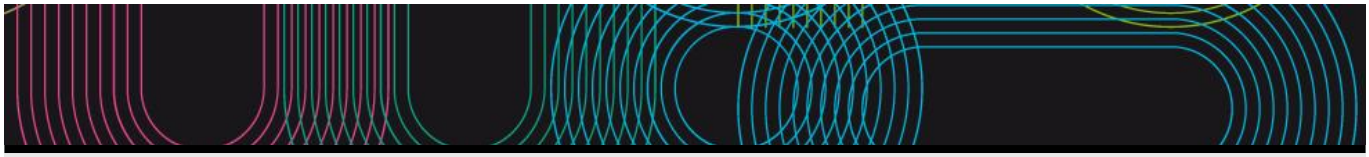

(*)Escola de Enxeñaría Aeronáutica e do Espazo

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).

Address

Escola de Enxeñaría Aeronáutica e do Espazo

Pavillón Manuel Martínez-Risco
Campus universitario
32004 Ourense

Tel.: +34 988 368 823
Web: http://aero.uvigo.es

Regulations and legislation

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

Grado en Ingeniería Aeroespacial

Subjects

Year 3rd

Code	Name	Quadmester	Total Cr.
O07G410V01501	Aerospace manufacturing	1st	6
O07G410V01921	Solid mechanics and aerospace structures	1st	9
O07G410V01922	Fluid mechanics II and CFD	1st	9
O07G410V01923	Aerodynamics and aeroelasticity	2nd	9
O07G410V01925	Systems engineering and aerospace communications	2nd	6
O07G410V01931	Air-jet and aeronautic alternative engines	1st	6
O07G410V01932	Mechanical design, FEM and vibrations	2nd	9
O07G410V01933	Space Vehicles	2nd	6
O07G410V01941	Numerical calculation	1st	6

O07G410V01942	Aerospace alloys and compound materials	2nd	9
O07G410V01943	Analytic and orbital mechanics	2nd	6

IDENTIFYING DATA				
Fabricación aeroespacial				
Subject	Fabricación aeroespacial			
Code	O07G410V01501			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	1c
Teaching language	Castelán			
Department	Deseño na enxeñaría			
Coordinator	Carou Porto, Diego			
Lecturers	Carou Porto, Diego			
E-mail	diecapor@uvigo.es			
Web	http://aero.uvigo.es			
General description	Esta materia introduce os fundamentos dos procesos de fabricación (deseño, tecnoloxías, planificación, simulación e control de calidade) no ámbito da fabricación aeroespacial.			

Competencias	
Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidade para o deseño, desenvolvemento e xestión no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de *aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
B2	Planificación, redacción, dirección e xestión de proxectos, cálculo e fabricación no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
C12	Comprender os procesos de fabricación.
D2	Liderado, iniciativa e espírito emprendedor
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D9	Capacidade de traballo en equipo de carácter interdisciplinar
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos
D13	Sustentabilidade e compromiso ambiental. Uso equitativo, responsable e eficiente dos recursos

Resultados de aprendizaxe				
Expected results from this subject	Training and Learning Results			
Interpretación, confección e xestión de documentos técnicos, para o deseño conceptual, preliminar e detalle de modelos físicos e sistemas.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13
Coñecemento dos principios xerais sobre deseño xeométrico, funcional e os específicos dos elementos e instalacións propias das especialidades.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13

Criterios de calidade e análise destes deseños. O estudante coñece os procesos de produción, os seus principais parámetros definitorios e o seu campo de aplicación.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D6 D8 D9 D11 D13
O estudante coñece toda a información necesaria para levar a cabo un proceso de produción.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13
O estudante é capaz de realizar un informe que permita a execución exitosa dun proceso de produción.	A2 A3 A5	B1 B2	C12	D2 D3 D4 D8 D11 D13

Contidos

Topic	
Bloque I	1. Integración do deseño e fabricación 2. Conformado por deformación plástica 3. Conformado por mecanizado 4. Conformado de plásticos 5. Conformado por moldeo 6. Pulvimetalurxia 7. Fabricación aditiva 8. Conformado de materiais compostos 9. Técnicas de unión e ensamblaxe 10. Metroloxía
Bloque II	Simulación de procesos de fabricación

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	17	36	53
Resolución de problemas	12	24	36
Aprendizaxe colaborativa	1	2	3
Prácticas con apoio das TIC	18	38	56
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	Exposición por parte do profesor dos contidos fundamentais da materia.
Resolución de problemas	Presentación e resolución por parte do profesor de problemas relativos aos procesos de fabricación estudados de maneira teórica coa participación activa dos estudantes.
Aprendizaxe colaborativa	O profesor exporá temas de estudo que os estudantes traballarán de maneira autónoma para elaborar contidos adicionais de maneira colaborativa.
Prácticas con apoio das TIC	Introdución ao emprego de software de simulación de procesos de fabricación por parte do profesor. Coas instrucións recibidas e traballo autónomo, os estudantes poderán resolver problemas específicos que permitan mellorar o seu coñecemento sobre os procesos estudados.

Atención personalizada

Methodologies	Description
Lección maxistral	Prestarase atención ao alumnado tanto no horario lectivo como no de tutorías.
Resolución de problemas	Prestarase atención ao alumnado tanto no horario lectivo como no de tutorías.
Prácticas con apoio das TIC	Prestarase atención ao alumnado tanto no horario lectivo como no de tutorías.
Aprendizaxe colaborativa	Prestarase atención ao alumnado tanto no horario lectivo como no de tutorías.

Avaliación

	Description	Qualification	Training and Learning Results		
Lección maxistral	Proba escrita	50	A2 A5	C12	D4 D8
Resolución de problemas	Entrega de problemas propostos resoltos	10	A2 A5	C12	D2 D3 D4 D8
Aprendizaxe colaborativa	Participación en actividades propostas	10	A2 A3 A5	C12	D2 D3 D4 D6 D8 D9 D13
Prácticas con apoio das TIC	Entrega de memorias de prácticas	30	A2 A5	C12	D2 D3 D4 D8 D11

Other comments on the Evaluation

PRIMEIRA EDICIÓN DE ACTA:

A materia avalíase en base a catro parámetros:

-Exame de teórico-práctico (nota máxima 5 puntos). Nesta proba avalíanse os coñecementos teóricos da materia e cuestións relacionadas cos problemas mediante un exame tipo test na data establecida para o exame oficial da materia.

-Resolución de problemas (nota máxima 1 punto). Avaliarase a entrega da resolución aos problemas expostos durante o curso nos prazos establecidos.

-Aprendizaxe colaborativo (nota máxima 1 punto). Deberase participar nas actividades propostas durante o curso.

-Prácticas (nota máxima 3 puntos). Avaliarase a entrega das memorias de prácticas durante o curso nos prazos establecidos.

Aprobarán a materia aqueles alumnos que consigan unha nota igual ou superior a 5 puntos. Non se fará media no caso de que no exame teórico-práctico a nota sexa inferior a 4.

SEGUNDA e SUCESIVAS EDICIÓNS DE ACTA:

O método de Avaliación é o mesmo que o descrito para a PRIMEIRA EDICIÓN DE ACTA.

OUTRAS CONSIDERACIÓNS:

Os estudantes non-asistentes serán avaliados cun exame final que cobre 100% das competencias da materia.

En caso de discrepancia entre o contido da Guía Docente nas súas versións en Castelán, Galego e Inglés, prevalecerá o establecido na versión en Castelán.

O calendario de probas de avaliación aprobado oficialmente pola Xunta de Centro da EEAE atópase publicado na páxina web http://aero.uvigo.es/gl/docencia/exames

Bibliografía. Fontes de información

Basic Bibliography

S. Kalpakjian, S.R. Schmid, **Manufacturing engineering and technology**, 7, Pearson Education, 2014

Mikell P. Groover, **Fundamentos de manufactura moderna : materiales, procesos y sistemas**, 3, Prentice-Hall, 2007

J.T. Black, Ronald A. Kohser, **DeGarmo□s Materials and Processes in Manufacturing**, 12, Wiley, 2017

Complementary Bibliography

Mikell P. Groover, **Principles of modern manufacturing**, 5, John Wiley & Sons, 2013

A. Sartal, D. Carou, J.P. Davim, **Enabling Technologies for the Successful Deployment of Industry 4.0**, 1, CRC Press, 2020

Recomendacións

Subjects that continue the syllabus

Tecnoloxías para conformado de materiais aeroespaciais/O07G410V01913

Plan de Continxencias

Description

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Ante a incerta e imprevisible evolución da alerta sanitaria provocada polo *COVID-19, a Universidade de Vigo establece unha planificación extraordinaria que se activará no momento en que as administracións e a propia institución determíneno atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou parcialmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dun modo máis áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o profesorado a través da ferramenta normalizada e institucionalizada das guías docentes.

=== ADAPTACIÓN DAS METODOLOXÍAS ===
* Metodoloxías docentes que se manteñen
Todas se manteñen en formato asíncrono ou síncrono a distancia. Para iso empregaranse os medios dispostos pola Universidade de Vigo: Campus Remoto e/ou FAITIC.
* Metodoloxías docentes que se modifican

* Mecanismo non presencial de atención ao alumnado (*tutorías)
Desenvolveranse mediante *email ou videoconferencia en despacho virtual.
* Modificacións (si proceden) dos contidos a impartir

* Bibliografía adicional para facilitar o auto-aprendizaxe

* Outras modificacións

=== ADAPTACIÓN DA AVALIACIÓN ===
* Probas xa realizadas
Proba *XX: [Peso anterior 00%] [Peso Proposto 00%]
...

* Probas pendentes que se manteñen
Proba *XX: [Peso anterior 00%] [Peso Proposto 00%]
...

* Probas que se modifican
[Proba anterior] =&*gt; [Proba nova]

* Novas probas

* Información adicional
A avaliación mantense sen cambios en calquera circunstancia.
No escenario multimodal e/ou non presencial, cando cumpra, o persoal docente implicado na impartición da docencia resérvase o dereito de non dar o consentimento para a captación, publicación, retransmisión ou reprodución do seu discurso, imaxe, voz e explicacións de cátedra, no exercicio das súas funcións docentes, no ámbito da Universidade de Vigo.

IDENTIFYING DATA

Mecánica de sólidos e estruturas aeronáuticas

Subject	Mecánica de sólidos e estruturas aeronáuticas			
Code	O07G410V01921			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3	1c
Teaching language	Castelán Galego			
Department	Enxeñaría dos materiais, mecánica aplicada e construción			
Coordinator	Comesaña Piñeiro, Rafael Conde Carnero, Borja			
Lecturers	Bendaña Jácome, Ricardo Javier Comesaña Piñeiro, Rafael Conde Carnero, Borja			
E-mail	bconde@uvigo.es racomesana@uvigo.es			
Web	http://faitic.uvigo.es/index.php/es/			
General description	Introdución á mecánica de sólidos e as estruturas aeronáuticas			

Competencias

Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A4	Que os estudantes poidan transmitir información, ideas, problemas e solucións a un público tanto especializado como non especializado
C20	Coñecemento adecuado e aplicado á Enxeñaría de: A mecánica de fractura do medio continuo e as formulacións dinámicas, de fatiga de inestabilidade estrutural e de aeroelasticidad.
C26	Coñecemento aplicado de: aerodinámica; mecánica e termodinámica, mecánica do voo, enxeñaría de aeronaves (á fixa e ás rotatorias), teoría de estruturas.
C33	Coñecemento aplicado de: aerodinámica; mecánica do voo, enxeñaría da defensa aérea (balística, mísiles e sistemas aéreos), propulsión espacial, ciencia e tecnoloxía dos materiais, teoría de estruturas.
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D5	Capacidade de resolución de problemas e toma de decisións
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos

Resultados de aprendizaxe

Expected results from this subject	Training and Learning Results		
Compresión das ecuacións e principios xerais do medio continuo, así como a axeitada selección dos diferentes modelos de compartamento de sólidos deformables	A2	C26 C33	D4 D5 D11
Análise de sólidos e estruturas sometidas a tensións superiores ao límite elástico e a cargas cíclicas	A3 A4	C20	D4 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese da teoría de estruturas	A3 A4	C26 C33	D3 D4 D5 D6 D8 D11
Coñecemento dos aspectos máis destacados do comportamento estrutural de aeronaves	A2 A3	C20 C26 C33	D4 D5 D8

Contidos	
Topic	
Introdución ás características e configuración das estruturas aeronáuticas	- Cargas sobre a estrutura. - Elementos estruturais. Estrutura da fuselaxe: monocasco, semimonocasco. Estrutura de ala e de cola.
Estruturas simétricas.	- Estruturas simétricas.
Esforzos producidos polo momento flector e pola forza cortante.	- Teorema do fluxo cortante. - Esforzos cortantes. - Flexión composta en estruturas simétricas.
Torsión.	- Seccións non circulares. Sección rectangular. - Seccións abertas de pequeno espesor. Seccións cerradas de pequeno espesor. Seccións cerradas multicelulares. - Centro de torsión. - Flexión-torsión.
Análise de tensións en alas.	- Análise de tensións en alas.
Análise de tensións en fuselaxes.	- Análise de tensións en fuselaxes.
Introducción á integridade estrutural	- Requisitos de resistencia e rixidez. Factor último de seguridade. - Fatiga. Criterios de fatiga basados en tensións. - Criterios de fatiga basados en deformacións. - Introdución á mecánica da fractura. Criterios de tolerancia ao dano. Marxe de seguridade e factor de reserva.
Elementos sometidos a esforzos axiais de tracción e momentos flectores.	- Elementos sometidos a esforzos axiais de tracción e momentos flectores. Momento flector último.
Problemas de inestabilidade	- Introducción á teoría da estabilidade. - Pandeo global. Inestabilidade primaria de columnas de sección estable. - Pandeo de viga-columna. Esforzo de crippling. - Inestabilidade de paneles planos e curvos. - Pandeo local de vigas de sección de parede delgada. - Paneles rixidizados. Formas de fallo a compresión e cortadura.
Unións en estruturas aeronáuticas.	- Unións en estruturas aeronáuticas.
Teoría de placas e láminas.	- Elementos estructurais tipo placa e lámina. - Hipóteses básicas de cálculo. - Flexión de placas e láminas. - Pandeo de placas.
Método dos elementos finitos (MEF).	- Análise estática lineal con elementos tipo barra, elasticidade 2D e 3D, placas e láminas. - Introdución a software de simulación MEF. - Inestabilidade estrutural. Pandeo mediante MEF. - Introducción á análise estática non-lineal de estruturas: non-linealidade xeométrica, non-linealidade do material (plasticidade), non-linealidade debida ás condicións de contorno.

Planificación	Class hours	Hours outside the classroom	Total hours
Lección maxistral	40	0	40
Resolución de problemas	10	0	10
Prácticas de laboratorio	24	10	34
Resolución de problemas de forma autónoma	0	120	120
Exame de preguntas de desenvolvemento	3.5	17.5	21
*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 na aula dos coñecementos básicos da materia.
Resolución de problemas	Resolución de problemas relacionados cos contidos teóricos.
Prácticas de laboratorio	Realización de prácticas no laboratorio e/ou realización de prácticas en aula informática e/ou resolución de problemas prácticos
Resolución de problemas de forma autónoma	Resolución de problemas e/ou exercicios de forma autónoma por parte do alumno

Atención personalizada	
Methodologies	**Description**

Prácticas de laboratorio	Nas prácticas intentarase na medida do posible atender personalmente a todas as dúbidas que xurdan ao longo do desenvolvemento das prácticas

Avaliación

	Description	Qualification	Training and Learning Results		
Prácticas de laboratorio	Asistencia e participación activa nas clases prácticas. Resolución de problemas e/ou exercicios de forma autónoma.	10	A2 A3	C20 C26 C33	D3 D4 D5 D8 D11
Exame de preguntas de desenvolvemento	Realizarase un examen ao final do curso sobre a totalidade do contido abordado na materia.	90	A2 A4	C20 C26 C33	D3 D4 D5 D6 D8

Other comments on the Evaluation

Para superar a materia na avaliación da 1ª convocatoria e na 2ª convocatoria requerirase obter unha calificación superior a 5 puntos sobre 10 na valoración conxunta da avaliación continua durante o desenvolmento das clases e o examen na data oficial. A calificación final obterase de acordo ás porcentaxes indicadas.

O calendario de probas de avaluación aprobado oficialmente pola Xunta de Centro da EEAE publícase na web:http://aero.uvigo.es/gl/docencia/exames
A duración máxima do examen será de 3 horas se non hai interrupción ou de 5 horas se hai unha pausa intermedia (sendo 3 horas o máximo para cada parte).

Estudantes que renuncien oficialmente á avaliación continua: a nota será obtida no exame correspondente que representará o 100% da calificación. Este examen poderá constar dunha parte a realizar en aula informática e/ou laboratorio cunha calificación que representará o 10% da calificación total.

Bibliografía. Fontes de información

Basic Bibliography

E. de la Fuente Tremps, **Introducción al análisis de las Estructuras Aeronáuticas**, 1ª, Garceta, 2014

T. H. G. Megson, **Aircraft Structures for engineering students**, 4ª, Elsevier, 2003

Eugenio Oñate Ibáñez de Navarra, **Cálculo de estructuras por el método de elementos finitos**, CIMNE, 1995

Complementary Bibliography

S.P. Timoshenko, **Theory of plates and shells**, 1ª, McGraw Hill, 1940

R. Bendaña, **Ejercicios de Resistencia de Materiales y cáculo de Estructuras para Ingenieros**, 1ª, Galiza Editora, 2005

Darrol Stinton, **The anatomy of the aeroplane.**, 1ª, BPS Profesional Book, 1985

John Cutler, **Understanding Aircraft Structures**, 1ª, Blackwell Science, 1992

Bruce K. donalson, **Analysis of Aircraft Structures**, 1ª, McGRAW-HILL. International Editions, 1993

Recomendacións

Subjects that it is recommended to have taken before

Expresión gráfica: Expresión gráfica/O07G410V01105
Física: Física I/O07G410V01103
Física: Física II/O07G410V01202
Matemáticas: Álxebra lineal/O07G410V01102
Matemáticas: Cálculo I/O07G410V01101
Matemáticas: Cálculo II/O07G410V01201
Ciencia e tecnoloxía dos materiais/O07G410V01304
Matemáticas: Estatística/O07G410V01401
Mecánica clásica/O07G410V01305
Resistencia de materiais e elasticidade/O07G410V01405
Termodinámica/O07G410V01303

Plan de Continxencias

Description

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Ante a incerta e imprevisible evolución da alerta sanitaria provocada pola COVID- 19, a Universidade establece una planificación extraordinaria que se activará no momento en que as administracións e a propia institución o determinen atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou non totalmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dun xeito mais áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o profesorado a través da ferramenta normalizada e institucionalizada das guías docentes DOCNET.

=== ADAPTACIÓN DAS METODOLOXÍAS ===
* Metodoloxías docentes que se manteñen

Lección maxistral: Exposición da teoría básica da materia.
Prácticas: Resolución de problemas relacionados cos contidos teóricos.
Ambas metodoloxías serán adaptadas a un contexto de docencia non presencial a tráves do uso de ferramentas de teledocencia dispoñibles na Universidade de Vigo (Faitic, Campus Remoto ou outros).
Primarase a impartición dos contidos teóricos por medios telemáticos así como aqueles contidos de prácticas de resolución de problemas, aula de informática, e outros, que poidan ser virtualizados ou desenvolvidos polo alumnado de xeito guiado.

* Mecanismo non presencial de atención ao alumnado (titorías)

As titorías serán atendidas no espacio temporal habitual a través de medios telemáticos ordinarios (correo electrónico, Faitic) así como dos despachos virtuais do profesorado dispoñibles no Campus Remoto da Universidade de Vigo.

=== ADAPTACIÓN DA AVALIACIÓN ===

* Probas pendentes que se manteñen
Exame de preguntas de desenvolvemento: [Peso anterior 90%] [Peso Proposto 90%]

* Probas que se modifican
[Prácticas de laboratorio: Asistencia e participación activa nas clases prácticas. (5%) Resolución de problemas e/ou exercicios de forma autónoma. (5%)]
=>
[Resolución de problemas e/ou exercicios de forma autónoma.
(10%)]

As probas de avaliación desenvolveranse de forma presencial salvo Resolución Reitoral que indique que se deben facer de forma non presencial, realizándose dese xeito a través das distintas ferramentas postas a disposición do profesorado. Aquelas probas non realizables de forma telemática se suplirán por outras (entregas de traballo autónomo guiado, etc.)

IDENTIFYING DATA				
Mecánica de fluídos II e CFD				
Subject	Mecánica de fluídos II e CFD			
Code	O07G410V01922			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3	1c
Teaching language	Castelán			
Department	Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	Martín Ortega, Elena Beatriz			
Lecturers	Martín Ortega, Elena Beatriz Rodríguez Pérez, Luis			
E-mail	emortega@uvigo.es			
Web	http://aero.uvigo.es			
General description	Coñecemento, compresión e aplicación de conceptos e técnicas da Mecánica de Fluídos de Enxeñaría Aeroespacial Parte de la asignatura se presenta como una introducción a la dinámica de fluidos computacional que, partiendo de un conocimiento de las ecuaciones de conservación de los fluidos (ya adquirido por los alumnos en asignaturas previas) permita al alumno realizar simulaciones sencillas que involucren a un fluido como medio de trabajo.			

Competencias	
Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
C16	Coñecemento adecuado e aplicado á Enxeñaría de: Os conceptos e as leis que gobernan os procesos de transferencia de enerxía, o movemento dos fluídos, os mecanismos de transmisión de calor e o cambio de materia e o seu papel na análise dos principais sistemas de propulsión aeroespaciais.
C18	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos da mecánica de fluídos; os principios básicos do control e a automatización do voo; as principais características e propiedades físicas e mecánicas dos materiais.
C19	Coñecemento aplicado de: a ciencia e tecnoloxía dos materiais; mecánica e termodinámica; mecánica de fluídos; aerodinámica e mecánica do voo; sistemas de navegación e circulación aérea; tecnoloxía aeroespacial; teoría de estruturas; transporte aéreo; economía e produción; proxectos; impacto ambiental.
C20	Coñecemento adecuado e aplicado á Enxeñaría de: A mecánica de fractura do medio continuo e as formulacións dinámicas, de fatiga de inestabilidade estrutural e de aeroelasticidad.
C22	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos da mecánica de fluídos que describen o fluxo en todos os réximes, para determinar as distribucións de presións e as forzas sobre as aeronaves.
C25	Coñecemento adecuado e aplicado á Enxeñaría de: os métodos de cálculo de deseño e proxecto aeronáutico; o uso da experimentación aerodinámica e dos parámetros máis significativos na aplicación teórica; o manexo das técnicas experimentais, equipamento e instrumentos de medida propios da disciplina; a simulación, deseño, análise e interpretación de experimentación e operacións en voo; os sistemas de mantemento e certificación de aeronaves.
C26	Coñecemento aplicado de: aerodinámica; mecánica e termodinámica, mecánica do voo, enxeñaría de aeronaves (á fixa e ás rotatorias), teoría de estruturas.
C28	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos da mecánica de fluídos que describen o fluxo en calquera réxime e determinan as distribucións de presións e as forzas aerodinámicas.
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D5	Capacidade de resolución de problemas e toma de decisións
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos

Resultados de aprendizaxe	
Expected results from this subject	Training and Learning Results

Coñecemento e comprensión dos principais conceptos e técnicas da Mecánica de Fluídos	A3	C16 C18 C19 C22 C28	D4 D5 D8 D11
Capacidade para aplicar os principais conceptos e técnicas da Mecánica de Fluídos ás Ciencias da Enxeñaría	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Comprensión dos procedementos básicos da dinámica de fluídos computacional	A5	C16 C18 C19 C22 C25 C26 C28	D4 D5 D8 D11

Contidos	
Topic	
CFD. Ecuacións xerais e fenómenos de transporte	Tema 1: Resumo das ecuacións xerais. Notación integral Notación diferencial Forma conservativa. Notación compacta Modelos límite máis comúns Condicións de contorno máis comúns
CFD. Turbulencia	Tema 2: Introdución á turbulencia Introdución Escala de Kolmogorov Inviabilidad da simulación numérica directa Modelos de turbulencia: Modelos RANS: -Medias de Reynolds e de Favre -Ecuacións promediadas. Esforzos aparentes de Reynolds. Problema do peche - Hipótese de Boussinesq: modelos algebraicos, dunha ecuación e de dúas ecuacións - Leis de parede. Modelos de alto e baixo número de Reynolds - Modelos de transporte de esforzos aparentes de Reynolds Modelos LLES: Descrición

CFD. Introdución á dinámica de Fluídos Computacional	Tema 3: Métodos FVM de resolución numérica das ecuacións de Navier-Stokes. Métodos de Volumes Finitos (FVM): - Introdución - Discretización do dominio computacional - Discretización das ecuacións de fluídos - Ecuacións discretizadas en FVM - Discretización das condicións de contorno Fluxos incompresibles. Ecuación de presión - Métodos de compresibilidad artificial - Axustes presión-velocidade - Métodos de aceleración da resolución numérica máis comúns Tema 4: Introdución ao uso de distintos software (OpenFoam e Fluent) de simulación numérica de fluídos. Prácticas en aula informática. *O uso deste software quedará condicionado á dispoñibilidade de licenzas de uso por parte do centro así como á correcta instalación dos mesmos na aula informática asignada Aplicacións: - Fluxo laminar no interior dunha cavidade - Fluxo nun dispositivo mesturador de correntes - Forzas aerodinámicas sobre corpos: Fluxo ao redor dun obstáculo. Fluxo laminar e fluxo turbulento Cálculo da rúa de Kármán tras un corpo romo Fluxo incompresible sobre perfil aerodinámico Fluxo transónico sobre perfil aerodinámico -Exercicios/Proxectos propostos de simulación numérica para ser resoltos de forma máis independente polos alumnos.
Mecánica de Fluídos II. Fluxo de fluídos ideais. Movementos irrotacionais	Tema 1: Movementos irrotacionais. Condicións de irrotacionalidad Ecuacións do movemento irrotacional Condicións iniciais e de contorno Movemento irrotacional de líquidos Principio de superposición Potencial de velocidades a grandes distancias dun obstáculo Movemento plano irrotacional de líquidos: Solucións elementais. Corrente en recunchos e esquinas. Corrente ao redor dun cilindro con circulación Movemento irrotacional bidimensional de gases Expansión de Prandtl-Meyer Tema 2: Movementos con superficies de discontinuidad Ecuacións do salto das magnitudes fluídas nunha discontinuidad Discontinuidades normais e tangenciales Ondas de choque normais Ondas de choque *oblicuas Aplicación: Movemento case *unidimensional de fluídos ideais: Área crítica. Movemento en *toberas. Carga e descarga en depósitos. Ondas de choque. Relación de *Hugoniot.
Mecánica de Fluídos II. Movementos unidimensionales non estacionarios de fluídos ideais	Tema 3: Movemento unidimensional non estacionario de fluídos ideais. Efecto de compresibilidad na líquidos Apertura e peche de válvulas. Golpe de ariete Ecuacións do movemento unidireccional non estacionario en gases. Ondas simples

Mecánica de Fluídos II. Movemento a baixos números de Reynolds	Tema 4: Movemento a baixos números de Reynolds Ecuacións. Condicións iniciais e de contorno Aplicación a fluídos incompresibles. Movementos ao redor dun cilindro e unha esfera Lubricación: Ecuación de Reynolds da lubricación 3D. Aplicacións. cojinete cilíndrico, lubricación con gases, patín rectangular, ...
Mecánica de Fluídos II. Capa límite	Tema 5: Capa límite laminar Capa límite laminar incompresible. Solucións de semellanza. Capa límite sobre placa plana. Solución de Blausius Capa límite laminar compresible Capa límite térmica a baixas velocidades
Mecánica de Fluídos II. Prácticas de laboratorio	- Ensaio en banco de aerodinámica: Medición capa límite - Ensaio en túnel de vento de baixa velocidade Distribución de presións sobre perfil aerodinámico Distribución de presións sobre corpo romo - Distribución de presións en toberas converxentes e converxentes-diverxentes. Magnitudes críticas. Ondas de choque. Bloqueo sónico. *A realización desta práctica quedará condicionada á dispoñibilidade do equipo experimental na data de realización da mesma

Planificación			
	Class hours	Hours outside the classroom	Total hours
Prácticas de laboratorio	4.5	5	9.5
Lección maxistral	35	35	70
Aprendizaxe baseado en proxectos	8	17	25
Prácticas con apoio das TIC	8	0	8
Resolución de problemas	19.5	73	92.5
Proxecto	0	15	15
Exame de preguntas de desenvolvemento	5	0	5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente	
	Description
Prácticas de laboratorio	Realización das prácticas de laboratorio
Lección maxistral	Exposición da teoría Translación de problemas de fluídos a modelos matemáticos para ser resoltos numericamente
Aprendizaxe baseado en proxectos	Formulación e resolución numérica de problemas propostos aplicados a fluxos de fluídos
Prácticas con apoio das TIC	Formulación e resolución de modelos aplicados a fluxos de fluídos
Resolución de problemas	Resolución de problemas e/ou exercicios de forma autónoma por parte do alumno para comprender e caracterizar os distintos tipos de movementos de fluídos e os seus simplificaciones

Atención personalizada	
Methodologies	**Description**
Prácticas de laboratorio	Atenderase persoalmente a todas as dúbidas que xurdan ao longo do desenvolvemento das prácticas
Resolución de problemas	Atenderase, na medida do posible, a todas as dúbidas que xurdan ao longo da resolución dos problemas
Prácticas con apoio das TIC	Nas prácticas tentarase na medida do posible organizar ao grupo de estudantes en distintas prácticas. Atenderase persoalmente a todas as dúbidas que xurdan ao longo do desenvolvemento das prácticas
Tests	**Description**
Proxecto	Atenderase en tutorías as dúbidas que xurdan ao longo do desenvolvemento do proxecto

Avaliación

	Description	Qualification	Training and Learning Results		
Aprendizaxe baseado en proxectos	Realización e entrega de informe das simulacións propostas ao alumno	20	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Prácticas con apoio das TIC	Asistencia e participación activa nas prácticas	1.5	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Resolución de problemas	Asistencia ás sesións de resolución de problemas e entrega dos problemas propostos	3.5	A2 A3 A5	C16 C18 C19 C20 C22 C25 C26 C28	D3 D4 D5 D6 D8 D11
Exame de preguntas de desenvolvemento	Realización de probas escritas, incluíndo o exame final da materia	75		C16 C18 C19 C20 C22 C25 C26 C28	D3 D5

Other comments on the Evaluation

Primeira edición da acta:
A avaliación da materia realizarase mediante:

- Proba ou probas escritas, incluída o exame escrito final (75% da nota final).
- Entrega do Proxecto/s (de simulación numérica) propostos ao alumnado polo profesorado (20% da nota final na materia). Esta entrega forma parte da avaliación continua da materia
- terase en conta a asistencia e participación activa nas clases prácticas e informáticas así como a entrega de problemas propostos polo profesorado nas clases prácticas e/ou teóricas si así o indica (5% da nota final na materia). Esta porcentaxe forma parte da avaliación continua

Os estudantes que non cursen a materia pola modalidade de avaliación continua, realizarán un exame final de 5h de duración (con descanso no medio) que suporá o 100% da súa nota

Segunda edición da acta:

- A nota do proxecto de simulación numérica gardarase para a segunda edición da acta.
- A nota de avaliación continua asociada a lle asistencia e participación activa e entrega de problemas propostos polo profesorado (si así o indica) gardarase para a segunda edición da acta.
- O resto da nota será un exame escrito.
- No caso dos estudantes que non teñan nota na avaliación continua na primeira convocatoria este exame final da segunda edición da acta representará o 100% da súa nota e contará con preguntas relacionadas con todo o temario da materia

Bibliografía. Fontes de información

Basic Bibliography

White, F.M, **Viscous fluid flow**, 3rd ed., McGraw-Hill, 2006

Panton, R. L., **Incompressible Flow**, 4th Edition, Wiley, 2013

Anderson, **Modern Compressible Flow**, 3nd Ed., Mc Graw Hill, 1992

BARRERO & PÉREZ-SABORID, **Fundamentos y aplicaciones de la Mecánica de Fluidos**, Mc Graw Hill, 2005

BLAZEK, J., **Computacional Fluid Dynamics: Principles and Applications**, Elsevier, 2001

H K Versteeg and W Malalasekera, **An Introduction to Computational Fluid Dynamics THE FINITE VOLUME METHOD**, 2nd Ed., Prentice Hall, 2007

Complementary Bibliography

Kundu , C., **Fluid Mechanics**, 4th Edition,, Academic Press, 2010

SCHLICHTING, H, **Boundary Layer Theory**, Mc Graw Hill, 1987

FERZIGER, J., MILOVAN, P., **Computational Methods for fluid Dynamics,**, Springer, 1999

F. Moukalled L. Mangani M. Darwish, **The Finite Volume Method in Computational Fluid Dynamics An Advanced Introduction with OpenFOAM® and Matlab®**, Springer, 2016

WILCOX, **Turbulence Modeling**, DCW Industries, 2004

www.openfoam.com,

Recomendacións

Subjects that it is recommended to have taken before

Matemáticas: Métodos matemáticos/O07G410V01301
Mecánica de fluídos/O07G410V01402

Plan de Contingencias

Description

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Ante a incerta e imprevisible evolución da alerta sanitaria provocada polo *COVID-19, a Universidade de Vigo establece unha planificación extraordinaria que se activará no momento en que as administracións e a propia institución determíneno atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou parcialmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dun modo máis áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o profesorado a través da ferramenta normalizada e institucionalizada das guías docentes.

=== ADAPTACIÓN DAS METODOLOXÍAS ===
* Metodoloxías docentes que se manteñen: Todas excepto Prácticas en laboratorio docente de Mecánica de Fluídos, sempre que as circunstancias excepcionais obriguen a iso

* Metodoloxías docentes que se modifican: Prácticas en laboratorio. En caso de no ser posible realizalas presencialmente, sustituirasen pola resolución de problemas realcionados coas mesmas

* Mecanismo non presencial de atención ao alumnado (titorías): Mediante aula virtual en Campus remoto ou sistema similar previa solicitude de cita por parte do alumno mediante email. Poderán ser individuais ou en grupos pequenos

* Modificacións (si proceden) dos contidos a impartir:Non procede

* Bibliografía adicional para facilitar o auto-aprendizaxe: Non procede

* Outras modificacións

...

* Probas que se modifican: As probas en si non se modificarán. Si o poderá facer a presencialidade das mesmas. De ser necesario pola situación de emerxencia realizaríanse telemáticamente usando preferentemente as ferramentas dispoñibles en Faitic.

* Novas probas

* Información adicional

IDENTIFYING DATA				
Aerodynamics and aeroelasticity				
Subject	Aerodynamics and aeroelasticity			
Code	O07G410V01923			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Navarro Medina, Fermín			
Lecturers	Navarro Medina, Fermín			
E-mail	fermin.navarro.medina@uvigo.es			
Web	http://aero.uvigo.es			
General description	The subject includes the aerodynamic forces that determine the dynamics of the flight and the role of the different variables involved in the aerodynamic phenomena of profiles, wings, and nozzles, considering both compressible and incompressible flow. An introduction to aeroelasticity is also made. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
C20	Appropriate knowledge applied to engineering: mechanics of fracture of the continuous media and their dynamic behavior, fatigue of structural instability and aeroelasticity.
C22	Appropriate knowledge applied to engineering: foundations of fluid mechanics that describe the flow in all regimes, to determine the distributions of pressures and forces on an aircraft.
C25	Appropriate knowledge applied to engineering: methods of design calculations and aeronautical projects; use of aerodynamic experimentation and the most significant parameters in the theoretical application; management of experimental techniques, equipment and measuring instruments; simulation, design, analysis and interpretation of experimentation and operations in flight; systems of maintenance and certification of aircrafts.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
C28	Appropriate knowledge applied to engineering: foundations of fluid mechanics that describe the flow in any regime and determine the distribution of pressures and aerodynamic forces.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D6	Capabiliity for interpersonal communication
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies

Learning outcomes	
Expected results from this subject	Training and Learning Results

- Knowledge, understanding, application and analysis of the aerodynamic phenomena and of the laws that govern his behaviour; - Knowledge, understanding and synthesis of the foundations of the flight of the aircraft - Knowledge, understanding, application, analysis and synthesis of the methods applied to the study of aeroelasticity; - Knowledge, understanding, application, analysis and synthesis of the aeroelasticity of a profile, from the static point of view (problems of torsional divergence and of investment of control) and dynamic (problems of flutter and buffet) - Knowledge, understanding, application, analysis and synthesis of aeroelasticity of one-dimensional and two-dimensional structures.; - Knowledge and understanding of the most important appearances of experimental aeroelasticity, and more specifically of the essays in earth and in flight of aerostructures	A2 A3	C22 C26 C28	D3 D4
New	A3 A5	C22 C25 C26	D5 D6
New	A2 A3	C20 C25 C28	D8 D11
New	A3 A5	C20 C25 C28	D3 D4
New	A3	C20 C22 C26	D6 D8
New	A5	C20 C25	D8

Contents

Topic	
1. Aerodynamics of uncompressible flow	Subject 1.1: Introduction Subject 1.2: Foundations and principles of the aerodynamic Subject 1.3: Foundations of the uncompressible flow Subject 1.4: Uncompressible flow on airfoils Subject 1.5: Uncompressible flow on finite wings Subject 1.6: Three-dimensional uncompressible flow
2. Aerodynamics of compressible flow	Subject 2.1: Foundations of the compressible flow Subject 2.2: Waves of crash Subject 2.3: compressible Flow in nozzles and diffusing Subject 2.4: linear Theory of compressible flow in airfoils
3. Aeroelasticity	Subject 3.1: Introduction to aeroelasticity Subject 3.2: Aeroelasticity of airfoil and one-dimensional structures Subject 3.3: Aeroelasticity of two-dimensional structures Subject 3.4: Experimental aeroelasticity

Planning

	Class hours	Hours outside the classroom	Total hours
Laboratory practical	15	0	15
Previous studies	0	126.5	126.5
Seminars	4	0	4
Problem solving	20	0	20
Workshops	6	0	6
Lecturing	30	0	30
Objective questions exam	3.5	0	3.5
Report of practices, practicum and external practices	0	20	20

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

Methodologies

	Description
Laboratory practical	Realisation of a practice programmed using the wind tunnel and the hot thread cutting machinne and other processes of manufacture. The realisation of the practice requires the preparation of the same by means of a previous design, the assistance to the sessions of practices and the realisation of a report by part of the group of students.
Previous studies	Study of the student of autonomous form, with the support of the professor if like this it requires it according to the procedures established by the university

Seminars	The seminars consist in the realisation of exercises in groups of students and individually, that will have to resolve during the time of the seminar. So much the conjoint resolution of the exercise, like the individual contribution will be valued. They will make two asset seminars during the course.
Problem solving	Resolution of problems and/or exercises that treat punctual appearances of the contents of the course, developed by the professor and/or the students in the classroom
Workshops	Workshop of software of aerodynamic simulation, whose utilisation serves of support for the rest of the subject, so much for the resolution of problems, as for the preparation of the practices.
Lecturing	Exhibition of a subject or resolution of problems by part of the professor according to a previously established script

Personalized assistance

Methodologies	Description
Previous studies	The student studies of autonomous form, with the support of the professor if like this it requires it according to the procedures established by the university
Workshops	Workshop of software of aerodynamic simulation, whose utilisation serves of support for the rest of the subject, so much for the resolution of problems, as for the preparation of the practices. The workshop will be guided by the professor of the subject.

Assessment

	Description	Qualification	Training and Learning Results		
Seminars	The seminars consist in the realisation of exercises in groups of students and individually, that will have to resolve during the time of the seminar. So much the conjoint resolution of the exercise, like the individual contribution will be valued. They will make two asset seminars during the course.	5	A2 A3	C20 C22 C26 C28	D3 D4 D5 D6 D8
Objective questions exam	Resolution of problems and/or conceptual questions on the contents of the subject	60	A2 A3 A5	C20 C22 C25 C26 C28	D3 D4 D5
Report of practices, practicum and external practices	Report of the works made in the laboratory, and of the design of the profile and the wing.	35	A2 A3 A5	C20 C22 C25 C26 C28	D3 D4 D6 D11

Other comments on the Evaluation

Continuous assessment

To pass the subject in the evaluation in the 1st call will be required to obtain a grade higher than 5 points out of 10 in the joint assessment of the continuous evaluation during the development of the classes and the exam on the official date.

The official exam grade must be greater than 5 points out of 10.

The final grade will be obtained according to the percentages indicated.

The evaluation testing calendar officially approved by the EEAE Center Board is published on the web http://aero.uvigo.es/gl/docencia/exames

The maximum duration of the exam will be 3 hours if there is no interruption or 5 hours if there is an intermediate break (3 hours maximum for each part).

Extraordinary exam

The student must submit to the extraordinary exam of all the contents of the subject, which will be 100% of the grade, if the final grade of continuous assessment is less than 5 points out of 10.

You will also have to take the ordinary exam in the following cases :- The non-performance or delivery of any of the points of the continuous evaluation.

- Obtain a grade below 5 points out of 10 in the final exam of continuous evaluation.

Sources of information

Basic Bibliography

John D. Anderson Jr, **Fundamentals of Aerodynamics**, McGraw-Hill Education, 2016

John J. Bertín, **Aerodynamics for engineers**, Pearso, 2013

Raymond L. Bisplinghoff, **Principles of Aeroelasticity**, Dover Books, 2013

José Meseguer Ruiz, Ángel Sanz Andrés, **Aerodinámica básica**, 2ª, Gaceta, grupo editorial, 2010

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Mechanics of flight/O07G410V01924

Subjects that are recommended to be taken simultaneously

Fluid mechanics II and CFD/O07G410V01922

Subjects that it is recommended to have taken before

Physics: Physics I/O07G410V01103
Physics: Physics II/O07G410V01202
Fluid mechanics/O07G410V01402

Contingency plan

Description

=== EXCEPTIONAL MEASURES SCHEDULED ===
In front of the uncertain and unpredictable evolution of the sanitary alert caused by the *COVID-19, the University of Vigo establishes an extraordinary planning that will activate in the moment in that the administrations and the own institution determine it attending to criteria of security, health and responsibility, and guaranteeing the teaching in a no face-to-face stage or partially face-to-face. These already scheduled measures guarantee, in the moment that was prescriptive, the development of the teaching of a more agile and effective way when being known in advance (or with a wide *antelación) by the students and the *profesorado through the tool normalised and institutionalised of the educational guides.

=== ADAPTATION OF THE METHODOLOGIES ===
* educational Methodologies that keep
ALL except the practices of laboratory. The methodologies that keep will be adapted to the available technological resources (remote campus, virtual blackboard, etc). The work *tutelado also can carry out on-line, without more than substituting the face-to-face meetings *grupales and the sessions *tutorizadas with the professor by telematic meetings.

* Educational methodologies that modify
The practices of laboratory will be substituted by a bulletin of problems of character researcher

* Mechanism no face-to-face of attention to the students (tutoring sessions)
virtual office of the remote campus

* Modifications (if they proceed) of the contents to give
ANY

* additional Bibliography to facilitate the car-learning
Can use the same references

* Other modifications

=== ADAPTATION OF THE EVALUATION ===
* Test already made
Tests Examination of objective questions: [previous Weight 60%] [Weight Proposed 60%]
Tests Seminar: [previous Weight 5%] [Weight Proposed 5%]
Tests Report of practices, *prácticum and external practices: [previous Weight 35%] [Weight Proposed 35%]

* pending Proofs that keep
Tests Examination of objective questions: [previous Weight 60%] [Weight Proposed 60%]
Tests Seminar: [previous Weight 5%] [Weight Proposed 5%]

* Proofs that modify
Proof Inform of practices, prácticum and external practices: [previous Weight 35%] [Weight Proposed 30%]. The work *tutelado included in this proof is the one who evaluates .

* New proofs
Tests Resolution of problems and/or exercises: [previous Weight 0%] [Weight Proposed 5%]. The problems will deliver in shape of bulletin, with a date established in the moment of the delivery.

* Additional information
will inform of the links and the keys to access to the virtual classroom and to the virtual dispatch. The tutoring sessions will be in the virtual office, after previous agreement of the date and hour via mail.

IDENTIFYING DATA

Systems engineering and aerospace communications

Subject	Systems engineering and aerospace communications			
Code	O07G410V01925			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Isasi de Vicente, Fernando Guillermo			
Lecturers	Isasi de Vicente, Fernando Guillermo			
E-mail	fisasi@uvigo.es			
Web	http:// aero.uvigo.es			
General description	Introduction to the engineering of systems and to the systems of communications with aerospace vehicles. International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code	
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Capabiliity for design, development and management in the field of aeronautical engineering (in according with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, aerospace propulsion systems, aerospace materials , airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
B4	Verification and certification in the field of aeronautical engineering that aim, in accordance with the knowledge acquired (in accordance with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, aerospace propulsion systems, aerospace materials, airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
C19	Applied knowledge of: science and technology of materials; mechanics and thermodynamics; fluid mechanics; aerodynamics and flight mechanics; navigation and air traffic systems; aerospace technology; theory of structures; airborne transportation; economy and production; projects; environmental impact.
D2	Leadership, initiative and entrepreneurship
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D6	Capabiliity for interpersonal communication
D8	Capabiliity for critical and self-critical reasoning
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Learning outcomes

Expected results from this subject	Training and Learning Results			
- Understanding of the concept of engineering of systems.	A3	B1	C19	D2
- Understanding, knowledge and application of the national and international standards applied to the aerospace engineering.	A5	B4		D3 D4
- Compression, knowledge of the systems of communications in aerospace vehicles				D5 D6 D8 D13

Contents

Topic	
Concept of Engineering of Systems	Need of an engineering of systems. Simple examples

Standard nations and Internaciones of Engineering of Systems in Aerospace projects	Study of the most used standards in: aerial Systems spatial Systems common Points
Application to national and international projects of Engineering of Systems.	Examples: aerial System: commercial aerial navigation spatial System: nano-hammer satellites
Introduction	Basic concepts of aerial navigation and communications
Direction finding	Principles Applications
VOR	Principle of operation Description Use
DME/TACAN	Principle of operation Description Use
ILS	Principle of operation Description Use
Primary radar	Principle of operation Description Use
Secondary radar	Principle of operation Description Use
GPS	Principle of operation Description Use
Augmented reality systems	Principle of operation Description Use

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	30	75	105
Laboratory practical	20	22	42
Problem and/or exercise solving	3	0	3

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

Methodologies

	Description
Lecturing	Lecture with help of blackboard and computer. These lectures treat about the theory of the subject. With this methodology work the competitions CG1, CG4, CB3, CB5, CE19, CT8 and CT5. This is a grupal activity.
Laboratory practical	Use of simulators of systems of communications and/or navigation. Use of basic tools in the engineering of systems. With this methodology work the competitions CG1, CG4, CB3, CE19, CT2, CT4, CT5, CT6, CT11 and CT13. It is a grupal.activity.

Personalized assistance

Methodologies	Description
Lecturing	Tutor sessions will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.
Laboratory practical	In the practices of laboratory the student can ask professor to resolve doubts. Tutor sessions will be scheduled by the professor when a student sends an email asking for it. They will be at the professor's virtual office.

Assessment

Description	Qualification	Training and Learning Results

Laboratory practical	Evaluation of group work and individual questions during the practical sessions. Cross asessment surveys can vary final marks as well. Also, cross assesment surveys may affect the marks.	20	A5	B1 B4	C19	D4 D5 D6 D8 D13
Problem and/or exercise solving	Tests will have short practical questions and theoretical questions about the contents of magistral lectures. There are two tests during the course: one about the middle of course about the first half of subject and other at the end of lectures. These tests worth 40% of final mark. The second test will cover the second half of the subject for students who have got a mark better than 3/10 in the middle course test. If a student didn't got a mark over 3/10 in first test or wants to improve mark, will make the test about all subject. In this case, the test will cover all subject. If the mark got in the first half part of test is not better than the one got in the middle of course test, the mark will be the one of middle course test. In case of online tuition, the tests would be online multiple choice tests or oral ones. In these cases the professor could ask student for a videoconference in which the student and near environment must be visible.	80	A3 A5	B1 B4	C19	D4 D5 D8

Other comments on the Evaluation

In the case that a student failed more than 20% of practice sessions, he / she will not be able to pass the subject by continuous evaluation. The second edition of the minutes will evaluate the whole subject. In the case that he / she prefers and has done laboratory practices and obtained more than a 3/10 in them, the student can do only the theoretical part. This theoretical part weighs 80% of the mark, the other 20% will be the mark obtained during the course. If the student has not practiced, they may be asked in a written exam or in the laboratory, weighing the mark of practices by 20% and the theory of 80%. Students who officially resign to the continuous assessment, the mark obtained in a corresponding exam will represent 100% of the qualification. The evaluation test calendar officially approved by the EEAE Center Board is published on the website http://aero.uvigo.es/gl/docencia/exames

Plan of contingency:

In case of online tuition, then the evaluation will be carried out as follows:

The tests would be by videoconference or by an online multiple choice test during a short time.

Also, oral tests may be done.

About the laboratory, the practices will be done by the student at home. The teams would work remotely and the laboratory lectures would be in remote mode. About the assesment, it would be similar as the normal case.

Sources of information

Basic Bibliography

Alexander V. NebylovJoseph Watson, **Aerospace Navigation Systems**, 1, WIley, 2016

ETSIA/EUITA/EIAE, **Sistemas y Equipos electrónicos para la navegación aérea**, 1, ETSIA/EUITA/EIAE,

Complementary Bibliography

NASA, **System engineering handbook**, Rev. 1,

Benjamin S. Blanchard, **SYSTEM ENGINEERING MANAGEMENT**, 5, Wiley, 2016

Recommendations

Subjects that it is recommended to have taken before

Electronics and automation/O07G410V01403

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in

advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained

* Teaching methodologies modified

* Non-attendance mechanisms for student attention (tutoring)

* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Pending tests that are maintained
Test XX: [Previous Weight 00%] [Proposed Weight 00%]
...

* Tests that are modified
[Previous test] => [New test]

* New tests

* Additional Information

IDENTIFYING DATA

Aerorreactores e motores alternativos aeronáuticos

Subject	Aerorreactores e motores alternativos aeronáuticos			
Code	O07G410V01931			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3	1c
Teaching language	Castelán Galego			
Department	Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	García Seoane, Santiago			
Lecturers				
E-mail				
Web	http://aero.uvigo.es			
General description	Coñecemento básico do funcionamento dos sistemas de propulsión empregados na industria aeroespacial.			

Competencias

Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidade para o deseño, desenvolvemento e xestión no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de *aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
B7	Capacidade de analizar e valorar o impacto social e medioambiental das solucións técnicas.
C21	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos de sustentabilidade, mantenibilidad e operatividade dos vehículos aeroespaciais.
C23	Coñecemento adecuado e aplicado á Enxeñaría de: Os fenómenos físicos do voo, as súas cualidades e o seu control, as forzas aerodinámicas, e propulsivas, as actuacións, a estabilidade.
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos
D13	Sustentabilidade e compromiso ambiental. Uso equitativo, responsable e eficiente dos recursos

Resultados de aprendizaxe

Expected results from this subject	Training and Learning Results			
- Coñecer as necesidades propulsivas das aeronaves	A2 A3 A5		C23	
- Coñecer os empuxes e resistencias relacionados cos aerorreactores	A2 A3 A5	B1	C23	
- Coñecer e cuantificar de forma aplicada o proceso de combustión dos aerorreactores e o rendemento da combustión	A2 A3 A5	B1	C21	D13
- Saber realizar un balance enerxético diferenciando e calculando os rendementos involucrados	A2 A3 A5			
- Saber resolver problemas relacionados co cálculo dos ciclos termodinámicos e as características dos aerorreactores; así como o efecto das características e calidade dos compoñentes	A2 A3 A5			

- Coñecer os diferentes aerorreactores e saber obter os sistemas óptimos baixo o punto de vista propulsivo	A2 A3 A5	B7		
- Dimensionar os compoñentes que interveñen no sistema propulsivo	A2 A3 A5	B7		
- Coñecer o efecto das condicións de voo: velocidade e altitude no funcionamento dos aerorreactores	A3 A5	B1	C23	
- Coñecer os problemas ambientais dos aerorreactores e as súas posibles solucións	A2 A3 A5	B7	C21	D13
- Redactar informes técnicos e facer exposicións orais técnicas relacionadas co anterior	A2 A3			D3 D4 D6 D8 D11
- Resolver problemas derivados do ámbito da materia de forma autónoma e en colaboración con outro	A2 A3			D3 D4 D6 D8
- Coñecemento, comprensión, aplicación, análise e síntese da influencia de parámetros de operación e deseño sobre as actuacións dos motores alternativos aeronáuticos e os seus sistemas	A2 A3 A5		C21 C23	D8
- Coñecemento dos aspectos máis destacados dos ensaios dos motores alternativos	A2 A3 A5	B7	C21 C23	

Contidos

Topic	
1.- Motores alternativos de combustión interna	1.1.- Necesidades propulsivas das aeronaves 1.2.- Clasificación dos motores 1.3.- Ciclos de traballo 1.4.- Renovación da carga 1.5.- Alimentación de combustible 1.6.- Combustión 1.7.- Sobrealimentación e turboalimentación 1.8.- Actuacións 1.9.- Elementos construtivos
2.- Aerorreactores	2.1.- Propulsión a reacción 2.2.- Compoñentes fundamentais dos turborreactores 2.3.- Análises do ciclo dun aerorreactor; turbina de gas 2.4.- Aplicación das ecuacións integrais da Mecánica de Fluídos aos aerorreactores: Continuidade: gasto másico; Cantidade de movemento: empuxes e resistencias; Enerxía: rendementos 2.5.- Comportamento motor e propulsor dos aerorreactores 2.6.- Turbohélices e a súa optimización 2.7.- Turbofanes e a súa optimización; turbofanes de fluxo mesturado; turbofanes avanzados 2.8.- Sistemas incrementadores de empuxe 2.9.- Actuacións 2.10- Problemas ambientais derivados do funcionamento dos aerorreactores

Planificación

	Class hours	Hours outside the classroom	Total hours
Prácticas de laboratorio	20	0	20
Estudo previo	0	89.5	89.5
Lección maxistral	30	0	30
Exame de preguntas obxectivas	2.5	0	2.5
Informe de prácticas, prácticum e prácticas externas	0	8	8

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

Metodoloxía docente

	Description
Prácticas de laboratorio	Prácticas informáticas, saídas de estudo e prácticas de laboratorio

Estudo previo	Preparación para o seguimento da materia, procura de información e preparación das probas de avaliación.
Lección maxistral	Docencia en aula con apoio audiovisual

Atención personalizada

Tests	Description
Exame de preguntas obxectivas	Prestarase atención colectiva e/ou persoalmente ás dúbidas que xurdan ao longo do desenvolvemento das probas escritas
Informe de prácticas, prácticum e prácticas externas	Atenderase persoalmente a todas as dúbidas que xurdan ao longo do desenvolvemento das prácticas e atenderase en titorías as dúbidas que xurdan ao preparar o informe de prácticas

Avaliación

	Description	Qualification	Training and Learning Results			
Exame de preguntas obxectivas	Exame escrito de preguntas curtas e resolución de problemas	90	A2 A3 A5	B1 B7	C21 C23	D3 D4 D8 D11 D13
Informe de prácticas, prácticum e prácticas externas	Informe de prácticas	10	A2 A3 A5	B1 B7	C21 C23	D3 D4 D6 D8 D11 D13

Other comments on the Evaluation

Para superar a materia na avaliación da 1ª edición da acta e na 2ª edición da acta requerirase obter una calificación superior a 5 puntos sobre 10 na valoración conxunta da avaliación continua durante o desenvolvemento das clases e o examen da data oficial

A cualificación final obterase de acordo ás porcentaxes indicadas

O calendario de probas de avaliación aprobado oficialmente por la Xunta de Centro da E.E.A.E. publícase na web http://aero.uvigo.es/gl/docencia/exames

A duración máxima do examen será de 3 horas se non hai interrupción ou de 5 horas se hai unha pausa intermedia (sendo 3 horas máximo para cada parte)

Estudantes que renuncien oficialmente á avaliación continua: a nota será obtida nun exame correspondente que representará o 100% da cualificación

Este examen poderá constar dunha parte a realizar en aula informática e/ou laboratorio cunha cualificación que representará o 30% da cualificación total

Bibliografía. Fontes de información

Basic Bibliography

CLAUDIO MATAIX, **TURBOMÁQUINAS TÉRMICAS**, 978-8423707270, DOSSAT EDICIONES, 2011

F. PAYRI / J. M. DESANTES, **MOTORES DE COMBUSTIÓN INTERNA ALTERNATIVOS**, 978-8429148022, EDITORIAL REVERTE, 2011

BORJA GALMÉS BELMONTE, **MOTORES DE REACCIÓN Y TURBINAS DE GAS**, 978-8428341462, EDICIONES PARANINFO, 2015

MARTÍN CUESTA ÁLVAREZ, **MOTORES DE REACCIÓN**, 978-8428328258, EDICIONES PARANINFO, 2001

ANTONIO ESTEBAN OÑATE, **CONOCIMIENTOS DEL AVIÓN (LIBROS II Y III)**, 978-8428341769, EDICIONES PARANINFO, 2019

Complementary Bibliography

JACK D. MATTINGLY, **ELEMENTS OF PROPULSION: GAS TURBINES AND ROCKETS**, 978-1563477799, AIAA EDUCATION SERIES, 2006

GORDON C. OATES, **AEROTHERMODYNAMICS OF GAS TURBINE AND ROCKET PROPULSION**, 978-1563472411, AIAA EDUCATION SERIES, 1997

Recomendacións

Subjects that it is recommended to have taken before

Física: Física I/O07G410V01103
Física: Física II/O07G410V01202
Química: Química/O07G410V01203
Tecnoloxía aeroespacial/O07G410V01205
Mecánica de fluídos/O07G410V01402
Termodinámica/O07G410V01303

Plan de Continxencias

Description

=== MEDIDAS EXCEPCIONAIS PLANIFICADAS ===
Ante a incerta e imprevisible evolución da alerta sanitaria provocada pola COVID- 19, a Universidade establece una planificación extraordinaria que se activará no momento en que as administracións e a propia institución o determinen atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou non totalmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dun xeito mais áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o profesorado a través da ferramenta normalizada e institucionalizada das guías docentes DOCNET.

=== ADAPTACIÓN DAS METODOLOXÍAS ===
* Metodoloxías docentes que se manteñen
- Estudo previo: preparación para o seguimento da materia, procura de información e preparación das probas de avaliación

* Metodoloxías docentes que se modifican
- Lección maxistral: docencia en aula virtual (campus remoto)
- Prácticas de laboratorio: prácticas informáticas a través da aula virtual (campus remoto) e resolución de problemas a través da aula virtual (campus remoto); anulación de saídas de estudo e anulación de prácticas de laboratorio

* Mecanismo non presencial de atención ao alumnado (titorías)
- Titorías en despacho virtual (campus remoto)

=== ADAPTACIÓN DA AVALIACIÓN ===
* Probas xa realizadas
- Mantense a calificación e a porcentaxe de peso para obter a nota final

* Probas pendentes que se manteñen
- Mantense a porcentaxe de peso para obter a nota final

* Probas que se modifican
- Nun escenario de docencia non presencial e sempre que non se permitan os exames escritos de xeito presencial, serán a través da aula virtual (campus remoto), consistente nunha serie de preguntas curtas e resolución de problemas

* Información adicional
- Nun escenario de docencia parcialmente presencial, os exames escritos serán de xeito presencial

IDENTIFYING DATA				
Deseño mecánico, MEF e vibracións				
Subject	Deseño mecánico, MEF e vibracións			
Code	O07G410V01932			
Study programme	Grao en Enxeñaría Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3	2c
Teaching language	Castelán			
Department	Enxeñaría mecánica, máquinas e motores térmicos e fluídos			
Coordinator	Fernández González, Santiago			
Lecturers				
E-mail				
Web	http://aero.uvigo.es			
General description	Esta materia introduce ao deseño mecánico, o método de elementos finitos e o estudo das vibracións.			

Competencias	
Code	
A2	Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvesen aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B1	Capacidade para o deseño, desenvolvemento e xestión no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de *aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
B2	Planificación, redacción, dirección e xestión de proxectos, cálculo e fabricación no ámbito da enxeñaría aeronáutica que teñan por obxecto, de acordo cos coñecementos adquiridos segundo o establecido no apartado 5 da orde CIN/308/2009, os vehículos aeroespaciais, os sistemas de propulsión aeroespacial, os materiais aeroespaciais, as infraestruturas aeroportuarias, as infraestruturas de aeronavegación e calquera sistema de xestión do espazo, do tráfico e do transporte aéreo.
C20	Coñecemento adecuado e aplicado á Enxeñaría de: A mecánica de fractura do medio continuo e as formulacións dinámicas, de fatiga de inestabilidade estrutural e de aeroelasticidad.
C22	Coñecemento adecuado e aplicado á Enxeñaría de: Os fundamentos da mecánica de fluídos que describen o fluxo en todos os réximes, para determinar as distribucións de presións e as forzas sobre as aeronaves.
C25	Coñecemento adecuado e aplicado á Enxeñaría de: os métodos de cálculo de deseño e proxecto aeronáutico; o uso da experimentación aerodinámica e dos parámetros máis significativos na aplicación teórica; o manexo das técnicas experimentais, equipamento e instrumentos de medida propios da disciplina; a simulación, deseño, análise e interpretación de experimentación e operacións en voo; os sistemas de mantemento e certificación de aeronaves.
D3	Capacidade de comunicación oral e escrita na lingua nativa
D4	Capacidade de aprendizaxe autónoma e xestión da información
D5	Capacidade de resolución de problemas e toma de decisións
D6	Capacidade de comunicación interpersoal
D8	Capacidade de razoamento crítico e autocrítico
D11	Ter motivación pola calidade con sensibilidade cara a temas do ámbito dos estudos

Resultados de aprendizaxe					
Expected results from this subject	Training and Learning Results				
Coñecemento, comprensión e aplicación de elementos mecánicos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11	

Coñecemento dos aspectos máis destacados das calidades dos Sistemas mecánicos: modos de fallo e fiabilidade.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Capacidade para identificar e resolver problemas mecánicos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Comprensión do método dos elementos finitos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Resolución de problemas relativamente complexos en mecánica de medios continuos mediante a selección do modelo de comportamento e da formulación adecuada para o mesmo.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese dos métodos aplicados ao estudo da resposta de aeronaves fronte a cargas non estacionarias.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese dos sistemas vibratorios dun grao de liberdade, de múltiples graos de liberdade e continuos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Coñecemento, comprensión, aplicación, análise e síntese dos métodos aproximados de cálculo para os sistemas continuos.	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11

Contidos

Topic	
Fundamentos do deseño mecánico.	- Introdución. Definición de máquina, mecanismo e cadea cinemática. Esquematización, modelización e simboloxia. Síntese estructural e dimensional. Pares cinemáticos. Ecuacións de ligadura. Graos de liberdade. - Analise de carga e esforzo. Círculo de Mohr. Esforzo plano, esforzo uniformemente distribuído, esforzos normais para vigas en flexión. Vigas curvas. Esforzos de contacto.
Analise da vibración.	- Fundamentos. - Vibracións lonxitudinais e torsionais: 1,2 G.L. Aplicacións técnicas dos sistemas de 1 e 2 G.L. - Vibracións de N G.L. - Análise modal. - Resposta a excitacións dinámicas xerais. - Análise de Fourier e resposta na frecuencia. - Medida da vibración. - Sistemas continuos. Vibracións lonxitudinais, torsionais e transversais. Determinación das pulsacións propias.

Vibración aleatoria.	- Excitacións non deterministas. - Propiedades estatísticas. - Correlación. - Densidade de potencia espectral. - Resposta dun sistema. - Deformación eficaz. - Deseño mecánico.
Deseño, control e mantemento baseado na vibración.	- Excitacións deterministas. - Fontes de vibración. - Eliminación da vibración. - Redución da transmisión. - Absorvedores dinámicos. - Enxeñaría do equilibrado. Fundamentos do equilibrado estático e dinámico. - Métodos espectrais. - Métodos estatísticos. - Mantemento predictivo.
Método dos elementos finitos.	- Fundamentos. - Xeometría do elemento. - Coordenadas nodais. - Ecuacións e definición de elementos. - Conectividade entre elementos. - Xeración de malla. - Imposición de ligaduras. - Determinación da matriz de inercia, elástica e amortiguamento. - Análise da vibración.

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	39	26	65
Prácticas de laboratorio	40	120	160
*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	- Clase maxistral na que se expoñen os contidos teórico-prácticos por medios tradicionais (lousa) e recursos multimedia.
Prácticas de laboratorio	- Realización de tarefas prácticas en laboratorio con computador.

Atención personalizada	
Methodologies	**Description**
Lección maxistral	Atención que o profesorado presta de maneira individual ou colectiva ao alumnado para resolver as dúbidas e dificultades que atopan na comprensión dos contidos da materia. Titorías individuais ou en grupos reducidos co profesorado da materia.
Prácticas de laboratorio	O profesor axudará ao alumno/á resolve-las diificultades que poida atopar na resolución de exercicios a realizar en laboratorio. Titorías individuais ou en grupos reducidos co profesorado da materia.

Avaliación						
	Description	Qualification	Training and Learning Results			
Lección maxistral	Avaliación dos coñecementos adquiridos mediante un exame teorico-práctico.	70	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11
Prácticas de laboratorio	Avaliarase a realización das memorías das prácticas realizadas no curso.	30	A2 A3 A5	B1 B2	C20 C22 C25	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

A materia aprobarase si se obten unha cualificación igual ou maior que un cinco como nota final, da seguinte forma:

1- A asistencia ao laboratorio, as memorías de cada práctica e traballos tutelados terán unha valoración de 3 puntos na nota final, esta cualificación conservarase na segunda edición da acta.

2.- O exame final terá unha valoración de 7 puntos na nota final.

Estudantes que renuncien á avaliación continua: a nota obtida nun exame que representará o 100% da cualificación. Este exame poderá constar dunha parte a realizar en aula informática e/ou laboratorio cuia cualificación poderá representar como máximo o 30% da cualificación total.

A duración máxima do exame será de 4 horas si se fai de forma continua ou de 5 horas si hai unha pausa intermedia (neste caso a duración máxima de cada parte non superará as 2,5 horas).

O calendario de probas de avaliación aprobado oficialmente polo Consello do Centro EEAE publícase na web http://aero.uvigo.es/gl/docencia/exames.

Bibliografía. Fontes de información

Basic Bibliography

Shigley, **Diseño en ingeniería mecánica**, Octava, McGrawHill, 2008

Singeresu S. Rao, **Vibraciones mecánicas**, Quinta, Pearson, 2012

Complementary Bibliography

A.S.Hall, A.R. Holowenco, H.R.Laughlin, **Diseño mecánico, teoría y 320 Problemas resueltos**, Serie Schaum,

William W. Seto, **Vibraciones mecánicas, teoría y 225 problemas resueltos**, Serie Schaum,

Justo Nieto, **Síntesis de mecanismos**, Editorial AC,

Recomendacións

Subjects that it is recommended to have taken before

Expresión gráfica: Expresión gráfica/O07G410V01105
Física: Física II/O07G410V01202
Informática: Informática/O07G410V01104
Matemáticas: Cálculo II/O07G410V01201
Ciencia e tecnoloxía dos materiais/O07G410V01304

Plan de Continxencias

Description

Ante a incerta e imprevisible evolución da alerta sanitaria provocada pola COVID- 19, a Universidade establece unha planificación extraordinaria que se activará no momento en que as administracións e a propia institución o determíne atendendo a criterios de seguridade, saúde e responsabilidade, e garantindo a docencia nun escenario non presencial ou non totalmente presencial. Estas medidas xa planificadas garanten, no momento que sexa preceptivo, o desenvolvemento da docencia dunha maneira mais áxil e eficaz ao ser coñecido de antemán (ou cunha ampla antelación) polo alumnado e o profesorado a través da ferramenta normalizada e institucionalizada das guías docentes DOCNET.

Adaptación das metodoloxías.

- Metodoloxías docentes que se manteñen.
Chegado o caso quedaría anulada a docencia presencial na aula e laboratorio, sustituindose por docencia non presencial vía telemática.

- Metodoloxías docentes que se modifican.
Impartición das clases de teoría e das prácticas de laboratorio mediante métodos telemáticos establecidos pola Universidade a distancia online.

- Mecanismo non presencial de atención ao alumnado (titorías).
Titorías online, mediante plataforma informática da Universidade ou resolución de dúbidas vía email.

- Modificacións (se procede) dos contidos a impartir.
Non procede.

- Bibliografía adicional para facilitar o auto-aprendizaxe.
Bibliografía xa establecida e revisada na actual guía docente.

- Outras modificacións.
Chegado o caso, os docentes poderán pedir ao alumnado a entrega de traballos/memorías/boletíns de problemas... de partes concretas da materia co fin de promove-lo autoaprendizaxe e a busca de información. Estes traballos/memorías/boletíns tamén terán un peso concreto á hora da avaliación da materia e conservarase a nota na 2ª edición da acta.

Adaptación da avaliación.

1.- Prácticas de laboratorio, con entregables por parte do alumnado terá un peso dun 30% na nota final da materia. A nota conservarase na 2ª edición da acta.

2.- Entrega de traballos/memorías/boletíns de problemas por parte do alumnado terá un peso dun 30% na nota final da materia. A nota conservarase na 2ª edición da acta.

3.- Exame final. Terá un peso dun 40%.

Estudantes que renuncien á avaliación continua: a nota obtida nun exame correspondente que representará o 100% da cualificación. Este exame poderá constar dunha parte a realizar en aula informática e/ou laboratorio cuia cualificación poderá representar o 30% da cualificación total.

IDENTIFYING DATA				
Space Vehicles				
Subject	Space Vehicles			
Code	O07G410V01933			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Ulloa Sande, Carlos			
Lecturers	Ulloa Sande, Carlos			
E-mail	carlos.ulloa@uvigo.es			
Web	http://aero.uvigo.es			
General description	The space vehicles operate in a very different environment than the earth. This environment is critical when defining the design requirements of the space vehicles. In addition to the space environment, it is under the scope of this subject the study of the necessary concepts of orbital mechanics for the understanding of the main application orbits, maneuvers and perturbations of the space vehicles. Main subsystems of a space vehicle are studied, as well, with special attention to the subsystem of thermal control and the subsystem of attitude control. Labs are included using specific material and simulation software of mission analysis. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B1	Capabiliity for design, development and management in the field of aeronautical engineering (in according with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, aerospace propulsion systems, aerospace materials , airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
B6	Capability to participate in flight testing programs for take-off and landing distances, ascent speeds, loss speeds, maneuverability and landing capacities.
C24	Appropriate knowledge applied to engineering: systems of aircrafts and automatic systems of flight control of the aerospace vehicles.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D6	Capabiliity for interpersonal communication
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Learning outcomes				
Expected results from this subject	Training and Learning Results			
- Knowledge, understanding, application and analysis of the basic configurations, subsystems and missions of the space vehicles	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
- Capacity for the analysis of the mission, of the type of law of guided and space path	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13

- Knowledge, understanding, application and analysis of the thermal control of the space vehicle	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
- Knowledge, understanding, application and analysis of control of attitude and orbit of the space vehicle	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
- Knowledge and understanding of the system of essays and of the support of earth of the space vehicle	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13

Contents	
Topic	
BLOCK 1: Introduction	Lesson 1.1: Brief historical review. Lesson 1.2: Classification of space vehicles Lesson 1.3: Types of subsystems of space vehicles Lesson 1.4: The solar system. Lesson 1.5: The space and planetary surroundings.
BLOCK 2: Orbital Mechanics	Lesson 2.1: Systems of reference and time. Lesson 2.2: The two-body problem. Time laws and orbital elements. Lesson 2.3: Tracks, coverage and visibility Lesson 2.4: Perturbations Lesson 2.5: Types of orbits Lesson 2.6: The three-body problem
BLOCK 3: Analysis of mission	Lesson 3.1: Space maneuvers Lesson 3.2: Rendezvous Lesson 3.3: Lunar and interplanetary missions
BLOCK 4: Subsystems	Lesson 4.1: Propulsion systems and launch vehicles Lesson 4.2: Space vehicles structures Lesson 4.3: System of attitude control Lesson 4.4: System of thermal control Lesson 4.5: Electrical , communications, commando and telemetry systems Lesson 4.6: Ground segment Lesson 4.7: Laboratory tests

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	28	0	28
Laboratory practical	12	0	12
Seminars	0	2	2
Previous studies	0	79.5	79.5
Objective questions exam	2.5	0	2.5
Report of practices, practicum and external practices	0	6	6
Essay	10	10	20
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Classroom lecture
Laboratory practical	Practicum with different subsystems of space vehicles Practicum of simulation of analysis of mission Essays and reports about space vehicles
Seminars	Tutorials in small groups
Previous studies	Autonomous work

Personalized assistance	
Methodologies	**Description**

Seminars	Small group tutoring with the teachers of the subject. The tutorials will be held, preferably, by appointment, in the teacher's virtual office, on the Remote Campus.

Assessment

	Description	Qualification	Training and Learning Results			
Objective questions exam	Partial examination of short questions and problems (20%) (Percentage can be divided into shorter tests) Final examination of short questions and problems (50%)	70	A2 A3 A5	B1 B6	C24	D3 D4 D11 D13
Report of practices, practicum and external practices	Report of the laboratory practices	10	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13
Essay	Reports and presentations of essays and assignment proposed along the course during the practicum sessions	20	A2 A3 A5	B1 B6	C24	D3 D4 D6 D11 D13

Other comments on the Evaluation

The evaluation of the course at the first opportunity will be carried out by Ongoing Assessment. Students who have a justification may officially waive the ongoing assessment and ask for a first oportunity final exam, on the official date. The grade obtained in this exam will represent 100% of the final grade. This exam may have a part to do in a computer room and / or laboratory. The waiver of ongoing assessment must be made during the first month of class. During this period, the justification of the resignation will be presented to the coordinator of the subject for evaluation.

To pass the course at the first opportunity, a score greater than 5 points out of 10 will be required in the continuous evaluation during the development of classes and the exam on the official date, toghether. The final grade will be obtained according to the indicated percentages.

Ongoing assessment is not passed in the following cases:

- The non-execution or delivery, without justification, of any of the items of the ongoing assessment (works reports, practicum reports, exams ...). In this case, the final grade reflected in the official record will be "not presented"

- Obtaining a grade of less than 5 points out of 10 in the final exam of ongoing assessment. In this case, the final grade reflected in the official record will be the grade of the ongoing assessment final exam.

The evaluation of the course in the second opportunity will be carried out in a final exam on the date set by the center. The grade obtained in this exam will represent 100% of the final grade. This exam may have a part to do in a computer room and / or laboratory.

To pass the subject in the second opportunity, a score higher than 5 points out of 10 will be required in the exam on the official date.

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

The maximum length of the exams will be 3 hours if there is no interruption, and 5 hours if there is an intermediate break (maximum 3 hours for each part).

Sources of information

Basic Bibliography

H.D. Curtis, **Orbital Mechanics for Engineering Students**, ELSEVIER, 2014

P. Fortescue, **Spacecraft Systems Engineering**, 4, Wiley, 2011

M.D. Griffin y J.R. French, **Space Vehicle Design**, AIAA Education Series, 2004

Charles Brown, **Elements of Spacecraft design**, AIAA Education Series, 2002

Complementary Bibliography

Bong Wie, **Space vehicle Dynamics and Control.**, AIAA Education Series, 1998

R. Karam, **Satellite Thermal Control for Systems Engineers**, AIAA Education Series, 1998

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/O07G410V01103
Physics: Physics II/O07G410V01202
Aerospace technology/O07G410V01205
Classical mechanics/O07G410V01305

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
The proposed methodologies are maintained but carried out through the Remote Campus. The platform faitic will be used more intensively as reinforcement to ensure accessibility of the students to the contents of the subject.

* Teaching methodologies modified
Laboratory practices that require interaction with physical elements are replaced by other activities that can be carried out on the remote campus, such as work in groups.

* Contactless mechanism for student attention (tutorials)
The tutorials will place in the teacher's virtual office on the remote campus.

=== ADAPTATION OF THE EVALUATION ===
* Tests already carried out
The tests already carried out maintain their weight in the evaluation.

* Pending tests
Pending tests are planned and will be carried out using the Moodle platform and the remote campus, and they maintain their weight in the evaluation.

IDENTIFYING DATA

Numerical calculation

Subject	Numerical calculation			
Code	O07G410V01941			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Cid Iglesias, María Begoña			
Lecturers	Cid Iglesias, María Begoña			
E-mail	bego@uvigo.es			
Web	http://aero.uvigo.es			
General description	The objective of this subject is that the students know and master different techniques and methods necessary for other subjects as well as for professional practice: the main numerical methods to solve large linear and non-linear systems, initial value and contour problems and the application of the finite element method. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies

Code	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B2	Planning, documentation, project management, calculation and manufacturing in the field of aeronautical engineering (in accordance with what is established in section 5 of order CIN / 308/2009), aerospace vehicles, propulsion systems, aerospace materials, airport infrastructures, air navigation infrastructures and space management, air traffic and transport management systems.
C32	Appropriate knowledge applied to engineering: methods of calculation and development of materials and defence systems; management of experimental techniques, equipment and measuring instruments; numerical simulation of the most significant physical-mathematical processes; inspection, quality control and fault detection techniques; their most appropriate methods and repair techniques.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D6	Capabiliity for interpersonal communication
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies

Learning outcomes

Expected results from this subject	Training and Learning Results			
LO1: Knowledge, understanding and application of numerical methods for solving typical Aerospace Technology models and problems.	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11
LO2: Know and use a numerical simulation software tool that uses the finite element method.	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11

Contents	
Topic	
Numerical resolution of big linear systems and non-linear systems	1. Direct methods 2. Methods iterativos. 3. Preconditioners. 4. Methods based in descent algorithms. 5. Methods for non-linear systems.
Methods for initial value and boundary value problems	1. Methods for initial value problems 2. Systems of ordinary differential equations. 3. Methods for boundary value problems.
Finite difference method for partial differential equations	1. FDM for elliptical PDE. 2. FDM for parabolic PDE. 3. FDM for hiperbolic PDE.
Finite element method	1. FEM in one dimension. 2. FEM in higher dimension. 3. FEM for vectorial problems. 4. FEM for evolutionary problems.

Planning	Class hours	Hours outside the classroom	Total hours
Introductory activities	2	0	2
Lecturing	30	60	90
Problem solving	6	12	18
Autonomous problem solving	0	13.5	13.5
Practices through ICT	12	12	24
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
Introductory activities	Activities directed to take contact and gather information on the students, as well as to present the subject.
Lecturing	The professor will expose in the theoretical classes the contents of the matter that illustrate with numerous examples and applications. The students will have basic texts of reference for the follow-up of the subject.
Problem solving	Approach, analysis, resolution and debate of a problem or exercise related with the matter given, so much by part of the educational as of the students. To illustrate and complete the explanation of each lesson and to help to that the student purchase the necessary capacities.
Autonomous problem solving	The student will have to resolve similar exercises to the realised in class to purchase the necessary capacities.
Practices through ICT	They will use computer tools to resolve problems and exercises and apply the knowledges obtained in the classes of theory, and the student will have to resolve similar exercises to purchase the necessary capacities.

Personalized assistance	
Methodologies	**Description**
Problem solving	The professor will attend personally the doubts and queries of the studentes. They will attend doubts in shape face-to-face, especially in the classes of problems and laboratory and in tutorials, as of form no face-to-face, by the available telematic systems for the subject.
Lecturing	The professor will attend personally the doubts and queries of the studentes. They will attend doubts in shape face-to-face, especially in the classes of problems and laboratory and in tutorials, as of form no face-to-face, by the available telematic systems for the subject.
Autonomous problem solving	The professor will attend personally the doubts and queries of the studentes. They will attend doubts in shape face-to-face, especially in the classes of problems and laboratory and in tutorials, as of form no face-to-face, by the available telematic systems for the subject.

Assessment			
	Description	Qualification	Training and Learning Results

Problem solving	Realization in an autonomous way of a collection of problems of each block of contents. LO1	30	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11
Practices through ICT	Assistance and correct realisation of the practices by means of computer programs. LO1, LO2	20	A3 A5	B2	C32	D4 D5 D8
Essay questions exam	Realization of a final exam in which they collect the corresponding contents to the master sessions and to the resolution of problems. LO1	50	A2 A3 A5	B2	C32	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

In case of not attending class in person, mixed or non-face-to-face teaching, in order to be eligible for the evaluation it is essential to upload an updated photo to the platform in order to identify the students.

In order to pass the subject, it is necessary to complete the laboratory practices and obtain a 5 out of 10 in the final exam.

In any call it is necessary to obtain 5 points to pass the subject. The maximum duration of any exam will be 3 hours.

Second chance evaluation (attendees):

The evaluation system for the second call is the same as for the first, with the grades obtained being maintained for problem solving and/or exercises and for practices with computer programs. The exam will be marked out of 10 and will represent 50 per cent of the final qualification.

Evaluation procedure for non-attendees (any call):

Theoretical and practical assessment: An examination to assess learning outcomes and achievement of the competencies listed in the teacher's guide. Rating: 80%

Practical evaluation of computer practices: It is essential to perform this test to pass the subject. It will consist of a practical examination on the topics covered in the computer practices during the course. Rating: 20%

Evaluation dates:

The evaluation schedule officially approved by the EEAE is published on the website http://aero.uvigo.es/es/docencia/examenes/

It expects that the students present a suitable ethical behaviour. In case to detect an ethical behaviour no suitable (copy, plagiarism, utilisation of electronic devices non authorised, and others) will consider that the/the student/to does not gather the necessary requirements to surpass the subject. In this case the global qualification in the present academic course will be of suspense (0.0).

It remembers the prohibition of the use of mobile devices or portable computers in exercises and practical since the Royal decree 1791/2010, of 30 December, by which approves the Statute of the University Student, establishes in his article 13.2.d), relative to the duties of the university students, the duty of :

"*Abstain of the utilisation or cooperation in fraudulent procedures in the proofs of evaluation, in the works that realise or in official documents of the university*".

Sources of information

Basic Bibliography

Burden, R.; Faires, J., **Análisis Numérico**, Iberoamericana,

Kreyszig, E., **Advanced engineering mathematics**, Wiley,

LeVeque, R.J., **Finite difference methods for ordinary and partial differential equations**, Siam,

Reddy, J. N., **An introduction to the finite element method**, McGraw-Hill,

Complementary Bibliography

Chapra, S., Canale, R., **Métodos numéricos para ingenieros**, McGraw-Hill,

Conde, L.; Winter,G., **Métodos y algoritmos básicos del álgebra numérica**, Reverté,

Grau, J. - Torres, R., **Introducción a la mecánica de fluidos y transferencia de calor con COMSOL Multiphysics**, Addlink,
Quintela,P., **Matemáticas en ingeniería con Matlab**, Universidade de Santiago de Compostela,
Taylor, R.L.; Nithiarasu, P.; Zienkiewicz, O.C., **The finite element method**, Oxford,

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/O07G410V01102
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201
Mathematics: Mathematical methods/O07G410V01301

Contingency plan

Description

In the event of exceptional circumstances:

Elearning platforms/tools
Online tuition will be supported by Campus Remoto and FAITIC. Other supplementary platforms may be used to guarantee the accessibility to teaching content.

Tutoring sessions
Tutoring sessions may be carried out online: either asynchronously (e-mail, FAITIC, forums, etc.) or by videoconference, in this case by appointment.

Assessment
Exams will be face-to-face unless academic authorities indicate otherwise. In any case, all the comments included in the Assessment section remain valid.

IDENTIFYING DATA				
Aerospace alloys and compound materials				
Subject	Aerospace alloys and compound materials			
Code	O07G410V01942			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Pena Uris, Gloria María			
Lecturers	Pena Uris, Gloria María			
E-mail	gpena@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	This course has to be considered as the continuation of Materials Science and Technology taught in the second year of the degree. In this course we will deepen in the study of the most used materials in the aerospace industry. We will study the light materials (metallic alloys and composite materials) used in the fuselage, wings and stabilizers, as well as the high performance alloys that are used in engines, landing gear and other elements of high responsibility. The most relevant mechanical and surface properties for its application will be presented. Some of the methods used to join materials as well as those used for tensting will be also addressed. English Friendly course: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
C11	Understand the technological benefits, the techniques of optimization of the materials and the modification of their properties through treatments.
C19	Applied knowledge of: science and technology of materials; mechanics and thermodynamics; fluid mechanics; aerodynamics and flight mechanics; navigation and air traffic systems; aerospace technology; theory of structures; airborne transportation; economy and production; projects; environmental impact.
C30	Appropriate knowledge applied to engineering: technological benefits, techniques of optimization of the materials used in the aerospace sector and the processes of treatments to modify their mechanical properties.
C32	Appropriate knowledge applied to engineering: methods of calculation and development of materials and defence systems; management of experimental techniques, equipment and measuring instruments; numerical simulation of the most significant physical-mathematical processes; inspection, quality control and fault detection techniques; their most appropriate methods and repair techniques.
C33	Applied knowledge of aerodynamics, flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, material science and technology, structure theory.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies
D13	Sustainability and environmental commitment. Equitable, responsible and efficient use of resources

Learning outcomes			
Expected results from this subject	Training and Learning Results		
Knowledge, understanding and application of the materials employed in the aerospace sector: capacity to identify his differences.	A3	C11 C19 C30 C33	D4 D8 D11 D13

Knowledge, understanding and application of the materials used in the aerospace sector: tools for the determination of the behaviour and properties.	A3 A5	C11 C32 C33	D4 D5 D8 D11
Knowledge, understanding and application of the materials employed in the aerospace sector: methods of manufacture and optimización.	A2 A3 A5	C11 C19 C32 C33	D3 D4 D5 D11 D13

Contents	
Topic	
Lesson 1.- Service performance of metallic alloys	Ductile and brittle fracture. Influence of emperature in fracture processes. Durability.Embrittlement processes. Corrosión and protection methods . Welding technologies: laser, difussion and friction stir welding.
Lesson 2.- Light alloys: Aluminium alloys. Magensium and Berilium alloys	Aluminium alloys: Processing and heat treatments. Classification. Main aluminium alloys for aerospace applications. Magnesium alloys for aerospace applications. Berilium alloy.Main aerospace applications
Lesson 3.- Ultra high strength steels	High resistance stelels: quench and tempering steels. PH Steels. Stainless steels. UHS steels. Maraging. Steels.
Lesson 4.- Titanium Alloys	Introduction to titanium alloys: physical metallurgy and processsing. Properties of titanium alloys.Aerospace applications. Titanium sponge.
Lesson 5.- Superallloys and special alloys.	Ni and Co based Superalloys. Structural intermetallics: titanium, Ni and Fe alluminides. Shape memory Alloys. Superplastic alloys. Aerospace applications.
Lesson 6.- Polymer Matrix Composites	General characteristics. Fibers and Matrix: carbon fibers. Ceramic Fibers (glass, Boron). Organic fibers (aramide, polyethilene), Metallic fibers. Resins (epoxi, poyester, fenolic). Prepregs. Sandwich cores. Thermoplastic matrix. Manufacturing processes. Structural adhesives.
Lesson 7.- Ceramic materials for aerospace	General characteristics. UHT ceramics. Borides, carbides, nitrides. Applications (TBC's, propulsion systems, heatshields). Ceramic matrix composites
Lesson 8.- Materials Selection	Design requirements. Materials for lifting surfaces . Materials for fuselages and propulsion systems. Integration of materials.
Lesson 10.- Quality Control and testing	Raw Materials quality control. Mechanical testing. thermal analysis techniques. Non destructive testing.

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	1	0	1
Lecturing	40	120	160
Laboratory practical	14	2.8	16.8
Problem solving	5	2.5	7.5
Case studies	4	20	24
Studies excursion	8	0	8
Objective questions exam	1.5	0	1.5
Problem and/or exercise solving	0.5	0	0.5
Presentation	0.5	3	3.5
Portfolio / dossier	0.5	1.7	2.2
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	Course presentation. Description of the teaching and evaluation methods. Presentation of the course contents and groups designation.
Lecturing	Teacher explains, clarifies and organizes the main concepts of the lesson, formulating and answering questions, motivating students for further study. Knowledge/skills across the course will be done . by means of an exam according to the official calendar published in web http://aero.uvigo.es/gl/docencia/exame This exam will include objective and short answer questions
Laboratory practical	Activities for the practical application of the acquired knowledge. It is developed in the laboratory and with specialized equipment. They will be evaluated through a practices report
Problem solving	Resolution of problems and exercises related to the subject. Students must be able to solve problems autonomously

Case studies	The teacher makes a proposal of real cases that the student has to analyze, collect information autonomously, individually or in groups with the guidance of the teaching staff. It will be evaluated through a public presentation made to the rest of the students
Studies excursion	Visits in small group made to any of the companies in the aeronautical sector. The student must present a report of the visit made

Personalized assistance

Methodologies	Description
Lecturing	Attention that the teachers individually provide to the students to help them to solve the doubts and difficulties they can find in understanding the contents of the subject.
Case studies	Guidance given by the teacher to the student or group of students to develop the real case that was proposed to solve
Problem solving	Time in which the teacher helps the student to solve the difficulties that can be found in solving problems and practical exercises

Assessment

	Description	Qualification	Training and Learning Results		
Objective questions exam	Written individual exam in which the student will answer solme questions related to the subject presented in the classroom, demonstrating good understanding of the basic concepts, ability to organize the information and to connect concepts	40	A2 A3	C32	D4 D8
Problem and/or exercise solving	Online questionnaires solved through the FAITIC platform, consisting of short questions in which students must show their ability to answer quickly, demonstrating decision-making capacity.	20		C32 C33	D5 D8
Presentation	Oral exam in which the student or a group of students presents the results of the study of a specific case that was formulated by the teachers staff. The summary of the analysis performed, the search for information, study, etc. will be presented on a poster session or the aid of a ppt to their classmates. The information must be well structured, documented and clearly exposed. The defense of the work will be carried out orally, demonstrating the acquired knowledge and its communication abiliity. They must answer the questions by the faculty and the rest of the students	30	A2 A3 A5		D4 D5 D8 D11 D13
Portfolio / dossier	In the portfolio, a compilation is done of the reports or the answer to the questions related to the laboratory practices done, as well as the summary visits to the selected companies. The quality of the information, clarity of exposition and adjustment of the regulations, if applicable, will be assessed.	10	A3 A5	C32 C33	D5 D8 D11 D13

Other comments on the Evaluation

The complete evaluation of the learning process and the skills developed by the student will be carried out through continuous assessment and a final written exam.

*-**Continuous assessment**: Weighing 60% of the total grade, will consist of activities performed throughout the entire semester (Online questionnaires: 20%; Individual or group work: 30%; Portfolio: 10%)*

*- The **written exam** (40%) consists of objective questions, short questions, and test questions. It will be held on the dates set in the evaluation alendar officially approved by the EEAE staff. It is published on the website http: //aero.uvigo.eres/gl/docencia/excursos.*

To pass the course, it will be necessary to achieve a minimum grade of 40% in each one of the assessment types (2.4 / 6 in the continuous assessment and 1.6 / 4 in the written exam). If this criterion is not reached, the maximum grade that the student can achieve is a 4/10.

***Second call exam** (June / July) the student who regularly attends the course, and has passed the continuous assessment, will be able to choose between maintaining the grade obtained in these tests and taking only the written exam with a value 40%, or renouncing to the the continuous assessment mark and take an exam that evaluate all the skills, with 100% of the score. This decision must be communicated in the period established by the School or by the teaching staff of th course.*

In the case of students who have not attended the course, grading will be based on the mark obtained in a final exam that wiill evaluate the learning outocomes and skills of the course, with 100% of the score.

***Ethical conduct**: As members of the University of Vigo, students are expected to promote an ethical culture and academic integrity. Any attempt to obtain an academic advantage by dishonest or unfair means is considered to be a lack of integrity*

that is unacceptable.

In the event the teacher detects unethical behavior by a student (cheating or copy in the written exam through any method, use of electronic devices if not expressly authorized, plagiarism, recycling/resubmitting work...) the student will be graded with FAIL (0,0) in the final grade. I this behaviour is repeated, the facts will be referred to the EEAE director for his consideration.

Sources of information

Basic Bibliography

Ashby, M.; Shercliff, H.; Cebon, D., **Materials. Engieneering, Science, Processing and Design**, 3ª, Elsevier, B.H., 2014

Antonio Miravete, director, **Materiales Compuestos, I y II**, 1ª, Reverté, 2007

Complementary Bibliography

Prasad, N.E.; Wanhill, R.J.H., Editors, **Aerospace MAterials and MAterial Tecnologies, vo:1,2**, 1ª, Springer, 2017

Daniel Gay, **Composite Materials**, 3ª, CRC Press, 2015

F.C, Campbell, **Manufacturing technology for Aerospace Structural Materials**, 1ª, Elsevier, 2006

Augusto Javier de Santos, **Análisis de Fallos en Sistemas Aeronáuticos**, 1ª, Ediciones PAraninfo, 2015

Peter J. Shull, editor, **Nondestructive evaluation**, 1ª, CRC Taylor & Francis, 2002

Recommendations

Subjects that are recommended to be taken simultaneously

Aerodynamics and aeroelasticity/O07G410V01923
Aerospace manufacturing/O07G410V01501

Subjects that it is recommended to have taken before

Chemistry: Chemistry/O07G410V01203
Aerospace technology/O07G410V01205
Materials science and technology/O07G410V01304
Resistance of materials and resilience/O07G410V01405

Other comments

In the event of inconsistency or discrepancy between the different linguistic versions of this publication, the Galician language version shall prevail

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
All the lecture-based sessions will be maintained, moving them totally or partially to an online version, through the Online Campus (Campus Remoto) of the UVigo.

* Teaching methodologies modified
Laboratory sessions will be modified to adapt the group size to that set by the University or the EEI as safe. Sessions will be organized to ensure the safety distance. All the activities that can be performed in non face-to-face mode will be deployed on online platforms.
In the case of total suspension of face-to-face teaching, alternative activities that allow covering the contents of the practical part of the subject will be provided: virtual tools, videos, etc.
- The defense of the work considered in the continuous assessment will be carried out preferably face-to-face. If this is not possible, it will be performed through the Virtual Campus

* Non-attendance mechanisms for student attention (tutoring)
Non-face-to-face tutorial services will be held through the virtual offices on the Virtual Campus, expanding the office-hours to encourage student participation. Student attention may be carried out also by other ways (email, videoconference, FAITIC forums, ...), always after previous agreement with the teacher.

* Modifications (if applicable) of the contents
According to the moment when the University decision of starting non-face-to face or mix teaching is made, modification in the lab contents will need to be done, following the defined organization. Students will be informed of the changes through FAITIC platform (see Adaptation of Assessment section)

* Additional bibliography to facilitate self-learning
Althoug additional bilbiography is already indicated at the end of each lesson, if student access to academic libraries is limited, additional documentation will be provided.

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests already carried out
The marks obtained in the continuous assessment tests already performed will maintain their weight in the final grade without changes, as defined in the teaching guide.

* Pending tests that are maintained
Those continuous assessment tests or exams that have not yet been done will also maintain their contribution in the final grade, as defined in the teaching guide.

* Tests that are modified
Despite the change in the fase-to-face/virtuallity of the assessment exams, the weight in the course grade indicated in the teaching guide will not change, except in the exceptional situation in which none of the lab sessions, or visits to the aeronautical companies coudl be carried out.
In this case, as the substitute activities will involve a greater workload on the part of the students, will be taken into account with 20% of the grade at the expense of areduction in the weight of the written exam from 40% to 30%.

* New tests
In the exceptional case indicated above, a new online test will be carried out to assess the knowledge acquired in the activities that substitute lab sessions. This new test, that replace the portfolio, will consist of short questions and exercises and will be valued with 20%.

* Additional Information
In any case, the requirement of achieving a minimum mark of 40% in both the continuous assessment and the written exam remains the same.

IDENTIFYING DATA				
Analytic and orbital mechanics				
Subject	Analytic and orbital mechanics			
Code	O07G410V01943			
Study programme	Grado en Ingeniería Aeroespacial			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Tommasini , Daniele			
Lecturers	Tommasini , Daniele			
E-mail	daniele@uvigo.es			
Web	http://faitic.uvigo.es/			
General description	We will study the methods of Lagrangian and Hamiltonian Analytical Mechanics, and apply them in particular to the orbital mechanics of space vehicles. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Competencies	
Code	
A2	That the students know how to apply their knowledge to their work or vocation in a professional way and that they possess the competences that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study
A3	That the students have the capability to gather and interpret relevant data (usually within their area of study) to issue judgments that include a reflection on relevant social, scientific or ethical issues
A5	That the students develop those learning capabilities necessary to undertake further studies with a high degree of autonomy.
B6	Capability to participate in flight testing programs for take-off and landing distances, ascent speeds, loss speeds, maneuverability and landing capacities.
C24	Appropriate knowledge applied to engineering: systems of aircrafts and automatic systems of flight control of the aerospace vehicles.
C26	Applied knowledge of aerodynamics; mechanics and thermodynamics, flight mechanics, aircraft engineering (fixed and rotary wings), theory of structures.
C33	Applied knowledge of aerodynamics, flight mechanics, air defense engineering (ballistics, missiles and air systems), space propulsion, material science and technology, structure theory.
D3	Capability of oral and written communication in native lenguage
D4	Capability of autonomous learning and information management
D5	Capability to solve problems and draw decisions
D6	Capabiliity for interpersonal communication
D8	Capabiliity for critical and self-critical reasoning
D11	Show motivation for quality with sensitivity towards subjects within the scope of the studies

Learning outcomes				
Expected results from this subject	Training and Learning Results			
Knowledge, understanding, application, analysis and synthesis of methods and techniques of Analytical Mechanics; specifically, of Lagrange and Hamilton-Jacobi equations, canonical transformations, and equilibrium, stability and oscillations of dynamical systems with N degrees of freedom.	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Knowledge, understanding, application, analysis and synthesis of the problems astrodinámicos related with the movement of the centre of masses of a spatial vehicle; in concrete, the orbits keplerianas, the real orbits conditioned by the different perturbacións orbitales, the orbits osculatrices and the numerical methods usual in Astrodinámica	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Knowledge and understanding of the dynamics of attitude of the space vehicles	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Contents	
Topic	
Analytical Mechanics	Introduction to Lagrangian Mechanics
	Introduction to Hamiltonian Mechanics
	Dynamical systems: examples; linearisation; Lyapunov stability; numerical integration
Orbital Mechanics	Kepler Movement
	Perturbative Forces: modeling; numerical methods for orbit determination and orbital elements computations
	Attitude Dynamics

Planning	Class hours	Hours outside the classroom	Total hours
Problem solving	12	18	30
Practices through ICT	12	18	30
Lecturing	26	39	65
Essay questions exam	2.5	0	2.5
Report of practices, practicum and external practices	0	22.5	22.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	Description
Problem solving	Solution of problems with the active participation of the students
Practices through ICT	The teacher will explain the theory
Lecturing	El docente expondrá la teoría en lecciones magistrales

Personalized assistance	
Methodologies	**Description**
Problem solving	The student will participate in the process of solving problems under the supervision of the teacher.
Practices through ICT	The student will take part in the resolution of numerical problems with the help of the teacher
Tests	**Description**
Report of practices, practicum and external practices	The student will take part in the elaboration of the practice reports of the practices with the help of the teacher

Assessment	Description	Qualification	Training and Learning Results			
Problem solving	Assistance and active participation in the classes of problem solving	5	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Practices through ICT	Assistance and active participation in the computer practices	5	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Essay questions exam	Exam	70	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11
Report of practices, practicum and external practices	Elaboration of a report describing the methodology and the results of the computer practices	20	A2 A3 A5	B6	C24 C26 C33	D3 D4 D5 D6 D8 D11

Other comments on the Evaluation

The students not following the continuous assessment will be evaluated only through the exam (100% in this case).

In second edition, there will be the opportunity to be evaluated only through the exam (100%) for the students who ask for it.
The dates of the final exams are published on the website of the EEAE in the web page http://aero.uvigo.es/gl/docencia/exames.

Sources of information

Basic Bibliography

H. Schaub, J. L. Junkins, **Analytical Mechanics of Space Systems**, AIAA Education Series, 2009

Howard Curtis, **Orbital Mechanics for Engeneering Students 3rd Edition**, 3ª, Elsevier, 2014

Oliver Montenbruck; Eberhard Gill, **Satellite Orbits: Models, Methods and Applications**, Springer; HAR/CDR edition (September 2, 2011), 2011

J. E. Prussing, B. A. Conway, **Orbital Mechanics**, 2ª, Oxford University Press, 2012

A. E. Roy, **Orbital Motion, Fourth Edition**, 4ª, CRC Press,

William T. Thomson, **Introduction to Space Dynamics**, Dover Publications, 1985

D. A. Vallado, **Fundamentals of Astrodynamics and Applications**, Springer, 2007

Complementary Bibliography

D. Tommasini, **Apuntes de la asignatura**,

R.R. Bate, D.D. Mueller, J.E. White, **Fundamentals of Astrodynamics (Dover Books on Aeronautical Engineering) Revised ed. Edition**,

P.C. Hughes, **Spacecraft Attitude Dynamics**, Dover Publications, 2004

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/O07G410V01103
Computer science/O07G410V01104
Mathematics: Linear algebra/O07G410V01102
Mathematics: Calculus I/O07G410V01101
Mathematics: Calculus II/O07G410V01201
Mathematics: Mathematical methods/O07G410V01301
Classical mechanics/O07G410V01305
Numerical calculation/O07G410V01941

Contingency plan

Description

=== EXCEPTIONAL PLANNING ===
Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes an extraordinary planning that will be activated when the administrations and the institution itself determine it, considering safety, health and responsibility criteria both in distance and blended learning. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance (or well in advance) by the students and teachers through the standardized tool.

=== ADAPTATION OF THE METHODOLOGIES ===
* Teaching methodologies maintained
In the event that they cannot be given face-to-face, the master classes and problem solving classes will be taught by

"Campus remoto" or by Microsoft Teams. These means, along with email, will also be used for interaction with students for the numerical practice exercises.

* Teaching methodologies modified
See above.

* Non-attendance mechanisms for student attention (tutoring)
The tutorials, in the case that they have to be non-face-to-face, will be held by email, by "Campus Remoto", or by Microsoft Teams, subject to prior agreement with the students.
* Modifications (if applicable) of the contents

* Additional bibliography to facilitate self-learning

* Other modifications

=== ADAPTATION OF THE TESTS ===
* Tests that are maintained
The continuous evaluation of the active participation in the classes and in the practices [total weight 10%] and of the memories of numerical practices [total weight 20%] will be maintained.

* Tests that are modified
In the case of not being allowed to do it face-to-face, the written exam will be done by email in a limited time (each student will have a different text) and will weigh 30%
* New tests
In the case of not being allowed to have face-to-face written exams, there will be an oral exam that will consist of two parts:
1. Individual oral presentation by videoconference of the report of the numerical calculation practices [weight 10%];
2. Individual presentation in videoconference with support in powerpoint, pdf, or another similar method of an individual work on an aspect of Orbital Mechanics (with the possibility of questions) [weight 30%]