Systems Guide: Exploring Designs, Operations, Regulations, and Economics, Aviation Supplies & Academics, Inc., 2017

- Douglas M. Marshall, Richard K. Barnhart, Eric Shappee, Michael Thomas Most Introduction to Unmanned Aircraft Systems, CRC Press, 2016