



(*)Escola de Enxeñaría Aeronáutica e do Espazo

Presentation

The School of Aeronautic and Space Engineering (EEAE) of the University of Vigo at the Campus of Ourense offers the degrees of the University of Vigo that are related both to bachelor's and to master's level in the field of aeronautical or aerospace engineering.

More information about the Center and its degrees is found in this document or on the web page (<http://aero.uvigo.es>).

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Regulations and legislation

The information is available on the Center's web site (<http://aero.uvigo.es> in the section: School -> Regulations).

(*)Máster Universitario en Enxeñaría Aeronáutica

Subjects

Year 2nd

Code	Name	Quadmester	Total Cr.
007M197V01301	Space projects management	1st	6
007M197V01302	Space environment and mission analysis	1st	6
007M197V01303	Space mechanical, thermal and electrical systems	1st	6
007M197V01304	Critical software for space systems	1st	6
007M197V01305	Space telecommunication systems	1st	6
007M197V01306	Space observation systems	1st	6
007M197V01307	Space Science	1st	6
007M197V01308	Orbit and attitude control systems	1st	6
007M197V01309	Space propulsion	1st	6

O07M197V01310	Artificial Intelligence in Space Engineering	1st	6
O07M197V01401	Operation of air transport	2nd	6
O07M197V01402	Development of aeronautical infrastructures	2nd	6
O07M197V01403	External practices	2nd	6
O07M197V01404	Final Master's Project	2nd	12

IDENTIFYING DATA				
Xestión de proxectos espaciais				
Subject	Xestión de proxectos espaciais			
Code	O07M197V01301			
Study programme	Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2	1c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	Rey González, Guillermo David			
Lecturers	Rey González, Guillermo David			
E-mail	guillermo.rey@uvigo.es			
Web	http://muea.webs.uvigo.es/			
General description	A materia cobre a planificación e xestión de proxectos espaciais, incluíndo a análise de riscos. Profúndase na fabricación e integración de vehículos espaciais, abordando os materiais e procesos involucrados. Ademais, estúdanse os ensaios e validacións necesarios para garantir o correcto funcionamento dos vehículos espaciais. O curso tamén inclúe o segmento terra e o control de operacións, así como os estándares de calidade e a garantía de produto para asegurar a fiabilidade na contorna espacial.			

Resultados de Formación e Aprendizaxe	
Code	
B3	Coñecemento adecuado dos materiais metálicos e materiais compostos utilizados na fabricación de vehículos aeroespaciais
B4	Coñecementos e habilidades que permitan comprender e levar a cabo os procesos de fabricación de vehículos aeroespaciais
C1	Capacidade para deseñar, executar e analizar as probas en terra e en voo de vehículos aeroespaciais, así como para realizar un proceso completo de certificación dos mesmos.
C8	Deseñar produtos espaciais que se correspondan coas necesidades dos axentes implicados, definindo funcións, conceptos e a súa arquitectura.
D11	Comprender e aplicar os coñecementos, métodos e ferramentas necesarios para desenvolver proxectos de enxeñería espacial.

Resultados previstos na materia	
Expected results from this subject	Training and Learning Results
ID6. Coñecemento adecuado dos materiais metálicos e materiais compostos utilizados na fabricación de vehículos aeroespaciais.	B3
ID7. Coñecementos e capacidades que permiten comprender e realizar os procesos de fabricación dos vehículos aeroespaciais.	B4
ID9. Capacidade para deseñar, executar e analizar os ensaios en terra e en voo dos vehículos aeroespaciais, e para levar a cabo un proceso completo de certificación dos mesmos.	C1
ID35. Comprender e aplicar os coñecementos e ferramentas necesarias para desenvolver proxectos de enxeñería espacial.	D11
ID36. Concibir produtos espaciais que correspondan ás necesidades dos axentes involucrados, definindo funcións, conceptos e a súa arquitectura.	C8

Contidos
Topic

<p>Bloque 1. Xestión de proxectos espaciais, planificación, análise de riscos.</p>	<p>Tema 1. Introducción á xestión de proxectos espaciais. Definición e características dos proxectos espaciais. Ciclo de vida dun proxecto espacial. Estrutura organizativa en proxectos espaciais.</p> <p>Tema 2. Planificación de proxectos espaciais. Metodoloxías de planificación (PMI, PRINCE2, Áxil). Xestión do alcance e cronograma. Xestión de recursos e orzamentos.</p> <p>Tema 3. Análise de riscos en proxectos espaciais. Identificación e clasificación de riscos. Análise cualitativa e cuantitativa de riscos. Estratexias de mitigación e xestión de riscos.</p> <p>Tema 4. Xestión de stakeholders e comunicación. Identificación e análise de stakeholders. Estratexias de comunicación. Xestión de expectativas e conflitos.</p> <p>Tema 5. Ferramentas e técnicas de xestión de proxectos. Software de xestión de proxectos. Técnicas de seguimento e control. Indicadores clave de rendemento (KPIs)</p>
<p>Bloque 2. Fabricación e integración de vehículos espaciais: materiais e procesos.</p>	<p>Tema 6. Deseño e desenvolvemento de vehículos espaciais. Tipos de vehículos espaciais (satélites, sondas, módulos tripulados). Principios de deseño aeroespacial. Integración de subsistemas.</p> <p>Tema 7. Materiais aeroespaciais. Materiais avanzados e as súas propiedades. Selección de materiais segundo aplicación. Probas de materiais e validación.</p> <p>Tema 8. Procesos de fabricación. Técnicas de manufactura aditiva e sustractiva. Fabricación de compoñentes estruturais e electrónicos. Control de calidade na fabricación.</p> <p>Tema 9. Integración de vehículos espaciais. Procedementos de ensamblaxe. Xestión da compatibilidade e interfaces. Documentación e rastrexabilidade.</p> <p>Tema 10. Loxística e xestión da cadea de subministración. Provedores e contratistas. Xestión de inventarios e almacéns. Transporte e manipulación de compoñentes críticos.</p>
<p>Bloque 3. Ensaio e validacións.</p>	<p>Tema 11. Introducción aos ensaios espaciais. Tipos de ensaios (mecánicos, térmicos, eléctricos). Normativas e estándares (NASA, ESA, ISO).</p> <p>Tema 12. Ensaio mecánicos e estruturais. Probas de vibración e choque. Ensaio de fatiga e resistencia. Técnicas de vixilancia e análise de datos.</p> <p>Tema 13. Ensaio térmicos e ambientais. Probas de ciclo térmico e baleiro térmico. Simulación de condicións espaciais. Validación de sistemas de control térmico.</p> <p>Tema 14. Ensaio eléctricos e electrónicos. Probas de compatibilidade electromagnética (EMC). Validación de sistemas de comunicación e control. Ensaio de resistencia a radiación.</p> <p>Tema 15. Campañas de validación e certificación. Proceso de validación e aceptación. Documentación e reporte de resultados. Certificación e cumprimento de normativas.</p>
<p>Bloque 4. Segmento terra e control de operacións.</p>	<p>Tema 16. Infraestrutura do segmento terra. Estacións terreas e redes de comunicación. Centros de control de misión. Sistemas de soporte en terra.</p> <p>Tema 17. Operacións e control de misión. Planificación e execución de operacións. Monitorización e control en tempo real. Xestión de continxencias e anomalías.</p> <p>Tema 18. Telemetría, seguimento e control (TT&C). Sistemas e tecnoloxías de TT&C. Procesamento e análise de datos de telemetría. Control de actitude e órbita.</p> <p>Tema 19. Segmento terra e soporte á misión. Interface entre o segmento terra e o vehículo espacial. Soporte durante as fases críticas da misión (lanzamento, inserción orbital, reentrada). Coordinación con axencias espaciais e outros actores.</p> <p>Tema 20. Ferramentas e software de xestión de operacións. Plataformas e sistemas de control de misión. Análise de datos e big data en operacións espaciais. Seguridade cibernética no segmento terra.</p>

Bloque 5. Calidade para o espazo, garantía de produto.

Tema 21. Xestión da calidade en proxectos espaciais. Sistemas de xestión da calidade (ISO 9001, AS9100). Políticas e obxectivos de calidade. Auditorías internas e externas.
 Tema 22. Aseguramento da calidade no deseño e desenvolvemento. Metodoloxías de aseguramento de calidade. Control de calidade no deseño. Validación e verificación de requisitos.
 Tema 23. Control de calidade na fabricación e integración. Inspección e probas de compoñentes. Xestión de non conformidades. Procedementos de mellora continua.
 Tema 24. Garantía de produto para o espazo. Avaliación da fiabilidade e vida útil. Xestión da obsolescencia. Programas de mantemento e soporte post-lanzamento.
 Tema 25. Normativas e estándares de calidade espacial. Estándares de calidade e certificación (ECSS, MIL-STD). Requisitos de calidade de axencias espaciais (NASA, ESA). Implementación e seguimento de estándares de calidade.

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	29	0	29
Prácticas con apoio das TIC	16.5	0	16.5
Proxecto	102	0	102
Exame de preguntas obxectivas	1.5	0	1.5
Presentación	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente

	Description
Lección maxistral	Exposición por parte do profesor dos contidos sobre a materia obxecto de estudo, bases teóricas e/o directrices dun traballo, exercicio que o/a estudante ten que desenvolver
Prácticas con apoio das TIC	Actividade na que se formulan problema e/o exercicios relacionados coa materia. O alumno debe desenvolver as solucións idóneas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Adóitase empregar como complemento da lección maxistral.

Atención personalizada

Tests	Description
Proxecto	O/A estudante, de maneira individual ou en grupo, elabora un documento sobre a temática da materia ou prepara seminarios, investigacións, memorias, ensaios, resumos de lecturas, conferencias, etc. No ámbito da acción titorial, distínguense accións de titoría académica, así como de titoría personalizada. No primeiro dos casos, o alumnado terá á súa disposición horas de titorías nas que pode consultar calquera dúbida relacionada cos contidos, organización e planificación da materia, co desenvolvemento do proxecto etc. As titorías poden ser individualizadas, pero fomentaranse titorías grupais para a resolución de problemas relacionados coas actividades para realizar en grupo, ou simplemente para informar o docente da evolución do traballo colaborativo. Nas titorías personalizadas, cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algúns tipos de solución. Conxugando ambos os tipos de acción titorial, preténdense compensar os diferentes ritmos de aprendizaxe mediante a atención á diversidade.

Avaliación

	Description	Qualification	Training and Learning Results
Proxecto	Realización dun proxecto relacionado cos contidos da materia.	30	B3 C1 D11 B4 C8
Exame de preguntas obxectivas	Exame de problemas e/o preguntas de desenvolvemento e/o tipo test	40	B3 C1 D11 B4 C8
Presentación	Presentación e defensa en clase do traballo grupal desenvolvido.	30	B3 C1 D11 B4 C8

Other comments on the Evaluation

O calendario de probas de avaliación atópase publicado na páxina web do centro.

Primeira oportunidade.

(1) Estudantes que seguen o curso por Avaliación Continua. Para poder superar a materia na primeira oportunidade, mediante Avaliación Continua, será necesario:

-Unha nota mínima de 4 en cada un dos exames da materia.

-Asistir a, como mínimo, o 90% das sesións de prácticas.

-Entregar a totalidade de memorias prácticas e traballos da materia obtendo, como mínimo, unha nota de 3 en cada un deles.

No caso de non cumprir ditas condicións a nota final será a resultante do mínimo da nota media ponderada de AC e de 4.9.

(2) Estudante que desexen ser avaliados mediante avaliación global.

A avaliación do curso na primeira oportunidade realizarase, por defecto, mediante Avaliación Continua. O estudantado ten dereito a optar pola avaliación global segundo o procedemento e o prazo que estableza o centro para cada convocatoria. A nota obtida neste exame representará o 100% da nota final. O estudante deberá obter unha nota mínima de 5.0 neste exame. Este exame pode ter unha parte para realizar nunha sala de computadores e / ou laboratorio, e comprenderá a totalidade da materia impartida, así como os contidos abordados en todas as sesións prácticas e traballos.

Segunda oportunidade e Fin de Carrera.

O estudantado que non superase a materia na primeira oportunidade poderá realizarán un exame que supoñerá o 100% da nota. O estudante deberá obter unha nota mínima de 5.0 neste exame. Este exame pode ter unha parte para realizar nunha sala de computadores e / ou laboratorio, e comprenderá a totalidade da materia impartida, así como os contidos abordados en todas as sesións prácticas e traballos.

En caso de detección de plaxio en calquera elemento de cualificación, a cualificación na devandita entrega será 0 e o feito será comunicado á dirección do Centro para os efectos oportunos.

Bibliografía. Fontes de información

Basic Bibliography

Project Management Institute, **A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - The Standard for Project Management**, 978-1628256796, 7, Project Management Institute, 2021

European Cooperation for Space Standardization, **ECSS handbooks**, European Cooperation for Space Standardization,

Complementary Bibliography

Recomendacións

Subjects that are recommended to be taken simultaneously

Cálculo avanzado de estruturas aeroespaciales/O07M197V01202

Deseño, cálculo e certificación de sistemas de propulsión aeroespaciales/O07M197V01203

Subjects that it is recommended to have taken before

Deseño, cálculo e certificación de aeronaves e vehículos espaciales/O07M197V01103

IDENTIFYING DATA**Space environment and mission analysis**

Subject	Space environment and mission analysis			
Code	O07M197V01302			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Navarro Medina, Fermín			
Lecturers	Navarro Medina, Fermín			
E-mail	fermin.navarro.medina@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	The subject "space environment and mission analysis" addresses the study of the space environmental conditions to which a space vehicle is subjected, and the analysis of all the elements of systems engineering to be considered to define and characterize a space mission. Vacuum, microgravity, magnetic fields, radiation, plasma and meteorites are considered. The mission analysis focuses on the concepts of operation, the definition of operations, the functional architecture, the definition of requirements, the orbital calculation, the calculation of budgets by subsystems, the definition of the launch and reentry system, and the control of guidance of the space vehicle.			

Training and Learning Results

Code	
B6	Adequate knowledge of the different subsystems of aircraft and spacecraft
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D3	Understanding and mastery of atmospheric flight mechanics (performance, stability, static and dynamic control), orbital mechanics and attitude dynamics.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Understanding and mastery of atmospheric flight mechanics (performance, stability, static and dynamic control), orbital mechanics and attitude dynamics.	D3
Adequate knowledge of the different subsystems of aircraft and spacecraft	B6
Understand and apply the knowledge, methods and tools necessary to develop space engineering projects	D11
To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.	C8

Contents

Topic	
1. Space missions in the solar system	1.1. Solar system. Overview of the space environment. 1.2. Mission analysis. 1.2.1. Systems engineering study. - Concept of operations - Functional architecture - Requirements - Interfaces. - Budgets 1.2.2. Orbital Dynamics. Mission types - Earth Missions. Nearby space environment Earth (magnetic, electric, gravitational field). Meteorites and space debris - Interplanetary missions. Plasma and space 1.2.3. Space propulsion systems. Dv Calculation
2. Launch into orbit and re-entry	2.1. Launch systems 2.2. Reentry vehicles
3. Guidance and control of space vehicles	3.1. Attitude dynamics 3.2. Attitude control and guidance. Effect of disturbances

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	29	0	29
Previous studies	0	30	30
Mentored work	6.5	66	72.5
Case studies	10	6	16
Objective questions exam	2	0	2
Presentation	0.5	0	0.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Lecturing	Presentation of a topic or resolution of problems by teachers according to a content guide previously established.
Previous studies	Study of the students autonomously, with the support of the teaching staff if required according to the procedures established by the university for tutoring sessions
Mentored work	The project of the subject consists of carrying out a conceptual design project for a space mission. The work is done individually, dedicating work sessions in class for tutoring and monitoring outside the classroom. The work includes: mission analysis, space environment, launch segment, and control and guidance subsystem. For each part of the project, case studies will be previously carried out in the classroom, which guide the students in the preparation of the project.
Case studies	Carrying out practical case studies on the contents of the subject, which will be explained and started in the classroom to be completed by the students outside the classroom. The case studies will require the use of software and will be applied in the supervised project.

Personalized assistance	
Methodologies	Description
Previous studies	Study of the students autonomously, with the support of the teaching staff if required according to the procedures established by the university for tutoring sessions
Mentored work	The project of the subject consists of carrying out a conceptual design project for a space mission. The work is done individually, dedicating work sessions in class for tutoring and monitoring outside the classroom. The work includes: mission analysis, space environment, launch segment, and control and guidance subsystem. For each part of the project, case studies will be previously carried out in the classroom, which guide the students in the preparation of the project.

Assessment					
	Description	Qualification	Training and Learning Results		
Mentored work	The work of the subject consists of carrying out a conceptual design project for a space mission. The work is done individually, dedicating work sessions in class for tutoring, and follow-up outside the classroom. The work is evaluated through three reports, and a presentation at the end. The reports are: 1) mission and space environment analysis (25% of the total subject), 2) launch segment (15%), and 3) control and guidance subsystem (15%). The reports are delivered separately at three different times during the course (approximately weeks 6, 9 and 12).	55	B6	C8	D3 D11
Objective questions exam	Exam based on problem solving and/or conceptual questions about the contents of the subject. It will be on the official exam date. Minimum mark of 5.0.	40	B6	C8	D3 D11
Presentation	Individual presentation of the work of the subject consisting of the conceptual design of a space mission.	5	B6	C8	D3 D11

Other comments on the Evaluation

First call evaluation

To pass the subject on the 1st call, it will be necessary to obtain a grade higher than 5 points out of 10 in the assessment of continuous evaluation, during the development of classes and the exam on the official date. Besides, the exam grade on the official date must be greater than or equal to 5 points out of 10. The final evaluation grade of continuous assessment will be obtained according to the indicated percentages.

For the global evaluation, and using the same evaluation percentages:

- An exam will be taken on the official date, which includes all the contents of the subject, and whose minimum grade to pass the subject will be 5 points out of 10.

- All supervised project reports and their presentation recorded on video must be delivered before the official date.

The calendar of evaluation tests officially approved by the EEAE Center Board is published on the website

<http://aero.uvigo.es/gl/docencia/exames>

Continuous evaluation tests will be carried out during school hours

The student has the right to opt for the global evaluation according to the procedure and deadline established by the center for each call.

Second call evaluation

Students must take the second chance exam for all the contents of the subject, if the final continuous evaluation grade is less than 5 points out of 10. They will also have to take the second chance exam in the case of obtaining a grade lower than 5 points out of 10 on the first opportunity final exam.

If you obtain a grade greater than or equal to 5 in the second chance exam, the final grade for the subject will be the highest grade among:

* the 2nd call exam

* the average with the activities carried out during the course (averaging with the percentages in the evaluation table substituting the grade of the first call exam for the second call exam)

End of degree evaluation

For the end-of-course evaluation, an exam will be taken on the official date, which includes all the contents of the subject. The grade for that exam to pass the subject will be 5 points out of 10.

Sources of information

Basic Bibliography

Larson W.J. and Wertz J.R., **Space mission analysis and design**, 3, Microcosm Press, 1999

Complementary Bibliography

Vincent L. Pisacane, **Fundamentals of Space Systems**, 2, Oxford University Press, 2005

Howard D. Curtis, **Orbital Mechanics for Engineering Students**, 4, Elsevier Ltd., 2020

Don Edberg and Willie Costa, **Design of Rockets and Space Launch Vehicles**, 2, AIAA, 2022

Recommendations

Subjects that are recommended to be taken simultaneously

Space Science/O07M197V01307

Space projects management/O07M197V01301

Space propulsion/O07M197V01309

Orbit and attitude control systems/O07M197V01308

Space observation systems/O07M197V01306

Space telecommunication systems/O07M197V01305

Space mechanical, thermal and electrical systems/O07M197V01303

Subjects that it is recommended to have taken before

Flight dynamic/O07M197V01201

Design, calculation and certification of aircraft and space vehicles/O07M197V01103

IDENTIFYING DATA**Space mechanical, thermal and electrical systems**

Subject	Space mechanical, thermal and electrical systems			
Code	O07M197V01303			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Gómez San Juan, Alejandro Manuel			
Lecturers	Gómez San Juan, Alejandro Manuel			
E-mail	alejandromanuel.gomez@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	In the subject "Mechanical System, Thermal and Electrical Space tackle said subsystems with the object that the student learn the foundations of the same, so much to theoretical level to be able to do initial designs, as that familiarise with the distinct technologies employed in the same.			
	English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
B5	Knowledge and skills for the structural analysis and design of aircraft and spacecraft, including the application of advanced structural design and calculation programs
B6	Adequate knowledge of the different subsystems of aircraft and spacecraft
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D4	Understanding and mastering the phenomena associated with combustion and heat and mass transfer.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject

Expected results from this subject	Training and Learning Results
G08. Knowledges and capacities for the analysis and structural design of the aircraft and space vehicles, including the application of programs of calculation and design advanced of structures.	B5
G010. Suitable knowledge of the distinct subsystems of the aircraft and space vehicles.	B6
G013. Understanding and command of the phenomena associated to combustion and to the transfer of heat and mass.	D4
G035. Comprise and apply the knowledges and necessary tools to develop projects of space engineering.	D11
G036. Conceive space products that correspond to the needs of the agents involved, defining functions, concepts and his architecture.	C8

Contents

Topic	
Electrical power subsystem	-Primary sources -Storage, distribution, regulation and control.
Structures and mechanisms	-Structural loads -Modelling and design.
Thermal control subsystem	-Technologies -Thermal loads -Modelling and design.
Protection to electromagnetic radiation and plasma.	-Electromagnetic radiation -Plasma.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	28	29	57

Practices through ICT	15.5	0	15.5
Case studies	1	73	74
Objective questions exam	2.5	0	2.5
Case studies	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Lecturing	Exhibition by part of the professor of the contents on the matter object of study, theoretical bases and guidelines of a work or exercise that the/the student has to develop.
Practices through ICT	Activities of application of the knowledges in a determinate context and of acquisition of basic skills and procedures in relation with the matter, through the TIC, fundamentally with tools of simulation used in the industry.
Case studies	Realisation of cases of practical study on the contents of the subject, the which will be explained and initiated in the classroom to be finished and delivered by part of the students out of the classroom. The cases of study will require of the use of specific software

Personalized assistance

Methodologies	Description
Case studies	Realisation of cases of practical study on the contents of the subject, the which will be explained and initiated in the classroom to be finished and delivered by part of the students out of the classroom. The students will have of the personal lessons necessary with the professor for the follow-up of the development of the cases of study

Assessment

	Description	Qualification	Training and Learning Results		
Objective questions exam	Examination based in the resolution of problems and/or conceptual questions on the contents of the subject. It will be in date of official examination. Minimum note of 5.0.	40	B5 B6	C8	D4 D11
Case studies	Along the subject will present 4 practical works, each one being 15% of the total note. 1 - Power system 2 - Spacecraft structure 3 - Thermal control subsystem 4 - Integration	60	B5 B6	C8	D4 D11

Other comments on the Evaluation

First Opportunity Evaluation

To pass the subject on the 1st opportunity, it will be necessary to obtain a grade higher than 5 points out of 10 in the overall assessment of continuous evaluation during the course and the exam on the official date. Additionally, the grade for the official exam must be equal to or higher than 5 points out of 10. The final grade for continuous evaluation will be obtained according to the indicated percentages.

For the overall evaluation, there will be an exam on the official date, which includes all the contents of the subject, including the contents and methods used in the case studies. The passing grade for this exam will be 5 points out of 10.

The officially approved schedule of evaluation tests by the EEAE Center Board will be published on the website:

<http://aero.uvigo.es/gl/docencia/exames>

The continuous evaluation tests will be conducted during regular class hours.

The student has the right to choose the overall evaluation according to the procedure and deadline established by the institution for each examination session.

Second Opportunity Evaluation

Students must take the resit exam, which covers all the subject contents and accounts for 100% of the final grade, if the final grade for continuous evaluation is lower than 5 points out of 10. They must also take the resit exam in the following cases:

- Obtaining a grade lower than 5 points out of 10 in the final exam of the first opportunity.

If a grade equal to or higher than 5 is obtained in the resit exam, the final grade for the subject will be the higher grade between:

- the resit exam grade,
- the average grade from the coursework activities (averaging with the percentages specified in the evaluation table, substituting the grade of the first opportunity exam with the grade of the resit exam).

Final Year Evaluation

For the final year evaluation, there will be an exam on the official date, which includes all the contents of the subject. The passing grade for this exam will be 5 points out of 10.

Sources of information

Basic Bibliography

Complementary Bibliography

J. Wijker, **Spacecraft Structures**, Springer, 2008

W. Larson, J. Wertz, **Space Mission Analysis and Design**, 3, Microcosm Press, 1999

D. Gilmore, **Spacecraft Thermal Control**, 2, Aerospace Press,

R, Patel, **Spacecraft Power Systems**, CRC Press, 2023

Recommendations

Subjects that are recommended to be taken simultaneously

Space environment and mission analysis/O07M197V01302

Subjects that it is recommended to have taken before

Advanced calculation of aerospace structures/O07M197V01202

Design, calculation and certification of aircraft and space vehicles/O07M197V01103

IDENTIFYING DATA**Critical software for space systems**

Subject	Critical software for space systems			
Code	O07M197V01304			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Formella , Arno			
Lecturers	Formella , Arno González Castro, Miguel Ramón Pérez Cota, Manuel			
E-mail	formella@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	It introduces and analyses critical software systems especially in the field of space engineering, how these systems are treated in the corresponding standards, and how their complexity is faced in interdisciplinary teams.			
	English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
B13	Adequate knowledge of aeronautical information technologies and communications.
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Know how to analyse and comprehend the complexity of critical software systems in the space sector including ground segment and general aeronautical/industrial support systems.	B13 C8 D11
Special emphasis is put on available standards, proposals already implemented, and the need of interdisciplinary team work.	
To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.	C8
Adequate knowledge of aeronautical information technologies and communications.	B13
Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.	D11

Contents

Topic	
Introduction	Critical software Examples of errors Complexity and tools Availability
Standards	ECSS ISO/IEC Industrial Control others
Software design	Hardware Requirements Redundancy Interfaces Documentation Quality

Verification and validation	Proving Test Integration Maintenance
Onboard computer	Example Embedded software TC/TM protocol (PUS)
Simulation	Use Virtualization Digital twin

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	29	0	29
Practices through ICT	16.5	40.5	57
Mentored work	0	40	40
Presentation	0.5	15.5	16
Objective questions exam	1	3	4
Essay questions exam	1	3	4

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation by the teachers of the contents on the subject under study, theoretical bases and/or guidelines of a work, exercise or project to be developed by the student.
Practices through ICT	Activities for applying knowledge to specific situations, and acquiring basic skills and procedures related to the subject matter of study, which are carried out in computer classrooms.
Mentored work	Activity in which one or several problems of a longer duration are formulated, where the student must apply the knowledge acquired both in the master classes and in the computer practical classes.

Personalized assistance

Methodologies	Description
Lecturing	The students will be attended to in a personalized way in the lectures, as well as in the computer practices. Likewise, students will be attended to in a personalized manner in the teachers' tutoring sessions.
Practices through ICT	The students will be attended to in a personalized way in the lectures, as well as in the computer practices. Likewise, students will be attended to in a personalized manner in the teachers' tutoring sessions.
Mentored work	Students will be attended to in a personalized manner in the teachers' tutoring sessions.

Tests	Description
Presentation	The students will be attended to in a personalized way during the preparation and exposition of their presentations. Likewise, students will be attended to in a personalized manner in the teachers' tutoring sessions.

Assessment

	Description	Qualification	Training and Learning Results
Lecturing	Resolution of problems and/or exercises during the master class or conference. Test in which the students must solve proposed problems or exercises in a time and under conditions established by the teacher. In this way, the students must apply the knowledge they acquired.	5	B13 C8 D11
Mentored work	Practice report in written format. Preparation of a report by the student body that reflects the characteristics of the work carried out. The student body must describe the tasks and procedures developed, show the results obtained or the observations made, as well as the analysis and processing of the data.	40	B13 C8 D11
Presentation	Practice report in oral format. Preparation of a presentation by the student in which the characteristics of the work carried out are reflected. The student body must present the tasks and procedures developed, show the results obtained or the observations made, as well as the analysis and processing of the data.	20	B13 C8 D11

Objective questions exam	Short question exam. Evaluation test that includes open questions on the topic. The student must develop, relate, organize and present the knowledge they have on the subject in a short answer.	15	B13 C8 D11
Essay questions exam	Development questions exam. Evaluation test that includes open questions on the topic. The student must develop, relate, organize and present the knowledge they have on the subject in a longer response.	20	B13 C8 D11

Other comments on the Evaluation

First opportunity evaluation:

To pass the subject on the 1st opportunity, it will be necessary to obtain a grade higher than 5 points out of 10 in the joint assessment of the continuous evaluation tests, the assignments delivered during the development of the classes, and the exam taken on the official date. The final grade of the continuous evaluation will be obtained according to the indicated percentages.

The student has the right to opt for the global evaluation according to the procedure and deadline established by the center for each call.

Overall evaluation:

An exam will be taken on the official date, which includes all the contents of the subject, including the contents and methods used in the case studies. The grade for said exam to pass the subject will be 5 points out of 10.

The calendar of evaluation tests officially approved by the "Junta de Centro" of the EEAE is published on the website <http://aero.uvigo.es/gl/docencia/exames>

Second chance evaluation:

Students must take the second call exam for all the contents of the subject, which will account for 100% of the grade, if the final continuous evaluation grade is less than 5 points out of 10. If you have a score equal to or greater than 5 out of 10 in the continuous evaluation assignments/tests, the grade will be saved for the second opportunity, having to take the official exam only, which will have a weight of 35% of the total. the final grade of the subject.

End of degree evaluation:

For the end-of-course evaluation, an exam will be taken on the official date, which includes all the contents of the subject. The grade for said exam to pass the subject will be 5 points out of 10.

Sources of information

Basic Bibliography

ESA, **ECSS standard**, <https://ecss.nl/>, ESA Requirements and Standards Division,

Naik Kshirasagar, Tripathy Priadarshi, **Software Testing and Quality Assurance**, 978-0-471-78911-6, Wiley, 2008

Clay Breshears, **The Art of Concurrency**, 978-0-596-52153-0, O'Reilly Media, Inc., 2009

Complementary Bibliography

various, **Material de apoyo seleccionado**, fuentes diversas, 1960-2024

Recommendations

Other comments

It is recommended to dedicate the indicated time of assigned personal work, as well as resort to personal tutoring with teachers to resolve possible doubts that arise during the studies and the preparation of work.

Complete follow-up of the subject is recommended as well as an active attitude in class and during the conferences.

IDENTIFYING DATA**Space telecommunication systems**

Subject	Space telecommunication systems			
Code	O07M197V01305			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Aguado Agelet, Fernando Antonio			
Lecturers	Aguado Agelet, Fernando Antonio Arias Acuña, Alberto Marcos Rubiños López, José Óscar			
E-mail	faguado@uvigo.gal			
Web	http://muea.webs.uvigo.es			

General description The subject "Space Telecommunication Systems" provides a comprehensive understanding of the technologies and systems used in space communication. First, it covers the study of radiofrequency and optical communication technologies, essential for data transmission in space. It delves into link budget, analyzing the necessary calculations to ensure effective communication between transmitters and receivers. Additionally, it examines the communication subsystems between ground stations and satellites, as well as the subsystems that enable inter-satellite communication. Satellite navigation systems are also covered.

Another important aspect of the subject is the study of antennas, where the principles and specific designs for space communications are explored. The performance and applications of different types of antennas in satellites and ground stations are analyzed. Furthermore, the subject reviews radiofrequency systems and space electronics, fundamental for the design and operation of equipment in the space environment. Finally, the ground segment is considered, addressing the terrestrial infrastructure necessary to support space operations and the concept of operations, which includes the planning and management of space missions to ensure efficient and continuous communication.

English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.

Training and Learning Results

Code	
B13	Adequate knowledge of aeronautical information technologies and communications.
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Adequate knowledge of aeronautical information technologies and communications.	B13
Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.	D11
To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.	C8

Contents

Topic	
1.- Technologies and Link Analysis of Communications	1.- Radiofrequency, Optical Communications 2.- Link Budget 3.- Antennas
2.- Communication Subsystems - Space Segment	1.- Space-to-Earth Communication Subsystems 2.- Inter-Satellite Communication Subsystems
3.- Satellite Navigation Systems	1.- Basics of Satellite Navigation. 2.- Main Satellite Navigation Systems. 3.- Generation and Reception of Navigation Signals.

4.- Radio Systems and Space Electronics	1.- Architecture of Radio Systems. 2.- Space Environment Requirements in the Electronics of Radio Systems.
5.- Ground Segment	1.- Architecture 2.- Concept of Operations 3.- Operations Standards and Software

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	15	10	25
Problem solving	14	10	24
Autonomous problem solving	0	20	20
Laboratory practical	10	10	20
Practices through ICT	6.5	12	18.5
Essay questions exam	1.5	0	1.5
Problem and/or exercise solving	1	0	1
Essay	0	40	40

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation by the faculty of the contents on the subject under study, theoretical foundations, and guidelines for a project or exercise that the student has to develop.
Problem solving	Activity in which problems and/or exercises related to the subject are formulated. Students must develop appropriate solutions through the practice of routines, the application of formulas or algorithms, the application of procedures to transform the available information, and the interpretation of the results. This is usually used as a complement to the lecture.
Autonomous problem solving	Activity in which problems and/or exercises related to the subject are formulated. Students must develop the analysis and resolution of the problems and/or exercises independently.
Laboratory practical	Laboratory practices. Activities for applying knowledge to specific situations and acquiring basic and procedural skills related to the subject under study. These are conducted in specialized spaces with specialized equipment (laboratories, computer rooms, etc.).
Practices through ICT	Practices in computer labs. Activities for applying knowledge in a specific context and acquiring basic and procedural skills related to the subject, through ICT.

Software used: Matlab, Python, Excel, STK (or similar).

Personalized assistance

Methodologies	Description
Lecturing	Students will have the opportunity to attend personalized tutoring sessions in the professor's office during the hours established by the professors for this purpose at the beginning of the course, which will be published on the course webpage (https://moovi.uvigo.gal). They may also ask their questions via telematic means.
Problem solving	Students will have the opportunity to attend personalized tutoring sessions in the professor's office during the hours established by the professors for this purpose at the beginning of the course, which will be published on the course webpage (https://moovi.uvigo.gal). They may also ask their questions via telematic means.
Autonomous problem solving	Students will have the opportunity to attend personalized tutoring sessions in the professor's office during the hours established by the professors for this purpose at the beginning of the course, which will be published on the course webpage (https://moovi.uvigo.gal). They may also ask their questions via telematic means.
Laboratory practical	Students will have the opportunity to attend personalized tutoring sessions in the professor's office during the hours established by the professors for this purpose at the beginning of the course, which will be published on the course webpage (https://moovi.uvigo.gal). They may also ask their questions via telematic means.
Practices through ICT	Students will have the opportunity to attend personalized tutoring sessions in the professor's office during the hours established by the professors for this purpose at the beginning of the course, which will be published on the course webpage (https://moovi.uvigo.gal). They may also ask their questions via telematic means.

Assessment

Description		Qualification	Training and Learning Results		
Laboratory practical	Preparation of a report by the students reflecting the characteristics of the work carried out. Students must describe the tasks and procedures developed, show the results obtained or the observations made, as well as the analysis and processing of the data.	10	B13	C8	D11
Practices through ICT	Preparation of a report by the students reflecting the characteristics of the work carried out. Students must describe the tasks and procedures developed, show the results obtained or the observations made, as well as the analysis and processing of the data.	10	B13	C8	D11
Essay questions exam	Activity in which problems and/or exercises related to the subject are formulated. Students must develop the analysis and resolution of the problems and/or exercises independently.	20	B13	C8	D11
Problem and/or exercise solving	A test in which students must solve a series of problems or exercises within a time and under conditions established by the professor. In this way, students must apply the knowledge they have acquired.	20	B13	C8	D11
Essay	Work(s) on the entire content of the subject.	40	B13	C8	

Other comments on the Evaluation

First Opportunity Evaluation:

To pass the subject on the first opportunity, students must obtain a grade higher than 5 out of 10 in the combined assessment of continuous evaluation tests, the submission of assignments during class sessions, and the exam held on the official date. The final grade for continuous evaluation will be determined according to the indicated percentages.

Students have the right to opt for a global evaluation according to the procedure and deadline established by the center for each call.

Global Evaluation:

An exam will be held on the official date, which includes all the content of the subject, including the content and methods used in case studies. The grade for this exam to pass the subject will be 5 out of 10.

The evaluation test schedule officially approved by the EEAE Center Board is published on the website <http://aero.uvigo.es/gl/docencia/exames>.

Second Opportunity Evaluation:

Students must take the second call exam covering all the content of the subject, which will account for 100% of the grade if the final grade for continuous evaluation is less than 5 out of 10.

If they have a score equal to or greater than 5 out of 10 in the combined work/continuous evaluation tests, the grade will be preserved for the second opportunity, requiring them to take only the official exam, which will weigh 30% of the final grade for the subject.

Final Year Evaluation:

For the final year evaluation, an exam will be held on the official date, covering all the content of the subject. The grade for this exam to pass the subject will be 5 out of 10.

Sources of information

Basic Bibliography

Documentación del curso y transparencias,

Maral y Busquet, **Satellite Communications Systems: Systems, Techniques and Technology.**, <http://www.ecss.nl>,

Teresa M. Braun, **Satellite Communications, Payload and System**,

Marcos Arias Acuña, Oscar Rubiños López, **Radiocomunicación**, Primera, Andavira Editora, 2011

Complementary Bibliography

John Griffiths, **Radio Wave Propagation and Antennas. An Introduction**, Primera, Prentice Hall, 1985

Recommendations

Other comments

Dedicate the indicated amount of personal study time, and make use of personal tutoring sessions with the professor to resolve any doubts that arise during personal study.

A complete follow-up of the subject and an active attitude in classes are recommended.

IDENTIFYING DATA**Space observation systems**

Subject	Space observation systems			
Code	O07M197V01306			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	González Jorge, Higinio			
Lecturers	González Jorge, Higinio			
E-mail	higiniog@uvigo.gal			
Web	http://muea.webs.uvigo.es			
General description	This subject provides an overview of the different observation systems used at satellite level, as well as their analogy at aeronautical, automotive or defense level			

English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.

Training and Learning Results

Code	
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Understanding of the different existing observation satellites and their main optical components	C8 D11
Understanding of the computer tools used for the processing of remote sensing satellite data	C8 D11
To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.	C8
Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.	D11

Contents

Topic	
1. Fundamentals of remote observation	<ul style="list-style-type: none"> - Fundamentals of remote sensing. - Satellites and sensors. - Satellite data processing levels. - Projections and coordinate systems. - Advantages and disadvantages of remote sensing. - Remote sensing technology
2. Optical sensors	<ul style="list-style-type: none"> - Fundamentals of remote sensing. - Satellites and sensors. - Satellite data processing levels. - Projections and coordinate systems. - Advantages and disadvantages of remote sensing. - Remote sensing technology.
3. Geometric optics	<ul style="list-style-type: none"> - Principles of geometric optics. - Planar and spherical diopter. - Plane and spherical mirror. - Thin lenses. - Multi-lens systems. - Magnifier and microscope - Telescope. - Photographic camera. - Optical aberrations.

4. LiDAR	<ul style="list-style-type: none"> - Active vs. passive sensors. - Distance determination. - Echoes. - Types of detectors. - LiDAR platforms (satellite and aerial). - Differences between LiDAR and RADAR. - LiDAR applications.
5. RADAR	<ul style="list-style-type: none"> - Pulsed RADAR. - CWFM RADAR. - Synthetic Aperture RADAR (SAR). - SAR imaging - SAR interaction with the earth's surface - Data preprocessing. - Applications.
6. SENTINEL Earth Observation Program	<ul style="list-style-type: none"> - Sentinel 1. - Sentinel 2. - Sentinel 3. - Sentinel 5.
7. Image processing	<ul style="list-style-type: none"> - Representation and basic treatments. - Transformations. - Geometric corrections. - Color corrections. - Radiometric corrections. - Edges. - Regions. - Points of interest extraction. - Edge description. - Region description. - Morphological operations. - Geometry and camera calibration.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	29	0	29
Laboratory practical	16.5	0	16.5
Mentored work	0	102	102
Essay questions exam	2.5	0	2.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation of the contents of the subject through audiovisual media
Laboratory practical	Solving image processing problems using software tools such as Matlab and SNAP
Mentored work	Development of a project related to the design and implementation of a gimbal for the self-leveling of a digital camera-based observation system

Personalized assistance

Methodologies	Description
Laboratory practical	Classroom service. Tutoring by appointment. Attention by e-mail
Lecturing	Classroom service. Tutoring by appointment. Attention by e-mail
Mentored work	Classroom service. Tutoring by appointment. Attention by e-mail

Assessment

	Description	Qualification	Training and Learning Results
Lecturing	Problem solving and exercises	35	C8 D11
Laboratory practical	Each practicum will define a deliverable that the student must send to the teacher before the deadline to the teacher before the indicated deadline	20	C8 D11
Mentored work	The student must submit a final report with the work done. In addition, he/she must make an exhibition of the work	40	C8 D11
Essay questions exam	Examination with developmental questions on the indicated topics	5	C8 D11

Other comments on the Evaluation

The student has the right to choose a comprehensive evaluation according to the procedure and deadlines established by the center for each exam period.

Continuous assessment tests will be conducted during course classes.

The official exam dates for all exam periods are used for the student to take a comprehensive exam on the subject if they do not follow continuous assessment or fail it. This exam will consist of a 50-question test, which will account for 100% of the subject grade and will have a duration of 2 hours.

Grades for each part are not carried over between different exam periods.

The official calendar of assessment tests approved by the Center Board of the EEAE is published on the website:

<http://aero.uvigo.es/es/docencia/examenes/>

Sources of information

Basic Bibliography

Emilio Chuvieco Salinero, **Teledetección ambiental: La observación de la Tierra desde el espacio**, 8494686496, 1st edition, Digital Reasons, 2023

Complementary Bibliography

JOHN A. RICHARDS , XIUPING JIA, **REMOTE SENSING DIGITAL IMAGE ANALYSIS**, 9783540648604, 3rd edition, SPRINGER-VERLAG, 1999

FLOYD F. SABINS, **REMOTE SENSING: PRINCIPLES AND INTERPRETATION**, 9780716724421, 1st edition, W. H. FREEMAN, 2005

Pierre-Philippe Mathieu, Christoph Aubrecht, **Earth Observation Open Science and Innovation**, 978-3-319-65632-8, 1st edition, SPRINGER, 2018

Recommendations

IDENTIFYING DATA**Ciencias do espazo**

Subject	Ciencias do espazo			
Code	O07M197V01307			
Study programme	Máster Universitario en Enxeñaría Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2	1c
Teaching language	Castelán			
Department	Física aplicada			
Coordinator	Paredes Galán, Ángel			
Lecturers	Michinel Álvarez, Humberto Javier Paredes Galán, Ángel Salgueiro Piñeiro, José Ramón			
E-mail	angel.paredes@uvigo.es			
Web	http://webs.uvigo.es/muea			
General description	O curso "Ciencias do Espazo" para o máster en Enxeñaría Aeronáutica proporciona unha comprensión integral dos principios fundamentais e as aplicacións avanzadas no campo da exploración e tecnoloxía espacial. Iníciase cos Fundamentos da Relatividade Especial e Xeral, proporcionando unha base sólida nas teorías de Einstein que son cruciais para comprender o comportamento do espazo-tempo e a gravitación. Continuando, explóranse os conceptos de Gravitación, Relatividade e Aceleración de Naves Espaciais, onde se aplican estes principios ao deseño e operación de vehículos espaciais. O curso tamén inclúe Nocións de Astrofísica e Cosmoloxía, ofrecendo unha visión xeral do universo, os seus compoñentes e evolución. Ademais, abárcanse Nocións de Física do Espazo, enfocándose nos fenómenos físicos que ocorren na contorna espacial. En canto á tecnoloxía, estúdanse as Tecnoloxías Ópticas para o Espazo, esenciais para a observación e exploración espacial, e as Tecnoloxías Cuánticas para o Espazo, que representan o futuro da comunicación e navegación espacial avanzada.			

Resultados de Formación e Aprendizaxe

Code	
C8	Deseñar produtos espaciais que se correspondan coas necesidades dos axentes implicados, definindo funcións, conceptos e a súa arquitectura.
D11	Comprender e aplicar os coñecementos, métodos e ferramentas necesarios para desenvolver proxectos de enxeñaría espacial.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
Comprender e aplicar os coñecementos, métodos e ferramentas necesarios para desenvolver proxectos de enxeñaría espacial	D11
Deseñar produtos espaciais que se correspondan coas necesidades dos axentes implicados, definindo funcións, conceptos e a súa arquitectura.	C8

Contidos

Topic	
Fundamentos de relatividade especial e relatividade xeral	Relatividade especial: espazo de Minkowski, transformacións de Lorentz, dilatación temporal Relatividade xeral: Nocións de relatividade xeral, ecuacións de Einstein, implicacións en tecnoloxía espacial.
Gravitación, relatividade e aceleración de naves espaciais	Velas solares Foguete fotónico Efecto Oberth Outros métodos de propulsión baseados en gravitación
Nocións de astrofísica	Estrutura e Evolución Estelar Buracos negros Dinámica Galáctica e Tipoloxía de Galaxias
Nocións de cosmoloxía	Modelos Cosmolóxicos e o Universo en Expansión Energía Escura e Materia Escura Cosmoloxía Observacional e Fondos Cósmicos
Nocións de física do espazo	Magnetosfera Fenómenos Electromagnéticos no Espazo Raios cósmicos

Tecnoloxías ópticas para o espazo	Telescopios espaciais Sistemas de imaxe Comunicacións ópticas
Tecnoloxías cuánticas para o espazo	Reloxos atómicos Comunicacións cuánticas

Planificación

	Class hours	Hours outside the classroom	Total hours
Actividades introdutorias	1	0	1
Lección maxistral	19	0	19
Resolución de problemas	12	32	44
Resolución de problemas de forma autónoma	0	60	60
Prácticas de laboratorio	14	0	14
Exame de preguntas de desenvolvemento	2	0	2
Traballo	0	10	10

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente

	Description
Actividades introdutorias	Descríbense de modo xeral e en perspectiva os contidos da materia.
Lección maxistral	O profesor explica os principais conceptos dos contidos da materia
Resolución de problemas	O profesor expón problemas adecuados para a comprensión e aplicación dos conceptos básicos presentados na lección maxistral.
Resolución de problemas de forma autónoma	O alumnado utiliza os materiais da materia e os conceptos explicados en clase para resolver de forma autónoma problemas propostos deseñados para alcanzar os obxectivos de aprendizaxe e as competencias da materia.
Prácticas de laboratorio	Realízanse prácticas de laboratorio relacionadas con algúns conceptos da materia baixo a supervisión do profesorado.

Atención personalizada

Methodologies	Description
Actividades introdutorias	Resolveranse dúbidas e ofrecerase apoio ao alumnado tanto en clase como en titorías individualizadas.
Lección maxistral	Resolveranse dúbidas e ofrecerase apoio ao alumnado tanto en clase como en titorías individualizadas.
Resolución de problemas	Resolveranse dúbidas e ofrecerase apoio ao alumnado tanto en clase como en titorías individualizadas.
Resolución de problemas de forma autónoma	Resolveranse dúbidas e ofrecerase apoio ao alumnado tanto en clase como en titorías individualizadas.
Prácticas de laboratorio	Resolveranse dúbidas e ofrecerase apoio ao alumnado tanto en clase como en titorías individualizadas.
Tests	Description
Traballo	Resolveranse dúbidas e ofrecerase apoio ao alumnado tanto en clase como en titorías individualizadas.

Avaliación

	Description	Qualification	Training and Learning Results	
Resolución de problemas de forma autónoma	Entrega da resolución de problemas propostos.	30	C8	D11
Prácticas de laboratorio	Asistencia e traballo en prácticas e entrega de memoria de prácticas.	20	C8	D11
Exame de preguntas de desenvolvemento	Exame de dúas horas de duración sobre os contidos da materia.	30	C8	D11
Traballo	Entrega dun traballo sobre un tema a elixir polo alumnado entre unha serie deles propostos polo profesorado.	20	C8	D11

Other comments on the Evaluation

Evaluación de primeira oportunidade: Para superar a materia na 1ª oportunidade requerirá obter unha calificación superior a 5 puntos sobre 10 na valoración conxunta das probas de avaliación continua, as entregas de traballos durante o desenvolvemento das clases, e o exame realizado na data oficial. A calificación final da avaliación continua obtense de

acordo coas porcentaxes indicadas.O/A estudante ten dereito a optar pola avaliación global segun o procedemento e o prazo que estableza o centro para cada convocatoria.

Evaluación global: Realízase un exame o día de a data oficial, que inclúe todos os contidos da materia, incluíndo os contidos e métodos utilizados nos casos de estudo. A calificación de devandito exame para superar a materia será de 5 puntos sobre 10.O calendario de probas de avaliación aprobado oficialmente pola Xunta de Centro dá EEAE publícase na web <http://aero.uvigo.es/gl/docencia/exames>

Evaluación da segunda oportunidade: O estudante deberá presentarse ao exame de segunda convocatoria de todos os contidos da materia, que suporá ata o 100% de la nota. En calquera caso e previo aviso ao coordinador da materia, cada estudante poderá conservar aquelas partes da nota de primeira oportunidade que desexe.

Evaluación de fin de carreira: Para a avaliación de fin de carreira, realízase un exame na data oficial, que inclúe todos os contidos da materia. A calificación de devandito exame para superar a materia será de 5 puntos sobre 10.

Bibliografía. Fontes de información

Basic Bibliography

Ray d'Inverno , James Vickers, **Introducing Einstein's Relativity: A Deeper Understanding**, 978-0198862031, OUP Oxford, 2022

Tim O'Brien, Jeffrey Forshaw, Helen Gleeson, Fred Loebinger, **Introduction to Astrophysics & Cosmology**, 978-1119483618, John Wiley & Sons Inc, 2024

B. K. Johnson, **Optics and Optical Instruments: An Introduction**, 978-0486606422, 3, Dover Publications, 2011

Shen-En Qian, **Optical Payloads for Space Missions**, 9781118945148, John Wiley & Sons, Ltd., 2016

Complementary Bibliography

Hamid Hemmati, **Deep Space Optical Communications**, 978-0470040027, Wiley-Interscience, 2006

Zheyu Jeff Ou, **Quantum optics for experimentalists**, 978-9813220195, World Scientific Publishing Company, 2017

Recomendacións

IDENTIFYING DATA**Sistemas de control órbita e actitude**

Subject	Sistemas de control órbita e actitude			
Code	O07M197V01308			
Study programme	Máster Universitario en Enxeñaría Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2	1c
Teaching language	Castelán Galego			
Department	Dpto. Externo Enxeñaría de sistemas e automática			
Coordinator	Balvís Outeiriño, Eduardo			
Lecturers	Balvís Outeiriño, Eduardo			
E-mail	ebalvis@uvigo.es			
Web	http://webs.uvigo.es/muea			
General description	A asignatura "Sistemas de Control de Órbita e Actitude" proporciona unha comprensión integral dos principios e técnicas utilizadas para estabilizar e dirixir vehículos espaciais. Os estudantes explorarán a dinámica orbital e actitude, aprendendo a deseñar e analizar sistemas de control eficientes para manobras e estabilidade de satélites. Traballarase con sensores e actuadores específicos, así como con estratexias de control avanzado, a través de estudos de casos reais e simulacións prácticas.			

Resultados de Formación e Aprendizaxe

Code	
C8	Deseñar produtos espaciais que se correspondan coas necesidades dos axentes implicados, definindo funcións, conceptos e a súa arquitectura.
D11	Comprender e aplicar os coñecementos, métodos e ferramentas necesarios para desenvolver proxectos de enxeñaría espacial.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
Os estudantes serán capaces de comprender e aplicar os principios da mecánica orbital e a dinámica de actitude no control de vehículos espaciais. Serán capaces de analizar e deseñar sistemas de control que aseguren a estabilidade e o control tanto estático como dinámico dos vehículos espaciais.	C8 D11
Os estudantes adquirirán a capacidade de aplicar os coñecementos, métodos e ferramentas de enxeñaría necesarios para o desenvolvemento e execución de proxectos espaciais, abordando problemas complexos e propoñendo solucións innovadoras.	D11
Os estudantes serán capaces de concibir e deseñar produtos espaciais que satisfagan as necesidades específicas dos diferentes axentes involucrados nun proxecto espacial. Isto inclúe a definición de funcións, conceptos e a arquitectura do sistema.	C8

Contidos

Topic	
(*)1. Introducción y Modelado de Sistemas Espaciales	(*)1.1 Introducción a los sistemas AOCS (Attitude & Orbit Control System) 1.2 Modelado matemático de sistemas dinámicos 1.3 Técnicas de simulación para el análisis de sistemas de control espacial
(*)2. Cinemática y Dinámica de Movimiento 6-DOF	(*)2.1 Cinemática de cuerpos rígidos en el espacio 2.2 Dinámica de traslación y rotación 2.3 Técnicas de control para sistemas 6-DOF
(*)3. Sistemas de Navegación y Sensores Inerciales	(*)3.1 Navegación estelar (star-sight) y sistemas inerciales de navegación 3.2 Sistemas de navegación por radio (GPS, GNSS) 3.3 Tipos de sensores inerciales (giroscopios, acelerómetros) y sus aplicaciones
(*)4. Estimación de Estados y Filtro de Kalman	(*)4.1 Teoría de la estimación de estados 4.2 Conceptos básicos de probabilidad y estadística 4.3 Implementación y aplicaciones del filtro de Kalman
(*)5. Teoría de Control y Control Óptimo	(*)5.1 Fundamentos de la teoría de control 5.2 Control óptimo y teoría de la optimización 5.3 Aplicaciones de control óptimo en sistemas AOCS

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	24	0	24
Prácticas con apoio das TIC	18	0	18
Resolución de problemas	0	40	40
Estudo de casos	4	0	4
Seminario	4	0	4
Traballo tutelado	0	58	58
Resolución de problemas e/ou exercicios	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente	
	Description
Lección maxistral	(*)La lección magistral consiste en la exposición oral y estructurada de los contenidos teóricos de la asignatura por parte del profesor. Durante estas sesiones, se presentan y explican los conceptos fundamentales, teorías, y principios relacionados con el control de órbita y actitud. Esta metodología permite a los estudiantes adquirir conocimientos sólidos y bien organizados sobre los temas tratados.
Prácticas con apoio das TIC	(*)Las prácticas con apoyo de las Tecnologías de la Información y la Comunicación (TIC) implican el uso de software y herramientas digitales para la simulación, modelado y análisis de sistemas de control de órbita y actitud. Estas prácticas permiten a los estudiantes aplicar los conocimientos teóricos en un entorno virtual y obtener experiencia práctica con herramientas utilizadas en la industria.
Resolución de problemas	(*)La metodología de resolución de problemas implica que los estudiantes se enfrenten a ejercicios y casos prácticos que deben resolver utilizando los conocimientos adquiridos. Este enfoque fomenta el pensamiento crítico y analítico, y ayuda a los estudiantes a desarrollar habilidades para la identificación y solución de problemas complejos.
Estudo de casos	(*)El estudio de casos implica el análisis detallado de situaciones reales o hipotéticas relacionadas con el control de órbita y actitud. Los estudiantes examinan los casos, identifican problemas, y proponen soluciones basadas en los conocimientos adquiridos. Esta metodología permite conectar la teoría con la práctica y comprender el contexto real de los problemas.
Seminario	(*)El seminario es una metodología interactiva en la que se discuten y analizan temas específicos en profundidad. Durante estas sesiones, los estudiantes presentan y debaten temas, casos, o artículos bajo la supervisión del profesor. Los seminarios fomentan la participación activa y el intercambio de ideas, y profundizan en el conocimiento de temas especializados.
Traballo tutelado	(*)El trabajo tutelado consiste en la realización de un proyecto o trabajo de investigación bajo la supervisión del profesor. Los estudiantes aplican los conocimientos adquiridos a lo largo de la asignatura para desarrollar un proyecto integral relacionado con el control de órbita y actitud. Esta metodología promueve la autonomía, la creatividad y la capacidad de gestión de proyectos.

Atención personalizada	
Methodologies	Description
Lección maxistral	
Prácticas con apoio das TIC	
Resolución de problemas	
Estudo de casos	
Seminario	
Traballo tutelado	

Avaliación			
	Description	Qualification	Training and Learning Results
Resolución de problemas	(*)Realización de dos pruebas para evaluar las competencias adquiridas. Estas pruebas pueden incluir la aplicación de conocimientos a la resolución de problemas concretos, ejercicios de simulación, y análisis de casos prácticos. Cada prueba tendrá un peso de un 30% sobre la nota final de la asignatura. Una de las pruebas se realizará en la fecha oficial del examen final.	60	C8 D11
Traballo tutelado	(*)Prueba en la que se plantea un proyecto integral relacionado con el control de órbita y actitud de un vehículo espacial. El alumno deberá desarrollar y presentar un proyecto aplicando los conocimientos adquiridos en la asignatura. Este trabajo se entregará en la plataforma correspondiente antes de la fecha oficial del examen.	40	C8 D11

Other comments on the Evaluation

Bibliografía. Fontes de información

Basic Bibliography

Kaplan, M. H., **Modern Spacecraft Dynamics and Control**, 978-0486819181, 1, Dover Publications, 2019

Brown, C. D., **Elements of Spacecraft Design**, 1563475243, 1, AIAA Education Series, 2003

Alexander Frias, **Modeling And Control Of Spacecraft Systems With Coupled Orbital And Attitude Dynamics**, 10.32920/RYERSON.14665602.V1, 2021

Zhankui Zeng, Qi Zheng, Xu Zou, Lili Jiang, Zhineng Qing, Junjie Wu, Ran Wei, Wei Jiang, Yuzhu Wan, **Attitude control method for final substage orbital application subsystem**, 2020

Complementary Bibliography

Wertz, J. R., & Larson, W. J., **Space Mission Analysis and Design**, 978-1881883104, 3, Microcosm, 1999

James R. Forbes, Christopher Damaren, Anton H. de Ruiter, **Spacecraft Dynamics and Control: An Introduction**, 9781118342367, 1, JOHN WILEY & SONS, 2013

Giorgio Fasano, Enrico Gaia, Stefano Ferroni, Mario Pessana, **End-to-end on-orbit servicing**, 2021

Recomendacións

IDENTIFYING DATA				
Space propulsion				
Subject	Space propulsion			
Code	O07M197V01309			
Study programme	(*)Máster Universitario en Enxeñaría Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Ulloa Sande, Carlos			
Lecturers	Ulloa Sande, Carlos			
E-mail	carlos.ulloa@uvigo.es			
Web	http://webs.uvigo.es/muea			
General description	Space propulsion refers to any technology capable of propelling a spacecraft through space. To perform space travel, some propulsion system capable of providing acceleration to the vehicles is necessary. Rocket engines are the most commonly used for spacecraft propulsion because they generate enormous power and do not require atmospheric oxygen to operate. The course focuses primarily on electric space propulsion, the leading new technology for propulsion in space, both in Earth environment and inner solar system applications. English Friendly subject: International students may request from the faculty: a) materials and bibliographic references to follow the subject in English, b) tutorials in English, c) tests and evaluations in English.			

Training and Learning Results	
Code	
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject	
Expected results from this subject	Training and Learning Results
ID35. Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.	D11
ID36. Conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.	C8

Contents	
Topic	
BLOCK 1: General principles	1.1. Propulsion in space vehicles: propulsion figures of merit, propulsion requirements in space missions, rocket equation.
BLOCK 2: Chemical propulsion	2.1. Chemical propulsion: figures of merit in chemical rockets, nozzles, thrust coefficient, characteristic velocity. 2.2. Monopropellant (cold gas and hydrazine based rockets) and bipropellant rockets. 2.3. Propellant control units. Valves, pressure regulators and tanks. 2.4. Tank sizing: pressurizing gas, propellant and supercritical fluids.
BLOCK 3: Electric propulsion	3.1. Electric propulsion: plasma thrusters, plasma production and acceleration mechanisms, optimum specific impulse, missions with electric propulsion. 3.2. Principles of operation of ion and Hall thrusters. Quasineutrality. 3.3. Collisional processes. Dynamics of magnetized particles. 3.4. Ion grating thrusters: elements and electrical configurations, global model of the discharge chamber, grating model and expansion of the plasma jet, performance laws.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	30	0	30
Laboratory practical	8	0	8
Case studies	8	0	8
Mentored work	0	102	102

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
	Description
Lecturing	Presentation by the teacher of the contents of the subject matter, theoretical bases and guidelines of a work or exercise that the student has to develop.
Laboratory practical	Computer laboratory. Activities of application of knowledge in a given context and acquisition of basic and procedural skills in relation to the subject, through ICT. Laboratory practices. Activities of application of knowledge to specific situations and acquisition of basic and procedural skills related to the subject matter. It is developed in special spaces with specialized equipment (laboratories, computer rooms, etc).
Case studies	Activity in which mini-projects related to the subject are formulated and the students must develop the appropriate solutions through the exercise of routines, the application of formulas or algorithms, the application of transformation procedures of the available information and the interpretation of the results. It is a complement to the lecturing class.
Mentored work	Group work where problems and/or exercises related to the subject are formulated. The students must develop the analysis and the resolution of the problems and/or exercises in an autonomous way.

Personalized assistance	
Methodologies	Description
Lecturing	Classroom interaction. Tutoring by appointment. Attention by e-mail. Mail: carlos.ulloa@uvigo.gal
Laboratory practical	Classroom interaction. Tutoring by appointment. Attention by e-mail. Mail: carlos.ulloa@uvigo.gal
Case studies	Classroom interaction. Tutoring by appointment. Attention by e-mail. Mail: carlos.ulloa@uvigo.gal
Mentored work	Tutoring by appointment. Attention by e-mail. Mail: carlos.ulloa@uvigo.gal

Assessment				
	Description	Qualification	Training	Learning Results
Laboratory practical	(*) Durante todo o curso en laboratorio de propulsión ou laboratorio de informática	20	C8	D11
Case studies	(*)Miniprojects durante todo o curso.	20	C8	D11
Mentored work	(*)Traballo en grupo	30	C8	D11
Essay questions exam	(*)Exame final na data aprobada polo centro	30	C8	D11

Other comments on the Evaluation

First call:(1) Students following the course by Continuous Assessment:In order to pass the course at the first opportunity, by Continuous Assessment, it will be necessary:-A grade in the final exam of continuous assessment of, at least, a 5.0.-Attend at least 80% of the practical sessions.-Submit all the practical reports and assignments of the subject, obtaining, at least, a grade of 3 in each one of them.In the case of not meeting these conditions, the final grade will be the result of the minimum of the average grade of EC and 4.9.The continuous assessment tests will be carried out during school hours, whenever possible. The final continuous assessment exam will be held on the date approved by the center for the first call.(2) Students who wish to be evaluated by exam-only assessment:The evaluation of the course at the first call will be made, by default, through Continuous Assessment. The student body has the right to opt for the exam-only assessment according to the procedure and the period established by the center for each call, which may not exceed one month.The grade obtained in this exam will represent 100% of the final grade. The student must obtain a minimum grade of 5.0 in this exam. This exam may have a part to be taken in a computer room and / or laboratory, and will cover the entire subject taught, as well as the contents covered in all practical sessions and assignments. The exam-only assessment exam will be held on the date approved by the center for the first call.Second call and end-of-program call:Students who have not passed the subject at the first call and have waived the continuous assessment, may take an exam only assessment exam that will account for 100% of the final grade. The student must obtain a minimum grade of 5.0 in this exam. This exam may have a part to be taken in a computer room and / or laboratory, and will cover the entire subject taught, as well as the contents covered in all practical sessions and assignments. The student who has been evaluated by continuous assessment at the first call and has not waived it, will be re-evaluated for the final exam of Continuous Assessment and must meet the requirements to pass the subject by continuous assessment. The second call and end-of-program assessment exam will be held on the dates approved by the center for each call.Other considerations:In case of detection of plagiarism in any qualification element, the qualification in said item will be 0 and the fact will be communicated to the direction of the Center for the appropriate effects.The evaluation test schedule officially approved by the Board of the EEAE Center is published on the websitepublished on the website <https://muea.webs.uvigo.es/gl/docencia/exames/>.

Sources of information

Basic Bibliography

D. Goebel, I. Katz, **Fundamentals of electric propulsion**, 1394163215, Wiley, 2024

G.P. Sutton, O. Biblarz, **Rocket propulsion elements**, 1118753658, Wiley, 2001

Complementary Bibliography

G. Jahn, **Physics of electric propulsion**, 0486450406, Dover, 2006

Recommendations

Subjects that it is recommended to have taken before

Design, calculation and certification of aerospace propulsion systems/O07M197V01203

IDENTIFYING DATA**Artificial Intelligence in Space Engineering**

Subject	Artificial Intelligence in Space Engineering			
Code	O07M197V01310			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	2nd	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Olivieri Cecchi, David Nicholas Rodríguez Liñares, Leandro			
Lecturers	Olivieri Cecchi, David Nicholas Rodríguez Liñares, Leandro			
E-mail	dnolivieri@gmail.com leandro@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	This course aims to educate the students on the fundamentals of artificial intelligence and its applications to the field of the aerospace engineering. The aim is to develop skills to be able to select, design and develop efficient solutions that allow to solve otherwise unsolvable problems. The aim is to empower students to develop code that harnesses the full potential of the application of artificial intelligence in the aerospace engineering.			
	English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
C8	To conceive spatial products that correspond to the needs of the agents involved, defining functions, concepts and their architecture.
D11	Understand and apply the knowledge, methods and tools necessary to develop space engineering projects.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Understand and apply knowledge, methods and tools to develop projects of space engineering.	C8 D11
Develop space products that fulfill the needs of the involved agents, defining functions, concepts and its architecture.	C8 D11

Contents

Topic	
Machine learning	Basics of supervised and no supervised learning Basic algorithms Advanced algorithms Artificial Intelligence in engineering
Neural networks (NNs)	CNNs, RNNs, transformers Generative Neural Networks Neural Networks in aerospace engineering
Reinforcement learning	Basics of state learning with Bellman equation Q-learning Reinforcement learning for the design, development and control of space systems
Other topics	PINNs: Partial differential equations with neural networks Other advanced topics Software quality in artificial intelligence and its verification and validation

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	29	0	29
Practices through ICT	10	0	10
Mentored work	0	102	102
Problem solving	6.5	0	6.5
Essay questions exam	2.5	0	2.5

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation by the teachers of the contents on the subject under study, the theoretical bases and guidelines.
Practices through ICT	Activities involving the application of knowledge to specific situations and the acquisition of basic skills and procedural abilities related to the subject under study using ICTs.
Mentored work	Activity in which problems and/or exercises related to the subject are formulated. The students have to work on the analysis and resolution of the problems and/or exercises in an autonomous way.
Problem solving	Activity with problems and/or exercises related with the subject. The students have to analyse and solve problems autonomously

Personalized assistance

Methodologies	Description
Practices through ICT	Academic activity carried out by the teachers with the purpose of addressing the needs and inquiries of students related to their studies and/or topics related to the subject, providing guidance, support, and motivation in the learning process. Tutoring sessions can take place using online resources (email, video conferencing, Moovi forums, etc.) always with previous appointment.
Mentored work	Academic activity carried out by the teachers with the purpose of addressing the needs and inquiries of students related to their studies and/or topics related to the subject, providing guidance, support, and motivation in the learning process. Tutoring sessions can take place using online resources (email, video conferencing, Moovi forums, etc.) always with previous appointment.
Problem solving	Academic activity carried out by the teachers with the purpose of addressing the needs and inquiries of students related to their studies and/or topics related to the subject, providing guidance, support, and motivation in the learning process. Tutoring sessions can take place using online resources (email, video conferencing, Moovi forums, etc.) always with previous appointment.

Assessment

	Description	Qualification	Training and Learning Results	
Practices through ICT	Problems and exercises used to verify if the students have achieved the training and learning results of the subject.	10	C8	D11
Mentored work	Work in which the students will apply the contents given in the subject to solve practical problems.	10	C8	D11
Problem solving	Problems used to verify if the students are able to apply the contents of the subject to practical problems.	40	C8	D11
Essay questions exam	Questionnaire composed by questions of different types to verify if the students reached the results of training and learning of the subject.	40	C8	D11

Other comments on the Evaluation

CONTINUOUS ASSESSMENT

PARTIAL EXAMS

Description: questionnaires conducted throughout the course

Applied Methodology: essay questions exam / problem solving

Weighting: 40%

Minimum required grade: a grade equal to or higher than 5 must be obtained

Assessed training and learning results: C8 D11

LAB ASSIGNMENTS:

Description: Practical exercises related to the contents

Applied Methodology: practices through ICT / mentored work

Weighting: 20%

Minimum required grade: a grade equal to or higher than 5 must be obtained

Assessed training and learning results: C8 D11

FINAL EXAM:

Description: final questionnaire consisting of different types of questions

Applied Methodology: essay questions exam / problem solving

Weighting: 40%

Minimum required grade: a grade equal to or higher than 5 must be obtained

Assessed training and learning results: C8 D11

- In all the methodologies/tests, a score equal to or greater than 5 points out of 10 must be obtained.
- Students must necessarily upload a ID-type photo to the profile of the Moovi platform in the first 2 weeks of the course.
- After the period for choosing the evaluation modality, students who carry out an evaluable activity, whatever the type, and who have not opted for the global evaluation system, will follow the continuous evaluation procedure described above.
- If a student does not show up for any of the evaluation activities, he/she will be assigned a grade of 0 in it.
- If a student abandons the continuous evaluation system having already been evaluated on some content of the subject, it will be considered that the he/she is suspended, and he/she will not be able to opt for the global evaluation system.

GLOBAL ASSESSMENT

FINAL EXAM:

Description: final questionnaire consisting of different types of questions

Applied Methodology: essay questions exam

Weighting: 100%

Minimum required grade: a grade equal to or higher than 5 must be obtained

Assessed training and learning results: C8 D11

Students who follow the global assessment procedure must take an exam with questions and exercises of various types in which they must obtain a grade greater than 5 out of 10 to pass.

EVALUATION CRITERIA FOR EXTRAORDINARY AND END OF CAREER EXAMS

The global evaluation system described above will be used.

QUALIFICATION PROCESS

To pass the subject it is ESSENTIAL to get a score equal to or greater than 5

ASSESSMENT DATES

The dates for the exams corresponding to the continuous assessment system will be published on the activity calendar, available on the faculty website

The official exam dates for the different exam periods, officially approved by the ESEI, are posted on the ESEI faculty website

USE OF MOBILE DEVICES

All students are reminded of the prohibition on the use of mobile or electronic devices and laptops in exercises and practices, in compliance with article 13.2.d) of the Statute of the University Student, regarding the duties of university students, which establishes the duty to refrain "from the use and cooperation in fraudulent procedures in the evaluation tests, in all academic assessments and reports, or in official documents of the university".

ACADEMIC FRAUD

All students are reminded that, according to article 3.2 of the Regulations for the Disciplinary Regime of the University of Vigo, the following will be considered very serious offences:

"e) Altering, falsifying, stealing or destroying academic documents or applications and computer systems of the University as well as using false documents or statements before the university.

...

i) Impersonate a person who is part of the university community in their own work or give consent to be impersonated, in relation to university activities."

It is also recalled that, according to the same Regulation, article 3.3, the following will be considered serious offenses:

"d) Committing academic fraud, when it does not constitute a very serious offense.

e) Improper use of content or means of reproduction and recording of university activities subject to intellectual property rights."

Article 3.5 indicates that "In accordance with the provisions of article 11. g) of the University Harmony Law, academic fraud is understood to be any premeditated behavior that tends to falsify the results of an exam or work, one's own or that of another, carried out as a requirement to pass a subject or accredit academic performance"

OFFICE HOURS

Office hours can be found on the personal pages of the teachers

Sources of information

Basic Bibliography

Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow**, 978-1098125974, 3, O'Reilly Media, 2022

Andrew W. Trask, **Grokking Deep Learning**, 978-1617293702, 1, Manning, 2019

Edward Raff, **Inside Deep Learning: Math, Algorithms, Models**, 978-1617298639, 1, Manning, 2022

Graesser, L., & Keng, W. L., **Foundations of Deep Reinforcement Learning: Theory and Practice in Python**, 978-0-13-517238-4, 1, Pearson Education, Inc., 2020

Morales, M, **Deep Reinforcement Learning**, 9781617295454, 1, Grokking, 2021

Goodfellow, I., Bengio, Y., Courville, A, **Deep Learning**, 9780262035613, 1, The MIT Press, 2016

Complementary Bibliography

Recommendations

IDENTIFYING DATA**Explotación do transporte aéreo**

Subject	Explotación do transporte aéreo			
Code	O07M197V01401			
Study programme	Máster Universitario en Enxeñaría Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	Rey González, Guillermo David			
Lecturers	Rey González, Guillermo David			
E-mail	guillermo.rey@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	A materia aborda a descrición da actividade empresarial na explotación do transporte aéreo, cubrindo a normativa e regulación aplicable, así como os aspectos legais, económicos e técnicos relevantes. Estúdase o proceso operativo das empresas de transporte aéreo, incluíndo a produción de oferta a través da operación de avións e a xestión de procedementos e recursos. Finalmente, analízanse os resultados económicos, avaliando o rendemento financeiro e a eficiencia operativa no contexto da industria aérea.			

Resultados de Formación e Aprendizaxe

Code	
B15	Coñecemento adecuado do funcionamento do transporte aéreo
B16	Comprensión e dominio da organización aeronáutica nacional e internacional e do funcionamento dos distintos modos do sistema mundial de transporte, con especial incidencia no transporte aéreo.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
ID28. Coñecemento adecuado da explotación do transporte aéreo.	B15
ID29. Comprensión e dominio da organización aeronáutica nacional e internacional e o funcionamento dos B16 distintos modos do sistema mundial de transportes, con especial énfase no transporte aéreo	

Contidos

Topic	
Bloque 1. Descrición da actividade empresarial de explotación do transporte aéreo.	
Bloque 2. Normativa e regulación aplicable á actividade do transporte aéreo. Aspectos legais, económicos e técnicos.	Tema 2.1. Introducción. Tema 2.2. Evolución histórica. Tema 2.3. Principais acordos internacionais. Tema 2.4. OACI. Tema 2.5. IATA. Tema 2.6. Liberalización do transporte aéreo.
Bloque 3. Proceso operativo das empresas de transporte aéreo. Produción de oferta (operación de avións) e xestión de procedementos e recursos.	Tema 3.1. Utilización da frota. Parámetros de utilización. Cálculo da utilización. Programación de avións. Tema 3.2. Seguridade no transporte aéreo. A accidentalidade nos transportes. Os accidentes na aviación civil. O sistema de seguridade no transporte aéreo. Investigación de accidentes de aviación. Causas de accidentes. Tema 3.3. Mantemento. Overhaul, Hard Time, On Condition. Programas de control de fiabilidade. Diagramas de decisión. MSG-1 e MSG-2. RCM. MSG-3. Características do mantemento actual. Tema 3.4. Análise da demanda e modelos de negocio. A demanda de transporte aéreo. O transporte por vía aérea. Segmentación do mercado. Tipoloxía de compañías aéreas. Tema 3.5. Planificación de roteiros. Obxectivos. Cuantificación da demanda. Estructuras de rede e obxectivos comerciais. Política de tarifas. Tema 3.6. Planificación de frotas. Factores de política de frotas. Metodoloxía. Selección e configuración de avións. Cálculo de custos. Avaliación de alternativas. Negociación do contrato.

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	29	0	29
Resolución de problemas	16.5	0	16.5
Proxecto	0	102	102
Exame de preguntas obxectivas	1.5	0	1.5
Presentación	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente	
	Description
Lección maxistral	Exposición por parte do profesor dos contidos sobre a materia obxecto de estudo, bases teóricas e/o directrices dun traballo, exercicio que o/a estudante ten que desenvolver
Resolución de problemas	Actividade na que se formulan problema e/o exercicios relacionados coa materia. O alumno debe desenvolver as solucións idóneas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Adóitase empregar como complemento da lección maxistral.

Atención personalizada	
Tests	Description
Proxecto	O/A estudante, de maneira individual ou en grupo, elabora un documento sobre a temática da materia ou prepara seminarios, investigacións, memorias, ensaios, resumos de lecturas, conferencias, etc. No ámbito da acción tutorial, distínguense accións de tutoría académica, así como de tutoría personalizada. No primeiro dos casos, o alumnado terá á súa disposición horas de tutorías nas que pode consultar calquera dúbida relacionada cos contidos, organización e planificación da materia, co desenvolvemento do proxecto etc. As tutorías poden ser individualizadas, pero fomentaranse tutorías grupais para a resolución de problemas relacionados coas actividades para realizar en grupo, ou simplemente para informar o docente da evolución do traballo colaborativo. Nas tutorías personalizadas, cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algúns tipos de solución. Conxugando ambos os tipos de acción tutorial, preténdense compensar os diferentes ritmos de aprendizaxe mediante a atención á diversidade.

Avaliación			
	Description	Qualification	Training and Learning Results
Proxecto	Realización dun proxecto relacionado cos contidos da materia.	30	B15 B16
Exame de preguntas obxectivas	Exame de problemas e/o preguntas de desenvolvemento e/o tipo test	40	B15 B16
Presentación	Presentación e defensa en clase do traballo grupal desenvolvido.	30	B15 B16

Other comments on the Evaluation

O calendario de probas de avaliación atópase publicado na páxina web do centro.

Primeira oportunidade.

(1) Estudantes que seguen o curso por Avaliación Continua. Para poder superar a materia na primeira oportunidade, mediante Avaliación Continua, será necesario:

-Unha nota mínima de 4 en cada un dos exames da materia.

-Asistir a, como mínimo, o 90% das sesións de prácticas.

-Entregar a totalidade de memorias prácticas e traballos da materia obtendo, como mínimo, unha nota de 3 en cada un deles.

No caso de non cumprir ditas condicións a nota final será a resultante do mínimo da nota media ponderada de AC e de 4.9.

(2) Estudante que desexen ser avaliados mediante avaliación global.

A avaliación do curso na primeira oportunidade realizarase, por defecto, mediante Avaliación Continua. O estudantado ten dereito a optar pola avaliación global segundo o procedemento e o prazo que estableza o centro para cada convocatoria. A nota obtida neste exame representará o 100% da nota final. O estudante deberá obter unha nota mínima de 5.0 neste exame. Este exame pode ter unha parte para realizar nunha sala de computadores e / ou laboratorio, e comprenderá a totalidade da materia impartida, así como os contidos abordados en todas as sesións prácticas e traballos.

Segunda oportunidade e Fin de Carrera.

O estudantado que non superase a materia na primeira oportunidade poderá realizarán un exame que supoñerá o 100% da nota. O estudante deberá obter unha nota mínima de 5.0 neste exame. Este exame pode ter unha parte para realizar nunha sala de computadores e / ou laboratorio, e comprenderá a totalidade da materia impartida, así como os contidos abordados en todas as sesións prácticas e traballos.

En caso de detección de plaxio en calquera elemento de cualificación, a cualificación na devandita entrega será 0 e o feito será comunicado á dirección do Centro para os efectos oportunos.

Bibliografía. Fontes de información

Basic Bibliography

Arturo Benito; Gustavo Alonso, **Transporte aéreo**, 978-8417289904, GARCETA, 2022

OACI, **Organización de Aviación Civil Internacional. Anexos Técnicos al Convenio de Chicago 1 a 19**, OACI,

Alejandro G. Gomez Artime, **Costes del Transporte Aereo Comercial**, 978-8440405952, 2, IBERIA, 1991

Complementary Bibliography

OACI, **Convenio sobre la Aviación Civil Internacional**, OACI, 1944

Recomendacións

IDENTIFYING DATA**Desenvolvemento de infraestruturas aeronáuticas**

Subject	Desenvolvemento de infraestruturas aeronáuticas			
Code	O07M197V01402			
Study programme	Máster Universitario en Enxeñaría Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	Rey González, Guillermo David			
Lecturers	Rey González, Guillermo David			
E-mail	guillermo.rey@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	A materia abarca o emprazamento e plan de aeroportos, incluíndo o estudo para a súa localización. Profúndase no plan director e o deseño ambiental, así como na configuración da área de movemento de aeronaves e edificios aeroportuarios. Tamén se cobren proxectos de construción e mantemento de edificacións e instalacións, con énfases en infraestrutura eléctrica e control topográfico de obras. Finalmente, abórdase a certificación e xestión operativa de aeroportos, asegurando o cumprimento de normativas e a eficiencia na operación.			

Resultados de Formación e Aprendizaxe

Code	
B17	Coñecemento adecuado das disciplinas de cartografía, xeodesia, topografía e xeotecnia, aplicadas ao deseño dun aeroporto e de todas as súas infraestruturas.
C6	Capacidade para levar a cabo plans directores e proxectos aeroportuarios e xestión de obras de infraestruturas, edificios e instalacións aeroportuarios
C7	Capacidade para a planificación, deseño, construción e xestión de aeroportos, e capacidade para o proxecto das súas instalacións eléctricas
D7	Capacidade para realizar a certificación aeroportuaria
D9	Competencia para planificar, proxectar, xestionar e certificar os procedementos, infraestruturas e sistemas de apoio á actividade aeroespacial, incluídos os sistemas de navegación aérea.
D10	Competencia para o proxecto de construcións e instalacións aeronáuticas e espaciais, que requiran dun proxecto conxunto integrado, pola diversidade das súas tecnoloxías, a súa complexidade ou os amplos coñecementos técnicos requiridos.

Resultados previstos na materia

Expected results from this subject	Training and Learning Results
ID26. Aptitude para realizar os plans directores de aeroportos e os proxectos e a dirección de construción das infraestruturas, edificacións e instalacións aeroportuarios.	C6
ID27. Capacidade para a planificación, deseño, construción e xestionar aeroportos, e capacidade para o proxecto das súas instalacións eléctricas.	C7
ID30. Coñecemento adecuado das disciplinas de cartografía, xeodesia, topografía e geotécnica, aplicadas ao deseño dun aeroporto e todas as súas infraestruturas.	B17
ID31. Capacidade para levar a cabo a certificación de aeroportos.	D7
ID33. Competencia para planificar, proxectar, xestionar e certificar os procedementos, infraestruturas e sistemas que soportan a actividade aeroespacial, incluíndo os sistemas de navegación aérea.	D9
ID34. Competencia para o proxecto de construcións e instalacións aeronáuticas e espaciais, que requiran dun proxecto integrado conxunto, pola diversidade das súas tecnoloxías, a súa complexidade ou polos amplos coñecementos técnicos necesarios.	D10

Contidos

Topic

Bloque 1. Emprazamento do aeroporto. Xeodesia, cartografía, topografía e geotecnia aplicadas.	Tema 1. Introducción ao emprazamento de aeroportos. Factores de selección de localizacións aeroportuarias. Impacto ambiental e social. Requisitos e normativas. Tema 2. Xeodesia, cartografía, geotecnia aplicada ao deseño aeroportuario. Estudos hidrolóxicos e climatolóxicos.
Bloque 2. Plan do aeroporto. Plan director. Deseño ambiental do aeroporto.	Tema 3. Plan aeroportuario. Etapas do plan aeroportuario. Normativas e estándares internacionais (ICAO, FAA). Análise de demanda e capacidade. Tema 4. Elaboración do Plan Director. Obxectivos e compoñentes do Plan Director. Avaliación de necesidades futuras. Integración con plans urbanísticos e rexionais. Tema 5. Deseño ambiental do aeroporto. Impacto ambiental dos aeroportos. Estratexias de mitigación ambiental. Avaliación de impacto ambiental (EIA). Tema 6. Sustentabilidade no deseño aeroportuario. Enerxías renovables e eficiencia enerxética. Xestión de residuos e recursos. Certificacións e estándares de sustentabilidade (LEDE, BREEAM).
Bloque 3. Deseño da configuración do aeroporto. Área de movemento de aeronaves. Edifícios do aeroporto e dos servizos de navegación aérea.	Tema 7. Configuración xeral do aeroporto. Disposición de pistas e rúas de rodaxe. Deseño de plataformas e áreas de estacionamento. Planificación do fluxo de tráfico aéreo Tema 8. Deseño da área de movemento de aeronaves. Criterios de deseño para pistas e rúas de rodaxe. Sinalización e balizamento. Sistemas de iluminación e axudas visuais. Tema 9. Edifícios do aeroporto. Deseño de terminais de pasaxeiros. Infraestruturas de carga e mantemento. Edifícios auxiliares e de apoio. Tema 10. Servizos de navegación aérea. Deseño de torres de control. Instalacións de comunicación e radar. Sistemas de axuda á navegación. Tema 11. Integración e conectividade. Conectividade co transporte terrestre. Deseño de aparcamentos e accesos. Xestión do fluxo de pasaxeiros e equipaxes.
Bloque 4. Proxectos aeroportuarios. Edificacións e área de movemento de aeronaves e as súas instalacións, en particular as eléctricas.	Tema 12. Desenvolvemento de proxectos aeroportuarios. Metodoloxía de proxectos de infraestrutura. Xestión de proxectos e cronogramas. Avaliación económica e financeira. Tema 13. Deseño e construción de edificacións aeroportuarias. Planificación e deseño arquitectónico. Normativas e códigos de construción. Tecnoloxías e materiais de construción. Tema 14. Instalacións eléctricas e de comunicacións. Deseño e distribución de sistemas eléctricos. Infraestrutura de telecomunicacións. Sistemas de enerxía de emerxencia. Tema 15. Sistemas de iluminación e balizamento. Deseño de sistemas de iluminación para pistas e plataformas. Mantemento e actualización de sistemas. Cumprimento de normativas internacionais. Tema 16. Xestión de recursos e eficiencia enerxética. Tecnoloxías de eficiencia enerxética. Xestión de recursos e sustentabilidade. Implementación de enerxías renovables.
Bloque 5. Construción das infraestruturas, edificacións e instalacións aeroportuarias. Dirección, control e vixilancia de obras. Topografía de control de obra.	Tema 17. Xestión da construción aeroportuaria. Planificación e programación de obras. Contratación e xestión de contratistas. Supervisión e control de calidade. Tema 18. Dirección e control de obras. Técnicas de dirección de obra. Control de custos e prazos. Xestión de cambios e continxencias. Tema 19. Finalización e entrega de obras. Inspección final e probas de aceptación. Documentación e entrega de obra. Xestión do peche do proxecto.
Bloque 6. Certificación e xestión de aeroportos.	Tema 20. Certificación de aeroportos. Proceso de certificación (ICAO, FAA). Cumprimento de normas e regulacións. Auditorías e verificacións. Tema 21. Xestión operativa de aeroportos. Estrutura organizativa e funcións. Planificación e xestión de operacións. Mantemento e actualización de infraestruturas.

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	29	0	29
Resolución de problemas	16.5	0	16.5
Proxecto	0	102	102
Exame de preguntas obxectivas	1.5	0	1.5
Presentación	1	0	1

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Metodoloxía docente

	Description
Lección maxistral	Exposición por parte do profesor dos contidos sobre a materia obxecto de estudo, bases teóricas e/o directrices dun traballo, exercicio que o/a estudante ten que desenvolver
Resolución de problemas	Actividade na que se formulan problema e/o exercicios relacionados coa materia. O alumno debe desenvolver as solucións idóneas ou correctas mediante a exercitación de rutinas, a aplicación de fórmulas ou algoritmos, a aplicación de procedementos de transformación da información dispoñible e a interpretación dos resultados. Adóitase empregar como complemento da lección maxistral.

Atención personalizada

Tests Description

Proxecto O/A estudante, de maneira individual ou en grupo, elabora un documento sobre a temática da materia ou prepara seminarios, investigacións, memorias, ensaios, resumos de lecturas, conferencias, etc. No ámbito da acción tutorial, distínguense accións de tutoría académica, así como de tutoría personalizada. No primeiro dos casos, o alumnado terá á súa disposición horas de tutorías nas que pode consultar calquera dúbida relacionada cos contidos, organización e planificación da materia, co desenvolvemento do proxecto etc. As tutorías poden ser individualizadas, pero fomentaranse tutorías grupais para a resolución de problemas relacionados coas actividades para realizar en grupo, ou simplemente para informar o docente da evolución do traballo colaborativo. Nas tutorías personalizadas, cada alumno, de maneira individual, poderá comentar co profesor calquera problema que lle estea impedindo realizar un seguimento adecuado da materia, co fin de atopar entre ambos algúns tipos de solución. Conxugando ambos os tipos de acción tutorial, preténdense compensar os diferentes ritmos de aprendizaxe mediante a atención á diversidade.

Avaliación

	Description	Qualification	Training and Learning Results		
Proxecto	Realización dun proxecto relacionado cos contidos da materia.	30	B17	C6 C7	D7 D9 D10
Exame de preguntas obxectivas	Exame de problemas e/o preguntas de desenvolvemento e/o tipo test	40	B17	C6 C7	D7 D9 D10
Presentación	Presentación e defensa en clase do traballo grupal desenvolvido.	30	B17	C6 C7	D7 D9 D10

Other comments on the Evaluation

O calendario de probas de avaliación atópase publicado na páxina web do centro.

Primeira oportunidade.

(1) Estudantes que seguen o curso por Avaliación Continua. Para poder superar a materia na primeira oportunidade, mediante Avaliación Continua, será necesario:

-Unha nota mínima de 4 en cada un dos exames da materia.

-Asistir a, como mínimo, o 90% das sesións de prácticas.

-Entregar a totalidade de memorias prácticas e traballos da materia obtendo, como mínimo, unha nota de 3 en cada un deles.

No caso de non cumprir ditas condicións a nota final será a resultante do mínimo da nota media ponderada de AC e de 4.9.

(2) Estudante que desexen ser avaliados mediante avaliación global.

A avaliación do curso na primeira oportunidade realizarase, por defecto, mediante Avaliación Continua. O estudantado ten dereito a optar pola avaliación global segundo o procedemento e o prazo que estableza o centro para cada convocatoria. A nota obtida neste exame representará o 100% da nota final. O estudante deberá obter unha nota mínima de 5.0 neste exame. Este exame pode ter unha parte para realizar nunha sala de computadores e / ou laboratorio, e comprenderá a totalidade da materia impartida, así como os contidos abordados en todas as sesións prácticas e traballos.

Segunda oportunidade e Fin de Carrera.

O estudantado que non superase a materia na primeira oportunidade poderá realizarán un exame que supoñerá o 100% da nota. O estudante deberá obter unha nota mínima de 5.0 neste exame. Este exame pode ter unha parte para realizar nunha

sala de computadores e / ou laboratorio, e comprenderá a totalidade da materia impartida, así como os contidos abordados en todas as sesións prácticas e traballos.

En caso de detección de plaxio en calquera elemento de cualificación, a cualificación na devandita entrega será 0 e o feito será comunicado á dirección do Centro para os efectos oportunos.

Bibliografía. Fontes de información

Basic Bibliography

Robert Horonjeff, **Planning and design of airports**, 978-0071446419, McGraw-Hill Education, 2010

Norman J. Ashford, Saleh Mumayiz, Paul H. Wright, **Airport Engineering: Planning, Design, and Development of 21st Century Airports**, 978-0470398555, John Wiley & Sons Inc, 2011

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IATA, **Ground Operations Manual**, 2024

Francisco Salazar De La Cruz, **Introducción a la gestion económica de aeropuertos**, 978-8495567352, 2, Fundación AENA, 2006

OACI, **Manual sobre los aspectos económicos de los aeropuertos**, 978-9292493394, 3, Organización de Aviación Civil Internacional, 2013

Comisión Europea, **Reglamento UE691/2010**, Comisión Europea,

Comisión Europea, **Reglamento de Ejecución UE2019/317**, Comisión Europea, 2019

Comisión Europea, **Reglamento de Ejecución UE2017/373**, Comisión Europea, 2017

Complementary Bibliography

Recomendacións

Subjects that are recommended to be taken simultaneously

Explotación do transporte aéreo/O07M197V01401

IDENTIFYING DATA				
Prácticas externas				
Subject	Prácticas externas			
Code	O07M197V01403			
Study programme	Máster Universitario en Enxeñaría Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2	2c
Teaching language	Castelán			
Department	Departamento do Centro Universitario da Defensa da Escola Naval Militar de Marín Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	Rey González, Guillermo David			
Lecturers	Rey González, Guillermo David			
E-mail	guillermo.rey@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	Mediante a realización de prácticas externas o estudante poderá aplicar as competencias e coñecementos adquiridos ao longo dos seus estudos, permitindo reforzar a súa formación e facilitar a súa incorporación ao mercado laboral.			

Resultados de Formación e Aprendizaxe	
Code	D12 Resolver situacións, problemas ou continxencias con iniciativa e autonomía no ámbito da competencia, con creatividade, innovación e espírito de mellora no traballo persoal e dos membros do equipo.

Resultados previstos na materia	
Expected results from this subject	Training and Learning Results
Resolver situacións, problemas ou continxencias con iniciativa e autonomía no ámbito da competencia, con creatividade, innovación e espírito de mellora no traballo persoal e dos membros do equipo.	D12

Contidos	
Topic	Realización de actividades ligadas ao desempeño - Visita ás instalacións. profesional do Enxeñeiro Aeronáutico e das súas funcións máis habituais nunha contorna industrial real de empresa.
Coñecemento xeral por parte do estudante do organigrama e das liñas de actividade da empresa ou institución.	- Familiarización coa instrumentación, ferramentas, linguaxes de programación e paquetes de software usuais. - Asignación do estudante a un grupo de traballo. - Asignación ao estudante dun paquete de traballo concreto, correspondente a un dos traballos activos da empresa ou a unha das súas liñas de I+D+i, co seu correspondente cronograma. - Realización do traballo encomendado. - Redacción dunha memoria final sobre o traballo realizado. Entrega da documentación requirida xunto coa memoria final

Planificación			
	Class hours	Hours outside the classroom	Total hours
Prácticum, Practicas externas e clínicas	150	0	150
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Prácticum, Practicas externas e clínicas	Realización das prácticas externas no organismo/empresa dentro do grupo de traballo e tarefa asignados

Atención personalizada	
Methodologies	Description
Prácticum, Practicas externas e clínicas	Os estudantes manterán contacto co coordinador académico da materia mediante envío regular de informes breves mediante emails, nos que informarán de calquera incidente que puidese existir e das tarefas realizadas na empresa. Recoméndase o envío semanal dos mesmos.

Avaliación			
	Description	Qualification	Training and Learning Results
Prácticum, Practicas externas e clínicas	<p>Avaliación por parte do titor da empresa durante o desenvolvemento das prácticas (25%)</p> <p>Autoavaliación do alumno (25%)</p> <p>Avaliación da memoria de prácticas entregada polo alumno ao finalizar a realización das mesmas(25%)</p> <p>Avaliación do informe do titor académico designado polo centro (25%)</p> <p>Os estudantes en prácticas deberán manter un contacto continuado non só co seu titor na empresa, senón tamén co seu titor académico.</p> <p>Ao concluír as prácticas, os alumnos deberán entregar ao seu titor académico unha memoria final e o informe en documento oficial Informe do estudante.</p> <p>Na avaliación terase en conta o seguimento realizado polo titor académico e os informes entregados polo alumno.</p>	100	D12

Other comments on the Evaluation

A avaliación das prácticas en empresa rexerase polo establecido no regulamento específico da Escola de Enxeñería Aeronáutica e do Espazo para as prácticas externas das titulacións do centro. No seguimento e a avaliación das prácticas farase referencia ás competencias concretas, sobre todo entre as específicas, que se traballaron nas prácticas externas do estudante.

Bibliografía. Fontes de información

Basic Bibliography

Complementary Bibliography

Recomendacións

IDENTIFYING DATA**Final Master's Project**

Subject	Final Master's Project			
Code	O07M197V01404			
Study programme	(*)Máster Universitario en Enxeñería Aeronáutica			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	12	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Gómez San Juan, Alejandro Manuel			
Lecturers	Gómez San Juan, Alejandro Manuel			
E-mail	alejandromanuel.gomez@uvigo.es			
Web	http://muea.webs.uvigo.es			
General description	The Master Thesis is an original and personal project that each student will carry out independently under the supervision of the teaching staff. It will allow the student to show the acquisition of knowledge and competences associated with the Master degree.			

English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.

Training and Learning Results

Code	
D8	Completion, presentation and defense, once all the credits of the study plan have been obtained, of an original exercise carried out individually before a university tribunal, consisting of an integral Aeronautical Engineering project of a professional nature in which the competences acquired in the courses are synthesized.

Expected results from this subject

Expected results from this subject	Training and Learning Results
GO 32. Realisation, presentation and defence, once obtained all the credits of the plan of studies, of an original exercise made of individual form in front of a university court, consistent in an integral project of Aeronautical Engineering of professional nature in which *sinteticen the competitions purchased in the educations	D8

Contents

Topic	
Knowledge, understanding, application, analysis and synthesis of a project in one of the following areas of aerospace engineering.	<ul style="list-style-type: none"> - Aerospace vehicles. - Propulsion systems. - Navigation and air traffic systems. - Airport engineering and aeronautical organisation.

Planning

	Class hours	Hours outside the classroom	Total hours
Previous studies	0	90	90
Project based learning	0	120	120
Mentored work	20	0	20
Project	0	50	50
Presentation	1	19	20

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Previous studies	Autonomous work of study oriented to the acquisition of theoretical knowledges.
Project based learning	Work of the student oriented to the practical application.

Mentored work On-site dedication of the student at the School of Aeronautical and Space Engineering facilities:

- Student attendance at the school's laboratories for project development.
- Tutorials with the tutor and/or co-tutor. Meetings with the student dedicated to the application of methods and techniques, document review, presentation rehearsals, etc.

Personalized assistance

Methodologies Description

Mentored work On-site dedication of the student at the School of Aeronautical and Space Engineering facilities: -Student attendance at the school's laboratories for project development. -Tutorials with the tutor and/or co-tutor. Meetings with the student dedicated to the application of methods and techniques, document review, presentation rehearsals, etc.

Assessment

	Description	Qualification	Training and Learning Results
Project	Evaluation of the tutor: 25% Evaluation of the court: 50% - Qualification of the scope of the project. It will value the scientific/technical difficulty of the work (25%) - Qualification of the documentation. It will value the quality of the memory of EMT (25%)	75	D8
Presentation	Evaluation of the court: 25% - Qualification of the defence. They value appearances like the clarity in the presentation, employment of the time, quality of the material employed and reply the questions of the court.	25	D8

Other comments on the Evaluation

The Master Thesis is an original exercise that is carried out individually, presented and defended before a university tribunal, consisting of a project in the fields of aerospace vehicles, propulsion systems, navigation and air traffic systems, and/or airport engineering and aeronautical organisation, of a professional nature, in which the competences acquired in the courses taught in the Master's Degree are synthesised and integrated.

The completion and evaluation of the Master Thesis is regulated according to the current regulations of both the University of Vigo and the EEAE.

In case of detection of plagiarism in any of the tests (short tests, mid-term exams or final exam), the final grade will be FAILED.

The final grade will be FAILED (0) and the fact will be communicated to the management of the School for appropriate effects.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

Other comments

Ethical commitment: it is expected that the student presents suitable ethical behaviour. In case any unethical behaviour is detected (copy, plagiarism or others) the global note in this course will be suspense (0,0).

Requirements: To enrol in the End of Master Thesis it is necessary to have surpassed or be enrolled in all the matters of the inferior courses up to the course in which it the EMT is found.

Important information: The EMT will only be possible to be defended and evaluated when there is proof that the student has surpassed all the necessary credits for obtaining the Master title, except the corresponding to the own EMT, according to the Regulation for the Realisation of the End of Master Thesis approved in the Council of Government on 15 June 2016 and modified on 13 November 2018 and 15 of october of 2022.

The originality of the thesis will be analysed through a computer application for the detection of plagiarism.