



Universidad
Politécnica
de Cartagena



Centro
Universitario
de la Defensa

General Air Force Academy

Course unit description:

Avionics and Aircraft

General Knowledge

Degree/s: Industrial Organization Engineering Degree

1. Subject data

Name	Avionics and Aircraft General Knowledge				
Subject area	Avionics and Aircraft General Knowledge				
Module	Optional Subject				
Code	511103010				
Degree programme	Industrial Organization Engineering Degree				
Curriculum	2009 (Decreto 269/2009 de 31 de julio)				
Centre	University Centre of Defense at the Spanish Air Force Academy				
Type	Optional (Flight specialty)				
Length of subject	Four-month course	Semester	2 nd	Course	4 th
Language	English				
ECTS	7.5	Hours / ECTS	25	Total workload (hours)	187.5

2. Lecturers data

Lecturer in charge	José Serna Serrano		
Department	Engineering and Applied Techniques		
Knowledge area	Aerospace Engineering		
Office location	Room 28 @ CUD building		
Telephone	+34.968.189927	Fax	+34.968188780
email	jose.serna@ cud.upct.es		
URL / WEB	Aula Virtual UPCT		
Office hours	Tuesday, Wednesday 12:50 – 14:35		
Location	Room 28 @ CUD building / Virtual classroom		

Qualification/Degree	Aeronautical Engineer. Ph.D. at the Universidad Politécnica de Madrid. (Aerospace Science and Technology Program)
Academic rank at CUD-UPCT	Assistant Professor (Tenure Track) at Associate Center
Year of admission in CUD-UPCT	2012
Number of five-year periods (<i>quinquenios</i>) if applicable	1
Research lines (if applicable)	<ul style="list-style-type: none"> * Experimental Aerodynamics: facilities design, instrumentation and experimental tests. * Boundary layer stability and control: experimental and numerical researches. * Aerodynamic profiles for “low” Reynolds numbers aerodynamics. * Heat Transfer Applications.
Number of six-year periods (<i>sexenios</i>) if applicable	1
Professional experience (if applicable)	<ul style="list-style-type: none"> * Fluid Mechanics Laboratory. School of Aeronautics. UPM (basic and industrial research) > 7 years. * BBVA (Quantitative developer at front desk: equity and FX derivatives valuation). 1 year.
Other topics of interest	UAVs: technology and integration in the air space.

Lecturer	Alejandro López Belchí		
Department	Engineering and Applied Techniques		
Knowledge area	Heat Engines		
Office location	Room 31 @ CUD building		
Telephone	+34.968.189932	Fax	+34.968188780
email	alejandro.lopez@ cud.upct.es		
URL / WEB	Aula Virtual UPCT		
Office hours	Tuesday, Wednesday 12:50 – 14:35		
Location	Room 28 @ CUD building / Virtual classroom		

Qualification/Degree	Mechanical Engineer. Ph.D. at the Universidad Politécnica de Cartagena
Academic rank at CUD-UPCT	Assistant Professor at Associate Center
Year of admission in CUD-UPCT	2015
Number of five-year periods (<i>quinquenios</i>) if applicable	0
Research lines (if applicable)	* Two-phase flow heat transfer * High efficiency cooling systems * Heat engines
Number of six-year periods (<i>sexenios</i>) if applicable	0
Professional experience (if applicable)	Thermal modelling and energetic systems. ETSII. UPCT (4years)
Other topics of interest	Experimental Aerodynamics

3. Subject description

3.1. General description

The special features of the Centro Universitario de la Defensa (CUD) placed at the Spanish Air Force Academy (AGA) make it necessary to complement the curriculum of the Organization Engineering Degree with specific courses related to aeronautics. This is due to the environment where the former students will develop their immediate professional activity.

The course "Avionics and Aircraft General Knowledge" is an optional subject within the academic conception of the curriculum, recommended for those students of the Flight specialty. This course is offered to cover the block 020 of the theoretical knowledge requirements for Flight Crew Licenses, according to Joint Aviation Authorities (JAR-FCL 1.470). During the previous three years, the student has acquired the theoretical and practical tools to undertake the study of the aircrafts structures, systems and avionics from an engineering and practical point of view.

3.2. How the subject contributes to a professional career

The course "Avionics and Aircraft General Knowledge" covers all the aspects within the block 020 of the JAA syllabus for obtaining Flight Crew Licenses. All this content can be summarized as the knowledge of the "aircraft's inside".

During the course "Fundamentals of Flight I (Aerodynamics)", among other subjects, the "aircraft's outside" was widely studied, justifying the wing and control surfaces external geometries to generate the aerodynamic forces and torques, the flight regimes and the aircraft's stability. During this course, the student will understand and will be able to justify the main aircrafts structural elements. From this point of view, the aircraft is a structure (elastic body) which is subjected to certain loads, and there are specific design solutions to appropriately handle with these loads under certain weight and deformations constrains imposed.

Aircrafts are very complex systems that need a wide variety of subsystems to ensure its operability: hydraulics, pneumatics, pressurization, landing gear, air conditioning, fuel, ... are the main subsystems and will be studied, showing their need, operating principles, design solutions and special useful examples for these students.

Within the aircraft, powerplants are enough complex systems to deserve a more specific study. The aircrafts powerplant solutions and their performances are known by the student (covered by the courses "Energetic Technology" and "Fundamentals of Flight"). The third part of this course will focus on the architecture and specific systems of powerplants.

The study of the Flight Instruments is also a course goal. These instruments provide the pilot with all the useful information to operate the aircraft in a safe and satisfactory way. From this point of view, the students are used to the presentations and information provided by the instruments. This course will show them the working principles of these equipments and the technological solutions adopted, besides the possible error sources.

Finally, an introduction to aircraft electronic systems is presented. The fast evolution of electronics has lead to a widely use of these systems. The basic knowledge of the components and standards within avionics systems must be obtained by the student.

3.3. Relationship with other subjects in the programme

To successfully face the course, students should have knowledge of the following subjects:

- Physics (1st year): mechanics and waves.
- Electric Technology and Industrial Automation (2nd year): components and working principles of electrical and electronic circuits (analogical and digital).
- Fluid Mechanics (2nd year): basic hydraulics knowledge
- Energetic Technology (2nd year): thermodynamics and performances of jet and piston engines.
- Mechanics of materials (2nd year): loads on structures, basic structures calculations.
- Materials (2nd year): aeronautical materials properties.
- Mechanical Technology and Manufacturing (2nd year): mechanisms.
- Fundamentals of Flight (3rd year): wings and control surfaces.
- Defence and Security Technologies (3rd year): EM waves, signal transmission, radar, satellite navigation systems.

During the 4th year, the course “Meteorology and Communications Phraseology” will be offered to the students as a part of their aeronautical training.

3.4. Incompatibilities defined in the programme

No incompatibilities have been defined

3.5. Recommendations to do the subject

See section 3.3

3.6. Special provisions

Special measures will be adopted to allow the simultaneity of the course with military and aeronautics training activities. Specifically, working groups will be formed to promote the cooperative learning, promoting the learning track by scheduled tutorships and continuous assessments delivery.

4. Competences and learning outcomes

4.1. Basic curricular competences related to the subject

KC5. Students must have developed the learning abilities needed to undertake subsequent studies with a high degree of autonomy.

4.2. General curricular competences related to the subject

GC2. Application of general technologies and fundamental subjects in the industrial domain for the solving of engineering problems.

4.3. Specific curricular competences related to the subject

SC30. Analyze topics applied to engineering and aircraft systems operations.

4.4. Transversal curricular competences related to the subject

CCC3. Autonomous learning.

4.5. Subject learning outcomes

At the end of the course, the student should be able:

1. To identify the different components of the **airframe**, justifying its need, geometry and materials in order to distribute the structural loads under weight and rigidity constraints.
2. To identify the **hydraulic and pneumatic** systems components, understanding their working principles, problems and adopted technological solutions.
3. To recognize the different **landing gear** types, their elements, and make basic calculations about their dimensions.
4. To justify the need of the **pressure** and **anti-ice/de-ice** systems.
5. To describe the **fuel** systems, identifying their critical points.
6. To understand the architecture and subsystems of aircrafts **piston engines**.
7. To understand the architecture and subsystems of aircrafts **jet engines**.
8. To understand the working principles and main problems of **air data instruments**.
9. To identify and understand the working principles of the **flight navigation instruments (VFR and IFR)**
10. To identify the cabin instruments related to **powerplant data**, understanding the need and source of the presented data.
11. To understand the aircrafts **electronics** applications, mainly those related to flight navigation
12. To identify the elements of a **military avionics** system.

5. Contents

5.1. Curricular contents related to the subject

Airframe: fuselage, wings and stabilizers. Piston engines and propellers. Jet engines. Aircraft systems: hydraulics, flight control, air conditioning, pneumatics, fuel, landing gear. Aircraft electronics equipment.

5.2. Theory syllabus (teaching modules and units)

DU 1. AIRCRAFT ARCHITECTURE.

Lesson 1. Aircraft architecture and structures (Airframes) (JAR 021 01 01 - 02 – 03 - 04)

DU 2. AIRCRAFT SYSTEMS.

Lesson 2. Hydraulic system (JAR 021 01 07)

Lesson 3. Landing gear (JAR 021 01 05)

Lesson 4. Flight control system (JAR 021 01 06)

Lesson 5. Pneumatic system (JAR 021 01 08 – 09)

Lesson 6. Air conditioning system (JAR 021 01 08 – 09)

Lesson 7. De-ice and anti-ice systems (JAR 021 01 08 – 09 - 10)

Lesson 8. Fuel system (JAR 021 01 11)

UD 3. AIRCRAFT POWERPLANTS

Lesson 9. Piston engines architecture (JAR 021 03 01)

Lesson 10. Piston engines systems (JAR 021 03 01)

Lesson 11. Jet engines architecture (JAR 021 03 03)

Lesson 12. Jet engines systems (JAR 021 03 03)

Lesson 13. Aviation fuels (JAR 021 03 01 – 03)

Lección 14. Control and operation of powerplants

UD 4. CLASSICAL FLIGHT INSTRUMENTS AND PRESENTATIONS

Lesson 15. Air data instruments (JAR 022 01 01)

Lesson 16. Gyroscopic instruments (JAR 022 01 02) and compass (JAR 022 01 03)

Lesson 17. Warning and recording equipment (JAR 022 03)

Lesson 18. Powerplants and system monitoring instruments (JAR 022 04)

UD 5. AVIONICS AND ADVANCED FLIGHT INSTRUMENTS

Lesson 19. Military avionics systems components. Technologies and architectures.

Lesson 20. Communication and radiofrequency fundamentals. A review.

Lesson 21. Radar systems. Fundamentals and types.

Lesson 22. Navigation aids systems. Fundamentals.

Lesson 23. Satellite navigation systems.

Lesson 24. Electronic flight instruments: radioaltimeter, EFIS y FMS (JAR 022 01 04 – 05 06)

Lesson 25. Autopilot systems (JAR 022 02)

5.3. Practice syllabus (name and description of every practical)

For Didactic Units 2 and 5, practical sessions are programmed after finishing the theoretical lectures:

1. DU2. "Aircrafts systems". Experimental work on aircraft systems (hydraulic, advanced cooling techniques, ...).
2. DU3. "Aircraft powerplants". Experimental measurements of performances (thrust, torque, specific fuel consumption, ...) on a scale model of a 4-stroke engine

with a propeller.

3. DU5. "Aircraft control systems". Software implementation (matlab or Simulink) and adjustment of a simple (1 axis) autopilot. A pitch control system will be adjusted by the students, the practice will begin with a short description of control techniques, followed by a simple feedback control design and finishing with a PID control adjust.

Risk prevention

Promoting the continuous improvement of working and study conditions of the entire university community is one of the basic principles and goals of the Universidad Politécnica de Cartagena.

Such commitment to prevention and the responsibilities arising from it concern all realms of the university: governing bodies, management team, teaching and research staff, administrative and service staff and students.

The UPCT Service of Occupational Hazards (*Servicio de Prevención de Riesgos Laborales de la UPCT*) has published a "Risk Prevention Manual for new students" (*Manual de acogida al estudiante en materia de prevención de riesgos*), which may be downloaded from the e-learning platform ("Aula Virtual"), with instructions and recommendations on how to act properly, from the point of view of prevention (safety, ergonomics, etc.), when developing any type of activity at the University. You will also find recommendations on how to proceed in an emergency or if an incident occurs.

Particularly when carrying out training practices in laboratories, workshops or field work, you must follow all your teacher's instructions, because he/she is the person responsible for your safety and health during practice performance. Feel free to ask any questions you may have and do not put your safety or that of your classmates at risk.

5.4. Theory syllabus in english (teaching modules and units)

See Section 5.1.

5.5. Detailed description of learning goals for every teaching module

The learning goals (identified by their number in Section 4.5) are related to the teaching modules according to the following table:

		LEARNING GOAL											
		1	2	3	4	5	6	7	8	9	10	11	12
TEACHING MODULE (DU)	1	X											
	2		X	X	X	X							
	3						X	X					
	4								X	X	X		
	5								X	X	X	X	X

6. Teaching method

6.1. Teaching method			
Teaching activity	Teaching techniques	Student workload	Hours
Lectures	Explanation of the subject and following of students' acquisition and application. Doubts solution. Special attention on fundamental and most complex aspects will be made.	<u>Attendance</u> : attendance to classes and participation. Notes taking. Questions.	50
		<u>Non-attendance</u> : individual subject study.	55
Classes	Typical problems resolution and practical cases study with teacher assistance.	<u>Attendance</u> : active attendance. Questions and problems resolution.	17
		<u>Non-attendance</u> : individual subject study. Proposed problems resolution.	20
Practicals (laboratory classes)	Explanation, manage and direction of laboratory classes and computer lab.	<u>Attendance</u> : Active participation. Notes taking. Questions and practice performance.	8
		<u>Non-attendance</u> : Reports writing.	4
Continuous assessment	Short theoretical-practical questions will be given to the student to be solved in the classroom (or virtual classroom) as a technique to monitor the learning process.	<u>Attendance</u> : Theoretical-practical problems solution.	4.5
Supervisions and group tutorials	Proposed problems revision and students' doubts resolution.	<u>Attendance</u> : Face theoretical and practical doubts.	7
		<u>Non-attendance</u> : Theoretical and practical doubts via e-mail and virtual classroom.	
Individual and collaborative workout for oral presentations	Subjects assignment and guidance through bibliography.	<u>Non-attendance</u> : Individually: material selection and understanding. Oral exposition trials. Groupally: aesthetic and contents coherence of the presentation must be obtained	17.5
	Evaluation of the oral presentations	<u>Attendance</u> : Oral presentation and answer to questions.	0.5
Course assessment	An individual, partial written examination about the first part of the course will take place at the middle of the term. At the end of the term, a final individual written examination will be done.	<u>Attendance</u> : Written assessment attendance and solution.	4
TOTAL			187.5

7. Assessment method

7.1 Assessment method					
Assesment activity	Type		Assessment methods and criteria	Percentage (%)	Assessed learning outcomes (4.5)
	Summative	Formative			
Individual written assessment ⁽¹⁾ / Continuous Assessment	X	X	Test questions: assessment tests will be done for the different Didactic Units. Additionally, there will be a final assessment test.	65%	1 to 12
Oral presentation / Workgroup ⁽²⁾	X	X	Oral exposition of a workgroup with time constrains. The subject will deepen into some studied system or technology. It will be important the critical point of view of the exposition.	20%	1 to 12
Practices ⁽³⁾	X	X	The proactive behavior of the student to the practical work and his ability to translate the theoretical knowledge to practice is evaluated. The student will fill an evaluation sheet during or at the end of the session.	15%	2 to 7, 11, 12
<p>COMMENTS:</p> <p>(1) There will be individual written assessments at the end of the different Didactic Units. The number of questions for each test assessment will approximately be:</p> <ul style="list-style-type: none"> ▪ Didactic Units 1 y 2 → NQ_{1y2} = 30 questions ▪ Didactic Unit 3 → NQ₃ = 18 questions ▪ Didactic Unit 4 → NQ₄ = 14 questions ▪ Didactic Unit NQ₅ = 18 questions <p>Test questions format: 4 possible answers with only 1 right answer. Each wrong answer deducts 1/3 of the right answer mark.</p> <p>The students who obtain a mark equal or greater than 4.5 (based on a 0-10 scale) in a written assessment will be exempt from doing the corresponding part in the final assessment. .</p> <p>Let UD_i be the mark (0-10 scale) obtained at each written assessment, the final mark of the Individual Written Assessments (PEI) will be calculated as:</p> $\text{If } \left\{ \begin{array}{l} \text{UD}_{1y2} \geq 4.5 \\ \text{UD}_3 \geq 4.5 \\ \text{UD}_4 \geq 4.5 \\ \text{UD}_5 \geq 4.5 \end{array} \right\} \Rightarrow \text{PEI} = \frac{\sum_i \text{NQ}_i \cdot \text{UD}_i}{\sum_i \text{NQ}_i}$ <p>Otherwise ⇒ PEI=min(UD_i)</p>					

(2) Students, in groups of 4- 5 people, will perform oral presentations, deepening inside some course subject. The workgroup will be scored based on its content, aesthetics, speech, quality of work, answers fluency and time constraints. Specific details for the presentations will be given to students.

The time constraints will be strictly required.

The oral presentation (EO) will have a numerical rating in the interval 0-10.

(3) The numerical rating of the practices (PR) will be from 0 to 10.

The course score (N) will be calculated according to the following expression:

$$0 < PEI < 4.5 \rightarrow N = PEI$$

$$4.5 \leq PEI < 5.0 \rightarrow N = \min(5.0, 0.65PEI + 0.2EO + 0.15PR)$$

$$PEI \geq 5.0 \rightarrow N = 0.65PEI + 0.2EO + 0.15PR$$

- To pass the course, the student has to obtain $N \geq 5.0$.

7.2. Control and monitoring methods (optional)

Monitoring will be done by some of the following mechanisms:

- Proposed class questions and cooperative learning activities (with problems).
- Monitoring and review of the proposed problems.
- Individual tutorials.
- Monitoring of the student activities.
- Individual partial written tests throughout the course.

8. Bibliography and resources

8.1. Basic bibliography

In Spanish:

- **Conocimientos del Avión. Antonio Esteban Oñate. 6ª Ed. Thomson Paraninfo.** Cubre las unidades didácticas 1, 2 y 3. ISBN 9788428329514
- **Cabinas de vuelo. Instrumentación. González Castillo y Hoyas Frontera. 2ª Edición.** Cubre la unidad didáctica 4 y parte de la 5. ISBN 9788493372002
- **Navegación. Sistemas y equipos, maniobras y procedimientos. Martínez Vadillo y Belda Valiente. 7ª Edición.** Cubre parte de la unidad didáctica 5. ISBN 84-604-7696-0.

In English:

- **JAA ATPL Training Series. JEPPESEN. 2nd Edition (> 2004)**
 - **Vol 3. Radio Navigation.** Cubre parte de la unidad didáctica 5
 - **Vol 4. Airframe and Systems.** Cubre las unidades didácticas 1 y 2
 - **Vol 5. Powerplant.** Cubre la unidad didáctica 3
 - **Vol 7 Instrumentation.** Cubre la unidad didáctica 4

8.2. Supplementary bibliography

- **Military Avionics Systems. Moir & Seabridge. 2006 John Wiley & Sons.**
ISBN-10 0-470-01632-9 (HB) (Didactic Unit 5)
The Jet Engine. 5th Ed. Ed. Rolls – Royce (Didactic Unit 3)

8.3. On-line resources and others

Virtual Classroom <https://aulavirtual.upct.es/>: links to online information and videos
Class slideshows