



Teaching Guide

Identifying Data				2019/20
Subject (*)	Mechanics	Code	730G03026	
Study programme	Grao en Enxeñaría Mecánica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Second	Obligatory	6
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e Industrial			
Coordinador	Ramil Rego, Alberto	E-mail	alberto.ramil@udc.es	
Lecturers	Ramil Rego, Alberto	E-mail	alberto.ramil@udc.es	
Web				
General description	The general objective is the development of the skills and attitudes necessary for the application of the fundamental principles of mechanics to the resolution of problems of interest in engineering. It addresses the static, kinematic and dynamic of the material point, the systems and the rigid solid from the Newtonian formulation and from the Lagrangian formulation. This subject will contribute to the improvement of the capacity for analysis and construction of mathematical models that describe the effects of forces and movements on a wide variety of structures and machines incorporating physical hypotheses and appropriate mathematical approaches.			

Study programme competences / results

Code	Study programme competences / results
A13	CR7 - Coñecemento dos principios de teoría de máquinas e mecanismos.
B1	CB01 - Que os estudantes demostren posuír e comprender coñecementos nunha área de estudo que parte da base da educación secundaria xeral e adoita encontrarse a un nivel que, aínda que se apoia en libros de texto avanzados, inclúe tamén algúns aspectos que implican coñecementos procedentes da vangarda do seu campo de estudo
B2	CB02 - 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
B3	CB03 - Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitiren xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
B6	B3 - Ser capaz de concibir, deseñar ou poñer en práctica e adoptar un proceso substancial de investigación con rigor científico para resolver calquera problema formulado, así como de comunicar as súas conclusións ?e os coñecementos e razóns últimas que as sustentan? a un público tanto especializados como leigo dun xeito claro e sen ambigüidades
B7	B5 - Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
B8	B7 - Deseñar e realizar investigacións en ámbitos novos ou pouco coñecidos, con aplicación de técnicas de investigación (con metodoloxías tanto cuantitativas como cualitativas) en distintos contextos (ámbito público ou privado, con equipos homoxéneos ou multidisciplinares etc.) para identificar problemas e necesidades
B9	B8 - Adquirir unha formación metodolóxica que garanta o desenvolvemento de proxectos de investigación (de carácter cuantitativo e/ou cualitativo) cunha finalidade estratéxica e que contribúan a situarnos na vangarda do coñecemento
C1	C3 - Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C5	C7 - Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.

Learning outcomes

Learning outcomes	Study programme competences / results



Know and understand the method of virtual works and the potential for their application in the resolution of static problems.	A13	B1 B2 B3 B6 B7 B8 B9	C1 C5
Know and understand the kinematics of the solid, being able to apply the composition of movements.	A13	B1 B2 B3 B6 B7 B8 B9	C1 C5
Know and understand the laws of dynamics, both in its vector and analytical formulation.	A13	B1 B2 B3 B6 B7 B8 B9	C1 C5

Contents	
Topic	Sub-topic
NOTE. The following blocks or themes develop the contents established in the Verification Report card =>	Kinematics of the rigid solid. Static Dynamic of systems.
1. Introduction to kinematics.	1.1. Change of orthonormal reference. Transformation of the components of a vector. 1.2. Matrix form of a rotation. 1.3. Second order Cartesian Tensors. 1.4. Rate of change of a vector. 1.5. Frenet frame. Frenet formulas. 1.6. Speed and acceleration. Intrinsic components
2. Kinematics of the rigid body.	2.1. Rigid body definition. 2.2. Translation and rotation movements. 2.3. Helical speed distribution. Chasles Theorem. 2.4. Kinematic group. Invariants. 2.5. Instantaneous axis of rotation. Minimum sliding speed. 2.6. Axoid Surfaces. 2.7. Acceleration distribution. 2.8. Angles and rotations of Euler.
3. Relative Motion	3.1. Relative velocity. 3.2. Addition theorem for angular velocity. 3.3. Relative acceleration. 3.4. Addition theorem for angular acceleration. 3.5. Inverse movements. 3.6. Movement of two solids in contact.
4. Plane Motion	4.1. Instantaneous centre of rotation. Base and rolling curve. 4.2. Speed of succession of the instantaneous centre of rotation. 4.3. Distribution of accelerations in the plane movement



5. Distributed forces.	<p>5.1. Centre of mass.</p> <p>5.2. Inertia tensor.</p> <p>5.3. Steiner's theorem or parallel axes.</p> <p>5.4. Diagonalization of the inertial tensor.</p> <p>5.5 Symmetries in mass distributions.</p> <p>5.6. Inertia Ellipsoid</p>
6. Rigid body equilibrium	<p>6.1 Rigid body equilibrium. Free-Body Diagrams</p> <p>6.2. Principle of virtual work.</p> <p>6.3. Potential energy and equilibrium conditions. Stability</p>
7. Cable equilibrium	<p>7.1. Equilibrium of the ideal cable.</p> <p>7.2. Equilibrium under a system of parallel forces.</p> <p>7.3. Cable under the action of its own weight. Catenary</p>
8. Principles of dynamics.	<p>8.1. Principles and laws of Newtonian mechanics.</p> <p>8.2. D'Alembert's principle.</p> <p>8.3. Hamilton's principle</p>
9. Basic elements of Analytical Mechanics.	<p>9.1. Constraints in physical systems. Definition, properties and classification.</p> <p>9.2. Equilibrium conditions and equations of movement in generalized coordinates.</p> <p>9.3. D'Alembert's principle.</p> <p>9.4. General equation of the dynamics for a system with constraints without friction.</p> <p>9.5. Forces, work and energy in generalized coordinates.</p>
10. Lagrange formulation.	<p>10.1. Lagrange equations.</p> <p>10.2. Generalized potentials and dissipation function.</p> <p>10.3. Simple applications of the Lagrange formulation.</p> <p>10.4. Constants of movement. Conservation theorems.</p> <p>10.5. Variational principle of Hamilton. Application to the derivation of the Lagrange equations.</p> <p>10.6. Hamiltonian function.</p> <p>10.7. Elimination of cyclical coordinates. Routh function.</p>
11. Dynamics of Rotational Motion about a Fixed Axis	<p>11.1. Equations of movement</p> <p>11.2. Reactions in the supports. Static and dynamic equilibrium</p>
12. Dynamic of the rigid body with one fixed point	<p>12.1. Equations of motion of a rigid body with one fixed point. Linear moment, angular moment and kinetic energy.</p> <p>12.2. Application of the angular moment theorem. Euler equations.</p> <p>12.3. Integration of Euler equations in the absence of pairs. Cases of ellipsoid of revolution and asymmetric ellipsoid.</p> <p>12.4. Stability of the rotation around the principal axes.</p> <p>12.5. Movement of a heavy solid around a fixed point. The Lagrange top.</p>
13. Small oscillations about equilibrium	<p>13.1. Small oscillations around stable equilibrium.</p> <p>13.2. Determination of natural frequencies and normal modes.</p> <p>13.3. Characterization of the movement according to the different modes of oscillation. Stability of motion.</p> <p>13.4. Temporal response of the system to applied forces. Machine vibrations like forced oscillations.</p>

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A13 B1 B2 B3 C5	27	36	63
Problem solving	A13 B1 B2 B3 C1	27	36	63



Supervised projects	A13 B1 B2 B3 B6 B7 B8 B9 C1 C5	0	12	12
Mixed objective/subjective test	A13 B1 B2	4	6	10
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Oral presentation complemented with the use of audio-visual media to develop the syllabus of the subject and make explanations and examples that allow the understanding of the principles of the subject to be able to apply them to practical examples.
Problem solving	Resolution of problems corresponding to the different subjects of the syllabus in order to understand the theoretical principles and know their practical application, comparing different methods highlighting the advantages of each.
Supervised projects	Individual student work designed to promote autonomous learning under the tutelage of the teacher. The theme is chosen to apply the knowledge developed in the subject but also includes aspects not addressed in the lectures to develop the capacity for research and self-learning.
Mixed objective/subjective test	It is a written test consisting of 2 parts (theory and problems) of approximately 1.5 and 2.5 hours, with a maximum total duration of 4 hours. The theory test will have about 5 questions of diverse amplitude and degree of concretion on the contents of the subject. The practical type test will consist of the resolution of 1 to 3 problems of varying complexity on the contents of the subject.

Personalized attention	
Methodologies	Description
Mixed objective/subjective test	It is recommended that all students attend tutorials to clarify issues related to both theory and problem classes. In the case of problems, it is also recommended that they analyse in detail the problems solved in class and that they try to solve those that are left unresolved, consulting any doubt or difficulty.
Guest lecture / keynote speech	Once this is done with the problems of each subject, the problems of the mixed tests of previous courses will be similarly dealt with, consulting any doubt or difficulty.
Problem solving	It is also recommended to consult any doubt about the contents, extension and detail with which the theory questions should be answered.
Supervised projects	In the supervised work there is a duty to attend a minimum of interviews with the teacher. These interviews aim to define its content and scope, as well as to check its progress. Students with academic dispensation may request the realization of tutorials in a different time from the one published on the UDC website.

Assessment			
Methodologies	Competencies / Results	Description	Qualification



Mixed objective/subjective test	A13 B1 B2	<p>The mixed test consists of two parts: theory (40%) and problems (60% of the test score).</p> <p>In the theory part the knowledge of the program of the subject is valued as well as the reasoned exposition of the theoretical developments.</p> <p>In the part of problems will be assessed both the formulation and the development applied to the specific case to obtain the solution.</p> <p>The qualification of this test in the first opportunity will be the average of two partial tests: the first one (subjects 1-7) in the middle of the semester and the second (subjects 8-13) at the end of the semester.</p> <p>Students who do not pass the subject at the first opportunity may perform a final test (topics 1-13) on the second opportunity period.</p> <p>The dates of these tests will be those that appear in the exam calendar and course planning published by the school.</p>	80
Supervised projects	A13 B1 B2 B3 B6 B7 B8 B9 C1 C5	<p>The work is of an individual nature, so the originality will be rewarded and the copy of results or the method used will be penalized.</p> <p>Each student must submit their report within the deadline and attend mandatory tutoring. In case of not fulfilling these conditions the work will be scored as 0.</p> <p>The delivery will be made through Moodle, in digital format without the need to print it.</p>	20
Others			

Assessment comments

Only students who do not attend any of the mixed tests will be rated as NOT PRESENTED.

Academic dispensation is allowed in the terms established in point 5 of article 7 of the "Standard that regulates the regime of dedication to study and the permanence and progression of undergraduate and master's degree students at the University of A Coruña", approved by the Social Council of 04/05/2017 Therefore, students with academic dispensation will be evaluated using the same system as the rest of the students, that is, supervised work 20% + mixed test 80%.

The evaluation criteria of the 2nd opportunity are the same as those of the 1st opportunity.

Sources of information

Basic	<ul style="list-style-type: none"> - J.M. Bastero; J. Casellas (1991). Curso de Mecánica (4ª Ed.). EUNSA - C.F. González (2003). Mecánica del sólido rígido. Ariel LIBROS DE PROBLEMAS: SPIEGEL, M.: "Teoría y Problemas de Mecánica Teórica". McGraw-Hill CARRIL, R.D., FANO, J.: "Mecánica. Problemas Explicados". Jucar (1987) MESHESKI, I.: "Problemas de Mecánica Teórica". Mir 2ªed (1985) LUMBROSO, H.: "Problemas resueltos de mecánica?". Reverté (1986) ESTELLÉS, H.: "Problemas de Dinámica". UPV 2ªed (1989) SEELY, ENSIGN: "Mecánica Analítica para Ingenieros". UTEHA 3ªed (1992) KOTKIN, SERBO: "Problemas de Mecánica Clásica". MIR 2ª ed (1988) WELLS, D. A.: "Teoría y Problemas de Dinámica de Lagrange". McGraw-Hill (1972)
Complementary	<ul style="list-style-type: none"> - Prieto Alberca, Manuel (1986-1994). Curso de mecánica racional. Aula Documental de Investigación - Fernández-Rañada, Antonio (1990). Dinámica clásica. Alianza - Goldstein, Herbert (2002). Classical Mechanics. San Francisco : Addison Wesley

Recommendations

Subjects that it is recommended to have taken before

Calculus /730G03001
 Physics I /730G03003
 Linear Algebra/730G03006
 Physics II/730G03009

Subjects that are recommended to be taken simultaneously



Differential Equations/730G03011

Fundamentals of Electricity/730G03012

Thermodynamics /730G03014

Subjects that continue the syllabus

Strength of Materials/730G03013

Theory of Machines/730G03019

Machine Components/730G03029

Other comments

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.