

220137 - An Introduction to Space Systems

Coordinating unit:	205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering		
Teaching unit:	220 - ETSEIAT - Terrassa School of Industrial and Aeronautical Engineering		
Academic year:	2019		
Degree:	BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional) BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Teaching unit Optional)		
ECTS credits:	3	Teaching languages:	English

Teaching staff

Coordinator: Enrique García-Berro Montilla

Teaching methodology

The course is essentially taught delivering theoretical classes. However, students will have to do autonomous learning and they will be required to solve a practical case, chosen by the students themselves. Students will be required to deliver a seminar to explain the team development project. Additionally, students will have to solve and deliver two exercises, under strict deadlines.

In the theoretical sessions I will introduce the basic concepts and emphasize on the fundamental issues, leaving the details for self-study. Students will be guided with some examples of real space missions, emphasizing not only the scientific goals, but also the mission concept, and the detailed implementation to fulfill the science requirements. This will ease the process of acquiring the basic concepts and to acquire a critical perspective of the processes involved in the design and implementation of a space mission. Also, students will have the opportunity of learning how to integrate different subsystems, acquiring in this way a wide perspective of the concepts learned in other subjects of the bachelor.

Learning objectives of the subject

Learn about the different systems of a space mission.

Study load

Total learning time: 75h	Hours large group:	30h	40.00%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	45h	60.00%

220137 - An Introduction to Space Systems

Content

<p>An introduction to space</p>	<p>Learning time: 2h Theory classes: 1h Self study : 1h</p>
<p>Description: Introduction to the topic</p> <p>Specific objectives:</p> <ol style="list-style-type: none"> 1. A premier on Cosmos. 2. A journey across our Cosmos. 3. The Solar System. 4. The Solar Neighborhood. 5. Our Galaxy. 6. ...and beyond. 	
<p>A historical perspective.</p>	<p>Learning time: 2h Theory classes: 1h Self study : 1h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. The beginnings. 2. The pioneers 3. Subsequent developements. 4. The space race. 5. Main milestones of unmanned flights. 6. Main milestones of manned flights. 7. European efforts. 8. New players. 	
<p>Space environment</p>	<p>Learning time: 9h Theory classes: 2h Self study : 7h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Generalities 2. Microgravity 3. Absence of atmosphere 4. Effects of the atmospheric upper layers 5. Effects of vacuum 6. Debris and space garbage 	

220137 - An Introduction to Space Systems

<p>Mission activities, classification, phases, systems and involvement</p>	<p>Learning time: 4h Theory classes: 2h Self study : 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Activities 2. Classification 3. Phases 4. Systems 5. Level of involvement <p>Related activities:</p> <p>Exercise 2</p>	
<p>Orbital Mechanics</p>	<p>Learning time: 14h Theory classes: 5h Self study : 9h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Simple treatment 2. Lagrangian formulation 3. Types of trajectories 4. Kepler's laws 5. Orbital elements 6. Perturbations 7. Osculating elements 8. Regression of the line of nodes. 9. Precession of the line of apses. 10. Lagrangian points. 11. Formation flight. 12. Reference frames. 13. Ground track. 14. Visibility. 	

220137 - An Introduction to Space Systems

Orbital maneuvers	Learning time: 8h Theory classes: 3h Self study : 5h
Description: <ol style="list-style-type: none"> 1. Definition and classification 2. Coplanar maneuvers of 1 and 2 impulses 3. Hohman transfer 4. Bi-elliptic transfer 5. Changes of orbital plane 6. Interplanetary trajectories 7. Gravitational assists 8. Orbital rendezvous 9. Launch windows 	
Attitude and orbit control system	Learning time: 5h Theory classes: 3h Self study : 2h
Description: <ol style="list-style-type: none"> 1. Preliminaries 2. Requirements and generalities 3. Angular moment, principal axes, torques 4. Equations of motion 5. Torque free motion stability 6. Spin stabilization 7. Satellite classification 8. Sensors 9. Actuators 	
Power system	Learning time: 5h Theory classes: 2h Self study : 3h
Description: <ol style="list-style-type: none"> 1. Mission and tasks 2. Power sources: classification 3. Definitions and general considerations 4. Solar panels 5. Batteries 6. Fuel cells 7. Nuclear energy: disintegration and fission 	

220137 - An Introduction to Space Systems

<p>Thermal controls system</p>	<p>Learning time: 5h Theory classes: 3h Self study : 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Generalities 2. Heat transport mechanisms 3. Thermal balance 4. Active and passive technologies 	
<p>Communications system</p>	<p>Learning time: 5h Theory classes: 3h Self study : 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Terminology. 2. Communications strategy. 3. Links. 4. Design of the communications architecture. 5. Classification of strategies. 6. Functionality. 7. Criteria for the design. 8. Digital communications. 9. Link design. 10. Modulation. 11. Multiple access. 	
<p>Payload Data Handling System.</p>	<p>Learning time: 5h Theory classes: 3h Self study : 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Introduction. 2. Generalities. 3. Definitions. 4. On board/on ground processing. 5. Hardware/Software processing. 6. Architecture. 7. Configuration. 8. Examples. 9. Data compression. 	

220137 - An Introduction to Space Systems

<p>Ground and User Segment</p>	<p>Learning time: 4h Theory classes: 2h Self study : 2h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Generalities. 2. Structure and organization. 3. Mission Control Center. 4. Scientific Operations Planning Committee. 5. User support system. 6. Control Authority Office. 7. Data format. 8. Databases. 	
<p>Life Support System</p>	<p>Learning time: 5h Theory classes: 2h Self study : 3h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Mission and tasks. 2. Overview. 3. An example: the ISS. 4. Physiological effects. 5. Psychological effects. 6. Solutions. 	
<p>Mission operations</p>	<p>Learning time: 3h Theory classes: 2h Self study : 1h</p>
<p>Description:</p> <ol style="list-style-type: none"> 1. Mission and tasks. 2. Technical support. 3. Design of Mission Operations Plan. 4. Key responsibilities. 5. Costs. 6. Operational complexity trade-off. 	

220137 - An Introduction to Space Systems

Logistics	Learning time: 2h Theory classes: 1h Self study : 1h
Description: 1. Generalities. 2. An example: the Space Shuttle.	

Qualification system

The final grade will be calculated based on the following rules:

- a) 50% from a team development project.
- b) 20% from the grades obtained from the individual exercises required in modules 1 and 4.
- c) 20% will be assigned based on the quality of the presentations delivered at the seminars.
- d) 10% will be assigned according to student's attitude, assistance, and interest on the matter subject.

Bibliography

Basic:

Wertz, J. R.; Larson, W. J. Space mission analysis and design. 3rd ed. Dordrecht [etc.]: Kluwer Academic, cop. 1999. ISBN 9781881883104.

Fortescue, P.; Stark, J.; Swinerd, G. Spacecraft systems engineering. 3rd ed. Chichester ; New York: Wiley, cop. 2003. ISBN 9780471619512.

Complementary:

Griffin, M. D.; French, J. R. Space vehicle design. 2nd ed. Reston, VA: American Institute of Aeronautics and Astronautics, Inc, 2004. ISBN 1563475391.