UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2022/23
Subject (*)	Theory of Vibration		Code	730G03040
Study programme	Grao en Enxeñaría Mecánica			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Optional	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Enxeñaría Naval e Industrial			
Coordinador	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Lecturers	Gutierrez Fernandez, Ruth Maria	E-mail	ruth.gutierrez@udc.es	
Web	https://sites.google.com/site/structuralanalysislab/home			
General description	This course is intended for the acquisition of the specific skills to analyze the behavior of structures and mechanical elements under vibrations and to design these elements under dynamic loads			

Study programme competences / results	
Code	Study programme competences / results
B5	CB05 - Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprenderen estudos posteriores cun alto grao de autonomía
B7	B5 - Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
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

Learning outcomes		
Learning outcomes	Study programme competences / results	
Handle the principles of vibration theory to analyze dynamic systems: response under free and forced vibration to single degrees of freedom SDOF and multiple degrees of freedom MDOF systems, harmonic load, and general type excitations.	B5 B7 B9	
Apply properly theoretical concepts into laboratory. Understand and apply some technical computing solution: numerical methods for the analysis of vibrating systems.	B5 B7 B9	
Use a rigorous language in the engineering structural dynamics in order to show and to explain information and results	B5 B7 B9	

Contents	
Topic	Sub-topic
Chapter 0. The following topics develop the contents set up in the verification memory.	Dynamic equations. Modelling. Vibration of systems of 1 and N degrees of freedom. Damping. Vibration of continuous systems
Chapter 1. Introduction to structural dynamics:dynamic equations and modeling.	Basic concepts. Classification of vibrations. Modelling systems: stiffness, inertia, and damping elements. Mathematical models of Single Degree Of Freedom (SDOF) systems. Application of Newton's laws. Application of the principle of virtual displacements. Hamilton principle. Application of the Lagrange equations.
Chapter 2. Free vibration of SDOF system. Damping.	Free vibration of undamped SDOF systems. Free vibration of viscous damped SDOF systems. Other types of damping.

Chapter 3. Response of SDOF to harmonic excitation. Damping.	Response of undamped SDOF to harmonic excitation. Response of viscous damped SDOF to harmonic excitation. Complex frequency response. Vibration isolation. Force Transmissibility. Base motion. Response of SDOF due to unbalance in rotating machines.
Chapter 4. Analytical methods of solution. Response of SDOF to a general dynamic excitation	Response of SDOF to special forms of excitation. Ideal step input, rectangular pulse and ramp loadings. Short-duration impulse. Unit impulse response. Classification of methods. Duhamel Integral Method.
Chapter 5. Numerical methods of solution. Response of SDOF to a general excitation.	Numerical evaluation of the integral of convolution. Method of linear forces. Step by step methods. The average acceleration method. Methods of Newmark family.
Chapter 6. Continuous systems. Mathematical models of Multiple Degrees Of Freedom (MDOF) systems	Continuous systems. Discrete systems: application of Newton's laws, application of the Lagrange equations. Equations of motion.
Chapter 7. Free vibration response of MDOF systems	Natural frequencies and modes of vibration of MDOF systems. Free vibration response of MDOF systems. Rigid body modes of vibration. Some properties of the natural frequencies and natural modes. Scaling or normalizing. Orthogonality. Expansion theorem. Free vibration response of MDOF systems. Mode-superposition method.
Chapter 8. Forced vibration response of MDOF systems.	Mode-superposition method response of undamped MDOF systems. Truncation. Damped MDOF systems. Orthogonal, modal, classic or proportional damping. Rayleigh damping. Non-proportional damping.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Laboratory practice	B5 B7 B9	10	35	45
Supervised projects	B5 B7 B9	12	25	37
Problem solving	B5 B7 B9	4	14	18
Guest lecture / keynote speech	B5 B7 B9	16	32	48
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
Laboratory practice	Methodology that allows the realization of activities of practical character, with computer, such as modelization, analysis and dynamic simulation of mechanical and structural elements.
Supervised projects	Methodology designed to promote autonomous learning of students, solving a problem that involves the contents of the course and involves specific skills, under teacher supervision.
Problem solving	Técnica a través da cal hai que resolver unha situación problemática específica, a partir da coñecemento que se traballou e que pode ter máis dunha solución.
Guest lecture / keynote speech	Oral lecture supplemented with the use of audiovisual means, aiming transmit knowledge and facilitate the learning within the scope of vibration analysis

Personalized attention	
Methodologies	Description
Laboratory practice Supervised projects	Guidance and revision about specific problems posed at the development of the different activities proposed in the course. Revision and help when making supervised projects.

Assessment			
Methodologies	Competencies / Results	Description	**Qualification**

Laboratory practice	B5 B7 B9	Students must systematically attend practices. The proposed activities have to be done along the practical sessions, in order to be revised and evaluated by the teacher. The practices that aren?t developed during the practical classes, and periodically revised by the teacher will not be considered in the qualification. The evaluation process of the laboratory lessons includes a two hour practice session, where the student solves with the computer the problems proposed by the teacher, individually.	30
Supervised projects	B5 B7 B9	The projects include the theoretical and practical contents of the course. They are to be done individually. The projects will be developed during the practical sessions along the course and completed at home on the student personal work hours. The tasks will be followed and revised during the practical lessons. If the projects aren?t matured during the practical classes, nor periodically revised by the teacher, will not be considered in the qualification.	70

Assessment comments
Students, whose presence throughout the semester where insufficient to track their work, by academic waiver or other causes, must also develop and present practices and tutored work for their evaluation. The follow-up of this work shall be carried out in tutoring sessions. In this case, the process of evaluation may include in addition to the presentation of practices and tutored work, a practice session,individually or in group, in which the student addresses manually or with the computer the problems raised by the teacher. For the second chance you can present or improve practices and tutored work. The tracking is done in tutorial sessions. The assessment is done through presentation of practices and tutored work pendingand/or improved. The process of evaluation may include, in addition to the presentation of practices and tutored work, a practical session, individually or in group, in which the student addresses manually or with the computer the problems posed by the teacher. The evaluation criteria of the early December call will be the same as those of the second opportunity of the previous year. Proven fraud in any work, test or evaluation activity will directly lead to a failing grade of "0" in the work, test or evaluation activity in question, without the option to resubmit it in the extraordinary or advanced call

Sources of information	
Basic	- R. Gutiérrez, E. Bayo, A. Loureiro y L.E. Romera (2009). Teoría de Estructuras III. Servicio de publicaciones de la Universidade da Coruña - Dassault Systèmes Simulia Corp. (2011). Abaqus Analysis User?s Manual. Providence, RI, USA. (1998) - R. R. Craig (1981). Structural Dynamics. John Wiley and Sons, Inc - S.S. Rao (2012). Vibraciones Mecánicas.Quinta Edición. Pearson Education, México.
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Diferential Equations/730G03011 Theory of Structures /730G03021 Mechanics/730G03026 FEM of Structures/730G03069
Subjects that are recommended to be taken simultaneously
Structural Typologies/730G03070
Subjects that continue the syllabus
Simulation of Mechanic and Structural Systems/730497224
Other comments

To help achieve a sustained immediate
environment and meet the objective of the action number 5: "Teaching and
healthy and sustainable environmental and social research" of the
"Plan of action Green Campus Ferrol":

 Documentary work presented in this matter:

* Should be requested in virtual format or computer support

* Will take place through Moodle, in digital format without having to
print them

* Should be required on paper:

   -Not be they used plastic

   -There will be double-side
printing.

   -Will use recycled
paper.

   -Prevent printing drafts.

 You should make a sustainable use of
resources and the prevention of negative impacts on the natural environmentBy decision of the EPEF quality commission, the optional subjects cannot work more than the basic skills already mentioned in this teaching guide. However, in the "Vibrations" subject, the following specific competences of the degree are also worked on:A1 FB1 - Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial derivative equations; numerical methods; numerical algorithmic; statistics and optimization.A2 FB2 - Understanding and command of the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application to solve engineering problems.A13 CR7 - Knowledge of the principles of theory of machines and mechanisms.A23 TEM4 - Knowledge and skills to apply the fundamentals of elasticity and resistance of materials to the behavior of real solids.The basic competences of all the electives are worked on together with these specific competences, which are initially acquired in other compulsory subjects, and are reinforced and consolidated in this elective.

