



| Teaching Guide | | | | |
|---------------------|---|--------|-----------------------|---------|
| Identifying Data | | | | 2020/21 |
| 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 | Hybrid | | | |
| 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 | | | |
| Contingency plan | <ol style="list-style-type: none"> Modifications to the contents Methodologies <ul style="list-style-type: none"> *Teaching methodologies that are maintained *Teaching methodologies that are modified Mechanisms for personalized attention to students Modifications in the evaluation <ul style="list-style-type: none"> *Evaluation observations: Modifications to the bibliography or webgraphy | | | |

| Study programme competences / results | |
|---------------------------------------|--|
| Code | Study programme competences / results |
| A1 | FB1 - Capacidade para a resolución dos problemas matemáticos que poidan formularse na enxeñaría. Aptitude para aplicar os coñecementos sobre: álgebra lineal; xeometría; xeometría diferencial; cálculo diferencial e integral; ecuacións diferenciais e en derivadas parciais; métodos numéricos; algorítmica numérica; estatística e optimización. |
| A2 | FB2 - Comprensión e dominio dos conceptos básicos sobre as leis xerais da mecánica, termodinámica, campos e ondas e electromagnetismo e a súa aplicación para a resolución de problemas propios da enxeñaría. |
| A13 | CR7 - Coñecemento dos principios de teoría de máquinas e mecanismos. |
| A23 | TEM4 - Coñecementos e capacidades para aplicar os fundamentos da elasticidade e resistencia de materiais ao comportamento de sólidos reais. |
| 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 |
| C3 | C5 - Entender a importancia da cultura emprendedora e coñecer os medios ao alcance das persoas emprendedoras. |
| C5 | C7 - Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida. |



| 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. | A1 A2 A13 A23 | B5 B7 B9 | C3 C5 |
| Apply properly theoretical concepts not laboratory. Understand and apply some technical computing solution: numerical methods for the analysis of vibrating systems. | A1 A2 A13 A23 | B5 B7 B9 | C3 C5 |
| Use a rigorous language in the engineering structural dynamics in order to show and to explain information and results | A1 A2 A13 A23 | B5 B7 B9 | C3 C5 |

| 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. Buffer. 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 | A1 A2 A13 A23 B5 B7 B9 C3 C5 | 10 | 35 | 45 |
| Supervised projects | A1 A2 A13 A23 B5 B7 B9 C3 C5 | 12 | 25 | 37 |
| Problem solving | A1 A2 A13 A23 B5 B7 B9 C5 C3 | 4 | 14 | 18 |
| Guest lecture / keynote speech | A1 A2 A13 A23 B5 B7 B9 C3 C5 | 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 do 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 to transmit knowledge and facilitate the learning within the scope of vibration analysis. |

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

| Assessment | | | |
|---------------------|---------------------------------|---|---------------|
| Methodologies | Competencies / Results | Description | Qualification |
| Laboratory practice | A1 A2 A13 A23 B5 B7 B9 C3 C5 | 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 | A1 A2 A13 A23 B5 B7 B9 C3 C5 | 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's 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 was 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 pending and/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.

Sources of information

| | |
|----------------------|--|
| Basic | <ul style="list-style-type: none">- 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

Differential 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

